LONGHORN ARMY AMMUNITION PLANT KARNACK, TEXAS

ADMINISTRATIVE RECORD

Volume 8

2024

Bate Stamp Numbers
01226413 – 01228194

Prepared for

Department of the Army
Longhorn Army Ammunition Plant

1976–2024

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
ADMINISTRATIVE RECORD – CHRONOLOGICAL INDEX

VOLUME 8

2024

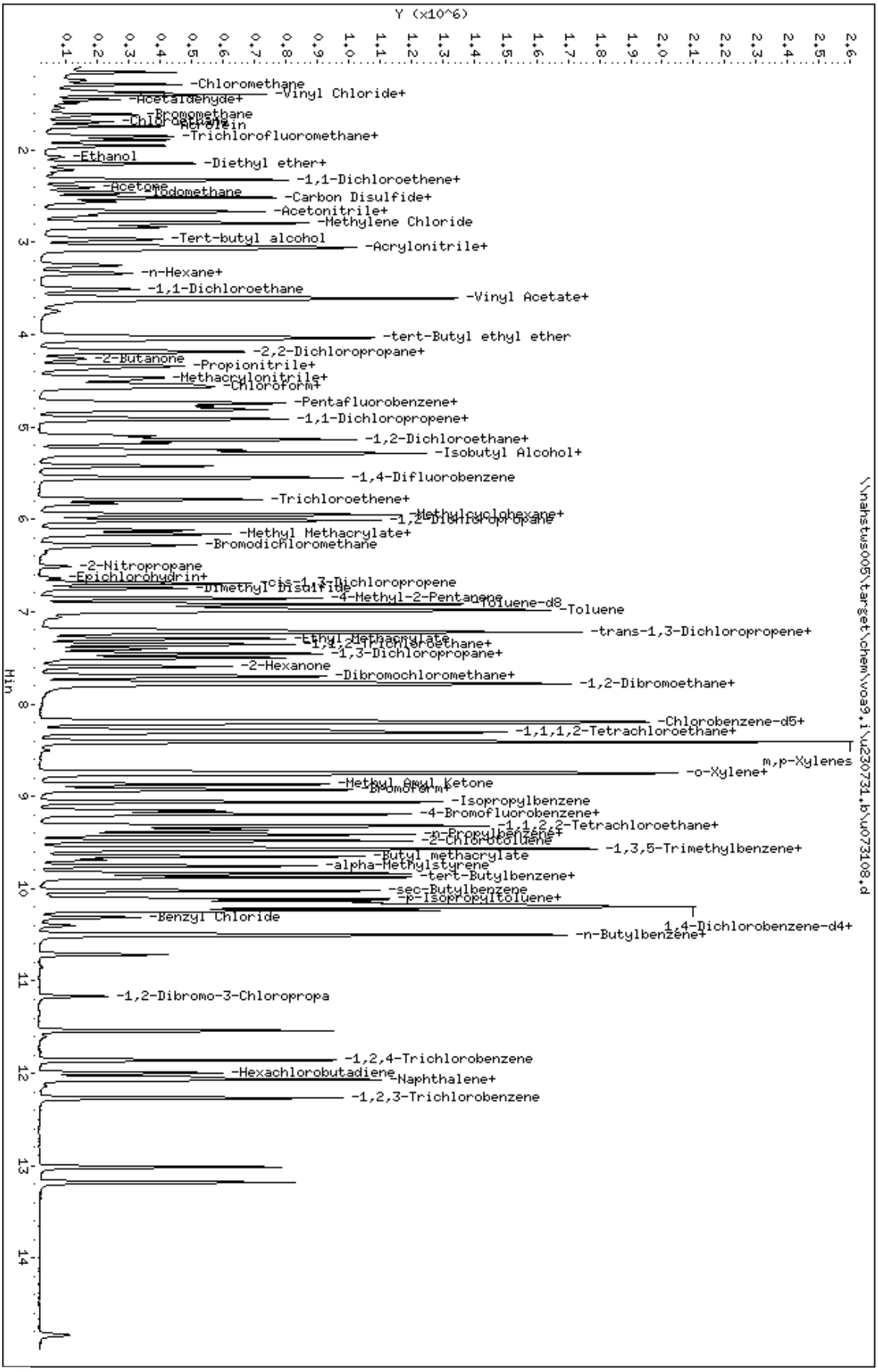
A.	Title:	Report (Cont'd) – Draft Final Ninth Annual Remedial Action Operation Report (September 2022–August 2023), LHAAP-35A (58) Shops Area, Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas, February 2024
	Author(s):	Department of the Army
	Recipient:	Environmental Protection Agency and Texas Commission on Environmental Quality
	Date:	February 6, 2024
	Bate Stamp:	01226413–01226571
B.	Title:	Minutes – Final Monthly Managers' Meeting (MMM), Longhorn Army Ammunition Plant, December 20, 2023
	Author(s):	Department of the Army
	Recipient:	All Parties
	Date:	February 27, 2024
	Bate Stamp:	01226572–01226592
C.	Title:	Minutes – Final Monthly Managers' Meeting (MMM), Longhorn Army Ammunition Plant, January 17, 2024
	Author(s):	Department of the Army
	Recipient:	All Parties
	Date:	February 27, 2024
	Bate Stamp:	01226593–01226619
D.	Title:	Report – Final Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
	Author(s):	Department of the Army
	Recipient:	Environmental Protection Agency and Texas Commission on Environmental Quality
	Date:	February 29, 2024
	Bate Stamp:	01226620–01227102
E.	Title:	Report – Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition, Plant, Karnack, Texas
	Author(s):	Department of the Army
	Recipient:	Environmental Protection Agency and Texas Commission on Environmental Quality
	Date:	March 1, 2024
	Bate Stamp:	01227103–01227823

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
ADMINISTRATIVE RECORD – CHRONOLOGICAL INDEX

VOLUME 8 (Continued)

2024

F. Title: Report – Draft Final Year 1 Annual Remedial Action Operation Report (August 2022–July 2023), LHAAP-17 Burning Ground No.2/Flashing Area Group 2, Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas, March 2024
Author(s): Department of the Army
Recipient: Environmental Protection Agency and Texas Commission on Environmental Quality
Date: March 5, 2024
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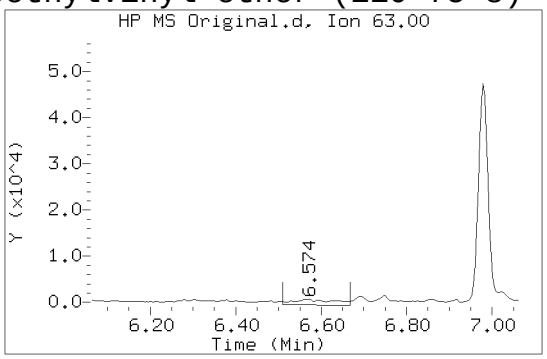
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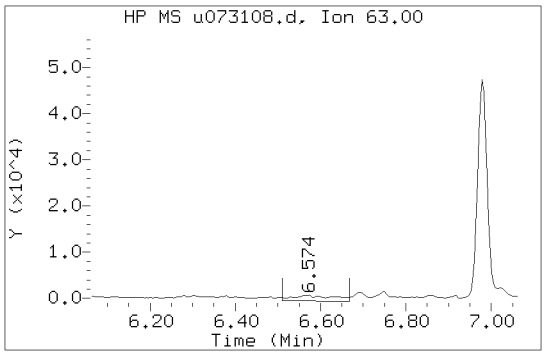
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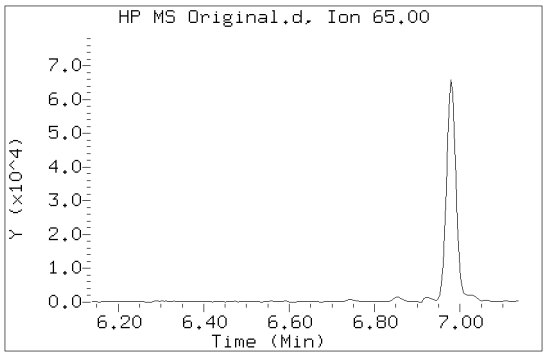
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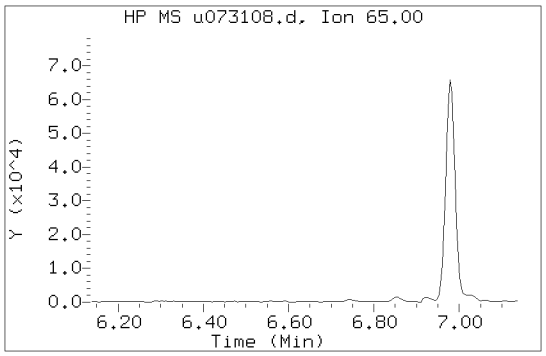
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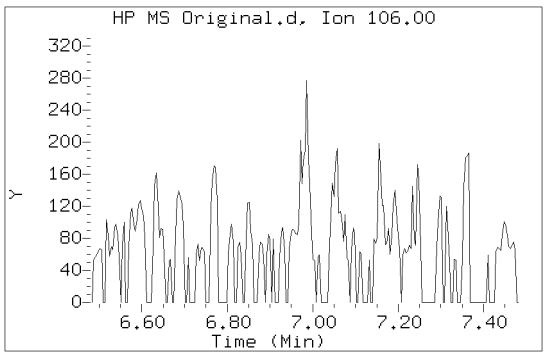
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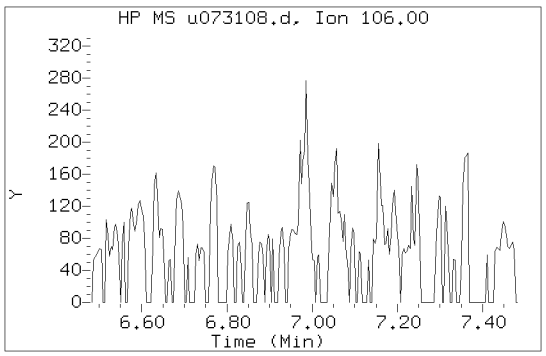
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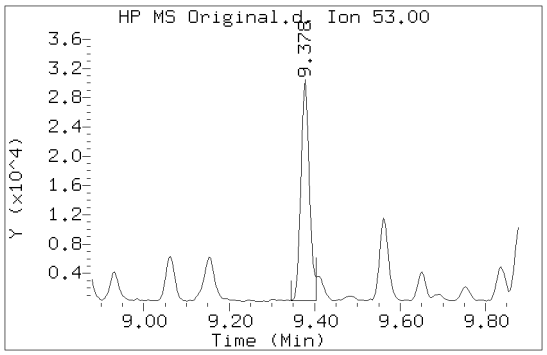
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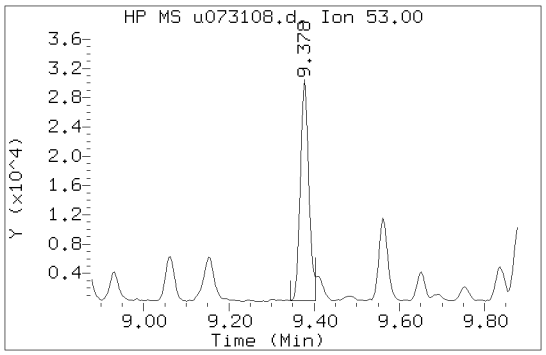
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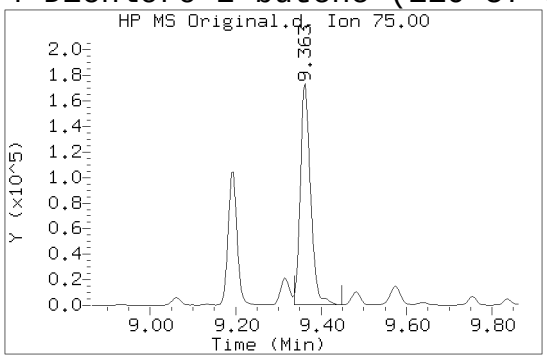
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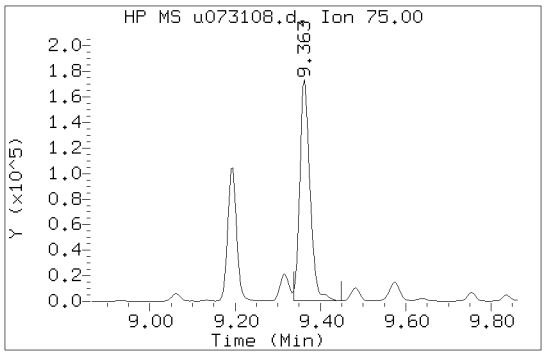
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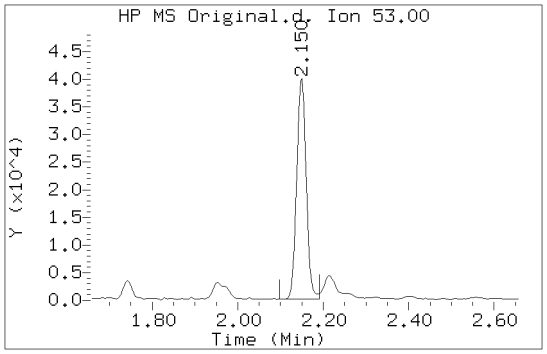


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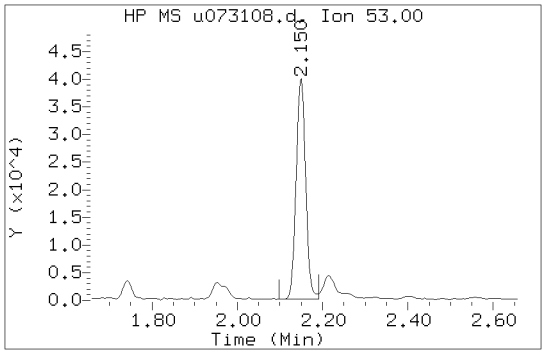
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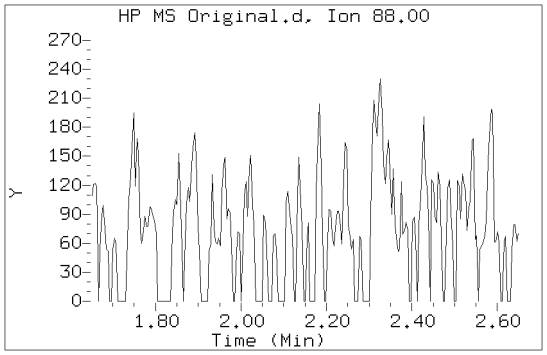
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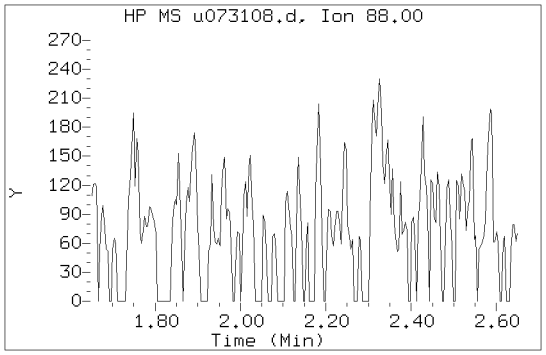
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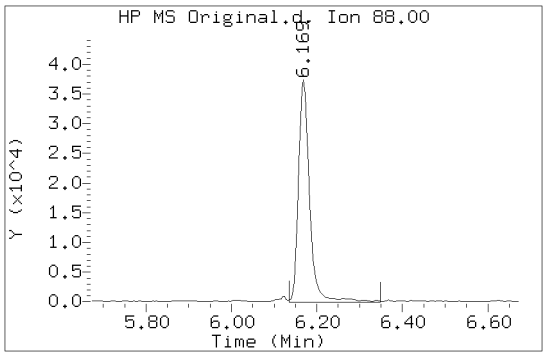


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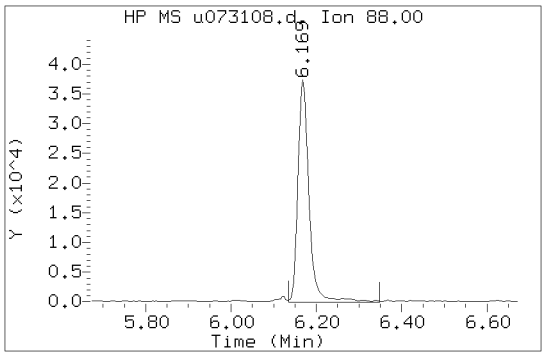
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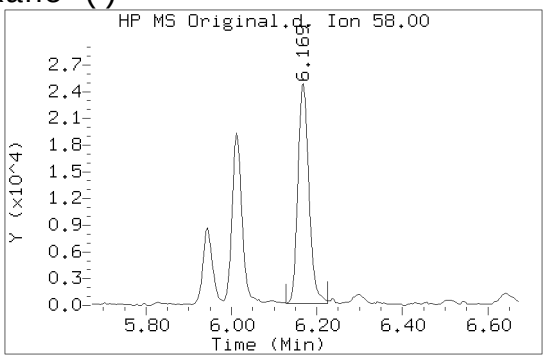


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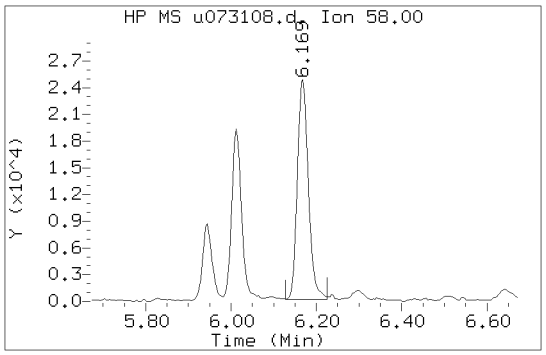
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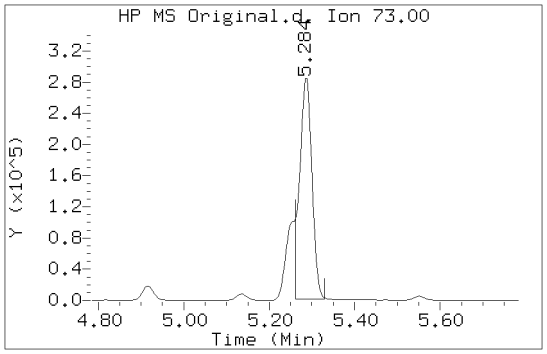
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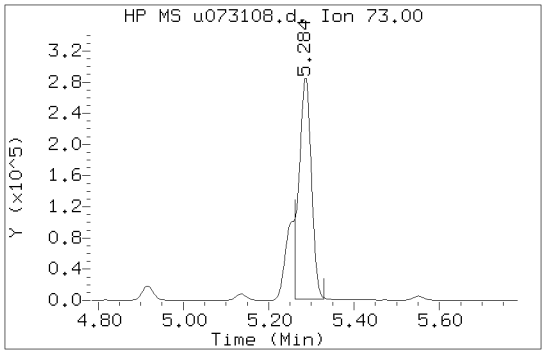
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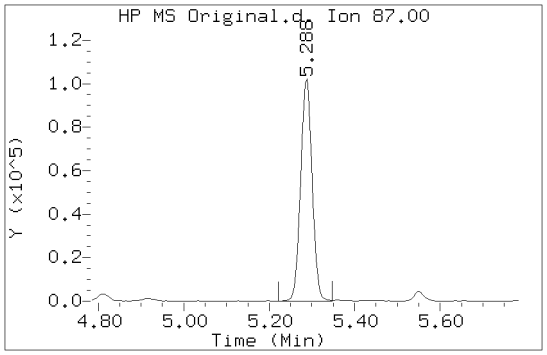
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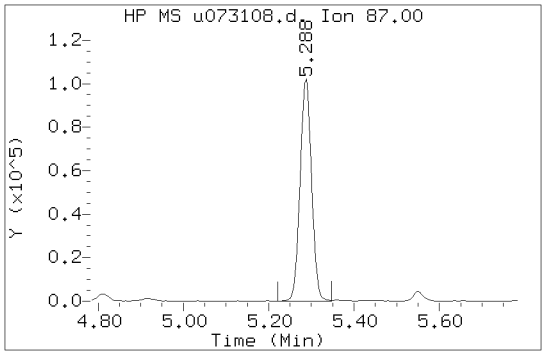
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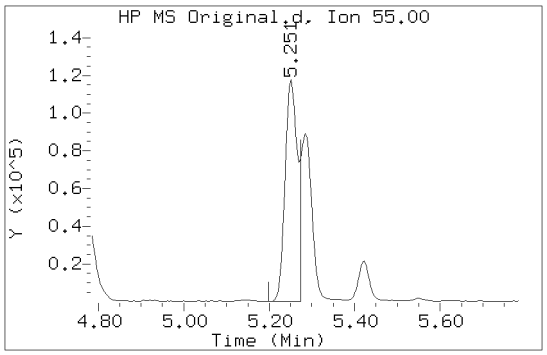
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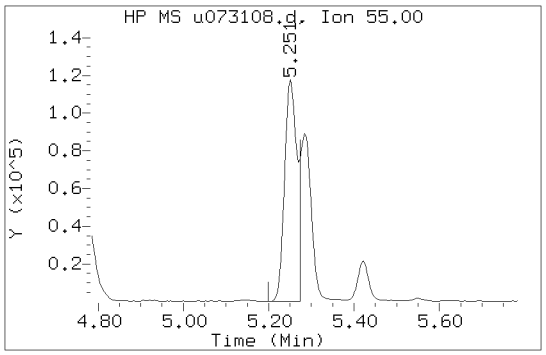
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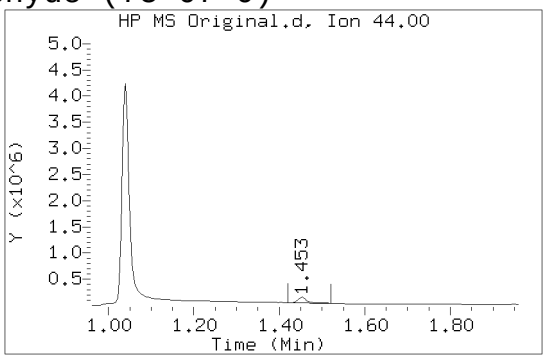
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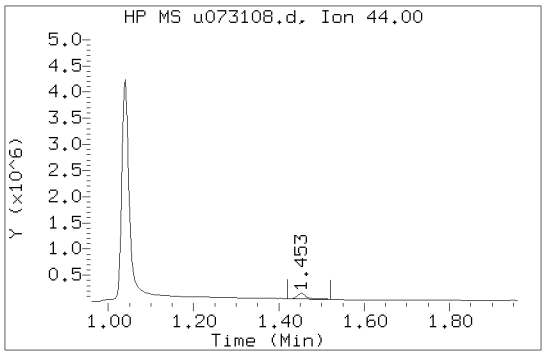
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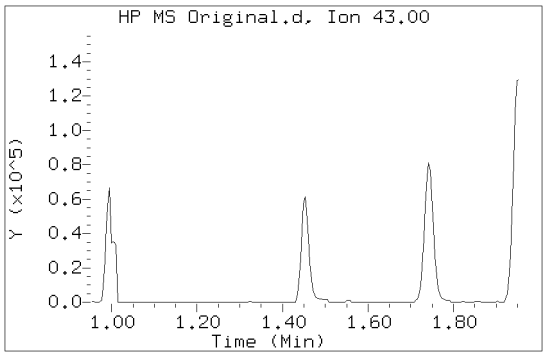
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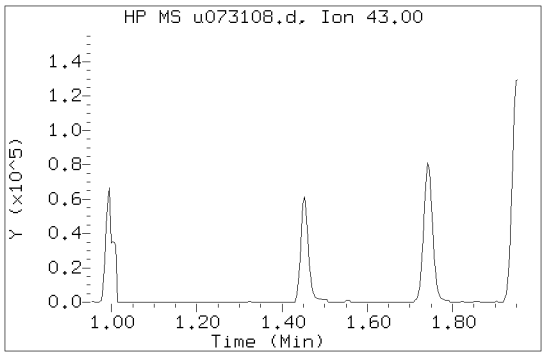
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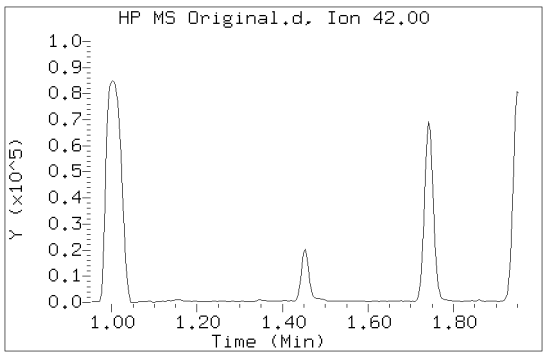
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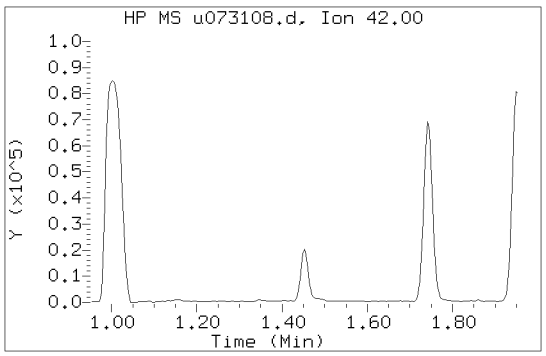
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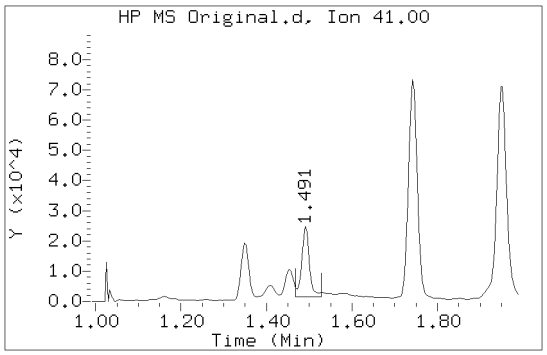


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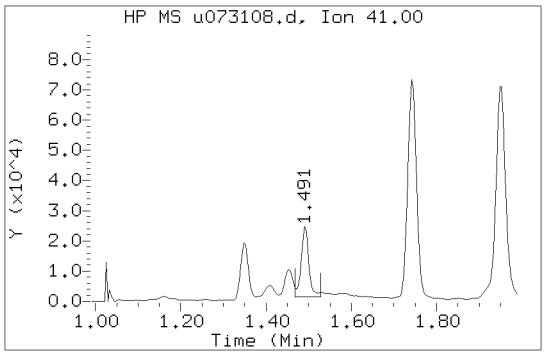
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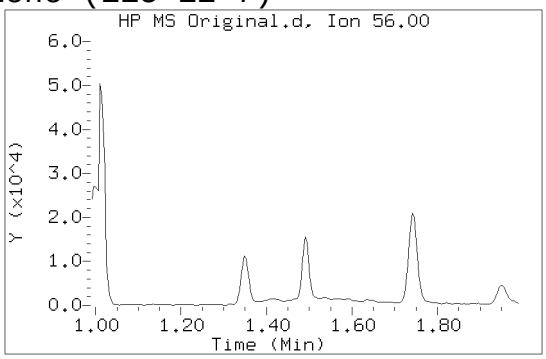


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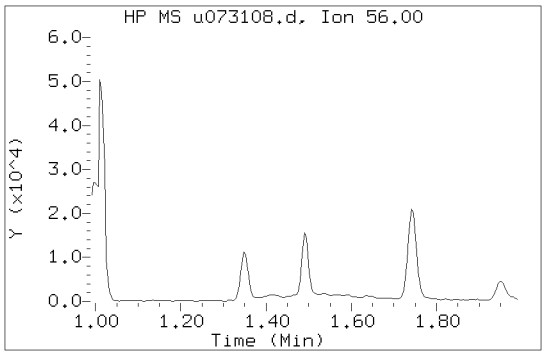
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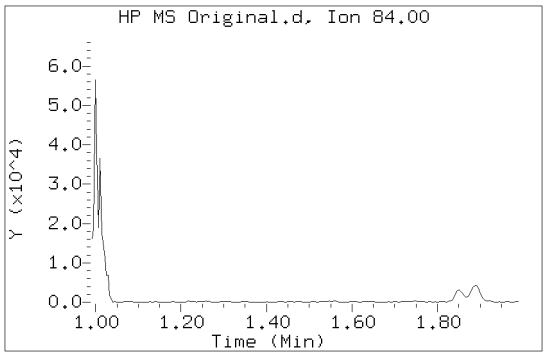
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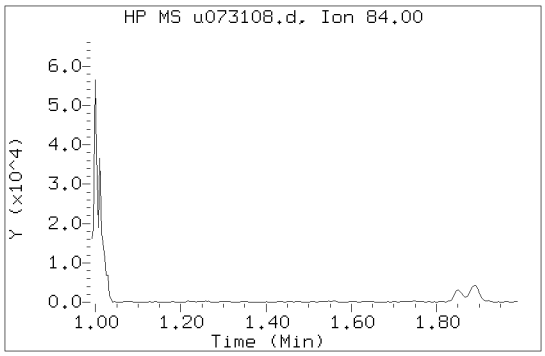
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ALS Laboratory Group

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Misc Info : V9;WATER;0;1;
Comment   :
Method   : \\NAHSTWS005\Target\chem\voa9.i\U230731.b\8260C.m
Meth Date : 07-Aug-2023 11:14 VOA9.i Quant Type: ISTD
Cal Date : 31-JUL-2023 14:06 Cal File: U073108.D
Als bottle: 10 Calibration Sample, Level: 8
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 08260V9.sub
Target Version: 4.14
Processing Host: NAHSTW7056

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
* 1 Pentafluorobenzene	168	4.811	4.811	(1.000)	531119	50.0000	
2 Dichlorodifluoromethane	85	1.160	1.160	(0.241)	539886	100.000	104.78
3 Chloromethane	50	1.291	1.291	(0.268)	647562	100.000	104.26
5 Vinyl Chloride	62	1.374	1.374	(0.286)	556620	100.000	106.44
6 Bromomethane	94	1.610	1.610	(0.335)	279477	100.000	100.74
7 Chloroethane	64	1.693	1.693	(0.352)	326908	100.000	99.27
8 Trichlorofluoromethane	101	1.891	1.891	(0.393)	708047	100.000	109.70
9 Acrolein	56	1.745	1.745	(0.363)	72803	200.000	213.70
10 Acetone	43	2.405	2.405	(0.500)	334973	200.000	209.83(A)
11 1,1-Dichloroethene	96	2.330	2.330	(0.484)	375202	100.000	107.22
15 Iodomethane	142	2.465	2.465	(0.512)	790175	200.000	209.83
16 Acrylonitrile	53	3.061	3.061	(0.636)	326846	200.000	195.77
17 Methylene Chloride	84	2.791	2.791	(0.580)	426614	100.000	100.55
18 Methyl tert-butyl ether	73	3.076	3.076	(0.639)	1061414	100.000	98.13
19 Carbon Disulfide	76	2.517	2.517	(0.523)	2172250	200.000	213.23
20 trans-1,2-Dichloroethene	96	3.053	3.053	(0.635)	387474	100.000	98.81
21 Vinyl Acetate	43	3.604	3.604	(0.749)	2321009	200.000	206.81
22 1,1-Dichloroethane	63	3.511	3.511	(0.730)	686592	100.000	95.79
24 2-Butanone	43	4.264	4.264	(0.886)	378901	200.000	181.59
26 2,2-Dichloropropane	77	4.178	4.178	(0.868)	526083	100.000	106.45

27 cis-1,2-Dichloroethene	96	4.193	4.193 (0.871)	444452	100.000	101.53
28 Chloroform	83	4.572	4.572 (0.950)	809862	100.000	97.09

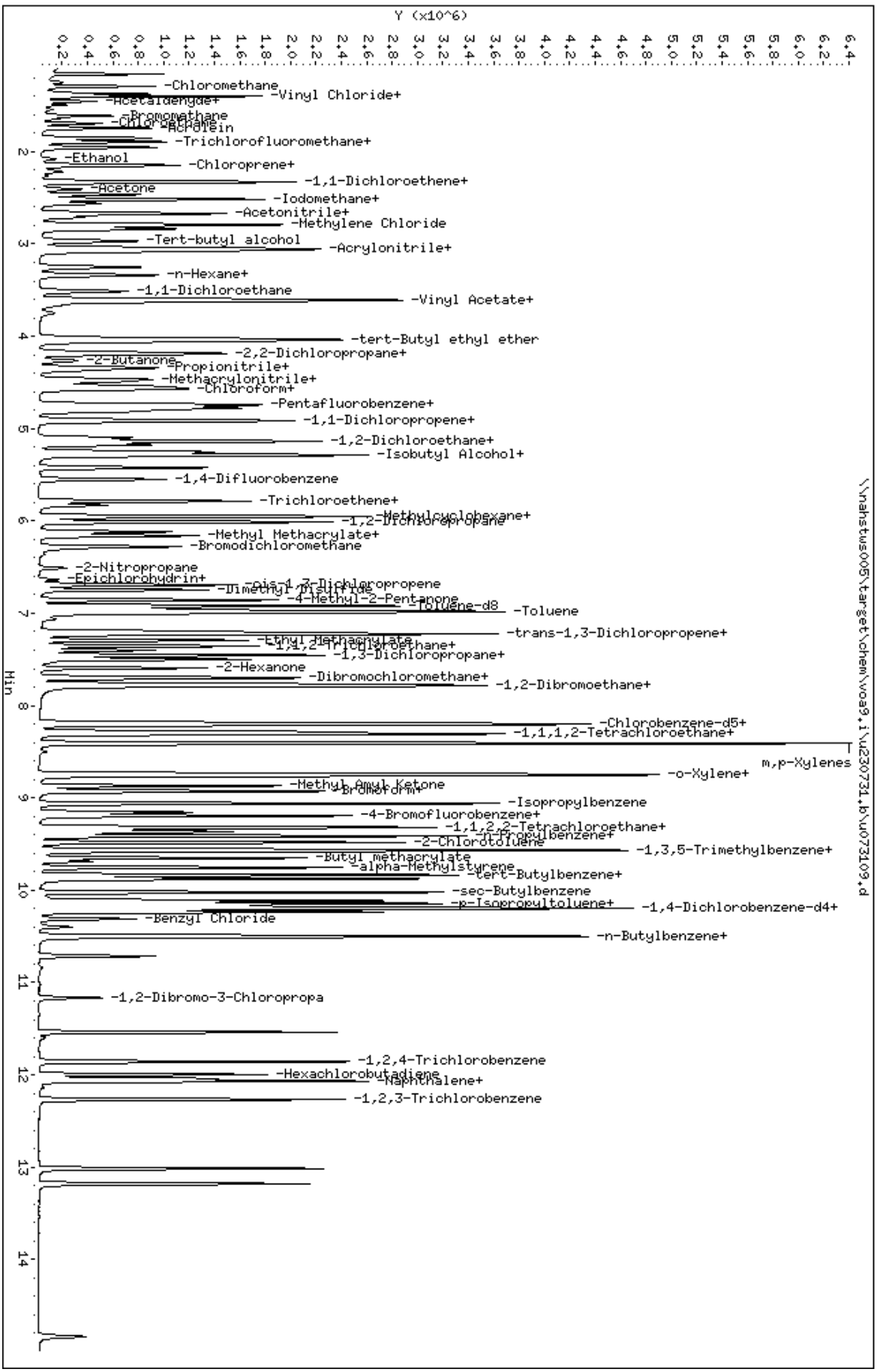
	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
	29 Bromochloromethane	128	4.467	4.467	(0.928)	251900	100.000	97.25
$	30 Dibromofluoromethane	113	4.748	4.748	(0.987)	432647	100.000	102.88
	31 1,1,1-Trichloroethane	97	4.740	4.740	(0.985)	692131	100.000	106.65
	32 1,1-Dichloropropene	75	4.916	4.916	(0.886)	621122	100.000	108.81
	33 1,2-Dichloroethane	62	5.175	5.175	(0.932)	653640	100.000	98.74
	34 Carbon Tetrachloride	117	4.909	4.909	(0.885)	590616	100.000	115.50
$	35 1,2-Dichloroethane-d4	65	5.096	5.096	(1.059)	469501	100.000	102.86
*	36 1,4-Difluorobenzene	114	5.550	5.550	(1.000)	768682	50.0000	
	37 Benzene	78	5.138	5.138	(0.926)	1881235	100.000	100.18
	38 Trichloroethene	130	5.786	5.786	(1.043)	546012	100.000	102.88
	39 Bromodichloromethane	83	6.277	6.277	(1.131)	626277	100.000	104.28
	41 2-Chloroethylvinyl ether	63	6.573	6.573	(1.184)	17476	200.000	201.52(M)
	42 1,2-Dichloropropane	63	6.007	6.007	(1.082)	503188	100.000	99.98
	44 Dibromomethane	93	6.120	6.120	(1.103)	317210	100.000	98.13
	45 4-Methyl-2-Pentanone	43	6.854	6.854	(0.837)	1113382	200.000	204.85
	46 cis-1,3-Dichloropropene	75	6.690	6.690	(1.205)	774336	100.000	98.89
*	47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	730455	50.0000	
$	48 Toluene-d8	98	6.922	6.922	(0.846)	1702517	100.000	100.20
	50 Toluene	91	6.978	6.978	(0.853)	2103575	100.000	105.92
	51 trans-1,3-Dichloropropene	75	7.196	7.196	(1.296)	657662	100.000	113.61
	52 2-Hexanone	43	7.593	7.593	(0.928)	745592	200.000	207.16
	53 1,1,2-Trichloroethane	83	7.357	7.357	(0.899)	399622	100.000	93.95
	54 1,3-Dichloropropane	76	7.499	7.499	(0.916)	852281	100.000	97.67
	55 Dibromochloromethane	129	7.690	7.690	(0.940)	562633	100.000	107.78
	56 Tetrachloroethene	164	7.458	7.458	(0.911)	508894	100.000	105.39
	57 1,2-Dibromoethane	107	7.784	7.784	(0.951)	511063	100.000	99.87
	58 1-Chlorohexane	55	8.196	8.196	(1.477)	456782	100.000	113.79
	59 Chlorobenzene	112	8.208	8.208	(1.003)	1400796	100.000	99.49
	60 1,1,1,2-Tetrachloroethane	131	8.283	8.283	(1.012)	524704	100.000	102.25
	61 Ethylbenzene	106	8.305	8.305	(1.015)	707960	100.000	111.08
	62 m,p-Xylenes	106	8.410	8.410	(1.027)	1748509	200.000	233.68
	63 o-Xylene	106	8.748	8.748	(1.069)	842626	100.000	115.11
	64 Styrene	104	8.759	8.759	(1.070)	1350547	100.000	118.23
	66 Bromoform	173	8.916	8.916	(1.089)	397643	100.000	109.03
	67 Isopropylbenzene	105	9.062	9.062	(1.107)	2157581	100.000	121.81
	68 1,1,2,2-Tetrachloroethane	83	9.329	9.329	(0.917)	678033	100.000	91.98
$	69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	681158	100.000	104.18
*	70 1,4-Dichlorobenzene-d4	152	10.172	10.172	(1.000)	382676	50.0000	
	71 1,2,3-Trichloropropane	75	9.362	9.362	(0.920)	649935	100.000	101.27
	73 n-Propylbenzene	91	9.411	9.411	(0.925)	2371517	100.000	108.15
	74 Bromobenzene	156	9.317	9.317	(0.916)	640155	100.000	101.11
	75 1,3,5-Trimethylbenzene	105	9.561	9.561	(0.940)	1580368	100.000	118.16
	76 2-Chlorotoluene	91	9.482	9.482	(0.932)	1466545	100.000	108.70
	77 4-Chlorotoluene	91	9.576	9.576	(0.941)	1658605	100.000	110.06
	78 tert-Butylbenzene	119	9.838	9.838	(0.967)	1531790	100.000	120.89
	79 1,2,4-Trimethylbenzene	105	9.880	9.880	(0.971)	1537488	100.000	113.52
	81 sec-Butylbenzene	105	10.022	10.022	(0.985)	2006353	100.000	100.11(M)
	82 p-Isopropyltoluene	119	10.146	10.146	(0.997)	1676245	100.000	100.10
	83 1,3-Dichlorobenzene	146	10.116	10.116	(0.994)	1093115	100.000	103.45
	84 1,4-Dichlorobenzene	146	10.191	10.191	(1.002)	1130176	100.000	96.52
	87 n-Butylbenzene	91	10.491	10.491	(1.031)	1404287	100.000	106.06
	88 1,2-Dichlorobenzene	146	10.506	10.506	(1.033)	1085919	100.000	100.16

89	1,2-Dibromo-3-Chloropropane	155	11.165	11.165 (1.098)	111083	100.000	104.52
90	1,2,4-Trichlorobenzene	180	11.855	11.855 (1.165)	779707	100.000	116.91

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
	91 Hexachlorobutadiene	225	11.998	11.998	(1.179)	351435	100.000	100.12
	92 Naphthalene	128	12.065	12.065	(1.186)	1846543	100.000	103.09
	93 1,2,3-Trichlorobenzene	180	12.268	12.268	(1.206)	758679	100.000	111.43
M	94 1,2-Dichloroethylene (total)	96				831926	200.000	
M	95 Xylenes (total)	106				2591135	300.000	
	135 1,4-Dioxane	88	6.168	6.168	(1.282)	133163	2000.00	1748.66
	141 Cyclohexane	56	4.778	4.778	(0.993)	724781	100.000	121.41
	138 Freon TF	101	2.330	2.330	(0.484)	376621	100.000	100.17
	140 1,3-Butadiene	54	1.400	1.400	(0.291)	471706	100.000	111.54
	147 Methylcyclohexane	55	5.947	5.947	(1.072)	1231847	100.000	110.02(A)
	146 Methyl Acetate	43	2.708	2.708	(0.563)	348427	100.000	91.42
	148 Tert-Butyl alcohol	59	2.967	2.967	(0.617)	876760	2000.00	1966.54
	149 Isopropyl Alcohol	45	2.562	2.562	(0.533)	542945	2000.00	1849.80

QC Flag Legend

A - Target compound detected but, quantitated amount exceeded maximum amount.
M - Compound response manually integrated.



Data File: \\nahstws005\target\chem\voa9,i\u230731,b\u073109,d
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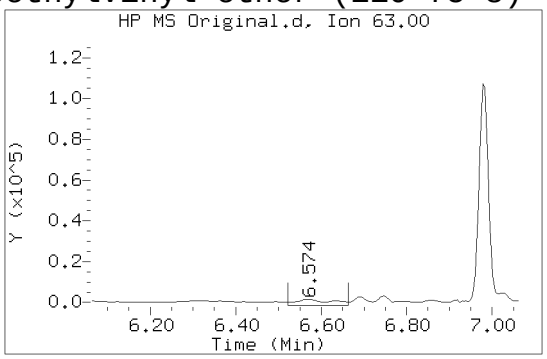
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Operator: PC
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LabSampID : VSTD100

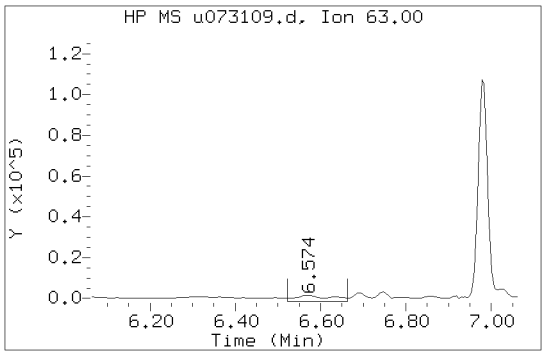
2-Chloroethylvinyl ether (110-75-8)

Reason Code:

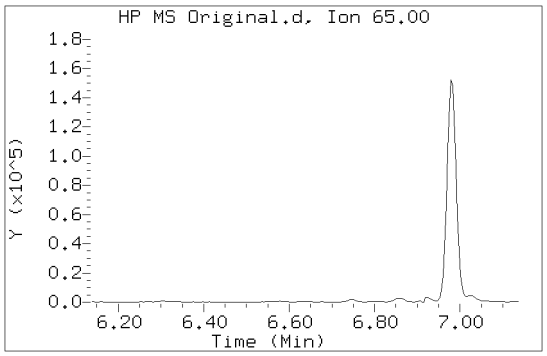
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01-Aug-2023
21:04



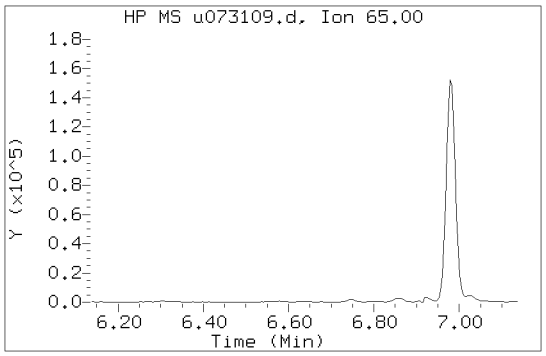
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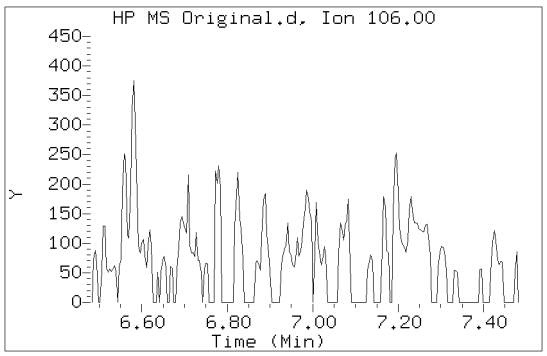
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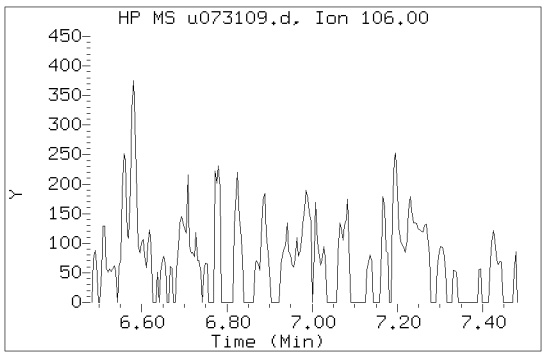
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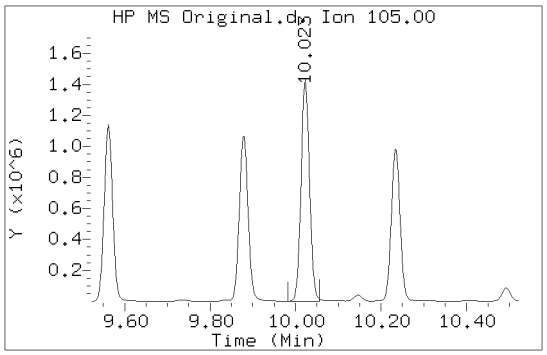
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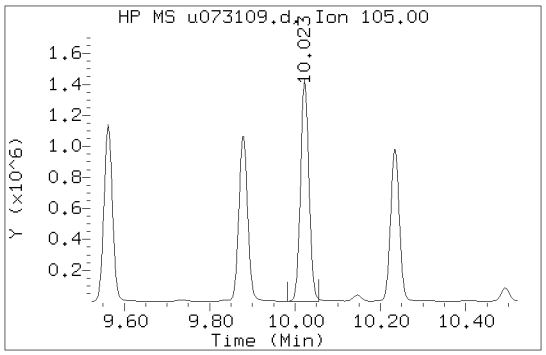
sec-Butylbenzene (135-98-8)

Reason Code:

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21:04



AFTER
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01-Aug-2023
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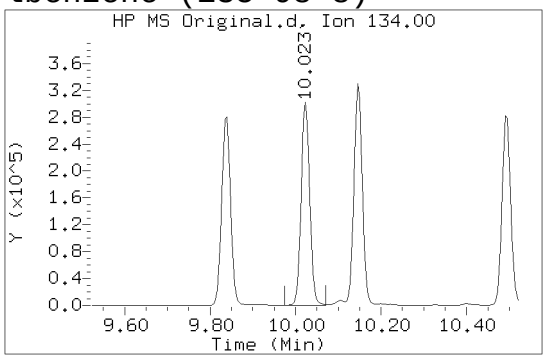


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Inj Date : 31-JUL-2023 14:28
InstruID : VOA9.i
LabSampID : VSTD100

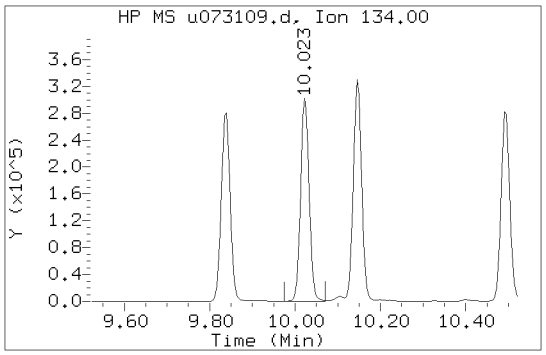
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Reason Code:

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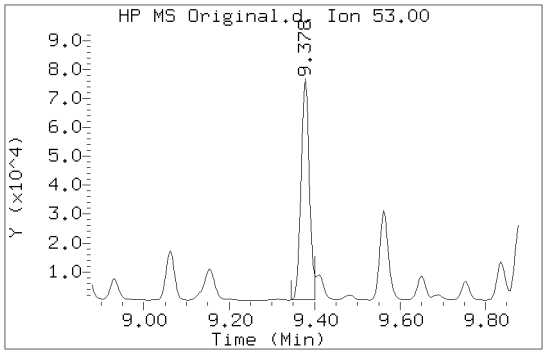
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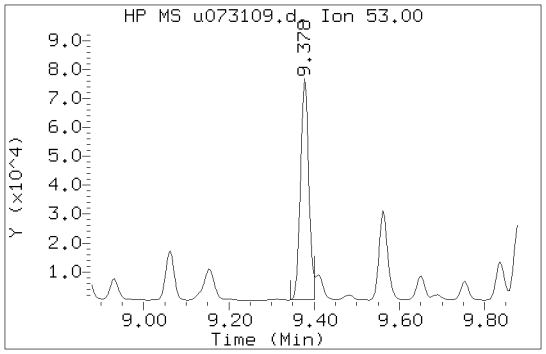
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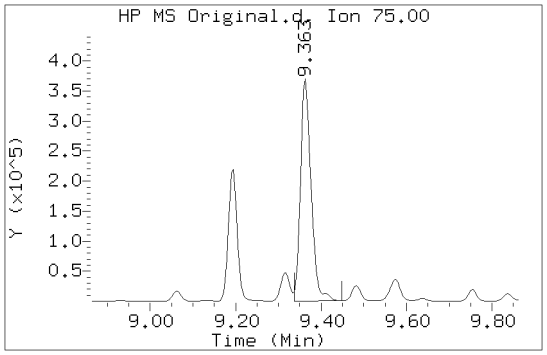
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01-Aug-2023
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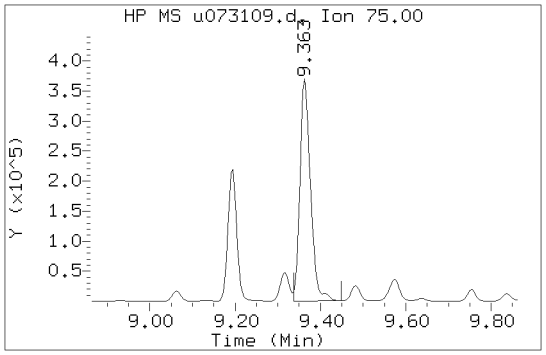
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BEFORE
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01-Aug-2023
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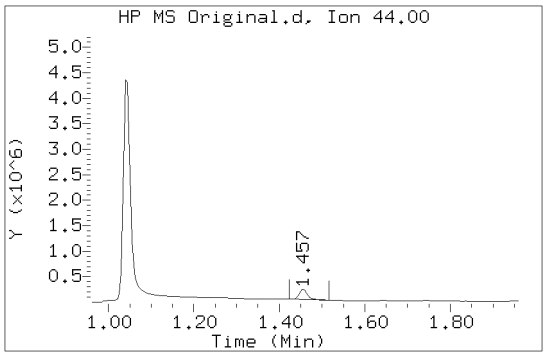
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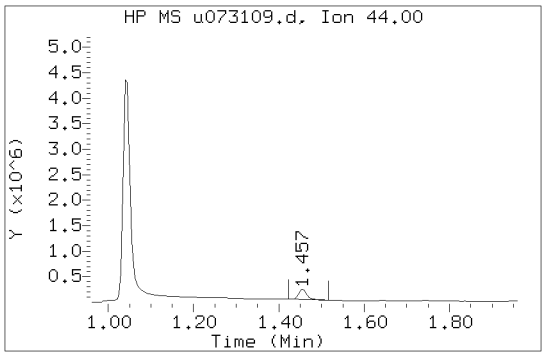
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Reason Code:

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21:04



AFTER
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01-Aug-2023
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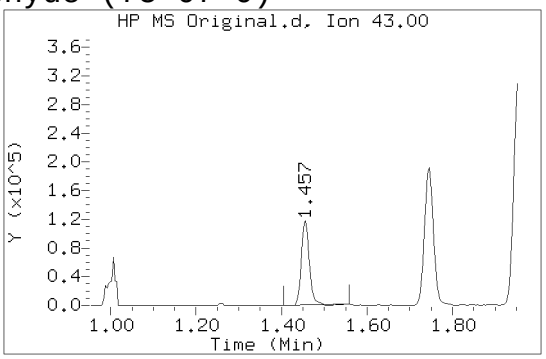


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Inj Date : 31-JUL-2023 14:28
InstruID : VOA9.i
LabSampID : VSTD100

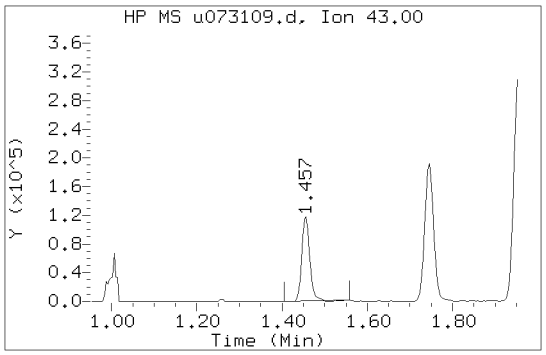
Acetaldehyde (75-07-0)

Reason Code:

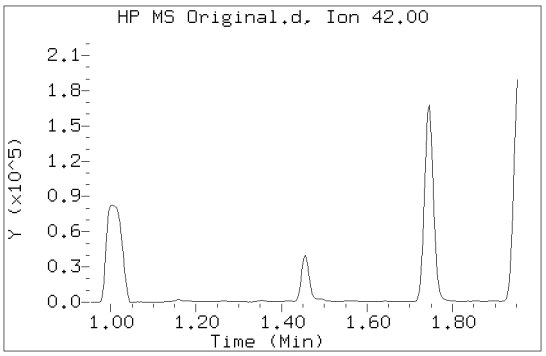
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01-Aug-2023
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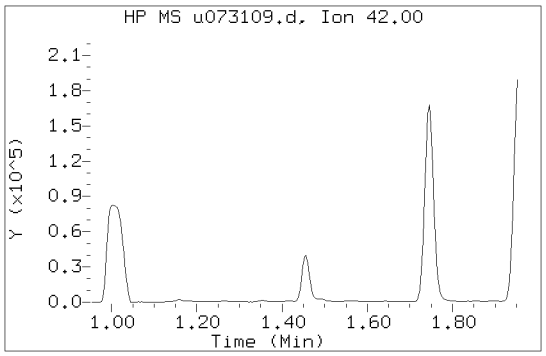
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BEFORE
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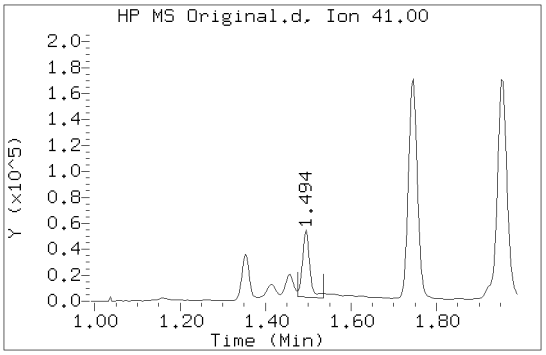
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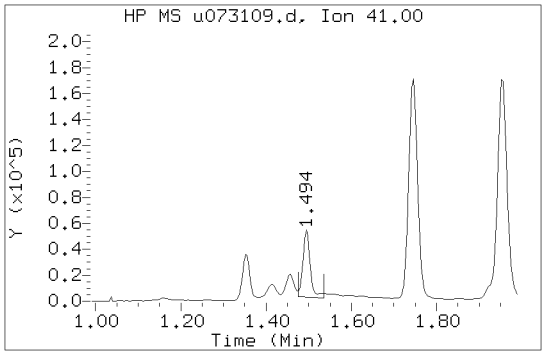
Isobutylene (115-11-7)

Reason Code:

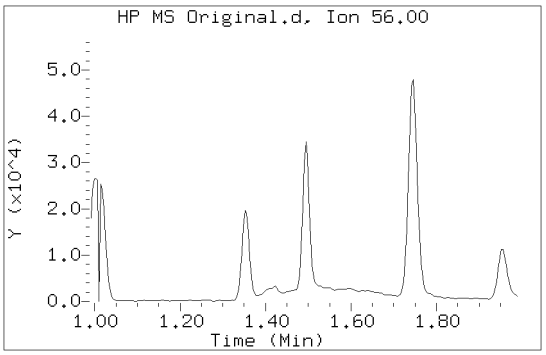
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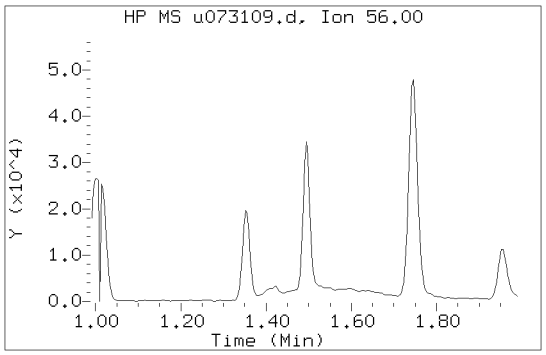
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AFTER
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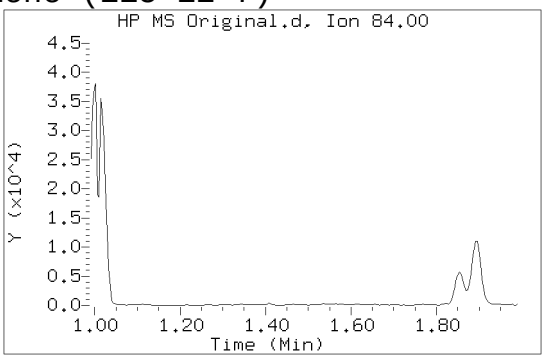
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Inj Date : 31-JUL-2023 14:28
InstruID : VOA9.i
LabSampID : VSTD100

Isobutylene (115-11-7)

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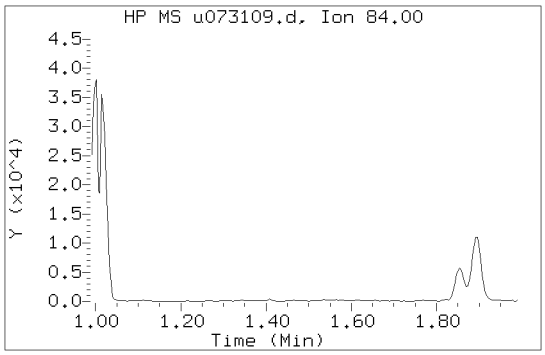
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AFTER

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01-Aug-2023
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Data File: \\NAHSTWS005\Target\chem\voa9.i\U230731.b\U073110.D Page 1
Report Date: 07-Aug-2023 11:14

ALS Laboratory Group

Data file : \\NAHSTWS005\Target\chem\voa9.i\U230731.b\U073110.D
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Inj Date : 31-JUL-2023 14:51
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Smp Info : VSTD150;VSTD150;1;9;
Misc Info : V9;WATER;0;1;
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Cal Date : 31-JUL-2023 14:28 Cal File: U073109.D
Als bottle: 11 Calibration Sample, Level: 9
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 08260V9.sub
Target Version: 4.14
Processing Host: NAHSTW7056

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
* 1	Pentafluorobenzene	168	4.811	4.811	(1.000)	557237	50.0000	
2	Dichlorodifluoromethane	85	1.157	1.157	(0.240)	807250	150.000	148.79
3	Chloromethane	50	1.288	1.288	(0.268)	961975	150.000	147.77
5	Vinyl Chloride	62	1.366	1.366	(0.284)	860938	150.000	156.92
6	Bromomethane	94	1.599	1.599	(0.332)	430983	150.000	148.84
7	Chloroethane	64	1.685	1.685	(0.350)	507306	150.000	146.83
8	Trichlorofluoromethane	101	1.887	1.887	(0.392)	1063202	150.000	157.01
9	Acrolein	56	1.738	1.738	(0.361)	119190	300.000	333.46
10	Acetone	43	2.401	2.401	(0.499)	501220	300.000	302.73(A)
11	1,1-Dichloroethene	96	2.322	2.322	(0.483)	590988	150.000	160.97
15	Iodomethane	142	2.457	2.457	(0.511)	1298909	300.000	296.63
16	Acrylonitrile	53	3.057	3.057	(0.635)	529815	300.000	302.48
17	Methylene Chloride	84	2.787	2.787	(0.579)	668149	150.000	150.20
18	Methyl tert-butyl ether	73	3.072	3.072	(0.639)	1727226	150.000	152.21
19	Carbon Disulfide	76	2.510	2.510	(0.522)	3392907	300.000	317.45
20	trans-1,2-Dichloroethene	96	3.050	3.050	(0.634)	617223	150.000	150.02
21	Vinyl Acetate	43	3.601	3.601	(0.748)	3717826	300.000	315.75
22	1,1-Dichloroethane	63	3.507	3.507	(0.729)	1090457	150.000	145.00
24	2-Butanone	43	4.260	4.260	(0.885)	600335	300.000	274.23
26	2,2-Dichloropropane	77	4.174	4.174	(0.868)	826727	150.000	159.44

27 cis-1,2-Dichloroethene	96	4.189	4.189 (0.871)	694795	150.000	151.29
28 Chloroform	83	4.568	4.568 (0.949)	1267508	150.000	144.83

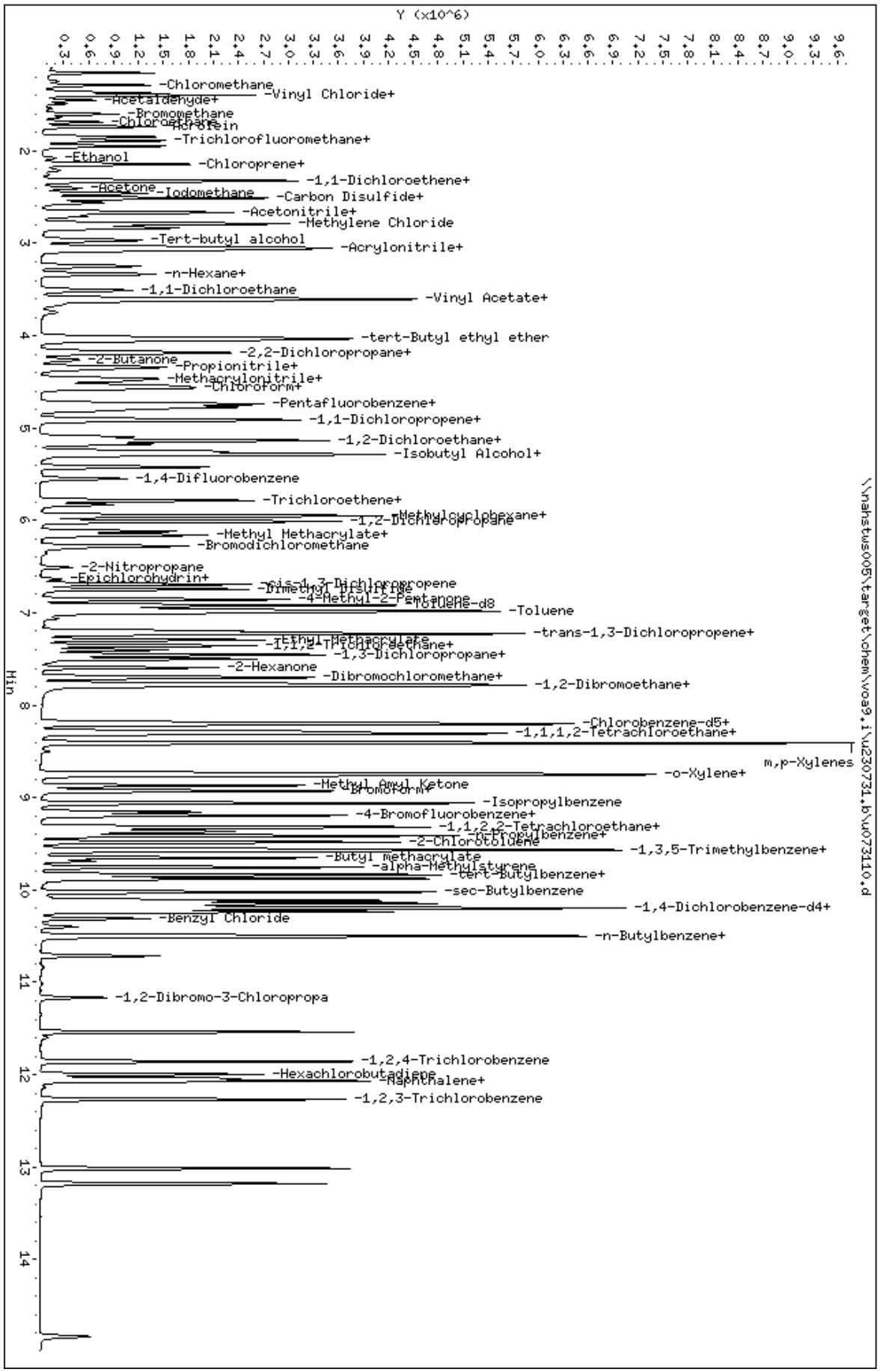
	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
	29 Bromochloromethane	128	4.463	4.463	(0.928)	404224	150.000	148.75
$	30 Dibromofluoromethane	113	4.744	4.744	(0.986)	673185	150.000	153.05
	31 1,1,1-Trichloroethane	97	4.737	4.737	(0.984)	1068384	150.000	156.92
	32 1,1-Dichloropropene	75	4.916	4.916	(0.886)	951085	150.000	158.71
	33 1,2-Dichloroethane	62	5.171	5.171	(0.932)	1009084	150.000	145.19
	34 Carbon Tetrachloride	117	4.905	4.905	(0.884)	911153	150.000	169.72
$	35 1,2-Dichloroethane-d4	65	5.093	5.093	(1.058)	729852	150.000	153.05
*	36 1,4-Difluorobenzene	114	5.550	5.550	(1.000)	807021	50.0000	
	37 Benzene	78	5.134	5.134	(0.925)	2909338	150.000	147.58
	38 Trichloroethene	130	5.786	5.786	(1.043)	851111	150.000	152.75
	39 Bromodichloromethane	83	6.277	6.277	(1.131)	994606	150.000	157.74
	41 2-Chloroethylvinyl ether	63	6.573	6.573	(1.184)	27126	300.000	298.47(M)
	42 1,2-Dichloropropane	63	6.007	6.007	(1.082)	784770	150.000	148.53
	44 Dibromomethane	93	6.116	6.116	(1.102)	492584	150.000	145.15
	45 4-Methyl-2-Pentanone	43	6.855	6.855	(0.837)	1760675	300.000	312.23
	46 cis-1,3-Dichloropropene	75	6.690	6.690	(1.205)	1255756	150.000	151.55
*	47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	757857	50.0000	
$	48 Toluene-d8	98	6.922	6.922	(0.846)	2578663	150.000	146.28
	50 Toluene	91	6.978	6.978	(0.853)	3174237	150.000	154.05
	51 trans-1,3-Dichloropropene	75	7.196	7.196	(1.296)	1058091	150.000	174.10
	52 2-Hexanone	43	7.593	7.593	(0.928)	1167264	300.000	312.60
	53 1,1,2-Trichloroethane	83	7.357	7.357	(0.899)	617355	150.000	139.89
	54 1,3-Dichloropropane	76	7.499	7.499	(0.916)	1323436	150.000	146.19
	55 Dibromochloromethane	129	7.690	7.690	(0.940)	898045	150.000	165.82
	56 Tetrachloroethene	164	7.454	7.454	(0.911)	763419	150.000	152.39
	57 1,2-Dibromoethane	107	7.784	7.784	(0.951)	793097	150.000	149.39
	58 1-Chlorohexane	55	8.197	8.197	(1.477)	680728	150.000	161.53
	59 Chlorobenzene	112	8.208	8.208	(1.003)	2133475	150.000	146.06
	60 1,1,1,2-Tetrachloroethane	131	8.283	8.283	(1.012)	815348	150.000	153.15
	61 Ethylbenzene	106	8.305	8.305	(1.015)	1067099	150.000	161.37
	62 m,p-Xylenes	106	8.410	8.410	(1.027)	2643756	300.000	340.56
	63 o-Xylene	106	8.748	8.748	(1.069)	1288431	150.000	169.65
	64 Styrene	104	8.759	8.759	(1.070)	2087563	150.000	176.15
	66 Bromoform	173	8.920	8.920	(1.090)	625679	150.000	165.36
	67 Isopropylbenzene	105	9.062	9.062	(1.107)	3206712	150.000	174.49
	68 1,1,2,2-Tetrachloroethane	83	9.329	9.329	(0.917)	1027356	150.000	135.02
$	69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	1028731	150.000	152.29
*	70 1,4-Dichlorobenzene-d4	152	10.172	10.172	(1.000)	395026	50.0000	
	71 1,2,3-Trichloropropane	75	9.362	9.362	(0.920)	1014556	150.000	153.14
	73 n-Propylbenzene	91	9.411	9.411	(0.925)	3432693	150.000	150.99
	74 Bromobenzene	156	9.317	9.317	(0.916)	973908	150.000	149.02
	75 1,3,5-Trimethylbenzene	105	9.561	9.561	(0.940)	2391650	150.000	173.24
	76 2-Chlorotoluene	91	9.482	9.482	(0.932)	2177941	150.000	156.38
	77 4-Chlorotoluene	91	9.576	9.576	(0.941)	2480954	150.000	159.48
	78 tert-Butylbenzene	119	9.838	9.838	(0.967)	2271872	150.000	173.70
	79 1,2,4-Trimethylbenzene	105	9.880	9.880	(0.971)	2354756	150.000	168.43
	81 sec-Butylbenzene	105	10.022	10.022	(0.985)	3013427	150.000	105.19
	82 p-Isopropyltoluene	119	10.146	10.146	(0.997)	2567946	150.000	102.53
	83 1,3-Dichlorobenzene	146	10.116	10.116	(0.994)	1653085	150.000	151.55
	84 1,4-Dichlorobenzene	146	10.191	10.191	(1.002)	1696943	150.000	140.39
	87 n-Butylbenzene	91	10.491	10.491	(1.031)	2119417	150.000	153.97
	88 1,2-Dichlorobenzene	146	10.506	10.506	(1.033)	1631585	150.000	145.79

89	1,2-Dibromo-3-Chloropropane	155	11.166	11.166 (1.098)	178139	150.000	162.38
90	1,2,4-Trichlorobenzene	180	11.859	11.859 (1.166)	1201951	150.000	174.59

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
	91 Hexachlorobutadiene	225	11.998	11.998	(1.179)	527704	150.000	98.49
	92 Naphthalene	128	12.065	12.065	(1.186)	2827642	150.000	152.16
	93 1,2,3-Trichlorobenzene	180	12.268	12.268	(1.206)	1161534	150.000	165.26
M	94 1,2-Dichloroethylene (total)	96				1312018	300.000	
M	95 Xylenes (total)	106				3932187	450.000	
	135 1,4-Dioxane	88	6.169	6.169	(1.282)	207196	3000.00	2593.31
	141 Cyclohexane	56	4.778	4.778	(0.993)	1079520	150.000	172.36(A)
	138 Freon TF	101	2.322	2.322	(0.483)	573884	150.000	110.31
	140 1,3-Butadiene	54	1.396	1.396	(0.290)	730457	150.000	164.62
	147 Methylcyclohexane	55	5.947	5.947	(1.072)	1960914	150.000	166.81(A)
	146 Methyl Acetate	43	2.705	2.705	(0.562)	569325	150.000	142.38
	148 Tert-Butyl alcohol	59	2.967	2.967	(0.617)	1418139	3000.00	3033.44
	149 Isopropyl Alcohol	45	2.559	2.559	(0.532)	897894	3000.00	2915.72

QC Flag Legend

A - Target compound detected but, quantitated amount exceeded maximum amount.
M - Compound response manually integrated.



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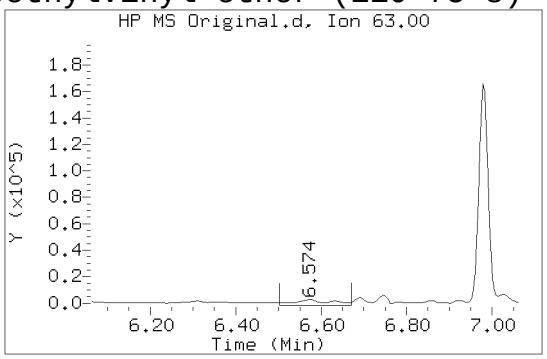
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Operator: PC
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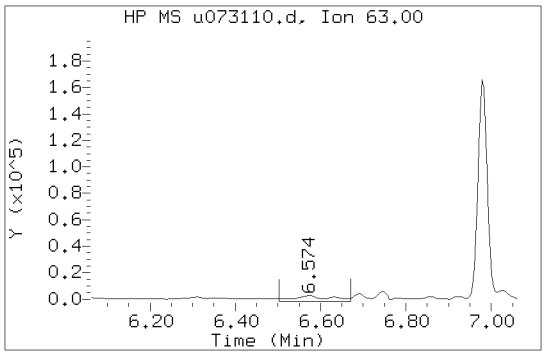
2-Chloroethylvinyl ether (110-75-8)

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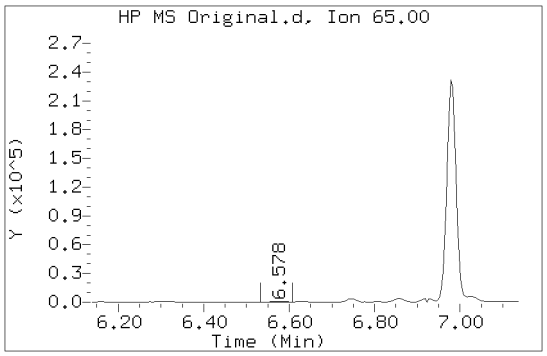
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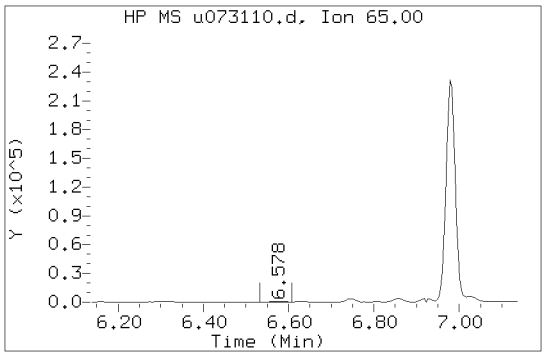
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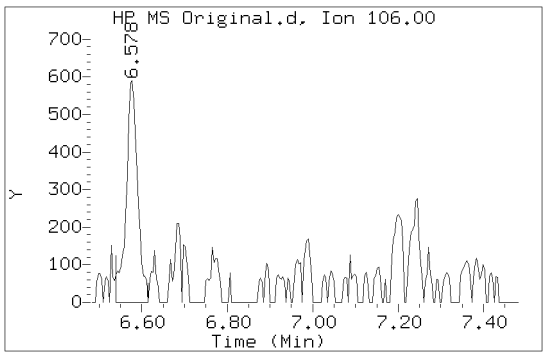
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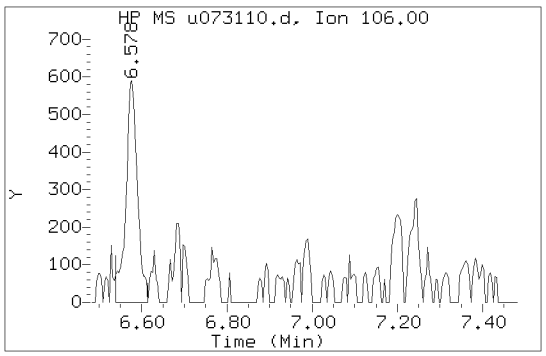
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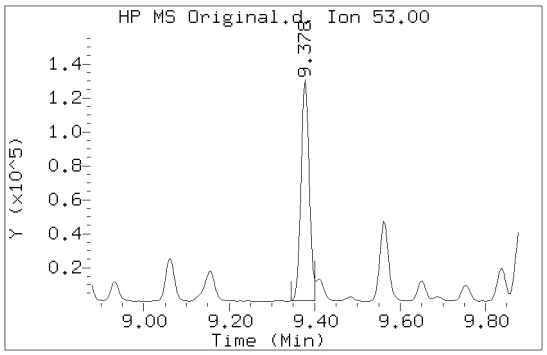
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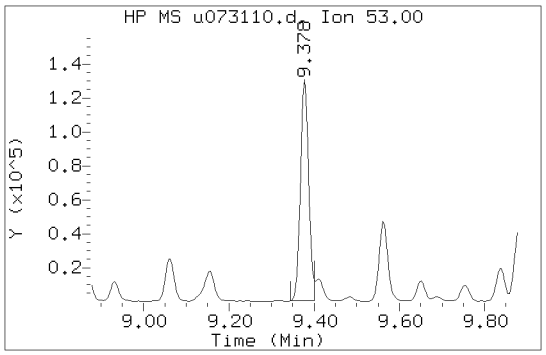
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Reason Code:

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AFTER
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01-Aug-2023
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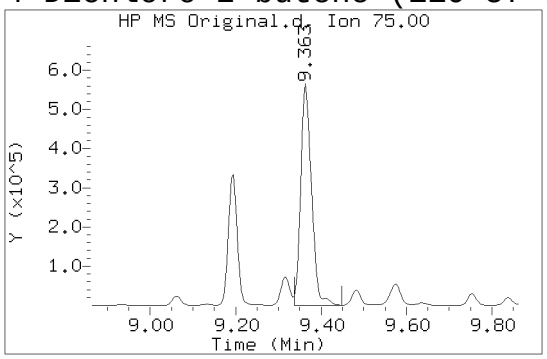
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Inj Date : 31-JUL-2023 14:51
InstruID : VOA9.i
LabSampID : VSTD150

trans-1,4-Dichloro-2-butene (110-57-6)

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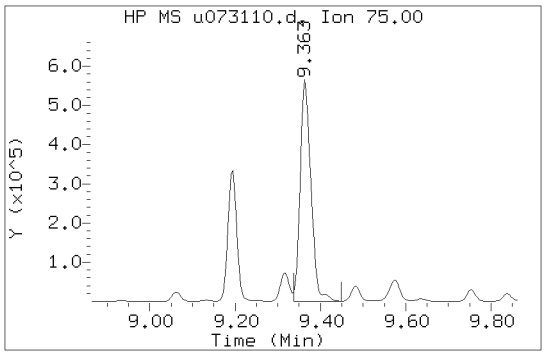
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AFTER

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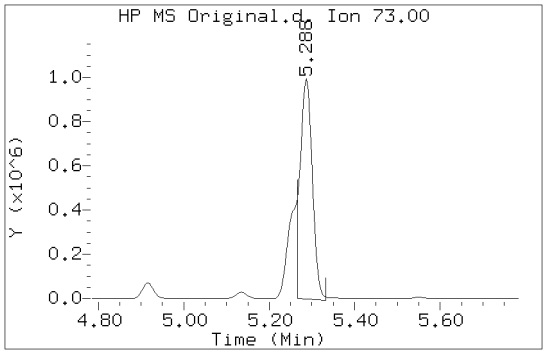


tert-Amyl methyl ether (974-05-08)

Reason Code:

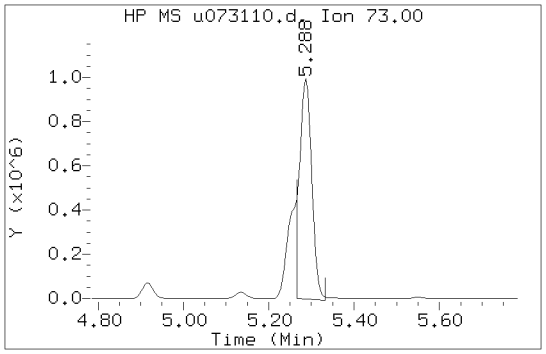
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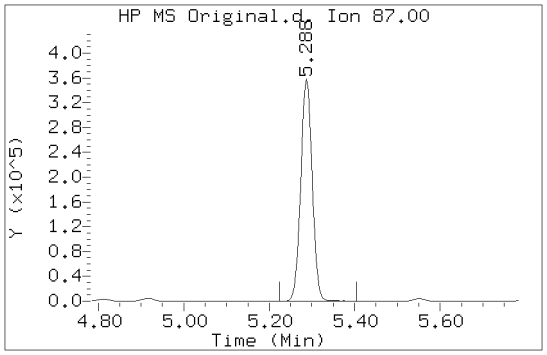
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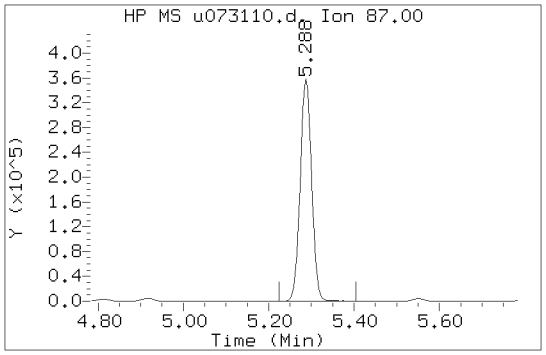
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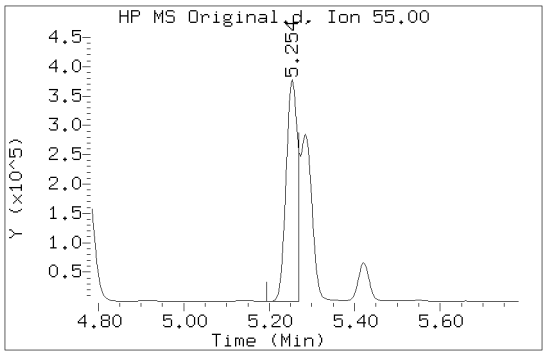
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01-Aug-2023
21:04



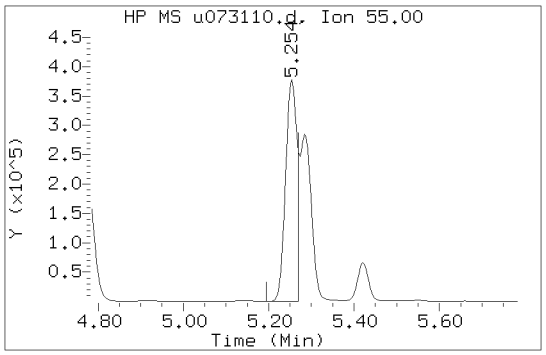
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01-Aug-2023
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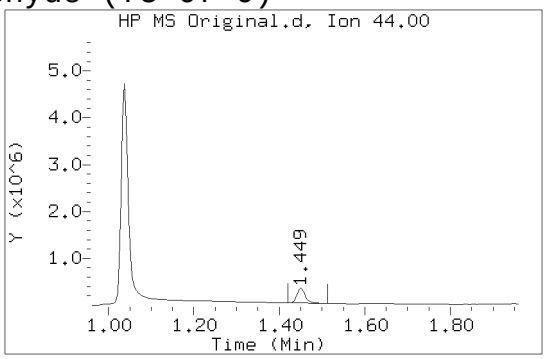


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Inj Date : 31-JUL-2023 14:51
InstruID : VOA9.i
LabSampID : VSTD150

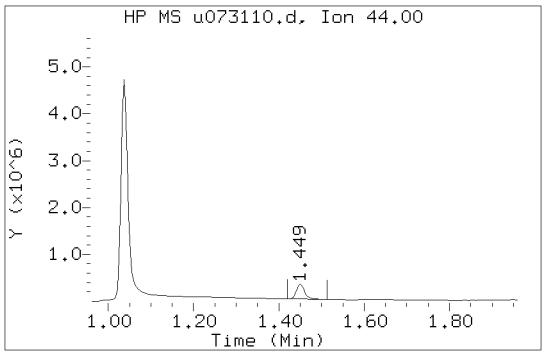
Acetaldehyde (75-07-0)

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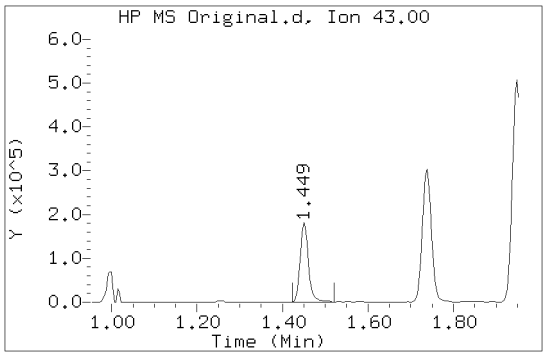
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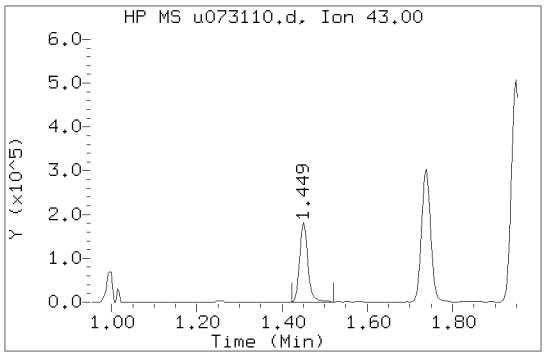
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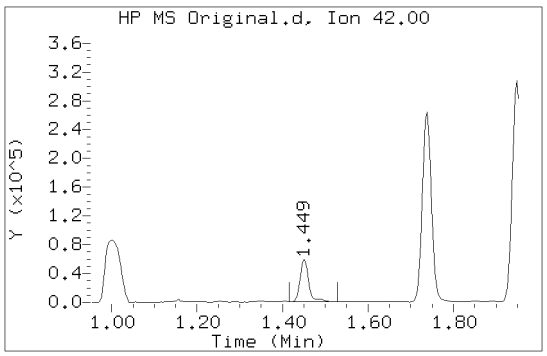
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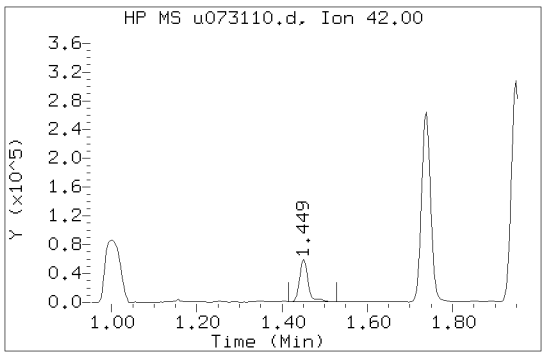
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BEFORE
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01-Aug-2023
21:04



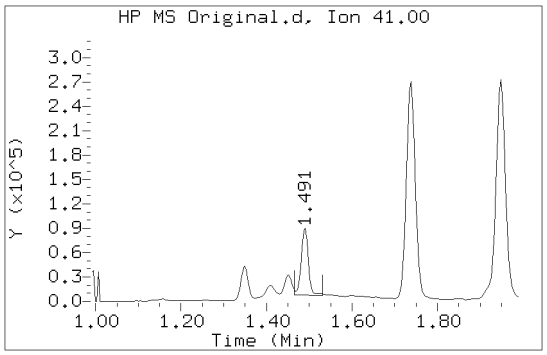
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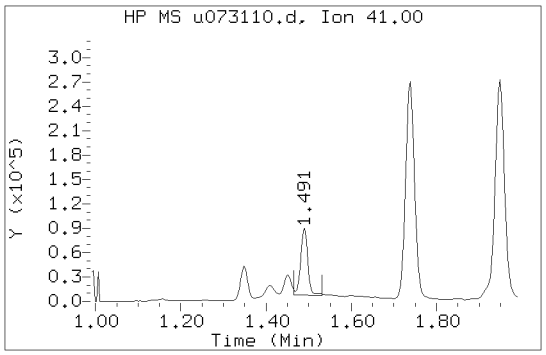
Isobutylene (115-11-7)

Reason Code:

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01-Aug-2023
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AFTER
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01-Aug-2023
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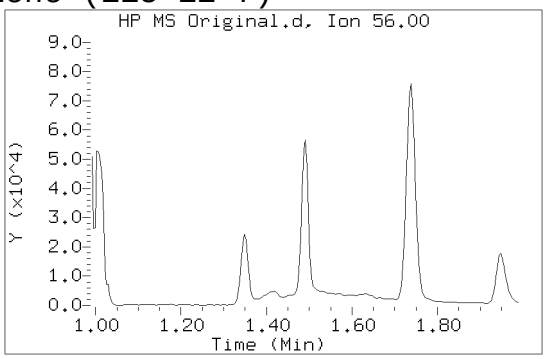
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Inj Date : 31-JUL-2023 14:51
InstruID : VOA9.i
LabSampID : VSTD150

Isobutylene (115-11-7)

Reason Code:

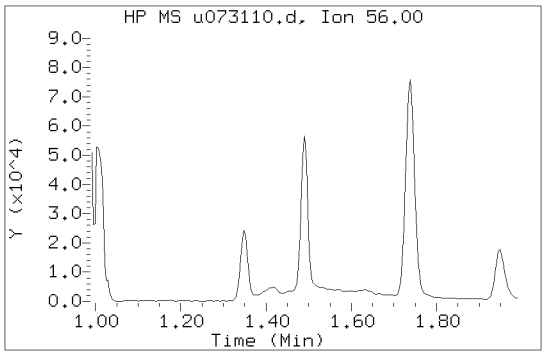
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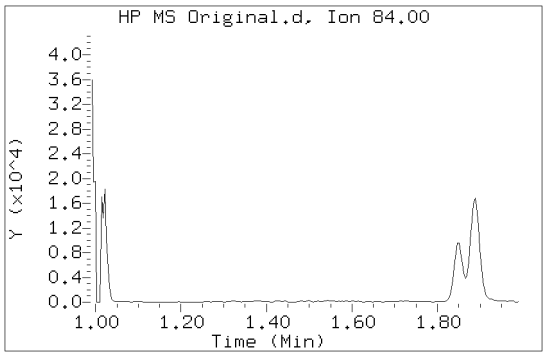
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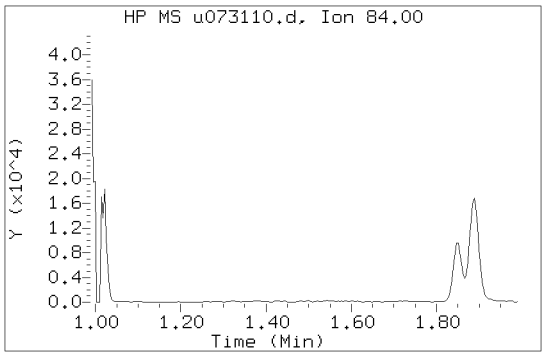
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01-Aug-2023
21:04



AFTER

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HEIGHT
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01-Aug-2023
21:04



Data File: \\NAHSTWS005\Target\chem\voa9.i\U230731.b\U073111.D Page 1
Report Date: 07-Aug-2023 11:14

ALS Laboratory Group

Data file : \\NAHSTWS005\Target\chem\voa9.i\U230731.b\U073111.D
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Inj Date : 31-JUL-2023 15:13
Operator : PC Inst ID: VOA9.i
Smp Info : VSTD200;VSTD200;1;10;
Misc Info : V9;WATER;0;1;
Comment   :
Method   : \\NAHSTWS005\Target\chem\voa9.i\U230731.b\8260C.m
Meth Date : 07-Aug-2023 11:14 VOA9.i Quant Type: ISTD
Cal Date : 31-JUL-2023 14:51 Cal File: U073110.D
Als bottle: 12 Calibration Sample, Level: 10
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 08260V9.sub
Target Version: 4.14
Processing Host: NAHSTW7056

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
* 1	Pentafluorobenzene	168	4.811	4.811	(1.000)	570202	50.0000	
2	Dichlorodifluoromethane	85	1.156	1.156	(0.240)	1019713	200.000	183.38
3	Chloromethane	50	1.291	1.291	(0.268)	1264921	200.000	189.98
5	Vinyl Chloride	62	1.370	1.370	(0.285)	1126971	200.000	200.74(A)
6	Bromomethane	94	1.599	1.599	(0.332)	507880	200.000	171.65
7	Chloroethane	64	1.685	1.685	(0.350)	666015	200.000	188.38
8	Trichlorofluoromethane	101	1.891	1.891	(0.393)	1308026	200.000	188.77
9	Acrolein	56	1.738	1.738	(0.361)	154362	400.000	422.04(A)
10	Acetone	43	2.405	2.405	(0.500)	658218	400.000	390.84(A)
11	1,1-Dichloroethene	96	2.326	2.326	(0.484)	759024	200.000	202.04(A)
15	Iodomethane	142	2.461	2.461	(0.512)	1727558	400.000	352.01
16	Acrylonitrile	53	3.061	3.061	(0.636)	707285	400.000	394.61
17	Methylene Chloride	84	2.787	2.787	(0.579)	909993	200.000	199.98
18	Methyl tert-butyl ether	73	3.076	3.076	(0.639)	2336621	200.000	201.23(A)
19	Carbon Disulfide	76	2.514	2.514	(0.522)	4402937	400.000	402.58(A)
20	trans-1,2-Dichloroethene	96	3.053	3.053	(0.635)	815001	200.000	193.59
21	Vinyl Acetate	43	3.604	3.604	(0.749)	4975358	400.000	412.95(A)
22	1,1-Dichloroethane	63	3.511	3.511	(0.730)	1435268	200.000	186.52
24	2-Butanone	43	4.264	4.264	(0.886)	788336	400.000	351.92
26	2,2-Dichloropropane	77	4.178	4.178	(0.868)	1066112	200.000	200.94(A)

27 cis-1,2-Dichloroethene	96	4.193	4.193 (0.871)	935978	200.000	199.17
28 Chloroform	83	4.572	4.572 (0.950)	1666771	200.000	186.13

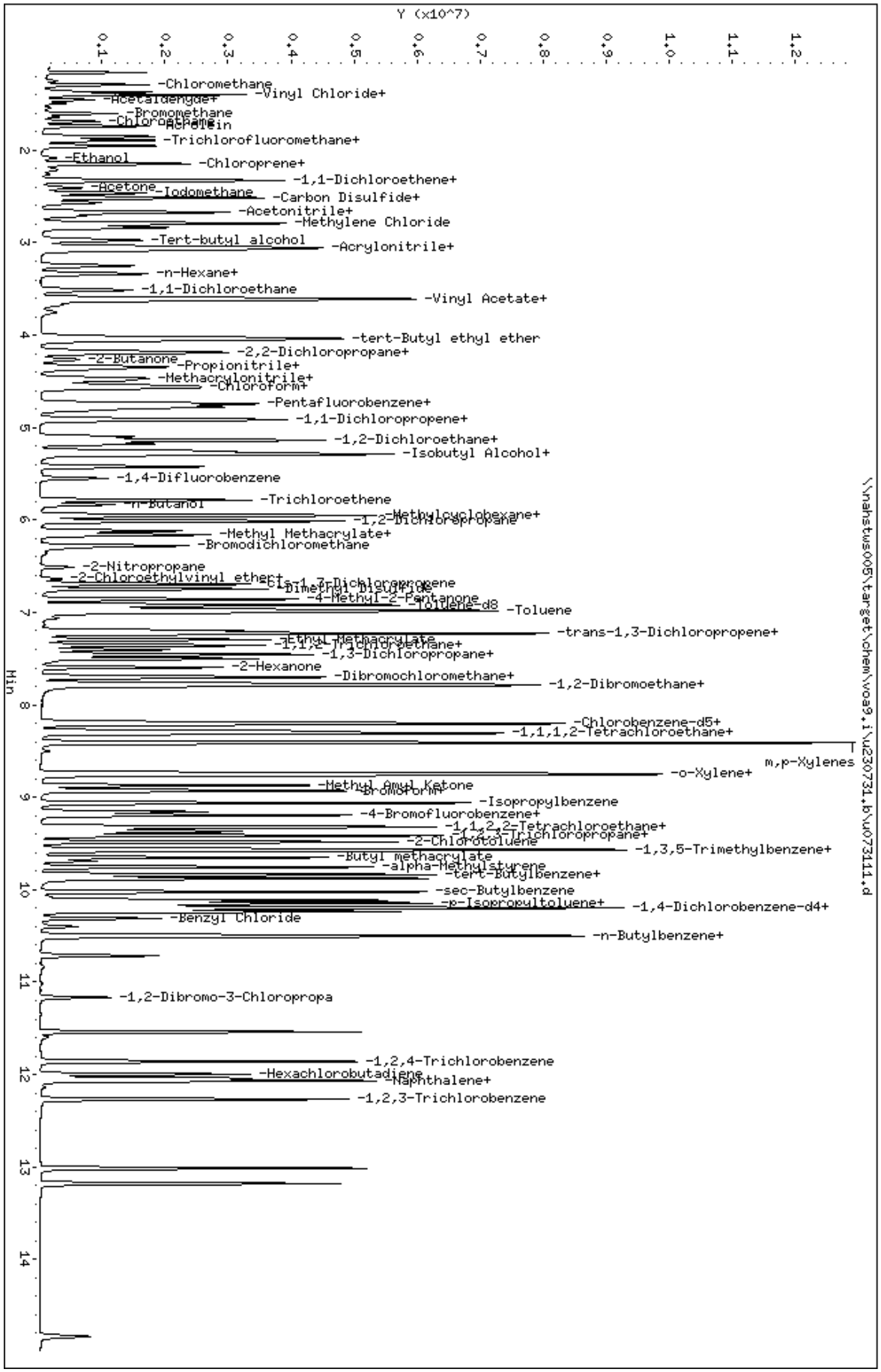
	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
	29 Bromochloromethane	128	4.467	4.467	(0.928)	498347	200.000	179.21
$	30 Dibromofluoromethane	113	4.748	4.748	(0.987)	879652	200.000	195.72
	31 1,1,1-Trichloroethane	97	4.740	4.740	(0.985)	1371560	200.000	196.87
	32 1,1-Dichloropropene	75	4.916	4.916	(0.886)	1207825	200.000	197.27
	33 1,2-Dichloroethane	62	5.175	5.175	(0.932)	1335743	200.000	188.11
	34 Carbon Tetrachloride	117	4.909	4.909	(0.885)	1133427	200.000	206.64(A)
$	35 1,2-Dichloroethane-d4	65	5.096	5.096	(1.059)	950577	200.000	195.17
*	36 1,4-Difluorobenzene	114	5.550	5.550	(1.000)	824550	50.0000	
	37 Benzene	78	5.138	5.138	(0.926)	3816784	200.000	189.49
	38 Trichloroethene	130	5.786	5.786	(1.043)	1105898	200.000	194.26
	39 Bromodichloromethane	83	6.277	6.277	(1.131)	1321967	200.000	205.21(A)
	41 2-Chloroethylvinyl ether	63	6.577	6.577	(1.185)	9808	400.000	104.91
	42 1,2-Dichloropropane	63	6.011	6.011	(1.083)	1039756	200.000	192.61
	44 Dibromomethane	93	6.120	6.120	(1.103)	666792	200.000	192.30
	45 4-Methyl-2-Pentanone	43	6.858	6.858	(0.838)	2391345	400.000	406.74(A)
	46 cis-1,3-Dichloropropene	75	6.693	6.693	(1.206)	1704761	200.000	200.64(A)
*	47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	790154	50.0000	
$	48 Toluene-d8	98	6.922	6.922	(0.846)	3405550	200.000	185.30
	50 Toluene	91	6.982	6.982	(0.853)	4184874	200.000	194.80
	51 trans-1,3-Dichloropropene	75	7.196	7.196	(1.296)	1452570	200.000	233.93(A)
	52 2-Hexanone	43	7.593	7.593	(0.928)	1597049	400.000	410.22(A)
	53 1,1,2-Trichloroethane	83	7.357	7.357	(0.899)	830168	200.000	180.42
	54 1,3-Dichloropropane	76	7.499	7.499	(0.916)	1766495	200.000	187.16
	55 Dibromochloromethane	129	7.694	7.694	(0.940)	1214851	200.000	215.14(A)
	56 Tetrachloroethene	164	7.458	7.458	(0.911)	979030	200.000	187.44
	57 1,2-Dibromoethane	107	7.784	7.784	(0.951)	1065136	200.000	192.43
	58 1-Chlorohexane	55	8.197	8.197	(1.477)	873975	200.000	202.98(A)
	59 Chlorobenzene	112	8.212	8.212	(1.003)	2824872	200.000	185.49
	60 1,1,1,2-Tetrachloroethane	131	8.286	8.286	(1.012)	1105730	200.000	199.21
	61 Ethylbenzene	106	8.309	8.309	(1.015)	1413378	200.000	205.00(A)
	62 m,p-Xylenes	106	8.410	8.410	(1.027)	3469755	400.000	428.69(A)
	63 o-Xylene	106	8.748	8.748	(1.069)	1710909	200.000	216.07(A)
	64 Styrene	104	8.763	8.763	(1.071)	2829265	200.000	228.98(A)
	66 Bromoform	173	8.920	8.920	(1.090)	865119	200.000	219.30(A)
	67 Isopropylbenzene	105	9.062	9.062	(1.107)	4166795	200.000	217.47(A)
	68 1,1,2,2-Tetrachloroethane	83	9.329	9.329	(0.917)	1373844	200.000	175.48
$	69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	1374126	200.000	195.49
*	70 1,4-Dichlorobenzene-d4	152	10.172	10.172	(1.000)	406460	50.0000	
	71 1,2,3-Trichloropropane	75	9.366	9.366	(0.921)	1391040	200.000	204.06(A)
	73 n-Propylbenzene	91	9.411	9.411	(0.925)	4612232	200.000	196.67
	74 Bromobenzene	156	9.317	9.317	(0.916)	1303306	200.000	193.82
	75 1,3,5-Trimethylbenzene	105	9.561	9.561	(0.940)	3157707	200.000	222.29(A)
	76 2-Chlorotoluene	91	9.482	9.482	(0.932)	2873591	200.000	200.53(A)
	77 4-Chlorotoluene	91	9.576	9.576	(0.941)	3265271	200.000	203.99(A)
	78 tert-Butylbenzene	119	9.838	9.838	(0.967)	2926405	200.000	217.45(A)
	79 1,2,4-Trimethylbenzene	105	9.880	9.880	(0.971)	3151112	200.000	219.06(A)
	81 sec-Butylbenzene	105	10.022	10.022	(0.985)	3876784	200.000	90.88
	82 p-Isopropyltoluene	119	10.146	10.146	(0.997)	3372466	200.000	80.89
	83 1,3-Dichlorobenzene	146	10.116	10.116	(0.994)	2183578	200.000	194.56
	84 1,4-Dichlorobenzene	146	10.191	10.191	(1.002)	2243745	200.000	180.41
	87 n-Butylbenzene	91	10.491	10.491	(1.031)	2783598	200.000	195.87
	88 1,2-Dichlorobenzene	146	10.506	10.506	(1.033)	2147264	200.000	186.47

89	1,2-Dibromo-3-Chloropropane	155	11.165	11.165 (1.098)	250171	200.000	221.63(A)
90	1,2,4-Trichlorobenzene	180	11.859	11.859 (1.166)	1610904	200.000	227.41(A)

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
	91 Hexachlorobutadiene	225	11.998	11.998	(1.179)	659381	200.000	80.10
	92 Naphthalene	128	12.065	12.065	(1.186)	3794466	200.000	197.95
	93 1,2,3-Trichlorobenzene	180	12.268	12.268	(1.206)	1538961	200.000	212.80(A)
M	94 1,2-Dichloroethylene (total)	96				1750979	400.000	
M	95 Xylenes (total)	106				5180664	600.000	
	135 1,4-Dioxane	88	6.168	6.168	(1.282)	278742	4000.00	3409.48
	141 Cyclohexane	56	4.778	4.778	(0.993)	1335056	200.000	208.31(A)
	138 Freon TF	101	2.326	2.326	(0.484)	699712	200.000	105.50
	140 1,3-Butadiene	54	1.396	1.396	(0.290)	922301	200.000	203.14(A)
	147 Methylcyclohexane	55	5.947	5.947	(1.072)	2583280	200.000	215.09(A)
	146 Methyl Acetate	43	2.708	2.708	(0.563)	747739	200.000	182.75
	148 Tert-Butyl alcohol	59	2.971	2.971	(0.617)	1911477	4000.00	3996.72
	149 Isopropyl Alcohol	45	2.566	2.566	(0.533)	1191893	4000.00	3782.42

QC Flag Legend

A - Target compound detected but, quantitated amount exceeded maximum amount.



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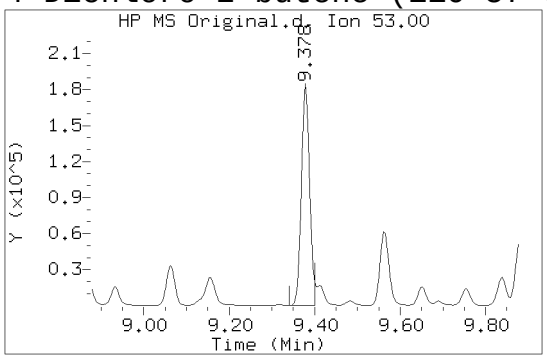
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Operator: PC
Column diameter: 0.18

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Inj Date : 31-JUL-2023 15:13
InstruID : VOA9.i
LabSampID : VSTD200

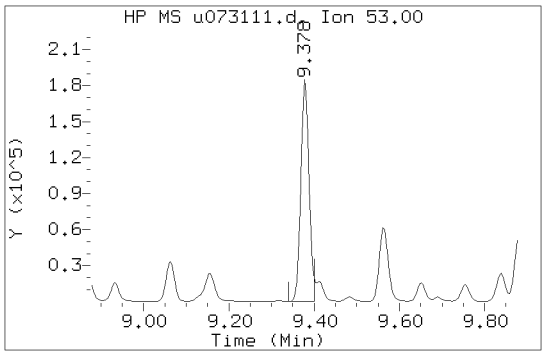
trans-1,4-Dichloro-2-butene (110-57-6)

Reason Code:

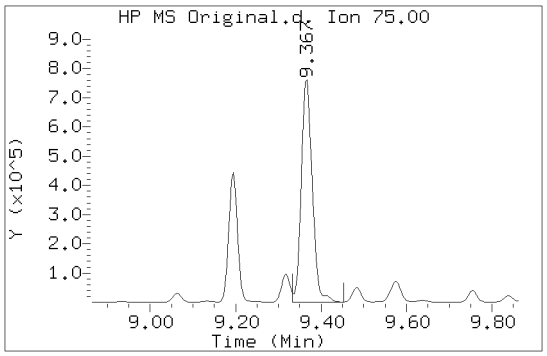
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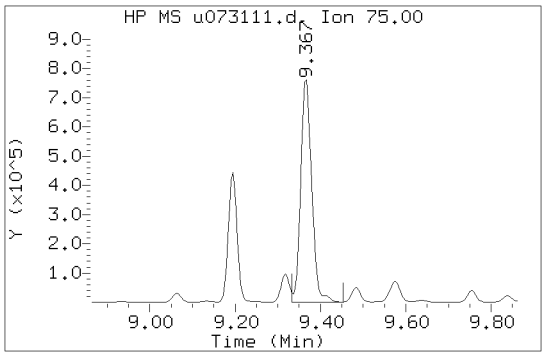
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01-Aug-2023
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BEFORE
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01-Aug-2023
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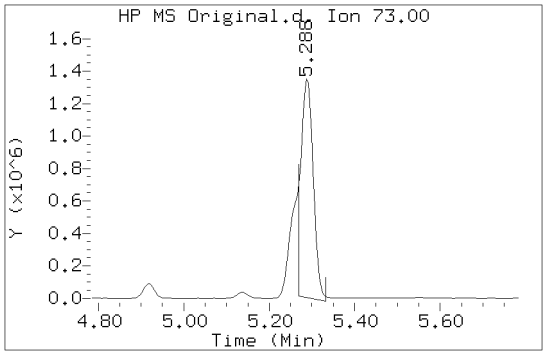
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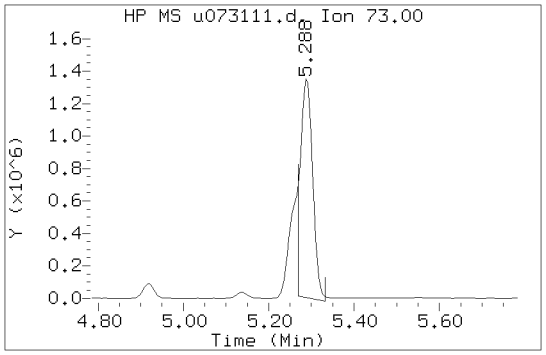
tert-Amyl methyl ether (974-05-08)

Reason Code:

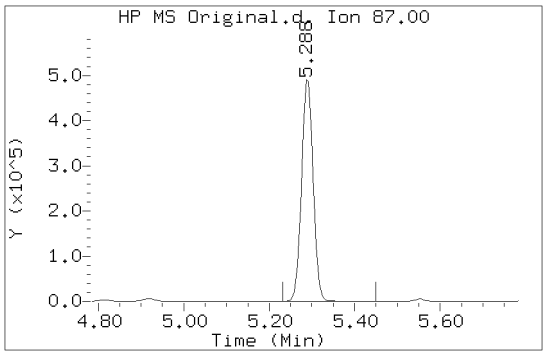
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01-Aug-2023
21:04



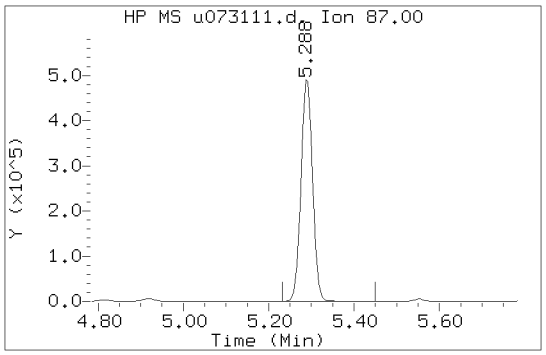
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01-Aug-2023
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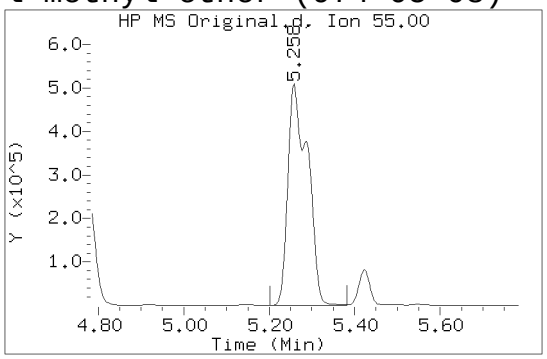
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Inj Date : 31-JUL-2023 15:13
InstruID : VOA9.i
LabSampID : VSTD200

tert-Amyl methyl ether (974-05-08)

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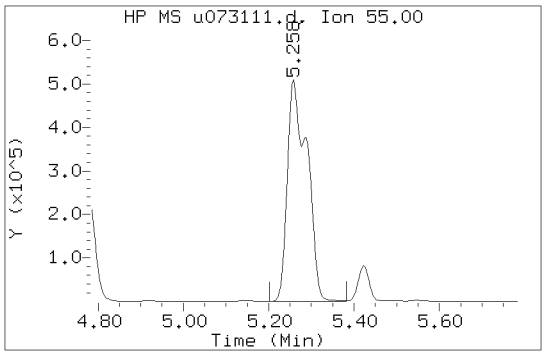
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AFTER

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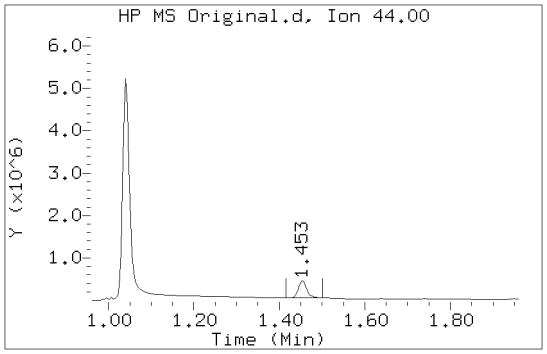


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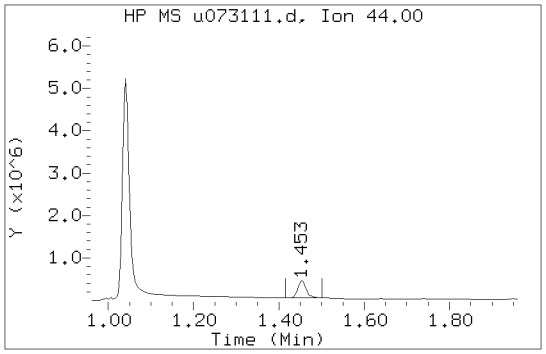
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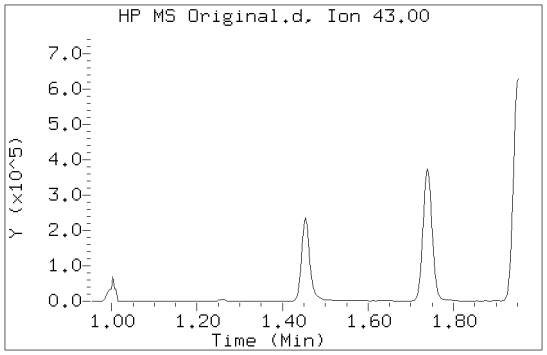
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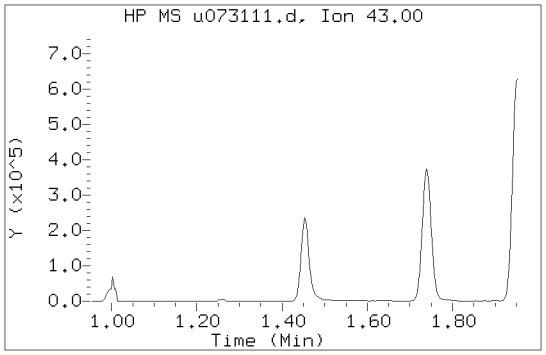
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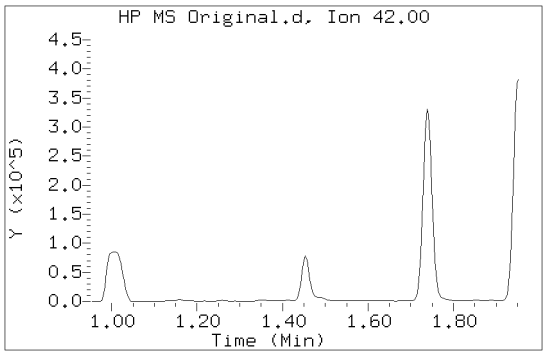
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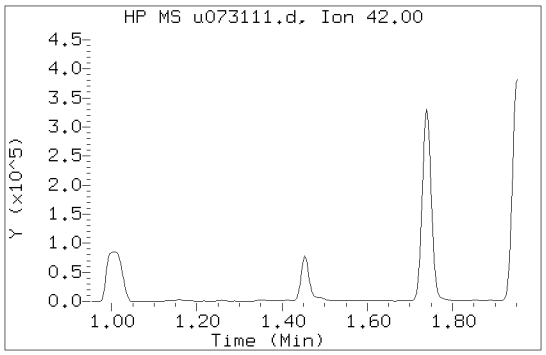
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AFTER

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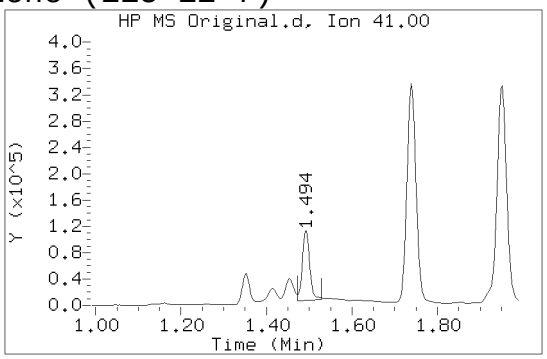


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InstruID : VOA9.i
LabSampID : VSTD200

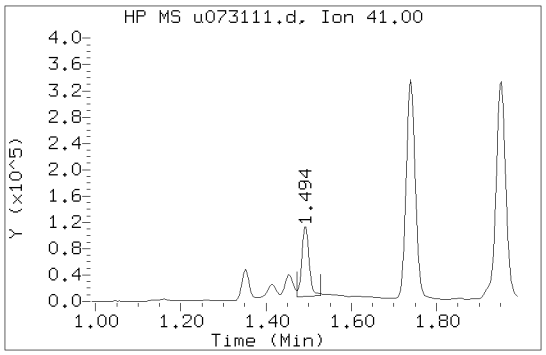
Isobutylene (115-11-7)

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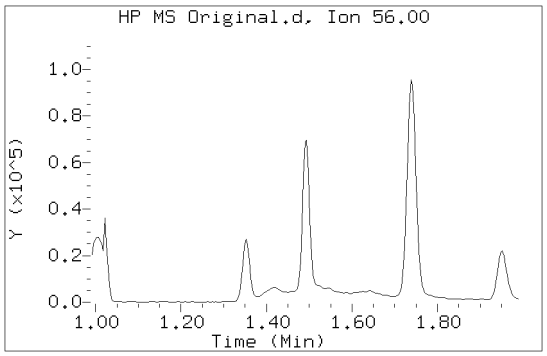
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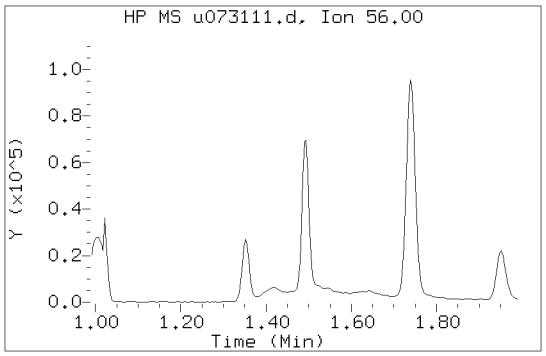
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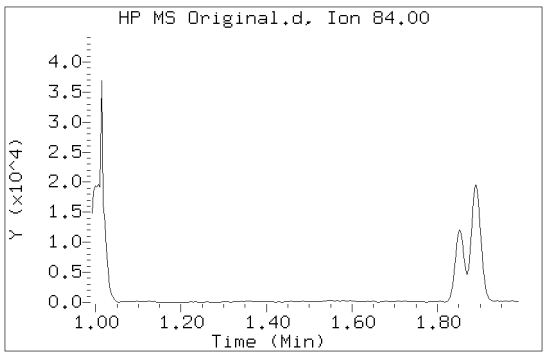
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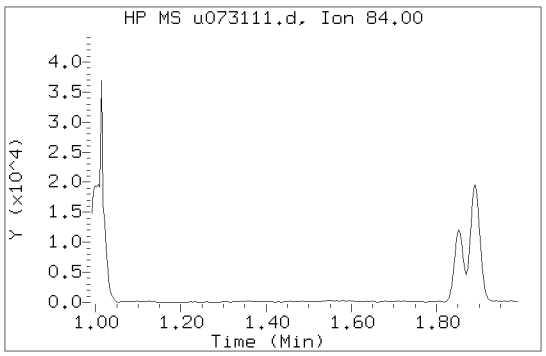
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BEFORE
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01-Aug-2023
21:04



AFTER
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AREA
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HEIGHT
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01-Aug-2023
21:04



Data File: \\NAHSTWS005\Target\chem\voa9.i\U230731.b\U073113.D Page 1
Report Date: 07-Aug-2023 11:14

ALS Laboratory Group

Data file : \\NAHSTWS005\Target\chem\voa9.i\U230731.b\U073113.D
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Inj Date : 31-JUL-2023 15:57
Operator : PC Inst ID: VOA9.i
Smp Info : CCV;CCV;2;;;ICV
Misc Info : V9;WATER;0;1;
Comment :
Method : \\NAHSTWS005\Target\chem\voa9.i\U230731.b\8260C.m
Meth Date : 07-Aug-2023 11:14 VOA9.i Quant Type: ISTD
Cal Date : 31-JUL-2023 15:13 Cal File: U073111.D
Als bottle: 14 QC Sample: METHSPIKE
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 08260V9.sub
Target Version: 4.14
Processing Host: NAHSTW7056

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	FINAL (ug/l)
* 1	Pentafluorobenzene	168	4.811	4.811	(1.000)	586872	50.0000	
2	Dichlorodifluoromethane	85	1.156	1.156	(0.240)	231901	41.5004	41.50
3	Chloromethane	50	1.291	1.291	(0.268)	308539	44.7605	44.76
5	Vinyl Chloride	62	1.370	1.370	(0.285)	254476	44.0407	44.04
6	Bromomethane	94	1.614	1.599	(0.335)	166237	53.4715	53.47
7	Chloroethane	64	1.693	1.685	(0.352)	158516	43.5644	43.56
8	Trichlorofluoromethane	101	1.887	1.891	(0.392)	298086	41.7982	41.79
9	Acrolein	56	1.741	1.738	(0.362)	30707	81.5725	81.57
10	Acetone	43	2.405	2.405	(0.500)	189178	103.249	103.24
11	1,1-Dichloroethene	96	2.326	2.326	(0.483)	171838	44.4419	44.44
15	Iodomethane	142	2.461	2.461	(0.512)	331402	89.7712	89.77
16	Acrylonitrile	53	3.061	3.061	(0.636)	173385	93.9898	93.98
17	Methylene Chloride	84	2.787	2.787	(0.579)	218974	46.6075	46.60
18	Methyl tert-butyl ether	73	3.076	3.076	(0.639)	564440	47.2299	47.22
19	Carbon Disulfide	76	2.514	2.514	(0.522)	1032983	91.7693	91.76
20	trans-1,2-Dichloroethene	96	3.050	3.053	(0.634)	190107	43.8748	43.87
21	Vinyl Acetate	43	3.601	3.604	(0.748)	1202045	96.9359	96.93
22	1,1-Dichloroethane	63	3.507	3.511	(0.729)	335609	42.3758	42.37
24	2-Butanone	43	4.264	4.264	(0.886)	205343	89.0635	89.06
26	2,2-Dichloropropane	77	4.174	4.178	(0.868)	254593	46.6233	46.62

27 cis-1,2-Dichloroethene	96	4.189	4.193 (0.871)	219638	45.4114	45.41
28 Chloroform	83	4.568	4.572 (0.949)	393581	42.7038	42.70

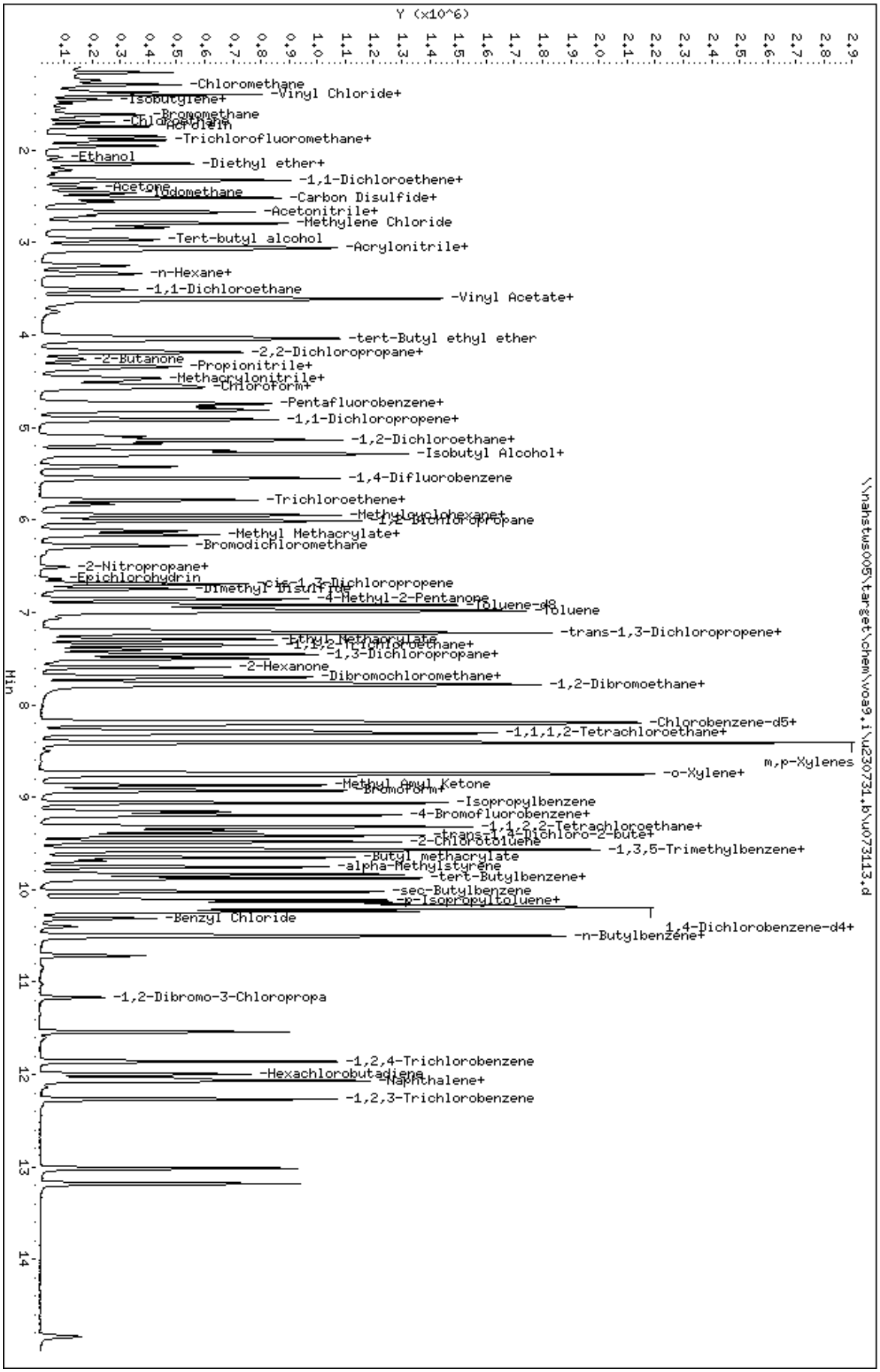
	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	FINAL (ug/l)
	29 Bromochloromethane	128	4.463	4.467	(0.928)	121210	42.3518	42.35
$	30 Dibromofluoromethane	113	4.744	4.748	(0.986)	228111	48.5703	48.57
	31 1,1,1-Trichloroethane	97	4.736	4.740	(0.984)	302944	42.2492	42.24
	32 1,1-Dichloropropene	75	4.916	4.916	(0.886)	276559	44.9086	44.90
	33 1,2-Dichloroethane	62	5.175	5.175	(0.932)	321433	45.0067	45.00
	34 Carbon Tetrachloride	117	4.905	4.909	(0.884)	228059	41.3385	41.33
$	35 1,2-Dichloroethane-d4	65	5.093	5.096	(1.058)	244458	47.7631	47.76
*	36 1,4-Difluorobenzene	114	5.550	5.550	(1.000)	829346	50.0000	
	37 Benzene	78	5.134	5.138	(0.925)	911920	45.0133	45.01
	38 Trichloroethene	130	5.786	5.786	(1.043)	254593	44.4633	44.46
	39 Bromodichloromethane	83	6.277	6.277	(1.131)	293437	45.2876	45.28
	41 2-Chloroethylvinyl ether	63	6.562	6.577	(1.182)	7925	84.0686	84.06(M)
	42 1,2-Dichloropropane	63	6.007	6.011	(1.082)	246953	45.4824	45.48
	44 Dibromomethane	93	6.116	6.120	(1.102)	158311	45.3943	45.39
	45 4-Methyl-2-Pentanone	43	6.855	6.858	(0.837)	567410	98.8517	98.85
	46 cis-1,3-Dichloropropene	75	6.690	6.693	(1.205)	370428	45.0728	45.07
*	47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	771437	50.0000	
$	48 Toluene-d8	98	6.922	6.922	(0.846)	907991	50.6041	50.60
	50 Toluene	91	6.978	6.982	(0.853)	989176	47.1624	47.16
	51 trans-1,3-Dichloropropene	75	7.196	7.196	(1.296)	312150	49.9815	49.98
	52 2-Hexanone	43	7.593	7.593	(0.928)	383453	100.884	100.88
	53 1,1,2-Trichloroethane	83	7.353	7.357	(0.898)	199841	44.4867	44.48
	54 1,3-Dichloropropane	76	7.499	7.499	(0.916)	419694	45.5457	45.54
	55 Dibromochloromethane	129	7.690	7.694	(0.940)	269696	48.9216	48.92
	56 Tetrachloroethene	164	7.454	7.458	(0.911)	221025	43.3447	43.34
	57 1,2-Dibromoethane	107	7.784	7.784	(0.951)	252062	46.6438	46.64
	58 1-Chlorohexane	55	8.197	8.197	(1.477)	175594	40.5459	40.54
	59 Chlorobenzene	112	8.208	8.212	(1.003)	678750	45.6510	45.65
	60 1,1,1,2-Tetrachloroethane	131	8.283	8.286	(1.012)	244784	45.1713	45.17
	61 Ethylbenzene	106	8.305	8.309	(1.015)	316080	46.9589	46.95
	62 m,p-Xylenes	106	8.406	8.410	(1.027)	793036	100.359	100.35
	63 o-Xylene	106	8.748	8.748	(1.069)	389527	50.3885	50.38
	64 Styrene	104	8.763	8.763	(1.071)	640797	53.1212	53.12
	66 Bromoform	173	8.920	8.920	(1.090)	188437	48.9270	48.92
	67 Isopropylbenzene	105	9.062	9.062	(1.107)	898452	48.0303	48.03
	68 1,1,2,2-Tetrachloroethane	83	9.329	9.329	(0.917)	342233	43.4452	43.44
$	69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	354282	50.6059	50.60
*	70 1,4-Dichlorobenzene-d4	152	10.172	10.172	(1.000)	408967	50.0000	
	71 1,2,3-Trichloropropane	75	9.362	9.366	(0.920)	325886	47.5154	47.51
	73 n-Propylbenzene	91	9.411	9.411	(0.925)	982839	42.9466	42.94
	74 Bromobenzene	156	9.317	9.317	(0.916)	307453	45.4426	45.44
	75 1,3,5-Trimethylbenzene	105	9.561	9.561	(0.940)	685273	47.9461	47.94
	76 2-Chlorotoluene	91	9.482	9.482	(0.932)	657409	45.5958	45.59
	77 4-Chlorotoluene	91	9.576	9.576	(0.941)	756542	46.9757	46.97
	78 tert-Butylbenzene	119	9.838	9.838	(0.967)	612686	45.2488	45.24
	79 1,2,4-Trimethylbenzene	105	9.876	9.880	(0.971)	716435	49.5002	49.50
	81 sec-Butylbenzene	105	10.022	10.022	(0.985)	795064	51.0573	51.05
	82 p-Isopropyltoluene	119	10.146	10.146	(0.997)	684325	53.0116	53.01
	83 1,3-Dichlorobenzene	146	10.116	10.116	(0.994)	503873	44.6211	44.62
	84 1,4-Dichlorobenzene	146	10.191	10.191	(1.002)	525749	42.0142	42.01
	87 n-Butylbenzene	91	10.491	10.491	(1.031)	575686	42.1612	42.16
	88 1,2-Dichlorobenzene	146	10.506	10.506	(1.033)	502953	43.4107	43.41

89	1,2-Dibromo-3-Chloropropane	155	11.169	11.165 (1.098)	51032	44.9334	44.93
90	1,2,4-Trichlorobenzene	180	11.859	11.859 (1.166)	346158	48.5682	48.56

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	CONCENTRATIONS FINAL (ug/l)
	91 Hexachlorobutadiene	225	11.998	11.998	(1.179)	148428	55.9981	55.99
	92 Naphthalene	128	12.065	12.065	(1.186)	841153	44.8549	44.85
	93 1,2,3-Trichlorobenzene	180	12.268	12.268	(1.206)	334790	46.0110	46.01
M	94 1,2-Dichloroethylene (total)	96				409745	89.2862	89.28
M	95 Xylenes (total)	106				1182563	150.748	150.74
	135 1,4-Dioxane	88	6.168	6.168	(1.282)	67615	803.552	803.55
	141 Cyclohexane	56	4.778	4.778	(0.993)	283626	42.9988	42.99
	138 Freon TF	101	2.326	2.326	(0.483)	156960	49.8056	49.80
	140 1,3-Butadiene	54	1.396	1.396	(0.290)	209079	44.7426	44.74
	147 Methylcyclohexane	55	5.947	5.947	(1.072)	551131	45.6239	45.62
	146 Methyl Acetate	43	2.708	2.708	(0.563)	179622	42.6545	42.65
	148 Tert-Butyl alcohol	59	2.963	2.971	(0.616)	469230	950.874	950.87
	149 Isopropyl Alcohol	45	2.559	2.566	(0.532)	287541	886.580	886.57

QC Flag Legend

M - Compound response manually integrated.



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Column phase: DB624

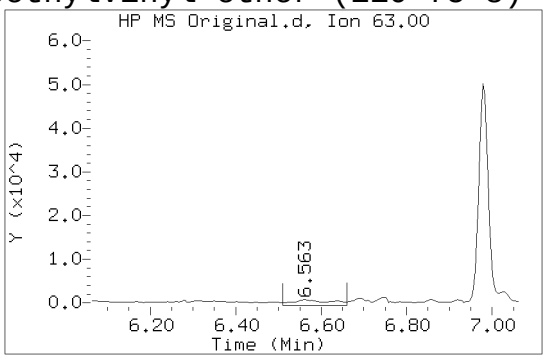
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LabSampID : CCV

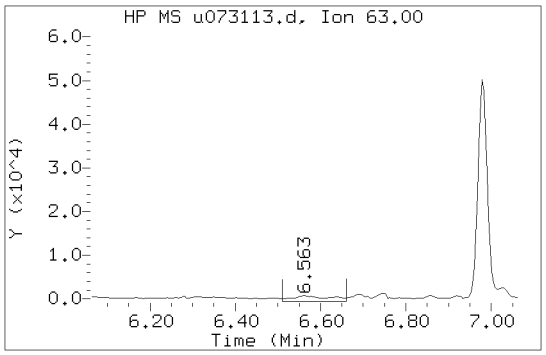
2-Chloroethylvinyl ether (110-75-8)

Reason Code:

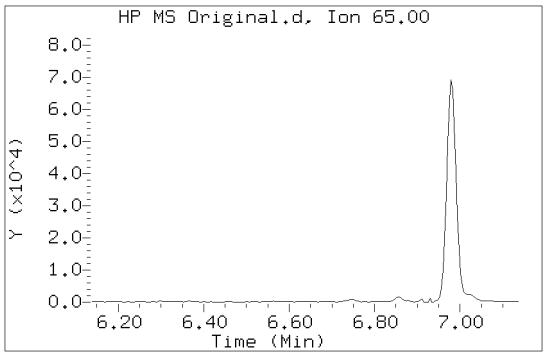
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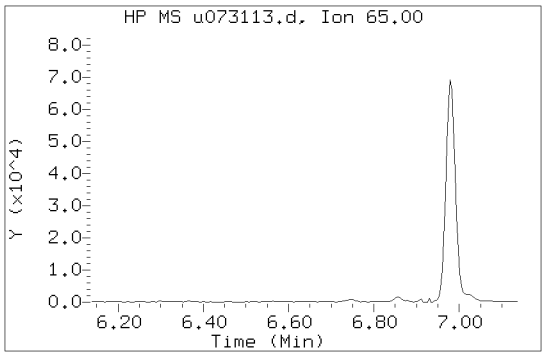
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1298
01-Aug-2023
21:06



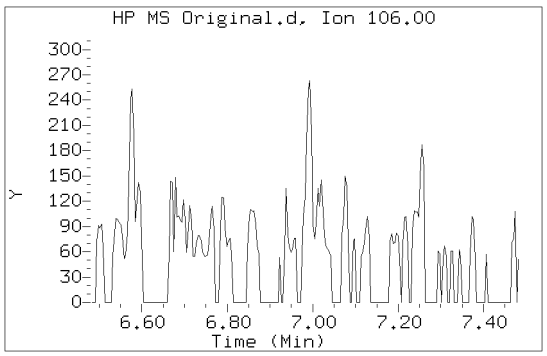
BEFORE
MASS
65
AREA
0
HEIGHT
0
01-Aug-2023
21:06



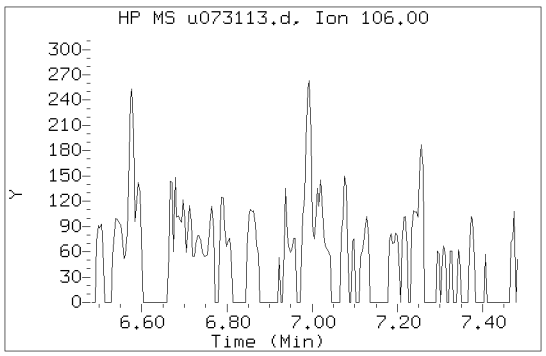
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MASS
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AREA
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HEIGHT
0
01-Aug-2023
21:06



BEFORE
MASS
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AREA
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HEIGHT
0
01-Aug-2023
21:06



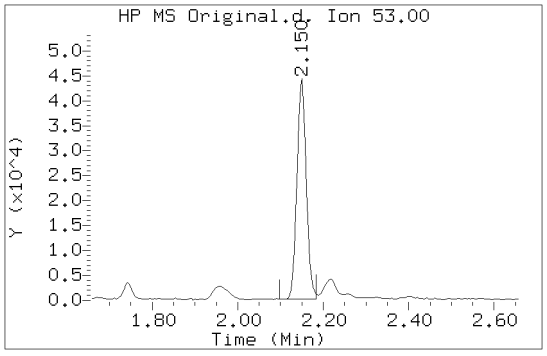
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MASS
106
AREA
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HEIGHT
0
01-Aug-2023
21:06



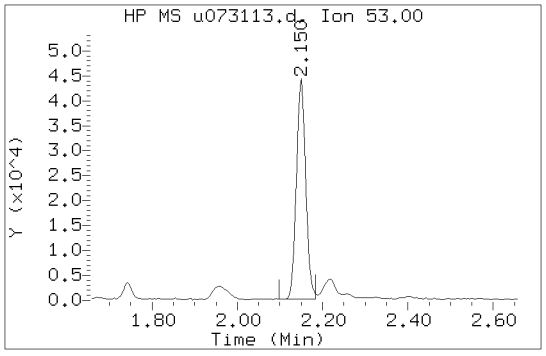
Chloroprene (126-99-8)

Reason Code:

BEFORE
MASS
53
AREA
69058
HEIGHT
44202
01-Aug-2023
21:06



AFTER
MASS
53
AREA
69058
HEIGHT
44202
01-Aug-2023
21:06



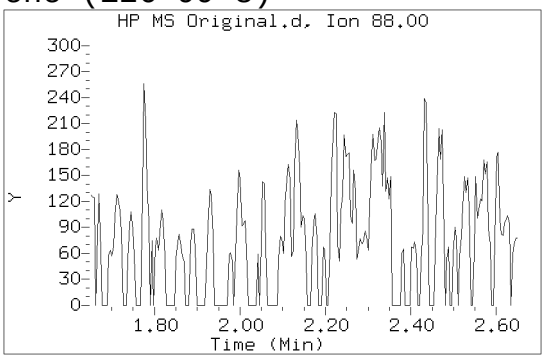
Data File : \\nahstws005\target\chem\voa9.i\u230731.b\u073113.d
Inj Date : 31-JUL-2023 15:57
InstruID : VOA9.i
LabSampID : CCV

Chloroprene (126-99-8)

Reason Code:

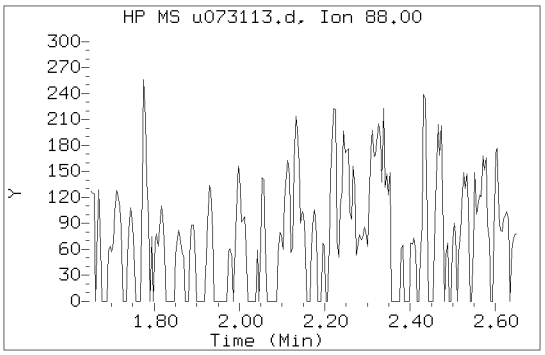
BEFORE

MASS
88
AREA
0
HEIGHT
0
01-Aug-2023
21:06



AFTER

MASS
88
AREA
0
HEIGHT
0
01-Aug-2023
21:06

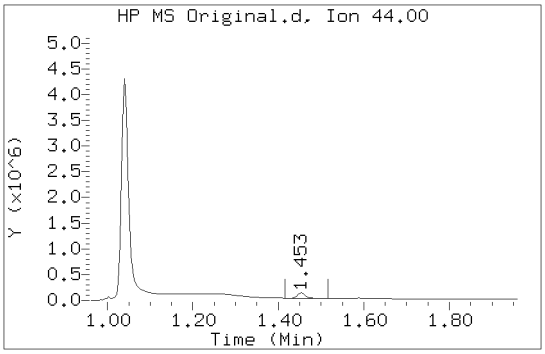


Acetaldehyde (75-07-0)

Reason Code:

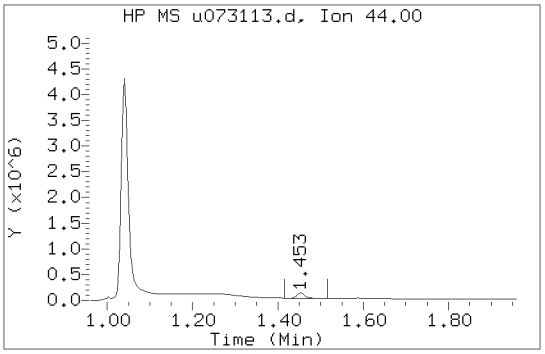
BEFORE

MASS
44
AREA
131239
HEIGHT
109290
01-Aug-2023
21:06



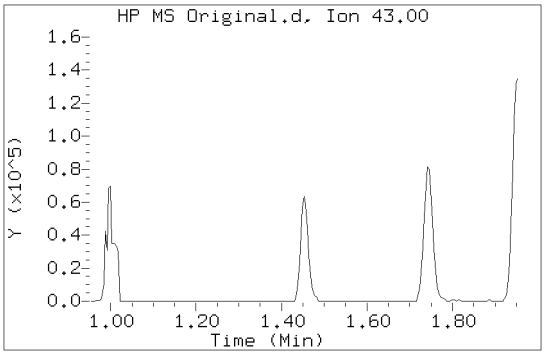
AFTER

MASS
44
AREA
131239
HEIGHT
109290
01-Aug-2023
21:06



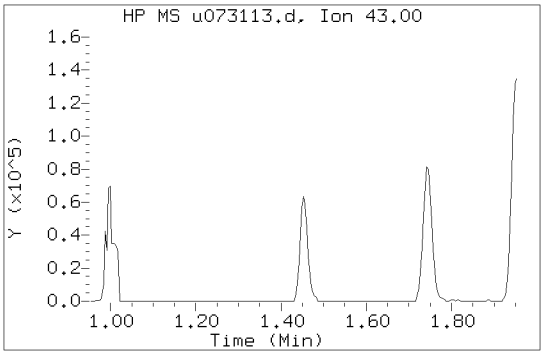
BEFORE

MASS
43
AREA
0
HEIGHT
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01-Aug-2023
21:06



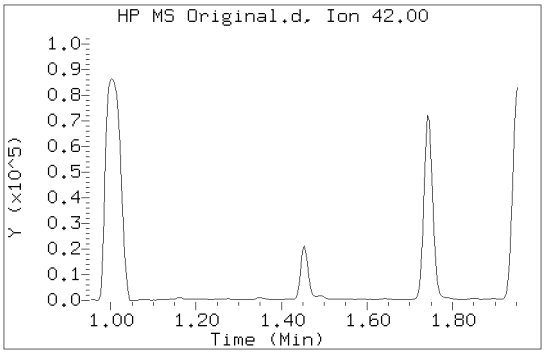
AFTER

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43
AREA
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HEIGHT
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01-Aug-2023
21:06



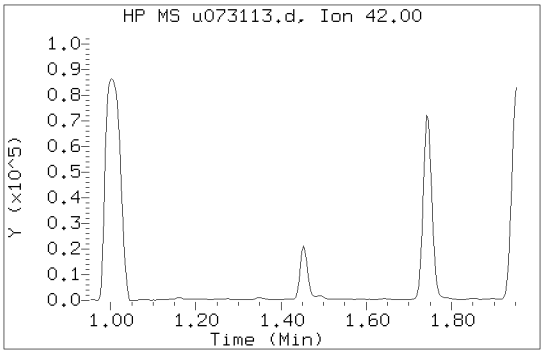
BEFORE

MASS
42
AREA
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HEIGHT
0
01-Aug-2023
21:06



AFTER

MASS
42
AREA
0
HEIGHT
0
01-Aug-2023
21:06

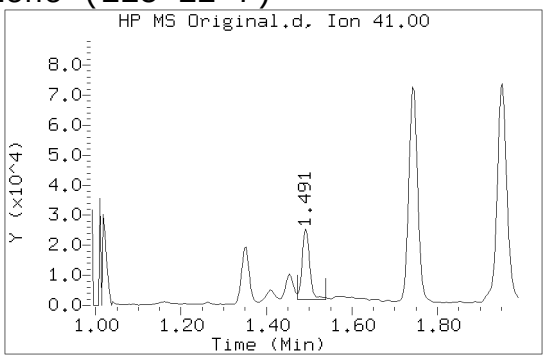


Data File : \\nahstws005\target\chem\voa9.i\u230731.b\u073113.d
Inj Date : 31-JUL-2023 15:57
InstruID : VOA9.i
LabSampID : CCV

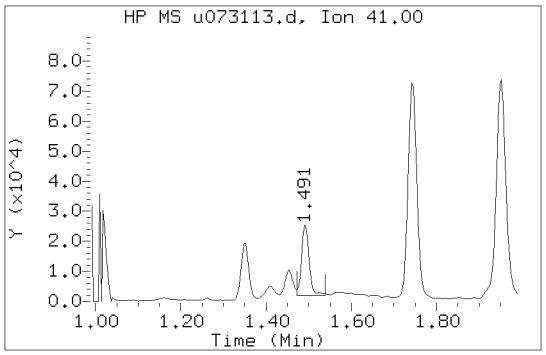
Isobutylene (115-11-7)

Reason Code:

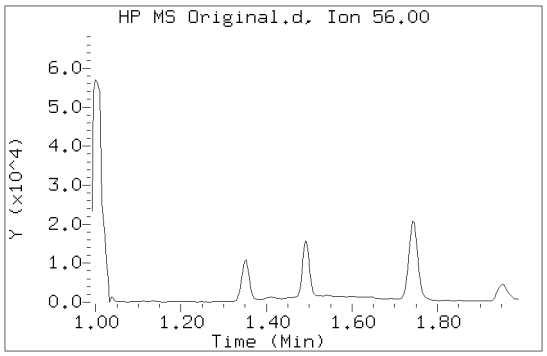
BEFORE
MASS
41
AREA
29878
HEIGHT
23533
01-Aug-2023
21:06



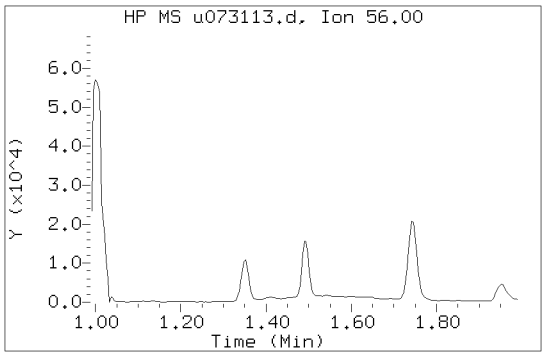
AFTER
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41
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HEIGHT
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01-Aug-2023
21:06



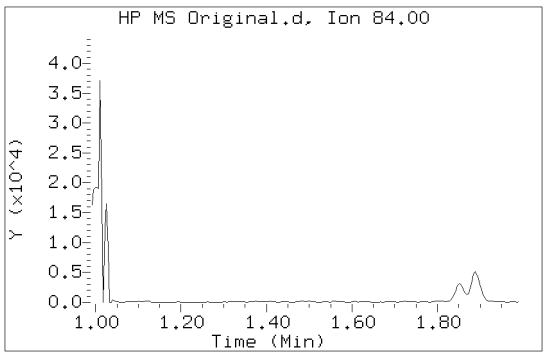
BEFORE
MASS
56
AREA
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HEIGHT
0
01-Aug-2023
21:06



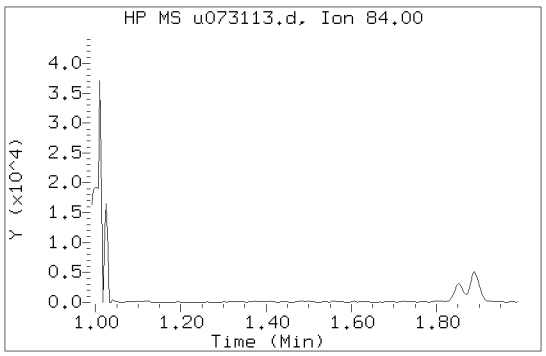
AFTER
MASS
56
AREA
0
HEIGHT
0
01-Aug-2023
21:06



BEFORE
MASS
84
AREA
0
HEIGHT
0
01-Aug-2023
21:06



AFTER
MASS
84
AREA
0
HEIGHT
0
01-Aug-2023
21:06



01226457

right solutions.
right partner.

Raw Data VOA9 443493

Volatiles by EPA 8260

Workorder

HS23080325

Client

Bhate Environmental Associates, Inc.

Project

LHAAP

08/10/2023

ALS Environmental–Houston Laboratory

10450 Stancliff Road, Suite 210, Houston, TX 77099

Phone (281) 530-5656 Fax (281) 530-5887

www.alsglobal.com

Data File: \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080801.D Page 1
Report Date: 08-Aug-2023 11:21

ALS Laboratory Group

Data file : \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080801.D
Lab Smp Id: BFB Client Smp ID: BFB
Inj Date : 08-AUG-2023 10:53
Operator : PC Inst ID: VOA9.i
Smp Info : BFB;BFB;3;;BFB
Misc Info : V9;WATER;0;1;
Comment :
Method : \\NAHSTWS005\Target\chem\voa9.i\U230808.b\bfb.m
Meth Date : 27-Jan-2023 08:08 apoluri Quant Type: ISTD
Cal Date : 30-MAR-2018 18:09 Cal File: U033003.d
Als bottle: 1 QC Sample: BFB
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: all.sub
Target Version: 4.14 Sample Matrix: WATER
Processing Host: NAHSTW7051

Concentration Formula: Amt * DF * Uf * Vf * Vi * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vf	1.000	Volumetric correction factor
Vi	2.000	Injection Volume
Cpnd Variable		Local Compound Variable

					CONCENTRATIONS ON-COL (ug/L)	FINAL (ug/l)		
RT	EXP RT	REL RT	MASS	RESPONSE			TARGET RANGE	RATIO
1 bfb							CAS #: 460-00-4	
9.194	9.180	(0.000)	95	136640			0.00- 100.00	100.00
9.194	9.180	(0.000)	50	24704			15.00- 40.00	18.08
9.194	9.180	(0.000)	75	65640			30.00- 60.00	48.04
9.194	9.180	(0.000)	96	9195			5.00- 9.00	6.73
9.194	9.180	(0.000)	173	0	0.0	0.0	0.00- 2.00	0.00
9.194	9.180	(0.000)	174	127808			50.00- 0.00	93.54
9.194	9.180	(0.000)	175	11209			5.00- 9.00	8.77
9.194	9.180	(0.000)	176	123744			95.00- 101.00	96.82
9.194	9.180	(0.000)	177	8581			5.00- 9.00	6.93

m/e	ION ABUNDANCE CRITERIA	% RELATIVE ABUNDANCE
95	Base Peak, 100% relative abundance	100.00
50	15.00 - 40.00% of mass 95	18.08
75	30.00 - 60.00% of mass 95	48.04
96	5.00 - 9.00% of mass 95	6.73
173	Less than 2.00% of mass 174	0.00 (0.00)
174	Greater than 50.00% of mass 95	93.54
175	5.00 - 9.00% of mass 174	8.20 (8.77)
176	95.00 - 101.00% of mass 174	90.56 (96.82)
177	5.00 - 9.00% of mass 176	6.28 (6.93)

Data File: U080801.D
Spectrum: Scan 2293 (9.19)
Location of Maximum: 95.05
Number of points: 132

m/z	Y	m/z	Y	m/z	Y	m/z	Y
36.10	1297	69.00	13436	109.70	102	145.90	208
37.00	6640	70.00	1324	110.60	135	146.90	121
38.00	5911	71.00	177	111.30	50	147.70	406
39.00	2399	72.10	917	112.00	51	148.80	116
39.90	406	73.00	5982	112.80	178	149.90	161
41.00	211	74.00	22224	114.90	181	151.80	83
41.70	120	75.00	65640	115.80	472	152.80	143
42.20	91	76.00	6293	116.90	943	153.90	160
43.00	187	77.10	1001	117.80	392	154.90	412
44.00	1188	77.80	717	118.70	618	156.80	263
44.90	1044	78.90	3119	120.00	70	157.70	63
45.80	194	80.00	1096	121.60	103	158.70	182
47.00	2147	80.90	3127	122.70	62	160.30	58
47.90	945	81.90	792	123.90	129	161.00	279
49.00	5564	82.80	106	126.10	80	161.40	52
50.00	24704	83.30	58	126.80	79	164.30	81
51.00	7510	84.00	97	127.80	665	165.10	59
52.00	525	86.90	6070	129.00	313	167.00	53
52.90	157	87.90	5262	129.80	665	168.00	74
53.60	91	89.30	116	131.00	172	170.00	140
54.20	116	91.00	555	132.00	75	171.00	262
55.10	524	92.00	3557	132.60	69	171.90	1209
56.00	1912	93.00	6147	134.00	62	173.90	127808
57.00	3528	94.00	16672	134.70	263	175.00	11209
58.00	188	95.00	136640	135.10	185	175.90	123744
58.80	92	96.00	9195	136.90	279	176.90	8581
60.00	1267	96.90	311	138.10	58	178.00	188
61.00	6086	97.90	83	138.50	78	207.00	66
62.00	6426	101.50	71	138.90	157	273.40	55
63.00	4439	102.10	76	141.00	1416	316.80	58
63.90	674	104.00	479	141.90	230		
65.00	603	105.10	239	142.90	1747		
66.90	347	106.00	552	143.80	77		
68.00	13180	106.80	223	145.10	253		

Data File: \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080801.D Page 1

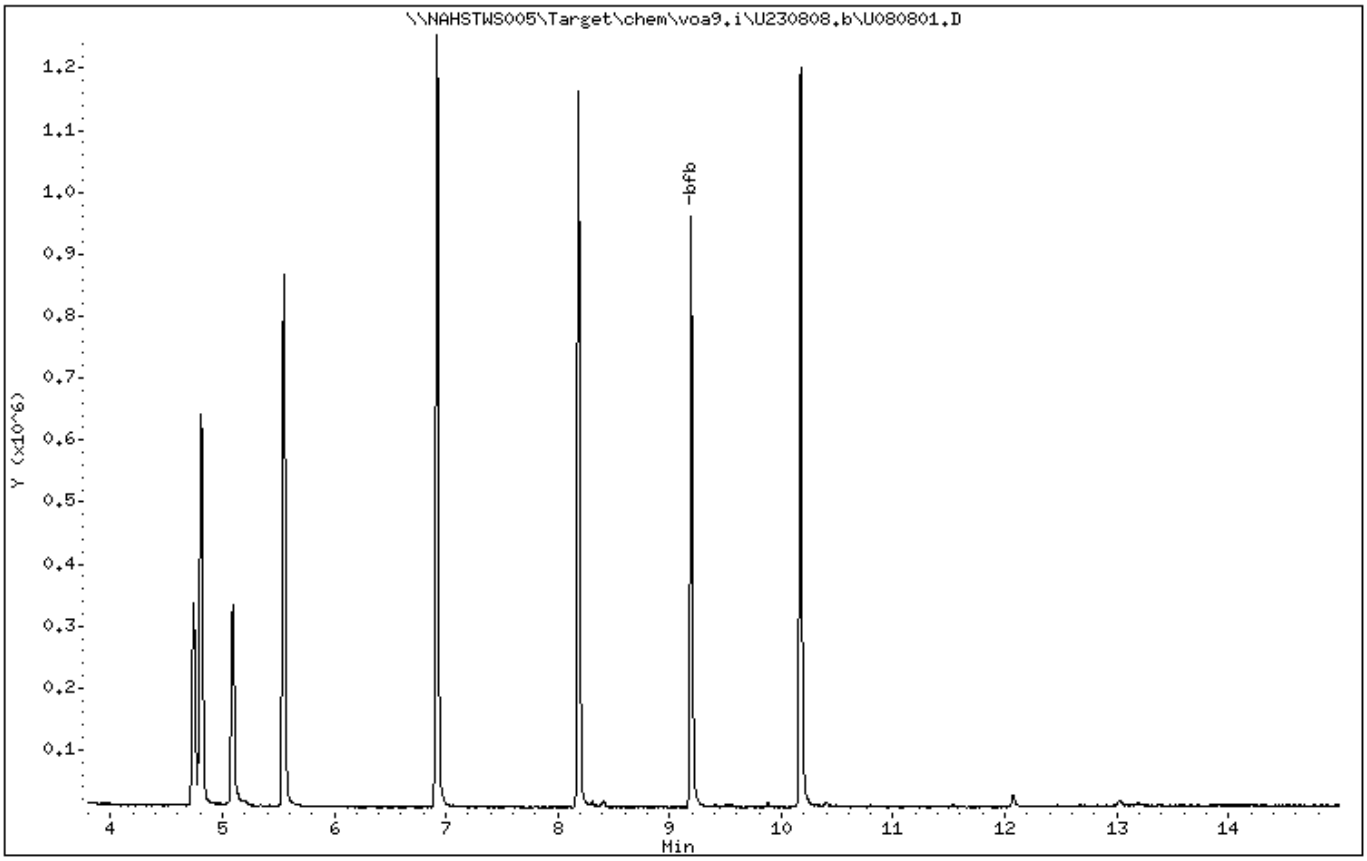
Date : 08-AUG-2023 10:53

Client ID: BFB Instrument: VOA9.i

Sample Info: BFB;BFB;3;;BFB

Volume Injected (uL): 2.0 Operator: PC

Column phase: DB624 Column diameter: 0.25



Data File: \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080801.D Page 2

Date : 08-AUG-2023 10:53

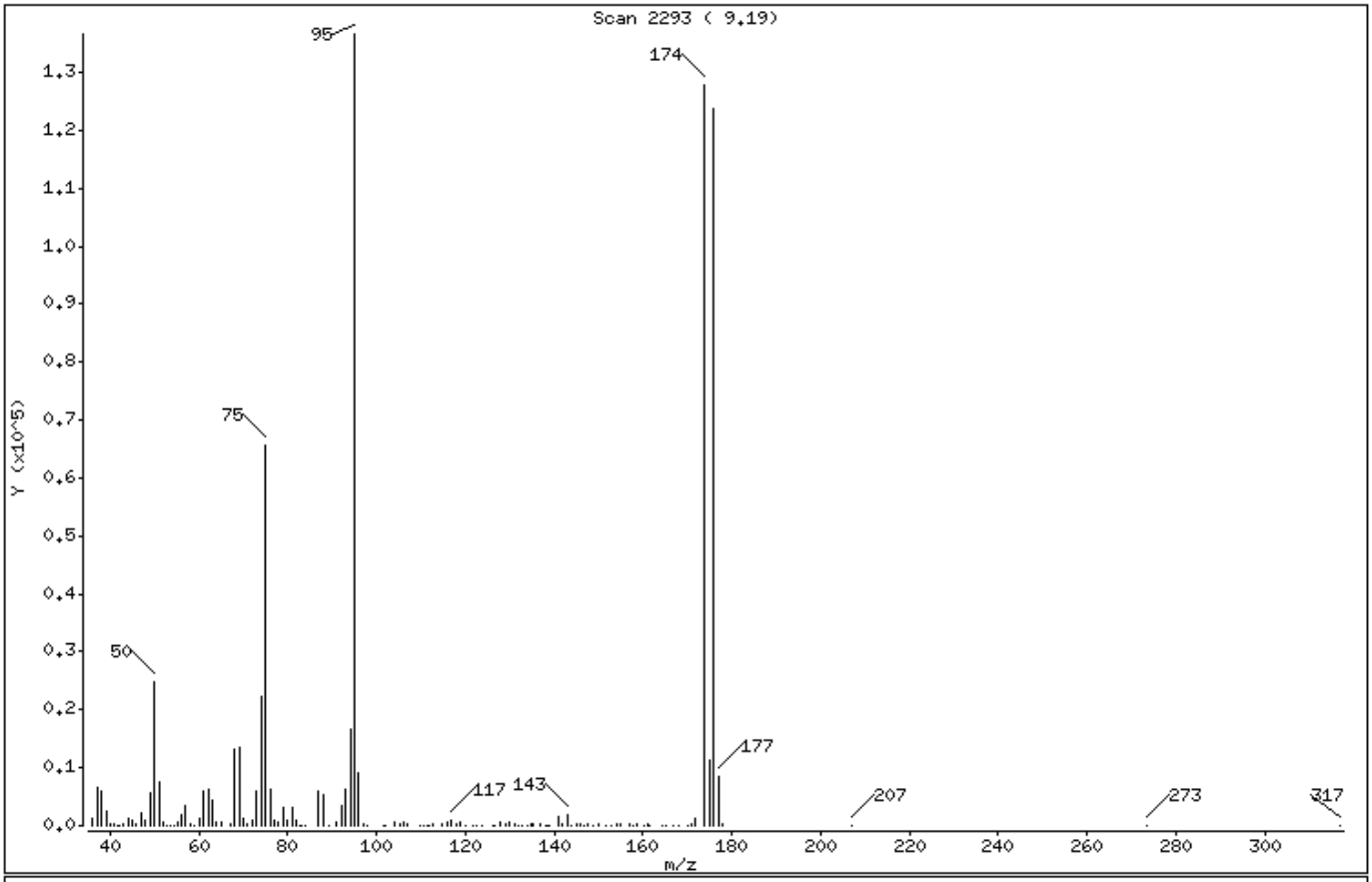
Client ID: BFB Instrument: VOA9.i

Sample Info: BFB;BFB;3;;BFB

Volume Injected (uL): 2.0 Operator: PC

Column phase: DB624 Column diameter: 0.25

1 bfb



m/e	ION ABUNDANCE CRITERIA	% RELATIVE ABUNDANCE
95	Base Peak, 100% relative abundance	100.00
50	15.00 - 40.00% of mass 95	18.08
75	30.00 - 60.00% of mass 95	48.04
96	5.00 - 9.00% of mass 95	6.73
173	Less than 2.00% of mass 174	0.00 (0.00)
174	Greater than 50.00% of mass 95	93.54
175	5.00 - 9.00% of mass 174	8.20 (8.77)
176	95.00 - 101.00% of mass 174	90.56 (96.82)
177	5.00 - 9.00% of mass 176	6.28 (6.93)

Data File: \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080801.D Page 3

Date : 08-AUG-2023 10:53

Client ID: BFB Instrument: VOA9.i

Sample Info: BFB;BFB;3;;BFB

Volume Injected (uL): 2.0 Operator: PC

Column phase: DB624 Column diameter: 0.25

Data File: U080801.D
Spectrum: Scan 2293 (9.19)
Location of Maximum: 95.05
Number of points: 132

m/z	Y	m/z	Y	m/z	Y	m/z	Y
36.10	1297	69.00	13436	109.70	102	145.90	208
37.00	6640	70.00	1324	110.60	135	146.90	121
38.00	5911	71.00	177	111.30	50	147.70	406
39.00	2399	72.10	917	112.00	51	148.80	116
39.90	406	73.00	5982	112.80	178	149.90	161
41.00	211	74.00	22224	114.90	181	151.80	83
41.70	120	75.00	65640	115.80	472	152.80	143
42.20	91	76.00	6293	116.90	943	153.90	160
43.00	187	77.10	1001	117.80	392	154.90	412
44.00	1188	77.80	717	118.70	618	156.80	263
44.90	1044	78.90	3119	120.00	70	157.70	63
45.80	194	80.00	1096	121.60	103	158.70	182
47.00	2147	80.90	3127	122.70	62	160.30	58
47.90	945	81.90	792	123.90	129	161.00	279
49.00	5564	82.80	106	126.10	80	161.40	52
50.00	24704	83.30	58	126.80	79	164.30	81
51.00	7510	84.00	97	127.80	665	165.10	59
52.00	525	86.90	6070	129.00	313	167.00	53
52.90	157	87.90	5262	129.80	665	168.00	74
53.60	91	89.30	116	131.00	172	170.00	140
54.20	116	91.00	555	132.00	75	171.00	262
55.10	524	92.00	3557	132.60	69	171.90	1209
56.00	1912	93.00	6147	134.00	62	173.90	127808
57.00	3528	94.00	16672	134.70	263	175.00	11209
58.00	188	95.00	136640	135.10	185	175.90	123744
58.80	92	96.00	9195	136.90	279	176.90	8581
60.00	1267	96.90	311	138.10	58	178.00	188
61.00	6086	97.90	83	138.50	78	207.00	66
62.00	6426	101.50	71	138.90	157	273.40	55
63.00	4439	102.10	76	141.00	1416	316.80	58
63.90	674	104.00	479	141.90	230		
65.00	603	105.10	239	142.90	1747		
66.90	347	106.00	552	143.80	77		
68.00	13180	106.80	223	145.10	253		

Data File : \\nahstws005\target\chem\voa9.i\u230808.b\u080801.d
Inj Date : 08-AUG-2023 10:53
InstruID : VOA9.i
LabSampID : BFB

NO MANUAL INTEGRATIONS

ALS Laboratory Group

Data file : \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080803.D
Lab Smp Id: CCV Client Smp ID: CCV
Inj Date : 08-AUG-2023 11:37
Operator : PC Inst ID: VOA9.i
Smp Info : CCV;CCV;2;;;
Misc Info : V9;WATER;0;1;
Comment :
Method : \\nahstws005\Target\chem\voa9.i\U230808.b\8260C.m
Meth Date : 08-Aug-2023 22:23 VOA9.i Quant Type: ISTD
Cal Date : 31-JUL-2023 14:06 Cal File: U073108.D
Als bottle: 2 Continuing Calibration Sample
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 8260_GB.sub
Target Version: 4.14

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
* 1	Pentafluorobenzene	168	4.812	4.812	(1.000)	407824	50.0000	
2	Dichlorodifluoromethane	85	1.157	1.157	(0.240)	155802	50.0000	40.16
3	Chloromethane	50	1.288	1.288	(0.268)	212388	50.0000	44.33
5	Vinyl Chloride	62	1.366	1.366	(0.284)	166495	50.0000	41.46
6	Bromomethane	94	1.610	1.610	(0.335)	107275	50.0000	49.53
7	Chloroethane	64	1.689	1.689	(0.351)	112508	50.0000	44.49
8	Trichlorofluoromethane	101	1.888	1.888	(0.392)	219466	50.0000	44.28
9	Acrolein	56	1.741	1.741	(0.362)	23405	100.000	89.47
10	Acetone	43	2.401	2.401	(0.499)	133934	100.000	105.34
11	1,1-Dichloroethene	96	2.322	2.322	(0.483)	126719	50.0000	47.16
15	Iodomethane	142	2.461	2.461	(0.512)	262330	100.000	101.00
16	Acrylonitrile	53	3.057	3.057	(0.635)	136017	100.000	106.10
17	Methylene Chloride	84	2.787	2.787	(0.579)	163566	50.0000	50.11
18	Methyl tert-butyl ether	73	3.072	3.072	(0.639)	496460	50.0000	59.77
19	Carbon Disulfide	76	2.514	2.514	(0.522)	693273	100.000	88.62
20	trans-1,2-Dichloroethene	96	3.050	3.050	(0.634)	141557	50.0000	47.01
21	Vinyl Acetate	43	3.601	3.601	(0.748)	964867	100.000	111.97
22	1,1-Dichloroethane	63	3.507	3.507	(0.729)	260197	50.0000	47.27
24	2-Butanone	43	4.260	4.260	(0.885)	146222	100.000	91.26
26	2,2-Dichloropropane	77	4.174	4.174	(0.868)	192364	50.0000	50.69
27	cis-1,2-Dichloroethene	96	4.189	4.189	(0.871)	169553	50.0000	50.44

28	Chloroform	83	4.568	4.568 (0.949)	285571	50.0000	44.58
29	Bromochloromethane	128	4.463	4.463 (0.928)	95509	50.0000	48.02

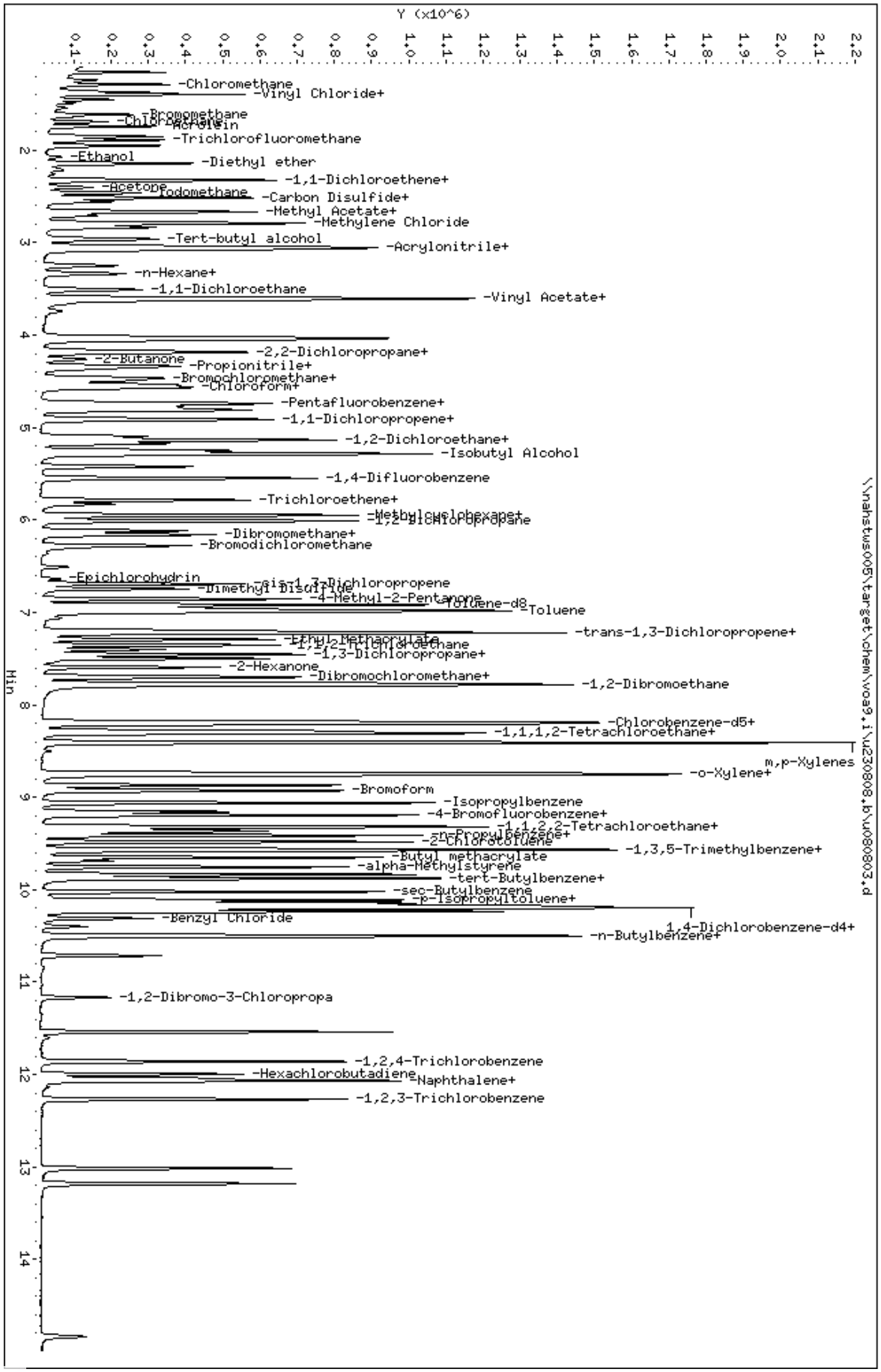
	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
$	30 Dibromofluoromethane	113	4.744	4.744	(0.986)	172773	50.0000	53.02
	31 1,1,1-Trichloroethane	97	4.737	4.737	(0.984)	225977	50.0000	45.35
	32 1,1-Dichloropropene	75	4.916	4.916	(0.886)	201865	50.0000	46.13
	33 1,2-Dichloroethane	62	5.171	5.171	(0.932)	255492	50.0000	50.34
	34 Carbon Tetrachloride	117	4.905	4.905	(0.884)	170272	50.0000	43.43
$	35 1,2-Dichloroethane-d4	65	5.093	5.093	(1.058)	190095	50.0000	53.60
*	36 1,4-Difluorobenzene	114	5.550	5.550	(1.000)	589261	50.0000	
	37 Benzene	78	5.134	5.134	(0.925)	670838	50.0000	46.60
	38 Trichloroethene	130	5.786	5.786	(1.043)	188638	50.0000	46.36
	39 Bromodichloromethane	83	6.277	6.277	(1.131)	222771	50.0000	48.38
	42 1,2-Dichloropropane	63	6.007	6.007	(1.082)	183727	50.0000	47.62
	44 Dibromomethane	93	6.116	6.116	(1.102)	122491	50.0000	49.43
	45 4-Methyl-2-Pentanone	43	6.855	6.855	(0.837)	404854	100.000	96.16
	46 cis-1,3-Dichloropropene	75	6.690	6.690	(1.205)	275516	50.0000	47.07
*	47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	565790	50.0000	
$	48 Toluene-d8	98	6.918	6.918	(0.845)	633817	50.0000	48.16
	50 Toluene	91	6.978	6.978	(0.853)	719334	50.0000	46.76
	51 trans-1,3-Dichloropropene	75	7.196	7.196	(1.296)	230619	50.0000	51.97
	52 2-Hexanone	43	7.593	7.593	(0.928)	268642	100.000	96.36
	53 1,1,2-Trichloroethane	83	7.353	7.353	(0.898)	151880	50.0000	46.09
	54 1,3-Dichloropropane	76	7.499	7.499	(0.916)	316961	50.0000	46.89
	55 Dibromochloromethane	129	7.691	7.691	(0.940)	200784	50.0000	49.65
	56 Tetrachloroethene	164	7.454	7.454	(0.911)	161513	50.0000	43.18
	57 1,2-Dibromoethane	107	7.784	7.784	(0.951)	193456	50.0000	48.81
	58 1-Chlorohexane	55	8.197	8.197	(1.477)	114280	50.0000	37.13
	59 Chlorobenzene	112	8.208	8.208	(1.003)	507773	50.0000	46.56
	60 1,1,1,2-Tetrachloroethane	131	8.283	8.283	(1.012)	183868	50.0000	46.26
	61 Ethylbenzene	106	8.305	8.305	(1.015)	233325	50.0000	47.26
	62 m,p-Xylenes	106	8.407	8.407	(1.027)	600268	100.000	103.57
	63 o-Xylene	106	8.748	8.748	(1.069)	303381	50.0000	53.50
	64 Styrene	104	8.759	8.759	(1.070)	508456	50.0000	57.47
	66 Bromoform	173	8.920	8.920	(1.090)	143328	50.0000	50.74
	67 Isopropylbenzene	105	9.063	9.063	(1.107)	654689	50.0000	47.72
	68 1,1,2,2-Tetrachloroethane	83	9.329	9.329	(0.917)	270379	50.0000	43.12
$	69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	280660	50.0000	54.77
*	70 1,4-Dichlorobenzene-d4	152	10.168	10.168	(1.000)	325510	50.0000	
	71 1,2,3-Trichloropropane	75	9.362	9.362	(0.921)	251567	50.0000	46.08
	73 n-Propylbenzene	91	9.411	9.411	(0.926)	734118	50.0000	40.40
	74 Bromobenzene	156	9.317	9.317	(0.916)	246907	50.0000	45.85
	75 1,3,5-Trimethylbenzene	105	9.561	9.561	(0.940)	536278	50.0000	47.14
	76 2-Chlorotoluene	91	9.482	9.482	(0.933)	506930	50.0000	44.17
	77 4-Chlorotoluene	91	9.576	9.576	(0.942)	585825	50.0000	45.70
	78 tert-Butylbenzene	119	9.835	9.835	(0.967)	464349	50.0000	43.08
	79 1,2,4-Trimethylbenzene	105	9.876	9.876	(0.971)	561506	50.0000	48.74
	81 sec-Butylbenzene	105	10.022	10.022	(0.986)	580938	50.0000	47.45
	82 p-Isopropyltoluene	119	10.146	10.146	(0.998)	525618	50.0000	51.44
	83 1,3-Dichlorobenzene	146	10.116	10.116	(0.995)	397974	50.0000	44.27
	84 1,4-Dichlorobenzene	146	10.191	10.191	(1.002)	423493	50.0000	42.51
	87 n-Butylbenzene	91	10.491	10.491	(1.032)	439268	50.0000	40.51
	88 1,2-Dichlorobenzene	146	10.506	10.506	(1.033)	407799	50.0000	44.22
	89 1,2-Dibromo-3-Chloropropane	155	11.166	11.166	(1.098)	42417	50.0000	46.92
	90 1,2,4-Trichlorobenzene	180	11.859	11.859	(1.166)	271738	50.0000	47.90

91 Hexachlorobutadiene	225	11.998	11.998 (1.180)	110466	50.0000	52.95
92 Naphthalene	128	12.065	12.065 (1.187)	690647	50.0000	46.22

		QUANT SIG					AMOUNTS	
	Compounds	MASS	RT	EXP RT	REL RT	RESPONSE	CAL-AMT (ug/l)	ON-COL (ug/l)
	93 1,2,3-Trichlorobenzene	180	12.268	12.268	(1.206)	267942	50.0000	46.26
M	94 1,2-Dichloroethylene (total)	96				311110	100.000	97.45
M	95 Xylenes (total)	106				903649	150.000	157.08
	135 1,4-Dioxane	88	6.169	6.169	(1.282)	51506	1000.00	880.84
	141 Cyclohexane	56	4.778	4.778	(0.993)	168410	50.0000	36.74
	138 Freon TF	101	2.326	2.326	(0.484)	103322	50.0000	47.50
	140 1,3-Butadiene	54	1.393	1.393	(0.290)	142538	50.0000	43.89
	147 Methylcyclohexane	55	5.944	5.944	(1.071)	427993	50.0000	49.86
	146 Methyl Acetate	43	2.705	2.705	(0.562)	142322	50.0000	48.63
	148 Tert-Butyl alcohol	59	2.960	2.960	(0.615)	351217	1000.00	1024.43
	149 Isopropyl Alcohol	45	2.555	2.555	(0.531)	212736	1000.00	943.90
	72 trans-1,4-Dichloro-2-butene	53	9.377	9.377	(1.146)	40839	50.0000	53.37
	12 Isobutyl Alcohol	43	5.284	5.284	(1.098)	592191	1000.00	1025.22
	13 Acetonitrile	39	2.664	2.664	(0.554)	191210	500.000	507.56
	14 Allyl Chloride	41	2.664	2.664	(0.554)	423180	50.0000	49.18
	25 Methacrylonitrile	41	4.489	4.489	(0.933)	112687	50.0000	49.20
	40 Methyl Methacrylate	41	6.154	6.154	(1.279)	182345	50.0000	51.74
	4 Propionitrile	54	4.332	4.332	(0.900)	251090	500.000	518.60
	131 Methyl Acrylate	55	4.362	4.362	(0.907)	198553	50.0000	50.89
	182 Epichlorohydrin	57	6.633	6.633	(1.195)	9456	200.000	260.93(M)

QC Flag Legend

M - Compound response manually integrated.



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Sample Info: CCV:CCV:2:::
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Column phase: DB624

Instrument: VOA9.i
Operator: PC
Column diameter: 0.18

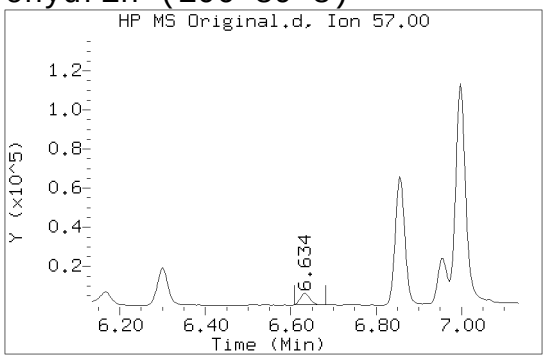
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InstruID : VOA9.i
LabSampID : CCV

Epichlorohydrin (106-89-8)

Reason Code:

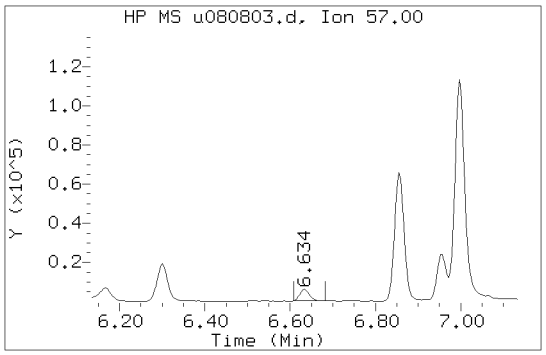
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22:26



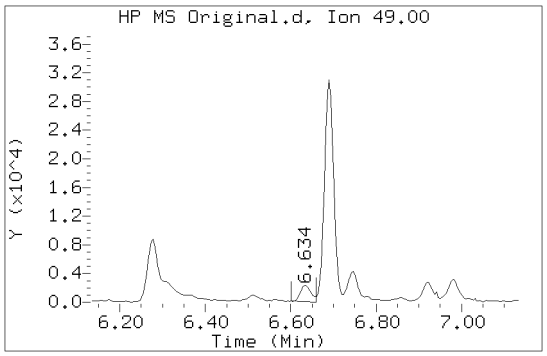
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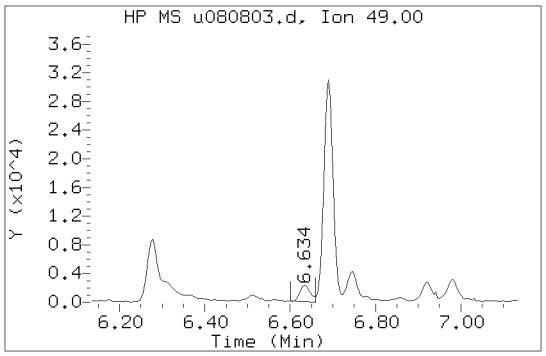
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08-Aug-2023
22:26



AFTER

MASS
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HEIGHT
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08-Aug-2023
22:26



Data File: \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080804.D Page 1
Report Date: 08-Aug-2023 22:27

ALS Laboratory Group

Data file : \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080804.D
Lab Smp Id: CCB Client Smp ID: CCB
Inj Date : 08-AUG-2023 12:00
Operator : PC Inst ID: VOA9.i
Smp Info : CCB;CCB;;;
Misc Info : V9;WATER;0;1;
Comment   :
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Meth Date : 08-Aug-2023 22:23 VOA9.i Quant Type: ISTD
Cal Date : 31-JUL-2023 14:06 Cal File: U073108.D
Als bottle: 3
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 8260_GB.sub
Target Version: 4.14
Processing Host: NAHSTWS005

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	FINAL (ug/l)
* 1 Pentafluorobenzene	168	4.815	4.812	(1.000)	463774	50.0000	
$ 30 Dibromofluoromethane	113	4.748	4.744	(0.986)	186262	50.2195	50.21
$ 35 1,2-Dichloroethane-d4	65	5.100	5.093	(1.059)	222714	55.2691	55.26
* 36 1,4-Difluorobenzene	114	5.554	5.550	(1.000)	623952	50.0000	
* 47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	560023	50.0000	
$ 48 Toluene-d8	98	6.922	6.918	(0.846)	687504	52.7806	52.78
$ 69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	250043	49.1610	49.16
* 70 1,4-Dichlorobenzene-d4	152	10.172	10.168	(1.000)	305007	50.0000	

01226473

Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080804.d

Page 1

Date : 08-AUG-2023 12:00

Client ID: CCB

Instrument: VOA9.i

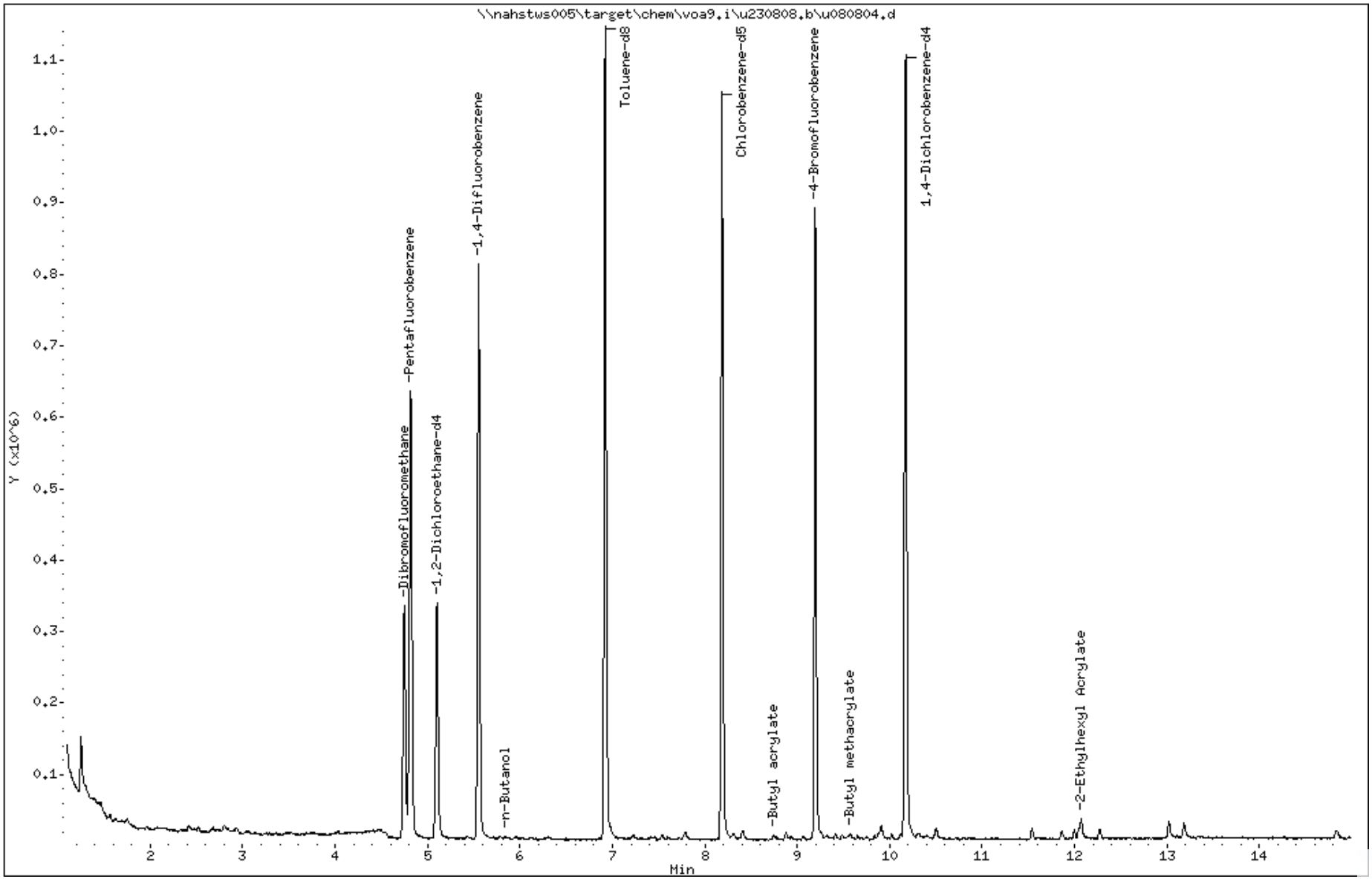
Sample Info: CCB;CCB;;;

Purge Volume: 5.0

Operator: PC

Column phase: DB624

Column diameter: 0.18



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Inj Date : 08-AUG-2023 12:00
InstruID : VOA9.i
LabSampID : CCB

NO MANUAL INTEGRATIONS

Data File: \\nahstws005\Target\chem\voa9.i\U230808.b\U080805.D Page 1
Report Date: 08-Aug-2023 12:38

ALS Laboratory Group

Data file : \\nahstws005\Target\chem\voa9.i\U230808.b\U080805.D
Lab Smp Id: VLCSW-230808 Client Smp ID: VLCSW-230808
Inj Date : 08-AUG-2023 12:22
Operator : PC Inst ID: VOA9.i
Smp Info : VLCSW-230808;VLCSW-230808;3;;LCS
Misc Info : V9;WATER;0;1;
Comment   :
Method   : \\nahstws005\Target\chem\voa9.i\U230808.b\8260C.m
Meth Date : 08-Aug-2023 11:53 pcabasca Quant Type: ISTD
Cal Date : 31-JUL-2023 14:06 Cal File: U073108.D
Als bottle: 4 QC Sample: LCS
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 8260_GB.sub
Target Version: 4.14
Processing Host: NAHSTWS005

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	FINAL (ug/l)
* 1 Pentafluorobenzene	168	4.815	4.812	(1.000)	430680	50.0000	
2 Dichlorodifluoromethane	85	1.160	1.157	(0.241)	69536	17.7004	17.70
3 Chloromethane	50	1.295	1.288	(0.269)	91845	17.9500	17.95
5 Vinyl Chloride	62	1.374	1.366	(0.285)	73053	17.2280	17.22
6 Bromomethane	94	1.617	1.610	(0.336)	49243	20.6051	20.60
7 Chloroethane	64	1.696	1.689	(0.352)	49210	18.4290	18.42
8 Trichlorofluoromethane	101	1.891	1.888	(0.393)	99412	18.9952	18.99
9 Acrolein	56	1.745	1.741	(0.362)	7839	28.3763	28.37
10 Acetone	43	2.405	2.401	(0.499)	61104	40.8665	40.86
11 1,1-Dichloroethene	96	2.330	2.322	(0.484)	56224	19.8146	19.81
15 Iodomethane	142	2.465	2.461	(0.512)	101953	40.8077	40.80
16 Acrylonitrile	53	3.064	3.057	(0.636)	53505	39.5232	39.52
17 Methylene Chloride	84	2.791	2.787	(0.580)	69286	19.9845	19.98
18 Methyl tert-butyl ether	73	3.079	3.072	(0.640)	189653	21.6246	21.62
19 Carbon Disulfide	76	2.517	2.514	(0.523)	296363	35.8771	35.87
20 trans-1,2-Dichloroethene	96	3.057	3.050	(0.635)	61072	19.2065	19.20
21 Vinyl Acetate	43	3.604	3.601	(0.749)	375819	41.2982	41.29
22 1,1-Dichloroethane	63	3.511	3.507	(0.729)	108534	18.6741	18.67
24 2-Butanone	43	4.268	4.260	(0.886)	62359	36.8560	36.85
26 2,2-Dichloropropane	77	4.178	4.174	(0.868)	81063	20.2287	20.22

27	cis-1,2-Dichloroethene	96	4.193	4.189 (0.871)	72461	20.4150	20.41
28	Chloroform	83	4.571	4.568 (0.949)	126388	18.6864	18.68

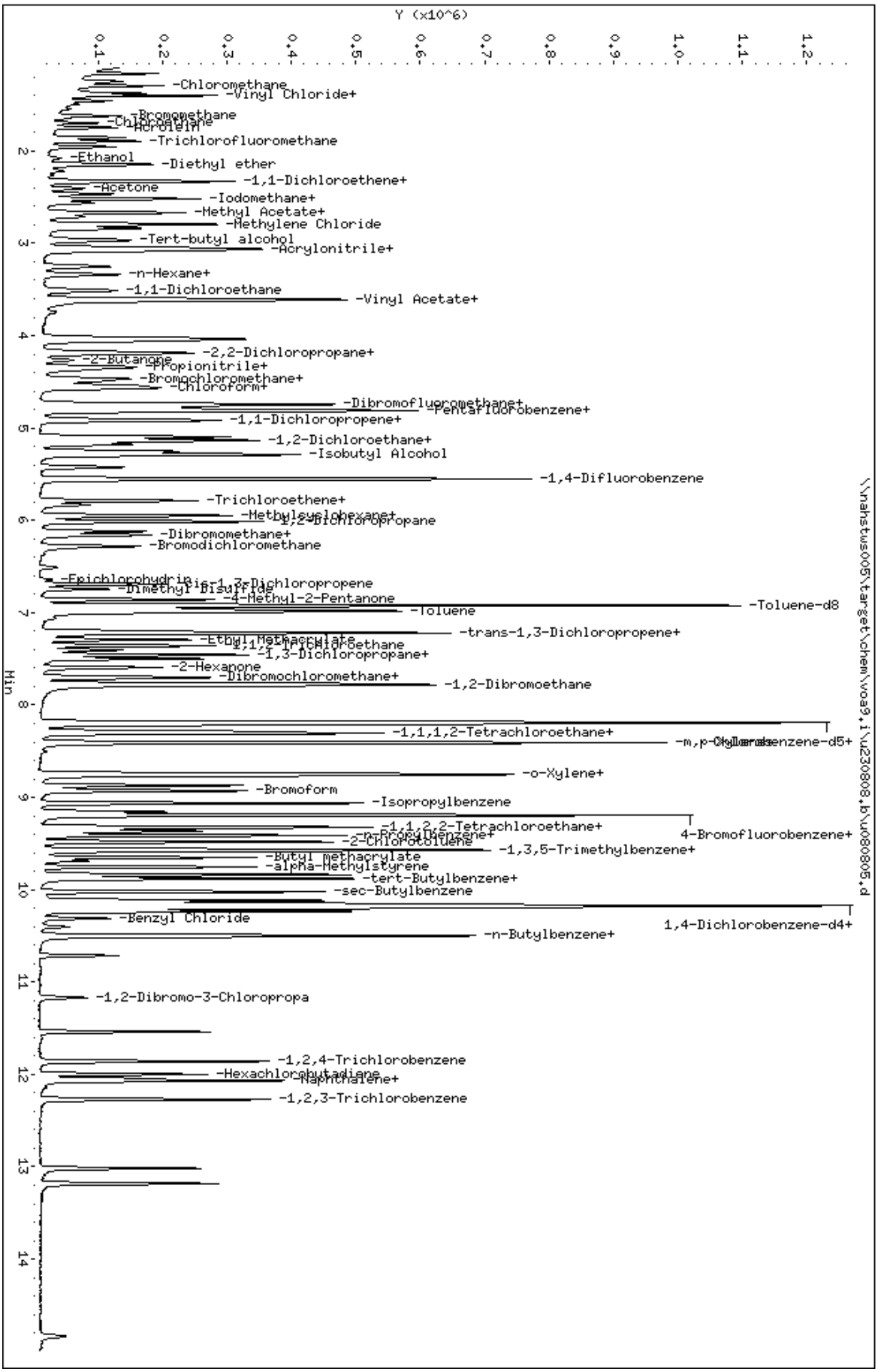
	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	CONCENTRATIONS FINAL (ug/l)
	29 Bromochloromethane	128	4.466	4.463	(0.928)	39072	18.6032	18.60
$	30 Dibromofluoromethane	113	4.748	4.744	(0.986)	178480	51.8508	51.85
	31 1,1,1-Trichloroethane	97	4.740	4.737	(0.984)	100010	19.0059	19.00
	32 1,1-Dichloropropene	75	4.920	4.916	(0.887)	89267	19.8264	19.82
	33 1,2-Dichloroethane	62	5.175	5.171	(0.932)	106534	20.4026	20.40
	34 Carbon Tetrachloride	117	4.909	4.905	(0.885)	74488	18.4673	18.46
$	35 1,2-Dichloroethane-d4	65	5.096	5.093	(1.058)	196043	52.3191	52.31
*	36 1,4-Difluorobenzene	114	5.550	5.550	(1.000)	606353	50.0000	
	37 Benzene	78	5.137	5.134	(0.926)	291973	19.7123	19.71
	38 Trichloroethene	130	5.786	5.786	(1.043)	84853	20.2690	20.26
	39 Bromodichloromethane	83	6.277	6.277	(1.131)	90304	19.0626	19.06
	42 1,2-Dichloropropane	63	6.011	6.007	(1.083)	75381	18.9890	18.98
	44 Dibromomethane	93	6.120	6.116	(1.103)	49249	19.3152	19.31
	45 4-Methyl-2-Pentanone	43	6.858	6.855	(0.838)	164123	38.5513	38.55
	46 cis-1,3-Dichloropropene	75	6.689	6.690	(1.205)	100183	18.0604	18.06
*	47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	572160	50.0000	
$	48 Toluene-d8	98	6.922	6.918	(0.846)	660649	49.6430	49.64
	50 Toluene	91	6.982	6.978	(0.853)	312794	20.1077	20.10
	51 trans-1,3-Dichloropropene	75	7.196	7.196	(1.297)	86311	18.9026	18.90
	52 2-Hexanone	43	7.593	7.593	(0.928)	109750	38.9312	38.93
	53 1,1,2-Trichloroethane	83	7.357	7.353	(0.899)	62967	18.8991	18.89
	54 1,3-Dichloropropane	76	7.499	7.499	(0.916)	130481	19.0917	19.09
	55 Dibromochloromethane	129	7.694	7.691	(0.940)	77338	18.9148	18.91
	56 Tetrachloroethene	164	7.458	7.454	(0.911)	72419	19.1483	19.14
	57 1,2-Dibromoethane	107	7.784	7.784	(0.951)	80876	20.1785	20.17
	58 1-Chlorohexane	55	8.196	8.197	(1.477)	59817	18.8918	18.89
	59 Chlorobenzene	112	8.211	8.208	(1.003)	218489	19.8131	19.81
	60 1,1,1,2-Tetrachloroethane	131	8.283	8.283	(1.012)	75262	18.7257	18.72
	61 Ethylbenzene	106	8.305	8.305	(1.015)	104847	21.0020	21.00
	62 m,p-Xylenes	106	8.410	8.407	(1.027)	268743	45.8547	45.85
	63 o-Xylene	106	8.747	8.748	(1.069)	131890	23.0032	23.00
	64 Styrene	104	8.762	8.759	(1.071)	210216	23.4961	23.49
	66 Bromoform	173	8.920	8.920	(1.090)	53478	18.7215	18.72
	67 Isopropylbenzene	105	9.062	9.063	(1.107)	310193	22.3581	22.35
	68 1,1,2,2-Tetrachloroethane	83	9.329	9.329	(0.917)	113534	18.0988	18.09
$	69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	284262	54.8598	54.85
*	70 1,4-Dichlorobenzene-d4	152	10.172	10.168	(1.000)	325675	50.0000	
	71 1,2,3-Trichloropropane	75	9.362	9.362	(0.920)	101131	18.5164	18.51
	73 n-Propylbenzene	91	9.411	9.411	(0.925)	344547	19.8243	19.82
	74 Bromobenzene	156	9.317	9.317	(0.916)	104220	19.3437	19.34
	75 1,3,5-Trimethylbenzene	105	9.561	9.561	(0.940)	248054	21.7942	21.79
	76 2-Chlorotoluene	91	9.482	9.482	(0.932)	236207	20.5725	20.57
	77 4-Chlorotoluene	91	9.576	9.576	(0.941)	267800	20.8812	20.88
	78 tert-Butylbenzene	119	9.838	9.835	(0.967)	222353	20.6213	20.62
	79 1,2,4-Trimethylbenzene	105	9.880	9.876	(0.971)	257372	22.3303	22.33
	81 sec-Butylbenzene	105	10.022	10.022	(0.985)	289055	25.0315	25.03
	82 p-Isopropyltoluene	119	10.146	10.146	(0.997)	251467	26.3843	26.38
	83 1,3-Dichlorobenzene	146	10.116	10.116	(0.994)	178256	19.8229	19.82
	84 1,4-Dichlorobenzene	146	10.191	10.191	(1.002)	192107	19.2781	19.27
	87 n-Butylbenzene	91	10.491	10.491	(1.031)	208563	20.4842	20.48
	88 1,2-Dichlorobenzene	146	10.506	10.506	(1.033)	184097	19.9535	19.95
	89 1,2-Dibromo-3-Chloropropane	155	11.169	11.166	(1.098)	16483	18.2250	18.22

90 1,2,4-Trichlorobenzene	180	11.859	11.859 (1.166)	117344	20.6749	20.67
91 Hexachlorobutadiene	225	11.998	11.998 (1.179)	53368	27.3123	27.31

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	CONCENTRATIONS FINAL (ug/l)
	92 Naphthalene	128	12.069	12.065	(1.186)	272989	19.2231	19.22
	93 1,2,3-Trichlorobenzene	180	12.267	12.268	(1.206)	117713	20.3150	20.31
M	94 1,2-Dichloroethylene (total)	96				133533	39.6215	39.62
M	95 Xylenes (total)	106				400633	68.8579	68.85
	135 1,4-Dioxane	88	6.172	6.169	(1.282)	20527	332.419	332.41
	141 Cyclohexane	56	4.778	4.778	(0.992)	91610	18.9253	18.92
	138 Freon TF	101	2.330	2.326	(0.484)	51664	23.5895	23.58
	140 1,3-Butadiene	54	1.400	1.393	(0.291)	61253	17.8619	17.86
	147 Methylcyclohexane	55	5.947	5.944	(1.072)	153333	17.3614	17.36
	146 Methyl Acetate	43	2.712	2.705	(0.563)	58198	18.8323	18.83
	148 Tert-Butyl alcohol	59	2.967	2.960	(0.616)	148343	407.855	407.85
	149 Isopropyl Alcohol	45	2.562	2.555	(0.532)	84930	356.835	356.83
	72 trans-1,4-Dichloro-2-butene	53	9.377	9.377	(1.146)	16120	20.8349	20.83
	12 Isobutyl Alcohol	43	5.287	5.284	(1.098)	235336	385.802	385.80
	13 Acetonitrile	39	2.667	2.664	(0.554)	74953	188.401	188.40
	14 Allyl Chloride	41	2.671	2.664	(0.555)	169050	18.6036	18.60
	25 Methacrylonitrile	41	4.496	4.489	(0.934)	42084	17.3996	17.39
	40 Methyl Methacrylate	41	6.157	6.154	(1.279)	68250	18.3406	18.34
	4 Propionitrile	54	4.339	4.332	(0.901)	102887	201.228	201.22(a)
	136 n-Hexane	57	3.338	3.335	(0.693)	58424	18.6877	18.68
	131 Methyl Acrylate	55	4.369	4.362	(0.907)	79044	19.1847	19.18
	200 Dimethyl Disulfide	94	6.746	6.746	(0.824)	50938	15.2419	15.24
	49 Ethyl Methacrylate	69	7.293	7.293	(1.314)	109773	19.7439	19.74
	166 1,2,3-Trimethylbenzene	105	10.236	10.232	(1.006)	256179	22.0375	22.03
	167 Ethanol	45	2.082	2.071	(0.433)	16342	353.682	353.68
	164 Dicyclopentadiene	66	10.198	10.198	(1.003)	250330	18.1328	18.13
	145 alpha-Methylstyrene	118	9.756	9.752	(0.959)	99339	19.9132	19.91
	142 Tetrahydrofuran	42	4.545	4.538	(0.944)	25916	35.9608	35.96
	156 Diisopropyl ether	45	3.619	3.616	(0.752)	204880	20.1333	20.13
	151 4-Methyl-2-pentanol	45	7.222	7.218	(1.301)	353769	448.689	448.68
	150 Allyl alcohol	57	3.338	3.335	(0.693)	58424	503.806	503.80
	86 Benzyl Chloride	91	10.311	10.311	(1.260)	70174	20.0109	20.01
	162 Butyl acrylate	55	8.736	8.733	(1.067)	130277	19.4763	19.47
	139 Diethyl ether	59	2.142	2.135	(0.445)	50734	20.8053	20.80
	203 2-Ethylhexyl Acrylate	55	12.043	12.043	(1.184)	54280	17.4022	17.40
	134 Cyclohexanone	55	9.156	9.153	(0.900)	75852	376.705	376.70(a)
	130 Ethyl Acetate	43	4.343	4.335	(0.902)	72164	18.5305	18.53
	189 n-Butyl acetate	43	7.709	7.706	(0.942)	121065	19.1682	19.16
	182 Epichlorohydrin	57	6.633	6.633	(1.195)	3043	93.9541	93.95
	132 n-Butanol	56	5.835	5.827	(1.212)	39504	343.981	343.98(a)
	133 Ethyl Acrylate	55	5.947	5.944	(1.235)	153333	17.2744	17.27
	163 Butyl methacrylate	41	9.651	9.651	(0.949)	84784	20.6782	20.67

QC Flag Legend

a - Target compound detected but, quantitated amount
Below Limit Of Quantitation(BLOQ).



Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080805.d
Date : 08-AUG-2023 12:22
Client ID: VLCSW-230808
Sample Info: VLCSW-230808;VLCSW-230808;3;;LCS
Purge Volume: 5.0
Column phase: DB624

Instrument: VOA9.i
Operator: PC
Column diameter: 0.18

Data File : \\nahstws005\target\chem\voa9.i\u230808.b\u080805.d
Inj Date : 08-AUG-2023 12:22
InstruID : VOA9.i
LabSampID : VLCSW-230808

NO MANUAL INTEGRATIONS

Data File: \\nahstws005\Target\chem\voa9.i\U230808.b\U080807.D Page 1
Report Date: 08-Aug-2023 13:32

ALS Laboratory Group

Data file : \\nahstws005\Target\chem\voa9.i\U230808.b\U080807.D
Lab Smp Id: VBLKW-230808 Client Smp ID: VBLKW-230808
Inj Date : 08-AUG-2023 13:17
Operator : PC Inst ID: VOA9.i
Smp Info : VBLKW-230808;VBLKW-230808;3;;BLANK
Misc Info : V9;WATER;0;1;
Comment :
Method : \\nahstws005\Target\chem\voa9.i\U230808.b\8260C.m
Meth Date : 08-Aug-2023 11:53 pcabasca Quant Type: ISTD
Cal Date : 31-JUL-2023 14:06 Cal File: U073108.D
Als bottle: 6 QC Sample: BLANK
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 8260_GB.sub
Target Version: 4.14
Processing Host: NAHSTWS005

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	FINAL (ug/l)
*	1 Pentafluorobenzene	168	4.808	4.812	(1.000)	431269	50.0000	
	2 Dichlorodifluoromethane	85	1.025	1.157	(0.213)	4323	2.27790	2.27(a)
	3 Chloromethane	50	1.007	1.288	(0.209)	79936	15.5558	15.55
	5 Vinyl Chloride	62	1.025	1.366	(0.213)	5869	1.38219	1.38(a)
	7 Chloroethane	64	1.235	1.689	(0.257)	108169	40.4536	40.45
	15 Iodomethane	142	2.457	2.461	(0.511)	2290	4.27004	4.27(a)
$	30 Dibromofluoromethane	113	4.740	4.744	(0.986)	171586	49.7401	49.74
	32 1,1-Dichloropropene	75	4.808	4.916	(0.866)	23755	5.11770	5.11
	33 1,2-Dichloroethane	62	5.550	5.171	(1.000)	19667	3.65345	3.65(a)
	34 Carbon Tetrachloride	117	4.808	4.905	(0.866)	36701	8.82598	8.82
$	35 1,2-Dichloroethane-d4	65	5.093	5.093	(1.059)	219423	58.6361	58.63
*	36 1,4-Difluorobenzene	114	5.550	5.550	(1.000)	625112	50.0000	
	42 1,2-Dichloropropane	63	5.546	6.007	(0.999)	116031	28.3518	28.35
*	47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	566691	50.0000	
$	48 Toluene-d8	98	6.922	6.918	(0.846)	692912	52.5698	52.56
	58 1-Chlorohexane	55	8.185	8.197	(1.475)	5094	1.56054	1.56(a)
$	69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	245453	47.6493	47.64
*	70 1,4-Dichlorobenzene-d4	152	10.172	10.168	(1.000)	306722	50.0000	
	71 1,2,3-Trichloropropane	75	9.194	9.362	(0.904)	116585	22.6649	22.66
	141 Cyclohexane	56	4.804	4.778	(0.999)	6541	1.34943	1.34(a)

QC Flag Legend

a - Target compound detected but, quantitated amount
Below Limit Of Quantitation(BLOQ).

01226485

Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080807.d

Date : 08-AUG-2023 13:17

Client ID: VBLKW-230808

Instrument: VOA9.i

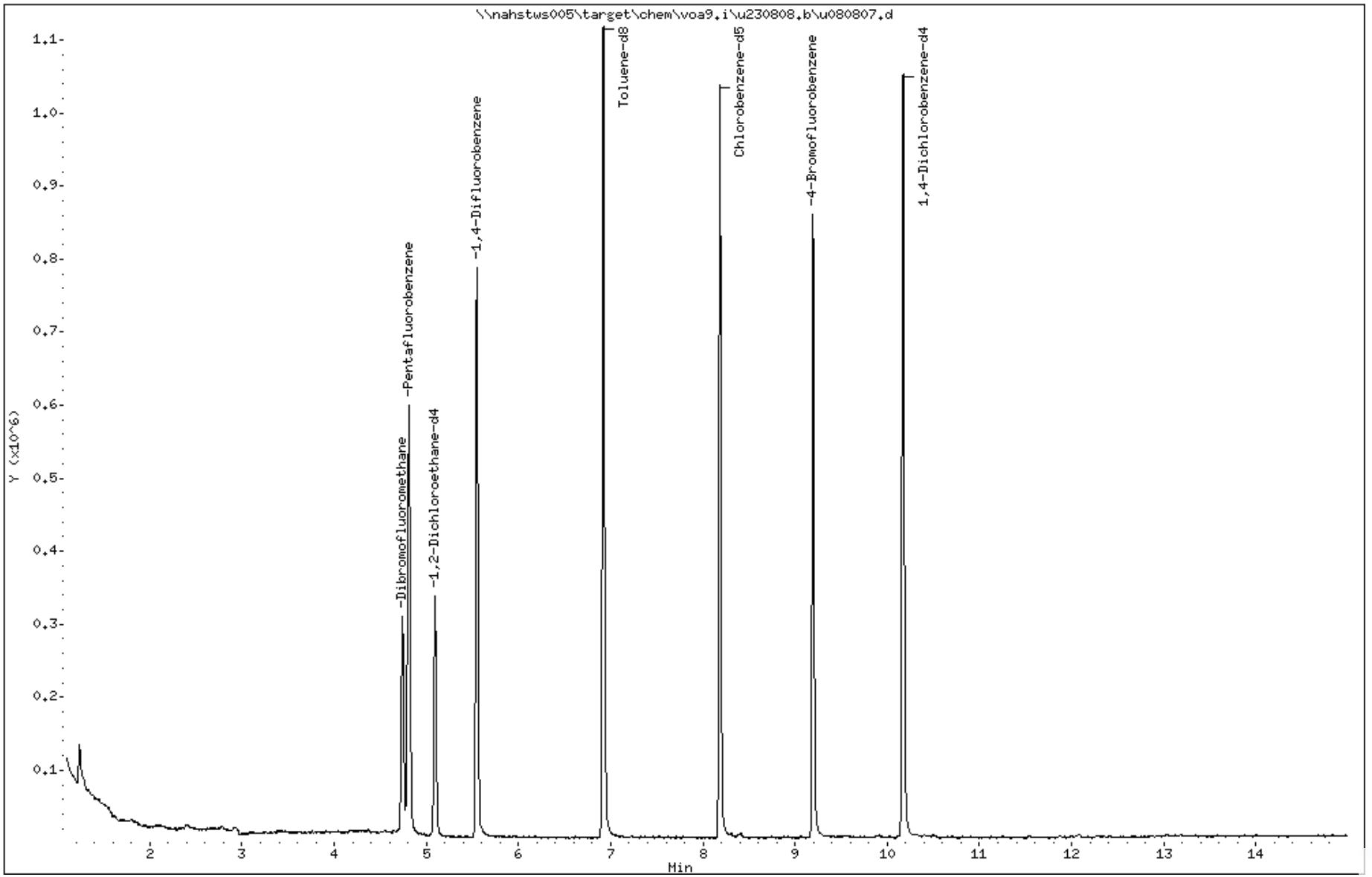
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Purge Volume: 5.0

Operator: PC

Column phase: DB624

Column diameter: 0.18



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Inj Date : 08-AUG-2023 13:17
InstruID : VOA9.i
LabSampID : VBLKW-230808

NO MANUAL INTEGRATIONS

Data File: \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080810.D Page 1
Report Date: 08-Aug-2023 22:29

ALS Laboratory Group

Data file : \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080810.D
Lab Smp Id: HS23080325-10 Client Smp ID: HS23080325-10
Inj Date : 08-AUG-2023 14:24
Operator : PC Inst ID: VOA9.i
Smp Info : HS23080325-10;HS23080325-10;;;
Misc Info : V9;WATER;0;1;
Comment   :
Method   : \\nahstws005\Target\chem\voa9.i\U230808.b\8260C.m
Meth Date : 08-Aug-2023 22:23 VOA9.i Quant Type: ISTD
Cal Date : 31-JUL-2023 14:06 Cal File: U073108.D
Als bottle: 9
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 8260_GB.sub
Target Version: 4.14
Processing Host: NAHSTWS005

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	FINAL (ug/l)
* 1 Pentafluorobenzene	168	4.811	4.812	(1.000)	454847	50.0000	
8 Trichlorofluoromethane	101	1.883	1.888	(0.392)	5288	0.95672	0.95(a)
$ 30 Dibromofluoromethane	113	4.744	4.744	(0.986)	184794	50.8131	50.81
$ 35 1,2-Dichloroethane-d4	65	5.092	5.093	(1.058)	218133	55.1929	55.19
* 36 1,4-Difluorobenzene	114	5.550	5.550	(1.000)	600743	50.0000	
* 47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	551260	50.0000	
$ 48 Toluene-d8	98	6.922	6.918	(0.846)	673176	52.5021	52.50
$ 69 4-Bromofluorobenzene	95	9.193	9.194	(1.123)	236247	47.1312	47.13
* 70 1,4-Dichlorobenzene-d4	152	10.172	10.168	(1.000)	297394	50.0000	

QC Flag Legend

a - Target compound detected but, quantitated amount
    Below Limit Of Quantitation(BLOQ).

01226488

Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080810.d

Page 1

Date : 08-AUG-2023 14:24

Client ID: HS23080325-10

Instrument: VOA9.i

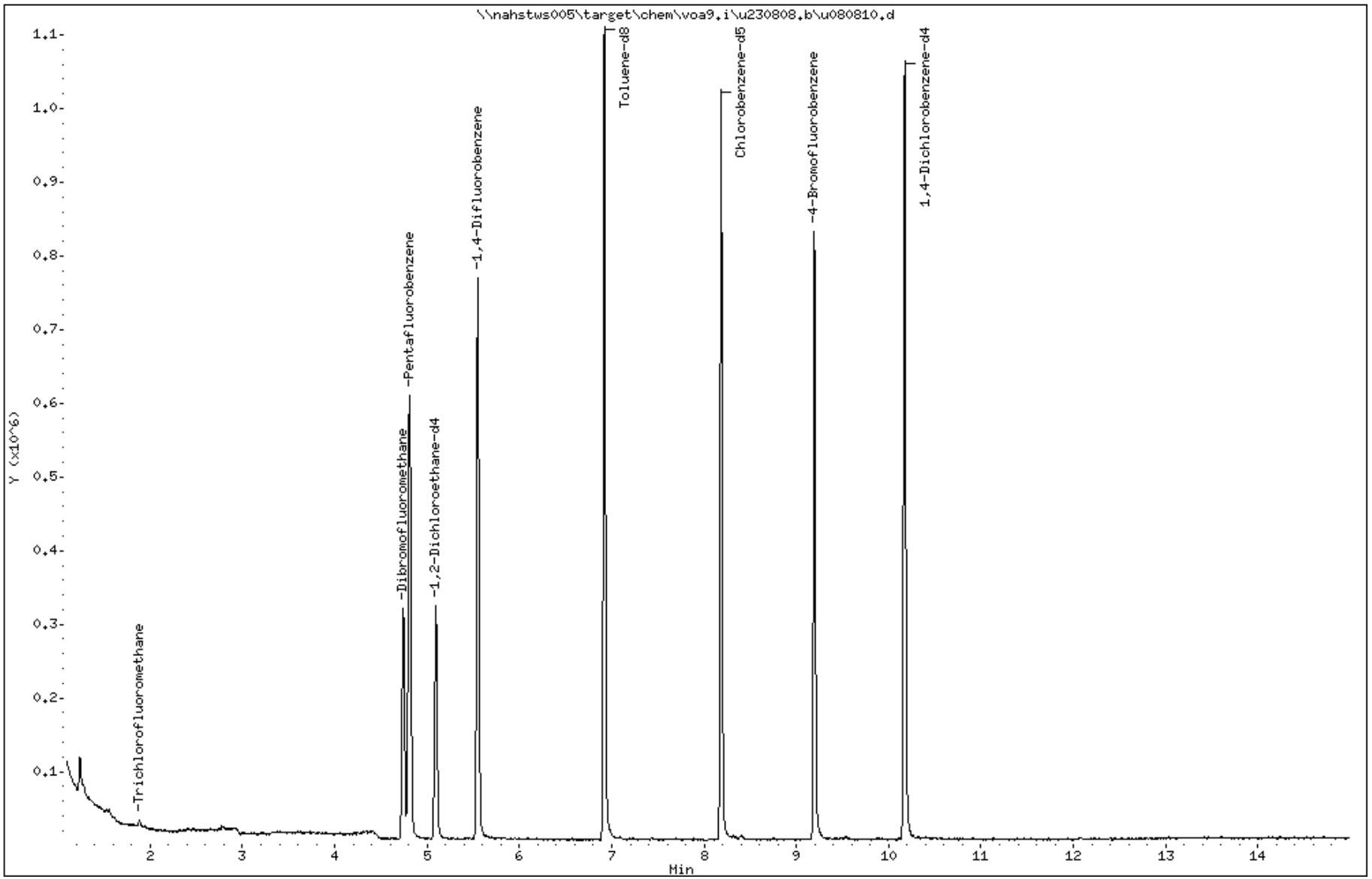
Sample Info: HS23080325-10;HS23080325-10;;;

Purge Volume: 5.0

Operator: PC

Column phase: DB624

Column diameter: 0.18



Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080810.d

Date : 08-AUG-2023 14:24

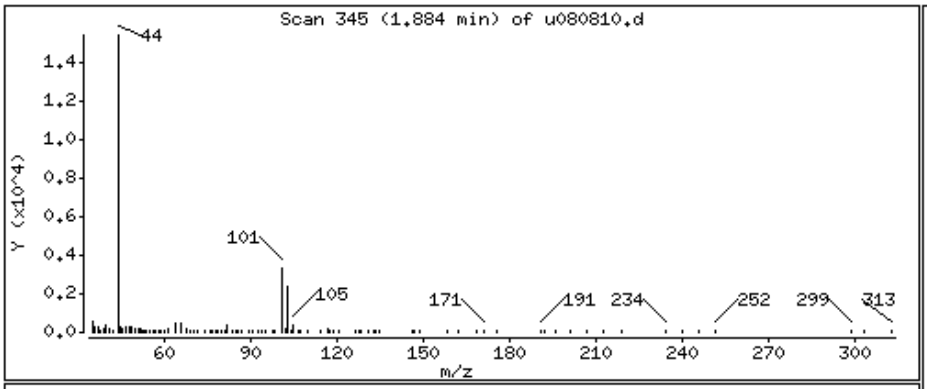
Client ID: HS23080325-10 Instrument: VOA9.i

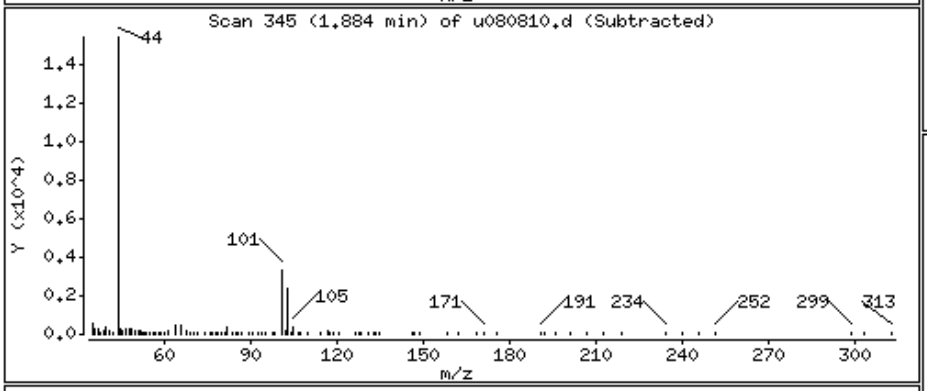
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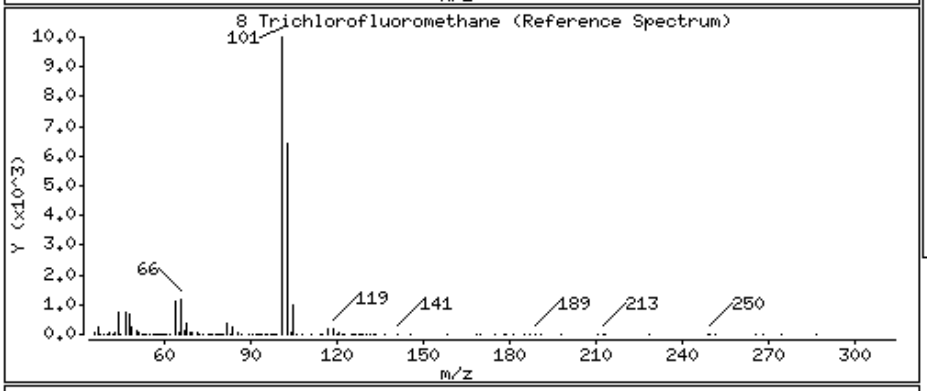
Purge Volume: 5.0 Operator: PC

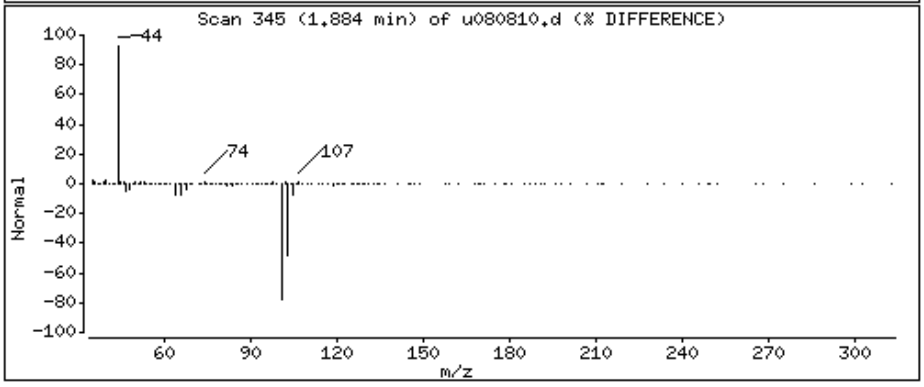
Column phase: DB624 Column diameter: 0.18

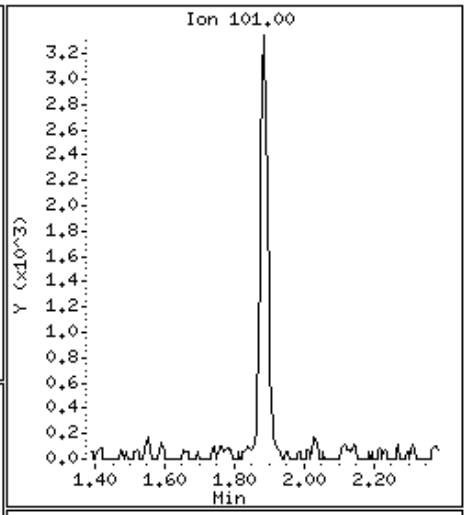
8 Trichlorofluoromethane Concentration: 0.95 ug/l

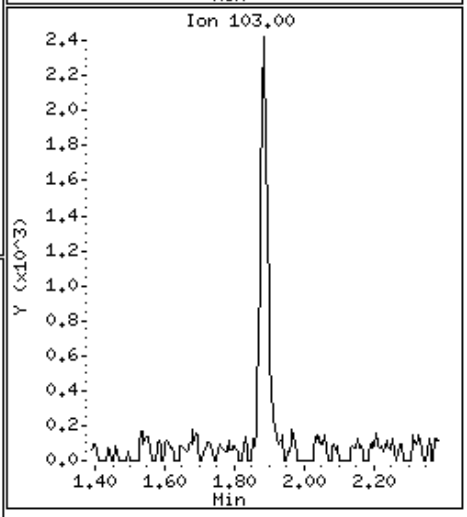












Data File : \\nahstws005\target\chem\voa9.i\u230808.b\u080810.d
Inj Date : 08-AUG-2023 14:24
InstruID : VOA9.i
LabSampID : HS23080325-10

NO MANUAL INTEGRATIONS

Data File: \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080812.D Page 1
Report Date: 08-Aug-2023 22:31

ALS Laboratory Group

Data file : \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080812.D
Lab Smp Id: HS23080325-01 Client Smp ID: HS23080325-01
Inj Date : 08-AUG-2023 15:08
Operator : PC Inst ID: VOA9.i
Smp Info : HS23080325-01;HS23080325-01;;;
Misc Info : V9;WATER;0;1;
Comment   :
Method   : \\nahstws005\Target\chem\voa9.i\U230808.b\8260C.m
Meth Date : 08-Aug-2023 22:23 VOA9.i Quant Type: ISTD
Cal Date : 31-JUL-2023 14:06 Cal File: U073108.D
Als bottle: 11
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 8260_GB.sub
Target Version: 4.14
Processing Host: NAHSTWS005

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	FINAL (ug/l)
*	1 Pentafluorobenzene	168	4.811	4.812	(1.000)	445191	50.0000	
	11 1,1-Dichloroethene	96	2.326	2.322	(0.483)	6579	2.24301	2.24(a)
	22 1,1-Dichloroethane	63	3.507	3.507	(0.729)	13934	2.31930	2.31(a)
	27 cis-1,2-Dichloroethene	96	4.193	4.189	(0.871)	2280	0.62143	0.62(a)
$	30 Dibromofluoromethane	113	4.744	4.744	(0.986)	185865	52.2436	52.24
	33 1,2-Dichloroethane	62	5.171	5.171	(0.932)	3943	0.78277	0.78(a)
$	35 1,2-Dichloroethane-d4	65	5.096	5.093	(1.059)	216599	56.0129	56.01
*	36 1,4-Difluorobenzene	114	5.550	5.550	(1.000)	584946	50.0000	
	38 Trichloroethene	130	5.786	5.786	(1.043)	6848	1.69566	1.69(a)
*	47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	537954	50.0000	
$	48 Toluene-d8	98	6.922	6.918	(0.846)	650282	51.9710	51.97
$	69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	230596	47.1421	47.14
*	70 1,4-Dichlorobenzene-d4	152	10.172	10.168	(1.000)	291967	50.0000	
M	94 1,2-Dichloroethylene (total)	96				2280	0.62143	0.62(a)

QC Flag Legend

a - Target compound detected but, quantitated amount
    Below Limit Of Quantitation(BLOQ).

01226492

Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080812.d

Date : 08-AUG-2023 15:08

Client ID: HS23080325-01

Instrument: VOA9.i

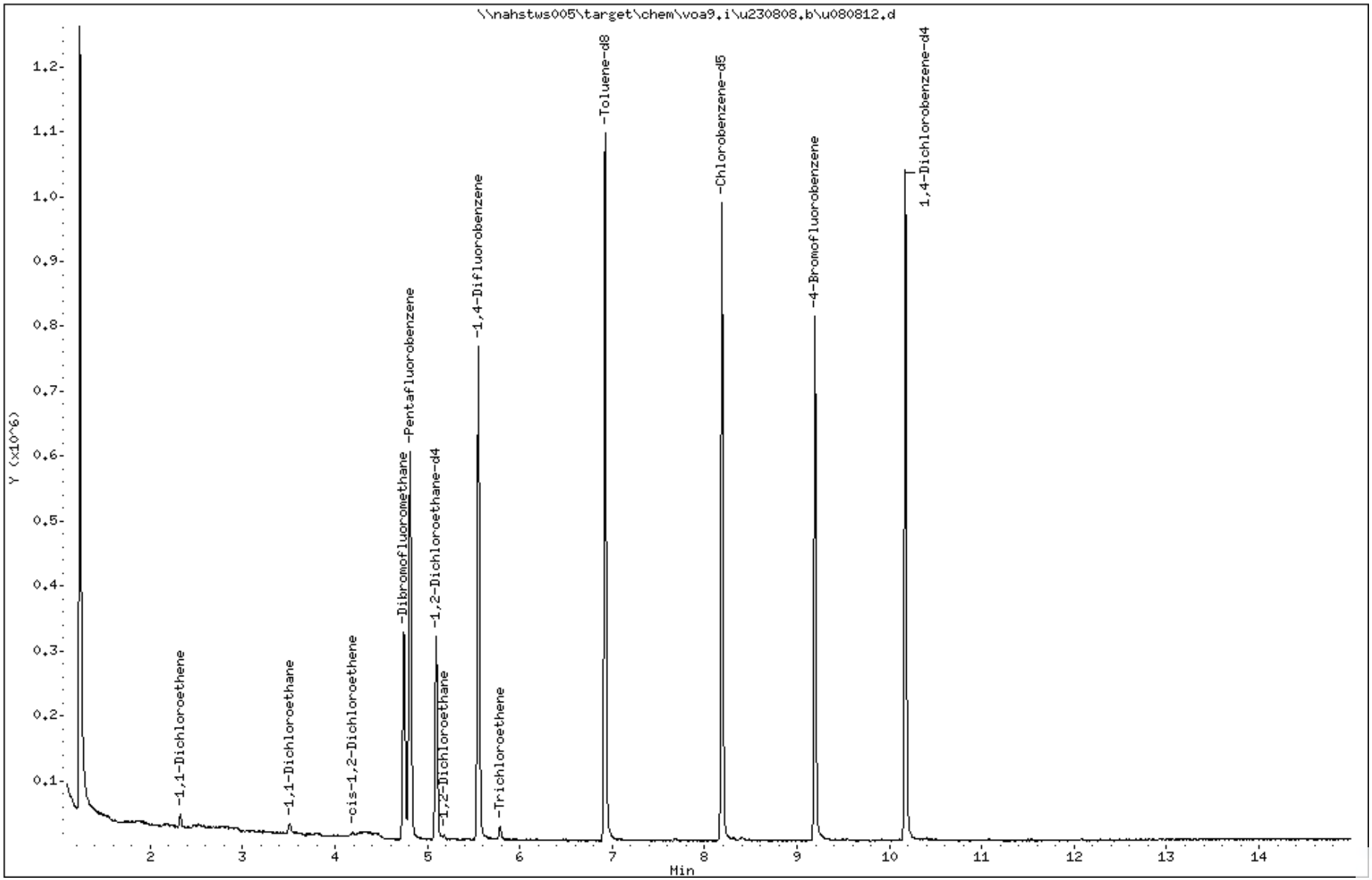
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Purge Volume: 5.0

Operator: PC

Column phase: DB624

Column diameter: 0.18



Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080812.d

Date : 08-AUG-2023 15:08

Client ID: HS23080325-01

Instrument: VOA9.i

Sample Info: HS23080325-01;HS23080325-01;;;

Purge Volume: 5.0

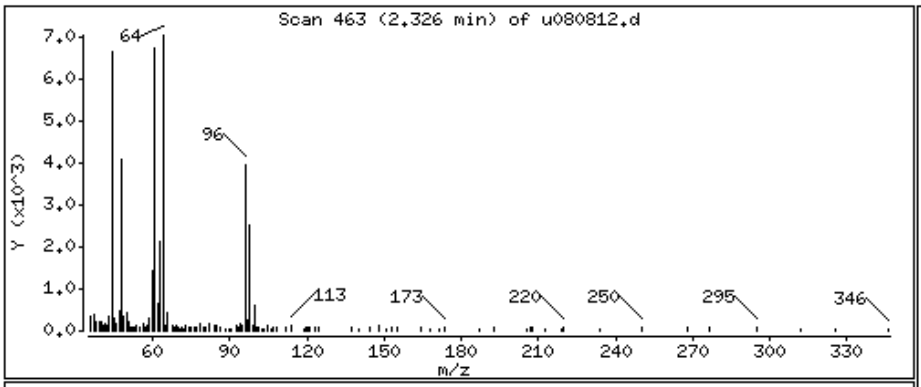
Operator: PC

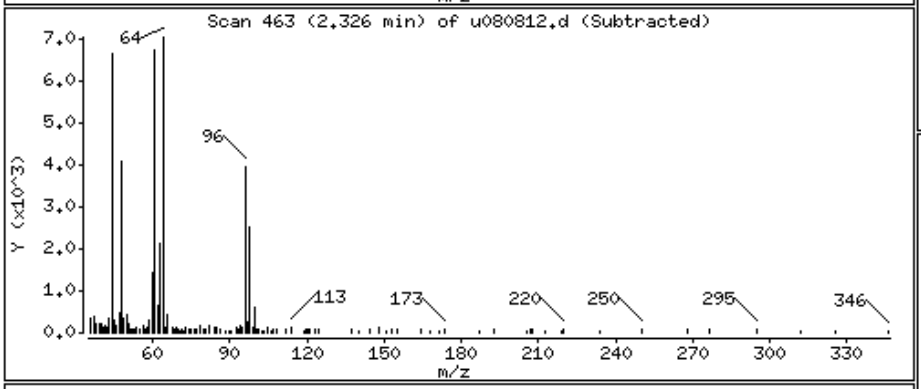
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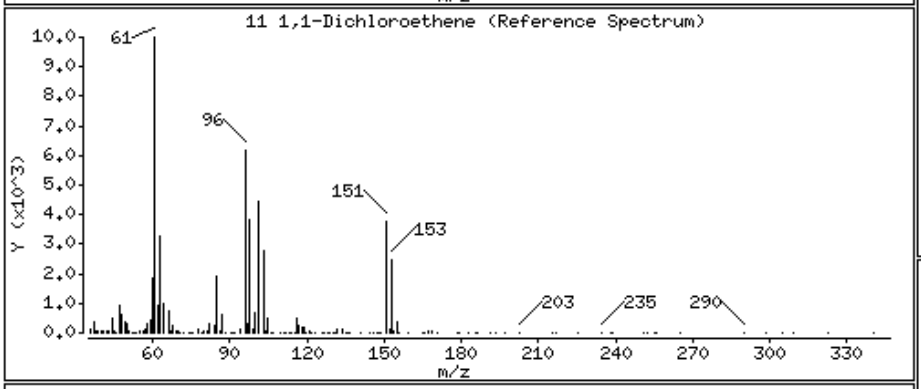
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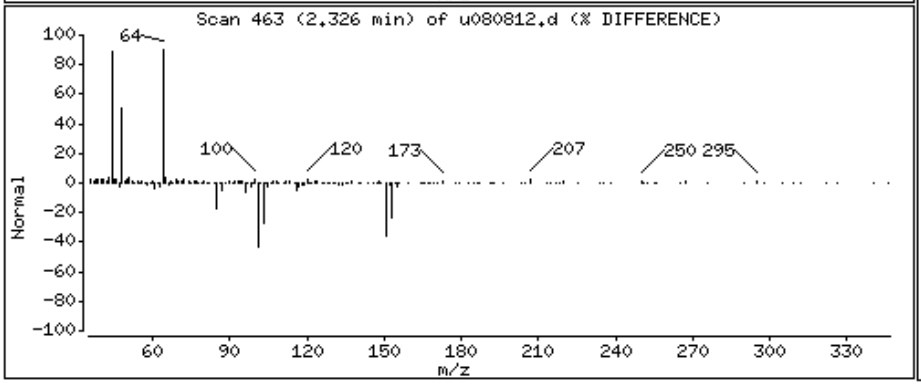
11 1,1-Dichloroethene

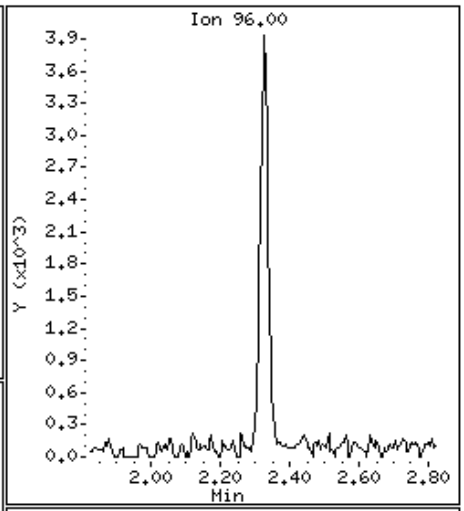
Concentration: 2.24 ug/l

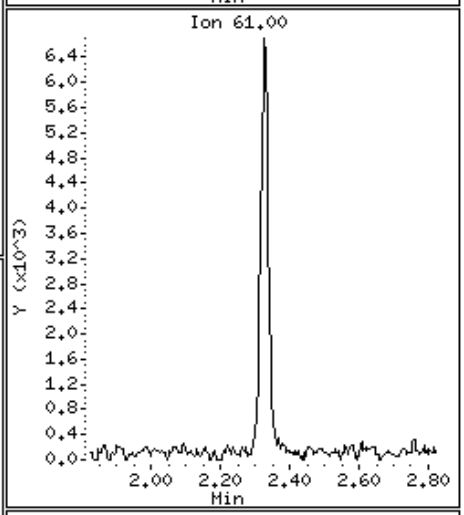


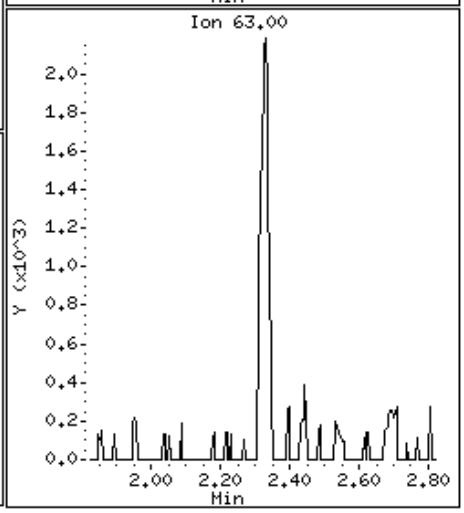












Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080812.d Page 3

Date : 08-AUG-2023 15:08

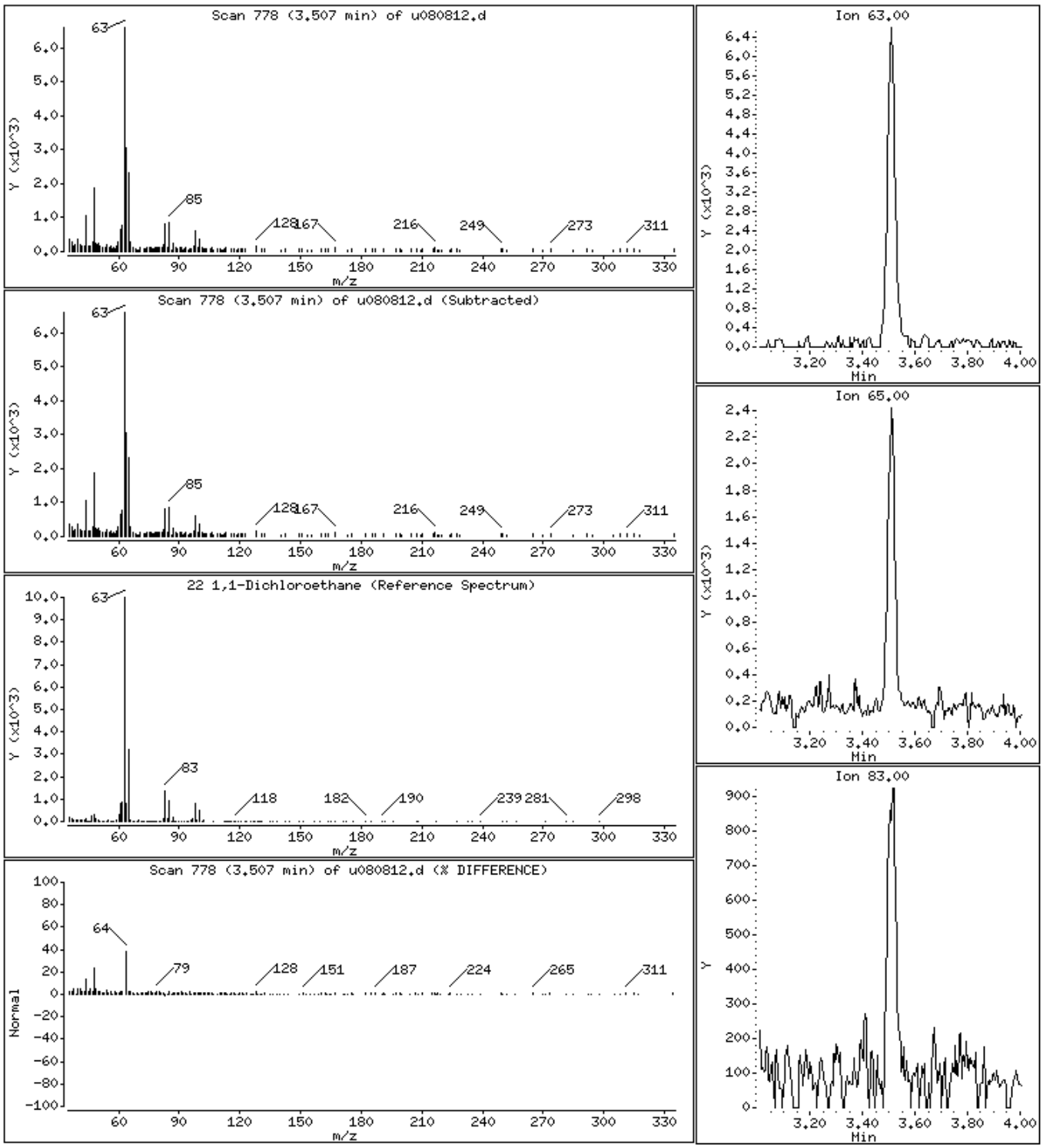
Client ID: HS23080325-01 Instrument: VOA9.i

Sample Info: HS23080325-01;HS23080325-01;;;

Purge Volume: 5.0 Operator: PC

Column phase: DB624 Column diameter: 0.18

22 1,1-Dichloroethane Concentration: 2.31 ug/l



Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080812.d Page 4

Date : 08-AUG-2023 15:08

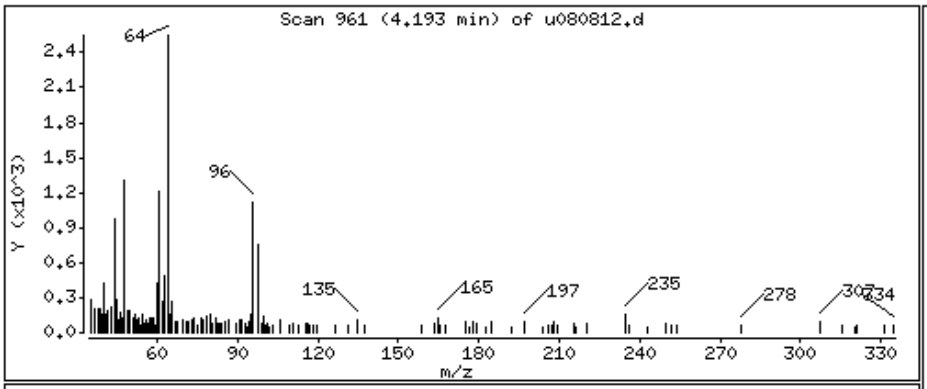
Client ID: HS23080325-01 Instrument: VOA9.i

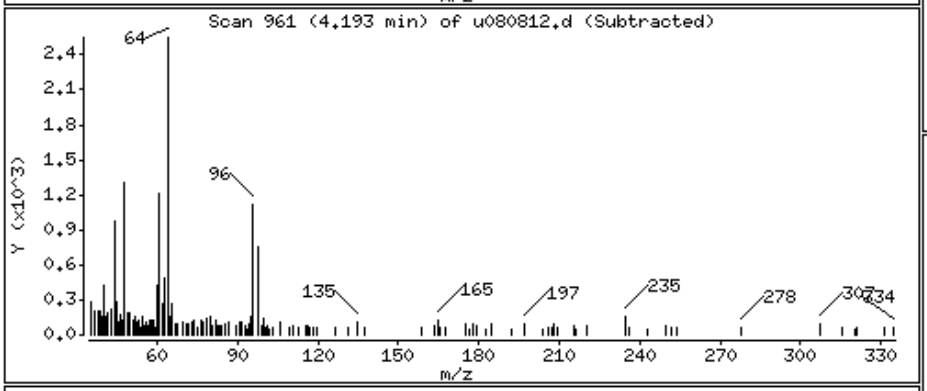
Sample Info: HS23080325-01;HS23080325-01;;;

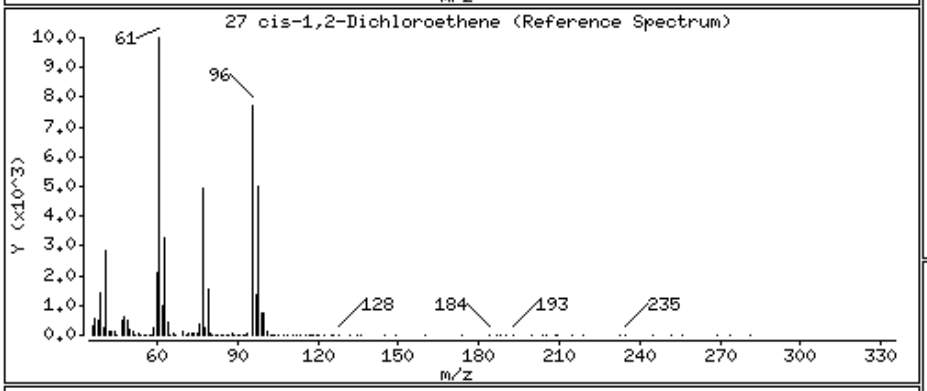
Purge Volume: 5.0 Operator: PC

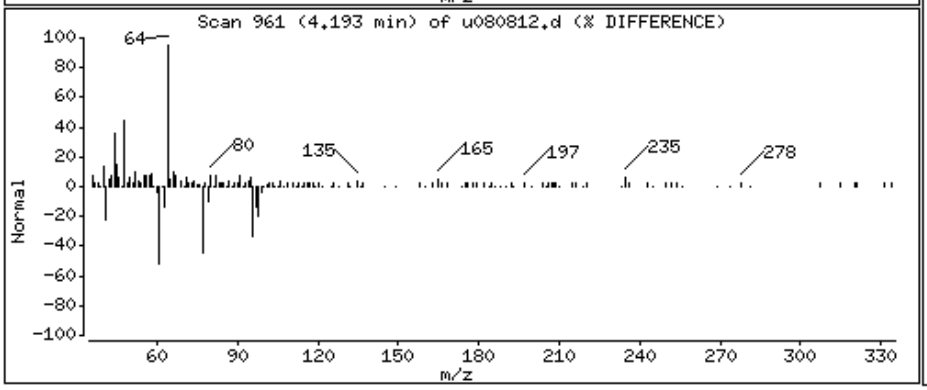
Column phase: DB624 Column diameter: 0.18

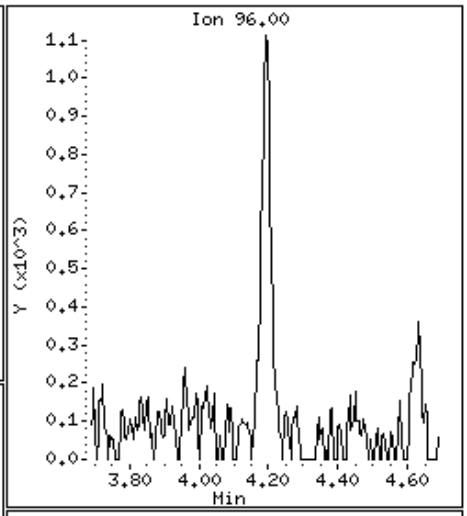
27 cis-1,2-Dichloroethene Concentration: 0.62 ug/l

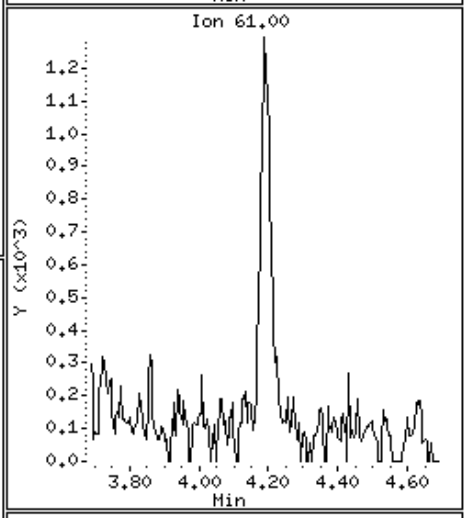


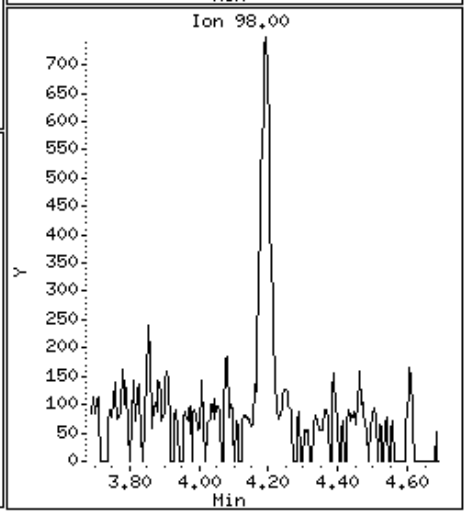












Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080812.d Page 5

Date : 08-AUG-2023 15:08

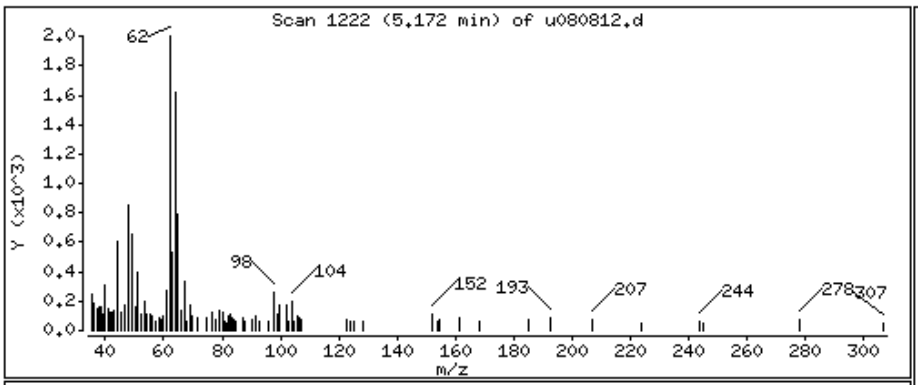
Client ID: HS23080325-01 Instrument: VOA9.i

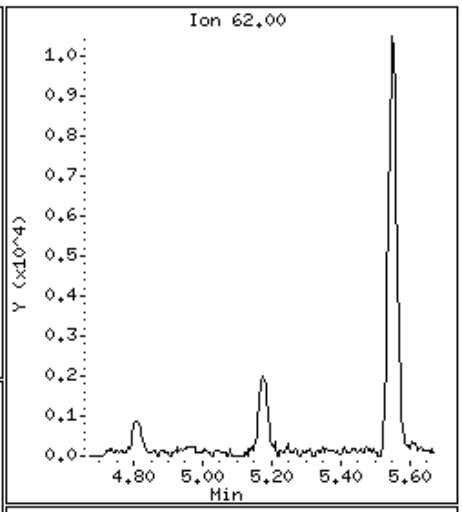
Sample Info: HS23080325-01;HS23080325-01;;;

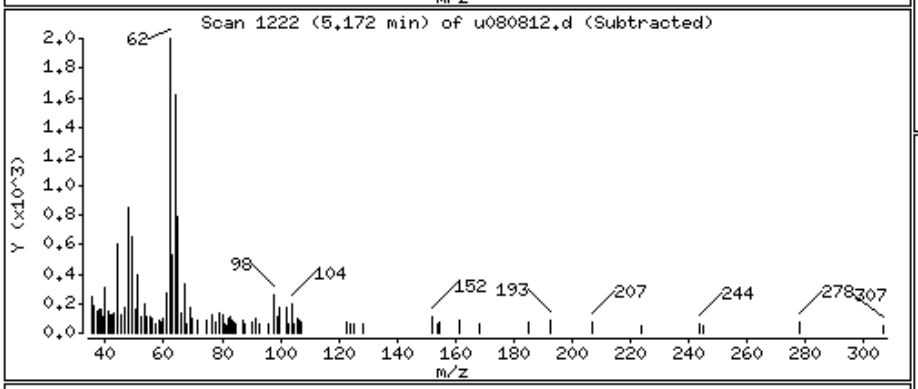
Purge Volume: 5.0 Operator: PC

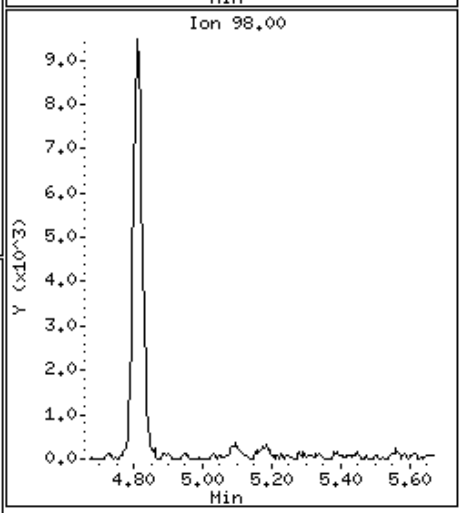
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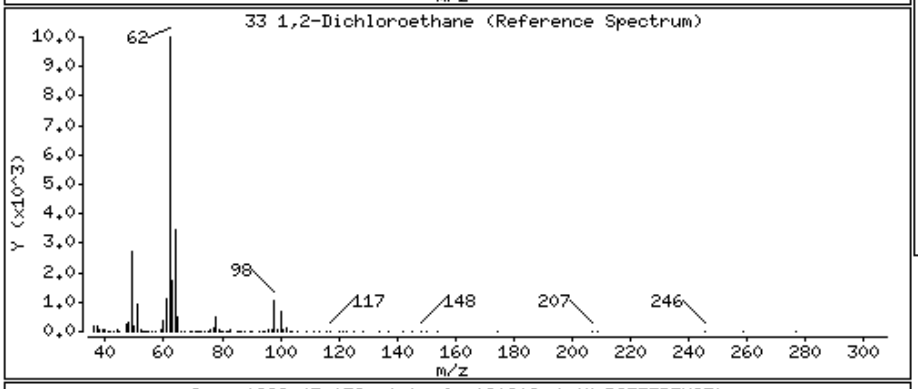
33 1,2-Dichloroethane Concentration: 0.78 ug/l

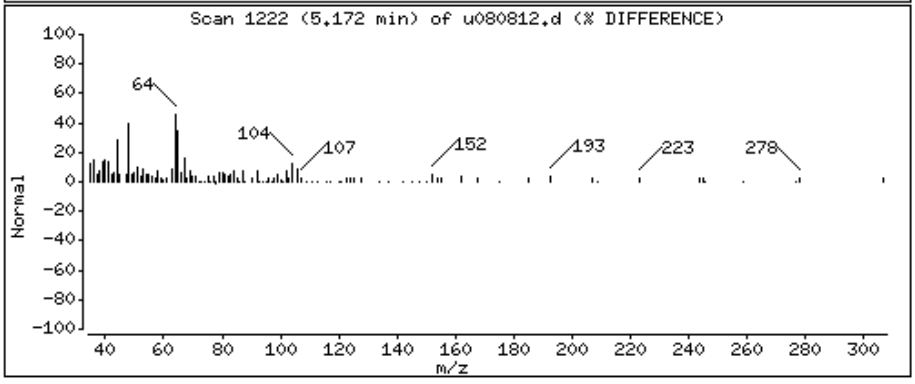












Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080812.d Page 6

Date : 08-AUG-2023 15:08

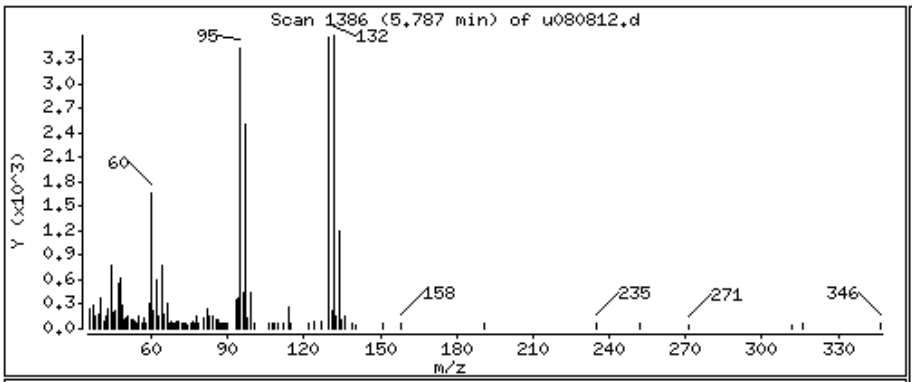
Client ID: HS23080325-01 Instrument: VOA9.i

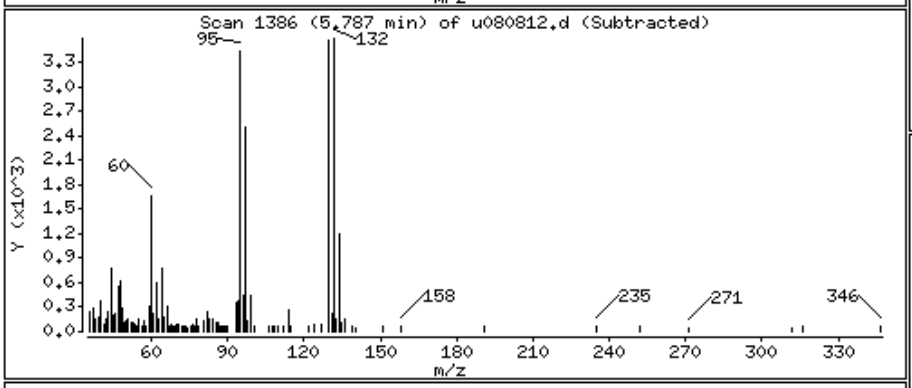
Sample Info: HS23080325-01;HS23080325-01;;;

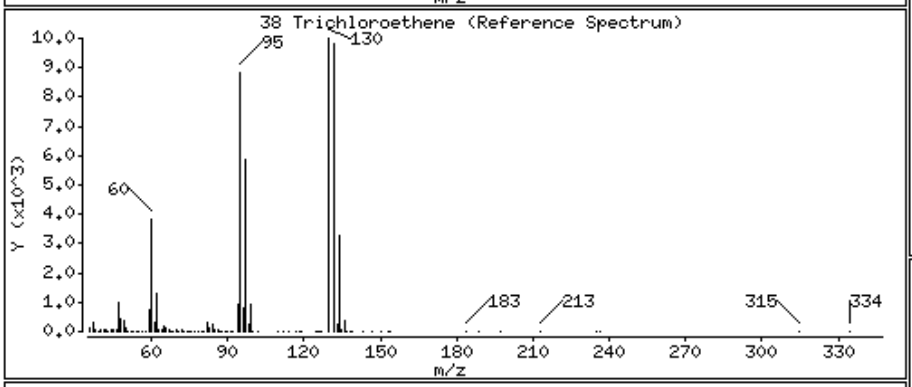
Purge Volume: 5.0 Operator: PC

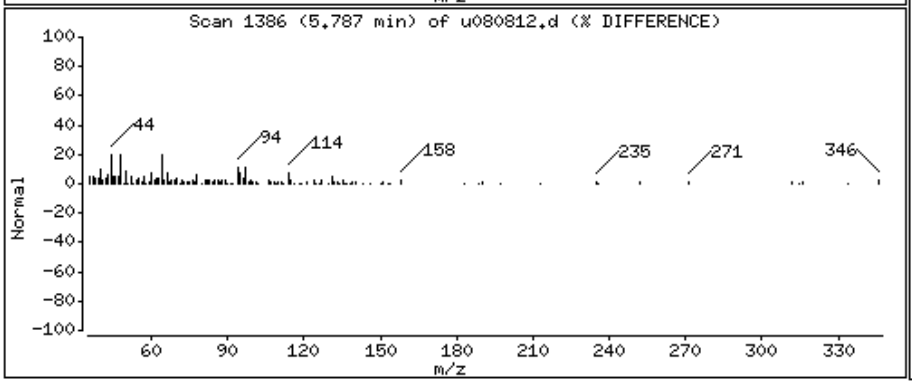
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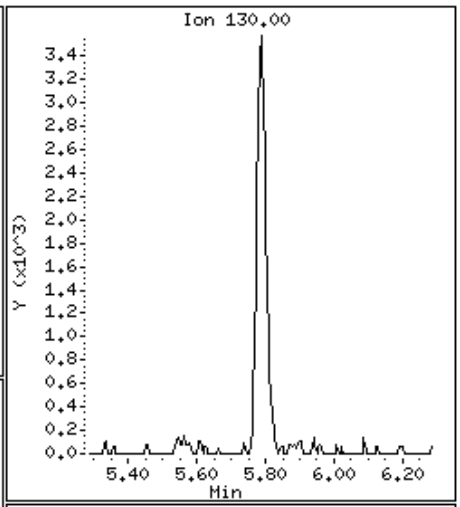
38 Trichloroethene Concentration: 1.69 ug/l

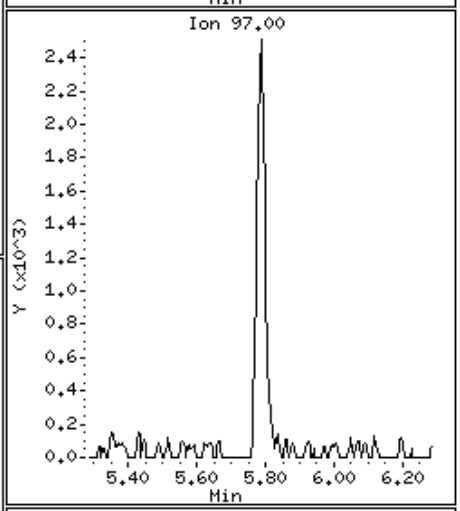


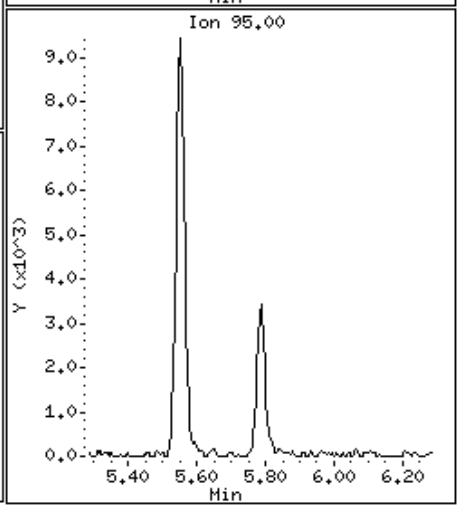












Data File : \\nahstws005\target\chem\voa9.i\u230808.b\u080812.d
Inj Date : 08-AUG-2023 15:08
InstruID : VOA9.i
LabSampID : HS23080325-01

NO MANUAL INTEGRATIONS

Data File: \\nahstws005\Target\chem\voa9.i\U230808.b\U080814.D Page 1
Report Date: 08-Aug-2023 16:09

ALS Laboratory Group

Data file : \\nahstws005\Target\chem\voa9.i\U230808.b\U080814.D
Lab Smp Id: HS23080101-01MS Client Smp ID: HS23080101-01MS
Inj Date : 08-AUG-2023 15:53
Operator : PC Inst ID: VOA9.i
Smp Info : HS23080101-01MS;HS23080101-01MS;3;;MS
Misc Info : V9;WATER;0;1;
Comment   :
Method   : \\nahstws005\Target\chem\voa9.i\U230808.b\8260C.m
Meth Date : 08-Aug-2023 11:53 pcabasca Quant Type: ISTD
Cal Date : 31-JUL-2023 14:06 Cal File: U073108.D
Als bottle: 13 QC Sample: MS
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 8260_GB.sub
Target Version: 4.14
Processing Host: NAHSTWS005

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	FINAL (ug/l)
* 1 Pentafluorobenzene	168	4.815	4.811	(1.000)	405384	50.0000	
2 Dichlorodifluoromethane	85	1.168	1.160	(0.243)	81475	21.7258	21.72
3 Chloromethane	50	1.303	1.295	(0.271)	96153	20.0035	20.00
5 Vinyl Chloride	62	1.378	1.374	(0.286)	87114	21.8259	21.82
6 Bromomethane	94	1.621	1.614	(0.337)	34986	15.1505	15.15
7 Chloroethane	64	1.250	1.696	(0.260)	3433604	1366.11	1366.11(A)
8 Trichlorofluoromethane	101	1.899	1.891	(0.394)	120739	24.5098	24.50
9 Acrolein	56	1.753	1.749	(0.364)	11476	44.1341	44.13
10 Acetone	43	2.412	2.405	(0.501)	48898	33.5190	33.51
11 1,1-Dichloroethene	96	2.334	2.330	(0.485)	61459	23.0110	23.01
15 Iodomethane	142	2.472	2.465	(0.513)	194505	77.4149	77.41
16 Acrylonitrile	53	3.068	3.061	(0.637)	53659	42.1103	42.11
17 Methylene Chloride	84	2.798	2.791	(0.581)	66911	20.5088	20.50
18 Methyl tert-butyl ether	73	3.083	3.076	(0.640)	186626	22.6073	22.60
19 Carbon Disulfide	76	2.521	2.517	(0.524)	391441	50.3440	50.34
20 trans-1,2-Dichloroethene	96	3.061	3.057	(0.636)	64139	21.4297	21.42
21 Vinyl Acetate	43	3.612	3.604	(0.750)	371302	43.3479	43.34
22 1,1-Dichloroethane	63	3.518	3.511	(0.731)	112158	20.5018	20.50
24 2-Butanone	43	4.272	4.264	(0.887)	59815	37.5584	37.55
26 2,2-Dichloropropane	77	4.182	4.182	(0.868)	94236	24.9833	24.98

27 cis-1,2-Dichloroethene	96	4.197	4.193 (0.872)	82507	24.6959	24.69
28 Chloroform	83	4.575	4.571 (0.950)	129891	20.4027	20.40

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	CONCENTRATIONS FINAL (ug/l)
	29 Bromochloromethane	128	4.470	4.466	(0.928)	38408	19.4282	19.42
$	30 Dibromofluoromethane	113	4.748	4.744	(0.986)	170567	52.6592	52.65
	31 1,1,1-Trichloroethane	97	4.744	4.740	(0.985)	113778	22.9716	22.97
	32 1,1-Dichloropropene	75	4.920	4.920	(0.886)	94527	23.3485	23.34
	33 1,2-Dichloroethane	62	5.179	5.175	(0.933)	110500	23.5348	23.53
	34 Carbon Tetrachloride	117	4.909	4.909	(0.884)	94467	26.0465	26.04
$	35 1,2-Dichloroethane-d4	65	5.100	5.096	(1.059)	209146	59.4773	59.47
*	36 1,4-Difluorobenzene	114	5.554	5.550	(1.000)	545222	50.0000	
	37 Benzene	78	5.138	5.137	(0.925)	280028	21.0256	21.02
	38 Trichloroethene	130	5.790	5.786	(1.043)	82313	21.8668	21.86
	39 Bromodichloromethane	83	6.281	6.277	(1.131)	89132	20.9247	20.92
	42 1,2-Dichloropropane	63	6.011	6.011	(1.082)	72972	20.4432	20.44
	44 Dibromomethane	93	6.120	6.120	(1.102)	47310	20.6351	20.63
	45 4-Methyl-2-Pentanone	43	6.858	6.858	(0.838)	162122	42.8835	42.88
	46 cis-1,3-Dichloropropene	75	6.693	6.689	(1.205)	92456	18.4781	18.47
*	47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	508088	50.0000	
$	48 Toluene-d8	98	6.922	6.922	(0.846)	633154	53.5766	53.57
	50 Toluene	91	6.982	6.982	(0.853)	303134	21.9441	21.94
	51 trans-1,3-Dichloropropene	75	7.199	7.195	(1.296)	79165	19.2815	19.28
	52 2-Hexanone	43	7.593	7.593	(0.928)	112155	44.8013	44.80
	53 1,1,2-Trichloroethane	83	7.357	7.357	(0.899)	58603	19.8074	19.80
	54 1,3-Dichloropropane	76	7.499	7.499	(0.916)	123479	20.3456	20.34
	55 Dibromochloromethane	129	7.691	7.694	(0.940)	74463	20.5082	20.50
	56 Tetrachloroethene	164	7.458	7.458	(0.911)	78872	23.4844	23.48
	57 1,2-Dibromoethane	107	7.784	7.784	(0.951)	76358	21.4537	21.45
	58 1-Chlorohexane	55	8.197	8.196	(1.476)	68306	23.9916	23.99
	59 Chlorobenzene	112	8.208	8.208	(1.003)	205649	21.0005	21.00
	60 1,1,1,2-Tetrachloroethane	131	8.283	8.283	(1.012)	73529	20.6016	20.60
	61 Ethylbenzene	106	8.305	8.305	(1.015)	102224	23.0587	23.05
	62 m,p-Xylenes	106	8.410	8.410	(1.027)	263731	50.6741	50.67
	63 o-Xylene	106	8.748	8.747	(1.069)	128810	25.2991	25.29
	64 Styrene	104	8.763	8.762	(1.071)	190026	23.9178	23.91
	66 Bromoform	173	8.920	8.920	(1.090)	51755	20.4031	20.40
	67 Isopropylbenzene	105	9.063	9.062	(1.107)	319263	25.9138	25.91
	68 1,1,2,2-Tetrachloroethane	83	9.329	9.328	(0.917)	104418	17.8321	17.83
$	69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	248872	54.0670	54.06
*	70 1,4-Dichlorobenzene-d4	152	10.172	10.172	(1.000)	304006	50.0000	
	71 1,2,3-Trichloropropane	75	9.362	9.362	(0.920)	93651	18.3691	18.36
	73 n-Propylbenzene	91	9.411	9.411	(0.925)	362776	22.1510	22.15
	74 Bromobenzene	156	9.317	9.317	(0.916)	94546	18.7989	18.79
	75 1,3,5-Trimethylbenzene	105	9.561	9.561	(0.940)	255654	24.0629	24.06
	76 2-Chlorotoluene	91	9.482	9.482	(0.932)	227536	21.2298	21.22
	77 4-Chlorotoluene	91	9.576	9.576	(0.941)	271090	22.6444	22.64
	78 tert-Butylbenzene	119	9.835	9.838	(0.967)	234086	23.2569	23.25
	79 1,2,4-Trimethylbenzene	105	9.880	9.880	(0.971)	267578	24.8706	24.87
	81 sec-Butylbenzene	105	10.022	10.022	(0.985)	300709	27.7517	27.75
	82 p-Isopropyltoluene	119	10.146	10.146	(0.997)	263146	29.3998	29.39
	83 1,3-Dichlorobenzene	146	10.116	10.116	(0.994)	174981	20.8457	20.84
	84 1,4-Dichlorobenzene	146	10.191	10.191	(1.002)	180021	19.3529	19.35
	87 n-Butylbenzene	91	10.495	10.491	(1.032)	222161	23.0375	23.03
	88 1,2-Dichlorobenzene	146	10.506	10.506	(1.033)	175258	20.3495	20.34
	89 1,2-Dibromo-3-Chloropropane	155	11.169	11.169	(1.098)	15238	18.0493	18.04

90 1,2,4-Trichlorobenzene	180	11.859	11.859 (1.166)	111455	21.0370	21.03
91 Hexachlorobutadiene	225	11.998	11.998 (1.179)	55012	30.0412	30.04

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	CONCENTRATIONS FINAL (ug/l)
	92 Naphthalene	128	12.069	12.065	(1.186)	279008	20.8963	20.89
	93 1,2,3-Trichlorobenzene	180	12.271	12.267	(1.206)	113364	20.9590	20.95
M	94 1,2-Dichloroethylene (total)	96				146646	46.1256	46.12
M	95 Xylenes (total)	106				392541	75.9732	75.97
	135 1,4-Dioxane	88	6.172	6.168	(1.282)	18205	313.212	313.21
	141 Cyclohexane	56	4.782	4.781	(0.993)	108650	23.8461	23.84
	138 Freon TF	101	2.337	2.333	(0.485)	63709	30.6448	30.64
	140 1,3-Butadiene	54	1.404	1.400	(0.292)	71957	22.2926	22.29
	147 Methylcyclohexane	55	5.951	5.947	(1.072)	182494	22.9799	22.97
	146 Methyl Acetate	43	2.716	2.708	(0.564)	54386	18.6969	18.69
	148 Tert-Butyl alcohol	59	2.975	2.963	(0.618)	145284	424.497	424.49
	149 Isopropyl Alcohol	45	2.570	2.558	(0.534)	79098	353.070	353.06
	72 trans-1,4-Dichloro-2-butene	53	9.377	9.377	(1.146)	15720	22.8801	22.88
	12 Isobutyl Alcohol	43	5.291	5.287	(1.099)	237317	413.327	413.32
	13 Acetonitrile	39	2.675	2.667	(0.556)	83538	223.083	223.08
	14 Allyl Chloride	41	2.675	2.667	(0.556)	170417	19.9243	19.92
	25 Methacrylonitrile	41	4.500	4.493	(0.935)	46283	20.3297	20.32
	40 Methyl Methacrylate	41	6.161	6.157	(1.279)	70740	20.1959	20.19
	4 Propionitrile	54	4.343	4.335	(0.902)	96739	201.010	201.00(a)
	136 n-Hexane	57	3.342	3.338	(0.694)	69289	23.5460	23.54
	131 Methyl Acrylate	55	4.373	4.365	(0.908)	77880	20.0817	20.08
	200 Dimethyl Disulfide	94	6.746	6.746	(0.824)	45404	15.2829	15.28
	49 Ethyl Methacrylate	69	7.293	7.293	(1.313)	112839	22.5709	22.57
	166 1,2,3-Trimethylbenzene	105	10.232	10.232	(1.006)	262647	24.2043	24.20
	167 Ethanol	45	2.086	2.079	(0.433)	16594	382.634	382.63
	164 Dicyclopentadiene	66	10.202	10.198	(1.003)	232559	18.0463	18.04
	145 alpha-Methylstyrene	118	9.756	9.756	(0.959)	86418	18.8110	18.81
	142 Tetrahydrofuran	42	4.549	4.541	(0.945)	29840	43.9894	43.98
	156 Diisopropyl ether	45	3.623	3.619	(0.752)	199834	20.8628	20.86
	151 4-Methyl-2-pentanol	45	7.222	7.222	(1.300)	400424	564.804	564.80
	150 Allyl alcohol	57	3.342	3.338	(0.694)	69289	629.586	629.58
	86 Benzyl Chloride	91	10.311	10.311	(1.260)	58098	18.9345	18.93
	162 Butyl acrylate	55	8.736	8.732	(1.067)	137380	22.6595	22.65
	139 Diethyl ether	59	2.146	2.142	(0.446)	50799	22.1319	22.13
	203 2-Ethylhexyl Acrylate	55	12.043	12.043	(1.184)	59235	20.0255	20.02
	134 Cyclohexanone	55	9.156	9.152	(0.900)	53264	283.381	283.38(a)
	130 Ethyl Acetate	43	4.347	4.339	(0.903)	73608	20.0807	20.08
	189 n-Butyl acetate	43	7.709	7.705	(0.942)	125865	22.4412	22.44
	132 n-Butanol	56	5.835	5.827	(1.212)	35942	332.494	332.49(a)
	133 Ethyl Acrylate	55	5.951	5.947	(1.236)	182494	21.8426	21.84
	163 Butyl methacrylate	41	9.651	9.651	(0.949)	88489	23.1201	23.12

QC Flag Legend

a - Target compound detected but, quantitated amount
Below Limit Of Quantitation(BLOQ).
A - Target compound detected but, quantitated amount
exceeded maximum amount.

01226504

Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080814.d

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Date : 08-AUG-2023 15:53

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Instrument: VOA9.i

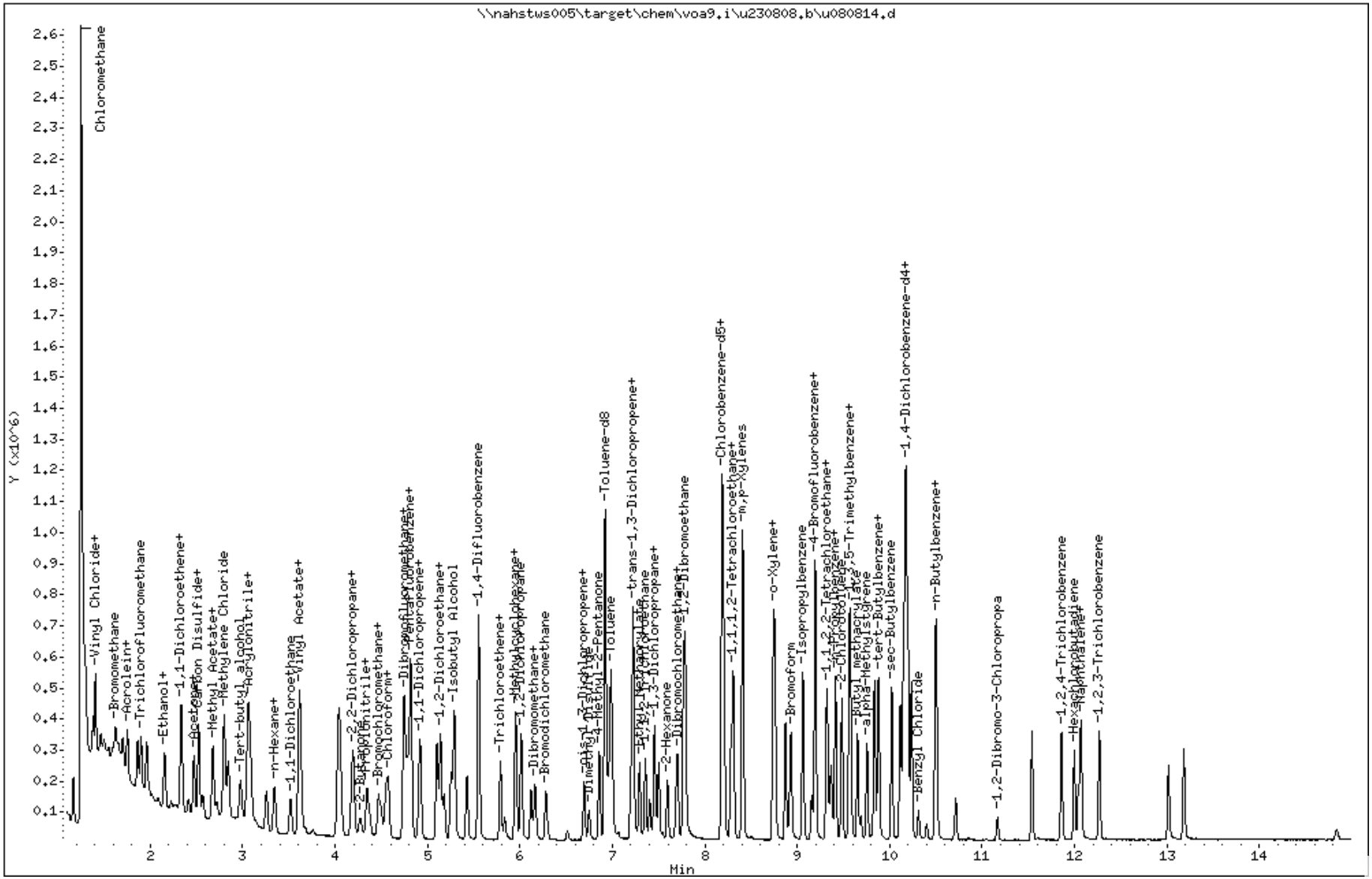
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Operator: PC

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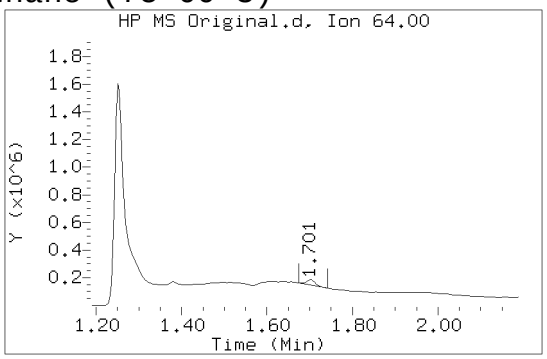


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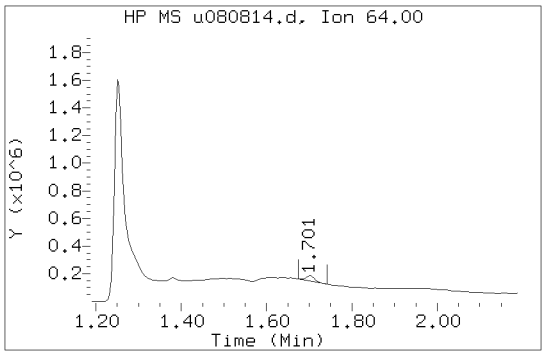
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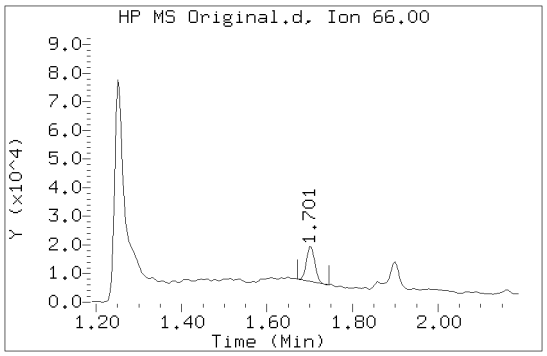
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22:32



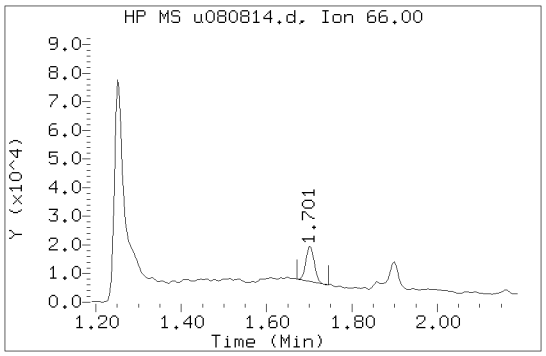
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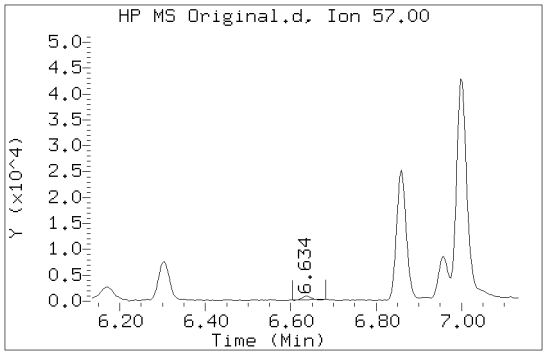
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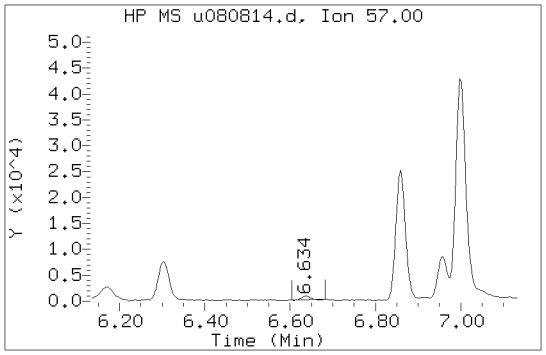
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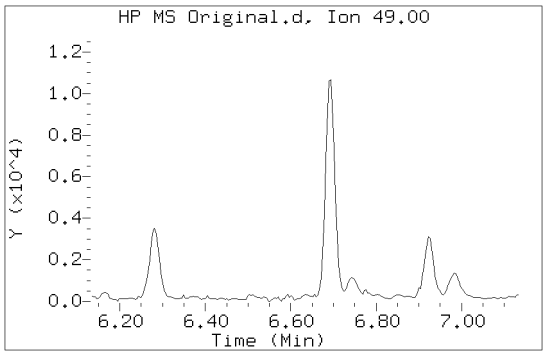
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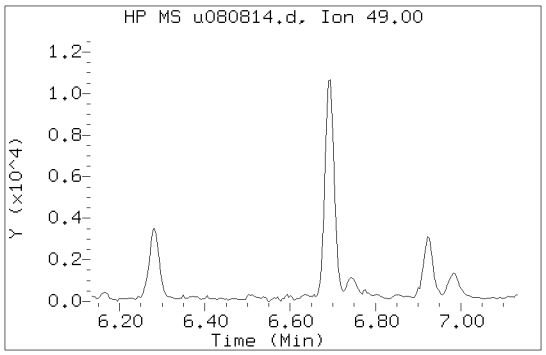
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AFTER
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08-Aug-2023
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Data File: \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080815.D Page 1
Report Date: 08-Aug-2023 22:32

ALS Laboratory Group

Data file : \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080815.D
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Cal Date : 31-JUL-2023 14:06 Cal File: U073108.D
Als bottle: 13 QC Sample: MSD
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 8260_GB.sub
Target Version: 4.14
Processing Host: NAHSTWS005

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	FINAL (ug/l)
* 1 Pentafluorobenzene	168	4.812	4.812	(1.000)	463959	50.0000	
2 Dichlorodifluoromethane	85	1.160	1.157	(0.241)	79706	18.7533	18.75
3 Chloromethane	50	1.295	1.288	(0.269)	92569	16.7715	16.77
5 Vinyl Chloride	62	1.374	1.366	(0.286)	87374	19.1273	19.12
6 Bromomethane	94	1.614	1.610	(0.335)	27793	10.0141	10.01
7 Chloroethane	64	1.696	1.689	(0.353)	63274	21.9962	21.99(M)
8 Trichlorofluoromethane	101	1.891	1.888	(0.393)	119716	21.2340	21.23
9 Acrolein	56	1.745	1.741	(0.363)	11859	39.8491	39.84
10 Acetone	43	2.405	2.401	(0.500)	52838	31.1905	31.19
11 1,1-Dichloroethene	96	2.330	2.322	(0.484)	62753	20.5292	20.52
15 Iodomethane	142	2.465	2.461	(0.512)	194718	68.5305	68.53
16 Acrylonitrile	53	3.065	3.057	(0.637)	53888	36.9509	36.95
17 Methylene Chloride	84	2.791	2.787	(0.580)	66992	17.9168	17.91
18 Methyl tert-butyl ether	73	3.080	3.072	(0.640)	193531	20.4839	20.48
19 Carbon Disulfide	76	2.517	2.514	(0.523)	387125	43.5030	43.50
20 trans-1,2-Dichloroethene	96	3.057	3.050	(0.635)	65888	19.2348	19.23
21 Vinyl Acetate	43	3.604	3.601	(0.749)	375309	38.2840	38.28
22 1,1-Dichloroethane	63	3.511	3.507	(0.730)	115357	18.4243	18.42
24 2-Butanone	43	4.268	4.260	(0.887)	61799	33.9051	33.90
26 2,2-Dichloropropane	77	4.182	4.174	(0.869)	90633	20.9946	20.99

27	cis-1,2-Dichloroethene	96	4.193	4.189 (0.871)	84589	22.1225	22.12
28	Chloroform	83	4.572	4.568 (0.950)	134383	18.4434	18.44

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	FINAL (ug/l)
	29 Bromochloromethane	128	4.467	4.463	(0.928)	40391	17.8518	17.85
$	30 Dibromofluoromethane	113	4.748	4.744	(0.987)	192671	51.9606	51.96
	31 1,1,1-Trichloroethane	97	4.740	4.737	(0.985)	115695	20.4096	20.40
	32 1,1-Dichloropropene	75	4.917	4.916	(0.886)	97581	21.0955	21.09
	33 1,2-Dichloroethane	62	5.175	5.171	(0.932)	111924	20.8638	20.86
	34 Carbon Tetrachloride	117	4.909	4.905	(0.885)	96898	23.3832	23.38
$	35 1,2-Dichloroethane-d4	65	5.096	5.093	(1.059)	220460	54.6739	54.67
*	36 1,4-Difluorobenzene	114	5.550	5.550	(1.000)	622950	50.0000	
	37 Benzene	78	5.138	5.134	(0.926)	296951	19.5142	19.51
	38 Trichloroethene	130	5.786	5.786	(1.043)	88085	20.4805	20.48
	39 Bromodichloromethane	83	6.277	6.277	(1.131)	94591	19.4355	19.43
	42 1,2-Dichloropropane	63	6.007	6.007	(1.082)	76383	18.7287	18.72
	44 Dibromomethane	93	6.120	6.116	(1.103)	52373	19.9931	19.99
	45 4-Methyl-2-Pentanone	43	6.858	6.855	(0.838)	174804	39.8680	39.86
	46 cis-1,3-Dichloropropene	75	6.690	6.690	(1.205)	100345	17.6628	17.66
*	47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	589270	50.0000	
$	48 Toluene-d8	98	6.922	6.918	(0.846)	725660	52.9448	52.94
	50 Toluene	91	6.978	6.978	(0.853)	330383	20.6218	20.62
	51 trans-1,3-Dichloropropene	75	7.199	7.196	(1.297)	86021	18.3372	18.33
	52 2-Hexanone	43	7.593	7.593	(0.928)	119616	41.1989	41.19
	53 1,1,2-Trichloroethane	83	7.357	7.353	(0.899)	64003	18.6523	18.65
	54 1,3-Dichloropropane	76	7.499	7.499	(0.916)	131695	18.7099	18.70
	55 Dibromochloromethane	129	7.691	7.691	(0.940)	78403	18.6185	18.61
	56 Tetrachloroethene	164	7.458	7.454	(0.911)	88816	22.8019	22.80
	57 1,2-Dibromoethane	107	7.784	7.784	(0.951)	81822	19.8218	19.82
	58 1-Chlorohexane	55	8.197	8.197	(1.477)	74168	22.8001	22.80
	59 Chlorobenzene	112	8.208	8.208	(1.003)	226860	19.9749	19.97
	60 1,1,1,2-Tetrachloroethane	131	8.283	8.283	(1.012)	79237	19.1423	19.14
	61 Ethylbenzene	106	8.305	8.305	(1.015)	111149	21.6179	21.61
	62 m,p-Xylenes	106	8.410	8.407	(1.027)	290639	48.1508	48.15
	63 o-Xylene	106	8.748	8.748	(1.069)	138620	23.4750	23.47
	64 Styrene	104	8.759	8.759	(1.070)	212956	23.1112	23.11
	66 Bromoform	173	8.920	8.920	(1.090)	54949	18.6779	18.67
	67 Isopropylbenzene	105	9.063	9.063	(1.107)	346609	24.2575	24.25
	68 1,1,2,2-Tetrachloroethane	83	9.329	9.329	(0.917)	110414	16.7762	16.77
$	69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	279054	52.2260	52.22
*	70 1,4-Dichlorobenzene-d4	152	10.172	10.168	(1.000)	341696	50.0000	
	71 1,2,3-Trichloropropane	75	9.362	9.362	(0.920)	102486	17.8847	17.88
	73 n-Propylbenzene	91	9.411	9.411	(0.925)	383481	20.9301	20.93
	74 Bromobenzene	156	9.317	9.317	(0.916)	107544	19.0247	19.02
	75 1,3,5-Trimethylbenzene	105	9.561	9.561	(0.940)	278952	23.3597	23.35
	76 2-Chlorotoluene	91	9.482	9.482	(0.932)	240202	19.9395	19.93
	77 4-Chlorotoluene	91	9.576	9.576	(0.941)	288319	21.4270	21.42
	78 tert-Butylbenzene	119	9.835	9.835	(0.967)	256492	22.6721	22.67
	79 1,2,4-Trimethylbenzene	105	9.880	9.876	(0.971)	292615	24.1977	24.19
	81 sec-Butylbenzene	105	10.022	10.022	(0.985)	325927	26.8117	26.81
	82 p-Isopropyltoluene	119	10.146	10.146	(0.997)	289105	28.7752	28.77
	83 1,3-Dichlorobenzene	146	10.116	10.116	(0.994)	189273	20.0612	20.06
	84 1,4-Dichlorobenzene	146	10.191	10.191	(1.002)	200647	19.1911	19.19
	87 n-Butylbenzene	91	10.491	10.491	(1.031)	240020	22.2368	22.23
	88 1,2-Dichlorobenzene	146	10.506	10.506	(1.033)	187189	19.3374	19.33
	89 1,2-Dibromo-3-Chloropropane	155	11.166	11.166	(1.098)	16416	17.2998	17.29

90 1,2,4-Trichlorobenzene	180	11.859	11.859 (1.166)	123412	20.7245	20.72	
91 Hexachlorobutadiene	225	11.998	11.998 (1.179)	57245	27.9015	27.90	

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	CONCENTRATIONS ON-COLUMN (ug/l)	FINAL (ug/l)
	92 Naphthalene	128	12.069	12.065	(1.186)	324006	21.5370	21.53
	93 1,2,3-Trichlorobenzene	180	12.268	12.268	(1.206)	127036	20.8960	20.89
M	94 1,2-Dichloroethylene (total)	96				150477	41.3573	41.35
M	95 Xylenes (total)	106				429259	71.6258	71.62
	135 1,4-Dioxane	88	6.172	6.169	(1.283)	21881	328.929	328.92
	141 Cyclohexane	56	4.778	4.778	(0.993)	111846	21.4484	21.44
	138 Freon TF	101	2.330	2.326	(0.484)	62710	26.5093	26.50
	140 1,3-Butadiene	54	1.400	1.393	(0.291)	72092	19.5147	19.51
	147 Methylcyclohexane	55	5.947	5.944	(1.072)	196978	21.7089	21.70
	146 Methyl Acetate	43	2.712	2.705	(0.564)	54880	16.4848	16.48
	148 Tert-Butyl alcohol	59	2.971	2.960	(0.617)	143265	365.318	365.31
	149 Isopropyl Alcohol	45	2.562	2.555	(0.533)	84624	330.047	330.04
	72 trans-1,4-Dichloro-2-butene	53	9.377	9.377	(1.146)	16696	20.9528	20.95
	12 Isobutyl Alcohol	43	5.288	5.284	(1.099)	247551	376.718	376.71
	13 Acetonitrile	39	2.667	2.664	(0.554)	85340	199.124	199.12
	14 Allyl Chloride	41	2.671	2.664	(0.555)	174867	17.8635	17.86
	25 Methacrylonitrile	41	4.497	4.489	(0.935)	45074	17.2991	17.29
	40 Methyl Methacrylate	41	6.157	6.154	(1.280)	73693	18.3828	18.38
	4 Propionitrile	54	4.339	4.332	(0.902)	100965	183.305	183.30(a)
	131 Methyl Acrylate	55	4.369	4.362	(0.908)	83208	18.7468	18.74
	182 Epichlorohydrin	57	6.633	6.633	(1.195)	836	24.9899	24.98(M)

QC Flag Legend

a - Target compound detected but, quantitated amount
Below Limit Of Quantitation(BLOQ).
M - Compound response manually integrated.

01226511

Data File: \\nahstws005\target\chem\voa9.i\u230808.b\u080815.d

Date : 08-AUG-2023 16:16

Client ID: HS23080101-01MSD

Instrument: VOA9.i

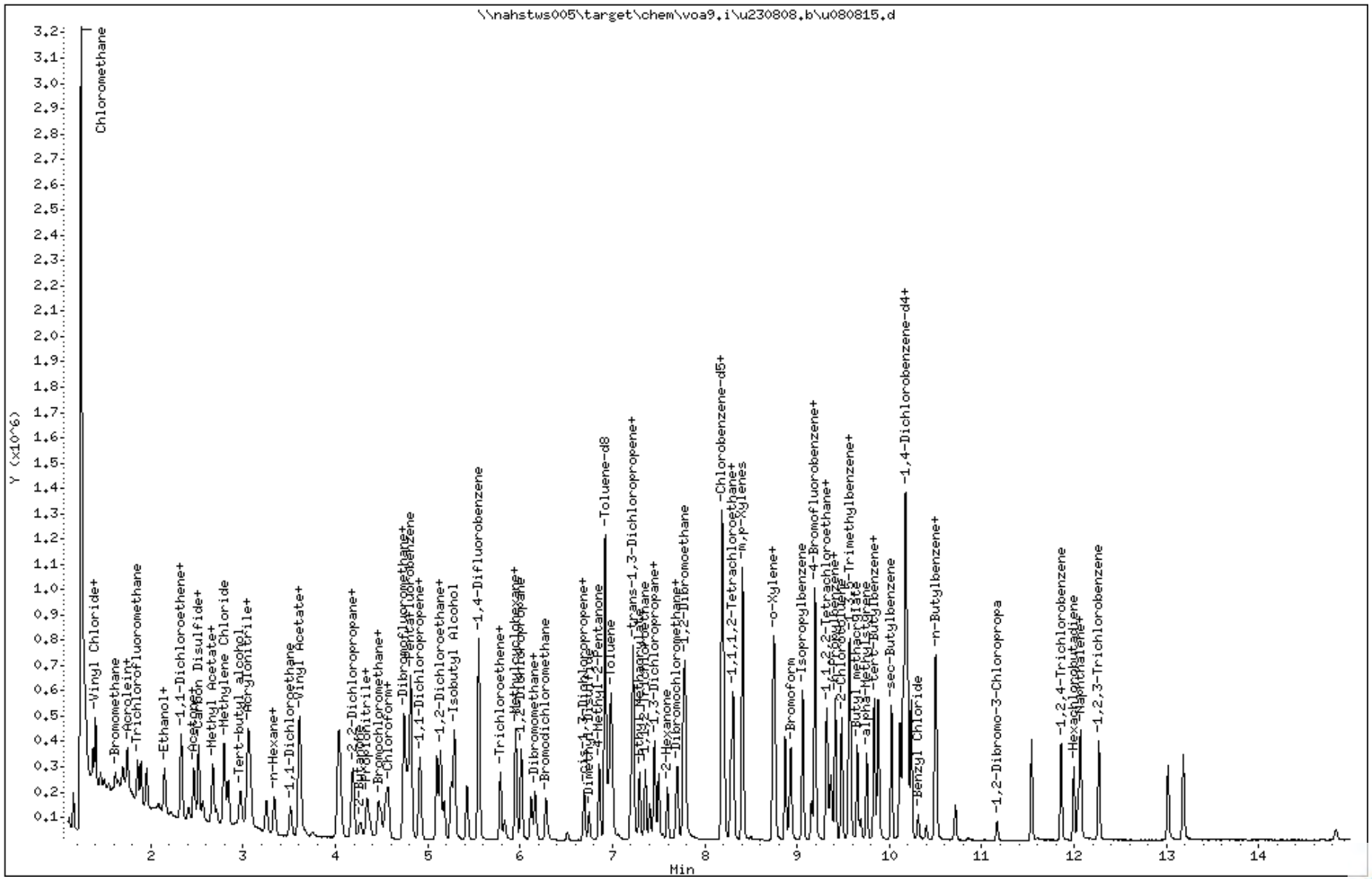
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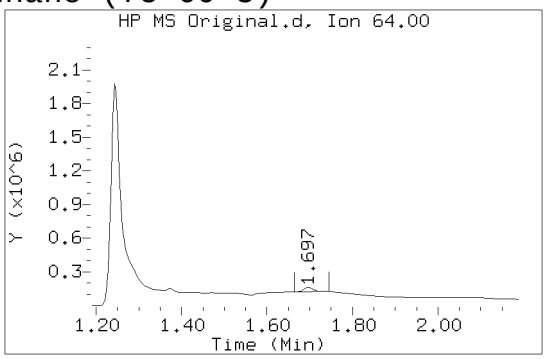


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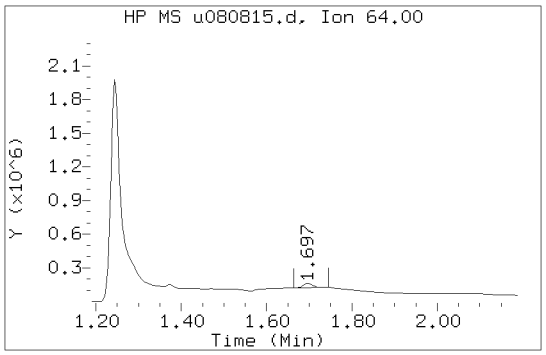
Chloroethane (75-00-3)

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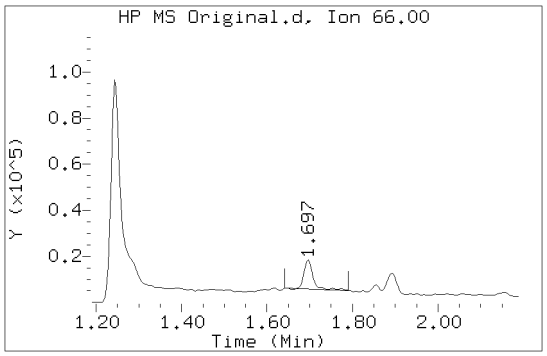
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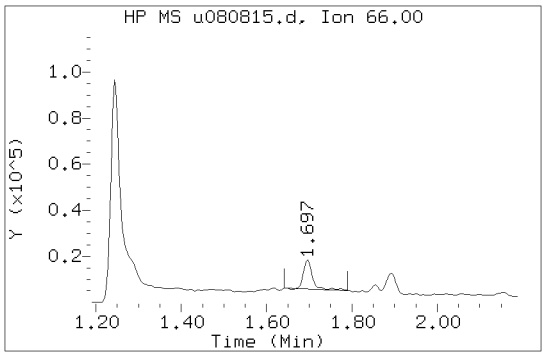
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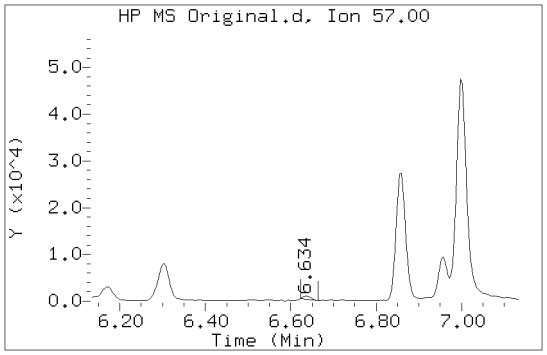
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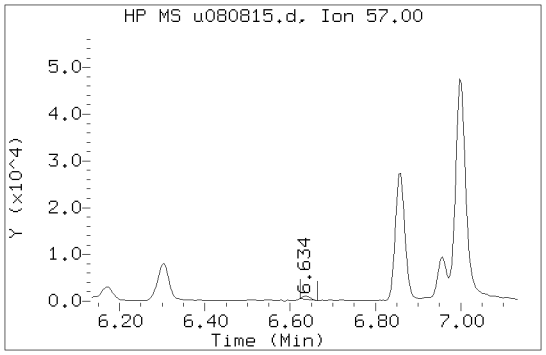
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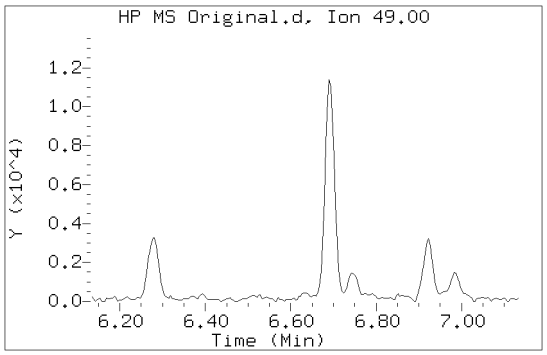
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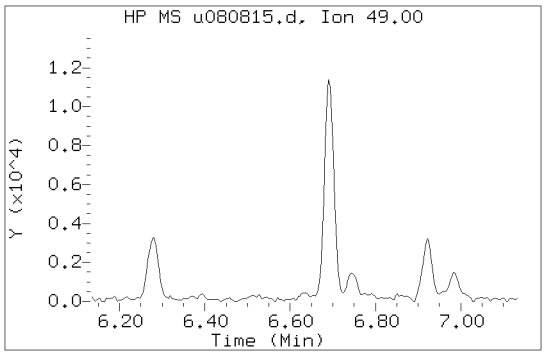
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AFTER
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08-Aug-2023
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Report Date: 08-Aug-2023 22:24

ALS Laboratory Group

Data file : \\NAHSTWS005\Target\chem\voa9.i\U230808.b\U080816.D
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Inj Date : 08-AUG-2023 16:38
Operator : PC Inst ID: VOA9.i
Smp Info : CCV-END;CCV-END;2;;;
Misc Info : V9;WATER;0;1;
Comment   :
Method   : \\nahstws005\Target\chem\voa9.i\U230808.b\8260C.m
Meth Date : 08-Aug-2023 22:23 VOA9.i Quant Type: ISTD
Cal Date : 31-JUL-2023 14:06 Cal File: U073108.D
Als bottle: 14 Continuing Calibration Sample
Dil Factor: 1.00000
Integrator: HP RTE Compound Sublist: 8260_GB.sub
Target Version: 4.14
Processing Host: NAHSTWS005

Concentration Formula: Amt * DF * (Uf/Vo)*1 * CpndVariable

Name	Value	Description
DF	1.000	Dilution Factor
Uf	5.000	ng unit correction factor
Vo	5.000	sample purged
Cpnd Variable		Local Compound Variable

Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
* 1 Pentafluorobenzene	168	4.812	4.812	(1.000)	417018	50.0000	
2 Dichlorodifluoromethane	85	1.157	1.157	(0.240)	158132	50.0000	39.87
3 Chloromethane	50	1.288	1.288	(0.268)	173991	50.0000	35.45
5 Vinyl Chloride	62	1.367	1.367	(0.284)	165560	50.0000	40.32
6 Bromomethane	94	1.610	1.610	(0.335)	86324	50.0000	38.63
7 Chloroethane	64	1.689	1.689	(0.351)	102684	50.0000	39.71(M)
8 Trichlorofluoromethane	101	1.888	1.888	(0.392)	225146	50.0000	44.42
9 Acrolein	56	1.741	1.741	(0.362)	18991	100.000	70.99
10 Acetone	43	2.401	2.401	(0.499)	125025	100.000	95.45
11 1,1-Dichloroethene	96	2.322	2.322	(0.483)	122076	50.0000	44.43
15 Iodomethane	142	2.461	2.461	(0.512)	302001	100.000	112.38
16 Acrylonitrile	53	3.057	3.057	(0.635)	124834	100.000	95.23
17 Methylene Chloride	84	2.787	2.787	(0.579)	151481	50.0000	45.36
18 Methyl tert-butyl ether	73	3.072	3.072	(0.639)	422238	50.0000	49.72
19 Carbon Disulfide	76	2.510	2.510	(0.522)	717990	100.000	89.76
20 trans-1,2-Dichloroethene	96	3.050	3.050	(0.634)	136007	50.0000	44.17
21 Vinyl Acetate	43	3.601	3.601	(0.748)	847874	100.000	96.22
22 1,1-Dichloroethane	63	3.507	3.507	(0.729)	243701	50.0000	43.30
24 2-Butanone	43	4.261	4.261	(0.885)	141897	100.000	86.61
26 2,2-Dichloropropane	77	4.174	4.174	(0.868)	182471	50.0000	47.02

27	cis-1,2-Dichloroethene	96	4.189	4.189 (0.871)	162678	50.0000	47.33
28	Chloroform	83	4.568	4.568 (0.949)	294276	50.0000	44.93

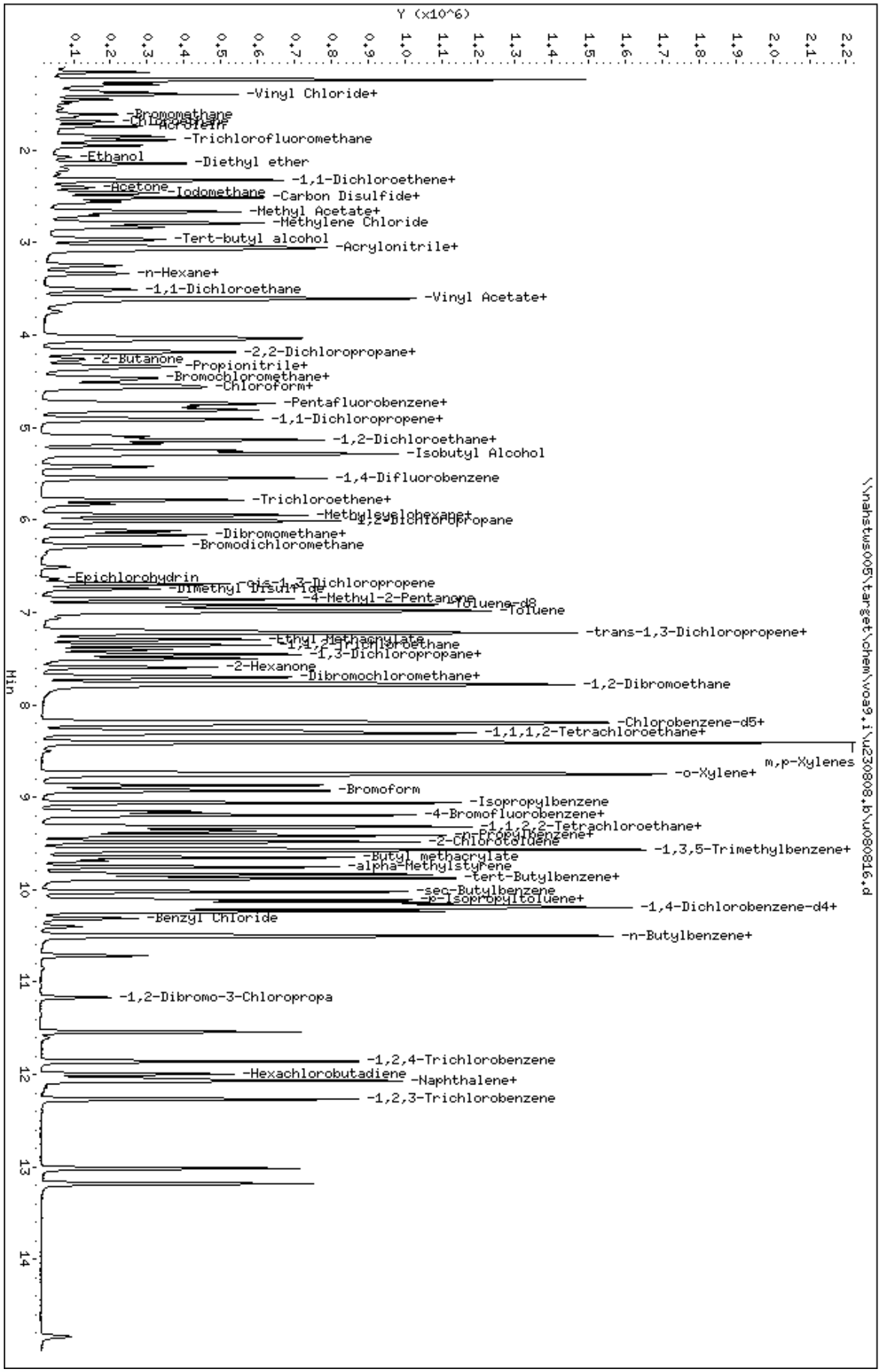
	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
	29 Bromochloromethane	128	4.463	4.463	(0.928)	90059	50.0000	44.28
$	30 Dibromofluoromethane	113	4.744	4.744	(0.986)	174891	50.0000	52.48
	31 1,1,1-Trichloroethane	97	4.737	4.737	(0.984)	229278	50.0000	44.99
	32 1,1-Dichloropropene	75	4.917	4.917	(0.886)	191335	50.0000	43.72
	33 1,2-Dichloroethane	62	5.171	5.171	(0.932)	246166	50.0000	48.50
	34 Carbon Tetrachloride	117	4.905	4.905	(0.884)	166434	50.0000	42.45
$	35 1,2-Dichloroethane-d4	65	5.093	5.093	(1.058)	195217	50.0000	53.84
*	36 1,4-Difluorobenzene	114	5.550	5.550	(1.000)	589312	50.0000	
	37 Benzene	78	5.134	5.134	(0.925)	637823	50.0000	44.30
	38 Trichloroethene	130	5.786	5.786	(1.043)	181496	50.0000	44.60
	39 Bromodichloromethane	83	6.277	6.277	(1.131)	216181	50.0000	46.95
	42 1,2-Dichloropropane	63	6.007	6.007	(1.082)	173730	50.0000	45.02
	44 Dibromomethane	93	6.116	6.116	(1.102)	115987	50.0000	46.80
	45 4-Methyl-2-Pentanone	43	6.855	6.855	(0.837)	398111	100.000	93.94
	46 cis-1,3-Dichloropropene	75	6.690	6.690	(1.205)	254060	50.0000	43.58
*	47 Chlorobenzene-d5	117	8.185	8.185	(1.000)	569541	50.0000	
$	48 Toluene-d8	98	6.918	6.918	(0.845)	651268	50.0000	49.16
	50 Toluene	91	6.978	6.978	(0.853)	689043	50.0000	44.49
	51 trans-1,3-Dichloropropene	75	7.196	7.196	(1.296)	216600	50.0000	48.80
	52 2-Hexanone	43	7.593	7.593	(0.928)	268236	100.000	95.58
	53 1,1,2-Trichloroethane	83	7.353	7.353	(0.898)	143553	50.0000	43.28
	54 1,3-Dichloropropane	76	7.499	7.499	(0.916)	303103	50.0000	44.55
	55 Dibromochloromethane	129	7.691	7.691	(0.940)	190748	50.0000	46.86
	56 Tetrachloroethene	164	7.454	7.454	(0.911)	157234	50.0000	41.76
	57 1,2-Dibromoethane	107	7.784	7.784	(0.951)	187281	50.0000	46.94
	58 1-Chlorohexane	55	8.197	8.197	(1.477)	128192	50.0000	41.65
	59 Chlorobenzene	112	8.208	8.208	(1.003)	492306	50.0000	44.84
	60 1,1,1,2-Tetrachloroethane	131	8.283	8.283	(1.012)	179682	50.0000	44.91
	61 Ethylbenzene	106	8.305	8.305	(1.015)	229885	50.0000	46.26
	62 m,p-Xylenes	106	8.407	8.407	(1.027)	595510	100.000	102.07
	63 o-Xylene	106	8.748	8.748	(1.069)	295498	50.0000	51.77
	64 Styrene	104	8.759	8.759	(1.070)	489442	50.0000	54.95
	66 Bromoform	173	8.920	8.920	(1.090)	135935	50.0000	47.80
	67 Isopropylbenzene	105	9.063	9.063	(1.107)	684522	50.0000	49.56
	68 1,1,2,2-Tetrachloroethane	83	9.329	9.329	(0.917)	254304	50.0000	40.09
$	69 4-Bromofluorobenzene	95	9.194	9.194	(1.123)	279188	50.0000	54.10
*	70 1,4-Dichlorobenzene-d4	152	10.172	10.172	(1.000)	329276	50.0000	
	71 1,2,3-Trichloropropane	75	9.362	9.362	(0.920)	243038	50.0000	44.01
	73 n-Propylbenzene	91	9.411	9.411	(0.925)	773621	50.0000	42.02
	74 Bromobenzene	156	9.317	9.317	(0.916)	237652	50.0000	43.62
	75 1,3,5-Trimethylbenzene	105	9.561	9.561	(0.940)	564592	50.0000	49.06
	76 2-Chlorotoluene	91	9.482	9.482	(0.932)	521228	50.0000	44.89
	77 4-Chlorotoluene	91	9.576	9.576	(0.941)	600948	50.0000	46.34
	78 tert-Butylbenzene	119	9.839	9.839	(0.967)	500035	50.0000	45.86
	79 1,2,4-Trimethylbenzene	105	9.880	9.880	(0.971)	596034	50.0000	51.14
	81 sec-Butylbenzene	105	10.022	10.022	(0.985)	627537	50.0000	50.20
	82 p-Isopropyltoluene	119	10.146	10.146	(0.997)	573518	50.0000	54.81
	83 1,3-Dichlorobenzene	146	10.112	10.112	(0.994)	403387	50.0000	44.36
	84 1,4-Dichlorobenzene	146	10.191	10.191	(1.002)	426668	50.0000	42.34
	87 n-Butylbenzene	91	10.491	10.491	(1.031)	468007	50.0000	42.54
	88 1,2-Dichlorobenzene	146	10.506	10.506	(1.033)	413283	50.0000	44.30
	89 1,2-Dibromo-3-Chloropropane	155	11.166	11.166	(1.098)	40251	50.0000	44.01

90 1,2,4-Trichlorobenzene	180	11.859	11.859 (1.166)	279198	50.0000	48.65
91 Hexachlorobutadiene	225	11.998	11.998 (1.179)	103612	50.0000	49.66

	Compounds	QUANT SIG MASS	RT	EXP RT	REL RT	RESPONSE	AMOUNTS CAL-AMT (ug/l)	ON-COL (ug/l)
	92 Naphthalene	128	12.065	12.065	(1.186)	706509	50.0000	46.72
	93 1,2,3-Trichlorobenzene	180	12.268	12.268	(1.206)	279429	50.0000	47.69
M	94 1,2-Dichloroethylene (total)	96				298685	100.000	91.50
M	95 Xylenes (total)	106				891008	150.000	153.85
	135 1,4-Dioxane	88	6.169	6.169	(1.282)	51535	1000.00	861.91
	141 Cyclohexane	56	4.778	4.778	(0.993)	183311	50.0000	39.10
	138 Freon TF	101	2.326	2.326	(0.484)	105642	50.0000	47.49
	140 1,3-Butadiene	54	1.393	1.393	(0.290)	137926	50.0000	41.53
	147 Methylcyclohexane	55	5.944	5.944	(1.071)	376057	50.0000	43.81
	146 Methyl Acetate	43	2.705	2.705	(0.562)	136693	50.0000	45.68
	148 Tert-Butyl alcohol	59	2.963	2.963	(0.616)	357884	1000.00	1020.85
	149 Isopropyl Alcohol	45	2.559	2.559	(0.532)	216681	1000.00	940.21
	72 trans-1,4-Dichloro-2-butene	53	9.377	9.377	(1.146)	44290	50.0000	57.50
	12 Isobutyl Alcohol	43	5.288	5.288	(1.099)	565436	1000.00	957.32
	13 Acetonitrile	39	2.664	2.664	(0.554)	179701	500.000	466.49
	14 Allyl Chloride	41	2.664	2.664	(0.554)	389173	50.0000	44.23
	25 Methacrylonitrile	41	4.489	4.489	(0.933)	105355	50.0000	44.98
	40 Methyl Methacrylate	41	6.157	6.157	(1.280)	170020	50.0000	47.18
	4 Propionitrile	54	4.335	4.335	(0.901)	236258	500.000	477.21
	131 Methyl Acrylate	55	4.365	4.365	(0.907)	192287	50.0000	48.19
	182 Epichlorohydrin	57	6.633	6.633	(1.195)	10974	200.000	291.30

QC Flag Legend

M - Compound response manually integrated.



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Column phase: DB624

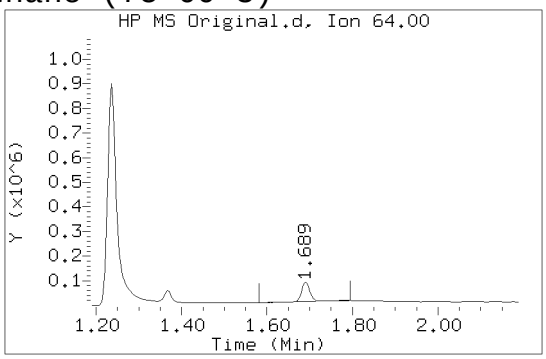
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Operator: PC
Column diameter: 0.18

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InstruID : VOA9.i
LabSampID : CCV-END

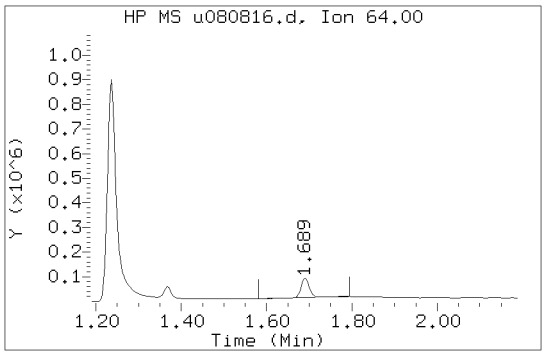
Chloroethane (75-00-3)

Reason Code:

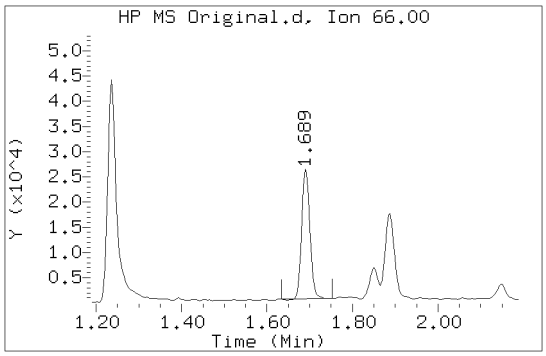
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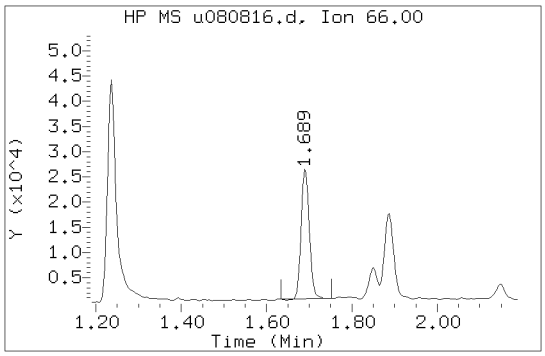
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BEFORE
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08-Aug-2023
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AFTER
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HEIGHT
25738
08-Aug-2023
22:24



10450 Stancliff Rd. Suite 210
Houston, TX 77099
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February 23, 2023

Marcia Olive
Bhate Environmental Associates, Inc.
445 Union Blvd Ste 129
Lakewood, CO 80228

Work Order: **HS23020407**

Laboratory Results for: **LHAAP-58**

Dear Marcia Olive,

ALS Environmental received 2 sample(s) on Feb 09, 2023 for the analysis presented in the following report.

The analytical data provided relates directly to the samples received by ALS Environmental and for only the analyses requested. Results are expressed as "as received" unless otherwise noted.

QC sample results for this data met EPA or laboratory specifications except as noted in the Case Narrative or as noted with qualifiers in the QC batch information. Should this laboratory report need to be reproduced, it should be reproduced in full unless written approval has been obtained by ALS Environmental. Samples will be disposed in 30 days unless storage arrangements are made.

If you have any questions regarding this report, please feel free to call me.

Sincerely,

Generated By: DANE.WACASEY
Dane J. Wacasey

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
Work Order: HS23020407

SAMPLE SUMMARY

Lab Samp ID	Client Sample ID	Matrix	TagNo	Collection Date	Date Received	Hold
HS23020407-01	LHAAP58IDW_020823	Soil		08-Feb-2023 10:00	09-Feb-2023 10:50	☐
HS23020407-02	Trip Blank	Water		08-Feb-2023 00:00	09-Feb-2023 10:50	☐

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc. **CASE NARRATIVE**
Project: LHAAP-58
Work Order: HS23020407

GCMS Volatiles by Method SW8260

Batch ID: R427645

- The test results meet requirements of the current NELAP standards, state requirements or programs where applicable.

Batch ID: R427823

Sample ID: CCV

- 2-Hexanone and Methylcyclohexane exceeded %D limits for CCV. The analytes were not detected in the associated samples.

Sample ID: HS23020267-03MS

- MS/MSD was performed on an unrelated sample.

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
Sample ID: LHAAP58IDW_020823
Collection Date: 08-Feb-2023 10:00

ANALYTICAL REPORT
WorkOrder:HS23020407
Lab ID:HS23020407-01
Matrix:Soil

ANALYSES	RESULT	QUAL	MDL	REPORT LIMIT	UNITS	DILUTION FACTOR	DATE ANALYZED
VOLATILES BY SW8260C	**Method:SW8260**						Analyst: WLR
1,1,1-Trichloroethane	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,1,2,2-Tetrachloroethane	< 0.00082		0.00082	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,1,2-Trichlor-1,2,2-trifluoroethane	< 0.00071		0.00071	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,1,2-Trichloroethane	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,1-Dichloroethane	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,1-Dichloroethene	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,2,4-Trichlorobenzene	< 0.0010		0.0010	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,2-Dibromo-3-chloropropane	< 0.0010		0.0010	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,2-Dibromoethane	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,2-Dichlorobenzene	< 0.0010		0.0010	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,2-Dichloroethane	< 0.00061		0.00061	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,2-Dichloropropane	< 0.00082		0.00082	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,3-Dichlorobenzene	< 0.0010		0.0010	0.0051	mg/Kg	1	09-Feb-2023 14:59
1,4-Dichlorobenzene	< 0.0010		0.0010	0.0051	mg/Kg	1	09-Feb-2023 14:59
2-Butanone	< 0.0013		0.0013	0.010	mg/Kg	1	09-Feb-2023 14:59
2-Hexanone	< 0.0014		0.0014	0.010	mg/Kg	1	09-Feb-2023 14:59
4-Methyl-2-pentanone	< 0.0020		0.0020	0.010	mg/Kg	1	09-Feb-2023 14:59
Acetone	< 0.0020		0.0020	0.020	mg/Kg	1	09-Feb-2023 14:59
Benzene	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
Bromodichloromethane	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
Bromoform	< 0.00061		0.00061	0.0051	mg/Kg	1	09-Feb-2023 14:59
Bromomethane	< 0.0010		0.0010	0.010	mg/Kg	1	09-Feb-2023 14:59
Carbon disulfide	< 0.00061		0.00061	0.010	mg/Kg	1	09-Feb-2023 14:59
Carbon tetrachloride	< 0.00061		0.00061	0.0051	mg/Kg	1	09-Feb-2023 14:59
Chlorobenzene	< 0.00061		0.00061	0.0051	mg/Kg	1	09-Feb-2023 14:59
Chloroethane	< 0.00082		0.00082	0.010	mg/Kg	1	09-Feb-2023 14:59
Chloroform	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
Chloromethane	< 0.00051		0.00051	0.010	mg/Kg	1	09-Feb-2023 14:59
cis-1,2-Dichloroethene	< 0.00082		0.00082	0.0051	mg/Kg	1	09-Feb-2023 14:59
cis-1,3-Dichloropropene	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
Cyclohexane	< 0.0010	n	0.0010	0.0051	mg/Kg	1	09-Feb-2023 14:59
Dibromochloromethane	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
Dichlorodifluoromethane	< 0.00071		0.00071	0.0051	mg/Kg	1	09-Feb-2023 14:59
Ethylbenzene	< 0.00071		0.00071	0.0051	mg/Kg	1	09-Feb-2023 14:59
Isopropylbenzene	< 0.00092		0.00092	0.0051	mg/Kg	1	09-Feb-2023 14:59
m,p-Xylene	< 0.0016		0.0016	0.010	mg/Kg	1	09-Feb-2023 14:59
Methyl acetate	< 0.00071		0.00071	0.0051	mg/Kg	1	09-Feb-2023 14:59
Methyl tert-butyl ether	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
Methylcyclohexane	< 0.0010		0.0010	0.0051	mg/Kg	1	09-Feb-2023 14:59

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
Sample ID: LHAAP58IDW_020823
Collection Date: 08-Feb-2023 10:00

ANALYTICAL REPORT
WorkOrder:HS23020407
Lab ID:HS23020407-01
Matrix:Soil

ANALYSES	RESULT	QUAL	MDL	REPORT LIMIT	UNITS	DILUTION FACTOR	DATE ANALYZED
VOLATILES BY SW8260C	**Method:SW8260**						Analyst: WLR
Methylene chloride	< 0.0010		0.0010	0.010	mg/Kg	1	09-Feb-2023 14:59
o-Xylene	< 0.0010		0.0010	0.0051	mg/Kg	1	09-Feb-2023 14:59
Styrene	< 0.00071		0.00071	0.0051	mg/Kg	1	09-Feb-2023 14:59
Tetrachloroethene	< 0.00071		0.00071	0.0051	mg/Kg	1	09-Feb-2023 14:59
Toluene	< 0.00061		0.00061	0.0051	mg/Kg	1	09-Feb-2023 14:59
trans-1,2-Dichloroethene	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
trans-1,3-Dichloropropene	< 0.00061		0.00061	0.0051	mg/Kg	1	09-Feb-2023 14:59
Trichloroethene	< 0.00061		0.00061	0.0051	mg/Kg	1	09-Feb-2023 14:59
Trichlorofluoromethane	< 0.00051		0.00051	0.0051	mg/Kg	1	09-Feb-2023 14:59
Vinyl chloride	< 0.00082		0.00082	0.0020	mg/Kg	1	09-Feb-2023 14:59
Xylenes, Total	< 0.0010		0.0010	0.0051	mg/Kg	1	09-Feb-2023 14:59
Surr: 1,2-Dichloroethane-d4	*92.8*			*70-126*	*%REC*	*1*	*09-Feb-2023 14:59*
Surr: 4-Bromofluorobenzene	*97.6*			*70-130*	*%REC*	*1*	*09-Feb-2023 14:59*
Surr: Dibromofluoromethane	*76.3*			*70-130*	*%REC*	*1*	*09-Feb-2023 14:59*
Surr: Toluene-d8	*93.8*			*70-130*	*%REC*	*1*	*09-Feb-2023 14:59*

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
Sample ID: Trip Blank
Collection Date: 08-Feb-2023 00:00

ANALYTICAL REPORT
WorkOrder:HS23020407
Lab ID:HS23020407-02
Matrix:Water

ANALYSES	RESULT	QUAL	MDL	REPORT LIMIT	UNITS	DILUTION FACTOR	DATE ANALYZED
VOLATILES ORGANICS BY METHOD 8260C	**Method:SW8260**						Analyst: PC
1,1,1-Trichloroethane	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
1,1,2,2-Tetrachloroethane	< 0.00050		0.00050	0.0010	mg/L	1	10-Feb-2023 18:06
1,1,2-Trichlor-1,2,2-trifluoroethane	< 0.00050		0.00050	0.0010	mg/L	1	10-Feb-2023 18:06
1,1,2-Trichloroethane	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
1,1-Dichloroethane	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
1,1-Dichloroethene	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
1,2,4-Trichlorobenzene	< 0.00050		0.00050	0.0010	mg/L	1	10-Feb-2023 18:06
1,2-Dibromo-3-chloropropane	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
1,2-Dibromoethane	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
1,2-Dichlorobenzene	< 0.00050		0.00050	0.0010	mg/L	1	10-Feb-2023 18:06
1,2-Dichloroethane	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
1,2-Dichloropropane	< 0.00050		0.00050	0.0010	mg/L	1	10-Feb-2023 18:06
1,3-Dichlorobenzene	< 0.00040		0.00040	0.0010	mg/L	1	10-Feb-2023 18:06
1,4-Dichlorobenzene	< 0.00040		0.00040	0.0010	mg/L	1	10-Feb-2023 18:06
2-Butanone	< 0.00050		0.00050	0.0020	mg/L	1	10-Feb-2023 18:06
2-Hexanone	< 0.0010		0.0010	0.0020	mg/L	1	10-Feb-2023 18:06
4-Methyl-2-pentanone	< 0.00070		0.00070	0.0020	mg/L	1	10-Feb-2023 18:06
Acetone	< 0.00040		0.00040	0.0020	mg/L	1	10-Feb-2023 18:06
Benzene	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
Bromodichloromethane	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
Bromoform	< 0.00040		0.00040	0.0010	mg/L	1	10-Feb-2023 18:06
Bromomethane	< 0.00040		0.00040	0.0010	mg/L	1	10-Feb-2023 18:06
Carbon disulfide	< 0.00060		0.00060	0.0020	mg/L	1	10-Feb-2023 18:06
Carbon tetrachloride	< 0.00050		0.00050	0.0010	mg/L	1	10-Feb-2023 18:06
Chlorobenzene	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
Chloroethane	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
Chloroform	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
Chloromethane	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
cis-1,2-Dichloroethene	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
cis-1,3-Dichloropropene	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
Cyclohexane	< 0.00030	n	0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
Dibromochloromethane	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
Dichlorodifluoromethane	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
Ethylbenzene	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
Isopropylbenzene	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
m,p-Xylene	< 0.00050		0.00050	0.0020	mg/L	1	10-Feb-2023 18:06
Methyl acetate	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
Methyl tert-butyl ether	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
Methylcyclohexane	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
Sample ID: Trip Blank
Collection Date: 08-Feb-2023 00:00

ANALYTICAL REPORT
WorkOrder:HS23020407
Lab ID:HS23020407-02
Matrix:Water

ANALYSES	RESULT	QUAL	MDL	REPORT LIMIT	UNITS	DILUTION FACTOR	DATE ANALYZED
VOLATILES ORGANICS BY METHOD 8260C	**Method:SW8260**						Analyst: PC
Methylene chloride	< 0.00040		0.00040	0.0020	mg/L	1	10-Feb-2023 18:06
o-Xylene	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
Styrene	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
Tetrachloroethene	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
Toluene	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
trans-1,2-Dichloroethene	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
trans-1,3-Dichloropropene	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
Trichloroethene	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
Trichlorofluoromethane	**0.0028**		**0.00030**	**0.0010**	**mg/L**	1	10-Feb-2023 18:06
Vinyl chloride	< 0.00020		0.00020	0.0010	mg/L	1	10-Feb-2023 18:06
Xylenes, Total	< 0.00030		0.00030	0.0010	mg/L	1	10-Feb-2023 18:06
Surr: 1,2-Dichloroethane-d4	*100*			*81-118*	*%REC*	*1*	*10-Feb-2023 18:06*
Surr: 4-Bromofluorobenzene	*107*			*85-114*	*%REC*	*1*	*10-Feb-2023 18:06*
Surr: Dibromofluoromethane	*94.1*			*80-119*	*%REC*	*1*	*10-Feb-2023 18:06*
Surr: Toluene-d8	*107*			*89-112*	*%REC*	*1*	*10-Feb-2023 18:06*

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 23-Feb-23

Weight / Prep Log

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

Batch ID: 5717 **Start Date:** 09 Feb 2023 13:38 **End Date:** 09 Feb 2023 13:38

Method: VOLATILES BY SW8260C

Sample ID	Container	Sample Wt/Vol	Final Volume	Weight Factor	Container Type
HS23020407-01	1	4.908 (g)	5 (mL)	1.02	Bulk (5030B)

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

DATES REPORT

Sample ID	Client Samp ID	Collection Date	Leachate Date	Prep Date	Analysis Date	DF
Batch ID: R427645 (0)	**Test Name :** VOLATILES BY SW8260C				**Matrix:** Soil	
HS23020407-01	LHAAP58IDW_020823	08 Feb 2023 10:00			09 Feb 2023 14:59	1
Batch ID: R427823 (0)	**Test Name :** VOLATILES ORGANICS BY METHOD 8260C				**Matrix:** Water	
HS23020407-02	Trip Blank	08 Feb 2023 00:00			10 Feb 2023 18:06	1

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427645 (0) **Instrument: VOA8** **Method: VOLATILES BY SW8260C**

MBLK Sample ID: **VBLKS1-020923** Units: **mg/Kg** Analysis Date: **09-Feb-2023 08:11**
Client ID: Run ID: **VOA8_427645** SeqNo: **7115669** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
1,1,1-Trichloroethane	< 0.00050	0.0050								
1,1,2,2-Tetrachloroethane	< 0.00080	0.0050								
1,1,2-Trichlor-1,2,2-trifluoroethane	< 0.00070	0.0050								
1,1,2-Trichloroethane	< 0.00050	0.0050								
1,1-Dichloroethane	< 0.00050	0.0050								
1,1-Dichloroethene	< 0.00050	0.0050								
1,2,4-Trichlorobenzene	< 0.0010	0.0050								
1,2-Dibromo-3-chloropropane	< 0.0010	0.0050								
1,2-Dibromoethane	< 0.00050	0.0050								
1,2-Dichlorobenzene	< 0.0010	0.0050								
1,2-Dichloroethane	< 0.00060	0.0050								
1,2-Dichloropropane	< 0.00080	0.0050								
1,3-Dichlorobenzene	< 0.0010	0.0050								
1,4-Dichlorobenzene	< 0.0010	0.0050								
2-Butanone	< 0.0013	0.010								
2-Hexanone	< 0.0014	0.010								
4-Methyl-2-pentanone	< 0.0020	0.010								
Acetone	< 0.0020	0.020								
Benzene	< 0.00050	0.0050								
Bromodichloromethane	< 0.00050	0.0050								
Bromoform	< 0.00060	0.0050								
Bromomethane	< 0.0010	0.010								
Carbon disulfide	< 0.00060	0.010								
Carbon tetrachloride	< 0.00060	0.0050								
Chlorobenzene	< 0.00060	0.0050								
Chloroethane	< 0.00080	0.010								
Chloroform	< 0.00050	0.0050								
Chloromethane	< 0.00050	0.010								
cis-1,2-Dichloroethene	< 0.00080	0.0050								
cis-1,3-Dichloropropene	< 0.00050	0.0050								
Cyclohexane	< 0.0010	0.0050								
Dibromochloromethane	< 0.00050	0.0050								
Dichlorodifluoromethane	< 0.00070	0.0050								
Ethylbenzene	< 0.00070	0.0050								

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427645 (0) **Instrument: VOA8** **Method: VOLATILES BY SW8260C**

MBLK Sample ID: **VBLKS1-020923** Units: **mg/Kg** Analysis Date: **09-Feb-2023 08:11**
Client ID: Run ID: **VOA8_427645** SeqNo: **7115669** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Isopropylbenzene	< 0.00090	0.0050								
m,p-Xylene	< 0.0016	0.010								
Methyl acetate	< 0.00070	0.0050								
Methyl tert-butyl ether	< 0.00050	0.0050								
Methylcyclohexane	< 0.0010	0.0050								
Methylene chloride	< 0.0010	0.010								
o-Xylene	< 0.0010	0.0050								
Styrene	< 0.00070	0.0050								
Tetrachloroethene	< 0.00070	0.0050								
Toluene	< 0.00060	0.0050								
trans-1,2-Dichloroethene	< 0.00050	0.0050								
trans-1,3-Dichloropropene	< 0.00060	0.0050								
Trichloroethene	< 0.00060	0.0050								
Trichlorofluoromethane	< 0.00050	0.0050								
Vinyl chloride	< 0.00080	0.0020								
Xylenes, Total	< 0.0010	0.0050								
Surr: 1,2-Dichloroethane-d4	*0.048*	*0*	*0.05*	*0*	*95.2*	*76 - 125*				
Surr: 4-Bromofluorobenzene	*0.049*	*0*	*0.05*	*0*	*98.9*	*80 - 120*				
Surr: Dibromofluoromethane	*0.040*	*0*	*0.05*	*0*	*80.9*	*80 - 119*				
Surr: Toluene-d8	*0.048*	*0*	*0.05*	*0*	*95.8*	*81 - 118*				

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427645 (0) **Instrument: VOA8** **Method: VOLATILES BY SW8260C**

LCS Sample ID: **VLCSS1-020923** Units: **mg/Kg** Analysis Date: **09-Feb-2023 07:31**
Client ID: Run ID: **VOA8_427645** SeqNo: **7115668** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
1,1,1-Trichloroethane	0.047	0.0050	0.05	0	94.9	72 - 130				
1,1,2,2-Tetrachloroethane	0.053	0.0050	0.05	0	106	71 - 124				
1,1,2-Trichlor-1,2,2-trifluoroethane	0.044	0.0050	0.05	0	87.4	70 - 130				
1,1,2-Trichloroethane	0.045	0.0050	0.05	0	89.5	78 - 117				
1,1-Dichloroethane	0.038	0.0050	0.05	0	76.1	76 - 128				
1,1-Dichloroethene	0.044	0.0050	0.05	0	88.5	72 - 130				
1,2,4-Trichlorobenzene	0.051	0.0050	0.05	0	103	70 - 128				
1,2-Dibromo-3-chloropropane	0.048	0.0050	0.05	0	96.8	70 - 128				
1,2-Dibromoethane	0.048	0.0050	0.05	0	95.5	78 - 120				
1,2-Dichlorobenzene	0.047	0.0050	0.05	0	93.9	79 - 121				
1,2-Dichloroethane	0.048	0.0050	0.05	0	96.2	77 - 120				
1,2-Dichloropropane	0.041	0.0050	0.05	0	82.5	77 - 121				
1,3-Dichlorobenzene	0.047	0.0050	0.05	0	94.1	78 - 121				
1,4-Dichlorobenzene	0.051	0.0050	0.05	0	101	78 - 120				
2-Butanone	0.096	0.010	0.1	0	96.2	70 - 128				
2-Hexanone	0.090	0.010	0.1	0	90.4	72 - 127				
4-Methyl-2-pentanone	0.097	0.010	0.1	0	97.5	70 - 128				
Acetone	0.098	0.020	0.1	0	98.5	70 - 130				
Benzene	0.046	0.0050	0.05	0	91.0	75 - 124				
Bromodichloromethane	0.046	0.0050	0.05	0	91.3	78 - 122				
Bromoform	0.044	0.0050	0.05	0	88.2	74 - 120				
Bromomethane	0.038	0.010	0.05	0	76.0	70 - 130				
Carbon disulfide	0.091	0.010	0.1	0	90.7	70 - 122				
Carbon tetrachloride	0.046	0.0050	0.05	0	92.8	72 - 128				
Chlorobenzene	0.047	0.0050	0.05	0	93.4	78 - 122				
Chloroethane	0.037	0.010	0.05	0	74.2	70 - 130				
Chloroform	0.041	0.0050	0.05	0	82.7	73 - 127				
Chloromethane	0.038	0.010	0.05	0	75.9	70 - 130				
cis-1,2-Dichloroethene	0.042	0.0050	0.05	0	83.9	77 - 125				
cis-1,3-Dichloropropene	0.044	0.0050	0.05	0	88.4	78 - 122				
Cyclohexane	0.048	0.0050	0.05	0	95.8	74 - 126				
Dibromochloromethane	0.046	0.0050	0.05	0	91.1	78 - 120				
Dichlorodifluoromethane	0.041	0.0050	0.05	0	81.3	70 - 130				
Ethylbenzene	0.047	0.0050	0.05	0	93.6	70 - 123				

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427645 (0) **Instrument: VOA8** **Method: VOLATILES BY SW8260C**

LCS Sample ID: **VLCSS1-020923** Units: **mg/Kg** Analysis Date: **09-Feb-2023 07:31**
Client ID: Run ID: **VOA8_427645** SeqNo: **7115668** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Isopropylbenzene	0.044	0.0050	0.05	0	87.6	78 - 127				
m,p-Xylene	0.099	0.010	0.1	0	98.8	77 - 125				
Methyl acetate	0.040	0.0050	0.05	0	79.9	69 - 123				
Methyl tert-butyl ether	0.050	0.0050	0.05	0	100	70 - 128				
Methylcyclohexane	0.042	0.0050	0.05	0	84.4	77 - 127				
Methylene chloride	0.043	0.010	0.05	0	86.6	71 - 125				
o-Xylene	0.048	0.0050	0.05	0	96.5	78 - 122				
Styrene	0.045	0.0050	0.05	0	90.0	80 - 123				
Tetrachloroethene	0.048	0.0050	0.05	0	95.0	70 - 130				
Toluene	0.048	0.0050	0.05	0	96.9	76 - 122				
trans-1,2-Dichloroethene	0.050	0.0050	0.05	0	99.3	75 - 128				
trans-1,3-Dichloropropene	0.043	0.0050	0.05	0	86.2	75 - 123				
Trichloroethene	0.046	0.0050	0.05	0	91.2	78 - 125				
Trichlorofluoromethane	0.036	0.0050	0.05	0	71.2	70 - 130				
Vinyl chloride	0.038	0.0020	0.05	0	76.1	70 - 130				
Xylenes, Total	0.15	0.0050	0.15	0	98.0	77 - 128				
Surr: 1,2-Dichloroethane-d4	*0.046*	*0*	*0.05*	*0*	*92.6*	*76 - 125*				
Surr: 4-Bromofluorobenzene	*0.048*	*0*	*0.05*	*0*	*96.4*	*80 - 120*				
Surr: Dibromofluoromethane	*0.043*	*0*	*0.05*	*0*	*85.2*	*80 - 119*				
Surr: Toluene-d8	*0.051*	*0*	*0.05*	*0*	*102*	*81 - 118*				

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427645 (0) **Instrument: VOA8** **Method: VOLATILES BY SW8260C**

MS Sample ID: **HS23020339-04MS** Units: **mg/Kg** Analysis Date: **09-Feb-2023 09:33**
Client ID: Run ID: **VOA8_427645** SeqNo: **7116101** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
1,1,1-Trichloroethane	0.043	0.0036	0.0355	0	121	70 - 130				
1,1,2,2-Tetrachloroethane	0.044	0.0036	0.0355	0	123	70 - 130				
1,1,2-Trichlor-1,2,2-trifluoroethane	0.036	0.0036	0.0355	0	103	70 - 130				
1,1,2-Trichloroethane	0.037	0.0036	0.0355	0	105	70 - 130				
1,1-Dichloroethane	0.037	0.0036	0.0355	0	104	70 - 130				
1,1-Dichloroethene	0.038	0.0036	0.0355	0	108	70 - 130				
1,2,4-Trichlorobenzene	0.037	0.0036	0.0355	0	104	70 - 130				
1,2-Dibromo-3-chloropropane	0.039	0.0036	0.0355	0	109	70 - 130				
1,2-Dibromoethane	0.039	0.0036	0.0355	0	111	70 - 120				
1,2-Dichlorobenzene	0.037	0.0036	0.0355	0	105	70 - 130				
1,2-Dichloroethane	0.036	0.0036	0.0355	0	101	70 - 130				
1,2-Dichloropropane	0.037	0.0036	0.0355	0	103	70 - 130				
1,3-Dichlorobenzene	0.038	0.0036	0.0355	0	106	70 - 130				
1,4-Dichlorobenzene	0.041	0.0036	0.0355	0	114	70 - 130				
2-Butanone	0.075	0.0071	0.071	0	106	70 - 130				
2-Hexanone	0.075	0.0071	0.071	0	106	70 - 130				
4-Methyl-2-pentanone	0.082	0.0071	0.071	0	115	70 - 128				
Acetone	0.086	0.014	0.071	0	121	70 - 130				
Benzene	0.039	0.0036	0.0355	0	111	70 - 130				
Bromodichloromethane	0.040	0.0036	0.0355	0	113	70 - 130				
Bromoform	0.037	0.0036	0.0355	0	104	70 - 130				
Bromomethane	0.040	0.0071	0.0355	0	114	70 - 130				
Carbon disulfide	0.079	0.0071	0.071	0	111	70 - 130				
Carbon tetrachloride	0.036	0.0036	0.0355	0	101	70 - 130				
Chlorobenzene	0.039	0.0036	0.0355	0	111	70 - 130				
Chloroethane	0.039	0.0071	0.0355	0	110	70 - 130				
Chloroform	0.037	0.0036	0.0355	0	104	70 - 130				
Chloromethane	0.043	0.0071	0.0355	0	122	70 - 130				
cis-1,2-Dichloroethene	0.036	0.0036	0.0355	0	101	70 - 130				
cis-1,3-Dichloropropene	0.039	0.0036	0.0355	0	110	70 - 130				
Cyclohexane	0.040	0.0036	0.0355	0	114	74 - 126				
Dibromochloromethane	0.039	0.0036	0.0355	0	110	70 - 130				
Dichlorodifluoromethane	0.043	0.0036	0.0355	0	122	70 - 130				
Ethylbenzene	0.040	0.0036	0.0355	0	111	70 - 130				

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427645 (0) **Instrument: VOA8** **Method: VOLATILES BY SW8260C**

MS Sample ID: **HS23020339-04MS** Units: **mg/Kg** Analysis Date: **09-Feb-2023 09:33**
Client ID: Run ID: **VOA8_427645** SeqNo: **7116101** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Isopropylbenzene	0.036	0.0036	0.0355	0	103	70 - 130				
m,p-Xylene	0.086	0.0071	0.071	0	122	70 - 130				
Methyl acetate	0.041	0.0036	0.0355	0	115	69 - 123				
Methyl tert-butyl ether	0.044	0.0036	0.0355	0	124	70 - 130				
Methylcyclohexane	0.037	0.0036	0.0355	0	103	77 - 127				
Methylene chloride	0.037	0.0071	0.0355	0	105	70 - 130				
o-Xylene	0.042	0.0036	0.0355	0	117	70 - 130				
Styrene	0.037	0.0036	0.0355	0	105	70 - 130				
Tetrachloroethene	0.039	0.0036	0.0355	0	110	70 - 130				
Toluene	0.042	0.0036	0.0355	0	119	70 - 130				
trans-1,2-Dichloroethene	0.040	0.0036	0.0355	0	112	70 - 130				
trans-1,3-Dichloropropene	0.038	0.0036	0.0355	0	108	70 - 130				
Trichloroethene	0.038	0.0036	0.0355	0	106	70 - 130				
Trichlorofluoromethane	0.038	0.0036	0.0355	0	107	70 - 130				
Vinyl chloride	0.044	0.0014	0.0355	0	124	70 - 130				
Xylenes, Total	0.13	0.0036	0.1065	0	120	70 - 130				
Surr: 1,2-Dichloroethane-d4	*0.039*	*0*	*0.0355*	*0*	*109*	*70 - 126*				
Surr: 4-Bromofluorobenzene	*0.034*	*0*	*0.0355*	*0*	*95.6*	*70 - 130*				
Surr: Dibromofluoromethane	*0.035*	*0*	*0.0355*	*0*	*99.2*	*70 - 130*				
Surr: Toluene-d8	*0.037*	*0*	*0.0355*	*0*	*103*	*70 - 130*				

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427645 (0) **Instrument: VOA8** **Method: VOLATILES BY SW8260C**

MSD Sample ID: **HS23020339-04MSD** Units: **mg/Kg** Analysis Date: **09-Feb-2023 09:53**
Client ID: Run ID: **VOA8_427645** SeqNo: **7116102** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	RPD %RPD	RPD Limit	Qual
1,1,1-Trichloroethane	0.045	0.0038	0.0375	0	120	70 - 130	0.04311	4.2	30	
1,1,2,2-Tetrachloroethane	0.045	0.0038	0.0375	0	120	70 - 130	0.04376	3.09	30	
1,1,2-Trichlor-1,2,2-trifluoroethane	0.039	0.0038	0.0375	0	103	70 - 130	0.03647	6.04	30	
1,1,2-Trichloroethane	0.039	0.0038	0.0375	0	105	70 - 130	0.03711	5.59	30	
1,1-Dichloroethane	0.038	0.0038	0.0375	0	102	70 - 130	0.03686	3.29	30	
1,1-Dichloroethene	0.039	0.0038	0.0375	0	104	70 - 130	0.03842	1.9	30	
1,2,4-Trichlorobenzene	0.037	0.0038	0.0375	0	99.9	70 - 130	0.03708	0.986	30	
1,2-Dibromo-3-chloropropane	0.038	0.0038	0.0375	0	102	70 - 130	0.03855	0.39	30	
1,2-Dibromoethane	0.040	0.0038	0.0375	0	107	70 - 120	0.03935	2.1	30	
1,2-Dichlorobenzene	0.038	0.0038	0.0375	0	101	70 - 130	0.03717	1.95	30	
1,2-Dichloroethane	0.043	0.0038	0.0375	0	114	70 - 130	0.03595	17.5	30	
1,2-Dichloropropane	0.039	0.0038	0.0375	0	104	70 - 130	0.03661	6.71	30	
1,3-Dichlorobenzene	0.038	0.0038	0.0375	0	102	70 - 130	0.03756	2.27	30	
1,4-Dichlorobenzene	0.041	0.0038	0.0375	0	110	70 - 130	0.04065	1.34	30	
2-Butanone	0.075	0.0075	0.075	0	99.8	70 - 130	0.07518	0.413	30	
2-Hexanone	0.074	0.0075	0.075	0	98.7	70 - 130	0.07510	1.39	30	
4-Methyl-2-pentanone	0.086	0.0075	0.075	0	115	70 - 128	0.08200	4.88	30	
Acetone	0.095	0.015	0.075	0	127	70 - 130	0.08590	10.4	30	
Benzene	0.042	0.0038	0.0375	0	111	70 - 130	0.03925	5.6	30	
Bromodichloromethane	0.042	0.0038	0.0375	0	112	70 - 130	0.04021	4.78	30	
Bromoform	0.036	0.0038	0.0375	0	97.3	70 - 130	0.03680	0.825	30	
Bromomethane	0.040	0.0075	0.0375	0	107	70 - 130	0.04035	0.451	30	
Carbon disulfide	0.079	0.0075	0.075	0	106	70 - 130	0.07908	0.082	30	
Carbon tetrachloride	0.039	0.0038	0.0375	0	105	70 - 130	0.03581	9.45	30	
Chlorobenzene	0.041	0.0038	0.0375	0	109	70 - 130	0.03943	3.78	30	
Chloroethane	0.040	0.0075	0.0375	0	105	70 - 130	0.03918	0.937	30	
Chloroform	0.038	0.0038	0.0375	0	100	70 - 130	0.03702	1.35	30	
Chloromethane	0.043	0.0075	0.0375	0	116	70 - 130	0.04320	0.457	30	
cis-1,2-Dichloroethene	0.036	0.0038	0.0375	0	96.8	70 - 130	0.03570	1.68	30	
cis-1,3-Dichloropropene	0.040	0.0038	0.0375	0	106	70 - 130	0.03908	1.84	30	
Cyclohexane	0.039	0.0038	0.0375	0	104	74 - 126	0.04034	3.47	30	
Dibromochloromethane	0.039	0.0038	0.0375	0	104	70 - 130	0.03903	0.217	30	
Dichlorodifluoromethane	0.044	0.0038	0.0375	0	116	70 - 130	0.04323	0.925	30	
Ethylbenzene	0.041	0.0038	0.0375	0	108	70 - 130	0.03956	2.67	30	

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427645 (0) **Instrument: VOA8** **Method: VOLATILES BY SW8260C**

MSD Sample ID: **HS23020339-04MSD** Units: **mg/Kg** Analysis Date: **09-Feb-2023 09:53**
Client ID: Run ID: **VOA8_427645** SeqNo: **7116102** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	RPD %RPD	RPD Limit	Qual
Isopropylbenzene	0.037	0.0038	0.0375	0	99.3	70 - 130	0.03640	2.31	30	
m,p-Xylene	0.090	0.0075	0.075	0	119	70 - 130	0.08641	3.57	30	
Methyl acetate	0.041	0.0038	0.0375	0	110	69 - 123	0.04091	0.72	30	
Methyl tert-butyl ether	0.043	0.0038	0.0375	0	114	70 - 130	0.04414	3.09	30	
Methylcyclohexane	0.036	0.0038	0.0375	0	97.1	77 - 127	0.03671	0.824	30	
Methylene chloride	0.037	0.0075	0.0375	0	99.5	70 - 130	0.03734	0.0979	30	
o-Xylene	0.043	0.0038	0.0375	0	115	70 - 130	0.04171	3.25	30	
Styrene	0.039	0.0038	0.0375	0	103	70 - 130	0.03741	2.91	30	
Tetrachloroethene	0.040	0.0038	0.0375	0	108	70 - 130	0.03890	3.89	30	
Toluene	0.044	0.0038	0.0375	0	117	70 - 130	0.04224	3.65	30	
trans-1,2-Dichloroethene	0.042	0.0038	0.0375	0	113	70 - 130	0.03986	5.71	30	
trans-1,3-Dichloropropene	0.040	0.0038	0.0375	0	106	70 - 130	0.03821	4.27	30	
Trichloroethene	0.040	0.0038	0.0375	0	108	70 - 130	0.03775	6.94	30	
Trichlorofluoromethane	0.039	0.0038	0.0375	0	104	70 - 130	0.03802	2.4	30	
Vinyl chloride	0.044	0.0015	0.0375	0	117	70 - 130	0.04415	0.673	30	
Xylenes, Total	0.13	0.0038	0.1125	0	118	70 - 130	0.1281	3.47	30	
Surr: 1,2-Dichloroethane-d4	*0.036*	*0*	*0.0375*	*0*	*96.0*	*70 - 126*	*0.03887*	*7.7*	*30*	
Surr: 4-Bromofluorobenzene	*0.036*	*0*	*0.0375*	*0*	*96.1*	*70 - 130*	*0.03392*	*6.1*	*30*	
Surr: Dibromofluoromethane	*0.037*	*0*	*0.0375*	*0*	*99.1*	*70 - 130*	*0.03523*	*5.37*	*30*	
Surr: Toluene-d8	*0.039*	*0*	*0.0375*	*0*	*105*	*70 - 130*	*0.03654*	*7.29*	*30*	

The following samples were analyzed in this batch: HS23020407-01

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427823 (0) **Instrument: VOA6** **Method: VOLATILES ORGANICS BY METHOD 8260C**

MBLK Sample ID: **VBLKW-230210** Units: **mg/L** Analysis Date: **10-Feb-2023 13:54**
Client ID: Run ID: **VOA6_427823** SeqNo: **7119659** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
1,1,1-Trichloroethane	< 0.00020	0.0010								
1,1,2,2-Tetrachloroethane	< 0.00050	0.0010								
1,1,2-Trichlor-1,2,2-trifluoroethane	< 0.00050	0.0010								
1,1,2-Trichloroethane	< 0.00030	0.0010								
1,1-Dichloroethane	< 0.00020	0.0010								
1,1-Dichloroethene	< 0.00020	0.0010								
1,2,4-Trichlorobenzene	< 0.00050	0.0010								
1,2-Dibromo-3-chloropropane	< 0.00020	0.0010								
1,2-Dibromoethane	< 0.00020	0.0010								
1,2-Dichlorobenzene	< 0.00050	0.0010								
1,2-Dichloroethane	< 0.00020	0.0010								
1,2-Dichloropropane	< 0.00050	0.0010								
1,3-Dichlorobenzene	< 0.00040	0.0010								
1,4-Dichlorobenzene	< 0.00040	0.0010								
2-Butanone	< 0.00050	0.0020								
2-Hexanone	< 0.0010	0.0020								
4-Methyl-2-pentanone	< 0.00070	0.0020								
Acetone	< 0.00040	0.0020								
Benzene	< 0.00020	0.0010								
Bromodichloromethane	< 0.00020	0.0010								
Bromoform	< 0.00040	0.0010								
Bromomethane	< 0.00040	0.0010								
Carbon disulfide	< 0.00060	0.0020								
Carbon tetrachloride	< 0.00050	0.0010								
Chlorobenzene	< 0.00030	0.0010								
Chloroethane	< 0.00030	0.0010								
Chloroform	< 0.00020	0.0010								
Chloromethane	< 0.00020	0.0010								
cis-1,2-Dichloroethene	< 0.00020	0.0010								
cis-1,3-Dichloropropene	< 0.00020	0.0010								
Cyclohexane	< 0.00030	0.0010								
Dibromochloromethane	< 0.00030	0.0010								
Dichlorodifluoromethane	< 0.00030	0.0010								
Ethylbenzene	< 0.00030	0.0010								

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427823 (0) **Instrument: VOA6** **Method: VOLATILES ORGANICS BY METHOD 8260C**

MBLK Sample ID: **VBLKW-230210** Units: **mg/L** Analysis Date: **10-Feb-2023 13:54**
Client ID: Run ID: **VOA6_427823** SeqNo: **7119659** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit Qual
Isopropylbenzene	< 0.00030	0.0010							
m,p-Xylene	< 0.00050	0.0020							
Methyl acetate	< 0.00020	0.0010							
Methyl tert-butyl ether	< 0.00020	0.0010							
Methylcyclohexane	< 0.00030	0.0010							
Methylene chloride	< 0.00040	0.0020							
o-Xylene	< 0.00030	0.0010							
Styrene	< 0.00030	0.0010							
Tetrachloroethene	< 0.00030	0.0010							
Toluene	< 0.00020	0.0010							
trans-1,2-Dichloroethene	< 0.00020	0.0010							
trans-1,3-Dichloropropene	< 0.00020	0.0010							
Trichloroethene	< 0.00020	0.0010							
Trichlorofluoromethane	< 0.00030	0.0010							
Vinyl chloride	< 0.00020	0.0010							
Xylenes, Total	< 0.00030	0.0010							
Surr: 1,2-Dichloroethane-d4	*0.051*	*0.0010*	*0.05*	*0*	*101*	*81 - 118*			
Surr: 4-Bromofluorobenzene	*0.054*	*0.0010*	*0.05*	*0*	*108*	*85 - 114*			
Surr: Dibromofluoromethane	*0.047*	*0.0010*	*0.05*	*0*	*94.1*	*80 - 119*			
Surr: Toluene-d8	*0.053*	*0.0010*	*0.05*	*0*	*107*	*89 - 112*			

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427823 (0) **Instrument: VOA6** **Method: VOLATILES ORGANICS BY METHOD 8260C**

LCS Sample ID: **VLCSW-230210** Units: **mg/L** Analysis Date: **10-Feb-2023 13:12**
Client ID: Run ID: **VOA6_427823** SeqNo: **7119658** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
1,1,1-Trichloroethane	0.019	0.0010	0.02	0	96.1	74 - 131				
1,1,2,2-Tetrachloroethane	0.021	0.0010	0.02	0	106	71 - 121				
1,1,2-Trichlor-1,2,2-trifluoroethane	0.017	0.0010	0.02	0	83.9	70 - 136				
1,1,2-Trichloroethane	0.020	0.0010	0.02	0	98.7	80 - 119				
1,1-Dichloroethane	0.020	0.0010	0.02	0	101	77 - 125				
1,1-Dichloroethene	0.016	0.0010	0.02	0	80.0	71 - 131				
1,2,4-Trichlorobenzene	0.023	0.0010	0.02	0	116	69 - 130				
1,2-Dibromo-3-chloropropane	0.022	0.0010	0.02	0	110	62 - 128				
1,2-Dibromoethane	0.020	0.0010	0.02	0	101	77 - 121				
1,2-Dichlorobenzene	0.020	0.0010	0.02	0	98.2	80 - 119				
1,2-Dichloroethane	0.021	0.0010	0.02	0	104	73 - 128				
1,2-Dichloropropane	0.020	0.0010	0.02	0	102	78 - 122				
1,3-Dichlorobenzene	0.020	0.0010	0.02	0	102	80 - 119				
1,4-Dichlorobenzene	0.020	0.0010	0.02	0	99.1	79 - 118				
2-Butanone	0.046	0.0020	0.04	0	115	56 - 143				
2-Hexanone	0.050	0.0020	0.04	0	124	57 - 139				
4-Methyl-2-pentanone	0.047	0.0020	0.04	0	118	67 - 130				
Acetone	0.042	0.0020	0.04	0	104	39 - 160				
Benzene	0.020	0.0010	0.02	0	98.0	79 - 120				
Bromodichloromethane	0.019	0.0010	0.02	0	93.8	79 - 125				
Bromoform	0.019	0.0010	0.02	0	95.8	66 - 130				
Bromomethane	0.018	0.0010	0.02	0	92.2	53 - 141				
Carbon disulfide	0.043	0.0020	0.04	0	107	64 - 133				
Carbon tetrachloride	0.018	0.0010	0.02	0	91.1	72 - 136				
Chlorobenzene	0.019	0.0010	0.02	0	96.6	82 - 118				
Chloroethane	0.017	0.0010	0.02	0	87.1	60 - 138				
Chloroform	0.019	0.0010	0.02	0	96.2	79 - 124				
Chloromethane	0.023	0.0010	0.02	0	114	50 - 139				
cis-1,2-Dichloroethene	0.019	0.0010	0.02	0	93.3	78 - 123				
cis-1,3-Dichloropropene	0.021	0.0010	0.02	0	103	75 - 124				
Cyclohexane	0.024	0.0010	0.02	0	121	71 - 130				
Dibromochloromethane	0.019	0.0010	0.02	0	95.0	74 - 126				
Dichlorodifluoromethane	0.017	0.0010	0.02	0	86.3	32 - 152				
Ethylbenzene	0.020	0.0010	0.02	0	101	79 - 121				

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427823 (0) **Instrument: VOA6** **Method: VOLATILES ORGANICS BY METHOD 8260C**

LCS Sample ID: **VLCSW-230210** Units: **mg/L** Analysis Date: **10-Feb-2023 13:12**
Client ID: Run ID: **VOA6_427823** SeqNo: **7119658** PrepDate: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Isopropylbenzene	0.021	0.0010	0.02	0	103	72 - 131				
m,p-Xylene	0.040	0.0020	0.04	0	101	80 - 121				
Methyl acetate	0.024	0.0010	0.02	0	118	56 - 136				
Methyl tert-butyl ether	0.022	0.0010	0.02	0	112	71 - 124				
Methylcyclohexane	0.026	0.0010	0.02	0	128	72 - 132				
Methylene chloride	0.019	0.0020	0.02	0	94.0	74 - 124				
o-Xylene	0.020	0.0010	0.02	0	101	78 - 122				
Styrene	0.021	0.0010	0.02	0	103	78 - 123				
Tetrachloroethene	0.019	0.0010	0.02	0	94.2	74 - 129				
Toluene	0.020	0.0010	0.02	0	98.6	80 - 121				
trans-1,2-Dichloroethene	0.019	0.0010	0.02	0	95.5	75 - 124				
trans-1,3-Dichloropropene	0.021	0.0010	0.02	0	105	73 - 127				
Trichloroethene	0.019	0.0010	0.02	0	95.5	79 - 123				
Trichlorofluoromethane	0.017	0.0010	0.02	0	83.8	65 - 141				
Vinyl chloride	0.018	0.0010	0.02	0	89.5	58 - 137				
Xylenes, Total	0.060	0.0010	0.06	0	101	78 - 122				
Surr: 1,2-Dichloroethane-d4	*0.055*	*0.0010*	*0.05*	*0*	*111*	*81 - 118*				
Surr: 4-Bromofluorobenzene	*0.055*	*0.0010*	*0.05*	*0*	*110*	*85 - 114*				
Surr: Dibromofluoromethane	*0.049*	*0.0010*	*0.05*	*0*	*98.3*	*80 - 119*				
Surr: Toluene-d8	*0.052*	*0.0010*	*0.05*	*0*	*103*	*89 - 112*				

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427823 (0) **Instrument: VOA6** **Method: VOLATILES ORGANICS BY METHOD 8260C**

MS Sample ID: **HS23020267-03MS** Units: **mg/L** Analysis Date: **10-Feb-2023 16:42**
Client ID: Run ID: **VOA6_427823** SeqNo: **7119666** PrepDate: DF: **100**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
1,1,1-Trichloroethane	2.2	0.10	2	0	112	74 - 131				
1,1,2,2-Tetrachloroethane	2.1	0.10	2	0	107	71 - 121				
1,1,2-Trichlor-1,2,2-trifluoroethane	2.2	0.10	2	0	108	70 - 136				
1,1,2-Trichloroethane	2.0	0.10	2	0	100	80 - 119				
1,1-Dichloroethane	2.1	0.10	2	0	104	77 - 125				
1,1-Dichloroethene	1.9	0.10	2	0	96.6	71 - 131				
1,2,4-Trichlorobenzene	2.5	0.10	2	0	126	69 - 130				
1,2-Dibromo-3-chloropropane	2.2	0.10	2	0	112	62 - 128				
1,2-Dibromoethane	2.0	0.10	2	0	102	77 - 121				
1,2-Dichlorobenzene	2.2	0.10	2	0	108	80 - 119				
1,2-Dichloroethane	2.2	0.10	2	0	110	73 - 128				
1,2-Dichloropropane	2.1	0.10	2	0	105	78 - 122				
1,3-Dichlorobenzene	2.3	0.10	2	0	114	80 - 119				
1,4-Dichlorobenzene	2.1	0.10	2	0	107	79 - 118				
2-Butanone	4.0	0.20	4	0	101	56 - 143				
2-Hexanone	4.5	0.20	4	0	113	57 - 139				
4-Methyl-2-pentanone	4.5	0.20	4	0	113	67 - 130				
Acetone	2.9	0.20	4	0	72.8	39 - 160				
Benzene	2.1	0.10	2	0	107	79 - 120				
Bromodichloromethane	2.0	0.10	2	0	99.6	79 - 125				
Bromoform	1.9	0.10	2	0	95.1	66 - 130				
Bromomethane	2.1	0.10	2	0	107	53 - 141				
Carbon disulfide	4.5	0.20	4	0	113	64 - 133				
Carbon tetrachloride	2.3	0.10	2	0	116	72 - 136				
Chlorobenzene	2.1	0.10	2	0	104	82 - 118				
Chloroethane	2.0	0.10	2	0	101	60 - 138				
Chloroform	2.0	0.10	2	0	100	79 - 124				
Chloromethane	2.5	0.10	2	0	127	50 - 139				
cis-1,2-Dichloroethene	2.4	0.10	2	0.4583	96.0	78 - 123				
cis-1,3-Dichloropropene	2.1	0.10	2	0	106	75 - 124				
Cyclohexane	3.1	0.10	2	0	157	71 - 130				S
Dibromochloromethane	2.0	0.10	2	0	99.6	74 - 126				
Dichlorodifluoromethane	2.3	0.10	2	0	115	32 - 152				
Ethylbenzene	2.3	0.10	2	0	116	79 - 121				

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427823 (0) **Instrument: VOA6** **Method: VOLATILES ORGANICS BY METHOD 8260C**

MS Sample ID: **HS23020267-03MS** Units: **mg/L** Analysis Date: **10-Feb-2023 16:42**
Client ID: Run ID: **VOA6_427823** SeqNo: **7119666** PrepDate: DF: **100**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Isopropylbenzene	2.5	0.10	2	0	125	72 - 131				
m,p-Xylene	4.6	0.20	4	0	114	80 - 121				
Methyl acetate	2.3	0.10	2	0	114	56 - 136				
Methyl tert-butyl ether	2.1	0.10	2	0	103	71 - 124				
Methylcyclohexane	2.7	0.10	2	0	135	72 - 132				S
Methylene chloride	1.8	0.20	2	0	92.2	74 - 124				
o-Xylene	2.2	0.10	2	0	110	78 - 122				
Styrene	2.1	0.10	2	0	103	78 - 123				
Tetrachloroethene	4.5	0.10	2	2.099	122	74 - 129				
Toluene	2.2	0.10	2	0	111	80 - 121				
trans-1,2-Dichloroethene	2.1	0.10	2	0	106	75 - 124				
trans-1,3-Dichloropropene	2.1	0.10	2	0	105	73 - 127				
Trichloroethene	15	0.10	2	12.02	125	79 - 123				SO
Trichlorofluoromethane	2.2	0.10	2	0	110	65 - 141				
Vinyl chloride	2.3	0.10	2	0	113	58 - 137				
Xylenes, Total	6.8	0.10	6	0	113	78 - 122				
Surr: 1,2-Dichloroethane-d4	*4.9*	*0.10*	*5*	*0*	*97.6*	*81 - 118*				
Surr: 4-Bromofluorobenzene	*5.3*	*0.10*	*5*	*0*	*106*	*85 - 114*				
Surr: Dibromofluoromethane	*4.6*	*0.10*	*5*	*0*	*92.6*	*80 - 119*				
Surr: Toluene-d8	*5.4*	*0.10*	*5*	*0*	*107*	*89 - 112*				

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427823 (0) **Instrument: VOA6** **Method: VOLATILES ORGANICS BY METHOD 8260C**

MSD Sample ID: **HS23020267-03MSD** Units: **mg/L** Analysis Date: **10-Feb-2023 17:03**
Client ID: Run ID: **VOA6_427823** SeqNo: **7119667** PrepDate: DF: **100**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	RPD %RPD	RPD Limit	Qual
1,1,1-Trichloroethane	2.1	0.10	2	0	104	74 - 131	2.242	7.31	20	
1,1,2,2-Tetrachloroethane	2.2	0.10	2	0	112	71 - 121	2.145	4.71	20	
1,1,2-Trichlor-1,2,2-trifluoroethane	2.0	0.10	2	0	101	70 - 136	2.165	6.74	20	
1,1,2-Trichloroethane	2.0	0.10	2	0	102	80 - 119	2.006	1.34	20	
1,1-Dichloroethane	2.0	0.10	2	0	101	77 - 125	2.083	2.87	20	
1,1-Dichloroethene	1.8	0.10	2	0	90.3	71 - 131	1.933	6.78	20	
1,2,4-Trichlorobenzene	2.6	0.10	2	0	129	69 - 130	2.517	2.2	20	
1,2-Dibromo-3-chloropropane	2.3	0.10	2	0	113	62 - 128	2.237	1.09	20	
1,2-Dibromoethane	2.0	0.10	2	0	102	77 - 121	2.031	0.806	20	
1,2-Dichlorobenzene	2.2	0.10	2	0	109	80 - 119	2.158	1.35	20	
1,2-Dichloroethane	2.1	0.10	2	0	103	73 - 128	2.193	6.34	20	
1,2-Dichloropropane	2.0	0.10	2	0	102	78 - 122	2.101	3.26	20	
1,3-Dichlorobenzene	2.3	0.10	2	0	115	80 - 119	2.288	0.858	20	
1,4-Dichlorobenzene	2.2	0.10	2	0	110	79 - 118	2.131	2.78	20	
2-Butanone	4.2	0.20	4	0	106	56 - 143	4.025	4.74	20	
2-Hexanone	4.6	0.20	4	0	116	57 - 139	4.523	2.61	20	
4-Methyl-2-pentanone	4.9	0.20	4	0	122	67 - 130	4.515	8.16	20	
Acetone	3.1	0.20	4	0	76.6	39 - 160	2.911	5.16	20	
Benzene	2.1	0.10	2	0	103	79 - 120	2.148	3.82	20	
Bromodichloromethane	1.9	0.10	2	0	96.6	79 - 125	1.991	3.06	20	
Bromoform	1.9	0.10	2	0	94.0	66 - 130	1.903	1.23	20	
Bromomethane	2.0	0.10	2	0	98.3	53 - 141	2.140	8.46	20	
Carbon disulfide	4.2	0.20	4	0	104	64 - 133	4.510	8.26	20	
Carbon tetrachloride	2.2	0.10	2	0	112	72 - 136	2.324	3.45	20	
Chlorobenzene	2.0	0.10	2	0	102	82 - 118	2.072	1.49	20	
Chloroethane	1.9	0.10	2	0	94.0	60 - 138	2.016	6.93	20	
Chloroform	1.9	0.10	2	0	94.8	79 - 124	2.002	5.41	20	
Chloromethane	2.4	0.10	2	0	119	50 - 139	2.536	5.96	20	
cis-1,2-Dichloroethene	2.3	0.10	2	0.4583	92.7	78 - 123	2.379	2.86	20	
cis-1,3-Dichloropropene	2.1	0.10	2	0	103	75 - 124	2.117	2.77	20	
Cyclohexane	3.0	0.10	2	0	149	71 - 130	3.135	5.22	20	S
Dibromochloromethane	2.0	0.10	2	0	99.1	74 - 126	1.991	0.444	20	
Dichlorodifluoromethane	2.1	0.10	2	0	105	32 - 152	2.297	9.37	20	
Ethylbenzene	2.2	0.10	2	0	112	79 - 121	2.317	3.39	20	

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: HS23020407

QC BATCH REPORT

Batch ID: R427823 (0) **Instrument: VOA6** **Method: VOLATILES ORGANICS BY METHOD 8260C**

MSD Sample ID: **HS23020267-03MSD** Units: **mg/L** Analysis Date: **10-Feb-2023 17:03**
Client ID: Run ID: **VOA6_427823** SeqNo: **7119667** PrepDate: DF: **100**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Isopropylbenzene	2.4	0.10	2	0	121	72 - 131	2.506	3.64	20	
m,p-Xylene	4.4	0.20	4	0	109	80 - 121	4.573	4.98	20	
Methyl acetate	2.2	0.10	2	0	110	56 - 136	2.283	4.06	20	
Methyl tert-butyl ether	2.1	0.10	2	0	104	71 - 124	2.055	1.52	20	
Methylcyclohexane	2.7	0.10	2	0	133	72 - 132	2.700	1.27	20	S
Methylene chloride	1.8	0.20	2	0	89.7	74 - 124	1.845	2.79	20	
o-Xylene	2.1	0.10	2	0	107	78 - 122	2.191	2.69	20	
Styrene	2.1	0.10	2	0	105	78 - 123	2.063	1.6	20	
Tetrachloroethene	4.3	0.10	2	2.099	109	74 - 129	4.540	5.99	20	
Toluene	2.1	0.10	2	0	107	80 - 121	2.218	3.92	20	
trans-1,2-Dichloroethene	1.9	0.10	2	0	97.2	75 - 124	2.111	8.26	20	
trans-1,3-Dichloropropene	2.1	0.10	2	0	105	73 - 127	2.092	0.0327	20	
Trichloroethene	14	0.10	2	12.02	89.4	79 - 123	14.51	4.98	20	O
Trichlorofluoromethane	2.0	0.10	2	0	99.5	65 - 141	2.202	10.1	20	
Vinyl chloride	2.1	0.10	2	0	103	58 - 137	2.264	9.62	20	
Xylenes, Total	6.5	0.10	6	0	108	78 - 122	6.765	4.23	20	
Surr: 1,2-Dichloroethane-d4	*4.9*	*0.10*	*5*	*0*	*98.1*	*81 - 118*	*4.878*	*0.537*	*20*	
Surr: 4-Bromofluorobenzene	*5.3*	*0.10*	*5*	*0*	*107*	*85 - 114*	*5.314*	*0.534*	*20*	
Surr: Dibromofluoromethane	*4.6*	*0.10*	*5*	*0*	*92.3*	*80 - 119*	*4.628*	*0.266*	*20*	
Surr: Toluene-d8	*5.4*	*0.10*	*5*	*0*	*108*	*89 - 112*	*5.362*	*0.351*	*20*	

The following samples were analyzed in this batch: HS23020407-02

ALS Houston, US Date: 23-Feb-23

Client: Bhate Environmental Associates, Inc.
Project: LHAAP-58
WorkOrder: **HS23020407**

QUALIFIERS, ACRONYMS, UNITS

Qualifier	Description
*	Value exceeds Regulatory Limit
a	Not accredited
B	Analyte detected in the associated Method Blank above the Reporting Limit
E	Value above quantitation range
H	Analyzed outside of Holding Time
J	Analyte detected below quantitation limit
M	Manually integrated, see raw data for justification
n	Not offered for accreditation
ND	Not Detected at the Reporting Limit
O	Sample amount is > 4 times amount spiked
P	Dual Column results percent difference > 40%
R	RPD above laboratory control limit
S	Spike Recovery outside laboratory control limits
U	Analyzed but not detected above the MDL/SDL

Acronym	Description
DCS	Detectability Check Study
DUP	Method Duplicate
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MBLK	Method Blank
MDL	Method Detection Limit
MQL	Method Quantitation Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PDS	Post Digestion Spike
PQL	Practical Quantitaion Limit
SD	Serial Dilution
SDL	Sample Detection Limit
TRRP	Texas Risk Reduction Program

Unit Reported	Description
mg/Kg-dry	Milligrams per Kilogram- Dry weight corrected
mg/L	Milligrams per Liter

CERTIFICATIONS,ACCREDITATIONS & LICENSES

Agency	Number	Expire Date
Arkansas	22-041-0	27-Mar-2023
California	2919 2022-2023	30-Apr-2023
Dept of Defense	L21-682	31-Dec-2023
Florida	E87611-36	30-Jun-2023
Illinois	2000322022-9	09-May-2023
Kansas	E-10352; 2022-2023	31-Jul-2023
Kentucky	123043, 2022-2023	30-Apr-2023
Louisiana	03087, 2022-2023	30-Jun-2023
Maryland	343, 2022-2023	30-Jun-2023
North Carolina	624-2023	31-Dec-2023
North Dakota	R-193 2022-2023	30-Apr-2023
Oklahoma	2022-141	31-Aug-2023
Texas	T104704231-22-29	30-Apr-2023
Utah	TX026932022-13	31-Jul-2023

ALS Houston, US Date: 23-Feb-23

Sample Receipt Checklist

Work Order ID: HS23020407 **Date/Time Received:** **09-Feb-2023 10:50**

Client Name: Bhate Environmental **Received by:** **Malcolm Burleson**

Completed By: */S/ Malcolm Burleson* (eSignature) 09-Feb-2023 12:56 (Date/Time) **Reviewed by:** */S/ Dane J. Wacasey* (eSignature) 13-Feb-2023 17:28 (Date/Time)

Matrices: **S/W** Carrier name: **FedEx**

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
VOA/TX1005/TX1006 Solids in hermetically sealed vials?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	1 Page(s)
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Samplers name present on COC?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	

Temperature(s)/Thermometer(s):	1.6UC 1.1C	IR31
Cooler(s)/Kit(s):	49548	
Date/Time sample(s) sent to storage:	02092023 1258	

Water - VOA vials have zero headspace?	Yes ☑	No ☐	No VOA vials submitted ☐
Water - pH acceptable upon receipt?	Yes ☑	No ☐	N/A ☐
pH adjusted?	Yes ☐	No ☑	N/A ☐
pH adjusted by:			

Login Notes: Terracore jars filled completely (> 5 grams)

Client Contacted: Date Contacted: Person Contacted:

Contacted By: Regarding:

Comments:

Corrective Action:

bhate

Page: of

Project/Phase No: NWO1312.0150

HS23020407

1608 13th Avenue South, Suite 300
Birmingham Alabama 35205
Tel: 205-918-4000
Fax: 205-918-4050

Chain of Custody and Analytical Request

Aptim Environmental & Infrastucture, Inc.
LHAAP /Site 58

Facility/Base I.D.: LHAAP

Project/Site Name: LHAAP / Site 58

Client Name:

Collected by: Scott Beesinger

Field Sample ID (30 Characters Max)	Date Collected (dd-mmm-yyyy)	Time Collected (Military) (hhmm)	Sample Depth (beginning - ending)	SA Code [2]	Sample Number [3]	Sample Matrix [4]	Sample Analysis Requested [5] Number of containers	VOC	Ambient Blank Lot Control Number	Equipment Blank Lot Control Number	Trip Blank Lot Control Number	Cooler ID
LHAAPS8 IDW-020823	08 FEB 2023	1000	-	N		SO	4	X				
TRIP BLANK	08 FEB 2023		-	TB		W	2	X				
			-									
			-									
			-									
			-									
			-									
			-									
			-									
			-									
			-									
			-									

COMMENTS:

STANDARD TAT

Custody Transfers Prior to Receipt by Laboratory

Relinquished By (signed)	Date	Time	Received by (signed)	Date	Time
1. Scott Beesinger	2/8/23	1400	1.		
2.			2.		
3.			3.		

Sample Delivery Details / Laboratory Receipt

Delivered Directly to Lab: Shipped No.:

Method of Shipment:

Fed Ex Airbill Number:

Analytical Lab: ALS 10450 Stanchiff Rd. Suite 210 Houston, TX 77099 (281) 530-5656

ATTN: SONIA WEST Lab Recipient: Delivery Date/Time:

1.) Chain of Custody Number = date collected + custody number (e.g. 09-02-1999-01)

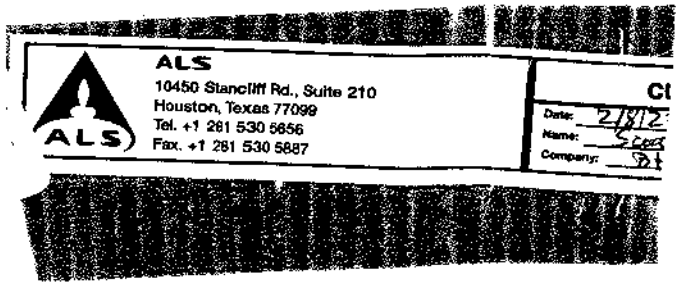
2.) Sample Type (SA) Codes: N = Normal Sample, TB = Trip Blank (-c) Sample, FD = Field Duplicate (-s) Samples, FR = Field Replicate (-b) Samples, EB = Equipment Blank (-d) Samples, MS = Matrix Spike, SD = Matrix Spike Duplicate, AB = Ambient Blank (-e)

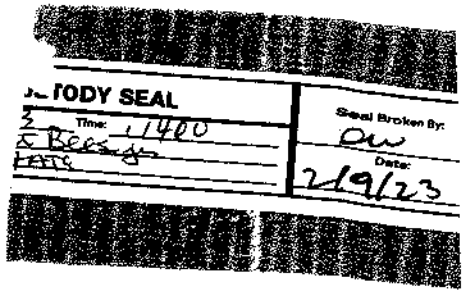
3.) Sample Number: Unique sample number collected from a particular location per day. (e.g. Groundwater sample collected from MW-1 on 10/10/99 = 01, if sampled again on 10/10/99 = 02, etc.)

4.) Matrix Codes: GS = Soil Gas, WG = Groundwater, WS = Surface Water, SO = Soil, SE = Sediment, SL = Sludge, SS = Surface Soil Samples, WQ = Aqueous Blank Samples (trip, equipment, ambient, etc), SQ = Soil Blanks

5.) Sample Analysis Requested: Analytical method requested and number of containers provided for each.

6.) Quality assurance samples are assigned by date (ddmmyy) and the sample number associated with the sample (01, 02, etc) (e.g. Equipment blank collected in association with MW-1 on 10/10/99 will be designated 10109901 in the Equipment Blank Lot Control





FedEx Trk# 0222 6230 2994 8381

THU — 09 FEB AA
PRIORITY OVERNIGHT

AB SGRA

77099
TX-US
IAH

APPENDIX H
MANN-KENDALL TREND TEST RESULTS

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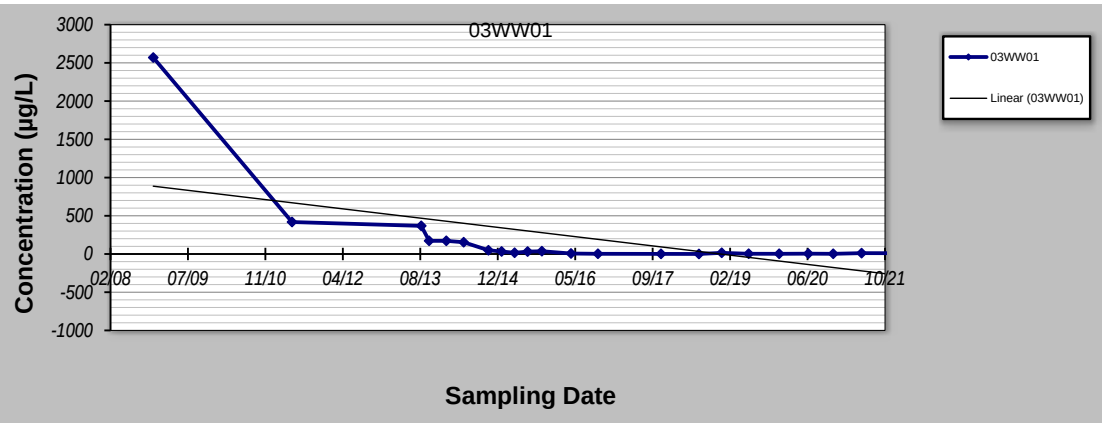
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **Tetrachloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **03WW01**

Sampling Event	Sampling Date	TETRACHLOROETHENE CONCENTRATION (µg/L)
1	24-Nov-08	2570
2	9-May-11	418
3	20-Aug-13	368
4	10-Oct-13	172
5	29-Jan-14	172
6	21-May-14	154
7	28-Oct-14	48.6
8	21-Jan-15	32.8
9	15-Apr-15	15.9
10	8-Jul-15	31.4
11	8-Oct-15	36.4
12	13-Apr-16	6.49
13	4-Oct-16	*2.5*
14	15-Nov-17	*1.25*
15	18-Jul-18	*0.25*
16	12-Dec-18	15
17	4-Jun-19	3.2
18	18-Dec-19	*2.5*
19	23-Jun-20	4.5
20	1-Dec-20	*2.5*
21	2-Jun-21	11
22	6-Jun-22	9.9
23	6-Jun-23	4.8
24		
25		
Coefficient of Variation:		**3.01**
Mann-Kendall Statistic (S):		**-163**
Confidence Factor:		**>99.9%**
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
4 *ND values are shown in red italics as 1/2 the limit of detection.*

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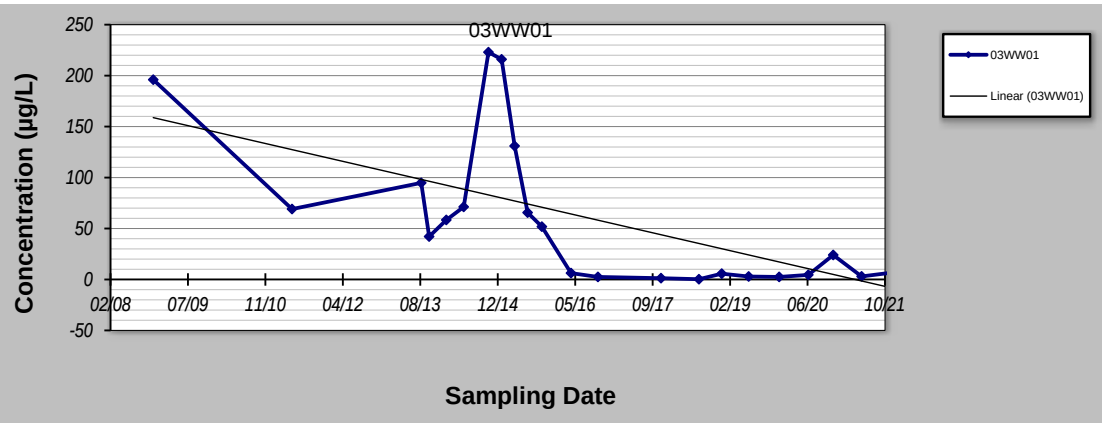
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **Trichloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **03WW01**

Sampling Event	Sampling Date	TRICHLOROETHENE CONCENTRATION (µg/L)
1	24-Nov-08	196
2	9-May-11	69.1
3	20-Aug-13	94.8
4	10-Oct-13	42.1
5	29-Jan-14	58.4
6	21-May-14	71.2
7	28-Oct-14	223
8	21-Jan-15	216
9	15-Apr-15	131
10	8-Jul-15	65.6
11	8-Oct-15	51.8
12	13-Apr-16	*6.25*
13	4-Oct-16	*2.5*
14	15-Nov-17	*1.25*
15	18-Jul-18	*0.25*
16	12-Dec-18	5.7
17	4-Jun-19	2.9
18	18-Dec-19	*2.5*
19	23-Jun-20	4.5
20	1-Dec-20	24
21	2-Jun-21	3
22	6-Jun-22	10
23	6-Jun-23	10
24		
25		
Coefficient of Variation:		1.27
Mann-Kendall Statistic (S):		-113
Confidence Factor:		99.9%
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
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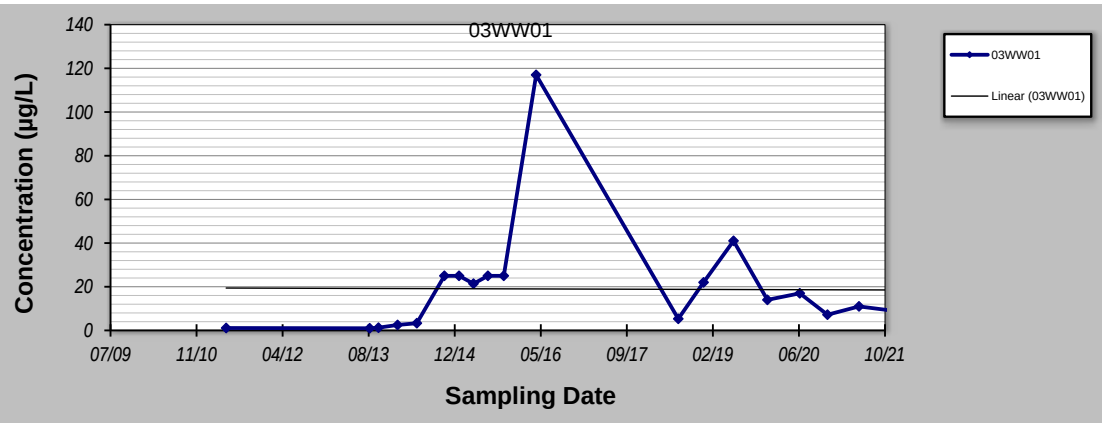
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **CIS-1,2-DICHLOROETHENE**
Concentration Units: **µg/L**

Sampling Point ID: **03WW01**

Sampling Event	Sampling Date	CIS-1,2-DICHLOROETHENE CONCENTRATION (µg/L)
1	9-May-11	1.1
2	20-Aug-13	0.978
3	10-Oct-13	*1.25*
4	29-Jan-14	*2.5*
5	21-May-14	3.3
6	28-Oct-14	*25*
7	21-Jan-15	*25*
8	15-Apr-15	21.4
9	8-Jul-15	*25*
10	8-Oct-15	*25*
11	13-Apr-16	117
12	18-Jul-18	5.3
13	12-Dec-18	22
14	4-Jun-19	41
15	18-Dec-19	14
16	23-Jun-20	17
17	1-Dec-20	7.2
18	2-Jun-21	11
19	6-Jun-22	7.3
20	6-Jun-23	6.1
21		
22		
23		
24		
25		
Coefficient of Variation:		**1.35**
Mann-Kendall Statistic (S):		**34**
Confidence Factor:		**85.6%**
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
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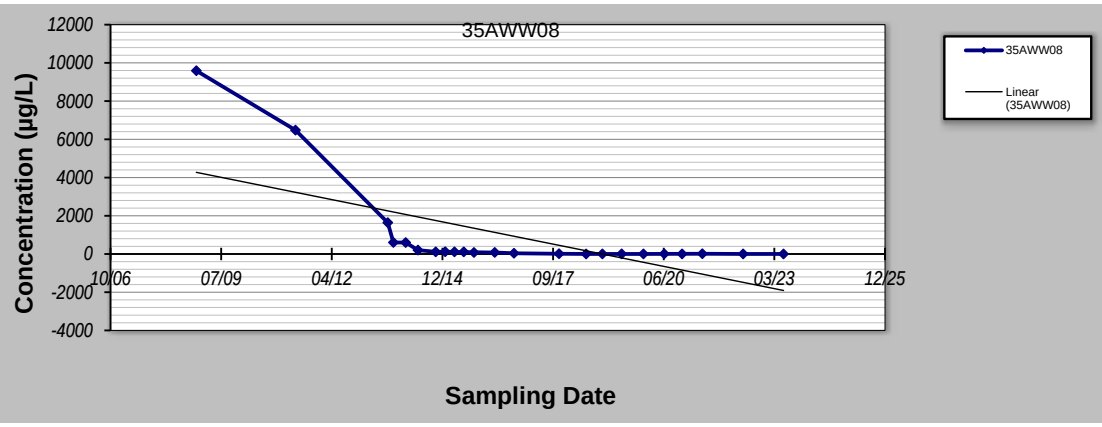
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **Tetrachloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **35AWW08**

Sampling Event	Sampling Date	TETRACHLOROETHENE CONCENTRATION (µg/L)
1	24-Nov-08	9590
2	9-May-11	6480
3	20-Aug-13	1640
4	10-Oct-13	603
5	29-Jan-14	599
6	20-May-14	204
7	27-Oct-14	112
8	21-Jan-15	119
9	15-Apr-15	110
10	8-Jul-15	110
11	8-Oct-15	79
12	13-Apr-16	80.1
13	4-Oct-16	36.9
14	15-Nov-17	12
15	18-Jul-18	*1.25*
16	12-Dec-18	*2.5*
17	4-Jun-19	4.8
18	18-Dec-19	*2.5*
19	23-Jun-20	6.7
20	1-Dec-20	*2.5*
21	2-Jun-21	*12.5*
22	6-Jun-22	*2.5*
23	6-Jun-23	*1.25*
24		
25		
Coefficient of Variation:		**2.72**
Mann-Kendall Statistic (S):		**-207**
Confidence Factor:		**>99.9%**
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
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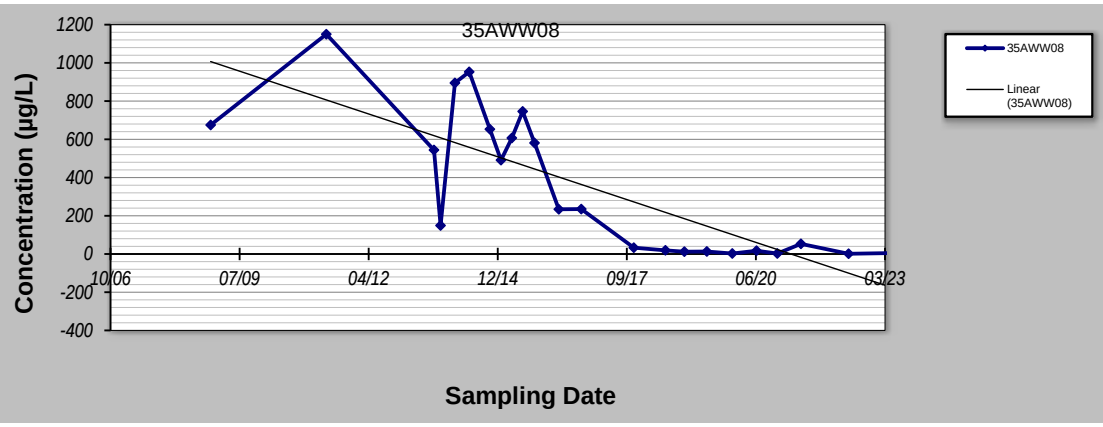
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Elizabeth Rhine**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **Trichloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **35AWW08**

Sampling Event	Sampling Date	TRICHLOROETHENE CONCENTRATION (µg/L)
1	24-Nov-08	675
2	9-May-11	1150
3	20-Aug-13	544
4	10-Oct-13	149
5	29-Jan-14	895
6	20-May-14	953
7	27-Oct-14	653
8	21-Jan-15	491
9	15-Apr-15	607
10	8-Jul-15	746
11	8-Oct-15	581
12	13-Apr-16	234
13	4-Oct-16	235
14	15-Nov-17	33
15	18-Jul-18	19
16	12-Dec-18	12
17	4-Jun-19	13
18	18-Dec-19	*2.5*
19	23-Jun-20	17
20	1-Dec-20	*2.5*
21	2-Jun-21	53
22	6-Jun-22	*1.25*
23	6-Jun-23	5.2
24		
25		
Coefficient of Variation:		**1.06**
Mann-Kendall Statistic (S):		**-172**
Confidence Factor:		**>99.9%**
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
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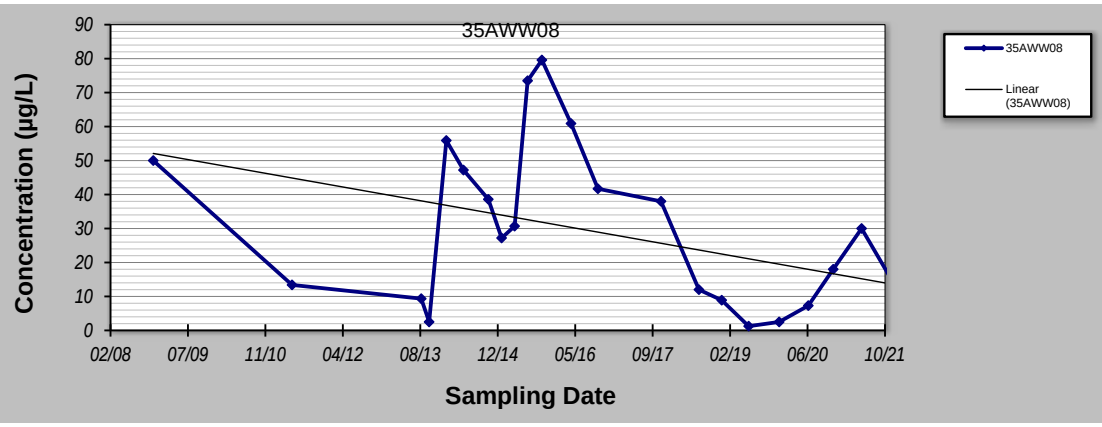
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **CIS-1,2-DICHLOROETHENE**
Concentration Units: **µg/L**

Sampling Point ID: **35AWW08**

Sampling Event	Sampling Date	CIS-1,2-DICHLOROETHENE CONCENTRATION (µg/L)
1	24-Nov-08	*50*
2	9-May-11	13.4
3	20-Aug-13	9.35
4	10-Oct-13	*2.5*
5	29-Jan-14	55.9
6	20-May-14	47.2
7	27-Oct-14	38.6
8	21-Jan-15	27.2
9	15-Apr-15	30.7
10	8-Jul-15	73.5
11	8-Oct-15	79.6
12	13-Apr-16	60.9
13	4-Oct-16	41.7
14	15-Nov-17	38
15	18-Jul-18	12
16	12-Dec-18	8.9
17	4-Jun-19	*1.25*
18	18-Dec-19	*2.5*
19	23-Jun-20	7.3
20	1-Dec-20	18
21	2-Jun-21	30
22	6-Jun-22	*1.25*
23	6-Jun-23	5.2
24		
25		
Coefficient of Variation:		**0.85**
Mann-Kendall Statistic (S):		**-81**
Confidence Factor:		**98.3%**
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
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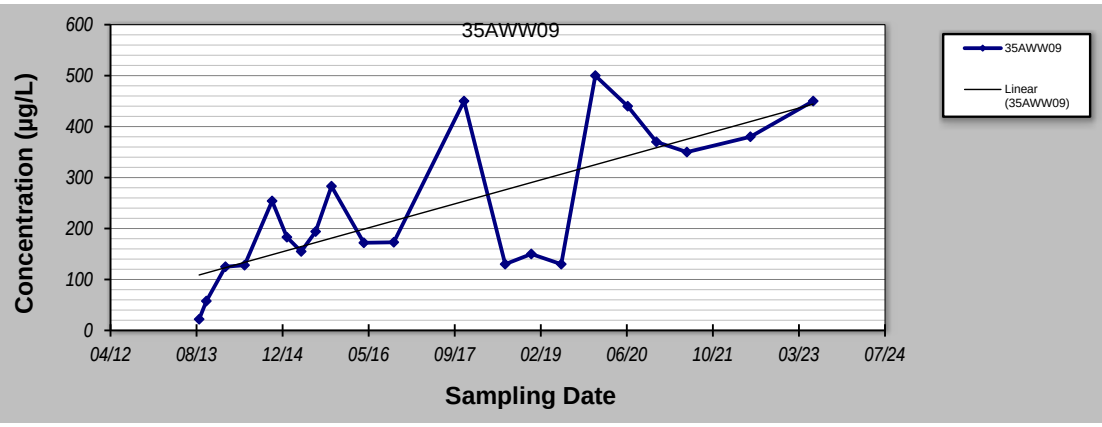
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **Tetrachloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **35AWW09**

Sampling Event	Sampling Date	TETRACHLOROETHENE CONCENTRATION (µg/L)
1	29-Aug-13	21.9
2	10-Oct-13	57.6
3	29-Jan-14	125
4	20-May-14	128
5	27-Oct-14	254
6	21-Jan-15	183
7	14-Apr-15	155
8	7-Jul-15	194
9	7-Oct-15	283
10	12-Apr-16	172
11	3-Oct-16	173
12	15-Nov-17	450
13	12-Jul-18	130
14	11-Dec-18	150
15	3-Jun-19	130
16	18-Dec-19	500
17	23-Jun-20	440
18	7-Dec-20	370
19	2-Jun-21	350
20	6-Jun-22	380
21	6-Jun-23	450
22		
23		
24		
25		
Coefficient of Variation:		0.59
Mann-Kendall Statistic (S):		108
Confidence Factor:		100.0%
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
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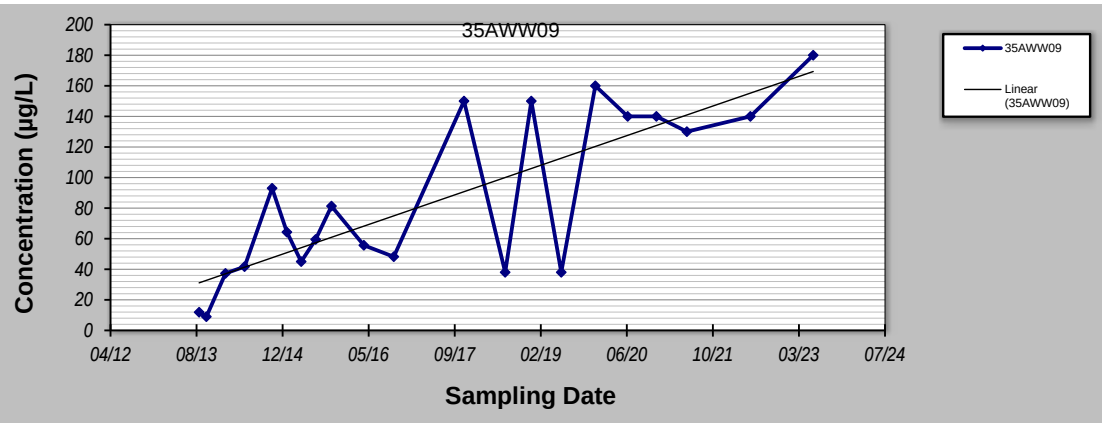
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **Trichloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **35AWW09**

Sampling Event	Sampling Date	TRICHLOROETHENE CONCENTRATION (µg/L)
1	29-Aug-13	11.9
2	10-Oct-13	8.97
3	29-Jan-14	37.3
4	20-May-14	41.7
5	27-Oct-14	93
6	21-Jan-15	64.3
7	14-Apr-15	45
8	7-Jul-15	59.5
9	7-Oct-15	81.3
10	12-Apr-16	55.7
11	3-Oct-16	48.2
12	15-Nov-17	150
13	12-Jul-18	38
14	11-Dec-18	150
15	3-Jun-19	38
16	18-Dec-19	160
17	23-Jun-20	140
18	7-Dec-20	140
19	2-Jun-21	130
20	6-Jun-22	140
21	6-Jun-23	180
22		
23		
24		
25		
Coefficient of Variation:		0.63
Mann-Kendall Statistic (S):		107
Confidence Factor:		100.0%
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
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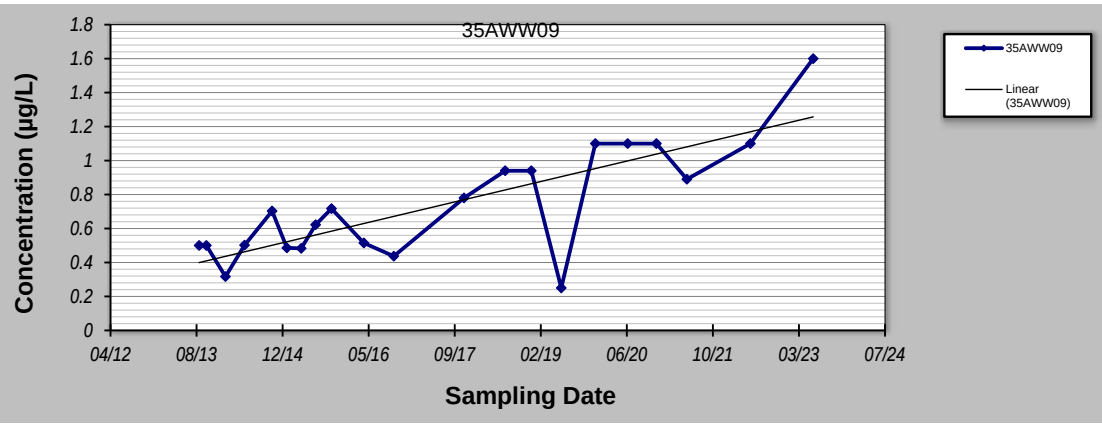
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **cis-1,2-Dichloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **35AWW09**

Sampling Event	Sampling Date	CIS-1,2-DICHLOROETHENE CONCENTRATION (µg/L)
1	29-Aug-13	*0.5*
2	10-Oct-13	*0.5*
3	29-Jan-14	0.317
4	20-May-14	0.502
5	27-Oct-14	0.703
6	21-Jan-15	0.486
7	14-Apr-15	0.483
8	7-Jul-15	0.622
9	7-Oct-15	0.717
10	12-Apr-16	0.515
11	3-Oct-16	0.437
12	15-Nov-17	0.78
13	12-Jul-18	0.94
14	11-Dec-18	0.94
15	3-Jun-19	*0.25*
16	18-Dec-19	1.1
17	23-Jun-20	1.1
18	7-Dec-20	1.1
19	2-Jun-21	0.89
20	6-Jun-22	1.1
21	6-Jun-23	1.6
22		
23		
24		
25		
Coefficient of Variation:		**0.45**
Mann-Kendall Statistic (S):		**116**
Confidence Factor:		**>99.9%**
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
4 *ND values are shown in red italics as 1/2 the limit of detection.*

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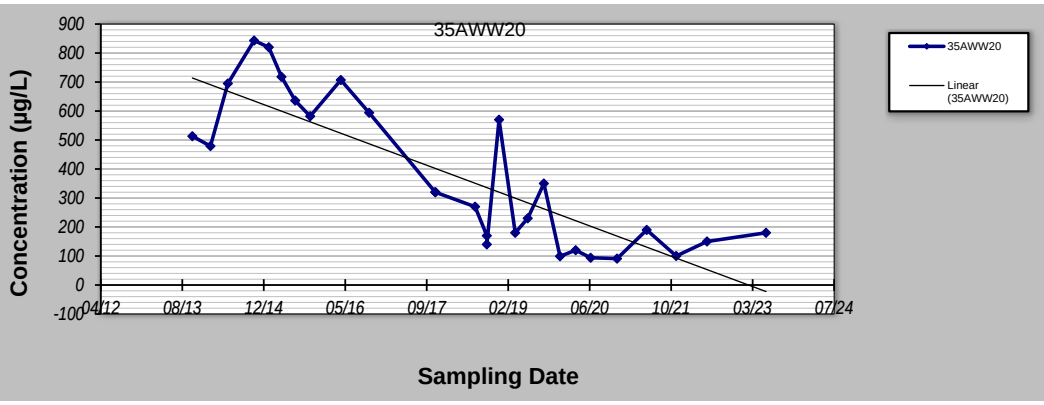
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **Trichloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **35AWW20**

Sampling Event	Sampling Date	TRICHLOROETHENE CONCENTRATION (µg/L)
1	15-Oct-13	513
2	3-Feb-14	479
3	21-May-14	695
4	29-Oct-14	843
5	27-Jan-15	820
6	15-Apr-15	718
7	8-Jul-15	636
8	8-Oct-15	582
9	13-Apr-16	707
10	4-Oct-16	594
11	14-Nov-17	320
12	14-Nov-17	320
13	16-Jul-18	270
14	26-Sep-18	170
15	26-Sep-18	140
16	10-Dec-18	570
17	19-Mar-19	180
18	4-Jun-19	230
19	11-Sep-19	350
20	19-Dec-19	99
21	24-Mar-20	120
22	24-Jun-20	94
23	3-Dec-20	91
24	3-Jun-21	190
25	1-Dec-21	100
26	8-Jun-22	150
27	5-Jun-23	180
28		
29		
30		
Coefficient of Variation:		0.67
Mann-Kendall Statistic (S):		-215
Confidence Factor:		>99.9%
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
4. *ND values are shown in red italics as 1/2 the limit of detection.*

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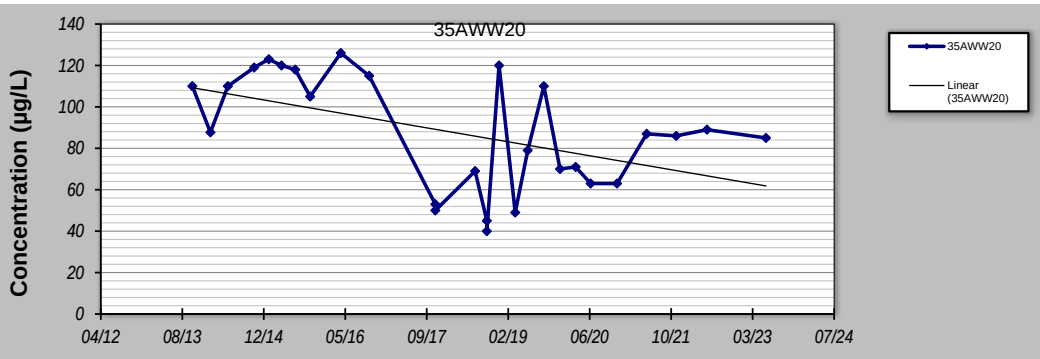
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: 14-Aug-23
Facility Name: LHAAP-58
Conducted By: Zachary Beck

Job ID: JVPCIBH.0001.0010.01
Constituent: cis-1,2-Dichloroethene
Concentration Units: µg/L

Sampling Point ID: 35AWW20

Sampling Event	Sampling Date	CIS-1,2-DICHLOROETHENE CONCENTRATION (µg/L)
1	15-Oct-13	110
2	3-Feb-14	87.7
3	21-May-14	110
4	29-Oct-14	119
5	27-Jan-15	123
6	15-Apr-15	120
7	8-Jul-15	118
8	8-Oct-15	105
9	13-Apr-16	126
10	4-Oct-16	115
11	14-Nov-17	53
12	14-Nov-17	50
13	16-Jul-18	69
14	26-Sep-18	45
15	26-Sep-18	40
16	10-Dec-18	120
17	19-Mar-19	49
18	4-Jun-19	79
19	11-Sep-19	110
20	19-Dec-19	70
21	24-Mar-20	71
22	24-Jun-20	63
23	3-Dec-20	63
24	3-Jun-21	87
25	1-Dec-21	86
26	8-Jun-22	89
27	5-Jun-23	85
28		
29		
30		
Coefficient of Variation:		0.31
Mann-Kendall Statistic (S):		-88
Confidence Factor:		96.6%
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
4. *ND values are shown in red italics as 1/2 the limit of detection.*

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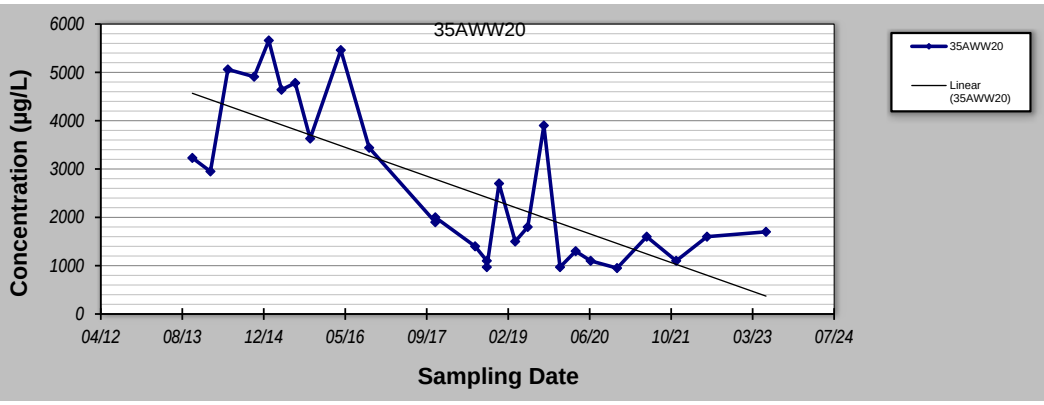
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **1,1-Dichloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **35AWW20**

Sampling Event	Sampling Date	1,1-DICHLOROETHENE CONCENTRATION (µg/L)
1	15-Oct-13	3230
2	3-Feb-14	2950
3	21-May-14	5060
4	29-Oct-14	4910
5	27-Jan-15	5660
6	15-Apr-15	4640
7	8-Jul-15	4780
8	8-Oct-15	3630
9	13-Apr-16	5460
10	4-Oct-16	3440
11	14-Nov-17	1900
12	14-Nov-17	2000
13	16-Jul-18	1400
14	26-Sep-18	1100
15	26-Sep-18	970
16	10-Dec-18	2700
17	19-Mar-19	1500
18	4-Jun-19	1800
19	11-Sep-19	3900
20	19-Dec-19	970
21	24-Mar-20	1300
22	24-Jun-20	1100
23	3-Dec-20	950
24	3-Jun-21	1600
25	1-Dec-21	1100
26	8-Jun-22	1600
27	5-Jun-23	1700
28		
29		
30		
Coefficient of Variation:		0.60
Mann-Kendall Statistic (S):		-176
Confidence Factor:		>99.9%
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
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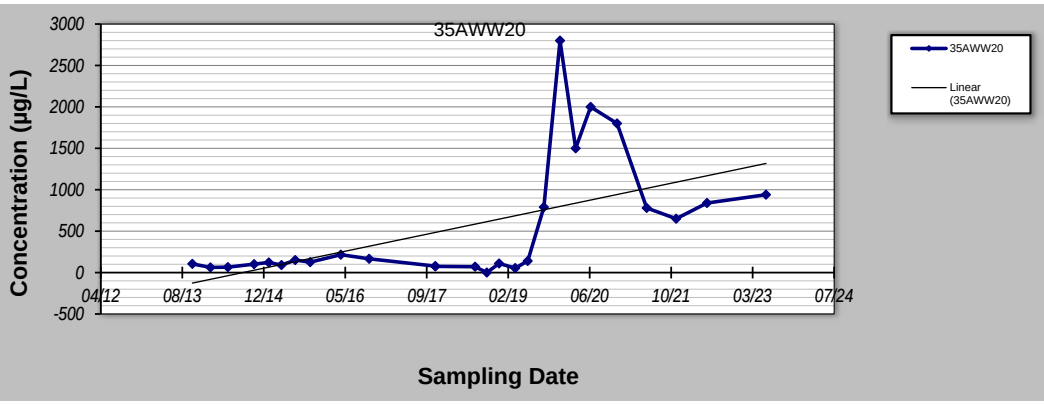
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: 14-Aug-23
Facility Name: LHAAP-58
Conducted By: Zachary Beck

Job ID: JVPCIBH.0001.0010.01
Constituent: Vinyl Chloride
Concentration Units: µg/L

Sampling Point ID: 35AWW20

Sampling Event	Sampling Date	VINYL CHLORIDE CONCENTRATION (µg/L)
1	15-Oct-13	105
2	3-Feb-14	62.4
3	21-May-14	65.7
4	29-Oct-14	102
5	27-Jan-15	122
6	15-Apr-15	90.6
7	8-Jul-15	151
8	8-Oct-15	126
9	13-Apr-16	216
10	4-Oct-16	166
11	14-Nov-17	78
12	14-Nov-17	75
13	16-Jul-18	71
14	26-Sep-18	*0.25*
15	10-Dec-18	110
16	19-Mar-19	54
17	4-Jun-19	140
18	11-Sep-19	790
19	19-Dec-19	2800
20	24-Mar-20	1500
21	24-Jun-20	2000
22	3-Dec-20	1800
23	3-Jun-21	780
24	1-Dec-21	650
25	8-Jun-22	840
26	5-Jun-23	940
27		
28		
29		
30		
Coefficient of Variation:		1.38
Mann-Kendall Statistic (S):		139
Confidence Factor:		99.9%
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
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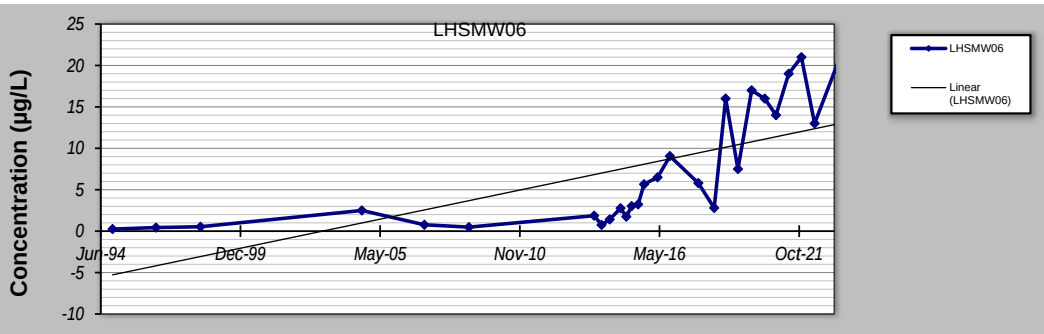
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **Trichloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **LHSMW06**

Sampling Event	Sampling Date	TRICHLOROETHENE CONCENTRATION (µg/L)
1	1-Dec-94	*0.25*
2	13-Aug-96	0.43
3	13-May-98	0.53
4	8-Sep-04	*2.5*
5	21-Feb-07	0.77
6	19-Nov-08	0.486
7	17-Oct-13	1.87
8	31-Jan-14	0.751
9	28-May-14	1.41
10	30-Oct-14	2.77
11	21-Jan-15	1.75
12	7-Apr-15	3.02
13	9-Jul-15	3.23
14	2-Oct-15	5.66
15	13-Apr-16	6.5
16	6-Oct-16	9.06
17	17-Nov-17	5.8
18	2-Jul-18	2.8
19	13-Dec-18	16
20	7-Jun-19	7.5
21	20-Dec-19	17
22	25-Jun-20	16
23	3-Dec-20	14
24	3-Jun-21	19
25	2-Dec-21	21
26	9-Jun-22	13
27	7-Jun-23	21
28		
29		
30		
Coefficient of Variation:		**0.99**
Mann-Kendall Statistic (S):		**283**
Confidence Factor:		**>99.9%**
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
4 *ND values are shown in red italics as 1/2 the limit of detection.*

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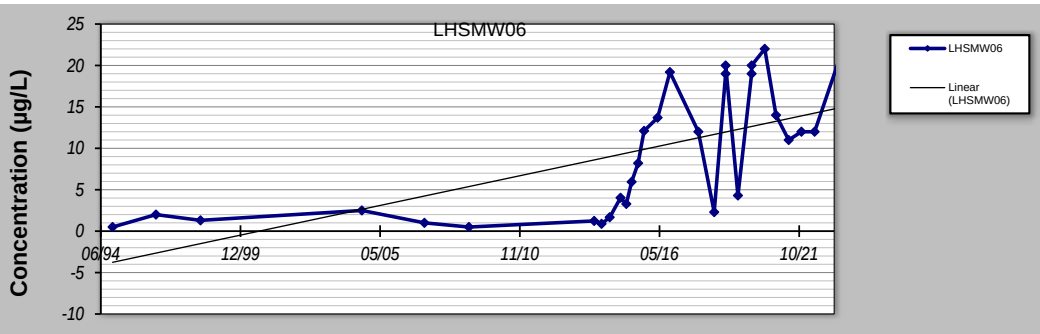
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **1,1-Dichloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **LHSMW06**

Sampling Event	Sampling Date	1,1-DICHLOROETHENE CONCENTRATION (µg/L)
1	1-Dec-94	*0.5*
2	13-Aug-96	2
3	13-May-98	1.3
4	8-Sep-04	*2.5*
5	21-Feb-07	*1*
6	19-Nov-08	*0.5*
7	17-Oct-13	1.23
8	31-Jan-14	0.884
9	28-May-14	1.68
10	30-Oct-14	4.03
11	21-Jan-15	3.28
12	7-Apr-15	5.95
13	9-Jul-15	8.2
14	2-Oct-15	12.1
15	13-Apr-16	13.7
16	6-Oct-16	19.2
17	17-Nov-17	12
18	2-Jul-18	2.3
19	13-Dec-18	19
20	13-Dec-18	20
21	7-Jun-19	4.3
22	20-Dec-19	19
23	20-Dec-19	20
24	25-Jun-20	22
25	3-Dec-20	14
26	3-Jun-21	11
27	2-Dec-21	12
28	9-Jun-22	12
29	7-Jun-23	21
30		
Coefficient of Variation:		**0.83**
Mann-Kendall Statistic (S):		**246**
Confidence Factor:		**>99.9%**
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
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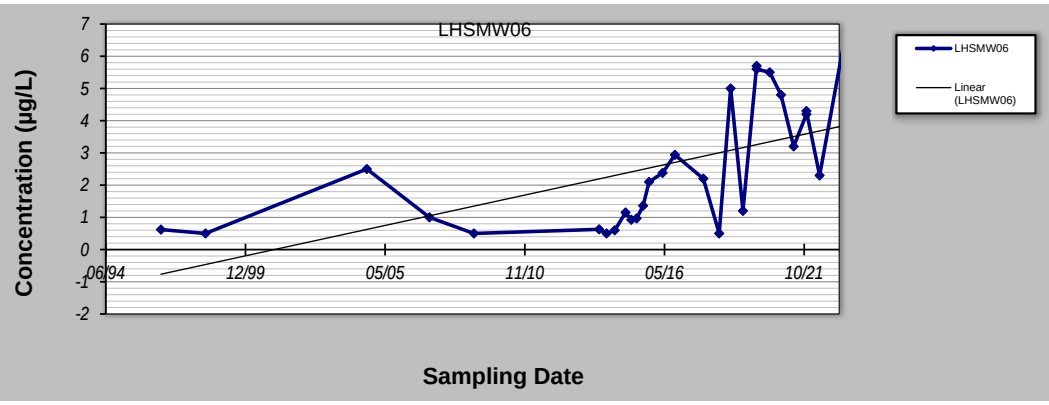
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **Vinyl Chloride**
Concentration Units: **µg/L**

Sampling Point ID: **LHSMW06**

Sampling Event	Sampling Date	VINYL CHLORIDE CONCENTRATION (µg/L)
1	13-Aug-96	0.62
2	13-May-98	*0.5*
3	8-Sep-04	*2.5*
4	21-Feb-07	*1*
5	19-Nov-08	*0.5*
6	17-Oct-13	0.627
7	31-Jan-14	0.5
8	28-May-14	0.597
9	30-Oct-14	1.15
10	21-Jan-15	0.924
11	7-Apr-15	0.967
12	9-Jul-15	1.36
13	2-Oct-15	2.1
14	13-Apr-16	2.38
15	6-Oct-16	2.94
16	17-Nov-17	2.2
17	2-Jul-18	*0.5*
18	13-Dec-18	5
19	7-Jun-19	1.2
20	20-Dec-19	5.7
21	20-Dec-19	5.6
22	25-Jun-20	5.5
23	3-Dec-20	4.8
24	3-Jun-21	3.2
25	2-Dec-21	4.2
26	2-Dec-21	4.3
27	9-Jun-22	2.3
28	7-Jun-23	6.6
29		
30		
Coefficient of Variation:		**0.78**
Mann-Kendall Statistic (S):		**210**
Confidence Factor:		**>99.9%**
Concentration Trend:		Increasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
4. *ND values are shown in red italics as 1/2 the limit of detection.*

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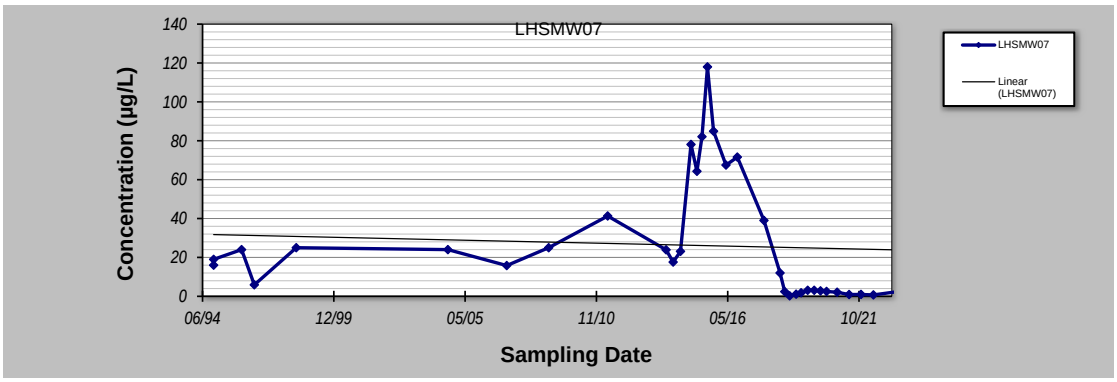
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **Trichloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **LHSMW07**

Sampling Event	Sampling Date	TRICHLOROETHENE CONCENTRATION (µg/L)
1	1-Dec-94	16
2	1-Dec-94	19
3	31-Jan-96	24
4	12-Aug-96	5.9
5	13-May-98	25
6	8-Sep-04	24
7	21-Feb-07	15.8
8	21-Nov-08	25
9	9-May-11	41.3
10	15-Oct-13	23.9
11	30-Jan-14	17.6
12	22-May-14	23.1
13	29-Oct-14	78.1
14	28-Jan-15	64.3
15	15-Apr-15	82.1
16	7-Jul-15	118
17	8-Oct-15	84.9
18	14-Apr-16	67.5
19	4-Oct-16	71.6
20	14-Nov-17	39
21	17-Jul-18	12
22	26-Sep-18	2.4
23	10-Dec-18	*0.25*
24	19-Mar-19	1.1
25	3-Jun-19	1.8
26	11-Sep-19	3.1
27	19-Dec-19	3.1
28	24-Mar-20	2.8
29	24-Jun-20	2.5
30	3-Dec-20	2.1
31	3-Jun-21	0.91
32	1-Dec-21	0.97
33	8-Jun-22	0.71
34	5-Jun-23	2.4
35		
Coefficient of Variation:		**1.17**
Mann-Kendall Statistic (S):		**-203**
Confidence Factor:		**99.9%**
Concentration Trend:		**Decreasing**



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
4 *ND values are shown in red italics as 1/2 the limit of detection.*

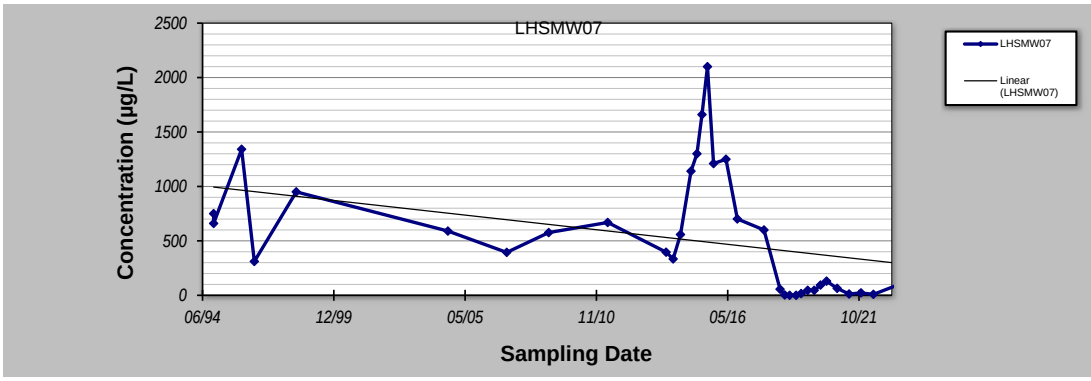
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GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**
Job ID: **JVPCIBH.0001.0010.01**
Constituent: **1,1-Dichloroethene**
Concentration Units: **µg/L**

Sampling Point ID: **LHSMW07**

Sampling Event	Sampling Date	1,1-DICHLOROETHENE CONCENTRATION (µg/L)
1	1-Dec-94	750
2	1-Dec-94	660
3	31-Jan-96	1341
4	12-Aug-96	311
5	13-May-98	950
6	8-Sep-04	590
7	21-Feb-07	394
8	21-Nov-08	576
9	9-May-11	669
10	15-Oct-13	396
11	30-Jan-14	334
12	22-May-14	558
13	29-Oct-14	1140
14	28-Jan-15	1300
15	15-Apr-15	1660
16	7-Jul-15	2100
17	8-Oct-15	1210
18	14-Apr-16	1250
19	4-Oct-16	701
20	14-Nov-17	600
21	17-Jul-18	56
22	26-Sep-18	3.1
23	10-Dec-18	*0.25*
24	19-Mar-19	*0.25*
25	3-Jun-19	16
26	11-Sep-19	46
27	19-Dec-19	46
28	24-Mar-20	94
29	24-Jun-20	130
30	3-Dec-20	64
31	3-Jun-21	12
32	1-Dec-21	22
33	8-Jun-22	8.8
34	5-Jun-23	93
35		
Coefficient of Variation:		**1.04**
Mann-Kendall Statistic (S):		**-221**
Confidence Factor:		**>99.9%**
Concentration Trend:		Decreasing



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
4 *ND values are shown in red italics as 1/2 the limit of detection.*

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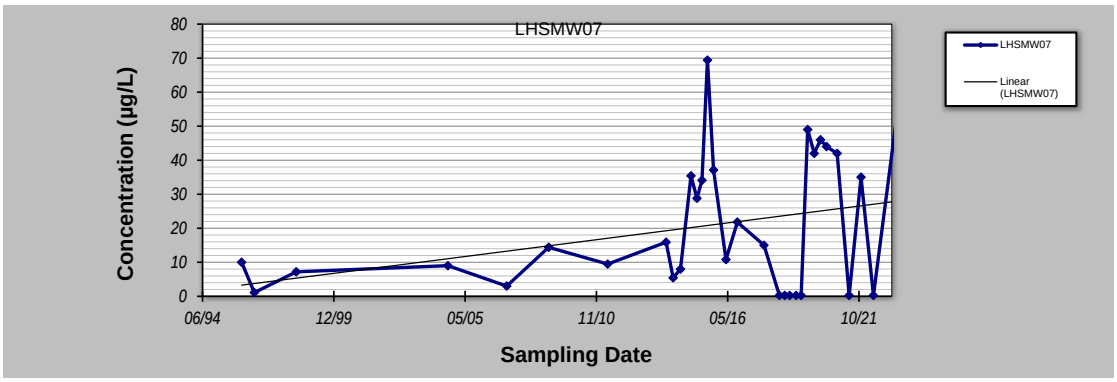
GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date: **14-Aug-23**
Facility Name: **LHAAP-58**
Conducted By: **Zachary Beck**

Job ID: **JVPCIBH.0001.0010.01**
Constituent: **Vinyl Chloride**
Concentration Units: **µg/L**

Sampling Point ID: **LHSMW07**

Sampling Event	Sampling Date	VINYL CHLORIDE CONCENTRATION (µg/L)
1	31-Jan-96	10
2	12-Aug-96	1.1
3	13-May-98	7.2
4	8-Sep-04	9
5	21-Feb-07	3
6	21-Nov-08	14.4
7	9-May-11	9.47
8	15-Oct-13	15.9
9	30-Jan-14	5.43
10	22-May-14	7.98
11	29-Oct-14	35.4
12	28-Jan-15	28.8
13	15-Apr-15	34.1
14	7-Jul-15	69.4
15	8-Oct-15	37.1
16	14-Apr-16	10.8
17	4-Oct-16	21.8
18	14-Nov-17	15
19	7-Jul-18	*0.25*
20	26-Sep-18	*0.25*
21	10-Dec-18	*0.25*
22	19-Mar-19	*0.25*
23	3-Jun-19	*0.25*
24	11-Sep-19	49
25	19-Dec-19	42
26	24-Mar-20	46
27	24-Jun-20	44
28	3-Dec-20	42
29	3-Jun-21	*0.25*
30	1-Dec-21	35
31	8-Jun-22	*0.25*
32	5-Jun-23	54
33		
34		
35		
Coefficient of Variation:		0.97
Mann-Kendall Statistic (S):		76
Confidence Factor:		88.7%
Concentration Trend:		No Trend



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.
4 *ND values are shown in red italics as 1/2 the limit of detection.*

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Subject:	**Final Monthly Managers' Meeting (MMM), Longhorn Army Ammunition Plant (LHAAP)**
Location of Meeting:	**WebEx**
Date of Meeting:	**20 December 2023 – 10:00 AM Central Daylight Time (CDT)**

Attendees:

USAEC:	Lena Sierocinski (LS)
USEPA:	Brian Follin (BF)
USGS:	Tim Bartos
USACE:	Aaron Williams (AW)
BRAC:	Kyle Russell (KR)
TCEQ:	April Palmie (AP)
TLI:	Jon Tatman (JT)
PCI/Bhate JV:	Zachary Beck (ZB), Erin Bradley
APTIM:	Praveen Srivastav (PS), William Foss (WF)
HDR:	Gregory Kelly (GK), Phil Werner (PW)

Defense Environmental Restoration Program (DERP) Performance-Based Remediation Update

There were no outstanding action items to discuss.

Groundwater Treatment Plant (GWTP) – ZB stated there have been no major repairs to report since last month's meeting. ZB explained this time of year lends itself to potential freeze issues, and therefore measures are being taken to mitigate concerns. ZB stated there are various repairs planned for January 2024, including fixing the potable water line. ZB explained the leak in the potable water line has resulted in low pressures at the GWTP. ZB said a contractor will arrive on site the first week of January 2024 and a firm schedule to repair the water line will be developed. ZB stated a potential additional repair includes the secondary containment sump, a sample of which indicated the presence of a great quantity of sediment. ZB said dependent on data from recent sampling, a contractor will be recruited to address the issue as well. ZB stated there are three pumps in the well field at LHAAP-18/24 that are experiencing electrical issues with a cause yet to be determined. ZB said replacement pumps will be installed and the lines will be investigated in January 2024. However, ZB concluded that overall, the GWTP is working well, with effective treatment taking place throughout the treatment chain.

ZB stated that although there is standing water, the Bayou continues to have no flow. Due to no flow in the Bayou, ZB explained that discharge has been directed to the Intermediate-Range Nuclear Forces Treaty (INF) pond which has a current staff gauge reading of 5.6 feet (ft). ZB further explained that once the staff gauge reads 6.3 ft, TCEQ will be notified that the pond is approaching capacity. However, ZB said rain is forecasted for the upcoming weekend, so the ability to discharge to the Bayou is likely and the water level of the INF pond would no longer be of concern. Additionally, with rain forecasted, the 4th Quarter surface water samples are likely to be collected.

ZB stated the validated data package was delivered 19 December 2023 and discussed the results. ZB said that on Sunday 29 October 2023, attempts to reprime the acetic acid pump failed. As a result, the GWTP was temporarily placed into recycle. The acetic acid pump helps regulate oxidation reduction potential (ORP) in the fluidized bed reactor (FBR). With the acetic acid pump inoperable, the ORP increased above the standard operating range which can negatively affect FBR treatment. ZB stated this occurrence is reflected in the data in late October where high perchlorate levels were

detected. ZB said that a new acetic acid pump was installed on 7 November 2023, which resulted in ORP returning to normal levels and allowed GWTP operation and discharge to resume on 9 November 2023. ZB stated that the perchlorate effluent data collected after the FBR and before the ion exchange vessels confirmed proper treatment of perchlorate.

Field Work – ZB stated that the Quarterly Sampling Event at LHAAP-17 as well as the Annual Sampling Event at LHAAP-12 were completed in December 2023. ZB said the Semi-Annual Event at LHAAP-18/24 is underway. WF discussed the Conceptual Site Model (CSM) survey for LHAAP-16, stating that procurement issues are currently being addressed with the surveyor, to initiate field activities as soon as possible. WF said materials will be delivered in January 2024, and he will be working with Scott to acquire equipment and install surface water gauges. WF stated it will be necessary to work around LHAAP-16 sampling as well**.**

ZB asked everyone to refer to the Document and Issues (DI) Tracking Table for December 2023.

- **Tasks 1 -5** (Project Management) – ZB stated the Monthly Manager's Meeting (MMM) November 2023 Minutes were submitted on 6 December 2023, Texas Commission on Environmental Quality (TCEQ) comments were received, and comments are currently being addressed. ZB said comments were received for the Restoration Advisory Board (RAB) Minutes from both TCEQ and United States Environmental Protection Agency (USEPA), and the Draft Final will be submitted to the RAB for review. ZB stated the next RAB is scheduled for 22 February 2024, and preparation for the meeting is in progress.
- **Task 6** (LHAAP-04) – ZB stated that the Year 4 Annual Remedial Action – Operation (RA-O) Report is in progress and submittal to the regulators is anticipated in January 2024. ZB stated the Year 5 1st Semi Annual RA-O Sampling Event is scheduled for February 2023 and the validated data package will be presented in March 2024.
- **Task 7** (LHAAP-12) – ZB stated the 2023 Annual Sampling Event was completed in December 2023, and the validated data will be presented in January 2024. The 2023 Annual RA-O Report is anticipated for submittal in February 2024.
- **Task 8** (LHAAP-16) – PS stated the Year 4 2nd Semi-Annual RA-O Sampling Event is scheduled for January 2024. PS said the Year 3 RA-O Report was submitted for army review and is scheduled for submittal to the regulators in January 2024.
- **Task 1022** (Option 22: LHAAP-16) – PS stated the CSM Work Plan received approvals, and field activities will commence as soon as contractual details are finalized with the contractor.
- **Task 9** (LHAAP-18/24/GWTP) – ZB said the Semi-Annual Sampling Event will be completed 20 December 2023 and the validated data package will be presented at the January 2024 MMM. ZB stated the Draft Final of the 1st Quarter 2023 GWTP Report includes revisions based on TCEQ comments regarding lab packages and bookmarks within the PDF document and throughout the Appendices for ease of navigation. ZB stated that the Draft Final differs from the initial submittal as it includes separate files with the complete Level IV laboratory data. ZB said the remainder of TCEQ comments are addressed in the 2nd Quarter 2023 report, as is standard practice. ZB said the 2nd Quarter 2023 GWTP Report covers May and June 2023, as well as the June 2023 Semi- Annual sampling data. ZB said the 2nd Quarter 2023 report is anticipated to be submitted by the first week of January 2024. ZB said the 3rd Quarter 2023 GWTP report is in the internal quality control process and is tentatively scheduled for submittal next month.

- **Task 10** (LHAAP-37) – PS stated the Year 7 Annual RA-O Sampling Event was completed in November 2023. PS said the Year 6 RA-O Draft Final was submitted in November 2023 and received approvals from both TCEQ and USEPA.
- **Task 11** (LHAAP-46) -PS said the Year 9 Annual RA-O Report is in progress under internal review.
- **Task 12** (LHAAP-50) **–** ZB stated the Year 9 Annual RA-O Report received comments from TCEQ and USEPA, and revisions are in progress. ZB asked if, based on USEPA comments, further discussion considering additional investigation moving forward was warranted. BF agreed to further discussion, stating however that comments should be received first. ZB stated a separate call would be scheduled, and that the response to comments (RTCs) are in progress. ZB brought attention to a comment received from both TCEQ and USEPA concerning the readability of figures and asked if the issue pertains to figures on other documents as well. AP explained that the issue is specific to the LHAAP-50 report, as the figures are pixelated and lack sharpness, particularly when enlarged, in comparison to the LHAAP-58 report figures which remain clear. AP stated the base layer may be the culprit for the lack of clarity, and the 2018 layer is preferred. ZB stated a discussion with Geographic Information System (GIS) personnel will transpire to ensure a resolution. ZB stated the Year 10 Semi-Annual Sampling Event was completed in October 2023 with the next event scheduled for May 2024. ZB said there is no field work update.
- **Task 13** (LHAAP-58) – ZB stated the Year 9 RA-O Report is under review. ZB said the Year 10 Annual RA-O Sampling Event is scheduled for June 2024, with the validated data to be presented in July 2024.
- **Task 14** (LHAAP-67) – PS stated the Year 10 Annual RA-O Annual Sampling Event was completed in November 2023. PS said that laboratory analysis and data management validation is underway.
- **Task 15** (LHAAP-001-R-01 and LHAAP-003-R-01) – ZB said the annual inspections are scheduled for December 2023. ZB stated the Annual LTM Report has a target submittal of January 2024; however, a delay is possible as inspections have yet to occur.
- **Task 16** (Surface Water) – ZB stated that sampling in the 3rd Quarter was unable to occur due to no flow in the Bayou. ZB said sampling also has yet to occur for the 4th Quarter, although the predicted weather event may allow for sample collection.
- **Task 17** (2023 Land Use Control [LUC] Management Plan) – ZB stated there is a tentative delivery date of February 2024 for the 2023 Comprehensive LUC Management Plan.
- **Task 18** (Administrative Record [AR]) – WF said the April to June 2023 AR Update was finalized, hard copies were sent to Scott, and compact disc versions were delivered. WF said to inform him if they were not received. WF stated the July to September 2023 tracking list is in progress.

Update on other DERP Sites:

- **LHAAP 18/24 –** PW stated the 100% Remedial Design was submitted for final review to the Army and revisions are in progress, with the next step being to submit sealed and signed final documents in January 2024.
- **LHAAP-29** – PW said the second 100% Remedial Design was submitted to the regulators for review in December 2023 and comments are anticipated to be received in late January 2024.

- **LHAAP-47** – GK stated TCEQ comments are currently being addressed for the Draft PDI Report and USEPA comments are expected by the end December 2023. GK said the Draft Final will likely be submitted by the end of January 2024.
- **LHAAP-17** – JT stated the Draft Final of the Remedial Action Construction Report (RACR) received comments from TCEQ and are awaiting USEPA comments. ZB stated the Year 1 RA-O Report was submitted 20 December 2023 and to inform him if there are any issues in retrieving the document. ZB said the Quarterly Performance Monitoring Event was completed in December 2023 and the validated data will be presented at the January 2024 MMM. ZB stated there is no update for LUC notices.

Per- and polyfluoroalkyl substances (PFAS) Update: LS stated verification is in progress that the Preliminary Assessment/ Site Inspection (PA/SI) Report was uploaded onto the United States Army Environmental Command (USAEC) website for community access. LS asked if other attendees had a copy to upload to the website, to which ZB responded that Bhate does not have a copy. LS stated the document will likely be sent through Department of Defense (DoD) Safe.

Five-Year Review: LS stated the Five-Year Review Report is in progress. LS stated a meeting with a contractor occurred in December 2023 and an updated Draft completion date of 11 March 2024 was established.

Transfer Update: KR stated there is no update on the review.

Schedule Next Managers' Meeting: After discussion, ZB, LS, and AW decided to cancel the next weekly update meeting; however, ZB stated the weekly summary will be sent out for the record.

ZB said the next MMM will be held via WebEx on Wednesday 17 January 2024 at 10:00 AM CDT. Meeting concluded at approximately 10:40 AM CDT.

ACRONYM LIST

AP	April Palmie
AR	Administrative Record
AW	Aaron Williams
BF	Brian Follin
CDT	Central Daylight Time
CSM	Conceptual Site Model
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
FBR	Fluidized bed reactor
Ft	Feet
GIS	Geographic Information Systems
GK	Gregory Kelly
GWTP	Groundwater Treatment Plant
INF	Intermediate-Range Nuclear Forces Treaty
KR	Kyle Russel
LHAAP	Longhorn Army Ammunition Plant
LS	Lena Sierocinski
LUC	Land Use Control
MMM	Monthly Managers' Meeting
OM&M	Operation, Maintenance, and Monitoring
ORP	Oxidation Reduction Potential
PA/SI	Preliminary Assessment/Site Inspection
PBJV	Poarch Creek Indians, Governmental Services, LLC /Bhate Environmental Associates Joint Venture
PS	Praveen Srivastav
PW	Phil Werner
RAB	Restoration Advisory Board
RACR	Remedial Action Construction Report
RA-O	Remedial Action – Operation
RTC	Response to comments
SB	Scott Beesinger
TCEQ	Texas Commission on Environmental Quality
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
WF	William Foss
ZB	Zachary Beck

LHAAP Validated Data Packages for December 2023 Monthly Manager's Meeting

GWTP Effluent	*Weekly Perchlorate Sampling –October and November 2023* Perchlorate (6850)
GWTP Effluent	*Weekly, Bi-Weekly, and Monthly Sampling – October and November 2023* Ammonia (350.3) Ortho-Phosphate (365.3) Total Organic Carbon (415.1) VOC (8260C) Metals (6020A) Hexavalent Chromium (7196A) 1,4-Dioxane (8270D-SIM) Anions (9056)
GWTP Influent	*Monthly Sampling – October and November 2023* Metals (6020A) Perchlorate (6850) Hexavalent Chromium (7196A)
GWTP Quarterly	*Influent and Effluent – November 2023* Oil and Grease (1664A) Perchlorate (6850) Metals (6020A/7470A) 1,4-Dioxane (8270D-SIM) Chemical Oxygen Demand (410.4) VOC (8260C) Anions (9056A)

GWTP Weekly/Effluent Perchlorate Sampling - October 2023

Location ID: Sample Date:	Units	Daily Maximum Conc	PCL	LH18/24-SP650_100323_BIX 10/3/23	LH18/24-SP650_100323_AIX 10/3/23	LH18/24-SP650_101023_BIX 10/10/23	LH18/24-SP650_101023_AIX 10/10/23	LH18/24-SP650_101023_AIX 10/10/23	LH18/24-SP650_101723_BIX 10/17/23	LH18/24-SP650_101723_AIX 10/17/23	LH18/24-SP650_102423_BIX 10/24/23	LH18/24-SP650_102423_AIX 10/24/23	LH18/24-SP650_103123_BIX 10/31/23	LH18/24-SP650_103123_AIX 10/31/23
Location Description				Weekly	Weekly	Weekly	Weekly	Monthly Eff	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly
Perchlorate (6850)														
Perchlorate	µg/L	589	17	**34.2**	**12.3**	**33.2**	**8.81**	**10.6**	**0.568**	**1.30**	**14.0**	**4.34**	**16,000**[1]	**2,600**[1]

PCL – Texas Risk Reduction Program (TRRP) Tier 1 Groundwater Residential Protective Concentration Level

µg/L - micrograms per liter

BIX - before ion exchange vessels /AIX - after first ion exchange vessel (before second ion exchange vessel)

Result exceeds the PCL

Bold Values- Detected result

All treated groundwater discharged to the INF Pond in October 2023 was below the PCL for perchlorate.

[1] Groundwater treatment plant was placed into recycle prior to sample collection on 31 October 2023 as a result of acetic acid pump failure.

GWTP Weekly/Effluent Perchlorate Sampling - November 2023

Location ID: Sample Date:	Units	Daily Maximum Conc	PCL	LH18/24-SP650_110723_BIX 11/7/23	LH18/24-SP650_110723_AIX 11/7/23	LH18/24-SP650_110723_AIX 11/7/23	LH18/24-SP650_110923_AIX 11/9/23	LH18/24-SP650_111423_BIX 11/14/23	LH18/24-SP650_111423_AIX 11/14/23	LH18/24-SP650_112123_BIX 11/21/23	LH18/24-SP650_112123_AIX 11/21/23	LH18/24-SP650_112123_AIX 11/21/23	LH18/24-SP650_112823_BIX 11/28/23	LH18/24-SP650_112823_AIX 11/28/23
Location Description				Weekly	Weekly	Monthly Eff	Confirmation	Weekly	Weekly	Weekly	Weekly	Quarterly Eff	Weekly	Weekly
Perchlorate (6850)														
Perchlorate	µg/L	589	17	**14,000**	**1,190**	**1,210**	**0.0811 J**	**6.02**	**3.66**	**0.179**	**0.159**	**0.130**	**6.36**	**0.170**

PCL – Texas Risk Reduction Program (TRRP) Tier 1 Groundwater Residential Protective Concentration Level

µg/L - micrograms per liter

BIX - before ion exchange vessels /AIX - after first ion exchange vessel (before second ion exchange vessel)

Result exceeds the PCL

Bold Values- Detected result

All treated groundwater discharged to the INF Pond in November 2023 was below the PCL for perchlorate.

GWTP Weekly Sampling - October 2023

Location ID: Sample Date:	Units	Daily Maximum Conc	LH18/24-SP650_100323 10/3/23	LH18/24-SP650_101023 10/10/23	LH18/24-SP650_101723 10/17/23	LH18/24-SP650_102423 10/24/23	LH18/24-SP650_103123 10/31/23
Location Description			**GWTP–Collected from a spigot on the discharge of effluent TK-650. Sampled Weekly.**				
Ammonia as N (350.3)							
Ammonia as N	mg/L	NV	**42**	**32**	**21**	**4.3**	**15**
Ortho-Phosphate (365.3)							
Ortho-Phosphate	mg/L	NV	**4.33**	**4.62**	**3.25**	**0.557**	**4.93**
Organic Carbon (415.1)							
Total Organic Carbon (TOC)	mg/L	NV	**3.08**	**2.58**	**3.13**	**2.32**	**4.00**

Notes:

GWTP - Groundwater Treatment Plant

TK - Tank

mg/L - milligrams per liter

NV - No Value

Bold Values- Detected result

GWTP Weekly Sampling - November 2023

Location ID: Sample Date:	Units	Daily Maximum Conc	LH18/24-SP650_110723 11/7/23	LH18/24-SP650_111423 11/14/23	LH18/24-SP650_112123 11/21/23	LH18/24-SP650_112823 11/28/23
Location Description			**GWTP–Collected from a spigot on the discharge of effluent TK-650. Sampled Weekly.**			
Ammonia as N (350.3)						
Ammonia as N	mg/L	NV	**20**	**26**	**9.7**	**17**
Ortho-Phosphate (365.3)						
Ortho-Phosphate	mg/L	NV	**4.03**	**4.96**	**3.19**	**21.2**
Organic Carbon (415.1)						
Total Organic Carbon (TOC)	mg/L	NV	**6.29**	**2.24**	**2.76**	**3.06**

Notes:

GWTP - Groundwater Treatment Plant

TK - Tank

mg/L - milligrams per liter

NV - No Value

Bold Values- Detected result

GWTP Bi-Weekly Sampling - October 2023

Location ID: / Sample Date:	Units	(Bayou) Daily Maximum Conc	(INF pond) MCL	LH18/24-SP650_100323 10/3/23	LH18/24-SP650_101723 10/17/23	LH18/24-SP650_101723 10/17/23
Location Description				**GWTP – Collected from a spigot on the discharge of effluent TK-650. Sampled Biweekly.**		
Volatile Organic Compounds (8260C)						
1,1,1-Trichloroethane	µg/L	7,230	200	< 0.50 U	< 0.50 U	< 1.0 U
1,1,2-Trichloroethane	µg/L	216.9	5	< 0.50 U	< 0.50 U	< 1.0 U
1,1-Dichloroethane	µg/L	14,032	NV	< 0.50 U	< 0.50 U	< 1.0 U
1,1-Dichloroethene	µg/L	253	7	< 0.50 U	< 0.50 U	< 1.0 U
1,2-Dichloroethane	µg/L	181	5	< 0.50 U	< 0.50 U	< 1.0 U
1,2-Dichloropropane	µg/L	5	5	< 0.50 U	< 0.50 U	< 1.0 U
Acetone	µg/L	2,395	NV	< 2.0 U	< 2.0 U	< 1.0 U
Benzene	µg/L	181	5	< 0.50 U	< 0.50 U	< 1.0 U
Carbon tetrachloride	µg/L	181	5	< 0.50 U	< 0.50 U	< 1.0 U
Chlorobenzene	µg/L	47,180	100	< 0.50 U	< 0.50 U	< 1.0 U
Chloroform	µg/L	3,615	NV	< 0.50 U	< 0.50 U	< 1.0 U
cis-1,2-Dichloroethene	µg/L	NV	70	**1.7**	**1.3**	**1.0**
Ethylbenzene	µg/L	57,025	700	< 0.50 U	< 0.50 U	< 1.0 U
m,p-Xylene	µg/L	83.6	NV	< 1.0 U	< 1.0 U	< 1.0 U
Methylene chloride	µg/L	1,699	5	< 2.0 U	< 2.0 U	< 1.0 U
o-Xylene	µg/L	83.6	NV	< 0.50 U	< 0.50 U	< 1.0 U
Styrene	µg/L	5,987	100	< 0.50 U	< 0.50 U	< 1.0 U
Tetrachloroethene	µg/L	180.7	5	< 0.50 U	< 0.50 U	< 1.0 U
Toluene	µg/L	4,189	10	< 0.50 U	< 0.50 U	< 1.0 U
Trichloroethene	µg/L	181	5	**1.2**	< 0.50 U	< 0.50 U
Vinyl chloride	µg/L	72	2	< 0.50 U	< 0.50 U	< 1.0 U
Anions (9056)						
Chloride	mg/L	NV	NV	**950**	**1,140**	**1,160**
Sulfate	mg/L	NV	NV	**58.4**	**76.3**	**73.6**

Notes:

GWTP - Groundwater Treatment Plant

INF - Intermediate Range Nuclear Forces

MCL - Maximum Contaminant Level

TK - Tank

µg/L - micrograms per liter

mg/L - milligrams per liter

Bold Values- Detected result

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

GWTP Bi-Weekly Sampling - November 2023

Location ID: / Sample Date:	Units	(Bayou) Daily Maximum Conc	(INF pond) MCL	LH18/24-SP650_111423 11/14/23	LH18/24-SP650_112823 11/28/23
Location Description				**GWTP – Collected from a spigot on the discharge of effluent TK-650. Sampled Biweekly.**	
Volatile Organic Compounds (8260C)					
1,1,1-Trichloroethane	µg/L	7,230	200	< 1.0 U	< 1.0 U
1,1,2-Trichloroethane	µg/L	216.9	5	< 1.0 U	< 1.0 U
1,1-Dichloroethane	µg/L	14,032	NV	< 1.0 U	< 1.0 U
1,1-Dichloroethene	µg/L	253	7	< 1.0 U	< 1.0 U
1,2-Dichloroethane	µg/L	181	5	< 1.0 U	< 1.0 U
1,2-Dichloropropane	µg/L	5	5	< 1.0 U	< 1.0 U
Acetone	µg/L	2,395	NV	< 1.0 U	< 1.0 U
Benzene	µg/L	181	5	< 1.0 U	< 1.0 U
Carbon tetrachloride	µg/L	181	5	< 1.0 U	< 1.0 U
Chlorobenzene	µg/L	47,180	100	< 1.0 U	< 1.0 U
Chloroform	µg/L	3,615	NV	< 1.0 U	< 1.0 U
cis-1,2-Dichloroethene	µg/L	NV	70	**1.2**	**1.1**
Ethylbenzene	µg/L	57,025	700	< 1.0 U	< 1.0 U
m,p-Xylene	µg/L	83.6	NV	< 1.0 U	< 1.0 U
Methylene chloride	µg/L	1,699	5	< 1.0 U	< 1.0 U
o-Xylene	µg/L	83.6	NV	< 1.0 U	< 1.0 U
Styrene	µg/L	5,987	100	< 1.0 U	< 1.0 U
Tetrachloroethene	µg/L	180.7	5	< 1.0 U	< 1.0 U
Toluene	µg/L	4,189	10	< 1.0 U	< 1.0 U
Trichloroethene	µg/L	181	5	< 0.50 U	< 1.0 U
Vinyl chloride	µg/L	72	2	< 1.0 U	< 1.0 U
Anions (9056)					
Chloride	mg/L	NV	NV	**1,010**	**1,050**
Sulfate	mg/L	NV	NV	**50.4**	**55.5**

Notes:

GWTP - Groundwater Treatment Plant

INF - Intermediate Range Nuclear Forces

MCL - Maximum Contaminant Level

TK - Tank

µg/L - micrograms per liter

mg/L - milligrams per liter

Bold Values- Detected result

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

GWTP Monthly Effluent Sampling - October 2023

Location ID: / Sample Date:	Units	Daily Maximum Conc	(INF pond) MCL	LH18/24-SP650_101023 10/10/23
Location Description				**GWTP – Collected from a spigot on the discharge of effluent TK-650. Sampled monthly**
Volatile Organic Compounds (8260C)				
1,1,1-Trichloroethane	µg/L	7,230	200	< 0.50 U
1,1,2-Trichloroethane	µg/L	216.9	5	< 0.50 U
1,1-Dichloroethane	µg/L	14,032	NV	< 0.50 U
1,1-Dichloroethene	µg/L	253	7	< 0.50 U
1,2-Dichloroethane	µg/L	181	5	< 0.50 U
1,2-Dichloropropane	µg/L	5	5	< 0.50 U
Acetone	µg/L	2,395	NV	< 2.0 U
Benzene	µg/L	181	5	< 0.50 U
Carbon tetrachloride	µg/L	181	5	< 0.50 U
Chlorobenzene	µg/L	47,180	100	< 0.50 U
Chloroform	µg/L	3,615	NV	< 0.50 U
cis-1,2-dichloroethene	µg/L	NV	70	**1.4**
Ethylbenzene	µg/L	57,025	700	< 0.50 U
m,p-Xylene	µg/L	83.6	NV	< 1.0 U
Methylene chloride	µg/L	1,699	5	< 2.0 U
o-Xylene	µg/L	83.6	NV	< 0.50 U
Styrene	µg/L	5,987	100	< 0.50 U
Tetrachloroethene	µg/L	180.7	5	< 0.50 U
Toluene	µg/L	4,189	10	< 0.50 U
Trichloroethene	µg/L	181	5	< 0.50 U
Vinyl chloride	µg/L	72	2	< 0.50 U
Metals (6020A)				
Barium	mg/L	2	2	**0.169**
Lead	mg/L	0.0046	0.015	< 0.00125 U
Selenium	mg/L	0.012	0.05	< 0.00250 U
Silver	mg/L	0.003	0.1	< 0.000500 U
Hexavalent Chromium (7196A)				
Hexavalent Chromium	mg/L	0.1244	NV	< 0.0100 U
Semi-Volatile Organic Compounds (8270D SIM)				
1,4-Dioxane	µg/L	134.2	NV	**0.68**

Notes:

GWTP - Groundwater Treatment Plant

INF - Intermediate Range Nuclear Forces

MCL - Maximum Contaminant Level

TK - Tank

SIM - Select Ion monitoring

µg/L - micrograms per liter

mg/L - milligrams per liter

Bold Values- Detected result

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

GWTP Monthly Effluent Sampling - November 2023

Location ID: / Sample Date:	Units	Daily Maximum Conc	(INF pond) MCL	LH18/24-SP650_110723 11/7/23
Location Description				**GWTP – Collected from a spigot on the discharge of effluent TK-650. Sampled monthly**
Volatile Organic Compounds (8260C)				
1,1,1-Trichloroethane	µg/L	7,230	200	< 1.0 U
1,1,2-Trichloroethane	µg/L	216.9	5	< 1.0 U
1,1-Dichloroethane	µg/L	14,032	NV	< 1.0 U
1,1-Dichloroethene	µg/L	253	7	< 1.0 U
1,2-Dichloroethane	µg/L	181	5	< 1.0 U
1,2-Dichloropropane	µg/L	5	5	< 1.0 U
Acetone	µg/L	2,395	NV	< 1.0 U
Benzene	µg/L	181	5	< 1.0 U
Carbon tetrachloride	µg/L	181	5	< 1.0 UJ
Chlorobenzene	µg/L	47,180	100	< 1.0 U
Chloroform	µg/L	3,615	NV	< 1.0 U
cis-1,2-dichloroethene	µg/L	NV	70	**1.1**
Ethylbenzene	µg/L	57,025	700	< 1.0 U
m,p-Xylene	µg/L	83.6	NV	< 1.0 U
Methylene chloride	µg/L	1,699	5	< 1.0 U
o-Xylene	µg/L	83.6	NV	< 1.0 U
Styrene	µg/L	5,987	100	< 1.0 U
Tetrachloroethene	µg/L	180.7	5	< 1.0 U
Toluene	µg/L	4,189	10	< 1.0 U
Trichloroethene	µg/L	181	5	< 1.0 U
Vinyl chloride	µg/L	72	2	< 1.0 U
Metals (6020A)				
Barium	mg/L	2	2	**0.240 J**
Lead	mg/L	0.0046	0.015	< 0.00125 U
Selenium	mg/L	0.012	0.05	< 0.00250 U
Silver	mg/L	0.003	0.1	< 0.000500 U
Hexavalent Chromium (7196A)				
Hexavalent Chromium	mg/L	0.1244	NV	< 0.0100 UJ
Semi-Volatile Organic Compounds (8270D SIM)				
1,4-Dioxane	µg/L	134.2	NV	**0.69**

Notes:

GWTP - Groundwater Treatment Plant

TK - Tank

mg/L - milligrams per liter

µg/L - micrograms per liter

J - Estimated result

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

Bold Values- Detected result

GWTP Monthly Influent Sampling - October 2023

Location ID: Sample Date:	Units	LH18/24-SP140_101023 10/10/23
Location Description		**GWTP – Collected from a spigot on the influent to TK-140. Sampled Monthly.**
Metals (6020A)		
Selenium	mg/L	< 0.00250 U
Silver	mg/L	< 0.000500 U
Hexavalent Chromium (7196A)		
Hexavalent Chromium	mg/L	< 0.0100 U
Perchlorate (6850)		
Perchlorate	µg/L	**9,550**

Notes:

GWTP - Groundwater Treatment Plant

TK - Tank

mg/L - milligrams per liter

µg/L - micrograms per liter

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

Bold Values- Detected result

GWTP Monthly Influent Sampling - November 2023

Location ID: Sample Date:	Units	LH18/24-SP140_110723 11/7/23
Location Description		**GWTP – Collected from a spigot on the influent to TK-140. Sampled Monthly.**
Metals (6020A)		
Selenium	mg/L	< 0.00250 U
Silver	mg/L	< 0.000500 U
Hexavalent Chromium (7196A)		
Hexavalent Chromium	mg/L	< 0.0100 U
Perchlorate (6850)		
Perchlorate	µg/L	**54,100**

Notes:

GWTP - Groundwater Treatment Plant

TK - Tank

mg/L - milligrams per liter

µg/L - micrograms per liter

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

Bold Values- Detected result

GWTP Quarterly Effluent Sampling - November 2023

Location ID: Sample Date:	Units	Daily Maximum Conc	(INF pond) MCL	LH18/24-SP650_112123 11/21/23
Location Description				**GWTP – Collected from a spigot on the discharge of effluent TK-650. Sampled quarterly**
Oil and Grease (1664A)				
Oil & Grease	mg/L	15	NV	**2.65**
Chemical Oxygen Demand (410.4)				
Chemical Oxygen Demand	mg/L	200	NV	**25.0**
Volatile Organic Compounds (8260C)				
1,1,1-Trichloroethane	µg/L	7,230	200	< 1.0 U
1,1,2-Trichloroethane	µg/L	216.9	5	< 1.0 U
1,1-Dichloroethane	µg/L	14,032	NV	< 1.0 U
1,1-Dichloroethene	µg/L	253	7	< 1.0 U
1,2-Dichloroethane	µg/L	181	5	< 1.0 U
1,2-Dichloropropane	µg/L	5	5	< 1.0 U
Acetone	µg/L	2,395	NV	< 1.0 U
Benzene	µg/L	181	5	< 1.0 U
Carbon tetrachloride	µg/L	181	5	< 1.0 U
Chlorobenzene	µg/L	47,180	100	< 1.0 U
Chloroform	µg/L	3,615	NV	< 1.0 U
cis-1,2-dichloroethene	mg/L	NV	70	**1.2**
Ethylbenzene	µg/L	57,025	700	< 1.0 U
m,p-Xylene	µg/L	83.6	NV	< 2.0 U
Methylene chloride	µg/L	1,699	5	< 1.0 U
o-Xylene	µg/L	83.6	NV	< 1.0 U
Styrene	µg/L	5,987	100	< 1.0 U
Tetrachloroethene	µg/L	180.7	5	< 1.0 U
Toluene	µg/L	4,189	10	< 1.0 U
Trichloroethene	µg/L	181	5	< 1.0 U
Vinyl chloride	µg/L	72	2	**0.80 J**

Notes:

GWTP - Groundwater Treatment Plant

INF - Intermediate Range Nuclear Forces

MCL - Maximum Contaminant Level

TK - Tank

µg/L - micrograms per liter

mg/L - milligrams per liter

Bold Values- Detected result

J - Estimated result

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

GWTP Quarterly Effluent Sampling - November 2023

Location ID: / Sample Date:	Units	Daily Maximum Conc	(INF pond) MCL	LH18/24-SP650_112123 11/21/23
Location Description				**GWTP – Collected from a spigot on the discharge of effluent TK-650. Sampled quarterly**
Metals (6020A)				
Aluminum	mg/L	1.644	NV	**0.318**
Antimony	mg/L	NV	0.006	< 0.00125 U
Arsenic	mg/L	0.722	0.01	< 0.00125 U
Barium	mg/L	2	2	**0.208**
Beryllium	mg/L	NV	0.004	< 0.000500 U
Cadmium	mg/L	0.0034	0.005	< 0.000500 U
Calcium	mg/L	NV	NV	**16.4**
Chromium	mg/L	0.752	0.1	**0.00180 J**
Cobalt	mg/L	11.495	NV	**0.000366 J**
Iron	mg/L	2.395	NV	**0.280**
Lead	mg/L	0.0046	0.015	< 0.00125 U
Magnesium	mg/L	NV	NV	**11.8**
Manganese	mg/L	15.494	NV	**0.0315**
Nickel	mg/L	0.184	NV	**0.00189 J**
Potassium	mg/L	NV	NV	**1.53**
Selenium	mg/L	0.012	0.05	< 0.00250 U
Silver	mg/L	0.003	NV	< 0.000500 U
Sodium	mg/L	NV	NV	**612**
Thallium	mg/L	NV	NV	< 0.000500 U
Vanadium	mg/L	3.592	NV	< 0.00125 U
Zinc	mg/L	0.31	NV	**0.00548**
Mercury	mg/L	NV	0.002	< 0.000100 U
Anions (9056)				
Chloride	mg/L	NV	NV	**1,100**
Sulfate	mg/L	NV	NV	**57.5**
Semi-Volatile Organic Compounds (8270D SIM)				
1,4-Dioxane	µg/L	134.2	NV	**0.88**

Notes:

GWTP - Groundwater Treatment Plant

INF - Intermediate Range Nuclear Forces

MCL - Maximum Contaminant Level

TK - Tank

µg/L - micrograms per liter

mg/L - milligrams per liter

Bold Values- Detected result

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

GWTP Quarterly Influent Sampling - November 2023

Location ID: / Sample Date:	Units	LH18/24-SP140_112123 11/21/23
Location Description		**GWTP – Collected from a spigot on the influent to TK-140. Sampled Quarterly.**
Oil and Grease (1664A)		
Oil & Grease	mg/L	< 1.00 U
Chemical Oxygen Demand (410.4)		
Chemical Oxygen Demand	mg/L	**21.0**
Perchlorate (6850)		
Perchlorate	µg/L	**25,700**
Volatile Organic Compounds (8260C)		
1,1,1,2-Tetrachloroethane	µg/L	< 1.0 U
1,1,1-Trichloroethane	µg/L	< 1.0 U
1,1,2,2-Tetrachloroethane	µg/L	< 1.0 U
1,1,2-Trichloroethane	µg/L	**1.3**
1,1-Dichloroethane	µg/L	**4.5**
1,1-Dichloroethene	µg/L	< 1.0 U
1,1-Dichloropropene	µg/L	< 1.0 U
1,2,3-Trichlorobenzene	µg/L	< 1.0 U
1,2,3-Trichloropropane	µg/L	< 1.0 U
1,2,4-Trichlorobenzene	µg/L	< 1.0 U
1,2,4-Trimethylbenzene	µg/L	< 1.0 U
1,2-Dibromo-3-chloropropane	µg/L	< 1.0 U
1,2-Dibromoethane	µg/L	< 1.0 U
1,2-Dichlorobenzene	µg/L	< 1.0 U
1,2-Dichloroethane	µg/L	**21**
1,2-Dichloropropane	µg/L	< 1.0 U
1,3,5-Trimethylbenzene	µg/L	< 1.0 U
1,3-Dichlorobenzene	µg/L	< 1.0 U
1,3-Dichloropropane	µg/L	< 1.0 U
1,4-Dichlorobenzene	µg/L	< 1.0 U
2,2-Dichloropropane	µg/L	< 1.0 U
2-Butanone	µg/L	< 1.0 U
2-Chlorotoluene	µg/L	< 1.0 U
2-Hexanone	µg/L	< 1.0 U
4-Chlorotoluene	µg/L	< 1.0 U
4-Isopropyltoluene	µg/L	< 1.0 U
4-Methyl-2-pentanone	µg/L	< 1.0 U
Acetone	µg/L	< 1.0 U
Benzene	µg/L	**0.75 J**
Bromobenzene	µg/L	< 1.0 U
Bromochloromethane	µg/L	< 1.0 U
Bromodichloromethane	µg/L	< 1.0 U

Notes:

GWTP - Groundwater Treatment Plant

TK - Tank

µg/L - micrograms per liter

mg/L - milligrams per liter

Bold Values- Detected result

J - Estimate result

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

GWTP Quarterly Influent Sampling - November 2023

Location ID: / Sample Date:	Units	LH18/24-SP140_112123 11/21/23
Location Description		**GWTP – Collected from a spigot on the influent to TK-140. Sampled Quarterly.**
Volatile Organic Compounds (8260C)		
Bromoform	µg/L	< 1.0 U
Bromomethane	µg/L	< 1.0 U
Carbon disulfide	µg/L	< 1.0 U
Carbon tetrachloride	µg/L	**1.6**
Chlorobenzene	µg/L	< 1.0 U
Chloroethane	µg/L	< 1.0 U
Chloroform	µg/L	**4.4**
Chloromethane	µg/L	< 1.0 U
cis-1,2-Dichloroethene	µg/L	**1,100 J**
cis-1,3-Dichloropropene	µg/L	< 1.0 U
Dibromochloromethane	µg/L	< 1.0 UJ
Dibromomethane	µg/L	< 1.0 U
Dichlorodifluoromethane	µg/L	< 1.0 U
Ethylbenzene	µg/L	< 1.0 U
Hexachlorobutadiene	µg/L	< 1.0 UJ
Isopropylbenzene	µg/L	< 1.0 U
m,p-Xylene	µg/L	< 2.0 U
Methylene chloride	µg/L	**3.0**
Naphthalene	µg/L	< 1.0 U
n-Butylbenzene	µg/L	< 1.0 U
n-Propylbenzene	µg/L	< 1.0 U
o-Xylene	µg/L	< 1.0 U
sec-Butylbenzene	µg/L	< 1.0 U
Styrene	µg/L	< 1.0 U
tert-Butylbenzene	µg/L	< 1.0 U
Tetrachloroethene	µg/L	**23**
Toluene	µg/L	**0.51 J**
trans-1,2-Dichloroethene	µg/L	**6.3**
trans-1,3-Dichloropropene	µg/L	< 1.0 U
Trichloroethene	µg/L	**2,000**
Trichlorofluoromethane	µg/L	< 1.0 U
Vinyl chloride	µg/L	**100**
Metals (6020A)		
Aluminum	mg/L	**0.0184**
Antimony	mg/L	**0.000678 J**
Arsenic	mg/L	**0.000923 J**
Barium	mg/L	**0.373**
Beryllium	mg/L	< 0.000500 U

Notes:

GWTP - Groundwater Treatment Plant

TK - Tank

µg/L - micrograms per liter

mg/L - milligrams per liter

Bold Values- Detected result

J - Estimate result

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

GWTP Quarterly Influent Sampling - November 2023

Location ID: Sample Date:	Units	LH18/24-SP140_112123 11/21/23
Location Description		**GWTP – Collected from a spigot on the influent to TK-140. Sampled Quarterly.**
Metals (6020A)		
Cadmium	mg/L	**0.000256 J**
Calcium	mg/L	**75.5**
Chromium	mg/L	**0.000642 J**
Cobalt	mg/L	**0.00318 J**
Iron	mg/L	**0.485**
Lead	mg/L	< 0.00125 U
Magnesium	mg/L	**53.3**
Manganese	mg/L	**0.377**
Nickel	mg/L	**0.00879**
Potassium	mg/L	**1.21**
Selenium	mg/L	< 0.00250 U
Silver	mg/L	< 0.000500 U
Sodium	mg/L	**381**
Thallium	mg/L	< 0.000500 U
Vanadium	mg/L	< 0.00125 U
Zinc	mg/L	**0.0146**
Mercury	mg/L	< 0.000100 U
Anions (9056)		
Chloride	mg/L	**670**
Sulfate	mg/L	**93.3**
Semi-Volatile Organic Compounds (8270D SIM)		
1,4-Dioxane	µg/L	**0.76**

Notes:

GWTP - Groundwater Treatment Plant

TK - Tank

µg/L - micrograms per liter

mg/L - milligrams per liter

Bold Values- Detected result

J - Estimate result

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

Subject: **Final Monthly Managers' Meeting (MMM), Longhorn Army Ammunition Plant (LHAAP)**
Location of Meeting: **WebEx**
Date of Meeting: **17 January 2024 – 10:00 AM Central Daylight Time (CDT)**

Attendees:

USAEC:	Lena Sierocinski (LS)
USEPA:	Brian Follin (BF)
USGS:	Tim Bartos
USACE:	Aaron Williams (AW) and Chelsea Montoya
BRAC:	Kyle Russell (KR)
TCEQ:	April Palmie (AP)
PCI/Bhate JV:	Zachary Beck (ZB), Erin Bradley, and Ike Eldridge
APTIM:	William Foss (WF)
HDR:	Gregory Kelly (GK) and Phil Werner (PW)

Defense Environmental Restoration Program (DERP) Performance-Based Remediation Update

There were no outstanding action items to discuss.

Groundwater Treatment Plant (GWTP) – ZB stated that due to the freezing conditions forecasted in Karnack, Texas for the week of 15 January 2024, the GWTP was winterized on Friday 12 January 2024. ZB explained that part of the winterization process is to turn off the ICT well field at LHAAP-18/24 and extraction wells at LHAAP-17. Turning off the pumps is necessary to help minimize the potential for the above ground pipes freezing. ZB stated that the FBR was placed into recycle until forecasted temperatures return to 32 degrees Fahrenheit or above. ZB said that due to freezing temperatures and icy roads Scott Beesinger and Kennie Moore were unable to reach the GWTP on Tuesday 16 January 2024. However, based on the remote checks, the FBR continues to operate in recycle. ZB explained that once temperatures normalize and the GWTP is brought back online an update will be provided to the team.

ZB said that rainfall over the last few weeks has resulted in flow in Harrison Bayou. Therefore, the 4th Quarter surface water samples were collected on 27 December 2024. In addition, ZB explained that discharge from the GWTP has been directed to Harrison Bayou.

Field Work – ZB stated that the Quarterly Sampling Event at LHAAP-17, the Annual Sampling Event at LHAAP-12, and Semi-Annual Event at LHAAP-18/24 were completed in December 2023. ZB said the Semi-Annual Event at LHAAP-16 is underway. WF discussed the Conceptual Site Model (CSM) survey for LHAAP-16, stating that the topographic survey was ongoing.

ZB asked everyone to refer to the Document and Issues (DI) Tracking Table for January 2024.

- **Tasks 1 -5** (Project Management) – ZB stated the Monthly Manager's Meeting (MMM) December 2023 Minutes are in progress. ZB said the Restoration Advisory Board (RAB) Draft Final Minutes were submitted to RAB members on 20 December 2023. ZB stated the next RAB is scheduled for 22 February 2024; however, ZB said there is no access to Karnack Community Center for the scheduled date. ZB explained that the Community Center is an early voting center for the Texas primary. LS recommended the February 2024 RAB meeting be canceled. LS stated that she has discussed with RAB Co-Chair Judy VanDeventer who indicated the RAB would approve canceling the February 2024 meeting.

AP and BF both concurred that Texas Commission on Environmental Quality (TCEQ) and United States Environmental Protection Agency (USEPA) had no problem canceling the February RAB meeting. AP requested an email be sent indicating the change in schedule. LS suggested an email be sent to the RAB members with a brief update on site progress and documents. ZB said that an email would be drafted for Army review in advance of submitting to the RAB.

- **Task 6** (LHAAP-04) – ZB stated that the Year 4 Annual Remedial Action – Operation (RA-O) Report is in progress and submittal to the regulators is anticipated by the end of January 2024. ZB stated the Year 5 1st Semi Annual RA-O Sampling Event is scheduled for February 2024 and the validated data package will be presented in March 2024.
- **Task 7** (LHAAP-12) – ZB stated the 2023 Annual Sampling Event was completed in December 2023, and presented the validated data. ZB said that trichloroethene (TCE) detected at monitoring well 12WW24 at 8.3 micrograms per liter (µg/L) in 2022, had decreased to 2.7 µg/L in December 2023. WF added that TCE has been decreasing over time at 12WW24. ZB said that there were no detections in the other monitoring wells sampled in December 2023. The 2023 Annual RA-O Report is in progress and is anticipated for submittal in February 2024.
- **Task 8** (LHAAP-16) – WF stated the Year 4 2nd Semi-Annual RA-O Sampling Event is being completed in January 2024 and the validated data will be presented at the March 2024 MMM. WF said the Year 3 RA-O Report is scheduled for submittal to the regulators in February 2024.
- **Task 1022** (Option 22: LHAAP-16) – WF stated the Draft Final CSM Work Plan received approvals from the TCEQ and the USEPA, and the next action is to place into the Administrative Record (AR).
- **Task 9** (LHAAP-18/24/GWTP) – ZB said the Semi-Annual Sampling Event was completed in December 2023 and the validated data package will be presented at the February 2024 MMM. ZB stated the Final of the 1st Quarter 2023 GWTP Report was issued 29 December 2023, and the next action is to place into the AR. ZB said the 2nd Quarter 2023 GWTP Report covers May and June 2023, as well as the June 2023 Semi- Annual sampling data. ZB said the Draft 2nd Quarter 2023 report was submitted for regulatory review on 21 December 2023 and is awaiting regulator comments. ZB said the 3rd Quarter 2023 GWTP report is in the internal quality control process and is scheduled for submittal in February 2024.
- **Task 10** (LHAAP-37) – WF presented the validated data from the Year 7 Annual RA-O Sampling Event completed in November 2023. WF stated well 35BWW25 had a trichloroethene detection of 12 micrograms per liter and well 35BWW24 had a trichloroethene detection of 5 micrograms per liter. WF explained that these results are similar to the results from the previous sampling event, where well 35BWW25 had a detection of 14 micrograms per liter and well 35BWW24 had a detection of 4.7 micrograms per liter. WF stated these wells are located in the north end of the site, and the data reinforces the need for potential additional delineation in that area as was requested per comments on the previous report. WF said the Army will need to consider additional delineation for future contracting. WF explained that concentrations in other wells remain fairly stable. WF said although there are minor fluctuations on the interior of the plume, there is nothing substantial. WF said the Year 6 RA-O Draft Final received approvals from

both TCEQ and USEPA and will be placed into the AR for the October through December cut off.

- **Task 11** (LHAAP-46) -WF said the Year 8 Annual RA-O Report was approved by TCEQ and USEPA and will be placed into the AR. WF stated the Year 9 RA-O Report is in progress and will likely be submitted to the regulators in February 2024.
- **Task 12** (LHAAP-50) **–** ZB stated the Year 9 Annual RA-O Report received comments from TCEQ and USEPA, and response to comments (RTCs) are in progress. ZB stated the next Year 10 Semi-Annual Sampling Event will take place in April 2024, and validated data will be presented in May 2024.
- **Task 13** (LHAAP-58) – ZB stated the RTCs for the Year 9 RA-O Report are in progress and likely to be completed slightly ahead of the LHAAP-50 Year 9 RA-O report. ZB said the Year 10 Annual RA-O Sampling Event is scheduled for June 2024.
- **Task 14** (LHAAP-67) – WF stated the Year 9 Annual RA-O Report received approval in October 2023, and will be in the October through December AR. WF presented the validated data from the Year 10 Annual RA-O Annual Sampling Event conducted in November 2023. WF explained that 67WW17 had a 1-1 dichloroethylene (DCE) detection of 1.7 µg/L, which is only slightly above the detection limit. WF stated that 67WW17 is one of the two newer wells installed on the far north end. WF explained further that wells in this area will need to be monitored closely in order to determine if the detection was solely a fluctuation or if the plume is beginning to spread to the north. WF stated this recent detection at 67WW17 is below the USEPA MCL (7 µg/L) but is the first detection of any contaminants of concern (COCs) in that particular well, and therefore is of note due to the data being inconsistent with previous results.
- **Task 15** (LHAAP-001-R-01 and LHAAP-003-R-01) – ZB said the Annual Inspections are scheduled for January 2024, but the impact of the cold weather on the schedule remains unclear. ZB also stated SB will complete LHAAP-16 sampling, however he has planned vacation days this month, and therefore may or may not be able to complete the annual inspections on the original timeline.
- **Task 16** (Surface Water) – ZB stated that sampling for the 4th Quarter was completed on 27 December 2023 and the validated data will be presented in February 2024. ZB said the Annual Surface Water Report is in progress and will be submitted in February 2024.
- **Task 17** (2023 Land Use Control [LUC] Management Plan) – ZB stated the LUC Management Plan has been delayed until February 2024 in order to include LUC updates for LHAAP-18/24 as well as potentially additional site updates.
- **Task 18** (Administrative Record [AR]) – WF said the April through June update was shipped. WF stated the tracking sheet is in progress, and documents are starting to be prepared for July through September.

Update on other DERP Sites:

- **LHAAP 18/24 –** PW stated the Final 100% Remedial Design will be submitted by 31 January 2024.
- **LHAAP-29** – PW said the 100% Remedial Design received TCEQ comments on 8 January 2024, and asked BF if the USEPA has any additional comments. BF stated there are no further comments. PW said the document will likely be submitted in early February 2024.
- **LHAAP-47** – GK stated regulatory comments were received for the Draft Pre-Design Investigation (PDI) Report and a CRM table and revisions had been completed. GK said the

PDI Report is currently under Army review, and the Draft Final and CRM will likely be submitted to the agencies by early February 2024.

- **LHAAP-17** – ZB stated the revisions of the Remedial Action Construction Report (RACR) are ongoing. AP asked to clarify that TCEQ comments were received and ZB confirmed that the revisions are in progress. ZB said the Year 1 RA-O Report received comments from TCEQ and is awaiting USEPA comments. ZB stated the Quarterly Performance Monitoring Event 9 was completed in December 2023 and proceeded to present the validated data. ZB stated the blue line of the graph presented represents extraction well 17WW06 and demonstrates a downward trend. ZB said the concentration of Perchlorate was detected at 57,500 µg/L, which remains above the 20,000 µg/L threshold established by the Remedial Action Work Plan. ZB stated however, that extraction efforts continue to decrease the concentration. ZB said the orange line on the graph represents extraction well 17WW02, and the Perchlorate concentration was detected at 11,400 µg/L. ZB explained concentrations of this well have fluctuated slightly, but have continued to be relatively stable and remain under the 20,000 microgram per liter threshold.

Per- and polyfluoroalkyl substances (PFAS) Update: LS stated the PFAS Preliminary Assessment/ Site Inspection (PA/SI) Report is available to the public on the United States Army Environmental Command (USAEC) website. LS explained that searching "Longhorn PA/SI" into google will likely bring up the document. LS asked WF if the PA/SI Report can be sent to Aptim directly through Department of Defense (DoD) Safe in order to place it into the AR. WF confirmed he is the correct contact, and DoD Safe would be fine to send to him. WF said APTIM would add the PA/SI Report to be posted on the Longhorn website. LS stated the Remedial Investigation is likely to be completed by fiscal year 2025. LS added that official specific PFAS sites have been established.

Five-Year Review: LS stated the Five-Year Review Report is in progress.

Transfer Update: KR stated there is no update on the transfer update.

Schedule Next Managers' Meeting: After discussion, a virtual meeting on the 21st of February 2024 at the regular meeting time of 10:00 AM CDT was agreed upon for the next MMM due to no longer requiring that it coincide with the RAB meeting. AP stated there should be confirmation that the RAB meeting will be cancelled. ZB stated he will follow up with the RAB and send out an email with the plan.

ZB said the next MMM will be held via WebEx on Wednesday 21 February 2024 at 10:00 AM CDT. Meeting concluded at approximately 10:40 AM CDT.

PCIbhate

ACRONYM LIST

µg/L	micrograms per liter
AP	April Palmie
AR	Administrative Record
AW	Aaron Williams
BF	Brian Follin
CDT	Central Daylight Time
CRM	Comment Response Matrix
COC	Contaminant of Concern
CSM	Conceptual Site Model
1-1 DCE	1-1 Dichloroethylene
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
FBR	Fluidized bed reactor
Ft	Feet
GIS	Geographic Information Systems
GK	Gregory Kelly
GWTP	Groundwater Treatment Plant
INF	Intermediate-Range Nuclear Forces Treaty
KR	Kyle Russel
LHAAP	Longhorn Army Ammunition Plant
LS	Lena Sierocinski
LUC	Land Use Control
MMM	Monthly Managers' Meeting
OM&M	Operation, Maintenance, and Monitoring
ORP	Oxidation Reduction Potential
PA/SI	Preliminary Assessment/Site Inspection
PBJV	Poarch Creek Indians, Governmental Services, LLC /Bhate Environmental Associates Joint Venture
PDI	Pre-Design Investigation
PS	Praveen Srivastav
PW	Phil Werner
RAB	Restoration Advisory Board
RACR	Remedial Action Construction Report
RA-O	Remedial Action – Operation
RI	Remedial Investigation
ROP	Renewal Operating Permit
RTC	Response to comments
SB	Scott Beesinger
TCE	Trichloroethene
TCEQ	Texas Commission on Environmental Quality
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
WF	William Foss
ZB	Zachary Beck

LHAAP Validated Data
January 2024 MMM

GWTP Effluent	*Weekly Perchlorate Sampling –December 2023* Perchlorate (6850)
GWTP Effluent	*Weekly, Bi-Weekly, and Monthly Sampling – December 2023* Ammonia (350.3) Ortho-Phosphate (365.3) Total Organic Carbon (415.1) VOC (8260C) Metals (6020A) Hexavalent Chromium (7196A) 1,4-Dioxane (8270D-SIM) Anions (9056)
GWTP Influent	*Monthly Sampling – December 2023* Metals (6020A) Perchlorate (6850) Hexavalent Chromium (7196A)
LHAAP-12	*Annual Sampling – December 2023* VOC (8260C)
LHAAP-17	*Quarterly Sampling – December 2023* Perchlorate (6850)
LHAAP-35B(37)	*Remedial Action Operation Monitoring (Year 7 Annual)-November 2023* Volatile Organic Compounds (8260C) Dissolved Gases (RSK-175) Nitrate, Chloride, and Sulfate (SW9056A) Total Organic Carbon (SM5310C) Field Measurements (Dissolved Oxygen, Oxidation Reduction Potential, Ferrous Iron, and pH)
LHAAP-67	*Remedial Action Operation-November 2023* Volatile Organic Compounds (SW8260C) Dissolved Gases (RSK-175) Nitrate, Chloride, and Sulfate (SW9056A) Total Organic Carbon (SM5310C) Field Measurements (Dissolved Oxygen, Oxidation Reduction Potential, Ferrous Iron, and pH)

GWTP Weekly/Effluent Perchlorate Sampling - December 2023

Location ID: Sample Date:	Units	Daily Maximum Concentration	PCL	LH18/24-SP650_120523_BIX 12/5/23	LH18/24-SP650_120523_AIX 12/5/23	LH18/24-SP650_120523_AIX 12/5/23	LH18/24-SP650_121223_BIX	LH18/24-SP650_121223_AIX	LH18/24-SP650_121923_BIX	LH18/24-SP650_121923_AIX	LH18/24-SP650_122723_BIX	LH18/24-SP650_122723_AIX
Location Description				Weekly	Weekly	Monthly Eff	Weekly	Weekly	Weekly	Weekly	Weekly	Weekly
Perchlorate (6850)												
Perchlorate	µg/L	589	17	**7.08**	**0.714**	**0.773**	**19.0**	**0.763**	**17.2**	**2.66**	**20.4**	**2.99**

Notes:

Bold Values- Detected result

PCL – Texas Risk Reduction Program (TRRP) Tier 1 Groundwater Residential Protective Concentration Level

µg/L - micrograms per liter

BIX - before ion exchange/AIX - after ion exchange

Result exceeds the PCL

All treated groundwater discharged to the INF Pond in December 2023 was below the PCL for perchlorate.

GWTP Weekly Sampling - December 2023

Location ID: Sample Date:	Units	Daily Maximum Concentration	LH18/24-SP650_120523 12/5/23	LH18/24-SP650_121223 12/12/23	LH18/24-SP650_121923 12/19/23	LH18/24-SP650_122723 12/27/23
Location Description			**GWTP–Collected from a spigot on the discharge of effluent TK-650. Sampled Weekly.**			
Ammonia as Nitrogen (350.3)						
Ammonia as Nitrogen	mg/L	NV	**16**	**25**	**20 J**	**11**
Ortho-Phosphate (365.3)						
Ortho-Phosphate	mg/L	NV	**5.56**	**5.57**	**0.479**	**0.866**
Organic Carbon (415.1)						
Total Organic Carbon (TOC)	mg/L	NV	**4.42**	**3.45**	**2.34**	**2.03**

Notes:

GWTP - Groundwater Treatment Plant

TK - Tank

mg/L - milligrams per liter

NV - No Value

Bold Values- Detections

GWTP Bi-Weekly Sampling - December 2023

Location Identification: Sample Date:	Units	Daily Maximum Concentration	MCL	LH18/24-SP650_121223 12/12/23	LH18/24-SP650_122723 12/27/23
Location Description				**GWTP – Collected from a spigot on the discharge of effluent TK-650. Sampled Biweekly.**	
Volatile Organic Compounds (8260C)					
1,1,1-Trichloroethane	µg/L	7,230	200	< 1.0 U	< 1.0 U
1,1,2-Trichloroethane	µg/L	216.9	5	< 1.0 U	< 1.0 U
1,1-Dichloroethane	µg/L	14,032	NV	< 1.0 U	< 1.0 UJ
1,1-Dichloroethene	µg/L	253	7	< 1.0 U	< 1.0 U
1,2-Dichloroethane	µg/L	181	5	< 1.0 U	< 1.0 U
1,2-Dichloropropane	µg/L	5	5	< 1.0 U	< 1.0 U
Acetone	µg/L	2,395	NV	< 1.0 U	< 1.0 UJ
Benzene	µg/L	181	5	< 1.0 U	< 1.0 U
Carbon tetrachloride	µg/L	181	5	< 1.0 U	< 1.0 U
Chlorobenzene	µg/L	47,180	100	< 1.0 U	< 1.0 U
Chloroform	µg/L	3,615	NV	< 1.0 U	< 1.0 UJ
cis-1,2-Dichloroethene	µg/L	NV	70	**0.99 J**	**1.0 J**
Ethylbenzene	µg/L	57,025	700	< 1.0 U	< 1.0 U
m,p-Xylene	µg/L	83.6	NV	< 1.0 U	< 1.0 U
Methylene chloride	µg/L	1,699	5	< 1.0 U	< 1.0 U
o-Xylene	µg/L	83.6	NV	< 1.0 U	< 1.0 U
Styrene	µg/L	5,987	100	< 1.0 U	< 1.0 U
Tetrachloroethene	µg/L	180.7	5	< 1.0 U	< 1.0 U
Toluene	µg/L	4,189	10	< 1.0 U	< 1.0 U
Trichloroethene	µg/L	181	5	< 1.0 U	< 1.0 U
Vinyl chloride	µg/L	72	2	< 1.0 U	< 1.0 U
Anions (9056)					
Chloride	mg/L	NV	NV	**1,080**	**916**
Sulfate	mg/L	NV	NV	**58.1**	**49.7**

Notes:

GWTP - Groundwater Treatment Plant

MCL - Maximum Contaminant Level

TK - Tank

NV - No Value

µg/L - micrograms per liter

mg/L - milligrams per liter

Bold Values- Detected result

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

UJ - estimated non-detect due to quality control issues

J - estimated value

GWTP Monthly Influent Sampling - December 2023

Location Identification: Sample Date:	Units	LH18/24-SP140_120523 12/5/23
Location Description		**GWTP – Collected from a spigot on the influent to TK-140. Sampled Monthly.**
Metals (6020A)		
Selenium	mg/L	< 0.00250 U
Silver	mg/L	**0.00223 J**
Hexavalent Chromium (7196A)		
Hexavalent Chromium	mg/L	< 0.00500 U
Perchlorate (6850)		
Perchlorate	µg/L	**14,600**

Notes:

GWTP - Groundwater Treatment Plant

TK - Tank

mg/L - milligrams per liter

µg/L - micrograms per liter

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

Bold Values- Detections

J - estimated value

GWTP Monthly Effluent Sampling - December 2023

Location Identification: Sample Date:	Units	Daily Maximum Concentration	MCL	LH18/24-SP650_120523 12/5/23
Location Description				**GWTP – Collected from a spigot on the discharge of effluent TK-650. Sampled monthly**
Volatile Organic Compounds (8260C)				
1,1,1-Trichloroethane	µg/L	7,230	200	< 1.0 U
1,1,2-Trichloroethane	µg/L	216.9	5	< 1.0 U
1,1-Dichloroethane	µg/L	14,032	NV	< 1.0 U
1,1-Dichloroethene	µg/L	253	7	< 1.0 U
1,2-Dichloroethane	µg/L	181	5	< 1.0 U
1,2-Dichloropropane	µg/L	5	5	< 1.0 U
Acetone	µg/L	2,395	NV	< 1.0 UJ
Benzene	µg/L	181	5	< 1.0 U
Carbon tetrachloride	µg/L	181	5	< 1.0 U
Chlorobenzene	µg/L	47,180	100	< 1.0 U
Chloroform	µg/L	3,615	NV	< 1.0 U
cis-1,2-dichloroethene	µg/L	NV	70	**1.1**
Ethylbenzene	µg/L	57,025	700	< 1.0 U
m,p-Xylene	µg/L	83.6	NV	< 2.0 U
Methylene chloride	µg/L	1,699	5	< 1.0 U
o-Xylene	µg/L	83.6	NV	< 1.0 U
Styrene	µg/L	5,987	100	< 1.0 U
Tetrachloroethene	µg/L	180.7	5	< 1.0 U
Toluene	µg/L	4,189	10	< 1.0 U
Trichloroethene	µg/L	181	5	< 1.0 U
Vinyl chloride	µg/L	72	2	< 1.0 U
Metals (6020A)				
Barium	mg/L	2	2	**0.202**
Lead	mg/L	0.0046	0.015	< 0.00125 U
Selenium	mg/L	0.012	0.05	< 0.00250 U
Silver	mg/L	0.003	0.1	< 0.000500 U
Hexavalent Chromium (7196A)				
Hexavalent Chromium	mg/L	0.1244	NV	< 0.00500 U
Semi-Volatile Organic Compounds (8270D SIM)				
1,4-Dioxane	µg/L	134.2	NV	**0.40**

Notes:

GWTP - Groundwater Treatment Plant

MCL - Maximum Contaminant Level

TK - Tank

NV - No Value

SIM - Select Ion monitoring

µg/L - micrograms per liter

mg/L - milligrams per liter

Bold Values- Detected result

U- Undetected: The analyte was analyzed for, but not detected and reported to the limit of detection.

UJ - estimated non-detect due to quality control issues

LHAAP-12 2023 Annual Event (December 2023)

Sample ID Well Identification Sample # ANALYTE	CAS NUMBER	UNITS	MCL/MSC	12WW10R_120523 12WW10R HS23120437-01	12WW10R_120523_a 12WW10R HS23120437-02	12WW20_120523 12WW20 HS23120437-05	12WW21_120523 12WW21 HS23120437-03	12WW24_120523 12WW24 HS23120437-04
Method: SW8260								
1,1,1,2-Tetrachloroethane	630-20-6	µg/L	110	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,1,1-Trichloroethane	71-55-6	µg/L	200	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,1,2,2-Tetrachloroethane	79-34-5	µg/L	14	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,1,2-Trichloroethane	79-00-5	µg/L	5	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,1-Dichloroethane	75-34-3	µg/L	10,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,1-Dichloroethene	75-35-4	µg/L	7	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,1-Dichloropropene	563-58-6	µg/L	2.9	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,2,3-Trichlorobenzene	87-61-6	µg/L	310	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,2,3-Trichloropropane	96-18-4	µg/L	0.041	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,2,4-Trichlorobenzene	120-82-1	µg/L	70	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,2,4-Trimethylbenzene	95-63-6	µg/L	5,100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,2-Dibromo-3-chloropropane	96-12-8	µg/L	0.2	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,2-Dibromoethane	106-93-4	µg/L	0.05	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,2-Dichlorobenzene	95-50-1	µg/L	600	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,2-Dichloroethane	107-06-2	µg/L	5	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,2-Dichloropropane	78-87-5	µg/L	5	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,3,5-Trimethylbenzene	108-67-8	µg/L	5,100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,3-Dichlorobenzene	541-73-1	µg/L	3,100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,3-Dichloropropane	142-28-9	µg/L	29	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
1,4-Dichlorobenzene	106-46-7	µg/L	75	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
2,2-Dichloropropane	594-20-7	µg/L	42	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
2-Butanone	78-93-3	µg/L	61,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
2-Chlorotoluene	95-49-8	µg/L	2,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
2-Hexanone	591-78-6	µg/L	6,100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
4-Chlorotoluene	106-43-4	µg/L	2,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
4-Isopropyltoluene	99-87-6	µg/L	10,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
4-Methyl-2-pentanone	108-10-1	µg/L	8,200	< 2.0 U	< 2.0 U	< 2.0 U	< 1.0 U	< 1.0 U
Acetone	67-64-1	µg/L	92,000	< 1.0 UJ	< 1.0 UJ	< 1.0 U	< 1.0 UJ	< 1.0 UJ
Benzene	71-43-2	µg/L	5	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Bromobenzene	108-86-1	µg/L	2,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Bromochloromethane	74-97-5	µg/L	4,100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Bromodichloromethane	75-27-4	µg/L	4.6	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Bromoform	75-25-2	µg/L	36	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Bromomethane	74-83-9	µg/L	140	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Carbon disulfide	75-15-0	µg/L	10,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Carbon tetrachloride	56-23-5	µg/L	5	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Chlorobenzene	108-90-7	µg/L	100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Chloroethane	75-00-3	µg/L	41,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U

Sample ID Well Identification Sample # ANALYTE	CAS NUMBER	UNITS	MCL/MSC	12WW10R_120523 12WW10R HS23120437-01	12WW10R_120523_a 12WW10R HS23120437-02	12WW20_120523 12WW20 HS23120437-05	12WW21_120523 12WW21 HS23120437-03	12WW24_120523 12WW24 HS23120437-04
Method: SW8260								
Chloroform	67-66-3	µg/L	1,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Chloromethane	74-87-3	µg/L	220	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
cis-1,2-Dichloroethene	156-59-2	µg/L	70	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	**6.8**
cis-1,3-Dichloropropene	10061-01-5	µg/L	5.3	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Dibromochloromethane	124-48-1	µg/L	34	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Dibromomethane	74-95-3	µg/L	380	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Dichlorodifluoromethane	75-71-8	µg/L	20,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Ethylbenzene	100-41-4	µg/L	700	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Hexachlorobutadiene	87-68-3	µg/L	20	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Isopropylbenzene	98-82-8	µg/L	10,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
m,p-Xylene	179601-23-1	µg/L	10,000*	< 1.0 U	< 1.0 U	< 1.0 U	< 2.0 U	< 1.0 U
Methylene chloride	75-09-2	µg/L	5	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
n-Butylbenzene	104-51-8	µg/L	4,100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
n-Propylbenzene	103-65-1	µg/L	4,100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Naphthalene	91-20-3	µg/L	2,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
o-Xylene	95-47-6	µg/L	10,000**	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
sec-Butylbenzene	135-98-8	µg/L	4,100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Styrene	100-42-5	µg/L	100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
tert-Butylbenzene	98-06-6	µg/L	4,100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Tetrachloroethene	127-18-4	µg/L	5	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Toluene	108-88-3	µg/L	1,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
trans-1,2-Dichloroethene	156-60-5	µg/L	100	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
trans-1,3-Dichloropropene	10061-02-6	µg/L	29	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Trichloroethene	79-01-6	µg/L	5	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	**2.7**
Trichlorofluoromethane	75-69-4	µg/L	31,000	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U
Vinyl chloride	75-01-4	µg/L	2	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U	< 1.0 U

Notes:

Blue highlighting indicates concentrations above the MCL/MSC

MCL/MSC - Maximum Contaminant Limit/Medium-Specific Concentrations

NA - Not Analyzed/Not Applicable; NV - No value

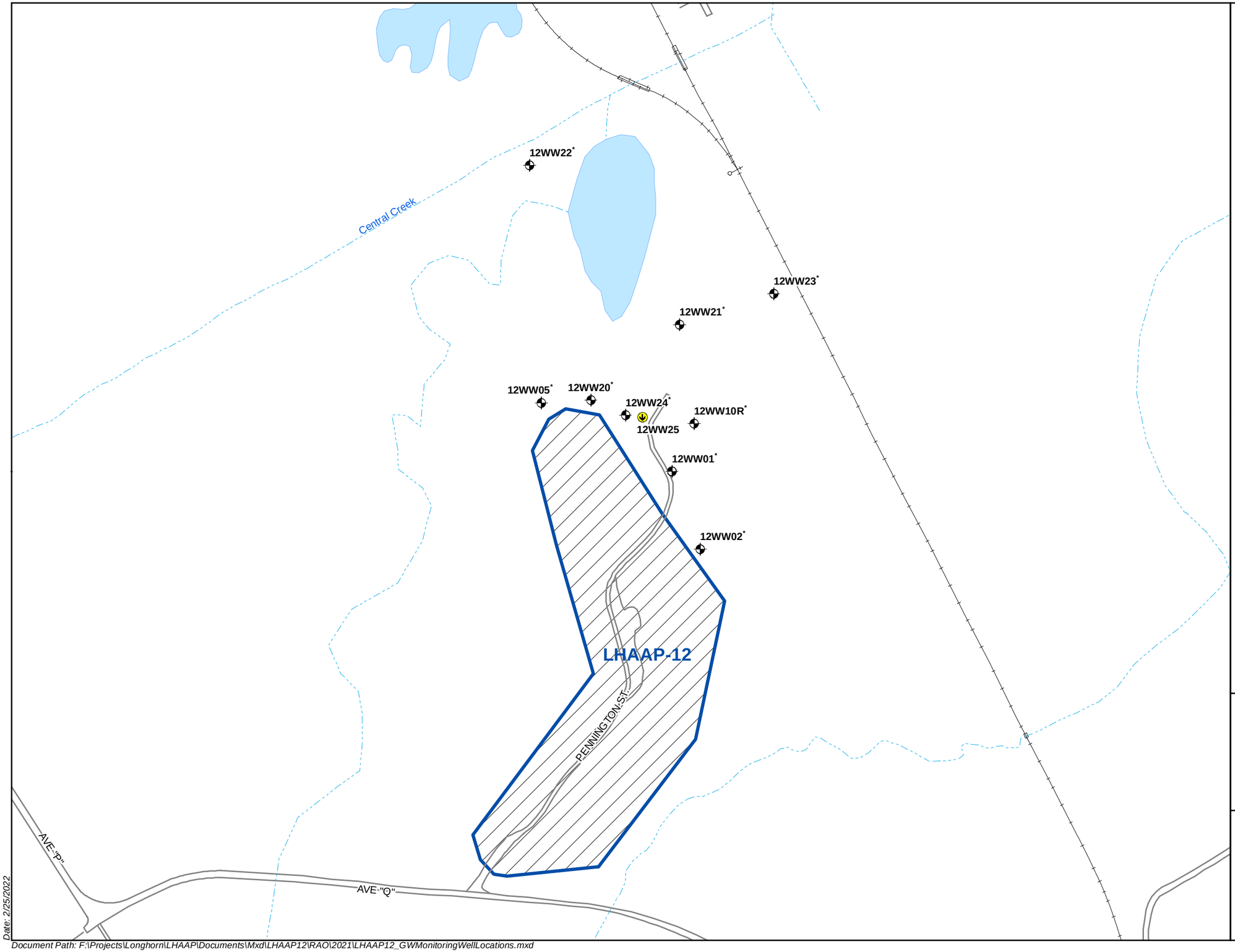
µg/L - micrograms per liter

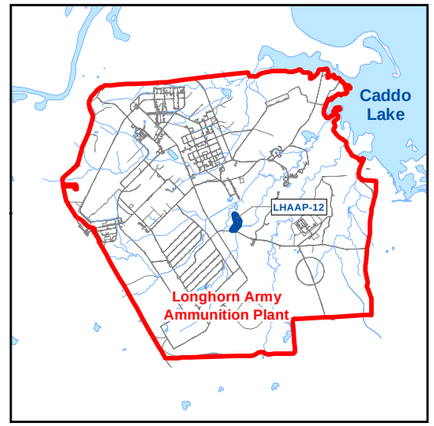
a - duplicate sample

U - Undetected: The analyte was analyzed for, but not detected at the limit of detection presented.

UJ - estimated non-detect due to quality control difficiencies

* Value is for total xylenes





- Monitoring Well
- 2014 direct push technology (DPT) Location (This was a DPT boring grab groundwater sample, no well was subsequently installed)
- Stream
- Road
- Site Boundary
- Landfill Cap Area
- Railroad

Note:
1. Each well has 5'x5' concrete surface monument surrounded by bollards. Each well has a polyvinyl chloride riser.
2. * Gauged for water levels.

N

0 125 250 Feet

U.S. ARMY CORP OF ENGINEERS
TULSA DISTRICT
TULSA, OKLAHOMA

bhate APTIM

Figure 2-1

Groundwater Monitoring Well Locations
LHAAP-12
2022 Annual RA-O Report

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 2/25/2022

Document Path: F:\Projects\Longhorn\LHAAP\Documents\Mxd\LHAAP12\RAO\2021\LHAAP12_GWMonitoringWellLocations.mxd

Perchlorate Quarterly Groundwater Analytical Results
LHAAP-17 December 2023

Location ID: Sample Date:	Units	PCL	130_120423 12/4/23	130_120423_a 12/4/23	17WW01_120423 12/4/23	17WW02_120423 12/4/23	17WW03_120423 12/4/23	17WW06_120423 12/4/23
Perchlorate (6850)								
Perchlorate	µg/L	17	**0.933**	**0.980**	< 0.0500 U	**11,400**	< 0.0500 U	**57,500**

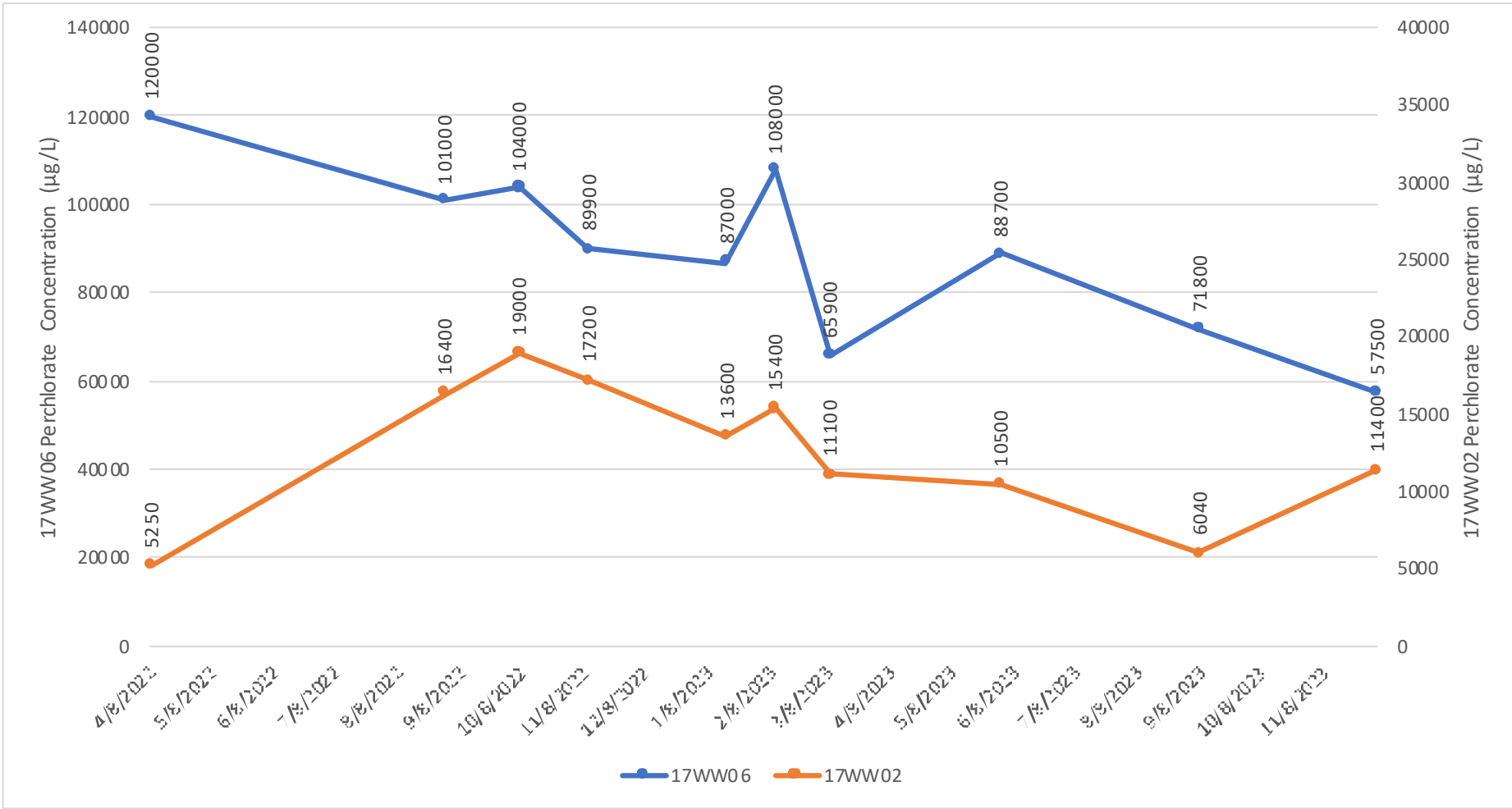
PCL – Texas Risk Reduction Program (TRRP) Tier 1 Groundwater Residential Protective Concentration Level

Highlighted results exceed the perchlorate PCL

µg/L - micrograms per liter

U - non detect

Figure 3-1
LHAAP-17 Perchlorate Trend Chart



17WW15
17WW20
17WW12
17WW11
17WW18
MW-19
17WW09
17WW10
17WW16
130
17WW02
17WW19
17WW06
SCUDDAY AVE
17WW13
17WW05
17WW17
17WW03
17WW01
17WW14
LHAAP-17
17WW04
Approximate Groundwater Flow Direction
17WW07
17WW08
18WW14
18WW15
Approximate Pump House Location
LONG POINT RD
AVE "Q"
C-07
Approximate Location of Overhead Electrical Lines
HAYSTACK RD.

N

Longhorn Army Ammunition Plant
Karnack
LHAAP-17
Installation Area Location

Legend

- 17WW02 Performance Monitoring Locations Highlighted
- Extraction Well
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- LHAAP-17 Boundary
- System Piping
- Effluent Line Piping
- Road
- Stream

Longhorn Army Ammunition Plant
Karnack, Texas

Figure 1-2
LHAAP-17 Site Map

0 50 100 200 Feet
1 inch = 100 feet

Prepared By: MMG TLI JOINT VENTURE

Map Date: 12/11/2023

Service Layer Credits: Google satellite imagery

Document Path: Z:\Projects\MSC2020\0016 Longhorn\0002 RIP\0031 RA RACR\Annual RAO YR1\Figure 1-2.mxd

LHAAP-35B(37) Year 7 Annual Remedial Action Operation Monitoring
(November 2023)

			Location Code	35BWW01		35BWW04				35BWW05		35BWW07	
			Sample ID	35BWW01-231106		35BWW04-231106		35BWW04-231106-FD		35BWW05-231106		35BWW07-231108	
			Sample Date	11/6/2023		11/6/2023		11/6/2023		11/6/2023		11/8/2023	
			Location Description:	Shallow zone, unimpacted, within site boundary		Shallow zone, impacted, within site boundary				Shallow zone, impacted, within site boundary		Shallow zone, unimpacted, downgradient	
Analyte	Units	MCL		Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual
Field Measurements													
Dissolved oxygen	mg/L	NV		0.2		2.04		2.04		0.05		0.58	
Ferrous Iron	mg/L	NV		NM		0.24		0.24		NM		NM	
Oxidation-Reduction Potential	mV	NV		190		175		175		16		136	
pH	Std. Units	NV		4.78		6.35		6.35		7.16		7.17	
Dissolved Gases (RSK175)													
Carbon dioxide	µg/L	NV		NA		61,000		60,000		NA		NA	
Ethane	µg/L	NV		NA		< 0.5	UJ	< 0.5	UJ	NA		NA	
Ethylene	µg/L	NV		NA		< 0.5	UJ	< 0.5	UJ	NA		NA	
Methane	µg/L	NV		NA		0.772	J	0.659	J	NA		NA	
General Chemistry (9056A/SM5310C)													
Chloride	mg/L	NV		NA		2.67		2.77		NA		NA	
Nitrate	mg/L	NV		NA		0.0641	J	0.0669	J	NA		NA	
Sulfate	mg/L	NV		NA		24.3		24.6		NA		NA	
Total organic carbon	mg/L	NV		NA		1.49		1.22		NA		NA	
Volatile Organic Compounds (8260C)													
1,1-Dichloroethene	µg/L	7		< 1	U	< 1	U	< 1	U	< 1	U	< 1	U
cis-1,2-Dichloroethene	µg/L	70		< 0.5	U	< 0.5	U	< 0.5	U	0.78	J	< 0.5	U
Tetrachloroethene	µg/L	5		< 1	U	4.8		4.6		3.2		< 1	U
Trichloroethene	µg/L	5		< 1	U	0.66	J	0.55	J	5.4		< 0.5	U
Vinyl chloride	µg/L	2		< 1	U	< 1	U	< 1	U	< 1	U	< 1	U

Notes:

Blue Highlighting Indicates concentrations above the MCL

J - Estimated: The analyte was positively identified, the quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria.

U - Undetected: The analyte was analyzed for, but not detected.

UJ - Undetected estimated: The analyte was analyzed for but, was not detected. Even though the analyte was not detected, certain discrepancies in meeting analyte specific quality control were not met.

MCL - Maximum Contaminant Limit, shown for contaminants of concern

Val Qual - validation qualifier

mg/L - milligrams per liter

ug/L - micrograms per liter

Std. Units - standard pH units

mV - millivolts

ID - identification

NV - MCL value not established and/or analyte is not a contaminant of concern

NA - not analyzed

NM - not measured

FD - field duplicate

LHAAP-35B(37) Year 7 Annual Remedial Action Operation Monitoring
(November 2023)

			Location Code	35BWW08		35BWW09		35BWW10		35BWW11		35BWW12	
			Sample ID	35BWW08-231106		35BWW09-231108		35BWW10-231106		35BWW11-231106		35BWW12-231107	
			Sample Date	11/6/2023		11/8/2023		11/6/2023		11/6/2023		11/7/2023	
			Location Description:	Shallow zone, impacted, within site boundary		Shallow zone, impacted outside site boundary		Shallow, impacted, within site boundary		Shallow zone, unimpacted, within site boundary		Shallow zone, impacted, within site boundary	
Analyte	Units	MCL	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual
Field Measurements												
Dissolved oxygen	mg/L	NV	1.71		0.04		0.65		0.26		0.11	
Ferrous Iron	mg/L	NV	0		NM		NM		NM		0.37	
Oxidation-Reduction Potential	mV	NV	223		289		213		93		168	
pH	Std. Units	NV	5.77		7.57		6.06		6.36		6.25	
Dissolved Gases (RSK175)												
Carbon dioxide	µg/L	NV	250,000		NA		NA		NA		72,000	
Ethane	µg/L	NV	0.949	J	NA		NA		NA		< 0.5	UJ
Ethylene	µg/L	NV	< 0.5	UJ	NA		NA		NA		< 0.5	UJ
Methane	µg/L	NV	0.556	J	NA		NA		NA		4.49	J
General Chemistry (9056A/SM5310C)												
Chloride	mg/L	NV	3.62		NA		NA		NA		7.75	
Nitrate	mg/L	NV	0.286		NA		NA		NA		0.0593	J
Sulfate	mg/L	NV	32.2		NA		NA		NA		48.2	
Total organic carbon	mg/L	NV	0.774	J	NA		NA		NA		0.731	J
Volatile Organic Compounds (8260C)												
1,1-Dichloroethene	µg/L	7	< 1	U	< 1	U	< 1	U	< 1	U	< 1	UJ
cis-1,2-Dichloroethene	µg/L	70	< 0.5	U	0.79	J	< 0.5	U	< 0.5	U	< 0.5	UJ
Tetrachloroethene	µg/L	5	< 1	U	< 1	U	21		< 1	U	5	J
Trichloroethene	µg/L	5	0.5	J	81		6.8		< 1	U	0.47	J
Vinyl chloride	µg/L	2	< 1	U	< 1	U	< 1	U	< 1	U	< 1	UJ

Notes:

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MCL - Maximum Contaminant Limit, shown for contaminants of concern

Val Qual - validation qualifier

mg/L - milligrams per liter

ug/L - micrograms per liter

Std. Units - standard pH units

mV - millivolts

ID - identification

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NM - not measured

FD - field duplicate

LHAAP-35B(37) Year 7 Annual Remedial Action Operation Monitoring
(November 2023)

			Location Code		35BWW13		35BWW14		35BWW15		35BWW16		35BWW17	
			Sample ID		35BWW13-231107		35BWW14-231107		35BWW15-231107		35BWW16-231107		35BWW17-231107	
			Sample Date		11/7/2023		11/7/2023		11/7/2023		11/7/2023		11/7/2023	
			Location Description:		Shallow zone, impacted, crossgradient		Shallow zone, impacted, within site boundary		Shallow zone, impacted, within site boundary		Shallow zone, impacted, outside site boundary		Shallow zone, unimpacted, within site boundary	
Analyte	Units	MCL	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual
Field Measurements														
Dissolved oxygen	mg/L	NV	0.37		0.04		0.9		0.02		0.73			
Ferrous Iron	mg/L	NV	NM		0.09		NM		NM		NM			
Oxidation-Reduction Potential	mV	NV	301		221		233		219		320			
pH	Std. Units	NV	4.8		6.79		6.59		5.78		4.89			
Dissolved Gases (RSK175)														
Carbon dioxide	µg/L	NV	NA		34,000		NA		NA		NA			
Ethane	µg/L	NV	NA		0.871	J	NA		NA		NA			
Ethylene	µg/L	NV	NA		< 0.5	UJ	NA		NA		NA			
Methane	µg/L	NV	NA		0.799	J	NA		NA		NA			
General Chemistry (9056A/SM5310C)														
Chloride	mg/L	NV	NA		11.6		NA		NA		NA			
Nitrate	mg/L	NV	NA		0.0608	J	NA		NA		NA			
Sulfate	mg/L	NV	NA		54.4		NA		NA		NA			
Total organic carbon	mg/L	NV	NA		1.05		NA		NA		NA			
Volatile Organic Compounds (8260C)														
1,1-Dichloroethene	µg/L	7	< 1	U	0.9	J	< 1	U	< 1	U	< 1	U		
cis-1,2-Dichloroethene	µg/L	70	< 0.5	U	< 0.5	U	< 0.5	U	< 0.5	U	< 0.5	U		
Tetrachloroethene	µg/L	5	1.1		21		9.9		5.7		< 1	U		
Trichloroethene	µg/L	5	< 1	U	4.8		4.1		1.9		< 1	U		
Vinyl chloride	µg/L	2	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U		

Notes:

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mV - millivolts

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FD - field duplicate

LHAAP-35B(37) Year 7 Annual Remedial Action Operation Monitoring
(November 2023)

			Location Code	35BWW18		35BWW19		35BWW20				35BWW23	
			Sample ID	35BWW18-231108		35BWW19-231108		35BWW20-231108		35BWW20-231108-FD		35BWW23-231107	
			Sample Date	11/8/2023		11/8/2023		11/8/2023		11/8/2023		11/7/2023	
			Location Description:	Shallow zone, unimpacted, outside site boundary		Shallow zone, unimpacted, outside site boundary		Shallow zone, impacted, within site boundary				Shallow zone, unimpacted, outside site boundary	
Analyte	Units	MCL		Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual
Field Measurements													
Dissolved oxygen	mg/L	NV		0.09		1.07		2.73		2.73		2.01	
Ferrous Iron	mg/L	NV		NM		NM		NM		NM		0.07	
Oxidation-Reduction Potential	mV	NV		297		300		293		293		234	
pH	Std. Units	NV		6.56		6.72		7.01		7.01		6.3	
Dissolved Gases (RSK175)													
Carbon dioxide	µg/L	NV		NA		NA		NA		NA		42,000	
Ethane	µg/L	NV		NA		NA		NA		NA		< 0.5	UJ
Ethylene	µg/L	NV		NA		NA		NA		NA		< 0.5	UJ
Methane	µg/L	NV		NA		NA		NA		NA		0.655	J
General Chemistry (9056A/SM5310C)													
Chloride	mg/L	NV		NA		NA		NA		NA		16.9	
Nitrate	mg/L	NV		NA		NA		NA		NA		0.0789	J
Sulfate	mg/L	NV		NA		NA		NA		NA		80.9	
Total organic carbon	mg/L	NV		NA		NA		NA		NA		0.768	J
Volatile Organic Compounds (8260C)													
1,1-Dichloroethene	µg/L	7		< 1	U	< 1	U	< 1	U	< 1	U	< 1	U
cis-1,2-Dichloroethene	µg/L	70		< 0.5	U	< 0.5	U	< 0.5	U	< 0.5	U	< 0.5	U
Tetrachloroethene	µg/L	5		< 1	U	< 1	U	17		18		< 1	U
Trichloroethene	µg/L	5		< 1	U	< 0.5	U	3		3		< 0.5	U
Vinyl chloride	µg/L	2		< 1	U	< 1	U	< 1	U	< 1	U	< 1	U

Notes:

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LHAAP-35B(37) Year 7 Annual Remedial Action Operation Monitoring
(November 2023)

			Location Code	35BWW24		35BWW25		35BWW26		LHSMW58			
			Sample ID	35BWW24-231108		35BWW25-231108		35BWW26-231106		LHSMW58-231106		LHSMW58-231106-FD	
			Sample Date	11/8/2023		11/8/2023		11/6/2023		11/6/2023		11/6/2023	
			Location Description:	Shallow zone, impacted, outside site boundary		Shallow zone, impacted, outside site boundary		Shallow zone, unimpacted, within site boundary		Shallow zone, impacted, within site boundary			
Analyte	Units	MCL		Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual
Field Measurements													
Dissolved oxygen	mg/L	NV		2.52		1.36		1.27		1.67		1.67	
Ferrous Iron	mg/L	NV		NM		NM		0.16		NM		NM	
Oxidation-Reduction Potential	mV	NV		228		269		162		170		170	
pH	Std. Units	NV		6.63		6.29		5.93		6.3		6.3	
Dissolved Gases (RSK175)													
Carbon dioxide	µg/L	NV		NA		NA		67,000		NA		NA	
Ethane	µg/L	NV		NA		NA		< 0.5	UJ	NA		NA	
Ethylene	µg/L	NV		NA		NA		< 0.5	UJ	NA		NA	
Methane	µg/L	NV		NA		NA		0.937	J	NA		NA	
General Chemistry (9056A/SM5310C)													
Chloride	mg/L	NV		NA		NA		31.1		NA		NA	
Nitrate	mg/L	NV		NA		NA		0.148		NA		NA	
Sulfate	mg/L	NV		NA		NA		28.4		NA		NA	
Total organic carbon	mg/L	NV		NA		NA		0.625	J	NA		NA	
Volatile Organic Compounds (8260C)													
1,1-Dichloroethene	µg/L	7		0.94	J	< 1	U	< 1	U	< 1	U	< 1	U
cis-1,2-Dichloroethene	µg/L	70		< 0.5	U	< 0.5	U	< 0.5	U	< 0.5	U	< 0.5	U
Tetrachloroethene	µg/L	5		< 1	U	1.4		< 1	U	15		17	
Trichloroethene	µg/L	5		5		12		< 0.5	U	0.8	J	0.83	J
Vinyl chloride	µg/L	2		< 1	U	< 1	U	< 1	U	< 1	U	< 1	U

Notes:

Blue Highlighting Indicates concentrations above the MCL

J - Estimated: The analyte was positively identified, the quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria.

U - Undetected: The analyte was analyzed for, but not detected.

UJ - Undetected estimated: The analyte was analyzed for but, was not detected. Even though the analyte was not detected, certain discrepancies in meeting analyte specific quality control were not met.

MCL - Maximum Contaminant Limit, shown for contaminants of concern

Val Qual - validation qualifier

mg/L - milligrams per liter

ug/L - micrograms per liter

Std. Units - standard pH units

mV - millivolts

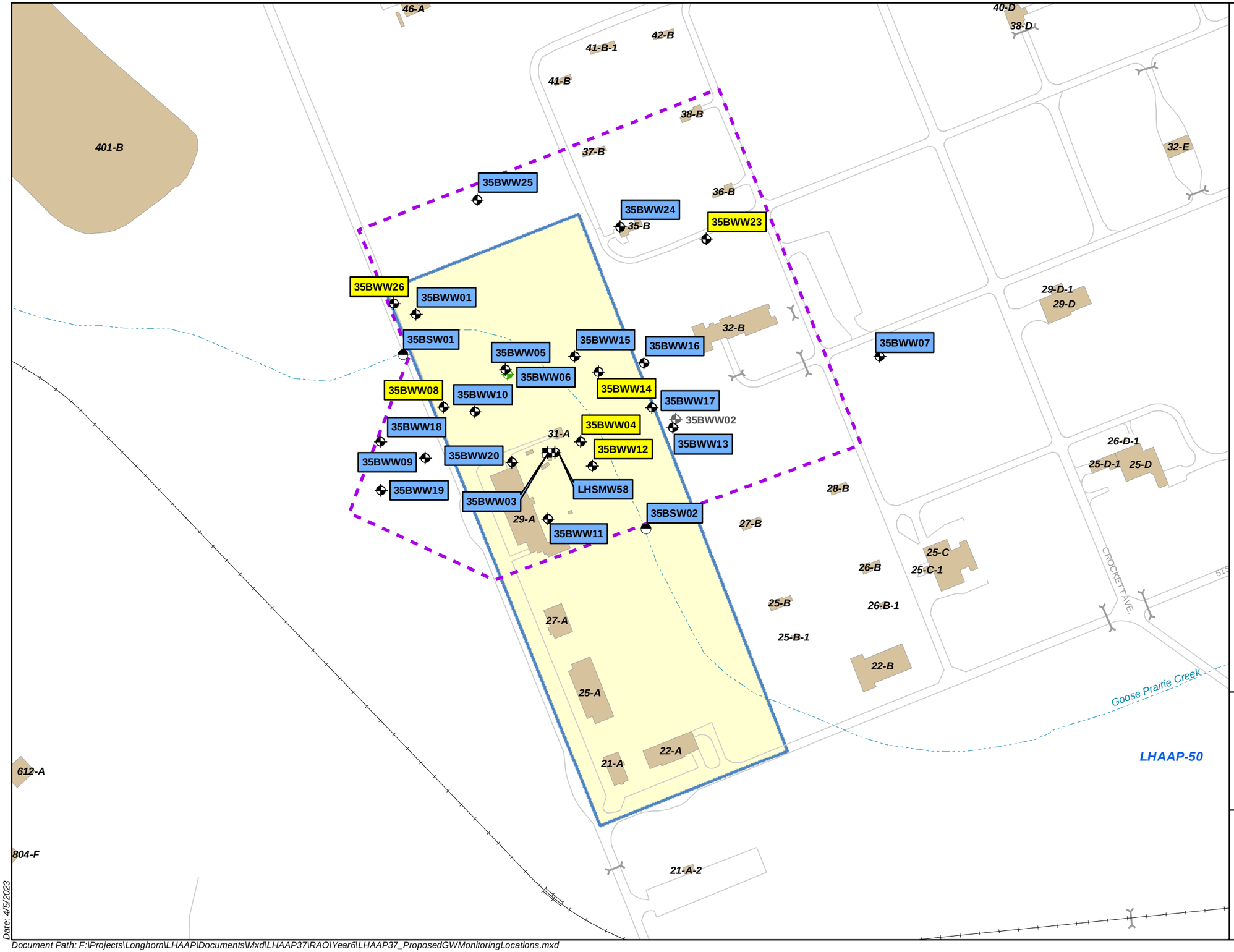
ID - identification

NV - MCL value not established and/or analyte is not a contaminant of concern

NA - not analyzed

NM - not measured

FD - field duplicate



- Shallow Zone Monitoring Well
- Lower Shallow Zone Monitoring Well
- Intermediate Zone Monitoring Well
- Surface Water Location
- Shallow Zone Monitoring Well - Not Sampled
- Former Railroad Location
- Land Use Control Boundary
- Goose Prairie Creek
- Roads
- Buildings
- LHAAP-35B(37) Site Boundary

Note:
1. RA-O = Remedial Action Operations

35BWW15 Proposed Sampling Location

35BWW14 Proposed Sampling Location including Monitored Natural Attenuation (MNA) Parameters

2. Monitoring wells 35BWW03 and 35BWW06 will continue to be sampled once every five years to support the Five Year Reviews. The next sampling event for these wells will be in 2026.

N

0 100 200 Feet

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PCIbhate APTIM

Figure 2-6

Year 7 Sampling Locations
Sixth Annual RA-O Report
LHAAP-35B(37)

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 4/5/2023

Document Path: F:\Projects\Longhorn\LHAAP\Documents\Mxd\LHAAP37\RAO\Year6\LHAAP37_ProposedGWMonitoringLocations.mxd

LHAAP-67 Year 10 Annual Remedial Action Operation Monitoring
(November 2023)

			Location Code	67WW01		67WW02		67WW05		67WW07		67WW08			
			Sample ID	67WW01-231101		67WW02-231101		67WW05-231102		67WW07-231102		67WW08-231101		67WW08-231101-FD	
			Sample Date	11/1/2023		11/1/2023		11/2/2023		11/2/2023		11/1/2023		11/1/2023	
			Location Description	Site 67 - Central, within site boundary		Site 67 - NW, within site boundary		Site 67 - WNW, outside site boundary		Site 67 - E, outside site boundary		Site 67 - S, within site boundary			
Analyte	Units	MCL		Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual
Field Measurements															
Dissolved oxygen	mg/L	NV		0.25		0.06		0.08		0.03		0.07		0.07	
Oxidation-Reduction Potential	mV	NV		-6		95		32		33		123		123	
pH	Std. Units	NV		6.83		6.68		6		6.34		6.24		6.24	
Ferrous Iron	mg/L	NV		NM		NM		NM		NM		0.55		0.55	
Dissolved Gases (RSK175)															
Carbon dioxide	µg/L	NV		NA		NA		NA		NA		98,000		96,000	
Ethane	µg/L	NV		NA		NA		NA		NA		< 0.5	UJ	1	J
Ethylene	µg/L	NV		NA		NA		NA		NA		< 0.5	UJ	< 0.5	UJ
Methane	µg/L	NV		NA		NA		NA		NA		2.92	J	2.7	J
General Chemistry (9056A/SM5310C)															
Chloride	mg/L	NV		NA		NA		NA		NA		1,830		1,900	
Nitrate	mg/L	NV		NA		NA		NA		NA		< 0.2	U	< 0.2	U
Sulfate	mg/L	NV		NA		NA		NA		NA		615		655	
Total organic carbon	mg/L	NV		NA		NA		NA		NA		3.52		3.51	
Volatile Organic Compounds (8260C)															
1,1,1-Trichloroethane	µg/L	200		< 1	U	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U
1,1,2-Trichloroethane	µg/L	5		< 1	U	0.73	J	< 1	U	< 1	U	< 1	U	< 1	U
1,1-Dichloroethene	µg/L	7		82		140		< 1	U	< 1	U	12		11	
1,2-Dichloroethane	µg/L	5		7.2		2.8		< 1	U	< 1	U	< 1	U	< 1	U
cis-1,2-Dichloroethene	µg/L	70		< 1	U	< 1	U	< 0.5	U	< 0.5	U	< 1	U	< 1	U
Trichloroethene	µg/L	5		< 1	U	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U
Vinyl chloride	µg/L	2		0.52	J	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U

Notes:

Blue highlighted/**bold** results indicate concentrations above the MCL/PCL.

J - Estimated. The analyte was positively identified, the quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria

UJ - Undetected estimated: The analyte was analyzed for but, was not detected. Even though the analyte was not detected, certain discrepancies in meeting analyte specific quality control were not met.

U - Undetected. The analyte was analyzed for, but not detected.

µg/L - micrograms per liter

mg/L - milligrams per liter

FD - field duplicate

ID - identification

MCL - maximum contaminant limit

Val Qual - validation qualifier

VOCs - volatile organic compounds

NV - No value established or analyte is not a COC

Std. Units - standard pH units

mV - millivolts

NA - not analyzed

NM - not measured

LHAAP-67 Year 10 Annual Remedial Action Operation Monitoring
(November 2023)

		Location Code	67WW09		67WW09A		67WW10		67WW11		67WW12		67WW13	
		Sample ID	67WW09-231101		67WW09A-231102		67WW10-231102		67WW11-231101		67WW12-231102		67WW13-231101	
		Sample Date	11/1/2023		11/2/2023		11/2/2023		11/1/2023		11/2/2023		11/1/2023	
		Location Description	Site 67 - S, outside site boundary		Site 67 - S, outside site boundary		Site 67 - SE, outside site boundary		Site 67 - SW, outside site boundary		Site 67 - NE, within site boundary		Site 67 - NE, within site boundary	
Analyte	Units	MCL	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual
Field Measurements														
Dissolved oxygen	mg/L	NV	0.05		0.08		0.06		0.08		0.05		1.75	
Oxidation-Reduction Potential	mV	NV	226		81		155		136		129		183	
pH	Std. Units	NV	6.49		6.74		5.54		6.62		6.98		6.79	
Ferrous Iron	mg/L	NV	NM		NM		NM		NM		NM		0.01	
Dissolved Gases (RSK175)														
Carbon dioxide	µg/L	NV	NA		NA		NA		NA		NA		55,000	J
Ethane	µg/L	NV	NA		NA		NA		NA		NA		< 0.5	UJ
Ethylene	µg/L	NV	NA		NA		NA		NA		NA		< 0.5	UJ
Methane	µg/L	NV	NA		NA		NA		NA		NA		1.06	J
General Chemistry (9056A/SM5310C)														
Chloride	mg/L	NV	NA		NA		NA		NA		NA		1,170	
Nitrate	mg/L	NV	NA		NA		NA		NA		NA		0.0647	J
Sulfate	mg/L	NV	NA		NA		NA		NA		NA		290	
Total organic carbon	mg/L	NV	NA		NA		NA		NA		NA		2.45	
Volatile Organic Compounds (8260C)														
1,1,1-Trichloroethane	µg/L	200	< 1	U	< 1	UJ	< 1	UJ	< 1	U	< 1	U	< 1	U
1,1,2-Trichloroethane	µg/L	5	< 1	U	< 1	UJ	< 1	UJ	< 1	U	< 1	U	5.2	
1,1-Dichloroethene	µg/L	7	< 1	U	< 1	UJ	< 1	UJ	< 1	U	20		560	
1,2-Dichloroethane	µg/L	5	< 1	U	< 1	UJ	< 1	UJ	< 1	U	0.32	J	39	
cis-1,2-Dichloroethene	µg/L	70	< 1	U	< 0.5	UJ	< 0.5	UJ	< 1	U	< 0.5	U	1.2	
Trichloroethene	µg/L	5	< 1	U	< 1	UJ	< 0.5	UJ	< 1	U	< 1	U	2.1	
Vinyl chloride	µg/L	2	< 1	U	< 1	UJ	< 1	UJ	< 1	U	< 1	U	< 1	U

Notes:

Blue highlighted/**bold** results indicate concentrations above the MCL/PCL.

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µg/L - micrograms per liter

mg/L - milligrams per liter

FD - field duplicate

ID - identification

MCL - maximum contaminant limit

Val Qual - validation qualifier

VOCs - volatile organic compounds

NV - No value established or analyte is not a COC

Std. Units - standard pH units

mV - millivolts

NA - not analyzed

NM - not measured

LHAAP-67 Year 10 Annual Remedial Action Operation Monitoring
(November 2023)

Location Code			67WW14		67WW15		67WW16I		67WW17		67WW18			
Sample ID			67WW14-231102		67WW15-231101		67WW16I-231101		67WW17-231102		67WW18-231102		67WW18-231102-FD	
Sample Date			11/2/2023		11/1/2023		11/1/2023		11/2/2023		11/2/2023		11/2/2023	
Location Description			Site 67 - SW, outside the site boundary beside Ignatius Ave.		Site 67 - W, outside site boundary		Site 67 - S, within site boundary		Site 67 - NW, within site boundary		Site 67 - N, outside site boundary			
Analyte	Units	MCL	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual	Result	Val Qual
Field Measurements														
Dissolved oxygen	mg/L	NV	0.2		0.36		0.43		2.13		0.05		0.05	
Oxidation-Reduction Potential	mV	NV	181		247		18		103		44		44	
pH	Std. Units	NV	6.21		6.33		6.43		7.03		7.01		7.01	
Ferrous Iron	mg/L	NV	NM		NM		NM		NM		NM		NM	
Dissolved Gases (RSK175)														
Carbon dioxide	µg/L	NV	NA		NA		NA		NA		NA		NA	
Ethane	µg/L	NV	NA		NA		NA		NA		NA		NA	
Ethylene	µg/L	NV	NA		NA		NA		NA		NA		NA	
Methane	µg/L	NV	NA		NA		NA		NA		NA		NA	
General Chemistry (9056A/SM5310C)														
Chloride	mg/L	NV	NA		NA		NA		NA		NA		NA	
Nitrate	mg/L	NV	NA		NA		NA		NA		NA		NA	
Sulfate	mg/L	NV	NA		NA		NA		NA		NA		NA	
Total organic carbon	mg/L	NV	NA		NA		NA		NA		NA		NA	
Volatile Organic Compounds (8260C)														
1,1,1-Trichloroethane	µg/L	200	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U
1,1,2-Trichloroethane	µg/L	5	< 1	U	3.5		< 1	U	< 1	U	< 1	U	< 1	U
1,1-Dichloroethene	µg/L	7	1.1		390		< 1	U	1.7		< 1	U	< 1	U
1,2-Dichloroethane	µg/L	5	0.36	J	24		< 1	U	< 1	U	< 1	U	< 1	U
cis-1,2-Dichloroethene	µg/L	70	< 0.5	U	0.99	J	< 1	U	< 0.5	U	< 0.5	U	< 0.5	U
Trichloroethene	µg/L	5	< 1	U	1.2		< 1	U	< 0.5	U	< 0.5	U	< 1	U
Vinyl chloride	µg/L	2	< 1	U	0.47	J	< 1	U	< 1	U	< 1	U	< 1	U

Notes:

Blue highlighted/**bold** results indicate concentrations above the MCL/PCL.

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UJ - Undetected estimated: The analyte was analyzed for but, was not detected. Even though the analyte was not detected, certain discrepancies in meeting analyte specific quality control were not met.

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µg/L - micrograms per liter

mg/L - milligrams per liter

FD - field duplicate

ID - identification

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VOCs - volatile organic compounds

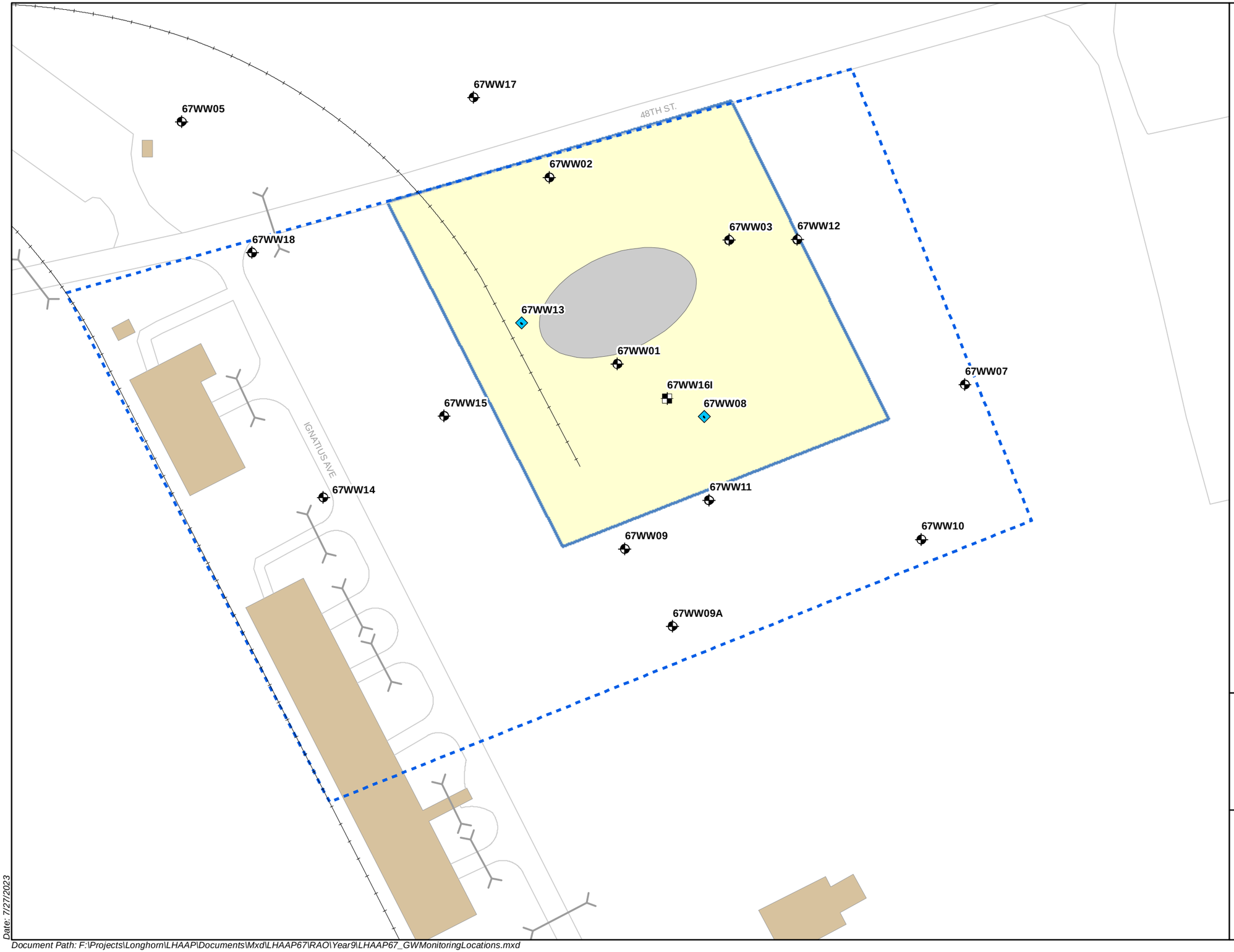
NV - No value established or analyte is not a COC

Std. Units - standard pH units

mV - millivolts

NA - not analyzed

NM - not measured



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TULSA, OKLAHOMA

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Figure 2-1

Groundwater Monitoring Well Locations
Ninth Annual RA-O Report
LHAAP-67

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Date: 7/27/2023

Document Path: F:\Projects\Longhorn\LHAAP\Documents\Mxd\LHAAP67\RAO\Year9\LHAAP67_GWMonitoringLocations.mxd

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
US ARMY ENVIRONMENTAL COMMAND
2455 REYNOLDS ROAD
JOINT BASE SAN ANTONIO FORT SAM HOUSTON, TX 78234-7588

February 29, 2024

SUBJECT: Final Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas

Ms. April Palmie
Texas Commission on Environmental Quality
Superfund Section, MC-136
12100 Park 35 Circle, Bldg D
Austin, TX 78753

Dear Ms. Palmie,

An electronic copy of the 100% Design Analysis Report Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas has been transmitted via DOD SAFE and is awaiting download for your records. A notice of availability has been generated and sent via email with the instructions and dates for download. The document includes revisions based on Texas Commission on Environmental Quality (TCEQ) comments received by the Army on 8 January 2024 on the second submittal of the Final 100% Remedial Design. The Army did not receive any comments from the Environmental Protection Agency (EPA) on the second submittal. Tables of the Army responses to all EPA and TCEQ comments (30% - 100%) are included with the document.

The document was prepared by HDR Environmental, Operations and Construction, Inc. (HDR) on behalf of the Army as part of HDR's contract for the facility. I ask that Phil Werner, HDR's Project Manager, be copied on any communications related to the project.

The point of contact for this action is the undersigned. I may be contacted at (726) 999-0505, or by email at lena.j.sierocinski.civ@army.mil.

Sincerely,

Lena Sierocinski

Lena Sierocinski
LHAAP Environmental Support Manager
U.S. Army Environmental Command

cc:
B. Follin, USEPA Region 6, Dallas, TX
E. Duerkop, USFWS, Caddo Lake NWR, TX (1 CD)
C. Montoya USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
K. Russell, BRAC, Huntsville, AL
P. Srivastav, APTIM, Houston, TX

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
US ARMY ENVIRONMENTAL COMMAND
2455 REYNOLDS ROAD
JOINT BASE SAN ANTONIO FORT SAM HOUSTON, TX 78234-7588

February 29, 2024

SUBJECT: Final Remedial Design for LHAAP-18/24, Former TNT Production Area Group 2, Longhorn Army Ammunition, Plant, Karnack, Texas

Mr. Brian Follin
U.S. Environmental Protection Agency
1201 Elm Street, Suite 500
Dallas, TX 75270-2002

Dear Mr. Follin,

An electronic copy of the 100% Design Analysis Report Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas has been transmitted via DOD SAFE and is awaiting download for your records. A notice of availability has been generated and sent via email with the instructions and dates for download. The document includes revisions based on Texas Commission on Environmental Quality (TCEQ) comments received by the Army on 8 January 2024 on the second submittal of the Final 100% Remedial Design. The Army did not receive any comments from the Environmental Protection Agency (EPA) on the second submittal. Tables of the Army responses to all EPA and TCEQ comments (30% - 100%) are included with the document.

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The point of contact for this action is the undersigned. I may be contacted at (726) 999-0505, or by email at lena.j.sierocinski.civ@army.mil.

Sincerely,

Lena Sierocinski

Lena Sierocinski
LHAAP Environmental Support Manager
U.S. Army Environmental Command

cc:
A. Palmie, TCEQ Austin, TX
E. Duerkop, USFWS, Caddo Lake NWR, TX (1 CD)
C. Montoya USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
K. Russell, BRAC, Huntsville, AL
P. Srivastav, APTIM, Houston, TX

Comments Response Matrix
Final (100%) Design Analysis Report, Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant Karnack, Texas
Submitted: December 14, 2023

Submitted by:
Responded by:
Date Responded:

1. Respondent concurs (C) or does not concur (D)
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1: April Palmie and Midori Campbell (Engineering support)						
1.	Comment # 20	Sheet 01C103	Thank you for the revisions. For NC-1 Excavation Bottom, please add "TO NC1-1" to close the box.	C	This has been added to sheet C01C103.	
2.	General	General	After you assemble the final RD, in Adobe Scan & OCR, run recognize text so all contents are searchable.	C	Final document will be scanned to make context searchable.	
3.	General	Comprehensive CRMs	For the final and admin record, I think we should have a full set of the CRMs with all responses to comments, not just the very last few edits on the Draft Final 100%. Please compile the CRMs from all reviews (30% to this last set) and include them with the final submittal. This could be a stand-alone pdf file or an appendix at the end of the final RD.	C	A final set of CRMS will be compiled and included as a stand-along PDF file.	
4.	Sheet G001	Backfill Requirements	Remove empty "2"; section will be renumbered 1-5.	C	The empty number "2" has been removed and all numbers are renumbered accordingly.	
5.	Appendix E		Thank you for the bookmarks for the logs that are included. About 60 pages of logs that were included in the last version are missing from this version. Please explain their exclusion or add to the final RD and bookmark.	C	The complete compiled boring logs/well construction logs are now included, and bookmarks have been provided for each log.	

Draft 100% Design Analysis Report, Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas

Submitted by: U.S. Environmental Protection Agency
Responded by:
Date Responded:

1. Respondent concurs (C) or does not concur (D)
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1:						
1	Section 1.5.3, p. 1-8	Table 1-1, "Notes" section	For note 2, need to provide citation for the "AECOM" report.	C	Citation to AECOM RI Addendum has been added.	
2	Section 1.7.1.2, p. 1-11	1st paragraph, 3rd sentence	Sentence indicates maximum detected concentration of 2,6-DNT was an estimated 15 mg/kg. However, this value does not have a corresponding "J" qualifier (indicating an estimated concentration) in fig. 1-12 (inset 5)—need to determine whether the text or the fig. is correct.	C	Text identifying the result as being an estimated concentration has been deleted.	
3	Section 2.2.1, p. 2-3	3rd paragraph, 4th and 5th sentences, and elsewhere throughout section 2.2	The "below ground surface" abbreviation ("bgs") is missing after the depth intervals identified in both sentences. This abbreviation is missing for depth intervals identified in other sentences in section 2.2, so this should be checked throughout the section (comment will not be repeated).	C	The text has been updated to include the "bgs" depth reference where appropriate. Specific instances include those identified by the comment in Section 2.2.1 and Section 2.2.	
4	Section 2.2.3, p. 2-4	2nd paragraph, 7th sentence	Hyphens are needed for "depth to water" modifier (i.e., should be "depth-to-water measurements"). Believe this occurs elsewhere in report — should search entire report and revise where needed.	C	Hyphens have been added as requested.	
5	Section 2.2.4, p. 2-5	1st paragraph, 1st complete sentence (begins with "Samples collected at...")	Fig. 2-4 is limited to selected explosive compound analyses, so the word "contaminants" at end of sentence should be replaced with the two explosive constituents for which the sample was analyzed (2,4-DNT and 2,6-DNT).	C	The word "contaminants" has been replaced with "2,4-DNT and 2,6-DNT".	
6	Section 2.3, p. 2-7	1st paragraph, 1st sentence	The "ISM" abbreviation is used twice in this report — for "incremental sampling methodology" here and "in-situ microcosm" elsewhere. Need to revise this abbreviation or the other one to eliminate duplication.	C	The abbreviation of ISM has been revised for Incremental Sampling Methodology. All instances of in-situ microcosm have been written out and are no longer abbreviated.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
7	Section 2.3, p. 2-7	1st paragraph, 1st and 2nd sentences; 3rd paragraph, 1st sentence; 5th paragraph, 3rd sentence	The following abbreviations introduced in the revised section 2.3 are missing from the list of acronyms and abbreviations at beginning of report: ITRC, DU, kg, and UCL. Note that the definition for the ISM abbreviation in the list of acronyms and abbreviations at beginning of report may need to be revised if it is changed to represent "incremental sampling methodology" instead of "in-situ microcosm" (see previous comment).	C	The text in Section 2.3 has been revised to remove some abbreviations. Abbreviations remaining include ISM, DU, and ITRC. These have been added to the list of abbreviations. Refer to the response above for the use of the ISM abbreviation.	
8	Section 3.4.4, p. 3-9	2nd paragraph, 2nd sentence	A hyphen is missing between "2" and "inch" (i.e., should be "… with a 2-inch diameter…").	C	A hyphen has been added as requested.	
9	Section 3.4.7, p. 3-12	Last black bullet in 1st bulleted list after 1st paragraph	Should specify that the 8,000 ug/L groundwater concentration is for MC.	C	Text has been revised to "A soil concentration that correlates to the 8,000 µg/l MC groundwater concentration..."	
10	Section 4, p. 4-1	Table 4-1, notes section, note #1	Should provide a formal citation for the Draft Site Data Summary Report so the reader can link what is being cited here with what is listed in the References section.	C	Citation to Draft Site Data Summary Report has been added to Note 1 of Table 4-1.	
11	Section 4.2.1, p. 4-4	3rd paragraph, 1st sentence	Believe the word "removal" is missing between "pipeline" and "is assumed"(i.e., "… TNT pipeline removal is assumed to be…").	C	The word "removal" has been added.	
12	Section 4.3.1, p. 4-7	1st paragraph, last sentence	Should cite table 4-1 at end of sentence (after LHAAP-32).	C	A reference to Table 4-1 has been added.	
13	Section 4.4.6, p. 4-14	1st paragraph, 1st sentence	Should provide citation for TCLP for solid wastes.	C	USEPA 1992 Test Method 1311 citation has been added to the last paragraph of Section 4.4.6 where TCLP testing is indicated. Section 9 has also been updated to include the document as a reference.	
14	Section 5.1.1, p. 5-3	1st paragraph, 2nd sentence	Should cite fig. 1-7 (shallow zone potentiometric-surface map) at end of sentence as supporting evidence.	C	A citation to Figure 1-7 has been added as requested.	
15	Section 6, p. 6-1	1st paragraph, 3rd sentence	Because of how the underlying bulleted sentences are constructed, the words "are to" should be changed to "include the following" or something similar.	C	Text has been revised to "include the following" as requested.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
16	Section 3.2, p. 3-2	1st paragraph, 1st sentence	Should cite source of information presented in sentence.	C	The first sentence of the first paragraph under Section 3.2 already contains a citation for the AECOM, 2016 report. No change was made as a result of this comment.	
17	References section, p. 9-2	Shaw references	Based on note 4 in figs. 2-1 and 2-2 , believe Shaw (2004) and Shaw (2005) should be included in the References section.	C	References have been updated. The 2005 report was included as an appendix to the Final Addendum 6 of the Additional Investigation Work Plan prepared by Shaw in 2006 and already included in Section 9 of the report. This has been identified in Note 4 of Figures 2-1 and 2-2. The Shaw 2004 information is included as part of the Final Feasibility prepared by Shaw in 2010 and already included in Section 9 of the report. The reference to Shaw, 2004 and been corrected on the figure to Shaw, 2010.	
18	Fig. 3-1	Legend portion of fig.	In legend portion of fig., should indicate the groundwater iso-concentration contours are for methylene chloride.	C	The legend has been updated to indicate the iso-contours are for methylene chloride. This has also been indicted in Notes 2 and 4.	
19	Figs. 5-1 to 5-3		Should add groundwater-flow direction arrows to all 3 figs.	C	Groundwater flow direction arrows have been added as requested.	
20	Appendix A, Sheet G002		1) For note 2 in the "Perchlorate and North TNT Plume Monitoring Wells" table, need to add date after "AECOM" so the reader can easily link this reference with the corresponding report listed in the References section. 2) Some well identifiers on the map portion of fig. are covered up (e.g., see 2 wells with covered identifiers in ISTD treatment area).	C	1) Note 2 of the table has been updated to include a citation. 2) Well identifiers for 29WW40 and 29WW15 are now visible.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
21	Appendix A, Sheet G003		1) Many of the well identifiers are partially overlain/covered by the colored lines delineating the nitrotoluene, perchlorate, and volatile organic compound contamination extent. Need to change layers so that well identifiers are placed on top of the colored lines. 2) Should add groundwater-flow direction arrows to all 4 maps shown on sheet. 3) Proposed well 29WW2023-13 and associated information is missing from the "Middle TNT Plume Monitoring Wells" table on sheet. 4) For note 3 in the "Perchlorate and North TNT Plume Monitoring Wells" table, need to add date after "AECOM" so the reader can easily link this reference with the corresponding report listed in the References section.	C	1) Well identifiers have been brought above the iso-contour lines. 2) Groundwater flow direction arrows have been added. 3) Proposed well 29WWRA-13 has been added to the proposed monitoring well table. 4) A citation has been added to Note 3.	
22	Appendix A, Sheet 02C101		1) Would be helpful if existing and proposed monitoring wells could be color-coded so that intermediate zone wells can be easily discerned from shallow zone wells in the ISTD area without having to consult the 2 tables on the sheet. 2) ISTD note #5 indicates the contractor is to install 5 new wells, including 4 **shallow** and 1 deep well in and around the IST treatment area; however, the "Proposed Monitoring Wells" table on this sheet indicates this should be 4 **intermediate** zone wells (29WW46, 47, 48, and 49) and 1 deep well (29WW45).	D C	There is only one shallow well 29WW15 and 3 deep wells (including existing and proposed) all of which are identified in the tables on this drawing sheet. The addition of colors to distinguish between the two is unnecessary on the drawings. Not #5 has been revised to 4 intermediate wells and 1 deep well.	
23	Appendix A, Sheet 02C102		1) Would be helpful if proposed monitoring wells are also shown on the map so that reader can examine cross sections in relation to proposed monitoring well locations. 2) Would be helpful to darken colored text showing numerical values for boreholes shown in both cross sections— numerical values are very hard to read on printed hardcopy. 3) Citations for supporting data should be provided for notes #1-3.	C C C	1) The proposed monitoring wells have been added to the plan view on Sheet 02C102. Proposed wells within 15-ft of a cross section line have been added to the applicable cross section. 2) Numerical values have been darkened and slightly enlarged. 3) Citations have been added to Notes #1-3.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
24	Appendix D (Draft Performance Work Statement for In Situ Thermal Treatment)	List of acronyms and all text throughout appendix D	Numerous acronyms/abbreviations used in appendix D are missing from the appendix D acronyms list (e.g., ASTM, TCEQ, GWP-IND, SAI-IND, DAR, RCRA, CDFR, DQCR, RSCC, SMO, EDDs). Need to check all used acronyms/abbreviations against appendix D acronyms list.	C	ASTM, TCEQ, GWP-IND, SAI-IND, DAR, RCRA, DQCR, RSCC, SMO, and EDDs have been added to the acronym list. CDFR was listed – no change required.	
25	Appendix D, Section 1.1, p. 1-1	1st paragraph, 4th sentence	The "non" prefix is missing before "aqueous" (i.e., should be dense **non**aqueous phase liquid).	C	The "non" prefix has been added to "aqueous".	
26	Appendix D, chapter 2, section 1.3, p. 1-1	1st paragraph, 1st sentence	Need to provide citation for 2019 ROD (including adding document to the References section).	C	2019 ROD has been cited and added to the References section.	
27	Appendix D, chapter 2	Chapter 2	Chapter 2 page numbering in appendix D is incorrect after page 2-16 (appendix 2 page numbering is "restarted" beginning with fig. 1).	C	Page numbering has been corrected.	
28	Appendix D, chapter 2, section 2.1.2, p. 2-1	2nd paragraph after table 2-1, 1st sentence (begins with "Based on the 2014…")	Need to provide citation for 2014 supplementary investigation (including adding document to the References section).	C	Citation to the AECOM Draft Final RI has been added. The reference for this document was already included in Section 6.	
29	Appendix D, chapter 2, section 2.1.7, p. 2-6	2nd paragraph, 4th sentence, and 3rd paragraph, 3rd sentence	Should provide citations for ASTM D1557 and D2487 (including adding document to the References section). Also note that there is an extra space between "D" and "1557."	C	Citations have been added and documents have been added to Section 6 References. The space between D1557 has been deleted.	
30	Appendix D, chapter 2, section 2.1.8, Hot Soil Sampling subsection, p. 2-9	2nd paragraph, 2nd and 3rd sentences	Should provide citations for Gaberell et al/Battelle and USEPA method 8260 (including adding documents to the References section).	C	Citations have been added and documents have been added to Section 6 References.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
31	Appendix D, chapter 2, Section 2.13.2 incorrect page 2-2 (see comment #27)	Section 2.13.2 heading	A space is needed between "2.13.2" and "ISTD Work Plan."	C	A space has been added between 2.13.2 and ISTD Work Plan.	
32	Appendix D, chapter 2, Section 2.13.2 incorrect page 2-2 (see comment #27)	1st paragraph, 2nd sentence	The "USACE 2006" reference cited at end of sentence is missing from the References section.	C	USACE 2006 citation in 2.13.3 has been added to the list of references in Section 6.	
33	Appendix D, chapter 2, Section 2.13.4 incorrect page 2-3: see comment #27)	Section 2.13.4 heading	A space is needed between "2.13.4" and "UFP-Quality Assurance Project Plan."	C	A space has been added between 2.13.4 and UFP-QAPP.	
34	Appendix D, chapter 2 section 2.13.4, incorrect page 2-3 (see comment #26)	1st paragraph, last sentence	Should provide a citation for the EPA Uniform Federal Policy for QAPPs.	C	A citation has been added and the document has been added to the list of references in Section 6.	
35	Appendix D, chapter 3, section 3.3	1st paragraph, 2nd sentence	Should provide citations for EPA 540-R-93-071 and USACE EM 200-1-6 (including adding documents to the References section).	C	Citations have been added and documents have been added to Section 6 References.	
36						
37						
38						

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
39						
40						

Comments Response Matrix
Final (100%) Design Analysis Report, Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 15, 2023

Submitted by:
Responded by:
Date Responded:

1. Respondent concurs (C) or does not concur (D)
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1: April Palmie and Midori Campbell (Engineering support)						
1.	Comment #20		Revised text is still awkward. Consider changing it to "Remove waste from all pipeline sections remaining in place."	C	Text in Note 3 on Drawing Sheet G001 under Pipe Inspection/Cleaning has been revised to "Remove waste from all pipeline sections remaining in place."	
2.	Comment #22		The reference to the earth dike detail on G004 is still missing from this sheet.	C	Note 7 has been added to the Diversion Dike Detail on Sheet G004 which references the construction ditch detail shown on Sheet G006.	
3.	Comment #24		The MC Plume ISTD Area is still missing from the legend on this Sheet.	C	The MC Plume line type has been added to the legend on drawing sheet 02C101.	
4.	Comment #27		Although the pump test described in Appendix D indicates a maximum ROI of 100 feet at a pumping rate of 0.4 gpm, site specific conditions will determine the actual ROI. If the ISTD contractor is responsible for making the determination of whether hydraulic control may be needed, the performance of a pump test is highly recommended. Consider adding this test as a requirement for the contractor to confirm whether hydraulic control is needed.	C	Text has been added to Section 2.1.5 of Appendix D to allow the Contractor to conduct a pump test to confirm existing known data for the site.	
5.	General		Please make sure all sections have bookmarks in the final version. Bookmarks are mostly present in this version but the bookmarks for Figures (after Section 9) are missing	C	All sections of the Final Design Package have bookmarks.	
6.	1.7.1.1	2nd paragraph	Please remove the pdf note	C	The PDF note has been removed from the final version of the document.	

Comments Response Matrix
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Submitted: August 15, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
7.	2.3	General: ISM Confirmation samples	We noticed the change to ISM confirmation samples. It is unexpected to see ISM introduced at the confirmation sample phase and as a change from the 90% design. Please explain the Army's rationale for this change. Add a statement to include the expected size (dimensions and/or square feet) of each DU.	C	ISM is a sampling protocol that reduces data variability and increases sample representativeness. It is also recommended for use in US EPA Method 8330B for explosive compounds. Based on this, it was determined to be the better confirmation sampling approach for the larger excavation areas than discrete sampling. Discrete confirmation sampling is still proposed for pipeline excavations where excavations areas are much smaller. The following text has been added to Section 2.3 "The areas for DUs will vary for each excavation. Areas for sidewall DUs will be between 20 sf to 400 sf. Areas for bottom DUs will be between 700 sf to 5,400 sf. "	
8.	2.3	General: ISM Confirmation samples - ISM Decision Units	Please provide an explanation for the criteria used to establish the decision units. Were the DUs based on observations such as soil type or COC concentrations from prior investigations, or on geometry, such as the total linear distance along the footprint of the excavation? The determination of DUs does not appear to be consistent between the excavations. For example, the footprint of E-2 is half of that of E-1, but they both contain the same number of DUs.	C	Each of the excavation sidewalls and bottoms have been designated as a DU in order to assess whether the estimated mean of COCs for each sidewall and bottom has been effectively reduced to levels below the cleanup limits. Sidewalls deeper than 5-ft are further broken up into increments of 5-ft or less in order to provide safe egress/ingress into the excavation for sample collection. Breaking out DUs into sidewalls and bottoms of excavation areas for confirmation sampling is in line with Section 4.4.3 of the ITRC Guidance document for ISM.	

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Submitted: August 15, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
9.	2.3	3/3	Should the mass of each incremental sample be 33 grams instead of 330 grams? If the individual mass is 330 grams, the total mass of the combined sample would be approximately 10 kg instead of 1 kg (330 grams x 30 samples = 9900 grams).	C	This has been corrected and the text states 33 grams will be collected for each incremental sample.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
10.	2.3	5/3	Please clarify how the UCL will be utilized in decision-making. As suggested in ITRC's ISM guidance document, will the calculated UCL be compared to the MSC to confirm that direct comparison of the individual confirmation samples will be satisfactory?	C	The purpose for collecting replicate samples is to evaluate whether the sampling design is providing sufficiently accurate results of the DU mean concentrations. If replicates determine accuracy is insufficient the sampling design will be revaluated and modified to provide more accurate results. Modifications of the sampling design would likely include an increase in the number of increments collected to form the DU sample for those DU samples that do not meet the requirements for reproducibility. Replicate samples will be used to calculate the relative standard deviation and the confidence interval using the 95% confidence limit to evaluate the reproducibility of the results and the range of concentrations anticipated based on the upper and lower 95% confidence limits. An acceptable relative standard deviation will be less than 30%. Because the same release pattern is expected for each of the excavation areas replicate samples will be collected from one sidewall DU for each excavation area. The results for the replicates collected from the sidewall DU for each excavation area will dictate whether the number of incremental samples need to be increased for all the sidewall DUs for that excavation area. This has been added to the text in Section 2.3.	
11.	2.3	6/1	How are you determining which sidewall and bottom DU will be selected for the replicate samples?	C	Replicates will be collected from the largest sidewall and bottom DU surface area for each excavation area. This has been added to the text in Section 2.3.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
12.	Table 2-2		Add Excavation areas NC-1 and NC-2 to the table and text in this section. You can reference Section 4 for details, but this table (and general explanation) would be more useful if it included all ISM DUs. If some excavations are not using ISM for confirmation sampling (such as NC-3 and pipelines), that should be noted in 2.3 with a cross-reference to 4.2.1.	C	Excavation areas NC-1 and NC-2 have been added to Table 2-2. A footnote has been added indicating further details for these excavations can be found in Section 4. A paragraph has been added at the end of Section 2.3 stating "Excavations associated with pipeline removals will use discrete samples for confirmation sampling. Further information for the collection of confirmation samples for these areas are discussed in **Section 4.2.1.**"	
13.	2.7.4	1st paragraph	For DU bottoms please add back "or soil is less than cleanup levels" or revise sentence so that clause applies to all confirmation samples. See similar sentence in 2.3 last paragraph.	C	The sentence has been revised to state: "Excavation will continue until concentrations in the soil are less than the soil cleanup levels for DU sidewalls and DU bottoms. In excavations where the groundwater table is breached, no samples will be collected from the DU bottom."	
14.	5.1.1, Figure 5-1, and other relevant sections and drawings		Regarding the wells numbered 29WW2023-XX – This is an unusual well number format for LHAAP, especially since these wells will not be installed in 2023. If you want this series of well to be distinctive from other site wells, perhaps you could include RA (for remedial action), such as 29WWXX-RA or 29WWRA-XX.	C	The format for proposed wells has been changed to 29WWRA-XX.	
15.	5.1.3	1/10	29WW2023-06 should be northeast of 29WW20 instead of east.	C	The direction in the text has been revised from east to northeast.	
16.	5.1.4		Sentence beginning "Two wells are planned to be installed 100 ft north" – north of which well(s)?	C	The text has been revised to: "Two wells are planned to be installed 100 ft north (29WWRA-10) and southwest (29WW2023-11) of 29WW33."	
17.	8.1		Remove or revise last sentence	C	The last sentence has been removed.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
18.	Drawing G003	Key Map	Please revise key map - There are <u>four</u> inset figures with <u>three</u> boxes on the key map. Also, add identifier of some kind to match inset figures to the boxes on the key map.	C	The larger inset in the middle was shown for the Middle TNT and VOC and Perchlorate Plume since these areas overlap. For clarity the key map now shows four different areas, two of which are shown overlapping.	
19.	Drawings 01C101-107	Note 2 under Excavation Notes	Revise the fourth sentence to read, "Incremental samples from each DU will be combined and processed into a single container for that DU and sent to the laboratory …"	C	Note 2 on Drawings 01C101 – 107 has been revised as provided.	
20.	Drawings 01C103-107		This applies to the large excavations - How is the bottom divided into DUs? Can you use the numbered points to describe each bottom DU instead of just a numbered quantity?	C	The bottom of all DUs has been broken out to show the point-to-point connection in the DU tables shown on these drawings.	
21.	Drawing 01C104		Excavation table needs additional clarifications to capture the mid-points. To clarify which sections are included, please revise: E4-3 to E4-14 change to E4-3 to E4-2 to E4-1 to E4-14 E4-11 to E4-8 change to E4-11 to E4-10 to E4-8 Between these two rows: E4-8 TO E4-9 TO E4-3 and E4-8 TO E4-3 (INTERIOR). It isn't clear what interior means – the bottom of 5ft or side wall below (E4-8 to E4-7 to E4-6 to E4-3)?	C	Revisions have been made as suggested. Interior has been removed and identifies the point-to-point connection for this sidewall.	
22.	Drawing 01C104		E6S-3 and 4 labels are not legible	C	Labels E6-3 and 4 have been revised to be more legible.	

23.	Appendix B	Construction Cost Estimate	First two pages of cost estimate, please update date and page numbers in the footer. 1.3.2 – Add to the Note that the cost basis for this task does not include disposal. 1.5.8 – Compared to 90%, underestimating cost of ISM sample costs due to collection time per sample and number of samples (which should equal number of DUs). 1.5.8 - The sample collection rate of 30 incremental samples per hour is inconsistent with the number of DUs (88) and the number hours included in the cost estimate (181 hours). Consider increasing the sample collection rate to 1 DU every three hours, inclusive of discrete sample collection, consolidation, and processing of discrete samples into their respective DU sample. 1.5.8 – The backup calculation for the geologist is based on 21 hours; will a greater number of units result in a lower per hour cost? 1.5.9 and 1.5.10 - Cost per sample also increases due to ISM sample preparation. 1.5.9, 1.5.10, 2.1.14, etc. – General question for sample analysis. Why are QC sample not included in the sample count? 4.1.1 – Why did the number of hours decrease compared to the 90% design? 8 days x 2 people x 8 hours/day = 128 hours.	C	Date has been updated in the heading and the page numbers have been updated in the footer. The date has been removed from the footer since it is included in the heading. A note to 1.3.2 has been added as requested to indicate the cost does not include disposal. 1.5.8 ISM Sample Costs: The cost for 1.5.8 was reviewed and revised as follows: Total DU samples collected including replicates will be 157 samples. It is assumed that each DU sample will take 1 hour to collect using 2 geologists. This estimate is based on the ISM Guidance. This results in 314 hours for DU sample collection. In addition, it was assumed that up to 10 additional DU samples may be collected for secondary excavations (~10%) which will result in an additional 20 hours for a total number of hours of 334 hours. Item 1.5.8 has been updated for this information. 1.5.8 Geologist Unit Rate Cost: The unit rate cost for the geologist is not dependent on the total number of hours for the bid estimate quantity in the back up tables. The unit rate cost is derived based the estimated raw hourly rate plus overhead and profit percentages. 1.5.9 and 1.5.10 – An additional processing cost of $100 per sample has been added to the cost estimate for lab preparation of the ISM sample. This is included as new line item 1.5.9 ISM Sample Processing.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
					1.5.9 (now 1.5.10), 1.5.10 (now 1.5.11), 2.1.14 – 20% has been added to these items to account for QC samples and to items 3.2.10, 4.1.3, and 4.3.3. 4.1.1 – Number of hours has been corrected and now is 128 hours.	
24.	Appendix B	Task-Based Estimate Backup Calculations	Description – For each description, add its respective task number from the Construction Cost Estimate Sampling (6th row) – Which sampling activity is this? It could not be found in the Construction Cost Estimate. Security Guard (7th row) – the quantity shown here (3024) is different from the quantity shown in the Construction Cost Estimate (3696).	C	Cost Item number has been added to each description. Sampling crew was not used and has been removed from this worksheet. All samples are assumed to be collected by geologists. Quanty for the security guard has been revised to match the quantity shown on the Construction Estimate. This did not change the cost since the unit rate for the security guard is an hourly rate.	
25.	Appendix D	5.9.1	Why is this sampling event an optional award? The sampling date (3 months after shut-down) is the same as 5.6. Did you intend for this to be a later sampling event? Should this section describe the measurement for the optional pre-shutdown hot groundwater sampling activities?	C	The groundwater confirmation sampling that will be conducted after the ISTD system is shutdown to verify that cleanup levels have been attained are included under Section 5.6. Section 5.9.1 is a second optional groundwater sampling event that may be opted by the USACE to be collected based on results of the first sampling event. Additional text has been added to Section 5.6, 5.9, and 5.9.1 to further clarify the requirements for the groundwater confirmation sampling.	

Draft (90%) Design Analysis Report, Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas

Submitted by: U.S. Environmental Protection Agency
Responded by:
Date Responded:

1. Respondent concurs (C) or does not concur (D)
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1:						
1	Section 1.5, p. 1-6	2nd paragraph, 1st sentence	The word "overlays" should be "overlies."	C	Text has been revised as requested.	
2	Section 1.5.2, p. 1-6	1st paragraph, 1st sentence	There is an extra parentheses after "50 million years ago."	C	Extra parenthesis has been deleted.	
3	Section 1.5.3, p. 1-7	3rd paragraph, 2nd sentence	The 2nd sentence of this paragraph is awkwardly constructed and should be revised for readability and clarity.	C	Text has been revised and states "Hydraulic conductivity was calculated from the slug test data using the Bouwer-Rice method. Hydraulic conductivity in the shallow saturated zone ranged from 4.9E-6 centimeter per second (cm/sec)..."	
4	Section 1.5.3, p. 1-7	3rd paragraph, 2nd sentence	Format of scientific notation in this paragraph differs from what is used in table 1-1. For example, the hydraulic conductivity value for well 29WW16 is shown in the form of "4.29E-**0**4" in the last sentence of paragraph and in the form "4.29E-4" in table 1-1. Should utilize same form of notation and make it internally consistent throughout document.	C	Text in this section has been revised to be consistent with text shown in Table 1-1.	
5	Table 1-1	Notes	"centimeters per second" should be "centimeter per second" because all hydraulic conductivity values are less than 1 cm/s.	C	Text has been revised as requested.	
6	Figs. 1-5 and 1-6	Explanation	1. "Down hole" should be one word. 2. "Flood plain" should be one word (2 locations in explanation). 3. Under "Sand lithofacies," a space is missing between "Wilcox Fm." and "marine and deltaic sands…".	C	1. "Down-hole" has been changed to "Downhole" as requested. 2. "flood plain" has been changed to "floodplain" as requested. 3. A space has been added between "Wilcox Fm." And "marine".	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
7	Figs. 1-9, 1-10, and 1-11	NOTES section of LEGEND	The "HDR, 2018" reference cited as a DATA SOURCE in all 3 figs. is not listed in the REFERENCES section.	C	The source for these figures is the 2019 Record of Decision. The reference on these figures has been updated.	
8	Section 1.12, p. 1-17	5th bullet on page	The word "Collection" should not be capitalized.	C	Text has been revised as requested.	
9	Fig. 1-13	Map	The "PZ-8" identifier is partially covered. Suggest use of leader for the numerical identifier.	C	The PZ-8 identifier has been relocated.	
10	Section 2.2, p. 2-2	1st paragraph after table 2-1, 2nd sentence	Should add a comma between "excavation areas" and "piezometers" to improve sentence readability.	C	Comma has been added as requested.	
11	Section 2.2, p. 2-2	1st paragraph after table 2-1, last sentence	The comma in the sentence (after "groundwater table") is misplaced.	C	Text has been revised to: "The water table is anticipated to fluctuate over time. To account for this fluctuation, the depth of excavations anticipated to be terminated at the groundwater table have been assumed to extend one ft beyond the water table depth observed during the 2022 investigation."	
12	Figs. 2-1, 2-2, 2-4, 2-5, and 2-6	Soil sample collection summary section of LEGEND	1) The "HDR, 2021" reference cited as a DATA SOURCE in all these figures is missing from the REFERENCES section. 2) The "Shaw, 2004" reference cited as a DATA SOURCE in figures 2-2 and 2-3 is missing from the REFERENCES section	C	1. Reference has been changed to HDR 2022. 2. Reference has been changed to Shaw, 2010.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
13	Fig. 2-1	map	No data is provided for boring 29SB107 — intentional or missing?		Please refer to Note 4 of Figure 2-3 which explains that the reason no results are shown for 29SB107 is because results could not be found in the RI Addendum prepared by AECOM, however the text of the report in Section 3.2 indicates that all perchlorate results from this location were below the cleanup levels. Final confirmation samples will be used to verify that the limits of the excavation meet the cleanup levels. No change has been made as a result of this comment.	
14	Fig. 2-4	map	The "8-FT" excavation text is hard to see on hardcopy because of all the intersecting lines.	C	The "8-ft" label has been relocated.	
15	Section 2.2.4, p. 2-4	1st paragraph, , last complete sentence on page (begins with "Of the…")	Sentence refers to 2 identified soil borings as "samples." However, sentence wording should be modified because soil boring 29SB174 had more than one sample (from more than one depth interval).	C	Text has been revised and states "Samples collected at boring locations 29SB174 and 29SB182 had no detections of contaminants.	
16	Section 3.2, p. 3-2	1st paragraph, 1st sentence	Should cite source of information presented in sentence.	C	A reference has been added to the Draft RI prepared by AECOM in 2016.	
17	Section 3.3, p. 3-5	1st bullet, 1st sentence	Sentence refers to depth of the water table and the intermediate zone — this is incorrect because report indicates the water table at the site is in the shallow zone and conditions in the intermediate zone are confined (including last sentence of this bullet).	D	This section is specific to the intermediate zone which will be treated by ISTD. As indicated the intermediate zone aquifer exists under confined conditions and has a depth to water table of approximately 40-ft bgs. No change has been made as a result of this comment.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
18	Section 3.4.4, p. 3-9	1st paragraph, 2nd sentence	To help reader better understand wells at ISTD location, strongly suggest the following modifications to this sentence: 1) add "(29WW46, 29WW47, 29WW48, and 29WW49)" after "four intermediate zone wells" 2) add "(29WW50 and 29WW51)" after "two hydraulic control monitoring wells" 3) add "(29WW45)" after "one deep well" 4) cite sheet 02C101 from appendix A at end of sentence as source of this new information. Note: If sentence is modified as suggested by adding items #1–4 above, considerable time/effort is saved for the reader trying to understand wells in/near the ISTD treatment area. This seems to be the best location to introduce this information before subsequent ISTD discussion/info. in the body and appendices of the report.	C	Wells have now been identified in the text and sheet 02C101 has been cited in the text.	
19	Section 3.4.4, p. 3-9	2nd paragraph, 1st sentence	Sentence indicates all new wells will be installed with 4-inch stainless steel casing and stainless steel screen. However, "Proposed Monitoring Wells" table at bottom of sheet 02C101 in appendix A indicates the deep well to be installed at the site (29WW45) will be constructed of 2-inch diameter stainless steel casing and screen.	C	Text has been revised to: "The new intermediate and hydraulic control monitoring wells will be installed with 4 inch stainless steel casing and 10 ft of stainless steel screen. The new deep well (29WW45) will be installed with a 2 inch diameter stainless steel casing and screen."	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
20	Section 3.4.4, p. 3-9	2nd paragraph, 2nd and 3rd sentences	Sentences indicate hollow stem and/or mud rotary method are to be used for ISTD well installation. Other parts of report indicate the rotosonic drilling method is to be used for well installation at other (non-ISTD) locations. Are only new wells at the ISTD going to be installed using hollow stem and/or mud rotary method and all other wells installed using rotosonic method? If so, should indicate why drilling method selected for ISTD site monitoring wells differs from the method (rotosonic) used for all other wells and clearly indicate here and elsewhere in appropriate report locations (including appendices) that selected drilling/installation method differs by site. Note: comments also apply to Draft Performance Work Statement for In-Situ Thermal Treatment appendix.	C	Rotosonic drilling will be used to install all new wells. DAR and Performance Work Statement has been revised to indicate this.	
21	Section 3.4.4, p. 3-9	3rd paragraph, 1st sentence	Unless there is more than one shallow groundwater zone, the word "zones" in "shallow groundwater zones" should be singular.	C	The 3rd paragraph in Section 3.4.4 has been deleted because the installation of an isolation casing is not needed when rotosonic drilling method is used to install wells	
22	Section 3.4.4, p. 3-9, (and Section 3.4.5.1, p. 3-10)	3rd paragraph, 2nd sentence	Table at top of Sheet 02C101 in appendix A indicates some existing wells in ISTD area do not have stainless steel isolation casing — is that a potential problem? Does it warrant discussion here and/or in the first paragraph at top of page 3-10 (and in the Draft Performance Work Statement for In-Situ Thermal Treatment appendix).		Existing wells 29WW42 and 29WW43 are located inside the ISTD area and were installed with an outer isolation casing of PVC to a depth of 35 ft. This casing will be 5-ft above the heated zone. Although temperatures may reach levels that could soften the outer casing, it is not expected to impact the overall construction of the well because the well casing is stainless steel. The outer casing was used as part of the well installation process to prevent cross contamination at the time of well construction, and now that the well is fully constructed it is no longer needed. As a result, no change has been made based on this comment.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
23	Section 3.4.4, p. 3-9	3rd paragraph, 2nd sentence	The word PVC is misspelled.	C	The 3rd paragraph in Section 3.4.4 has been deleted because the installation of an isolation casing is not needed when rotosonic drilling method is used to install wells	
24	Section 3.4.4, Sheet 02C101 in appendix A, and appendix D (Draft Performance Work Statement for In Situ Thermal Treatment)	Proposed new monitoring wells in ISTD area	1) Proposed well 29WW49 location. If purpose of well is to monitor concentrations downgradient of the portion of the MC plume/plume treatment area with highest concentrations, the well probably should be moved northward about 10–20 feet if groundwater-flow direction is correct (as indicated by arrow in Sheet 02C101 that reflects intermediate zone groundwater-flow direction shown in earlier potentiometric-surface map) and does not vary substantially seasonally/annually. 2) Report indicates purpose(s) of monitor wells in ISTD area are to monitor (in part) for potential downgradient mobilization of DNAPL once treatment (heating) begins. If so, and assuming groundwater-flow direction is correct as shown in Sheet 02C101, there are no downgradient monitoring locations (i.e. wells) for about the western one-third of area downgradient from the treatment area (as defined by green dashed line). In contrast, other areas downgradient of the treatment area will be monitored by 3 wells (by installation of new monitoring wells 29WW50, 29WW51, and 29WW49).	C	1. The purpose of monitoring well 29WW49 is to provide further delineation for the eastern edge of the plume and to evaluate whether the cleanup levels have been achieved following completion of ISTD. This well has now been shifted slightly west and is now shown inside the limit of the ISTD treatment area. 2. Section 3.4.4 states that seven new wells will be installed of which only 2 are installed for the purpose of hydraulic control monitoring. These two wells will be installed downgradient of the ISTD area as shown on drawing sheet 02C101. Four new wells will be installed in the intermediate zone to evaluate achievement of the cleanup levels inside the ISTD area. One new deep well will be installed to evaluate if there are any impacts to the deeper groundwater zone as a result of ISTD.	
25	Section 3.4.5.1, p. 3-9	2nd paragraph, 1st sentence	A comma is needed after “wells” (i.e., “Heating elements, wells, and monitoring points…”).	C	The comma has been added.	
26	Section 3.4.5.1, p. 3-9	2nd paragraph, 2nd sentence (and throughout report)	The words “federal” and “state” are not capitalized here, but they are capitalized in other parts of the report. Suggest selecting one approach to capitalization of these 2 words and apply it consistently throughout the report.	C	The text has been revised to capitalize “federal” and “state”.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
27	Section 4.2.1, p. 4-3	1st paragraph, 3rd sentence	As constructed, sentence indicates "Concentrations of 2,4,6-TNT" were detected instead of indicating the compound (2,4,6-TNT) was detected. Suggest revising sentence.	C	The text has been revised and states "Compound 2,4,6-TNT was also detected in the surrounding soils at three of eight PDI soil...."	
28	Section 4.2.1, p. 4-4	1st paragraph, 4th complete sentence (begins with "Samples collected for…"	"TAT" is not defined here (or in list of acronyms and abbreviations).	C	The text has been revised define TAT.	
29	Section 4.2.1, p. 4-4	1st paragraph, last sentence	Should indicate location of drawing G002 (appropriate appendix).	C	A reference to "sheet G002 (**Appendix A**)" has been included.	
30	Section 4.2.2, p. 4-5	1st paragraph, 4th sentence	Should cite table 4-2 as source of information (volumes presented in sentence).	C	A reference to **Table 4-2** has been added after the 4th sentence in this paragraph.	
31	Section 4.2.3, p. 4-5	1st paragraph, next-to-last and last sentences in paragraph	Should cite table 4-2 as source of information (volumes presented in sentence).	C	A reference to **Table 4-2** has been added.	
32	Section 4.4.6, p. 4-11	Table 4-3	In table cell defined by 2nd row and column, the word "to" between "will contain" and "residual waste" presumably should be "no" (i.e., "…and cleaning and will contain **no** residual waste inside the pipe.").	C	The text has been revised.	
33	Section 4	Fig. 4-3	The abbreviation "ft" is missing for all the depth intervals associated with 29SB138.	C	The abbreviation "ft" has been added for 29SB138.	
34	Section 5, p. 5-2	1st paragraph, 1st sentence	1) "29WW16" should be in parentheses after "one intermediate well." 2) The word "concentration" in "MC concentration" should be pluralized.	C	Parentheses have been added around 29WW16. Concentration has been pluralized.	
35	Section 5, p. 5-2	1st paragraph, 2nd sentence	Unclear if "COCs" in "COCs degradations" should be singular or plural? Revise, if necessary.	C	Sentence has been revised to "which can be used as electron acceptors and carbon sources for the degradation of other COCs mediated by microbial activities."	
36	Section 5, p. 5-2	2nd paragraph, 3rd sentence	1) The word "zones" in "shallow groundwater zones" should be singular. 2) The word "suggest" should be pluralized. 3) The word "as" after "alternative pathway" should be "is".	C	Zone has been revised to singular form. The word "suggest" has been pluralized. The word "as" has been changed to "is".	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
37	Section 5, p. 5-2	3rd paragraph, 3rd sentence	"DHC" is not defined here (or in list of acronyms and abbreviations).	C	DHC has been defined and added to the list of acronyms and abbreviations.	
38	Section 5.1.1, p. 5-3	1st paragraph, 2nd sentence	Should cite fig. 1-7 at end of sentence to direct the reader to potentiometric-surface map showing groundwater-flow direction.	C	Text has been revised as follows: "Additionally, there are no existing wells to further delineate the longitudinal extent of the plume to the west and east (downgradient) edge in the direction of groundwater flow (see **Figure 1-7** for groundwater flow direction)."	
39	Sections 5.1.1 and 5.1.2, p. 5-3 & 5-4	Figs. 5-1 and 5-2	Per discussions in sections 5.1.1 and 5.1.2 on pages 5-3 and 5-4, current numbering of figs. 5-1 and 5-2 should be reversed. Specifically, fig. 5-2 needs renumbered to fig. 5-1, and fig. 5-1 needs renumbered to fig. 5-2.	C	Numbering for figures in Section 5 have been corrected.	
40	Figs. 5-1 (currently incorrectly numbered as fig. 5-2)	LEGEND	"WATER EDGE" in legend is not relevant to features shown on map. Comment applies to fig. 5-2 (5-1) as well.	C	Numbering for figures in Section 5 have been corrected. The legend has been updated to remove "water edge".	
41	Section 5.1.1, p. 5-3	1st paragraph	Paragraph indicates purpose(s) of monitor wells are to (in part) laterally define and demonstrate shrinking of VOC and perchlorate plume. This cannot be determined for a substantial portion of the plume, specifically the southern and southeastern part of the plume, because no new monitoring wells are planned for this area. This area also intersects/coincides with the northern portion of the middle nitrotoluene plume. Section 5.1.3 ("Middle Nitrotoluene Plume") also indicates no wells are planned for this area. Considering this area coincides with the lateral extent of multiple plumes, should consider at least one monitoring well for this area.	C	Drawing G003 has been revised to show a new well (29WW2023-13) proposed in between wells 29WW15 and 29WW20. The text in sections 5.1.1 and 5.1.3 has also been updated to reflect this addition.	
42	Section 5.1.1, p. 5-3	1st paragraph, 8th sentence	Would be very helpful to identify new wells in sentence/section by adding parentheticals identifying new wells to be installed, including "(29WW2023-06 and 29WW2023-05)" after "100 ft west of and 100 ft east of 29WW15") and "(29WW2023-05) (fig. 5-2)" after "200 ft east of 29WW15". By citing fig. 5-2 here, could remove last sentence of paragraph. Alternatively, could cite fig. 5-2 earlier in paragraph.	C	Wells have now been identified in the text as requested. The reference to Figure 5-1 remains unchanged.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
43	Section 5.1.1, p. 5-3, and fig. 5-1	Proposed well locations	Proposed upgradient well 29WW2023-06 is fairly close to well 29WW43, so may want to consider moving it a little farther upgradient (about 20-25 ft?).	D	These wells are shown approximately 50-ft apart. Additionally, 29WW43 is installed in the intermediate groundwater zone and 29WW2023-06 will be installed in the shallow zone. No change has been made as a result of this comment.	
44	Section 5.1.2, p. 5-4	1st paragraph, 2nd sentence	Should cite fig. 1-7 at end of sentence to direct the reader to potentiometric-surface map showing groundwater-flow direction.	C	A reference to Figure 1-7 has been added.	
45	Section 5.1.2, p. 5-4	1st paragraph, 6th sentence	Would be very helpful to identify new wells in sentence/section by adding parentheticals identifying new wells to be installed (in same manner as comment #42).	C	Wells have now been identified in the text.	
46	Section 5.1.3, p. 5-4	1st paragraph, 2nd sentence	1) Should cite fig. 1-7 at end of sentence to direct the reader to potentiometric-surface map showing groundwater-flow direction. 2) At end of sentence: fig. 1-7 indicates flow direction is more to the southeast than to the east.	C	1) A reference to Figure 1-7 has been included. 2) Sentence has been revised to state, "Based on the groundwater potentiometric surface in this area, the groundwater flow direction in the vicinity of this well is generally to the southeast (Figure 1-7)."	
47	Section 5.1.3, p. 5-4	1st paragraph, 7th sentence	Would be very helpful to identify new wells in sentence/section by adding parentheticals identifying new wells to be installed (in same manner as comment #42).	C	Wells have now been identified in the text.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
48	Section 5.1.3, p. 5-4 and fig. 5-1	Well locations	Use of only the 2 planned new monitoring wells, both of which are located close to (within about 100 ft of) well 29WW20, would allow for assessment of current extent and future changes in lateral/longitudinal extent over a relatively limited portion of the middle NT plume in comparison to its size/extent. This includes the area that intersects/coincides with the southern portion of the VOC and perchlorate plume (as described previously in comment #41). Consequently, should consider adding 1–2 additional wells. Alternatively, if only 2 wells can be drilled, may want to reconsider preliminary locations of both wells (shown in fig. 5-1), possibly by moving well 29WW2023-08 directly south and farther away from well 29WW20, and possibly moving well 29WW2023-06 farther away and more downgradient (southeastward) from well 29WW20 (another 75–100 ft?). If additional wells can be installed, these 2 locations would be good options to consider for potential new wells.	C	New well 29WW2023-08 has been relocated approximately 50-ft south of its original location and is now shown approximately 150-ft from 29WW20. New well 29WW2023-06 previously shown approximately 100-ft downgradient of 29WW20 has been relocated further downgradient and is now shown approximately 290-ft from 29WW20.	
49	Section 5.1.4, p. 5-4	1st paragraph, 2nd sentence	Should cite fig. 1-7 at end of sentence to direct the reader to potentiometric-surface map showing groundwater-flow direction.	C	A reference to Figure 1-7 has been included.	
50	Section 5.1.4, p. 5-4 and fig. 5-3	1st paragraph, 8th and 9th sentences	Would be very helpful to identify new wells in sentence/section by adding parentheticals identifying new wells to be installed (in same manner as comment #42).	C	Wells have now been identified in the text.	
51	Section 5.1.4, p. 5-4 and fig. 5-3	1st paragraph, 8th and 9th sentences	Considering extent/size of plume, may want to consider moving well 29WW2023-09 farther away and more downgradient (southeastward) from well 29WW33.	C	The location of 29WW2023-09 has been moved further from 29WW33 as requested and is now shown approximately 160-ft from 29WW33.	
52	Section 5.1.5, p. 5-5	1st paragraph, 1st sentence	Would be helpful to cite a fig. showing location of 3 excavation areas cited in sentence.	C	A reference to Figures 2-3, 2-4, and 4-4 has been included.	
53	Section 5.1.5, p. 5-5	1st paragraph, 6th sentence	1) A hyphen is missing between “2” and “inch” 2) the word “diameter” is missing before “schedule 40” 3) the word “schedule” in “Schedule 40” does not need capitalized 4) a space is missing between “polyvinyl” and “chloride”	C	Hyphen has been added as requested. The word “diameter” has been added. The word “schedule” is now shown as lowercase. This instance of polyvinyl chloride has been revised to PVC. PVC is now defined in Section 3.4.4 where it first appears in the text.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
54	Section 5.2.1, p. 5-4	1st paragraph, 1st sentence	Should cite fig. 1-11 at end of sentence.	C	A reference to Figure 1-11 has been included.	
55	Section 5.2.1, p. 5-4	1st paragraph, 2nd sentence	Should cite fig. 1-8 at end of sentence.	C	A reference to Figure 1-8 has been included.	
56	Section 5.2.1, p. 5-4	1st paragraph, 3rd sentence	Sentence indicates well 29WW43 is located "along" the south of the plume, but figs. indicate it is in the southern part of the plume.	C	Text has been revised and states, "29WW43 is located along the southern part of the plume"	
57	Section 5.2.1, p. 5-4	2nd paragraph, 1st sentence	Should cite a fig. showing location of 29WW41 at end of sentence. Recommend using fig. 1-11 (and labeling/identifying well).	E	The text has been revised to indicate that monitoring will be conducted at newly installed deep well 29WW45. A reference to new Figure 5-4 has been added. This figure shows all wells proposed to be installed as part of the ISTD remedial action. These wells will be used to monitor MNA of the plume following completion of ISTD.	
58	Section 5.3, p. 5-6	2nd paragraph, 1st sentence (after intermediate zone groundwater bullets)	The word "contaminations" should be "contaminants."	C	The word "contaminations" has been revised to "contaminants."	
59	Section 5.4.1, p. 5-8	1st paragraph, 1st sentence	A hyphen should be added between "low" and "flow" (i.e., "low-flow sampling").	C	A hyphen has been added as requested.	
60	Section 5.4.1, p. 5-8	1st paragraph, 3rd sentence	A hyphen should be added between "Teflon" and "lined" (i.e., "Teflon-lined").	C	A hyphen has been added as requested.	
61	Section 5.4.1, p. 5-8	1st paragraph, last sentence	Should "Millisiemens" be "microsiemens"?		The stabilization criteria were taken directly from the Final Installation-Wide Work Plan for Longhorn Army Ammunition Plan, dated May 2018, prepared by Bhate Environmental Associates. Per that work plan the units are indicated as millisiemens per centimeter (mS/cm). No change has been made based on this comment.	
62	Section 5.4.2, p. 5-9	1st paragraph, 1st sentence	See earlier comments regarding use of different drilling methods at ISTD site (and modify this paragraph, if necessary).	C	Rotosonic drilling will be used to install all wells. No change has been made as a result of this comment.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
63	Section 5.4.2, p. 5-9	1st paragraph, 2nd sentence	A hyphen should be added between "0.01" and "inch. "	C	Hyphen has been added as requested.	
64	Section 5.4.2, p. 5-9	3rd paragraph, 1st sentence	The word "stainless" is missing before "steel."	C	The word stainless has been added.	
65	Section 5.4.2, p. 5-10	2nd paragraph, 4th sentence	The word "drilling" should be "driller."	C	Drilling has been revised to driller.	
66	Section 5.4.4, p. 5-11	2nd paragraph, 4th sentence	The word "monitoring" should be "monitor."	C	Monitoring has been revised to monitor.	
67	Section 6.1, p. 6-1	1st solid bullet (an associated underlying 2nd open bullet)	Unclear if "Boundaries" should be capitalized.	C	Boundaries has been revised to be uncapitalized.	
68	Section 6.1, p. 6-1	1st open bullet, 2nd sentence	The word "is" located before the word "well-defined" should be changed to "are" because "limits" is plural (subject-verb agreement)	C	Text has been revised as requested.	
69	Section 7.1, p. 7-1	Item #4	A comma should be added between "remove" and "access roads."	C	Text has been revised as requested.	
70	Section 7.1, p. 7-1	Item #5, 3rd sentence	A comma should be added after "Once completed."	C	Text has been revised as requested.	
71	Section 7.1, p. 7-1	Item #6, 1st sentence	"Sampling event" should be replaced with "sample" (can't collect a sampling event).	C	Sentence revised to "Monitoring wells will be installed followed by the collection of groundwater samples at existing and newly installed monitoring wells prior to installing the ISTD system."	
72	Sheet G001	Well installation notes, 2B.	See earlier comments regarding drilling methods, and well installation.	C	All wells will be drilled using rotosonic drilling method. The text in the report has been modified to be consistent with the drawings. No change is necessary to Sheet G001.	
73	Sheet G001	Well installation notes, 2E.B.	The word "intermediate" is misspelled.	C	The spelling of the word "intermediate" has been corrected.	
74	Sheet G005	Note #3, 3rd sentence	The word "lithology" is misspelled at end of sentence.	C	The spelling of the word "lithology" has been corrected.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
75	Sheet 02C101	Tables on sheet	Should add outer isolation casing information to "Proposed Monitoring Wells" table at bottom of sheet (in same manner as "Existing Wells Summary" table at top of sheet). This would help to tie the information presented on the sheet with the discussion of outer isolation casing in the main body of the report. It also would be helpful to add a column to both tables that indicates the groundwater zone in which the wells are completed (existing well table) or the zone in which they are to be completed (proposed wells. Table).	C	All new wells will be installed using rotosonic drilling method. As a result, outer isolation casings will not be needed. Text in the report has been revised to indicate this. The table has been updated to include the groundwater zone for the new wells shown on this sheet.	
76	Sheet 02C101	ISTD Note #1	The word "monitoring" before "hydraulic control" should be "monitor."	C	Note 1 has been updated to revise the word to "monitor".	
77	Numerous Sheets	LEGEND	A line symbol for "Water Edge" is provided in the legend of many sheets. However, no such feature is shown on the various maps presented on the sheets.	C	The "water edge" line type has been removed from figures where it is not shown.	
78	Appendix D (Draft Performance Work Statement for In Situ Thermal Treatment), section 2.1.1, p. 2-1	1st paragraph, 2nd sentence	The word "a" before "location 29CPT12" is extraneous and should be removed.	C	Text has been revised and states "The highest MC groundwater concentration detected in the treatment area during groundwater grab sampling was 2,350,000 µg/l at a depth of 85 ft below ground surface (bgs) from location 29CPT12."	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
79	Appendix D (Draft Performance Work Statement for In Situ Thermal Treatment), section 2.1.4, p. 2-3	1st solid black bullet, 1st sentence	1st sentence indicates "approximately" 6 monitor wells are currently used to monitor local groundwater flow and contaminant migration in the vicinity of the ISTD area. However, if the well to be abandoned that is currently being monitored is included (29WW40), the number of wells would be 7 — wells 29WW15–16 & wells 29WW40– 44. If well 29WW17 located in the western corner of the proposed staging area also is included, the number of wells would be 8. Note: Well construction information for well 29WW17 is not included in Existing Well Summary Table at top of sheet (presumably unneeded?).	C	The purpose of this bullet is to make the ISTD contractor aware of the monitoring wells that are in the vicinity of the ISTD area. Text has been revised to: "There are 7 monitoring wells, located in the vicinity of the ISTD area." No change has been made to add 29WW17 since this well is outside the limits of the ISTD and should not be impacted by the heating of the treatment area.	
80	Appendix D (Draft Performance Work Statement for In Situ Thermal Treatment), section 2.1.4, p. 2-3	1st solid black bullet, sentences 2–4	Discussion in bullet would be much clearer if parentheticals were used to specifically ID the wells being discussed in sentences 2, 3, and 4 (and cited in relation to sheet 02C101). For example, the 4th sentence indicates there are 2 wells that are outside of the ISTD area, but within the limits of the area, that shall be protected during site activities—without the wells identified, it is unclear if this is referring to wells 29WW15 and 29WW41 or wells 29WW41 and 29WW17.	C	Wells have now been identified in the text.	

Comments Response Matrix
DRAFT (90%) Design Analysis Report, Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 14, 2023

Submitted by:
Responded by:
Date Responded:

1. Respondent concurs (C) or does not concur (D)
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1: April Palmie and Midori Campbell (Engineering support)						
1.	RTC #13		Section 1.7.1.1 - Because the actual calculation of the plume volume is not available, consider revising "are estimated to be approximately 9 million gallons" with "are reported to be approximately 9 million gallons in the April 2010 Final Feasibility Study (Shaw Environmental), …"	C	Text has been revised as requested and states "The volumes of the VOC, perchlorate, and NT plumes are reported to be approximately 9 million gallons in the April 2010 Final Feasibility Study (Shaw Environmental), assuming a total porosity of 0.25 (or 25 percent) with a thickness ranging from 5 to 10 ft (Shaw 2010)."	
2.	RTC #15		Section 1.10- Reference the ROD for designating 8000 ug/L as the trigger level: "As identified in the ROD, the trigger level or target value for successful ISTD…"	C	The text has been revised as requested and states "As identified in the ROD, the trigger level or target value for successful ISTD treatment…"	
3.	RTC #21		Section 2 - For clarification, separate E-5 from E-6S and E-6N in the bulleted list: 5. Excavation Area E-5: Cooling Water Outfall Ditch 6. Excavation Areas E-6S and E-6N: Cooling Water Outfall Ditch	C	The text has been revised as requested and now lists E-5 and E-6N and E-6S separately.	

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Submitted: April 14, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
4.	RTC #24		Table 2-1 - Columns 3 and 4 in Table 2-1 are still unclear. Three options discussed below: a) Consider identifying the shallower and lower excavation depths in column 3 with their respective locations. For example, for E-3, Column 3 could specify "10' in the north portion and 14' in the south portion". b) Or you could add a footnote explaining that the excavation depth is not uniform at E-3, E-4, and E-5. c) Or you could remove the "Excavation Depth" column.	C	Table 2-1 has been revised to include a footnote explaining that the excavation depths are not uniform at E-3, E-4, and E-5.	

Comments Response Matrix
DRAFT (90%) Design Analysis Report, Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 14, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
5.	RTC #33		Section 2.5 - Fill material particle diameter should be less than 6 inches, and a maximum particle diameter of 3 inches is recommended. Replace "one-half the lift thickness (12 inches)" with "no greater than 3 inches." In addition, because clean, broken up concrete is being considered for re-use as backfill, add a sentence to include concrete as backfill as follows: "Unstained broken up concrete with a diameter no greater than 3 inches can also be used backfill above the groundwater table."	C	The text has been revised as requested and states "The maximum particle diameter shall be no greater than 3 inches. Unstained broken up concrete with a diameter no greater than 3 inches can also be used as backfill above the groundwater table.".	
6.	General		Please perform Scan and OCR Recognize Text on the final assembled pdf file so all pages are searchable.	C	Searchable files of the contract documents have been included in the draft final RD submission.	
7.	Table 1-4/1-16		Please shift Table 1-4 to the next page rather than allowing the table to break across pages.	C	Table 1-4 has been shifted to the next page as requested.	
8.	2.7 and 4.4	1	Please notify 15 days in advance.	C	The text has been revised from 10 days to 15 days advance notice.	

Comments Response Matrix
DRAFT (90%) Design Analysis Report, Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 14, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
9.	Table 4-1/4-1	Note 1	Please check Note 1 which references "Appendix A to the Final Addendum 6 Additional Investigation at LHAAP-29 Former TNT Production Area to Final Installation-Wide Work Plan" (and check reference). Please confirm this is the correct title and location of this document. If this is Appendix A to the Final IWWP, title might be: Appendix A to the Final Installation-Wide Work Plan Addendum 6, Additional Investigation at LHAAP-29 Former TNT Production Area	C	Table 4-1 has been revised to reference "as Appendix A to the Final Installation-Wide Work Plan Addendum 6, Additional Investigation at LHAAP-29 Former TNT Production Area."	
10.	Table 4-2/4-2		Please adjust Table 4-2 so the notes don't break across pages. Also, there is no note for "TNT Wood Wastewater Gravity Line Removal[4]".	C	Table 4-2 has been adjusted to keep the footnotes on the same page as the table. The footnote 4 has been corrected to footnote 3 for the TNT Wood Wastewater Gravity Line Removal.	
11.	Table 4-3/4-10		Please shift Table 4-3 to the next page so the table to breaks across fewer pages.	C	Table 4-3 is too large to be kept on one page and breaks across two pages.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
12.	Table 4-3 and corresponding narrative (Section 4.4.6, pages 4-10 through 4-12)		The contained-in policy applies to contaminated environmental media. The residue remaining in the pipeline is not environmental media and should be considered as a solid waste. As such, water used for flushing the pipeline, as well as the solid residue, would be considered a listed waste instead of media contaminated with a listed waste.	C	Table 4-3 and the text has been revised to remove references to the contained-in policy for the wash water used to clean the TNT wastewater pipelines.	
13.	4.4.4	1/last	Why does this section of the RD include an option to amend the ROD for an alternative cleaning method? Amending the ROD would be a time-consuming administrative process that would slow remedy implementation. Suggest you strike that new language. The remedy must be implemented as described in the ROD for the whole RD not just this specific component. The ROD isn't something to be revised for a contractor's convenience.	C	The text has been revised to remove language on amending the ROD for an alternative cleaning method and now states "Because the ROD specifies flushing, any cleaning methods used will be required to use water at some point in the process."	
14.	5/5-1	Bullet 2/last sentence	The phrase "groundwater concentrations based on" is repeated.	C	Text has been revised to remove repetitive phrase.	

Comments Response Matrix
DRAFT (90%) Design Analysis Report, Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 14, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
15.	5/5-2	3/3	A phrase should be added to connect the absence of DHC with calculated attenuation rates in considering the third line of evidence for MNA. Consider starting the third sentence with, "In the absence of DHC observations, predictive calculations of time-dependent in-well natural attenuation rates …"	C	Text has been revised as requested and now states "In the absence of DHC observations, predictive calculations of time-dependent in-well natural attenuation rates were calculated for perchlorate, explosives, TCE, 1,2-DCA, and MC.".	
16.	Table 5-5/5-12		Please shift Table 5-5 to the next page rather than allowing the table to break across pages.	C	Table 5-5 has been shifted to the next page as requested.	
17.	6	LUC bullets	The LUC to maintain integrity of remedial or monitoring systems should be included, copy from 6.2.	C	The LUC bullets in Section 6.2 have been copied and inserted into Section 6.	
18.	Figure 1-3		Please try to reduce the margin white space, increase the size of this figure, and improve the image resolution.	C	The size of Figure 1-3 has been increased to reduce the white space.	
19.	Figures 5-1 to 5-3 (and G003)		It is very difficult to evaluate the placement of the proposed wells using figures that don't include the known plume boundaries. The title of Figures 5-1 to 5-3 implies they include the groundwater plumes; please add that information. Well placement will be evaluated when figures contain the necessary information.	C	Figures 5-1 to 5-3 have been updated to include the estimated limits of the plume as shown in figures taken from the Record of Decision. Plume limits have also been added to drawing sheet G003.	

Comments Response Matrix
DRAFT (90%) Design Analysis Report, Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 14, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
20.	Sheet G001		Pipe Inspection and Cleaning, # 3, correct first sentence (incomplete sentence).	C	Sentence has been corrected to provide a complete sentence.	
21.	Sheet G005		Intermediate/Deep Monitoring Well Detail, # 3, second sentence, add "zone" between "shallow" and "this".	C	The word "zone" has now added after "shallow" and "intermediate" in Note #3.	
22.	Sheet G006	Cross-Section of construction ditch detail	Add a reference to Sheet G005 for the Earth Dike detail.	C	A reference to the earth dike detail shown on G004 has been added to detail 1 of Sheet G006.	
23.	Sheet G007		Restoration, # 1, add "to" in "including but not limited to" Wildflower Seed Mix Requirements, # 1. Correct "US Fish and Wildlife Service"	C	The word "to" has been added to Note 1. The spelling of the word "Service" has been corrected.	
24.	Sheet 01C103		Add MC Plume Treatment Area to legend for green dashed line. Suggest adding ISTD to the green dashed line in all relevant legends (ISTD MC Plume Treatment Area).	C	The MC Plume Treatment Area line type has been added to Sheet 01C103. All other drawing sheets that include this line type already have it shown in the legend.	
25.	Sheet 01C109		Stormwater Management, # 2, correct "erosiion" to "erosion" (on this sheet and the others in series)	C	The spelling of the word "erosion" has been corrected in sheets 01C109 – 01C112.	

Comments Response Matrix
DRAFT (90%) Design Analysis Report, Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 14, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
26.	Appendix D 1.1/1-1	1/5-6	While nitrotoluenes and perchlorate are not the targeted with ISTD, these COCs should still be identified, with a short explanation of why they're not included in the design (e.g., high boiling point and not easily vaporized)	D	The ROD identifies ISTD to treat groundwater in the intermediate zone. COCs identified in the ROD for the intermediate zone groundwater include MC, TCE and daughter products, 1,2-dichloroethane, and arsenic (see Section 2.5.5 of the ROD). This text has been added to Section 1.1 which now reads: "*This PWS identifies the performance criteria for the implementation of ISTD for the LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant Site (Site) located in Karnack, Texas, in accordance with the published Record of Decision (ROD). The ROD specified ISTD treatment for the dense aqueous phase liquid (DNAPL) methylene chloride (MC) plume identified in the intermediate groundwater zone to reduce concentrations to levels amenable to monitored natural attenuation (MNA). Other contaminants identified as chemicals of concern (COCs) in the intermediate groundwater zone include trichloroethene (TCE) and daughter products, 1,2-dichloroethane (1,2-DCA), and arsenic. In past sampling events, TCE has been detected at maximum concentrations of 28,100 ug/l at monitoring well 29WW16. As a result, ISTD shall be provided at sufficient temperatures to reduce concentrations of TCE in addition to treating MC.*"	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
27.	Appendix D 2.1.2/2-2	1/bullet 7	102 feet seems to be a fairly large radius of influence at a pumping rate of 0.4 gpm. How much of an impact will there be if the ROI is significantly different from +-100 feet?		Soils in the intermediate groundwater zone consist of fine-grained sand interbedded with silt and clay with estimated hydraulic conductivities ranging between $1.5x10^{-4}$ to $3.95x10^{-4}$ centimeters per second. The zone is overlayed by a thick clay layer and is a confined aquifer. As a result, it is expected that a lower pumping rate would affect a relatively large radius of influence. It will be left up to the ISTD contractor to determine if any hydraulic control is necessary during ISTD operation and based on the information presented how many wells (if proposed) will be needed to provide hydraulic control. The estimated number of wells will be proposed by the ISTD contractor and will be reviewed and accepted by the Army and Regulators as part of the RA implementation process. Considering the low groundwater flow in the intermediate zone (~0.2 ft/day) it is likely that hydraulic control will not be necessary and there will be negligible effect on the ISTD operation in the unlikely event that a much higher pumping rate is required to achieve the desired ROI.	
28.	Appendix D 2.1.6/ 2-5	1/8	What is the lower tolerance for well yields? If the yield is less than the lower tolerance, consider adding statement that the well will be plugged and abandoned and be drilled in another location		Because the wells discussed in Section 2.1.6 are for the purpose of monitoring chemicals in the aquifer, there is no specific minimum well yield identified. In the event no water is encountered in a well, the well would then be required to be plugged and abandoned and a new well drilled. Because these wells will be drilled in the intermediate zone, this is not anticipated as being an issue. No change has been made as a result of this comment.	
29.	Appendix D 2.1.7/2-5	2/third bullet	Add a sentence providing for additional wells, if deemed necessary as determined by groundwater flow direction.	C	The following sentence has been added as requested: "Additional wells, if deemed necessary, may be required based on groundwater flow direction."	
30.	Appendix D 2.1.7/2-5	2/second to the last bullet	What type of hydraulic control is proposed to prevent downward DNAPL migration?	C	The method of hydraulic control will be left up to the contractor and will be proposed in the ISTD Work Plan prepared by the Contractor and submitted for review and approval. Due to the low groundwater flow estimated for the intermediate zone it is possible that hydraulic control may not be necessary.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
31.	Appendix D 2.1.7/2-6	Second to the last paragraph/3	For consistency, use the same specifications for backfill used for excavation and pipeline work in the main body of the document.	C	This paragraph has been revised as follows "The backfill material shall be coarse-grained soils classified by ASTM D2487 as well-graded gravel (GW), poorly graded gravel (GP), silty gravel (GM), clayey gravel (GC), well graded sand (SW), poorly graded sand (SP), or combination, that is free of debris, roots, wood, scrap material, vegetation, refuse, soft unsound particles, and frozen, deleterious, or objectionable materials. The maximum particle diameter shall be no greater than 3 inches. Documentation of clean fill shall be in the form of a written certification provided by the supplier of the fill material that to the best of the affiant's knowledge and belief the fill material being imported does not contain constituents of concern in excess of the Texas Commission on Environmental Quality (TCEQ) Risk Reduction Standard No. 2 MSCs industrial use standards (GWP-IND or SAI-IND), and that the material originates from a natural environment without degradation caused by human influences. The clean fill shall be sampled and analyzed in accordance with the requirements of the DAR."	
32.	Appendix D 2.1.8/2-8	2/2	There are soil remediation goals for the excavations; will volatilized VOCs or mobilized DNAPL possibly impact soils to increase COC concentrations in the soil?		As the treatment area is heated concentrations in the groundwater and DNAPL will be volatilized and desorption of COCs from the soil into the water will also occur. As a result, it is not expected that concentrations in soil will increase in the heated zone of the ISTD. Vapors generated will be extracted which will prevent migration of contaminated vapors into the untreated zones. No change has been made as result of this comment.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
33.	Appendix D 2.1.8/2-9	Shutdown based on soil and groundwater sample results (general question)	Before system removal/decommissioning, there should be a longer waiting period to go back to re-sample certain areas, as during cooling condensation of VOCs in the vapor adsorb on to the soil matrix. Section 5.9.1 suggests groundwater sampling one to two months for the initial shutdown sampling. TCEQ recommends another soil and groundwater sampling event before decommissioning, if possible.		Section 5.9.1 has been revised to have the groundwater sampling event occur 3 months after the ISTD system is shut down. This will allow some time for the subsurface to cool before the samples are collected to verify the cleanup goals are met.	
34.	Appendix D 2.5.2/2-13	Table 2-3	TCEQ requests courtesy participation in virtual progress meetings at the beginning of the project, mid-point, and before shutdown. These could be separate from the Army and Contractor) internal meetings.	C	A sentence has been added at the end of Section 2.5.2 stating, “Virtual progress meetings will be offered to TCEQ and EPA at the beginning of the project, at the mid-point and before shutdown.”	
35.	Appendix G 3.1.7.2/7	Condition d	Include pipeline leaks from cleaning (e.g., pipe rupture in a weak spot during cleaning) to Condition d, pertaining to spill notification.	C	Condition d now reads, “Immediately notify the Contracting Officer of any spill and begin cleaning up any such spill or waste. This will include any material leaking from pipelines during cleaning activities (e.g., pipe ruptures in a weak spot during cleaning).”	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Submitted by: Brian Follin, USEPA Region 6
Responded by: Lena Sierocinski, Environmental Support Manager, US AEC
Date Responded: April 10, 2023

1. **Respondent concurs (C) or does not concur (D)**
2. **Commenter agrees (A) or does not agree (D) with response.**

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1:						
1	1.2.1/ 1-2	2nd paragraph, mid-paragraph	The phrase "medium-specific concentration for industrial use based on groundwater protection" is missing before the abbreviation ("GWP-Ind MSC") is first introduced in the report at the end of the sentence. It is spelled out later in section 1.3	C	The acronym "GWP-Ind MSC" has been first introduced in the Section 1.2.1 and removed from Section 1.3.	
2	1-4	2nd to last solid black bullet	The abbreviation/acronym "BERS" should be "BERA."	C	BERS has been corrected to BERA.	
3	1.3/ 1-5	1st solid black bullet	The abbreviation/acronym "SAI-IND" is not spelled out here (1st occurrence in report).	C	The acronym "SAI-Ind" has been defined in Section 1.3. It is the soil MSC for industrial use based on inhalation, ingestion, and dermal contact.	
4	1.4/1-5	1st paragraph	It would be helpful to add Goose Prairie Creek and Central Creek to fig. 1-3 and cite the fig. here.	C	Figure 1-3 has been revised to display Goose Prairie Creek and Central Creek. In addition, Section 1.4 has been revised to cite Figure 1-3.	
5	1.5.3/ 1-7	3rd paragraph, 2nd sentence	Was the well 29WW16 pump test described in the last 2 sentences of the paragraph a single-well or multi-well test. If a multi-well test, the storage values determined using the test should be provided.	C	The full details of this pump test are presented in the July 2016 Pump Test report prepared by AECOM and included as Appendix E to the RI Addendum. A summary of the aquifer parameters derived from the pump test has now been included in this section as Table 1-1.	
6	1.6.1/ 1-7	1st paragraph, 1st and 2nd sentences	Should cite fig. 1-2 at end of 1st sentence. Would be helpful to add Uncertain, Texas to fig. 1-2 (or another fig.) and cite at end of 2nd sentence.	C	Figure 1-2 has been revised to display Uncertain, Texas and the DAR text has been revised as requested.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

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7	1.7.1.1/ 1-10	2nd to last sentence in 2nd paragraph	Sentence/text uses 2-NT, 3-NT, and 4-NT here, but fig. 1-10 uses 2(o)-, 3(m)-, and 4(p)-NT identifiers for these nitrotoluenes. Some subsequent report sections use the o-, m-, and p-NT identifiers instead of 2-NT, 3-NT, and 4-NT, so terminology is not consistent within the text of the report. It would be easier for the reader if the nitrotoluenes were consistently identified within the different sections of the text and also among the text, figs., and tables.	C	References to 2-NT, 3-NT, and 4-NT in the text of the report has been revised to be consistent with the references shown on Figure 1-10.	
8	1.7.1.4/ 1-11	3rd sentence	The word "ranging" is misspelled	C	This has been corrected.	
9	1.10/ 1-13	3rd solid black bullet	At the end of the 2nd sentence, there is an extraneous "4" in "µg/L" after "8,000."	C	This has been corrected.	
10	Table 1-2, 1-16		The "PLC" after "Residential Groundwater" should be "PCL" instead of "PLC."	C	Now Table 1-3. This has been corrected.	
11	2.2.2/ 2-3	1st paragraph, 2nd to last sentence	Sentence as currently constructed is not correct for soil boring 29SB95, because fig. 2-2 indicates the sample from 29SB95 was collected from 0–1 ft bgs.	C	Text is revised to read "Samples were collected from 0 to 1 ft from all locations with the exception of four soil borings (29DLineWHC01, 29SB96, 29DLineWHC02, and **29DLineWHW01**)."	
12	2.2.5/ 2-6	1st complete paragraph	Should revise the sentence because fig. 2-6 indicates one of the sampling locations (29SB117) is actually a soil boring because samples also were collected at depth (2–4 ft bgs) at this location (in addition to the surficial sample collected from 0–0.5 ft bgs). In addition, it would help to cite fig. 2-6 at the end of the sentence. It also would be helpful to add Avenue D to fig. 2-6 because it is discussed in relation to the sampling locations at the site throughout this report section.	C	This sentence has been revised to read: "To delineate the contaminated soils surrounding 29SD13, located south of Avenue D, samples were collected from four locations (29SB114 to 29SB117), during the 2014 supplement RI, at approximately 30 ft from the original sample location." A reference to Figure 2-6 has also been added to the text. Figure 2-6 has been revised to include a label for Avenue D.	
13	2.5/ 2-7		This is the 1st and only place that "PCBs" is used in the report—it is not spelled out here at 1st use, and it is not listed in the LIST OF ACRONYMS AND ABBREVIATIONS.	C	"PCBs" has been added to the list of acronyms and is now defined in Section 2.5.	
14	2.7.3.2/ 2-9	1st paragraph, 1st sentence	Limits are shown on figs. 2-1 to 2-6, not figs. 2-1 to 2-7.	C	Text has been revised.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
15	2.7.3.3/ 2-10		Note that title uses stormwater as 1 word, but the text below and elsewhere in the report uses the 2-word form	C	Text is revised to replace storm water with "stormwater."	
16	3.1/ 3-1	1st paragraph	Are "bio-simulate" and "bio-stimulation referring to the same process or is this a typo?	C	This was a typo which has now been corrected.	
17	3.2/ 3-2	1st sentence, 1st paragraph	1st sentence, 1st paragraph, page 3-2. A comma is misplaced, or the number of zeros reported is incorrect, for the MC concentration. After confirming the correct value in a text, need to cross-compare the value with what is currently shown in tables and figs. to ensure it is correct among all report components.	C	The MC concentration has been corrected. The 10,300,000 ug/l concentration of MC was from a sample collected in 2008 and is shown on Figure 1-11. This concentration is not shown on Figure 3-1 because this figure only summarizes the most recent groundwater sampling results which were collected in 2014 by AECOM. This is identified by Note 1 on Figure 3-1.	
18	Table 3-1/ 3-3		The MC concentration for 29CPT11 and 29CPT12 in table 3-1 do not match the concentration in figure 3-1. Please resolve the discrepancies.	C	Table 3-1 has been revised to be consistent with Figure 3-1.	
19	3.2/ 3-3	2nd paragraph after table 3-1, 2nd to last sentence in paragraph	Sentence needs revised because the sample date of October 14, 2014, is only applicable to well 29WW16—per fig. 3-1, the other three wells were sampled on October 20, 2014.	C	Sentence is revised to "Groundwater samples were collected from 29WW16 on October 14, 2014, and from 29WW42, 29WW43, and 29WW44 on October 20, 2014"	
20	3.4.1.2/ 3-6 & 3-7	1st and 2nd Solid Black bullets	Are the parameters for ISTD based on a SOP or other guidance. Please reference any guidance used to determine temperature probe locations and well placement rationale.	C	The parameters provided are based on past experience and on input received from ISTD vendors as part of the FS and remedial design activities.	
21	3.4.6/ 3-11	2nd to last paragraph	The word "verify" in the phrase, "to verify the ISTD," is misspelled.	C	Now Section 3.4.7. This has been corrected.	
22	4.2.2/ 4-3	1st paragraph, 2nd sentence	Would be helpful to cite fig. 1-13 after "that exceed the cleanup level" because sampling results for these borings are not shown in figs. 4-1 and 4-2 cited in this report section.	C	A reference to Figure 1-13 has been added to the text.	
23	4.2.3/ 4-4	2nd paragraph, 1st sentence	Should cite figs. 1-14 and 1-15 at end of sentence.	C	A reference has been added to Figures 1-14 and 1-15 in parentheses at the end of this sentence.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
24	4.3.1/ 4-5	1st paragraph, last sentence	Sentence indicates the pipeline extends approximately 1,000 linear ft, but table 4-1 indicates 1,700 linear ft.	C	The total length of the pressurized pipeline from the pond to where it discharges on Site LHAAP-32 is approximately 1,700 linear feet. The length of pipe that extends from the pond to the boundary of Site LHAAP-29 is approximately 700 linear feet. The text has been revised as follows: "The gravity portion of the wood pipeline is 12 inches in diameter and extends approximately 2,900 lf from just north of former Wash House Building 806-A to the pump station, and its pressurized portion is 6 inches in diameter and extends approximately 1,700 lf from the pump station to LHAAP-32. Due to the deteriorated condition of the pipeline, the presence of residual explosives within sediment inside the pipeline, and the detected release to the surrounding soil, the wooden pipeline along with the surrounding soil will be excavated and disposed off site. The excavation for the pressurized portion of the pipeline will end at the LHAAP-29 site boundary (approximately 700 lf).".	
25	4.4.6/ 4-9	1st paragraph, 2nd sentence	"TCLP" is missing from the LIST OF ACRONYMS AND ABBREVIATIONS.	C	"TCLP" has been added to the list of acronyms.	
26	5/ 5-1	1st paragraph, 1st sentence	Should the sentence reference adsorption instead of "absorption mechanisms"	C	The correct term is sorption which is the reaction between aquifer matrix and solute whereby relatively hydrophobic organic compounds become sorbed to organic carbon or clay minerals. This has been corrected in the text.	
27	5/ 5-3	1st paragraph, 1st sentence	Awkward phrasing. Sentence indicates "monitoring events are being collected." Suggest rewording to Monitoring events conducted. Additionally, a comma should be added after the phrase, "To do this," in the next sentence.	C	Text is revised to "Monitoring events conducted over the course of the LTM program." Second sentence is revised to read "To do this, a monitoring network will be needed…"	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
28	5.1/ 5-3	1st paragraph, 1st sentence	The word "to" needs added between "extends" and "approximately" (i.e., "…zone extends to approximately 50 ft bgs…").	C	Text has been revised.	
29	5.2/ 5-5	1st paragraph, 1st sentence	The word "approximately" should be added before "50 to 100 ft bgs" because section 1.5.3 indicates the shallow zone ranges from about 17 to 45 ft bgs and intermediate zone between about 45 to 88 ft bgs.	C	The word "approximately" has been added.	
30	5.2/ 5-5	1st paragraph, last sentence	"Tier 1" should be added between "TRRP" and "Residential"; "PCLs" should be singular ("PCL") because the sentence is referring to a single constituent (perchlorate).	C	Text is revised to read "Perchlorate was present at levels below its TRRP Tier 1 Residential Groundwater PCL (Shaw 2010)"	
31	6/ 6-1	2nd solid black bullet	This is the 1st use of the "UEP" acronym/abbreviation in report, so it needs defined here. It also needs added to the LIST OF ACRONYMS AND ABBREVIATIONS.	C	References to UEP have been removed as there is no unlined evaporative pond on Site 29.	
32	Fig. 1-1		Karnack, Texas is identified in lower right section of LEGEND, but the town is not plotted on either the primary map or the inset map.	C	Figure 1-1 has been revised to include the location of Karnack, TX.	
33	Fig. 1-2		The word "VICINITY" is misspelled in the LEGEND (the "I" is missing between "N" and "T."	C	Figure 1-2 has been revised to correct spelling of "VICINITY".	
34	Fig. 1-7		Unless groundwater elevations from wells not shown in the fig. were used for contouring, the groundwater-elevation contours extending beyond the yellow shading representing site LHAAP-29 should be dashed	C	Figure 1-7 has been revised to dash all contour lines where data does not exist to support further interpretation.	
35	Fig. 1-8		Unless groundwater elevations from wells not shown in the fig. were used for contouring, the 186 ft groundwater-level elevation contour north of 29WW37 should be dashed where it extends beyond the yellow shading representing site LHAAP-29. Similarly, the 184 ft groundwater-level elevation contour north of the yellow shaded area representing the site should be completely dashed (unless additional elevations were available from wells not plotted on the fig.).	C	Figure 1-8 has been revised to dash all contour lines where data does not exist to support further interpretation.	
36	Fig. 1-9		"1,2-DCE" is mistakenly used instead of "1,2-DCA" (associated with 5,520 value), as indicated in the LEGEND and described in the report (section 1.7.1.1 Groundwater, 2nd paragraph, 2nd sentence, page 1-10).	C	Figure 1-9 has been revised to show 1,2-DCA.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
37	Fig. 1-10		COC is identified as a "contaminant of concern" in fig. 1-10, but COC is identified as a "chemical of concern" in the text.	C	Figure 1-10 has been revised to define "COC" as "chemical of concern".	
38	Fig. 1-11		11 in relation to section 1.7.1.1 Groundwater, 3rd paragraph, page 1-10. There may be a discrepancy between what is plotted on the fig. and what is discussed in the report and/or shown in the LEGEND. The 4th sentence mentions 1,2-DCA, but the primary map in fig. 1-11 shows 1, 2-DCE instead of 1,2-DCA for well 29WW16 (and 3 other wells on fig.) and the inset map shows contours for 1,1-DCE and cis-1,2-DCE. Need to confirm that the contours are properly identified and determine if "1,2-DCE" plotted for the 4 wells on the primary map should be "1,2-DCA." Then, need to reconcile any discrepancies (if present) between the primary and inset maps, and the text (and reconcile any potential discrepancies between the maps and the LEGEND).	C	Figure 1-11 has been revised to correct 1,2-DCE to 1,2-DCA in the legend and on the map. Text has been revised to the following, "Intermediate zone groundwater COCs are MC, TCE and daughter products of TCE **including 1,1-DCE and cis-1,2-DCE**, 1,2-DCA, and arsenic."	
39	Fig. 1-11		All wells on primary map are identified as shallow using the "(S)" designation after the well number/identifier. Text indicates well 29WW16 is completed in the intermediate zone, but the "(S)" designation is appended to the well number on the primary map. Also need to correct this issue (as applicable) for any of the other wells on the fig.	C	Figure 1-11 has been revised to move the well label 29WW16 (I) above the intermediate well symbol.	
40	Fig. 1-13		Map on fig. uses "J+" and "J-" to indicate concentrations were "Estimated Biased High" and "Estimated Biased Low," respectively. However, some data values for 2 historical sample locations use "JH" or "JL" instead of "J+" and "J-" (i.e., 29WL14 and 32WL05). Should use these data value qualifiers consistently within the same fig. and among figs.	C	Figures have been revised to have a consistent use of "J", J+", and "J-" qualifiers.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
41	Fig. 1-13		Note that many of the COCs shown in the "boxes" associated with the various sample locations on the map are missing the hyphens between the numbers and letters identifying a given constituent (e.g., 29WL14 is missing the hyphen between "2,4,6" and "TNT" [and missing the hyphens for the 3 other constituents]). Note: This comment is applicable to all other figures where this occurs in the report and will not be repeated.	C	Figures have been revised to include hyphens where missing.	
42	Figs. 1-13, 1-14. 1-15		In relation to 1.12.4 North and South TNT Cooling Water Lines. It would be very helpful to plot the piezometers on figs. 1-13 to 1-15 to facilitate the discussion of water levels measured in piezometers in relation to the soil borings discussed in this and subsequent report sections.	D	Figures 1-13 through 1-15 have the piezometers already plotted.	
43	Fig. 2-1		Historic wasteline/pipe and CPT symbols in LEGEND are unneeded because they are not plotted on map.	C	Symbology has been revised for all figures to only include symbols used in the sheet.	
44	Fig. 2-2		CPT symbol in LEGEND is unneeded because CPT sampling locations are not plotted on map. Four references (citations #1, 2, 3, and 6) in the SOIL SAMPLE COLLECTION SUMMARY can be removed because they are for borings/sample locations not plotted on the map.	C	Symbology has been revised for all figures and reference citation 1,2,3, and 6 has been removed from the Soil Sample Collection Summary in Figure 2-2.	
45	Fig. 2-3		Unclear why "ND" is used instead of reporting levels (by using "<" symbol) on this fig. ND should be defined somewhere on fig.	C	"ND" has been revised to identify the reporting level by using the "<" symbol.	
46	Fig. 2-3		PDI sample location, historic wasteline, and CPT symbols in LEGEND are unneeded because they are not plotted on map. Note #4 in NOTES is not applicable to fig. 2-3. Four references (citations #1, 2, 3, and 6) in the SOIL SAMPLE COLLECTION SUMMARY are not applicable to the borings/sample locations shown on map. The source of the data for the "STEP" sampling locations is not provided in the SOIL SAMPLE COLLECTION SUMMARY.	C	Symbology has been revised for all figures. Note #4 and reference citation 1,2,3, and 6 has been removed from the Soil Sample Collection Summary in Figure 2-3. In addition, the source for the "STEP" sampling location has been included in the Soil Sample Collection Summary.	
47	Fig. 2-4		Historic wasteline and CPT symbols in LEGEND are unneeded because they are not plotted on map. Five references (citations #1–5) in the SOIL SAMPLE COLLECTION SUMMARY are not applicable to the borings/sample locations shown on map.	C	The legend has been revised to show only symbols and line types presented on the figure. Reference citations 1-5 have been removed.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
48	Fig. 2-5		The excavation depth identifiers should be bolded like the other figs. in section 2 (figs. 2-1–2-4 and 2-6). The "29" prefix is missing in the sample result "boxes" for 3 soil borings: SB184, SB185, and SB186	C	Labels identifying the excavation depths have been darkened on the figure. Result boxes have been revised to include the "29" prefix for soil borings 29SB184, 29SB185, and 29SB186.	
49	Fig. 2-5		Historic wasteline and CPT symbols in LEGEND are unneeded because they are not plotted on map. Four references (citations #1–4) in the SOIL SAMPLE COLLECTION SUMMARY are not applicable to the borings/sample locations shown on map.	C	The legend has been revised to show only symbols and line types presented on the figure.	
50	Fig. 2-5		Two different identifiers are applied to the one of the soil borings shown on figure. On the map, "29SD30" is used, but note #4 in the NOTES section identifies the same boring as "29SDS30." Need to reconcile the discrepancy.	C	The typographical error in Note #4 has been corrected.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
51	Fig. 2-6		Because of discussion in text, it would be helpful to add (or identify) Avenue D to fig. 2-6. Historic wasteline and CPT symbols in LEGEND are unneeded because they are not plotted on map. Four references (citations #1–4) in the SOIL SAMPLE COLLECTION SUMMARY are not applicable to the borings/sample locations shown on map. The source of the information for site GPS-12 is not cited in the SOIL SAMPLE COLLECTION SUMMARY The "29" prefix is missing in the sample result "boxes" for 3 soil borings: SB187, SB188, and SB189. NOTES section. Note #4 refers to boring 29SB15, but fig. shows results for 29SB15R. Same note refers to 29SDS29, but this boring is not shown on fig. 2-6.	C	Avenue D has now been labeled on the figure. The Figure's symbology and citation references have been refined. Figure 2-6 has been revised to include the "29" prefix for soil borings 29SB187, 29SB188, and 29SB189. Sample label has been revised from 29SB15 to 29SD15 on the figure. The note has been revised to remove the reference to 29SDS29 and now states "SAMPLE RESULTS FOR 29SD15 ARE REPORTED AS 29SD15R BECAUSE SAMPLE RESULTS FROM 29SD15 WERE DETERMINED TO BE UNUSABLE BY THE EPA. SAMPLES FROM 29SD15R WERE COLLECTED IN 2013 AND ARE REPORTED IN THE FINAL BASELINE ECOLOGICAL RISK ASSESSMENT ADDENDUM PREPARED BY AGEISS INC AND CB&I DATED JULY 2014."	
52	Fig. 3-1		Title on left lower right corner of fig. mistakenly indicates "Soil Sample Results" instead of "Groundwater Sample Results."	C	The link in the report was incorrect and was linked to Figure 3-2. This has now been corrected.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
53	Figs. 3-1, 3-2		Would be helpful to add groundwater flow arrows (or very light groundwater-level contours) to both figures because plume sizes/shapes are discussed in relation to groundwater flow/movement at the site. LEGEND. Historic sample location and PDI sample location symbols unneeded because they are not shown on fig. The identifier, "ISTT," for the green dashed line should be "ISTD." The data value qualifiers, "J" and "U," are not defined. Previous figures provided appropriate cleanup levels in the NOTES section and highlighted exceedances with yellow shading, but both "features" are missing from these 2 figs.	C C C	The groundwater flow direction has been added to Figures 3-1 and 3-2. The symbology of Figure 3-1 has been refined for the next submittal. "ISTT" has been revised to "ISTD" Data qualifiers for "J" and "U" have been defined in Note 6 on Figure 3-1 and in Note 5 on Figure 3-2. Exceedances are noted in bold as defined in Note 3 of these figures. The ROD does not require ISTD treatment to the regulatory limits and so these limits are not identified on these figures. The purpose of the figures is to provide the Contractor with the concentration information needed to design the ISTD system to meet the cleanup goals discussed in Section 3.1 of the Design Analysis Report. No change has been made on the presentation of data on these figures.	
53	Fig. 4-1		The "29" prefix is missing in the sample result "boxes" for 3 soil borings: SB202, SB200, and SB201. In addition, the abbreviation "ft" is missing for all the depth intervals associated with 29SB137. Also note that the historic sample location, historic waste line, and historic wastewater symbols are unneeded in the legend because they are not plotted on map.	C	Figure 4-1 has been revised to include the "29" prefix for soil borings 29SB200, 29SB201, and 29SB202. In addition, soil boring 29SB137 has been revised to include the abbreviation "ft" for all depth intervals. The symbology for Figure 4-1 will also be refined for the next submittal.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
54	Fig. 4-2		The “29” prefix is missing in the sample result “boxes” for 3 soil borings: SB191, SB194, and SB195. In addition, the abbreviation “ft” is missing for all the depth intervals associated with 29SB143. Also note that the historic waste line and CPT symbols are unneeded in the LEGEND because they are not plotted on map, and NOTE 4 is not applicable to fig. 4-2.	C	Figure 4-2 has been revised to include the “29” prefix for soil borings 29SB191, 29SB194, and 29SB195. In addition, soil boring 29SB143 has been revised to include the abbreviation “ft” for all depth intervals. The symbology and citation references for Figure 4-2 will also be refined for the next submittal. Note 4 has been deleted.	
55	Fig. 4-3		The “29” prefix is missing in the sample result “boxes” for 3 soil borings: SB190, SB192, and SB193. In addition, the abbreviation “ft” is missing for all the depth intervals associated with 29SB138. Also note that the CPT symbol is unneeded in the LEGEND because CPT sites are not plotted on map.	C	Figure 4-3 has been revised to include the “29” prefix for soil borings 29SB190, 29SB192, and 29SB193. In addition, soil boring 29CB138 has been revised to include the abbreviation “ft” for all depth intervals. The symbology and citation references for Figure 4-3 have been refined for the next submittal.	
56	Fig. 4-4		The “29” prefix is missing in the sample result “boxes” for 2 soil borings: SB196 and SB196. In addition, the abbreviation “ft” is missing for all the depth intervals associated with 29SB139. Also note that the historic sample location CPT symbols are unneeded in the LEGEND because CPT sites are not plotted on map.	C	Figure 4-4 has been revised to include the “29” prefix for soil borings 29SB196 and 29SB197. In addition, soil boring 29SB139 has been revised to include the abbreviation “ft” for all depth intervals. The symbology and citation references for Figure 4-4 have been refined for the next submittal.	
57	Fig. 6-1		TNT cooling water drain line and TNT wastewater line symbols are provided in the LEGEND, but these features are not plotted on the map.	C	The legend on this figure has been revised to remove features not shown.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
	References		(section 1.3 page 1-4) Three of the "Sverdrup Environmental, Inc." references are missing from the REFERENCES section in the back of report: 1996a, 1996b, and 1999. (Figs. 1-9 & 1-10) The "HDR, 2018" reference cited as a DATA SOURCE is not listed in the REFERENCES section. (Figs. 2-1 to 2-5) The three Jacobs references in the SOIL SAMPLE COLLECTION SUMMARY in the lower right corner of these five figures (Jacobs, 1993, 1995, and 1998) are not listed in the REFERENCES section (Section 3) In-Situ Thermal Desorption Design, 2nd paragraph, last sentence, page 3-1. The "(EPA, 2015)" reference is missing from the REFERENCES section.	C	Sverdrup references have been added. References on these figures have been changed to HDR, 2019 which is when the ROD was finalized. The 2019 ROD is included in the reference section of the report. The three Jacobs references on the figure have been corrected to Sverdrup which was the firm that completed the Phase I, II, and III investigation activities. Notes on Figures 2-6 and 2-1 have been revised to reflect the dates indicated in the reference section of the report. A reference has been added in this section the EPA Engineering Paper: In Situ Thermal Treatment Technologies: Lessons Learned, published in May 2014. The reference in the text has been revised to reflect the correct reference.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Submitted by: April Palmie, TCEQ PM, Remediation | Superfund Section
Responded by: Lena Sierocinski, Environmental Support Manager, US AEC
Date Responded: 3 March 2023

1. Respondent concurs (C) or does not concur (D)
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1: TCEQ, April Palmie and Midori Campbell (engineering support)						
1.	Comment 13		Can the Army authorize collection of current groundwater data (elevation and/or analytical results) to support the next phase of work? This data could be supplemental to the RD or a separate document.	C	Army has added an option task for groundwater monitoring at LHAAP-29 to the new one year contract anticipated to be awarded in April 2023.	
2.	Acronym List		Please move acronym list to beginning of report (after List of Appendices).	C	The Acronym List has been relocated to the beginning of the report as requested.	
3.	1.2.1	General	In the descriptions, clarify which are historic results including dates of the results where possible. Please add dates to support statements such as “historic results”, “past investigations”, and “when unearthed”.	C	Dates have been added in order to better define when data was collected. Dates for samples are also included in Figures 2-1 through 2-6 on the notes which can further provide this information to the reader.	
4.	1.2.1/1-2	2/12	The definition of GWP-Ind MSC is missing before the acronym in parenthesis. Please define this acronym - medium-specific concentration for industrial use based on groundwater protection.	C	The acronym “GWP-Ind MSC” has been defined in the text.	
5.	1.2.1/1-2	1st sentence, last paragraph on page 1-2	In the sentence beginning “The wooden pipeline was replaced with a transite TNT wastewater pipeline”, please clarify that the wooden line was still in place but no longer used.	C	The text has been revised to “The wooden pipeline was abandoned in place and a transite TNT wastewater pipeline, which, according to 1943 records, was installed parallel to the wooden TNT wastewater pipeline approximately 5 ft to the north”.	
6.	1.2.1/1-3	1/7	Is there a specific reason why the 3-4’ bgs depth interval is described as “relatively shallow” for 29SB151 and 29SB152, but not for Borings 29SB137 and 29SB201? Because “relatively shallow” is a subjective description, the words “but at the relatively shallow depth of” can be replaced with the word “at”.	C	The text has been revised to read “borings 29SB151 and 29SB152 contained 2,4-DNT at concentrations that exceeded the GWP-Ind MSC at 3 – 4 ft bgs”	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
7.	1.3/1-4	Second to the last bullet	Change "(BERS)" to "(BERA)".	C	The DAR text has been revised to correct the typographical error.	
8.	1.5.3/1-7	1/lines 2-6	When discussing the depth of the groundwater zones, it's unclear whether this depth is to the top or bottom of the zone. Consider revising the sentence to "The bottom of the shallow groundwater zone generally extends to depths between 17 to 45 ft bgs because of the variable ground surface elevations across the site and conditions attributable to recurring drought. While less well-defined, the bottom of the intermediate zone extends to approximately 88 ft bgs. The bottom of the deep groundwater zone extends to approximately 155 ft bgs."	C	The DAR text has been revised to read "The bottom of the shallow groundwater zone generally extends to depths between 17 to 45 ft bgs because of the variable ground surface elevations across the site and conditions attributable to recurring drought. While less well-defined, the bottom of the intermediate zone extends to approximately 88 ft bgs. The bottom of the deep groundwater zone extends to approximately 155 ft bgs."	
9.	1.5.3/1-7	3/lines 5-7	How is the northeastern "side" distinguished from the northeastern "portion"? An explanation of why the hydraulic conductivities differ by three orders of magnitude within the same area would be helpful.	C	The text has been revised to provide more detail on the location of wells being referenced in this paragraph. The wells referenced that differ more than three orders of magnitude are actually located at opposite ends of the site. Well 116 is located north of Avenue D in the northeast area of the site and well 29WW03 is located in the southwest portion of the site, north of Avenue E.	
10.	1.7	1st paragraph,	Please revise as shown (or similar) "Releases from the rocket motor soakout process that used MC-based solvents are the suspected contamination sources of VOCs in groundwater."	C	The text has been revised to read "Releases from the rocket motor soakout process that used MC-based solvents are the suspected contamination sources of VOCs in groundwater."	
11.	1.7	2nd paragraph	In this sentence, add the date transite line was installed (i.e. in the 1940's) – "The transite TNT wastewater pipeline was added parallel to and north of the wooden line to carry the TNT wastewater."	C	The text has been revised to read "The transite TNT wastewater pipeline was installed in the 1940s and was added parallel to and north of the wooden line to carry the TNT wastewater."	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
12.	1.7	general	In several places, the narrative states "has solid residues contaminated with explosives" (and similar language). It would help the distinguish when these results were collected (which phase). As written it is difficult to distinguish between historic investigations and PSI results.	C	Text has been updated to state that sample results discussed in the latter part of the 2nd paragraph under this section is discussing samples collected during the PDI investigation conducted in 2021 to 2022.	
13.	1.7.1.1/1-10	2/9	If the thickness of the shallow zone is given as a range from 5 to 10 feet, the plume volumes should also be presented as a range instead of as a single value of 9 million gallons.	D	The 9 million gallons was calculated by Shaw Environmental and is first presented in the Final Feasibility Study dated April 2010. HDR does not have the original calculation to determine how this volume was estimated (whether an average thickness over the entire area or actual varied thicknesses across the aquifer were used). If the latter, then the total volume would not be a range but would be the actual total estimated volume based on the varied thicknesses identified over the aquifer. No change has been made in response to this comment.	
14.	1.8/1-12	Last sentence	Add "Tier 1" before "Residential". Search for "TRRP Residential Groundwater PCL" and correct all occurrences.	C	"TRRP Residential Groundwater PCL" has been replaced with "TRRP Tier 1 Residential Groundwater PCL."	
15.	1.10/1-13	3 solid bullet/5	Typo – the trigger level should be 8000 ug/l instead of 8000 ug/4l. Please provide an explanation of how 8000 ug/l determined to be the trigger point. Is 8000 ug/l the concentration at which MNA can take over to reach 5 ug/L?	C	The DAR text has been revised to correct the typographical error. 8,000 ug/l was identified in the ROD as the cleanup limit for MC and is based on the results of in-situ microcosm testing completed by AECOM and presented in the RI Addendum dated July 2016 prepared by AECOM. No change to the document has been made based on this comment.	
16.	1.12 subsections		Add figure references.	C	A reference to the figure showing the locations for each of the subsections has been added as the first sentence to each subsection.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
17.	1.12.1		Add reference to Figures 1-13 to 1-15 for piezometer locations. Note location of PZ-10 is not included on the figures	C	A reference to these figures has been included at the end of the paragraph under section 1.12.1. PZ-10 has now been added to these figures.	
18.	1.12.5/1-20	1/second to the last line	Please describe visual observations which suggest that the horizontal limits of the excavations have been reached, such as the condition of the line or observed staining.	C	The text has been revised to "The final horizontal limits for this excavation area and the excavation area surrounding 29SB201 will be based on visual observations **(i.e., stained soil)** and the results of confirmation samples collected as part of the remedial action."	
19.	1.13/1-21	1/5	Specify the type of pipeline (i.e., transite).	C	The text has been revised to read "Video Inspection, cleaning and plugging of the transite TNT wastewater and cooling water pipelines"	
20.	2		Reference G002 Site Plan	C	A reference to drawing sheet G002 has been added.	
21.	2/2-1	1/3-4	Six target areas are mentioned, but only five target areas are listed. Is the Cooling Water Outfall Ditch, which is included with Excavation Areas E-5, E-6S, and E-6N, actually the sixth target area?	C	The six target areas are identified E-1, E-2, E-3, E-4, E-5, and E-6. Areas 5 and 6 were listed together because they are located along the Cooling Water Outfall Ditch. No change has been made to the text as a result of this comment.	
22.	2/2-1	1/ listed item 4	Sheet G002 has Excavation Area E-4 identified as B812F Area	C	B812F Area has been relabeled as Excavation Area E-4 in Sheet G002.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
23.	2.2		Include discussion of unimpacted overbearing soil and soils removed from benching of the excavation face. Will these soils be stockpiled and used as fill? Will the soils be sampled before they are used as fill?	C	The following text has been added to Section 2.2 "Material excavated along slopes constructed to facilitate completion of the excavations will be stockpiled separately from the contaminated soils. These soils will then be tested for explosive compounds and if soils meet the cleanup levels, will be used to backfill excavations once areas are approved for backfill."	
24.	Table 2-1/2-2	Area and Volume columns	Add a superscript to "Area" and indicate in the notes that the area does not include the outer limits determined by sloping. In addition, for Areas E-3, E-4, and E-5, the associated excavation volumes should also be expressed as a range based on the range of excavation depths.	C D	A note has been added underneath Table 2-1 to indicate "Area excludes outer limits determined by sloping." The excavation volume listed is the actual volume estimated based on the area of each individual depth interval defined on the plan. Providing a range is not applicable.	
25.	2.2/2-2	Paragraph under Table 2-1	2nd sentence, add depth of piezometers (20 ft bgs)	C	The text has been revised to read "To aid in determining the depth to groundwater in the vicinity of the excavation areas piezometers were installed **to a depth of 20 ft bgs** as part of the 2022 PDI activities"	
26.	2.2 Subsections		Add Figure and Design sheet numbers to the headings. Example: 2.2.1 Excavation E-1: B806A Area (See Figure 2-1 and Design Sheet 01C101)	C	Subsection headings have been included in the subsection headings as requested.	
27.	2.2.4/2-4	1/1	Sheet G002 has Excavation E-4 identified as B812F Area, which seems more consistent with other area nomenclature.	C	Sheet G002 has been revised to identify the excavation area as E-4.	
28.	2.2.4/2-4	2/1	Figure 2-4 shows the excavation top of slope area. For clarification, add the words "excluding the top of slope area" after "excavation E-4" so that it reads, "The estimated area for excavation E-4, excluding the top of slope area, is approximately 4,860 sf …"	C	The text has been revised to read "The estimated area for excavation E-4, excluding the top of slope area, is approximately 4,860 sf …"	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
29.	2.2.5/2-5	3/1	Figure 2-5 shows the excavation top of slope area. For clarification, add the words "excluding the top of slope area" after "excavation E-4" so that it reads, "The estimated area for excavation E-5, excluding the top of slope area, is approximately 2.840 sf …"	C	The text has been revised to read "The estimated area for excavation E-5, excluding the top of slope area, is approximately 2.840 sf …"	
30.	2.3/2-6	1/5-6	For sloped sidewalls, how will the horizontal extent of excavation be determined if the top of the sidewall is non-detect but the bottom of the sidewall exceeds the cleanup level?	C	If the bottom exceeds the cleanup level the entire excavation will be expanded as described in the text and a new bottom sample will be collected. A second top of sidewall sample will not be required in this situation. This text has been added to the end of Section 2.3.	
31.	2.3/2-6 2.7.4/2-11	2/2 3 / 1-2	Additional soil removal is specified to be 2 to 5 feet laterally. Please describe the criteria used to determine whether the lateral extent of additional removal will be 2 or 5 feet.	C	This has been revised to 2 ft.	
32.	2.4	1st Paragraph, 2nd sentence	Remove repeated statement "soils removed from benching of the excavation face".	D	Text could not be found in the report. No change has been made.	
33.	2.5/2-7	1 /2	Include a statement that specifications for backfill placement, compaction, and testing will be included in the RAWP.	C	Additional details for backfill placement have been included in Section 2.5, including the requested statement.	
34.	2.7.1/2-8	Last bullet	In the 90% design document, include provision for SWPPP requirements as applicable.	C	The following text has been added to the Soil erosion and sediment controls bullet "A Stormwater Pollution Prevent Plan (SWP3) will also be prepared as part of the RAWP.	
35.	2.7.3.1, cost estimate, design drawings	Concrete	Inconsistent final use of concrete. 2.7.3.1 includes "off-site disposal or recycling", while cost estimate and design drawings indicate unstained crushed concrete may be used as fill. Clarify 2.7.3.1. Also, concrete used as fill should be above the water table.	C	Text has been revised to "Concrete that is not stained or visibly contaminated will be broken up and reused as backfill in excavated areas above the groundwater table. Concrete visually determined to be contaminated will be broken up into pieces for disposal at an approved facility." The cost estimate will be updated to reflect the reuse of concrete on site as backfill.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
36.	2.7.3.2/2-10	2/7	Strike out "nonhazardous" and add the following sentence: "If the contaminated soil is determined to be hazardous, it will be transported to a preapproved hazardous waste disposal facility."	C	The DAR text has been revised as requested.	
37.	2.7.4/2-11	Last paragraph, 1st sentence	Revise "sideways" to "laterally".	C	The text has been revised to read "excavations will be performed at least one additional foot deeper or 2 additional ft laterally."	
38.	2.7.5/2-11	1/ 8	Include a statement that backfill placement specifications will be detailed in the RAWP.	C	The sentence "Specification for backfill placement, compaction, and testing to be included in the RAWP" has been included in the text.	
39.	3/3-1	1/5	Define ERH and TCH the first time these acronyms are used.	E	ERH and TCH are defined in Section 1.10. No change is required.	
40.	3/3-1	1/7	ERH is less efficient in areas with higher permeabilities (10^{-3} cm/sec) and should be noted in this paragraph.	C	The text has been revised to include "ERH is less efficient in areas with permeabilities greater than 10^{-3} cm/sec."	
41.	3/3-1	2/last line	Is the citation for EPA (2015) for the white paper referenced in lines 2-3? If not, add the applicable citation for the white paper.	C	The citation is from "Engineering Paper: in Situ Thermal Treatment Technologies: Lessons Learned" dated May 2014. The citation has been revised to EPA 2014 and the reference has been added to Section 9.	
42.	3.4/3-5	1/7	TCEQ requests 15 days advance notification before startup of ISTD field activities to plan for onsite visit.	C	The sentence has been revised to read "the regulators will be notified at least 15 days in advance."	
43.	3.4.1.2/3-7	1/3-4	Add the following sentence: "The actual well depths and screened intervals will be determined in the field based on the lithology encountered during drilling."	C	The text has been revised to include "The actual well depths and screened intervals will be determined in the field based on the lithology encountered during drilling."	
44.	3.4.2/3-7	1/first bullet	Define APP the first time this acronym is used.	E	APP is defined in Section 2.7.1. No change is required.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
45.	3.4.2/3-8	Last bullet	Include a description of how treated wastewater effluent will be managed (such as discharge to facility groundwater treatment system).	C	Treated water is anticipated to be collected and take off site for disposal at an approved water treatment and disposal facility or a public owned treatment works (POTW) after being treated on site by a temporary water treatment system that will be operated as part of the ISTD system.	
46.	3.4.5/3-10	1/3	Change “minimizes” to “prevents.”	C	Now located in Section 3.4.6, the sentence has been revised to “The ISTD will be operated in a manner that prevents migration…”	
47.	3.4.6/3-11	1/fourth bullet	Weekly performance monitoring is proposed, which includes groundwater COC concentrations in the fourth bullet. However, the following paragraph indicates that groundwater sampling during ISTD operation will be difficult. Will the system be shutdown weekly to allow groundwater performance monitoring?	C	Now located in Section 3.4.7, the text has been revised to clarify that groundwater concentration information will only be used to evaluate mass removal if groundwater extraction is included as part of the ISTD system design. Whether groundwater extraction will be necessary will be determined by the ISTD vendor.	
48.	3.4.6/3-11	2/fifth bullet	What is the soil concentration that correlates to 8000 ug/l, and how is this determined? Will this be determined through SPLP or through a calculated value?	C	The soil concentration that correlates to a groundwater concentration can be estimated using a solid phase to liquid phase isotherm and can be calculated using the contaminants organic carbon partition coefficient and the fraction of organic carbon in the soil. A sentence has been added at the end of this bullet (Now Section 3.4.7): “If this criterion is used, the Contractor will be responsible for providing calculations performed to estimate this correlation.”	
49.	4		In Section 4, add a table comparable to Table 2-1 Excavation Areas.	C	Table 4-2 has been added to summarize excavation volumes for pipeline removals and excavations.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
50.	4.2.1/4-2	1st paragraph	5th sentence beginning with " The gravity portion…" – should this reference Building 806-A? Will stockpiled soil be sampled for site COCs before used as fill?	C	Reference has been corrected to building 806-A. Stockpiled soil will be sampled for site COCs before being used as fill. This text has been added. This is discussed at the end of Section 2.2.	
51.	4.2.1/4-3	2/8	If deeper excavation is required based on the bottom confirmation samples, additional excavation to the sidewalls will also be required to maintain the maximum allowable slope. If continued lateral excavation runs into the transite pipeline, will the transite pipeline be removed?	C	Yes. All sections of the transite pipe that are disturbed during the wooden pipeline removal will be removed. No change has been made to the text based on this comment.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
52.	4.2.3/4-4	2/8	Include a statement that if the integrity of the south cooling water line is found to be defective during the video inspection, these sections will also be excavated and pipeline cut (as with the north cooling water line).	E	Defective sections of pipe observed during the video inspection will be staked in the field for the collection of soil samples to confirm whether any contaminants have leached into the soil. If contaminants are above the soil cleanup levels, the pipe section and surrounding soils will be excavated. This is in line with what was described in the response to comments section of the ROD. This methodology will be applied to both the north and south cooling water lines and the sections of the gravity and pressure transite TNT wastewater lines that will not be disturbed and excavated with the wooden TNT wastewater pipe. Text has been added to this section that states “If the integrity of the south cooling water line is found to be defective during the video inspection, these sections will be staked in the field and samples will be collected via geo-probe or other similar method at 30 ft intervals on either side of the affected pipeline. The samples will be collected within 2 ft of the estimated outer edge of the pipeline and at two depths, the estimated mid-point of the pipe and within 1 ft below the estimated bottom depth of the pipe. If sample results for explosives are below the cleanup levels, then the pipe will remain in place and be abandoned per the design. If soil sample results are above the cleanup levels, then the area will be excavated, and the pipeline will be cut and removed along with the surrounding soils for disposal off site.”	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
53.	4.3.2/4-6		Please add this sentence from 4.3.1: Sections of pipeline identified with cracks or other defects, will be excavated, and removed as described in Section 4.2.	E	Please refer to the response for Comment 52. Text in this section has been revised to "Cooling water lines will be inspected and cleaned as described above for the TNT wastewater pipeline in **Section 4.3.1**, except where soil samples indicate that releases have occurred as described above."	
54.	4.3.2/4-6	2/2	Unlike the TNT wastewater pipeline, the cooling water lines flow to the cooling water ditch. Will sediment flushed out of the cooling water lines be contained or excavated out of the ditch, characterized, and disposed of offsite?	C	It is anticipated that water flowing from the cooling water lines will be collected and not discharged into the ditch. This water will be characterized and disposed off site in the same manner as water generated from the TNT wastewater pipeline cleaning. No change has been made based on this comment.	
55.	4.4.6/4-8	2/5	Include a statement that if the wash water from the TNT wastewater line can not be treated at the 18/24 GWTP, it should be managed as a listed water and disposed of at an approved hazardous waste disposal facility.	C	Text has been revised to require off site disposal for all wastewater generated during the pipeline cleanings.	
56.	4.4.6/4-8	1/6-8	Delisting the solid residue is not a realistic option. Delisting a waste is a lengthy rule-making process which may not be successful, and depending upon the volume of residue collected, disposal at a hazardous waste disposal facility may be more cost effective. Consider removing delisting as an option.	C	Delisting has been removed as an option.	
57.	5/5-1	2/line of evidence #2	The presence of daughter products should be added to the second line of evidence.	C/E	Item 1 (first line of evidence) under Section 5.0 has been revised to add the sentence: "An increase in degradation daughter products is also an indicator that reductive dechlorination is occurring and degrading contaminant mass."	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
58.	5/5-1		Bullet 2, after "without MCL" change to "groundwater concentrations based on TRRP Tier 1 Residential Groundwater PCLs." 4th paragraph – This is not a complete list of site COCs (see Table 1-2). Elsewhere, nitrotoluene isomers are identified by number (2, 3, 4). Conclusions – There is no recent groundwater data. This paragraph should not be so "conclusive" without recent data to support. Revise language.	C C C	Text has been revised as requested. Text in this paragraph has been modified to state "COCs included as part of the MNA evaluation at LHAAP-29 area are TCE, 1,2-DCA, perchlorate, 2,4-DNT, 2,6-DNT, 2-NT, and 4-NT in the shallow groundwater zone…". The text in the conclusion has been revised to: "The historical sample results suggest that the COC plumes are not expanding. Thus, the extent of the plumes appears to be stable. Additional monitoring results over time will serve to confirm or contradict that determination. Reductions in concentrations of perchlorate, explosives, TCE, 1,2-DCA and MC based on the available historical groundwater sampling results suggest that natural attenuation is occurring and is likely controlling COCs in the shallow, intermediate and deep groundwater zones of LHAAP-29. Based on the historic groundwater sample results, natural attenuation of COCs was observed in nearly all wells, except for well 29WW16 where MC concentrations exceeded the tolerant range for microorganism's activities. It is expected that conditions in the intermediate groundwater zone at 29WW16 will be more conducive to MNA once the concentrations are reduced by ISTD."	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
59.	5/5-2	3/2	The absence of a robust population of microbes suggests that the third line of evidence is not present. Calculations used to estimate the time to achieve natural attenuation does not provide a third line of evidence. Provide an explanation of how the attenuation rates were calculated.	C	Calculations used to estimate the natural attenuation rates were performed by Shaw Environmental and were documented in the April 2010 Natural Attenuation Evaluation included as Appendix C to the final Feasibility Study. Based on the calculations presented in this evaluation the attenuation rate constant was estimated using the in-well attenuation rate and assuming first order degradation kinetics (see figures C-4 to C-12 of Appendix C to the Final Feasibility Study).	
60.	5/5-2	4/1	While a stable to decreasing plume supports attenuation, the mechanism for natural attenuation does not appear to be evident from the data. Consider adding a statement that geochemical parameters and microbial analysis will continue during performance monitoring to demonstrate that MNA is effective. This statement will be a good lead-in to the paragraph on the following page.	C	The statement has been added as requested.	
61.	5.1 and subsections		Well names should only include (S) if that is the official well name. As previously noted by EPA, figures 5-1 to 5-3 were discussed in the narrative but not included in the 60% package. We defer consideration of the proposed new wells (placement and number) until the figures are included.	C C	Well names have been revised to reflect the official names. Figures 5-1 through 5-3 are now included.	
62.	5.1/5-3	4/2	Add geochemical parameters and microbial analysis for groundwater samples.	C	A sentence has been added to the Conclusion paragraph under Section 5 which states: ” Geochemical parameters and microbial analysis will continue during performance monitoring to demonstrate that MNA is effective.”	
63.	5.1.1/5-3	1 /4	Figure 5-1, which is not included in the list of figures, is referenced, but the correct figure number should be Figure 1-9.	C	The reference has been revised to “Figure 1-9.”	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
64.	5.1.2/5-4	1 /5	Figures 5-2 and 5-3 which are not included in the list of figures, are referenced; the plume maps are shown in Figures 1-9 and 1-10	C	The references have been revised "(Figure 1-9 and 1-10)."	
65.	5.1.3/5-4	1/6	Figure 5-3, which is not included in the list of figures, is referenced; the plume map is shown in Figure 1-10.	C	The reference has been revised "(Figure 1-10)."	
66.	5.1.4/5-4	1/3	Figure 5-3, which is not included in the list of figures, is referenced; the plume map is shown in Figure 1-10.	C	The reference has been revised "(Figure 1-10)."	
67.	5.2/5-5	2/1	MNA will not start until ISTD has successfully achieved the required COC concentrations. Change "implementation" to "completion." In addition, Figure 5-4, which is not included in the list of figures, is referenced; the plume map is shown in Figure 1-11.	C	The text has been revised as requested and the reference has been revised to "(Figure 1-11)."	
68.	6/6-1	1/second bullet	Define UEP the first time this acronym is used. This acronym is not listed in Section 10.	C	UEP has been removed from the list of acronyms since it is not applicable to Site 29.	
69.	6.3.2/6-4	1/3	Define ECP the first time this acronym is used.	C	ECP is defined in Section 6.3.1. No change is required.	
70.	6.3.4/6-4	1 /2-3	Strike out the sentence, "These actions are taken to reestablish its protectiveness." The sentence repeats the previous sentence.	C	The repeated sentence has been removed from the text.	
71.	Tables		Include a table with GPS coordinates for wells and borings.	E	GPS coordinates for wells that will be sampled as part of the long-term monitoring program are provided on drawing sheet G003. Coordinates for excavations are shown on the applicable drawing sheets (01C101 – 01C108).	
72.	Figures		Add a cover page before figures	C	A cover page has been included before the figures.	
73.	Figure 1-4		Typo in figure title "SIte LHAAP-29"	C	Typographical error was corrected.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
74.	Figures 1-5 and 1-6	Down-hole Data Legend	Under the Down-hole Data Legend, there is no explanation for the colored rectangles adjacent to each monitoring well (e.g., blue, yellow, green, etc.). Please identify these colors in the legend.	C	Figures 1-5 and 1-6 were created by AECOM for the approved document entitled "Final LHAAP-29 RI/FS Addendum Work Plan dated June 2014". The purpose of the "Down-hole Data Legend" is to identify where monitoring well screens have been placed. The colored rectangles are believed to be defined under the "Grain Size Log". No change to the figure completed.	
75.	Figures 1-7 and 1-8	Iso-contours	It would be helpful if arrows were added perpendicular to the iso-contours to illustrate the direction of groundwater flow in these groundwater elevations maps.	C	Figures 1-7 and 1-8 were revised to include arrows to represent the groundwater flow.	
76.	Figure 1-10	Legend	The description "all occurrences" for the groundwater PCLs is unclear. Please explain what is meant by "all occurrences."	C	Figure 1-10 has been revised to remove "All Occurrences" from the legend. The legend text has been changed to state (example), "(TRRP Tier 1 Residential Groundwater PCL = 1.3 ug/L)".	
77.	Figure 1-12	Legend, Notes	The symbols representing the historical sediment sample location, historical soil boring location, historical surface soil sample location, shallow zone monitoring well, and intermediate zone monitoring well are all of the same gray color, making it difficult to differentiate one symbol from the other on the map. Consider using different colors for each symbol. Additionally, under NOTES, please explain why there is the number "7" in front of GWP-ind.	D C	Figure 1-12 was taken directly from the approved ROD and has been previous reviewed and accepted by the agency. No change has been made to the colors of the historical sample locations shown on this figure. The typographical error was corrected by removing the "7" and replacing with a "-" in front of the GWP-ind.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
78.	Figure 1-13	Legend, Screening Levels	There are two symbols representing solid residual sample from line or man hole; one is an orange circle and the other is a yellow circle. What is the difference between these two symbols? Additionally, under Screening Levels, the annotation "b" next 5.1 for 2,4,6-Trinitrotoluene is difficult to read. Please change the "a" and "b" to superscripts and add a space between the "5.1" and "b".	C	The orange symbol and text has been removed since they represent the same type. One "orange" (29WL14) sample point has been changed to yellow. The screening levels annotation for "a" and "b" has been added as superscript and a space has been included between the superscript and the "5.1" in Figure 1-13.	
79.	Figure 1-14	Screening Levels	The superscript "b" next to 5.1 for 2,4,6-Trinitrotoluene is difficult read. Please add a space between the "5.1" and "b".	C	Figure 1-14 has been revised as requested.	
80.	Figure 1-15	Screening Levels	The annotation "b" next 5.1 for 2,4,6-Trinitrotoluene is difficult to read. Please change the "a" and "b" to superscripts and add a space between the "5.1" and "b".	C	Figure 1-15 has been revised as requested.	
81.	Figure 2-3		Note 2 should include perchlorate	C	Figure 2-3 will include the soil cleanup standard for perchlorate under Note 2.	
82.	Figures 2-1 through 4-4	Ground surface elevation contours	The iso-contours on all of these figures generally have only one major contour line labeled with the ground surface elevation. Without referring to Figure 1-4, the slope on the ground surface can not be determined. Consider either adding hatch marks indicating the downhill side of the contours or labeling the minor contour lines.	D	The purpose for Figures 2-1 through 4-4 are to show the contaminant concentrations and overall excavation limits. For detailed information on the ground surface elevations please refer to design drawing sheets 01C101 – 01C108. No change has been made as a result of this comment.	
83.	Figures 2-1 through 4-4	Legend	If a symbol is not used within the figure, please remove it from the legend so that they legend does not convey that a feature is missing from the figure. For example, Excavation Area E-2 does not need sloped sidewalls due to the shallow depth of excavation. The blue dashed line indicating the excavated top of slope can be removed from the legend.	C	Symbology for figures 2-1 through 4-4 has been updated to only include symbols used in the sheet.	
84.	Figures 3-1, 3-2	Legend	There is a typo for ISTD in the legend.	C	ISTT has been revised to ISTD.	
85.	Figure 4-4		Near the southeast corner of this figure, a partial line excavation is shown, but no sample locations are shown by this excavation. Should this excavation be shown on this Figure?	C	Excavation line has been removed from this figure.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
86.	Figures 5-1 to 5-3		As previously noted by EPA, these figures were discussed in the narrative but not included in the 60% package.	C	These figures are included as part of the 90% design submission.	
87.	Sheet G001	Land Grading Notes/ #11	"Contact Documents" should be corrected to read "Contract Documents." Remove the Legend from this sheet	C	Land Grading note #7 has been revised to "design documents". Legend has been removed.	
88.	For all excavation sheets	Excavation Notes	Note #2 – remove the second "of" (it reads, "of of every" Note #4 – The narrative indicates that stained concrete will be brushed or washed before offsite disposal, but the note does not indicate decontamination of the concrete before disposal.	C	Typographical error has been corrected in Note #2 for all excavation sheets. Notes for concrete have been revised to clarify decontamination before disposal.	
89.	Sheet 01C102 Sheet 01C105 Sheet 01C107 Sheet 01C108 Sheets03C101 Sheets03C102 Sheets03C103		The pipeline excavation is shown cutting across the access road. Will a temporary bridge be built over the excavation, or will the excavation be completed first and backfilled before the temporary access road is constructed?	C	The access road has been modified to be constructed along the pipeline excavation. It is anticipated that this access road will be constructed as the pipeline excavation progresses southwest.	
90.	Sheet 01C103		Add a label to identify excavation area NC-3 (the 13-ft excavation area).	C	A label has been added for this excavation. Please note that the excavation has been renamed to NC-1 to be consistent with the figures in the Design Analysis Report.	
91.	Sheet 01C104		The excavation top of slope is shown to cut into the temporary access road. The access road should be relocated south of the excavation.	C	The access road has been shifted away from the top of slope to provide a minimum of 5-ft buffer.	
92.	Sheet 01C106		There is a 24" concrete culvert shown beneath the E6S excavation. How will this culvert be managed?	C	The culvert will be cleaned with water or similar methods used for underground pipeline cleaning and then will be visually inspected to verify it is clean. This information is included as Note 4 on this drawing sheet.	
93.	Sheet 01C108		The excavation top of slope abuts the staging area; the staging area may need to relocated slightly southeast of its current proposed location.	C	Now Sheet 01C107. The staging area has been shifted away from the top of slope shown on this drawing.	

Comments Response Matrix
Draft Design Analysis Report, Intermediate (60%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: November 14, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
94.	Sheet 02C101	ISTD Notes	Note #4: Revise as follows: "The depth interval for thermal treatment shall include the entire saturated zone and shall extend 5 feet below the base of the contaminated groundwater. The heated depth interval shall be from 50-ft bgs to 95-ft bgs. This will ensure contamination does not condense in cooler saturated zones above the contaminated groundwater occurring from 70-ft bgs to 90-ft bgs and will mitigate the potential for DNAPL in the treated area to migration vertically."	C	Note #4 in Sheet 02C101 has been revised to read "The depth interval for thermal treatment shall include the entire saturated zone and shall extend 5 feet below the base of the contaminated groundwater. The heated depth interval shall be from 40-ft bgs to 95-ft bgs. This will ensure contamination does not condense in cooler saturated zones above the contaminated groundwater occurring from 70-ft bgs to 90-ft bgs and will mitigate the potential for DNAPL in the treated area to migrate vertically."	
95.	Sheet 02C101		Part of the staging area is shown to extend outside of the fenced area. Either move the fence or reduce this portion of the staging area so that all of the staging area is enclosed by the fence. Add a gate leading to the staging area.	C	The staging area is now shown within the fenced area. The gravel access road is shown outside this fenced area to allow access to the manhole without having to enter the fenced area.	

Comments Response Matrix
Preliminary (30%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: July 20, 2022

Submitted by: Brian Follin, EPA Region 6
Responded by: Rose Zeiler, Longhorn AAP Site Manager
Date Responded: November 14, 2022

1. Respondent concurs (C) or does not concur (D)
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1:						
1	3	1st paragraph	Depth ranges should be provided for each generalized lithologic unit discussed in paragraph rather than indicating how far they "extend" below overlying units. This eliminates potential confusion with respect to the depth of expected subsurface occurrence for each unit. To prevent potential confusion, lithologic units should always be identified using the same name/identifier given when first introduced. Thus, the "sand deposit" in the second to last sentence of paragraph should be changed to "silty to clayey sand."	C	The description for the geology at the site is in Section 1.5 of the DAR and has been written as follows: "The LHAAP-29 site is located on the southern edge of the Big Cypress Bayou Floodplain where modern alluvium directly overlays older sediments. The stratigraphy at LHAAP-29 consists of silts, sands, and clays deposited in fluvial (riverine) and fluvial-deltaic (riverine and/or marine) settings (**Figures 1-5** and **1-6)**. The stratigraphic architecture of fluvial and deltaic systems is generally called "cut-and-fill" because fluvial channels are cut into floodplain sediments (silts/clays) and filled with coarser point bar and channel sediments (sands/gravels) prior to being abandoned and preserved as distinct sand/gravel bodies within a finer grained matrix. (AECOM, 2014) In general, the upper 30 ft of sediment at LHAAP-29 is alluvium associated with evolution of the modern Big Cypress Bayou, its floodplain, and its tributary streams. Underlying this are the semi-consolidated sediments of the Wilcox Formation, which consists of fluvial and fluvial-deltaic sediments deposited in the Eocene (approximately 50 million years ago). The elevation of contact between the Wilcox and overlying modern alluvium	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
					ranges from 180 to 210 ft, mean sea level (msl) in the area of LHAAP-29 and is irregular because the contact is an erosional surface created by exposure of the Wilcox, fluvial incision, and reworking of the Wilcox Formation sediments. “	
2	3	2nd Paragraph	1. The report indicates the shallow groundwater zone has been divided into two zones, “shallow” and “lower shallow,” but it is unclear if they reflect differing site-specific geologic/hydrogeologic characteristics or if they simply reflect arbitrarily assigned depths/depth intervals. If the former, additional explanation is warranted; if the latter, the depth intervals for the different zones should be specified. 2. Should add “-surface” after “potentiometric” (i.e., “potentiometric-surface map”). 3. Per discussion in this paragraph and fig. 4, groundwater-flow directions are described/characterized using a “historic” potentiometric-surface map constructed using groundwater-level elevation measurements from 15 years ago (2007). Because groundwater systems are dynamic and can change over time, it would be very helpful to construct a potentiometric-surface map using “recent” groundwater levels. Characterization of horizontal groundwater-flow directions is critically important to understanding the direction of contaminant movement in the saturated zone. Additionally, it would be preferable/helpful to construct two potentiometric-surface maps using	C C C	1. The shallow and lower shallow zones have similar water levels and were identified as such because shallow wells were screened at different depths. They are actually both considered the shallow zone, which generally ranges from 17 to 45 feet below ground surface because of the variable ground surface elevations across the site (Shaw, 2010). Section 1.5 of the Design Analysis Report (DAR) is written as follows: There are three groundwater zones at LHAAP-29: shallow, intermediate, and deep. Semi-confining clay or silty clay layers of varying thickness separate the three groundwater zones. The depth of the shallow groundwater zone generally ranges from 17 to 45 ft bgs due to the variable ground surface elevations across the site and conditions due to reoccurring drought. The intermediate zone is less well-defined, but its depth has been measured to approximately 88 ft bgs. The deep groundwater zone extends to a depth of approximately 155 ft bgs. 2. Text in Section 1.5 of the DAR has been revised to include the word “surface” and is written as follows:	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
			groundwater levels measured during the time of year when groundwater levels in the area are highest (shallowest) and when they are lowest (deepest). This would help characterize the potential range of changes in flow direction(s) for a given area that may be expected annually. 4. The predominant groundwater-flow direction in the shallow zone is described as "east/southeast." While this is true, examination of the potentiometric-surface map in fig. 4 indicates groundwater in a substantial portion of the northeastern part of LHAAP-29 flows to the north/northeast. 5. The predominant groundwater-flow direction in the intermediate zone is described as "east/northeast." However, examination of the potentiometric-surface map in fig. 5 indicates groundwater in the intermediate zone flows to the north and northeast. Thus, "east/northeast" needs changed to "north/northeast.	C C	"Based on the 2007 water levels and historic potentiometric surface maps, the predominant flow of both the shallow zone and intermediate zones groundwater is to the north/northeast based on November 2007 water levels." 3. More recent groundwater potentiometric data is not available. The collection of groundwater elevation data will be a requirement for development of the RAWP. 4. The groundwater flow directions is described in Section 1.5 of the DAR and has been revised to: "Based on the 2007 water levels and historic potentiometric surface maps, the predominant flow of both the shallow zone and intermediate zone groundwater is to the north/northeast based on November 2007 water levels." 5. Please refer to the response to 4 above for revised language.	
3	Fig. 5		LEGEND. The word "Monitoring" is misspelled in the 2nd legend entry: "Intermediate Monitoring Well."	C	This misspelling has been corrected for this Figure (Figure 1-8 of the DAR).	
4	Site Geology and Hydrogeology section, page 3		Seasonal/annual water-table fluctuations are not discussed/described in the report. Because removal of contaminated materials will be limited to contaminated soil/sediment in the unsaturated zone, it is important to understand the range of these fluctuations because the water-table depth at the time contaminated materials are removed will determine the volume of materials to be	D	While what the reviewer states is true, the approach presented here is consistent with the approved Memorandum Data Summary and Data Gap Proposed Approach and the Final PDI Report.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
			removed. If fluctuations have been characterized as part of previous investigations, they should be broadly discussed/summarized in this report section and described for the specific sites in subsequent sections (also see comment #14).			
5	Nature and Extent of Contamination section, page 3	1st bullet	"Shallow soil" is mentioned here and elsewhere in the report, but a depth range is not provided. There is an extraneous "and" before "2, 6-DNT."	C	The term "shallow soil" will be removed to be consistent with the ROD which does not distinguish between shallow and deep soils. The text referenced in this comment has not been included in the text of the DAR. Section 1.7.1.2 of the DAR provides the nature and extent of soil contamination.	
6	Nature and Extent of Contamination section, page 4	1st bullet after 1st paragraph	First comment: "motor rocket" needs corrected to "rocket motor." Second comment: "washout" needs changed to "soak out" to reflect description of rocket motor cleaning operations provided on previous page and usage elsewhere in report.	D	Both terms are used historically, are in the ROD, and are interchangeable.	
7	Selected Remedy section, page 5		The acronym/abbreviation "ISTD" is not defined at 1st occurrence (and is not defined anywhere in report).	C	Acronyms are defined the first time they appear in the text for the DAR.	lease
8	Selected Remedy section, page 6	2nd paragraph	Excavation depth in relation to water-table depth is briefly discussed here, but there is no corresponding discussion of seasonal water-table fluctuations. As noted in comment #9, the depth and volume of excavation can vary substantially, depending upon when excavation activities occur. In fact, it would be helpful if known	D	Please refer to the response to comment 4.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
			water-table depth ranges were provided for monitoring wells in the vicinity of each site described in subsequent report sections. These comments apply to all subsequent sections of this document.			
9	Excavation E-1—B806A Area section, page 7	2nd paragraph	1st occurrence of "BERA" acronym in report needs abbreviated here (page 7) instead of 2nd occurrence on page 11. Thus, the page 11 occurrence will need to be revised after this correction.	C	Acronyms are defined the first time they appear in the text for the DAR.	
10	Excavation E-2—B806D Area section, page 8	1st Paragraph	To reflect the order of the soil boring numbers presented in the parenthetical in the 2nd sentence, "northwest, southwest, and southeast," should be changed to "southwest, southeast, and northwest." The third to last sentence in the first paragraph indicates samples were collected from 0-1 feet (ft) below ground surface (bgs) from all locations. However, depth information for the six soil borings shown in fig. 7 indicates four of borings (29DLineWHC01, 29SB96, 29DLineWHC02, & 29SB95) only had samples collected from 0 to 0.5 ft bgs (note that this includes one of the 2014 borings, 29SB96).	C	This text is in Section 2.2.2 of the DAR and has been revised to:" During the 2014 supplemental RI three boring locations (29SB94, 29SB95, and 29SB96) were drilled 20 ft from 29DLineWHW01 to the southwest, southeast, and northwest." This text is in Section 2.2.2 of the DAR and has been revised to:" Samples were collected from 0-1 ft from all locations with the exception of four borings (29DLineWHC01, 29SB96, 29DLineWHC02, & 29SB95) which had samples collected from 0 to 0.5 ft bgs. "	
11	Excavation E-3—Perchlorate Excavation, page 8	2nd paragraph	Reference is made to soil boring 29SB107 in the 1st sentence, but this boring and its associated sample results are missing in fig. 8.	C	Boring location 29SB107 was completed as part of the RI Addendum by AECOM. The sample results for this location were not found in the RI Addendum, however the text in Section 3.2 of the RI Addendum indicates perchlorate sample results at this location were below the GWP-IND MSC. Note 5 has been added to the figure (Figure 2-3) explaining this. .	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
12	Excavation E-4—29SG118 Excavation, page 9	1st paragraph	In the second sentence, the numeral "1" is missing for boring 29SB1**1**0 in the parenthetical after "four additional sample locations" (missing numeral "1" is bolded above).	C	The number "1" has been added for boring 29SB110. This text can be found in Section 2.2.5 of the DAR.	
13	Fig. 11		The SB133 identifier needs to be moved closer to the actual boring location.	C	Figure 11 has been updated to move the sample identifier for SB133 closer to the boring location (now Figure 2-6 in the DAR).	
14	ISTD Treatment Area section and fig. 12 Page 11		Treatment area and contoured methylene chloride plume concentrations discussed in report section and shown in fig. 12 reflect analyses for water-quality samples collected by AECOM in 2014. It is unclear how well these 2014 data reflect current plume extent given that these data are now 8 years old. In particular, the high concentrations near/along the leading edges of the plume may currently (2022) extend beyond the contours shown in fig. 12 (including the area within the dashed line representing the methylene chloride plume treatment area).	C	The collection of groundwater samples for analysis of COCs will be a requirement for development of the RAWP.	
15	Transite TNT Wastewater Line section Page 15	3rd paragraph	The acronym/abbreviation "ACM" is not defined at 1st occurrence (or anywhere in document).	C	The first use of acronyms are defined in the text for the DAR.	
16	Transite TNT Wastewater Line section, page 15	Last paragraph 2nd sentence	"and another had concentrations of TNT exceed the cleanup level at 3-4 BGS (figure 13)." There are two errors in this portion of the sentence as currently written. First, according to fig. 13 the constituent detected was 2, 4-DNT, not TNT. Second, there was only one detection (3-4 ft BGS), so the word "concentrations" needs changed to "concentration." Additionally, suggest a parenthetical is added after "and another" to identify boring SB201. Thus, recommend revising this portion of the sentence as follows: "and another boring (SB201) had	C	This text is included in Section 4.2.2 of the DAR and has been revised as follows: "and another (29SB201) had a concentration of 2,4-DNT exceed the cleanup level at 3-4 ft bgs (**Figure 4-1**)."	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
			a concentration of 2,4-DNT exceed the cleanup level at 3-4 bgs (figure 13)."			
17	Cooling Water Lines section, page 16	1st sentence of last paragraph	Order of soil borings listed near end of first sentence should be changed to reflect the order of listed figure numbers in the parenthetical at the end of the sentence. Thus, order should be 29SB143, 29SB138, and 29SB139.	C	This text is included in Section 4.2.3 of the DAR and has been revised to list the borings in the order suggested, 29SB143, 29SB138, and 29SB139.	
18	Cooling Water Lines section, page 16	3rd sentence of last paragraph	Sentence indicates samples were offset 10 ft to either side of the impacted samples. However, the distances of offset samples shown in the figures look greater than 10 ft.	C	This text is in Section 4.2.3 of the DAR and has been revised to "Additional samples were collected in 2022 to provide further delineation for these areas. Samples were generally offset 10 ft to either side of the impacted samples, although some were greater than 10 ft."	

Comments Response Matrix
Preliminary (30%) Remedial Design for LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant, Karnack, Texas
Submitted: July 20, 2022

Submitted by: April Palmie, TCEQ
Responded by: Rose Zeiler, Longhorn AAP Site Manager
Date Responded: November 14, 2022

1. **Respondent concurs (C) or does not concur (D)**
2. **Commenter agrees (A) or does not agree (D) with response.**

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1: April Palmie, TCEQ						
1.	General	Document formatting and organization	There are two RDs in progress from HDR (18/24 and 29). It would be very helpful as we go forward if there were consistencies in the formatting and structure of the narrative portion. From 18/24, please bring in numbering of the sections, for example.	C	As part of the 60% submittal a Design Analysis Report (DAR) has been prepared. The format for this DAR (including section numbers, etc.) is the same as provided for the 18/24 site.	
2.	1	Site History	First sentence - Remove "is" before "an inactive". 3rd sentence – Please revise "The U.S. Army, the United States Environmental Protection Agency (~~US~~EPA), and the Texas Water Commission (currently known as the Texas Commission on Environmental Quality (TCEQ)) entered into a CERCLA §120 Federal Facilities Agreement (FFA)…"	D C	The first sentence in Section 1.1 of the DAR reads "The former LHAAP is an inactive, government-owned, formerly contractor-operated and -maintained U.S. Department of Defense facility located in central east Texas (see **Figure 1-1**; note that figures are provided at the end of this report) in the northeastern corner of Harrison County." The word will remain in the sentence and no change was made to the text based on this comment. This text is in Section 1.1 of the DAR and has been revised as follows: "After its listing on the NPL, the U.S. Army, the U.S. Environmental Protection Agency (EPA), and the Texas Water Commission (currently known as the Texas Commission on Environmental Quality (TCEQ)) entered into a CERCLA §120 FFA for remedial activities at LHAAP."	
3.	2	Site History	First complete paragraph (P), last sentence add "was" between "pipeline" and "installed" Next P, please revise first sentence for clarity: "Cooling water (blue water) ~~drain lines~~ from the former production lines ~~were~~ was collected…"	C	The Site History section has been rewritten and is included in Section 1.2.1 of the DAR. The text referenced in this comment no longer exists.	
4.	3	Site History	First sentence, EPA is already defined.	C	Acronyms are only defined the first time the term is used in the 60% DAR.	
5.	3	Site Geology	The first paragraph description isn't very clear, but I note it is basically copied from the ROD. In the "Except for boreholes" sentence, would it be accurate to say the sandy		A description of the geology is included as Section 1.5 of the DAR. Language presented in this section is as follows: "The LHAAP-29 site is located on the southern edge of the Big Cypress Bayou Floodplain where modern alluvium directly overlays older sediments. The stratigraphy at	

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			silt to silty clay layer was encountered within (rather than below) the sand deposit?	C	LHAAP-29 consists of silts, sands, and clays deposited in fluvial (riverine) and fluvial-deltaic (riverine and/or marine) settings (Figures 1-5 and 1-6). The stratigraphic architecture of fluvial and deltaic systems is generally called “cut-and-fill” because fluvial channels are cut into floodplain sediments (silts/clays) and filled with coarser point bar and channel sediments (sands/gravels) prior to being abandoned and preserved as distinct sand/gravel bodies within a finer grained matrix. (AECOM, 2014) In general, the upper 30 ft of sediment at LHAAP-29 is alluvium associated with evolution of the modern Big Cypress Bayou, its floodplain, and its tributary streams. Underlying this are the semi-consolidated sediments of the Wilcox Formation, which consists of fluvial and fluvial-deltaic sediments deposited in the Eocene (approximately 50 million years ago). The elevation of contact between the Wilcox and overlying modern alluvium ranges from 180 to 210 ft, mean sea level (msl) in the area of LHAAP-29 and is irregular because the contact is an erosional surface created by exposure of the Wilcox, fluvial incision, and reworking of the Wilcox Formation sediments.”	
			Historic GW flow in shallow zone northern part of the site is depicted more northeast than east/southeast.	C	The text describing groundwater flow at the site is included in Section 1.5 and has been revised as follows: “Based on the 2007 water levels and historic potentiometric surface-maps, the predominant flow of both the shallow zone and intermediate zone groundwater is to the north/northeast based on November 2007 water levels. “	
			The deep zone – note how many wells were installed (and where) to sample the deep zone.	C	There are four wells installed in the deep groundwater zone. Sampling results from these wells indicated the deep groundwater zone is not impacted. This text is included in Section 1.7.1.1 of the DAR. The RTC for the Final FS states in the minutes that “It was decided that an additional well (29WW41) would be installed down gradient approximately 50 feet (northeast) of 29WW40 and that the data from this well would be evaluated to determine if the remedy for LHAAP-29 needs to be modified.” This well was sampled and found not to contain VOCs above the method detection limit. However, sampling of this well (29WW41) will be included in the monitoring plan to confirm the remedial action does not move contamination deeper.”	

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					For the 60% DAR, Section 5.2.1 discusses monitoring for the deep groundwater at well 29WW41.	
6.	3-4	Nature and Extent	This is not a very well-developed section, especially compared to the 18/24 30% RD. Add findings from the PDI work and include separate discussions for soil and groundwater. In 60% include a section for clean-up levels before design approach. In 18/24 this was right after nature and extent. If you leave this information imbedded in the design approach, please bookmark for easy reference.	C	Section 1.7.1 of the DAR provides the nature and extent for the groundwater, soil and pipelines for LHAAP-29. Findings from the PDI are included in Section 1.12 of the DAR. Cleanup levels are included in Section 1.11 of the DAR. The PDF of the report will be provided with bookmarks for each section and sub-section of the report.	
7.	5	Design Approach	The 18/24 30% RD did include MNA and LUC components. While "passive" is an accepted term to describe MNA, the correct term to describe LUCS would be "administrative". LUCs (institutional controls) are administrative controls.	C	Sections 5 and 6 of the DAR include the MNA and LUC components for LHAAP-29. The term "passive" has been removed from the text for the DAR.	
8.	6	Design Approach, Excavation Areas	P below Table 1 – Last sentence add "The six target excavation areas identified in the ROD are shown…" Also note and briefly explain the North Cooling Water Line Excavation Areas 1-3 that are NOT numbered E-1 to E-6.	C	The text referenced in this comment has not been included in the text of the DAR. A discussion of the excavation areas is included in Section 2 of the DAR. Text discussing the excavation areas along the North Cooling Water Line are included in Section 4.2.3 of the DAR and have been identified as excavation areas NC-1, NC-2 and NC-3.	
9.	7	Design Approach, Excavation Area subsections	Add reference to the applicable design sheet(s) at the beginning or even in the title The text describes stained soil areas which are depicted with purple dashes on the design sheets. Note that a lot of the stained "soil" is on areas characterized as concrete. This should be explained and concrete removal/disposal should be noted.	C	The Design Drawings will be included in Appendix A of the DAR. Figures depicting the excavation limits discussed in the text will be identified in the text for the reader's reference. Specific design sheet numbers will not be referenced. The removal of concrete structures to access some of the excavation areas has been included in Section 2.7.3.1 of the DAR. Text states: "Concrete structures inside the boundaries of excavation areas will be removed as part of the excavation. Concrete will be broken up into pieces that can easily be loaded into trucks for off-site disposal or recycling. Stained concrete will be segregated from unstained concrete and will require off-site disposal to a nonhazardous waste landfill. Unstained concrete that is mixed with contaminated soils will not be permitted for recycling and will need to be decontaminated with water or brushes to visibly remove all soil before being permitted for transport to a recycling facility."	

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Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
10.	13	Design Approach, Inspection and Excavation/ Abandonment of Pipelines	Introduction P – Add excavation of wooden pipeline to this paragraph.	C	The excavation and removal of the wooden pipeline is included in Section 4.2 1 of the DAR.	
11.	Table 1		Note for “a” – Since all values in this table are the same standard for clean-up, rather than use superscript “a”, treat that note as a definition and add GWP-Ind in front of the explanation.	C	Tables providing the cleanup levels for different media at the site have been included as Tables 1-1 to 1-3 and are included in Section 1.11 of the DAR. The format has changed such that the standard is in the header of the table and a reference to define the standard has been shown as Note 1 beneath the table.	
12.	Figure 3		What are the arrows (shades of green/blue) by 812-F? By green dot and Manhole in legend, add superscript 1 to reference the note below.	C	Arrows that are not applicable to this figure have been removed (now Figure 1-3 in the DAR). A superscript has been added to the “Manhole” in the legend to reference Note 1 shown on this figure (now Figure 1-3 in the DAR).	
13.	Figure 4		Please fix the duplicated labels in 301-308 area (NW corner of figure). Data Source – add where the data was originally reported. As written, it is confusing to have 2007 data and a 2016 report. Also confirm this is the most recent data set.	C	The figure (now Figure 1-7 of the DAR) has been revised to remove duplicate labels for the 301-308 area. The groundwater contours are based on data collected in 2007. The data source note has been updated to identify the Shaw, 2010 Final Feasibility Study prepared in April which is where contour data was first reported. Additionally, the text in Section 1.5.3 of the DAR states, “Based on the 2007 water levels and historic potentiometric surface-maps, the predominant flow of both the shallow zone and intermediate zone groundwater is to the north/northeast based on November 2007 water levels.” There is no more recent groundwater data that has been collected for this site.	
14.	Figure 12		Add comma number separators to the results pop-outs. Choose a different color for the MC contours and the treatment area line.	C	Comma number separators have been added to the chemical summary boxes shown on this figure (now Figure 3-1 of the DAR). The color of the treatment area line has been revised to green to stand out from the MC contours.	
15.	Excavation results figures		It would be helpful to have something more than map symbols to distinguish the data sets. Please add the sample date to the call out boxes or as notes.	C	Dates identifying when samples were collected have been included as a note on the excavation figures (Figures 2-1 to 2-6).	
16.	Design set	General	Please include G001 and G002 in the 60% set. This is a complicated site with many different types of features to	C	Drawing sheets G001 and G002 will be included as part of the 60% design set.	

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			portray. It is difficult to review these figures without a consistent acronym list and legend. Many of the sheets are missing key features in the legends.	C	Legends will be updated as part of the 60% design submittal to identify all line types and patterns used for the drawing sheets.	
			There is a feature depicted with a *dashes and triangles* fill. This fill pattern should be clearly defined in the legends. Some sheets call this pattern a concrete structure, but concrete foundation and concrete-lined pits is more accurate.	C	The fill pattern using dashes and triangles depicts a concrete structure. This will be added to the legend of Sheet G-003. It is already shown on other sheets where concrete structures are present.	
			Would it be possible to distinguish between surface level concrete and the concrete-lined pits, perhaps with a different fill pattern?	D	Only visible surface structures are shown on the survey drawing. Because it is unknown which structures are concrete foundations versus concrete lined-pits all concrete structures have been shown with the same hatching pattern. There has been no change to the drawings as a result of this comment.	
			Display the fill patterns in the legend at the same scale as the pattern in the figure so they match. Sheet 01C101 is a good example of the mismatch (dash and triangle for fill and little dots in the legend).	C	Legends have been updated to accurately depict line types and hatches used in the drawings. This has been modified as part of the 60% design.	
			Use different symbols and/or colors for ISTD treatment area, stained soil, and GW plumes.	C	Different colors are used to identify the ISTD treatment area and groundwater plumes. This has been modified as part of the 60% design.	
			Because of all the contour lines, it would help if other features (especially the cooling water, wastewater, and pipe removal trenches) were different colors. Please take this into consideration as the drawings get more technically complicated. I recognize the importance of the contours, but it would help if they were a background to the site activities (not the same color as everything else – all gray/black). Different colors for different features would help.	C	Contour lines are grayed out more to allow other site features to better stand out. Every drawing sheet has also been provided with a legend showing all line types. Important features such as the limits for excavations and trenches are shown in color. These modifications have been made as part of the 60% design submission.	
			The drawings set does not include north cooling water line excavation areas 2 and 3.		These excavation areas are shown on the Piping Site Plan sheets. Drawing sheets have been added to provide a larger scaled drawing for these areas as part of the 60% design drawing package.	

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17.	Drawing G003		My computer struggles to render this specific drawing. I'm noting in case there is anything HDR can do. I think it is because of the 1-foot contours. If there is nothing you can do, I have a work-around. Some of the excavation areas are not solid lines.	C	The drawing file size has been reduced in an attempt to allow this file to open more easily. Excavations associated with pipe removals have been shown as dashed lines instead of solid lines. This is identified in the legend on this drawing. These features are also now shown in color.	
18.	Drawing 01C101		Purple dashed line seems to be for stained soil – not in legend and that is very similar to symbol for ISTD on G003.	C	Because stained soil was approximate this has been removed from the drawings. Drawings instead show the extent of soil planned to be removed based on all the available data. The color for the ISTD treatment area is shown as green.	
19.	Drawing 01C102		Correct the SB labels – some say 29DLineWXXX rather than the SB #	D	Labels shown for locations are as presented on Figure 2-12 of the Record of Decision. In order to maintain consistency with the ROD labels will remain unchanged. Soil borings have been removed from the construction drawings in order to show the limits of the excavation more easily. In the draft final drawings coordinates will be provided for the excavation corners which will be used by the contractor to locate the excavation in the field. The locations of the soil borings are not needed for the contractor to perform the work	
20.	Drawing 01C103		Two excavation areas are depicted - change title to include North Cooling Water Line Excavation Area 1	C	Title has been modified as part of the 60% design package to identify each area as a separate excavation area.	
21.	Drawing 01C104		Several of the SB data points and labels are missing, such as 29SB167 and 29SB171.	D	Soil borings have been removed from the construction drawings in order to show the limits of the excavation more easily. In the draft final drawings coordinates will be provided for the excavation corners which will be used by the contractor to locate the excavation in the field. The locations of the soil borings are not needed for the contractor to perform the work.	
22.	Drawing 01C105		Several of the SB data points and labels are missing, such as SB185 and SB186.	D	Soil borings have been removed from the construction drawings in order to show the limits of the excavation more easily. In the draft final drawings coordinates will be provided for the excavation corners which will be used by the contractor to locate the excavation in the field. The locations of the soil borings are not needed for the contractor to perform the work.	

100% Design Analysis Report
Remedial Design
for
LHAAP-29, Former TNT Production Area Group 2
Longhorn Army Ammunition Plant
Karnack, Texas

Prepared for:

U.S. Army Corps of Engineers, Tulsa District

Contract No. W912BV19D0016

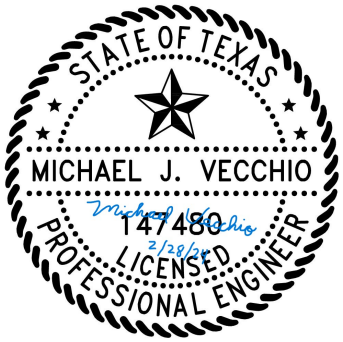
Task Order No. W912BV20F0096

Prepared by:

HDR

2650 Park Tower Drive, Suite 400
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February 2024



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TABLE OF CONTENTS

LIST OF FIGURES **5**
LIST OF TABLES **6**
LIST OF APPENDICES **6**
1 INTRODUCTION **1-1**
1.1 Longhorn Army Ammunition Plant Background **1-1**
1.2 LHAAP-29 Site Description and Background **1-1**
1.2.1 LHAAP-29 Site History 1-2
1.3 History of Investigative Activities **1-3**
1.4 Surface Water Hydrology **1-6**
1.5 Geology and Hydrogeology **1-6**
1.5.1 Shallow Unit, Modern Alluvium 1-6
1.5.2 Wilcox Formation 1-6
1.5.3 Hydrogeology 1-7
1.6 Current and Future Land and Resource Uses **1-8**
1.6.1 Current and Future Land Uses 1-8
1.6.2 Current and Future Surface Water Uses 1-8
1.6.3 Current and Future Groundwater Uses 1-9
1.7 Conceptual Site Model **1-9**
1.7.1 Nature and Extent of Contamination 1-10
1.8 Basis of Action **1-12**
1.9 Remedial Action Objectives **1-12**
1.10 Selected Remedy **1-13**
1.11 Site Cleanup Levels **1-15**
1.12 Predesign Investigation **1-17**
1.12.1 Unsaturated Zone: Temporary Piezometers 1-18
1.12.2 Building 812-F 1-18
1.12.3 Cooling Water Outfall / Ditch 1-19
1.12.4 North and South TNT Cooling Water Lines 1-19
1.12.5 Transite and Wooden TNT Wastewater Lines 1-20
1.12.6 Wooden TNT Wastewater Line 1-21
1.13 Planned Remedial Action **1-21**
2 SOIL EXCAVATION REMEDIAL DESIGN **2-1**

2.1 Design Criteria 2-1
2.2 Excavation Areas 2-1
2.2.1 Excavation E-1: B806A Area (See Figure 2-1 and Design Sheet 01C101) 2-2
2.2.2 Excavation E-2: B806D Area (See Figure 2-2 and Design Sheet 01C102) 2-3
2.2.3 Excavation E-3: Perchlorate Excavation (See Figure 2-3 and Design Sheet 01C103) .. 2-4
2.2.4 Excavation E-4: 29SG118 Location (See Figure 2-4 and Design Sheet 01C104) 2-4
2.2.5 Excavations E-5, E-6S, and E-6N: Cooling Water Outfall Ditch (See Figures 2-5 and 2-6 and Design Sheets 01C105 and 01C106) 2-5
2.3 Post-excavation Confirmation Sampling 2-7
2.4 Waste Characterization and Disposal 2-8
2.5 Backfill and Site Restoration 2-9
2.6 Other Design Considerations 2-9
2.7 Implementation of Soil Excavation Remedial Design 2-10
2.7.1 Mobilization and Site Preparation 2-10
2.7.2 Surveying 2-11
2.7.3 Soil Excavation and Disposal 2-11
2.7.4 Confirmation Soil Sampling 2-12
2.7.5 Backfilling and Site Restoration 2-13
2.7.6 Reporting 2-13
2.7.7 As-built Survey 2-13
3 IN-SITU THERMAL DESORPTION DESIGN 3-1
3.1 Design Criteria 3-1
3.2 ISTD Treatment Area 3-2
3.3 ISTD Area Characteristics 3-4
3.4 Implementation of ISTD 3-5
3.4.1 Preparation of ISTD Treatment Work Plan 3-5
3.4.2 Mobilization and Site Preparation 3-7
3.4.3 Surveying 3-8
3.4.4 Monitoring Well Installation and Sampling 3-8
3.4.5 ISTD Treatment System Installation 3-9
3.4.6 System Operation 3-11
3.4.7 Process Monitoring Requirements 3-11
3.4.8 System Decontamination and Residuals Management 3-12

3.4.9 Demobilization 3-12
3.4.10 Site Restoration 3-13
3.4.11 Reporting 3-13
4 INSPECTION, CLEANING AND PLUGGING OF PIPELINES 4-1
4.1 Design Criteria 4-2
4.2 Pipeline Removal (Excavation) Areas 4-2
4.2.1 Wooden TNT Wastewater Line Removal 4-3
4.2.2 Transite TNT Wastewater Line Removal 4-5
4.2.3 North Cooling Water Line Removal 4-6
4.3 Pipeline Video Inspection, Cleaning and Plugging 4-7
4.3.1 Transite TNT Wastewater Line 4-7
4.3.2 Cooling Water Lines 4-7
4.4 Implementation of Video Inspection, Cleaning, and Plugging 4-8
4.4.1 Mobilization and Site Preparation 4-9
4.4.2 Surveying 4-10
4.4.3 Pre- and Post-cleaning Video Inspection 4-10
4.4.4 Pipeline Cleaning 4-10
4.4.5 Pipeline Plugging 4-10
4.4.6 Waste Management 4-11
4.4.7 Demobilization 4-13
4.4.8 Reporting 4-13
5 MONITORED NATURAL ATTENUATION DESIGN 5-1
5.1 Shallow Groundwater Zone 5-3
5.1.1 VOC and Perchlorate Plume 5-3
5.1.2 Perchlorate and North Nitrotoluene Plumes 5-4
5.1.3 Middle Nitrotoluene Plume 5-4
5.1.4 South Nitrotoluene Plume 5-4
5.1.5 Shallow Groundwater Monitoring for Excavations 5-5
5.2 Intermediate Groundwater Zone 5-5
5.2.1 Intermediate Zone VOC Plume 5-5
5.3 MNA Design Criteria 5-6
5.4 MNA Implementation 5-7
5.4.1 Initial Groundwater Sampling 5-7

5.4.2 Well Installation and Development 5-9
5.4.3 Surveying 5-10
5.4.4 Long-term Monitoring 5-10
5.4.5 Reporting 5-13
6 LAND USE CONTROL REMEDIAL DESIGN 6-1
6.1 LUC Implementation 6-1
6.2 Maintenance and Monitoring Requirements 6-2
6.3 Reporting of LUC Inspection and Monitoring 6-3
6.3.1 Notice of Planned Property Conveyances 6-3
6.3.2 Opportunity to Review Text of Intended Land Use Controls 6-4
6.3.3 Notification Should Action(s) which Interfere with Land Use Control Effectiveness be Discovered Subsequent to Conveyance 6-4
6.3.4 Land Use Control Enforcement 6-4
6.3.5 Modification or Termination of Land Use Controls 6-4
7 REMEDIAL CONSTRUCTION SCHEDULE 7-1
7.1 Construction Sequence 7-1
7.2 Preliminary Construction Schedule 7-2
8 SUMMARY OF PROJECT COSTS 8-1
8.1 Summary of Project Costs 8-1
8.2 Estimating Method 8-1
8.3 Task-Based Estimates 8-1
8.3.1 Labor Rates 8-1
8.3.2 Equipment Rates 8-2
8.3.3 Earthwork 8-2
8.3.4 Monitoring Wells 8-2
8.3.5 Indirect Cost Markups 8-2
8.4 Subcontractor Quotes 8-2
8.5 Project-level Markups 8-3
8.5.1 Contingency 8-3
8.5.2 Construction Oversight and Management 8-3
9 REFERENCES 9-1

LIST OF FIGURES

(Included at the end of the report)

Figure 1-1 Site Location Map
Figure 1-2 Site Vicinity Map
Figure 1-3 Site Map
Figure 1-4 Site Topography
Figure 1-5 Site Cross Section A-A'
Figure 1-6 Site Cross Section B-B'
Figure 1-7 Groundwater Elevation Map (Shallow Zone)
Figure 1-8 Groundwater Elevation Map (Intermediate Zone)
Figure 1-9 VOCs and Perchlorate in Shallow Zone Groundwater
Figure 1-10 Nitrotoluenes in Shallow Zone Groundwater
Figure 1-11 VOCs in Intermediate Zone Groundwater
Figure 1-12 Soil Contamination and Areas of Soil Remediation
Figure 1-13 Wooden and Transite TNT Wastewater Lines
Figure 1-14 North Cooling Water Lines
Figure 1-15 South Cooling Water Lines
Figure 2-1 Excavation Area E-1
Figure 2-2 Excavation Area E-2
Figure 2-3 Excavation Area E-3
Figure 2-4 Excavation Area E-4
Figure 2-5 Excavation Area E-5
Figure 2-6 Excavation Area E-6
Figure 3-1 ISTD Treatment Area and Groundwater Sample Results
Figure 3-2 Soil Samples VOC Results
Figure 4-1 Transite TNT Pressure Pipe Excavation Area
Figure 4-2 North Cooling Water Line Excavation Area 1 Sample Results
Figure 4-3 North Cooling Water Line Excavation Area 2 Sample Results
Figure 4-4 North Cooling Water Line Excavation Area 3 Sample Results
Figure 5-1 North TNT and The Perchlorate Plumes Proposed Well Locations
Figure 5-2 Middle TNT and The VOC and Perchlorate Plumes Proposed Well Locations
Figure 5-3 Southern TNT Plume Proposed Well Locations
Figure 5-4 Intermediate Plume Proposed Well Locations
Figure 6-1 Preliminary Land Use Control Boundary

LIST OF TABLES

Table 1-1 – Summary of Aquifer Properties 1-8
Table 1-2 – Soil Cleanup Levels at LHAAP-29 1-15
Table 1-3 – Groundwater Cleanup Levels at LHAAP-29 1-16
Table 1-4 – Solid Residue Cleanup Levels at LHAAP-29 1-17
Table 1-5 – Temporary Piezometers 1-18
Table 2-1 – Excavation Areas 2-2
Table 2-2 – Excavation Areas DUs 2-7
Table 2-3 – Waste Characterization Samples Summary 2-9
Table 3-1 – Intermediate Zone Groundwater Grab Sample MC Results 3-3
Table 3-2 – Intermediate Zone Groundwater Monitoring Wells MC Results 3-3
Table 3-3 – ISTD Treatment Area 3-4
Table 4-1 – Pipeline Information Summary 4-1
Table 4-2 – Excavation Areas 4-3
Table 4-3 – Identification and Preliminary Classification of Waste Streams Associated with Pipelines 4-11
Table 5-1 – Proposed Excavation Monitoring Wells 5-5
Table 5-2 – Baseline Groundwater Monitoring 5-7
Table 5-3 – Parameters and Analytical Methods 5-9
Table 5-4 – Shallow Long-Term Monitoring Program Well List 5-11
Table 5-5 – Intermediate and Deep Long-Term Monitoring Program Well List 5-13

LIST OF APPENDICES

Appendix A - Remedial Design Drawings
Appendix B - Remedial Design Cost Estimate
Appendix C - Excavation Volume Calculations
Appendix D - ISTD Scope of Work
Appendix E - Boring and Well Construction Logs
Appendix F - EnSys TNT Soil Field Testing Fact Sheet
Appendix G - Scope of Work for TV Inspection of Pipelines
Appendix H - Annual LUC Compliance Documentation and Inspection Checklist Forms

LIST OF ACRONYMS AND ABBREVIATIONS

AECOM	AECOM Technical Services, Inc.
APP	Accident Prevention Plan
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
°C	degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
cm/sec	centimeters per second
COC	chemical of concern
COPEC	chemical of potential ecological concern
CPT	cone penetrometer test
cy	cubic yard
DHC	Dehalococcoides
DL	detection limit
DNAPL	dense nonaqueous phase liquid
DPT	direct push technology
DU	decision unit
ECP	environmental condition of property
EPA	U.S. Environmental Protection Agency
ERH	electrical resistance heating
FFA	Federal Facility Agreement
FS	feasibility study
ft	feet
GPS	Global Positioning System
GWP-Ind	medium-specific concentration for industrial use based on groundwater protection
GWTP	groundwater treatment plant
HASP	Health and Safety Plan
ID	identification
ISM	Incremental Sampling Methodology
ISTD	in-situ thermal desorption
ITRC	Interstate Technology Regulatory Council
Jacobs	Jacobs Engineering Group, Inc.
JH	estimate biased high
lf	linear feet
LHAAP	Longhorn Army Ammunition Plant
LTM	long-term monitoring
LUC	land use control
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
MC	methylene chloride
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
MNA	monitored natural attenuation
MOA	Memorandum of Agreement
MSC	medium-specific concentration
msl	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEC	National Electrical Code

NFPA	National Fire Protection Association
NPL	National Priorities List
OSHA	Occupational Safety and Health Administration
PCBs	Polychlorinated biphenyls
PCL	protective concentration level
PDI	predesign investigation
RA	remedial action
RACR	Remedial Action Completion Report
RAO	remedial action objective
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RFA	RCRA Facility Assessment
RI	remedial investigation
ROD	Record of Decision
SAI-Ind	Soil MSC for industrial use based on inhalation, ingestion, and dermal contact
SDWA	Safe Drinking Water Act
SESC	soil erosion and sediment control
sf	square feet
SVE	soil vapor extraction
TAC	Texas Administrative Code
TAT	turnaround time
TCE	trichloroethylene
TCEQ	Texas Commission on Environmental Quality
TCH	thermal conduction heating
TCLP	Toxicity Characteristic Leachate Procedure
TRRP	Texas Risk Reduction Program Tier 1 Residential Groundwater Protective Concentration Level
U.S. Army	U.S. Department of the Army
USACE	U.S. Army Corps of Engineers
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USFWS	U.S. Fish and Wildlife Service
VC	vinyl chloride
VOC	volatile organic compound

1 INTRODUCTION

This design report presents the technical basis, design methodologies, and supporting documents for the (100%) remedial design (RD) to achieve the Remedial Action Objectives (RAOs) specified in the Final Record of Decision (ROD) (HDR 2019) for the former Longhorn Army Ammunition Plant (LHAAP) Site 29 – Former TNT Production Area Group 2, located in Karnack, Texas. The RD documents were prepared for the U.S. Army Corps of Engineers (USACE), under U.S. Army Tulsa District Contract Number W912BV19D0016, Task Order No. W912BV20F0096.

Tables, figures, and appendices included in this design report provide additional information, summarize relevant data, and serve as the basis for design decisions. In addition, the design report includes the RD drawings and a cost estimate for the remedial action (RA) as **Appendix A** and **B**, respectively.

The design report was prepared based on the nature and extent of contamination determined during the Pre-Design Investigation (PDI) conducted in 2021 and 2022 (HDR 2022), the Supplemental Remedial Investigation (RI) (AECOM Technical Services [AECOM] 2016), and the Final Feasibility Study (FS) Addendum (AECOM 2017) and its supporting documents.

1.1 Longhorn Army Ammunition Plant Background

The former LHAAP is an inactive, government-owned, formerly contractor-operated and -maintained U.S. Department of Defense facility located in central east Texas (see **Figure 1-1**) in the northeastern corner of Harrison County. LHAAP is approximately 14 miles northeast of Marshall, Texas, and approximately 40 miles west of Shreveport, Louisiana. The former U.S. Army installation occupied 8,416 acres between State Highway 43 at Karnack, Texas, and the southwestern shore of Caddo Lake. The facility can be accessed via State Highways 43 and 134.

LHAAP was placed on the Superfund National Priorities List (NPL) on August 9, 1990. Activities to remediate contamination began in 1990. After its listing on the NPL, the U.S. Army, the U.S. Environmental Protection Agency (EPA), and the Texas Water Commission (currently known as the Texas Commission on Environmental Quality [TCEQ]) entered into a Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) § 120 Federal Facility Agreement (FFA) for remedial activities at LHAAP. The FFA took effect on December 30, 1991. LHAAP operated until 1997, when it was placed on inactive status and classified by the U.S. Army Armament, Munitions, and Chemical Command as excess property. Most of LHAAP, excluding LHAAP-29, has been transferred by the U.S. Army to the U.S. Fish and Wildlife Service (USFWS) for management as the Caddo Lake National Wildlife Refuge.

1.2 LHAAP-29 Site Description and Background

The site boundary of LHAAP-29 encompasses approximately 85 acres in the west-central portion of LHAAP (**Figure 1-2**). The surface features include the foundations for the former production facilities and the underground pipelines that were originally built for cooling water drainage and trinitrotoluene (TNT) wastewater conveyance. The site is currently heavily wooded. Surface runoff is collected by ditches constructed in 1942 when the production facility was built.

1.2.1 LHAAP-29 Site History

The former TNT production area was in operation from April 1943 to August 1945 as a six-line plant with a supporting acid plant. LHAAP-29 produced 400 million pounds of flake TNT using five TNT production lines (A through E) and one standby line (F). Each production line was essentially the same and consisted of four main components: an unloading area where acids and toluene were unloaded and held in tanks until ready for use, a nitrating area where TNT flakes were produced by nitrating toluene with nitric acid and oleum, a wash area where the TNT flakes were washed to remove impurities and then dried, and a loading area where the cardboard-boxed TNT was loaded onto trucks. The unloading area included aboveground holding tanks for acids (Tanks 508 and 817) and toluene (Tank 804).

TNT wastewater (red water) from the production of the TNT was sent through wooden pipelines to a storage tank and pump house and then to the TNT Wastewater Treatment Plant (LHAAP-32). The wooden red water line was installed at a depth of 3 to 5 feet (ft) below ground surface (bgs) and was clear-flushed and abandoned in place in 1946 (HDR 2019). The pipeline was approximately 4,800 ft in length, 12 inches in diameter, and coated with an asphalt material. Several trenches were excavated across the wooden line in 1993, and the wood was found to be soft and severely degraded at most locations (HDR 2019). Two samples collected (liquid sample 29WL01 and sediment/sludge sample 29WL03) identified high concentrations of 2,4,6-trinitrotoluene (2,4,6-TNT) (liquid – 3,500 micrograms per liter [µg/L] and sediment – 3,700 milligrams per kilogram [mg/kg]), but that data was later deemed unusable for environmental decision making (Jacobs, 2001). Of concern is that the deteriorated condition of the line and the potential for residual explosives may present a continuing source of groundwater contamination. Samples collected from three soil borings adjacent to the TNT wooden wastewater line were found to contain explosives that were above the medium-specific concentration for industrial use based on groundwater protection (GWP-Ind MSC). Historic soil borings 29SB09 and 29SB09R, collected from the southwestern end of the pipeline, contained 2,4,6-TNT (7.5 mg/kg and 14.7 mg/kg, respectively), while soil boring 29SB85, collected from the northwestern end of the pipeline, contained 2-amino-4,6-dinitrotoluene (2-amino-4,6-DNT) (0.9 mg/kg) and 4-amino-2,6-dinitrotoluene (4-amino-2,6-DNT) (0.3 mg/kg). Additional investigation of the TNT wooden wastewater line was conducted during the PDI in March 2021. A total of 8 trenches were excavated along the length of the wooden TNT wastewater pipeline. The TNT wooden wastewater line was exposed by excavating trenches and the line breached to collect liquid and sediment/sludge samples for explosives analysis. The pipeline was located within approximately 5 feet from the line of surface marker signs and at depths between 1.5 and 10 ft bgs. At most locations, the wooden pipeline was mostly intact and comprised of wood staves with 2-inch-wide metal bands spaced at 6-inch intervals. The wooden pipeline was also encapsulated in an asphaltic coating.

Multiple explosives were detected in all of the liquid and residue samples collected from the Wooden TNT wastewater pipeline including: 1,3-Dintrobenzene (1,3-DNB); 2,4,6-TNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; 2,4-DNT, and 4-NT. Seven of the residue samples contained concentrations of 2,4,6-TNT, 2-amino-4,6-DNT, 4-amino-2,6-DNT, and 2,4-Dinitrotoluene (2,4-DNT) that exceeded the GWP-Ind MSC. The results indicate that liquid, sediment, and the pipeline material itself may be potential sources of contamination. The pipeline at several excavated locations was also found to be in poor condition (deteriorated or cracked).

The wooden pipeline was abandoned in place and a transite TNT wastewater pipeline, which, according to 1943 records, was installed parallel to the wooden TNT wastewater pipeline approximately 5 ft to the north (Rose M. Zeiler – file review). The transite TNT wastewater line had two solid residue samples with detections of explosives that were above the GWP-Ind MSC. Solid residue sample 29WL14, collected from the southwestern end of the pipeline, contained 2,4,6-TNT (58.4 mg/kg), 2,4-dinitrotoluene (2,4-DNT) (7.21 mg/kg), 2-amino-4,6-DNT (19 JH mg/kg [JH = estimated biased high]), and 4-amino-2,6-DNT (13.3 mg/kg), while solid residue sample 29WL13 collected from the midpoint of the pipeline contained 2,4,6-TNT (526 mg/kg), 2,4-DNT (89 mg/kg), and 1,3-dintrobenzene (1,3-DNB) (1.08 mg/kg). Additional investigation of the TNT transite wastewater line conducted during the PDI in March 2021 and March 2022 detected 2,4,6-TNT and 2,4-DNT at concentrations that exceeded the GWP-Ind MSCs at four borings: boring 29SB137 contained concentrations of 2,4,6-TNT and 2,4-DNT from 3 – 4 and 11 – 16 ft bgs; boring 29SB201 contained concentrations of 2,4-DNT at levels exceeding the GWP-Ind MSC between 3 – 4 ft bgs; and borings 29SB151 and 29SB152 contained 2,4-DNT at concentrations that exceeded the GWP-Ind MSC at 3 – 4 ft bgs.

Cooling water (blue water) from the production area ran through vitreous clay main lines and discharged into an open ditch. The transite wastewater pipeline was made of concrete and asbestos material, while the vitreous clay piping also contained an asbestos wicking. There are approximately 5,000 ft of pipe in the main lines, approximately 1,680 linear ft of pipe from each production area to the main line, and 12 manholes. These lines were gravity fed and were fitted with manholes. Past investigations conducted in 2004 determined the lines contained solid residues that are contaminated with explosives at concentrations that are above the GWP-Ind MSC (solid residue). The liquid and solid residue were collected from the manholes. When the transite TNT wastewater line was unearthed in 1993, the line was reported to be in good condition. The cooling water lines discharged to the cooling water outfall/ditch near the LHAAP-29 pump house. The lines were reportedly buried at depths from 3 to 5 ft bgs or deeper.

The former production line facilities and aboveground storage tanks were demolished and removed in 1959. Components of the production facility that remain on site include concrete foundations of production and pump house buildings, open-top concrete-lined pits, most of the underground utilities, and the deteriorated wooden TNT wastewater pipeline, transite TNT wastewater pipeline, and cooling water lines. Later activities included the soak-out of out-of-specification rocket motors that took place from 1959 to the mid-1970s and involved the use of a methylene chloride-based industrial solvent at tank 801-F (HDR, 2019). Site features are shown in **Figure 1-3** and topography is provided in **Figure 1-4**.

1.3 History of Investigative Activities

A brief history of the investigative activities conducted at the LHAAP-29 is provided below. For some of the earlier investigations, LHAAP sites were organized into groups, and LHAAP-29 was included in Group 2. The group designation was deemphasized as the complexities of the individual sites increased.

- 1976: As part of the Installation Restoration Program, the U.S. Army began an environmental investigation at LHAAP followed by installation-wide assessments/investigations that included the following:

  - 1980: The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) conducted a record search to assess the impact of the LHAPP installation activities including use, storage, treatment, and disposal of toxic and hazardous materials on the environment, and defined conditions that may have adversely affected human health and the environment (USATHAMA 1980)
  - 1982: As part of the LHAAP contamination survey, Environmental Protection Systems collected six groundwater samples for laboratory analyses.
  - 1987: The U.S. Army Environmental Hygiene Agency (USAEHA) identified, described, and evaluated all solid waste management units at LHAPP as part of the Resource Conservation and Recovery Act (RCRA) permit application process. Units requiring further sampling, investigation, and corrective action were delineated (USAEHA 1987).
  - 1988: A preliminary RCRA Facility Assessment (RFA) was conducted by the U.S. Army (Maley 1988). As a result of the investigation, waste at various sites was characterized but no samples were collected.

- 1982 to 1998: Numerous investigations were conducted by the U.S. Army in a phased approach and included installation of monitoring wells and analysis of groundwater, surface water, soil, and sediment samples. The results are documented in the RI for Group 2 sites (Jacobs 2001).
- 1993 to 1999: Numerous remedial investigations to determine the nature and extent of contamination in the soil, groundwater, surface water, and sediments were conducted during Phase I, Phase II, and Phase III investigations in 1993, 1995, and 1998, respectively (Sverdrup Environmental, Inc. 1993, 1996a, 1996b, 1999). The Phase I, Phase II, and Phase III investigations at LHAAP- 29 are documented in the Group 2 Sites RI (Jacobs 2001).
- 2000 to 2002: Groundwater investigation was conducted to delineate perchlorate contamination (Solutions to Environmental Problems, Inc. 2005).
- 2002: The Baseline Human Health Risk Assessment was conducted using data from the investigations conducted through 2001 (Jacobs 2002), including the plant-wide perchlorate investigation results up to that time. The report concluded that the soil at site posed a noncarcinogenic hazard and the groundwater posed an unacceptable carcinogenic risk and noncarcinogenic hazard to the hypothetical future maintenance worker.
- 2003: An Environmental Site Assessment was completed for soil and groundwater based on previous samples collected at the site. No sampling was conducted as part of the Environmental Site Assessment (Plexus Scientific Corporation 2005).
- 2004: Additional investigations were conducted to further delineate the extent of groundwater contamination identified during previous sampling events. One new monitoring well was installed, and 20 monitoring wells were sampled in August 2004. The results of the investigation are documented in the *Data Gap Investigation* (Shaw Environmental, Inc. [Shaw] 2007a).
- 2004 to 2005: Additional investigations were conducted in December 2004 and February 2005; they included sampling soil near the TNT wastewater line, sediments from the cooling water lines, the pump house pond, the outfall ditch, and manholes along the cooling water lines. Water was also sampled at the 12 manholes along the cooling water lines. Additional groundwater monitoring well sampling was conducted in May 2005 (Shaw 2010).
- 2005 to 2008: Sampling of soil at the foundation of the former Wash House 806D was conducted in February 2005 (USACE 2005) and additional investigations were conducted in August 2006, February 2007, and February 2008 to further delineate the extent of

contamination; these investigations included the activated persulfate oxidation study report (Shaw 2010).

- 2007: Chemicals of potential ecological concern (COPECs) for the industrial sub-area, which included LHAAP-29, were identified in the Baseline Ecological Risk Assessment (BERA) (Shaw, 2007b).
- 2008 to 2009: Groundwater sampling events occurred in October 2008, January 2009, and June 2009 (Shaw 2010).
- 2010: The FS was prepared based on all available data from previous investigations through 2009 and the data collected since the risk assessment was evaluated in the FS. Data not formally submitted were incorporated into the FS. The potential soil-to-groundwater pathway was evaluated for the emerging contaminant perchlorate (found in groundwater) and the explosives posing risks or hazards in soil. The concentrations of these chemicals were compared to their TCEQ GWP-Ind MSC, which is more stringent than the soil MSC for industrial use based on inhalation, ingestion, and dermal contact (SAI-Ind) (TCEQ 2006). The data collected from the shallow groundwater sampling indicated that methylene chloride (MC) concentrations were below Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) and 1,1-DCE concentrations were above the MCL. Additionally, all volatile organic compound (VOC) groundwater data within the plumes were used to evaluate natural attenuation. The FS identified and evaluated three remedial alternatives to address the soil and groundwater contamination in the shallow and intermediate zones.
- 2011: A Final Proposed Plan (U.S. Army 2011) and Draft ROD were prepared in 2011 based on the RI, other investigation results, and the FS. During further evaluation of the RD requirements for the selected alternative, USACE determined that additional data were needed to refine the extent of the intermediate zone MC plume and to evaluate additional treatment technologies.
- 2014: A supplemental investigation was conducted and included the installation of additional wells in the intermediate zone to define the extent of the MC plume inferred to be dense nonaqueous phase liquid (DNAPL), measure aquifer parameters, and evaluate use of thermal treatment and in-situ bioremediation of the MC plume (AECOM 2016).
- 2014: A BERA Addendum was completed (AGEISS, Inc. 2014). The results of the reevaluation indicated that the replacement data collected during the data gaps investigation confirmed the conclusions of the BERA that no explosives compounds in soil should be identified as COPECs in the industrial sub-area. These results did not change the original conclusion that elevated concentrations of nitrotoluenes could pose a risk to small range ecological receptors that should be addressed as part of the remediation.
- 2017: A supplemental FS was prepared using the data collected during the supplemental investigation. A fourth alternative, In-situ Thermal Desorption (ISTD), was identified and evaluated to address the MC DNAPL plume in the intermediate groundwater zone (AECOM 2017). The shallow zone groundwater and soil remediation components of the alternatives did not change from the initial FS.
- 2019: The ROD was signed on September 19, 2019 (HDR 2019).
- 2021 - 2022: A PDI was conducted to gather additional site data to support development of the RD by refining the extent of soil contaminated by explosives in three specific areas: Building 812-F, cooling water outfall/ditch, and areas adjacent to the north and south cooling water lines and wooden and transite TNT wastewater lines.

1.4 Surface Water Hydrology

Surface runoff is collected by ditches constructed in 1942 when the production facility was built. Surface runoff from the northern part of the site (about 40 percent of the site) enters Goose Prairie Creek approximately 1,500 ft to the north and east of the site. Surface water runoff in the southern portion of the site (about 60 percent of the site) flows into a tributary of Central Creek located near the southeast portion of the site. Eventually, runoff from the two creeks enters Caddo Lake (**Figure 1-3**).

1.5 Geology and Hydrogeology

The LHAAP-29 site is located on the southern edge of the Big Cypress Bayou Floodplain, where modern alluvium directly overlies older sediments. The stratigraphy at LHAAP-29 consists of silts, sands, and clays deposited in fluvial (riverine) and fluvial-deltaic (riverine and/or marine) settings (**Figures 1-5** and **1-6**). The stratigraphic architecture of fluvial and deltaic systems is generally called “cut-and-fill” because fluvial channels are cut into floodplain sediments (silts/clays) and filled with coarser point bar and channel sediments (sands/gravels) prior to being abandoned and preserved as distinct sand/gravel bodies within a finer-grained matrix (AECOM 2014).

In general, the upper 30 ft of sediment at LHAAP-29 is alluvium associated with evolution of the modern Big Cypress Bayou, its floodplain, and its tributary streams. Underlying this are the semi-consolidated sediments of the Wilcox Formation, which consists of fluvial and fluvial-deltaic sediments deposited in the Eocene (approximately 50 million years ago). The elevation of contact between the Wilcox and overlying modern alluvium ranges from 180 to 210 ft mean sea level (msl) in the area of LHAAP-29 and is irregular because the contact is an erosional surface created by exposure of the Wilcox, fluvial incision, and reworking of the Wilcox Formation sediments.

1.5.1 Shallow Unit, Modern Alluvium

The modern alluvium consists of silts and clays (likely low transmissivity) associated with floodplain deposition as well as coarser intervals of silty sands, clayey sands, and sands associated with abandoned channel, levee, and point bar deposits (higher transmissivity). This shallow interval is heterogeneous. In cross section view (**Figures 1-5** and **1-6**), discrete sand bodies are encapsulated within the sheet-like deposits of floodplain clays and silts. When mapped in plan view, channel and levee deposits tend to be linear and point bar and splay deposits tend to be crescent-shaped. The three-dimensional depositional morphology of the sands is significant to consider when evaluating contaminant migration (that is, groundwater analytical results and plume delineation). Channel and point bar sands tend to be 10 to 15 ft thick (with the exception of a 25-ft-thick channel sand at 29WW38). Levee and splay (ruptured levee) deposits tend to be thinner, about 5 to 10 ft thick (AECOM 2014).

1.5.2 Wilcox Formation

The Wilcox sediments are semi-consolidated, despite their age (approximately 50 million years ago) and consist of a range of grain sizes similar to that found in the modern alluvium (clay to coarse sands). The depositional environment of the Wilcox Formation is similar as well, although the scale of river and delta in which the sediments were deposited was likely much larger than the Big Cypress and its tributaries. The upper Wilcox fluvial sediments transition downward into deltaic and marine sediments, although an exact depth where this transition is complete is difficult to pinpoint and would vary laterally. In cross section view (**Figures 1-5** and **1-6**), Wilcox channel and deltaic sands are significantly thicker

(more than 20 ft thick on average) than the channel and point bar deposits of the overlying modern alluvium and more laterally continuous. Levee deposits within the Wilcox are approximately 10 ft thick. In cross section view, the sands are, again, discrete bodies encapsulated within more laterally continuous clays and silts. Clay and silts were deposited in interdistributary and offshore settings (AECOM 2014).

1.5.3 Hydrogeology

There are three groundwater zones at LHAAP-29: shallow, intermediate, and deep. Semi-confining clay or silty clay layers of varying thickness separate the three groundwater zones. The bottom of the shallow groundwater zone generally extends to depths between 17 to 45 ft bgs because of the variable ground surface elevations across the site and conditions attributable to recurring drought. While less well-defined, the bottom of the intermediate zone extends to approximately 88 ft bgs. The bottom of the deep groundwater zone extends to approximately 155 ft bgs.

Based on the 2007 water levels and historic potentiometric surface maps, the predominant flow of both the shallow zone and intermediate zone groundwater is to the north/northeast based on November 2007 water levels. **Figures 1-7** and **1-8** illustrate the groundwater elevations in the shallow zone and intermediate zone, respectively. The deep zone was determined to be unaffected by site contaminants.

Hydraulic conductivity at Site 29 was estimated through slug tests conducted on several of the pre-Phase I wells and results were reported in the RI report (Jacobs 2001). Hydraulic conductivity was calculated from the slug test data using the Bouwer-Rice method. Hydraulic conductivity in the shallow saturated zone ranged from 4.94E-6 centimeter per second (cm/sec) at well 116, located on the northeastern side of the site (north of Avenue D), to a maximum value of 1.33E-3 cm/sec at monitoring well 29WW03, located in the southwestern portion of the site(north of Avenue E in production area “A”).For the intermediate saturated zone, hydraulic conductivity values ranged from a minimum value of 9.28E-5 cm/sec at well 29WW16, located in the north-central portion of the site, to a maximum value of 1.34E-3 cm/sec at well 29WW14, located in the northeastern side of the site near the cooling water line outfall into the ditch (Jacobs 2001). A pump test was conducted by AECOM in 2014 on well 29WW16. Based on the pump test, hydraulic conductivity for the intermediate zone was estimated to be between 1.08E-4 cm/sec to 4.29E-4 cm/sec. A summary of the aquifer properties derived from this pump test are summarized in **Table 1-1**.

Table 1-1 – Summary of Aquifer Properties

Well ID	Well Type	Transmissivity		Hydraulic Conductivity	Storativity	Saturated Thickness	Distance from 29WW16
		sf/day	gal/day/ft	cm/sec	unitless	ft	ft
29WW16	pumping	0.737	5.6	1.08E-4	--	2.4	--
29WW42	observation	2.19	16.5	4.29E-4	3.95E-4	1.8	23.16
29WW43	observation	6.06	45.7	3.56E-4	1.50E-4	6.0	74.22
29WW44	observation	2.86	21.6	3.15E-4	1.74E-4	3.2	35.93

Notes:
1. All wells are screened from 78 to 88 ft bgs.
2. Information is taken from Table 2 of the Pumping Test Report prepared by AECOM (AECOM, 2016).

sf/day – square feet per day
gal/day/ft – gallons per day per foot of drawdown
cm/sec – centimeter per second

1.6 Current and Future Land and Resource Uses

1.6.1 Current and Future Land Uses

LHAAP is near the unincorporated community of Karnack, Texas. Karnack is a rural community with a population of 775 (**Figure 1-2)**. The incorporated community of Uncertain, Texas, population 205, is located to the northeast of LHAAP on the edge of Caddo Lake and is a resort area and an access point to Caddo Lake (**Figure 1-2)**. The industries in the surrounding area consist of agriculture, timber, oil and natural gas production, and recreation.

LHAAP has been an industrial facility since 1942. Production activities and associated waste management activities continued until the facility was determined to be in excess of the U.S. Army's needs in July 1997 and became inactive. The plant area has been relatively dormant since that time. LHAAP is surrounded by a fence (except on the border with Caddo Lake), and current security measures at the LHAAP preclude unlimited public access to areas within the fence. The fence now represents the National Wildlife Refuge boundary. Approved access for hunters is very limited.

The reasonably anticipated future use of LHAAP-29 is as part of a national wildlife refuge. This anticipated future use is based on a Memorandum of Agreement (U.S. Army 2004) between USFWS and the U.S. Army. The Memorandum of Agreement documents the transfer process of LHAAP acreage to USFWS to become the Caddo Lake National Wildlife Refuge and will be used to facilitate a future transfer of LHAAP-29. Presently, the Caddo Lake National Wildlife Refuge occupies a little more than 7,100 acres of the 8,416-acre former installation. In accordance with the National Wildlife Refuge System Administration Act of 1966 and its amendments (16 U.S. Code 668dd), the land will remain as a national wildlife refuge unless a change is brought about by an act of Congress or the land is part of an exchange authorized by the Secretary of the Interior.

1.6.2 Current and Future Surface Water Uses

Streams on LHAAP currently support wildlife and aquatic life. While humans may have limited access to some streams during annual hunts, there is no routine human use of streams on LHAAP. The streams do not carry adequate numbers and size of fish to support either sport or subsistence fishing.

During the summer months, the streams cease flowing and/or dry up. When flowing, the streams flow into Caddo Lake, a large recreational area that covers 51 square miles and has a mean depth of 6 ft. The watershed of the lake encompasses approximately 2,700 square miles. It is used extensively for fishing and boating. Caddo Lake is a drinking water supply for multiple cities in Louisiana including Vivian, Oil City, Mooringsport, South Shore, Blanchard, Shreveport, and Bossier City.

The anticipated future uses of the streams and lake are the same as the current uses.

1.6.3 Current and Future Groundwater Uses

Groundwater in the aquifer (250 to 430 ft bgs) near LHAAP is currently used as a drinking water source. The drinking water aquifer should not be confused with the deep zone groundwater, which extends only to a depth of approximately 151 ft bgs. The deep zone groundwater and the drinking water aquifer are distinct from each other and there is no connectivity between the contaminated zone and the drinking water aquifer. Five active water supply wells near LHAAP are completed in the drinking water aquifer (**Figure 1-2**). One well is located in and owned by Caddo Lake State Park. The well is completed to a depth of 315 ft bgs and has been in use since 1935. A second well owned by the Karnack Water Supply Corporation serves the town of Karnack and is located approximately 0.3 mile northwest of town. This well is completed to approximately 430 ft bgs and has been in use since 1942. The Caddo Lake Water Supply Corporation has three wells located both north and northwest of LHAAP. These wells are identified as Caddo Lake Water Supply Corporation Wells 1, 2, and 3, and all are hydraulically upgradient of LHAAP (Jacobs 2002). These wells are completed deeper than the deepest zone of contamination at LHAAP. Because of this and the large distance between these wells and LHAAP, water removal from these wells is not expected to affect groundwater flow at the site. In addition, several livestock and domestic wells are located in the vicinity of LHAAP with depths averaging approximately 250 ft bgs.

Three water supply wells are located within the boundary of LHAAP. One well is located at the fire station; the second well is located approximately 0.35 mile southwest of the fire station. The third well is located north of the USFWS administration building for the Caddo Lake National Wildlife Refuge, near the main entrance to LHAAP. The distances from these water supply wells to LHAAP-29 are approximately 0.4, 0.2, and 0.5 mile, respectively (**Figure 1-2**). The three water supply wells were completed at a depth much greater than the zone of contamination described at LHAAP-29. None of these three wells are currently used for drinking water at LHAAP, although they may supply water for nonpotable uses. Two additional wells previously supplied water to the installation but these have been plugged and abandoned.

Although the anticipated future use of the facility as a wildlife refuge does not include the use of groundwater at LHAAP-29 as a drinking water source, the State of Texas designates all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 Texas Administrative Code (TAC) 335.563(h)(1). To be conservative, a hypothetical industrial use scenario was evaluated for risk. The future industrial scenario for LHAAP assumes limited use of groundwater as a drinking water source.

1.7 Conceptual Site Model

Explosive compound releases resulting from the manufacturing process of TNT as well as releases from process tanks and process waste pipelines are the suspected contamination sources of

explosives contamination of soil and groundwater at LHAAP-29. Releases from the rocket motor soak-out process that used MC-based solvents are the suspected contamination sources of VOCs in groundwater. The pipelines include the TNT process wastewater gravity line ("red and/or yellow liquor") that transported the TNT process wastewater to LHAAP-32 for treatment and two cooling water lines (blue water) that transported the cooling water to an outfall ditch. The remaining potential sources of contamination at the site are explosives compounds in stained soils around the foundation of former Buildings 806A and 806-D, isolated perchlorate containing soils in the northeastern portion of LHAAP-29 at a depth of 8 ft bgs, and TNT-contaminated sediment in the cooling water outfall ditch at a depth between 2 to 8 ft bgs.

The red liquor TNT wastewater line was originally installed as a wooden pipeline at a depth reported to be between 3 and 5 ft bgs and was taken out of service, clear-flushed, and abandoned in 1946 (Bate Stamp 001446, RFA, April 1988). Several trenches were excavated across the wooden line in 1993, and the wood was found to be soft and severely degraded at most locations (Sverdrup Environmental, Inc. 1993). Samples collected at that time resulted in high concentrations of 2,4,6-TNT - in the liquid and sludge (3,500 µg/l and 3,700 mg/kg, respectively), but the data were later deemed unusable for environmental decision making (Jacobs 2001). The PDI investigation conducted by HDR from 2021 to 2022 confirmed the presence of explosives in water and residue samples taken from the pipeline above the GWP-Ind MSC. The transite TNT wastewater pipeline was installed in the 1940s and was added parallel to and north of the wooden line to carry the TNT wastewater. The transite TNT wastewater line has solid residues contaminated with explosives at concentrations above the GWP-Ind based on sample results collected during the PDI investigation conducted in 2021 to 2022.

Two blue cooling water lines, called cooling water line north and cooling water line south, exist at LHAAP-29 and range from 8 to 18 inches in diameter. These are gravity-fed lines and are constructed of vitrified clay pipe with manholes. These lines have solid residues contaminated with explosives at concentrations above the GWP-Ind MSC (solid residue).

Contamination in the form of explosive compounds, VOCs, perchlorate, and metals from rocket motor washout and TNT production is present in the shallow groundwater zone at LHAAP-29 and poses potential risk to the hypothetical future maintenance worker. In the intermediate groundwater zone, concentrations of VOCs and arsenic are present, with MC posing the highest risk. At monitoring well 29WW16, the MC concentrations in the intermediate zone are approximately half the solubility limit, which indicates a potential for the presence of DNAPL. The horizontal extent of contamination in the shallow and intermediate groundwater zones is presented in **Figures 1-9**, **1-10**, and **1-11**.

The soil and groundwater at LHAAP-29 may pose an unacceptable risk for hypothetical future maintenance workers. Even though no impact to surface water from groundwater has been established (Shaw 2007c), the migration pathway of groundwater contaminants to surface water is being considered for remediation along with soil, soil to groundwater, and future industrial groundwater use.

1.7.1 Nature and Extent of Contamination

Contamination was found in the soil, groundwater (shallow and intermediate zones), and liquid and solid residue remaining in the cooling water and TNT process wastewater underground lines. The chemicals of concern (COCs) are toxic and carcinogenic. Since a high cancer risk is associated with

exposure to groundwater from this region of the intermediate zone, such residual source material may be considered a principal threat waste at LHAAP-29.

1.7.1.1 Groundwater

Shallow zone groundwater COCs are volatile organic compounds (VOCs) such as trichloroethene (TCE), 1,2-dichloroethane (1,2-DCA), and daughter products. Other COCs include perchlorate, explosives (2,4-DNT, 2,6-DNT, 2(o)-nitrotoluene [2(o)-NT], 3(m)-nitrotoluene [3(m)-NT], 4(p)-nitrotoluene [4(p)-NT]) and metals (arsenic, mercury, nickel, selenium).

The shallow zone plumes for VOCs and perchlorate are shown in **Figure 1-9**. The most recent maximum concentrations of COCs in shallow groundwater were all detected in samples collected from monitoring well 29WW15 and included TCE at 344 µg/l, 1,2-DCA at 5,520 µg/l, and perchlorate at 16,800 µg/l. The calculated volume of the perchlorate plume is 4 million gallons. There are three shallow zone plumes for explosives, as shown on **Figure 1-10**. The highest concentration of 2,4-DNT detected was 50.9 µg/l at monitoring well 29WW05. The highest concentration of 2,6-DNT was 239 µg/l at monitoring well 116. The highest concentrations of 2(o)-NT, 3(m)-NT, and 4(p)-NT are 8,140 µg/l, 451 µg/l, and 1,400 µg/l, respectively, also reported at monitoring well 116. The volumes of the VOC, perchlorate, and NT plumes are reported to be approximately 9 million gallons in the April 2010 Final Feasibility Study (Shaw Environmental), assuming a total porosity of 0.25 (or 25 percent) with a thickness ranging from 5 to 10 ft (Shaw 2010).

Intermediate zone groundwater COCs are MC, TCE and daughter products of TCE including 1,1-DCE and cis-1,2-DCE, 1,2-DCA, and arsenic. The intermediate zone plume for VOCs is shown on **Figure 1-11**. The highest concentration of MC detected was 10,300,000 µg/l at monitoring well 29WW16 in 2008. The most recently reported MC concentration in a 2014 sample collected from this well was 8,260,000 µg/l. Other COCs identified for the intermediate groundwater zone are degradation (daughter) products of TCE that have been nondetect or have not been detected above their SDWA MCLs; however, given historic results and the high detection limits (DLs) at 29WW16, it has been assumed that concentrations of 1,2-DCA and TCE still exceed their SDWA MCLs. The calculated volume of contaminated groundwater that exceeds MCLs is 650,000 gallons, assuming a total porosity of 0.40 (or 40 percent) with an average thickness of 15 ft based on drilling observations (HDR 2019).

There are four groundwater monitoring wells installed in the deep zone. As demonstrated by previous sampling results from these wells, the deep groundwater zone at LHAAP-29 is not affected.

1.7.1.2 Soil

Soil COCs and COPECs are explosives (2,4,6-TNT, 2,4-DNT, 2,6-DNT) and perchlorate. **Figure 1-12** shows the approximate areas of contaminated soil. The maximum 2,4,6-TNT concentration in the soil is 26,000 mg/kg. Other explosives, 2,4-DNT and 2,6-DNT, have maximum concentrations of 8,000 mg/kg and 15 mg/kg, respectively. Additionally, perchlorate has been detected in the soil at a maximum concentration of 8.6 mg/kg.

1.7.1.3 TNT Wastewater Lines

Line solid residue COCs from the transite TNT wastewater line are explosives (2,4,6-TNT, 2,4-DNT, 1,3 DNB, 2-amino-4,6-DNT, and 4-amino-2,6-DNT). Contaminated explosive solid residue remains within the transite TNT wastewater line at concentrations above the GWP-Ind MSCs, but access to

the pipe is limited to the inlets and outlets unless the pipe is penetrated. Additionally, the line is buried 3 ft bgs or deeper. The gravity flow portion of the line is approximately 3,000 linear ft. The pressurized portion of the line is approximately 1,000 linear ft (lf). The line is in good condition. **Figure 1-13** shows the TNT wastewater lines at LHAAP-29 and the soil, sediment, and solid residue sampling results and MSC values.

The wooden TNT wastewater line was previously flushed and abandoned. The results from limited soil samples collected near the line indicate there has been one release to the surrounding soil above the cleanup levels. The line is buried 3 ft bgs or deeper, but the deteriorated condition of the line and the potential for residual explosives may present a continuing source of groundwater contamination. Water and residue samples collected from the TNT wooden wastewater pipeline show concentrations of 2,4,6-TNT, 2,4-DNT, 2-amino-4,6-DNT, and 4-amino-2,6-DNT above the GWP-Ind MSC

1.7.1.4 Cooling Water Lines

Line solid residue COCs from the vitrified clay cooling water lines are explosives (2,4,6-TNT, 2,4-DNT, 2,6-DNT, 2-amino-4,6-DNT, and 4-amino-2,6-DNT). The solid residues from the manholes are contaminated with explosives at concentrations that are above the GWP-Ind (solid residue). Soil samples collected during the PDI showed concentrations at 4 borings where explosives (2,4,6-TNT, 2,4-DNT) exceeded the GWP-Ind MSC at depths ranging between 3 and 16 ft bgs. The north and south vitrified clay cooling water lines are accessible through manholes, and the liquid and solid residue contents from the manholes were sampled. There are approximately 5,000 ft of pipe in the main lines, approximately 1,680 lf of pipe from each production area to the main line, and 12 manholes. **Figures 1-14** and **1-15** show the cooling water lines and sampling results of the line contents at LHAAP-29.

1.8 Basis of Action

The remedial action selected in the ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment. Actions for groundwater are necessary to address the potential for human health risks in the unlikely event there is an attempt to use groundwater as a potable water source.

Actions for soil are necessary to address human health risk including the pathway from soil to groundwater and ecological risks. **Tables 1-2**, **1-3**, and **1-4** present the COCs and the final cleanup levels for soil and groundwater, with groundwater COCs for the shallow zone and the intermediate zone listed separately and solid residue remaining in pipelines, which takes into account both ecological and human receptors.

The SDWA MCL is the cleanup level for the groundwater COCs. In the absence of Federal drinking water standards, cleanup levels are based on the TRRP Tier 1 Residential Groundwater Protective Concentration Levels (PCLs).

1.9 Remedial Action Objectives

The RAOs for LHAAP-29 presented in the 2019 ROD address contamination associated with the media at the site and consider the future uses of LHAAP surface waters, land, and groundwater. The RAOs are:

- Protection of human health by preventing human exposure to the contaminants in the soil, sediment, transite TNT wastewater line, vitrified clay cooling water lines, and groundwater
- Protection of human health and the environment by preventing the migration of contaminants to groundwater and surface water from potential sources in the soil, sediment, and process lines (TNT wastewater and cooling water)
- Protection of human health and the environment by preventing contaminated groundwater from migrating into nearby surface water
- Protection of ecological receptors by preventing exposure to the contaminated soil and sediment
- Return of groundwater to its potential beneficial uses, wherever practicable within a timeframe that is reasonable given the particular circumstances of the site [40 Code of Federal Regulations § 300.430(a)(1)(iii)(F)]

The above RAOs recognize EPA's policy to return all groundwater to beneficial uses, based on a nonbinding programmatic expectation in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and is consistent with the NCP regulations requiring the lead agency to establish RAOs specifying contaminants and media of concern, potential exposure pathways, and remediation goals.

In accordance with these RAOs, and consistent with the NCP, groundwater will be returned to its beneficial use. In the absence of Federal drinking water standards, the groundwater cleanup level at the site is the TRRP Tier 1 Residential Groundwater PCL and is protective of human health and the environment.

1.10 Selected Remedy

As described in the 2019 ROD, the final selected remedy for LHAAP-29 includes:

- Contaminated soil removal with off-site disposal to protect the hypothetical future maintenance worker and ecological receptors and eliminate the soil-to-groundwater pathway. Additional confirmation soil sampling during the RD implementation will be needed to define the final excavation extent and volume of soil contaminated with explosives near former Building 812-F and in the cooling water outfall/ditch and may identify additional areas for soil removal adjacent to the north and south cooling water lines as well as the wooden and transite TNT wastewater lines.
- Flushing, inspection, and plugging of the transite TNT wastewater line and the vitrified clay cooling water lines to eliminate potential exposure from residual contamination. Confirmation sampling of the transite TNT wastewater line and vitrified clay cooling water lines during the RD implementation may result in additional excavations. The wooden TNT wastewater line will be removed as described in this RD.
- Monitored natural attenuation (MNA) in the shallow groundwater zone to confirm protection of human health and the environment by documenting that contaminated groundwater remains localized with minimal migration and that COCs are being reduced to cleanup levels.
    - Performance objectives will be evaluated after 2 years of MNA. During those 2 years, monitoring will be quarterly. If MNA is found to be effective, it will be continued, and long-term monitoring (LTM) will be semiannual for 3 years. In subsequent years, LTM will be annual until the next 5-year review and annually thereafter until recommended otherwise

by the 5-year review. The monitoring and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue until recommended otherwise at the 5-year review.

  - If MNA is found to be ineffective, a contingency remedy to enhance MNA would be developed. The contingency remedy would consist of injection of bioremediation amendments to enhance degradation of the groundwater contaminants at selected locations based on data available at the time it is determined MNA is not successful. Development and specific description of the contingency remedy would be presented in a Remedial Design/Remedial Action Work Plan (RD/RAWP) that would be prepared in the future following implementation of MNA.

- ISTD treatment will be performed for the DNAPL MC plume in the intermediate groundwater zone to reduce concentrations to levels amenable to MNA. One of two ISTD treatment process options—electrical resistance heating (ERH) or thermal conduction heating (TCH)—will be selected during the RD implementation.
- MNA will be implemented in the intermediate groundwater zone following successful implementation of ISTD to confirm protection of human health and the environment by documenting that the contaminated groundwater remains localized with minimal migration and that contaminant concentrations are being reduced to cleanup levels. As identified in the ROD, the trigger level or target value for successful ISTD treatment of MC in the intermediate zone is 8,000 μg/l. Performance monitoring will be conducted at a frequency necessary to evaluate the effectiveness of the in-situ treatment, with sampling and LTM conducted as described for the shallow groundwater MNA.
- Groundwater monitoring will be conducted to evaluate inorganic COCs. The need to continue groundwater monitoring for this purpose will be evaluated at 5-year reviews.
- The land use control (LUC) objectives include maintaining the integrity of any current or future remedial or monitoring systems and preventing the use of groundwater contaminated above cleanup levels as a potable water source. The groundwater treatment and MNA remedial components include a groundwater monitoring system that will be used to characterize the condition of the groundwater during the period the groundwater remedy is in place until the groundwater remediation goals are achieved, and to demonstrate achievement of the groundwater remediation goals when the groundwater remedy is complete. As a part of this groundwater remedy, the U.S. Army will maintain the remedial and monitoring systems associated with the groundwater remedies until these components of the remedy are no longer needed to achieve cleanup levels and cleanup levels have been achieved. During the period of operation of the groundwater remedy, if any of the elements of the remedial and groundwater monitoring systems are damaged, destroyed, or become ineffective, they will be repaired or replaced with suitable components to ensure that the remedial and groundwater monitoring systems are able to provide data of the quality necessary to determine the progress of and eventual completion of this component of the remedy. The actions to be taken to implement these LUC objectives and requirements will be provided by modifying the *Comprehensive Land Use Control (LUC) Management Plan, Former Longhorn Army Ammunition Plant, Karnack, Texas* and detailed in the LUC RD (see **Section 6**).
- The LUC for prohibition of groundwater use (except for monitoring and testing) shall be implemented and shall remain in place at the site until the COCs (that is, all hazardous substances, pollutants, and contaminants found at the site at cleanup levels) in soil and groundwater remaining at the site are reduced below levels that would support unlimited use

and unrestricted exposure. An LUC RD is provided in Section 6 as the land use component of the RD. The LUC RD contains implementation and maintenance actions, including periodic inspections. The long-term groundwater and surface water monitoring and MNA performance monitoring plan is presented in **Section 6**. The recordation notification for the site, which will be filed with Harrison County, will include a description of the LUCs.

- The LUC restricting land use to nonresidential shall be implemented until it is demonstrated that surface and subsurface soil and groundwater COCs (that is, all hazardous substances, pollutants, and contaminants found at the site at cleanup levels) are at levels that allow for unlimited use and unrestricted exposure.
- The LUC to maintain the integrity of any current or future remedial or monitoring systems will remain in place until the levels of COCs (that is, all hazardous substances, pollutants, and contaminants found at the site at cleanup levels) in groundwater are met. The LUC to prohibit groundwater use (except for environmental monitoring and testing) as a potable source will remain in place until the levels of COCs (that is, all hazardous substances, pollutants, and contaminants found at the site at cleanup levels) in soil and groundwater allow for unlimited use and unrestricted exposure.

The groundwater treatment and MNA remedial components include a groundwater monitoring system that will be used to characterize the condition of the groundwater during the period the groundwater remedy is in place until the groundwater remediation goals are achieved, and to demonstrate achievement of the groundwater remediation goals when the groundwater remedy is complete. As a part of this groundwater remedy, the RD includes maintenance of the remedial and monitoring systems associated with the groundwater remedies until these components of the remedy are no longer needed to achieve cleanup levels.

1.11 Site Cleanup Levels

From the 2019 ROD, site cleanup levels for the soil, shallow and intermediate zone groundwater and solid residue in the transite TNT wastewater line and the cooling water drain line are listed in **Tables 1-2** through **1-4** (HDR 2019).

Table 1-2 – Soil Cleanup Levels at LHAAP-29

COCs	**GWP-Ind MSC[1] (mg/kg)**
Perchlorate	7.2
2,4,6-Trinitrotoluene	4.7[2] 5.1[3]
2,4-DNT	0.042
2,6-DNT	0.042

Notes:
1. GWP-Ind MSC – TCEQ soil MSC for industrial use based on groundwater protection
2. Applies to 0 to 3 ft bgs
3. Applies from 3 ft bgs to groundwater interface

Table 1-3 – Groundwater Cleanup Levels at LHAAP-29

Medium	COC	Cleanup Level
Shallow Zone Groundwater		**MCL (µg/L)**
	Trichloroethene	5
	1,2-Dichloroethane	5
	1,1-Dichloroethene[1]	7
	cis-1,2-Dichloroethene[1]	70
	trans-1,2-Dichloroethene[1]	100
	Vinyl chloride[1]	2
	Arsenic	10
	Mercury	2
	Selenium	50
		TRRP Tier 1 Residential Groundwater PCL (µg/L)
	2,4-Dinitrotoluene	1.3
	2,6-Dinitrotoluene	1.3
	2-Nitrotoluene	4.1
	3-Nitrotoluene	240
	4-Nitrotoluene	57
	Perchlorate	17
	Nickel	490
Intermediate Zone Groundwater		**MCL (µg/L)**
	Methylene chloride	5
	Trichloroethene	5
	1,2-Dichloroethane	5
	1,1-Dichloroethene[1]	7
	cis-1,2-Dichloroethene[1]	70
	trans-1,2-Dichloroethene[1]	100
	Vinyl chloride[1]	2
	Arsenic	10

Notes:
1. Trichloroethene daughter products

Table 1-4 – Solid Residue Cleanup Levels at LHAAP-29

Medium	COC	Cleanup Level
Transite TNT Wastewater Line		**GWP-Ind MSC[1] (mg/kg)**
	1,3-Dinitrobenzene	1
	2,4,6-Trinitrotoluene	5.1
	2,4-Dinitrotoluene	0.042
	2-amino-4,6-Dinitrotoluene	1.7
	4-amino-2,6-Dinitrotoluene	1.7
Cooling Water Drain Line		**GWP-Ind MSC[1] (mg/kg)**
	2,4,6-Trinitrotoluene	5.1
	2,4-Dinitrotoluene	0.042
	2,6-Dinitrotoluene	0.042
	2-amino-4,6-Dinitrotoluene	1.7
	4-amino-2,6-Dinitrotoluene	1.7

Notes:
1. GWP-Ind MSC – TCEQ soil MSC for industrial use based on groundwater protection

1.12 Predesign Investigation

A PDI was conducted to gather additional site data to support development of the RD. The objectives of the PDI field investigations were as follows:

- Further evaluate the extent of explosives-contaminated soil present at levels exceeding the TCEQ GWP-Ind MSC at Building 812-F;
- Further evaluate the extent of explosives-contaminated soil present at levels exceeding the TCEQ GWP-Ind MSC at the cooling water outfall/ditch;
- Further evaluate the extent of explosives-contaminated soil present at levels exceeding the TCEQ GWP-Ind MSC located adjacent to the north and south cooling water lines and wooden and transite TNT wastewater lines; and
- Provide extent and volume data for contaminated soil that supports development of the RD.

The PDI included the following components:

- Advancement of 24 direct push technology (DPT) boreholes adjacent to Building 812-F to 16 ft bgs or top of the saturated zone and installation of one temporary piezometer and the collection of up to four soil samples per boring and analysis for explosives via method SW8330A and/or SW8321A;
- Advancement of 15 DPT borings around the cooling water outfall/ditch to 8 ft bgs or top of the saturated zone and installation of two temporary piezometers and the collection of up to four soil samples per boring and analysis for explosives via method SW8330A and/or SW8321A;
- Advancement of 48 DPT borings adjacent to the north and south cooling water lines and wooden and transite TNT wastewater lines to 16 ft bgs or top of the saturated zone, the installation of three temporary piezometers, and the collection of sediment / sludge samples from within the wooden TNT wastewater line, where excavated, for explosives analysis via method SW8330A. Borings included the collection of up to four soil samples per boring and analysis for explosives via method SW8330A and/or SW8321A; and

- Completion of a topographic survey of the LHAAP-29 site delineated to 1-foot contour intervals that include the Refuge boundary.

A summary of key investigation findings from the PDI is provided below.

1.12.1 Unsaturated Zone: Temporary Piezometers

Depth to groundwater and saturated soils varies across the site depending on elevation and subsurface soil type. Depth to groundwater ranges between 7.5 ft bgs to greater than 20 ft bgs, with depth to the water table tending to be greater in the eastern part of the site. Temporary piezometers were installed to find depth to the water table and thickness of unsaturated soils, thereby providing information on vertical extent of contaminated soils to be removed during the remedial action. The depth to groundwater is summarized in **Table 1-5**. Locations for piezometers PZ-2 through PZ-10 are shown on **Figures 1-13** to **1-15**.

Table 1-5 – Temporary Piezometers

Piezometer ID	Installed Depth	Observed Groundwater Depth
	ft bgs	ft bgs
PZ-1	20	NA[1]
PZ-2	20	14.1
PZ-3	20	10.7
PZ-4	20	14.9
PZ-5	20	>20[2]
PZ-6	20	7.5
PZ-7	20	8.7
PZ-8	20	10.3
PZ-9	20	15.5
PZ-10	20	>20[2]

Notes:
1. After 24 hours, well did not equilibrate. A replacement well (PZ-4) was installed several feet away from this location.
2. After 24 hours, well remained dry.

NA = not available

1.12.2 Building 812-F

The building 812-F location is shown on **Figure 1-3**. Twenty of the 24 DPT borings showed detections of explosives (2,4,6-TNT, 2,4-DNT, and 2,6-DNT) that exceeded the GWP-Ind MSCs. The explosives 2,4-DNT and 2,6-DNT were the most widespread of the contaminants detected. A clear pattern of distribution is not distinct; however, the northeastern section of the grid had the greatest vertical depth (that is, 3 to 15 ft bgs) of contamination, while in the southwestern section the explosives were typically detected at deeper intervals (14.5 to 15 ft bgs). With the water table measured at 14.9 ft bgs, contamination extends to the top of the water table. The horizontal extent of contamination has not

fully been defined. Therefore, additional soil characterization through confirmation sampling will be required during the implementation of the RD.

1.12.3 Cooling Water Outfall / Ditch

The cooling water outfall/ditch location is shown on **Figure 1-3**. Two of the 15 DPT borings showed detections of explosives (2,4,6-TNT, 2,4-DNT, and 2,6-DNT) that exceeded the GWP-Ind MSCs. Contamination is centered on DPT locations 29SB126 and 29SB129 on the northeast side of the site at depths ranging between 8 ft bgs (29SB129) and 2 ft bgs (29SB126). Depth to the water table in this area was measured at 14.1 ft bgs, well below the vertical extent of contaminated soil. Samples collected during the March 2022 field investigation did not reveal any explosives present at concentrations above the DL so the extent of contamination downgradient is limited. Boring locations 29SB184 and 29SB185, which were offset 10 ft to either side of 29SB129, and 29SB186 collocated with 29SB129 did not detect any explosives. Samples collected to the southeast and southwest from 29SB129 and 29SB126 did not detect explosives above the DL.

Three excavation areas are identified along the cooling water outfall/ditch. Based on the results of the PDI two of the three excavation areas have been delineated. The final limits for the un-delineated excavation area will be based on visual observations and the results of confirmation samples collected as part of the remedial action.

1.12.4 North and South TNT Cooling Water Lines

The north and south cooling water lines are shown on **Figure 1-3**. Three of the 16 DPT borings collected adjacent to the North Cooling Water Line and former production buildings showed detections of the explosive 2,4,6-TNT that exceeded the GWP-Ind MSC. DPT borings 29SB138 and 29SB139 were collected adjacent to the main line, while 29SB143 was collected at a spur line to a production building. Boring 29SB138 was collected adjacent to historic sample MH10 and the cooling water line. Historic sample MH-10 was a residue sample taken from sediment within the line. Sample 29SB138 had detections of 2,4,6-TNT in samples taken from below the pipeline (11 to 12 ft bgs and 15 to 16 ft bgs). Concentrations of 2,4,6-TNT were similar in concentration between the historic and DPT soil sample (~7 mg/kg) indicating a potential release from the pipe. Samples collected adjacent and offset from 29SB138 (29SB190, 29SB192, and 29SB193) during the March 2022 field investigation did not detect explosives above the DL. Groundwater in piezometer PZ-6 was measured at 7.5 ft bgs, the shallowest encountered across the site. The nearest piezometer (PZ-8) to PZ-6 and boring location 29SB138, by comparison, was measured at 10.3 ft bgs.

Sample 29SB139 was collected adjacent to the main North Cooling Water Line. A single detection of 2,4,6-TNT that exceeded the GWP-Ind MSC was detected at the shallow depth of 3 - 4 ft bgs. Deeper samples collected below this interval had lower detections of 2,4,6-TNT that were below the GWP-Ind MSC which provides vertical delineation for this location. Two offset borings advanced during the March 2022 field investigation did not detect explosives in any of the samples collected. Based on the results, the vertical and horizontal extent of 2,4,6-TNT contamination has been delineated.

Boring 29SB143 was installed adjacent to a former production building and had detections of 2,4,6-TNT at all intervals (3 to 16 ft bgs) that exceeded the GWP-Ind MSC. Collocated boring 29SB191 did not contain 2,4,6-TNT above the DL but did have levels of 2,4-DNT greater than the GWP-Ind MSC at a depth of 9.5 to 10 ft bgs. Samples collected from two borings offset from 29SB143 did not detect

any explosives. With no additional detections of explosives at the offset boring locations, contamination at 29SB143 is horizontally delineated. The closest piezometers to this location are PZ-10 (430 ft south) and PZ-4 (460 ft northeast). PZ-10 (approximate surface elevation of 230.3 ft msl) remained dry at 20 ft bgs (approximate elevation of 210.3 ft msl) and PZ-4 (approximately surface elevation of 225 ft msl) had a depth to groundwater of 14.9 ft bgs (approximate elevation of 210.1 ft msl). The surface elevation at 29SB143 is approximately 228 ft msl. Assuming a water table depth of 210.1 ft msl, the depth to groundwater at 29SB143 is estimated to approximately 17 ft bgs. This water depth is in line with historic depth-to-water measurements collected from well 29WW18, which is located in the vicinity of this excavation area. Based on the depth interval of contaminated soil and depth to the water table, the vertical extent of the excavation to remove 2,4,6-TNT contamination will terminate at the groundwater table estimated to be at 17 ft bgs.

2,4,6-TNT was the single explosive detected along the South Cooling Water Line. Three of the 13 DPT soil boring locations contained 2,4,6-TNT at concentrations that exceeded the DL but at levels below the GWP-Ind MSC. Collocated borings installed during the March 2022 field investigation did not detect explosives in any of the samples collected.

1.12.5 Transite and Wooden TNT Wastewater Lines

The transite and wooden TNT wastewater lines are shown on **Figure 1-3**. The explosives 2,4,6-TNT and 2,4-DNT were detected at concentrations that exceeded the GWP-Ind MSCs at three borings. Samples collected from boring 29SB137 contained concentrations of 2,4,6-TNT and 2,4-DNT from 3 to 4 and 11 to 16 ft bgs. Sample 29SB137 was collected adjacent to the transite line that branches off to the north to Building 32. Historic sample 32WL05, a solid residue sample collected from within the transite pipeline had similar concentrations of 2,4,6-TNT detections; this sample is located approximately 825 ft to the north of DPT 29SB137. One sample collected from offset boring 29SB201 detected concentrations of 2,4-DNT at levels exceeding the GWP-Ind MSC between 3 – 4 ft bgs. Samples collected from collocated boring 29SB200 and offset boring 29SB202 did not show explosives above the DL. Based on the depth interval of contaminated soil (3 to 4 ft bgs and 11 to 16 ft bgs) and depth to the water table (15.5 ft bgs), the vertical extent of excavation in this area will be limited by the water table, estimated to be 16 ft bgs. The overall horizontal extent of contamination is expected to be limited due to the release being from the TNT wastewater pipeline. The final horizontal limits for this excavation area and the excavation area surrounding 29SB201 will be based on visual observations (i.e., stained soil) and the results of confirmation samples collected as part of the remedial action.

Borings 29SB151 and 29SB152 contained 2,4-DNT at concentrations that exceeded the GWP-Ind MSC at a depth of 3 to 4 ft bgs; subsequent deeper samples collected below this interval had nondetects of explosives. Samples collected from borings offset from 29SB151 did not contain explosives above the DL. Sample 29SB152 had a single detection of 2,4-DNT that exceeded the cleanup level at the 3 to 4 ft bgs interval. This sample was collected adjacent to the transite pipeline in an area that did not have historic data. These results indicate there are breaks along the transite pipe within the vicinity of these sample locations and these sections of pipe will be removed as part of the removal of the wooden TNT wastewater line.

Three samples (29SB134, 29SB155, and 29SB156) collected adjacent to the Wooden TNT Wastewater Line had low detections of 2,4,6-TNT that did not exceed the cleanup levels.

1.12.6 Wooden TNT Wastewater Line

The wooden TNT wastewater lines are shown on **Figure 1-3**. A total of 8 trenches were excavated along the length of the wooden TNT wastewater pipeline. The TNT wooden wastewater line was exposed by excavating trenches and the line breached to collect liquid and sediment/sludge samples for explosives analysis. The pipeline was located within approximately 5 ft from the line of surface marker signs and at depths between 1.5 and 10 ft bgs. At most locations, the wooden pipeline was mostly intact and comprised of wood staves with 2-inch-wide metal bands spaced at 6-inch intervals. The wooden pipeline was also encapsulated in an asphaltic coating.

Multiple explosives were detected in all of the liquid and residue samples collected from the Wooden TNT Wastewater line including: 1,3-DNB; 2,4,6-TNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; 2,4-DNT, and 4-NT. Seven of the residue samples contained concentrations of 2,4,6-TNT, 2-amino-4,6-DNT, 4-amino-2,6-DNT, and 2,4-DNT that exceeded the GWP-Ind MSC. The results indicate that liquid, sediment, and the pipeline material itself may be potential sources of contamination. The pipeline at several excavated locations was also found to be in poor condition (deteriorated or cracked). Based on the analytical results and observations of the pipeline condition, the Wooden TNT Wastewater line will be excavated and removed as part of the RD. Depth to the pipeline varies between 1.5 ft bgs to 10 ft bgs.

1.13 Planned Remedial Action

The planned RA will likely be implemented in phases. The phases for the RA at LHAAP-29 are listed below. An anticipated sequence for construction is discussed in **Section 7.1.**

- Phase I:
    - Excavation of unsaturated soil in identified excavation areas exceeding GWP-Ind.
    - Video Inspection, cleaning and plugging of the transite TNT wastewater and cooling water pipelines
    - Excavation of TNT wooden wastewater line
    - Implementation of ISTD treatment to remove high concentrations of MC in the intermediate groundwater zone
    - Groundwater sampling and well installation for implementing MNA
    - Implementation of LUCs:
        - To prohibit access to the contaminated groundwater except for environmental monitoring and testing only.
        - To restrict land use to nonresidential.
        - To maintain the integrity of any current or future remedial or monitoring systems.
- Phase II:
    - LTM for MNA Evaluation

The contingency remedy for LHAAP-29 includes the below design elements. Development and specific description of the contingency remedy are not included in this RD.

- If MNA is found to be ineffective, a contingency remedy to enhance MNA would be developed. The contingency remedy would consist of injection of bioremediation

amendments to enhance degradation of the groundwater contaminants at selected locations based on data available at the time it is determined MNA is not successful.

The focus of this RD is remedial components included in phases I and II.

Prior to implementing any of the construction activities the Contractor will be required to submit a RAWP. This work plan shall be submitted, reviewed, and approved by USACE prior to mobilization. The RAWP shall be prepared in accordance with the requirements of this design report and the approved Installation Wide Work Plan (Bhate, 2018) and shall contain the following minimum information.

- Health and Safety Plan/Accident Prevention Plan including decontamination procedures meeting the requirements of the USACE Safety and Health Manual (EM-385-1-1);
- Proposed schedule and sequence of operations;
- Locations for proposed staging and equipment areas, layout for access roads, stormwater and erosion control measures, temporary facilities, and the location of decontamination stations;
- Borrow sources and haul routes;
- Means and methods for implementing the remedial design (excavations, pipe removal, well installation, well abandonment, backfilling, site restoration). ISTD is anticipated to be submitted in a separate work plan as noted below;
- Waste management activities and identification of disposal facilities;
- Spill contingency measures that will be implemented in the event of a spill;
- Quality Assurance Project Plan (QAPP) for samples collected as part of the remedial action. A separate QAPP is anticipated to be prepared and included as part of the ISTD Work Plan;
- Incorporate separate RAWPs that will be provided by vendors or subcontractors who will provide support to the Contractor. This includes but is not limited to, the pipe inspection and cleaning contractor and the ISTD contractor.

2 SOIL EXCAVATION REMEDIAL DESIGN

The basis of the soil excavation remedial design and implementation is provided in this section. The leaching of contaminants from the unsaturated soil to groundwater was considered a complete transport pathway that will be addressed during the RA. The ROD identified unsaturated soil in six target areas containing explosive compounds at concentrations that exceeded their respective GWP-Ind MSCs, which have the potential to leach to groundwater at concentrations exceeding the MCLs:

1. Excavation Area E-1: B806A Area
2. Excavation Area E-2: B806D Area
3. Excavation Area E-3: Perchlorate Excavation
4. Excavation Area E-4: 29SG118 Location
5. Excavation Areas E-5: Cooling Water Outfall Ditch
6. E-6S, and E-6N: Cooling Water Outfall Ditch

In addition to the above excavation areas, soil samples were collected along the TNT transite wastewater line and the north and south cooling water lines to evaluate whether there were any additional areas with unsaturated soil contamination that required excavation and off-site disposal. Excavation areas identified as a result of these samples are discussed further in **Section 4**. Locations for these excavation areas are presented on drawing sheet G002 (**Appendix A**).

2.1 Design Criteria

The soil design criteria define the goals to be achieved and are based on the RAO of protection of human health and the environment by preventing the migration of contaminants to groundwater from potential sources in the soil. The soil cleanup levels included in the 2019 ROD are listed in **Table 1-2** and provided below:

- 2,4,6-Trinitrotoluene 4.7 mg/kg (0 to 3 ft bgs), 5.1 mg/kg (3 ft bgs to groundwater interface)
- 2,4-DNT 0.042 mg/kg
- 2,6-DNT 0.042 mg/kg
- Perchlorate 7.2 mg/kg

The design for soil includes excavation of the contaminated soil above the cleanup levels or until groundwater is encountered. If the contamination is present at or below groundwater level, the excavation will be terminated at the depth where saturated conditions are encountered. No confirmation samples will be collected from the bottom of excavations that terminate at the groundwater table.

2.2 Excavation Areas

The extent of excavations identified for each area was based on sample results collected during the previous investigations and sample results collected during the PDI conducted in 2021 and 2022. Limits for excavation areas were extended to the next closest clean sample, when available. For excavation areas where no samples were available to define the excavation limits, the excavation limit was then estimated based on engineering judgement and information known about the suspected release pattern for the contamination source. The final excavation limits for un-delineated areas will be based on visual indications of contamination and confirmation samples collected as part of the RA.

The overall estimated in-place volume for removal and off-site disposal is approximately 5,790 cubic yards (cy). This volume is greater than the estimate provided in the ROD (3,900 cy). Volumes estimated for excavations associated with the TNT wastewater and cooling water pipelines are not included in this estimate and are discussed in **Section 4**. Details for the development of excavation limits are discussed for each area below. A summary of the excavation areas is provided in **Table 2-1** and the backup calculations for the volumes are included in **Appendix C**.

Table 2-1 – Excavation Areas

Area ID	Area[1]	Excavation Depth	Volume[2]
	sf	ft bgs	cy
E-1	1,520	5	280
E-2	700	1	30
E-3	3,220	10 - 14[3, 4]	1,420
E-4	4,860	5 - 16[3, 4]	3,250
E-5	2,840	3 - 9[4]	690
E-6N	1,770	1	70
E- 6S	1,380	1	50
		Total Volume	5,790

Notes:
1. Area excludes outer limits determined by sloping.
2. Volume excludes clean soils removed as part of sloping required to the complete excavations.
3. The excavation will terminate at the groundwater table. The excavation depth has been ended 1 ft below the observed water table to account for fluctuations in the groundwater table.
4. Excavation depths at E-3, E-4, and E-5 are not uniform.

Excavations will be limited to the removal of contaminated soils in the unsaturated zone and deeper excavations will be terminated at the groundwater table. To aid in determining the depth to groundwater in the vicinity of the excavation areas, piezometers were installed to a depth of 20 ft bgs as part of the 2022 PDI activities (**Section 1.12.1**). Based on the results, the depth to groundwater was observed between 7.5 ft bgs to approximately 15.5 ft bgs, with depth to the water table tending to be greater in the eastern part of the site. Two piezometers (PZ-5 and PZ-10) did not encounter groundwater and indicates groundwater in this area is greater than 20 ft bgs. The water table is anticipated to fluctuate over time. To account for this fluctuation, the depth of excavations anticipated to be terminated at the groundwater table have been assumed to extend one ft beyond the water table depth observed during the 2022 investigation.

Material excavated along slopes constructed to facilitate completion of the excavations will be stockpiled separately from the contaminated soils. These soils will then be tested for explosive compounds and if soils meet the cleanup levels, will be used to backfill excavations once areas are approved for backfill.

2.2.1 Excavation E-1: B806A Area (See Figure 2-1 and Design Sheet 01C101)

Excavation area E-1 is in the vicinity of former Building 806-A which was used as a Wash House where TNT flakes were washed to remove impurities and generated red liquor wastewater. The wash out

areas included a Wash House (806 building), several aboveground holding tanks, and shallow concrete lined pits. A covered conveyor connected the Wash House with the Nail House (808 building) in the Loading Area. TNT wastewater (red liquor) was generated at each of the Wash Areas and was collected by a 12-inch underground wood stave pipeline (wooden TNT wastewater pipeline). This wooden TNT wastewater pipeline was later replaced with a 6-inch transite pipeline. The red liquor flowed by gravity through the pipeline to a storage tank and pump house located at the northeastern end of the area adjacent to 16th Street. Wastewater was then pumped from this location through a 6-inch underground bored wood pipeline to the TNT Waste Disposal Plant (LHAAP-32) located approximately ¼ mile northwest of the LHAAP-29 site. The transite pressure wastewater pipeline is located parallel to and approximately 5 ft to the east of this wooden TNT wastewater pressure pipeline.

This area was first identified as a target area based on the existence of stained surface soil surrounding the foundation of the former Wash House and a 2,4,6-TNT exceedance in surface soils at location 29SB09R (BERA dated 2013), which is located in the vicinity of the wooden TNT wastewater pipeline northwest of the former Wash House building. As discussed below, the wooden TNT wastewater pipeline exists in a deteriorated condition and will be excavated as part of the RA. The area surrounding sample location 29SB09R will therefore be excavated along with the wooden pipeline and is not included as part of the excavation area for E-1.

Two soil borings (29SB93 and 29SB92) were completed at random locations within the stained soil area as part of the supplemental RI to evaluate the concentration of explosive compounds in the stained soil area surrounding the former Wash House building foundation. If concentrations were below the soil cleanup objectives, no further action would be proposed in this location. Boring 29SB92 was located southwest of the former building. Two samples were collected with 2,6-DNT results exceeding the soil cleanup standard at both depths (0 to 2 ft bgs and 2 to 4 ft bgs). Boring 29SB93 was located in the northeast area of the former building footprint. One sample (0 to 2 ft bgs) was collected from this boring which did not have any exceedances for explosive compounds. The excavation area surrounding this sample is defined to the northeast by sample location 29SB93 and to the southeast by historic sample 29SB10. No samples are available to delineate the southwest and northwest boundaries and current estimation of these limits is based on the extent of stained soil identified during historic investigations. The final limit will be verified by visual observation and the collection of confirmation samples.

Results for samples used to assist in delineating the excavation limits for E-1 are shown on **Figure 2-1**. Excavation area E-1 is approximately 1,520 square feet (sf) and is planned to be excavated to a depth of 5 ft based on the depth of contamination observed at 29SB92. The in-place volume for this area is estimated to be approximately 280 cy. The excavation is assumed to be completed using a 1H:1V slope. This will increase the total volume for this excavation to 330 cy.

2.2.2 Excavation E-2: B806D Area (See Figure 2-2 and Design Sheet 01C102)

Excavation area E-2 was identified as a target area based on the existence of stained surface soil southwest of the former Wash House building foundation in this area and a 2,4,6-TNT exceedance at sample location 29DLineWHW01. During the 2014 supplemental RI three boring locations (29SB94, 29SB95, and 29SB96) were drilled 20 ft from 29DLineWHW01 to the southwest, southeast, and northwest. No samples were completed northeast as clean samples already existed from historic sample locations 29DLineWHC01 and 29DLineWHC02. Samples were collected from 0 to 1 ft bgs

from all locations with the exception of four borings (29DLineWHC01, 29SB96, 29DLineWHC02, and 29DLineWHW01) which had samples collected from 0 to 0.5 ft bgs. Results from 29SB94 and 29SB96 were nondetect. Results from 29SB95 had a concentration of 2,4,6-TNT of 3.28 mg/kg at 0 to 1 ft bgs, which is below the cleanup standard of 4.7 mg/kg.

Delineation of excavation area E-2 is provided via sample locations 29SB94, 29SB95, 29SB96 and 29DLineWHC01 and is shown on **Figure 2-2**. The excavation encompasses an area of 700 sf and will be excavated to a depth of 1 ft bgs. The in-place volume is estimated to be 30 cy. The collection of confirmation samples will be used to verify cleanup objectives are met at this location.

2.2.3 Excavation E-3: Perchlorate Excavation (See Figure 2-3 and Design Sheet 01C103)

Excavation area E-3 was identified as a target area based on perchlorate concentrations detected in soil at 29SB86 (8.6 mg/kg at 6 to 8 ft bgs). As part of the 2014 supplemental RI, seven new borings (29SB101 to 29SB107) were drilled and soil samples were collected for perchlorate analysis. Four soil borings (29SB102 and 29SB104 to 29SB106) were drilled approximately 20 ft from 29SB86 and the remaining three borings (29SB101, 29SB103, and 29SB107) were drilled 40 ft from 29SB86.

Sample results from borings 29SB103, 29SB102, 29SB105, and 29SB107 had perchlorate concentrations less than the soil cleanup standard and were used to define the boundary of the E-3 excavation as shown on **Figure 2-3**. The E-3 excavation is approximately 3,220 sf and will consist of two excavation depths. The north portion (1,600 sf) will be excavated to 13 ft bgs and the south portion (1,620 sf) will be excavated to 10 ft bgs. As indicated in Footnote 3 of Table 2-1 the volume estimate is based on an excavation depth of 14 ft bgs which is one foot below the observed groundwater table in order to account for fluctuations in the groundwater table. Vertical delineation of the southern portion of the excavation is defined by sample 29SB104. No vertical delineation is defined for the north portion and a deeper excavation may be necessary based on results of confirmation samples collected during the RA. Deeper excavations will be limited by the depth of groundwater which is 13 ft bgs based on depth-to-water measurements collected in 2022. No bottom confirmation samples will be collected for excavations stopped at the groundwater table. Excavations will be backfilled once confirmation samples meeting the cleanup levels have been received. The estimated in-place contaminated volume is 1,420 cy with a total volume of 1,800 cy assuming the excavation will be completed using a 1H:1V slope.

2.2.4 Excavation E-4: 29SG118 Location (See Figure 2-4 and Design Sheet 01C104)

Excavation area E-4 was identified as a target area based on explosive compound results detected in soil at 29SG118 completed during the 2014 supplemental RI. Samples for explosive compounds were collected at this location due to a strong, sweet odor observed during drilling. The sample location was completed southwest of former Building 812-F which was reportedly used as an acid and fume recovery house as part of the TNT production process and is also in the vicinity of a cooling water service line that carried cooling water from former Buildings 801-F and 803-F. Results for explosive compounds were greater than the cleanup standard at depths of 6 ft bgs (0.138 mg/kg of 2,4-DNT) and 10 ft bgs (17.1 mg/kg of 2,4-DNT and 3.42 mg/kg of 2,6-DNT) at sample location 29SG118. Eight soil borings were conducted approximately 10 ft from the 29SG118 location during the PDI. Results from samples collected from these locations indicate contaminated soil extend beyond the PDI sample locations collected to the northeast, southeast, and southwest of the original sample location. Additional samples were collected in 2021 and 2022 to further delineate this area. These samples

were generally collected 15 ft or more from the impacted samples. Samples collected at boring locations 29SB174 and 29SB182 had no detections of 2,4-DNT and 2,6-DNT. All other locations had exceedances of explosives at one or more depth intervals as shown on **Figure 2-4**. The excavation limits were revised to extend out beyond additional boring locations that were identified with impacts. The area still remains undefined spatially and confirmation samples will need to be collected to verify the cleanup objectives have been met in this area. Explosive concentrations greater than the soil cleanup levels extend to a depth of 15 to 16 ft bgs. The depth for this excavation will end at the groundwater table, estimated to be 15 ft bgs based on depth-to-water measurements collected as part of the PDI. As indicated in Footnote 3 of Table 2-1 the volume estimate is based on an excavation depth of 16 ft bgs which is one foot below the observed groundwater table in order to account for fluctuations in the groundwater table.

The estimated area for excavation E-4, excluding the top of slope area, is approximately 4,860 sf with the majority of the area assumed to be excavated to 15 ft bgs and smaller portions excavated to 5 and 8 ft bgs. The excavation limit is shown on **Figure 2-4.** Because this area has not been delineated horizontally, the extent of excavation could be enlarged during the RA depending upon results of confirmation samples collected as part of the RA. The depth will be defined by the groundwater table and no bottom confirmation samples will be collected for areas dug to the top of the groundwater table. The excavation is currently estimated to be 3,250 cy which includes a 30% contingency for sloping and uncertainties in the excavation limit. Because the excavation will be ended at the groundwater table and no confirmation samples will be collected a single monitoring well will be installed in the vicinity of this excavation following restoration. The newly installed monitoring well will be screened at the shallow water table to provide long term monitoring of the shallow groundwater in this area.

2.2.5 Excavations E-5, E-6S, and E-6N: Cooling Water Outfall Ditch (See Figures 2-5 and 2-6 and Design Sheets 01C105 and 01C106)

Sediment sampled in cooling water pipelines identified concentrations of contaminants exceeding the soil cleanup levels. As a result, investigations were conducted along the open ditch historically used to convey cooling water to the Neutralization House for treatment. Samples along the ditch identified two areas of contamination that required remedial action. These areas have been identified as excavation areas E-5 and E-6.

Excavation area E-5 is approximately 180 ft from the pipeline discharge points and surrounds historic surface soil sample location 29SD46 (46,000 mg/kg of 2,4,6-TNT). To further define this area, four additional sample locations (29SB110 to 29SB113) were completed as part of the 2014 supplemental RI. Based on results horizontal delineation was provided on the southwest, northwest, and southeast boundaries. Sample 29SB112, collected northeast of the original sample had explosive concentrations greater than the cleanup levels in the surface soil and between 2 to 4 ft bgs. Location 29SB113 was then collected as a step out from 29SB112 to define the northeast limit. Results for this location all met the soil cleanup levels. As part of the PDI, four samples were collected closer to 29SD46 to potentially reduce the extent of excavation in this area. Based on results from these sample locations (29SB128 and 29SB127) the southwest and southeast boundaries of the excavation were moved closer to the original sample location. Location 29SB126 northeast of the original sample location had a detection of 2,6-DNT (0.178 mg/kg) greater than the soil cleanup limit at 1 to 2 ft bgs, but no other detections at deeper depths which provides horizontal and vertical delineation for 29SB112 (2,6-DNT at 2 to 4 ft bgs). Location 29SB113 collected during the supplemental RI is still used to provide overall

horizontal delineation to the northeast. PDI location 29SB129, northwest of the original sample location, was impacted from 3 to 8 ft bgs with explosive compounds greater than the soil cleanup levels. Additional samples were collected in 2022 to define the limits of 29SB129. This location has now been delineated for depth by 29SB186 and 29SB184 and the northwest boundary along the road has been shifted inward slightly based on results of 29SB184 and 29SB185. Location 29SB126 has been vertically and horizontally delineated by results from 29SB183.

The estimated excavation area for E-5, excluding the top of slope area, is 2,840 sf and is divided into three depths and is shown on **Figure 2-5**. The most southern portion (1,480 sf) is estimated to be excavated to a depth of 9 ft bgs, the middle portion (1,100 sf) is estimated to be excavated to a depth of 4 ft bgs and the north portion (260 sf) is estimated to be excavated to a depth of 3 ft bgs. The estimated in-place volume is 690 cy with a total estimated volume of approximately 930 cy assuming excavations will be completed using a 1H:1V slope.

Excavation area E-6 is located along the cooling water ditch at the culvert that conveys water beneath Avenue D and includes area on the north side of Avenue D at the discharge end of the culvert. Historic surface sample locations with exceedances included locations 29SD13 and subsurface soils in GPS-12. Based on exceedances at both the inlet and outlet of the culvert, it is possible contaminated sediment may exist in the culvert beneath Avenue D that would also require removal.

To delineate the contaminated soils surrounding 29SD13, located south of Avenue D, samples were collected from four locations (29SB114 to 29SB117), during the 2014 supplement RI, at approximately 30 ft from the original sample location (**Figure 2-6**). No explosive compounds were detected at any of the sample locations. Four additional borings (29SB130 to 29SB133) were completed as part of the 2021 PDI at approximately 20 ft from the original sample location to reduce the overall excavation area. Results from these locations were nondetect and provide horizontal delineation for the south portion of the excavation area.

Sample location GPS-12 located north of Avenue D had a concentration of 2,4,6-TNT in surface soil that exceeded the cleanup standard. One additional soil sample (29SB15R) conducted as part of the BERA completed in 2013 had no concentrations of explosive compounds and is used to provide delineation to the northeast of this sample location. No other additional samples have been collected in the vicinity of this sample location. As a result, the extent of excavation for the north portion is estimated to the northwest, southwest, and southeast and is based on a 20 ft distance from the original sample location. The vertical extent for this excavation is estimated to be 1 ft bgs.

Excavation area E-6 is broken up into the north (E-6N) and south (E-6S) excavations and is shown on **Figure 2-6**. It is assumed that any sediment inside the existing culvert beneath Avenue D is also contaminated and will be removed as part of the RA. The north excavation area is approximately 1,770 sf and will be excavated to 1 ft bgs for an estimated in-place volume of approximately 70 cy. The south excavation area is approximately 1,380 sf and will be excavated to 1 ft bgs for an estimated in-place volume of approximately 50 cy for a total estimated volume of 120 cy. The excavation is expected to be bounded on the southwest by the road and the culvert. The southeast and northwest limits are expected to remain inside the drainage ditch, but because there are no samples defining these limits visual observations and confirmation samples will be needed to verify remaining soils meet the cleanup objectives for the site.

2.3 Post-excavation Confirmation Sampling

Post-excavation confirmation samples will be collected using the incremental sampling methodology (ISM) presented by the Interstate Technology Regulatory Council (ITRC). Using this methodology, each excavation area will be broken into a specified number of decision units (DUs) from which a minimum of 30 incremental samples will be collected on an evenly spaced grid over the DU. The 30 incremental samples are the default number of increments recommended by the ITRC ISM Guidance Document (ITRC, October 2020). The incremental samples collected from each DU will be combined to provide one sample which will then be shipped to the laboratory for analysis.

DUs for the excavation areas will be based on each sidewall and bottom of the excavation areas in order to assess whether the estimated mean of COCs for each sidewall and bottom has been effectively reduced to levels below the cleanup limits. The DUs for the excavation areas are identified on design drawing sheets 01C101 through 01C108 (Appendix A) The areas for DUs will vary for each excavation. Areas for sidewall DUs will be between 20 sf to 400 sf. Areas for bottom DUs will be between 700 sf to 5,400 sf. For excavation areas where bottom depths vary such as E-3, E-4, and E-5, a DU will be identified for each bottom depth proposed and each interior sidewall will be a separate DU. Sidewalls deeper than 5-ft are further broken up into increments of 5-ft or less in order to provide safe egress/ingress into the excavation for sample collection. The total number of DUs identified for each of the excavation areas are summarized in **Table 2-2**.

Table 2-2 – Excavation Areas DUs

Area ID	Proposed Decision Units
E-1	5
E-2	5
E-3	18
E-4	23
E-5	16
E-6N	5
E- 6S	5
NC-1[1]	13
NC-2[1]	13

Note:
1. Refer to Section 4.0 for further details.

Each incremental sample will consist of approximately 33 grams of soil that will be combined to comprise a single soil sample of 1 kilogram. Incremental samples will be collected within 2 to 6 inches of the exposed soil surface from each DU and will be placed in a clean container (such as a bucket, bowl, bag, or jar). The incremental samples will be collected in an evenly spaced grid across the entire DU. The process will be repeated until the total increments now representing the single ISM confirmation sample have been placed together in the single container. The ISM confirmation samples will then be packaged in coolers with ice and shipped to the laboratory for analysis.

For excavations deeper than 5 ft, the collection of incremental samples for sidewall DUs will require a phased approach. Incremental samples are anticipated to be collected at 4 or 5 ft depth intervals and analyzed by the laboratory. The results from the sample collected for each DU will be compared to

the cleanup levels. If the result from a DU exceeds the cleanup levels, the excavation will then be expanded laterally or will be deepened by sloping and benching in accordance with OSHA requirements to provide safe egress and ingress for incremental sampling along the sidewalls at the deeper depths. This process of sample collection will continue until the final excavation depth is achieved.

Three replicate samples will be collected from one bottom DU and one sidewall DU for each excavation area. Replicate samples will be collected as described above from different areas of the grid laid out for the original incremental samples. The purpose for collecting replicate samples is to evaluate whether the sampling design is providing sufficiently accurate results of the DU mean concentrations. If replicates determine accuracy is insufficient the sampling design will be revaluated and modified to provide more accurate results. Modifications of the sampling design would likely include an increase in the number of increments collected to form the DU sample for those DU samples that do not meet the requirements for reproducibility. Replicate samples will be used to calculate the relative standard deviation and the confidence interval using the 95% confidence limit to evaluate the reproducibility of the results. An acceptable relative standard deviation will be less than 30%. Because the same release pattern is expected for each of the excavation areas replicate samples will be collected from one sidewall DU for each excavation area. The results for the replicates collected from the sidewall DU for each excavation area will dictate whether the number of incremental samples need to be increased for all the sidewall DUs for that excavation area. Replicates will be collected for the DU sidewall and bottom having the greatest surface area for each excavation area.

Additional excavation will be conducted for each DU if contaminants above the cleanup levels are detected in the DU confirmatory sample. Based on the DUs identified in **Table 2-2,** approximately 103 confirmation samples are estimated to be collected from the excavation areas and 54 replicate samples (6 from each excavation area).

The results of the sample collected from each DU will be reviewed to verify the cleanup levels have been met. If the confirmation sample is above the cleanup level, additional soil will be removed (2 ft laterally and 1 ft vertically). After each subsequent excavation, additional confirmation samples will be collected from the excavation DU (bottom and/or wall(s)) as needed. The excavation depth will continue to be deepened until the bottom confirmation sample meets the cleanup level or the groundwater table is reached. Once the groundwater table is reached, no samples will be collected. For the lateral extent of the excavation, this process of excavation and collection of additional sidewall confirmation samples will continue until the cleanup levels are attained.

Excavations associated with pipeline removals will use discrete samples for confirmation sampling. Further information for the collection of confirmation samples for these areas are discussed in **Section 4.2.1.**

2.4 Waste Characterization and Disposal

The contaminated excavated material will be transported and disposed of off site at approved disposal facilities in compliance with all Federal, State, local regulations. Waste characterization samples will be collected at a rate of one sample for every 250 cy (or as otherwise required by the disposal facility) of excavated soil to characterize the waste, or as otherwise required by the disposal facility. Estimates of waste characterization samples that will be collected from each area are summarized in **Table 2-3**.

Table 2-3 – Waste Characterization Samples Summary

Area ID	Disposal Volume (cy)	Estimated Number of Waste Samples
E-1	280	1
E-2	30	1
E-3	1,420	6
E-4	3,250	13
E-5	690	3
E-6N	70	1
E- 6S	50	1
	Total Samples	26

It is anticipated that soil will be classified as nonhazardous. Samples will be analyzed for the analytes required by State and Federal regulations, and the selected waste disposal facility.

2.5 Backfill and Site Restoration

Following the receipt of clean confirmation samples for a given excavation area, clean fill dirt will be placed in the excavation and compacted as described in **Section 2.7.5** (specification for backfill placement, compaction, and testing to be included in the RAWP). The backfill material shall be coarse-grained soils classified by ASTM D2487 as well-graded gravel (GW), poorly graded gravel (GP), silty gravel (GM), clayey gravel (GC), well graded sand (SW), poorly graded sand (SP), or combination, that is free of debris, roots, wood, scrap material, vegetation, refuse, soft unsound particles, and frozen, deleterious, or objectionable materials. The maximum particle diameter shall be no greater than 3 inches. Unstained broken up concrete with a diameter no greater than 3 inches can also be used as backfill above the groundwater table. The top six inches of backfilled areas shall be suitable for future vegetation growth and shall consist of natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one-inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth with a minimum organic content of 2.75 percent and soluble salts less than 0.5 milliohms per centimeter. The top six inches of soil shall be amended if necessary to have a pH range between 5.5 to 7.0.

Borrow source material will be considered clean if all contaminants (metals, explosives, perchlorate, VOCs, semi-volatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs)/pesticides) are below the lower of the TCEQ Risk Reduction Standard No. 2 MSCs industrial use standards (GWP-IND or SAI-IND). Approximately 6,400 loose cy of clean backfill will be brought on site. Borrow source samples will be collected at a rate of one per 1,000 cy of borrow soil.

The site will be reseeded with a native grass and wildflower mix with guidance from USFWS.

2.6 Other Design Considerations

Several of the bridges at LHAAP have weight limits. Routes for trucks filled with excavated soil as well as for trucks bringing clean backfill from borrow sources will be selected with coordination from USFWS. Additional gates may need to be unlocked to allow access to and from LHAAP from another gate besides the main gate in Karnack to avoid bridges where weight limits may be exceeded with loaded trucks.

2.7 Implementation of Soil Excavation Remedial Design

This section describes the remedial action field activities planned at the site for the unsaturated soil excavation. A RAWP for the unsaturated soil excavation and off-site disposal will be prepared and implemented by the Contractor. Prior to initiation of the field activities performed as part of the RAWP, the regulators will be notified at least 15 days in advance. Site-specific activities are described in associated subsections. The construction sequence for soil excavations is outlined below and described in detail in the following subsections:

- Mobilization and Site Preparation
- Surveying
- Soil Excavation and Disposal
- Confirmation Soil Sampling
- Backfilling and Site Restoration
- Reporting
- As-built Survey

2.7.1 Mobilization and Site Preparation

The following field activities will be conducted as part of the mobilization and site preparation activity.

- **Site Safety and Health: Site Safety and Health:** The responsibility for the development, implementation, and enforcement of the Accident Prevention Plan (APP) and Health and Safety Plan (HASP) lies with the Contractor and its health and safety personnel. The APP/HASP will be developed by the Contractor including programs for accident prevention, personnel protection, medical surveillance, site control/decontamination, emergency response/contingency planning, and air monitoring. The Contractor's APP/HASP will be submitted to the regulator for approval prior to the commencement of any on-site activities.
- **Mobilization:** Appropriate personnel, subcontractors, and equipment necessary to perform excavation and disposal will be mobilized to the site.
- **Site Access**: U.S. Army will be responsible for providing site access needed to complete the work. Improvement of the site access road using geotextile and additional gravel may be performed to allow trucks and heavy equipment to enter and exit the site safely. USFWS will be consulted regarding any improvements to minimize impact to the surrounding terrain to the degree possible.
- **Preconstruction Documentation**: Prior to the start of any site preparation activities, a preconstruction video/photographic recording of the excavation areas will be conducted. This recording will document the existing conditions of the site, and any other features of interest on and adjacent to the site. The Contractor will enlist the services of a qualified surveyor, licensed in the State of Texas, to field verify the existing site conditions. This preconstruction survey will identify and mark-out the limits of construction, limits of excavation, existing site topography, property boundaries, and capture any and all structures and other existing physical features of the site.
- **Clearing**: Prior to the mobilization, work locations for overhead and ground level accessibility will be evaluated. In areas that have excessive vegetation and/or tree growth, a backhoe or other appropriate earthmoving equipment will be used to clear the areas to allow equipment

access. Grubbing is not anticipated. Clearing shall consist of the felling, trimming, and cutting of trees and other vegetation, as required to perform the work.

- **Utility Mark-outs**: After coordinating with underground utility locators for utility clearances, excavation locations and areas that require surface soil removal will be located and staked.
- **Soil erosion and sediment controls (SESCs):** SESCs will be installed at the site where necessary to prevent the migration of sediment into non contaminated areas and existing drainage swales. The controls anticipated for use include but are not limited to the installation of silt fence around the area of disturbance, and hay bales and diversion berms to control stormwater flow. Additional controls to prevent the migration of sediment may be employed if necessary. A Stormwater Pollution Prevent Plan (SWP3) will be prepared as part of the RAWP.
- **Decontamination:** Equipment and personnel decontamination procedures should be included and detailed in the HASP. Temporary decontamination pads shall be shown on the drawings included as part of the RAWP and shall be constructed at approved on-site locations to decontaminate equipment and prevent cross-contamination between the excavation areas.

2.7.2 Surveying

The limits of excavation and locations of soil confirmation samples will be surveyed using Global Positioning System (GPS) equipment. A professional land surveyor licensed in the State of Texas will survey the final horizontal excavation limits, bottom of the excavation surface, and restored surface to the nearest 0.01 foot.

2.7.3 Soil Excavation and Disposal

The limits and plans for excavation are described in **Section 2.2**. Excavation of soils will consist of preparing each excavation area, excavating contaminated soils and stockpiling for loadout into trucks for off-site disposal. Uncontaminated soils excavated from slopes needed to complete excavations deeper than 3 ft bgs, will be stockpiled separately, and used as backfill when excavations are deemed complete based on results from confirmation samples. When excavations depths are reached, confirmation samples will be collected, followed by surveying of the excavation limits and confirmation sample locations, then backfill, and restoration.

2.7.3.1 Area Preparation

The areas to initially be excavated, as shown on the design drawings, will be first established using the GPS and excavation limits will be physically marked with survey stakes, pin flags, paint, or other appropriate markings. Clearing of vegetation and concrete foundations in the excavation areas will largely be conducted using conventional equipment. A temporary decontamination station will be constructed near each of the excavation areas as needed. Most of the site is heavily wooded and tree clearing will be necessary to gain access to excavation areas and prepare areas for equipment and material staging. Contaminated stockpile areas will be encircled with a berm covered with polyethylene sheeting to prevent cross contamination of clean areas with impacted soils.

Concrete structures inside the boundaries of excavation areas will be removed as part of the excavation. Concrete that is not stained or visibly contaminated will be broken up and reused as backfill in excavated areas above the groundwater table. Concrete visually determined to be contaminated will be broken up into pieces for disposal at an approved facility. Concrete will be broken up into pieces that can easily be loaded into trucks for off-site disposal. Concrete taken off-site for disposal is assumed to be classified as nonhazardous material.

2.7.3.2 Soil Excavation and Disposal

Excavations will be completed to the initial limits shown on **Figures 2-1** to **2-6**. It is anticipated that all excavations greater than 3 ft will be accomplished using a side slope of 1H:1V.

A selected disposal facility will require sample collection and/or evaluation of existing soil data for characterization of the waste and may provide pre-excavation acceptance of contaminated soil. If provided, pre-excavation acceptance will allow direct loading of contaminated soil and avoid staging and double handling of material. In these instances, the soil will be removed from the excavation and placed directly in transport trailers or dump trucks for immediate transport to the disposal facility. Licensed transporters will be used to haul the excavated soil to the preapproved landfill for disposal. If the contaminated soil is determined to be hazardous, it will be transported to a preapproved hazardous waste disposal facility.

If the direct loading is not implemented, then, the excavated soil will be temporarily staged on plastic sheeting adjacent to the excavation before being loaded into trucks for off-site disposal. The excavated soil stockpile will be covered by polyethylene sheeting to protect the pile from rain and reduce the potential for erosion and contaminated soil runoff.

Composite samples will be collected from the contaminated stockpiled material at a rate of one sample per 250 cy (or as otherwise required by the disposal facility) and analyzed for the necessary analytes to meet all State and Federal requirements and to obtain acceptance at the selected disposal facility. Each composite sample will consist of equal parts of five samples collected at evenly spaced locations within the stockpile. Once characterized, contaminated soil will be loaded into dump trucks and removed from the site for disposal in accordance with State and Federal regulations. Loading of trucks will be coordinated with USFWS to ensure that load ratings for bridges along the haul route out of the refuge are not exceeded.

2.7.3.3 Stormwater Management

Stormwater will be diverted away from and around open excavation areas using temporary diversion ditches, berms, or other methods. Water that collects in the bottom of open excavation areas during storm events will be removed, as needed, to keep the excavation progressing. Water that has come into contact with impacted soil will be considered impacted and will be managed as contaminated water. Collected stormwater will be pumped to fractional tanks for disposal off site. The Contractor shall describe stormwater management controls to be implemented in the RAWP.

2.7.4 Confirmation Soil Sampling

Confirmation samples will be collected as described in **Section 2.3**. Confirmation soil sampling will be conducted concurrently with excavation and will document that the remaining soil meets the established cleanup levels as shown in **Table 1-2**. After the initial excavation, confirmation samples will be collected from the designated DUs for each excavation area. Excavation will continue until concentrations in the soil are less than the soil cleanup levels for DU sidewalls and DU bottoms. In excavations where the groundwater table is breached, no samples will be collected from the DU bottom.

If contaminants are detected above their cleanup levels during the confirmation sampling, subsequent excavations will be performed at least one additional foot deeper or 2 additional ft laterally. Following

each subsequent excavation, confirmation samples will be collected to determine whether soils are below the cleanup levels. This process will continue until soils along the DU sidewalls meet the cleanup levels and the DU bottom of the excavation has reached the groundwater table or has also reached the soil cleanup levels. Once groundwater is encountered, the excavation depth will be considered complete, and no bottom confirmation samples will be collected.

2.7.5 Backfilling and Site Restoration

The backfill operations will proceed after excavation confirmation samples have been received and confirmed to meet the soil cleanup levels. The excavation areas will be backfilled with soil excavated from slopes of the excavation area and imported clean backfill (specifications for backfill placement, compaction, and testing to be included in the RAWP). Clean backfill will be placed in 1-foot lifts and compacted to a minimum density of 80% of ASTM D698 (Standard Proctor). Following placement density testing will be conducted in accordance with ASTM D1556/D1556M/D6938. Tests will be conducted at each lift at randomly selected locations for every 2,500 sf or for each excavation area if the areal extent is less than 2,500 sf.

Prior to placement, the subgrade surface shall be scarified to a depth of 6 inches. Sloped surfaces steeper than 1 vertical ft to 4 horizontal ft shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. Backfill material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

After backfilling is complete, the area will be graded, with a mound approximately one foot above finished grade to allow for settling without creating a depression and positive drainage. Grading will be accomplished in a manner that will not create swales or areas where ponding of water will occur. The fill surface will be made smooth and free from ruts or indentations at the end of any working day when significant precipitation is forecast. Further specifications for backfill placement, compaction, and testing will be included in the RAWP.

The top six inches will consist of soil suitable for vegetative growth. The surface will be reseeded with a native grass and wildflower seed mixture selected in coordination with USFWS.

2.7.6 Reporting

After the soil excavation remedial action has been completed, a removal action completion report will be prepared to document the implementation of the remedial action. The removal action completion report will include a description of the remedy as constructed, a discussion of any problems encountered during construction along with their resolution, a description of any changes to the design, and quantities and concentrations of contaminants removed. The report will also include documentation of all waste manifests or waste disposal tickets and results of all analysis.

2.7.7 As-built Survey

Final restoration will be documented by an as-built survey drawing. The survey will include the location of all soils removed indicating the surveyed limits of the excavation and location of all documentation samples. Information will be certified by a State of Texas licensed Engineer.

3 IN-SITU THERMAL DESORPTION DESIGN

The installation and operation of ISTD will follow the completion of the excavation activities described in **Section 2**. Investigations completed as part of the RI Addendum delineated the DNAPL MC plume present in the intermediate groundwater zone. The ISTD treatment consists of the application of heat to the subsurface to mobilize COCs. A variety of methods may be applied to generate heat, including ERH and TCH. TCH is applicable to sites with low to moderate groundwater flow rates and treats VOCs effectively in both saturated and dry conditions. ERH delivers electricity through subsurface media via an array of electrodes and treats VOCs effectively in saturated conditions only. ERH is less efficient in areas with permeabilities greater than 10^{-3} cm/sec. The presence of metal debris and pipes may prevent uniform heating under the ERH application. The heat generated by electrical resistance typically can raise subsurface temperatures to around the boiling point of water. The steam produced from pore-water serves as a medium to carry out volatilized VOCs for capture via soil vapor extraction (SVE) and subsequent ex-situ treatment of extracted vapors. In addition, the applied heat can increase hydrolysis of chlorinated solvents, such as MC, and promote in-situ biological activity in two ways. First, biological activity is boosted by moderately high temperatures (30 degrees Celsius [°C]) found at the periphery of the heated area during active thermal treatment, and throughout the heated area as it cools. Second, high temperatures increase the solubility of DNAPL, resulting in an increase in contaminant concentrations in the dissolved form that the microbes are able to use, provided the concentrations of the dissolved COCs are not toxic to the microorganisms.

Either ERH or TCH is a viable technology at the site and will be evaluated by the Contractor prior to final technology selection. According to the white paper published on thermal remediation technologies for treatment of chlorinated solvents, thermal treatment and extraction can remove up to 99.9% of residual DNAPL mass, even within low permeability zones including fractured bedrock (CDM Smith 2018). Thermal treatment can also enhance mobilization of organic matter from the soil to groundwater, which will act to enhance biodegradation of the COCs. Additionally, research has shown that slightly higher ambient soil temperature imposed by the thermal treatment process during startup and cool down periods during the winter months will potentially increase the biodegradation in ambient soil temperature up to approximately 30 to 35°C. Above these temperatures, bacterial activity would decrease (EPA 2014).

3.1 Design Criteria

ISTD treatment is to be performed to reduce levels of MC to concentrations amenable to MNA. As part of the RI Addendum, AECOM conducted an in-situ microcosm study using stable isotope probing into two intermediate zone monitoring wells (29WW43 and 29WW44) to determine whether the addition of oxygen release compound or emulsified vegetable oil would enhance or bio-stimulate the biodegradation of MC in groundwater. Aside from the two bio-stimulation in-situ microcosms, or “Bio-Traps,” each well was also fitted with a control unit to simulate MNA, for a total of three Bio-Trap units installed in each of the two wells. The purpose of the Control Bio-Trap unit was to quantify contaminant degrading bacteria and daughter product formation under MNA conditions and to serve as a baseline for comparison to the bio-stimulate units. The Bio-Traps were deployed in each well for 60 days and then sent to Microbial Insights in Knoxville, Tennessee, for analysis (AECOM 2016).

Results of the study indicated that biodegradation was limited under existing conditions for well 29WW43, but that MC biodegradation was occurring under existing site conditions and in response to both aerobic and anaerobic treatment options for well 29WW44. The difference in the results was

determined to be related to the differences in MC concentrations in groundwater between the wells. Monitoring well 29WW43 had an MC groundwater concentration of 279,000 µg/L and 29WW44 had an MC groundwater concentration of 11,500 µg/L. In a previous MNA study conducted by Shaw and included in the Final FS for LHAAP-29 (Shaw 2010), MC concentrations over 93,000 µg/L were indicated to inhibit microbial activity.

Site cleanup levels for the Intermediate Zone groundwater are listed in **Table 1-3**. The ROD stipulated the implementation of ISTD to reduce MC concentrations to levels that will allow MC to naturally degrade through MNA and final site cleanup levels will be achieved through MNA. Based on the results of the MNA and in-situ microcosm studies, the performance goal for the ISTD treatment specified in the ROD is:

- Groundwater
    - o MC 8,000 µg/l

Elevated concentrations of TCE also exist within the treatment area. The Contractor shall ensure temperatures for ISTD treatment will be high enough to reduce concentrations of TCE while providing treatment for MC.

3.2 ISTD Treatment Area

Groundwater analytical results from a sample collected from monitoring well 29WW16 in 2008 had an MC concentration of 10,300,000 µg/l, indicating the presence of an MC plume (AECOM, 2016). Additional investigation activities were performed in 2014 by AECOM to search for the source and further delineate the extent of the MC plume. As part of the investigation activities, a screening-level assessment of VOCs in unsaturated soil was performed in the former Building 801-F area and in the area surrounding monitoring well 29WW16 to determine whether high levels of MC were present in unsaturated soils that may indicate one or more potential sources of the MC plume. Suspected former site operations in former Building 801-F included rocket soak-out operations, which used an MC solvent as part of the process. Soil and groundwater samples were also collected from soil borings drilled into the intermediate groundwater zone in the area surrounding monitoring well 29WW16 to further delineate the extent of the MC plume.

The 2014 investigation included the installation of 15 soil borings (29CPT01 to 29CPT07 and 29CPT11 to 29CPT18) drilled into the intermediate zone to a minimum depth of 90 ft bgs. One groundwater grab sample was collected from each borehole at a depth between 75 to 85 ft bgs and analyzed for VOCs. Analytical results for the groundwater grab samples are presented in **Table 3-1** and in **Figure 3-1**. Soil samples were also collected from these 15 borings and results are summarized in **Figure 3-2**.

Table 3-1 – Intermediate Zone Groundwater Grab Sample MC Results

Sample Location	MC Concentration	Sample Location	MC Concentration
29CPT01	<0.5 µg/l	29CPT12	2,350,000 µg/l
29CPT02	<0.5 µg/l	29CPT13	1,400 µg/l
29CPT03	<1.25 µg/l	29CPT14	54,600 µg/l
29CPT04	<0.5 µg/l	29CPT15	36,400 µg/l
29CPT05	295,000 µg/l	29CPT16	<0.5 µg/l
29CPT06	63.8 µg/l	29CPT17	261,000 µg/l
29CPT07	<0.5 µg/l	29CPT18	<0.5 µg/l
29CPT11	132,000 µg/l	—	—

The results indicate that the MC concentrations attenuate rapidly with distance from the area where DNAPL is inferred (1 percent of the MC solubility limit, or 130,000 µg/l).

Groundwater monitoring wells were constructed in three boreholes to monitor the MC-plume over the long term and to serve as observation wells during the pumping tests on 29WW16 that were performed as part of the 2014 field investigations. Wells 29WW42, 29WW43, and 29WW44 were constructed using stainless steel casing and well screens in boreholes 29CPT11, 29CPT14, and 29CPT15, respectively. Groundwater samples were collected from 29WW16 on October 14, 2014, and from 29WW42, 29WW43, and 29WW44 on October 20, 2014, using low-flow techniques. Results of MC are summarized in **Table 3-2**.

Table 3-2 – Intermediate Zone Groundwater Monitoring Wells MC Results

Monitoring Well Location	MC Concentration µg/l
29WW16	8,260,000[1]
29WW42 (29CPT11)	1,380,000
29WW43 (29CPT14)	279,000
29WW44 (29CPT15)	11,500

Note:
1. Results from 2008 had an MC concentration of 10,300,000 µg/l.

Based on the samples collected during the 2014 investigation, the extent of the MC plume was delineated and is shown on **Figure 3-1**. The ISTD treatment area is defined by the estimated area of groundwater with MC concentrations greater than or equal to 8,000 µg/l. The treatment depth was estimated based on the groundwater grab samples and soil samples collected during the 2014 supplement RI and a correlation between the concentration in groundwater and soil based on the water octanol partitioning factor for MC. The thickness of the contaminated area is 20 ft and is between

70 to 90 ft bgs. Thermal treatment will be applied below and above the targeted treatment area to mitigate the potential for downward migration of DNAPL as it is heated and to reduce the potential of contaminating cooler zones above the thermal treatment area as a result of condensation of contaminant vapors. A summary of the target treatment area is summarized in **Table 3-3** and the area is shown in **Figure 3-1**.

Table 3-3 – ISTD Treatment Area

Treatment Area	Contaminated Thickness	Heated Thickness	Contaminated Volume	Total Heated Volume	Approximate Target Heated Depth[1]
sf	ft	ft	cy	cy	ft bgs
6,600	20	55	4,450	13,444	40 to 95

Note:
1. The total saturated depth will be heated to prevent contaminated vapors from condensing in the cooler zones.

Although 8 years have passed since the 2014 investigation, the overall extent of the MC plume is expected to remain relatively unchanged from that defined in 2014. Groundwater movement at the site is slow, and historic sampling completed for groundwater contamination in the intermediate zone indicates the plume boundary has been shrinking over time (Shaw 2010). Results of the MNA and in-situ microcosm studies completed for the site also support this conclusion because the results of these studies indicate areas of the MC plume outside concentrations that are toxic to natural bacteria (less than 93,000 µg/L) are naturally degrading the plume, thereby providing natural attenuation of the plume.

The performance criteria for ISTD will require the installation of the thermal well field to extend at least 5 ft laterally beyond the treatment limits. This is standard practice to ensure the delineated target treatment zone is effectively treated. It will also provide treatment of the edge of the plume in the event it has migrated slightly downgradient of its predefined limit.

3.3 ISTD Area Characteristics

ISTD area will be implemented for the area and depths bgs provided in **Table 3-3**. ISTD treatment will be provided to the depth of contaminated saturated zone specified to ensure complete treatment of the contaminated zone. The total ISTD area encompasses approximately 6,600 sf and a total impacted volume of 4,450 cy.

Based on the 2014 supplemental RI investigation, predominant features of the site's geology in the ISTD treatment area are identified as follows:

- Soils beneath the Project site consist of predominantly interlayered fine-grained soils (silts and clays) to about 90 ft bgs, with thin interlayered intervals of fine-grained sand interbedded among silt and clay. Often, sequences of clay/silt contain lamina of fine sand ranging in thickness from 0.04 inch (1 millimeter) to 0.4 inch (10 millimeter) thick. Occasionally, thin layers of black, hard lignite (a type of coal) were encountered in the subsurface.
- Depth to the water table in the intermediate zone is approximately 40 ft bgs. According to the boring log for monitoring well 29WW16, water saturated soils (silty sand to sand) were

encountered from approximately 78.5 ft to 80.9 ft bgs, for a saturated thickness of 2.4 ft. Overlying the saturated soils was a thick layer of clay that extended from 78.5 to 27 ft bgs with an interlayer of silt (from 50 to 52 ft bgs) and sandy clay (from 38.5 to 38.9 ft bgs). With a thick layer of clay overlying the saturated zone and the static groundwater level occurring well above the saturated zone in 29WW16, groundwater in the intermediate zone occurs under confined conditions (AECOM 2016).

- Based on results of the 2014 pump test the aquifer has the following characteristics:
    - Specific capacity of the pumping well: 0.004 to 0.032 gallons per minute/ft drawdown
    - Aquifer transmissivity: between 5.6 and 45.7 gallons per day/ft drawdown
    - Hydraulic conductivity: between 1.08E-04 cm/sec and 4.29E-04 cm/sec
    - Aquifer storativity: ranged from 1.5×10^{-4} to 3.95×10^{-4} (unitless)
- Based on the results of the 2014 pump test, the maximum radius of influence was determined to be 102 ft at a constant pumping rate of 0.4 gallons per minute.
- There was no change in water levels in the deeper well assessed during the pump test indicating there is no vertical connectivity between the intermediate and deep zones.

3.4 Implementation of ISTD

This section describes the remedial action field activities planned at the site for the ISTD treatment implementation. The Contractor will be responsible for selecting and implementing the ISTD treatment technology (for example, resistive heating, conductive heating) and specific means and methods appropriate for the site and cost-effective for the project, in accordance with the requirements of this section and the Scope of Work included as **Appendix D**. A RAWP for the implementation of the selected ISTD treatment will be prepared and implemented. Prior to initiation of the field activities performed as part of the RAWP, the regulators will be notified at least 15 days in advance. Site-specific activities are described in associated subsections. The construction sequence for the ISTD treatment is outlined below and described in detailed in the following subsections:

- Preparation of ISTD Treatment Work Plan and Other Preconstruction Submittals
- Mobilization and Site Preparation
- Surveying
- ISTD Treatment System Installation
- System Operation
- Process Monitoring Requirements
- System Decontamination and Residuals Management
- Site Restoration
- Demobilization
- Reporting

3.4.1 Preparation of ISTD Treatment Work Plan

As part of the RAWP, the Contractor will prepare and submit for approval an ISTD Treatment Work Plan in accordance with applicable sections of EM 200-1-21, Design: In Situ Thermal Remediation (USACE 2014). The Work Plan will provide a detailed description of the selected ISTD technology equipment, construction procedures, and operations, as well as all associated field activities. The ISTD Work Plan will address all items specified in this section as listed below and other relevant information

including detailed information to verify that it meets substantive requirements and a project schedule. The ISTD Treatment Work Plan will need to include the following information:

- A basis of design for its selected ISTD equipment and approach, including mass calculation, targeted design temperature, heating element layout/spacing, and design approach/basis for vapor/liquid treatment equipment.
- A discussion of substantive requirements for air emissions.
- Modeled estimates of energy need for optimal temperature increase and duration necessary
- Equipment sizing
- Well-field layout (number, spacing, depths of heating elements/wells, all other wells)
- Process piping and instrumentation diagrams
- Electrical one-line diagrams
- Vapor/liquid collection and treatment system layout plans
- Component process flow diagrams
- The estimated amount of energy, water, fuel, and other consumable materials (for example, granular activated carbon) to operate the ISTD system during the duration of the treatment period.
- Other information as required to describe the design, construction, and operations approach of the system to implement the remediation in accordance with the ISTD Contract Documents.

3.4.1.1 ISTD Design Calculations

An estimate of the DNAPL and VOC mass to be addressed by the ISTD treatment will be developed by the Contractor and the basis/rationale for their mass estimate calculations will be included in their ISTD design provided in the Work Plan. The Contractor will be responsible for appropriately designing, procuring, installing, and operating all required ISTD treatment equipment based on their understanding of the ISTD areas and other site characteristics. The Work Plan will include an evaluation of the potential range in the mass estimate based on the degree of uncertainty in the calculations, and a discussion of the factors of safety incorporated into the process design (for example, equipment sizing/selection) to accommodate the potential range in mass. In addition, the Contractor will be providing all other equipment/operational measures required to address any other characteristics of the ISTD areas (for example, metals, soil total organic content, moisture content) and/or other relevant site conditions (for example, groundwater flow), as obtained through available site data/historical reports, that may affect their ISTD treatment operations and/or compliance with associated air emissions/liquid discharge requirements. If the Contractor identifies any data gaps/additional data needs as part of their bid preparation, then they will need to identify the data collection requirements and associated costs in their bid.

3.4.1.2 ISTD Design

The ISTD design will be performance-based and the actual location, number and design of monitoring wells, extraction wells and monitoring points will be provided by Contractor in site plan layouts included with their ISTD Treatment Work Plan. The minimum performance criteria to be met by the contractor's ISTD design will include the following:

- Minimum target heating temperature of 100 degrees Celsius.
- Installation of temperature monitoring probes along the edge of the treatment area at a frequency of one monitoring point every 80 lf along the perimeter of the treatment area and

inside the ISTD area at a frequency of one probe every 1,200 sf for an estimated total of 10 temperature monitoring probe locations. Each probe location will provide temperature readings for every 4.5 ft interval (total of 12 sensors) across the specified heating depth.

- Installation of a minimum of two groundwater monitoring wells downgradient of the ISTD treatment area in the direction of groundwater flow to monitor temperature and hydraulic control of the plume. The wells will be installed approximately 20 ft downgradient of the treatment area and at a depth of 88 ft bgs with a 10 ft screen. The actual well depths and screened intervals will be determined in the field based on the lithology encountered during drilling.
- Provide hydraulic control to prevent the potential movement of mobilized MC DNAPL from migrating downward or laterally away from the treatment area during thermal treatment. Final method for providing hydraulic control shall be determined by the contractor but could include the installation of extraction wells if it is determined to be necessary.
- Provide adequate measures to control all vapors generated during ISTD to prevent uncontrolled emissions of contaminants and/or discharges of steam. The system shall also be designed to prevent any condensation of contaminated vapors from entering and contaminating areas outside the target treatment zone.

Capabilities will be incorporated into the Work Plan to allow safe and effective monitoring of vapor concentrations, air pressures and vacuums, air flows, water flows, and subsurface temperatures over the course of the treatment and post-treatment periods.

The downgradient hydraulic control monitoring wells will be monitored monthly for VOCs and temperature during ISTD operations (specification for monitoring to be included in the Draft Final RD submittal), including a collection of baseline monitoring samples no more than one month prior to starting up the ISTD system. All results will be reported to the Corps. Results with elevated VOCs (for example, concentrations greater than 1 order of magnitude above baseline conditions) or elevated temperatures above baseline conditions may trigger additional action such as more frequent monitoring, adjustments of ISTD operations, or implementation of additional groundwater extraction or hydraulic control measures (that is, increasing flow rates from existing hydraulic control wells).

3.4.2 Mobilization and Site Preparation

The following field activities will be conducted as part of the mobilization and site preparation activity.

- **Site Safety and Health:** The responsibility for the development, implementation, and enforcement of the APP and HASP lies with the Contractor and its health and safety personnel. APP/HASP will be developed by the Contractor including programs for accident prevention, personnel protection, medical surveillance, site control/decontamination, emergency response/contingency planning, and air monitoring. The Contractor's APP/HASP will be submitted to the regulator for approval prior to the commencement of any on-site activities.
- **Mobilization:** Appropriate personnel, subcontractors, and equipment necessary to install and operate ISTD treatment system, including the ISTD well-field installation and liquid and vapor recovery and treatment systems, will be mobilized to the site.
- **Site Access**: U.S. Army will be responsible for providing site access needed to complete the work. Improvement of the site access road using geotextile and additional gravel may be performed to allow drilling and heavy equipment to enter and exit the site safely.

- **Preconstruction Documentation**: Prior to the start of any site preparation activities, a preconstruction video/photographic recording of the ISTD areas will be conducted. This recording will document the existing conditions of the site, and any other features of interest on and adjacent to the site. The Contractor will enlist the services of a qualified surveyor, licensed in the State of Texas, to field verify the existing site conditions. This preconstruction survey will identify and mark-out the limits of ISTD areas, existing site topography, site features, property boundaries, and capture any and all structures and other existing physical features of the site.
- **Clearing**: Prior to the mobilization, work locations for overhead and ground level accessibility will be evaluated. In areas that have excessive vegetation and/or tree growth, a backhoe or other appropriate earthmoving equipment will be used to clear the areas to allow equipment access. Grubbing is not anticipated. Clearing shall consist of the felling, trimming, and cutting of trees and other vegetation, as required to perform the work.
- **Utility Mark-outs**: The Contractor will coordinate with underground utility locators for utility clearances in the ISTD area.
- **Decontamination:** Equipment and personnel decontamination procedures should be included and detailed in the HASP. Temporary decontamination pads shall be shown on drawings included as part of the RAWP and shall be constructed at approved on-site locations to decontaminate equipment and prevent cross-contamination between the drilling locations. Wash water will be held and treated through the temporary groundwater treatment plant that will be installed as part of the ISTD operations.
- **New Utilities**: During the ISTD operations, the Contractor will be responsible for all utility costs associated with energy, water, fuel, and other consumable materials to operate all equipment related to the ISTD treatment system. The Contractor will be designing, furnishing, and installing all utilities required to support the selected operations, as listed below:

    - Electrical Service Drop – Overhead power lines are located at the intersection of Avenue C and Avenue Q at the north corner of the site.
    - Process Water Supply –Water supply service districts near the site include the Leigh and Caddo Lake Water Supply Districts that can be contacted for providing potable water for use during ISTD operations. The Contractor will be required to truck water from these areas to the project site.
    - Water Discharges – Wastewater generated from the ISTD operations will be treated on site with a temporary water treatment system provided as part of the ISTD system. Treated water will then be transported off site for discharge to a public owned treatment works (POTW) or an approved water disposal facility.

3.4.3 Surveying

The limits of ISTD areas and locations of well points will be surveyed preliminarily using GPS equipment. A professional land surveyor licensed in the State of Texas will survey the performance monitoring borehole/well locations to the nearest 0.01 foot.

3.4.4 Monitoring Well Installation and Sampling

Seven new monitoring wells will be installed in the vicinity of the ISTD treatment area prior to installing the ISTD system. The monitoring wells will include four intermediate wells (29WW46, 29WW47, 29WW48, and 29WW49) installed in and immediately surrounding the ISTD treatment area, two hydraulic control monitoring wells (29WW50 and 29WW51) installed approximately 20 ft downgradient

of the ISTD treatment area and one deep well (29WW45) to replace deep monitoring well 29WW40 which is constructed with polyvinyl chloride (PVC) casing and screen and will need to be abandoned before implementing ISTD as presented on drawing Sheet 02C101 in Appendix A. Boring and well construction logs for existing monitoring wells installed at the site are included in **Appendix E**.

The new intermediate and hydraulic control monitoring wells will be installed with 4 inch stainless steel casing and 10 ft of stainless steel screen. Other temperature resistant well materials may also be used if approved by the USACE. The new deep well (29WW45) will be installed with a 2-inch diameter stainless steel casing and screen. Monitoring wells will be drilled using rotosonic drilling techniques to reach the specified depth. Installation for monitoring wells is further described in **Section 5.4.2**.

Following well installation, wells will be developed as described in **Section 5.4.2**. Samples will then be collected from the newly installed monitoring wells and the five existing wells in and around the ISTD treatment area and analyzed for VOCs. These sample results will be used to assess the overall treatment effectiveness following completion of ISTD treatment.

3.4.5 ISTD Treatment System Installation

3.4.5.1 ISTD Well-Field Installation

The following elements (subsurface and aboveground components) of the ISTD treatment system will be installed as part of the well-field installation:

- Heating elements
- Temperature and pressure monitoring points
- Vapor recovery extraction wells
- Vapor recovery vacuum monitoring points
- Groundwater extraction wells (if necessary)

Heating elements, wells, and monitoring points will be suitable for the selected thermal technology and will be constructed and installed in accordance with 16 TAC 76.1000 and other applicable local, State, and Federal regulations, statutes, and codes. The contractor will secure any applicable approvals and notifications, which can include Federal, State, and local requirements (that is, Section 76.1000 for well installation, notification of Texas 811) prior to the commencement of drilling and well installation operations. All required utility clearances will be completed prior to conducting invasive activities.

All heating elements and monitoring points/wells will be installed in accordance with the approved Work Plan. Drill cuttings and other waste generated during installation will be containerized and disposed of off site. Drawings showing details and locations of the electrodes and monitoring points will be provided as part of the Work Plan. Locations for the heater elements and monitoring points/wells within each treatment area will be surveyed to verify correct placement of the required ISTD treatment components within each ISTD area. Existing monitoring wells located within the ISTD treatment area (29WW16, 29WW42, 29WW43, and 29WW44) shall remain as they were installed with stainless steel casings and well screens. These existing wells shall be monitored by the Contractor to determine if they are impacted by the ISTD system.

3.4.5.2 Liquid And Vapor Recovery and Treatment Systems Installation

A detailed installation procedure of the ISTD treatment liquid and vapor recovery equipment, and site plan layouts/figures depicting the locations of all proposed equipment will be included in the ISTD Treatment Work Plan prepared for the site. All the components to be used and where they will be assembled will be communicated prior to the installation. Site preparation for recovery system equipment installation prior to delivery may include preparing staging area and secondary containment. The equipment location, power requirements, acquiring new utility service during treatment, location of the heating elements, wells and monitoring points, as well as any trenching, compaction, or construction requirements will be included in the ISTD Treatment Work Plan. An access road will need to be constructed to access the ISTD area.

The ISTD Treatment Work Plan will indicate whether any thermal insulating cap or cover is required for the selected ISTD treatment implementation. Due to the depth of the ISTD it is not anticipated that one will be required; however, if the Contractor determines a cover to be necessary the design of the cover shall include an installation that provides positive drainage for stormwater runoff and prevents any ponding on the cap. Any backfill required during the installation of liquid and vapor recovery piping, will meet the definitions of certified clean fill requirements in accordance with **Section 2.7.5**.

All necessary electric service to the system will be installed in accordance with State, local, and National Electrical Code (NEC) requirements. All wiring, conduits, and interconnections will be installed appropriately for a fully operable system. Power feed wiring and distribution cables, lighting, ventilation fans, heaters, disconnects, instrumentation, controls, and other requirements will be required to be furnished and installed as necessary.

A suitably sized source of back-up/secondary power (for example, generator) to allow the ISTD vapor/liquid recovery and treatment equipment and all monitoring systems and controls will be included to continue uninterrupted operation in the event of a loss in utility power (backup power for the well-field heating elements is not required). The backup power source will be designed to provide a minimum of 24 hours of operation without the need for refueling.

All electrical work for installing and operating the ISTD treatment system will be required to meet NEC, National Fire Protection Association (NFPA), and Occupational Safety and Health Administration (OSHA) requirements for hazardous locations. Proper electrical grounding will be installed for all equipment as applicable.

All piping and other lines will be constructed in such a manner (sloped) to prevent any media from condensing or collecting where it would not be recovered or otherwise interfere with effective operations. When completed, the system construction details will be submitted as part of As-Built drawings. All piping and equipment used for the ISTD system will be constructed with materials compatible with the ISTD system operating conditions (temperature, pH, etc.). Installed piping, hoses, and orifices will be of sufficient size to transmit soil vapor, groundwater/process water, blow-down, treated air, and other media without any significant pressure drop or restriction to the system. All piping/connections will be installed, properly supported, and maintained in a neat and workmanlike manner.

3.4.6 System Operation

3.4.6.1 Safety and Environmental Controls

The Contractor will be required to ensure that no excessive steam pressure is created in the subsurface that can create hazardous site condition. The ISTD will be operated in a manner that prevents migration of the impacted groundwater plume, and effectively captures soil gas vapors within the established heating area. If electric heating is used, then stray voltage will need to remain below 15 Volts within the site boundaries. It will be ensured that no surface expression of excessive heat, steam or electrical current is occurring at the site.

3.4.6.2 VOC Removal and Emissions

The vapor recovery will be performed throughout the heating operations and as required during the additional operating period following the heating shutdown. All recovered vapors will be treated for removal and/or destruction of VOCs. Emission rates and monitoring/reporting requirements will be consistent with the Air Contaminants – General Nuisance Rules (30 TAC 101.4). The method of VOC treatment will be provided in the approved Work Plan.

3.4.7 Process Monitoring Requirements

Process monitoring of the ISTD system will be required to monitor performance of the ISTD system and verify emissions from the vapor treatment system are in substantive requirements with applicable air emissions regulations. Monitoring will include the collection of samples from extracted and treated vapor and groundwater to verify treated concentrations are within acceptable limits for disposal to an approved water disposal facility or a POTW. Samples collected of the treated water will verify concentrations are within acceptable limits imposed by the receiving facility. Waste characterization samples will also be collected for the disposal of spent materials such as granular activated carbon that may be used to treat extracted vapors and groundwater.

Performance monitoring will be conducted on a weekly basis to verify the operation of the ISTD system is in accordance with the requirements specified for the ISTD performance-based design, to track treatment progress, and to determine when the system can be shut down. At a minimum, monitoring will be conducted for components of the system listed below:

- Electrical (or fuel) use;
- Subsurface temperature;
- Vacuum monitoring; and
- Mass removal estimates based on concentrations in extracted vapor. If DNAPL and groundwater extraction are included as part of the ISTD operation proposed by the ISTD vendor, then these concentrations may also be used for mass removal estimates.

The cleanup criterion for ISTD is a groundwater concentration, which is difficult to measure during operation of an ISTD. While the collection of groundwater samples may be possible it will require monitoring wells to be vented to prevent the collection of steam building up inside the well. Because the collection of groundwater samples from the heated treatment zone is dangerous, alternative shutdown criteria will likely be used to determine when the system can be shut down. It is intended that the actual shutdown criteria will be proposed by the ISTD contractor as part of their ISTD Work Plan. Shutdown criteria may include one or more of the following:

- Mass removal rate in the extracted fluids reaches a point of diminishing return or reaches an asymptotic level;
- Mass removal rate meets a pre-determined percentage of the peak removal rate (i.e., 90%);
- A mass removal percentage is reached based on a pre-remediation mass estimate;
- A specified target temperature is maintained for a pre-determined amount of time; and
- A soil concentration that correlates to the 8,000 µg/l MC groundwater concentration is achieved and demonstrated through the collection of soil samples collected using hot soil sampling procedures. If this criterion is used, the Contractor will be responsible for providing calculations performed to estimate this correlation.

Once the shutdown criteria are met the ISTD system will be shut down but will remain in place until groundwater samples are collected, and results received to verify cleanup levels have been obtained. Soils will then be allowed to cool (3 months) before groundwater samples will be collected from the four existing monitoring wells and seven new monitoring wells installed in the interior and surrounding area of the MC plume. It is anticipated that groundwater samples can be collected once groundwater has cooled to temperatures below 100 degrees Celsius. During this shutdown period, vapor samples and downgradient groundwater samples will continue to be collected and vapor and water treatment portions of the ISTD system will continue to operate.

Samples collected from wells installed in the treatment area will be compared with the groundwater cleanup goal of 8,000 µg/l of MC to verify the ISTD has met the cleanup criteria. Based on the results, the system will be either decommissioned and removed or the system will be turned back on to continue heating the subsurface to reach the cleanup goal.

3.4.8 System Decontamination and Residuals Management

Once approval to shut down the ISTD system is provided by the USACE the system will be shut down and demobilization activities will begin. All piping and equipment will be decontaminated. Waste generated during the decontamination process will be stored in frac tanks for characterizing and then transported for disposal to an approved disposal facility. Piping and other materials that cannot be reused will be transported off site for disposal.

3.4.9 Demobilization

Demobilization activities are anticipated to include the following:

- Removal of all equipment
- Removal of temporary facilities, including site trailers, bathroom facilities, and dumpsters for general trash
- Dismantling piping connections from the thermal wellfield to the temporary treatment system
- Disconnection of the electrical service
- Abandonment of wells associated with thermal treatment such as the heating wells and vapor recovery wells.

Wells associated with the ISTD are assumed to be abandoned in place by filling and sealing the well. The well will then be cut 3 ft below the ground surface and backfilled.

3.4.10 Site Restoration

Site restoration activities will include re-grading the ISTD treatment area and surrounding area that were disturbed to provide positive drainage across the area and prevent any ponding. The area will then be reseeded with a wildflower seed mix.

3.4.11 Reporting

The contractor will provide weekly periodic reports and a final ISTD completion report once all work associated with ISTD is complete.

3.4.11.1 Periodic Reporting

The contractor will prepare weekly ISTD progress reports which will summarize the operations and monitoring conducted each week. The report will include system operational information such as weekly average power usage, cumulative power usage, average subsurface temperature, effluent flow rates, and average condensation production rates. The report will also identify any operation problems that occur during the reporting period and corrective actions taken. Monitoring samples for air discharges will also be summarized each week along with an estimate of VOC mass removed based on VOC concentrations in the extracted vapor.

3.4.11.2 ISTD Treatment Completion Report

Following completion of ISTD the contractor will prepare a final report that will summarize the overall design, construction, operation, and demobilization of the ISTD system. The report will include all documentation including but not limited to ISTD system design drawings, boring and well logs for wells installed, waste materials generated and disposed off site, waste disposal documentation, water treatment sampling results, air monitoring sampling results, confirmation sampling results (if used by the Contractor), baseline, and final groundwater sampling results, and well abandonment records.

3.4.11.3 As-Built Survey

The Contractor will have a Texas licensed land surveyor perform an as-built survey of the final conditions of the ISTD area, including all the associated staging areas disturbed as part of the ISTD system installation and operation. The survey will include topography, location of all existing structures remaining after ISTD completion, and the location of all monitoring wells.

4 INSPECTION, CLEANING AND PLUGGING OF PIPELINES

The ROD specifies that existing pipelines be flushed to remove visual residue and be inspected to visually confirm residue was removed, followed by plugging of the lines. Three types of pipelines exist at the site: transite (asbestos-containing) TNT wastewater pipeline, a wooden TNT wastewater pipeline, and two vitrified clay cooling water pipelines with associated manholes. A summary of the different pipelines is provided in **Table 4-1**.

Table 4-1 – Pipeline Information Summary

Underground Line	Construction Material	Diameter (inches)	Estimated Total Length[1] (ft)	Estimated Pipe Volume (ft^3)	Estimated Cover Depth (ft)
TNT Wood Wastewater Gravity Line	Wood stave with 2-inch-wide metal bands spaced at 6-inch intervals; asphaltic coating	12	2,900	2,300	1.5 to 10
TNT Wood Wastewater Pressure Line	Wood stave with 2-inch-wide metal bands spaced at 6-inch intervals; asphaltic coating	6	1,700	340	1.5 to 10
TNT Transite Wastewater Gravity Line	Transite (asbestos)	6	3,000	590	1.5 to 10[2]
TNT Transite Wastewater Pressure Line	Transite (asbestos)	6	1,700	340	1.5 to 10[2]
North Cooling Water Drain Line	Vitrified clay pipe	8 to 18	2,500	4,420	9
South Cooling Water Drain Line	Vitrified clay pipe	8 to 18	2,800	4,950	5 to 6
Laterals to Cooling Water Drain Lines	Vitrified clay pipe	8[3]	5,100	1,790	3 to 9

Notes:

1. Lengths of pipelines are based on Table 2-1 of the Draft Site Data Summary Report prepared by Shaw Environmental, Inc. and included as Appendix A to the Final Installation-Wide Work Plan Addendum 6, Additional Investigation at LHAAP-29 Former TNT Production Area (Shaw, 2006).
2. Historic information indicates the pipe is buried between 3 and 3.5 ft bgs; however, based on the buried depth of the wooden line, it is assumed that the transite line is buried at the same depth as the wooden line.
3. Laterals are assumed to be 8 inches. Actual diameter will need to be field-verified as part of the RA.

4.1 Design Criteria

Site cleanup levels for the solid residue in pipelines are listed in **Table 1-4** and provided below:

Transite TNT Wastewater Line Residue:

- 1,3-Dinitrobenzene 1 mg/kg
- 2,4,6-TNT 5.1 mg/kg
- 2,4-DNT 0.042 mg/kg
- 2-amino-4,6-DNT 1.7 mg/kg
- 4-amino-2,6-DNT 1.7 mg/kg

Cooling Water Drain Line Residue:

- 2,4,6-TNT 5.1 mg/kg
- 2,4-DNT 0.042 mg/kg
- 2,6-DNT 0.042 mg/kg
- 2-amino-4,6-DNT 1.7 mg/kg
- 4-amino-2,6-DNT 1.7 mg/kg

Based on the results of residue samples collected as part of the PDI it is assumed that all residue in the pipelines exceed the cleanup criteria and will require removal and off site disposal.

4.2 Pipeline Removal (Excavation) Areas

Based on the results and observations of the PDI, the wooden TNT wastewater pipeline will require excavation and disposal off site to comply with the requirements of the ROD. The current deteriorated condition of the pipeline does not allow for flushing and plugging of this pipeline, and results of samples collected of the solid residue in the pipeline and explosive concentrations in soils adjacent and immediately beneath the pipeline, indicate that explosive concentrations are greater than the site cleanup levels and require removal and disposal off site. As part of the wooden pipeline removal, approximately 1,100 lf of the transite pipeline will also be removed. Contaminated soils identified adjacent to the transite pipeline at PDI locations 29SB151 and 29SB152 are within this section of pipeline. Two sections of the pressure portion of the transite TNT pipeline that runs from the pump station to LHAAP-32 will also be excavated and removed based on results from PDI locations 29SB137 and 29SB201.

In addition to the excavation and removal of the wooden TNT wastewater line and portions of the transite TNT wastewater line, three excavations will be performed along the north cooling water pipeline to remove pipe sections and contaminated soils identified at PDI sample locations 29SB139, 29SB138, and 19SB143. These excavations are identified as NC-1, NC-2, and NC-3. A summary of the volume of material estimated from these excavations is provided in **Table 4-2**.

Table 4-2 – Excavation Areas

Area ID	Length	Area[1]	Excavation Depth	Impacted Volume[2]
	ft	sf	ft bgs	cy
TNT Wood Wastewater Gravity Line Removal[3]	2,900	8,700	varies	640
TNT Transite Wastewater Gravity Line Removal[3]	1,350	4,050	varies	300
TNT Wood Wastewater Pressure Line Removal[3]	700	2,190	varies	160
TNT Transite Wastewater Pressure Line Excavation	NA	600	5 and 16	300
NC-1 Excavation	NA	5,400	13	2,600
NC-2 Excavation	NA	3,940	14	2,040
NC-3 Excavation	NA	700	6	150
			Total Approximate Volume	6,190

Notes:
1. Area excludes outer limits determined by sloping. For pipeline excavation the area is estimated based on a trench width of 3 ft and the length of the pipeline.
2. Volume excludes clean soils removed as part of sloping required to the complete excavations.
3. The impacted excavation volume is estimated assuming a 3 ft wide x 2 ft deep trench. Soils above the pipe are anticipated to be clean and will be stockpiled for testing and reuse as backfill.

NA – not applicable

These excavations are further described in this section. The implementation for excavations along the pipelines will generally be completed as described for contaminated soils discussed in **Section 2.**

Confirmation soil samples from the larger excavation areas identified in Table 4-2 (NC-1 and NC-2) will be collected as described in **Section 2.3**. The DUs for these excavation areas are identified on design drawing sheets 01C-103 and 01C-107 (Appendix A). Total DUs are 13 for excavation area NC-1 and 13 for excavation area NC-2. Confirmation samples for the other areas identified in **Table 4-2** will be collected as described in **Section 4.2.1**.

Once confirmation sample results are received indicating that soils meet the cleanup levels the excavations will be backfilled. The excavation areas will be backfilled with soil excavated from slopes of the excavation and imported clean backfill. Clean backfill will be placed in 1-foot lifts and compacted with mechanical means to a minimum density of 80% of ASTM D698 (Standard Proctor). Following placement density testing will be conducted in accordance with ASTM D1556/D1556M/D6938. Tests will be conducted at each lift at randomly selected locations for every 2,500 sf of trench or excavation area.

4.2.1 Wooden TNT Wastewater Line Removal

The wooden TNT wastewater pipeline was previously flushed and abandoned. However, during the March 2021 PDI, explosive solids residue was encountered within the line with COC concentrations (2,4,6-TNT, 2,4-DNT, 2-amino-4,6-DNT, and 4-amino-2,6-DNT) greater than the GWP-Ind MSCs. Compound 2,4,6-TNT was also detected in the surrounding soils at three of eight PDI soil boring locations completed along the wooden pipeline (29SB134, 29SB155, and 29SB156). As summarized in **Table 4-1**, the pipeline is constructed of wood staves with 2-inch-wide metal bands spaced at 6-

inch intervals and covered with an asphaltic coating. Based on test pits completed during the 2021 PDI the pipeline is buried between 1.5 to 10 ft bgs. The gravity portion of the wood pipeline is 12 inches in diameter and extends approximately 2,900 lf from just north of former Wash House Building 806-A to the pump station, and its pressurized portion is 6 inches in diameter and extends approximately 1,700 lf from the pump station to LHAAP-32. Due to the deteriorated condition of the pipeline, the presence of residual explosives within sediment inside the pipeline, and the detected release to the surrounding soil, the wooden pipeline along with the surrounding soil will be excavated and disposed off site. The excavation for the pressurized portion of the pipeline will end at the LHAAP-29 site boundary (approximately 700 lf). The excavation along the pipeline is estimated to be 3 ft wide and a minimum depth of 6 inches beneath the pipeline. Unimpacted soil above the pipeline will be stockpiled alongside the trench and used as backfill if analytical testing results are below the cleanup levels.

In order to minimize disturbance to the TNT transite pipeline that is reported to be approximately 5 ft north of the wooden TNT pipeline, excavations to remove the wood pipeline will be accomplished using a 1V:1H slope starting at the top of the excavation and ending with a 3.5 ft vertical cut along the sides running parallel with the pipeline to remove the pipeline and surrounding soil. For areas where the pipeline is buried within the top 7.5 ft, it is assumed that removal of the wooden TNT wastewater pipeline can be accomplished without disturbing the transite TNT wastewater pipeline. There is an estimated 1,350 lf of the gravity wooden pipeline that is buried greater than 7.5 ft and may result in disturbance to the transite TNT pipeline depending on the buried depth of the transite TNT pipeline. It is assumed the 1,350 lf of transite pipeline will be disturbed during the removal of the wooden TNT pipeline. Sections of the transite pipeline disturbed will be cut, excavated, and disposed off site as part of the wooden TNT pipeline removal.

The wooden TNT pipeline removal is assumed to be completed in phases due to the long linear length of the excavation and the potential for surface water intrusion into the excavation. The excavation is anticipated to begin at the pond and work southwest toward Excavation Area E-1. It is anticipated that the Contractor will limit the linear feet of open excavation to 500 ft at any one time to allow the construction of surface water diversion ditches to convey surface water runoff around the open excavation. To aid in determining whether a length of trench can be backfilled, it is anticipated that field sampling analysis may be implemented to screen whether an excavation may meet the cleanup levels before proceeding with sampling for analysis by the laboratory. Achievable detection limits for the field screening analysis are not low enough to clearly determine whether a location will meet the cleanup levels but can be used as a guide for when to collect samples for laboratory analysis. Information on the proposed field sampling method is included in **Appendix F**. Samples collected for laboratory analysis will be submitted for a 48 hour (hr) turnaround time (TAT), or quicker if available. Once the samples analyzed by the laboratory are determined to meet the cleanup levels, the excavation will then be backfilled, and the drainage will be redirected into newly restored areas and around the excavation as it continues to progress southwest. Along with the drainage channel diversions it is anticipated that a haul road will be simultaneously constructed along the northwest side of the trench to allow material to be loaded into trucks for disposal. As the excavation progresses further southwest, material may also be stockpiled along the southeast side and loaded into trucks for transport using the southeast haul road shown on drawing G002 (Appendix A).

Following removal of the wooden TNT wastewater pipeline, samples will be collected at the bottom of the trench and sidewalls to confirm remaining material meets the soil cleanup level. Confirmatory samples for the pipeline excavation will be taken as discrete samples. Two sidewall confirmation

samples will be collected every 30 ft to the right and left of the pipeline excavation. One sidewall sample will be collected in line with the depth of the pipe removed from that location and one will be collected at the bottom of the sidewall. Bottom samples will be collected every 30 ft along the bottom for the trench. If a sidewall sample exceeds the soil cleanup level the side of the excavation will be excavated laterally one ft and two additional sidewall samples will be collected. This process for sidewalls will be repeated until all sidewall samples meet the soil cleanup levels. If a bottom sample exceeds the cleanup levels, the bottom of the excavation will be excavated an additional one ft, followed by an additional bottom sample. This process will continue until the groundwater table is reached or a clean bottom sample is achieved. Once the groundwater table is breached, no bottom samples will be collected.

4.2.2 Transite TNT Wastewater Line Removal

Approximately 1,350 lf of the 6-inch gravity transite pipeline is anticipated to be disturbed during the wooden TNT gravity pipeline removal. The disturbed pipeline will be cut and removed along with the wooden TNT pipeline. This length of pipe includes the two sample locations (29SB151 and 29SB152) that had concentrations of 2,4-DNT at depths of 3 to 4 ft bgs that exceed the cleanup level (**Figure 1-13**) and will be removed as part of this excavation. Excavations completed as part of the wooden TNT pipeline removal within the location of these borings will be excavated a minimum of 5 ft from the edge of the transite pipeline to a depth of 5 ft or a minimum of 1 ft below the bottom of the transite pipeline (whichever is shallower) before collecting confirmation samples. Subsequent excavations will be completed if cleanup levels are not met as described above for removal of the wooden TNT wastewater line and confirmation samples will be collected until cleanup levels are met at the sidewall and either cleanup levels are met at the bottom, or the groundwater table is breached.

In addition to the above, there were two samples collected along the pressure portion of the transite pipeline that runs from the former pump station to LHAAP-32 that exceeded the soil cleanup levels. One sample result (29SB137) had concentrations exceeding the cleanup levels for 2,4,6-TNT and 2,4-DNT at depths of 11 to 12 ft and 15 to 16 ft bgs and another (29SB201) had a concentration of 2,4-DNT exceed the cleanup level at 3 to 4 ft bgs (**Figure 4-1**). These sample locations were approximately 10 to 15 ft from the assumed location of the pipeline. The deeper location (29SB137) will be excavated down to the water table which is estimated to be approximately 16 ft bgs. The areas and volumes estimated for these excavations are 400 sf and 260 cy (29SB137), and 200 sf and 40 cy (29SB201) for a total in-place volume of 300 cy (**Table 4-2**). Estimated volumes accounting for side slopes of 1H:1V are approximately 410 cy.

Following any excavation of the transite pipeline, the exposed soil surrounding the section of pipeline removed will be visually inspected for any indications of contamination before collecting confirmation samples along the sidewalls and bottom to confirm all residual contamination has been removed and the remaining soils meets the cleanup levels. If samples exceed the cleanup levels, the process described above for removal of the wooden TNT wastewater line will be followed until cleanup levels are achieved for sidewalls and the cleanup level is achieved for the bottom sample, or the groundwater table is breached by the bottom of the excavation.

Because the transite TNT wastewater pipeline is only accessible from the two ends of the pipe it is anticipated that the line will be video inspected and cleaned before any pipeline excavations will take place. This will allow sections of the pipe to be left in place to be accessed for filling via the excavations

completed to remove the wooden pipeline. Filling of these sections is expected to occur prior to the section of pipe being backfilled.

During the video inspection of the transite TNT wastewater pipeline there may be other sections of pipeline that will be identified with cracks or other defects. These pipeline sections will be marked in the field and samples will be collected along these sections as described in **Section 4.3.1** to determine whether they will require removal and off site disposal.

4.2.3 North Cooling Water Line Removal

Based on sample results collected adjacent to the north cooling water pipeline during the 2021 PDI, there are indications that sections of this pipeline will be removed along with surrounding impacted soil at sample locations 29SB143 (NC-1), 29SB138 (NC-2), and 29SB139 (NC-3) (**Figures 4-2**, **4-3**, and **4-4**). Additional samples were collected in 2022 to provide further delineation for these areas. Samples were generally offset 10 ft to either side of the impacted samples, although some were greater than 10 ft. All sample results for samples collected in 2022 were nondetect, with the exception of 29SB191 (NC-1), which had an exceedance of 2,4-DNT (0.11 mg/kg) at a depth of 9.5 to 10 ft. Boundaries for the excavation areas are shown in **Figures 4-2**, **4-3**, and **4-4**. These areas will be excavated, and associated piping will be cut at either end of the excavation and the pipeline section will be removed and disposed off site along with the soil impacted above the cleanup level. The final extent of the excavation will be determined based on visual observations and the collection of confirmation samples as described above for removal of the wooden TNT wastewater pipeline. The depth of the excavations will be based on the depth to groundwater. An estimated in-place volume for removal of contaminated soils from excavations NC-1, NC-2, and NC-3 are 2,600, 2,040, and 150 cy, respectively (**Table 4-2**). The overall estimated volumes for the deeper excavations NC-1 and NC-2, assuming side slopes of 1H:1V, are 3,600 and 3,900 cy, respectively.

There were also four other sample locations (29SB165, 29SB147, 29SB146, and 29SB142) where impacts were observed but the results were all below the cleanup standard (**Figures 1-14 and 1-15**). If the integrity of the pipeline is found to be defective during the video inspection, these sections will also be excavated, and the pipeline will be cut and the section of pipeline along with surrounding soil will be removed and disposed off site. All other sections along the north cooling water pipeline, where no soil impacts have been observed will be video inspected, cleaned, and abandoned in-place as described in **Section 4.3.** Samples collected adjacent to the south cooling water line did not have any detections of COCs. As a result, it is assumed that the south cooling water line is generally intact and can be video inspected, cleaned, and abandoned in-place. If the integrity of the south cooling water line is found to be defective during the video inspection, these sections will be staked in the field and samples will be collected via geo-probe or other similar method at 30 ft intervals on either side the affected pipeline. The samples will be collected within 2 ft of the estimated outer edge of the pipeline and at two depths, the estimated mid-point of the pipe and within 1 ft below the estimated bottom depth of the pipe. If sample results for explosives are below the cleanup levels, then the pipe will remain in place and be abandoned per the design. If soil sample results are above the cleanup levels, then the area will be excavated, and the pipeline will be cut and removed along with the surrounding soils for disposal off site.

4.3 Pipeline Video Inspection, Cleaning and Plugging

The design for solid residue removal from pipelines includes flushing of pipes followed by visual inspection to verify solid residue has been removed. Details for each pipeline that will be inspected, flushed, and plugged are included in this section.

4.3.1 Transite TNT Wastewater Line

The ROD specified that solid residue containing COCs (2,4,6-TNT, 2,4-DNT, 1,3 dinitrobenzene, 2-amino-4,6-DNT, 4-amino-2,6-DNT) present inside the transite TNT wastewater line be removed and the pipeline to be sealed and abandoned in place. The transite pipe is a 6-inch diameter pipeline installed approximately 5 ft north of the wooden TNT wastewater pipeline and extends from the production buildings to the pump-house. From the pump house the pipeline is approximately 5 ft east of the wooden TNT wastewater pipeline and conveyed wastewater to the TNT Waste Disposal Plant designated as LHAAP-32 (*Final Addendum Phase 2 Work Plan for Wasteline Sampling*, Sverdrup, April 1995). The depth of the transite pipeline is estimated to be buried between 3 to 3.5 ft bgs based on previous historic investigations where the transite pipeline was uncovered; however, based on information collected on the depth of the wooden TNT pipeline which runs parallel to the transite pipeline it is possible this pipeline may be buried up to 10 ft in some areas. Historic investigations indicated the transite TNT pipeline to be in good condition. The gravity flow portion of the pipeline extends approximately 3,000 lf, and the pressurized portion of the pipeline extends approximately 1,700 lf which goes from the pond to former treatment plant at site LHAAP-32 (**Table 4-1**).

The transite pipeline is close to 80 years old. Typical lifespan for transite pipeline is estimated to be 70 years. As a result, it is possible that the pipeline may not be in good enough condition to clean and abandon in place per the ROD. If this is the case, the pipeline will be excavated and transported off site for disposal as described above in **Section 4.2**. Prior to performing cleaning, the line will be inspected using video inspection equipment to visually confirm the integrity of the pipeline and whether any cracks or other defects are visually apparent. The video inspection will also provide visual indication of the amount of sediment or sludge that may be present in the pipeline. Following the video inspection, sections of pipe determined to be visually sound will be cleaned. The means and methods for cleaning the pipeline will determined by the Contractor, but at a minimum will include a method for rinsing the pipeline with water. Following cleaning, the section of pipe will be video inspected to verify the inside of the pipe is visually clean, and the pipe section will be filled with grout, flowable fill or similar low-permeable material.

Sections of pipeline outside the sections that will be removed along with the wooden TNT wastewater pipeline described in **Section 4.2.2** will be marked in the field. If video inspection determines these sections to be intact enough for cleaning and abandonment, soil samples will be collected along these sections to determine whether contamination has leached from the defective sections into the surrounding soils. Samples will be analyzed for explosives using a 48-hour TAT. If results are below the cleanup goals the sections will be cleaned and abandoned in place. If results exceed the cleanup levels, then the section of pipe and surrounding soils will be removed as described in **Section 4.2**.

4.3.2 Cooling Water Lines

Two drain pipelines (north cooling water line and south cooling water line) were historically used to collect cooling water that came into direct contact with TNT production mixtures from the six TNT production plants. The pipelines conveyed water to an open drainage ditch that continued to convey

the water east beneath Avenue D to the Neutralization House located in the Toluene Bulk Storage Area on the northeast side of Avenue D. Cooling water was neutralized at the Neutralization House before being discharged to surface water.

During previous investigations conducted in 2004 by Shaw the following observations were noted:

- Manhole 4 was collapsed and unable to be sampled
- Manholes 1, 3, and 11 did not contain enough residue to collect samples
- Manholes 3, 5 and 12 were the only locations where water samples could be collected.

The cooling water lines are reported as having pipeline diameters of 8-inches and 18-inches. For the design it was assumed that all the service laterals to the production buildings were constructed of 8-inch pipeline and the main trunkline that runs across the site collecting water from each of the service lines consists of an 18-inch pipeline. The actual sizes of the pipeline will be field verified by the Contractor as part of the precleaning video inspection.

The north cooling pipeline consists of 8-inch drain lines that carried water from the TNT production buildings to the main 18-inch diameter pipeline that carried water to the cooling water ditch. Each of the service lines is connected to the main pipeline with five manholes. The south cooling water pipeline is similarly constructed and consists of 8-inch drain lines from each of the former production areas and is connected to the main 18-inch diameter pipeline via seven manholes. The northern cooling water line is approximately 2,500 lf of pipeline and the southern cooling water line is approximately 2,800 lf of pipeline. The service laterals connecting to the cooling water lines total approximately 5,100 lf in length. Based on field observations service laterals remain as open-end pipelines which will allow access to each of the service lateral pipeline sections from the former building foundations.

Cooling water lines will be inspected and cleaned as described above for the TNT wastewater pipeline in **Section 4.3.1**, except where soil samples indicate that releases have occurred as described above. Following cleaning, the pipeline will be reinspected to verify all sediment has been removed from a pipeline section and then the pipeline will be abandoned in place by filling the pipeline section completely with flowable fill or a similar low-permeable material. The actual means and methods for cleaning the pipeline will be designed by the Contractor; however, it is likely that the existing manholes will be used as collection sumps and access ports for pipeline cleaning. Sediment and water will be removed via a vacuum truck and temporarily stored in a fractional tank. Once sediment has settled, water will be removed from the tank and taken for off site treatment and discharge and sediment will be transported off site for disposal.

Sections of cooling water pipeline observed with cracks and defects will be staked in the field for sampling as described in **Section 4.2.3**. These sections will only be excavated and removed if soil samples indicate a release has occurred that has resulted in soil concentrations greater than the cleanup levels.

4.4 Implementation of Video Inspection, Cleaning, and Plugging

This section describes the remedial action field activities planned at the site for the pipeline cleaning and plugging. A RAWP for the pipeline inspection, cleaning and plugging will be prepared and implemented by the Contractor in accordance with the requirements specified in the scope of work included in **Appendix G**. Prior to initiation of the field activities performed as part of the RAWP, the

regulators will be notified at least 15 days in advance. Site-specific activities are described in associated subsections. The construction sequence for video inspection, cleaning, and plugging of pipelines is outlined below and described in detail in the following subsections:

- Mobilization and Site Preparation
- Surveying
- Pre- and Post-cleaning Video Inspection
- Pipeline Cleaning
- Pipeline Plugging
- Waste Management
- Demobilization
- Reporting

4.4.1 Mobilization and Site Preparation

The following field activities will be conducted as part of the mobilization and site preparation activity.

- **Site Safety and Health: Site Safety and Health:** The responsibility for the development, implementation, and enforcement of the APP and HASP lies with the Contractor and its health and safety personnel. APP/HASP will be developed by the Contractor including programs for accident prevention, personnel protection, medical surveillance, site control/decontamination, emergency response/contingency planning, and air monitoring. The Contractor's APP/HASP will be submitted to the regulator for approval prior to the commencement of any on-site activities.
- **Mobilization:** Appropriate personnel, subcontractors, and equipment necessary to perform video inspection, cleaning, and plugging of the pipeline will be mobilized to the site.
- **Site Access**: U.S. Army will be responsible for providing site access needed to complete the work. Improvement of the site access road using geotextile and additional gravel may be performed to allow trucks and heavy equipment to enter and exit the site safely. USFWS will be consulted regarding any improvements to minimize impact to the surrounding terrain to the degree possible.
- **Preconstruction Documentation**: Prior to the start of any site preparation activities, a preconstruction video/photographic recording of the areas along the pipelines will be conducted. This recording will document the existing conditions of the site, and any other features of interest on and adjacent to the site. The Contractor will enlist the services of a qualified surveyor, licensed in the State of Texas, to field verify the existing site conditions. This preconstruction survey will identify and mark-out the pipelines, manholes, existing site topography, property boundaries, and capture any and all structures and other existing physical features of the site.
- **Clearing**: Prior to the mobilization, work locations for overhead and ground level accessibility will be evaluated. In areas that have excessive vegetation and/or tree growth, a backhoe or other appropriate earthmoving equipment will be used to clear the areas to allow equipment access. Grubbing is not anticipated. Clearing shall consist of the felling, trimming, and cutting of trees and other vegetation, as required to perform the work.
- **Utility Mark-outs**: The Contractor will coordinate with underground utility locators for utility clearances.

- **SESCs:** SESCs will be installed at the site where necessary to allow access to pipelines for cleaning and prevent the migration of sediment into existing drainage swales. The controls anticipated for use include but are not limited to the installation of silt fence around the area of disturbance, temporary culvert crossings for areas where the access road will cross existing drainage swales, and diversion berms to control stormwater flow around points of access. Additional controls to prevent the migration of sediment may be employed if necessary.
- **Decontamination:** Equipment and personnel decontamination procedures should be included and detailed in the HASP.

4.4.2 Surveying

The locations of the underground pipelines, entry and exit points, and manholes along the north and south cooling water pipelines will be surveyed preliminarily using GPS equipment.

4.4.3 Pre- and Post-cleaning Video Inspection

A pre- and post-cleaning video inspection will be performed using video equipment capable of producing a sharply focused, well-lit and color balanced picture and specifically designed to perform closed-circuit television.

The pre- and post-cleaning video inspections will be conducted for three pipelines (transite TNT wastewater, north and south cooling water pipelines). The entry point for the TNT wastewater line that traverses the site from east to west (gravity portion of the pipe) will be either from the former pump station area or the B806-A area. The entry point for the TNT wastewater line that heads to LHAAP-32 will be at the former pump station area. Entry points for the north and south cooling water pipelines will be from the existing manholes.

Following the precleaning video inspection, any sections of pipe that are noted as having cracks or defects that will not allow for cleaning and plugging of the line will be marked in the field using stakes. Soil samples will be collected along the broken sections to determine if a release has occurred in order to determine whether these sections will be removed. This is discussed in **Section 4.3**.

4.4.4 Pipeline Cleaning

The final means and methods for pipeline cleaning will be determined by the Contractor and will be based on the results of the precleaning video inspection. Two main types of cleaning methods are pipeline flushing or pigging. Because the ROD specifies flushing, any cleaning methods used will be required to use water at some point in the process.

4.4.5 Pipeline Plugging

The final means and methods for plugging the pipeline will be determined by the Contractor but are anticipated to be completed by filling cleaned sections of pipe with flowable fill. Prior to pumping flowable fill into a pipe section, the end of the pipe will be plugged using a grout plug or manufactured plug specifically designed for plugging of abandoned pipes.

Manholes connected to the cooling water lines will also be abandoned in-place. Pipes entering these structures will be plugged. The top four ft of the structure will then be destroyed and removed, and any existing frame and cover will also be removed. The removed concrete, cover and frames will be

disposed off site. The remaining portion of the manhole will then be completed filled with flowable fill or other approved material. Following placement of flowable fill the remaining upper portion will be backfilled with clean soil and compacted to provide a smooth surface.

4.4.6 Waste Management

Types of waste that will be managed as part of the pipeline cleaning include solid residue from the TNT wastewater line, solid residue from the cooling water lines, and wash water generated during cleaning and are summarized in **Table 4-3**.

Table 4-3 – Identification and Preliminary Classification of Waste Streams Associated with Pipelines

Waste Stream	Process Generating Waste Stream	Minimum Testing Requirement[1]	Preliminary Characterization[2]
TNT Wastewater Pipeline Removals			
TNT wooden pipeline, waste residue inside pipe, and soils immediately surrounding the pipeline (assumed to be within 12" of the pipe edges)	Excavation and removal of TNT pipeline, residual waste inside the pipeline, and soils immediately surrounding the pipes that are expected to be removed when excavating the pipe out.	Explosive compounds; RCRA reactivity testing	K047 listed waste
Contaminated soil removed outside the immediate excavation from the TNT pipeline removal	Soils outside the pipe removal trench identified above that are contaminated above the soil cleanup levels	Explosives compounds; RCRA reactivity testing	K047 listed waste; will require a contained-in determination to be taken off site as a nonhazardous waste
Cleaned transite TNT wastewater pipeline	Pipe sections excavated during the wooden pipeline removal will be cleaned of soil and segregated for separate waste disposal. Sections would be previously decontaminated as part of pipeline video inspection and cleaning and will contain no residual waste inside the pipe.	Visual assessment or as otherwise required by disposal facility to ensure that the outside of the pipe is cleaned of all soil.	Asbestos-containing material;

Waste Stream	Process Generating Waste Stream	Minimum Testing Requirement[1]	Preliminary Characterization[2]
Cooling Water Pipeline Removals and Excavations			
Cooling Water Pipeline	Excavation and removal of cooling water pipeline and soils immediately surrounding the pipes that are expected to be removed when excavating the pipe out.	Explosive compounds; RCRA reactivity testing	Nonhazardous unless determined to be characteristically hazardous
Contaminated soil removed from areas surrounding the pipeline	Soils contaminated above the soil cleanup levels	Explosives compounds; RCRA reactivity testing	Nonhazardous unless determined to be characteristically hazardous
Pipeline Cleaning			
Solid waste residue from cooling water pipelines	Solid residue generated from cleaning the pipeline	Explosives compounds; RCRA reactivity testing	Nonhazardous unless determined to be characteristically hazardous
Liquid waste from cooling water pipelines	Solid residue and water generated from cleaning the TNT transite wastewater pipeline	Explosives compounds; RCRA reactivity testing	Nonhazardous unless determined to be characteristically hazardous
Liquid waste from transite TNT wastewater pipelines	Water generated from cleaning the TNT transite wastewater pipeline	Explosives compounds; RCRA reactivity testing	K047 listed waste
Solid waste from transite TNT wastewater pipelines	Solid residue generated from cleaning the TNT transite wastewater pipeline	Explosives compounds; RCRA reactivity testing	K047 listed waste
General Remediation Waste			
Contaminated PPE	Disposable PPE worn by workers to prevent contact with contaminated materials	As required by the disposal facility	nonhazardous

Notes:

1. Additional testing will likely be required by the disposal facility that is not included in this table.
2. Final waste classification will be made based on the results of testing.

Pink/red wastewaters from TNT operations are a listed hazardous waste (K047) according to RCRA. This listing includes solid residue remaining in the pipeline that was produced from the TNT wastewater. Dried residue can be easily ignited by heat, sparks, or flames. Solid residue and water in contact with solid residue generated during the TNT wastewater pipeline cleaning will be kept separate

from solid residues removed from the cooling water pipeline cleaning to prevent mixing of the waste streams. Solid residue removed from the cooling water pipelines is not a listed hazardous waste.

Wastewater from pipe flushing and solid residue removed from the TNT wastewater transite pipeline will be collected in frac tanks or other container for transport to an approved disposal facility. For purposes of the design, it is assumed that these materials will be taken off site as a listed hazardous waste.

Wastewater generated from pipe flushing of the north and south cooling water lines will be collected in separate frac tanks or other containers for waste characterization testing to determine whether waste generated will be characteristically hazardous. If testing determines waste is not characteristically hazardous, it will be disposed off site as a nonhazardous waste to an approved disposal facility.

For the design, it was assumed that contaminated soils immediately surrounding the wooden TNT wastewater pipeline removed as part of the wooden pipeline removal will be taken off site with the pipeline as a listed hazardous waste. Soils outside the immediate excavation will be stockpiled separately and a contained-in determination will be requested from the TCEQ to manage these soils as a nonhazardous waste.

Contaminated soils surrounding the cooling water pipeline was assumed to be disposed off site as nonhazardous material with the cooling water pipe sections. Waste characterization samples will be collected to confirm this preliminary determination.

The final list of analytes to be sampled for waste characterization will be determined by State and Federal requirements and the waste disposal facility, but will likely include ignitability, corrosivity, reactivity, and toxicity for metals, VOCs, SVOCs, pesticides, and herbicides using the Toxicity Characteristic Leachate Procedure (TCLP) for solid wastes (EPA, 1992). Waste characterization samples will also be collected and analyzed for explosive compounds.

4.4.7 Demobilization

Following pipeline cleaning and plugging, all materials and equipment will be removed from the site. Areas disturbed to access the pipelines will be restored as described for site restoration of excavated areas.

4.4.8 Reporting

After the cleaning and plugging of the pipelines a report will be prepared to document the implementation of the remedial action. The report will include a description of the remedy as completed, a discussion of any problems encountered during construction along with their resolution, a description of any changes to the design, and quantities and concentrations of solid residue and wash waters generated, waste characterization results and waste disposal documentation, product information and volumes for flowable fill used to abandon the pipelines and manholes.

5 MONITORED NATURAL ATTENUATION DESIGN

Natural attenuation is defined as the reduction of contaminants from the combined effect of intrinsic biodegradation, advection, dispersion, dilution, volatilization, and sorption mechanisms. Generally, intrinsic biodegradation is the most important natural attenuation mechanism to result in contaminant destruction. Intrinsic biodegradation can occur in any environment that supports microbial activity. The biodegradation may be limited by the lack of a suitable respiratory substrate (for example, oxygen) or inorganic nutrients, extreme pH, or limited contaminant bioavailability. MNA entails the use of natural attenuation within the context of a monitoring plan to demonstrate reductions in contaminant concentrations and achievement of remedial action objectives (Shaw 2010).

An MNA evaluation for the LHAAP-29 site was conducted by Shaw in 2010 as part of the original FS. The evaluation was based on the EPA guidance, *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater* (EPA 1998). The EPA guidance specifies a tiered approach of recommended lines of evidence required for demonstrating that MNA is an effective remedy. These three lines of evidence are:

1. Observed Reduction in Contaminant Mass and Concentration. Relies on use of historical groundwater data that demonstrate a clear trend of stable or decreasing COC concentrations over time at appropriate monitoring or sampling points. An increase in degradation daughter products is also an indicator that reductive dechlorination is occurring and degrading contaminant mass.
2. Identified and Quantified Natural Attenuation Processes. Uses geochemical indicators to document certain geochemical signatures or “footprints” in the groundwater that demonstrate (indirectly) the type of natural attenuation process(es) occurring at the site and the rate at which such processes will reduce COCs to the MCLs or for those compounds without MCLs, groundwater concentrations based on TRRP Tier 1 Residential Groundwater PCLs established by TCEQ.
3. Microcosm Studies. Most often consists of predictive modeling studies and other laboratory/field studies that demonstrate the occurrence of natural attenuation process(es) at the site and its ability to degrade the COCs.

All three lines of evidence were evaluated for LHAAP-29 to demonstrate the occurrence of natural attenuation of groundwater COCs. A summary of the conclusions from the evaluation are provided below.

The COCs included as part of the MNA evaluation at LHAAP-29 are TCE, 1,2-DCA, perchlorate, 2,4-DNT, 2,6-DNT, 2(o)-NT, and 4(p)-NT in the shallow groundwater zone, and TCE and MC in the intermediate groundwater zone. These zones are separated by layers of clay that may prevent or slow migration from one zone to the next. Wells designated as deep are not affected by COCs, although MC was present in the deep zone in past samples.

First line of evidence: Historical analytical trends indicate the occurrence of perchlorate biodegradation at LHAAP-29. In the shallow groundwater zone, perchlorate, TCE, 1,2-DCA, DNTs and NTs exhibited decreasing trends, suggesting natural attenuation is effectively controlling the contaminants. In particular, MC concentrations in the shallow zone have attenuated completely to below the MCL. In the intermediate groundwater zone, significant reductions of MC and TCE were also observed in the monitoring wells exhibiting historical high values. Furthermore, MC was detected

at approximately half of solubility in one intermediate well (29WW16), where MC concentrations fluctuated at elevated levels. In the deep groundwater zone, MC has been reduced to below the MCL. MC degradation produces acetate and formate, which can be used as electron acceptors and carbon sources for the degradation of other COCs mediated by microbial activities. The presence of readily degradable MC may enhance TCE and 1,2-DCA reduction via a cometabolic pathway, instead of reductive dechlorination. Furthermore, the lack of DCE and vinyl chloride (VC) suggest that chlorinated solvents cannot achieve complete dechlorination under current conditions, thus the reductions of TCE and 1,2-DCA is via a cometabolic pathway. In the shallow, intermediate and deep groundwater zones, natural attenuation is effectively controlling contaminant plume migration and reducing the COCs concentrations, except for MC in the intermediate zone around monitoring well 29WW16.

Second line of evidence: The qualitative assessment of the geochemical indicators in the shallow and intermediate groundwater zones at LHAAP-29 presents evidence that geochemical conditions are adequate for perchlorate, MC, and explosives reduction; however, only a localized area is suitable for reductive dechlorination of chlorinated solvents such as TCE. In the comparison of different groundwater zones, the shallow groundwater zone is more aerobic than the intermediate groundwater zone. The elevated sulfate concentrations are at levels capable of inhibiting reductive dechlorination in the shallow groundwater zone, but the adequate total organic carbon present at the same location suggests the possible alternative pathway is cometabolic degradation.

Third line of evidence: An important indicator of reductive dechlorination is the presence of Dehalococcoides (DHC) which is the only known species capable of complete dechlorination of TCE. During the February 2007 sampling event, DHC was not observed in groundwater at LHAAP-29. In the absence of DHC observations, predictive calculations of time-dependent in-well natural attenuation rates were calculated for perchlorate, explosives, TCE, 1,2-DCA, and MC. Perchlorate attenuation rates ranged from 0.00786 to 0.000239 per day in the shallow groundwater zone, and the estimated time to achieve criteria used in the Natural Attenuation Evaluation (Shaw 2010) ranged from already completed to 32 years. Explosive compounds attenuation rates ranged from 0.00256 to 0.000384 per day in the shallow groundwater zone, and the estimated time to achieve concentrations identified in the Natural Attenuation Evaluation (Shaw 2010) ranged from already completed to 22 years. In shallow and intermediate groundwater zones, TCE attenuation rates ranging from 0.0100 to 0.000209 per day, and the estimated time to achieve MCL ranged from already completed to 89 years. The 1,2-DCA attenuation rate was calculated as 0.000283 per day in the shallow groundwater zone, and the estimated time to achieve MCL was 68 years. In shallow, intermediate, and deep groundwater zones, MC attenuation rates ranged from 0.0650 to 0.00115 per day, and for these wells, natural attenuation has already achieved the MCL. One monitoring well, 29WW16, still exhibits substantial MC concentrations and a time-dependent attenuation rate for this well is not currently available.

Conclusion: The historical sample results suggest that the COC plumes are not expanding. Thus, the extent of the plumes appears to be stable. Additional monitoring results over time will serve to confirm or contradict that determination. Reductions in concentrations of perchlorate, explosives, TCE, 1,2-DCA and MC based on the available historical groundwater sampling results suggest that natural attenuation is occurring and is likely controlling COCs in the shallow, intermediate and deep groundwater zones of LHAAP-29. Based on the historic groundwater sample results, natural attenuation of COCs was observed in nearly all wells, except for well 29WW16 where MC concentrations exceeded the tolerant range for microorganism’s activities. It is expected that conditions in the intermediate groundwater zone at 29WW16 will be more conducive to MNA once the

concentrations are reduced by ISTD. Geochemical parameters and microbial analysis will continue during performance monitoring to demonstrate that MNA is effective.

Monitoring events conducted over the course of the LTM program will be used to continue to evaluate the three lines of evidence described above to determine the effectiveness of MNA for each of the groundwater plumes. To do this, a monitoring network will be needed for each of the plume areas to provide effective monitoring. An effective monitoring network will provide monitoring well locations to evaluate the background groundwater concentrations, the lateral extent of the plume perpendicular to groundwater flow, source zone monitoring, and downgradient monitoring along the edge of the plume in the direction of groundwater flow. Some plumes will require the installation of additional monitoring wells to establish an effective monitoring well network. These are also indicated in the table below. The monitoring well network for each of the plumes identified for monitoring in the shallow and intermediate zones are discussed further in the following sections. No impacts were identified for the deep zone, however deeper groundwater will be monitored as part of the monitoring program in the vicinity of the intermediate zone plume to ensure the plume does not migrate downward and impact the deep groundwater zone over time. This is discussed in **Section 5.2.1**.

5.1 Shallow Groundwater Zone

The shallow groundwater zone extends to approximately 50 ft bgs and the flow direction is generally toward the east-northeast (Shaw 2010). The COCs exceeding MCLs or TRRP Tier 1 Residential Groundwater PCLs at LHAAP-29 are TCE, 1,2-DCA, perchlorate, 2,4-DNT, 2,6-DNT, o-NT, and p-NT in the shallow groundwater zone.

MNA will be conducted for the VOC and perchlorate plume in the vicinity of well 29WW15, the perchlorate plume in the vicinity of well 116 (**Figure 1-9**), and the three nitrotoluene plumes shown on **Figure 1-10.**

Shallow monitoring wells will also be installed in the vicinity of excavations that are terminated at the groundwater table. These excavation areas are E-2, E-3, and NC-3.

Additional monitoring wells will be installed to monitor MNA for the shallow groundwater zones. Prior to installing new monitoring wells, the Contractor will collect a round of groundwater samples and analyze for the COCs. The results from these samples will be evaluated and used to verify the limits of the plumes and refine the placement for proposed monitoring wells.

5.1.1 VOC and Perchlorate Plume

The VOC and perchlorate plume is in the vicinity of well 29WW15. Groundwater flow direction in this area of the site is generally to the east (**Figure 1-7**). Four existing wells [29WW17, 29WW18, 29WW22, and 29WW20] are shown surrounding the plume, outside the perchlorate plume boundary shown in **Figure 1-9**. These wells are located between 173 ft (29WW17) to 505 ft (20WW22) away from well 29WW15. No wells exist in the interior portion of the plume to provide lateral delineation of the plume and to demonstrate shrinking of the plume over time. Additionally, there are no existing wells to further delineate the longitudinal extent of the plume to the west and east (downgradient) edge in the direction of groundwater flow (see **Figure 1-7** for groundwater flow direction). It is planned to install four additional wells in this plume area, one of which will be shared with the middle TNT plume discussed in **Section 5.1.3**. Two wells are planned to be installed 100 ft west (29WWRA-06) and 100

ft east (29WWRA-05) of 29WW15 and then one well approximately 200 ft east (29WWRA-04) of 29WW15. The final well (29WWRA-13) is planned to be installed approximately 200 ft southwest of 29WW15. The final location of these wells will be selected following review and evaluation of the baseline groundwater sampling event. The current proposed well locations are shown in **Figure 5-1**.

5.1.2 Perchlorate and North Nitrotoluene Plumes

The perchlorate and north nitrotoluene plumes are in the vicinity of monitoring wells 116 and 29WW05. Based on the groundwater potentiometric surface in this area, the water table at these wells are higher than the surrounding area and groundwater flows radially away from these wells in all directions (**Figure 1-7**). Other existing wells within the vicinity of these plumes include 29WW06, 29WW09, 29WW10, and 29WW11 (**Figures 1-9** and **1-10**). These existing monitoring wells are located outside the boundaries for both the perchlorate plume and nitrotoluene plumes, with the exception of 29WW09 which is located approximately 330 ft southeast of well 116 and is along the estimated boundary of the 17 µg/l perchlorate plume. Three additional monitoring wells are planned to be installed for these plumes. Wells are planned to be installed approximately 100 ft to the north (29WWRA-02) and east (29WWRA-01) of well 116 and one well approximately 200 ft southwest (29WWRA-03) of well 116. The final location of these wells will be selected following review and evaluation of the baseline groundwater sampling event. Proposed locations for these wells are shown in **Figure 5-2**.

5.1.3 Middle Nitrotoluene Plume

The middle nitrotoluene plume is in the vicinity of monitoring well 29WW20. Based on the groundwater potentiometric surface in this area, the groundwater flow direction in the vicinity of this well is generally to the southeast (**Figure 1-7**). Other existing wells within the vicinity of this plume include 29WW22, 29WW26, 29WW23, and 29WW15. These wells are between 133 ft (29WW22) and 412 ft (29WW15) from well 29WW20. Monitoring well 29WW19 is the closest downgradient well and is 511 ft from 29WW20 and greater than 100 ft from the estimated edge of the plume (**Figure 1-10**). Two of the four monitoring wells are shown on the edge of the plume, and no wells are located interior to the plume to monitor changes in the lateral extent of the plume over time. Three additional monitoring wells are planned to be installed to monitor this plume. Wells are planned to be installed approximately 150 ft to the south (29WWRA-08) and approximately 290 ft northeast (29WWRA-06) of 29WW20 in the direction of groundwater flow. A third monitoring well is proposed approximately 200 ft northeast (29WWRA-13) of 29WW20. The final location of these wells will be selected following review and evaluation of the baseline groundwater sampling event. The current proposed well locations are shown in **Figure 5-1**.

5.1.4 South Nitrotoluene Plume

The south nitrotoluene plume is in the vicinity of monitoring well 29WW33 and 29WW03. Based on the groundwater potentiometric surface in this area, the groundwater flow direction in the vicinity of this well is generally to the southeast (**Figure 1-7**). Other existing wells within the vicinity of this plume include 29WW32, 29WW29, and 29WW01 (**Figure 1-10**). These wells are between 420 ft (29WW01) to 452 ft (29WW29) from well 29WW33. Monitoring well 29WW32 is the closest downgradient well and is approximately 425 ft from 29WW33. All three monitoring wells are shown outside the edge of the plume, and no wells are located interior to the plume to monitor changes in the lateral extent of the plume over time. Four additional monitoring wells are planned to be installed to monitor this plume. Two wells are planned to be installed 100 ft north (29WWRA-10) and southwest (29WWRA-11) of

29WW33. The two remaining wells are planned to be installed 160 ft southeast (29WWRA-09) and approximately 200 ft southwest (29WWRA-12) of 29WW33. The final location of these wells will be selected following review and evaluation of the baseline groundwater sampling event. The current proposed well locations are shown on **Figure 5-3**.

5.1.5 Shallow Groundwater Monitoring for Excavations

At least three excavation areas (E-3, E-4, NC-3) are anticipated to be terminated at the groundwater depth (**Figures 2-3, 2-4**, and **4-4**). Other excavations may also meet this criterion if bottom confirmation samples do not achieve the soil cleanup levels before the groundwater table is breached. For these excavation areas a single well will be installed in the vicinity of the excavation following backfill and restoration of the area. The monitoring well will be installed with a bottom depth 10 ft below the bottom of the excavation. A 10 ft screen will then be installed which will put the top of the screen at the bottom of the excavation. Wells will be constructed of 2-inch diameter schedule 40 PVC riser pipe and 0.01-inch slot well screens. Anticipated wells needed to monitor groundwater in the vicinity of excavations stopped at the groundwater table are summarized in **Table 5-1**.

Table 5-1 – Proposed Excavation Monitoring Wells

Proposed Well ID	Anticipated Well Depth (ft bgs)
29WW-E3	24
29WW-E4	26
29WW-NC3	23

5.2 Intermediate Groundwater Zone

The intermediate groundwater zone extends from approximately 50 to 100 ft bgs, separated from the shallow and deep groundwater zones by clay layers. The interconnection between different groundwater zones varies with locations, so contaminants could migrate from shallow to intermediate groundwater zone at certain locations. MC and chlorinated ethenes and ethanes were detected in the intermediate groundwater zone, while explosive compounds were not detected. Perchlorate was present at levels below its TRRP Tier 1 Residential Groundwater PCL (Shaw 2010).

MNA will be conducted for the VOC plume in the vicinity of well 29WW16, following the completion of ISTD (**Figure 1-11**).

5.2.1 Intermediate Zone VOC Plume

The VOC plume is in the vicinity of existing well 29WW16 and 29WW42 (**Figure 1-11**). Based on the groundwater potentiometric surface for the intermediate zone, the groundwater flow direction in the vicinity of this well is generally to the north (**Figure 1-8**). Other existing wells within the vicinity of this plume include 29WW43 and 29WW44. 29WW43 is located along the southern part of the plume (upgradient) and 29WW44 is located to the north (downgradient). All three monitoring wells are shown inside the plume, and no wells are located outside the plume. Additional monitoring wells will be installed as part of the ISTD remedial action. These additional wells will continue to be used to monitor MNA following completion ISTD and are shown in **Figure 5-4**.

In addition to monitoring the intermediate wells in this area, deep monitoring well 29WW45 will also be monitored (see **Figure 5-4**). Monitoring of this well will confirm the ISTD did not move contamination deeper and impact the deep groundwater zone in this area.

5.3 MNA Design Criteria

MNA will be implemented to reduce groundwater contamination in the shallow and intermediate zones to the cleanup levels listed in **Table 1-3** and summarized below:

Shallow Zone Groundwater:

- TCE 5 µg/l
- 1,2-DCA 5 µg/l
- 1,1-DCE 7 µg/l
- Cis-1,2-DCE 70 µg/l
- Trans-1,2-DCE 100 µg/l
- VC 2 µg/l
- Arsenic 10 µg/l
- Mercury 2 µg/l
- Selenium 50 µg/l
- 2,4-DNT 1.3 µg/l
- 2,6-DNT 1.3 µg/l
- 2(o)-NT 4.1 µg/l
- 3(m)-NT 240 µg/l
- 4(p)-NT 57 µg/l
- Perchlorate 17 µg/l
- Nickel 490 µg/l

Intermediate Zone Groundwater:

- TCE 5 µg/l
- MC 5 µg/l
- 1,2-DCA 5 µg/l
- 1,1-DCE 7 µg/l
- cis-1,2-DCE 70 µg/l
- trans-1,2-DCE 100 µg/l
- VC 2 µg/l
- Arsenic 10 µg/l

A contingency remedy consisting of the injection of bioremediation amendments to enhance degradation of groundwater contaminants may be implemented in the future if MNA is found to be ineffective after a minimum period of 5 years. The contingency remedy would depend on groundwater data collected during LTM and would be designed in the future and is not included as part of the remedial design for this RA.

5.4 MNA Implementation

This section describes the remedial action field activities and LTM planned at the site for implementing MNA in the shallow and intermediate groundwater zones. MNA will occur in the shallow and intermediate zones for the plumes discussed in **Sections 5.1** and **5.2**:

- Initial Groundwater Sampling
- Well Installation and Development
- Surveying
- LTM
- Reporting

5.4.1 Initial Groundwater Sampling

Prior to installing any new shallow monitoring wells, a baseline sampling event will be conducted on the existing shallow monitoring wells listed in **Table 5-2**. All wells will be sampled for MNA parameters including chloride, nitrate, nitrite, sulfate, sulfide, total alkalinity, total organic carbon, ethane, ethene, methane, and field parameters (pH, specific electrical conductance, dissolved oxygen, turbidity, oxidation-reduction potential, and temperatures). Additional COCs that will be analyzed for each well are summarized in **Table 5-2**. Initial groundwater sampling that will be completed as part of the ISTD remedial action is discussed in **Section 3.4.4**.

Table 5-2 – Baseline Groundwater Monitoring

Well ID	Associated Plume	COC Sample Parameters
114	Southern TNT Plume	Explosives, metals
116	Perchlorate and North TNT Plume	Explosives, perchlorate, metals
29WW01	Southern TNT Plume	Explosives, metals
29WW03	Southern TNT Plume	Explosives, metals
29WW05	Perchlorate and North TNT Plume	Explosives, perchlorate, metals
29WW06	Perchlorate and North TNT Plume	Explosives, perchlorate, metals
29WW09	Perchlorate and North TNT Plume	Explosives, perchlorate, metals
29WW10	Perchlorate and North TNT Plume	Explosives, perchlorate, metals
29WW11	Perchlorate and North TNT Plume	Explosives, perchlorate, metals
29WW15	Middle TNT Plume; VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals
29WW17	VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals
29WW18	VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals
29WW19	VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals

Well ID	Associated Plume	COC Sample Parameters
29WW20	Middle TNT Plume; VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals
29WW22	Middle TNT Plume; VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals
29WW23	Middle TNT Plume	Explosives, metals
29WW26	Middle TNT Plume	Explosives, metals
29WW32	Southern TNT Plume	Explosives, metals
29WW33	Southern TNT Plume	Explosives, metals

Monitoring wells will be sampled using low-flow techniques in accordance with EPA's standard operating procedures for low-flow sampling (EPA/540/S-95/504). Each well will be purged using a bladder pump or similarly suitable pump that will be capable of sustainable flows as low as 0.1 liter/minute (l/min). Wells that will be sampled for VOC analysis will be sampled using Teflon-lined tubing. Well locations that will be sampled for explosive analysis can use polyethylene tubing.

To minimize sediment disturbance and water mixing, the pump will be slowly lowered through the water column to the midpoint of the well screen (or slightly above) for wells screened below the water table and to at least 2 ft below the water table for wells screened at the water table interface. The pump will be started at its lowest speed setting and slowly increased until a discharge occurs and then will be adjusted so there is little to no drawdown (less than 0.3 ft) in the water level. The water level and water quality parameters (pH, specific electrical conductance, dissolved oxygen, turbidity, oxidation-reduction potential, and temperatures) will be monitored and purging will continue until these parameters have stabilized. A groundwater sample will then be collected once stabilization has occurred and the turbidity is reduced to 10 NTUs or less. If parameters do not stabilize or turbidity remains greater than 10 NTUs, a sample may be collected after a minimum of three to six casing volumes have been purged. Water quality indicator parameters will be measured every 3 to 5 minutes by instruments contained in an in-line flow-through cell attached to the pump. Purging will be considered complete when parameters stabilize for at least three consecutive readings within the following limits: 1 °C for temperature, ± 0.1 pH, ± 0.01 millisiemens per centimeter (mS/cm) for conductivity, ± 10 millivolts (mV) or 10% (whichever is less) for oxidation-reduction potential, ± 10% for turbidity, and ± 10% for dissolved oxygen.

If the recharge rate of a well is slower than the extraction rate capabilities of currently manufactured pumps and a drawdown of more than 2 ft is observed, purging will be stopped to allow the well to recover before collecting a sample. Purging will continue for a period of at least one hour using the lowest pumping rate available, before attempting to collect a sample. For this situation, samples may be collected even though the indicator field parameters have not stabilized.

Samples will be collected in certified-clean glassware provided by the laboratory and placed on ice for preservation. Samples will then be shipped to the selected laboratory under chain of custody protocols for the parameters identified in **Table 5-2**. Analytical methods that will be used are summarized in **Table 5-3**.

Table 5-3 – Parameters and Analytical Methods

Parameters	Analytical Method No.
Explosives	8330A or 8321A
VOCs	8260B
Metals: • Arsenic, Selenium, Nickel, • Mercury	6010B 7470A
Anions: • Chloride • Nitrate • Nitrite • Sulfate • Sulfide • Perchlorate	300.0 353.2 353.2 300.0 SM 4500 314.0
Gases: • Ethane • Ethene • Methane	RSK-175
Total organic Carbon	5310 B

5.4.2 Well Installation and Development

Monitoring wells are anticipated to be installed using a rotosonic drilling method. Each well will be constructed with flush-joint threaded, schedule 40, PVC. Soil samples will be collected continuously using a sampler advanced ahead of the drill bit and will be described according to ASTM International (ASTM) D2488-09a, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 2009), and logged on USACE Engineering Form 1836 (Drilling Log) or equivalent.

The PVC well screen for each well will be constructed with 0.01-inch slots and will be 10 feet in length. A threaded PVC bottom cap will be secured to the bottom of the screen interval. Solid PVC casing will be installed from the top of the screen interval to approximately 3 ft above the surface grade. A filter pack consisting of clean silica sand (20 to 40 size) will be placed in the auger-well annulus from the well bottom to approximately 2 feet above the screen interval. A 3 ft thick bentonite seal (pellets or chips) will be placed above the sand filter pack and hydrated with potable water. The annular space from the top of the bentonite seal to the surface will be filled with a bentonite-cement grout.

For the wells installed in the intermediate and deep groundwater zones as part of the ISTD system monitoring, the well casing and screens will be stainless steel in order to withstand temperatures anticipated during the operation of the ISTD system.

The drilling equipment will be decontaminated prior to the arrival at the site and between wells. Upon completion of drilling activities, the drilling equipment will be decontaminated prior to demobilizing and leaving the installation. Core samplers will be decontaminated between sampling intervals with a detergent/water solution and multiple rinse stages in clean buckets. The decontamination wastewater and drill cuttings will be placed in drums or frac tanks for temporary storage before being taken off site for disposal.

Well surface completions will be constructed for each monitoring well installed. Surface completion will consist of protective steel casing, with a hinged, lockable lid set in a concrete pad. Concrete-filled steel bollards will be installed at the corners of the concrete pad. The monitoring wells and surface completions will be installed in general accordance with USACE and State of Texas requirements by a driller licensed in the State of Texas. Monitoring wells shall comply with applicable technical requirements of 16 Texas Administrative Code (TAC) Chapter 76. State of Texas Well Reports shall be submitted to the Texas Department of Licensing and Regulation for each well.

The new monitoring wells will be developed between 48 hours to 7 days from well installation to remove drilling fines and enhance hydraulic communication between the well and the groundwater zone. Well development will typically be performed by pumping and gentle surging of the screened interval using a rubber-lined surge block. A minimum of three well borehole volumes of water will be removed. The volume of groundwater removed from each well will be calculated from the static water level measurement referenced from the top-of-casing. An electronic interface probe will be used to measure the water levels. As an alternative to pumping, a bottom filling bailer may be used to remove water from low-yielding wells. Water quality parameters (temperature, pH, conductivity, and turbidity) of the development discharge water will be monitored. Well development will continue until the water quality parameters have stabilized and the water is visually clear.

Downhole development equipment will either be disposed after each use or will be decontaminated prior to and following use at each well location by cleaning in a detergent/water solution and multiple rinse stages in clean buckets. The development and decontamination wastewater will be placed in 55-gallon drums or other appropriate containers and taken off site for disposal.

5.4.3 Surveying

A professional land surveyor licensed in the State of Texas will survey the locations and elevations of the newly installed monitoring wells. The horizontal coordinates (northing and easing) of the wells will be surveyed to the nearest foot and will be based on the NAD of 1983. The vertical elevations of the top of the wells (top-of-casing) will be based on the NAVD of 1988 and will be surveyed to the nearest 0.01 feet at a reference point (i.e., groove or marking on the north side of the well casing). The ground surface (top of the actual ground surface) elevation at each well location will be surveyed to the nearest 0.1 foot. To ensure compatibility with pre-existing well elevations, the top-of-casing for one of the existing wells in each plume area will also be surveyed. If discrepancies are noted, the USACE will be consulted for resolution.

5.4.4 Long-term Monitoring

The long-term monitoring (LTM) program will begin once all aspects of the remedial action have been completed and not less than 48 hours after the completion of newly installed monitoring wells. The first sampling event for the LTM program will be separated from the baseline sampling event discussed

in **Section 5.4.1** by a period of at least 3 months. The LTM program will include the collection of groundwater samples on a quarterly basis (4 times per year) for a period of two years, followed by semi-annual (2 times per year) basis for the next three years. In subsequent years LTM will be annual until the next five-year period. This will continue until an alternative frequency is recommended based on the results of a five-year review.

LTM will include monitoring for the four shallow plumes discussed in **Section 5.1,** monitoring wells installed for excavations stopped at the groundwater table described in **Section 5.1.5**, and the intermediate and deep groundwater for the ISTD area described in **Section 3.2.** The final number of wells may change if more excavations areas are stopped at the water table or if baseline groundwater sampling results indicate the need for additional monitoring wells to be installed to monitor plumes.

Table 5-4 summarizes the shallow wells that will be sampled as part of the LTM program. MNA parameters will be sampled for all shallow wells except those that are installed to monitor the groundwater in the vicinity of an excavation area. Samples collected for wells installed in an excavation area will only be analyzed for explosive compounds. The MNA parameters that will be sampled for are described in **Section 5.4.1**.

Table 5-4 – Shallow Long-Term Monitoring Program Well List

Well ID	Associated Plume/Purpose	Sample Groups
114	Southern TNT Plume	Explosives, metals, MNA
116	Perchlorate and North TNT Plume	Explosives, perchlorate, metals, MNA
29WW01	Southern TNT Plume	Explosives, metals, MNA
29WW03	Southern TNT Plume	Explosives, metals, MNA
29WW05	Perchlorate and North TNT Plume	Explosives, perchlorate, metals, MNA
29WW06	Perchlorate and North TNT Plume	Explosives, perchlorate, metals, MNA
29WW09	Perchlorate and North TNT Plume	Explosives, perchlorate, metals, MNA
29WW10	Perchlorate and North TNT Plume	Explosives, perchlorate, metals, MNA
29WW11	Perchlorate and North TNT Plume	Explosives, perchlorate, metals, MNA
29WW15	Middle TNT Plume; VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals, MNA
29WW17	VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals, MNA
29WW18	VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals, MNA
29WW19	VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals, MNA

Well ID	Associated Plume/Purpose	Sample Groups
29WW20	Middle TNT Plume; VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals, MNA
29WW22	Middle TNT Plume; VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals, MNA
29WW23	Middle TNT Plume	Explosives, metals, MNA
29WW26	Middle TNT Plume	Explosives, metals, MNA
29WW32	Southern TNT Plume	Explosives, metals, MNA
29WW33	Southern TNT Plume	Explosives, metals, MNA
29WWRA-01	Perchlorate and North TNT Plume	Explosives, perchlorate, metals, MNA
29WWRA-02	Perchlorate and North TNT Plume	Explosives, perchlorate, metals, MNA
29WWRA-03	Perchlorate and North TNT Plume	Explosives, perchlorate, metals, MNA
29WWRA-04	VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals, MNA
29WWRA-05	VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals, MNA
29WWRA-06	VOC & Perchlorate Plume	Explosives, perchlorate, VOCs, metals, MNA
29WWRA-07	Middle TNT Plume	Explosives, metals, MNA
29WWRA-08	Middle TNT Plume	Explosives, metals, MNA
29WWRA-09	Southern TNT Plume	Explosives, metals, MNA
29WWRA-10	Southern TNT Plume	Explosives, metals, MNA
29WWRA-11	Southern TNT Plume	Explosives, metals, MNA
29WWRA-12	Southern TNT Plume	Explosives, metals, MNA
29WW-E3	Excavation E-3	Explosives
29WW-E4	Excavation E-4	Explosives
29WW-NC3	Excavation NC-3	Explosives

Table 5-5 summarizes the intermediate and deep wells that will be sampled as part of the LTM program for the ISTD area. Samples from these wells will include VOCs and MNA parameters.

Table 5-5 – Intermediate and Deep Long-Term Monitoring Program Well List

Well ID	Groundwater Monitoring Zone
29WW45D	Deep
29WW16	Intermediate
29WW42	Intermediate
29WW43	Intermediate
29WW44	Intermediate
29WW46	Intermediate
29WW47	Intermediate
29WW48	Intermediate
29WW49	Intermediate
29WW50	Intermediate
29WW51	Intermediate

All samples are anticipated to be analyzed using a standard TAT.

5.4.5 Reporting

Groundwater monitoring reports will be prepared following each monitoring event. The report will include the following minimum information and be submitted within 60 days of completing the sampling event.

- Introduction
- Summary of field and sample collection activities
- Laboratory analysis
- Data validation
- Summary of the groundwater sample results
- Evaluation of the sample results

6 LAND USE CONTROL REMEDIAL DESIGN

This section describes the LUC RD for LHAAP-29. In accordance with the 2019 ROD, the LUC RD will be finalized as the land use component of the remedial design. In accordance with the 2019 ROD, LUCs' performance objectives include the following:

- The LUCs restricting the use of groundwater (except for environmental monitoring and testing) will remain in place until the levels of COCs (that is, including all hazardous substances, pollutants, and contaminants found at the site at cleanup levels as listed in the 2019 ROD) in groundwater allow for unlimited use and unrestricted exposure.
- The LUC to maintain the integrity of any current or future remedial or monitoring systems will remain in place until groundwater cleanup levels of COCs (that is, including all hazardous substances, pollutants and contaminants found at the site at cleanup levels as listed in the 2019 ROD) are met; and,
- The LUC restricting land use to nonresidential shall be implemented until it is demonstrated that surface and subsurface soil and groundwater COCs (that is, all hazardous substances, pollutants, and contaminants found at the site at cleanup levels as listed in the 2019 ROD) are at levels- that allow for unlimited use and unrestricted exposure.

The implementation, maintenance, and inspection requirements associated with each of the performance objectives that comprise this LUC RD are described below. The actions taken to implement the LUC objectives during the RA phase, as well as ongoing maintenance, monitoring and reporting requirements will be presented in the Remedial Action Completion Report (RACR), as the final LUC RD. Upon regulatory review and concurrence with the final LUC RD, it will be distributed as part of the Comprehensive LUC Management Plan.

For portions of the site subject to land use controls that are not owned by the U.S. Army, the U.S. Army will monitor and report on the implementation, maintenance, and enforcement of land use controls, and coordinate with Federal, State, and local governments and owners and occupants of properties subject to land use controls. The Army remains responsible for ensuring that the remedy remains protective of human health and the environment.

6.1 LUC Implementation

The actions required to implement the LUCs for LHAAP-29 are described below. The first of these, the initial notice of LUCs, was completed, and a figure depicting the preliminary LUC boundaries as presented in the 2019 ROD is provided as **Figure 6-1**. The following actions either were completed or will be undertaken to implement the LUCs for LHAAP- 29:

- Provide initial notice of the LUCs before remedial action is implemented.
    - Develop the initial notice of the groundwater and soil (surface and subsurface) contamination and any land use restrictions referenced in the 2019 ROD. The notice will consist of a brief description of the contaminants present in groundwater and soil, a written description of the LUCS and a figure depicting the preliminary LUC boundaries presented in **Figure 6-1**.
- The notice to Federal, State and local governments involved at this site and the owners and occupants of the properties subject to those use restrictions and land use controls were

transmitted within 90 days of ROD signature. The notices were sent to Federal, State and local officials including U.S. Senator Ted Cruz, U.S. Senator John Cornyn, U.S. Congressman Louie Gohmert, State Senator Bryan Hughes, State Representative Chris Paddie, Harrison County Judge Chad Sims, Harrison County Commissioner Precinct 1 William D. Hatfield, and City of Uncertain Mayor Sam Canup. Notice was also sent to the Caddo Lake National Wildlife Refuge Manager Erik Duerkop, the Leigh Water Supply Corporation Board of Directors, and Caddo Lake Water Supply Corporation Board of Directors.

- Finalize the boundaries for the LUCs as a part of the remedial action.
    - Revise the boundaries if necessary. The LUC boundary presented in this RD is not subject to change as the limits of groundwater contamination are well defined within the off-site area. However, the final boundaries of the groundwater LUCs (prevent the use of groundwater contaminated above cleanup levels as a potable water source and prohibit access to the contaminated groundwater except for environmental monitoring and testing only); and the remedial or monitoring system LUCs (maintain the integrity of any current or future remedial or monitoring systems); will be reviewed during remedial action activities after an evaluation of new data has been completed and revised if necessary.
    - Survey the LUC boundaries. The boundaries will be finalized after concurrence by EPA and TCEQ, and the LUC boundaries will be surveyed by a State-licensed surveyor. A legal description of the surveyed areas will be appended to the survey plat.
- Record the LUCs in Harrison County. The LUC plat, legal description and LUC restriction language will be recorded in the Harrison County Courthouse in accordance with TAC Title 30, § 335.566.
- Notify the Texas Department of Licensing and Regulation of the groundwater LUCs. The Texas Department of Licensing and Regulation will be notified of the groundwater restrictions, which include the prohibition of water well installation for any purpose other than environmental monitoring and testing without prior approval from the U.S. Army, EPA, and TCEQ. The survey plat, legal boundary, and description of the groundwater restriction LUCs, in conjunction with a locator map, will be provided in hard and electronic copy.

6.2 Maintenance and Monitoring Requirements

The LUCs will be maintained in place as follows:

- The LUCs restricting the use of groundwater (except for environmental monitoring and testing) will remain in place until the levels of COCs (that is, including all hazardous substances, pollutants, and contaminants found at the site at cleanup levels as listed in the 2019 ROD) in groundwater allow for unlimited use and unrestricted exposure.
- The LUC to maintain the integrity of any current or future remedial or monitoring systems will remain in place until groundwater cleanup levels of COCs (that is, including all hazardous substances, pollutants and contaminants found at the site at cleanup levels as listed in the 2019 ROD) are met; and,

The LUC restricting land use to nonresidential shall be implemented until it is demonstrated that surface and subsurface soil and groundwater COCs (that is, all hazardous substances, pollutants, and contaminants found at the site at cleanup levels as listed in the 2019 ROD) are at levels- that allow for unlimited use and unrestricted exposure. Remedial or Monitoring System LUCs include physical components that require repair and maintenance. These are described in **Section 1.10**.

The administrative maintenance required to ensure the three LUCs remain in place and effective until the cleanup levels of the COCs are at levels that allow unrestricted use and unlimited exposure are:

- Annual field inspections of the site to confirm that no violations of the LUCs have occurred. Documentation of the inspection will be included in the Inspection and Maintenance Checklist (**Appendix H**).
- Annual certifications that no LUC-restricted activities have been authorized and that site conditions and use are consistent with the LUCs. (**Appendix H**)
- Periodic transmittal of a LUC Notice to Federal, State, and local authorities and to owners and occupants of LHAAP-29. The notice will include the groundwater and soil (surface and subsurface) contamination and any land use restrictions referenced in the 2019 ROD, a written description of the LUCs and a figure depicting the LUC boundaries. The transmittal will coincide with each Five-Year Review and will be documented in the report.
- The final LUC RD appendix of the RACR will be added to the Comprehensive LUC Management Plan and the plan will be provided to the owner or occupant of LHAAP-29.

The U.S. Army will address LUC problems within its control that are likely to impact remedy integrity and shall address problems as soon as practicable.

6.3 Reporting of LUC Inspection and Monitoring

Beginning with finalization of this RD and approval of the inspection and maintenance forms and the Annual Certification Form, the U.S. Army will undertake inspections and certify continued compliance with the LUC objectives. The U.S. Army, or the transferee after transfer, will retain the LUC inspection and certification documents in the project files for incorporation into the 5-year review reports, and these documents will be made available to EPA and TCEQ upon request. In addition, should any violations be found during the certification, the U.S. Army will provide to EPA and TCEQ, along with the document, a separate written explanation indicating the specific violations found and what efforts or measures have or will be taken to correct those violations. The need to continue inspections and certifications will be revisited at 5-year reviews.

6.3.1 Notice of Planned Property Conveyances

Upon transfer of Army-owned property, the Army will provide written notice to the transferee of the LHAAP-29 groundwater and soil (surface and subsurface) contamination and any land use restrictions. Within 15 days of transfer, the U.S. Army will provide written notice to EPA and TCEQ of the division of implementation, maintenance, and enforcement responsibilities unless the information has already been provided in the LUC RD. The notice will describe the mechanism by which the LUC will continue to be implemented, maintained, inspected, reported, and enforced. Upon transfer, such responsibilities may shift to the transferee via appropriate provisions placed in the Environmental Condition of Property (ECP) or other environmental document for transfer. Although the U.S. Army may transfer responsibility for various implementation actions, the U.S. Army will also retain ultimate responsibility for the remedy integrity. This means that the U.S. Army is responsible for addressing substantive violations of the LUC performance objectives that would undermine the U.S. Army's CERCLA remedy. The U.S. Army also will be responsible for incorporating RD information and outlining the transferee's LUC obligations into property transfer documentation. In the event property is transferred out of Federal control, the land use controls relating to property and groundwater

restrictions shall be recorded in the deed and shall be enforceable by the United States and the State of Texas.

6.3.2 Opportunity to Review Text of Intended Land Use Controls

The U.S. Army will provide a copy of the groundwater and land use restriction notification to TCEQ for review and approval prior to its recordation in Harrison County. EPA will also receive a copy for review. The U.S. Army will produce an ECP or other environmental document for transfer of LHAAP-29, but before executing transfer, the U.S. Army will provide EPA and TCEQ with a copy of the ECP or other environmental document for transfer so that they may have reasonable opportunity, before transfer, to review all LUC-related provisions.

6.3.3 Notification Should Action(s) which Interfere with Land Use Control Effectiveness be Discovered Subsequent to Conveyance

Should the U.S. Army discover after conveyance of the site any activity on the property inconsistent with the LUC performance objectives, the U.S. Army shall notify EPA and TCEQ within 72 hours of such discovery. Consistent with **Section 6.3.5** below, the U.S. Army will then work with EPA, TCEQ and the transferee to correct the problem(s) discovered. This reporting requirement does not preclude the U.S. Army from taking immediate action pursuant to its CERCLA authorities to prevent any perceived risk(s) to human health or the environment.

6.3.4 Land Use Control Enforcement

Should the LUC remedy reflected in this RD fail, the U.S. Army will coordinate with EPA and TCEQ to ensure that appropriate actions are taken to reestablish its protectiveness. These actions may range from informal resolutions with the USFWS or its lessee, to the institution of judicial action against nonfederal third parties. Alternatively, should the circumstances warrant such, the U.S. Army could choose to exercise its response authorities under CERCLA. Should the U.S. Army become aware that any future owner or user of the property has violated any LUC requirement over which a local agency may have independent jurisdiction, the U.S. Army may notify those agencies of such violation(s) and work cooperatively with them to re-achieve owner/user compliance with the LUC.

6.3.5 Modification or Termination of Land Use Controls

The LUCs shall remain in effect until such time as the U.S. Army and EPA agree that the concentrations of COCs in groundwater have met cleanup levels in groundwater and that surface and subsurface soil concentrations allow unrestricted use. When this occurs, the LUC will be terminated as needed. The decision to terminate the LUC will be documented consistent with the NCP process for post-ROD changes, potentially including an explanation of significant differences or a remedial action complete report. If the property has been transferred and a determination by the U.S. Army and EPA has been made to terminate the LUC, the U.S. Army shall provide to the owner of the property an appropriate release for recordation pertaining to the site and will also timely advise other local stakeholders of the action.

7 REMEDIAL CONSTRUCTION SCHEDULE

This section provides a preliminary schedule for the activities necessary to complete the RD. The actual sequence will be determined by the Contractor and shall be included in the work plan that will be submitted prior to commencing the work.

7.1 Construction Sequence

The final sequence of construction will be proposed by the Contractor and may depend on the means and methods selected by the Contractor to complete the remedial action. The proposed construction sequence is as follows:

1. Site mobilization and preparation: Under this phase the outer access roads will be constructed, and areas will be cleared of trees and vegetation to allow for construction access to the site. Temporary facilities such as toilet facilities, construction trailers, frac tanks, and construction equipment will be mobilized to the site and set up. Utility mark-outs in areas of work will also be completed and monitoring wells will be located and visually marked in the field for protection.
2. Video inspection and clean the TNT wastewater pipeline: A video inspection and cleaning for the TNT wastewater pipe will be completed. During the inspection all broken sections will be marked in the field for removal with the wooden TNT wastewater pipeline. Intact sections will then be filled concurrent with the wooden TNT pipeline removal.
3. Excavate and remove the wooden TNT wastewater pipeline: During this phase the wooden TNT wastewater pipe will be excavated and removed. In addition, any sections of the transite pipeline that are disturbed or found to be defective will also be removed. While the transite pipe is exposed, intact sections will be filled with flowable fill or similar material and abandoned in place prior to backfilling the exposed sections.
4. Video inspection, clean, and plug the north and south cooling water lines: Once the wooden TNT wastewater pipe has been excavated and removed, access roads will be constructed to the manholes associated with the north and south cooling water lines for access by the video inspection and cleaning trucks and equipment. Sections of pipe identified with cracks or other defects will be visually marked in the field and samples will be collected along these sections to determine whether the pipe needs to be removed or can be abandoned in place. Following cleaning, sections identified for abandoning in place will be filled with flowable fill or similar material. Manholes will also be abandoned by filling.
5. Individual excavation areas: Areas identified for excavation will be completed. Some areas may be done concurrent with the pipeline inspections and cleaning. Once completed, areas will be backfilled and restored. Areas ending at the groundwater table will be identified for future well installation identified as Item 8.
6. ISTD: Monitoring wells will be installed followed by the collection of groundwater samples at existing and newly installed monitoring wells prior to installing the ISTD system. The ISTD system will then be installed and operated. Once complete the ISTD system will be removed, and the area will be restored.
7. Baseline groundwater sampling: A round of groundwater samples will be collected from identified wells. Samples will be analyzed using standard TAT and results will be evaluated to select final locations for proposed monitoring wells.
8. Monitoring well installation: New monitoring wells will be installed at designated locations.
9. Begin long-term monitoring program: Following the installation of new monitoring wells the long-term monitoring program will begin.

7.2 Preliminary Construction Schedule

A preliminary schedule is provided below. The actual time frames for construction will depend on the sequence of construction and the means and methods selected by the Contractor. Additionally, some work activities may be done concurrently which could decrease the overall construction schedule.

- Mobilization & Site Preparation: 5 to 10 days
- TNT transite pipe inspection and cleaning: 5 to 10 days
- Wooden TNT pipe and transite pipe section removal & transite pipe filling: 20 to 30 days
- North & South Cooling Water pipe cleaning and abandonment: 10 to 20 days
- Individual Excavation Areas: 30 to 40 days
- ISTD: 160 to 275 days [includes operating time frame between 103 to 200 days]
- Well Sampling, Data Evaluation and Well Installation: 40 to 50 days
- Restoration: 20 to 30 days
- Total Estimate Time: 250 to 415 days (~11 to 18 months)

8 SUMMARY OF PROJECT COSTS

8.1 Summary of Project Costs

A cost estimate for the proposed RA was developed as part of the RD and is provided in **Appendix B**. The total estimated cost is $14.6 million. Additional investigation data collected in the PDI have resulted in changes to the remedial project, including larger volumes of contaminated material requiring removal and off-site disposal.

8.2 Estimating Method

The cost estimate combines task-based estimates for major construction items, quotes for material disposal and subsurface thermal treatment, and historical unit pricing for incidental and minor costs. Task-based estimates were developed for approximately 40% of construction costs for excavation remedial action and 25% of pipeline inspection and plugging/abandonment remedial action. Quotes for non-hazardous and hazardous disposal comprise approximately 40% of excavation and pipeline inspection and plugging/abandonment remedial action costs and 25% of total construction costs. A vendor quote from Terra Therm comprises approximately 75% of construction costs for ISTD. Details regarding these methods are discussed below.

8.3 Task-Based Estimates

Task-based estimating considers a work breakdown by task, construction method, production rates, equipment types, labor classifications, and material pricing appropriate for the scope of work, site properties, and level of design detail to calculate project costs. Assumptions made within the task-based estimates may be revised as needed as design progresses. Task-based estimates follow the requirements of the United States Army Corps of Engineers (USACE) regulations for civil works projects. The USACE software Micro-Computer Aided Cost Estimating System, Generation II, Version 4.4.3 (MII) was used for some calculations of equipment operating costs and production rates. The basis for these costs is described below followed by a discussion of major task-based estimates.

8.3.1 Labor Rates

All labor rates and fringes are based on Davis Bacon Act (DBA) and Service Contract Act (SCA) wage determinations, as available online at www.wdol.gov. Typically, rates for the county where work is located would be used; however, the DBA rates for Karnack County were far out of date, as well as rates for larger nearby counties such as Shreveport, LA, and Houston, TX. Therefore, the estimate considered the national DBA rates published by USACE, which reflect a 2021 cost basis and local Seattle labor pricing. These costs were adjusted to Texas and escalated to 2024 (the expected midpoint of construction) per USACE Engineering Manual (EM) 1110-2-1304, September 2022 release. SCA rates were available and recently updated for Karnack County and were used for any non-construction labor. SCA rates were based on wage determination 2015-5191, revision 20, released December 27, 2022. Fringe benefits were assumed to be 30% of the base rate for SCA labor. Texas payroll tax (13.74%), workman's compensation insurance (WCI, 22.47%), and overtime (10%) were applied to all labor rates. The overtime markup assumes five 10-hour days per week. Note that payroll tax is calculated on the base rate plus fringe benefits, WCI is calculated only on the base rate, and the overtime markup applies to the base rate and payroll tax increase. A 20% markup was applied to DBA labor for HTRW work.

8.3.2 Equipment Rates

Equipment rates are based on the 2020 Region 6 MII equipment library which considers USACE Engineering Pamphlet (EP) 1110-1-8 rates. Operating costs were calculated in MII to account for current fuel prices in the project area, and a Federal cost-of-money (COM) rate of 4.0%. The estimate includes fuel rates of $4.60/gallon for on-road diesel, $4.16 for off-road diesel, and $3.20 for gasoline. The overtime FCCM discount markup is applied to the total equipment rate after calculating operating costs.

8.3.3 Earthwork

Production rates for earthwork follow an assumed earthwork handling plan based on the type of soil excavation. Unsaturated soil excavation assumes material will be excavated and directly loaded into trucks for transport to an on-site stockpile. After waste characterization, the soil would be reloaded into trucks for either off-site disposal or replacement on-site. Excavation for pipe removal assumes soil will be side cast along the trench and replaced after pipe disposal. Hauling assumes 10-wheel dump trucks and 11 CY per load. The earthwork handling plan is as follows:

1. Excavation: All material will be excavated and stockpiled on-site. Costs assume an excavator to remove material and a dozer to manage stockpiles, plus a water truck for dust control.
2. Material Characterization: Samples from the excavations or stockpiles will classify the material as 1) reusable as backfill (for soils excavated from side slopes, 2) non-hazardous disposal, or 3) hazardous disposal.
3. Off haul of Contaminated Soils: Costs for off haul include hauling and disposal fees and are based on a quote received from CG Environmental.
4. Backfill: Backfill costs include purchase, placement, compaction, and grading of certified clean material from 2 sources:
    - 4.1. Material from the side slopes of excavations deemed suitable for reuse assumes material will be pushed into place by a dozer and compacted.
    - 4.2. Imported material assumed purchase from A&T Sand and Gravel in Longview, Texas. A purchase and hauling quote were received by phone on January 10, 2023.

8.3.4 Monitoring Wells

Monitoring well costs are mostly based on drilling costs from the LHAAP Site 18/24 PDI.

8.3.5 Indirect Cost Markups

The above discussion calculates a direct cost to the Contractor. To advance these costs to representative bid item costs, the following indirect markups are applied:

- Home Office Overhead (HOOH): 6%
- Job Office Overhead (JOOH): 10%
- Contractor Profit: 8%
- Contractor Bond: 2%

8.4 Subcontractor Quotes

Costs for the ISTD treatment system are based on an estimate provided by Terra Therm, a leading thermal treatment vendor. The estimate provided is based on a treatment volume of 11,500 cy. The cost was scaled up to account for the design treatment volume of 13,444 cy. Design parameters and assumptions used to develop the ISTD cost estimate are included in **Appendix B**.

8.5 Project-level Markups

The estimate includes the following “below-the-line" cost markups:

8.5.1 Contingency

A 25% contingency is applied to all project costs. The contingency accounts for potential price fluctuations, the reliance on an outside quote for the ISTD portion of the remedy, and other unknowns, such as possible secondary excavations based on post-excavation confirmatory sampling results.

8.5.2 Construction Oversight and Management

Parametric costs for construction oversight (6%) and construction management (8%) are calculated for all items in the estimate. These are considered owner costs and would not be included in the construction contract.

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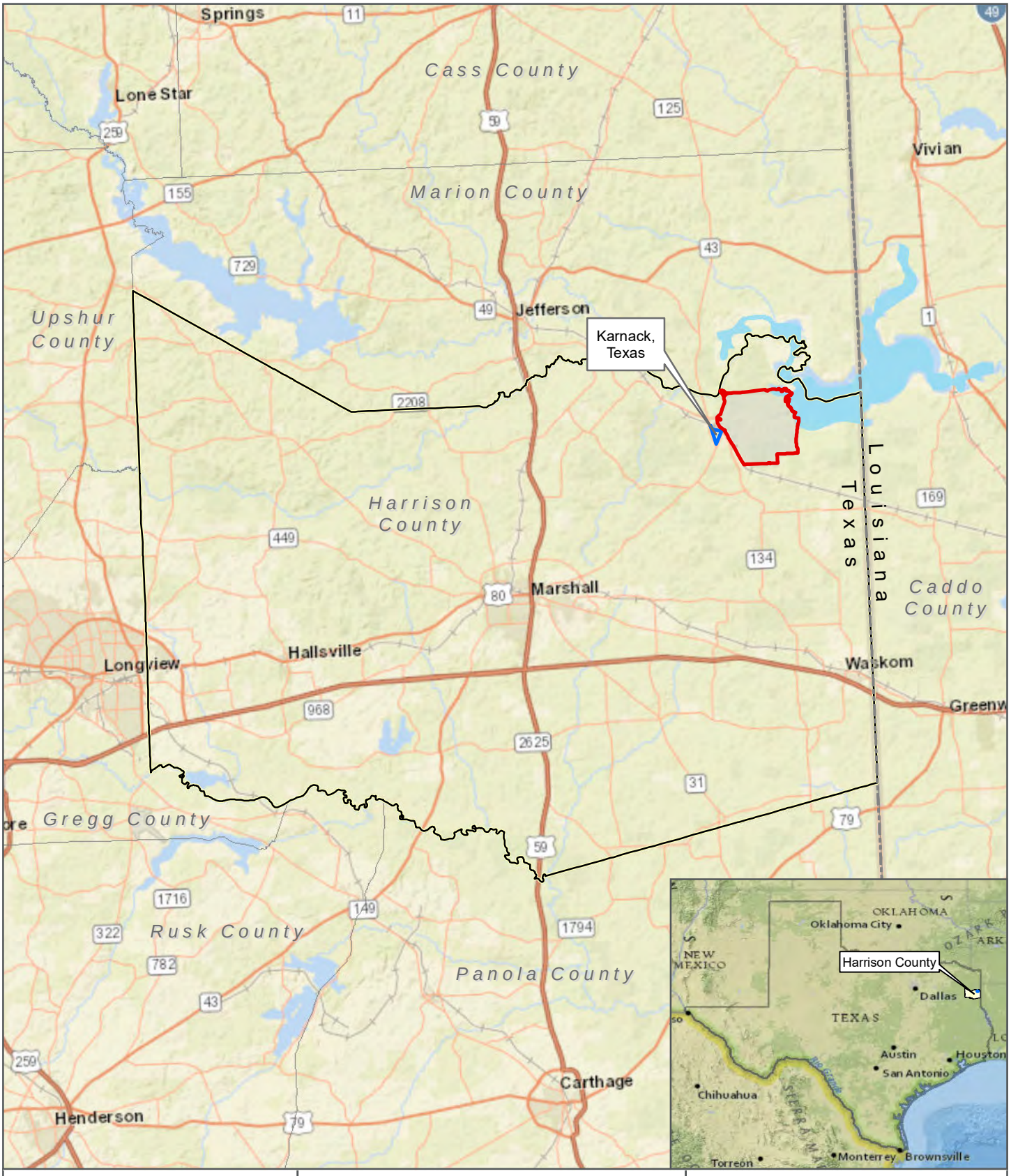
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Figures



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LEGEND

- LHAAP Installation Boundary
- Karnack
- Harrison County
- State Boundary

SITE LOCATION

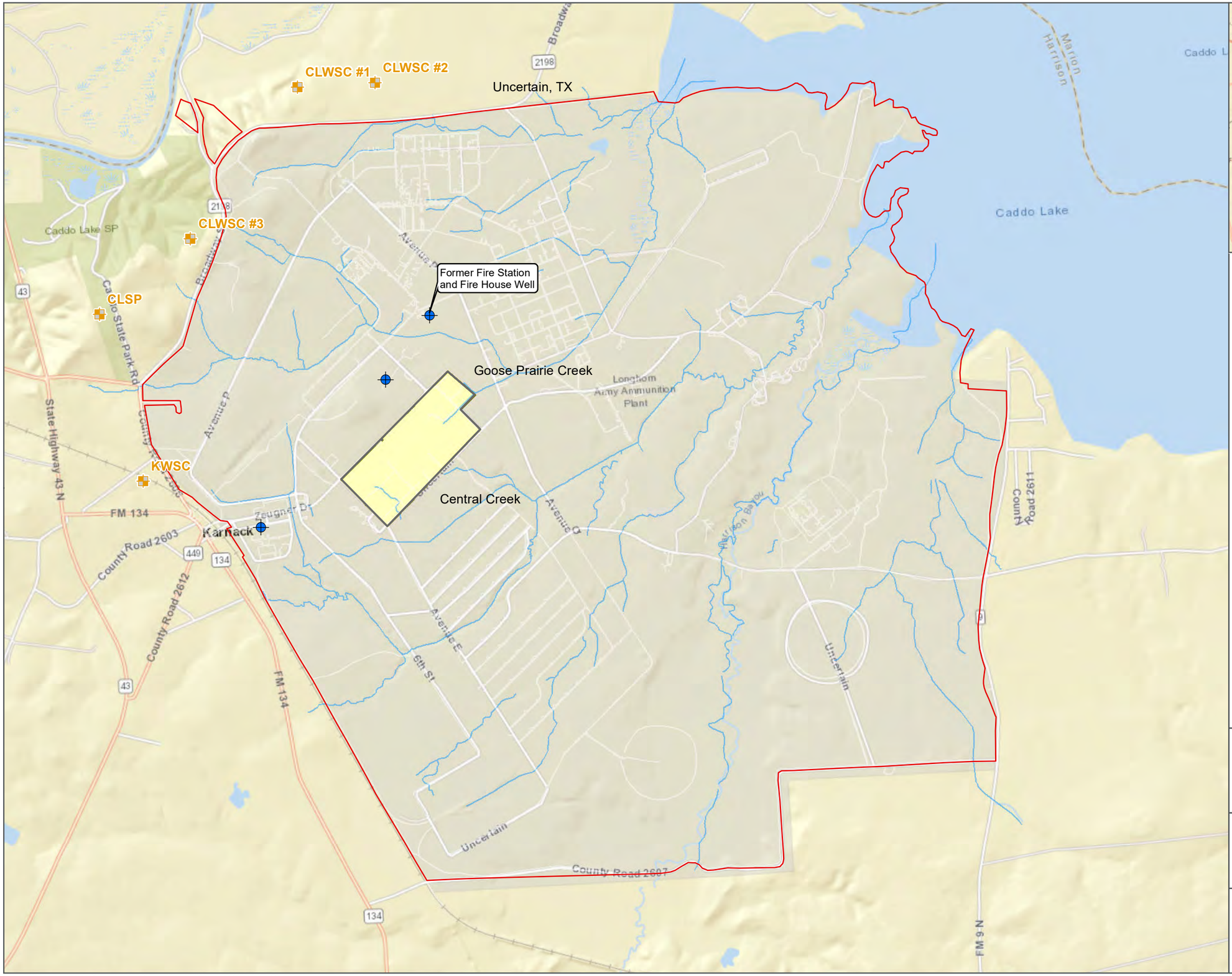
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KARNACK, TEXAS

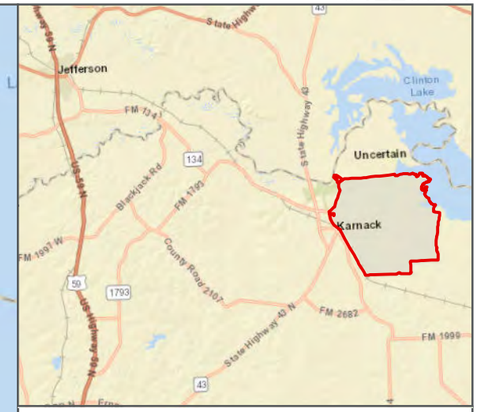
DATA SOURCES: AECOM, 2017, Draft Final Feasibility Study Addendum LHAAP-29, Former TNT Production Area, Group 2 Longhorn Army Ammunition Plant, Karnack, Texas. August

DISCLAIMER: Map information was compiled from the best available sources. No warranty is made for its accuracy or completeness.

FIGURE 1-1

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LEGEND

- Public Water Supply Well Locations
- Water Supply Well
- Roads
- Streams
- Site LHAAP-29
- LHAAP Installation Boundary

DATA SOURCES: AECOM, 2016, Draft Final Remedial Investigation Addendum LHAAP-29, Former TNT Production Area, Group 2 Longhorn Army Ammunition Plant, Karnack, Texas. July. ESRI

DISCLAIMER: Map information was compiled from the best available sources. No warranty is made for its accuracy or completeness.

SITE VICINITY MAP

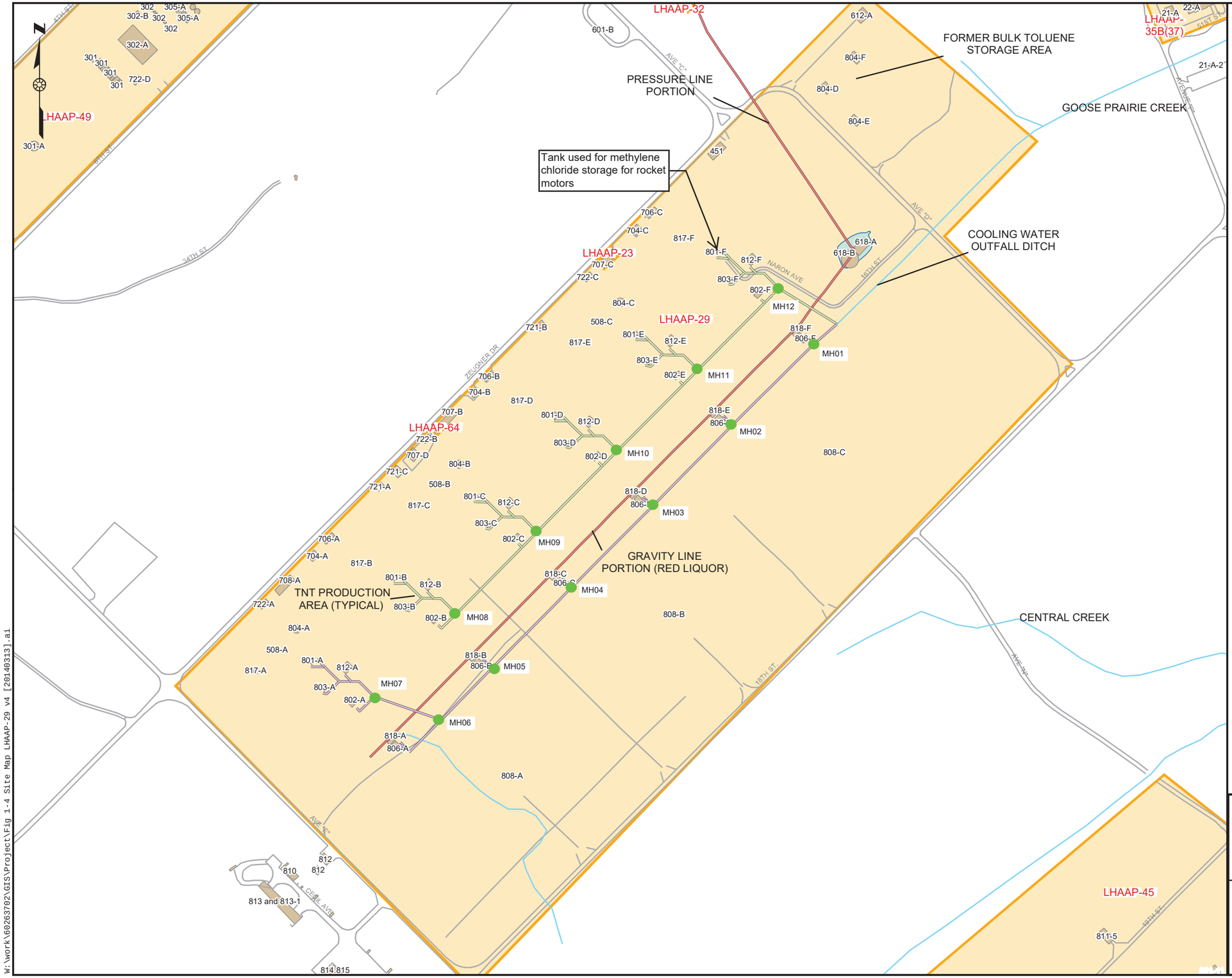
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FIGURE 1-2

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LEGEND

- TNT Cooling Water Drain Line (South)
- TNT Cooling Water Drain Line (North)
- TNT Wastewater Lines (Wood/Transite)
- Stream
- Road
- Former Building or Concrete Slab
- Pond
- Site
- Manhole

Former Buildings and Structures in or Adjacent to LHAAP-29

Structure or Building Number	Description	Materials Handled
Original Use (1942-1945)		
451	Compressed Air Plant	- - -
508-A to -C	Start-Up Mixed Acid Storage	Acids
612-A	Neutralization House	Cooling water from production (blue water)
618-A	Pump House	TNT waste water (red liquor)
618-B	Wooden Storage Tank	TNT waste water (red liquor)
704-A to -C	Supervisor's Office	- - -
706-A to -C	Solvent Storage Building and/or Powder Magazine	Solvents
707-B to -D	Change House	- - -
708-A	Garage Building	- - -
721-A to -C	Inspector's Office	- - -
722-A to -C	Paint Shop	- - -
801-A to -F	Mono-Nitrating House	Toluene, nitrotoluene, nitric acid, sulfuric acid
802-A to -F	Tri-Nitrating House	Dinitrotoluene, TNT, nitric acid, sulfuric acid
803-A to -F	Bi-Nitrating House	Nitrotoluene, dinitrotoluene, nitric acid, sulfuric acid
804-A to -C	Toluene Working Storage	Toluene
804-D to -F	Toluene Tank	Toluene
806-A to -F	Wash House	TNT, caustic soda, sellite, residual acids, TNT wastewater (red liquor), yellow liquor
808-A to -C	Nail House	TNT, boxes, nails
812-A to -F	Acid & Fume Recovery House	Nitric acid fumes, recovered acid
817-A to -F	Oleum Storage	Oleum
818-A to -F	Barricade	- - -
Subsequent Use		
707-C	General Purpose Warehouse	- - -
801-F	Rocket Motor Soak-Out Facility	Out-of-specification rocket motors containing composite propellants (e.g. polysulfide perchlorate), methylene chloride-based industrial solvent, liquid solvent waste, lubricants, polymers, fuels

- - - Not documented
Reference: Environmental Site Assessment, Phase I and II Report (Plexus, 2004)

Notes:
1. Manholes located along the TNT cooling water drain line.
2. 806 series buildings are wash houses and generated red liquor.

Source: Shaw, 2010, Final Feasibility Study. LHAAP-29, Former TNT Production Area, Group 2, Longhorn Army Ammunition Plant, Karnack, Texas, April.

0 205 410 820 Feet

HDR

Figure 1-3
Site Map
LHAAP-29

Longhorn Army Ammunition Plant
Karnack, Texas

W:\work\60263702\GIS\Project\Fig 1-4 Site Map LHAAP-29 v4 [20140313].ai

LHAAP-49

LHAAP-32

LHAAP-35B (37)

Goose Prairie Creek

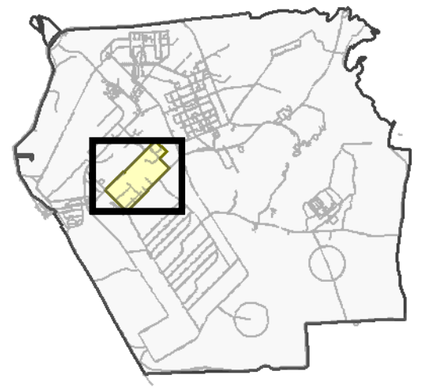
LHAAP-23

LHAAP-64

LHAAP-29

Central Creek

LHAAP-45



LEGEND

- Index Contour
- Intermediate Contour
- TNT Cooling Water Drain Line (North)
- TNT Cooling Water Drain Line (South)
- TNT Wooden Wastewater Line
- TNT Transite Wastewater Line
- Stream
- Road
- Building
- Site LHAAP-29

DATA SOURCES: Shaw, 2010, Final Feasibility Study, LHAAP-29, Former TNT Production Area, Group 2, Longhorn Army Ammunition Plant, Karnack, Texas, December.

TOPOGRAPHIC MAP
SITE FEATURES

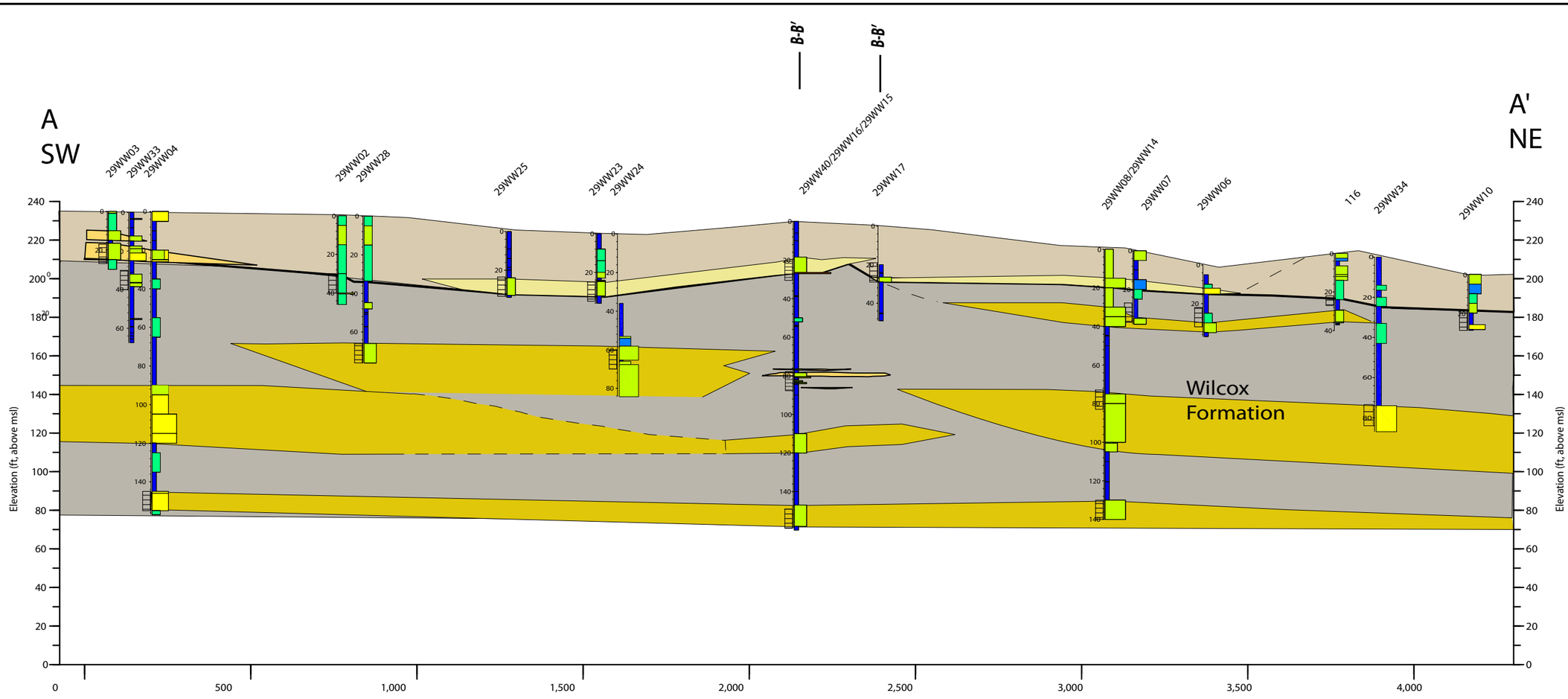
LHAAP-29 PDI REPORT JUNE 2022
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

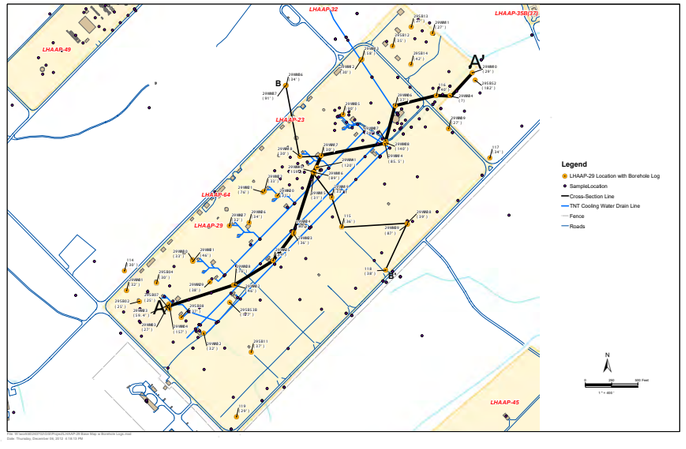
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FIGURE 1-4

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP29\LHAAP_29_PDI_2022REPORT_TOPOGRAPHIC_FIG2.MXD - USER: PRAFATIAN - DATE: 2/21/2023





Grain Size Log

- Clay
- Silt-Sandy Silt
- Fine Sand w/fines
- Fine Sand
- Medium Sand w/fines
- Medium Sand
- Coarse Sand w/fines
- Coarse Sand
- Gravel, Sand w/ gravel

Lithofacies

Sand Lithofacies

- Channel and point bar deposits
- Levee and splay deposits
- Wilcox Fm. marine and deltaic sands (Eocene)

Silt/Clay Lithofacies

- Fine overbank deposition (floodplain silts and clays)
- Wilcox Fm.marine and deltaic clays and silts (Eocene)

Downhole Data Legend

Monitoring Well
Data Explanation

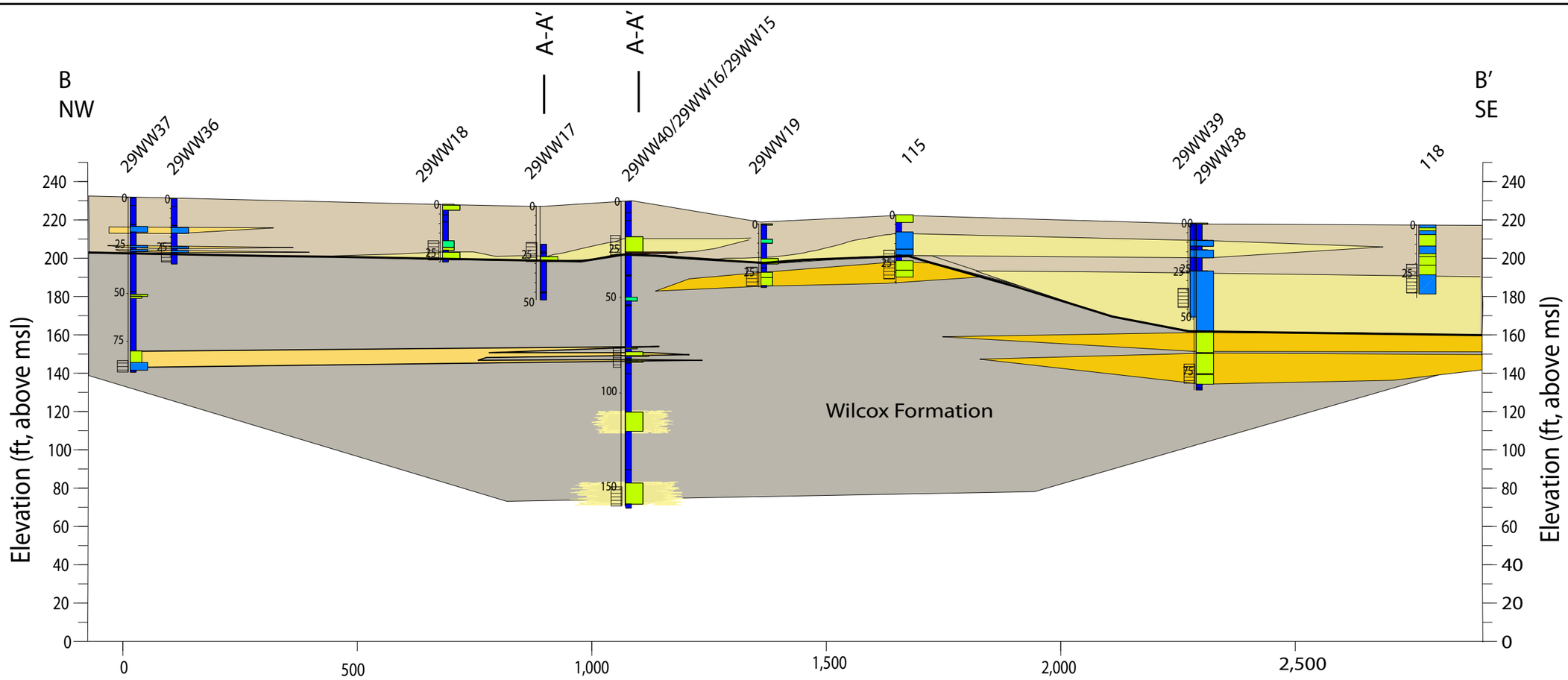
Monitoring Well Screen

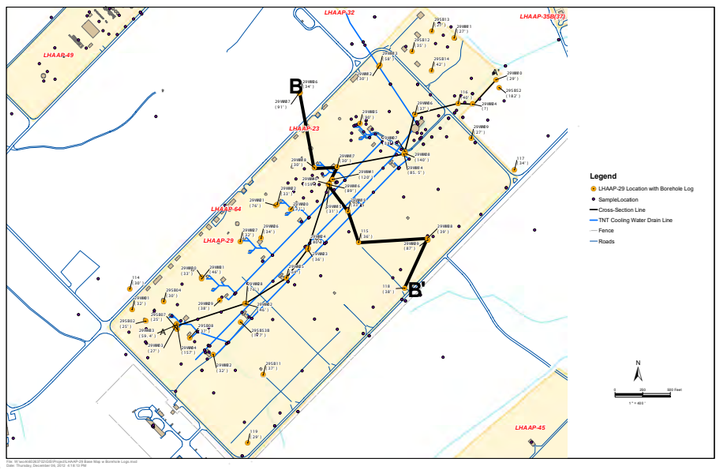
Nested wells labeled as follows: Deeper/Shallower

Source: Figure taken from Figure 1-5 of the Final LHAAP-29 RI/FS Addendum Work Plan dated June 2014 and prepared by AECOM.

Figure 1-5
Cross Section A-A'
LHAAP-29

Longhorn Army Ammunition Plant, Karnack, Texas





Grain Size Log

- Clay
- Silt-Sandy Silt
- Fine Sand w/fines
- Fine Sand
- Medium Sand w/fines
- Medium Sand
- Coarse Sand w/fines
- Coarse Sand
- Gravel, Sand w/ gravel

Lithofacies

Sand Lithofacies

- Channel and point bar deposits
- Levee and splay deposits
- Wilcox Fm. marine and deltaic sands (Eocene)

Silt/Clay Lithofacies

- Fine overbank deposition (floodplain silts and clays)
- Wilcox Fm.marine and deltaic clays and silts (Eocene)

Downhole Data Legend

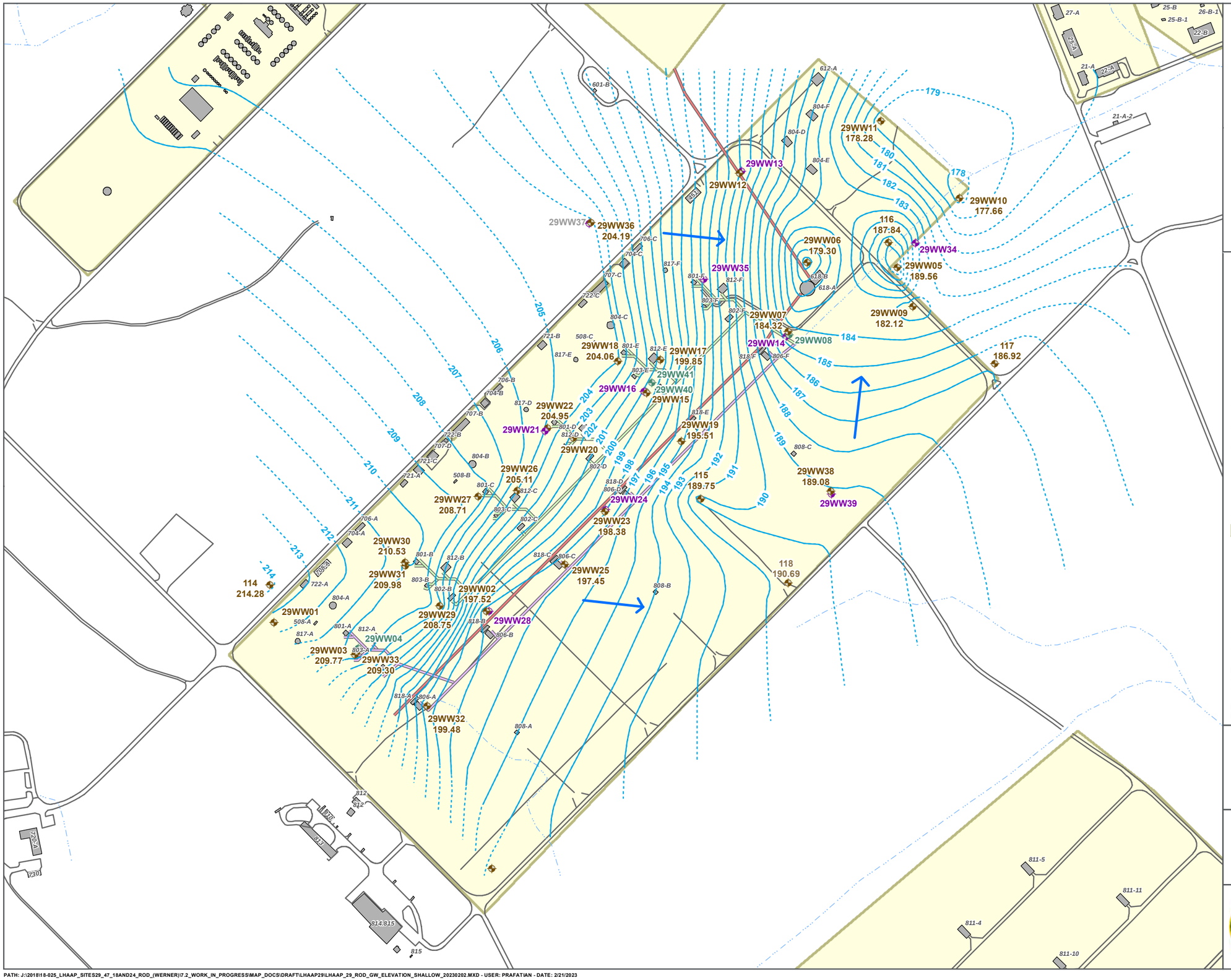
Monitoring Well
Data Explanation

Monitoring Well Screen

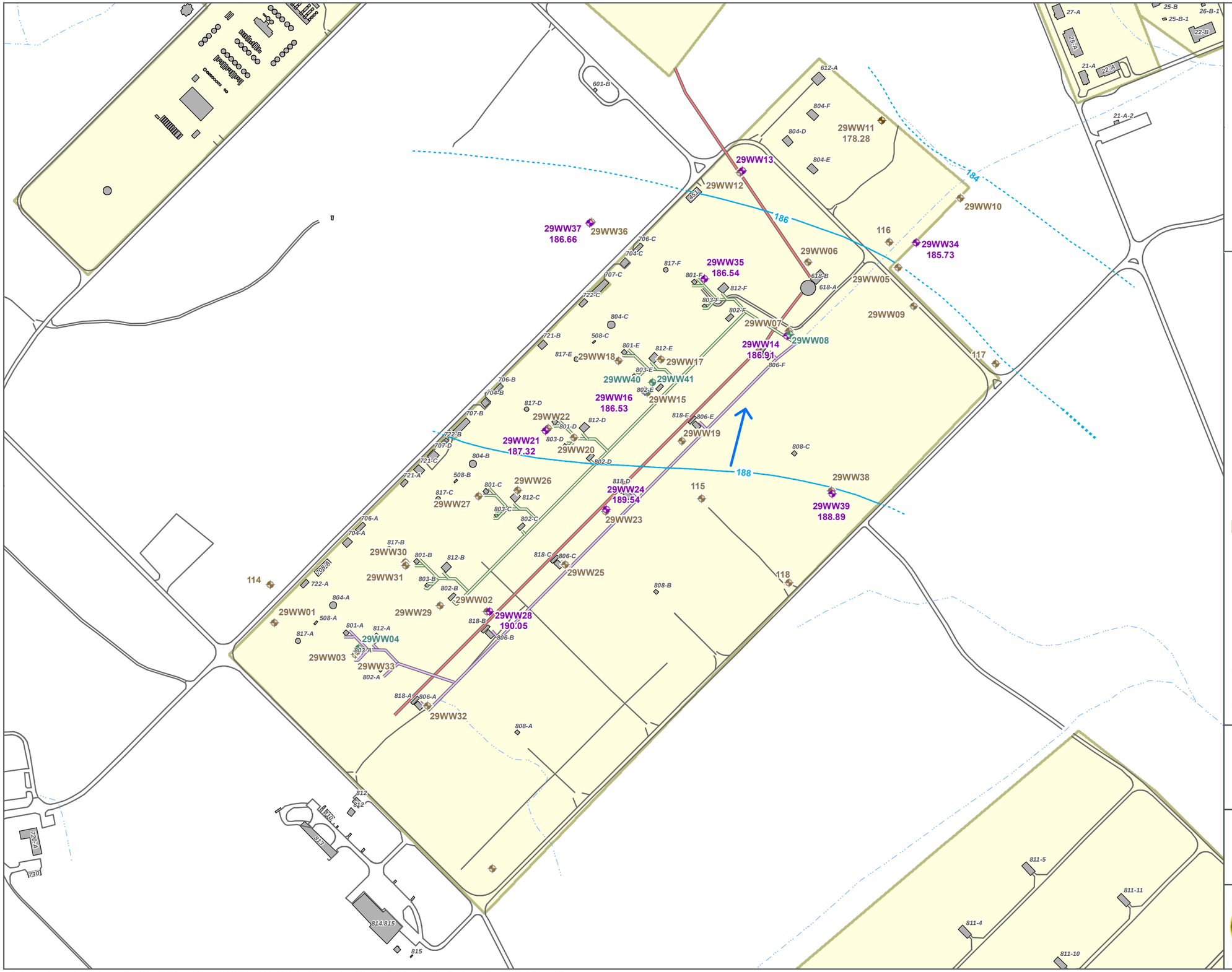
Nested wells labeled as follows: Deeper/Shallower

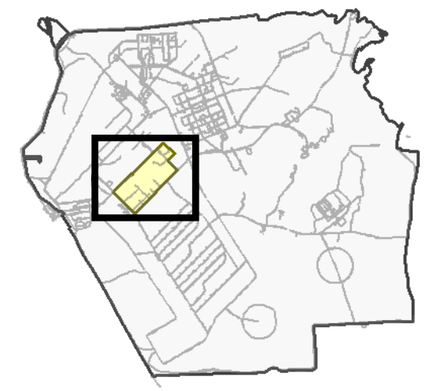
Source: Figure taken from Figure 1-6 of the Final LHAAP-29 RI/FS Addendum Work Plan dated June 2014 and prepared by AECOM.

Figure 1-6
Cross Section B-B'
LHAAP-29
Longhorn Army Ammunition Plant, Karnack, Texas



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LEGEND

- Shallow or Lower Shallow Monitoring Well
- Intermediate Monitroing Well
- Deep Monitoring Well
- Groundwater Elevation Contour (Dashed Where Inferred)
- TNT Cooling Water Drain Line
- TNT Cooling Water Drain Line
- TNT Wastewater Line
- Stream
- Road
- Building
- Site LHAAP-29

NOTE:
Groundwater contours are based on data collected November 29, 2007 through December 3, 2007.

DATA SOURCES: AECOM, 2016, Draft Final Remedial Investigation Addendum LHAAP-29, Former TNT Production Area, Group 2 Longhorn Army Ammunition Plant, Karnack, Texas. July.

DISCLAIMER: Map information was compiled from the best available sources. No warranty is made for its accuracy or completeness.

GROUNDWATER ELEVATION MAP (INTERMEDIATE ZONE)

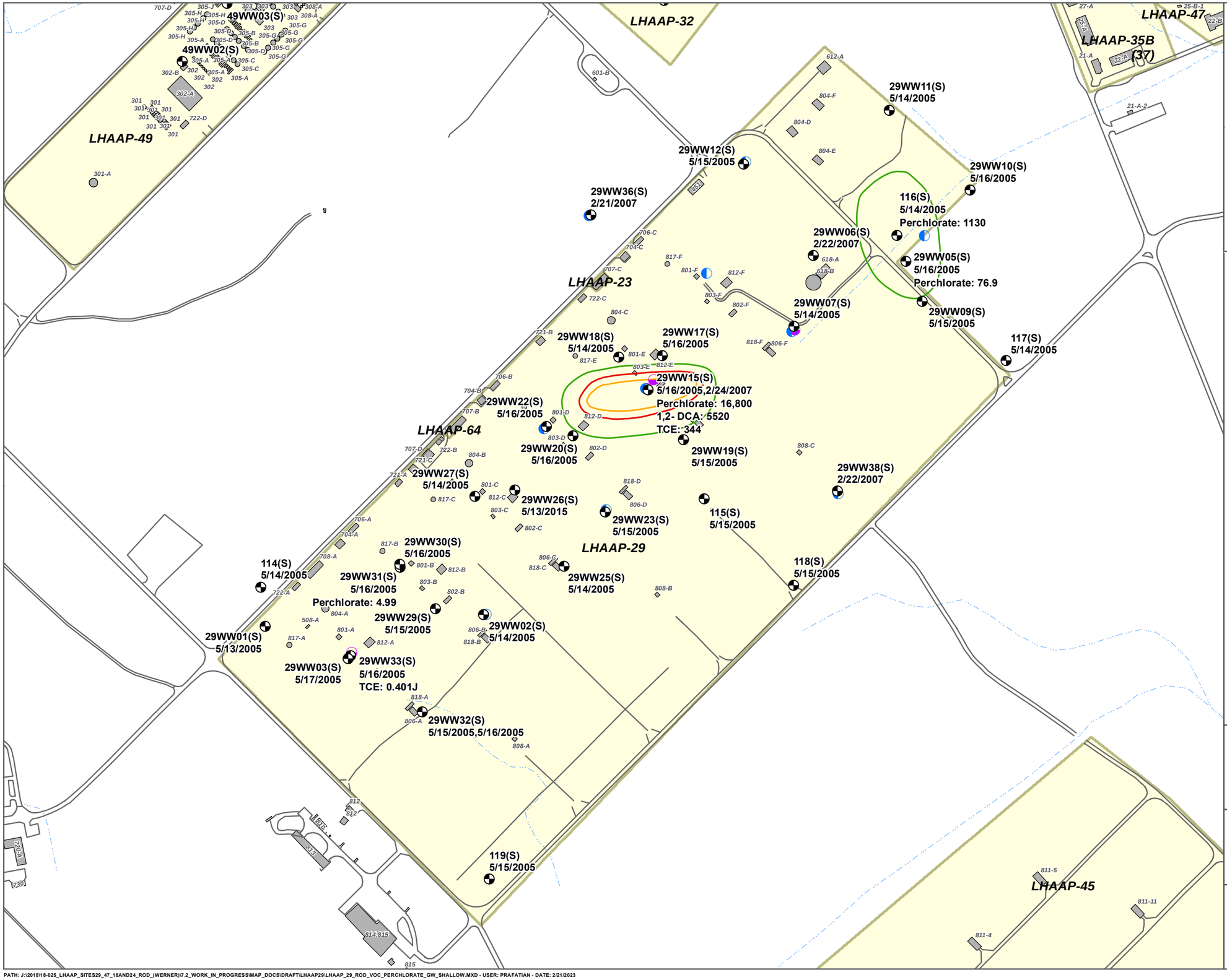
LHAAP 29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

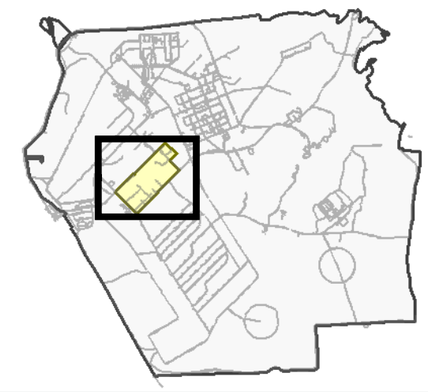
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FIGURE 1-8

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LEGEND

- Shallow Groundwater Monitoring Well (S)
- Intermediate Groundwater Monitoring Well (I)
- Deep Groundwater Monitoring Well (D)

Plume in Shallow Groundwater

- 1,2-Dichloroethane (MCL= 5 µg/L)
- Perchlorate (TRRP Tier 1 Residential Groundwater PCL = 17 ug/L)
- Trichloroethene (MCL= 5 µg/L)
- Stream
- Road
- Building
- Site LHAAP-29

NOTES:
-All perchlorate concentrations in the intermediate and deep zones are below the TRRP Tier 1 Residential Groundwater PCL of 17 ug/L
-All concentrations are reported in micrograms per liter (µg/L).
-Analytes are non detect unless labeled on map.
-MCL = Maximum Contaminant Level.

DATA SOURCES: HDR, 2019, Final Record of Decision for LHAAP-29, Former TNT Production Area, Group 2, Longhorn Army Ammunition Plant.

DISCLAIMER: Map information was compiled from the best available sources. No warranty is made for its accuracy or completeness.

VOCS AND PERCHLORATE IN SHALLOW ZONE GROUNDWATER

LHAAP 29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

N

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FEET

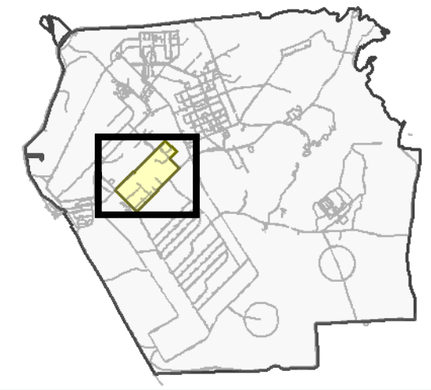
FIGURE 1-9

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP29\LHAAP_29_ROD_VOC_PERCHLORATE_GW_SHALLOW.MXD - USER: PRAFATIAN - DATE: 2/21/2023

LHAAP-49
LHAAP-32
LHAAP-47
LHAAP-35B (37)
LHAAP-23
LHAAP-64
LHAAP-29

29WW11(S) 5/14/2005
29WW12(S) 5/15/2005
29WW13 (I) 5/15/2005
116(S) 5/14/2005
2,4-DNT: 1 U
2,6-DNT: 239
m-NT: 451
o-NT: 8140
p-NT: 1400
29WW10(S) 5/16/2005
29WW36(S) 2/21/2007
29WW37 (I) 2/1/2008
29WW06(S) 2/22/2007
29WW35 (I) 2/22/2007
29WW34 (I) 5/16/2005
29WW05(S) 5/16/2005
2,4-DNT: 50.9
2,6-DNT: 224
m-NT: 123
o-NT: 1230
p-NT: 42.7
29WW09(S) 5/15/2005
29WW07(S) 5/14/2005
29WW14 (I) 5/14/2005
29WW08 (D) 5/14/2005
117(S) 5/14/2005
29WW18(S) 5/14/2005
29WW17(S) 5/16/2005
29WW16 (I) 5/16/2005
29WW41 (D) 6/10/2009
29WW40 (D) 12/19/2006
29WW22(S) 5/16/2005
29WW15(S) 2/24/2007
29WW21 (I) 5/15/2005
29WW20(S) 5/16/2005
2,4-DNT: 32.4
2,6-DNT: 112
m-NT: 43.3
o-NT: 401
p-NT: 374
29WW19(S) 5/15/2005
29WW26(S) 5/13/2005
29WW27(S) 5/14/2005
29WW24 (I) 5/15/2005
29WW23(S) 5/15/2005
115(S) 5/15/2005
29WW38(S) 2/22/2007
29WW39 (I) 2/1/2008
29WW30(S) 5/16/2005
29WW31(S) 5/16/2005
114(S) 5/14/2005
29WW29(S) 5/15/2005
29WW28 (I) 5/15/2005
29WW01(S) 5/13/2005
29WW04 (D) 4/17/2005
29WW02(S) 5/14/2005
29WW25(S) 5/14/2005
118(S) 5/15/2005
29WW33(S) 5/16/2005
29WW03(S) 5/17/2005
2,4-DNT: 1 U
2,6-DNT: 9.32
J, m-NT: 5.5
o-NT: 71.3
p-NT: 37.2
29WW32(S) 5/16/2005
119(S) 4/15/2005

2,6-DNT
o-NT
p-NT
m-NT
2,4-DNT



LEGEND

- Shallow Groundwater Monitoring Well (S)
- Intermediate Groundwater Monitoring Well (I)
- Deep Groundwater Monitoring Well (D)
- 2,4-DNT and 2,6-DNT (TRRP Tier 1 Residential Groundwater PCL = 1.3 ug/L)
- Inferred 2,4-DNT and 2,6-DNT (TRRP Tier 1 Residential Groundwater PCL = 1.3 ug/L) *
- 2(o)-NT (TRRP Tier 1 Residential Groundwater PCL = 4.1 µg/L)*
- Inferred 2(o)-NT (TRRP Tier 1 Residential Groundwater PCL
- 3(m)-NT and 4(p)-NT (TRRP Tier 1 Residential Groundwater PCL = 240 µg/L and 57 µg/L)*
- Stream
- Road
- Building
- Site

* Contours based on the TRRP Tier 1 Residential Groundwater PCLs

DATA SOURCES: HDR, 2019, Final Record of Decision for LHAAP-29 Former TNT Production Area Group 2 Longhorn Army Ammunition Plant. August.

DISCLAIMER: Map information was compiled from the best available sources. No warranty is made for its accuracy or completeness.

NOTES:
-All concentrations in the intermediate and deep zones are below the TRRP Tier 1 Residential Groundwater PCLs for 2(o)-, 3(m)- and 4 (p)-nitrotoluenes (4.1, 240 and 57 ug/L respectively), 2,4-DNT and 2,6-DNT (1.3 ug/L); therefore no plumes exist in these zones
-All concentrations are reported in micrograms per liter (µg/L).
-Analytes are non detect unless labeled on map.
-COC - Chemical of concern, DNT - Dinitrotoluene, NT - Nitrotoluene

NITROTOLUENES IN SHALLOW ZONE GROUNDWATER

LHAAP 29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

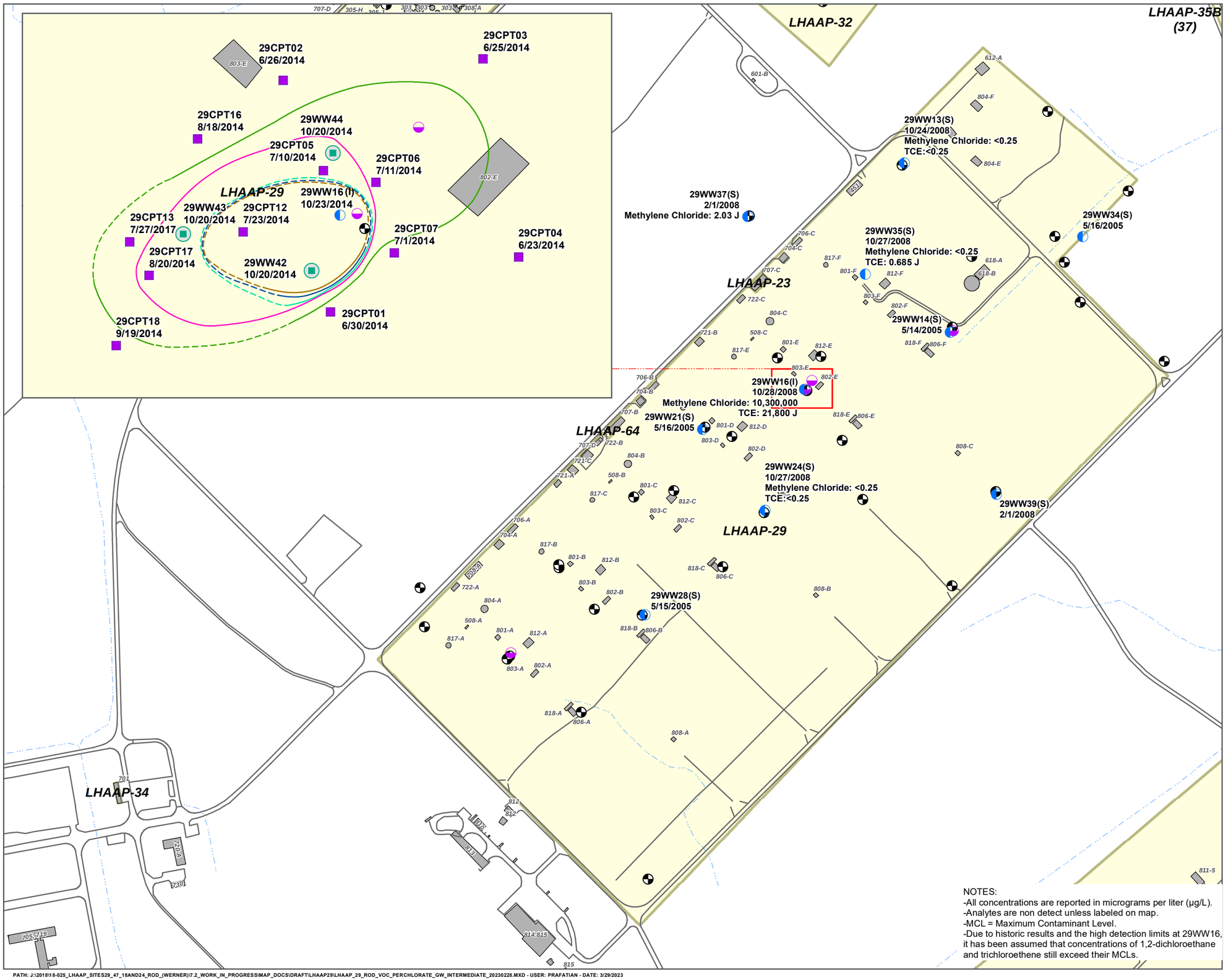
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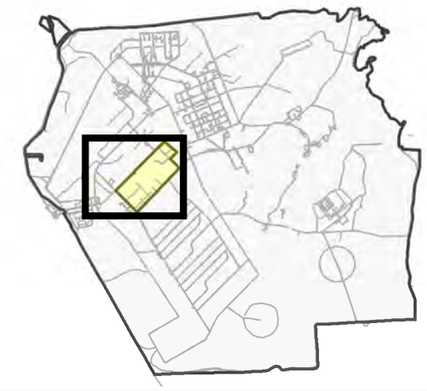
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FIGURE 1-10

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP29\LHAAP_29_ROD_NITROTOLUENES_GW_SHALLOW.MXD - USER: PRAFATIAN - DATE: 2/21/2023

01226813





LEGEND

- Shallow Groundwater Monitoring Well (S)
- Intermediate Groundwater Monitoring Well (I)
- Deep Groundwater Monitoring Well (D)
- Intermediate Zone Well (2014)
- Intermediate Zone Soil Boring (2014)

Intermediate Groundwater Contours (Dashed Where Inferred), Contour Concentration

- Trichloroethene (MCL = 5 µg/L)
- 1,2 - DCA (MCL = 5 µg/L)
- cis - 1,2 - DCE (MCL = 70 µg/L)
- Vinyl Chloride (MCL = 2 µg/L)
- MC (MCL = 5 µg/L)
- Stream
- Road
- Building
- Site LHAAP-29

DATA SOURCES: HDR, 2019, Final Record of Decision for LHAAP-29 Former TNT Production Area Group 2 Longhorn Army Ammunition Plant. August.

DISCLAIMER: Map information was compiled from the best available sources. No warranty is made for its accuracy or completeness.

NOTES:
-All concentrations are reported in micrograms per liter (µg/L).
-Analytes are non detect unless labeled on map.
-MCL = Maximum Contaminant Level.
-Due to historic results and the high detection limits at 29WW16, it has been assumed that concentrations of 1,2-dichloroethane and trichloroethene still exceed their MCLs.

VOCS IN INTERMEDIATE ZONE GROUNDWATER

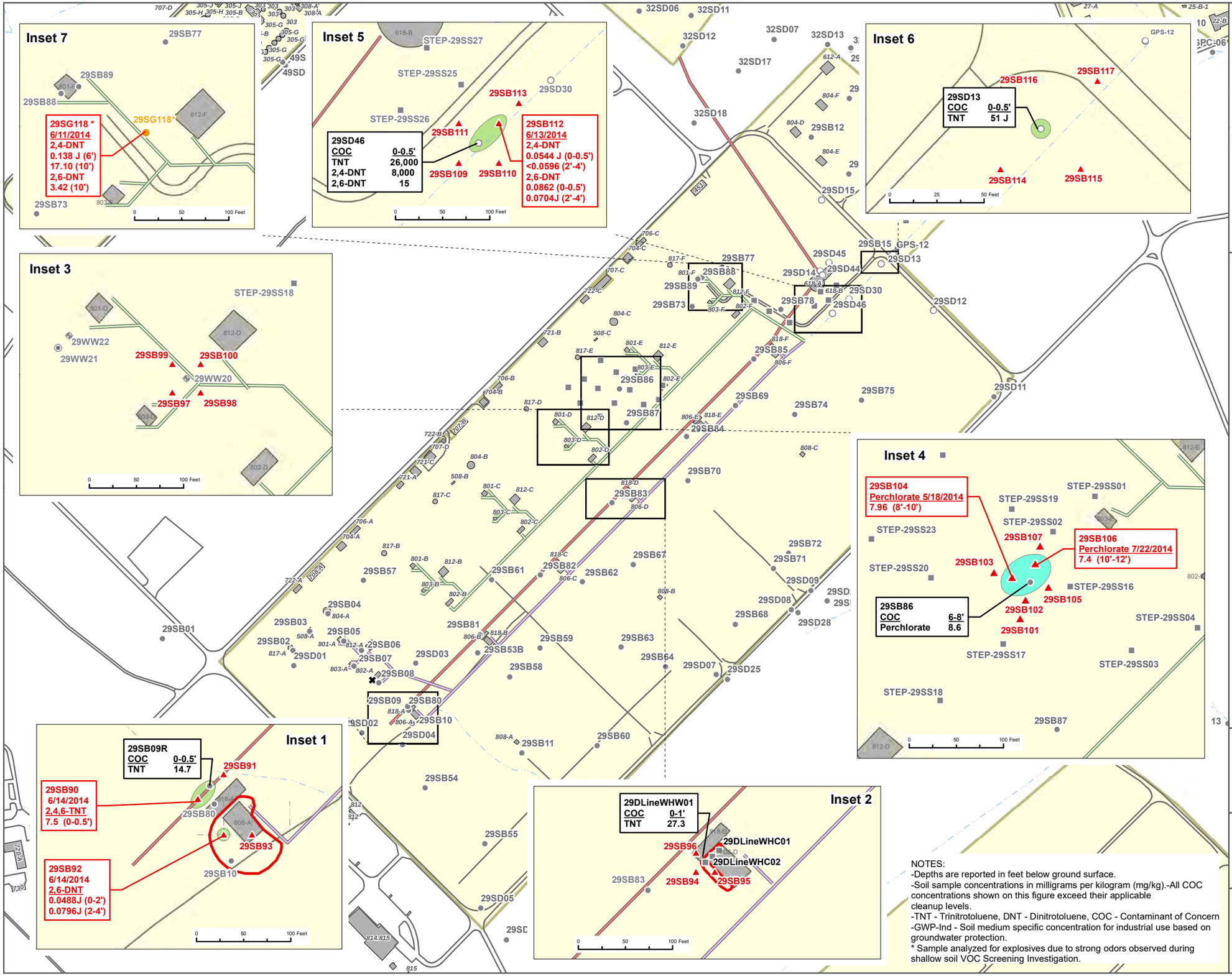
LHAAP 29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

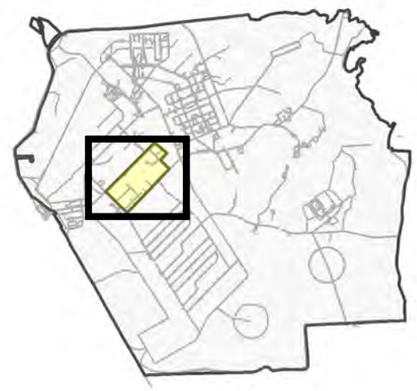
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FIGURE 1-11

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LEGEND

- Shallow Soil Sample Location (2014)*
- 2014 Soil Sample Locations
- Former Building Locations
- Historical Sediment Sample Location
- Historical Soil Boring Location
- Historical Surface Soil Sample Location
- Shallow Zone Monitoring Well
- Intermediate Zone Monitoring Well
- Stained Soil
- TNT Cooling Water Drain Line (North)
- TNT Cooling Water Drain Line (South)
- TNT Wastewater Line
- Road
- Stream
- Building
- Site LHAAP-29

Approximate Extent of Excavations

- Explosive
- Perchlorate

DATA SOURCES: AECOM, 2017, Draft Final Feasibility Study Addendum LHAAP-29, Former TNT Production Area, Group 2 Longhorn Army Ammunition Plant, Karnack, Texas. August.

DISCLAIMER: Map information was compiled from the best available sources. No warranty is made for its accuracy or completeness.

NOTES:
-Depths are reported in feet below ground surface.
-Soil sample concentrations in milligrams per kilogram (mg/kg).-All COC concentrations shown on this figure exceed their applicable cleanup levels.
-TNT - Trinitrotoluene, DNT - Dinitrotoluene, COC - Contaminant of Concern
-GWP-Ind - Soil medium specific concentration for industrial use based on groundwater protection.
* Sample analyzed for explosives due to strong odors observed during shallow soil VOC Screening Investigation.

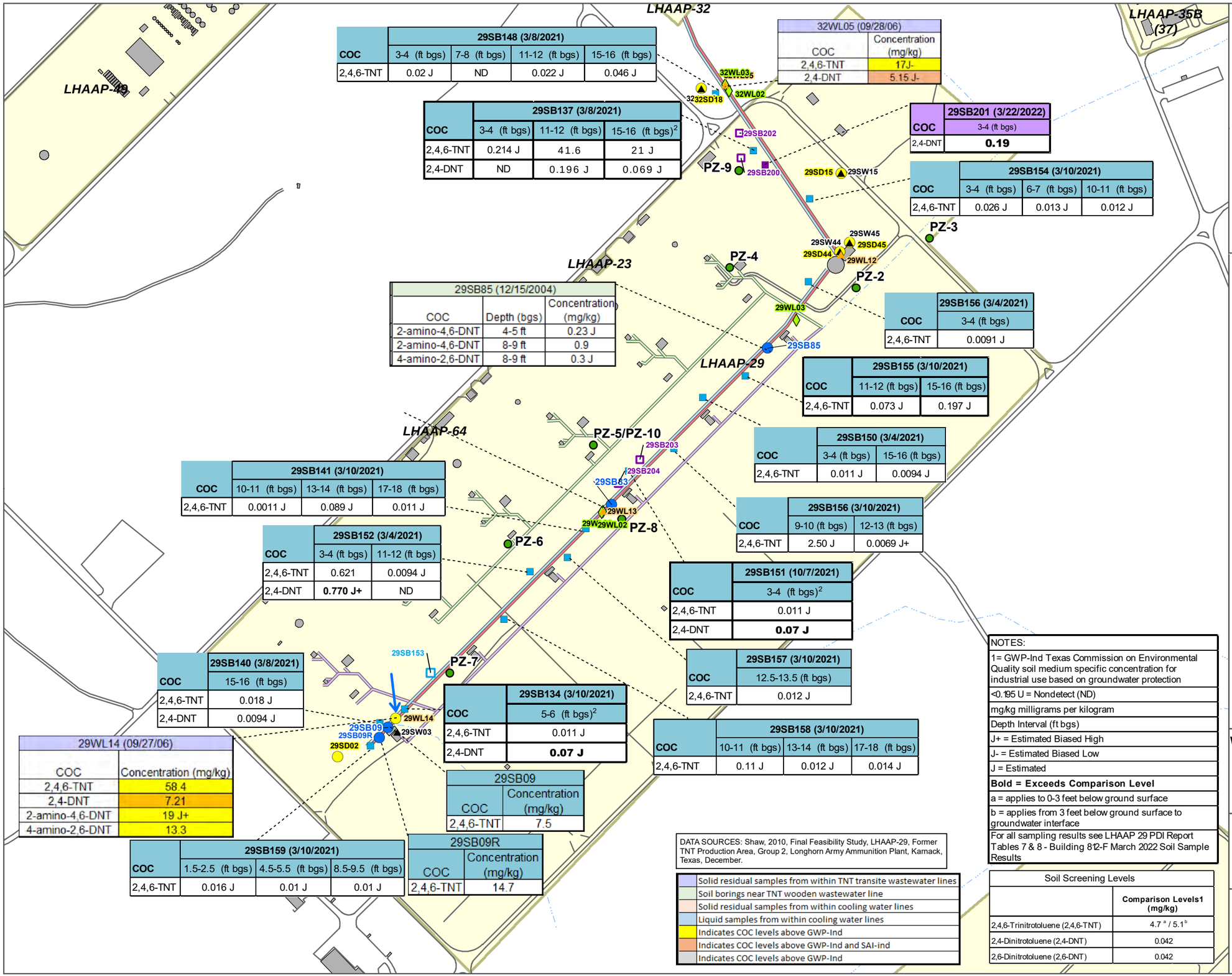
SOIL CONTAMINATION AND AREAS OF SOIL REMEDIATION

LHAAP 29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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0 250 500
FEET

FIGURE 1-12

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP29\LHAAP_29_ROD_SOILCONTAMINATION_SOILREMEDIATION.MXD - USER: KLOFGREN - DATE: 7/12/2019



COC	29SB148 (3/8/2021)			
	3-4 (ft bgs)	7-8 (ft bgs)	11-12 (ft bgs)	15-16 (ft bgs)
2,4,6-TNT	0.02 J	ND	0.022 J	0.046 J

32WL05 (09/28/06)	
COC	Concentration (mg/kg)
2,4,6-TNT	17J-
2,4-DNT	5.15 J-

COC	29SB137 (3/8/2021)		
	3-4 (ft bgs)	11-12 (ft bgs)	15-16 (ft bgs)[2]
2,4,6-TNT	0.214 J	41.6	21 J
2,4-DNT	ND	0.196 J	0.069 J

COC	29SB201 (3/22/2022)
	3-4 (ft bgs)
2,4-DNT	**0.19**

COC	29SB154 (3/10/2021)		
	3-4 (ft bgs)	6-7 (ft bgs)	10-11 (ft bgs)
2,4,6-TNT	0.026 J	0.013 J	0.012 J

29SB85 (12/15/2004)		
COC	Depth (bgs)	Concentration (mg/kg)
2-amino-4,6-DNT	4-5 ft	0.23 J
2-amino-4,6-DNT	8-9 ft	0.9
4-amino-2,6-DNT	8-9 ft	0.3 J

COC	29SB156 (3/4/2021)
	3-4 (ft bgs)
2,4,6-TNT	0.0091 J

COC	29SB155 (3/10/2021)	
	11-12 (ft bgs)	15-16 (ft bgs)
2,4,6-TNT	0.073 J	0.197 J

COC	29SB150 (3/4/2021)	
	3-4 (ft bgs)	15-16 (ft bgs)
2,4,6-TNT	0.011 J	0.0094 J

COC	29SB141 (3/10/2021)		
	10-11 (ft bgs)	13-14 (ft bgs)	17-18 (ft bgs)
2,4,6-TNT	0.0011 J	0.089 J	0.011 J

COC	29SB156 (3/10/2021)	
	9-10 (ft bgs)	12-13 (ft bgs)
2,4,6-TNT	2.50 J	0.0069 J+

COC	29SB152 (3/4/2021)	
	3-4 (ft bgs)	11-12 (ft bgs)
2,4,6-TNT	0.621	0.0094 J
2,4-DNT	**0.770 J+**	ND

COC	29SB151 (10/7/2021)
	3-4 (ft bgs)[2]
2,4,6-TNT	0.011 J
2,4-DNT	**0.07 J**

COC	29SB157 (3/10/2021)
	12.5-13.5 (ft bgs)
2,4,6-TNT	0.012 J

COC	29SB140 (3/8/2021)
	15-16 (ft bgs)
2,4,6-TNT	0.018 J
2,4-DNT	0.0094 J

COC	29SB134 (3/10/2021)
	5-6 (ft bgs)[2]
2,4,6-TNT	0.011 J
2,4-DNT	**0.07 J**

COC	29SB158 (3/10/2021)		
	10-11 (ft bgs)	13-14 (ft bgs)	17-18 (ft bgs)
2,4,6-TNT	0.11 J	0.012 J	0.014 J

29WL14 (09/27/06)	
COC	Concentration (mg/kg)
2,4,6-TNT	58.4
2,4-DNT	7.21
2-amino-4,6-DNT	19 J+
4-amino-2,6-DNT	13.3

29SB09	
COC	Concentration (mg/kg)
2,4,6-TNT	7.5

COC	29SB159 (3/10/2021)		
	1.5-2.5 (ft bgs)	4.5-5.5 (ft bgs)	8.5-9.5 (ft bgs)
2,4,6-TNT	0.016 J	0.01 J	0.01 J

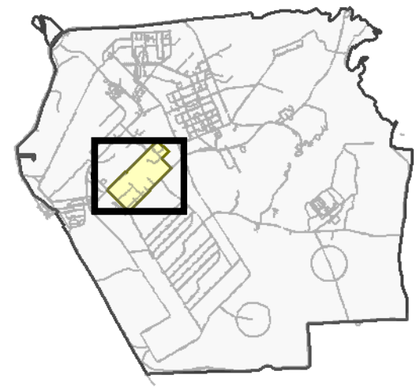
29SB09R	
COC	Concentration (mg/kg)
2,4,6-TNT	14.7

DATA SOURCES: Shaw, 2010, Final Feasibility Study, LHAAP-29, Former TNT Production Area, Group 2, Longhorn Army Ammunition Plant, Karnack, Texas, December.

Solid residual samples from within TNT transite wastewater lines
Soil borings near TNT wooden wastewater line
Solid residual samples from within cooling water lines
Liquid samples from within cooling water lines
Indicates COC levels above GWP-Ind
Indicates COC levels above GWP-Ind and SAI-ind
Indicates COC levels above GWP-Ind

NOTES:
1= GWP-Ind Texas Commission on Environmental Quality soil medium specific concentration for industrial use based on groundwater protection
<0.195 U = Nondetect (ND)
mg/kg milligrams per kilogram
Depth Interval (ft bgs)
J+ = Estimated Biased High
J- = Estimated Biased Low
J = Estimated
Bold = Exceeds Comparison Level
a = applies to 0-3 feet below ground surface
b = applies from 3 feet below ground surface to groundwater interface
For all sampling results see LHAAP 29 PDI Report Tables 7 & 8 - Building 812-F March 2022 Soil Sample Results

Soil Screening Levels	
	Comparison Levels1 (mg/kg)
2,4,6-Trinitrotoluene (2,4,6-TNT)	4.7 [a] / 5.1 [b]
2,4-Dinitrotoluene (2,4-DNT)	0.042
2,6-Dinitrotoluene (2,6-DNT)	0.042



LEGEND

- 2022 Piezometer Locations

2022 DPT Soil Boring Location (29SB200 - 29SB204)

- Nondetect
- Detect

2021 DPT Soil Boring Location (Wooden TNT Wastewater Line: 29SB134, 29SB141, 29SB54 - 29SB159)(Transite TNT Wastewater Line: 29SB137, 29SB140, 29SB148 - 29SB153)

- Nondetect
- Detect

Historic Sample Locations and Results (Shaw 2010)

- Water Sample from Line or Man Hole
- Soil Boring
- Water Sample from Line or Man Hole
- Solid residual Sample from Line or Man Hole
- Water Line Sample
- TNT Cooling Water Drain Line (North)
- TNT Cooling Water Drain Line (South)
- TNT Wooden Wastewater Line
- TNT Transite Wastewater Line
- Stream
- Road
- Building
- Site LHAAP-29

2 = ETA reanalyzed results with LOD below the screening levels

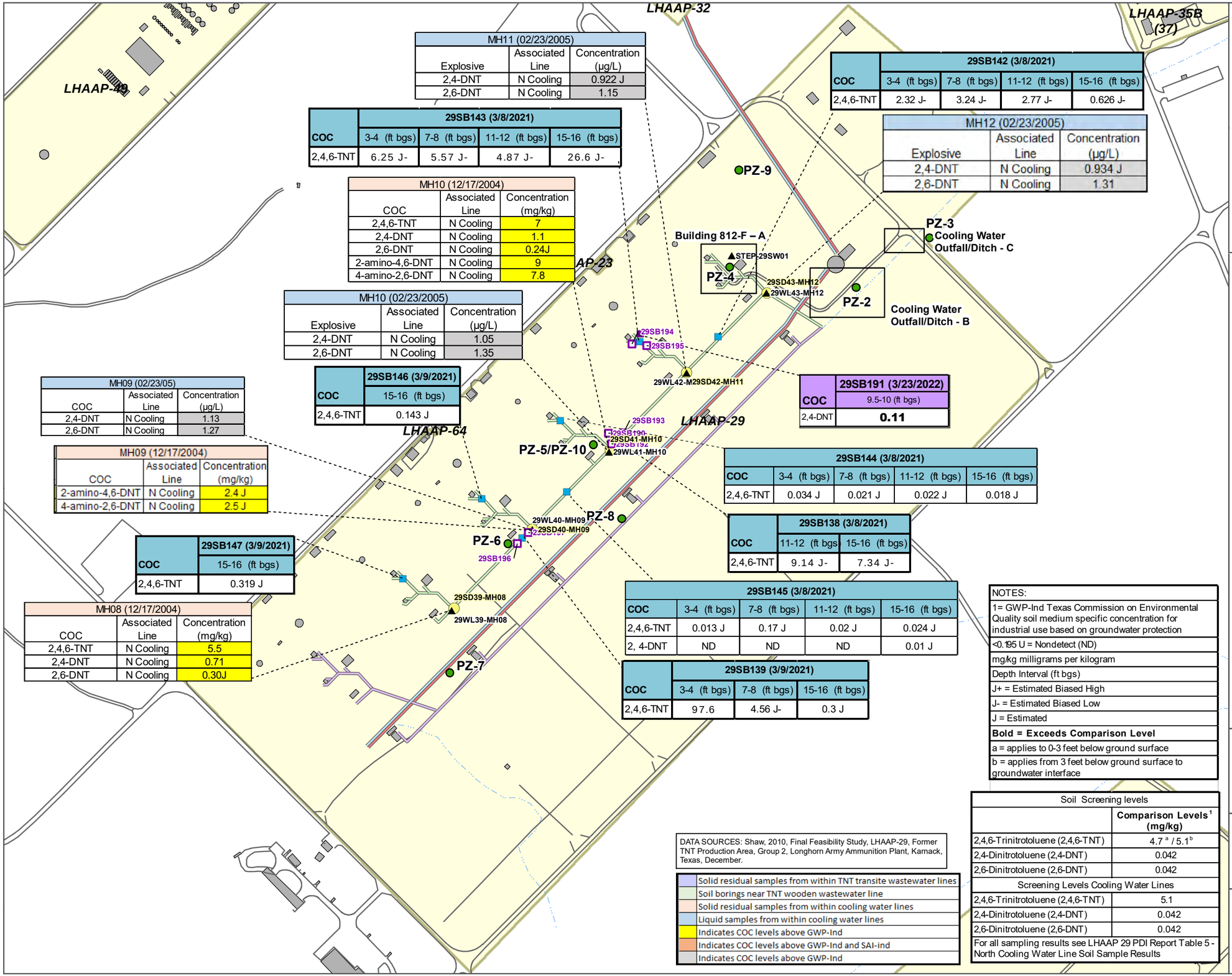
WOODEN AND TRANSITE TNT WASTEWATER LINES
DPT SOIL SAMPLE RESULTS
EXPLOSIVES DETECTIONS

LHAAP-29 PDI REPORT JUNE 2022
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

N

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FIGURE 1-13



MH11 (02/23/2005)		
Explosive	Associated Line	Concentration (µg/L)
2,4-DNT	N Cooling	0.922 J
2,6-DNT	N Cooling	1.15

COC	29SB143 (3/8/2021)			
	3-4 (ft bgs)	7-8 (ft bgs)	11-12 (ft bgs)	15-16 (ft bgs)
2,4,6-TNT	6.25 J-	5.57 J-	4.87 J-	26.6 J-

MH10 (12/17/2004)		
COC	Associated Line	Concentration (mg/kg)
2,4,6-TNT	N Cooling	7
2,4-DNT	N Cooling	1.1
2,6-DNT	N Cooling	0.24J
2-amino-4,6-DNT	N Cooling	9
4-amino-2,6-DNT	N Cooling	7.8

MH10 (02/23/2005)		
Explosive	Associated Line	Concentration (µg/L)
2,4-DNT	N Cooling	1.05
2,6-DNT	N Cooling	1.35

COC	29SB146 (3/9/2021)
	15-16 (ft bgs)
2,4,6-TNT	0.143 J

MH09 (02/23/05)		
COC	Associated Line	Concentration (µg/L)
2,4-DNT	N Cooling	1.13
2,6-DNT	N Cooling	1.27

MH09 (12/17/2004)		
COC	Associated Line	Concentration (mg/kg)
2-amino-4,6-DNT	N Cooling	2.4 J
4-amino-2,6-DNT	N Cooling	2.5 J

COC	29SB147 (3/9/2021)
	15-16 (ft bgs)
2,4,6-TNT	0.319 J

MH08 (12/17/2004)		
COC	Associated Line	Concentration (mg/kg)
2,4,6-TNT	N Cooling	5.5
2,4-DNT	N Cooling	0.71
2,6-DNT	N Cooling	0.30J

COC	29SB142 (3/8/2021)			
	3-4 (ft bgs)	7-8 (ft bgs)	11-12 (ft bgs)	15-16 (ft bgs)
2,4,6-TNT	2.32 J-	3.24 J-	2.77 J-	0.626 J-

MH12 (02/23/2005)		
Explosive	Associated Line	Concentration (µg/L)
2,4-DNT	N Cooling	0.934 J
2,6-DNT	N Cooling	1.31

COC	29SB191 (3/23/2022)
	9.5-10 (ft bgs)
2,4-DNT	**0.11**

COC	29SB144 (3/8/2021)			
	3-4 (ft bgs)	7-8 (ft bgs)	11-12 (ft bgs)	15-16 (ft bgs)
2,4,6-TNT	0.034 J	0.021 J	0.022 J	0.018 J

COC	29SB138 (3/8/2021)	
	11-12 (ft bgs	15-16 (ft bgs)
2,4,6-TNT	9.14 J-	7.34 J-

29SB145 (3/8/2021)				
COC	3-4 (ft bgs)	7-8 (ft bgs)	11-12 (ft bgs)	15-16 (ft bgs)
2,4,6-TNT	0.013 J	0.17 J	0.02 J	0.024 J
2, 4-DNT	ND	ND	ND	0.01 J

COC	29SB139 (3/9/2021)		
	3-4 (ft bgs)	7-8 (ft bgs)	15-16 (ft bgs)
2,4,6-TNT	97.6	4.56 J-	0.3 J

NOTES:

1= GWP-Ind Texas Commission on Environmental Quality soil medium specific concentration for industrial use based on groundwater protection

<0.195 U = Nondetect (ND)

mg/kg milligrams per kilogram

Depth Interval (ft bgs)

J+ = Estimated Biased High

J- = Estimated Biased Low

J = Estimated

Bold = Exceeds Comparison Level

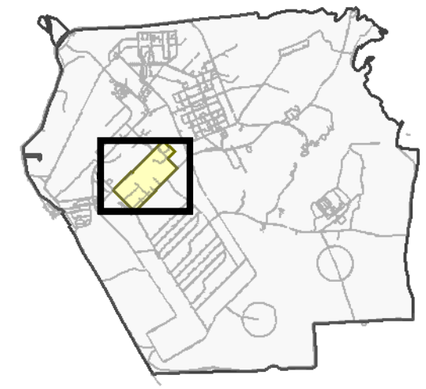
a = applies to 0-3 feet below ground surface

b = applies from 3 feet below ground surface to groundwater interface

Soil Screening levels	
	Comparison Levels[1] (mg/kg)
2,4,6-Trinitrotoluene (2,4,6-TNT)	4.7 [a] / 5.1 [b]
2,4-Dinitrotoluene (2,4-DNT)	0.042
2,6-Dinitrotoluene (2,6-DNT)	0.042
Screening Levels Cooling Water Lines	
2,4,6-Trinitrotoluene (2,4,6-TNT)	5.1
2,4-Dinitrotoluene (2,4-DNT)	0.042
2,6-Dinitrotoluene (2,6-DNT)	0.042
For all sampling results see LHAAP 29 PDI Report Table 5 - North Cooling Water Line Soil Sample Results	

DATA SOURCES: Shaw, 2010, Final Feasibility Study, LHAAP-29, Former TNT Production Area, Group 2, Longhorn Army Ammunition Plant, Karnack, Texas, December.

Solid residual samples from within TNT transite wastewater lines
Soil borings near TNT wooden wastewater line
Solid residual samples from within cooling water lines
Liquid samples from within cooling water lines
Indicates COC levels above GWP-Ind
Indicates COC levels above GWP-Ind and SAI-ind
Indicates COC levels above GWP-Ind



LEGEND

- 2022 Piezometer Locations

2022 DPT Soil Boring Location (29SB190 - 29SB197)

- Nondetect
- Detect

2021 DPT Soil Boring Location (29SB138 - 29SB139, 29SB142 - 29SB147)

- Nondetect
- Detect

Historic Sample Locations and Results (Shaw 2010)

- Water Sample from Line or Man Hole
- Solid residual Sample from Line or Man Hole
- TNT Cooling Water Drain Line (North)
- TNT Cooling Water Drain Line (South)
- TNT Wooden Wastewater Line
- TNT Transite Wastewater Line
- Stream
- Road
- Building
- Site LHAAP-29

NORTH TNT COOLING WATER LINES
DPT SOIL SAMPLE RESULTS
EXPLOSIVES DETECTIONS

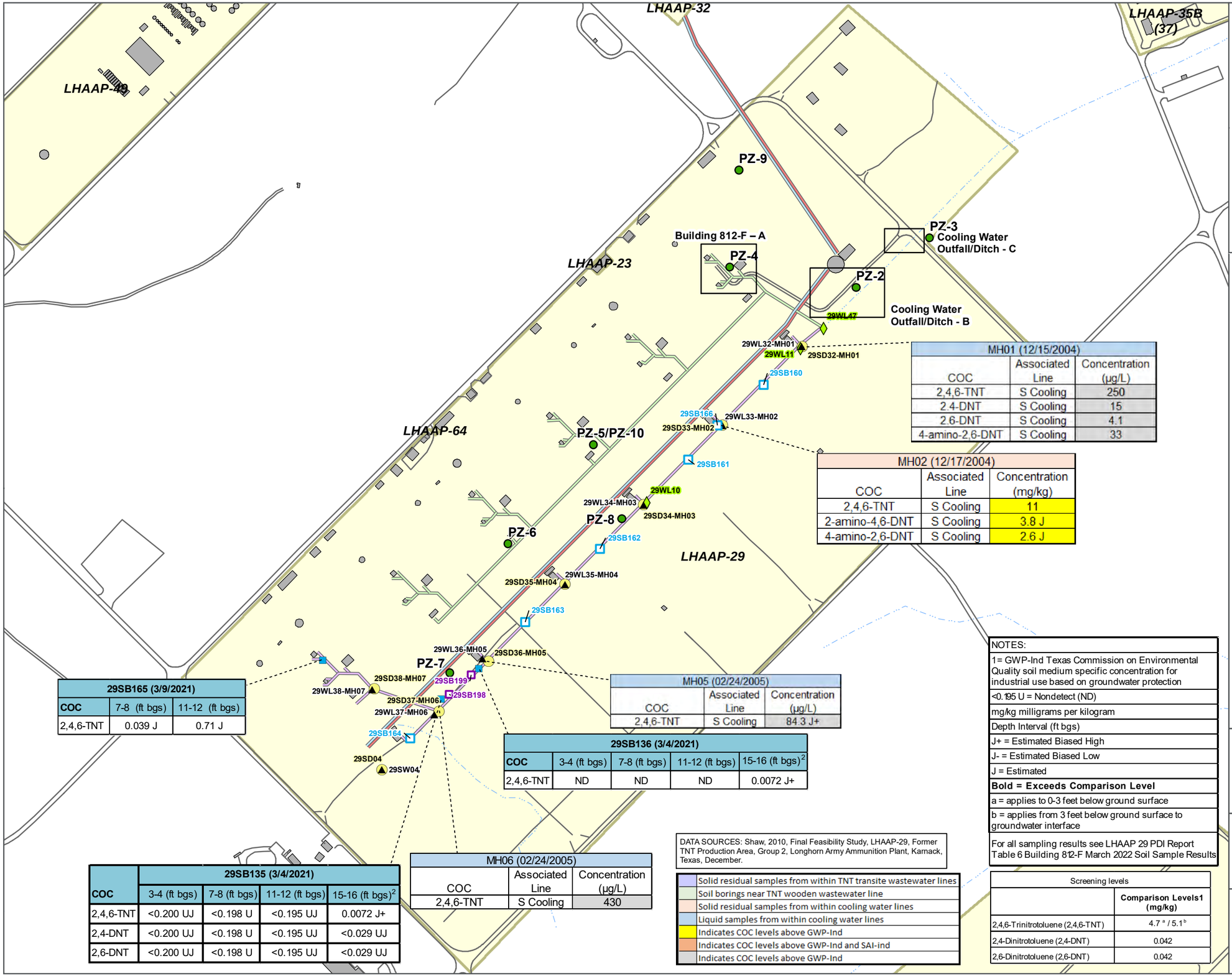
LHAAP-29 PDI REPORT JUNE 2022
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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FIGURE 1-14

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP29\LHAAP_29_PDI_2022REPORT_N_COOLING_WATER_DRAIN_LINE_HISTORIC_SAMPLERESULTS_FIG1_14.MXD - USER: EBOWLIN - DATE: 4/12/2023



MH01 (12/15/2004)		
COC	Associated Line	Concentration (µg/L)
2,4,6-TNT	S Cooling	250
2,4-DNT	S Cooling	15
2,6-DNT	S Cooling	4.1
4-amino-2,6-DNT	S Cooling	33

MH02 (12/17/2004)		
COC	Associated Line	Concentration (mg/kg)
2,4,6-TNT	S Cooling	11
2-amino-4,6-DNT	S Cooling	3.8 J
4-amino-2,6-DNT	S Cooling	2.6 J

29SB165 (3/9/2021)		
COC	7-8 (ft bgs)	11-12 (ft bgs)
2,4,6-TNT	0.039 J	0.71 J

MH05 (02/24/2005)		
COC	Associated Line	Concentration (µg/L)
2,4,6-TNT	S Cooling	84.3 J+

29SB136 (3/4/2021)				
COC	3-4 (ft bgs)	7-8 (ft bgs)	11-12 (ft bgs)	15-16 (ft bgs)[2]
2,4,6-TNT	ND	ND	ND	0.0072 J+

	29SB135 (3/4/2021)			
COC	3-4 (ft bgs)	7-8 (ft bgs)	11-12 (ft bgs)	15-16 (ft bgs)[2]
2,4,6-TNT	<0.200 UJ	<0.198 U	<0.195 UJ	0.0072 J+
2,4-DNT	<0.200 UJ	<0.198 U	<0.195 UJ	<0.029 UJ
2,6-DNT	<0.200 UJ	<0.198 U	<0.195 UJ	<0.029 UJ

MH06 (02/24/2005)		
COC	Associated Line	Concentration (µg/L)
2,4,6-TNT	S Cooling	430

DATA SOURCES: Shaw, 2010, Final Feasibility Study, LHAAP-29, Former TNT Production Area, Group 2, Longhorn Army Ammunition Plant, Karnack, Texas, December.

Solid residual samples from within TNT transite wastewater lines
Soil borings near TNT wooden wastewater line
Solid residual samples from within cooling water lines
Liquid samples from within cooling water lines
Indicates COC levels above GWP-Ind
Indicates COC levels above GWP-Ind and SAI-ind
Indicates COC levels above GWP-Ind

NOTES:

1= GWP-Ind Texas Commission on Environmental Quality soil medium specific concentration for industrial use based on groundwater protection

<0.195 U = Nondetect (ND)

mg/kg milligrams per kilogram

Depth Interval (ft bgs)

J+ = Estimated Biased High

J- = Estimated Biased Low

J = Estimated

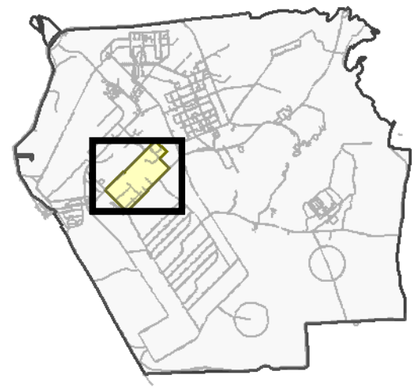
Bold = Exceeds Comparison Level

a = applies to 0-3 feet below ground surface

b = applies from 3 feet below ground surface to groundwater interface

For all sampling results see LHAAP 29 PDI Report Table 6 Building 812-F March 2022 Soil Sample Results

Screening levels	
	Comparison Levels1 (mg/kg)
2,4,6-Trinitrotoluene (2,4,6-TNT)	4.7 [a] / 5.1 [b]
2,4-Dinitrotoluene (2,4-DNT)	0.042
2,6-Dinitrotoluene (2,6-DNT)	0.042



LEGEND

- 2022 Piezometer Locations

2022 DPT Soil Boring Location (29SB198 - 29SB199)

- Nondetect
- Detect

2021 DPT Soil Boring Location (29SB135 - 29SB136, 29SB160 - 29SB166)

- Nondetect
- Detect

Historic Sample Locations and Results (Shaw 2010)

- Water Sample from Line or Man Hole
- Solid residual Sample from Line or Man Hole
- Water Line Sample
- TNT Cooling Water Drain Line (North)
- TNT Cooling Water Drain Line (South)
- TNT Wooden Wastewater Line
- TNT Transite Wastewater Line
- Stream
- Road
- Building
- Site LHAAP-29

2 = ETA reanalyzed results wth LOD below the screening levels

SOUTH TNT COOLING WATER LINES
DPT SOIL SAMPLE RESULTS
EXPLOSIVES DETECTIONS

LHAAP-29 PDI REPORT JUNE 2022
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

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FIGURE 1-15

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP29\LHAAP_29_PDI_2022REPORT_S_COOLING_WATER_DRAIN_LINE_HISTORIC_SAMPLERESULTS_FIG11.MXD - USER: EBOWLIN - DATE: 4/12/2023

29SB140				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	<0.015	<0.199	<0.015	0.018
2,4-DNT	<0.029	<0.199	<0.029	0.0094
2,6-DNT	<0.029	<0.199	<0.029	<0.029

29SB09R	
	0-0.5 ft
2,4,6-TNT	**14.7**

29SB90		
	0-0.5 ft	0-2 ft
2,4,6-TNT	**7.5**	0.332
2,4-DNT	<0.0276	NA
2,6-DNT	<0.0276	NA

29SB92		
	0-2 ft	2-4 ft
2,4,6-TNT	<0.195	NA
2,4-DNT	0.0385	<0.126
2,6-DNT	**0.0488**	**0.0796**

29SB159			
	1.5-2 ft	4.5-5.5 ft	8.5-9.5 ft
2,4,6-TNT	0.016	0.01	0.01
2,4-DNT	<0.028	<0.029	<0.03
2,6-DNT	<0.028	<0.029	<0.03

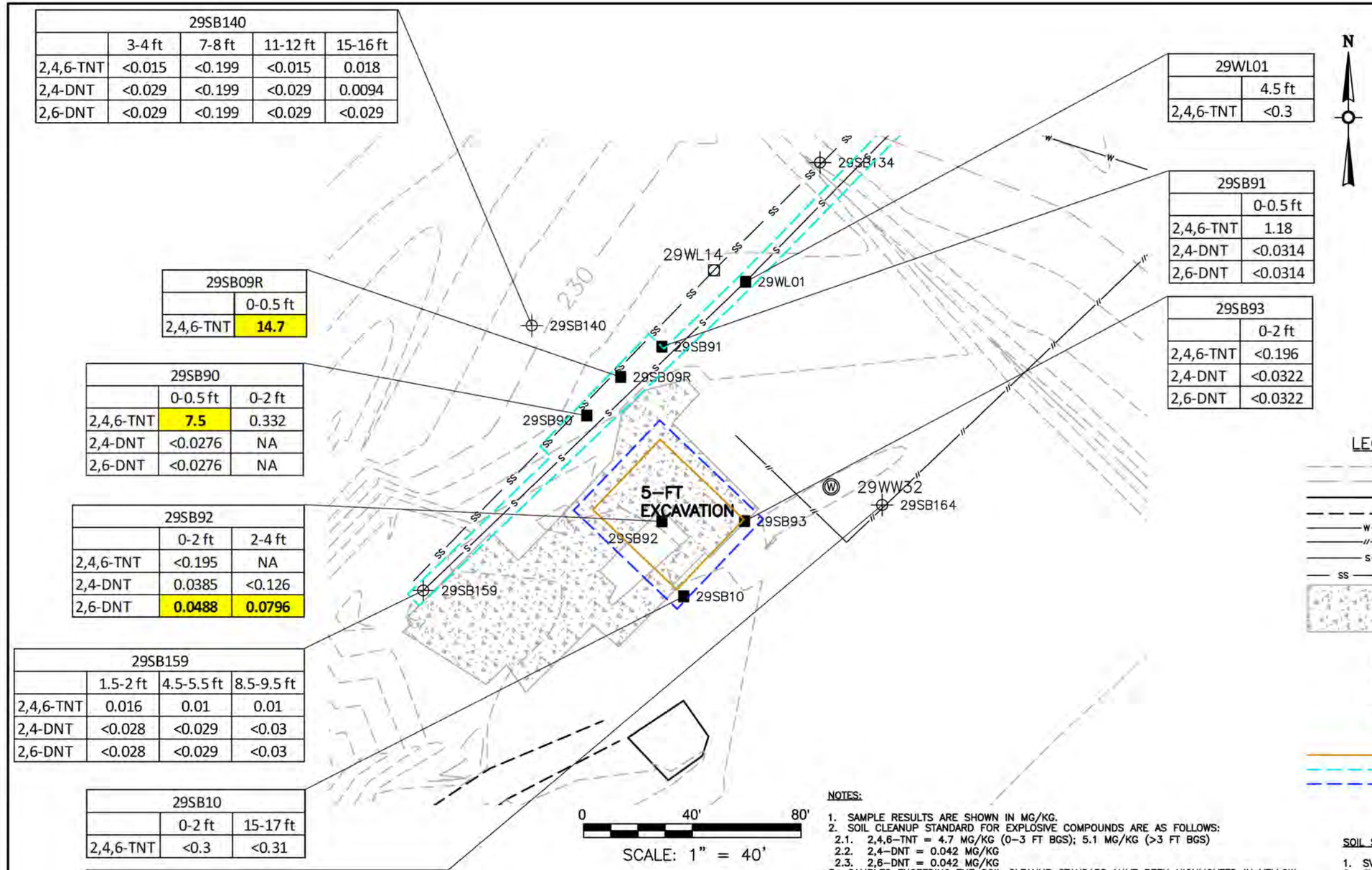
29SB10		
	0-2 ft	15-17 ft
2,4,6-TNT	<0.3	<0.31

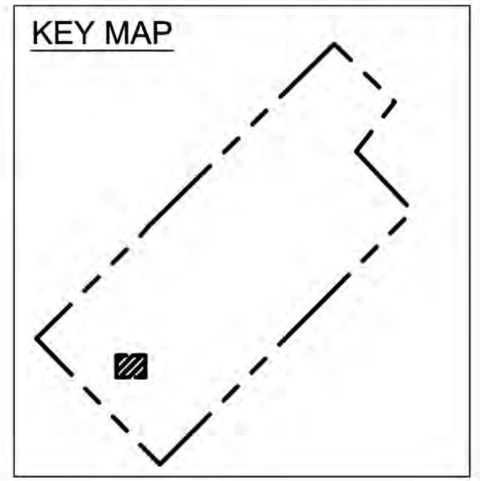
29SB164				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	<0.191	0.0096	<0.014	<0.015
2,4-DNT	<0.191	<0.029	<0.029	<0.029
2,6-DNT	<0.191	<0.029	<0.029	<0.029

29WL01	
	4.5 ft
2,4,6-TNT	<0.3

29SB91	
	0-0.5 ft
2,4,6-TNT	1.18
2,4-DNT	<0.0314
2,6-DNT	<0.0314

29SB93	
	0-2 ft
2,4,6-TNT	<0.196
2,4-DNT	<0.0322
2,6-DNT	<0.0322





N

LEGEND:

- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- EXISTING UNPAVED ROAD
- COOLING WATER MAIN PIPE – ASSUMED 18"
- COOLING WATER BUILDING SERVICE PIPE
- 12" WOOD TNT WASTEWATER LINE
- 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE BUILDING FOUNDATION
- HISTORIC SAMPLE LOCATION
- 2021/2022 PDI SAMPLE LOCATION
- MONITORING WELL
- HISTORIC WASTELINE/PIPE SAMPLE LOCATION
- EXCAVATION LIMIT
- ESTIMATED PIPE REMOVAL TRENCH LIMIT
- EXCAVATION TOP OF SLOPE

NOTES:

1. SAMPLE RESULTS ARE SHOWN IN MG/KG.
2. SOIL CLEANUP STANDARD FOR EXPLOSIVE COMPOUNDS ARE AS FOLLOWS:
   - 2.1. 2,4,6-TNT = 4.7 MG/KG (0-3 FT BGS); 5.1 MG/KG (>3 FT BGS)
   - 2.2. 2,4-DNT = 0.042 MG/KG
   - 2.3. 2,6-DNT = 0.042 MG/KG
3. SAMPLES EXCEEDING THE SOIL CLEANUP STANDARD HAVE BEEN HIGHLIGHTED IN YELLOW AND BOLDED.
4. SAMPLE RESULTS FOR 29SB10 AND 29WL01 WERE TAKEN FROM FIGURE 4-5 OF THE DRAFT DATA SUMMARY REPORT PREPARED BY SHAW ENVIRONMENTAL, INC, DATED JUNE 2005 INCLUDED AS AN APPENDIX TO THE FINAL ADDENDUM 6, ADDITIONAL INVESTIGATION AT LHAAP-29, TO FINAL INSTALLATION-WIDE WORK PLAN PREPARED BY SHAW IN AUGUST 2006 (SHAW, 2006).
5. LOCATIONS OF THE TNT WASTEWATER PIPES ARE ESTIMATED BASED ON HISTORIC WASTE SAMPLES COLLECTED FROM THE PIPES AND BEST AVAILABLE INFORMATION. THE TRANSITE PIPE IS REPORTED AS BEING 5-FT NORTH OF THE WOODEN TNT WASTEWATER PIPE.

SOIL SAMPLE COLLECTION SUMMARY:

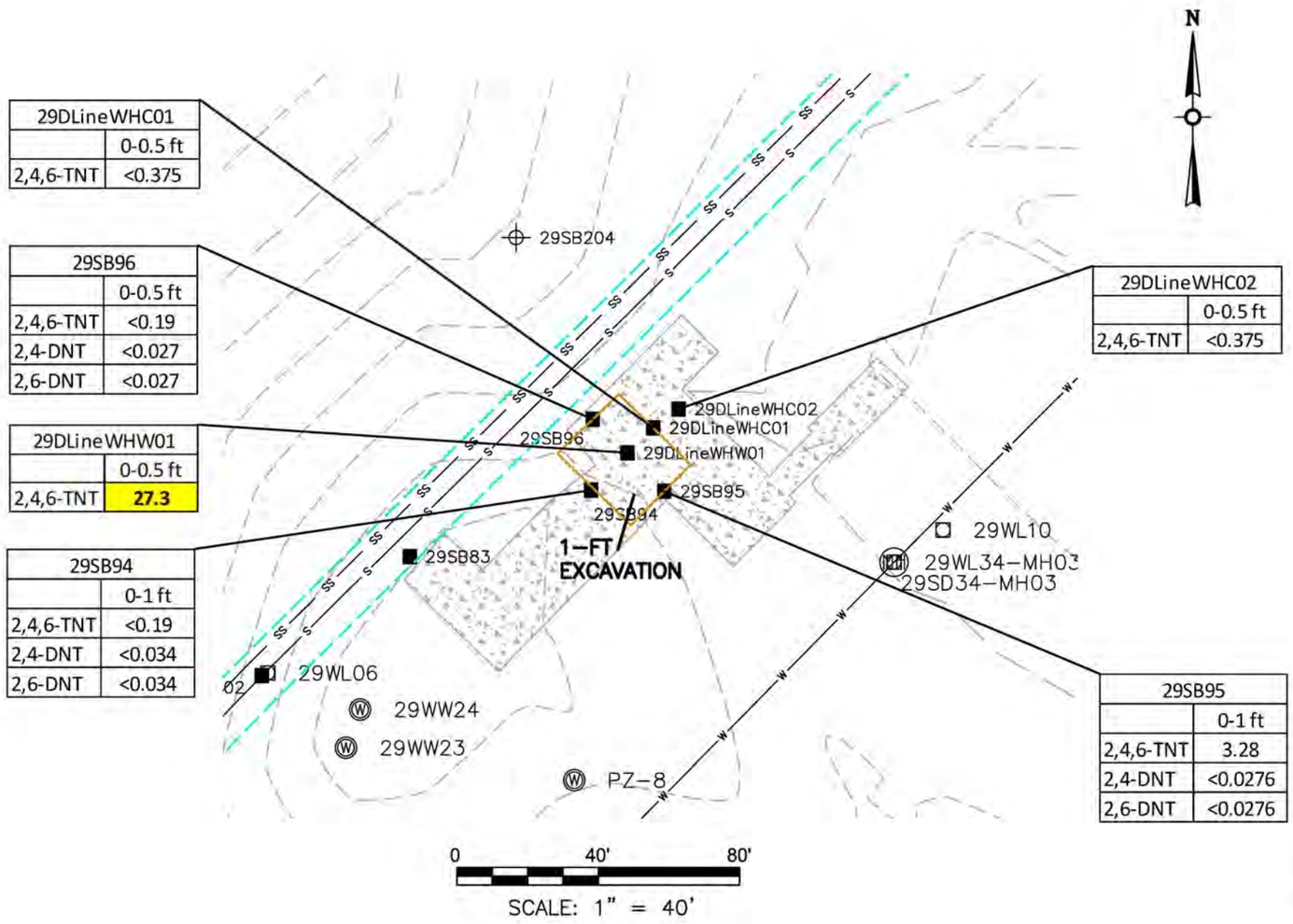
1. SVERDRUP, PHASE I 1993: BORINGS 29SB01-29SB15
2. SVERDRUP, PHASE II 1996a,b: BORINGS 29SB53-29SB76
3. SVERDRUP, PHASE III 1999: LOCATIONS 29SS01-29SS08
4. SHAW, 2010: BORINGS 29SB81-29SB85 EXPLOSIVES; 29SB86-29SB89 PERCHLORATE
5. AECOM, 2014: BORINGS 29SB90-29SB117
6. HDR, 2022: BORINGS 29SB118-29SB204

HDR

EXCAVATION AREA E-1
SOIL SAMPLE RESULTS
LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
2-1



29DLineWHC01	
	0-0.5 ft
2,4,6-TNT	<0.375

29SB96	
	0-0.5 ft
2,4,6-TNT	<0.19
2,4-DNT	<0.027
2,6-DNT	<0.027

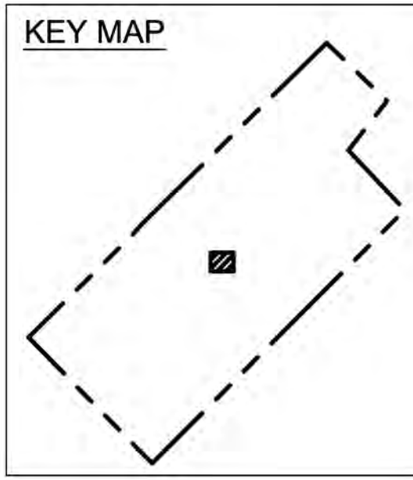
29DLineWHW01	
	0-0.5 ft
2,4,6-TNT	**27.3**

29SB94	
	0-1 ft
2,4,6-TNT	<0.19
2,4-DNT	<0.034
2,6-DNT	<0.034

29DLineWHC02	
	0-0.5 ft
2,4,6-TNT	<0.375

29SB95	
	0-1 ft
2,4,6-TNT	3.28
2,4-DNT	<0.0276
2,6-DNT	<0.0276

KEY MAP



LEGEND:

- MANHOLE
- CONTOUR MINOR
- CONTOUR MAJOR
- COOLING WATER MAIN PIPE – ASSUMED 18"
- 12" WOOD TNT WASTEWATER LINE
- 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE BUILDING FOUNDATION
- HISTORIC SAMPLE LOCATION
- 2021/2022 PDI SAMPLE LOCATION
- MONITORING WELL
- HISTORIC WASTELINE/PIPE SAMPLE LOCATION
- EXCAVATION LIMIT
- ESTIMATED PIPE REMOVAL TRENCH LIMIT

NOTES:

1. SAMPLE RESULTS ARE SHOWN IN MG/KG.
2. SOIL CLEANUP STANDARD FOR EXPLOSIVE COMPOUNDS ARE AS FOLLOWS:
   2.1. 2,4,6-TNT = 4.7 MG/KG (0-3 FT BGS); 5.1 MG/KG (>3 FT BGS)
   2.2. 2,4-DNT = 0.042 MG/KG
   2.3. 2,6-DNT = 0.042 MG/KG
3. SAMPLES EXCEEDING THE SOIL CLEANUP STANDARD HAVE BEEN HIGHLIGHTED IN YELLOW AND BOLDED.
4. SAMPLE RESULTS FOR 29SD46, AND 29SDS30 WERE TAKEN FROM FIGURES 4-5 AND 4-6 OF THE DRAFT SITE DATA SUMMARY REPORT PREPARED BY SHAW ENVIRONMENTAL, INC, DATED JUNE 2005 INCLUDED AS AN APPENDIX TO THE FINAL ADDENDUM 6, ADDITIONAL INVESTIGATION AT LHAAP-29, TO FINAL INSTALLATION-WIDE WORK PLAN PREPARED BY SHAW IN AUGUST 2006 (SHAW, 2006).
5. RESULTS FOR SAMPLES COLLECTED ALONG THE WASTEWATER TNT LINES AND COOLING WATER LINES ARE NOT SHOWN ON THIS FIGURE.
6. LOCATIONS OF THE TNT WASTEWATER PIPES ARE ESTIMATED BASED ON HISTORIC WASTE SAMPLES COLLECTED FROM THE PIPES AND BEST AVAILABLE INFORMATION. THE TRANSITE PIPE IS REPORTED AS BEING 5-FT NORTH OF THE WOODEN TNT WASTEWATER PIPE.
7. SAMPLE LOCATION 29DLINEWHC01 WAS COLLECTED AT A CRACK IN THE SLAB AND 29DLINEWHC02 WAS COLLECTED BENEATH THE CONCRETE FOUNDATION. 29DLINEWHW01 WAS COLLECTED ALONG THE FOUNDATION AT THE LOCATION WITH THE MOST OBVIOUS STAINING. THESE SAMPLES WERE COLLECTED BY THE USACE AND ARE DISCUSSED IN THE FINAL FEASIBILITY STUDY PREPARED BY SHAW ENVIRONMENTAL, DATED APRIL 2010.

SOIL SAMPLE COLLECTION SUMMARY:

1. SHAW, 2010: BORINGS 29SB81-29SB85 EXPLOSIVES; 29SB86-29SB89 PERCHLORATE
2. AECOM, 2014: BORINGS 29SB90-29SB117

HDR

EXCAVATION AREA E-2
SOIL SAMPLE RESULTS
LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
2-2

STEP-29SS19	
	1-2 ft
PERCHLORATE	<0.015

29SB106			
	6-8 ft	8-10 ft	10-12 ft
PERCHLORATE	1.19	3.23	**7.40**

29SB104				
	0-2 ft	6-8 ft	8-10 ft	10-12 ft
PERCHLORATE	NA	6.06	**7.96**	6.49

29SB103				
	0-2 ft	6-8 ft	8-10 ft	10-12 ft
PERCHLORATE	NA	4.56	3.63	2.92

STEP-29SS20	
	1-2 ft
PERCHLORATE	<0.015

29SB86			
	0-0.5 ft	6-8 ft	20-21 ft
PERCHLORATE	0.04	**8.60**	0.689

29SB102			
	0-2 ft	6-8 ft	8-10 ft
PERCHLORATE	NA	0.00334	0.00301

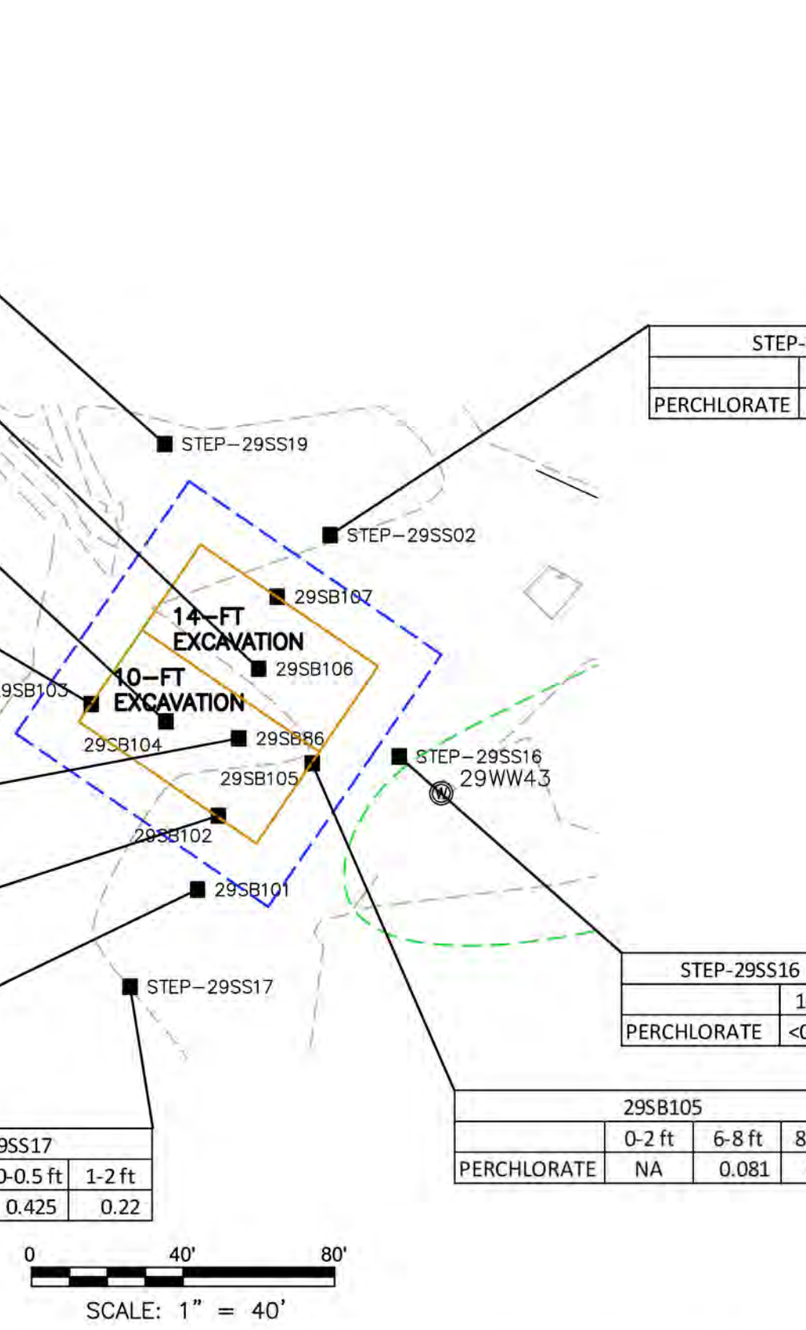
29SB101	
	0-1 ft
PERCHLORATE	NA

STEP-29SS17		
	0-0.5 ft	1-2 ft
PERCHLORATE	0.425	0.22

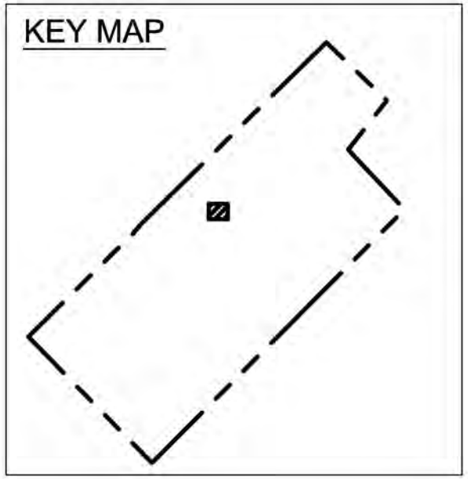
STEP-29SS02		
	0-0.5 ft	1-2 ft
PERCHLORATE	0.104	2.41

STEP-29SS16	
	1-2 ft
PERCHLORATE	<0.015

29SB105			
	0-2 ft	6-8 ft	8-10 ft
PERCHLORATE	NA	0.081	0.265



KEY MAP



LEGEND:

- CONTOUR MINOR
- CONTOUR MAJOR
- COOLING WATER MAIN PIPE – ASSUMED 18"
- CONCRETE BUILDING FOUNDATION
- HISTORIC SAMPLE LOCATION
- MONITORING WELL
- EXCAVATION LIMIT
- EXCAVATION TOP OF SLOPE
- MC PLUME TREATMENT AREA

NOTES:

1. SAMPLE RESULTS ARE SHOWN IN MG/KG.
2. SOIL CLEANUP STANDARD FOR EXPLOSIVE COMPOUNDS ARE AS FOLLOWS:
   - 2.1. 2,4,6–TNT = 4.7 MG/KG (0–3 FT BGS); 5.1 MG/KG (>3 FT BGS)
   - 2.2. 2,4–DNT = 0.042 MG/KG
   - 2.3. 2,6–DNT = 0.042 MG/KG
   - 2.4. PERCHLORATE = 7.2 MG/KG
3. SAMPLES EXCEEDING THE SOIL CLEANUP STANDARD HAVE BEEN HIGHLIGHTED IN YELLOW AND BOLDED.
4. BORING LOCATION 29SB107 WAS COMPLETED BY AECOM AS PART OF THE RI ADDENDUM. SAMPLE RESULTS COULD NOT BE FOUND IN THE RI ADDENDUM DATED JULY 2016, PREPARED BY AECOM. BECAUSE SAMPLE RESULTS COULD NOT BE FOUND, NO RESULTS HAVE BEEN SHOWN FOR THIS LOCATION. THE TEXT IN SECTION 3.2 OF THE RI ADDENDUM INDICATES ALL PERCHLORATE RESULTS FROM 29SB107 WERE BELOW THE GWP–IND MSC AND THE EXCAVATION LIMIT HAS BEEN SHOWN TO END A THIS LOCATION. FINAL CONFIRMATION SAMPLES WILL BE USED TO VERIFY THE LIMITS OF THE EXCAVATION MEET THE SOIL CLEANUP LEVELS.
5. THE DEEP EXCAVATION WILL BE COMPLETED TO THE GROUNDWATER TABLE WHICH MAY VARY FROM THE 14–FT DEPTH SHOWN ON THIS FIGURE.

SOIL SAMPLE COLLECTION SUMMARY:

1. SHAW, 2010: BORINGS 29SB81–29SB85 EXPLOSIVES; 29SB86–29SB89 PERCHLORATE
2. STEP, PLANT–WIDE PERCHLORATE INVESTIGATION, 2005: ALL LOCATIONS IDENTIFIED WITH "STEP" IN NAME.
3. AECOM, 2014: BORINGS 29SB90–29SB117

HDR

EXCAVATION AREA E-3 SOIL SAMPLE RESULTS

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
2–3

29SB176	
	14.5-15 ft
2,4-DNT	**3.2**
2,6-DNT	**1.1**

29SB118				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	<0.196	<0.202	<0.203	<0.200
2,4-DNT	**0.258**	<0.202	<0.203	**0.132**
2,6-DNT	<0.196	<0.202	<0.203	<0.200

29SB175				
	3-4 ft	6-7 ft	11-12 ft	14.5-15 ft
2,4-DNT	**0.057**	<0.047	<0.047	<0.049
2,6-DNT	<0.049	<0.047	<0.047	<0.049

29SB121				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	0.014	<0.015	<0.014	<0.015
2,4-DNT	**0.068J**	0.0081	<0.027	0.0096
2,6-DNT	<0.028	0.02	<0.027	0.023

29SB182	
	14.5-15 ft
2,4-DNT	<0.048
2,6-DNT	<0.048

29SB123				
	2-3 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	<0.015	<0.014	<0.014	0.0066
2,4-DNT	0.012	<0.028	<0.028	<0.028
2,6-DNT	<0.029	<0.028	<0.028	**0.047**

29SB174				
	3-4 ft	6-7 ft	11-12 ft	14.5-15 ft
2,4-DNT	<0.047	<0.048	<0.049	<0.049
2,6-DNT	<0.047	<0.048	<0.049	<0.049

29SB181	
	14.5-15 ft
2,4-DNT	**1.9**
2,6-DNT	**0.74**

29SB173				
	3-4 ft	6-7 ft	11-12 ft	14.5-15 ft
2,4-DNT	<0.048	<0.048	<0.048	**1.6**
2,6-DNT	<0.048	<0.048	<0.048	**0.58**

29SB124				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	<0.193	<0.196	<0.208	<0.203
2,4-DNT	<0.193	<0.196	<0.208	**5.78**
2,6-DNT	<0.193	<0.196	<0.208	**1.13**

29SB180	
	14.5-15 ft
2,4-DNT	**0.56**
2,6-DNT	**0.072**

29SB125				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	<0.200	<0.204	<0.201	<0.208
2,4-DNT	<0.200	**0.201**	<0.201	**0.3**
2,6-DNT	<0.200	<0.204	<0.201	<0.208

29SB119				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	1.04	<0.201	<0.205	<0.196
2,4-DNT	**0.647**	<0.201	**0.548**	**0.763**
2,6-DNT	**0.0996**	<0.201	<0.205	**0.683**

29SB167				
	3-4 ft	6-7 ft	11-12 ft	14.5-15 ft
2,4-DNT	**0.2**	<0.049	<0.048	<0.047
2,6-DNT	<0.049	<0.049	<0.048	<0.047

29SB177	
	14.5-15 ft
2,4-DNT	**2.2**
2,6-DNT	**0.51**

29SB168				
	3-4 ft	6-7 ft	11-12 ft	14.5-15 ft
2,4-DNT	**1**	**5.1**	**31**	**0.19**
2,6-DNT	**0.1**	**0.47**	**4.8**	<0.047

29SB120				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	<0.197	0.296	<0.194	<0.207
2,4-DNT	**0.581**	**0.746**	**2.12**	**0.571**
2,6-DNT	<0.197	<0.201	**0.45**	**0.135**

29SB178	
	14.5-15 ft
2,4-DNT	**0.19**
2,6-DNT	<0.048

29SB169				
	3-4 ft	6-7 ft	11-12 ft	14.5-15 ft
2,4-DNT	<0.048	**0.76**	**0.14**	**0.11**
2,6-DNT	<0.048	<0.050	<0.048	<0.047

29SB170				
	3-4 ft	6-7 ft	11-12 ft	14.5-15 ft
2,4-DNT	<0.049	**0.37**	<0.049	**0.079**
2,6-DNT	<0.049	<0.047	<0.049	<0.048

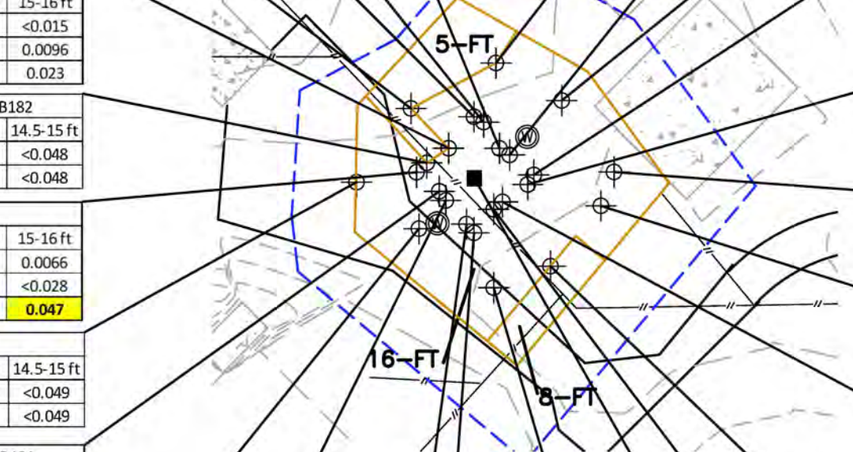
29SB122				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	<0.199	<0.196	<0.206	<0.198
2,4-DNT	**0.418**	**0.43**	**0.609**	**4.78**
2,6-DNT	<0.199	<0.196	<0.206	**0.318**

29SB171				
	3-4 ft	6-7 ft	11-12 ft	14.5-15 ft
2,4-DNT	<0.049	**0.066**	<0.049	<0.048
2,6-DNT	<0.049	<0.050	<0.049	<0.048

29SB179	
	14.5-15 ft
2,4-DNT	**0.27**
2,6-DNT	<0.050

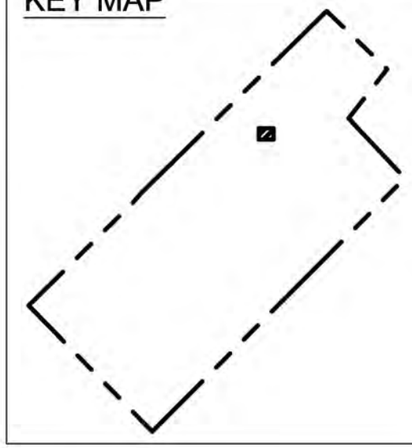
29SG118		
	6 ft	10 ft
2,4-DNT	**0.138**	**17.10**
2,6-DNT	<0.379	**3.42**

29SB172				
	3-4 ft	6-7 ft	11-12 ft	14.5-15 ft
2,4-DNT	<0.048	<0.047	<0.048	<0.049
2,6-DNT	<0.048	<0.047	<0.048	**0.11**



N

KEY MAP



LEGEND:

- SITE BOUNDARY
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING UNPAVED ROAD
- COOLING WATER BUILDING SERVICE PIPE
- CONCRETE BUILDING FOUNDATION
- HISTORIC SAMPLE LOCATION
- 2021/2022 PDI SAMPLE LOCATION
- MONITORING WELL
- EXCAVATION LIMIT
- EXCAVATION TOP OF SLOPE

NOTES:

1. SAMPLE RESULTS ARE SHOWN IN MG/KG.
2. SOIL CLEANUP STANDARD FOR EXPLOSIVE COMPOUNDS ARE AS FOLLOWS:
   - 2.1. 2,4,6-TNT = 4.7 MG/KG (0-3 FT BGS); 5.1 MG/KG (>3 FT BGS)
   - 2.2. 2,4-DNT = 0.042 MG/KG
   - 2.3. 2,6-DNT = 0.042 MG/KG
3. SAMPLES EXCEEDING THE SOIL CLEANUP STANDARD HAVE BEEN HIGHLIGHTED IN YELLOW AND BOLDED.
4. ONLY CONTAMINANTS WITH DETECTIONS ABOVE THE CLEANUP STANDARD ARE SHOWN ON THIS PLAN.
5. THE DEEP EXCAVATION IN THIS AREA WILL END AT THE GROUNDWATER TABLE WHICH IS ESTIMATED TO BE 16-FT BGS BUT MAY VARY FROM THAT SHOWN.

SOIL SAMPLE COLLECTION SUMMARY:

1. HDR, 2022: BORINGS 29SB118-29SB204

0 40' 80'

SCALE: 1" = 40'

HDR

EXCAVATION AREA E-4
SOIL SAMPLE RESULTS

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
2-4

29SB185				
	3-4 ft	7-8 ft	11-12 ft	13.5-14 ft
2,4,6-TNT	<0.048	<0.048	<0.048	<0.049
2,4-DNT	<0.048	<0.048	<0.048	<0.049
2,6-DNT	<0.048	<0.048	<0.048	<0.049

29SB126				
	1-2 ft	3-4 ft	5-6 ft	7-8 ft
2,4,6-TNT	<0.197	0.011	<0.015	<0.204
2,4-DNT	<0.197	0.0088	<0.029	<0.204
2,6-DNT	**0.178**	0.022	<0.029	<0.204

29SB129				
	1-2 ft	3-4 ft	5-6 ft	7-8 ft
2,4,6-TNT	<0.205	**5.13**	**22**	2.72
2,4-DNT	<0.205	**1.45**	**180**	**6.7**
2,6-DNT	<0.205	**21.3**	**130**	**58.3**

29SB183		
	1-2 ft	3-4 ft
2,4,6-TNT	<0.049	<0.048
2,4-DNT	<0.049	<0.048
2,6-DNT	<0.049	<0.048

29SB184				
	3-4 ft	7-8 ft	11-12 ft	13.5-14 ft
2,4,6-TNT	<0.050	<0.050	<0.047	<0.047
2,4-DNT	<0.050	<0.050	<0.047	<0.047
2,6-DNT	<0.050	<0.050	<0.047	<0.047

29SD30	
	0-0.5 ft
2,4,6-TNT	<0.1

29SB113	
	0-0.5 ft
2,4,6-TNT	NA
2,4-DNT	0.022
2,6-DNT	0.0365

29SB111	
	0-0.5 ft
2,4,6-TNT	<0.193
2,4-DNT	<0.0284
2,6-DNT	<0.0284

29SB112		
	0-0.5 ft	2-4 ft
2,4,6-TNT	<0.202	<0.202
2,4-DNT	**0.0544**	<0.0596
2,6-DNT	**0.0862**	**0.0704**

29SD46	
	0-0.5 ft
2,4,6-TNT	**26,000**
2,4-DNT	**8,000**
2,6-DNT	**15**

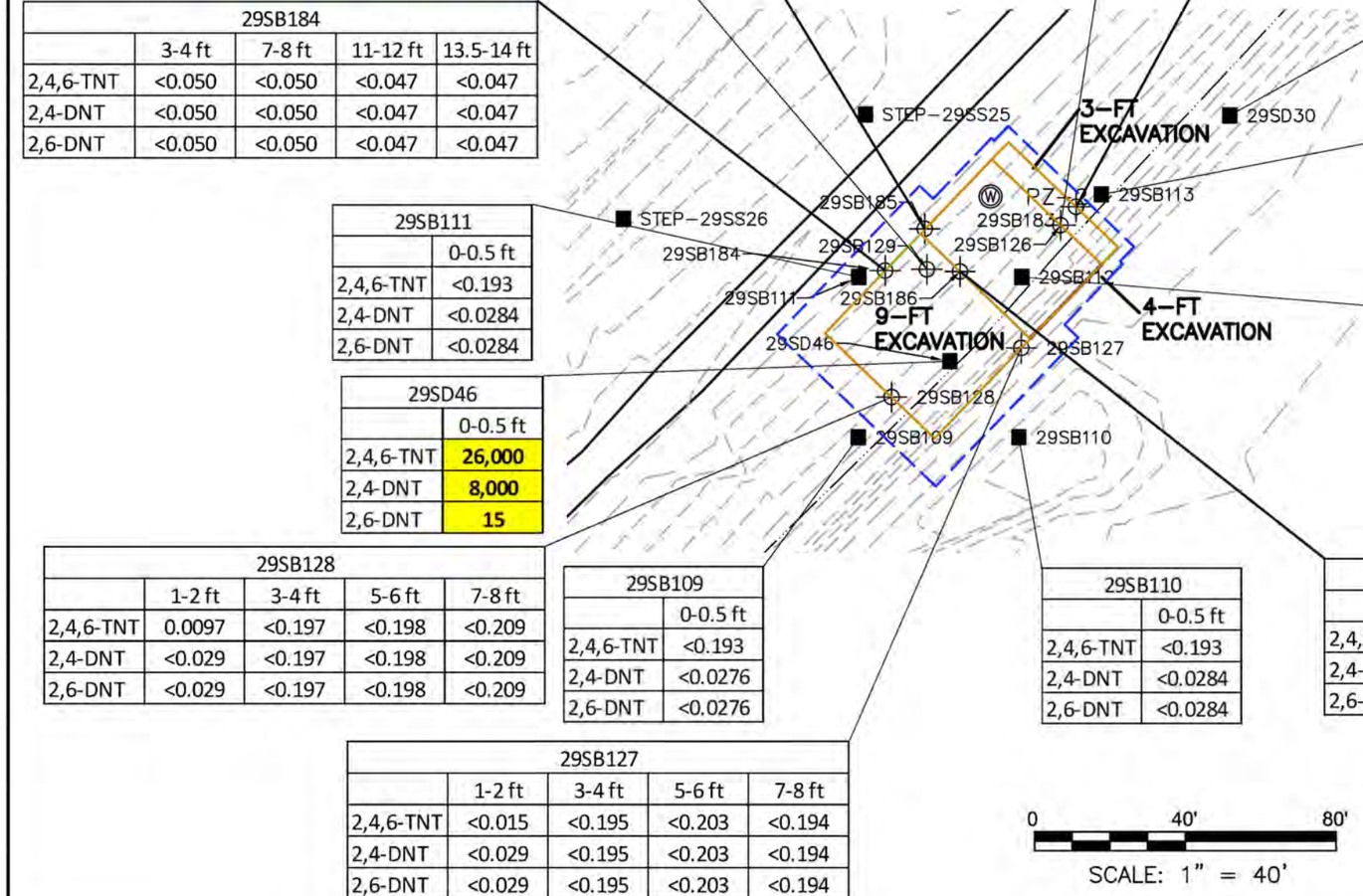
29SB128				
	1-2 ft	3-4 ft	5-6 ft	7-8 ft
2,4,6-TNT	0.0097	<0.197	<0.198	<0.209
2,4-DNT	<0.029	<0.197	<0.198	<0.209
2,6-DNT	<0.029	<0.197	<0.198	<0.209

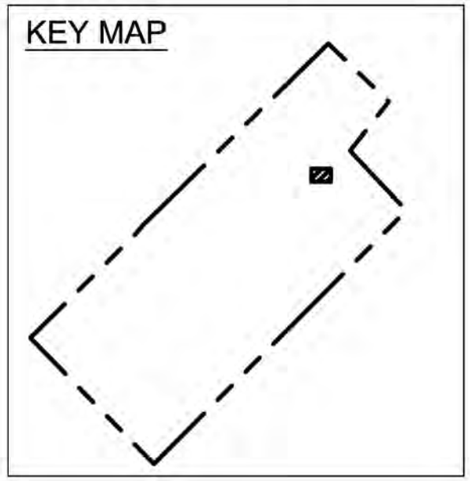
29SB109	
	0-0.5 ft
2,4,6-TNT	<0.193
2,4-DNT	<0.0276
2,6-DNT	<0.0276

29SB110	
	0-0.5 ft
2,4,6-TNT	<0.193
2,4-DNT	<0.0284
2,6-DNT	<0.0284

29SB186			
	9-10 ft	11-12 ft	13.5-14 ft
2,4,6-TNT	<0.047	<0.049	<0.047
2,4-DNT	<0.047	<0.049	<0.047
2,6-DNT	<0.047	<0.049	<0.047

29SB127				
	1-2 ft	3-4 ft	5-6 ft	7-8 ft
2,4,6-TNT	<0.015	<0.195	<0.203	<0.194
2,4-DNT	<0.029	<0.195	<0.203	<0.194
2,6-DNT	<0.029	<0.195	<0.203	<0.194





N

LEGEND:

- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- WATER EDGE
- CONCRETE BUILDING FOUNDATION
- HISTORIC SAMPLE LOCATION
- 2021/2022 PDI SAMPLE LOCATION
- MONITORING WELL
- HISTORIC WASTELINE/PIPE SAMPLE LOCATION
- EXCAVATION LIMIT
- EXCAVATION TOP OF SLOPE

NOTES:

1. SAMPLE RESULTS ARE SHOWN IN MG/KG.
2. SOIL CLEANUP STANDARD FOR EXPLOSIVE COMPOUNDS ARE AS FOLLOWS:
   2.1. 2,4,6–TNT = 4.7 MG/KG (0–3 FT BGS); 5.1 MG/KG (>3 FT BGS)
   2.2. 2,4–DNT = 0.042 MG/KG
   2.3. 2,6–DNT = 0.042 MG/KG
3. SAMPLES EXCEEDING THE SOIL CLEANUP STANDARD HAVE BEEN HIGHLIGHTED IN YELLOW AND BOLDED.
4. SAMPLE LOCATIONS LABELED AS "STEP" WERE SAMPLES COLLECTED FOR PERCHLORATE ANALYSIS. RESULTS ARE NOT SHOWN ON THIS FIGURE.
5. SAMPLE RESULTS FOR 29SD46, AND 29SD30 WERE TAKEN FROM FIGURES 4–5 AND 4–6 OF THE DRAFT SITE DATA SUMMARY REPORT PREPARED BY SHAW ENVIRONMENTAL, INC, DATED JUNE 2005 INCLUDED AS AN APPENDIX TO THE FINAL ADDENDUM 6, ADDITIONAL INVESTIGATION AT LHAAP–29, TO FINAL INSTALLATION–WIDE WORK PLAN PREPARED BY SHAW IN AUGUST 2006 (SHAW, 2006).

SOIL SAMPLE COLLECTION SUMMARY:

1. AECOM, 2014: BORINGS 29SB90–29SB117
2. HDR 2022: BORINGS 29SB118–29SB204

0 40' 80'

SCALE: 1" = 40'

HDR

EXCAVATION AREA E-5 SOIL SAMPLE RESULTS

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
2–5

29SB189			
	0-2 ft	5-7 ft	10-10.5 ft
2,4,6-TNT	<0.047	<0.049	<0.047
2,4-DNT	<0.047	<0.049	<0.047
2,6-DNT	<0.047	<0.049	<0.047

29SB117		
	0-0.5 ft	2-4 ft
2,4,6-TNT	<0.202	NA
2,4-DNT	<0.52	<0.536
2,6-DNT	<0.52	<0.536

29SB130				
	1-2 ft	3-4 ft	5-6 ft	7-8 ft
2,4,6-TNT	<0.014	<0.196	<0.199	<0.197
2,4-DNT	<0.029	<0.196	<0.199	<0.197
2,6-DNT	<0.029	<0.196	<0.199	<0.197

29SB133				
	1-2 ft	3-4 ft	5-6 ft	7-8 ft
2,4,6-TNT	<0.193	<0.196	<0.203	<0.206
2,4-DNT	<0.193	<0.196	<0.203	<0.206
2,6-DNT	<0.193	<0.196	<0.203	<0.206

29SB116	
	0-0.5 ft
2,4,6-TNT	<0.199
2,4-DNT	<0.0304
2,6-DNT	<0.0304

29SD13	
	0-0.5 ft
2,4,6-TNT	**51**

29SB132				
	1-2 ft	3-4 ft	5-6 ft	7-8 ft
2,4,6-TNT	<0.015	<0.192	<0.201	<0.202
2,4-DNT	<0.029	<0.192	<0.201	<0.202
2,6-DNT	<0.029	<0.192	<0.201	<0.202

29SB114	
	0-0.5 ft
2,4,6-TNT	<0.185
2,4-DNT	<0.0248
2,6-DNT	<0.0248

29SB131				
	1-2 ft	3-4 ft	5-6 ft	7-8 ft
2,4,6-TNT	<0.197	<0.201	<0.210	<0.200
2,4-DNT	<0.197	<0.210	<0.210	<0.200
2,6-DNT	<0.197	<0.210	<0.210	<0.200

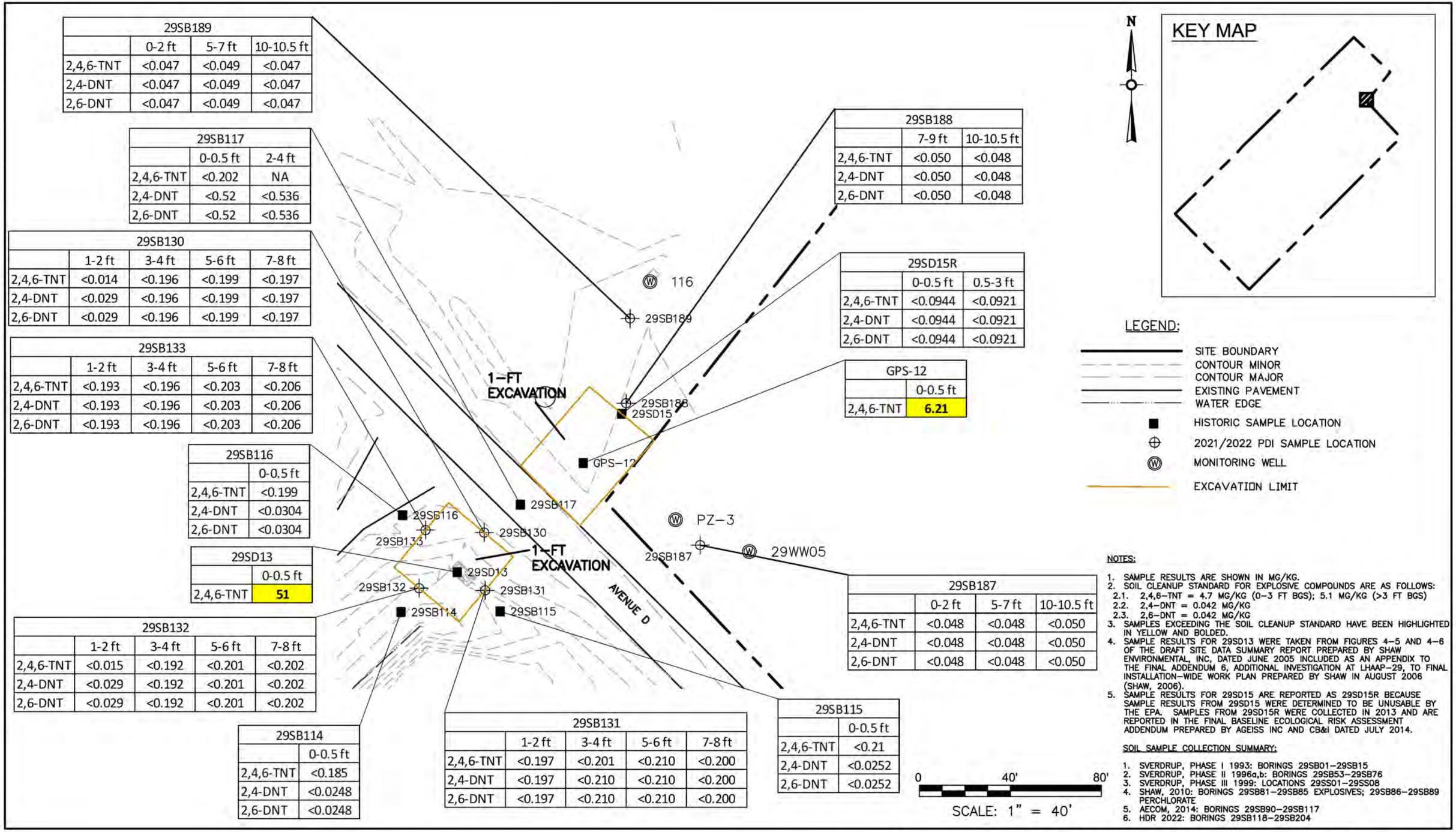
29SB115	
	0-0.5 ft
2,4,6-TNT	<0.21
2,4-DNT	<0.0252
2,6-DNT	<0.0252

29SB188		
	7-9 ft	10-10.5 ft
2,4,6-TNT	<0.050	<0.048
2,4-DNT	<0.050	<0.048
2,6-DNT	<0.050	<0.048

29SD15R		
	0-0.5 ft	0.5-3 ft
2,4,6-TNT	<0.0944	<0.0921
2,4-DNT	<0.0944	<0.0921
2,6-DNT	<0.0944	<0.0921

GPS-12	
	0-0.5 ft
2,4,6-TNT	**6.21**

29SB187			
	0-2 ft	5-7 ft	10-10.5 ft
2,4,6-TNT	<0.048	<0.048	<0.050
2,4-DNT	<0.048	<0.048	<0.050
2,6-DNT	<0.048	<0.048	<0.050



LEGEND:

- SITE BOUNDARY
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- WATER EDGE
- HISTORIC SAMPLE LOCATION
- 2021/2022 PDI SAMPLE LOCATION
- MONITORING WELL
- EXCAVATION LIMIT

NOTES:

1. SAMPLE RESULTS ARE SHOWN IN MG/KG.
2. SOIL CLEANUP STANDARD FOR EXPLOSIVE COMPOUNDS ARE AS FOLLOWS:
   - 2.1. 2,4,6-TNT = 4.7 MG/KG (0-3 FT BGS); 5.1 MG/KG (>3 FT BGS)
   - 2.2. 2,4-DNT = 0.042 MG/KG
   - 2.3. 2,6-DNT = 0.042 MG/KG
3. SAMPLES EXCEEDING THE SOIL CLEANUP STANDARD HAVE BEEN HIGHLIGHTED IN YELLOW AND BOLDED.
4. SAMPLE RESULTS FOR 29SD13 WERE TAKEN FROM FIGURES 4-5 AND 4-6 OF THE DRAFT SITE DATA SUMMARY REPORT PREPARED BY SHAW ENVIRONMENTAL, INC, DATED JUNE 2005 INCLUDED AS AN APPENDIX TO THE FINAL ADDENDUM 6, ADDITIONAL INVESTIGATION AT LHAAP-29, TO FINAL INSTALLATION-WIDE WORK PLAN PREPARED BY SHAW IN AUGUST 2006 (SHAW, 2006).
5. SAMPLE RESULTS FOR 29SD15 ARE REPORTED AS 29SD15R BECAUSE SAMPLE RESULTS FROM 29SD15 WERE DETERMINED TO BE UNUSABLE BY THE EPA. SAMPLES FROM 29SD15R WERE COLLECTED IN 2013 AND ARE REPORTED IN THE FINAL BASELINE ECOLOGICAL RISK ASSESSMENT ADDENDUM PREPARED BY AGEISS INC AND CB&I DATED JULY 2014.

SOIL SAMPLE COLLECTION SUMMARY:

1. SVERDRUP, PHASE I 1993: BORINGS 29SB01-29SB15
2. SVERDRUP, PHASE II 1996a,b: BORINGS 29SB53-29SB76
3. SVERDRUP, PHASE III 1999: LOCATIONS 29SS01-29SS08
4. SHAW, 2010: BORINGS 29SB81-29SB85 EXPLOSIVES; 29SB86-29SB89 PERCHLORATE
5. AECOM, 2014: BORINGS 29SB90-29SB117
6. HDR 2022: BORINGS 29SB118-29SB204

0 40' 80'

SCALE: 1" = 40'

EXCAVATION AREA E-6
SOIL SAMPLE RESULTS
LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
2-6

29CPT16	
8/18/2014	85 ft bgs
1,1-DICHLOROETHANE	<0.25 U
1,1-DICHLOROETHENE	<1 U
1,2-DICHLOROETHANE	<0.5 U
BROMODICHLOROMETHANE	<0.5 U
CARBON DISULFIDE	<1 U
CHLOROMETHANE	<1 U
CIS-1,2-DICHLOROETHENE	<0.5 U
CIS-1,3-DICHLOROPROPENE	<0.5 U
METHYLENE CHLORIDE	<0.5 U
TRICHLOROETHENE	<0.5 U
VINYL CHLORIDE	<0.5 U

29CPT05	
7/10/2014	73 ft bgs
1,1-DICHLOROETHANE	97.6
1,1-DICHLOROETHENE	3.77 J
1,2-DICHLOROETHANE	0.617 J
BROMODICHLOROMETHANE	<1 U
CARBON DISULFIDE	<2 U
CHLOROMETHANE	63.6 J
CIS-1,2-DICHLOROETHENE	34.2
CIS-1,3-DICHLOROPROPENE	<1 U
METHYLENE CHLORIDE	**285,000**
TRICHLOROETHENE	**508**
VINYL CHLORIDE	1.92 J

29CPT02		
6/26/2014	63 FT BGS	80 FT BGS
1,1-DICHLOROETHANE	<0.25 U	<0.25 U
1,1-DICHLOROETHENE	<1 U	<1 U
1,2-DICHLOROETHANE	<0.5 U	<0.5 UJ
BROMODICHLOROMETHANE	<0.5 U	<0.5 UJ
CARBON DISULFIDE	<1 U	<1 UJ
CHLOROMETHANE	<1 U	<1 UJ
CIS-1,2-DICHLOROETHENE	<0.5 U	<0.5 UJ
CIS-1,3-DICHLOROPROPENE	<0.5 U	<0.5 UJ
METHYLENE CHLORIDE	<0.5 U	<0.5 UJ
TRICHLOROETHENE	<0.5 U	<0.5 UJ
VINYL CHLORIDE	<0.5 U	<0.5 UJ

29CPT15	
8/12/2014	85 ft bgs
1,1-DICHLOROETHANE	54 J
1,1-DICHLOROETHENE	<200 U
1,2-DICHLOROETHANE	<100 U
BROMODICHLOROMETHANE	<100 U
CARBON DISULFIDE	<200 U
CHLOROMETHANE	<200 U
CIS-1,2-DICHLOROETHENE	<100 U
CIS-1,3-DICHLOROPROPENE	<100 U
METHYLENE CHLORIDE	**36,400**
TRICHLOROETHENE	**138**
VINYL CHLORIDE	<100 U

29WW44	
10/20/2014	77.5-87.1 FT
1,1-DICHLOROETHANE	23 J
1,1-DICHLOROETHENE	1.69 J
1,1-DICHLOROPROPENE	<0.5 U
1,2-DICHLOROETHANE	<0.5 U
BROMOCHLOROMETHANE	1.24
CHLOROMETHANE:	8.73
CIS-1,2-DICHLOROETHENE	11.1
METHYLENE CHLORIDE	**11,500**
TRICHLOROETHENE	**135**
VINYL CHLORIDE	0.388 J

29CPT12	
7/23/2014	85 ft bgs
1,1-DICHLOROETHANE	820 J
1,1-DICHLOROETHENE	<1000 U
1,2-DICHLOROETHANE	<500 U
BROMODICHLOROMETHANE	<500 U
CARBON DISULFIDE	**2,760**
CHLOROMETHANE	**614**
CIS-1,2-DICHLOROETHENE	<500 U
CIS-1,3-DICHLOROPROPENE	<500 U
METHYLENE CHLORIDE	**2,350,000**
TRICHLOROETHENE	**1,210**
VINYL CHLORIDE	<500 U

29CPT03	
6/25/2014	80 ft bgs
1,1-DICHLOROETHANE	<0.626 U
1,1-DICHLOROETHENE	<2.5 U
1,2-DICHLOROETHANE	<1.25 U
BROMODICHLOROMETHANE	<1.25 U
CARBON DISULFIDE	<2.5 U
CHLOROMETHANE	1.77 J
CIS-1,2-DICHLOROETHENE	<1.25 U
CIS-1,3-DICHLOROPROPENE	<1.25 U
METHYLENE CHLORIDE	<1.25 U
TRICHLOROETHENE	<1.25 U
VINYL CHLORIDE	<1.25 U

29WW43	
10/20/2014	77.5-87.1 FT
1,1-DICHLOROETHANE	114
1,1-DICHLOROETHENE	<1 U
1,1-DICHLOROPROPENE	<0.5 U
1,2-DICHLOROETHANE	0.439 J
BROMOCHLOROMETHANE	12.5
CHLOROMETHANE	10.2
CIS-1,2-DICHLOROETHENE	10.2
METHYLENE CHLORIDE	**279,000**
TRICHLOROETHENE	**34.1**
VINYL CHLORIDE	0.991 J

29CPT14	
8/6/2014	85 ft bgs
1,1-DICHLOROETHANE	<50 U
1,1-DICHLOROETHENE	<200 U
1,2-DICHLOROETHANE	<100 U
BROMODICHLOROMETHANE	<100 U
CARBON DISULFIDE	<200 U
CHLOROMETHANE	<200 U
CIS-1,2-DICHLOROETHENE	<100 U
CIS-1,3-DICHLOROPROPENE	<100 U
METHYLENE CHLORIDE	**54,600**
TRICHLOROETHENE	<100 U
VINYL CHLORIDE	<100 U

29CPT06	
7/11/2014	88 ft bgs
1,1-DICHLOROETHANE	2.73
1,1-DICHLOROETHENE	<1 U
1,2-DICHLOROETHANE	<0.5 U
BROMODICHLOROMETHANE	<0.5 U
CARBON DISULFIDE	<1 U
CHLOROMETHANE	<1 U
CIS-1,2-DICHLOROETHENE	<0.5 U
CIS-1,3-DICHLOROPROPENE	<0.5 U
METHYLENE CHLORIDE	**63.8**
TRICHLOROETHENE	0.262 J
VINYL CHLORIDE	<0.5 U

29CPT13	
7/27/2014	85 ft bgs
1,1-DICHLOROETHANE	<1.25 U
1,1-DICHLOROETHENE	<5 U
1,2-DICHLOROETHANE	<2.5 U
BROMODICHLOROMETHANE	<2.5 U
CARBON DISULFIDE	<5 U
CHLOROMETHANE	<5 U
CIS-1,2-DICHLOROETHENE	<2.5 U
CIS-1,3-DICHLOROPROPENE	<2.5 U
METHYLENE CHLORIDE	**1,400**
TRICHLOROETHENE	<2.5 U
VINYL CHLORIDE	<2.5 U

29CPT07	
7/1/2014	87 ft bgs
1,1-DICHLOROETHANE	<0.25 U
1,1-DICHLOROETHENE	<1 U
1,2-DICHLOROETHANE	<0.5 U
BROMODICHLOROMETHANE	<0.5 U
CARBON DISULFIDE	<1 U
CHLOROMETHANE	<1 U
CIS-1,2-DICHLOROETHENE	<0.5 U
CIS-1,3-DICHLOROPROPENE	<0.5 U
METHYLENE CHLORIDE	<0.5 U
TRICHLOROETHENE	<0.5 U
VINYL CHLORIDE	<0.5 U

29CPT17	
8/20/2014	85 ft bgs
1,1-DICHLOROETHANE	59
1,1-DICHLOROETHENE	<1 U
1,2-DICHLOROETHANE	<0.5 U
BROMODICHLOROMETHANE	<0.5 U
CARBON DISULFIDE	<1 UJ
CHLOROMETHANE	6.2
CIS-1,2-DICHLOROETHENE	3.7
CIS-1,3-DICHLOROPROPENE	<0.5 U
METHYLENE CHLORIDE	**261,000**
TRICHLOROETHENE	**15.3**
VINYL CHLORIDE	0.553 J

29CPT18	
9/19/2014	75 ft bgs
1,1 DICHLOROETHANE	<0.25 U
1,1-DICHLOROLETHENE	<1 U
1,2-DICHLOROETHANE	<0.5 U
BROMODICHLOROMETHANE	<0.5 U
CARBON DISULFIDE	<1 U
CHLOROMETHANE	<1 U
CIS 1,2 DICHLOROETHENE	<0.5 U
CIS 1,3-DICHLOROPROPENE	<0.5 U
METHYLENE CHLORIDE	<0.5 U
TRICHLOROETHENE	<0.5 U
VINYL CHLORIDE	<0.5 U

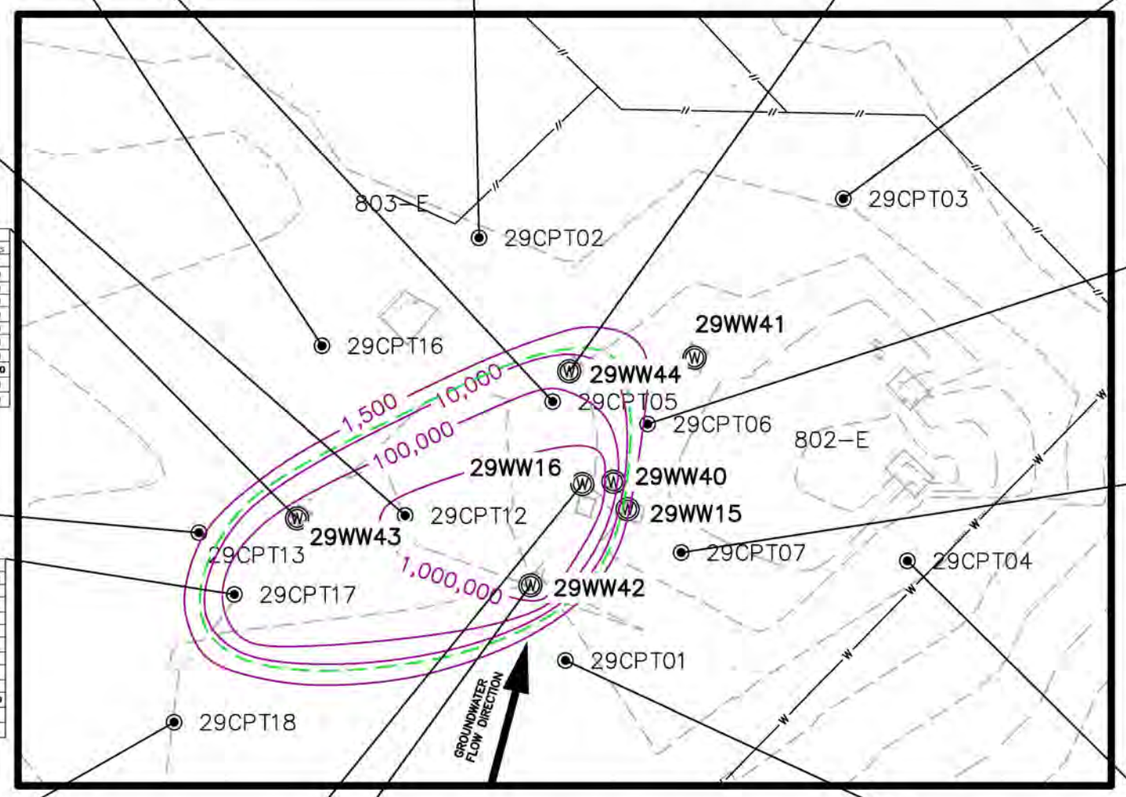
29WW16	
10/14/2014	78-88 FT
1,1-DICHLOROETHANE	4,320 J
1,1-DICHLOROETHENE:	<25,000 U
1,1-DICHLOROPROPENE	<12,500 U
1,2-DICHLOROETHANE	<12,500 U
BROMOCHLOROMETHANE	**6,330**
CHLOROMETHANE	<25,000 U
CIS-1,2-DICHLOROETHENE	<12,500 U
METHYLENE CHLORIDE	**8,280,000**
TRICHLOROETHENE	**28,100**
VINYL CHLORIDE	<12,500 U

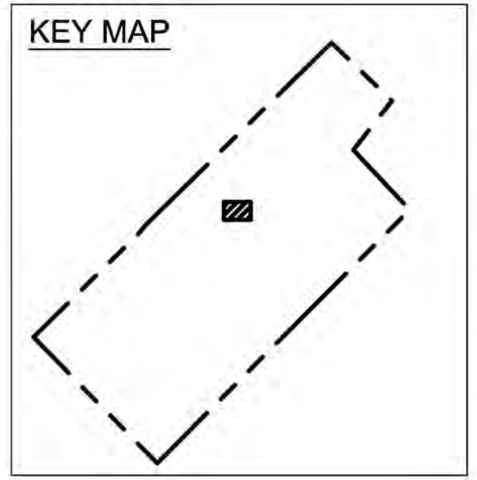
29WW42	
10/20/2014	77.5-87.1 FT
1,1-DICHLOROETHANE	1,140
1,1-DICHLOROETHENE	**68.2**
1,1-DICHLOROPROPENE	**13.3**
1,2-DICHLOROETHANE	4.81
BROMOCHLOROMETHANE	100
CHLOROMETHANE	**333**
CIS-1,2-DICHLOROETHENE	**319**
METHYLENE CHLORIDE	**1,380,000**
TRICHLOROETHENE	**4,300**
VINYL CHLORIDE	**18**

29CPT11	
7/14/2014	80 ft bgs
1,1-DICHLOROETHANE	721
1,1-DICHLOROETHENE:	**48.1**
1,2-DICHLOROETHANE	1.38
BROMODICHLOROMETHANE	<0.5 U
CARBON DISULFIDE	<1 U
CHLOROMETHANE	26.8 J
CIS-1,2-DICHLOROETHENE	**183**
CIS-1,3-DICHLOROPROPENE	<0.5 U
METHYLENE CHLORIDE	**132,000**
TRICHLOROETHENE	**3,380**
VINYL CHLORIDE	**9.2**

29CPT01	
6/30/2014	85 ft bgs
1,1-DICHLOROETHANE	<0.25 U
1,1-DICHLOROETHENE	<1 U
1,2-DICHLOROETHANE	<0.5 U
BROMODICHLOROMETHANE	<0.5 U
CARBON DISULFIDE	<1 U
CHLOROMETHANE	<1 U
CIS-1,2-DICHLOROETHENE	<0.5 U
CIS-1,3-DICHLOROPROPENE	<0.5 U
METHYLENE CHLORIDE	<0.5 U
TRICHLOROETHENE	<0.5 U
VINYL CHLORIDE	<0.5 U

29CPT04	
6/23/2014	87 ft bgs
1,1-DICHLOROETHANE	<0.25 U
1,1-DICHLOROETHENE	<1 U
1,2-DICHLOROETHANE	<0.5 U
BROMODICHLOROMETHANE	<0.5 U
CARBON DISULFIDE	<1 U
CHLOROMETHANE	<1 U
CIS-1,2-DICHLOROETHENE	<0.5 U
CIS-1,3-DICHLOROPROPENE	<0.5 U
METHYLENE CHLORIDE	<0.5 U
TRICHLOROETHENE	<0.5 U
VINYL CHLORIDE	<0.5 U





N

LEGEND:

- CONTOUR MINOR
- CONTOUR MAJOR
- W — COOLING WATER MAIN PIPE – ASSUMED 18"
- // — COOLING WATER BUILDING SERVICE PIPE
- CONCRETE BUILDING FOUNDATION
- (W) MONITORING WELL
- CONTINUOUS CONE PENETROMETER (CPT) / MEMBRANE INTERFACE PROBE (MIP) LOCATION
- GROUNDWATER MC ISO-CONCENTRATION CONTOURS
- ISTD TREATMENT AREA

NOTES:

1. SAMPLES WERE COLLECTED BY AECOM IN 2014.
2. METHYLENE CHLORIDE (MC) SAMPLE RESULTS ARE SHOWN IN UG/L.
3. SAMPLE RESULTS SHOWN IN BOLD EXCEED THE FEDERAL MAXIMUM CONTAMINANT LEVEL (MCL)/TEXAS RISK REDUCTION PROGRAM TIER 1 PROTECTIVE CONCENTRATION LEVEL FOR RESIDENTIAL GROUNDWATER (PCL).
4. MC ISO-CONCENTRATIONS ARE SHOWN IN UG/L.
5. LOCATION OF UNDERGROUND PIPES ARE APPROXIMATE.
6. DATA QUALIFIERS STAND FOR:
   - 6.1. J – ESTIMATED VALUE
   - 6.2. UJ – ESTIMATED VALUE BELOW THE DETECTION LIMIT
   - 6.3. U – VALUE IS BELOW THE DETECTION LIMIT

0 40' 80'

SCALE: 1" = 40'

HDR

ISTD TREATMENT AREA AND GROUNDWATER SAMPLE RESULTS

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
3-1

29CPT16			
	1,2-DCA	MC	TCE
56 FT	<1.11 U	<2.22 U	<1.11 U
76 FT	<1.3 U	4.53 J	<1.3 U

29CPT05			
	1,2-DCA	MC	TCE
72 FT	<125 U	**7,610**	<125 U
76 FT	<1410 U	**257,000**	2,430
80 FT	<1.33 U	8.51	<1.33 U
88 FT	<5.56 U	146	<5.56 U

29CPT02		
	MC	TCE
60 FT	<2.48 U	<1.24 U
71 FT	<2.54 U	<1.27 U
84 FT	<2.54 U	<1.27 U

29CPT15			
	1,2-DCA	MC	TCE
40 FT	<1.26 UJ	<2.52 UJ	<1.26 UJ
76 FT	<142 U	**29,500**	2,230

29CPT03		
	MC	TCE
70 FT	<2.42 U	<1.21 U
74 FT	<2.38 U	<1.19 U
88 FT	<2.64 U	<1.32 U

29CPT12			
	1,2-DCA	MC	TCE
82 FT	<1470 UJ	<2,940 UJ	<1470 UJ
88 FT	<6.22 U	**937**	<6.22 U

29CPT06		
	MC	TCE
8 FT	<2.3 U	<1.15 U
72 FT	<2.36 U	<1.18 U
78 FT	1.56 J	<1.32 U
84 FT	<2.56 U	<1.28 U

29CPT14			
	1,2-DCA	MC	TCE
2 FT	<1.25 U	7.95	<1.25 U
16 FT	**1,130**	30.2 J	14.6 J
21 FT	**3,880**	35.7 J	485
38 FT	<1.27 U	1.96 J	<1.27 U
50 FT	<1.2 U	2.18 J	<1.2 U
82 FT	<1.26 U	3.46 J	<1.26 U
88 FT	<1.21 U	60.2	<1.21 U

29CPT04		
	MC	TCE
40 FT	<2.52 U	<1.26 U
45 FT	<2.46 U	<1.23 U
50 FT	<2.32 U	<1.16 U
54 FT	<2.36 U	<1.18 U
56 FT	<2.48 U	<1.24 U
61 FT	<2.48 U	<1.24 U
64 FT	<2.38 U	<1.19 U
66 FT	<2.52 U	<1.26 U
70 FT	<2.22 U	<1.11 UJ
74 FT	<2.24 U	<1.12 UJ
78 FT	<2.34 U	<1.17 U
84 FT	<2.2 U	<1.1 UJ
86 FT	<2.58 U	<1.29 U
88 FT	<2.36 U	<1.18 U

29CPT13			
	1,2-DCA	MC	TCE
14 FT	17.2 J	<12.5 U	87.6
18 FT	26.3	5.04 J	4.09 J
44 FT	<1.15 U	5.68 J	<1.15 U

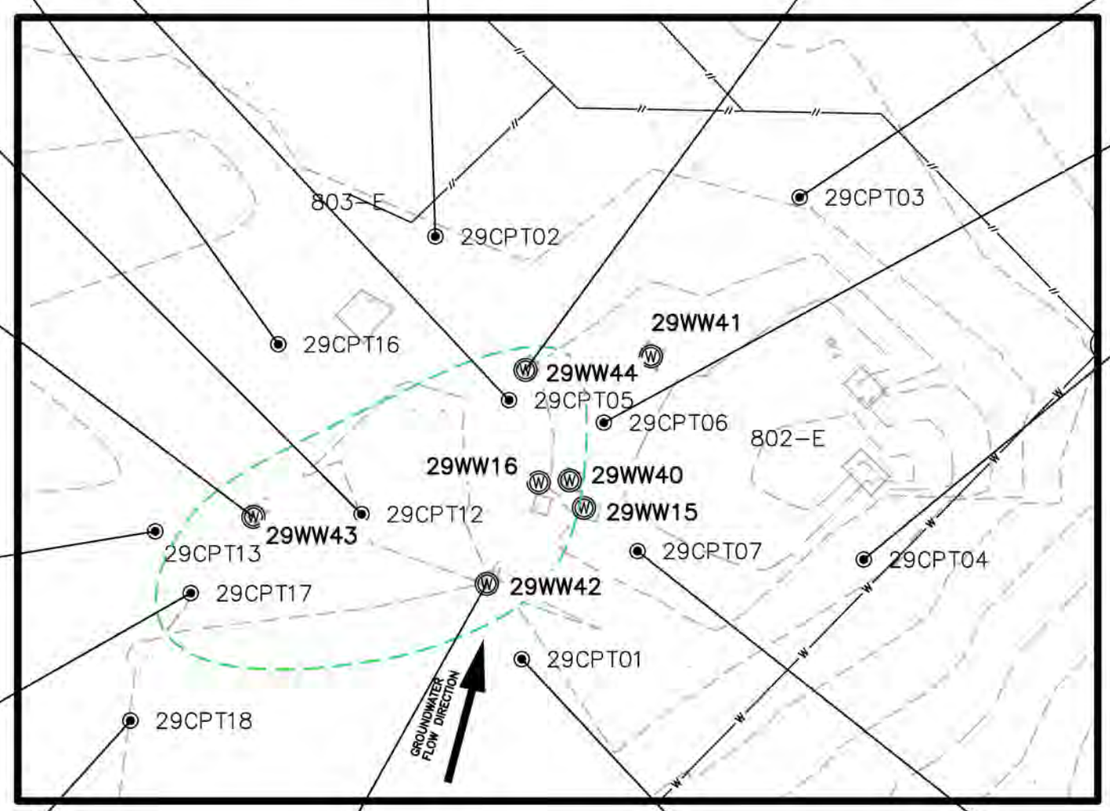
29CPT17			
	1,2-DCA	MC	TCE
18 FT	365 J	<258 U	**593**
68 FT	<1.3 U	5.96 J	<1.3 U
74 FT	<1.29 U	7.22	<1.29 U
80 FT	<1.28 U	**17,400**	4.7 J
84 FT	<1.27 U	137	<1.27 U
86 FT	<1.33 U	168	<1.33 U

29CPT18			
	1,2-DCA	MC	TCE
4 FT	<1.24 U	6.03 J	<1.24 U
72 FT	<1.24 U	5.36 J	<1.24 U

29CPT11			
	1,2-DCA	MC	TCE
66 FT	<1.22 U	2.29 J	<1.22 U
80 FT	<1.2 U	258 J	266 J
82 FT	<5.9 U	**561**	<5.9 U

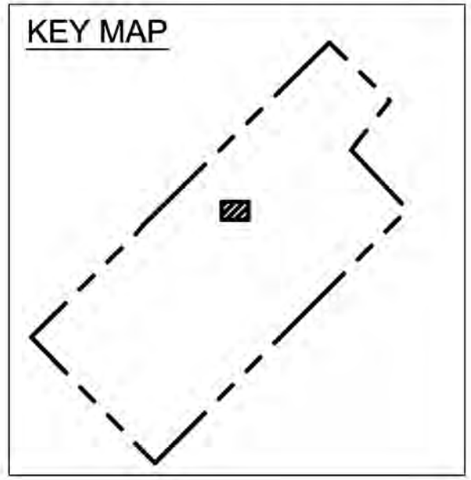
29CPT01		
	MC	TCE
58 FT	<2.68 U	<1.34 U
74 FT	<2.38 U	<1.19 U
80.5 FT	<2.5 U	<1.25 U

29CPT07			
	1,2-DCA	MC	TCE
71 FT	<1.43 UJ	<2.86 UJ	<1.43 UJ
82 FT	<1.13 U	<2.26 U	<1.13 U
86 FT	<1.25 U	<2.5 U	<1.25 U



N

KEY MAP



LEGEND:

- CONTOUR MINOR
- CONTOUR MAJOR
- COOLING WATER MAIN PIPE – ASSUMED 18"
- COOLING WATER BUILDING SERVICE PIPE
- CONCRETE BUILDING FOUNDATION
- MONITORING WELL
- CONTINUOUS CONE PENETROMETER (CPT) / MEMBRANE INTERFACE PROBE (MIP) LOCATION
- ISTD TREATMENT AREA

NOTES:

1. SAMPLES WERE COLLECTED BY AECOM FROM JUNE TO SEPTEMBER 2014.
2. SAMPLE RESULTS ARE SHOWN IN UG/KG.
3. SAMPLE RESULTS SHOWN IN BOLD EXCEED THE MAXIMUM CONTAMINANT LEVEL (MCL)/MEDIUM-SPECIFIC CONCENTRATION AS SHOWN IN TABLE 3-3 OF THE RI ADDENDUM PREPARED BY AECOM DATED JULY 2016.
4. LOCATION OF UNDERGROUND PIPES ARE APPROXIMATE.
5. DATA QUALIFIERS STAND FOR:
   - 5.1. J – ESTIMATED VALUE
   - 5.2. UJ – ESTIMATED VALUE BELOW THE DETECTION LIMIT
   - 5.3. U – VALUE IS BELOW THE DETECTION LIMIT

0 40' 80'

SCALE: 1" = 40'

HDR

ISTD TREATMENT AREA SOIL SAMPLE RESULTS

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

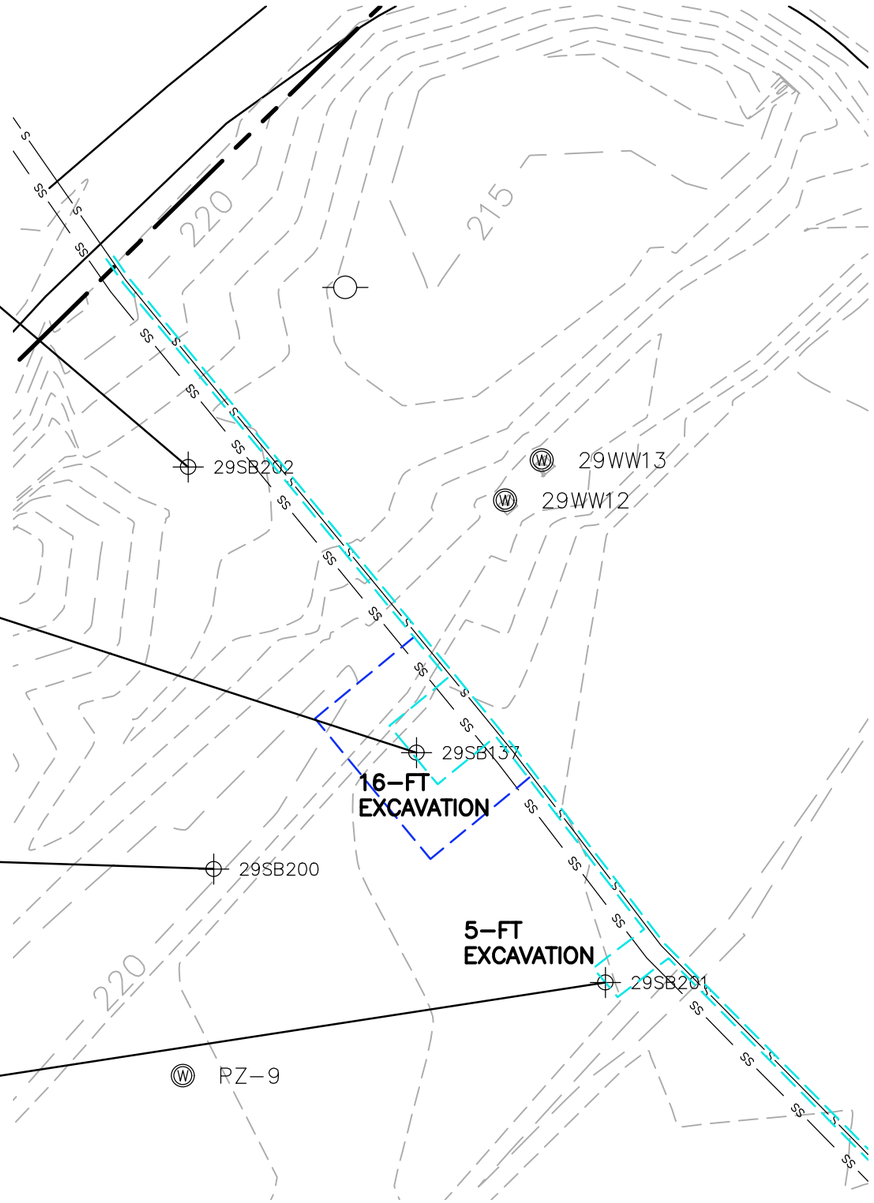
FIGURE
3-2

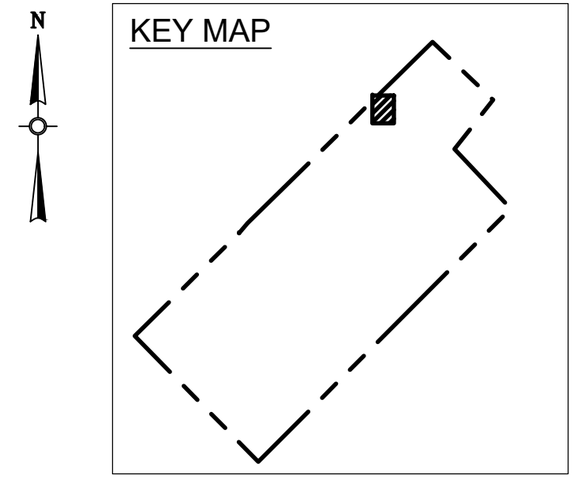
29SB202			
	3-4 ft	11-12 ft	15-15.5 ft
2,4,6-TNT	<0.049	<0.047	<0.050
2,4-DNT	<0.049	<0.047	<0.050
2,6-DNT	<0.049	<0.047	<0.050

29SB137				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	0.209	<0.208	**41.6**	**21**
2,4-DNT	<0.193	<0.208	**0.196**	**0.069**
2,6-DNT	<0.193	<0.208	<0.201	0.029

29SB200	
	15-15.5 ft
2,4,6-TNT	<0.048
2,4-DNT	<0.048
2,6-DNT	<0.048

29SB201			
	3-4 ft	11-12 ft	15-15.5 ft
2,4,6-TNT	<0.048	<0.047	<0.049
2,4-DNT	**0.19**	<0.047	<0.049
2,6-DNT	<0.048	<0.047	<0.049





LEGEND:

- UTILITY POLE
- SITE BOUNDARY
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- 12" WOOD TNT WASTEWATER LINE
- 6" TRANSITE TNT WASTEWATER LINE
- 2021/2022 PDI SAMPLE LOCATION
- MONITORING WELL
- ESTIMATED PIPE REMOVAL TRENCH LIMIT
- EXCAVATION TOP OF SLOPE

0 40' 80'

SCALE: 1" = 40'

NOTES:

1. SAMPLE RESULTS ARE SHOWN IN MG/KG.
2. SOIL CLEANUP STANDARD FOR EXPLOSIVE COMPOUNDS ARE AS FOLLOWS:
   - 2.1. 2,4,6–TNT = 4.7 MG/KG (0–3 FT BGS); 5.1 MG/KG (>3 FT BGS)
   - 2.2. 2,4–DNT = 0.042 MG/KG
   - 2.3. 2,6–DNT = 0.042 MG/KG
3. SAMPLES EXCEEDING THE SOIL CLEANUP STANDARD HAVE BEEN HIGHLIGHTED IN YELLOW AND BOLDED.
4. LOCATION OF TNT WASTEWATER LINES ARE APPROXIMATE.

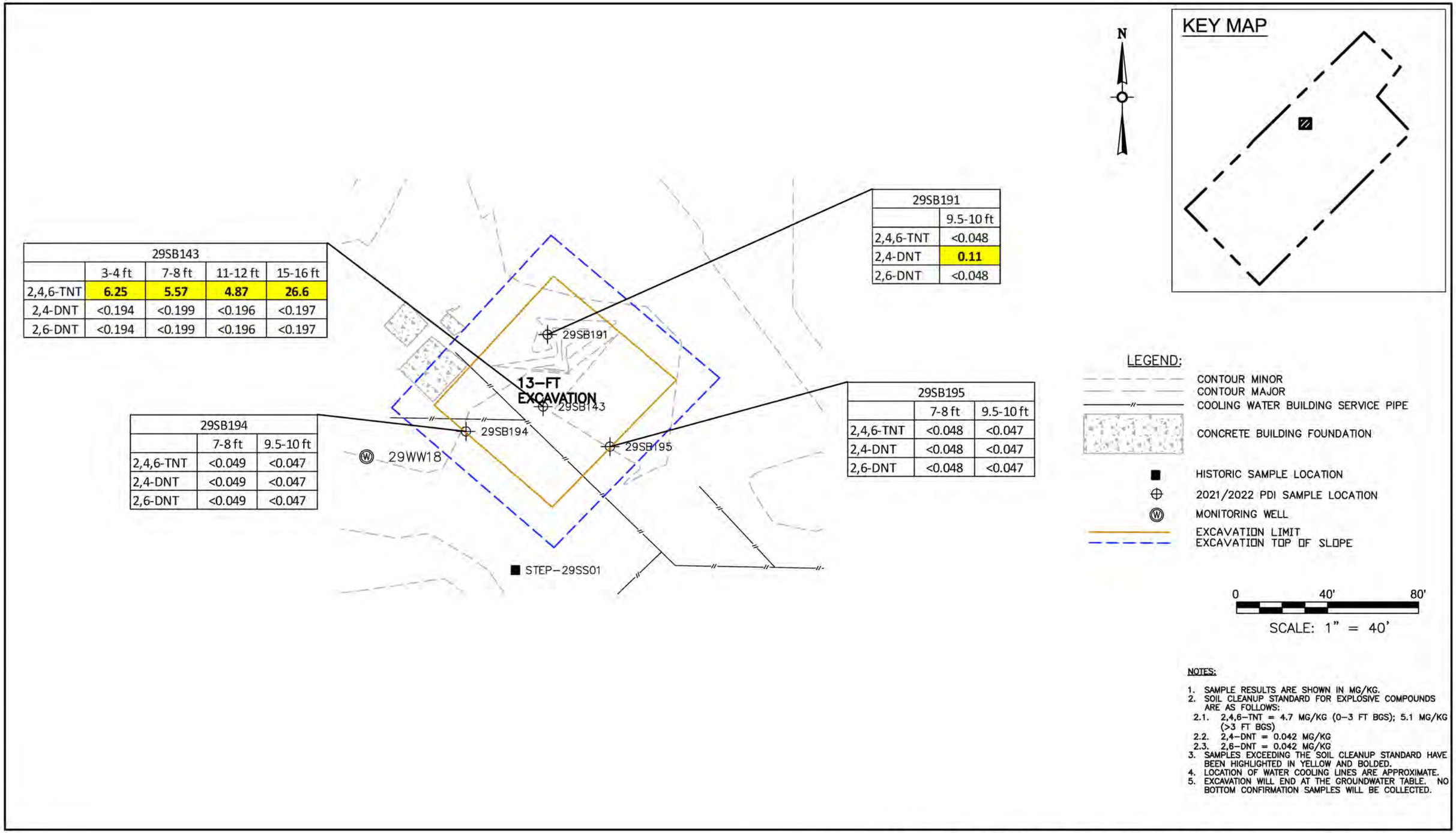
HDR

TRANSITE TNT PRESSURE PIPE EXCAVATION AREA

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
4–1



NOTES:

1. SAMPLE RESULTS ARE SHOWN IN MG/KG.
2. SOIL CLEANUP STANDARD FOR EXPLOSIVE COMPOUNDS ARE AS FOLLOWS:
   - 2.1. 2,4,6–TNT = 4.7 MG/KG (0–3 FT BGS); 5.1 MG/KG (>3 FT BGS)
   - 2.2. 2,4–DNT = 0.042 MG/KG
   - 2.3. 2,6–DNT = 0.042 MG/KG
3. SAMPLES EXCEEDING THE SOIL CLEANUP STANDARD HAVE BEEN HIGHLIGHTED IN YELLOW AND BOLDED.
4. LOCATION OF WATER COOLING LINES ARE APPROXIMATE.
5. EXCAVATION WILL END AT THE GROUNDWATER TABLE. NO BOTTOM CONFIRMATION SAMPLES WILL BE COLLECTED.

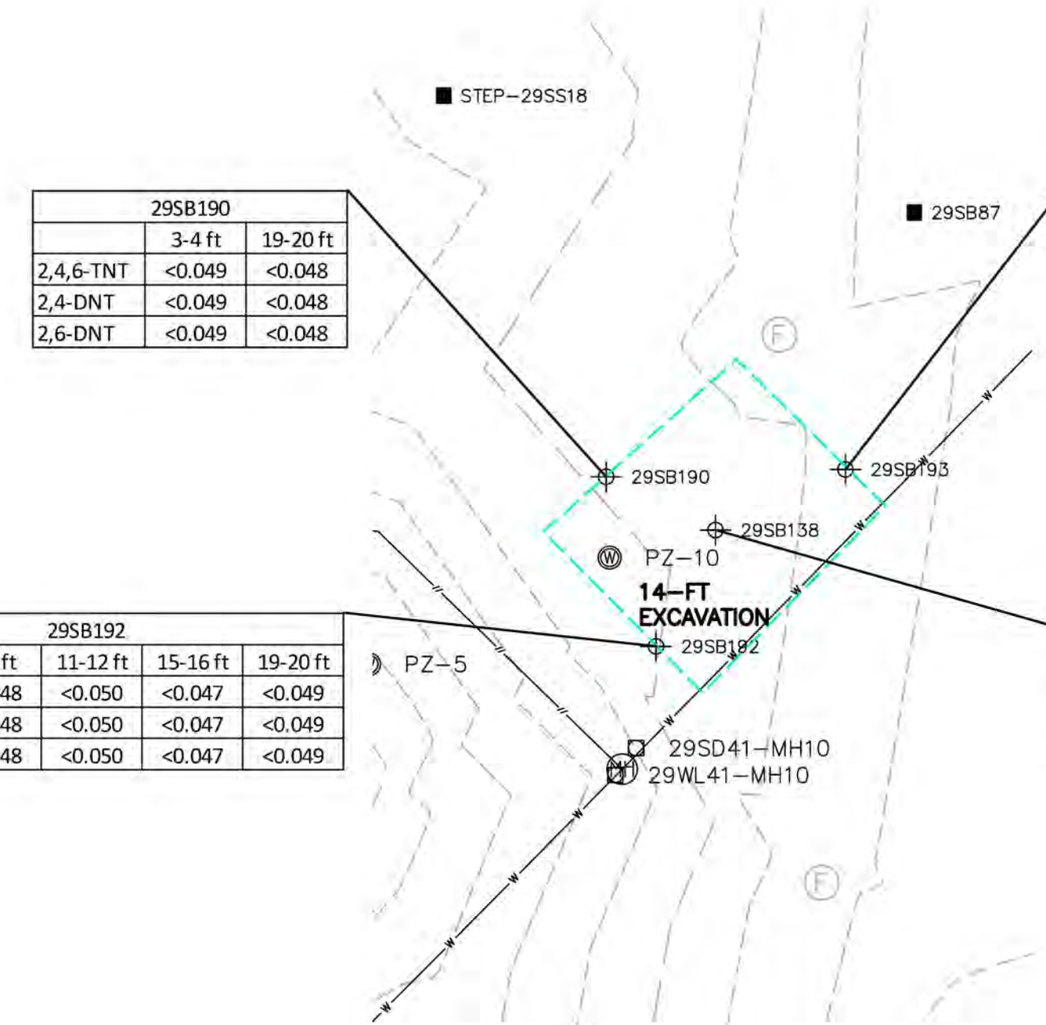
HDR

NORTH COOLING WATER LINE EXCAVATION AREA 1 SAMPLE RESULTS

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
4–2



29SB190		
	3-4 ft	19-20 ft
2,4,6-TNT	<0.049	<0.048
2,4-DNT	<0.049	<0.048
2,6-DNT	<0.049	<0.048

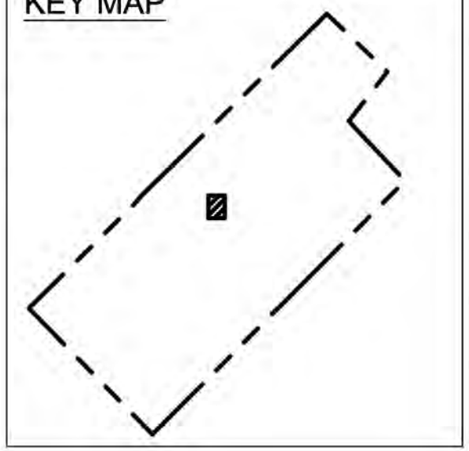
29SB193				
	7-8 ft	11-12 ft	15-16 ft	19-20 ft
2,4,6-TNT	<0.047	<0.049	<0.050	<0.048
2,4-DNT	<0.047	<0.049	<0.050	<0.048
2,6-DNT	<0.047	<0.049	<0.050	<0.048

29SB192				
	7-8 ft	11-12 ft	15-16 ft	19-20 ft
2,4,6-TNT	<0.048	<0.050	<0.047	<0.049
2,4-DNT	<0.048	<0.050	<0.047	<0.049
2,6-DNT	<0.048	<0.050	<0.047	<0.049

29SB138				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	<0.199	<0.199	**9.14**	**7.34**
2,4-DNT	<0.199	<0.199	<0.194	<0.200
2,6-DNT	<0.199	<0.199	<0.194	<0.200

N

KEY MAP



LEGEND:

- FIRE HYDRANT
- MANHOLE
- CONTOUR MINOR
- CONTOUR MAJOR
- COOLING WATER MAIN PIPE – ASSUMED 18"
- COOLING WATER BUILDING SERVICE PIPE
- HISTORIC SAMPLE LOCATION
- 2021/2022 PDI SAMPLE LOCATION
- MONITORING WELL
- HISTORIC WASTELINE/PIPE SAMPLE LOCATION
- ESTIMATED PIPE REMOVAL TRENCH LIMIT

0 40' 80'

SCALE: 1" = 40'

NOTES:

1. SAMPLE RESULTS ARE SHOWN IN MG/KG.
2. SOIL CLEANUP STANDARD FOR EXPLOSIVE COMPOUNDS ARE AS FOLLOWS:
   - 2.1. 2,4,6–TNT = 4.7 MG/KG (0–3 FT BGS); 5.1 MG/KG (>3 FT BGS)
   - 2.2. 2,4–DNT = 0.042 MG/KG
   - 2.3. 2,6–DNT = 0.042 MG/KG
3. SAMPLES EXCEEDING THE SOIL CLEANUP STANDARD HAVE BEEN HIGHLIGHTED IN YELLOW AND BOLDED.
4. LOCATION OF WATER COOLING LINES ARE APPROXIMATE.
5. SAMPLE LOCATIONS LABELED AS "STEP" WERE SAMPLES COLLECTED FOR PERCHLORATE ANALYSIS. RESULTS ARE NOT SHOWN ON THIS FIGURE.
6. EXCAVATION WILL BE COMPLETED TO THE WATER TABLE WHICH IS ESTIMATED TO BE 14–FT BGS. NO BOTTOM CONFIRMATION SAMPLES WILL BE COLLECTED.

HDR

NORTH COOLING WATER LINE EXCAVATION AREA 2 SAMPLE RESULTS

LHAAP-29
KARNACK, TX

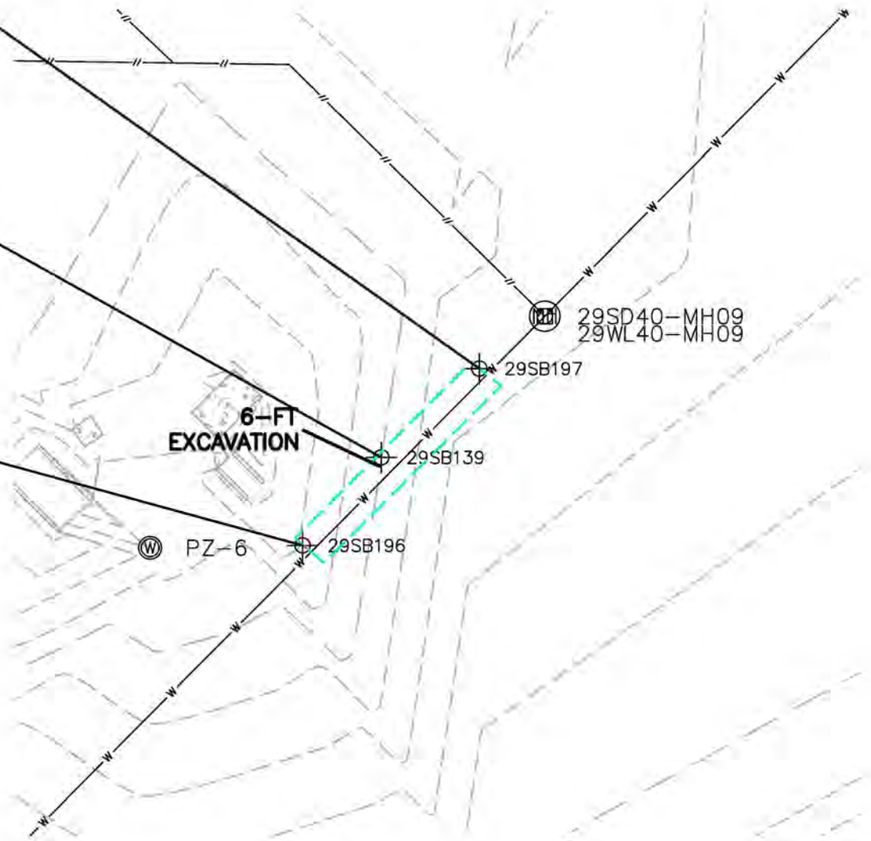
DATE
FEBRUARY 2024

FIGURE
4–3

29SB197		
	3-4 ft	7-7.5 ft
2,4,6-TNT	<0.047	<0.048
2,4-DNT	<0.047	<0.048
2,6-DNT	<0.047	<0.048

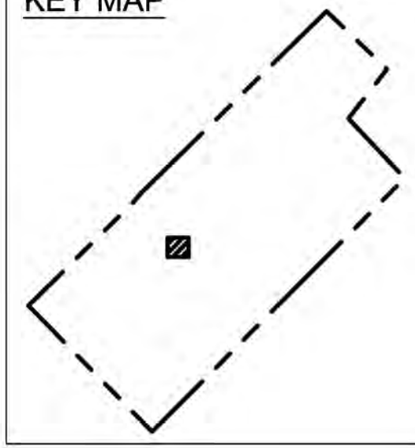
29SB139				
	3-4 ft	7-8 ft	11-12 ft	15-16 ft
2,4,6-TNT	**97.6**	4.56	<0.196	0.3
2,4-DNT	<0.193	<0.192	<0.196	<0.202
2,6-DNT	<0.193	<0.192	<0.196	<0.202

29SB196		
	3-4 ft	7-7.5 ft
2,4,6-TNT	<0.049	<0.048
2,4-DNT	<0.049	<0.048
2,6-DNT	<0.049	<0.048





KEY MAP



LEGEND:

- MANHOLE
- CONTOUR MINOR
- CONTOUR MAJOR
- COOLING WATER MAIN PIPE – ASSUMED 18"
- COOLING WATER BUILDING SERVICE PIPE
- CONCRETE BUILDING FOUNDATION
- 2021/2022 PDI SAMPLE LOCATION
- MONITORING WELL
- HISTORIC WASTELINE/PIPE SAMPLE LOCATION
- ESTIMATED PIPE REMOVAL TRENCH LIMIT

0 40' 80'

SCALE: 1" = 40'

NOTES:

1. SAMPLE RESULTS ARE SHOWN IN MG/KG.
2. SOIL CLEANUP STANDARD FOR EXPLOSIVE COMPOUNDS ARE AS FOLLOWS:
   - 2.1. 2,4,6–TNT = 4.7 MG/KG (0–3 FT BGS); 5.1 MG/KG (>3 FT BGS)
   - 2.2. 2,4–DNT = 0.042 MG/KG
   - 2.3. 2,6–DNT = 0.042 MG/KG
3. SAMPLES EXCEEDING THE SOIL CLEANUP STANDARD HAVE BEEN HIGHLIGHTED IN YELLOW AND BOLDED.
4. LOCATION OF WATER COOLING LINES ARE APPROXIMATE.
5. EXCAVATIONS WILL STOP AT THE GROUNDWATER TABLE. ANY EXCAVATIONS COMPLETED TO THE GROUNDWATER TABLE WILL NOT REQUIRE COLLECTION OF CONFIRMATION SAMPLES.

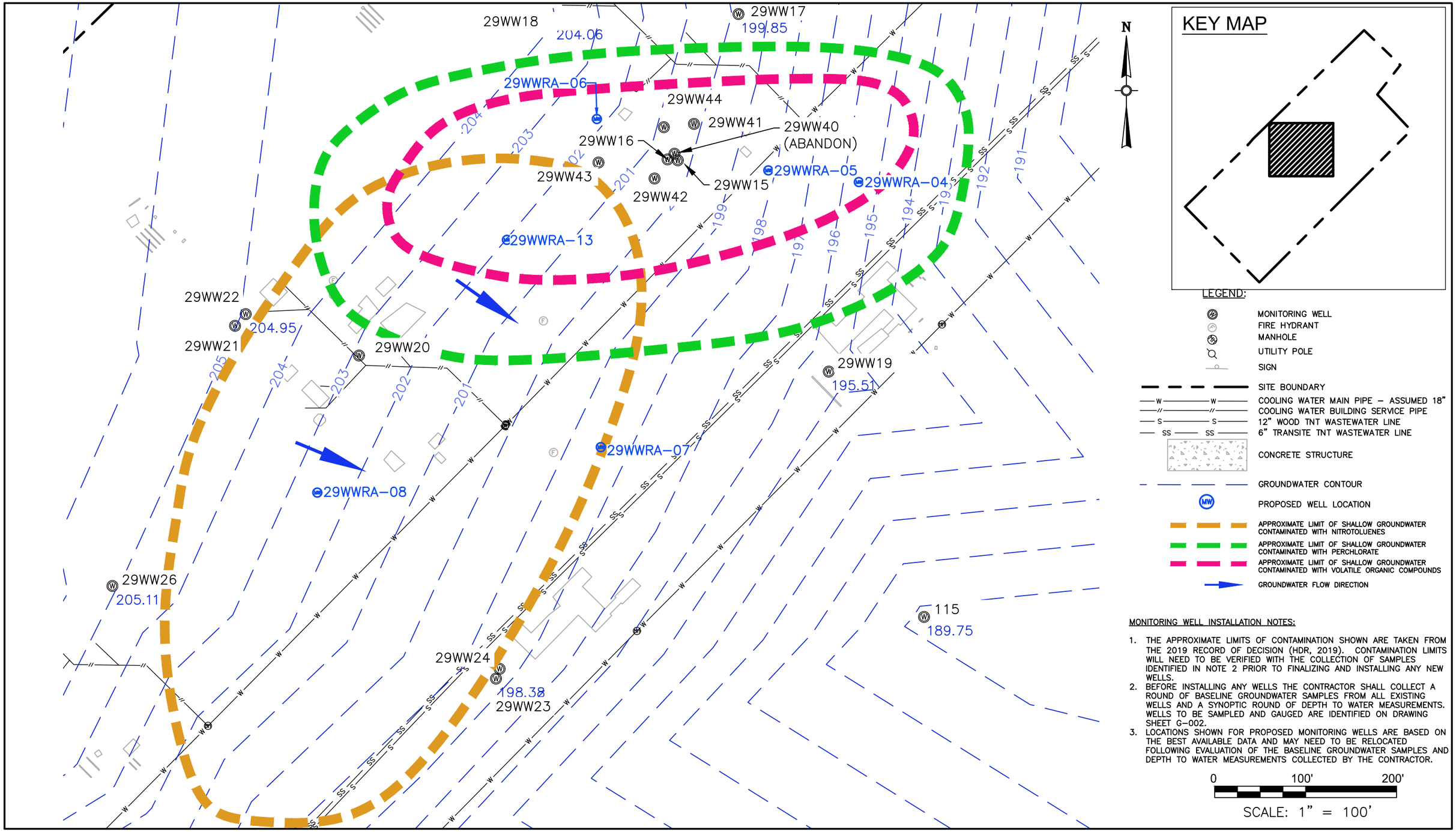
HDR

NORTH COOLING WATER LINE EXCAVATION AREA 3 SAMPLE RESULTS

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
4–4



MONITORING WELL INSTALLATION NOTES:

1. THE APPROXIMATE LIMITS OF CONTAMINATION SHOWN ARE TAKEN FROM THE 2019 RECORD OF DECISION (HDR, 2019). CONTAMINATION LIMITS WILL NEED TO BE VERIFIED WITH THE COLLECTION OF SAMPLES IDENTIFIED IN NOTE 2 PRIOR TO FINALIZING AND INSTALLING ANY NEW WELLS.
2. BEFORE INSTALLING ANY WELLS THE CONTRACTOR SHALL COLLECT A ROUND OF BASELINE GROUNDWATER SAMPLES FROM ALL EXISTING WELLS AND A SYNOPTIC ROUND OF DEPTH TO WATER MEASUREMENTS. WELLS TO BE SAMPLED AND GAUGED ARE IDENTIFIED ON DRAWING SHEET G–002.
3. LOCATIONS SHOWN FOR PROPOSED MONITORING WELLS ARE BASED ON THE BEST AVAILABLE DATA AND MAY NEED TO BE RELOCATED FOLLOWING EVALUATION OF THE BASELINE GROUNDWATER SAMPLES AND DEPTH TO WATER MEASUREMENTS COLLECTED BY THE CONTRACTOR.

0 100' 200'

SCALE: 1" = 100'

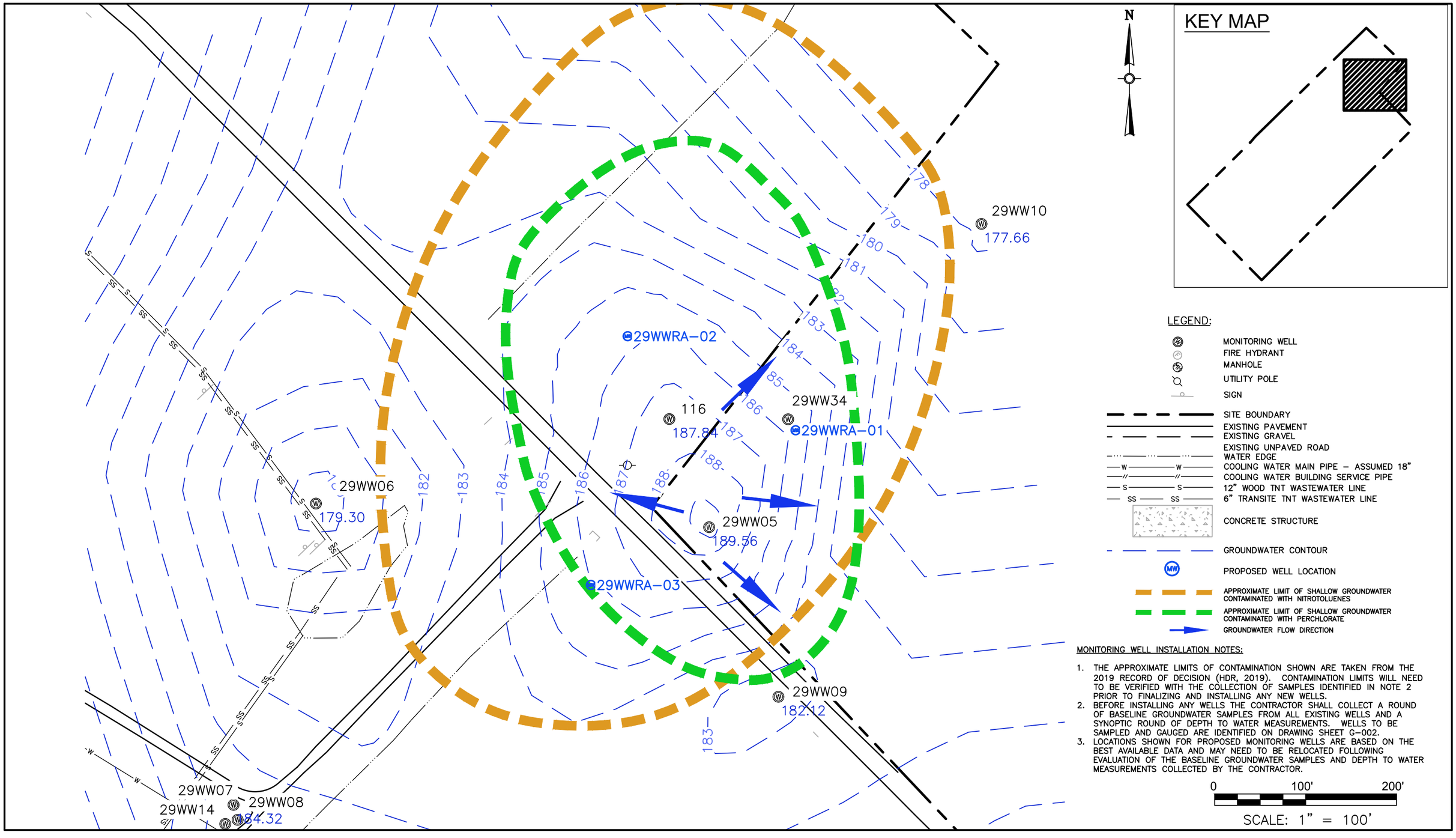
HDR

MIDDLE TNT AND THE VOC AND PERCHLORATE PLUMES PROPOSED WELL LOCATIONS

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
5–1

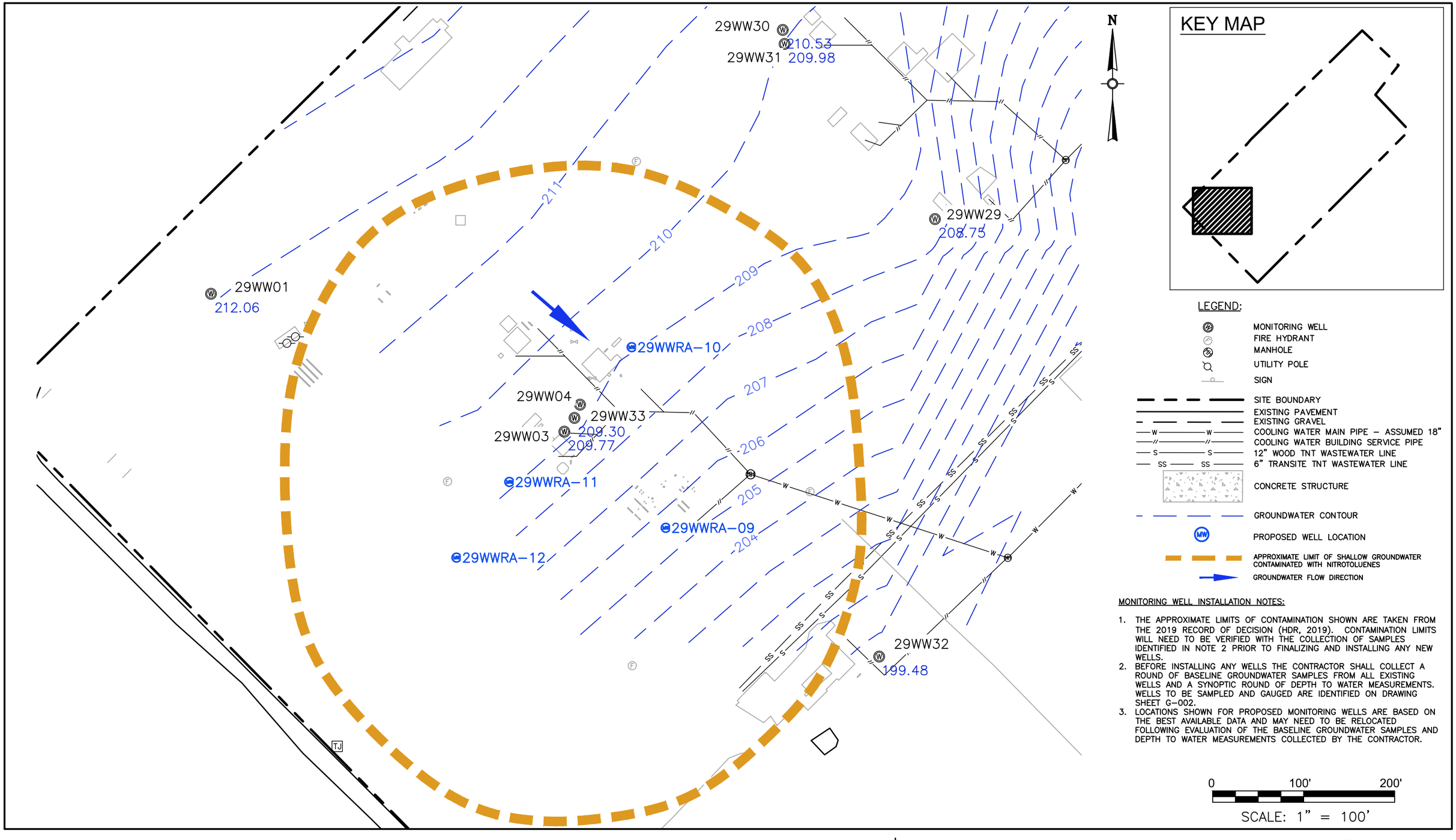


NORTH TNT AND THE PERCHLORATE PLUMES PROPOSED WELL LOCATIONS

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
5–2



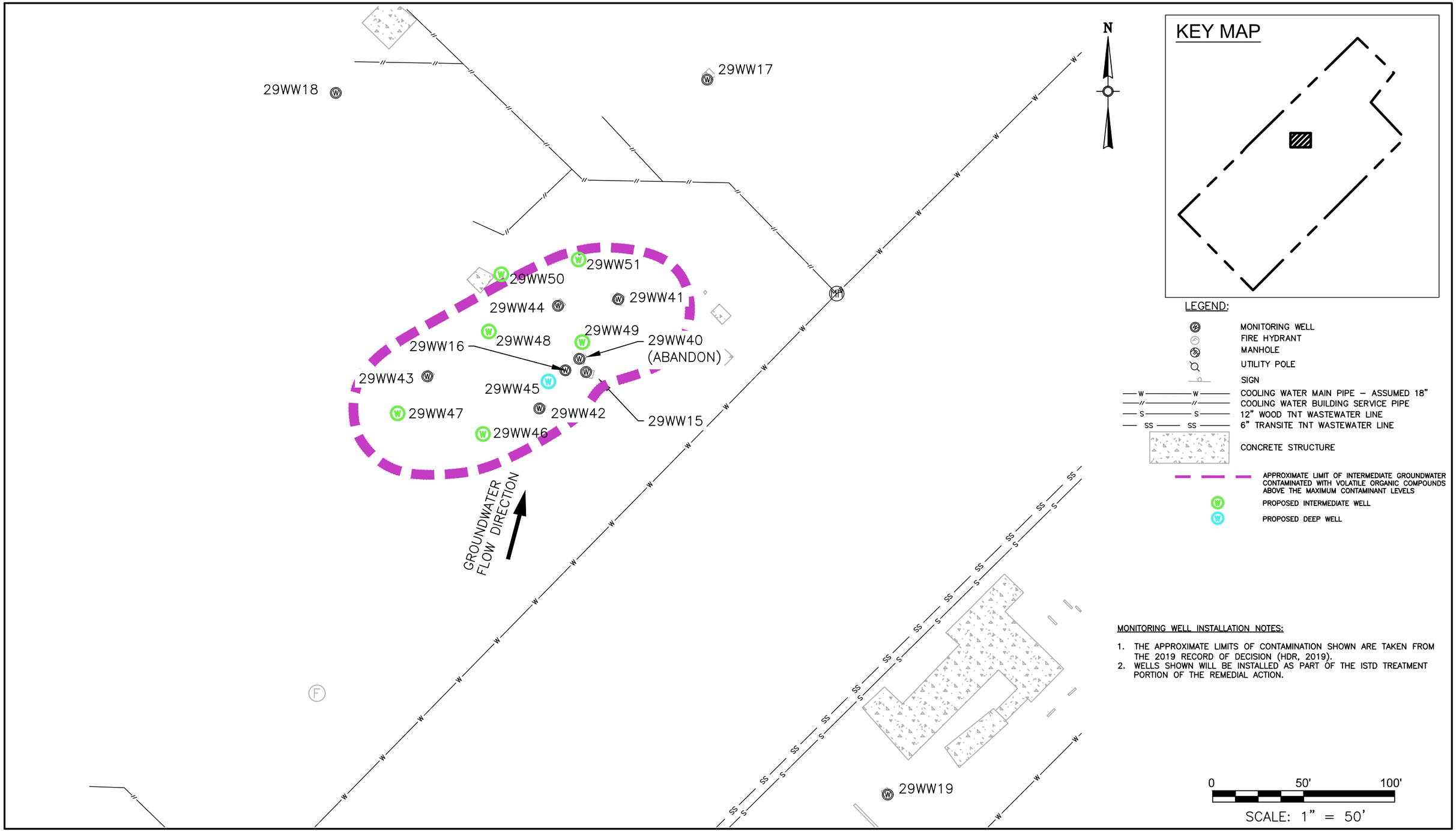
HDR

SOUTHERN TNT PLUME
PROPOSED WELL LOCATIONS

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
5–3



HDR

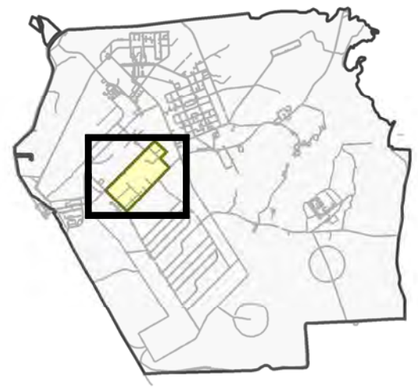
INTERMEDIATE PLUME PROPOSED WELL LOCATIONS

LHAAP-29
KARNACK, TX

DATE
FEBRUARY 2024

FIGURE
5–4





LEGEND

- Preliminary Land Use Control Boundary
- Stream
- Road
- Site LHAAP-29

DISCLAIMER: Map information was compiled from the best available sources. No warranty is made for its accuracy or completeness.

PRELIMINARY
LAND USE CONTROL BOUNDARY
LHAAP 29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

N

0 250 500
FEET

FIGURE 6-1

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP29\LHAAP_29_ROD_LUC_BOUNDARY.MXD - USER: KLOFGREN - DATE: 5/17/2019

A

Remedial Design Drawings

US ARMY CORPS
OF ENGINEERS
USACE TULSA DISTRICT



Contract Drawings For

LHAAP-29

FORMER TNT PRODUCTION AREA GROUP 2

100% DESIGN

REMEDIAL ACTION DESIGN

CONTRACT NO. W912BV 19 D0016
TASK ORDER NO. W912BV20F0096

KARNACK, TEXAS
FEBRUARY 2024

STATE OF TEXAS
MICHAEL J. VECCHIO
147480
LICENSED
PROFESSIONAL ENGINEER

INDEX OF DRAWINGS

GENERAL (G)

G000	COVER SHEET AND SHEET INDEX
G001	GENERAL NOTES
G002	REMEDIAL ACTION SITE PLAN
G003	MONITORING WELL INSTALLATION PLAN
G004	CONSTRUCTION DETAILS SHEET 1
G005	CONSTRUCTION DETAILS SHEET 2
G006	CONSTRUCTION DETAILS SHEET 3
G007	OVERALL RESTORATION PLAN

EXCAVATION AREAS CIVIL (C)

01C101	EXCAVATION AREA E-1 SITE PLAN
01C102	EXCAVATION AREA E-2 SITE PLAN
01C103	EXCAVATION AREA E-3 & NC-1 SITE PLAN
01C104	EXCAVATION AREA E-4 SITE PLAN
01C105	EXCAVATION AREA E-5 SITE PLAN
01C106	EXCAVATION AREA E-6 SITE PLAN
01C107	EXCAVATION AREA NC-2 SITE PLAN
01C108	EXCAVATION AREA NC-3 SITE PLAN
01C109	SITE ACCESS AND EROSION CONTROL PLAN (SHEET 1)
01C110	SITE ACCESS AND EROSION CONTROL PLAN (SHEET 2)
01C111	SITE ACCESS AND EROSION CONTROL PLAN (SHEET 3)
01C112	SITE ACCESS AND EROSION CONTROL PLAN (SHEET 4)

ISTD AREA CIVIL (C)

02C101	ISTD SITE PLAN
02C102	ISTD SECTION PLAN

PIPELINES CIVIL (C)

03C101	PIPING SITE PLAN - SHEET 1
03C102	PIPING SITE PLAN - SHEET 2
03C103	PIPING SITE PLAN - SHEET 3
03C301	TNT WOOD GRAVITY LINE - PROFILE
03C302	TNT TRANSITE GRAVITY LINE - PROFILE
03C303	TNT WOOD AND TRANSITE PRESSURE PIPE - PROFILE
03C304	NORTH COOLING LINE - PROFILE
03C305	SOUTH COOLING LINE - PROFILE

GENERAL NOTES:

1. ALL WORK SHALL BE PERFORMED IN STRICT ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL CODES AND REGULATIONS.
2. THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL NECESSARY APPROVALS BEFORE BEGINNING WORK.
3. SITE IS LOCATED AT THE LONGHORN ARMY AMMUNITION PLANT (LHAPP) SITE 29 IN KARNACK, TEXAS.
4. USACE WILL PROVIDE ALL ACCESS AGREEMENTS NECESSARY TO PERFORM WORK.
5. ALL SITE FEATURES SHALL BE FIELD VERIFIED BY CONTRACTOR PRIOR TO CONSTRUCTION. ANY DISCREPANCIES NOTED SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE CONTRACTING OFFICER.
6. IT IS RECOMMENDED THAT THE CONTRACTOR HAVE A GEOPHYSICAL SURVEY COMPLETED TO LOCATE ALL EXISTING UNDERGROUND UTILITIES AND STRUCTURES IN THE VICINITY OF THE WORK. ANY DAMAGE TO THE CONTRACTOR'S EQUIPMENT OR ENVIRONMENTAL IMPACTS THAT MAY OCCUR AS THE RESULT OF THE CONTRACTOR DECIDING TO NOT PERFORM AN UNDERGROUND SURVEY WILL BE THE RESPONSIBILITY OF THE CONTRACTOR TO CORRECT.
7. IN THE EVENT THE CONTRACTOR DAMAGES ANY EXISTING UTILITY SERVICE CAUSING SERVICE INTERRUPTION, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE CONTRACTING OFFICER.
8. PROVISIONS SHALL BE TAKEN TO MINIMIZE NOISE.
9. THE CONTRACTOR IS RESPONSIBLE FOR ENSURING UNAUTHORIZED PERSONS DO NOT ENTER THE EXCLUSION ZONE. PROVIDE FENCING OR OTHER ACCEPTABLE MEANS AROUND THE HAZARDOUS WORK ZONES TO RESTRICT ACCESS.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE SECURITY OF THE SITE. ANY REPAIRS RESULTING FROM DAMAGE CAUSED BY TRESPASSERS SHALL BE AT THE EXPENSE OF THE CONTRACTOR.
11. ALL AREAS DISTURBED BY THE CONTRACTOR SHALL BE RESTORED TO THEIR ORIGINAL CONDITIONS OR AS OTHERWISE SHOWN ON THE DRAWINGS AND TO THE SATISFACTION OF THE CONTRACTING OFFICER.
12. THE CONTRACTOR SHALL PREPARE A REMEDIAL ACTION WORK PLAN PROVIDING ALL THE MEANS AND METHODS FOR COMPLETING THE WORK INCLUDING ALL HEALTH AND SAFETY MEASURES AND DECONTAMINATION MEASURES THAT WILL BE IMPLEMENTED. THE WORK PLAN SHALL BE PREPARED IN ACCORDANCE WITH THE USACE APPROVED SITE WIDE INSTALLATION PLAN (BHATE, 2018) AND ALL APPLICABLE RULES AND REGULATIONS. THE REMEDIAL ACTION WORK PLAN SHALL BE REVIEWED AND APPROVED BY THE USACE AND ANY OTHER REQUIRED REGULATING AGENCY.

SURVEY NOTES:

1. SURVEY WAS PERFORMED OF THE ABOVE GROUND STRUCTURES AND TOPOGRAPHY BY MTX SURVEYING IN APRIL 2021.
2. ALL UNDERGROUND PIPING SHOWN IS APPROXIMATE AND SHALL BE FIELD VERIFIED BY THE CONTRACTOR. THE EXISTING TNT WASTEWATER LINES ARE MARKED IN THE FIELD BY EXISTING SIGNS. DURING THE PDI WORK PERFORMED BY HDR THE TNT WASTEWATER LINES WERE GENERALLY FOUND WITHIN 5 FT OF THESE SIGNS.

WASTE DISPOSAL NOTES:

1. THE CONTRACTOR MUST TAKE EVERY EFFORT TO REDUCE THE AMOUNT OF WASTE THAT IS GENERATED, TO REUSE MATERIALS WITH THE CONCURRENCE OF THE CONTRACTING OFFICER, AND TO SEGREGATE WASTE MATERIALS FOR WASTE DISPOSAL.
2. ALL WASTE MATERIALS MUST BE PROPERLY TRANSPORTED, STORED, HANDLED, AND CONTAINED TO PREVENT SPILLS, LEAKAGE, DISCHARGE OR RELEASE TO THE ENVIRONMENT. WASTE CONTAINERS MUST BE PROPERLY LABELED TO IDENTIFY CONTENTS.
3. CONTRACTOR MUST NOT DISCHARGE OR DISPOSE OF ANY WASTE INTO ANY WATER BODY OR DRAINAGE SYSTEM.
4. CONTRACTOR MUST DISPOSE OF ALL WASTE MATERIALS ACCORDING TO ALL LOCAL, STATE AND FEDERAL REGULATIONS.
5. ALL WASTE MANIFESTS REQUIRED FOR THE PROJECT SHALL BE PREPARED BY THE CONTRACTOR AND SIGNED BY THE CONTRACTING OFFICER UNLESS OTHERWISE REQUIRED BY THE USACE.

MAINTENANCE AND PROTECTION OF TRAFFIC:

1. ALL TRAFFIC CONTROL DEVICES USED FOR MAINTENANCE AND PROTECTION OF TRAFFIC SHALL CONFORM TO THE APPLICABLE SPECIFICATIONS AS SET FORTH IN THE NATIONAL MUTCD 2009 EDITION.
2. THE CONTRACTOR SHALL NOT PARK EQUIPMENT OR STORE MATERIAL OVERNIGHT WHERE IT IS DEEMED BY THE CONTRACTING OFFICER TO BE A HAZARD TO TRAFFIC.
3. THE CONTRACTOR SHALL NOT ALLOW CONSTRUCTION RELATED VEHICLES OR ACTIVITIES TO IMPEDE OR ADVERSELY AFFECT THE FLOW OF TRAFFIC WITHOUT PROVIDING PRIOR NOTIFICATION TO THE CONTRACTING OFFICER. ANY ACTIVITIES THAT WILL IMPEDE TRAFFIC SHALL BE PROVIDED WITH PROPER SIGNAGE AND TRAFFIC CONTROLS.
4. DURING THE PROGRESS OF CONSTRUCTION, TRUCKS ENTERING OR LEAVING THE SITE SHALL USE ONLY ROADS THAT PERMIT TRUCK TRAVEL AS GOVERNED BY ANY AGENCY HAVING JURISDICTION. ALL ROADWAYS AFFECTED BY CONSTRUCTION OF THIS PROJECT SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITIONS.

LAND GRADING NOTES:

1. PROVISIONS SHALL BE MADE TO DIVERT SURFACE RUNOFF AWAY FROM EXPOSED AREAS AND OPEN EXCAVATIONS. RUNOFF THAT COMES IN CONTACT WITH IMPACTED SOILS SHALL BE COLLECTED AND TRANSPORTED OFFSITE FOR DISPOSAL.
2. ALL GRADED OR DISTURBED AREAS, INCLUDING SLOPES, SHALL BE PROPERLY PROTECTED DURING CLEARING AND CONSTRUCTION IN ACCORDANCE WITH THE EROSION AND SEDIMENT CONTROL PLAN UNTIL THEY ARE ADEQUATELY STABILIZED.
3. ALL EROSION AND SEDIMENT CONTROL PRACTICES AND MEASURES SHALL BE CONSTRUCTED, APPLIED, AND MAINTAINED IN ACCORDANCE WITH THE SEDIMENT CONTROL PLAN AND THE TEXAS EROSION CONTROL STANDARDS.
4. AREAS THAT ARE TO BE TOPSOILED SHALL BE SCARIFIED TO A MINIMUM DEPTH OF FOUR INCHES PRIOR TO PLACEMENT OF TOPSOIL.
5. SEEPS OR SPRINGS ENCOUNTERED DURING CONSTRUCTION SHALL BE CONTAINED TO THE EXTENT PRACTICABLE AND WATER PUMPED TO FRAC TANKS FOR TEMPORARY STORAGE BEFORE DISPOSING OFF SITE.
6. ALL GRADED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY FOLLOWING BACKFILLING AND FINISHED GRADING.
7. STOCKPILES, BORROW AREAS, AND SPOIL AREAS SHALL BE PROTECTED AS REQUIRED BY THE DESIGN DOCUMENTS. STOCKPILES SHALL NOT BE STORED WITHIN 50 FEET OF A WATER BODY OR IN ANY DRAINAGE PATHS. ALL MATERIALS SHALL BE ENCIRCLED WITH SILT FENCE AND COVERED WHEN NOT IN USE.

CLEARING AND GRUBBING REQUIREMENTS:

1. UNLESS INDICATED OTHERWISE THE CONTRACTOR SHALL REMOVE ALL TREES, STUMPS, LOGS, SHRUBS, BRUSH AND VEGETATION AND OTHER ITEMS THAT WOULD INTERFERE WITH CONSTRUCTION OPERATIONS WITHIN THE CLEARING LIMITS SHOWN. STUMPS SHALL BE REMOVED ENTIRELY.
2. FOR AREAS IDENTIFIED AS LIGHT CLEARING, THE CONTRACTOR SHALL LIMIT CLEARING TO ONLY THOSE TREES, SHRUBS, BRUSH AND VEGETATION NEEDED TO ACCESS THE COOLING WATER PIPE LATERALS FOR TV INSPECTION, CLEANING, AND PLUGGING AND TO ACCESS AREAS WITH A DRILL RIG FOR MONITORING WELL INSTALLATION.
3. SUITABLE SOIL FROM THE SITE WHERE EXCAVATION OR GRADING IS INDICATED SHALL BE STRIPPED AND STOCKPILED SEPARATELY FROM OTHER EXCAVATED MATERIAL. MATERIAL SUITABLE FOR USE AS TOPSOIL SHALL BE STOCKPILED SEPARATELY FOR REUSE. TOPSOIL STOCKPILES SHALL BE LOCATED SO THAT MATERIAL CAN BE READILY USED FOR FINISHED GRADING. WHERE SUFFICIENT EXISTING TOPSOIL IS NOT AVAILABLE, THE CONTRACTOR SHALL PROVIDE A BORROW SOURCE MATERIAL SUITABLE FOR USE AS TOPSOIL.

EXCAVATION NOTES:

1. EXCAVATION EQUIPMENT AND WORK SHALL COMPLY WITH ALL FEDERAL, STATE, AND LOCAL CODES AND REGULATIONS INCLUDING BUT NOT LIMITED TO OSHA 29 CFR 1926, SUBPARTS M, O, AND P.
2. THE CONTRACTOR SHALL PERFORM THE EXCAVATIONS AT THE MINIMUM DEPTHS AND LIMITS SHOWN ON THE PLANS. THE EXCAVATION LIMITS SHOWN MAY BE ENLARGED BASED ON THE RESULTS OF THE POST EXCAVATION SAMPLE RESULTS. ALL EXCAVATIONS BEYOND THE DEPTHS OR LIMITS SHOWN SHALL BE APPROVED BY THE CONTRACTING OFFICER PRIOR TO COMMENCING.
3. ESTIMATED VOLUME OF SOIL TO BE REMOVED IS NOT NECESSARILY EQUAL TO THE ACTUAL VOLUME THAT WILL BE REMOVED. THE CONTRACTOR SHALL SLOPE AND/OR SHORE EXCAVATIONS TO PROTECT EXISTING STRUCTURES AND UTILITIES THAT ARE TO REMAIN. MAXIMUM ALLOWABLE SLOPES FOR EXCAVATIONS SHALL BE 1H:1V.
4. METHODS USED FOR PROTECTING INDIVIDUALS WITHIN AN EXCAVATION SHALL MEET THE REQUIREMENTS OF 29 CFR 1926.625. STRUCTURAL METHODS, IF NOT DESIGNED USING TABULATED DATA, SHALL BE DESIGNED AND CERTIFIED BY A TEXAS LICENSED PROFESSIONAL ENGINEER.
5. PROVIDE BARRICADES, COVERINGS, OR OTHER TYPES OF PROTECTION NECESSARY TO PREVENT DAMAGE TO EXISTING STRUCTURES AND UTILITIES TO REMAIN IN PLACE.
6. CONTRACTOR MUST PROVIDE LADDERS, STAIRWAYS, RAMPS, OR OTHER SAFE MEANS OF EGRESS IN ALL EXCAVATIONS THAT ARE FOUR FEET DEEP OR MORE SO THAT A WORKER DOES NOT NEED TO TRAVEL MORE THAN 25 FEET IN ANY DIRECTION BEFORE BEING ABLE TO EXIT THE EXCAVATION.
7. DIRT, DEBRIS, AND OTHER MATERIAL MUST BE EFFECTIVELY STORED AND RETAINED AT LEAST TWO FEET FROM THE EDGE OF EXCAVATIONS THAT PERSONNEL MAY BE REQUIRED TO ENTER.
8. THE CONTRACTOR SHALL CONTINUALLY INSPECT, EVALUATE, AND MAINTAIN THE EXCAVATION SLOPE TO PREVENT CRACKS, BULGES, SLOUGHS, OR FAILURES.
9. GROUNDWATER FLOWING TOWARD OR INTO EXCAVATIONS SHALL BE CONTROLLED TO PREVENT SLOUGHING OF EXCAVATION SLOPES AND WALLS, BOILS, UPLIFT AND HEAVE IN THE EXCAVATION AND TO ELIMINATE INTERFERENCE WITH ORDERLY PROGRESS OF CONSTRUCTION. CONTROL MEASURES SHALL BE TAKEN BY THE TIME THE EXCAVATION REACHES THE WATER LEVEL IN ORDER TO MAINTAIN THE INTEGRITY OF THE IN SITU MATERIAL. WHILE THE EXCAVATION IS OPEN, THE WATER LEVEL SHALL BE MAINTAINED CONTINUOUSLY, AT LEAST 1 FT BELOW THE WORKING LEVEL FOR PIPE TRENCH EXCAVATIONS IN ORDER TO REMOVE THE PIPE. EXCAVATIONS FOR INDIVIDUAL EXCAVATION AREAS SHALL BE ENDED AT THE GROUNDWATER TABLE.
10. THE CONTRACTOR SHALL LIMIT THE MOVEMENT OF CONSTRUCTION MACHINERY AND EQUIPMENT OVER EXISTING PIPES DURING CONSTRUCTION. EXISTING PIPELINES DAMAGED WILL NEED TO BE EVALUATED TO DETERMINE WHETHER REMOVAL WILL BE NECESSARY BASED ON WHETHER A RELEASE OF CONTAMINANTS OCCURS AS A RESULT OF THE DAMAGE.
11. EXCAVATIONS FOR PIPELINE REMOVALS SHALL BE BACKFILLED AS RAPIDLY AS EXCAVATION, TESTING, AND ACCEPTANCE OF THE WORK PERMITS. OPEN EXCAVATIONS FOR PIPE REMOVALS SHALL BE LIMITED TO 500 LINEAR FT AT ANY ONE TIME.

REMEDIAL ACTION SUMMARY:

A SUMMARY OF THE REMEDIAL ACTION (RA) IS BELOW. THE ACTUAL SEQUENCE WILL BE DETERMINED BY THE CONTRACTOR AND SHALL BE IN ACCORDANCE WITH SEQUENCING IDENTIFIED ON SHEETS 01C-109 TO 01C112. THE CONTRACTOR SHALL PROVIDE THEIR PROPOSED CONSTRUCTION SEQUENCE IN THEIR WORK PLAN THAT WILL BE SUBMITTED PRIOR TO COMMENCING THE WORK.

GENERAL REQUIREMENTS FOR ALL WORK:

1. LOCATE ALL UNDERGROUND UTILITIES AND VERIFY EXISTING SITE CONDITIONS IN THE VICINITY OF THE WORK AREAS.
2. MOBILIZE EQUIPMENT AND TRAILERS TO THE SITE. SET UP STAGING AREAS. SECURE CONSTRUCTION AREAS AS NECESSARY TO PREVENT UNAUTHORIZED ACCESS.
3. IDENTIFY AND CLEARLY MARK IN THE FIELD FOR PROTECTION ALL MONITORING WELLS IN THE VICINITY OF THE WORK AREAS.
4. SET UP AIR MONITORING STATIONS.
5. CLEAR SITE AND CONSTRUCT TEMPORARY ACCESS ROADS.

PIPE INSPECTION/CLEANING:

1. VIDEO INSPECT AND CLEAN PIPELINES IDENTIFIED TO BE INSPECTED. VISUALLY MARK IN THE FIELD ALL LOCATIONS WHERE BREAKS ARE IDENTIFIED ALONG THE PIPELINES VIDEO INSPECTED. COLLECT SOIL SAMPLES AT BREAK LOCATIONS TO VERIFY WHETHER PIPE SECTIONS WILL REQUIRE REMOVAL OR CAN BE CLEANED AND ABANDONED IN PLACE.
2. EXCAVATE AND REMOVE PORTIONS OF PIPELINES IDENTIFIED FOR REMOVAL BASED ON SOIL SAMPLING RESULTS. PROVIDE CAPS FOR SECTIONS OF PIPE TO REMAIN.
3. REMOVE WASTE FROM ALL PIPELINE SECTIONS REMAINING IN PLACE. VIDEO INSPECT CLEANED PIPELINES TO VERIFY ALL SLUDGE HAS BEEN REMOVED AND PIPELINE IS VISUALLY CLEAN.
4. FILL CLEANED SECTIONS OF PIPE WITH FLOWABLE FILL OR OTHER APPROVED MATERIAL.

SOIL/PIPELINE EXCAVATIONS:

1. SITE PREPARATION: INSTALL EROSION CONTROL MEASURES, CLEAR TREES AND CONSTRUCT ACCESS ROADS TO EXCAVATION AREAS.
2. EXCAVATE AREAS TO LIMITS DEFINED OR FOR PIPELINES IDENTIFIED FOR REMOVAL BASED ON VIDEO INSPECTION AND SOIL SAMPLING, DELINEATE AN AREA FOR REMOVAL ENCOMPASSING 1-FT TO EITHER SIDE HORIZONTALLY FROM THE PIPELINE AND 1-FT BEYOND EITHER SIDE OF THE BREAK ALONG THE PIPELINE. EXCAVATION DEPTH FOR BROKEN PIPELINES SHALL BE A MINIMUM OF 1-FT BELOW THE PIPE.
3. VISUALLY INSPECT THE EXCAVATIONS AND IF NO IMPACTS ARE OBSERVED, COLLECT CONFIRMATION SAMPLES. FOR PIPELINE EXCAVATIONS COLLECT CONFIRMATION SAMPLES ALONG SIDEWALLS AND BOTTOMS OF EXCAVATIONS. 2 SIDEWALL SAMPLES AND 1 BOTTOM SAMPLE SHALL BE COLLECTED EVERY 30 LINEAR FEET. SIDEWALL SAMPLES SHALL BE COLLECTED AT THE BOTTOM OF THE SIDEWALL AND INLINE WITH THE PIPE.
4. BASED ON RESULTS PROCEED WITH ADDITIONAL EXCAVATIONS OR IF RESULTS ARE CLEAN THEN BACKFILL THE EXCAVATION.
5. FOLLOWING BACKFILL, RESTORE WITH TOPSOIL AND SEED.
6. ONCE ALL WORK IN AN AREA IS COMPLETE REMOVE ALL EQUIPMENT AND MATERIALS FROM THE SITE AND RESTORE ALL AREAS AS SHOWN ON THE CONTRACT DRAWINGS. ONCE FINAL STABILIZATION HAS BEEN ACHIEVED TEMPORARY EROSION CONTROL MEASURES CAN BE REMOVED.

ISTD TREATMENT:

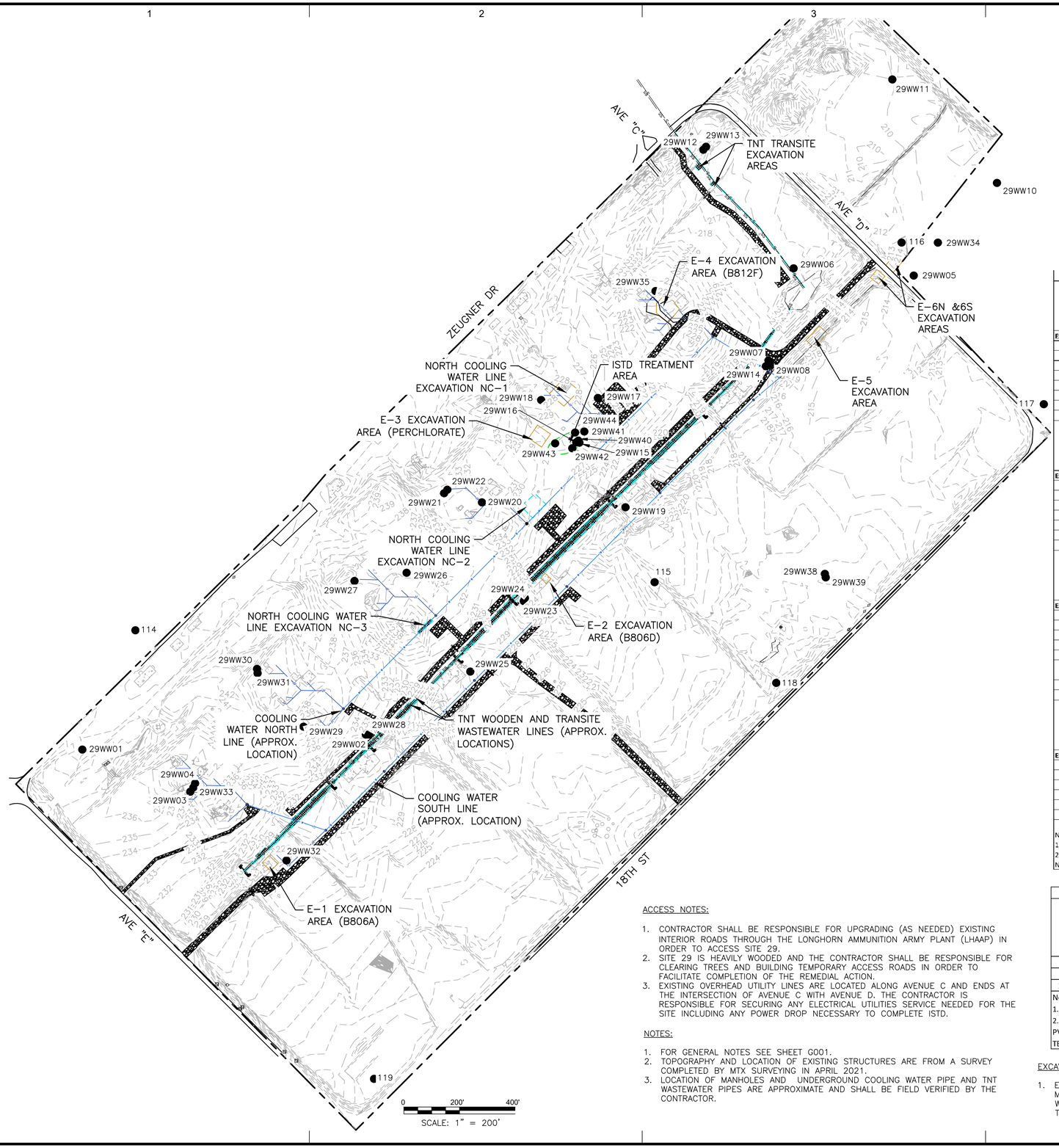
1. SECURE POWER DROP.
2. PROVIDE SITE CLEARING AND INSTALL CONSTRUCTION ACCESS ROAD AND STAGING AREA.
3. INSTALL MONITORING WELLS AND COLLECT BASELINE GROUNDWATER SAMPLES FROM EXISTING AND NEWLY INSTALLED MONITORING WELLS. ANALYZE RESULTS USING A 48-HOUR TAT OR AS OTHERWISE APPROVED BY THE USACE.
4. INSTALL INFRASTRUCTURE FOR SYSTEM.
5. STARTUP THE ISTD SYSTEM
6. OPERATE SYSTEM UNTIL CRITERIA INDICATING CLEANUP OBJECTIVES HAVE BEEN MET. ONCE CRITERIA IS MET SYSTEM SHALL BE SHUT DOWN.
7. PERFORM ONE ROUND OF GROUNDWATER SAMPLING. SAMPLING SHALL BE AT A POINT WHEN GROUNDWATER TEMPERATURES HAVE DROPPED BELOW 100 DEG. CELSIUS OR AS OTHERWISE APPROVED BY THE USACE.
8. FOLLOWING RECEIPT OF GROUNDWATER SAMPLES ACHIEVING THE CLEANUP LEVEL OF 8,000 UG/L OF METHYLENE CHLORIDE AND 300 UG/L OF TCE, THE ISTD SYSTEM CAN BE DECOMMISSIONED.
9. RESTORE THE AREA TO PRE-EXISTING CONDITIONS TO THE EXTENT PRACTICABLE FOLLOWING REMOVAL AND DEMOBILIZATION OF ALL EQUIPMENT AND MATERIALS FROM THE SITE.

MONITORING WELL INSTALLATION:

1. COLLECT WATER LEVEL MEASUREMENTS FROM ALL EXISTING WELLS. COLLECT ONE ROUND OF GROUNDWATER SAMPLES FROM EXISTING WELLS IDENTIFIED TO BE SAMPLED. GROUNDWATER SAMPLES SHALL BE ANALYZED FOR EXPLOSIVES, PERCHLORATE, AND VOCS. PROVIDE STANDARD 10 DAY TURN AROUND ON COLLECTED SAMPLES.
2. BASED ON SAMPLE RESULTS UP TO 12 NEW MONITORING WELLS MAY BE INSTALLED AS INDICATED ON SHEET G003. FINAL LOCATIONS WILL BE SELECTED BY THE USACE AND PROVIDED TO THE CONTRACTOR. THREE ADDITIONAL SHALLOW MONITORING WELLS WILL BE INSTALLED IN THE VICINITY OF EXCAVATIONS STOPPED AT THE WATER TABLE.
3. INSTALL AND DEVELOP NEW MONITORING WELLS. ALL MONITORING WELLS SHALL BE FINISHED AS MONUMENT WELLS AND PROTECTED WITH BOLLARDS PAINTED WITH A HIGHLY VISIBLE COLOR.
4. COLLECT ONE COMPLETE ROUND OF GROUNDWATER SAMPLES FROM EXISTING AND NEWLY INSTALLED WELLS. THE SAMPLING EVENT SHALL BE COMPLETED NOT LESS THAN 48 HOURS FROM THE TIME THE NEW MONITORING WELLS HAVE BEEN INSTALLED AND DEVELOPED AND SHALL BE A MINIMUM OF 3 MONTHS AFTER THE BASELINE SAMPLING EVENT DISCUSSED IN NOTE 1. RESULTS SHALL BE ANALYZED ON A STANDARD TURN AROUND TIME.

WELL INSTALLATION NOTES:

1. THE FOLLOWING REQUIREMENTS SHALL BE USED FOR THE INSTALLATION OF GROUNDWATER MONITORING WELLS. THE CONTRACTOR SHALL OBTAIN WRITTEN APPROVAL FROM THE USACE PRIOR TO WELL INSTALLATION IF EQUIVALENT ALTERNATIVES TO THESE REQUIREMENTS ARE BE USED.
2. DRILLING:
   - A. MONITORING WELLS SHALL BE DRILLED BY A TEXAS-LICENSED DRILLER WHO IS QUALIFIED TO DRILL AND INSTALL MONITORING WELLS. THE INSTALLATION AND DEVELOPMENT SHALL BE SUPERVISED BY A LICENSED PROFESSIONAL GEOSCIENTIST OR ENGINEER WHO IS FAMILIAR WITH THE GEOLOGY OF THE AREA.
   - B. THE WELL SHALL BE DRILLED BY ROTOSONIC DRILLING METHOD, UNLESS OTHERWISE APPROVED BY THE USACE. IF OTHER METHODS ARE APPROVED, THE ALTERNATIVE DRILLING METHOD USED SHALL ALLOW INSTALLATION OF THE CASING, SCREEN, ETC., AND THAT WILL NOT INTRODUCE CONTAMINANTS INTO THE BOREHOLE OR CASING. DRILLING TECHNIQUES USED FOR BORING SHALL CONSIDER THE MATERIALS TO BE DRILLED, DEPTH TO GROUNDWATER, TOTAL DEPTH OF THE HOLE, ADEQUATE SOIL SAMPLING, AND OTHER SUCH FACTORS THAT AFFECT THE SELECTION OF THE DRILLING METHOD. ANY DRILLING FLUIDS USED SHALL BE APPROVED IN WRITING BY THE USACE BEFORE ITS USE ON SITE.
   - C. THE DIAMETER OF THE BORING SHALL BE AT LEAST FOUR INCHES LARGER THAN THE DIAMETER OF THE CASING.
   - D. A LOG OF THE BORING SHALL BE MADE BY OR UNDER THE SUPERVISION OF A LICENSED PROFESSIONAL GEO-SCIENTIST OR ENGINEER WHO IS FAMILIAR WITH THE GEOLOGY OF THE AREA, AND SHALL BE SEALED, SIGNED, AND DATED BY THE LICENSED PROFESSIONAL.
   - E. CASING, SCREEN, FILTER PACK, AND SEALS:
     - E.A. THE WELL CASING FOR SHALLOW WELLS SHALL BE FOUR INCHES IN DIAMETER; NATIONAL SCIENCE FOUNDATION-CERTIFIED POLYVINYL CHLORIDE (PVC) SCHEDULE 40 PIPE, FLUSH-THREAD, SCREW JOINT (NO GLUE OR SOLVENTS); POLYTETRAFLUOROETHYLENE (PTFE, SUCH AS TEFLON) TAPE OR O-RINGS IN THE JOINTS; NO COLLAR COUPLINGS.
     - E.B. THE WELL CASING FOR INTERMEDIATE WELLS INSTALLED IN THE VICINITY OF THE ISTD AREA SHALL BE FOUR INCHES IN DIAMETER; STAINLESS STEEL SCHEDULE 40 PIPE, FLUSH-THREAD, SCREW JOINT;
     - E.B. THE WELL CASING FOR DEEP WELLS INSTALLED IN THE VICINITY OF THE ISTD AREA SHALL BE TWO INCHES IN DIAMETER; STAINLESS STEEL SCHEDULE 40 PIPE, FLUSH-THREAD, SCREW JOINT;
   - F. THE TOP OF THE INNER PVC CASING SHALL BE 6 INCHES TO 2 FEET ABOVE GROUND LEVEL. THE TOP OF THE OUTER PROTETCIVE CASING SHALL BE 2 TO 3 FEET ABOVE GROUND LEVEL FOR MONITORING WELLS.
   - G. WHERE HIGH LEVELS OF VOLATILE ORGANIC COMPOUNDS OR CORROSIVE COMPOUNDS ARE ANTICIPATED, STAINLESS STEEL OR PTFE CASING AND SCREEN MAY BE USED, SUBJECT TO APPROVAL BY THE USACE. WELLS INSTALLED IN THE ISTD AREA SHALL HAVE STAINLESS STEEL CASINGS AND SCREENS.
   - H. THE CASING SHALL BE CLEANED AND PACKAGED AT THE PLACE OF MANUFACTURE; THE PACKAGING SHALL INCLUDE A PVC WRAPPING ON EACH SECTION OF CASING TO KEEP IT FROM BEING CONTAMINATED PRIOR TO INSTALLATION. THE CASING SHALL BE FREE OF INK, LABELS, OR OTHER MARKINGS. THE CASING (AND SCREEN) SHALL BE CENTERED IN THE HOLE TO ALLOW INSTALLATION OF A GOOD FILTER PACK AND ANNULAR SEAL. CENTRALIZERS ARE RECOMMENDED ON WELLS OVER SIX METERS (20 FEET) IN LENGTH BUT MAY NOT BE NEEDED IF THE WELLS ARE INSTALLED THROUGH HOLLOW-STEM AUGERS. THE TOP OF THE CASING SHALL BE PROTECTED BY A THREADED OR SLIP-ON TOP CAP OR BY A SEALING CAP OR SCREW-PLUG SEAL INSERTED INTO THE TOP OF THE CASING. THE CAP SHALL BE VENTED TO PREVENT BUILDUP OF ANY GASES AND SHALL BE DESIGNED TO PREVENT MOISTURE FROM ENTERING THE WELL.
   - I. THE SCREEN SHALL BE COMPATIBLE WITH THE CASING AND SHOULD GENERALLY BE OF THE SAME MATERIAL. THE SCREEN SHALL NOT INVOLVE THE USE OF ANY GLUES OR SOLVENTS FOR CONSTRUCTION. FIELD-CUT SLOTS ARE NOT PERMITTED FOR WELL SCREEN. FILTER CLOTH SHALL NOT BE USED. A BLANK-PIPE SEDIMENT TRAP, TYPICALLY 4 TO 6 INCHES, SHOULD BE INSTALLED BELOW THE SCREEN. A BOTTOM CAP IS TYPICALLY PLACED ON THE BOTTOM OF THE SEDIMENT TRAP. THE SEDIMENT TRAP SHALL NOT EXTEND THROUGH THE LOWER CONFINING LAYER OF THE WATER-BEARING ZONE BEING TESTED. SCREEN STERILIZATION METHODS ARE THE SAME AS THOSE FOR CASING. SELECTION OF THE SIZE OF THE SCREEN OPENING SHOULD BE DONE BY A PERSON EXPERIENCED WITH SUCH WORK AND SHALL INCLUDE CONSIDERATION OF THE DISTRIBUTION OF PARTICLE SIZES BOTH IN THE WATER-BEARING ZONE AND IN THE FILTER PACK SURROUNDING THE SCREEN. THE SCREEN OPENING SHALL NOT BE LARGER THAN THE SMALLEST FRACTION OF THE FILTER PACK.
   - J. THE FILTER PACK, PLACED BETWEEN THE SCREEN AND THE WELL BORE, SHALL CONSIST OF PREPACKAGED, INERT, CLEAN SILICA SAND OR GLASS BEADS. OPEN STOCKPILE SOURCES OF SAND OR GRAVEL ARE NOT PERMITTED. THE FILTER PACK USUALLY HAS A 30% FINER GRAIN SIZE THAT IS ABOUT FOUR TO TEN TIMES LARGER THAN THE 30% FINER GRAIN SIZE OF THE WATER-BEARING ZONE; THE FILTER PACK SHOULD HAVE A UNIFORMITY COEFFICIENT LESS THAN 2.5. THE FILTER PACK SHOULD BE PLACED WITH A TREMIE PIPE TO ENSURE THAT THE MATERIAL COMPLETELY SURROUNDS THE SCREEN AND CASING WITHOUT BRIDGING. THE TREMIE PIPE SHALL BE STEAM CLEANED PRIOR TO THE FIRST WELL AND BEFORE EACH SUBSEQUENT WELL.
   - K. THE ANNULAR SEAL SHALL BE PLACED ON TOP OF THE FILTER PACK AND SHALL BE AT LEAST THREE FEET THICK. IT SHOULD BE PLACED IN THE ZONE OF SATURATION TO MAINTAIN HYDRATION. THE SEAL SHOULD BE COMPOSED OF COARSE-GRAIN SODIUM BENTONITE, COARSE-GRIT SODIUM BENTONITE, OR BENTONITE GROUT. SPECIAL CARE SHOULD BE TAKEN TO ENSURE THAT THE MATERIAL OR GROUT DOES NOT PLUG THE UNDERLYING FILTER PACK. PLACEMENT OF A FEW INCHES OF PREPACKAGED CLEAN FINE SAND ON TOP OF THE FILTER PACK WILL HELP TO PREVENT MIGRATION OF THE ANNULAR SEAL MATERIAL INTO THE FILTER PACK. THE SEAL SHOULD BE PLACED ON TOP OF THE FILTER PACK WITH A STEAM-CLEANED TREMIE PIPE TO ENSURE GOOD DISTRIBUTION AND SHOULD BE TAMPED WITH A STEAM-CLEANED ROD TO DETERMINE THAT THE SEAL IS THICK ENOUGH. THE BENTONITE SHALL BE HYDRATED WITH CLEAN WATER PRIOR TO ANY FURTHER ACTIVITIES ON THE WELL AND LEFT TO STAND UNTIL HYDRATION IS COMPLETE (EIGHT TO 12 HOURS, DEPENDING ON THE GRAIN SIZE OF THE BENTONITE). IF A BENTONITE-GROUT (WITHOUT CEMENT) CASING SEAL IS USED IN THE WELL BORE, THEN IT MAY REPLACE THE ANNULAR SEAL DESCRIBED IN THIS PARAGRAPH.
   - L. A CASING SEAL SHALL BE PLACED ON TOP OF THE ANNULAR SEAL TO PREVENT FLUIDS AND CONTAMINANTS FROM ENTERING THE BOREHOLE FROM THE SURFACE. THE CASING SEAL SHALL CONSIST OF A COMMERCIAL BENTONITE GROUT OR A CEMENT-BENTONITE MIXTURE. DRILLING SPOIL, CUTTINGS, OR OTHER NATIVE MATERIALS ARE NOT PERMITTED FOR USE AS A CASING SEAL.
   - M. QUICK-SETTING CEMENTS ARE NOT PERMITTED FOR USE BECAUSE CONTAMINANTS MAY LEACH FROM THEM INTO THE GROUNDWATER. THE TOP OF THE CASING SEAL SHALL BE BETWEEN FIVE AND TWO FEET FROM THE SURFACE.
3. CONCRETE PAD. HIGH-QUALITY STRUCTURAL-TYPE CONCRETE SHALL BE PLACED FROM THE TOP OF THE CASING SEAL (TWO TO FIVE FEET BELOW THE SURFACE) CONTINUOUSLY TO THE TOP OF THE GROUND TO FORM A PAD AT THE SURFACE. THIS FORMED SURFACE PAD SHALL BE AT LEAST SIX INCHES THICK AND NOT LESS THAN FOUR (PREFERABLY SIX) FEET SQUARE OR FIVE (PREFERABLY SIX) FEET IN DIAMETER. THE PAD SHALL CONTAIN SUFFICIENT REINFORCING STEEL TO ENSURE ITS STRUCTURAL INTEGRITY IN THE EVENT THAT SOIL SUPPORT IS LOST. THE TOP OF THE PAD SHALL SLOPE AWAY FROM THE WELL BORE TO THE EDGES TO PREVENT PONDING OF WATER AROUND THE CASING OR COLLAR.
4. PROTECTIVE COLLAR. A STEEL PROTECTIVE PIPE COLLAR SHALL BE PLACED AROUND THE CASING "STICKUP" TO PROTECT IT FROM DAMAGE AND UNWANTED ENTRY. THE COLLAR SHALL BE SET AT LEAST ONE FOOT INTO THE SURFACE PAD DURING ITS CONSTRUCTION. THE WELL NUMBER OR OTHER DESIGNATION SHALL BE MARKED PERMANENTLY ON THE PROTECTIVE STEEL COLLAR; IT IS USEFUL TO MARK THE TOTAL DEPTH OF THE WELL AND ITS ELEVATION ON THE COLLAR. THE COLLAR SHOULD EXTEND AT LEAST THREE INCHES ABOVE THE TOP OF THE WELL CASING (AND TOP CAP, IF PRESENT). THE TOP OF THE COLLAR SHALL HAVE A LOCKABLE HINGED TOP FLAP OR COVER. A STURDY LOCK SHALL BE INSTALLED AND A COPY SHALL BE PROVIDED TO THE USACE.
5. PROTECTIVE BARRIER. WHERE MONITORING WELLS ARE LIKELY TO BE DAMAGED BY MOVING EQUIPMENT OR ARE LOCATED IN HEAVILY TRAVELED AREAS, A PROTECTIVE BARRIER SHALL BE INSTALLED. A TYPICAL BARRIER IS THREE OR FOUR 6- TO 12-INCH DIAMETER PIPES SET IN CONCRETE JUST OFF THE PROTECTIVE PAD. THE PIPES CAN BE JOINED BY PIPES WELDED BETWEEN THEM, BUT CONSIDERATION SHALL BE GIVEN TO WELL ACCESS FOR SAMPLING AND OTHER ACTIVITIES. SEPARATION OF SUCH A PIPE BARRIER FROM THE PAD MEANS THAT THE BARRIER CAN BE DAMAGED WITHOUT RISK TO THE PAD AND WELL.
6. DEVELOPMENT. WELLS SHALL BE DEVELOPED WITHIN 4 TO 7 DAYS AFTER INSTALLATION IS COMPLETE. DEVELOPMENT SHOULD CONTINUE UNTIL ALL OF THE WATER USED OR AFFECTED DURING DRILLING ACTIVITIES HAS BEEN REMOVED AND FIELD MEASUREMENTS OF PH, SPECIFIC CONDUCTANCE, AND TEMPERATURE HAVE STABILIZED.
7. LOCATION AND ELEVATION. UPON COMPLETION OF A MONITORING WELL, THE LOCATION OF THE WELL AND ALL APPROPRIATE ELEVATIONS (GROUND SURFACE, TOP OF OUTER CASING AND TOP OF INNER CASING) SHALL BE SURVEYED BY A REGISTERED PROFESSIONAL SURVEYOR. THE ELEVATION SHALL BE SURVEYED TO THE NEAREST 0.01 FOOT ABOVE MEAN SEA LEVEL (WITH YEAR OF THE SEA-LEVEL DATUM SHOWN). THE POINT ON THE WELL CASING FOR WHICH THE ELEVATION WAS DETERMINED SHALL BE PERMANENTLY MARKED ON THE CASING. THE LOCATION SHALL BE GIVEN IN TERMS OF THE LATITUDE AND LONGITUDE TO THE NEAREST TENTH OF A SECOND.
8. REPORTING. MONITORING WELL INSTALLATION AND CONSTRUCTION DETAILS SHALL BE SUBMITTED ON FORMS A



Southern TNT Plume Monitoring Wells

Well ID	Easting	Northing	Ground Surface Elevation[1]	Monitoring Point Elevation[1]	Well Casing Materials	Well Screen Materials	Well Screen Slot Size	Well Dia.	Well Depth[1]	Screen Interval		Screen Interval Elevation		Measured Water Level Elevation[2]
	ft	ft	ft amsl	ft amsl				inches	ft bgs	ft bgs	ft bgs	ft amsl	ft amsl	ft amsl
Existing Wells														
114	3304550.50	6955173.50	241.13	242.88	PVC	PVC	NA	2	36	15	30	227.88	212.88	214.28
29WW01	3304359.50	6954744.60	239.37	242.34	SS	SS	0.01	4	32	22	32	220.34	210.34	212.06
29WW03	3304747.80	6954593.10	234.72	237.68	SS	SS	0.01	4	27	17	27	220.68	210.68	209.77
29WW29	3305155.20	6954826.80	239.43	242.91	SS	SS	0.01	4	37	27	37	215.91	205.91	208.75
29WW32	3305093.90	6954345.90	226.51	229.09	SS	SS	0.01	4	28	18	28	211.09	201.09	199.48
29WW33	3304759.00	6954608.20	234.43	237.8	SS	SS	0.01	4	40	30	40	207.80	197.80	209.30

Middle TNT Plume Monitoring Wells

Well ID	Easting	Northing	Ground Surface Elevation[1]	Monitoring Point Elevation[1]	Well Casing Materials	Well Screen Materials	Well Screen Slot Size	Well Dia.	Well Depth[1]	Screen Interval		Screen Interval Elevation		Measured Water Level Elevation[2]
	ft	ft	ft amsl	ft amsl				inches	ft bgs	ft bgs	ft bgs	ft amsl	ft amsl	ft amsl
Existing Wells														
29WW15	3306147.40	6955848.20	229.69	232.98	SS	SS	0.01	4	30	20	30	212.98	202.98	NA
29WW20	3305795.90	6955633.60	232.4	235.7	SS	SS	0.01	4	29.6	20	30	215.70	205.70	NA
29WW22	3305672.40	6955679.10	233.04	236.1	SS	SS	0.01	4	32.6	23	33	213.10	203.10	204.95
29WW23	3305947.50	6955278.40	223.29	226.63	SS	SS	0.01	4	35	25	35	201.63	191.63	198.38
29WW26	3305525.90	6955380.30	234.54	237.21	SS	SS	0.01	4	33	23	33	214.21	204.21	205.11

VOC and Perchlorate Plume Monitoring Wells

Well ID	Easting	Northing	Ground Surface Elevation[1]	Monitoring Point Elevation[1]	Well Casing Materials	Well Screen Materials	Well Screen Slot Size	Well Dia.	Well Depth[1]	Screen Interval		Screen Interval Elevation		Measured Water Level Elevation[2]
	ft	ft	ft amsl	ft amsl				inches	ft bgs	ft bgs	ft bgs	ft amsl	ft amsl	ft amsl
Existing Wells														
29WW15	3306147.40	6955848.20	229.69	232.98	SS	SS	0.01	4	30	20	30	212.98	202.98	NA
29WW17	3306214.00	6956008.90	227.25	230.48	SS	SS	0.01	4	29	19	29	211.48	201.48	199.85
29WW18	3306009.90	6956001.60	228.09	231.18	SS	SS	0.01	4	29	19	29	212.18	202.18	204.06
29WW19	3306313.20	6955615.90	217.85	220.69	SS	SS	0.01	4	32.5	23	33	197.69	187.69	195.51
29WW20	3305796.90	6955633.60	232.40	235.70	SS	SS	0.01	4	29.6	20	30	215.70	205.70	NA
29WW22	3305672.40	6955679.10	233.04	236.10	SS	SS	0.01	4	32.6	23	33	213.10	203.10	204.95

Perchlorate and North TNT Plume Monitoring Wells

Well ID	Easting	Northing	Ground Surface Elevation[1]	Monitoring Point Elevation[1]	Well Casing Materials	Well Screen Materials	Well Screen Slot Size	Well Dia.	Well Depth[1]	Screen Interval		Screen Interval Elevation		Measured Water Level Elevation[2]
	ft	ft	ft amsl	ft amsl				inches	ft bgs	ft bgs	ft bgs	ft amsl	ft amsl	ft amsl
Existing Wells														
116	3307306.40	6956567.80	213.47	216.21	PVC	PVC	NA	2	37	22	37	194.21	179.21	187.84
29WW05	3307350.10	6956449.00	206.01	208.95	SS	SS	0.01	4	22	12	22	196.95	186.95	189.56
29WW06	3306918.00	6956475.00	207.05	210.34	SS	SS	0.01	4	37	22	32	188.34	178.34	179.30
29WW09	3307426.30	6956262.70	208.11	211.02	SS	SS	0.01	4	27	17	27	194.02	184.02	182.12
29WW10	3307649.40	6956782.20	202.18	204.95	SS	SS	0.01	4	29	19	29	185.95	175.95	177.66
29WW11	3307273.10	6957154.30	202.68	205.68	SS	SS	0.01	4	27	17	27	188.68	178.68	178.28

Notes:
1. Ground surface and measuring point elevations for existing wells are taken from well construction logs prepared for these wells.
2. Groundwater elevations are taken from Figure 1-6 of the Final FS prepared by Shaw (2010). This figure indicates water levels were collected in November through December 2007.
NA - Not Available

Proposed Monitoring Wells for Excavation Areas Ending at Water Table

Well ID	Northing[1]	Easting[1]	Well Casing Materials	Well Screen Materials	Well Screen Slot Size	Well Dia	Estimated Well Depth[2]	Screen Interval	
	ft	ft				inches	ft bgs	ft bgs	ft bgs
29WW-E3	TBD	TBD	PVC	PVC	0.01	2	24	14	24
29WW-E4	TBD	TBD	PVC	PVC	0.01	2	26	16	26
29WW-NC3	TBD	TBD	PVC	PVC	0.01	2	23	13	23

Notes:
1. Locations will be selected in the field once the excavation has been completed and backfilled.
2. Final well depth will be based on the final depth of the excavation. The well depth shall be installed 10-ft below the bottom of the excavation.
PVC - polyvinyl chloride
TBD - to be determined

ACCESS NOTES:

1. CONTRACTOR SHALL BE RESPONSIBLE FOR UPGRADING (AS NEEDED) EXISTING INTERIOR ROADS THROUGH THE LONGHORN AMMUNITION ARMY PLANT (LHAAP) IN ORDER TO ACCESS SITE 29.
2. SITE 29 IS HEAVILY WOODED AND THE CONTRACTOR SHALL BE RESPONSIBLE FOR CLEARING TREES AND BUILDING TEMPORARY ACCESS ROADS IN ORDER TO FACILITATE COMPLETION OF THE REMEDIAL ACTION.
3. EXISTING OVERHEAD UTILITY LINES ARE LOCATED ALONG AVENUE C AND ENDS AT THE INTERSECTION OF AVENUE C WITH AVENUE D. THE CONTRACTOR IS RESPONSIBLE FOR SECURING ANY ELECTRICAL UTILITIES SERVICE NEEDED FOR THE SITE INCLUDING ANY POWER DROP NECESSARY TO COMPLETE ISTD.

NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
2. TOPOGRAPHY AND LOCATION OF EXISTING STRUCTURES ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021.
3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND SHALL BE FIELD VERIFIED BY THE CONTRACTOR.

EXCAVATION MONITORING WELL NOTES:

1. EXCAVATIONS ENDING AT THE WATER TABLE WILL HAVE A SINGLE MONITORING WELL INSTALLED TO PROVIDE LONG TERM MONITORING OF THE GROUNDWATER IN THESE AREAS. THREE EXCAVATIONS ARE CURRENTLY IDENTIFIED TO END AT THE WATER TABLE. PROPOSED WELLS ARE SHOWN IN THE ABOVE TABLE. IF OTHER EXCAVATION AREAS END AT THE WATER TABLE THESE ALSO WILL REQUIRE THE INSTALLATION OF A SINGLE WELL.

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STATE OF TEXAS · MICHAEL J. VECCHIO · 147486 · LICENSED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
4	100% DRAFT DESIGN EPA/TCEQ SUBMISSION	07/05/2023
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8	FINAL APPROVED DESIGN	02/28/2024
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DESIGNED BY: S. KLING
DRWN BY: S. KLING
CHKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO: W912BV20F0096
CONTRACT NO: W912BV19D0016
FILE NUMBER: 112645357
PLOT DATE: 2/28/2024
PLOT SCALE: AS NOTED
SIZE: ANSI D
FILE NAME: "G2645378\0_CAD_BIM\8-2_WP\8-2-4_FINAL DESIGN

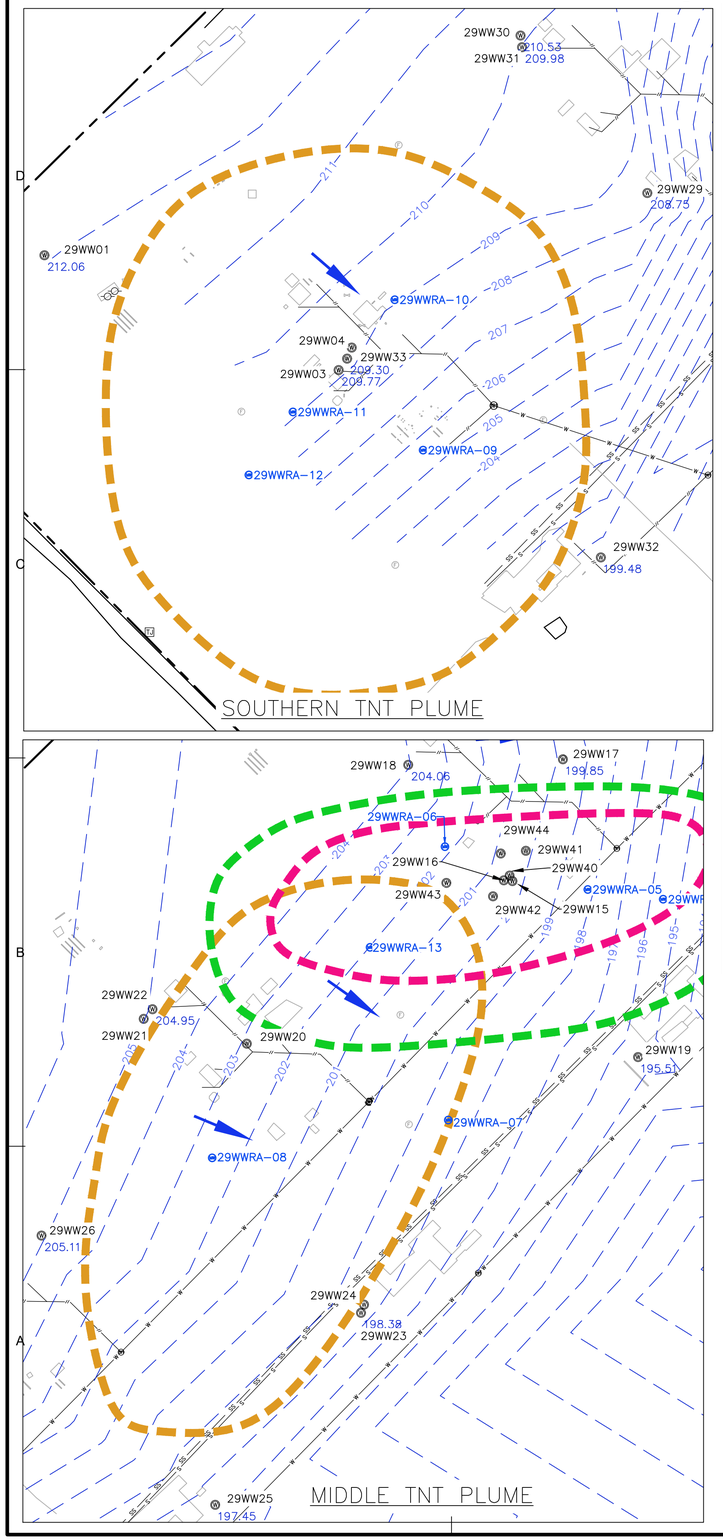
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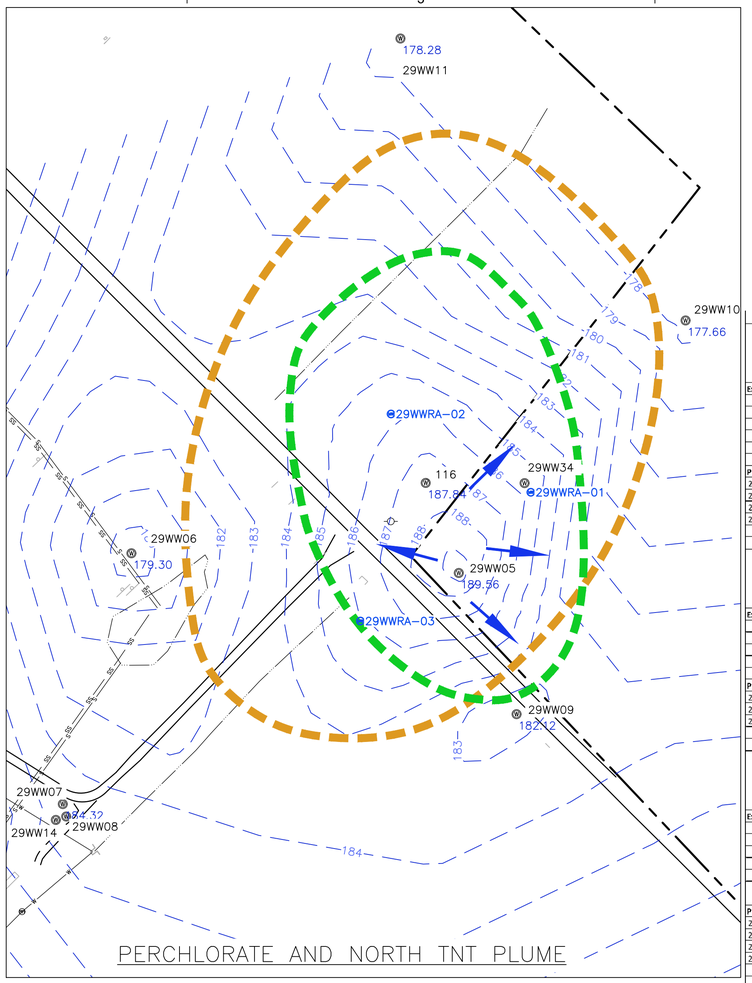
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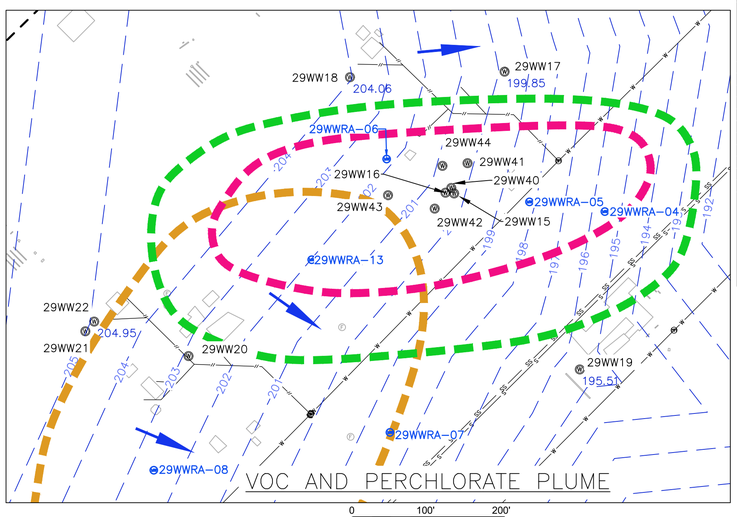
LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

REMEDIAL ACTION SITE PLAN

SHEET IDENTIFICATION
G002
SHEET 3 OF 30







LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- UTILITY POLE
- SIGN
- SITE BOUNDARY
- EXISTING PAVEMENT
- EXISTING GRAVEL
- WATER EDGE
- COOLING WATER MAIN PIPE – ASSUMED 18"
- COOLING WATER BUILDING SERVICE PIPE
- 12" WOOD TNT WASTEWATER LINE
- 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE STRUCTURE
- GROUNDWATER CONTOUR
- PROPOSED WELL LOCATION
- APPROXIMATE LIMIT OF SHALLOW GROUNDWATER CONTAMINATED WITH NITROTOLUENES
- APPROXIMATE LIMIT OF SHALLOW GROUNDWATER CONTAMINATED WITH PERCHLORATE
- APPROXIMATE LIMIT OF SHALLOW GROUNDWATER CONTAMINATED WITH VOLATILE ORGANIC COMPOUNDS
- GROUNDWATER FLOW DIRECTION

N

KEY MAP

Southern TNT Plume Monitoring Wells

Well ID	Distance from Estimated Plume Center	Location from Estimated Plume Center	Easting	Northing	Ground Surface Elevation[1]	Monitoring Point Elevation[2]	Well Casing Materials	Well Screen Materials	Well Screen Slot Size	Well Dia.	Well Depth[1]	Screen Interval		Screen Interval Elevation		Measured Water Level Elevation[3]
	ft		ft	ft	ft amsl	ft amsl				inches	ft bgs	ft bgs	ft bgs	ft amsl	ft amsl	ft amsl
Existing Wells																
114	600	Upgradient	3304550.50	6955173.50	241.13	242.88	PVC	PVC	NA	2	36	15	30	227.88	212.88	214.28
29WW01	422	Upgradient	3304359.50	6954744.60	239.37	242.34	SS	SS	0.01	4	32	22	32	220.34	210.34	212.06
29WW03	0	Interior	3304747.80	6954593.10	234.72	237.68	SS	SS	0.01	4	27	17	27	220.68	210.68	209.77
29WW29	455	Side Gradient	3305155.20	6954826.80	239.43	242.91	SS	SS	0.01	4	37	27	37	215.91	205.91	208.75
29WW32	427	Downgradient	3305093.90	6954345.90	226.51	229.09	SS	SS	0.01	4	28	18	28	211.09	201.09	199.48
29WW33	0	Interior	3304759.00	6954608.20	234.43	237.8	SS	SS	0.01	4	40	30	40	207.80	197.80	209.30
Proposed Wells[4]																
29WW2023-09	154	Downgradient	3304859.30	6954487.42	236.18	238.18	PVC	PVC	0.01	4	31	21	31	217.18	207.18	NA
29WW2023-10	100	Side Gradient	3304821.93	6954685.95	234.54	236.54	PVC	PVC	0.01	4	28	18	28	218.54	208.54	NA
29WW2023-11	100	Side Gradient	3304687.45	6954537.83	234.86	236.86	PVC	PVC	0.01	4	28	18	28	218.86	208.86	NA
29WW2023-12	200	Side Gradient	3304629.35	6954454.72	235.04	237.04	PVC	PVC	0.01	4	29	19	29	218.04	208.04	NA

Middle TNT Plume Monitoring Wells

Well ID	Distance from Estimated Plume Center	Location from Estimated Plume Center	Easting	Northing	Ground Surface Elevation[1]	Monitoring Point Elevation[2]	Well Casing Materials	Well Screen Materials	Well Screen Slot Size	Well Dia.	Well Depth[1]	Screen Interval		Screen Interval Elevation		Measured Water Level Elevation[3]
	ft		ft	ft	ft amsl	ft amsl				inches	ft bgs	ft bgs	ft bgs	ft amsl	ft amsl	ft amsl
Existing Wells																
29WW15	411	Side Gradient	3306147.40	6955848.20	229.69	232.98	SS	SS	0.01	4	30	20	30	212.98	202.98	NA
29WW20	0	Interior	3305796.90	6955633.60	232.4	235.7	SS	SS	0.01	4	29.6	20	30	215.70	205.70	NA
29WW22	132	Upgradient	3305672.40	6955679.10	233.04	236.1	SS	SS	0.01	4	32.6	23	33	213.10	203.10	204.95
29WW23	399	Downgradient	3305947.50	6955278.40	223.29	226.63	SS	SS	0.01	4	35	25	35	201.63	191.63	198.38
29WW26	374	Side Gradient	3305525.90	6955380.30	234.54	237.21	SS	SS	0.01	4	33	23	33	214.21	204.21	205.11
Proposed Wells[4]																
29WW2023-07	285	Downgradient	3305052.70	6955532.87	227.41	229.41	PVC	PVC	0.01	4	28	18	28	211.41	201.41	NA
29WW2023-08	157	Side Gradient	3305751.08	6955482.93	231.00	233.00	PVC	PVC	0.01	4	30	20	30	213.00	203.00	NA
29WW2023-13	207	Side Gradient	3305959.48	6955760.74	229.74	231.74	PVC	PVC	0.01	4	30	20	30	211.74	201.74	NA

VOC and Perchlorate Plume Monitoring Wells

Well ID	Distance from Estimated Plume Center	Location from Estimated Plume Center	Easting	Northing	Ground Surface Elevation[1]	Monitoring Point Elevation[2]	Well Casing Materials	Well Screen Materials	Well Screen Slot Size	Well Dia.	Well Depth[1]	Screen Interval		Screen Interval Elevation		Measured Water Level Elevation[3]
	ft		ft	ft	ft amsl	ft amsl				inches	ft bgs	ft bgs	ft bgs	ft amsl	ft amsl	ft amsl
Existing Wells																
29WW15	0	Interior	3306147.40	6955848.20	229.69	232.98	SS	SS	0.01	4	30	20	30	212.98	202.98	NA
29WW17	177	Side Gradient	3306214.00	6956008.90	227.25	230.48	SS	SS	0.01	4	29	19	29	211.48	201.48	199.85
29WW18	210	Upgradient	3306009.90	6956001.60	228.09	231.18	SS	SS	0.01	4	29	19	29	212.18	202.18	204.06
29WW19	289	Downgradient	3306313.20	6955615.90	217.85	220.69	SS	SS	0.01	4	32.5	23	33	197.69	187.69	195.51
29WW20	416	Side Gradient	3305796.90	6955633.60	232.40	235.70	SS	SS	0.01	4	29.6	20	30	215.70	205.70	NA
29WW22	505	Upgradient & Side Gradient	3305672.40	6955679.10	233.04	236.10	SS	SS	0.01	4	32.6	23	33	213.10	203.10	204.95
Proposed Wells[4]																
29WW2023-04	100	Downgradient	3306346.34	6955824.28	222.22	224.22	PVC	PVC	0.01	4	23	13	23	211.22	201.22	NA
29WW2023-05	100	Side Gradient	3306246.82	6955837.11	227.17	229.17	PVC	PVC	0.01	4	28	18	28	211.17	201.17	NA
29WW2023-06	100	Side Gradient	3306058.33	6955893.58	228.60	230.60	PVC	PVC	0.01	4	29	19	29	211.60	201.60	NA
29WW2023-13	205	Side Gradient	3305959.48	6955760.74	229.74	231.74	PVC	PVC	0.01	4	30	20	30	211.74	201.74	NA

Perchlorate and North TNT Plume Monitoring Wells

Well ID	Distance from Estimated Plume Center	Location from Estimated Plume Center	Easting	Northing	Ground Surface Elevation[1]	Monitoring Point Elevation[2]	Well Casing Materials	Well Screen Materials	Well Screen Slot Size	Well Dia.	Well Depth[1]	Screen Interval		Screen Interval Elevation		Measured Water Level Elevation[3]
	ft		ft	ft	ft amsl	ft amsl				inches	ft bgs	ft bgs	ft bgs	ft amsl	ft amsl	ft amsl
Existing Wells																
116	0	Interior	3307306.40	6956567.80	213.47	216.21	PVC	PVC	NA	2	37	22	37	194.21	179.21	187.84
29WW05	0	Interior	3307350.10	6956449.00	206.01	208.95	SS	SS	0.01	4	22	12	22	196.95	186.95	189.56
29WW06	430	Downgradient	3306918.00	6956475.00	207.05	210.34	SS	SS	0.01	4	37	22	32	188.34	178.34	179.30
29WW09	207	Downgradient	3307426.30	6956262.70	208.11	211.02	SS	SS	0.01	4	27	17	27	194.02	184.02	182.12
29WW10	452	Downgradient	3307649.40	6956782.20	202.18	204.95	SS	SS	0.01	4	29	19	29	185.95	175.95	177.66
29WW11	709	Downgradient	3307273.10	6957154.30	202.68	205.68	SS	SS	0.01	4	27	17	27	188.68	178.68	178.28
Proposed Wells[4]																
29WW2023-01	100	Downgradient	3307406.32	6956571.90	214.50	216.50	PVC	PVC	0.01	4	37	27	37	189.50	179.50	NA
29WW2023-02	100	Downgradient	3307260.64	6956658.84	211.03	213.03	PVC	PVC	0.01	4	34	24	34	189.03	179.03	NA
29WW2023-03	100	Downgradient	3307445.16	6956555.50	214.49	216.49	PVC	PVC	0.01	4	37	27	37	189.49	179.49	NA

Notes:
1. Measuring point for newly installed monitoring wells is assumed to be 2-ft above the ground surface elevation.
2. Ground surface and measuring point elevations for existing wells are taken from well construction logs prepared for these wells. Ground surface elevations for proposed wells are taken from the survey prepared for the remedial design.
3. Groundwater elevations are taken from Figure 1-6 of the Final FS prepared by Shaw (2010). This figure indicates water levels were collected in November through December 2007.
4. Locations and depths for proposed monitoring wells may be modified in the field based on results of baseline groundwater sampling and depth to water measurements.

NA - Not Available

MONITORING WELL INSTALLATION NOTES:

1. APPROXIMATE LIMITS OF GROUNDWATER CONTAMINATION WERE TAKEN FROM THE 2019 RECORD OF DECISION (HDR, 2019). LIMITS WILL NEED TO BE VERIFIED AND UPDATED WITH GROUNDWATER SAMPLES COLLECTED AS DIRECTED BY NOTE 2.
2. BEFORE INSTALLING ANY WELLS THE CONTRACTOR SHALL COLLECT A ROUND OF BASELINE GROUNDWATER SAMPLES FROM EXISTING WELLS INDICATED ON THIS PLAN AND A SYNOPTIC ROUND OF DEPTH TO WATER MEASUREMENTS FROM ALL EXISTING WELLS SHOWN ON DRAWING SHEET G002. WELLS WHERE GROUNDWATER SAMPLES WILL BE COLLECTED ARE IDENTIFIED IN THE TABLES ABOVE. LOCATIONS OF THESE WELLS ARE SHOWN ON DRAWING SHEET G002.
3. LOCATIONS SHOWN FOR PROPOSED MONITORING WELLS ARE BASED ON THE BEST AVAILABLE DATA AND MAY NEED TO BE ADJUSTED FOLLOWING EVALUATION OF THE BASELINE GROUNDWATER SAMPLES AND DEPTH TO WATER MEASUREMENTS COLLECTED BY THE CONTRACTOR. FINAL LOCATIONS WILL BE SELECTED BY THE USACE.
4. MONITORING WELL INSTALLATION REQUIREMENTS ARE IDENTIFIED ON SHEET G001.

NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
2. GROUNDWATER ELEVATION DATA IS BASED ON ELEVATIONS PRESENTED ON FIGURE 1–6 OF THE LONGHORN FINAL FS PREPARED BY SHAW AND DATED APRIL 2010 (SHAW, 2010). ACCORDING TO THIS FIGURE THE ELEVATIONS ARE BASED ON DATA COLLECTED NOVEMBER 29, 2007 THROUGH DECEMBER 3, 2007.
3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND SHALL BE FIELD VERIFIED BY THE CONTRACTOR.

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STATE OF TEXAS – MICHAEL LEE VECCHIO – 147460 – LICENSED PROFESSIONAL ENGINEER

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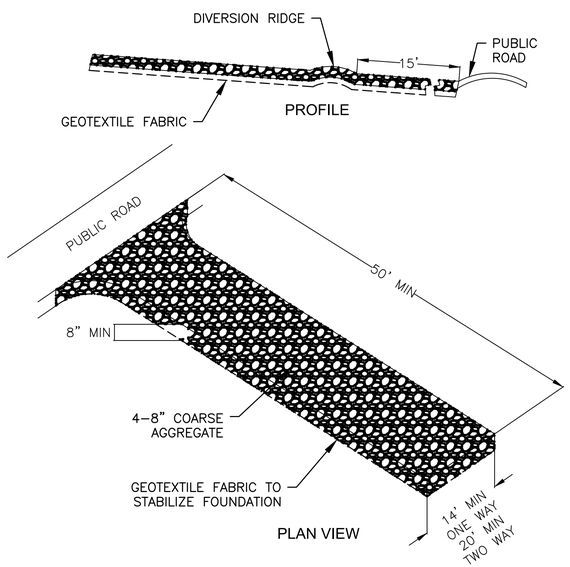
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KARNACK, TEXAS

MONITORING WELL INSTALLATION SITE PLAN

SHEET IDENTIFICATION
G003
SHEET 4 OF 30

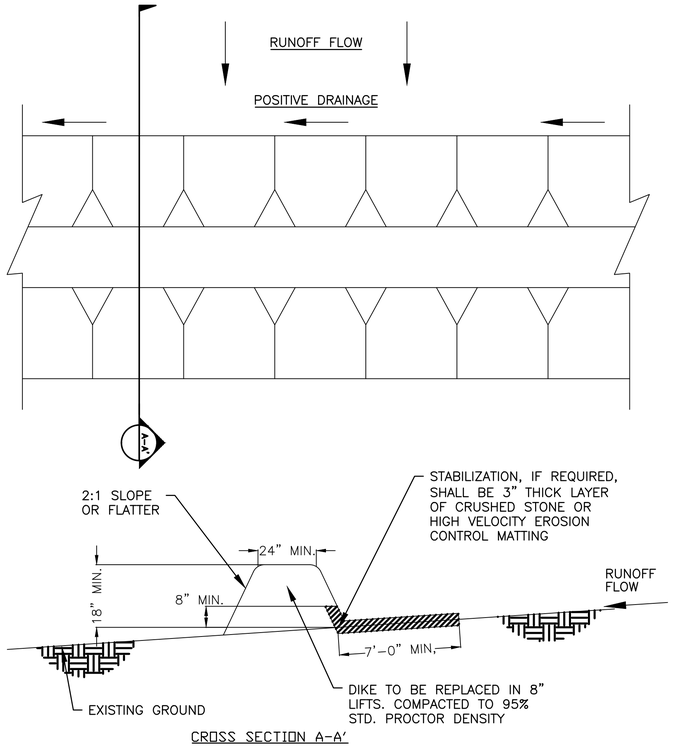


CONSTRUCTION SPECIFICATIONS:

1. THE AGGREGATE SHOULD CONSIST OF 4 TO 8 INCH WASHED STONE OVER A STABLE FOUNDATION.
2. THE AGGREGATE SHOULD BE PLACED WITH A MINIMUM THICKNESS OF 8 INCHES.
3. THE GEOTEXTILE FABRIC SHOULD BE DESIGNED SPECIFICALLY FOR USE AS A SOIL FILTRATION MEDIA WITH AN APPROXIMATE WEIGHT OF 6 OZ/YD^2, A MULLEN BURST RATING OF 140 LB/IN^2, AND AN EQUIVALENT OPENING SIZE GREATER THAN A NUMBER 50 SIEVE.
4. IF A WASHING FACILITY IS REQUIRED, A LEVEL AREA WITH A MINIMUM OF 4 INCH DIAMETER WASHED STONE OR COMMERCIAL RACK SHOULD BE PROVIDED. DIVERT WASTEWATER TO A SEDIMENT TRAP OR BASIN.
5. AVOID CURVES ON PUBLIC ROADS AND STEEP SLOPES. REMOVE VEGETATION AND OTHER OBJECTIONABLE MATERIAL FROM THE FOUNDATION AREA. GRADE CROWN FOUNDATION FOR POSITIVE DRAINAGE.
6. THE MINIMUM WIDTH OF THE ENTRANCE/EXIT SHOULD BE 14 FEET OR THE FULL WIDTH OF EXIT ROADWAY, WHICHEVER IS GREATER FOR ONE–WAY– AND 20 FT FOR TWO–WAY TRAFFIC.
7. THE CONSTRUCTION ENTRANCE SHOULD BE AT LEAST 50 FEET LONG.
8. IF THE SLOPE TOWARD THE ROAD EXCEEDS 2%, CONSTRUCT A RIDGE, 6 TO 8 INCHES HIGH WITH 3:1 (H:V) SIDE SLOPES, ACROSS THE FOUNDATION APPROXIMATELY 15 FEET FROM THE ENTRANCE TO DIVERT RUNOFF AWAY FROM THE PUBLIC ROAD.
9. PLACE GEOTEXTILE FABRIC AND GRADE FOUNDATION TO IMPROVE STABILITY, ESPECIALLY WHERE WET CONDITIONS ARE ANTICIPATED.
10. LEAVE SURFACE SMOOTH AND SLOPE FOR DRAINAGE.
11. DIVERT ALL SURFACE RUNOFF AND DRAINAGE FROM THE STONE PAD TO A SEDIMENT TRAP OR BASIN.

STABILIZED CONSTRUCTION ENTRANCE — 1 / G004

SCALE: N.T.S.



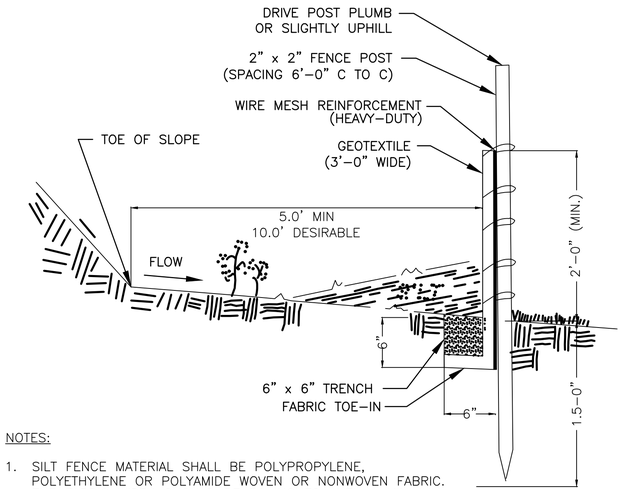
CROSS SECTION A–A'

CONSTRUCTION SPECIFICATIONS

1. ALL DIKES SHALL BE COMPACTED BY EARTH–MOVING EQUIPMENT.
2. ALL DIKES SHALL HAVE POSITIVE DRAINAGE TO AN OUTLET.
3. TOP WIDTH MAY BE WIDER AND SIDE SLOPES BE FLATTER IF DESIRED TO FACILITATE CROSSING BY CONSTRUCTION TRAFFIC.
4. FIELD LOCATION SHOULD BE ADJUSTED AS NEEDED TO UTILIZE A STABILIZED SAFE OUTLET.
5. EARTH DIKES SHALL HAVE AN OUTLET THAT FUNCTIONS WITH A MINIMUM OF EROSION. RUNOFF SHALL BE CONVEYED TO A SEDIMENT TRAPPING DEVICE SUCH AS A SEDIMENT TRAP OR SEDIMENT BASIN WHERE EITHER THE DIKE CHANNEL OR THE DRAINAGE AREA ABOVE THE DIKE ARE NOT ADEQUATELY STABILIZED.
6. FILL STABILIZATION SHALL BE: (A) IN ACCORDANCE WITH STANDARD SPECIFICATIONS FOR SEED AND STRAW MULCH IF NOT IN SEEDING SEASON, (B) FLOW CHANNEL STABILIZATION PER THE STANDARD CHART BASED ON CHANNEL GRADE.
7. REFER TO DRAWING SHEET G006 FOR CONSTRUCTION DITCH DETAIL.

DIVERSION DIKE — 2 / G004

SCALE: N.T.S.

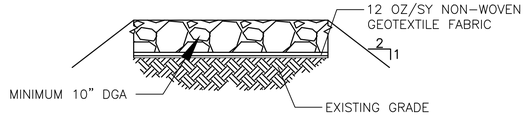


NOTES:

1. SILT FENCE MATERIAL SHALL BE POLYPROPYLENE, POLYETHYLENE OR POLYAMIDE WOVEN OR NONWOVEN FABRIC. THE FABRIC WIDTH SHOULD BE 36 INCHES, WITH A MINIMUM UNIT WEIGHT OF 4.5 OZ/YD, MULLEN BURST STRENGTH EXCEEDING 190 LB/IN^2, ULTRAVIOLET STABILITY EXCEEDING 70%, AND MINIMUM APPARENT OPENING SIZE OF U.S. SIEVE NO. 30.
2. FENCE POSTS SHOULD BE MADE OF HOT ROLLED STEEL, AT LEAST 4 FT LONG WITH TEE OR YBAR CROSS SECTION, SURFACE PAINTED OR GALVANIZED, MINIMUM NOMINAL WEIGHT 1.25 LB/FT2, AND BRINDELL HARDNESS EXCEEDING 140.
3. WOVEN WIRE BACKING TO SUPPORT THE FABRIC SHOULD BE GALVANIZED 2" X 4" WELDED WIRE, 12 GAUGE MINIMUM.

SILT FENCE — 3 / G004

SCALE: N.T.S.



NOTES

1. ROAD WIDTH OF 10 FEET MINIMUM FOR ONE–WAY TRAFFIC OR 20 FEET MINIMUM FOR TWO–WAY TRAFFIC.
2. MAXIMUM SLOPE OF 10%.
3. CLEAR AND STRIP ROADBED AND PARKING AREAS OF ALL VEGETATION, ROOTS AND OTHER OBJECTIONABLE MATERIAL.
4. LOCATE PARKING AREAS ON NATURALLY FLAT AREAS AS AVAILABLE. KEEP GRADES SUFFICIENT FOR DRAINAGE BUT NOT MORE THAN 2 TO 3 PERCENT.
5. PROVIDE SURFACE DRAINAGE AND DIVERT EXCESS RUNOFF AROUND DISTURBED AREAS AND TOWARDS STABILIZED AREAS.
6. MAINTAIN CUT AND FILL SLOPES TO 2:1 OR FLATTER AND STABILIZE DISTURBED AREAS NOT COVERED WITH DGA WITH VEGETATION AS SOON AS GRADING IS COMPLETE.
7. PROVIDE APPROPRIATE SEDIMENT CONTROL MEASURES TO PREVENT OFFSITE SEDIMENTATION.

CONSTRUCTION ACCESS ROAD — 4 / G004

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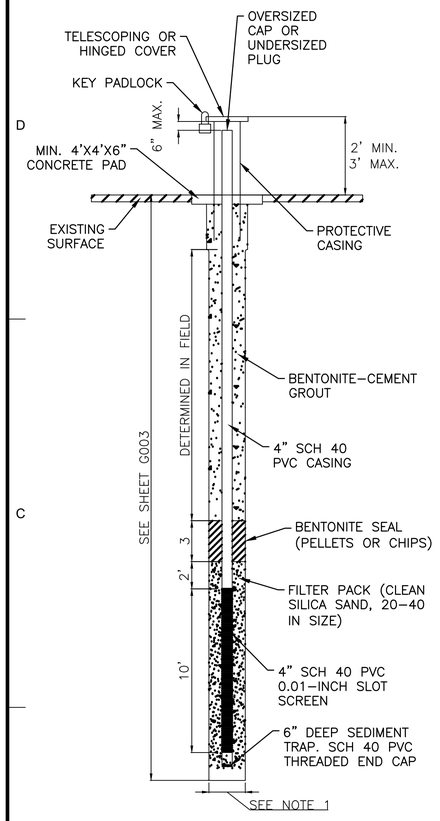
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LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

CONSTRUCTION DETAILS SHEET 1

SHEET IDENTIFICATION
G004
SHEET 5 OF 30

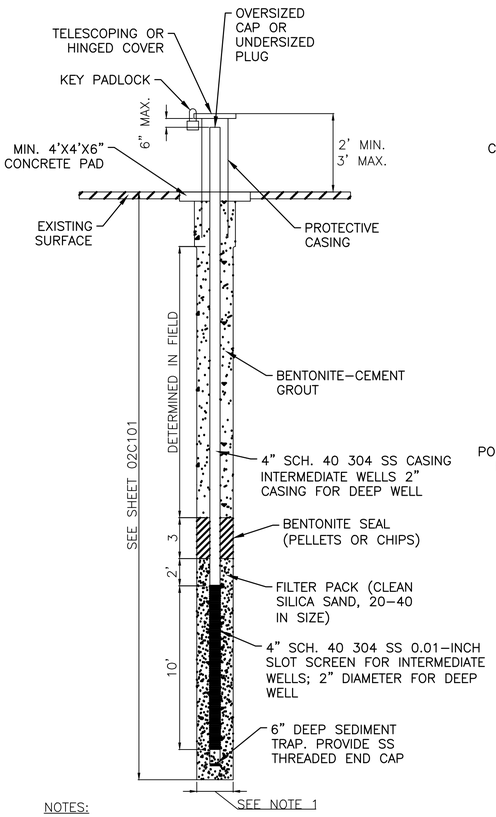


NOTES:

1. MINIMUM BOREHOLE DIAMETER SHALL PROVIDE AT LEAST 2 INCHES OF ANNULAR SPACE BETWEEN THE FORMATION EXPOSED AT THE BORING WALL AND THE OUTSIDE DIAMETER OF THE WELL CASING.

SHALLOW MONITORING WELL DETAIL — 1 / G005

SCALE: N.T.S.

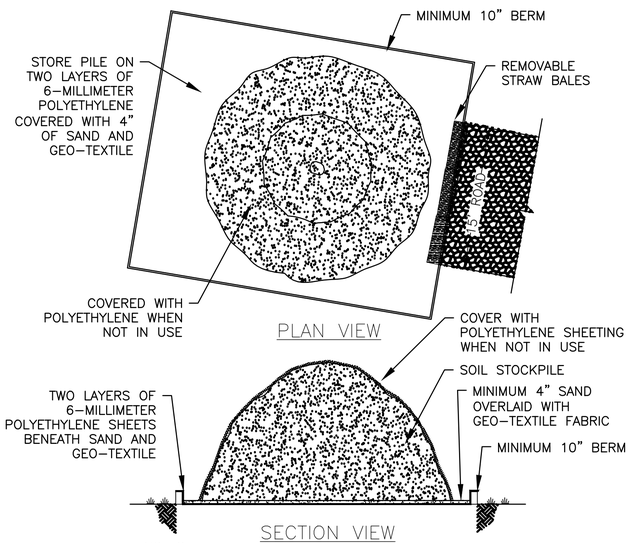


NOTES:

1. MINIMUM BOREHOLE DIAMETER SHALL PROVIDE AT LEAST 2 INCHES OF ANNULAR SPACE BETWEEN THE FORMATION EXPOSED AT THE BORING WALL AND THE OUTSIDE DIAMETER OF THE WELL CASING.
2. WELL INSTALLATION SHALL BE COMPLETED USING ROTOSONIC DRILLING METHODS IN ORDER TO ISOLATE THE SHALLOW, INTERMEDIATE, AND DEEP GROUNDWATER ZONES DURING INSTALLATION.
3. IF ALTERNATIVE DRILLING METHODS ARE PROPOSED AND APPROVED BY THE USACE, THE LENGTH OF ISOLATION CASINGS REQUIRED DURING WELL INSTALLATION SHALL BE EXTENDED FROM THE NEAR SURFACE GRADE TO THE TOP OF THE CONFINING LAYER. FOR THE SHALLOW ZONE THIS IS ESTIMATED AT 35 FT AND FOR THE INTERMEDIATE ZONE IT IS ESTIMATED AT 90 FT DEEP. ACTUAL DEPTHS SHALL BE DETERMINED IN THE FIELD BASED ON THE SOIL BORING LITHOLOGY. THE INSTALLATION OF ISOLATION CASINGS WILL NOT BE REQUIRED FOR WELLS INSTALLED USING ROTOSONIC DRILLING METHOD.

INTERMEDIATE/DEEP MONITORING WELL DETAIL — 2 / G005

SCALE: N.T.S.

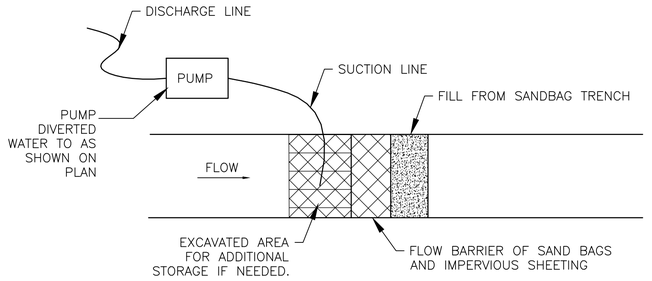


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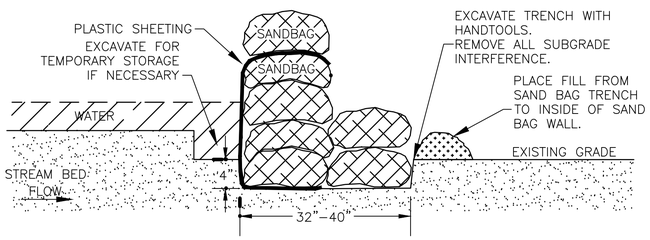
1. CONTAMINATED SOIL STOCKPILES MUST BE PLACED ON TWO LAYERS OF 6-MILLIMETER POLYETHYLENE SHEETS COVERED WITH A 4 INCH LAYER OF SAND AND GEO-TEXTILE FILTER FABRIC.
2. A BERM SHALL BE INSTALLED AROUND THE STOCKPILED SOIL TO PREVENT THE MIGRATION OF CONTAMINANTS.
3. STOCKPILES SHALL BE COVERED WITH POLYETHYLENE SHEETING TO PREVENT RAIN OR SURFACE WATER FROM COMING INTO CONTACT WITH THE CONTAMINATED SOIL.
4. THE COVER SHALL BE ANCHORED WITH SANDBAGS TO PREVENT IT FROM BEING BLOWN AWAY.

CONTAMINATED SOIL STOCKPILE DETAIL — 3 / G005

SCALE: N.T.S.



PLAN VIEW



*WALL HEIGHT TO BE DETERMINED BASED ON FIELD CONDITIONS – NOT TO EXCEED 3 FEET.

CROSS SECTION

1. PROVIDE MINIMUM OF 2 PUMPS (ONE BACKUP) WITH A MINIMUM FLOW OF 8 CFS TO BYPASS CHANNEL. PROVIDE APPROPRIATE PIPE SIZE TO ACCOMMODATE MINIMUM DESIGN FLOWS.
2. PROVIDE MINIMUM LENGTH OF HOSE NEEDED TO DISCHARGE TO LOCATIONS INDICATED ON THE PLAN..

DRAINAGE DITCH DIVERSION DETAIL — 4 / G005

SCALE: N.T.S.

US Army Corps of Engineers
TULSA DISTRICT

STATE OF TEXAS — MICHAEL J. VECCHIO — 147480 — LICENSED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
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DESIGNED BY: S. KUNG
DWN BY: S. KUNG
CKD BY: T. CONNORS
SUBMITTED BY:
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/24
FILE NAME: LHAAP29-G-CAD_BIM-2_WIP#2.4_FINAL DESIGN
SIZE: ANSI D
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
FILE NUMBER: 102446377

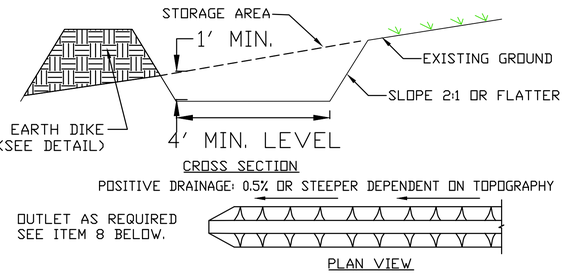
U.S. ARMY ENGINEER DIVISION
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LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

CONSTRUCTION DETAILS SHEET 2

SHEET IDENTIFICATION
G005
SHEET 6 OF 30



CONSTRUCTION SPECIFICATIONS

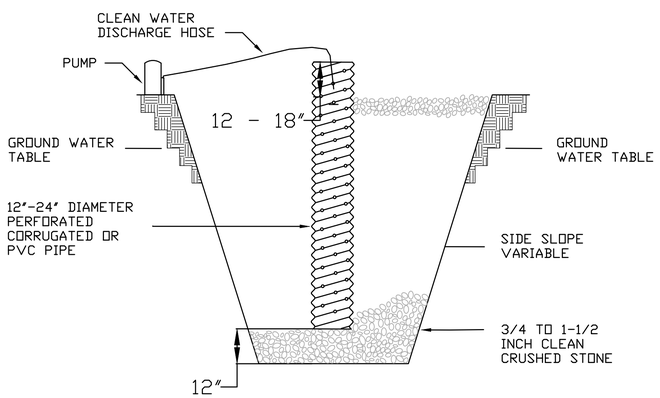
1. ALL CONSTRUCTION DITCHES SHALL HAVE UNINTERUPTED POSITIVE GRADE TO AN OUTLET.
2. DIVERTED RUNOFF FROM A DISTURBED AREA SHALL BE CONVEYED TO A SEDIMENT TRAPPING DEVICE.
3. DIVERTED RUNOFF FROM AN UNDISTURBED AREA SHALL OUTLET DIRECTLY INTO AN UNDISTURBED STABILIZED AREA AT NON-EROSIVE VELOCITY.
4. ALL TREES, BRUSH, STUMPS, OBSTRUCTIONS, AND OTHER OBJECTIONABLE MATERIAL SHALL BE REMOVED AND DISPOSED OF SO AS NOT TO INTERFERE WITH THE PROPER FUNCTIONING OF THE SWALE.
5. THE DITCH SHALL BE EXCAVATED OR SHAPED TO LINE, GRADE, AND CROSS SECTION AS REQUIRED TO MEET THE CRITERIA SPECIFIED HEREIN AND BE FREE OF BANK PROJECTIONS OR OTHER IRREGULARITIES WHICH WILL IMPEDE NORMAL FLOW.
6. FILLS SHALL BE COMPACTED BY EARTH MOVING EQUIPMENT.
7. ALL EARTH REMOVED AND NOT NEEDED FOR CONSTRUCTION SHALL BE PLACED SO THAT IT WILL NOT INTERFERE WITH THE FUNCTIONING OF THE DITCH.
8. STABILIZATION SHALL BE AS PER THE FLOW CHANNEL STABILIZATION CHART BELOW:

TYPE OF TREATMENT	CHANNEL GRADE	A(5 AC. OR LESS)	B(5 AC -10AC)
1	0.5-3.0%	SEED AND STRAW MULCH	SEED AND STRAW MULCH
2	3.1-5.0%	SEED AND STRAW MULCH	SEED AND COVER USING RECP
3	5.1-8.0%	SEED AND COVER WITH RECP	LINED WITH 4-8" RIP-RAP OR GEOTEXTILE
4	8.1-10.%	LINED WITH 4-8" RIP-RAP OR GEOTEXTILE	SITE SPECIFIC DESIGN

9. PERIODIC INSPECTION AND REQUIRED MAINTENANCE MUST BE PROVIDED AFTER EACH RAIN EVENT.
10. COMBINE WITH EARTH DIKE TO PREVENT FLOW FROM ENTERING CONSTRUCTION AREAS REFER TO DRAWING SHEET G004 FOR EARTH DIKE DETAIL.

CONSTRUCTION DITCH DETAIL 1/G006

SCALE: N.T.S.

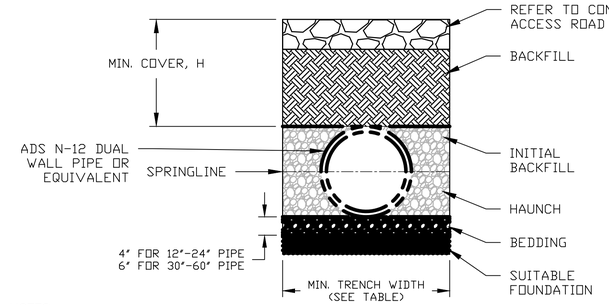


CONSTRUCTION SPECIFICATIONS

1. PIT DIMENSIONS ARE VARIABLE.
2. THE STANDPIPE SHOULD BE CONSTRUCTED BY PERFORATING A 12-24" DIAMETER CORRUGATED OR PVC PIPE.
3. A BASE AGGREGATE SHOULD BE PLACED IN THE PIT TO A DEPTH OF 12". PIT TO A DEPTH OF 12". AFTER INSTALLING THE STANDPIPE, THE PIT SURROUNDING THE STANDPIPE SHOULD BE BACKFILLED WITH CLEAN AGGREGATE.
4. THE STANDPIPE SHOULD EXTEND 12-18" ABOVE THE LIP OF THE PIT.
5. WATER SHALL BE DISCHARGED TO A FRAC TANK FOR TEMPORARY STORAGE. COLLECTED WATER SHALL BE MANAGED IN ACCORDANCE WITH THE DESIGN DOCUMENTS.

DEWATERING SUMP PIT DETAIL 3/G006

SCALE: N.T.S.



NOTES:

1. ALL PIPE SYSTEMS SHALL BE INSTALLED IN ACCORDANCE WITH ASTM D2321, "STANDARD PRACTICE FOR UNDERGROUND INSTALLATION OF THERMOPLASTIC PIPE FOR SEWERS AND OTHER GRAVITY FLOW APPLICATIONS", LATEST ADDITION
2. MEASURES SHOULD BE TAKEN TO PREVENT MIGRATION OF NATIVE FINES INTO BACKFILL MATERIAL, WHEN REQUIRED.
3. FOUNDATION: WHERE THE TRENCH BOTTOM IS UNSTABLE, THE CONTRACTOR SHALL EXCAVATE TO A DEPTH REQUIRED BY THE ENGINEER AND REPLACE WITH SUITABLE MATERIAL AS SPECIFIED BY THE ENGINEER. AS AN ALTERNATIVE AND AT THE DISCRETION OF THE DESIGN ENGINEER, THE TRENCH BOTTOM MAY BE STABILIZED USING A GEOTEXTILE MATERIAL.
4. BEDDING: SUITABLE MATERIAL SHALL BE CLASS I, II OR III. THE CONTRACTOR SHALL PROVIDE DOCUMENTATION FOR MATERIAL SPECIFICATION TO ENGINEER. UNLESS OTHERWISE NOTED BY THE ENGINEER, MINIMUM BEDDING THICKNESS SHALL BE 4" FOR 4"-24"; 6" FOR 30"-60".
5. INITIAL BACKFILL: SUITABLE MATERIAL SHALL BE CLASS I, II OR III IN THE PIPE ZONE EXTENDING TO THE CROWN OF PIPE. THE CONTRACTOR SHALL PROVIDE DOCUMENTATION FOR MATERIAL SPECIFICATION TO ENGINEER. MATERIAL SHALL BE INSTALLED AS REQUIRED IN ASTM D2321, LATEST EDITION.
6. MINIMUM COVER: MINIMUM COVER SHALL BE AS SPECIFIED IN TABLE INDICATING SINGLE AXLE VEHICLE TEMPORARY MINIMUM COVER.

PLASTIC CORRUGATED CULVERT DETAIL 2/G006

SCALE: N.T.S.

RECOMMENDED MINIMUM TRENCH WIDTHS

PIPE DIAM.	MIN. TRENCH WIDTH
4"	21"
6"	23"
8"	26"
10"	28"
12"	30"
15"	34"
18"	39"
24"	48"

SINGLE AXLE VEHICLE TEMPORARY MINIMUM COVER

VECHICLE	VEHICLE DESCRIPTION	MINIMUM TIRE	SINGLE AXLE LOAD lbs.	PIPE DIAMETER	TEMPORY MINIMUM COVER HEIGHTS CLASS I COMPACTED	TEMPORY MINIMUM COVER HEIGHTS CLASS II @ 95% SPD
FORD F150	PICKUP TRUCK (GWVR)	P275/55R20	7,450	12"- 48" *	3"	3"
CHEVY 3500	UTILITY TRUCK (GWVR)	235/80-17	13,200	12"- 48"	6"	6"
				60"	6"	9"
CAT CS78B	DRUM ROLLER	84" SMOOTH DRUM ROLLER	29,626	12"- 48"	9"	9"
				60"	9"	12"
CAT 637G	SCRAPER	37.25-35	102,145	12"- 60"	12"	15"
KOMATSU WA800-3	MEDIUM LOADER	45/65-45	158,270	12"- 60"	15"	18"
CAT 993K	LARGE LOADER	50/65-51	276,808	12"- 15"	21"	24"
				18"- 60"	24"	27"
CAT 789D	MINING TRUCK	37.00-R57	479,050	12"-18"	27"	30"
				21"-60"	30"	33"

* COVER OVER 60" (1500mm) PIPE SHOULD BE NO LESS THAN 6" (152mm)

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US Army Corps of Engineers
TULSA DISTRICT

MICHAEL J. VECCHIO 147490 REGISTERED PROFESSIONAL ENGINEER

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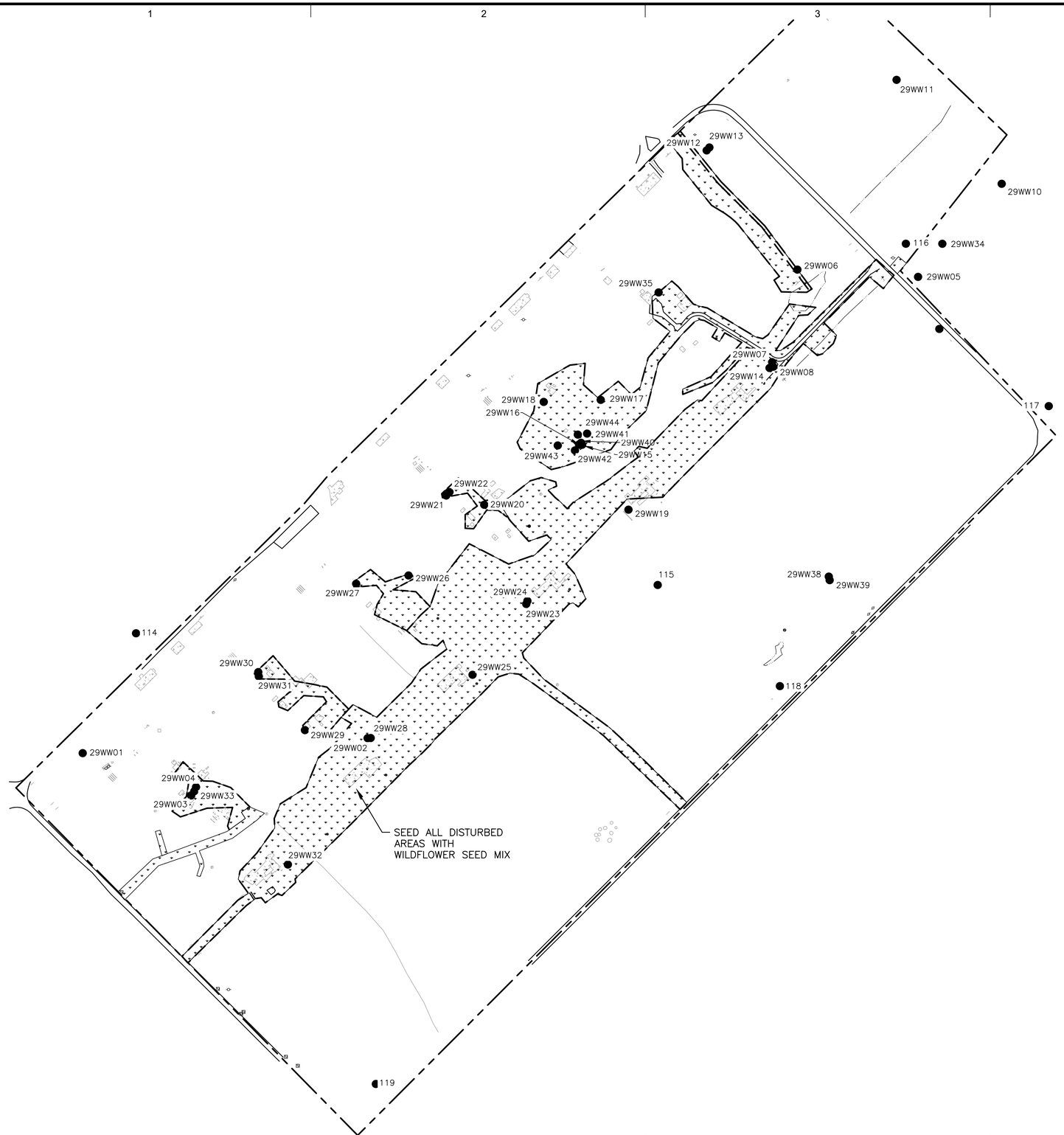
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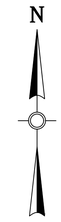
DESIGNED BY: S. KLING
DWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
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SIZE: ANSI D
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CONTRACT NO.: W912BV19D0016
FILE NUMBER: 10244337

LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

CONSTRUCTION DETAILS
SHEET 3

SHEET IDENTIFICATION
G006
SHEET 7 OF 30





LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- UTILITY POLE
- SIGN
- SITE BOUNDARY
- EXISTING PAVEMENT
- WATER EDGE
- CONCRETE STRUCTURE
- ESTIMATED SITE RESTORATION SEED AREA

RESTORATION:

1. CONTRACTOR SHALL REMOVE ALL CONSTRUCTION RELATED MATERIALS FROM THE SITE INCLUDING BUT NOT LIMITED TO WASTE MATERIALS, CONSTRUCTION EQUIPMENT, TRAILERS, STOCKPILE AREAS, AND TEMPORARY CONSTRUCTION ROADS.
2. CONTRACTOR SHALL GRADE ALL DISTURBED AREAS TO PROVIDE POSITIVE DRAINAGE AND PREVENT PONDING. BACKFILLED AREAS SHALL BE BROUGHT UP TO MATCH EXISTING SURFACES SURROUNDING THE EXCAVATED AREAS.
3. CONTRACTOR SHALL RESTORE EXISTING NATURAL DRAINAGE PATTERNS BACK TO THEIR ORIGINAL CONDITIONS. ANY ROADS LEFT IN PLACE AT THE REQUEST OF USACE SHALL BE PROVIDED WITH PROPER DRAINAGE STRUCTURES TO PREVENT WASH–OUT AND EROSION OF ROAD SURFACES.
4. LIMITS SHOWN ON THIS DRAWING ARE FOR REFERENCE ONLY. THE CONTRACTOR SHALL RESTORE ALL AREAS DISTURBED AS PART OF THE REMEDIAL ACTION. DISTURBED AREAS SHALL BE SEEDED AS REQUIRED BY THE DESIGN DOCUMENTS.
5. AREAS PROVIDED WITH TEMPORARY SEED MIXES SHALL BE RE–GRUBBED AND CLEARED BEFORE SEEDING WITH THE FINAL SEED MIX UNLESS IT IS DETERMINED TO BE UNNECESSARY AND APPROVAL IS RECEIVED FROM USACE TO PROCEED WITH FINAL SEEDING WITHOUT CLEARING TEMPORARY VEGETATION ESTABLISHED AS PART OF EROSION CONTROL MEASURES.
6. RESTORATION SHALL BE DETERMINED TO BE COMPLETE WHEN ALL DISTURBED AREAS ACHIEVE A 95% GROUND COVER OF THE SEEDED SPECIES.

SEEDING:

1. CULTIVATE THE DISTURBED AREA TO A DEPTH OF 4 INCHES BEFORE PLACING SEED UNLESS OTHERWISE DIRECTED. USE APPROVED EQUIPMENT TO VERTICALLY TRACK THE SEEDBED AS SHOWN ON THE PLANS OR AS DIRECTED. CULTIVATE THE SEEDBED TO A DEPTH OF 4 IN. OR MOW THE AREA BEFORE PLACEMENT OF THE PERMANENT SEED WHEN PERFORMING PERMANENT SEEDING AFTER AN ESTABLISHED TEMPORARY SEEDING. PLANT THE SEED SPECIFIED AND MULCH, IF REQUIRED, AFTER THE AREA HAS BEEN COMPLETED TO LINES AND GRADES AS SHOWN ON THE PLANS.
2. DO NOT PLANT WHEN THE GROUND IS FROZEN, MUDDY, OR WHEN AIR TEMPERATURES EXCEED 90 DEGREES FAHRENHEIT.
3. BROADCAST SEEDING. DISTRIBUTE THE SEED OR SEED MIXTURE UNIFORMLY OVER THE AREAS SHOWN ON THE PLANS USING HAND OR MECHANICAL DISTRIBUTION OR HYDRO–SEEDING ON TOP OF THE SOIL UNLESS OTHERWISE DIRECTED. APPLY THE MIXTURE TO THE AREA TO BE SEEDED WITHIN 30 MIN. OF PLACEMENT OF COMPONENTS IN THE EQUIPMENT WHEN SEED AND WATER ARE TO BE DISTRIBUTED AS A SLURRY DURING HYDRO–SEEDING. ROLL THE PLANTED AREA WITH A LIGHT ROLLER OR OTHER SUITABLE EQUIPMENT. ROLL SLOPED AREAS ALONG THE CONTOUR OF THE SLOPES.
4. STRAW OR HAY MULCH SEEDING. APPLY STRAW OR HAY MULCH UNIFORMLY OVER THE SEEDED AREA IMMEDIATELY AFTER PLANTING THE SEED OR SEED MIXTURE. APPLY STRAW MULCH AT 2 TO 2.5 TONS PER ACRE. APPLY HAY MULCH AT 1.5 TO 2 TONS PER ACRE. USE A TACKING METHOD OVER THE MULCHED AREA. STRAW AND HAY SHALL BE AIR–DRY CONDITION AND OF PROPER CONSISTENCY FOR PLACING WITH COMMERCIAL MULCH BLOWING EQUIPMENT. STRAW AND HAY MUST BE STERILE, CONTAINING NO FERTILE SEED.
5. APPLY FERTILIZER UNIFORMLY AT A RATE EQUAL TO 60 LB OF NITROGEN PER ACRE OR AS OTHERWISE DETERMINED BASED ON ANALYSIS. SEED AND FERTILIZER MAY BE DISTRIBUTED SIMULTANEOUSLY DURING "BROADCAST SEEDING" OPERATIONS, PROVIDED EACH COMPONENT IS APPLIED AT THE SPECIFIED RATE. APPLY HALF OF THE REQUIRED FERTILIZER DURING THE TEMPORARY SEEDING OPERATION AND THE OTHER HALF DURING THE PERMANENT SEEDING OPERATION WHEN TEMPORARY AND PERMANENT SEEDING ARE BOTH SPECIFIED FOR THE SAME AREA.
6. FERTILIZER. USE A COMPLETE FERTILIZER CONTAINING NITROGEN (N), PHOSPHORIC ACID (P), AND POTASH (K) NUTRIENTS UNLESS OTHERWISE SPECIFIED ON THE PLANS. ENSURE AT LEAST 50% OF THE NITROGEN COMPONENT IS A SLOW–RELEASE SULFUR–COATED UREA. ENSURE THAT FERTILIZER IS IN AN ACCEPTABLE CONDITION FOR DISTRIBUTION IN CONTAINERS LABELED WITH THE ANALYSIS. FERTILIZER IS SUBJECT TO TESTING BY THE TEXAS A&M FEED AND FERTILIZER CONTROL SERVICE IN ACCORDANCE WITH THE TEXAS FERTILIZER LAW
7. WATER THE SEEDED AREAS AS NECESSARY TO KEEP THE GROUND MOIST. WATERING SHALL OCCUR AT A MINIMUM TWICE PER DAY FOR 5–10 MINUTES UNTIL SEED IS ESTABLISHED. FOR WILDFLOWER MIXES WATERING CAN BE COMPLETED EVERY THREE DAYS UNTIL SEED HAS BEEN ESTABLISHED. SOURCE OF WATER SHALL BE APPROVED BY THE USACE AND OF SUITABLE QUALITY FOR IRRIGATION, CONTAINING NO ELEMENTS TOXIC TO PLANT LIFE.
8. MAINTAIN SEEDED AREAS UNTIL FINAL ACCEPTANCE OF THE PROJECT. THE MAINTENANCE PERIOD SHALL NOT BE LESS THAN 90 DAYS AFTER PLANTING.

WILDFLOWER SEED MIX REQUIREMENTS:

1. A WILDFLOWER SEED MIXTURE THAT ORIGINATES WITHIN 150–200 MILES OF THE SITE SHALL BE USED TO STABILIZE DISTURBED AREAS. THE FINAL SEED MIX SHALL BE COORDINATED AND APPROVED BY THE US FISH AND WIILDLIFE SERVICE (USFWS).
2. ALL GRASS AND WILDFLOWER SEED MUST MEET THE REQUIREMENTS OF THE TEXAS SEED LAW [AGRICULTURAL CODE; TITLE 5, PRODUCTION, PROCESSING AND SALE OF HORTICULTURAL PRODUCTS; SUBTITLE A, SEED AND FERTILIZER; CHAPTER 61, INSPECTION, LABELING AND SALE OF AGRICULTURAL AND VEGETABLE SEED (1981)], INCLUDING THE LABELING REQUIREMENTS FOR SHOWING PURE LIVE SEED (PLS), NAME AND TYPE OF SEED.
3. PLANT WILDFLOWER MIX IN LATE SUMMER OR EARLY FALL.

NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
2. TOPOGRAPHY AND LOCATION OF EXISTING STRUCTURES ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021.
3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND SHALL BE FIELD VERIFIED BY THE CONTRACTOR.

0 200' 400'

SCALE: 1" = 200'

US Army Corps of Engineers
TULSA DISTRICT

STATE OF TEXAS
MICHAEL J. VECCHIO
147480
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PROFESSIONAL
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PLOT SCALE: AS NOTED
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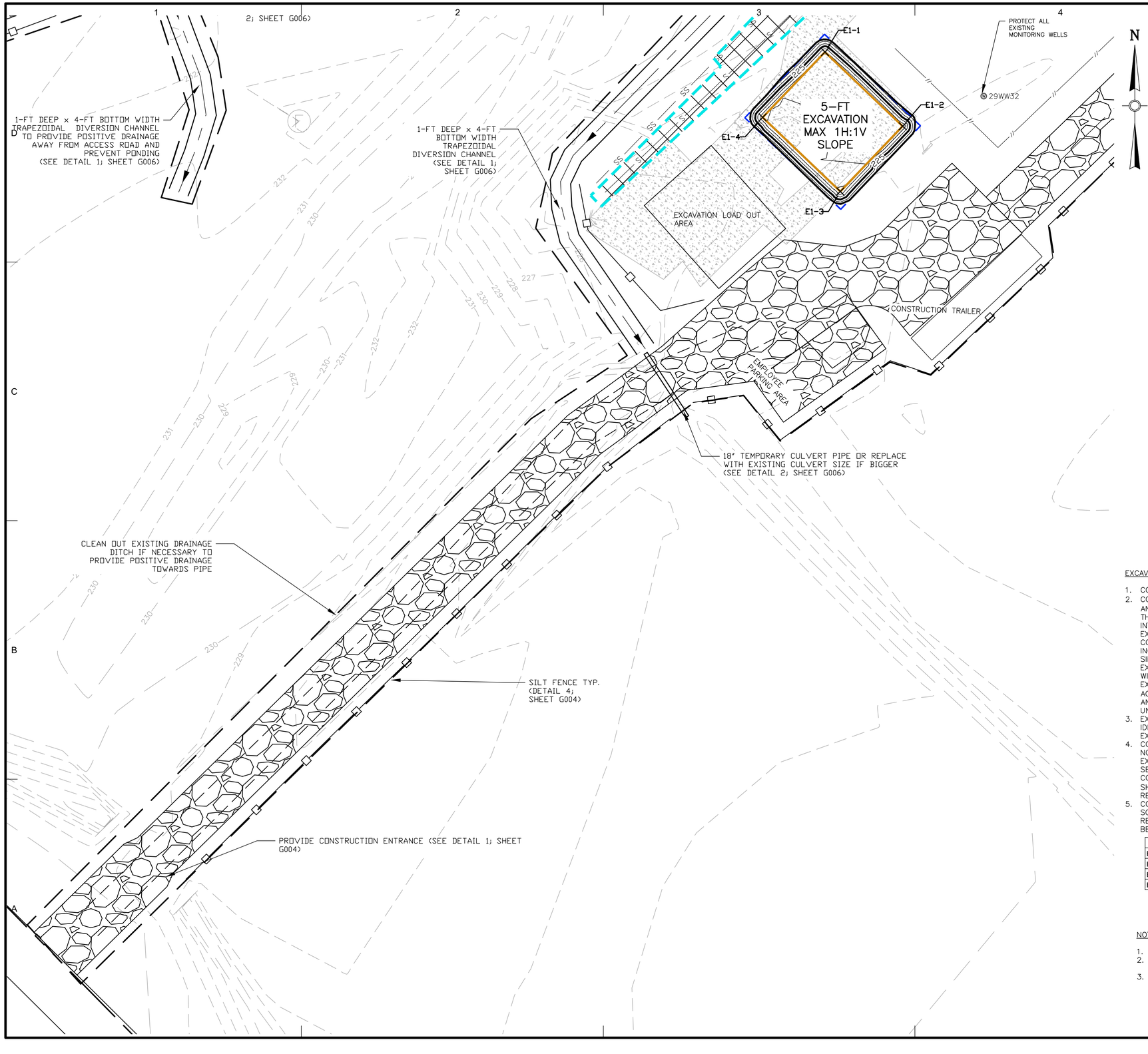
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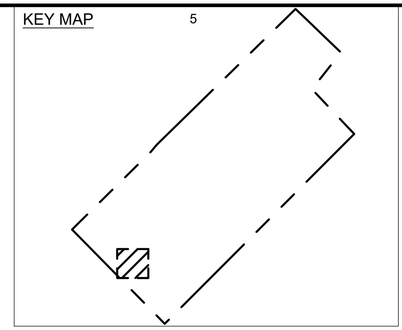
LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

SITE RESTORATION PLAN

SHEET IDENTIFICATION
G007
SHEET 8 OF 30



KEY MAP



LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- SITE BOUNDARY
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- EXISTING GRAVEL
- EXISTING UNPAVED ROAD
- COOLING WATER BUILDING SERVICE PIPE
- 12" WOOD TNT WASTEWATER LINE
- 6" TRANSITE TNT WASTEWATER LINE
- EXCAVATION LIMIT
- ESTIMATED PIPE REMOVAL TRENCH LIMIT
- EXCAVATION TOP OF SLOPE
- TEMPORARY CONSTRUCTION ACCESS ROAD
- LIMITS OF CLEARING
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PIPE EXCAVATION
- SILT FENCE
- TEMPORARY DRAINAGE DITCH

EXCAVATION NOTES:

1. CONTRACTOR SHALL PERFORM INITIAL EXCAVATIONS AT THE LIMITS SHOWN ON THIS PLAN.
2. CONTRACTOR SHALL USE INCREMENTAL SAMPLING METHODOLOGY (ISM). EACH SIDEWALL AND BOTTOM WILL BE IDENTIFIED AS A DECISION UNIT (DU). FOR EXCAVATIONS GREATER THAN 5 FT SIDEWALLS WILL BE BROKEN INTO MULTIPLE DECISION UNITS BASED ON DEPTH INTERVALS OF 4 OR 5 FT IN ORDER TO PROVIDE SAFE EGRESS AND INGRESS INTO THE EXCAVATION TO COLLECT INCREMENTAL SAMPLES. WITHIN EACH DU THE CONTRACTOR SHALL COLLECT 30 INCREMENTAL SAMPLES AT EVENLY SPACED GRID LOCATIONS ACROSS THE DU. INCREMENTAL SAMPLES FROM EACH DU WILL BE COMBINED AND PROCESSED INTO A SINGLE CONTAINER FOR THAT DU AND SENT TO THE LABORATORY FOR ANALYSIS OF EXPLOSIVES USING A 48-HR TURN-AROUND TIME. RESULTS OF CONFIRMATION SAMPLES WILL BE REVIEWED BY THE USACE TO VERIFY CLEANUP LEVELS ARE ACHIEVED BEFORE THE EXCAVATION IS BACKFILLED. IF RESULTS INDICATE CLEANUP LEVELS HAVE NOT BEEN ACHIEVED THEN THE CONTRACTOR SHALL EXCAVATE 2 FT LATERALLY AND/OR 1 FT DEEPER AND COLLECT ADDITIONAL CONFIRMATION SAMPLES FOR ANALYSIS. THIS SHALL CONTINUE UNTIL CLEANUP LEVELS ARE ACHIEVED.
3. EXCAVATIONS SHALL MEET OSHA REQUIREMENTS AND THOSE ADDITIONAL REQUIREMENTS IDENTIFIED ON SHEET G001. MAXIMUM PERMISSIBLE SLOPES USED TO COMPLETE EXCAVATIONS SHALL BE 1H:1V.
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Point ID	Easting	Northing
E1-1	3305030.96	6954363.36
E1-2	3305061.75	6954333.97
E1-3	3305037.05	6954308.10
E1-4	3305006.26	6954337.48

Excavation E-1	
Decision Unit Boundary	Number of Decision Units
E1-4 TO E1-3	1
E1-3 TO E1-2	1
E1-2 TO E1-1	1
E1-1 TO E1-4	1
Excavation Bottom (E1-1 TO E1-2 TO E1-3 TO E1-4)	1
Total Samples	5

NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
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3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND SHALL BE FIELD VERIFIED BY THE CONTRACTOR.

0 20' 40'

SCALE: 1" = 40'

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STATE OF TEXAS · MICHAEL L. VECCHIO · 147486 · LICENSED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
4	100% DRAFT DESIGN EPA/TCEQ SUBMISSION	07/05/2023
5	100% DRAFT DESIGN EPA/TCEQ SUBMISSION	08/15/2023
6	100% DESIGN USACE SUBMISSION	10/19/2023
7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023
8	FINAL APPROVED DESIGN	02/28/2024
9		
10		
11		
12		
13		
14		

DESIGNED BY: S. KLING
DWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/24
SIZE: ANSI D
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
FILE NUMBER: 1024637
FILE NAME: 1024637#0_CAD_BIM#2_WIP#2.4_FINAL DESIGN

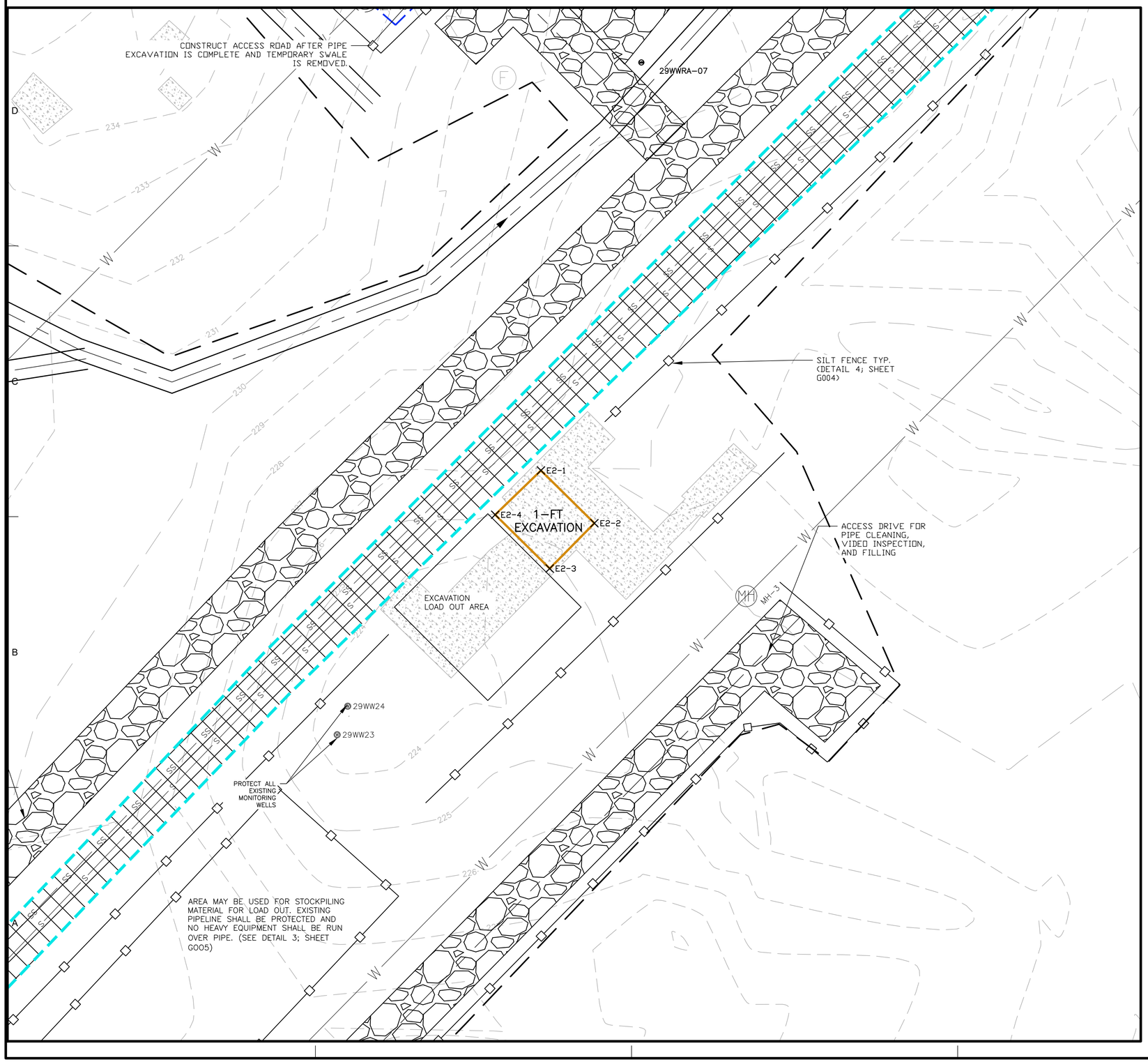
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CORPS OF ENGINEERS
TULSA DISTRICT

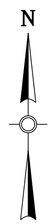
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OMAHA, NE 68114
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LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

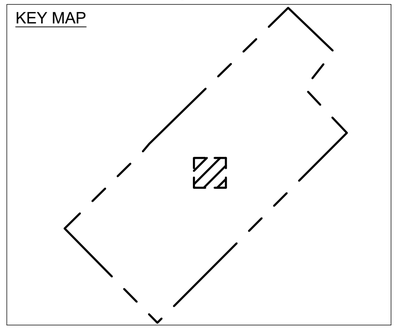
EXCAVATION AREA E-1 SITE PLAN

SHEET IDENTIFICATION
01C101
SHEET 9 OF 30





KEY MAP



LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- CONTOUR MINOR
- CONTOUR MAJOR
- COOLING WATER MAIN PIPE – ASSUMED 18"
- COOLING WATER BUILDING SERVICE PIPE
- 12" WOOD TNT WASTEWATER LINE
- 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE STRUCTURE
- EXCAVATION LIMIT
- ESTIMATED PIPE REMOVAL TRENCH LIMIT
- EXCAVATION TOP OF SLOPE
- TEMPORARY CONSTRUCTION ACCESS ROAD
- LIMITS OF CLEARING
- PIPE EXCAVATION
- SILT FENCE
- TEMPORARY DRAINAGE DITCH

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Point ID	Easting	Northing
E2-1	3306024.66	6955378.43
E2-2	3306044.90	6955358.46
E2-3	3306027.98	6955341.31
E2-4	3306007.34	6955361.68

Excavation E-2	
Decision Unit Boundary	Number of Decision Units
E2-4 TO E2-3	1
E2-3 TO E2-2	1
E2-2 TO E2-1	1
E2-1 TO E2-4	1
Excavation Bottom (E2-1 TO E2-2 TO E2-3 TO E2-4)	1
Total Samples	5

NOTES:

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4. FOR OVERALL ACCESS TO THE SITE REFER TO SHEET G002.

0 20' 40'
SCALE: 1" = 20'

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STATE OF TEXAS · MICHAEL L. VECCHIO · 147486 · LICENSED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
8	FINAL APPROVED DESIGN	02/28/2024
9		
10		
11		
12		
13		
14		

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
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6	100% DESIGN USACE SUBMISSION	10/19/2023
7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023

DESIGNED BY: S. KLING
DRWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/2024
SIZE: ANSI D
SOLICITATION NO.: W912BV20T0096
CONTRACT NO.: W912BV19D0016
FILE NUMBER: 102463527
FILE NAME: 102463527\6.0_CAD_BIM\6.2_WIP\6.2.4_FINAL DESIGN

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LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

EXCAVATION AREA E-2 SITE PLAN

SHEET IDENTIFICATION
01C102
SHEET 10 OF 30

1-FT DEEP x 4-FT BOTTOM WIDTH TRAPEZOIDAL DIVERSION CHANNEL (SEE DETAIL 1; SHEET G006)

REMOVE PORTION OF CONCRETE STRUCTURE TO COMPLETE EXCAVATION

1-FT DEEP x 4-FT BOTTOM WIDTH TRAPEZOIDAL DIVERSION CHANNEL (SEE DETAIL 1; SHEET G006)

AREA NC-1
13-FT EXCAVATION

NC1-1
NC1-2
NC1-3
NC1-4

PROTECT ALL EXISTING MONITORING WELLS

29WW18

PROTECT ALL EXISTING MONITORING WELLS

29WW17

STAGING AREA

29WWRA-06

4-FT VERTICAL CUT BETWEEN EXCAVATION DEPTHS

AREA E3
14-FT EXCAVATION
10-FT EXCAVATION

E3-1
E3-2
E3-3
E3-4
E3-5
E3-6

PROTECT ALL EXISTING MONITORING WELLS

29WW44
29WW41
29WW40
29WW16
29WW15
29WW43
29WW42

ABANDON EXISTING MONITORING WELL

PROTECT EXISTING MONITORING WELLS AND CAP DURING THERMAL HEATING

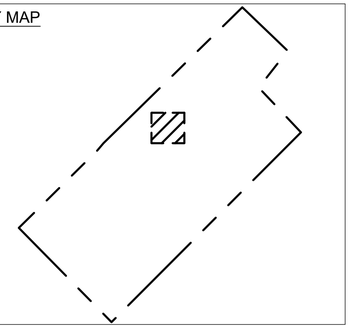
29WWRA-05

MH-11

29WWRA-13

N

KEY MAP



LEGEND:

- MONITORING WELL
- MANHOLE
- CONTOUR MINOR
- CONTOUR MAJOR
- W — COOLING WATER MAIN PIPE – ASSUMED 18"
- COOLING WATER BUILDING SERVICE PIPE
- CONCRETE STRUCTURE
- MC PLUME TREATMENT AREA
- EXCAVATION LIMIT
- EXCAVATION TOP OF SLOPE
- TEMPORARY CONSTRUCTION ACCESS ROAD
- LIMITS OF CLEARING
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
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Excavation NC-1	
Decision Unit Boundary	Number of Decision Units
NC1-1 TO NC1-4	3
NC1-4 TO NC1-3	3
NC1-3 TO NC1-2	3
NC1-2 TO NC1-1	3
Excavation Bottom (NC1-1 TO NC1-2 TO NC1-3 TO NC1-4 TO NC1-1)	1
Total Samples	13

Excavation E-3	
Decision Unit Boundary	Number of Decision Units
E3-2 TO E3-1	2
E3-1 TO E3-6	2
E3-6 TO E3-5	2
E3-5 TO E3-4	3
E3-4 TO E3-3	3
E3-3 TO E3-2	3
E3-2 TO E3-5	1
Excavation Bottom (E3-1 TO E3-2 TO E3-5 TO E3-6 TO E3-1)	1
Excavation Bottom (E3-2 TO E3-3 TO E3-4 TO E3-5 TO E3-2)	1
Total Samples	18

Point ID	Easting	Northing
NC1-1	3306039.64	6956024.24
NC1-2	3306092.09	6956081.00
NC1-3	3306146.06	6956035.34
NC1-4	3306091.50	6955979.49

Point ID	Easting	Northing
E3-1	3305964.52	6955864.69
E3-2	3305981.15	6955888.90
E3-3	3305996.65	6955911.46
E3-4	3306043.45	6955879.31
E3-5	3306027.96	6955856.75
E3-6	3306011.33	6955832.54

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0 20' 40'
SCALE: 1" = 20'

US Army Corps of Engineers
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MARK	DESCRIPTION	DATE
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DESIGNED BY: S. KLING
DRAWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: 1:1
PLOT DATE: 2/28/2024
FILE NUMBER: 102452637
SIZE: ANSI D
FILE NAME: 102452637-01, CAD, BIM# 2, WIP# 2.4, FINAL DESIGN

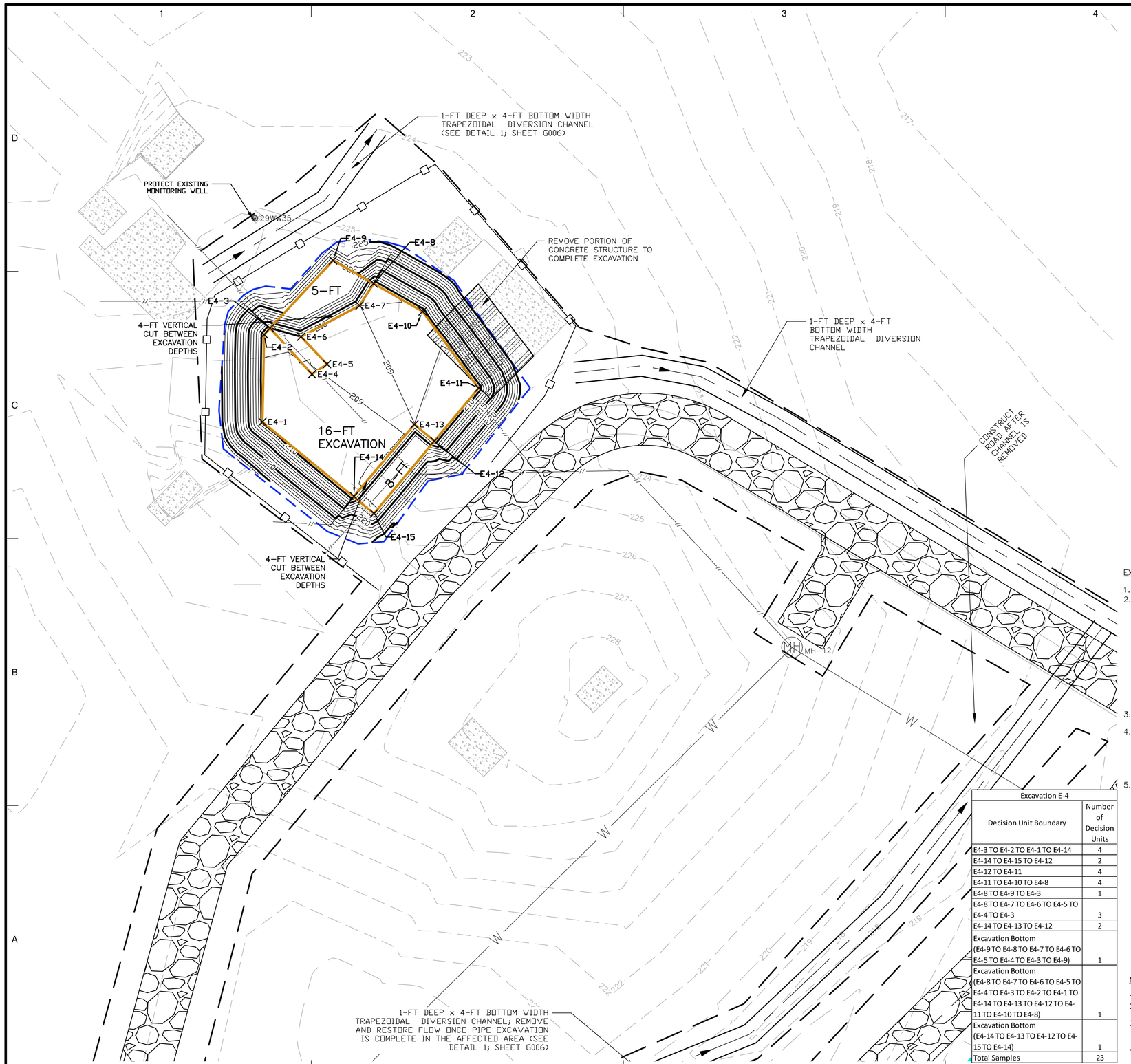
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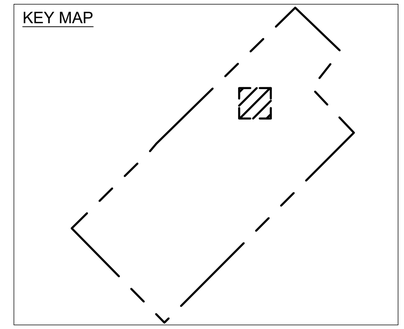
EXCAVATION AREAS E-3 & NC-1 SITE PLAN

SHEET IDENTIFICATION
01C103
SHEET 11 OF 30



N

KEY MAP



LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- CONTOUR MINOR
- CONTOUR MAJOR
- COOLING WATER MAIN PIPE – ASSUMED 18"
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- EXCAVATION LIMIT
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Excavation E-4	
Decision Unit Boundary	Number of Decision Units
E4-3 TO E4-2 TO E4-1 TO E4-14	4
E4-14 TO E4-15 TO E4-12	2
E4-12 TO E4-11	4
E4-11 TO E4-10 TO E4-8	4
E4-8 TO E4-9 TO E4-3	1
E4-8 TO E4-7 TO E4-6 TO E4-5 TO E4-4 TO E4-3	3
E4-14 TO E4-13 TO E4-12	2
Excavation Bottom (E4-9 TO E4-8 TO E4-7 TO E4-6 TO E4-5 TO E4-4 TO E4-3 TO E4-9)	1
Excavation Bottom (E4-8 TO E4-7 TO E4-6 TO E4-5 TO E4-4 TO E4-3 TO E4-2 TO E4-1 TO E4-14 TO E4-13 TO E4-12 TO E4-11 TO E4-10 TO E4-8)	1
Excavation Bottom (E4-14 TO E4-13 TO E4-12 TO E4-15 TO E4-14)	1
Total Samples	23

Point ID	Easting	Northing
E4-1	3306424.14	6956315.32
E4-2	3306424.82	6956348.86
E4-3	3306427.09	6956351.30
E4-4	3306443.16	6956333.62
E4-5	3306448.92	6956337.49
E4-6	3306438.96	6956348.00
E4-7	3306461.42	6956359.97
E4-8	3306466.83	6956368.40
E4-9	3306451.24	6956377.26
E4-10	3306485.60	6956357.72
E4-11	3306507.10	6956328.27
E4-12	3306490.12	6956307.93
E4-13	3306482.44	6956314.34
E4-14	3306459.27	6956286.80
E4-15	3306466.93	6956280.16

NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
2. TOPOGRAPHY AND LOCATION OF EXISTING STRUCTURES ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021.
3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND ARE BASED ON FIGURE 1-4 OF THE RI ADDENDUM DATED 2014 AND PREPARED BY AECOM.
4. FOR OVERALL ACCESS TO THE SITE REFER TO SHEET G002.

0 20' 40'
SCALE: 1" = 20'

US Army Corps of Engineers
TULSA DISTRICT

STATE OF TEXAS · MICHAEL T. VECCHIO · 114480 · REGISTERED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
8	FINAL APPROVED DESIGN	02/28/2024
9		
10		
11		
12		
13		
14		

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
4	100% DRAFT DESIGN EPA/TCEQ SUBMISSION	07/05/2023
5	100% DRAFT DESIGN EPA/TCEQ SUBMISSION	08/15/2023
6	100% DESIGN USACE SUBMISSION	10/19/2023
7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023

DESIGNED BY: S. KLING
DRWN BY: S. KLING
SUBMITTED BY:
CKD BY: T. CONNORS
PLOT SCALE: AS NOTED
SIZE: ANSI D
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT DATE: 2/28/24
FILE NUMBER: 102463377
FILE NAME: 102463378\G_CAD_BIM\6.2_WIP\6.2-4_FINAL DESIGN

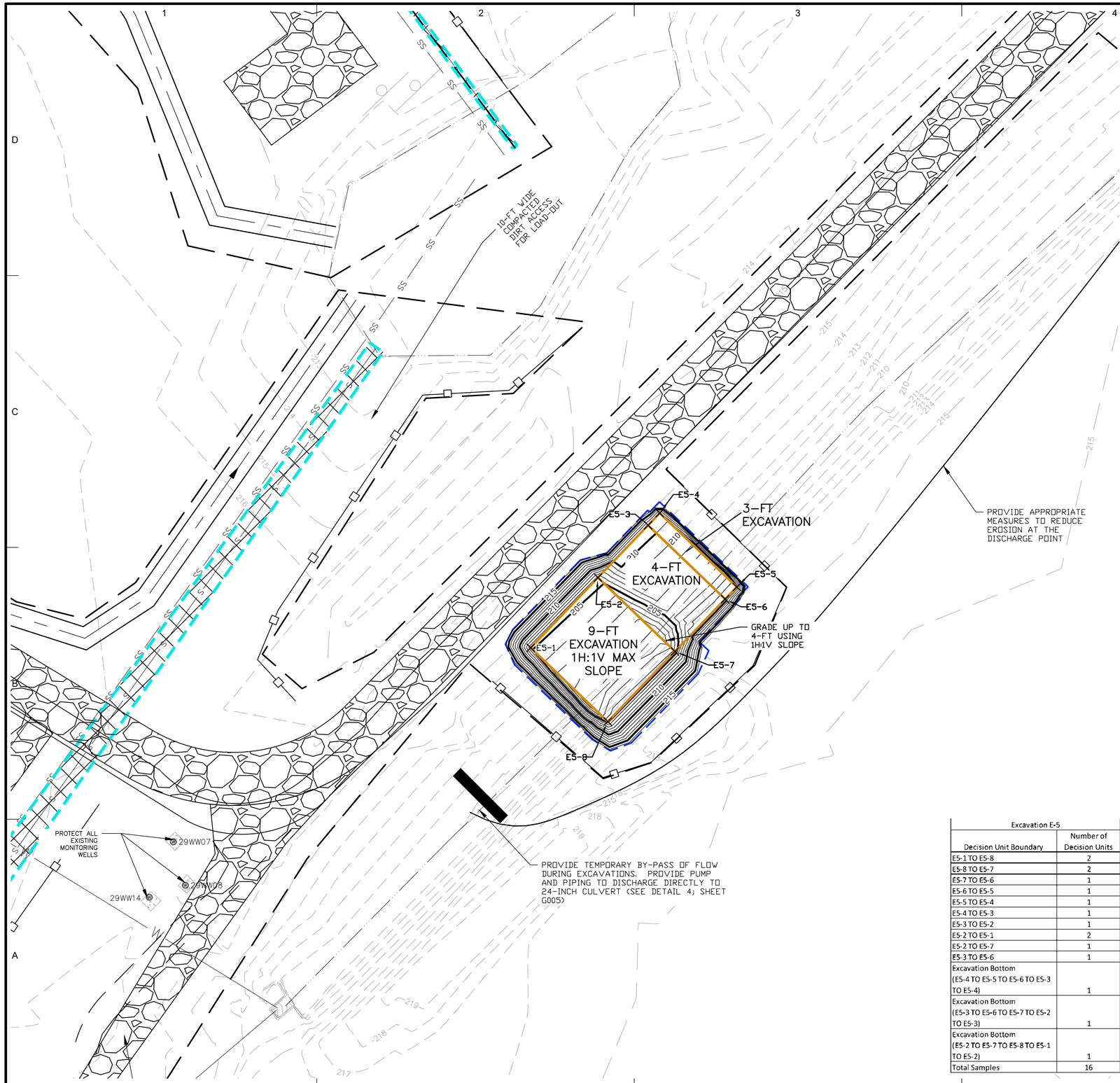
U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
TULSA DISTRICT

HDR
HDR Engineering, Inc.
8404 INDIAN HILLS DRIVE
OMAHA, NE 68114
(402) 399-1000

LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

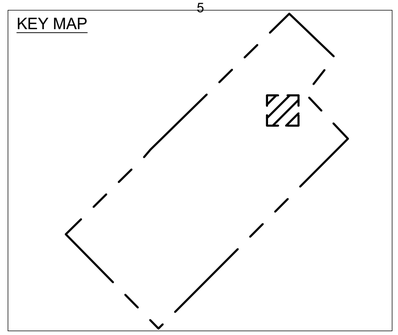
EXCAVATION AREA E-4 SITE PLAN

SHEET IDENTIFICATION
01C104
SHEET 12 OF 30



N

KEY MAP



LEGEND:

- MONITORING WELL
- SIGN
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- WATER EDGE
- COOLING WATER MAIN PIPE – ASSUMED 18"
- 12" WOOD TNT WASTEWATER LINE
- 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE STRUCTURE
- EXCAVATION LIMIT
- ESTIMATED PIPE REMOVAL TRENCH LIMIT
- EXCAVATION TOP OF SLOPE
- TEMPORARY CONSTRUCTION ACCESS ROAD
- LIMITS OF CLEARING
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PIPE EXCAVATION
- SILT FENCE
- TEMPORARY DRAINAGE DITCH
- WATER BY-PASS PIPE
- TEMPORARY WATER BARRIER

EXCAVATION NOTES:

1. CONTRACTOR SHALL PERFORM INITIAL EXCAVATIONS AT THE LIMITS SHOWN ON THIS PLAN.
2. CONTRACTOR SHALL USE INCREMENTAL SAMPLING METHODOLOGY (ISM). EACH SIDEWALL AND BOTTOM WILL BE IDENTIFIED AS A DECISION UNIT (DU). FOR EXCAVATIONS GREATER THAN 5 FT SIDEWALLS WILL BE BROKEN INTO MULTIPLE DECISION UNITS BASED ON DEPTH INTERVALS OF 4 OR 5 FT IN ORDER TO PROVIDE SAFE EGRESS AND INGRESS INTO THE EXCAVATION TO COLLECT INCREMENTAL SAMPLES. WITHIN EACH DU THE CONTRACTOR SHALL COLLECT 30 INCREMENTAL SAMPLES AT EVENLY SPACED GRID LOCATIONS ACROSS THE DU. INCREMENTAL SAMPLES FOR EACH DU WILL BE COMBINED AND PROCESSED INTO A SINGLE CONTAINER FOR THAT DU AND SENT TO THE LABORATORY FOR ANALYSIS OF EXPLOSIVES USING A 48-HR TURN-AROUND TIME. RESULTS OF CONFIRMATION SAMPLES WILL BE REVIEWED BY THE USACE TO VERIFY CLEANUP LEVELS ARE ACHIEVED BEFORE THE EXCAVATION IS BACKFILLED. IF RESULTS INDICATE CLEANUP LEVELS HAVE NOT BEEN ACHIEVED THEN THE CONTRACTOR SHALL EXCAVATE 2 FT LATERALLY AND/OR 1 FT DEEPER AND COLLECT ADDITIONAL CONFIRMATION SAMPLES FOR ANALYSIS. THIS SHALL CONTINUE UNTIL CLEANUP LEVELS ARE ACHIEVED. NO BOTTOM SAMPLES WILL BE COLLECTED FOR EXCAVATIONS WHERE THE WATER TABLE IS BREACHED.
3. EXCAVATIONS SHALL MEET OSHA REQUIREMENTS AND THOSE ADDITIONAL REQUIREMENTS IDENTIFIED ON SHEET G001. MAXIMUM PERMISSIBLE SLOPES USED TO COMPLETE EXCAVATIONS SHALL BE 1H:1V.
4. WATER IN THE EXISTING DITCH SHALL BE BARRICADED AS SHOWN AND SHALL BE PUMPED DIRECTLY TO THE 24-INCH CULVERT. APPROPRIATE MEASURES SHALL BE PROVIDED AT THE DISCHARGE TO PREVENT EROSION. IF EROSION IS OBSERVED ADDITIONAL MEASURES SHALL BE PROVIDED BY THE CONTRACTOR.
5. FOLLOWING THE EXCAVATION AND APPROVAL BY THE USACE THE CONTRACTOR SHALL IMMEDIATELY BACKFILL THE AREAS WITH CLEAN MATERIAL TO RESTORE THE EXISTING GRADES OF THE WATERWAY AND SEED AND MULCH ALL DISTURBED AREA.

Point ID	Easting	Northing
E5-1	3306962.13	6956217.17
E5-2	3306987.48	6956243.62
E5-3	3307006.39	6956263.35
E5-4	3307010.77	6956267.93
E5-5	3307039.84	6956240.07
E5-6	3307035.46	6956235.50
E5-7	3307016.55	6956215.76
E5-8	3306991.19	6956189.31

Excavation E-5	
Decision Unit Boundary	Number of Decision Units
E5-1 TO E5-8	2
E5-8 TO E5-7	2
E5-7 TO E5-6	1
E5-6 TO E5-5	1
E5-5 TO E5-4	1
E5-4 TO E5-3	1
E5-3 TO E5-2	1
E5-2 TO E5-1	2
E5-2 TO E5-7	1
E5-3 TO E5-6	1
Excavation Bottom (E5-4 TO E5-5 TO E5-6 TO E5-3 TO E5-4)	1
Excavation Bottom (E5-3 TO E5-6 TO E5-7 TO E5-2 TO E5-3)	1
Excavation Bottom (E5-2 TO E5-7 TO E5-8 TO E5-1 TO E5-2)	1
Total Samples	16

NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
2. TOPOGRAPHY AND LOCATION OF EXISTING STRUCTURES ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021.
3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND SHALL BE FIELD VERIFIED BY THE CONTRACTOR.

0 20' 40'
SCALE: 1" = 20'

US Army Corps of Engineers
TULSA DISTRICT

STATE OF TEXAS · MICHAEL L. VECCHIO · 147488 · REGISTERED PROFESSIONAL ENGINEER · 02/28/2024

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
4	100% DRAFT DESIGN USACE SUBMISSION	07/05/2023
5	100% DRAFT DESIGN EPA/TCEQ SUBMISSION	08/15/2023
6	100% DESIGN USACE SUBMISSION	10/19/2023
7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023
8	FINAL APPROVED DESIGN	02/28/2024

DESIGNED BY: S. KLING
DRWN BY: S. KLING
CHKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
FILE NUMBER: 702643S7
PLOT DATE: 2/28/24
PLOT SCALE: 1
SET SIZE: ANSI D
FILE NAME: 02643S7#U_CAD_BIM#2_2_WIP#2.2.4_FINAL DESIGN

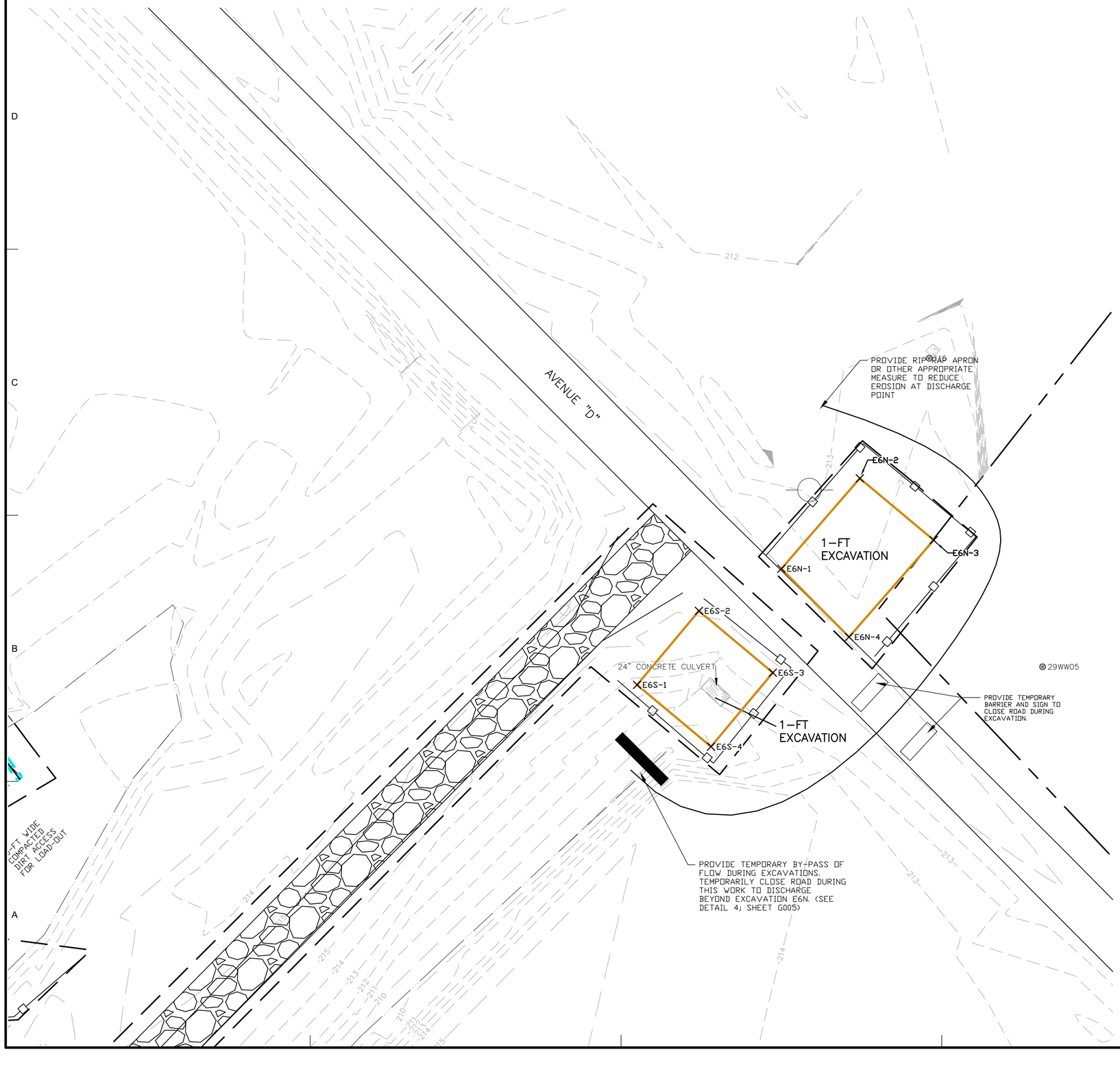
U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
TULSA DISTRICT

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OMAHA, NE 68114
(402) 399-1000

LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

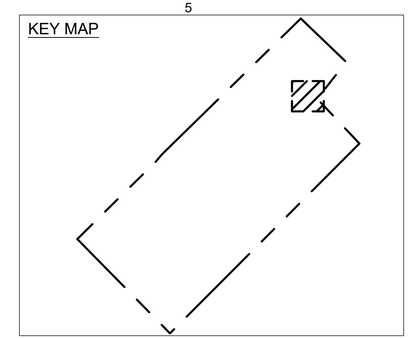
EXCAVATION AREA E-5 SITE PLAN

SHEET IDENTIFICATION
01C105
SHEET 13 OF 30



N

KEY MAP



LEGEND:

- MONITORING WELL
- UTILITY POLE
- SITE BOUNDARY
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- WATER EDGE
- EXCAVATION LIMIT
- TEMPORARY CONSTRUCTION ACCESS ROAD
- LIMITS OF CLEARING
- SILT FENCE
- WATER BY-PASS PIPE

EXCAVATION NOTES:

1. CONTRACTOR SHALL PERFORM INITIAL EXCAVATIONS AT THE LIMITS SHOWN ON THIS PLAN.
2. CONTRACTOR SHALL USE INCREMENTAL SAMPLING METHODOLOGY (ISM). EACH SIDEWALL AND BOTTOM WILL BE IDENTIFIED AS A DECISION UNIT (DU). FOR EXCAVATIONS GREATER THAN 5 FT SIDEWALLS WILL BE BROKEN INTO MULTIPLE DECISION UNITS BASED ON DEPTH INTERVALS OF 4 OR 5 FT IN ORDER TO PROVIDE SAFE EGRESS AND INGRESS INTO THE EXCAVATION TO COLLECT INCREMENTAL SAMPLES. WITHIN EACH DU THE CONTRACTOR SHALL COLLECT 30 INCREMENTAL SAMPLES AT EVENLY SPACED GRID LOCATIONS ACROSS THE DU. INCREMENTAL SAMPLES FOR EACH DU WILL BE COMBINED AND PROCESSED INTO A SINGLE CONTAINER FOR THAT DU AND SENT TO THE LABORATORY FOR ANALYSIS OF EXPLOSIVES USING A 48-HR TURN-AROUND TIME. RESULTS OF CONFIRMATION SAMPLES WILL BE REVIEWED BY THE USACE TO VERIFY CLEANUP LEVELS ARE ACHIEVED BEFORE THE EXCAVATION IS BACKFILLED. IF RESULTS INDICATE CLEANUP LEVELS HAVE NOT BEEN ACHIEVED THEN THE CONTRACTOR SHALL EXCAVATE 2 FT LATERALLY AND/OR 1 FT DEEPER AND COLLECT ADDITIONAL CONFIRMATION SAMPLES FOR ANALYSIS. THIS SHALL CONTINUE UNTIL CLEANUP LEVELS ARE ACHIEVED.
3. EXCAVATIONS SHALL MEET OSHA REQUIREMENTS AND THOSE ADDITIONAL REQUIREMENTS IDENTIFIED ON SHEET G001. MAXIMUM PERMISSIBLE SLOPES USED TO COMPLETE EXCAVATIONS SHALL BE 1H:1V.
4. CONCRETE CULVERT UNDERNEATH E6S WILL BE PROTECTED AND SUPPORTED DURING EXCAVATION. CULVERT SHALL BE CLEANED OF ALL SEDIMENT AS PART OF THE EXCAVATION ACTIVITIES. ACCEPTANCE OF CLEANING SHALL BE VISUALLY DETERMINED AND IF NECESSARY VIDEO CAMERA INSPECTION SHALL BE USED TO VERIFY ALL SEDIMENT HAS BEEN REMOVED.
5. WATER IN THE EXISTING DITCH SHALL BE BARRICADED AS SHOWN AND SHALL BE PUMPED OVER THE ROAD PAST EXCAVATION AREA E6N. THE CONTRACTOR SHALL PROVIDE AN ENERGY DISSIPATER SUCH AS RIP RAP APRON IF NECESSARY TO PREVENT EROSION AT THE DISCHARGE POINT. ANY EROSION OBSERVED SHALL BE IMMEDIATELY REPAIRED AND ADDITIONAL MEASURES TO PREVENT EROSION SHALL BE IMPLEMENTED.
6. PROVIDE ROAD SIGNS AND APPROPRIATE BARRICADES TO CLOSE AVENUE "D" TO LOCAL TRAFFIC DURING THE EXCAVATION AND BACKFILL ACTIVITIES FOR EXCAVATION AREAS E6-N/S. SIGNS CLOSING AVE "D" SHALL BE PROVIDED AT THE INTERSECTIONS OF 18TH STREET AND ZEUGNER DRIVE WITH AVE "D". AVE "D" SHALL BE LEFT OPEN FOR CONSTRUCTION TRAFFIC. BARRICADES SHALL BE PROVIDED ON EITHER SIDE OF THE WATER BY-PASS DISCHARGE PIPING THAT WILL CROSS OVER TOP OF THE ROAD TO PREVENT TRAFFIC FROM DRIVING OVER THE PIPE. ROAD SIGNS AND CLOSURES SHALL BE IN ACCORDANCE WITH THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS (MUTCD).
7. FOLLOWING THE EXCAVATION AND APPROVAL BY THE USACE THE CONTRACTOR SHALL IMMEDIATELY BACKFILL THE AREAS WITH CLEAN MATERIAL TO RESTORE THE EXISTING GRADES OF THE WATERWAY AND SEED AND MULCH ALL DISTURBED AREA.

Point ID	Easting	Northing
E6N-1	3307249.50	6956486.76
E6N-2	3307279.71	6956521.57
E6N-3	3307308.17	6956497.76
E6N-4	3307275.55	6956460.47

Point ID	Easting	Northing
E6S-1	3307193.93	6956442.04
E6S-2	3307217.75	6956470.52
E6S-3	3307246.21	6956446.72
E6S-4	3307222.39	6956418.24

Excavation E-6N	
Decision Unit Boundary	Number of Decision Units
E6N-1 TO E6N-4	1
E6N-4 TO E6N-3	1
E6N-3 TO E6N-2	1
E6N-2 TO E6N-1	1
Excavation Bottom (E6N-1 TO E6N-4 TO E6N-3 TO E6N-2 TO E6N-1)	1
Total Samples	5

Excavation E-6S	
Decision Unit Boundary	Number of Decision Units
E6S-1 TO E6S-4	1
E6S-4 TO E6S-3	1
E6S-3 TO E6S-2	1
E6S-2 TO E6S-1	1
Excavation Bottom (E6S-1 TO E6S-4 TO E6S-3 TO E6S-2 TO E6S-1)	1
Total Samples	5

NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
2. TOPOGRAPHY AND LOCATION OF EXISTING STRUCTURES ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021.

0 20' 40'
SCALE: 1" = 20'

US Army Corps of Engineers
TULSA DISTRICT

STATE OF TEXAS — MICHAEL J. VECCHIO — 147489 — LICENSED PROFESSIONAL ENGINEER — 2/28/2024

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
4	100% DRAFT DESIGN USACE SUBMISSION	07/05/2023
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6	100% DESIGN USACE SUBMISSION	10/19/2023
7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023
8	FINAL APPROVED DESIGN	02/28/2024
9		
10		
11		
12		
13		
14		

DESIGNED BY: S. KLING
DRWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: 1 = 1
PLOT DATE: 2/28/24
FILE NUMBER: 102453737
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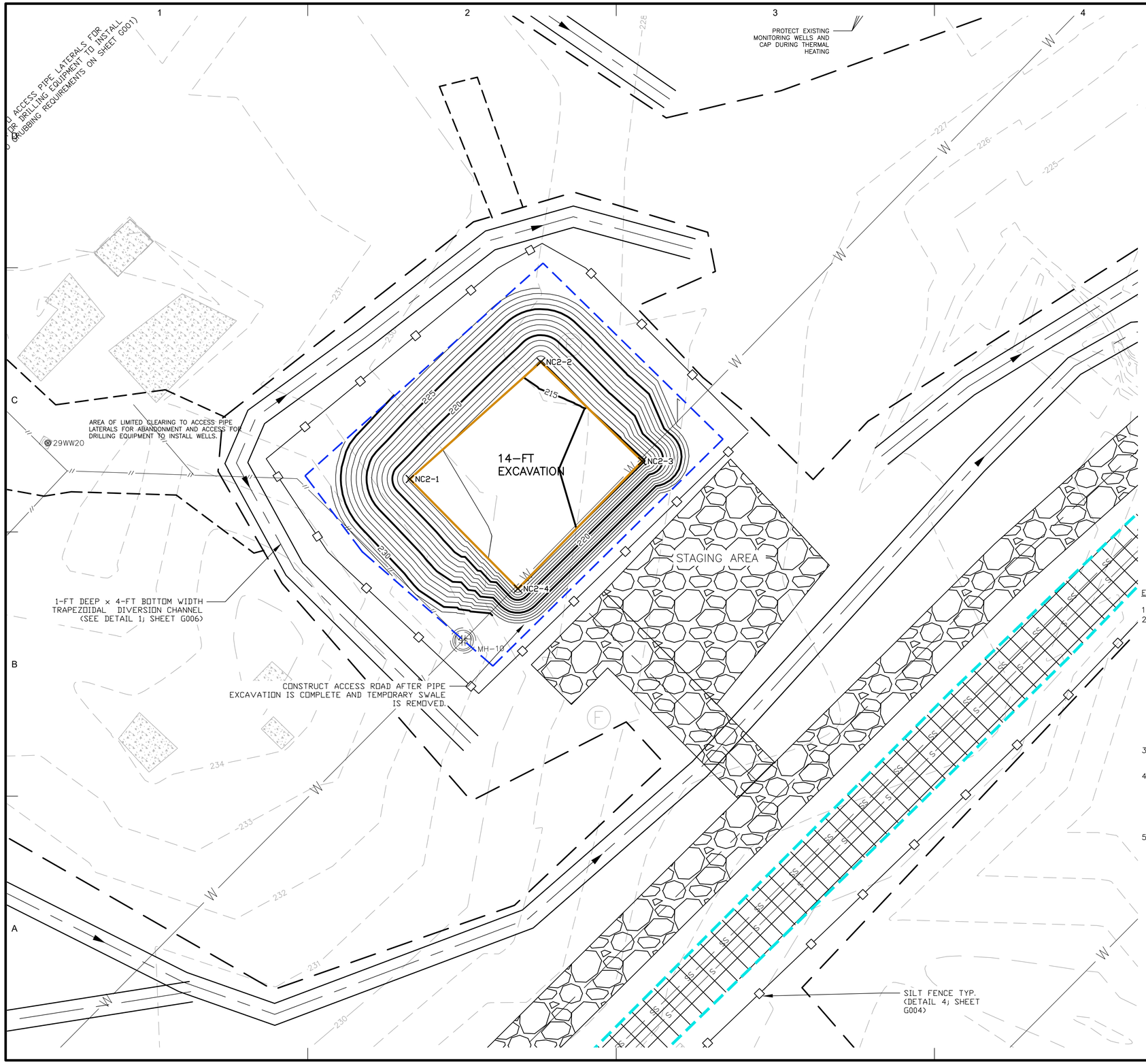
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TULSA DISTRICT

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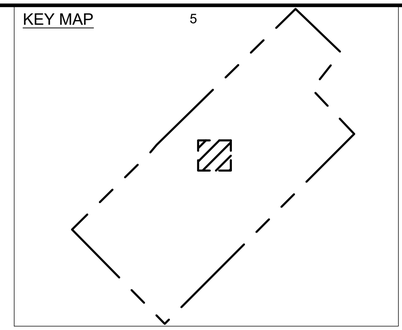
LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

EXCAVATION AREA E-6 SITE PLAN

SHEET IDENTIFICATION
01C106
SHEET 14 OF 30



KEY MAP



LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- CONTOUR MINOR
- CONTOUR MAJOR
- COOLING WATER MAIN PIPE – ASSUMED 18"
- COOLING WATER BUILDING SERVICE PIPE
- 12" WOOD TNT WASTEWATER LINE
- 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE STRUCTURE
- EXCAVATION LIMIT
- ESTIMATED PIPE REMOVAL TRENCH LIMIT
- EXCAVATION TOP OF SLOPE
- TEMPORARY CONSTRUCTION ACCESS ROAD
- LIMITS OF CLEARING
- PROPOSED CONTOUR MAJOR
- PROPOSED CONTOUR MINOR
- PIPE EXCAVATION
- LIMITS OF LIGHT CLEARING
- SILT FENCE
- TEMPORARY DRAINAGE DITCH

EXCAVATION NOTES:

1. CONTRACTOR SHALL PERFORM INITIAL EXCAVATIONS AT THE LIMITS SHOWN ON THIS PLAN.
2. CONTRACTOR SHALL USE INCREMENTAL SAMPLING METHODOLOGY (ISM). EACH SIDEWALL AND BOTTOM WILL BE IDENTIFIED AS A DECISION UNIT (DU). FOR EXCAVATIONS GREATER THAN 5 FT SIDEWALLS WILL BE BROKEN INTO MULTIPLE DECISION UNITS BASED ON DEPTH INTERVALS OF 4 OR 5 FT IN ORDER TO PROVIDE SAFE EGRESS AND INGRESS INTO THE EXCAVATION TO COLLECT INCREMENTAL SAMPLES. WITHIN EACH DU THE CONTRACTOR SHALL COLLECT 30 INCREMENTAL SAMPLES AT EVENLY SPACED GRID LOCATIONS ACROSS THE DU. INCREMENTAL SAMPLES FOR EACH DU WILL BE COMBINED AND PROCESSED INTO A SINGLE CONTAINER FOR THAT DU AND SENT TO THE LABORATORY FOR ANALYSIS OF EXPLOSIVES USING A 48–HR TURN–AROUND TIME. RESULTS OF CONFIRMATION SAMPLES WILL BE REVIEWED BY THE USACE TO VERIFY CLEANUP LEVELS ARE ACHIEVED BEFORE THE EXCAVATION IS BACKFILLED. IF RESULTS INDICATE CLEANUP LEVELS HAVE NOT BEEN ACHIEVED THEN THE CONTRACTOR SHALL EXCAVATE 2 FT LATERALLY AND/OR 1 FT DEEPER AND COLLECT ADDITIONAL CONFIRMATION SAMPLES FOR ANALYSIS. THIS SHALL CONTINUE UNTIL CLEANUP LEVELS ARE ACHIEVED. NO BOTTOM SAMPLES WILL BE COLLECTED FOR EXCAVATIONS WHERE THE WATER TABLE IS BREACHED.
3. EXCAVATIONS SHALL MEET OSHA REQUIREMENTS AND THOSE ADDITIONAL REQUIREMENTS IDENTIFIED ON SHEET G001. MAXIMUM PERMISSIBLE SLOPES USED TO COMPLETE EXCAVATIONS SHALL BE 1H:1V.
4. CONCRETE REMOVED AS PART OF THE EXCAVATION SHALL BE STOCKPILED SEPARATELY. IF NO STAINS ARE PRESENT CONCRETE MAY BE CRUSHED AND USED AS BACKFILL FOR EXCAVATED AREAS ABOVE THE GROUNDWATER TABLE. STAINED CONCRETE SHALL BE SEGREGATED AND BROKEN UP FOR TRANSPORT TO AN APPROVED DISPOSAL FACILITY. CONCRETE WILL BE DECONTAMINATED BEFORE BEING DISPOSED OFF SITE. DECONTAMINATION SHALL INCLUDE THE REMOVAL OF DIRT WITH BRUSHES AND/OR WASHING TO VISUALLY REMOVE STAINING OR SOIL FROM CONCRETE.
5. CONTRACTOR SHALL STOCKPILE EXCAVATED SOILS FROM SLOPES SEPARATE FROM IMPACTED SOIL FOR REUSE AS BACKFILL ONCE EXCAVATIONS ARE COMPLETED. STOCKPILED SOILS SHALL BE SAMPLED FOR EXPLOSIVES TO VERIFY LEVELS MEET THE CLEANUP LEVELS BEFORE REUSE ON SITE.

Point ID	Easting	Northing
NC2-1	3305937.32	6955619.60
NC2-2	3305988.18	6955665.02
NC2-3	3306027.53	6955626.52
NC2-4	3305979.29	6955577.08

Excavation NC-2	
Decision Unit Boundary	Number of Decision Units
NC2-1 TO NC2-4	3
NC2-4 TO NC2-3	3
NC2-3 TO NC2-2	3
NC2-2 TO NC2-1	3
Excavation Bottom (NC2-1 TO NC2-2 TO NC2-3 TO NC2-4 TO NC2-1)	1
Total Samples	13

NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
2. TOPOGRAPHY AND LOCATION OF EXISTING STRUCTURES ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021.
3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND SHALL BE FIELD VERIFIED BY THE CONTRACTOR.

0 20' 40'
SCALE: 1" = 40'

US Army Corps of Engineers
TULSA DISTRICT

STATE OF TEXAS · MICHAEL L. VECCHIO · 147489 · REGISTERED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
4	100% DRAFT DESIGN USACE SUBMISSION	07/05/2023
5	100% DRAFT DESIGN EPA/TCEQ SUBMISSION	08/15/2023
6	100% DESIGN USACE SUBMISSION	10/19/2023
7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023
8	FINAL APPROVED DESIGN	02/28/2024

DESIGNED BY: S. KLING
DRWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
FILE NUMBER: 102463537
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/24
FILE NAME: 102463378\J, CAD, BIM\6-2_WIP\6-2-4_FINAL DESIGN
SIZE: ANSI D

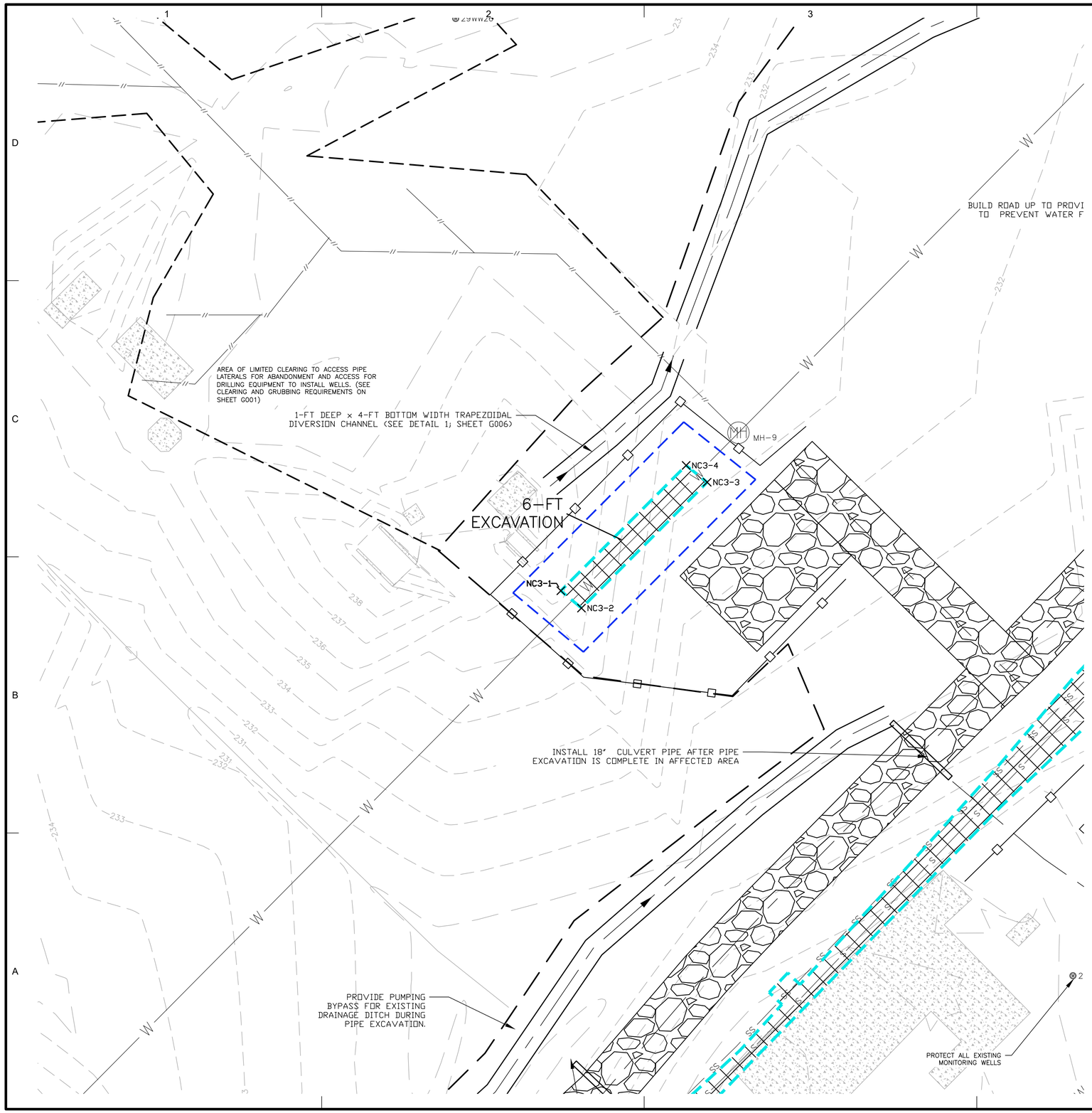
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LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

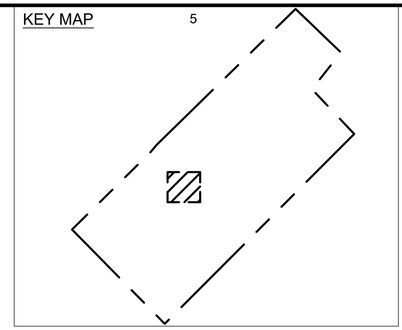
EXCAVATION AREA NC-2 SITE PLAN

SHEET IDENTIFICATION
01C107
SHEET 15 OF 30



N

KEY MAP



LEGEND:

- MONITORING WELL
- CONTOUR MINOR
- CONTOUR MAJOR
- COOLING WATER MAIN PIPE – ASSUMED 18"
- COOLING WATER BUILDING SERVICE PIPE
- 12" WOOD TNT WASTEWATER LINE
- 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE STRUCTURE
- ESTIMATED PIPE REMOVAL TRENCH LIMIT EXCAVATION TOP OF SLOPE
- TEMPORARY CONSTRUCTION ACCESS ROAD
- LIMITS OF CLEARING
- PIPE EXCAVATION
- LIMITS OF LIGHT CLEARING
- SILT FENCE
- TEMPORARY DRAINAGE DITCH
- TEMPORARY EARTHEN DIKE

EXCAVATION NOTES:

1. CONTRACTOR SHALL PERFORM INITIAL EXCAVATIONS AT THE LIMITS SHOWN ON THIS PLAN OR TO THE GROUNDWATER TABLE.
2. CONTRACTOR SHALL COLLECT CONFIRMATION SAMPLES AT A FREQUENCY OF EVERY 30 LINEAR FEET ALONG SIDEWALLS AND EVERY 900 SQUARE FEET OF BOTTOM AREA. A MINIMUM OF TWO SIDEWALL SAMPLES SHALL BE COLLECTED; ONE AT THE BOTTOM AND ONE AT THE TOP OF THE EXCAVATION. CONFIRMATION SAMPLES SHALL BE ANALYZED FOR EXPLOSIVES USING A 48-HOUR TURN-AROUND-TIME OR AS OTHERWISE APPROVED BY THE USACE. RESULTS OF CONFIRMATION SAMPLES WILL BE REVIEWED BY THE USACE TO VERIFY CLEANUP LEVELS ARE ACHIEVED BEFORE THE EXCAVATION IS BACKFILLED. IF RESULTS INDICATE CLEANUP LEVELS HAVE NOT BEEN ACHIEVED THEN THE CONTRACTOR SHALL EXCAVATE 2 FT LATERALLY AND/OR 1 FT DEEPER AND COLLECT ADDITIONAL CONFIRMATION SAMPLES FOR ANALYSIS. THIS SHALL CONTINUE UNTIL CLEANUP LEVELS ARE ACHIEVED OR THE GROUNDWATER TABLE IS ENCOUNTERED.
3. PIPE ENCOUNTERED DURING THE EXCAVATION SHALL BE CUT AT BOTH ENDS OF THE EXCAVATION LIMIT AND CAPPED. THE SECTION OF PIPE REMOVED SHALL BE DISPOSED OFF SITE WITH THE CONTAMINATED SOIL.
4. EXCAVATIONS SHALL MEET OSHA REQUIREMENTS AND THOSE ADDITIONAL REQUIREMENTS IDENTIFIED ON SHEET G001. MAXIMUM PERMISSIBLE SLOPES USED TO COMPLETE EXCAVATIONS SHALL BE 1H:1V.
5. CONCRETE REMOVED AS PART OF THE EXCAVATION SHALL BE STOCKPILED SEPARATELY. IF NO STAINS ARE PRESENT CONCRETE MAY BE CRUSHED AND USED AS BACKFILL FOR EXCAVATED AREAS ABOVE THE GROUNDWATER TABLE. STAINED CONCRETE SHALL BE SEGREGATED AND BROKEN UP FOR TRANSPORT TO AN APPROVED DISPOSAL FACILITY. CONCRETE WILL BE DECONTAMINATED BEFORE BEING DISPOSED OFF SITE. DECONTAMINATION SHALL INCLUDE THE REMOVAL OF DIRT WITH BRUSHES AND/OR WASHING TO VISUALLY REMOVE ALL STAINING OR SOIL FROM CONCRETE.
6. CONTRACTOR SHALL STOCKPILE EXCAVATED CLEAN SOILS FROM SLOPED AREAS SEPARATE FROM IMPACTED SOIL FOR REUSE AS BACKFILL ONCE EXCAVATIONS ARE COMPLETED. STOCKPILED SOIL SHALL BE SAMPLED FOR EXPLOSIVES TO VERIFY LEVELS MEET THE CLEANUP LEVELS BEFORE REUSE ON SITE.

Point ID	Easting	Northing
NC3-1	3305564.95	6955167.89
NC3-2	3305572.61	6955161.45
NC3-3	3305619.28	6955208.17
NC3-4	3305611.47	6955214.41

NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
2. TOPOGRAPHY AND LOCATION OF EXISTING STRUCTURES ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021.
3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND SHALL BE FIELD VERIFIED BY THE CONTRACTOR.

0 20' 40'
SCALE: 1" = 40'

US Army Corps of Engineers
TULSA DISTRICT

STATE OF TEXAS · MICHAEL J. VECCHIO · 147480 · LICENSED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
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6	100% DESIGN USACE SUBMISSION	10/19/2023
7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023
8	FINAL APPROVED DESIGN	02/28/2024
9		
10		
11		
12		
13		
14		

DESIGNED BY: S. KLING
DWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: As NOTED
PLOT DATE: 2/28/24
FILE NUMBER: 10264537
SIZE: ANSI D
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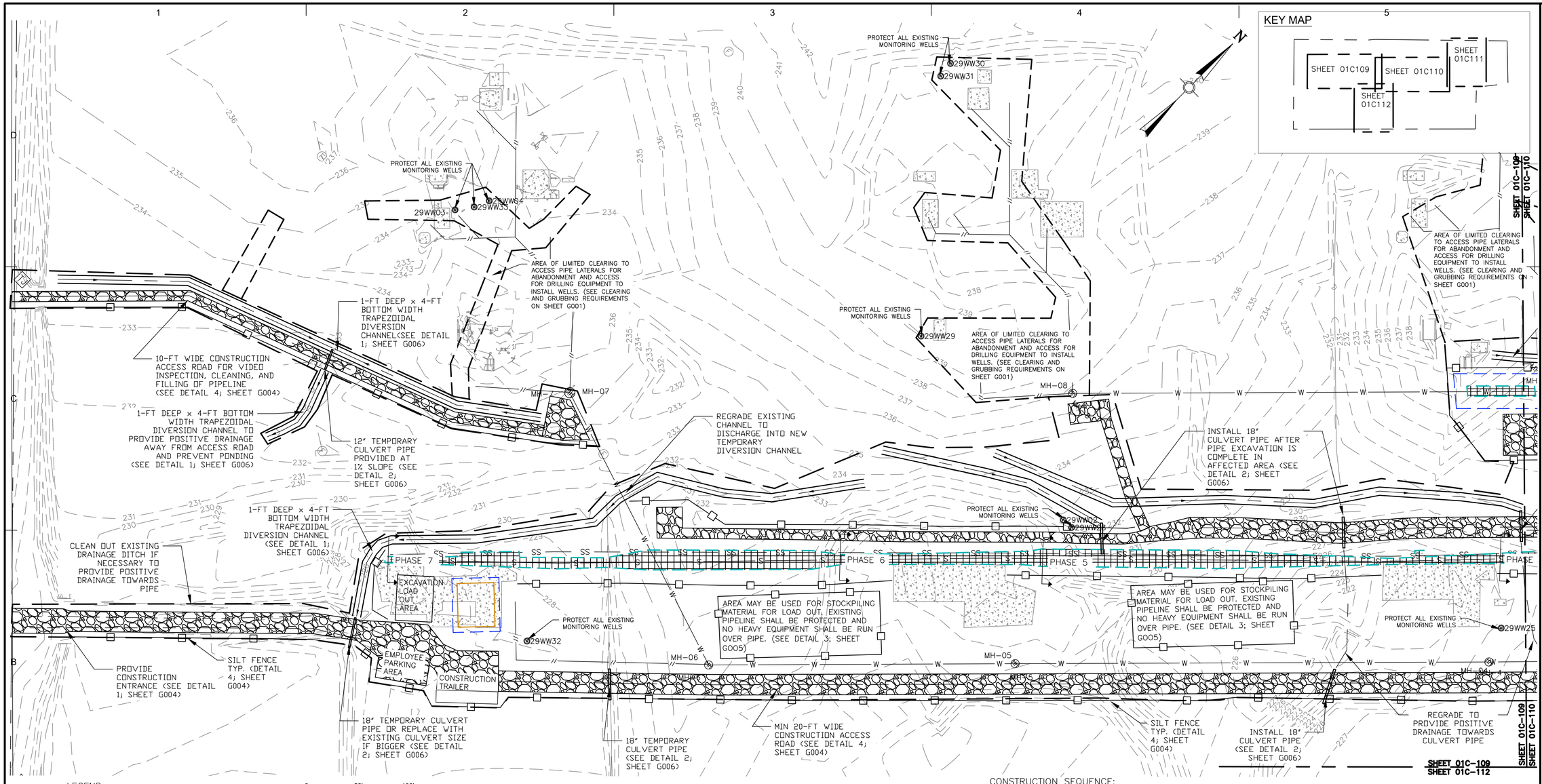
U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
TULSA DISTRICT

HDR
HDR Engineering, Inc.
8404 INDIAN HILLS DRIVE
OMAHA, NE 68114
(402) 399-1000

LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

EXCAVATION AREA NC-3 SITE PLAN

SHEET IDENTIFICATION
01C108
SHEET 16 OF 30



LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- UTILITY POLE
- SIGN
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- EXISTING GRAVEL
- EXISTING UNPAVED ROAD
- WATER EDGE
- W — COOLING WATER MAIN PIPE – ASSUMED 18"
- // — COOLING WATER BUILDING SERVICE PIPE
- S — 12" WOOD TNT WASTEWATER LINE
- SS — 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE STRUCTURE
- TEMPORARY CONSTRUCTION ACCESS ROAD
- PIPE REMOVAL EXCAVATION
- EXCAVATION LIMIT
- EXCAVATION TOP OF SLOPE
- LIMITS OF CLEARING
- LIMITS OF LIGHT CLEARING
- SILT FENCE
- TEMPORARY DRAINAGE DITCH
- SHEET MATCHLINE

0 50' 100'

SCALE: 1" = 50'

NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
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3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND ARE BASED ON BEST AVAILABLE INFORMATION. THE CONTRACTOR SHALL LOCATE THESE LINES AS PART OF THE REMEDIAL ACTION.
4. ALL EXISTING MONITORING WELLS SHALL BE PROTECTED UNLESS OTHERWISE NOTED TO BE ABANDONED. CONTRACTOR IS RESPONSIBLE FOR MEANS AND METHODS OF PROTECTING MONITORING WELLS. MONITORING WELLS DAMAGED DURING CONSTRUCTION SHALL BE REPLACED BY THE CONTRACTOR.

STORMWATER MANAGEMENT AND EROSION CONTROL REQUIREMENTS:

1. THE CONTRACTOR SHALL PROVIDE STORMWATER RUNOFF CONTROLS TO PREVENT WATER FROM ENTERING EXCAVATION AREAS AND MINIMIZE RUNOFF OF CONTAMINATED SEDIMENT FROM THE SITE.
2. THE EROSION CONTROL MEASURES SHOWN ARE THE MINIMUM ANTICIPATED AND ADDITIONAL MEASURES SHALL BE PROVIDED BY THE CONTRACTOR BASED ON THE MEANS AND METHODS USED TO COMPLETE THE WORK AND IF NECESSARY TO PREVENT SEDIMENT MIGRATION.
3. THE SITE SHALL MEET THE REQUIREMENTS OF THE STORMWATER CONSTRUCTION GENERAL PERMIT TPDES GENERAL PERMIT NO. TXR150000. THE CONTRACTOR SHALL PREPARE A SWP3 IN GENERAL CONFORMANCE WITH THE STORMWATER CONSTRUCTION GENERAL PERMIT TPDES GENERAL PERMIT NO. TXR150000. THE CONTRACTOR SHALL MAINTAIN THE SWP3 WITH ALL PERTINENT RECORDS, CORRESPONDENCE, ENVIRONMENTAL DOCUMENTS, ETC. AT THE PROJECT FIELD OFFICE. ALL DOCUMENTATION SHALL BE SUBMITTED TO THE USACE FOR THEIR RECORDS AND THE USACE SHALL BE PROVIDED THE THE SWP3 FOR REVIEW AND APPROVAL.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING THE BEST MANAGEMENT PRACTICES (BMPs) FOR CONTROLLING EROSION AND SEDIMENTATION DURING DAY-TO-DAY OPERATIONS.
5. THE CONTRACTOR SHALL INSPECT ALL DISTURBED AREAS AND EROSION AND SEDIMENT CONTROL DEVICES AT LEAST ONCE EVERY SEVEN (7) DAYS. INSPECTIONS SHALL BE RECORDED ON APPROVED INSPECTION FORMS INCLUDED IN THE SWP3 AND ALL COMPLETED COPIES SHALL BE MAINTAINED AT THE FIELD OFFICE. ELECTRONIC COPIES SHALL BE PROVIDED TO THE USACE IF REQUESTED BY THE USACE.
6. THE CONTRACTOR SHALL PROPERLY MAINTAIN ALL INSTALLED EROSION CONTROL PRACTICES TO MAINTAIN THEIR EFFECTIVENESS. IF IT IS DETERMINED THAT A BMP OR CONTROL MEASURE IS NOT OPERATING EFFECTIVELY, MAINTENANCE MUST BE ACCOMPLISHED AS SOON AS POSSIBLE AND BEFORE THE NEXT ANTICIPATED RAIN EVENT, BUT IN NO CASE LATER THAN 7 CALENDAR DAYS AFTER BEING ABLE TO ACCESS THE SITE. MAINTENANCE PERFORMED BY THE CONTRACTOR SHALL BE INDICATED ON THE INSPECTION FORMS INCLUDED IN THE SWP3 AND MAINTAINED ON SITE.

CONSTRUCTION SEQUENCE:

A PRELIMINARY OVERALL SEQUENCE FOR THE ACTIVITIES NECESSARY TO COMPLETE THE REMEDIAL ACTION (RA) IS BELOW. THE ACTUAL SEQUENCE WILL BE DETERMINED BY THE CONTRACTOR AND SHALL BE INCLUDED IN THE WORK PLAN THAT WILL BE SUBMITTED PRIOR TO COMMENCING THE WORK.

1. COMPLETE VIDEO INSPECTION AND CLEANING OF TRANSITE TNT WASTEWATER LINE. REMOVE ALL WASTE MATERIALS FROM TRANSITE TNT PIPELINE. STAKE AND COLLECT SAMPLES FOR DEFECTIVE PIPE SECTIONS OUTSIDE THE REMOVAL LIMITS IDENTIFIED AS PART OF THE WOODEN PIPELINE REMOVAL TO VERIFY WHETHER ADDITIONAL PIPE SECTIONS WILL NEED TO BE REMOVED. SAMPLES COLLECTED SHALL BE ANALYZED USING A 48-HOUR TAT.
2. EXCAVATE WOODEN TNT WASTE LINE AND PORTIONS OF TRANSITE TNT WASTE LINE THAT ARE IMPACTED BY WOODEN PIPE REMOVAL AND/OR IDENTIFIED AS DEFECTIVE DURING THE VIDEO INSPECTION AND CONFIRMED BY SOIL SAMPLE RESULTS COLLECTED AS DESCRIBED ABOVE. CONSTRUCT ACCESS ROADS ALONG SIDE THE PIPE EXCAVATION FOR LOAD OUT OF MATERIAL. AS AN AREA IS DETERMINED TO BE CLEAN THE AREA SHALL BE BACKFILLED AND THE DRAINAGE RESTORED AS INDICATED TO FLOW TO NEW CULVERTS INSTALLED IN THE CONSTRUCTION ACCESS ROAD. THE PIPE EXCAVATION SHALL BE LIMITED TO NO MORE THAN 500 FEET OF OPEN LENGTH.
3. PIPE FILLING OF INTACT SECTIONS OF THE TRANSITE TNT WASTEWATER LINE WILL BE COMPLETED BEFORE EXCAVATIONS ARE BACKFILLED IN ORDER TO PROVIDE ACCESS TO ENDS OF THE PIPE CUT AND EXPOSED DURING THE WOODEN PIPE EXCAVATION.
4. ONCE WOODEN PIPE IS EXCAVATED AND AREAS ARE RESTORED FINISH CONSTRUCTING ACCESS ROADS TO OUTLYING EXCAVATION AREAS AND COOLING WATER LINE MANHOLES FOR VIDEO INSPECTION AND CLEANING.
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TULSA DISTRICT

STATE OF TEXAS — MICHAEL J. VECCHIO — 147480 — LICENSED PROFESSIONAL ENGINEER

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DESIGNED BY: S. KLING
DRN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO.: W912BV23F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/24
FILE NUMBER: 102246337
FILE NAME: ...\CONTRACT_CAD_BIM\G_WP#2-4_FINAL DESIGN
SIZE: ANSI D

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CORPS OF ENGINEERS
TULSA DISTRICT

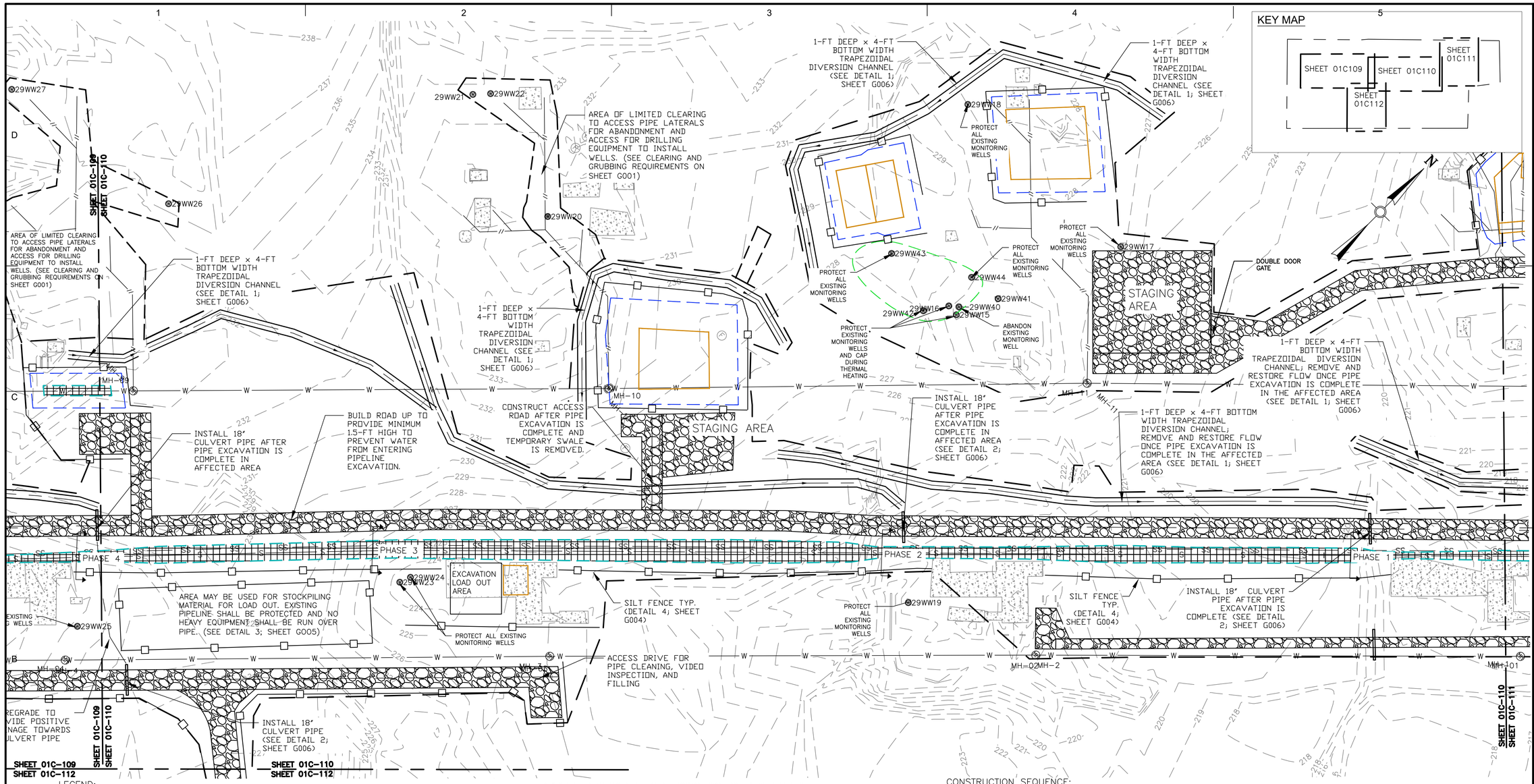
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LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

SITE ACCESS AND EROSION CONTROL PLAN SHEET 1

SHEET IDENTIFICATION
01C109
SHEET 17 OF 30

01226853



LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- UTILITY POLE
- SIGN
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
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8	FINAL APPROVED DESIGN	02/28/2024

DESIGNED BY: S. KUNG
DRAWN BY: S. WILKINS
CKD BY: J. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SCA/TCEQ CONTRACT NO.: WS128P2P0080
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/24
FILE NUMBER: 102246337
SIZE: ANSI D
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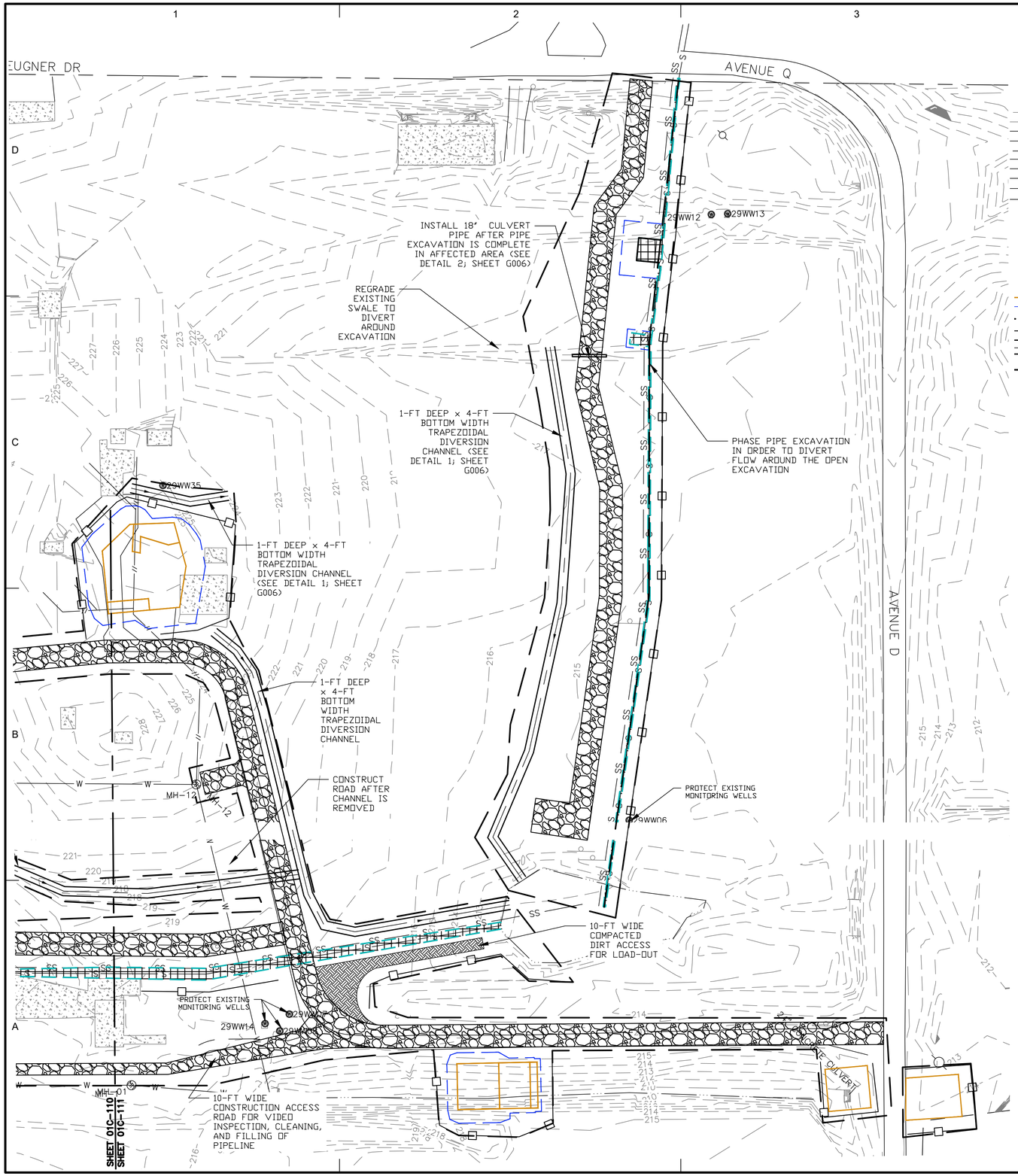
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LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

SITE ACCESS AND EROSION CONTROL PLAN SHEET 2

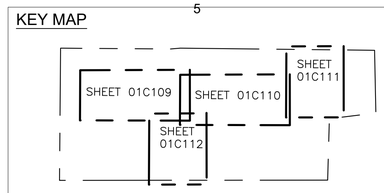
SHEET IDENTIFICATION
01C110
SHEET 18 OF 30



LEGEND:

- MONITORING WELL
- FIRE HYDRANT
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- CONTOUR MINOR
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KEY MAP



STORMWATER MANAGEMENT AND EROSION CONTROL REQUIREMENTS:

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1. COMPLETE VIDEO INSPECTION AND CLEANING OF TRANSITE TNT WASTEWATER LINE. REMOVE ALL WASTE MATERIALS FROM TRANSITE TNT PIPELINE. STAKE AND COLLECT SAMPLES FOR DEFECTIVE PIPE SECTIONS OUTSIDE THE REMOVAL LIMITS IDENTIFIED AS PART OF THE WOODEN PIPELINE REMOVAL TO VERIFY WHETHER ADDITIONAL PIPE SECTIONS WILL NEED TO BE REMOVED. SAMPLES COLLECTED SHALL BE ANALYZED USING A 48-HOUR TAT.
2. EXCAVATE WOODEN TNT WASTE LINE AND PORTIONS OF TRANSITE TNT WASTE LINE THAT ARE IMPACTED BY WOODEN PIPE REMOVAL AND/OR IDENTIFIED AS DEFECTIVE DURING THE VIDEO INSPECTION AND CONFIRMED BY SOIL SAMPLE RESULTS COLLECTED AS DESCRIBED ABOVE. CONSTRUCT ACCESS ROADS ALONG SIDE THE PIPE EXCAVATION FOR LOAD OUT OF MATERIAL. AS AN AREA IS DETERMINED TO BE CLEAN THE AREA SHALL BE BACKFILLED AND THE DRAINAGE RESTORED AS INDICATED TO FLOW TO NEW CULVERTS INSTALLED IN THE CONSTRUCTION ACCESS ROAD. THE PIPE EXCAVATION SHALL BE LIMITED TO NO MORE THAN 500 FEET OF OPEN LENGTH.
3. PIPE FILLING OF INTACT SECTIONS OF THE TRANSITE TNT WASTEWATER LINE WILL BE COMPLETED BEFORE EXCAVATIONS ARE BACKFILLED IN ORDER TO PROVIDE ACCESS TO ENDS OF THE PIPE CUT AND EXPOSED DURING THE WOODEN PIPE EXCAVATION.
4. ONCE WOODEN PIPE IS EXCAVATED AND AREAS ARE RESTORED FINISH CONSTRUCTING ACCESS ROADS TO OUTLYING EXCAVATION AREAS AND COOLING WATER LINE MANHOLES FOR VIDEO INSPECTION AND CLEANING.
5. EXCAVATE AREAS IDENTIFIED FOR EXCAVATION.
6. VIDEO INSPECT, CLEAN, AND ABANDON NORTH AND SOUTH COOLING WATER LINES. DURING THE VIDEO INSPECTION MARK OUT DEFECTIVE SECTIONS OF PIPE FOR COLLECTION OF CONFIRMATION SOIL SAMPLES. IF CLEANUP LEVELS ARE MET CONTINUE CLEANING AND ABANDONING PIPE SECTIONS PER THE DESIGN. AREAS WHERE CLEANUP LEVELS ARE NOT MET WILL BE EXCAVATED AND DISPOSED OFF SITE.
7. COMPLETE ISTD TREATMENT
8. COMPLETE SHALLOW ZONE BASELINE GROUNDWATER SAMPLING EVENT, AFTER REVIEWING AND EVALUATING DATA INSTALL SHALLOW GROUNDWATER MONITORING WELLS. FOLLOWING WELL INSTALLATION COMPLETE ONE ROUND OF SAMPLING ON EXISTING AND NEWLY INSTALLED SHALLOW, INTERMEDIATE, AND DEEP MONITORING WELLS IDENTIFIED FOR SAMPLING.

NOTES:

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2. TOPOGRAPHY AND LOCATION OF EXISTING STRUCTURES ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021.
3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND ARE BASED ON BEST AVAILABLE INFORMATION. THE CONTRACTOR SHALL LOCATE THESE LINES AS PART OF THE REMEDIAL ACTION.
4. ALL EXISTING MONITORING WELLS SHALL BE PROTECTED UNLESS OTHERWISE NOTED TO BE ABANDONED. CONTRACTOR IS RESPONSIBLE FOR MEANS AND METHODS OF PROTECTING MONITORING WELLS. MONITORING WELLS DAMAGED DURING CONSTRUCTION SHALL BE REPLACED BY THE CONTRACTOR.

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SCALE: 1" = 50'

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MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
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8	FINAL APPROVED DESIGN	02/28/2024

DESIGNED BY: S. KLING
DRAWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO: W912BV20P0096
CONTRACT NO: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/24
SIZE: ANSI D
FILE NAME: \ENGINEER\CAD_BIM\2_WP\2-4_FINAL DESIGN
FILE NUMBER: 102443.57

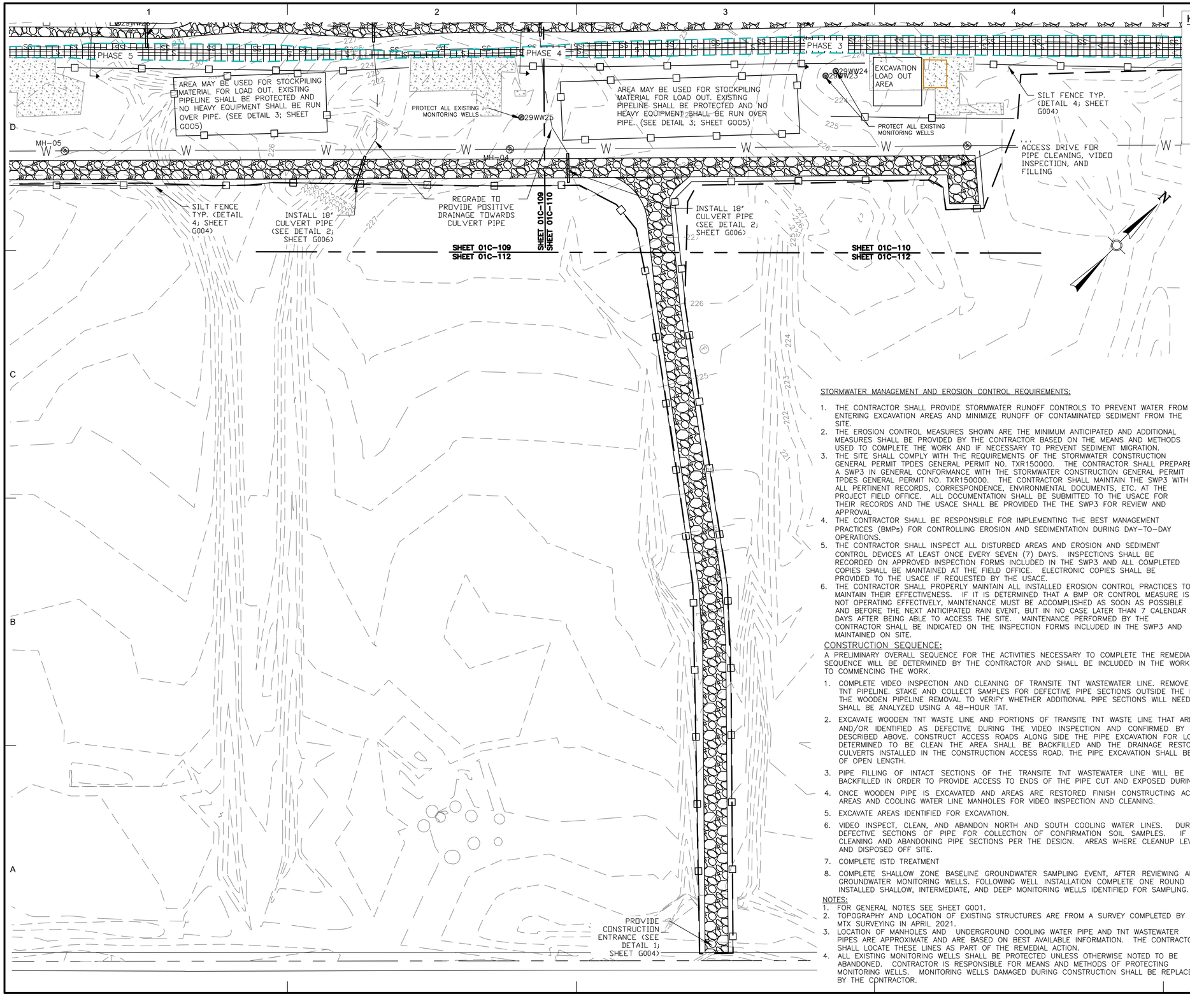
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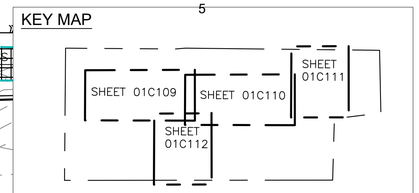
LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

SITE ACCESS AND EROSION CONTROL PLAN SHEET 3

SHEET IDENTIFICATION
01C111
SHEET 19 OF 30



KEY MAP



LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- UTILITY POLE
- SIGN
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- EXISTING GRAVEL
- EXISTING UNPAVED ROAD
- WATER EDGE
- W — COOLING WATER MAIN PIPE – ASSUMED 18"
- // — COOLING WATER BUILDING SERVICE PIPE
- S — 12" WOOD TNT WASTEWATER LINE
- SS — 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE STRUCTURE
- TEMPORARY CONSTRUCTION ACCESS ROAD
- PIPE REMOVAL EXCAVATION
- EXCAVATION LIMIT
- EXCAVATION TOP OF SLOPE
- LIMITS OF CLEARING
- SILT FENCE
- SHEET MATCHLINE

STORMWATER MANAGEMENT AND EROSION CONTROL REQUIREMENTS:

1. THE CONTRACTOR SHALL PROVIDE STORMWATER RUNOFF CONTROLS TO PREVENT WATER FROM ENTERING EXCAVATION AREAS AND MINIMIZE RUNOFF OF CONTAMINATED SEDIMENT FROM THE SITE.
2. THE EROSION CONTROL MEASURES SHOWN ARE THE MINIMUM ANTICIPATED AND ADDITIONAL MEASURES SHALL BE PROVIDED BY THE CONTRACTOR BASED ON THE MEANS AND METHODS USED TO COMPLETE THE WORK AND IF NECESSARY TO PREVENT SEDIMENT MIGRATION.
3. THE SITE SHALL COMPLY WITH THE REQUIREMENTS OF THE STORMWATER CONSTRUCTION GENERAL PERMIT TPDES GENERAL PERMIT NO. TXR150000. THE CONTRACTOR SHALL PREPARE A SWP3 IN GENERAL CONFORMANCE WITH THE STORMWATER CONSTRUCTION GENERAL PERMIT TPDES GENERAL PERMIT NO. TXR150000. THE CONTRACTOR SHALL MAINTAIN THE SWP3 WITH ALL PERTINENT RECORDS, CORRESPONDENCE, ENVIRONMENTAL DOCUMENTS, ETC. AT THE PROJECT FIELD OFFICE. ALL DOCUMENTATION SHALL BE SUBMITTED TO THE USACE FOR THEIR RECORDS AND THE USACE SHALL BE PROVIDED THE THE SWP3 FOR REVIEW AND APPROVAL
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IMPLEMENTING THE BEST MANAGEMENT PRACTICES (BMPs) FOR CONTROLLING EROSION AND SEDIMENTATION DURING DAY-TO-DAY OPERATIONS.
5. THE CONTRACTOR SHALL INSPECT ALL DISTURBED AREAS AND EROSION AND SEDIMENT CONTROL DEVICES AT LEAST ONCE EVERY SEVEN (7) DAYS. INSPECTIONS SHALL BE RECORDED ON APPROVED INSPECTION FORMS INCLUDED IN THE SWP3 AND ALL COMPLETED COPIES SHALL BE MAINTAINED AT THE FIELD OFFICE. ELECTRONIC COPIES SHALL BE PROVIDED TO THE USACE IF REQUESTED BY THE USACE.
6. THE CONTRACTOR SHALL PROPERLY MAINTAIN ALL INSTALLED EROSION CONTROL PRACTICES TO MAINTAIN THEIR EFFECTIVENESS. IF IT IS DETERMINED THAT A BMP OR CONTROL MEASURE IS NOT OPERATING EFFECTIVELY, MAINTENANCE MUST BE ACCOMPLISHED AS SOON AS POSSIBLE AND BEFORE THE NEXT ANTICIPATED RAIN EVENT, BUT IN NO CASE LATER THAN 7 CALENDAR DAYS AFTER BEING ABLE TO ACCESS THE SITE. MAINTENANCE PERFORMED BY THE CONTRACTOR SHALL BE INDICATED ON THE INSPECTION FORMS INCLUDED IN THE SWP3 AND MAINTAINED ON SITE.

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DESIGNED BY: S. KLING
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SOLICITATION NO.: W912BV20P0096
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FILE NUMBER: 102463J7
FILE NAME: 102463J7_CAD_BIM\E.2_WP\E.2-4_FINAL DESIGN

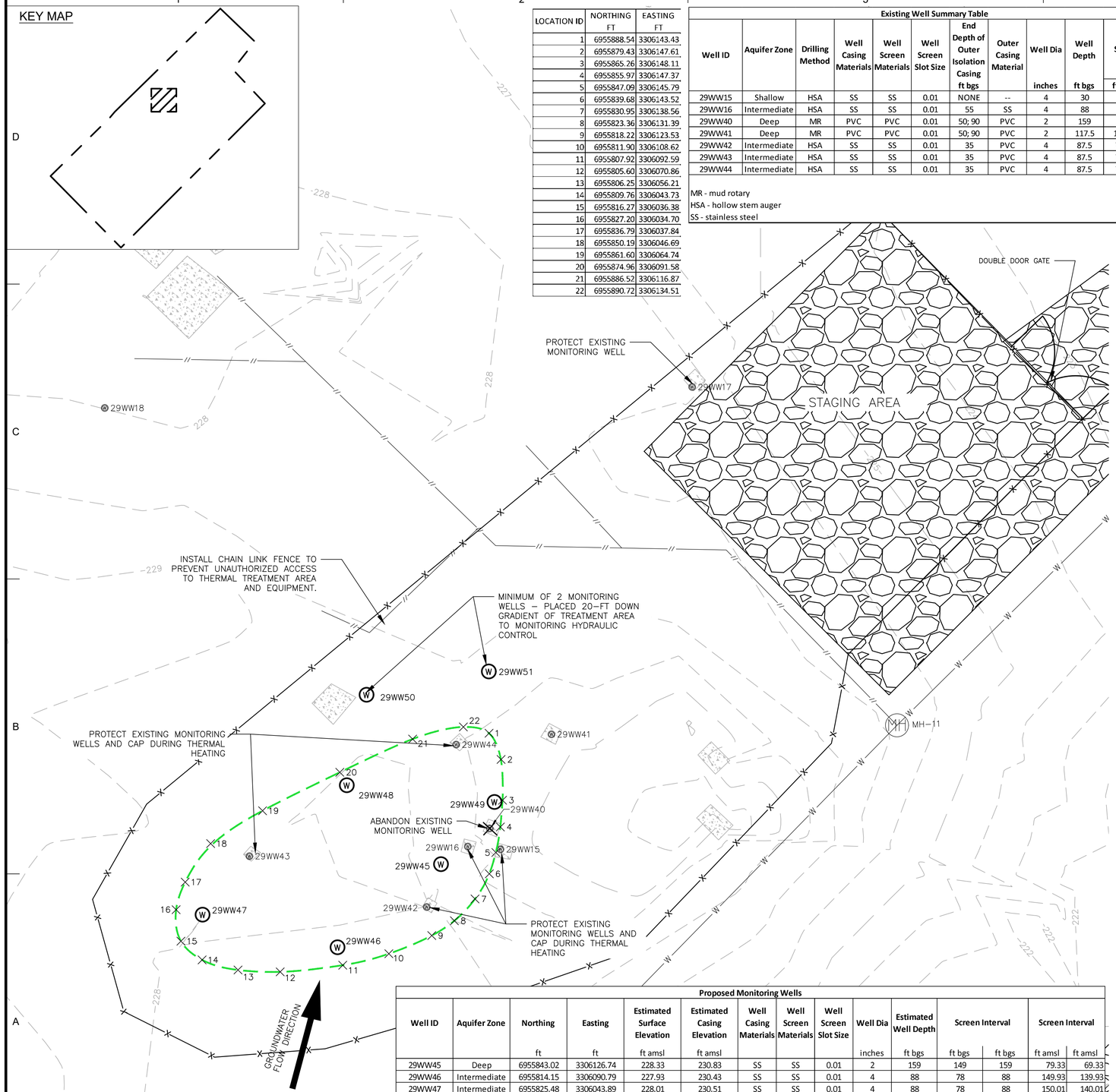
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LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

SITE ACCESS AND EROSION CONTROL PLAN SHEET 4

SHEET IDENTIFICATION
01C112
SHEET 20 OF 30



LOCATION ID	NORTHING FT	EASTING FT
1	6955888.54	3306143.43
2	6955879.43	3306147.61
3	6955865.26	3306148.11
4	6955855.97	3306147.37
5	6955847.09	3306145.79
6	6955839.68	3306143.52
7	6955830.95	3306138.56
8	6955823.36	3306131.39
9	6955818.22	3306123.53
10	6955811.90	3306108.62
11	6955807.92	3306092.59
12	6955805.60	3306070.86
13	6955806.25	3306056.21
14	6955809.76	3306043.73
15	6955816.27	3306036.38
16	6955827.20	3306034.70
17	6955836.79	3306037.84
18	6955850.19	3306046.69
19	6955861.60	3306064.74
20	6955874.96	3306091.58
21	6955886.52	3306116.87
22	6955890.72	3306134.51

Existing Well Summary Table

Well ID	Aquifer Zone	Drilling Method	Well Casing Materials	Well Screen Materials	Well Screen Slot Size	End Depth of Outer Isolation Casing ft bgs	Outer Casing Material	Well Dia inches	Well Depth ft bgs	Screen Interval ft bgs	Screen Interval ft bgs
29WW15	Shallow	HSA	SS	SS	0.01	NONE	--	4	30	20	30
29WW16	Intermediate	HSA	SS	SS	0.01	55	SS	4	88	78	88
29WW40	Deep	MR	PVC	PVC	0.01	50; 90	PVC	2	159	149	159
29WW41	Deep	MR	PVC	PVC	0.01	50; 90	PVC	2	117.5	102.5	117.5
29WW42	Intermediate	HSA	SS	SS	0.01	35	PVC	4	87.5	77.5	87.5
29WW43	Intermediate	HSA	SS	SS	0.01	35	PVC	4	87.5	77.5	87.5
29WW44	Intermediate	HSA	SS	SS	0.01	35	PVC	4	87.5	77.5	87.5

MR - mud rotary
HSA - hollow stem auger
SS - stainless steel

Proposed Monitoring Wells

Well ID	Aquifer Zone	Northing ft	Easting ft	Estimated Surface Elevation ft amsl	Estimated Casing Elevation ft amsl	Well Casing Materials	Well Screen Materials	Well Screen Slot Size	Well Dia inches	Estimated Well Depth ft bgs	Screen Interval ft bgs	Screen Interval ft bgs	Screen Interval ft amsl	Screen Interval ft amsl
29WW45	Deep	6955843.02	3306126.74	228.33	230.83	SS	SS	0.01	2	159	149	159	79.33	69.33
29WW46	Intermediate	6955814.15	3306090.79	227.93	230.43	SS	SS	0.01	4	88	78	88	149.93	139.93
29WW47	Intermediate	6955825.48	3306043.89	228.01	230.51	SS	SS	0.01	4	88	78	88	150.01	140.01
29WW48	Intermediate	6955870.45	3306093.99	227.92	230.42	SS	SS	0.01	4	88	78	88	149.92	139.92
29WW49	Intermediate	6955864.65	3306145.32	229.24	231.74	SS	SS	0.01	4	88	78	88	151.24	141.24
29WW50	Intermediate	6955901.91	3306100.85	228.51	231.01	SS	SS	0.01	4	88	78	88	150.51	140.51
29WW51	Intermediate	6955910.01	3306143.35	228.37	230.87	SS	SS	0.01	4	88	78	88	150.37	140.37

ss - stainless steel

N

LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- UTILITY POLE
- SIGN
- SITE BOUNDARY
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- EXISTING GRAVEL
- EXISTING UNPAVED ROAD
- W — W — COOLING WATER MAIN PIPE – ASSUMED 18"
- // — // — COOLING WATER BUILDING SERVICE PIPE
- S — S — 12" WOOD TNT WASTEWATER LINE
- SS — SS — 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE STRUCTURE
- X — X — TEMPORARY CONSTRUCTION FENCE
- (W) PROPOSED MONITORING WELL
- ABANDON EXISTING MONITORING WELL
- MC PLUME TREATMENT AREA

ISTD NOTES:

1. INSTALL A MINIMUM OF TWO MONITORING WELLS APPROXIMATELY 20–FT FROM THE HEATED TREATMENT AREA TO MONITOR HYDRAULIC CONTROL OF THE PLUME DURING HEATING. WELL SHALL BE INSTALLED WITH STAINLESS STEEL CASING AND 10–FT OF SCREEN. BASELINE SAMPLES SHALL BE COLLECTED FROM THESE WELLS WITHIN THREE WEEKS OF STARTING HEATING AND THEN MONTHLY ONCE HEATING BEGINS AND WILL CONTINUE FOR A PERIOD OF 6 MONTHS FOLLOWING DECOMMISSIONING OF THE ISTD SYSTEM. GROUNDWATER SAMPLES SHALL BE ANALYZED FOR VOCs. GROUNDWATER TEMPERATURE SHALL ALSO BE RECORDED. GROUNDWATER CONCENTRATIONS 10X ABOVE BASELINE CONCENTRATIONS OBSERVED DURING ISTD OPERATION MAY REQUIRE FURTHER ACTION BY THE CONTRACTOR TO PROVIDE HYDRAULIC CONTROL OF THE PLUME.
2. FINAL MEASURES FOR HYDRAULIC CONTROL (IF NEEDED) SHALL BE PROPOSED BY THE CONTRACTOR, BUT MAY INCLUDE THE INSTALLATION OF ONE OR TWO (OR MORE) EXTRACTION WELLS INSIDE THE TREATMENT AREA.
3. THE CONTRACTOR SHALL PROVIDE A FENCE OR OTHER ACCEPTABLE MEANS TO PREVENT UNAUTHORIZED ACCESS INTO THE HEATED TREATMENT AREA AND EQUIPMENT STAGING AREAS.
4. ISTD SHALL BE DONE IN ACCORDANCE WITH THE ISTD PERFORMANCE WORK STATEMENT (APPENDIX D OF THE DESIGN ANALYSIS REPORT). THE DEPTH INTERVAL FOR THERMAL TREATMENT SHALL INCLUDE THE ENTIRE SATURATED ZONE AND SHALL EXTEND 5–FT BELOW THE BASE OF THE CONTAMINATED GROUNDWATER. THE HEATED DEPTH INTERVAL SHALL BE FROM 40–FT BGS TO 95 FT BGS (APPROX. ELEVATIONS 185.6 TO 132.9 FT AMSL). THIS WILL ENSURE CONTAMINATION DOES NOT CONDENSE IN COOLER SATURATED ZONES ABOVE THE CONTAMINATED GROUNDWATER OCCURRING FROM 70–FT TO 90–FT BGS AND WILL MITIGATE THE POTENTIAL FOR DNAPL IN THE TREATMENT AREA TO MIGRATE VERTICALLY.
5. THE CONTRACTOR SHALL INSTALL FIVE NEW WELLS (FOUR INTERMEDIATE AND ONE DEEP) IN AND AROUND THE ISTD TREATMENT AREA PRIOR TO OPERATING THE ISTD SYSTEM. THESE WELLS SHALL BE INSTALLED WITH STAINLESS STEEL CASING AND SCREEN AND SHALL REMAIN IN PLACE THROUGHOUT THE ISTD SYSTEM OPERATION. ONE ROUND OF SAMPLES SHALL BE COLLECTED FOR VOC ANALYSIS FROM THESE WELLS AND THE 5 EXISTING WELLS IN AND AROUND THE TREATMENT SYSTEM AT THE SAME TIME SAMPLES ARE COLLECTED FROM THE HYDRAULIC CONTROL MONITORING WELLS PRIOR TO STARTING THE ISTD SYSTEM. ALL WELLS INCLUDING THE HYDRAULIC CONTROL MONITORING WELLS SHALL ALSO BE GAUGED FOR WATER DEPTH. THE NEW WELLS SHALL BE INSTALLED WITH 10–FT OF SCREEN.
6. THERMAL HEATING SHALL BE COMPLETED UNTIL GROUNDWATER INSIDE THE TREATMENT AREA HAS REACHED A METHYLENE CHLORIDE CONCENTRATION OF 8,000 UG/L. THERMAL TEMPERATURES SHALL BE HIGH ENOUGH TO PROVIDE TREATMENT FOR EXISTING TCE CONCENTRATIONS. FINAL CLEANUP CRITERIA WILL BE BASED ON THE COLLECTION OF GROUNDWATER SAMPLES COLLECTED FROM THE THERMAL TREATMENT AREA USING EXISTING AND PROPOSED WELLS SHOWN.
7. CRITERIA FOR SHUTTING DOWN THE ISTD SYSTEM SHALL BE PROPOSED BY THE CONTRACTOR AND MAY INCLUDE MEASURES SUCH AS A REDUCTION IN THE MASS RECOVERY RATE, MASS REMOVAL RATES REACHING ASYMPTOTIC LEVELS, MAINTAINING A MINIMUM TEMPERATURE OVER A REQUIRED TIME PERIOD IDENTIFIED VIA MODELING COMPLETED BY THE CONTRACTOR WHICH WILL REDUCE CONTAMINATION TO LEVELS ACHIEVING CLEANUP CRITERIA OR OTHER CRITERIA THAT MAY BE PROPOSED BY THE CONTRACTOR.
8. IF SOIL SAMPLES ARE PROPOSED TO BE USED AS A MEASURE FOR SHUTTING DOWN THE SYSTEM THE CONTRACTOR SHALL IDENTIFY THE NUMBER AND LOCATIONS IN THE ISTD TREATMENT WORK PLAN. THE PLAN SHALL ALSO IDENTIFY THE VERTICAL INTERVALS FOR SAMPLES PROPOSED TO BE COLLECTED AT EACH LOCATION. THE PROPOSED SOIL CONFIRMATION SAMPLING PLAN SHALL BE REVIEWED AND APPROVED BY THE USACE.
9. THE CONTRACTOR SHALL PROVIDE HEATING WELLS 5–FT OUTSIDE THE TREATMENT AREA SHOWN TO ENSURE THE ENTIRE TREATMENT AREA IS HEATED. TEMPERATURE MONITORING POINTS SHALL BE PROVIDED ALONG THE TREATMENT BOUNDARY AT 80 FT INTERVALS AND INSIDE THE TREATMENT AREA AT A RATE OF ONE TEMPERATURE SENSOR PER 1,200 SF OF AREA. TOTAL MINIMUM NUMBER OF TEMPERATURE SENSOR LOCATIONS SHALL BE 10. TEMPERATURE SENSORS FOR EACH LOCATION SHALL BE AT 4.5–FT INTERVALS VERTICALLY FOR A TOTAL OF 12 SENSORS PER LOCATION.
10. THERE IS NO EXISTING WATER SUPPLY ON SITE AND THE CONTRACTOR WILL NEED TO TRUCK WATER NEEDED FOR THE SYSTEM OPERATION TO THE SITE. THE NEAREST WATER SUPPLY DISTRICTS ARE THE LEIGH WATER DISTRICT AND THE CADDO LAKE WATER DISTRICT.
11. THE NEAREST OVERHEAD ELECTRIC LINES ARE AT THE INTERSECTION OF AVENUE C AND D. REFER TO SHEET G002.
12. WASTEWATER GENERATED DURING THE SYSTEM OPERATION SHALL BE TREATED ON SITE BEFORE BEING TRANSPORTED OFF SITE FOR DISCHARGE TO AN APPROVED TREATMENT DISPOSAL FACILITY OR PUBLIC OWNED TREATMENT WORKS. FINAL LOCATION FOR DISPOSAL SHALL BE APPROVED BY THE USACE.
13. FOLLOWING ISTD SYSTEM SHUT OFF THE CONTRACTOR SHALL COLLECT GROUNDWATER SAMPLES FROM ALL NEWLY INSTALLED (7 WELLS) AND EXISTING WELLS (5 WELLS) TO VERIFY GROUNDWATER IN THE TREATMENT AREA MEETS THE CLEANUP LEVEL FOR METHYLENE CHLORIDE OF 8,000 UG/L AND TCE OF 300 UG/L. SAMPLES SHALL BE COLLECTED 3–4 MONTHS AFTER THE SYSTEM HAS BEEN SHUT DOWN TO ALLOW SOILS TO COOL IN THE ISTD AREA BEFORE COLLECTING SAMPLES. IF CLEANUP LEVELS HAVE NOT BEEN MET THE ISTD SYSTEM SHALL CONTINUE TO OPERATE AND A SECOND ROUND OF GROUNDWATER SAMPLES SHALL BE COLLECTED. THIS SHALL CONTINUE UNTIL SAMPLE RESULTS INSIDE THE ISTD AREA (ALL WELLS EXCEPT HYDRAULIC CONTROL WELLS) MEET THE CLEANUP LEVELS. USACE APPROVAL IS REQUIRED PRIOR TO DECOMMISSIONING AND REMOVING THE ISTD SYSTEM. DURING THE INTERIM PERIOD BEFORE GROUNDWATER SAMPLES ARE COLLECTED AND RESULTS ARE RECEIVED THE TREATMENT PORTIONS OF THE ISTD SYSTEM SHALL CONTINUE TO OPERATE.

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5	100% DRAFT DESIGN EPA/TCEQ SUBMISSION	08/15/2023
6	100% DESIGN USACE SUBMISSION	10/19/2023
7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023

DESIGNED BY: S. KLING
DRN BY: S. KLING
CHD BY: T. CONNORS
SUBMITTED BY:
PLOT SCALE: ANSI D
PLOT DATE: 2/28/2024
FILE NAME: 102463378.0_CAD_BMK6.2_WPK6.2.4_FINAL DESIGN
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
TASK NUMBER: 102463378.0

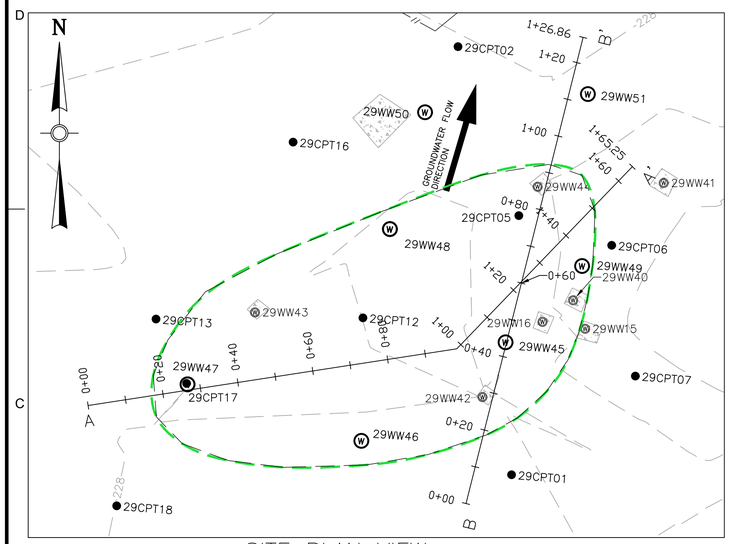
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U.S. ARMY ENGINEER DIVISION
CORPS OF ENGINEERS
TULSA DISTRICT

LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

ISTD AREA SITE PLAN

SHEET IDENTIFICATION
02C101
SHEET 21 OF 30



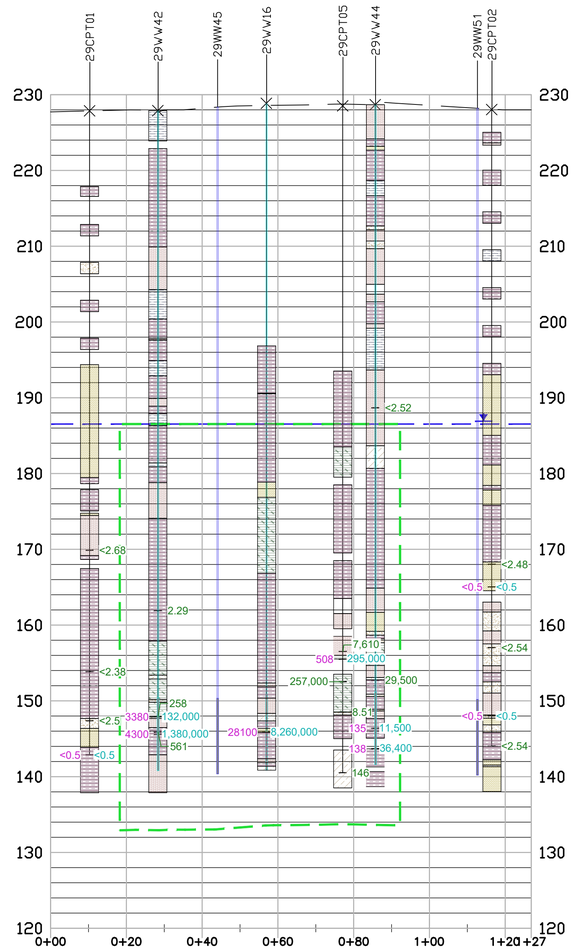
SITE PLAN VIEW

0 20' 40'

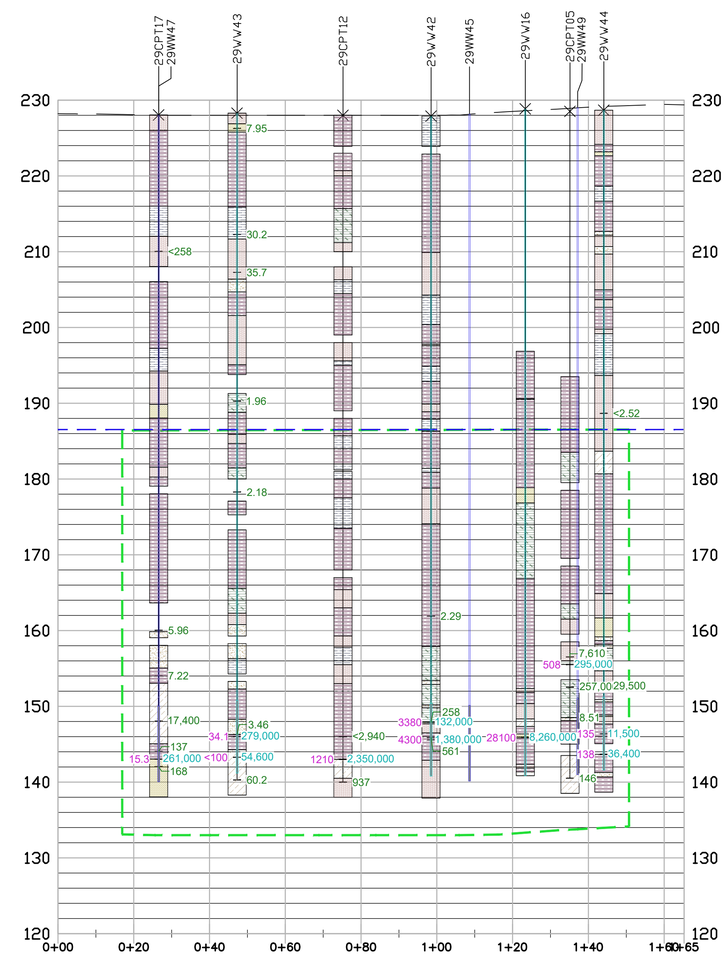
SCALE: 1" = 20'

LEGEND:

- MONITORING WELL
- CONTOUR MINOR
- CONTOUR MAJOR
- CONCRETE STRUCTURE
- 4.53 MC SOIL SAMPLE (UG/KG)
- 4.53 MC GROUNDWATER SAMPLE (UG/L)
- 4.53 TCE GROUNDWATER SAMPLE (UG/L)
- ISTD TREATMENT AREA
- GROUNDWATER TABLE
- SAMPLE LOCATION
- CLAY
- CLAY AND SANDY CLAY
- CLAY AND SILTY SAND
- CLAY AND SILT
- SILT
- SILTY SAND
- SAND
- WELL SCREEN
- WELL CASING
- PROPOSED WELL SCREEN
- PROPOSED WELL CASING



B B'



A A'

PROFILE VIEW

0 1" 2"

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 10'

ISTD NOTES:
1. REFER TO DRAWING SHEET 02C101 FOR ISTD REQUIREMENTS AND LAYOUT.

NOTES:
1. GEOLOGICAL INFORMATION FOR ALL LOCATIONS EXCEPT 29WW16 CAME FROM BORING LOGS PREPARED BY AECOM AND INCLUDED IN THE REMEDIAL INVESTIGATION ADDENDUM DATED JULY 2016 (AECOM, 2016).
2. GEOLOGICAL INFORMATION FOR LOCATION 29WW16 CAME FROM BORING LOGS PREPARED BY JACOBS ENGINEERING AND INCLUDED IN THE REMEDIAL INVESTIGATION REPORT FOR THE GROUP 2 SITES, DATED APRIL 2001 (JACOBS, 2001).
3. THE GROUNDWATER ELEVATION SHOWN IS FROM WATER ELEVATIONS COLLECTED BY SHAW AND INCLUDED IN THE FINAL FEASIBILITY STUDY DATED APRIL 2010 (SHAW, 2010).

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TULSA DISTRICT

STATE OF TEXAS · MICHAEL J. VECCHIO · 147480 · LICENSED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
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7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023
8	FINAL APPROVED DESIGN	02/28/2024
9		
10		
11		
12		
13		
14		

DESIGNED BY: S. KLING
DRWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
TDR NUMBER:
FILE NUMBER: 1024637
PLOT DATE: 2/28/24
PLOT SCALE: AS NOTED
FILE NAME: 1024637#0,0_CAD_BMI6-2_WP#2-4_FINAL DESIGN
SIZE: D ANSI

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CORPS OF ENGINEERS
TULSA DISTRICT

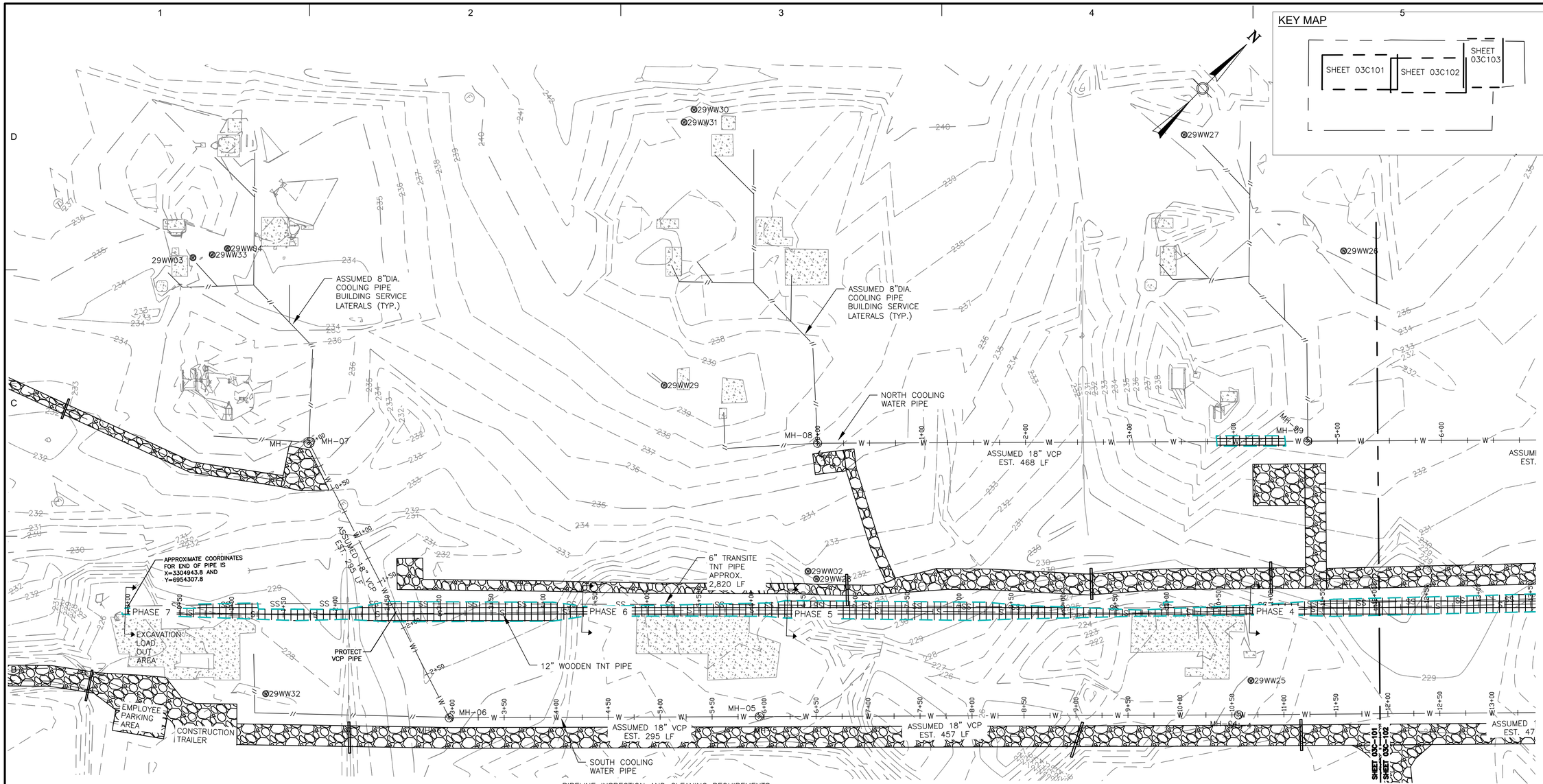
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LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

ISTD AREA CROSS SECTION PLAN

SHEET IDENTIFICATION
02C102
SHEET 22 OF 30

01226858



0 50' 100'

SCALE: 1" = 50'

LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- UTILITY POLE
- SIGN
- WATER VALVE
- SITE BOUNDARY
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- EXISTING GRAVEL
- EXISTING UNPAVED ROAD
- WATER EDGE
- W — COOLING WATER MAIN PIPE – ASSUMED 18"
- // — COOLING WATER BUILDING SERVICE PIPE
- S — 12" WOOD TNT WASTEWATER LINE
- SS — 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE STRUCTURE
- ESTIMATED PIPE REMOVAL TRENCH LIMIT
- TEMPORARY CONSTRUCTION ACCESS ROAD
- PIPE REMOVAL EXCAVATION
- SHEET MATCHLINE

NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
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3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND ARE BASED ON BEST AVAILABLE INFORMATION. THE CONTRACTOR SHALL LOCATE THESE LINES AS PART OF THE REMEDIAL ACTION.
4. ALL EXISTING MONITORING WELLS SHALL BE PROTECTED UNLESS OTHERWISE NOTED TO BE ABANDONED. MONITORING WELLS DAMAGED DURING CONSTRUCTION SHALL BE REPLACED BY THE CONTRACTOR.

PIPELINE INSPECTION AND CLEANING REQUIREMENTS:

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2. PRIOR TO PERFORMING THE VIDEO INSPECTION THE CONTRACTOR SHALL FIELD VERIFY THE LOCATIONS OF ALL PIPING. LOCATIONS SHOWN IN THIS PLAN ARE APPROXIMATE AND REQUIRE FIELD VERIFICATION. VERIFICATION SHALL INCLUDE THE DIAMETER OF ALL EXISTING PIPELINES. DIAMETERS SHOWN ARE BASED ON BEST AVAILABLE INFORMATION AND MAY NOT BE ACCURATE.
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5. SECTIONS OF PIPE IDENTIFIED TO BE BROKEN WHERE SOIL SAMPLES CONFIRM RELEASES HAVE OCCURRED WILL BE EXCAVATED AND REMOVED. IF CONCENTRATIONS MEET THE CLEANUP LEVELS AND RESULTS OF THE VIDEO INSPECTION INDICATE THE PIPE CAN BE SUCCESSFULLY ABANDONED IN PLACE, THE SECTIONS WILL BE CLEANED ALONG WITH OTHER SECTIONS.
6. FOLLOWING CLEANING, A POST VIDEO INSPECTION SHALL BE PERFORMED TO VISUALLY VERIFY ALL SLUDGE AND LIQUIDS HAVE BEEN REMOVED FROM THE PIPE LINE. PIPELINE SECTIONS IDENTIFIED AS STILL CONTAINING SLUDGE OR WASTE RESIDUE SHALL BE RE–CLEANED AND RE–INSPECTED UNTIL ALL SECTIONS ARE VISUALLY CLEANED AND READY FOR FILLING.
7. ONCE PIPELINES ARE DETERMINED TO BE VISUALLY CLEANED, THE PIPELINE SECTIONS SHALL BE CAPPED AND FILLED IN ACCORDANCE WITH THE CONTRACT SPECIFICATIONS.

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1. THE CONTRACTOR SHALL EXCAVATE AND COMPLETELY REMOVE THE WOODEN TNT WASTEWATER LINE FOR OFF–SITE DISPOSAL. THE EXCAVATIONS SHALL BE PERFORMED USING A MAXIMUM SLOPE OF 1H:1V WITH A VERTICAL CUT ALONG THE PIPELINE OF NO MORE THAN 3.5–FT. OTHER CONFIGURATIONS FOR SLOPING IS ACCEPTABLE AND CAN BE PROPOSED BY THE CONTRACTOR. TO THE EXTENT PRACTICABLE SLOPING SHALL BE COMPLETED TO MINIMIZE DISTURBANCE TO THE TNT TRANSITE PIPELINE SECTIONS THAT HAVE BEEN DETERMINED TO BE INTACT BASED ON THE VIDEO INSPECTION.
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3. PORTIONS OF THE TRANSITE TNT WASTEWATER LINE MAY BE IMPACTED BY THE WOODEN PIPELINE REMOVAL. THESE SECTIONS HAVE BEEN IDENTIFIED ON THE DRAWINGS AND SHALL BE REMOVED WITH THE TNT WASTEWATER WOODEN PIPE.
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5. ALL EXCAVATIONS SHALL BE IN ACCORDANCE WITH OSHA REQUIREMENTS AND ADDITIONAL REQUIREMENTS IDENTIFIED ON SHEET G001.
6. THE PIPELINE EXCAVATION SHALL BE COMPLETED IN PHASES IN ORDER TO LIMIT THE AMOUNT OF OPEN EXCAVATIONS TO NO MORE THAN 500–FT AT ONE TIME. THE ANTICIPATED PHASES FOR THE EXCAVATION ARE SHOWN ON THE DRAWINGS AND ARE ASSUMED TO START AT THE POND AND WORK SOUTHWEST TOWARDS EXCAVATION AREA E–1. AS AREAS ARE CONFIRMED CLEAN WITH THE RESULTS OF CONFIRMATION SAMPLES THE AREAS SHALL BE BACKFILLED. ANTICIPATED SEQUENCING IS FURTHER DISCUSSED ON SHEETS 01C–109 TO 01C–112.
7. FOLLOWING THE INITIAL EXCAVATION, CONFIRMATION SAMPLES SHALL BE COLLECTED AT THE BOTTOM AND INLINE WITH THE PIPE ALONG SIDEWALLS AND THE BOTTOM OF THE TRENCH EVERY 30–FT. FOR EXCAVATIONS ENDING AT THE WATER TABLE NO BOTTOM SAMPLES WILL BE COLLECTED. CONFIRMATION SAMPLING IS FURTHER DISCUSSED ON SHEET G–001.

US Army Corps of Engineers®
TULSA DISTRICT

STATE OF TEXAS — MICHAEL J. TECCHIO — 147480 — LICENSED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
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7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023
8	FINAL APPROVED DESIGN	02/28/2024

DESIGNED BY: S. KLING
DWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 02/28/2024
SOLICITATION NO: W912BV20T0086
CONTRACT NO.: W912BV19D0016
FILE NUMBER: 102463.37
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/24
SIZE: ANSI D
FILE NAME: 102463.37-G-CAD_BIM-8.2_WIP-8.2.4_FINAL DESIGN

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CORPS OF ENGINEERS
TULSA DISTRICT

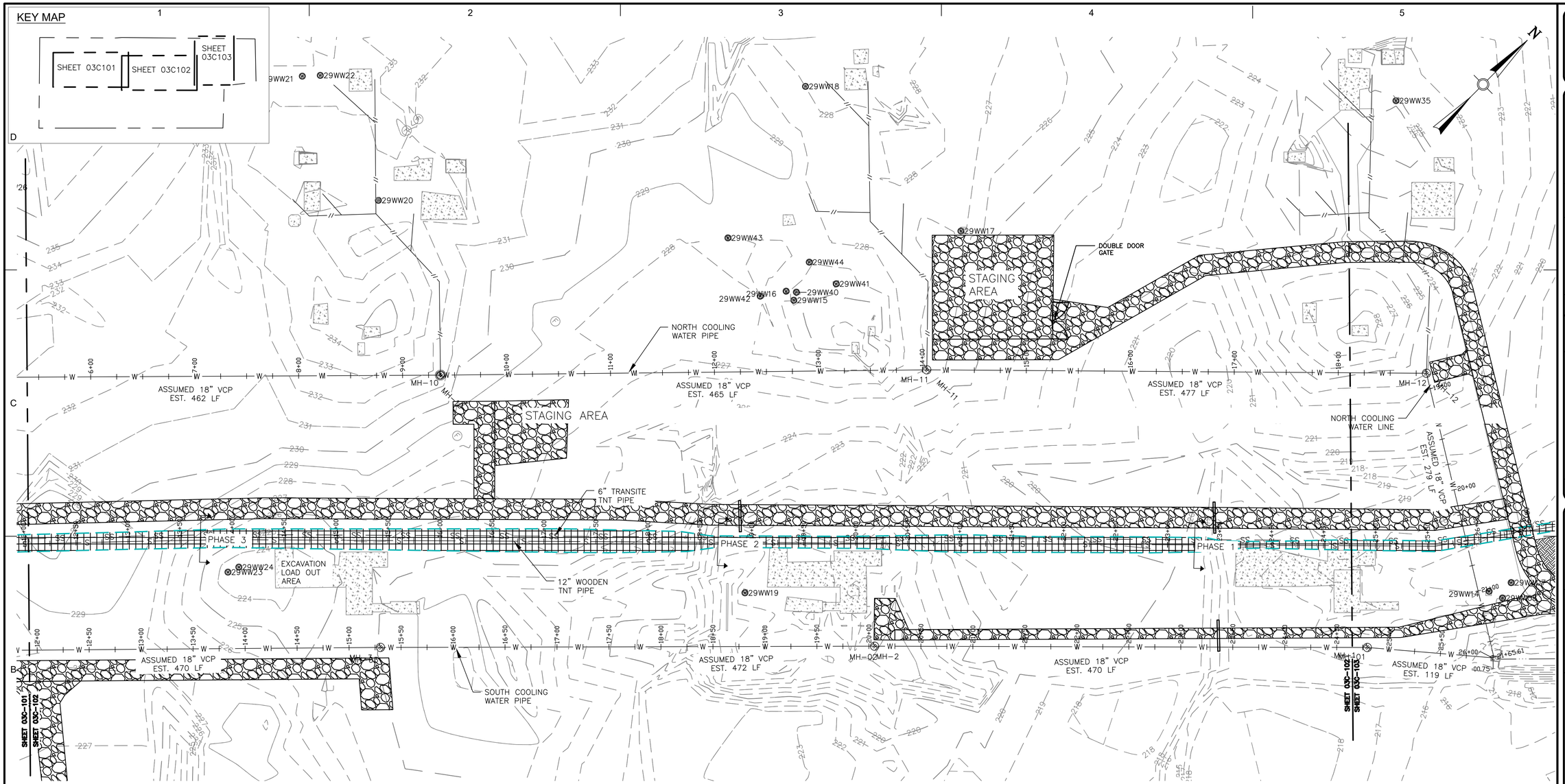
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LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

PIPING SITE PLAN SHEET 1

SHEET IDENTIFICATION
03C101
SHEET 23 OF 30

KEY MAP



LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- UTILITY POLE
- SIGN
- WATER VALVE
- SITE BOUNDARY
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- EXISTING GRAVEL
- A — EXISTING UNPAVED ROAD
- WATER EDGE
- W — COOLING WATER MAIN PIPE – ASSUMED 18"
- // — COOLING WATER BUILDING SERVICE PIPE
- S — 12" WOOD TNT WASTEWATER LINE
- SS — 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE STRUCTURE
- ESTIMATED PIPE REMOVAL TRENCH LIMIT
- TEMPORARY CONSTRUCTION ACCESS ROAD
- PIPE REMOVAL EXCAVATION
- SHEET MATCHLINE

0 50' 100'

SCALE: 1" = 50'

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US Army Corps of Engineers®
TULSA DISTRICT

STATE OF TEXAS – MICHAEL L. NEICHO – 147480 – LICENSED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
8	FINAL APPROVED DESIGN	02/28/2024
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DESIGNED BY: S. KLING
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SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/24
SIZE: ARCH D
FILE NAME: 03C102.dwg, CAD, BIM2.2, WIP6.2.4, FINAL DESIGN
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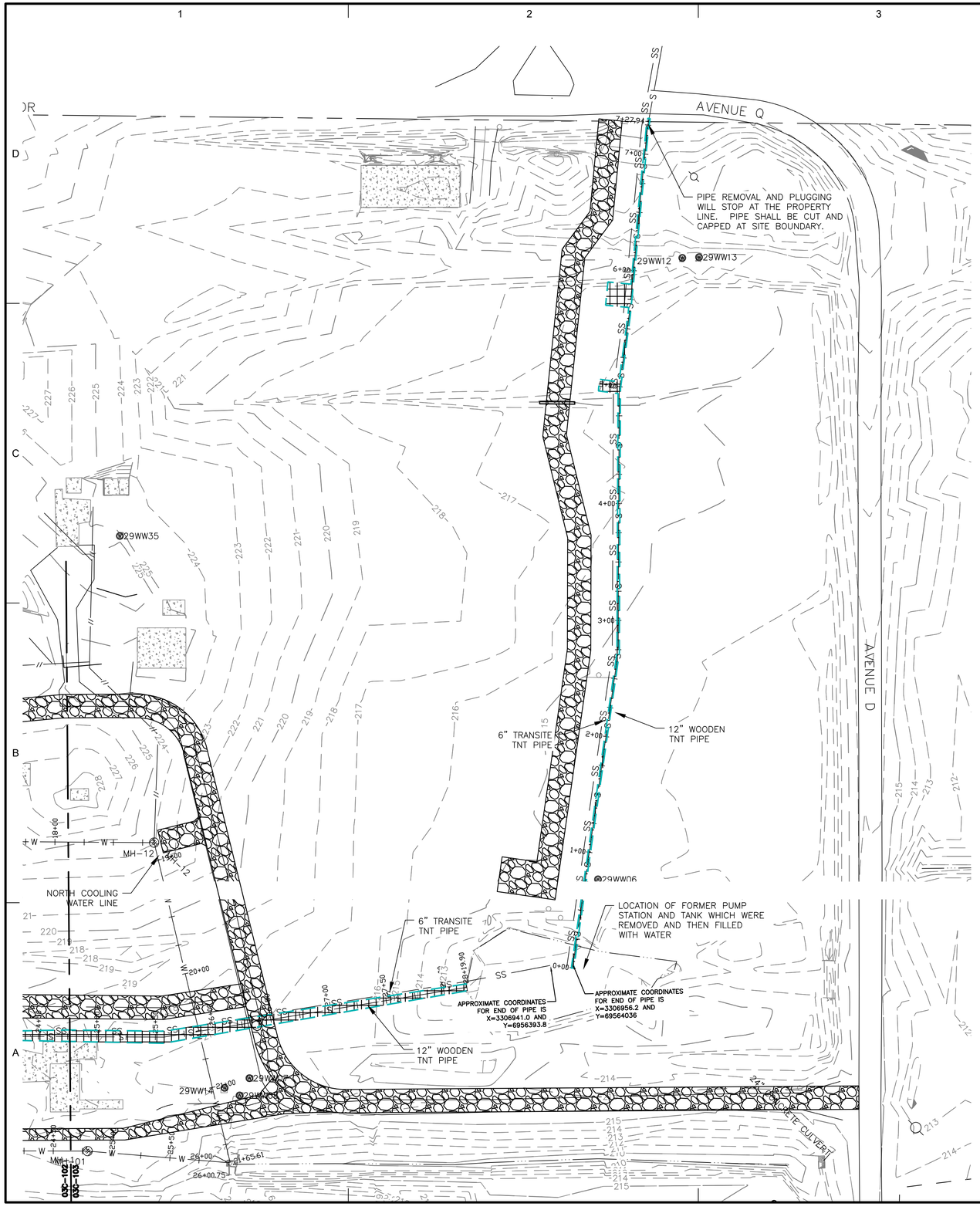
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HDR Engineering, Inc.

LHAAP-29
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

PIPING SITE PLAN SHEET 2

SHEET IDENTIFICATION
03C102
SHEET 24 OF 30



PIPELINE INSPECTION AND CLEANING REQUIREMENTS:

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PIPELINE EXCAVATIONS:

1. THE CONTRACTOR SHALL EXCAVATE AND COMPLETELY REMOVE THE WOODEN TNT WASTEWATER LINE FOR OFF-SITE DISPOSAL. THE EXCAVATIONS SHALL BE PERFORMED USING A MAXIMUM SLOPE OF 1H:1V WITH A VERTICAL CUT ALONG THE PIPELINE OF NO MORE THAN 3.5-FT. OTHER CONFIGURATIONS FOR SLOPING IS ACCEPTABLE AND CAN BE PROPOSED BY THE CONTRACTOR. TO THE EXTENT PRACTICABLE SLOPING SHALL BE COMPLETED TO MINIMIZE DISTURBANCE TO THE TNT TRANSITE PIPELINE SECTIONS THAT HAVE BEEN DETERMINED TO BE INTACT BASED ON THE VIDEO INSPECTION.
2. PIPE TRENCH EXCAVATIONS SHALL BE A MINIMUM OF 1-FT ON EITHER SIDE OF THE PIPELINE AND A MINIMUM DEPTH OF SIX INCHES BELOW THE PIPELINE UNLESS OTHERWISE INDICATED ON THE DRAWINGS. MATERIAL EXCAVATED FROM GROUND SURFACE TO THE TOP OF THE PIPE SHALL BE STOCKPILED SEPARATE FROM KNOWN CONTAMINATED MATERIAL. THIS MATERIAL SHALL BE SAMPLED FOR EXPLOSIVES. IF RESULTS INDICATE MATERIAL MEETS SOIL CLEANUP LEVELS THIS MATERIAL WILL BE REUSED AS BACKFILL.
3. PORTIONS OF THE TRANSITE TNT WASTEWATER LINE MAY BE IMPACTED BY THE WOODEN PIPELINE REMOVAL. THESE SECTIONS HAVE BEEN IDENTIFIED ON THE DRAWINGS AND SHALL BE REMOVED WITH THE TNT WASTEWATER WOODEN PIPE.
4. THE TRANSITE TNT WASTEWATER PIPELINE CONTAINS ASBESTOS. REMOVAL OF THESE PIPELINE SECTIONS SHALL BE IN ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE AND FEDERAL REGULATIONS AND REQUIREMENTS FOR HANDLING AND DISPOSAL OF ASBESTOS CONTAINING MATERIALS.
5. ALL EXCAVATIONS SHALL BE IN ACCORDANCE WITH OSHA REQUIREMENTS AND ADDITIONAL REQUIREMENTS IDENTIFIED ON SHEET G001.
6. THE PIPELINE EXCAVATION SHALL BE COMPLETED IN PHASES IN ORDER TO LIMIT THE AMOUNT OF OPEN EXCAVATIONS TO NO MORE THAN 500-FT AT ONE TIME. THE ANTICIPATED PHASES FOR THE EXCAVATION ARE SHOWN ON THE DRAWINGS AND ARE ASSUMED TO START AT THE POND AND WORK SOUTHWEST TOWARDS EXCAVATION AREA E-1. AS AREAS ARE CONFIRMED CLEAN WITH THE RESULTS OF CONFIRMATION SAMPLES THE AREAS SHALL BE BACKFILLED. ANTICIPATED SEQUENCING IS FURTHER DISCUSSED ON SHEETS 01C-109 TO 01C-112.
7. FOLLOWING THE INITIAL EXCAVATION, CONFIRMATION SAMPLES SHALL BE COLLECTED AT THE BOTTOM AND INLINE WITH THE PIPE ALONG SIDEWALLS AND THE BOTTOM OF THE TRENCH EVERY 30-FT. FOR EXCAVATIONS ENDING AT THE WATER TABLE NO BOTTOM SAMPLES WILL BE COLLECTED. CONFIRMATION SAMPLING IS FURTHER DISCUSSED ON SHEET G-001.

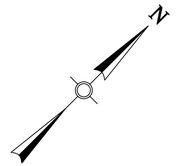
NOTES:

1. FOR GENERAL NOTES SEE SHEET G001.
2. TOPOGRAPHY AND LOCATION OF EXISTING STRUCTURES ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021.
3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND ARE BASED ON BEST AVAILABLE INFORMATION. THE CONTRACTOR SHALL LOCATE THESE LINES AS PART OF THE REMEDIAL ACTION.
4. ALL EXISTING MONITORING WELLS SHALL BE PROTECTED UNLESS OTHERWISE NOTED TO BE ABANDONED. MONITORING WELLS DAMAGED DURING CONSTRUCTION SHALL BE REPLACED BY THE CONTRACTOR.

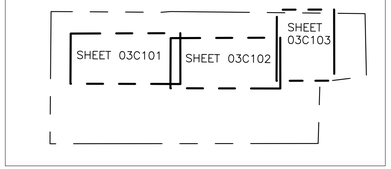
LEGEND:

- MONITORING WELL
- FIRE HYDRANT
- MANHOLE
- UTILITY POLE
- SIGN
- WATER VALVE
- SITE BOUNDARY
- CONTOUR MINOR
- CONTOUR MAJOR
- EXISTING PAVEMENT
- EXISTING GRAVEL
- EXISTING UNPAVED ROAD
- WATER EDGE
- W — COOLING WATER MAIN PIPE – ASSUMED 18"
- // — COOLING WATER BUILDING SERVICE PIPE
- S — 12" WOOD TNT WASTEWATER LINE
- SS — 6" TRANSITE TNT WASTEWATER LINE
- CONCRETE STRUCTURE
- ESTIMATED PIPE REMOVAL TRENCH LIMIT
- TEMPORARY CONSTRUCTION ACCESS ROAD
- PIPE REMOVAL EXCAVATION
- SHEET MATCHLINE

SCALE: 1" = 50'



KEY MAP



US Army Corps of Engineers®
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STATE OF TEXAS – REGISTERED – MICHAEL L. MCCORD – 147480 – PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
8	FINAL APPROVED DESIGN	02/28/2024
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14		

MARK	DESCRIPTION	DATE
1	60% DRAFT DESIGN SUBMISSION	11/14/2022
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3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
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6	100% DESIGN USACE SUBMISSION	10/19/2023
7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023

DESIGNED BY: S. KLING
DWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/24
FILE NAME: 02G-003.DGN
SIZE: ANSI D
DATE: 2/28/2024
SOLICITATION NO.: W912BV20P0090
CONTRACT NO.: W912BV19D0016
FILE NUMBER: 102-46537
LEVEL: 1, CAD, BMM-2, WVP-6, 2-4, FINAL DESIGN

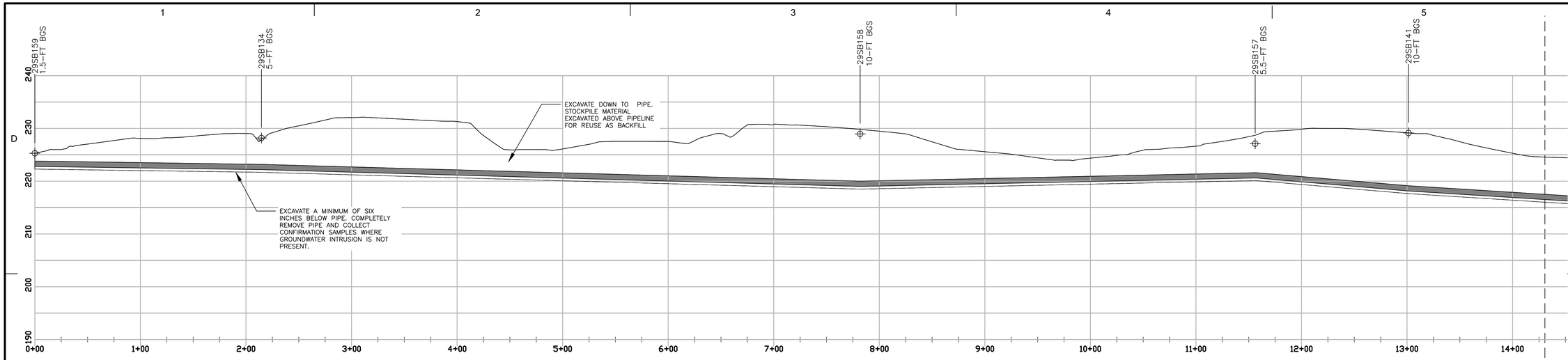
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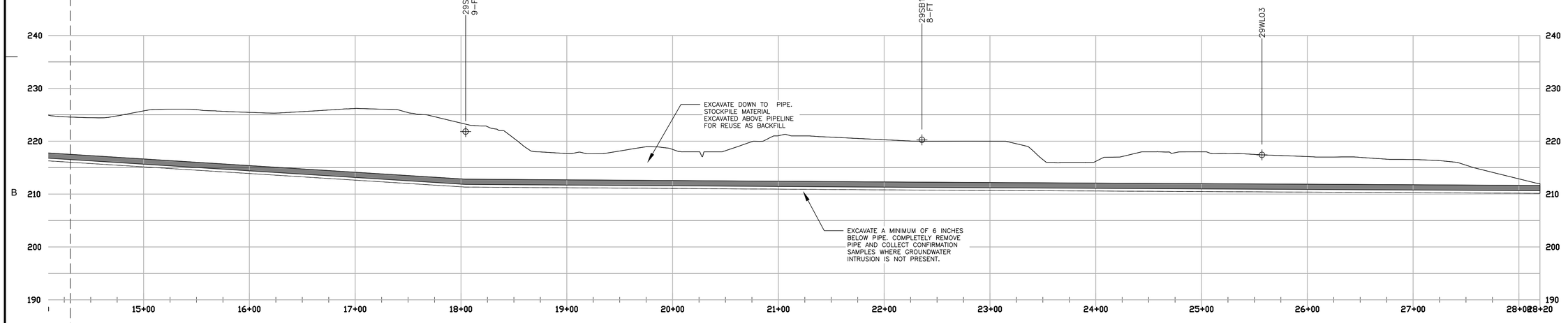
PIPING SITE PLAN SHEET 3

SHEET IDENTIFICATION
03C103
SHEET 25 OF 30



WOODEN TNT WASTEWATER LINE – GRAVITY FLOW PORTION

12" DIAMETER WOOD PIPE



WOODEN TNT WASTEWATER LINE – GRAVITY FLOW PORTION

12" DIAMETER WOOD PIPE

NOTES:
1. DEPTH OF PIPE SHOWN IS BASED ON PDI SAMPLE RESULTS AND TRENCHES CONDUCTED AS PART OF THE PDI IN 2021 AND 2022.
2. ALIGNMENT OF THE PIPE IS APPROXIMATE AND BASED ON BEST AVAILABLE INFORMATION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONFIRMING THE PIPE LOCATION AND DEPTH.

LEGEND:
- GROUND SURFACE
- TNT WASTEWATER PIPELINE (APPROXIMATE)
- SOIL SAMPLE LOCATION (MARCH 2021)
- PROPOSED EXCAVATION

0 50' 100'
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

0' 10' 20'

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7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023
8	FINAL APPROVED DESIGN	02/28/2024
9		
10		
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12		
13		
14		

DESIGNED BY: S. KLING
DWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE: 2/27/24
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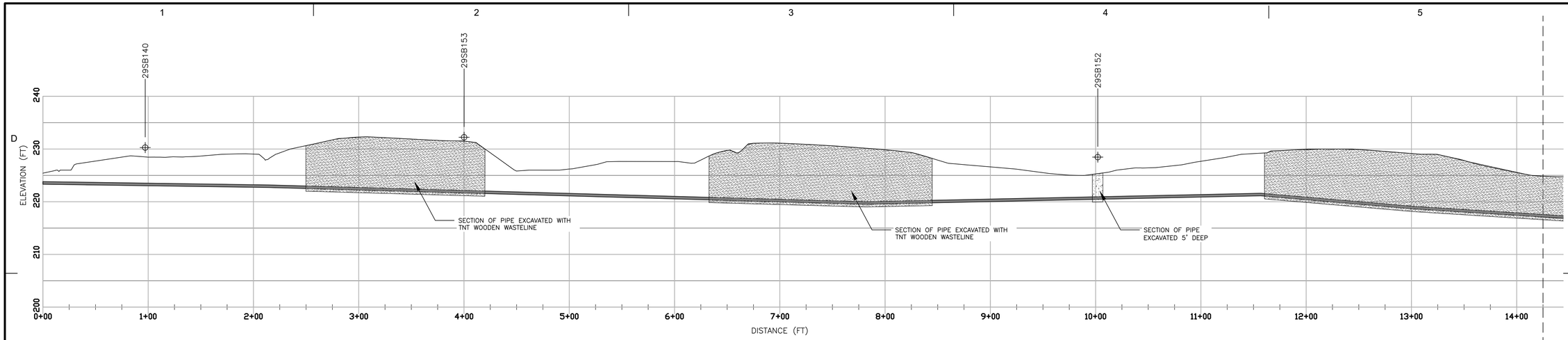
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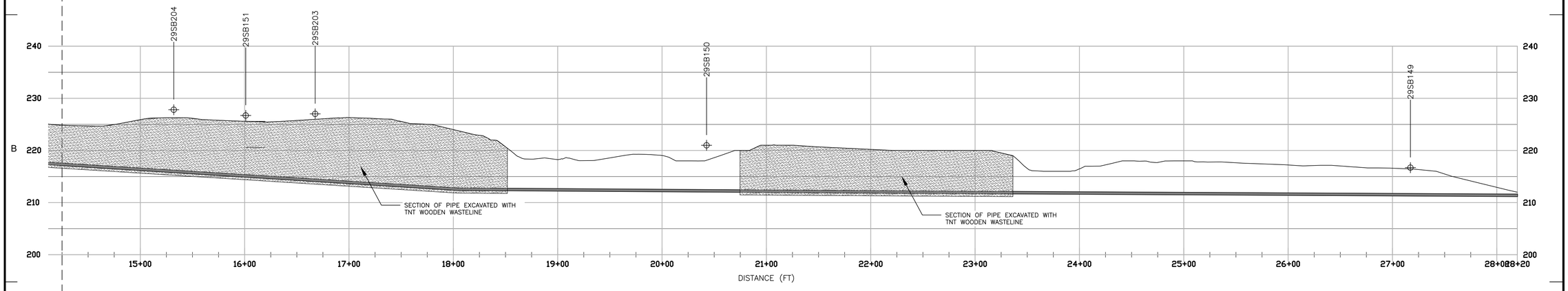
WOODEN TNT WASTEWATER LINE - GRAVITY FLOW PORTION PROFILE SHEET

SHEET IDENTIFICATION
03C301
SHEET 26 OF 30



TRANSITE TNT WASTEWATER LINE – GRAVITY FLOW PORTION

PIPE: 6" DIAM.



TRANSITE TNT WASTEWATER LINE – GRAVITY FLOW PORTION

PIPE: 6" DIAM.

NOTES:

1. DEPTH OF PIPE SHOWN IS BASED ON PDI SAMPLE RESULTS AND TRENCHES CONDUCTED AS PART OF THE PDI IN 2021 AND 2022 ALONG THE WOODEN TNT WASTEWATER PIPELINE. THE TRANSITE LINE IS ASSUMED TO BE AT THE SAME DEPTH AS THE WOODEN TNT WASTEWATER PIPELINE.
2. ALIGNMENT OF THE PIPE IS APPROXIMATE AND BASED ON BEST AVAILABLE INFORMATION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR FIELD VERIFYING THE PIPE LOCATION AND DEPTH.
3. PIPE SECTIONS SHOWN FOR REMOVAL ARE THOSE ASSUMED TO BE DISTURBED AS PART OF THE TNT WOODEN WASTEWATER PIPELINE REMOVAL. OTHER PIPE SECTIONS MAY REQUIRE REMOVAL BASED ON THE RESULTS OF THE VIDEO INSPECTION OF THE PIPELINE THAT WILL BE PERFORMED PRIOR TO REMOVING THE TNT WOODEN WASTEWATER PIPELINE.
4. SECTIONS OF PIPELINE IDENTIFIED FOR REMOVAL CAN BE ABANDONED IN PLACE PER THE CONTRACT REQUIREMENTS IF THE FOLLOWING TWO CONDITIONS ARE MET: 1.) THE TRANSITE PIPELINE CAN BE ADEQUATELY PROTECTED TO PREVENT DAMAGE OR REMAINS UNDISTURBED DURING THE WOODEN PIPELINE REMOVAL, 2.) VIDEO INSPECTION BEFORE AND AFTER THE REMOVAL OF THE WOODEN TNT PIPELINE CONFIRMS THAT THE TRANSITE PIPELINE SECTIONS ARE INTACT AND CAN BE CLEANED AND ABANDONED IN PLACE (FILLED) PER THE CONTRACT REQUIREMENTS.

HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

LEGEND:

- GROUND SURFACE
- TNT WASTEWATER PIPELINE (APPROXIMATE)
- SOIL SAMPLE LOCATION (MARCH 2021)
- PROPOSED EXCAVATION

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8	FINAL APPROVED DESIGN	02/28/2024

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DWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/24
FILE NUMBER: 1024637
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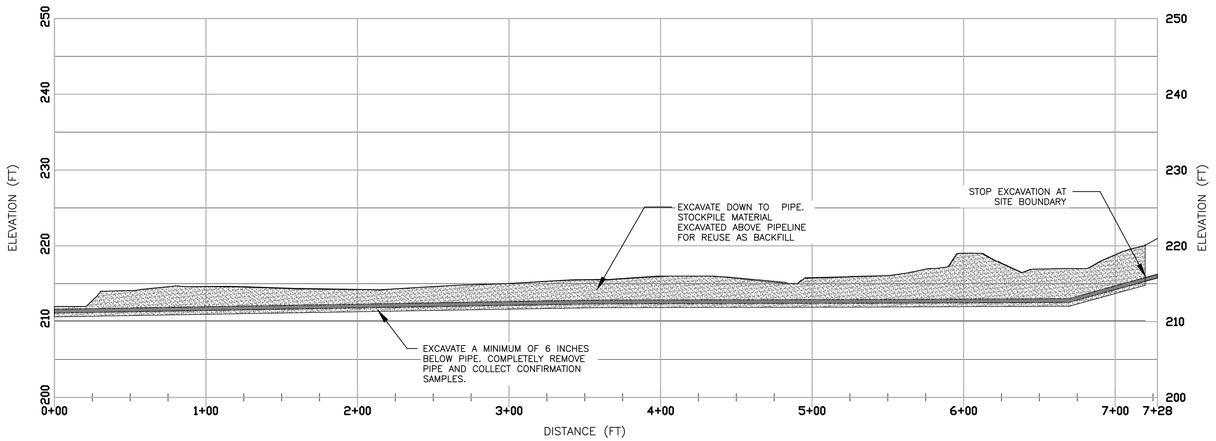
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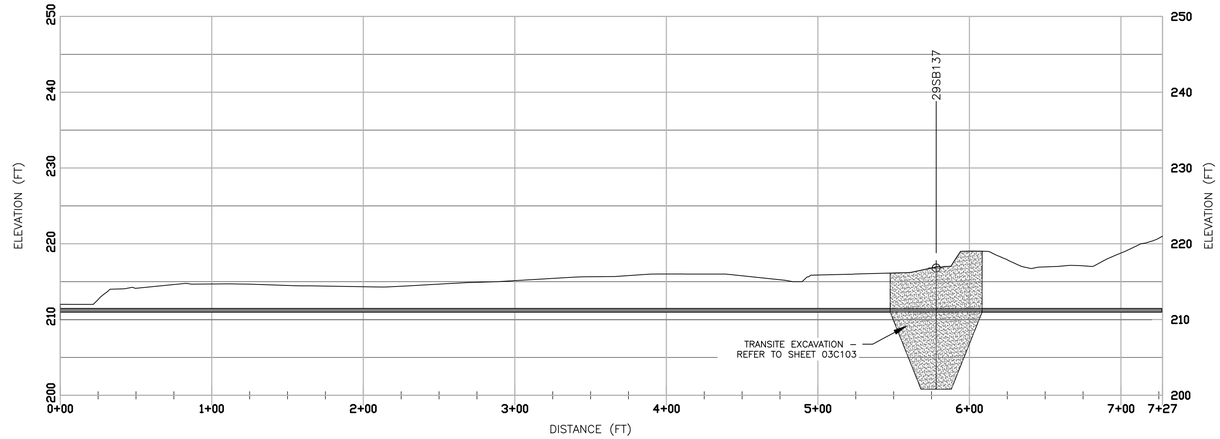
TRANSITE TNT WASTEWATER LINE - GRAVITY FLOW PORTION PROFILE SHEET

SHEET IDENTIFICATION
03C302
SHEET 27 OF 30



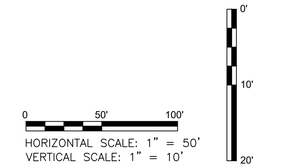
WOODEN TNT WASTEWATER LINE PRESSURIZED PORTION

12" DIAMETER PIPE



TRANSITE TNT WASTEWATER LINE PRESSURIZED PORTION

6" DIAMETER PIPE



LEGEND:

- GROUND SURFACE
- TNT WASTEWATER PIPELINE (APPROXIMATE)
- SOIL SAMPLE LOCATION (MARCH 2021)
- PROPOSED EXCAVATION



NOTES:

1. DEPTHS OF PIPES SHOWN ARE BASED ON PDI SAMPLE RESULTS AND TRENCHES CONDUCTED AS PART OF THE PDI IN 2021 AND 2022 AND HISTORIC INFORMATION.
2. ALIGNMENTS OF THE PIPES ARE APPROXIMATE AND BASED ON BEST AVAILABLE INFORMATION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONFIRMING THE PIPES LOCATIONS AND SIZES.

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DESIGNED BY: S. KLING
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SOLICITATION NO.: W912BV20F0096
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PLOT SCALE: AS NOTED
PLOT DATE: 2/27/2024
SIZE: ANSI D
FILE NUMBER: 152463537
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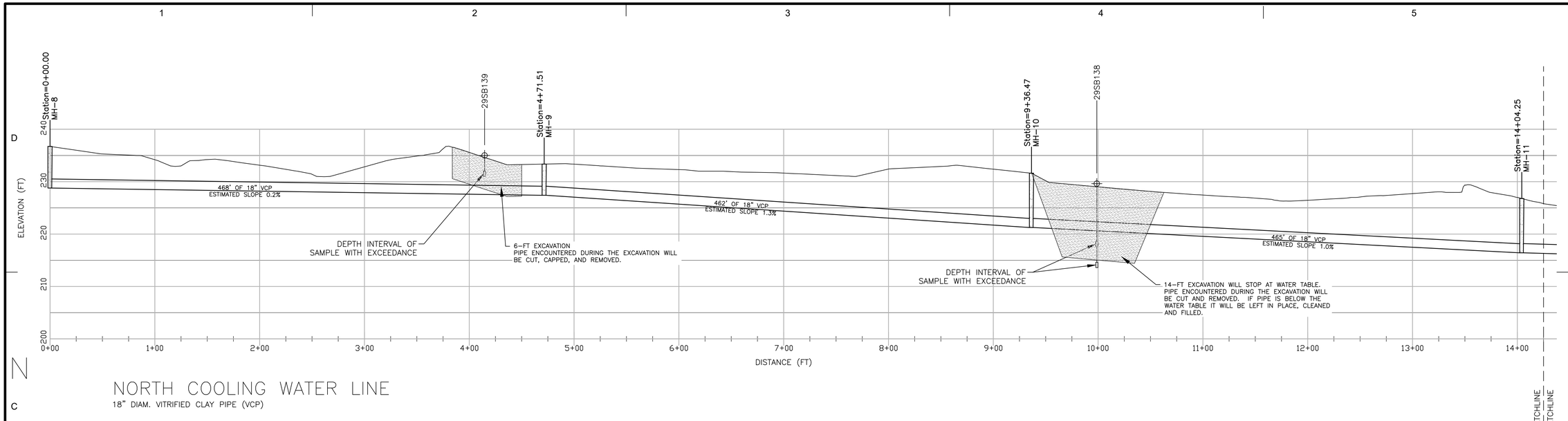
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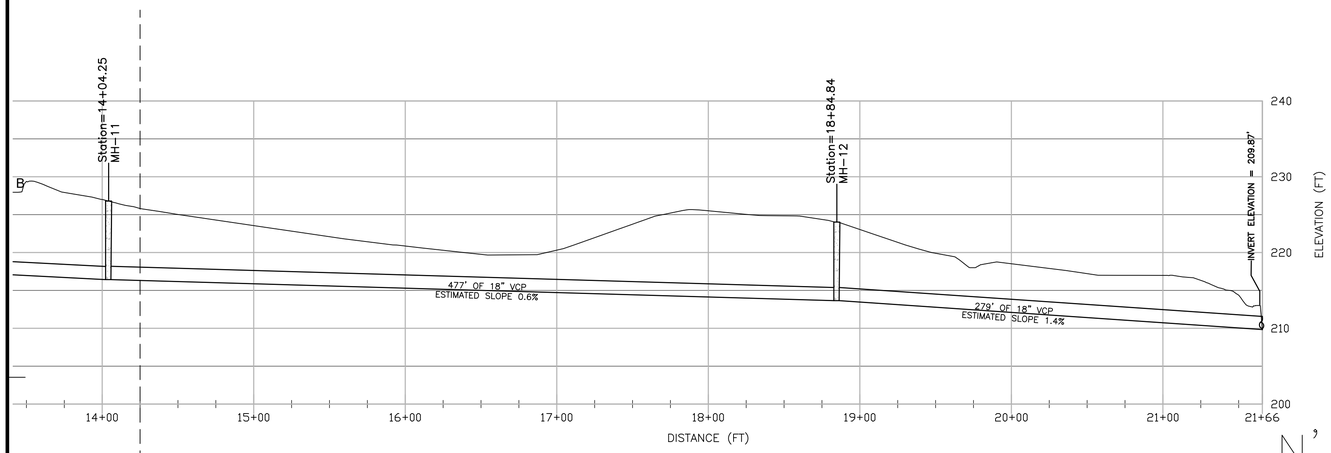
TNT WASTEWATER LINES - PRESSURIZED PORTIONS PROFILE SHEET

SHEET IDENTIFICATION
03C303
SHEET 28 OF 30



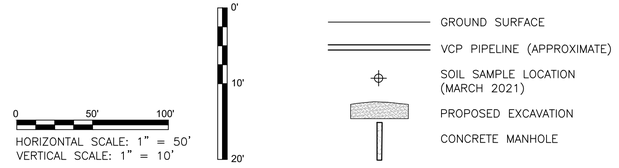
NORTH COOLING WATER LINE

18" DIAM. VITRIFIED CLAY PIPE (VCP)



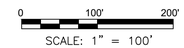
NORTH COOLING WATER LINE

18" DIAM. VITRIFIED CLAY PIPE (VCP)



Manhole ID	Easting[1]	Northing[1]	Associated Cooling Water Line	Assumed Diameter	Estimated Depth[2]
MH-08	3305298.94	6954891.67	North	4'	8'
MH-09	3305630.90	6955226.52	North	4'	5'
MH-10	3305958.03	6955556.93	North	4'	10'
MH-11	3306285.18	6955891.29	North	4'	10'
MH-12	3306627.35	6956228.76	North	4'	10'

Notes:
1. Easting and Northings are approximate and are based on Figures presented in the ROD.
2. Manhole depths are estimated and need to be field verified by the Contractor. Depths are based on a minimum manhole depth of 10-ft and/or minimimum pipe slope of 0.2% working backwards from the discharge point



NOTES:

1. FOR GENERAL NOTES SEE SHEET G002.
2. TOPOGRAPHY AND LOCATION OF EXISTING STRUCTURES ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021.
3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND ARE BASED ON FIGURE 1-4 OF THE RI ADDENDUM DATED 2014 AND PREPARED BY AECOM.

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DESIGNED BY: S. KLING
DRWN BY: S. KLING
SUBMITTED BY:
DATE: 2/28/2024
CKD BY: T. CONNORS
PLOT SCALE: AS NOTED
SIZE: ANSI D
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT DATE: 2/28/24
FILE NUMBER: 102483376
FILE NAME: 102483376.0_CAD_BIM6.2_WIP6.2-4_FINAL DESIGN

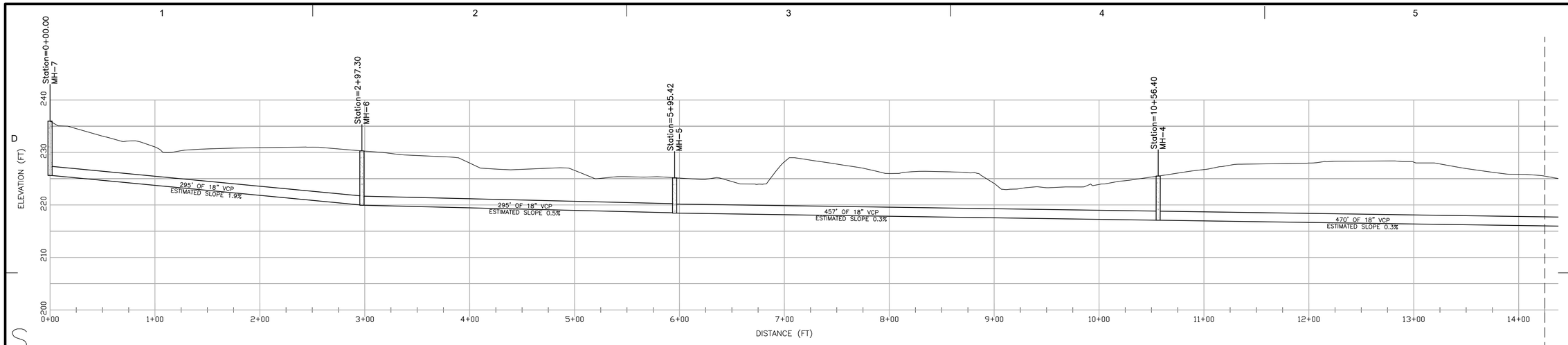
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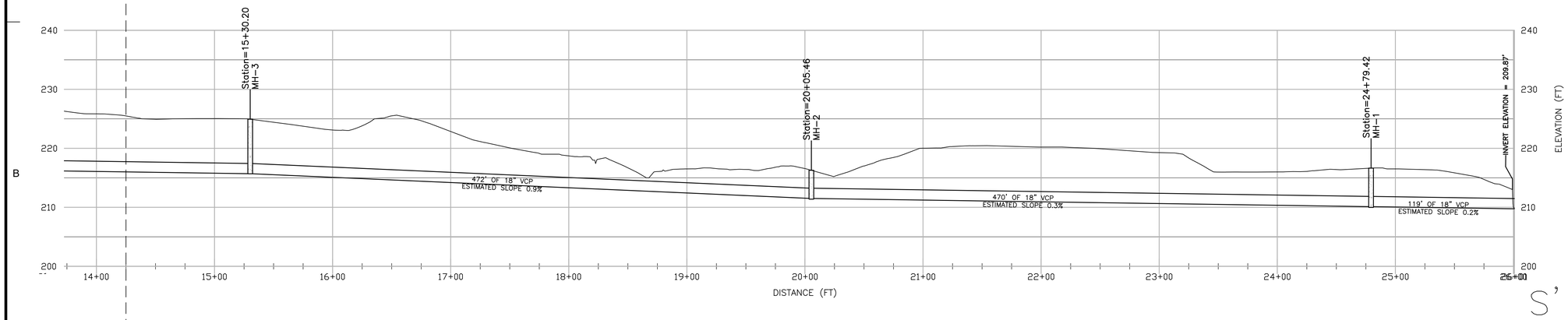
NORTH COOLING WATER LINE PROFILE VIEW

SHEET IDENTIFICATION
03C304
SHEET 29 OF 30



SOUTH COOLING WATER LINE

MATCHLINE
MATCHLINE



SOUTH COOLING WATER LINE

MATCHLINE
MATCHLINE

Manhole ID	Easting[1]	Northing[1]	Associated Cooling Water Line	Assumed Diameter	Estimated Depth[2]
MH-01	3306773.67	6956002.05	South	4'	7'
MH-02	3306437.66	6955667.78	South	4'	5'
MH-03	3306102.44	6955330.89	South	4'	10'
MH-04[3]	3305770.03	6954993.26	South	4'	9'
MH-05	3305445.25	6954666.12	South	4'	7'
MH-06	3305235.32	6954454.45	South	4'	10'
MH-07	3304952.54	6954546.21	South	4'	10'

Notes:
1. Easting and Northings are approximate and are based on Figures presented in the ROD.
2. Manhole depths are estimated and need to be field verified by the Contractor. Depths are based on a minimum manhole depth of 10-ft and/or minimimum pipe slope of 0.2% working backwards from the discharge point
3. Shaw observed manhole to be collapsed during the December 2004/February 2005 Field Work.

0 50' 100'
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 10'

0' 10' 20'

PROFILE VIEW LEGEND:

- GROUND SURFACE
- VCP PIPELINE (APPROXIMATE)
- SOIL SAMPLE LOCATION (MARCH 2021)
- PROPOSED EXCAVATION
- CONCRETE MANHOLE

NOTES:

1. FOR GENERAL NOTES SEE SHEET G002.
2. TOPOGRAPHY AND LOCATION OF EXISTING STRUCTURES ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021.
3. LOCATION OF MANHOLES AND UNDERGROUND COOLING WATER PIPE AND TNT WASTEWATER PIPES ARE APPROXIMATE AND ARE BASED ON FIGURE 1-4 OF THE RI ADDENDUM DATED 2014 AND PREPARED BY AECOM.

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1	60% DRAFT DESIGN SUBMISSION	11/14/2022
2	90% DRAFT DESIGN USACE SUBMISSION	03/06/2023
3	90% DRAFT DESIGN EPA/TCEQ SUBMISSION	04/14/2023
4	100% DRAFT DESIGN USACE SUBMISSION	07/05/2023
5	100% DRAFT DESIGN EPA/TCEQ SUBMISSION	08/15/2023
6	100% DESIGN USACE SUBMISSION	10/19/2023
7	100% DESIGN EPA/TCEQ SUBMISSION	12/13/2023
8	FINAL APPROVED DESIGN	02/28/2024

DESIGNED BY: S. KLING
DWN BY: S. KLING
CKD BY: T. CONNORS
SUBMITTED BY:
DATE: 2/28/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE: 2/28/24
FILE NAME: 102645370_CAD_BIM\2-2_WIP\2-2_FINAL DESIGN\102645370_G

B

Remedial Design Cost Estimate

CONSTRUCTION COST ESTIMATE

Site: LHAAP-29, Former TNT Production Area, Group 2
Location: Karnack, Texas
Phase: 100% Remedial Design
Base Year: 2021
Date: December 13, 2023

	Item	Quantity	Unit	Unit Cost	Estimated Cost	Subtotal	Note	Source of Pricing
1.0 Excavation Remedial Action								
1.1 General								
1.1.1	Submittals/Implementation Plans	1	LS	$80,000.00	$80,000		Work Plan, QAPP, HASP, CQCP, Air Monitoring Plan, Waste Mgmt Plan;	Based on past project experience
1.1.2	TCEQ/Approvals	1	LS	$10,000.00	$10,000			Based on past project experience
1.1.3	Pre-construction Meetings and Community Relations	1	LS	$10,000.00	$10,000			Based on past project experience
1.1.4	Post-Construction Submittals	1	LS	$80,000.00	$80,000		Manifests, asbuilts, air monitoring results, verification sample results, boring logs, etc.	Based on past project experience
	Subtotal					**$180,000**		
1.2 Mobilization/Demobilization for Excavation								
1.2.1	General Mobilization/Demobilization	1	LS	$200,000.00	$200,000		Excavators, loader, dozer, etc.	Appx. 5% of construction costs
	Subtotal					**$200,000**		
1.3 Site Preparation & Stormwater and Erosion Control Management								
1.3.1	Pre-Construction Survey	4	Day	$2,436.79	$9,747		Survey stakeout	Task-based estimate
1.3.2	Clearing and grubbing	23.00	acre	$3,525.89	$81,095		Cut and Chip Trees up to 12" Dia; grub stumps and remove; for complete RA; Excludes disposal costs	Task-based estimate
1.3.3	Silt Fence	2,106	LF	$3.25	$6,845		Assume silt fence around excavation perimeters	RSMeans
1.3.4	Maintain Erosion Controls	220	Hr	$216.07	$47,535		Assumes 10 hours per week; 22 weeks; 2 laborers, task-based estimate.	Task-based estimate
1.3.5	Temporary Drainage Ditches	8,000	LF	$2.85	$22,827		1-ft deep x 4-ft bottom width	Task-based estimate - assume similar to exc and sidecast cost developed for trench exc and backfill
1.3.6	Access Roads	2,088	SY	$14.30	$29,861		10" gravel depth; underlying geotexile	RSMeans
1.3.7	12-in Dia. Access Road Culvert	30	LF	$67.15	$2,014		Includes earthwork, bedding material, and haunch.	Task-based estimate
1.3.8	18-in Dia. Access Road Culvert	390	LF	$128.96	$50,296		Includes earthwork, bedding material, and haunch.	Task-based estimate
1.3.9	Utility Mark-Out	8	Day	$2,436.79	$19,494		1 day per excavation area	Task-based estimate - survey crew
1.3.10	Temporary Facilities Rentals	20	Mo	$1,790.92	$35,818		2-50'x12' trailer rental;wi-fi/telephone; electric; storage box; portable toilet; includes ISTD O&M period	Task-based estimate
1.3.11	Construction Fence	15,000	LF	$3.29	$49,350		Orange snow fence around excavation areas	RSMeans
1.3.12	Temporary Gates	5	EA	$2,223.58	$11,118		20-ft wide double swing; 8-ft high; at each entrance to the site	RSMeans
1.3.13	Dewater Pumphouse Pond	7	Day	$934.44	$6,541		Assumed 282,000 gallons to be pumped; 6" centrigal pump; 1000 gpm capacity	RSMeans 312319201100
1.3.14	Cooling Water Ditch Bypass	3	Day	$583.78	$1,751		3" centrifugal pump with 100 lf of discharge hose	RSMeans 312319200900
1.3.15	Frac Tank Delivery	1	LS	$1,500.00	$1,500		20,000 gallon frac tank	Based on past project experience
1.3.16	Frac Tank Rental	2	Week	$450.00	$900			Based on past project experience
1.3.17	Transport to 18/25 GWTP for Treatment	93	Hr	$128.50	$11,951		2200 gallon vac truck; 30 min load/unload + 12 min travel = 42 min per trip; 8 hr day = approx. 11 trips/day	RSMeans
	Subtotal					**$389,000**		
1.4 Health and Safety for Excavation								
1.4.1	Perimeter Air Monitoring	40	Day	$1,097.11	$43,884		Environmental monitor, service contract rate + truck	Task-based estimate
1.4.2	H&S Monitoring	8	Week	$2,742.77	$21,942			Task-based estimate
1.4.3	PPE and Field Supplies	8	Week	$200.00	$1,600			Based on past project experience
1.4.4	H&S Superintendant	160	Hr	$164.15	$26,263		H1S Officer, service contract rate, 20 HR/WK, 8 weeks	Task-based estimate
	Subtotal					**$94,000**		
1.5 Excavation								
1.5.1	Excavation, Load into Trucks for Stockpiling/Removal	14,644	BCY	$22.05	$322,921		Excavate soil to temporary staging area, load into trucks	Task-based estimate
1.5.2	Concrete Removal	169	SY	$155.31	$26,265		Assumed 4" thick with rod reinforcement	RSMeans
1.5.3	Contaminated Soil Load-Out Into Trucks	9,673	BCY	$7.58	$73,282		Load out into trucks for disposal	Task-based estimate
1.5.4	Concrete Crushing On-Site	56	CY	$10.44	$589		assumed crushed and used as backfill	RSMeans
1.5.5	Survey Work	48	Day	$2,436.79	$116,966		1 day field per excavation; 3 days office per excavation	Task-based estimate
1.5.6	Field Screening Sample Analysis	0	EA	$59.78	$0		Colorimetric Test Kit for Explosives; includes 30% for secondary samples;	JJS Technical Services Internet Quote; 20 samples per kit
1.5.7	Field Screening Sample Collection	0	HR	$164.99	$0		0.75 hour per sample assumed; geologist	Task-based estimate
1.5.8	Confirmation Sample Collection	334	HR	$164.99	$55,106		1 hour per collection of DU samples assumed; 2 geologists; Includes 10 additional samples for secondary excavations.	Task-based estimate
1.5.9	ISM Sample Processing	167	EA	$100.00	$16,700		Processing completed by the laboratory; includes 10 additional samples for secondary excavations	
1.5.10	Confirmation Sample Analysis - Perchlorate	24	EA	$195.00	$4,680		48 hr TAT inc. 1.75 markup; includes additional 20% for QC sample analysis	2022 Longhorn PDI work
1.5.11	Confirmation Sample Analysis - Explosives	212	EA	$195.00	$41,278		48 hr TAT inc. 1.75 markup; includes additional 20% for QC sample analysis	2022 Longhorn PDI work
	Subtotal					**$658,000**		
1.6 Waste Disposal for Excavation								
1.6.1	Non-Hazardous Waste Transport & Disposal	10,640	LCY	$183.61	$1,953,665		Assumes 10% conversion from bank to loose cy	CG Environmental Quote; excludes surcharges & tax
1.6.2	Waste Characterization Samples	59	EA	$1,092.88	$64,016		Assumes 1 sample per 250 cy of material; inc. 1.75 markup for 48-hour TAT	2022 Longhorn PDI work
	Subtotal					**$2,018,000**		
1.7 Post-Excavation Restoration								
1.7.1	BackFill from Stockpile	4,971	BCY	$27.21	$135,281			Task-based estimate
1.7.2	Import and Place Clean Backfill	11,608	LCY	$88.04	$1,021,879		Importing certified clean soil; includes placement, hauling, compaction	Task-based estimate
1.7.3	Backfill Source Sampling	12	EA	$520.00	$6,036		1 sample per 1,000 cy	Based on past project experience
1.7.4	Hydro Seed	1,002	MSF	$41.54	$41,621		Wildflower Seed Mix over all disturbed areas	Task-based estimate
	Subtotal					**$1,205,000**		
	Subtotal for 1.0 Excavation Remedial Action					**$4,744,000**		
2.0 In-Situ Thermal Desorption (ISTD) Remedial Action - Electrical Resistance Heating (ERH)								
2.1 Well Installation & Baseline Sampling								
2.1.1	Driller Mobilization/Demobilization	1	LS	$3,000.00	$3,000		Sonic Drill Rig	2022 Longhorn PDI work
2.1.2	Drilling - Sonic Drill Rig	7	Day	$6,000.00	$42,000		Assumes 1 well drilled per day; includes installation costs	2022 Longhorn PDI work
2.1.3	4-inch SS Well Casing	630	LF	$85.86	$54,090		6 wells installed to 90 ft; 1 well installed to 160 ft	2022 MCACES Cost Book
2.1.4	4-inch SS Screen - 10 ft	70	LF	$41.54	$2,908		10-ft casings; 7 wells total	2022 MCACES Cost Book
2.1.5	Well Completion - Abovegrade with Guard Posts	7	EA	$600.00	$4,200			2022 Longhorn PDI work
2.1.6	Well Development - Driller	21	HR	$200.00	$4,200		3 hours per well for development	2022 Longhorn PDI work
2.1.7	Well Development - Field Geologist	21	HR	$164.99	$3,465		3 hours per well for development	Task-based estimate
2.1.8	Drums for purge water	15	EA	$75.00	$1,145		Assumes 120 gallons generated per well	2022 Longhorn PDI work
2.1.10	Decontamination	1	LS	$750.00	$750			2022 Longhorn PDI work
2.1.11	Field Documentation	1	LS	$3,000.00	$3,000			2022 Longhorn PDI work
2.1.12	Groundwater Sampling Labor	64	HR	$164.99	$10,559		2 person crew; 2 hours per well; 8 hr days, assuming 6 hrs/day active sampling	Task-based estimate
2.1.13	Groundwater Sampling Equipment & Materials	4	Day	$1,200.00	$4,800		8 hr days; 6 hrs per day active sampling of 12 wells	Past project experience
2.1.14	Groundwater Samples Analysis	14	EA	$100.63	$1,449		48-Hr TAT inc. 1.75 markup; VOCs; 12 wells; 20% for QC samples	2022 Longhorn PDI work
2.1.15	Groundwater Sampling Reporting	1	LS	$10,000.00	$10,000		Prepare summary report of results	
2.1.16	Drums for purge water	2	EA	$75.00	$150			Past project experience
2.1.17	Transport drums to 18/24 GWTP	2	LS	$500.00	$1,000		10 drums per load	Past project experience
	Subtotal					**$147,000**		
2.2 Health and Safety for ISTD								
2.2.1	Perimeter Air Monitoring	44	Week	$4,799.86	$211,194		VOCs monitoring; Based on task-based estimate.	Task-based estimate
2.2.2	H&S Monitoring	44	Week	$1,063.08	$46,775		VOCs monitoring; Based on task-based estimate.	Task-based estimate
2.2.3	PPE and Field Supplies	44	Week	$200.00	$8,800		Based on experience on similar projects.	
2.2.4	H&S Superintendent	440	Hr	$164.15	$72,224		Based on task-based estimate.	Task-based estimate
2.2.5	ISTD System Security	3,696	HR	$56.73	$209,670		Security guard during non-working hours; 12 hrs./day; 30 days per mo. Based on task-based estimate.	Task-based estimate
	Subtotal					**$549,000**		
2.3 Power Drop for ISTD								
2.3.1	Power Drop and Transformer Installation	1	LS	$177,282.00	$177,282		9 45' class 3 poles to and 1000 kva pad-mount transformer	2015 FS quote escalated to 2023
	Subtotal					**$177,000**		
2.4 ISTD System Installation, Operation, and Decommissioning								
2.4.1	ISTD System Installation, Operation and Decommissioning	1	LS	$2,724,000.00	$2,724,000			2022 TerraTherm Quote; Scaled up 13,444 cy volume
2.4.2	Utilities	1	LS	$230,000.00	$230,000			2022 TerraTherm Quote
2.4.3	Perimeter Chainlink Fence	890	LF	$25.24	$22,466			Task-based estimate
2.4.4	Temporary Gates	1	EA	$2,223.58	$2,224		20-ft wide double swing; 8-ft high	RSMeans
2.4.5	Abandon Monitoring Well	1	EA	$17,225.80	$17,226			2022 MCACES Cost Book
2.4.6	Confirmation Groundwater Sampling	1	EA	$12,040.61	$12,041			cost same as baseline sampling event above
	Subtotal					**$3,008,000**		
2.5 Site Restoration								
2.5.1	Hydro Seed	0	MSF	$41.54	$0		Included above under Excavation Restoration	Task-based estimate
	Subtotal					**$0**		

CONSTRUCTION COST ESTIMATE

Site: LHAAP-29, Former TNT Production Area, Group 2
Location: Karnack, Texas
Phase: 100% Remedial Design
Base Year: 2021
Date: December 13, 2023

	Item	Quantity	Unit	Unit Cost	Estimated Cost	Subtotal	Note	Source of Pricing
					Subtotal for 2.0 ISTD Remedial Action	**$3,881,000**		
3.0 Pipeline Inspection and Plugging/Abandonment Remedial Action								
3.1 TNT Transite Pipeline Inspection and Cleaning								
3.1.1	Equipment and Crew Mobilization	1	LS	$10,000.00	$10,000			RSMeans Line Item 330130116120
3.1.2	Pipeline Video Inspection	4,000	LF	$1.50	$6,000			RSMeans Line Item 330130119060
3.1.3	Install Temporary Sump	2	EA	$400.00	$800		Install temporary tanks at ends of transite TNT wastewater line	
3.1.4	Pig Method	4,000	LF	$20.16	$80,640			2022 MCACES Cost Book Ave. of Line Items 330130110140 & 330130110160
3.1.5	Pipe Jetting 4"-12"	4,000	LF	$0.75	$3,000		Light cleaning to flush residual solids;	Taken from 2021 MGA SSES study published online
3.1.6	Frac Tank Delivery	1	LS	$1,500.00	$1,500			Based on past project experience
3.1.7	Frac Tank Rental	4	Week	$450.00	$1,800			Based on past project experience
3.1.8	Water Disposal (Listed Hazardous Waste)	9,600	gal	$2.75	$26,400		Assumes 5 gpm flow rate for 4 - 8 hr days of cleaning	Based on past project experience
3.1.9	Sludge Disposal (Listed Hazardous Waste)	11	drum	$495.00	$5,445		Estimated volume based on 10% of pipeline volume	Based on past project experience
3.1.10	Pipeline Filling	30	CY	$144.32	$4,330		Includes materials, labor and equipment	RSMeans Item 033113354350 & 033113700800
	Subtotal					**$140,000**		
3.2 Wooden TNT Wastewater Line Removal								
3.2.1	Wooden TNT Wastewater Line Excavation	6,755	BCY	$8.00	$54,042		Excavate soil around pipeline; stockpile material above pipe along trench for reuse	Task-based estimate
3.2.2	Wooden Pipeline Removal	5,730	LF	$15.70	$89,973		Pipe Removal; Excludes excavation	Task-based estimate
3.2.3	Wooden TNT Wastewater Line (and Surrounding Soil) Haz Waste Disposal	1,390	CY	$333.60	$463,593		K047 listed waste; Pipe and surrounding materials; assumes 3-ft wide and 2 ft depth	CG Environmental Quote; excludes surcharges & tax
3.2.4	Disposal of Transite Pipe Sections	1,350	LF	$97.00	$130,950		Pipe sections disturbed during wooden pipe removal; Decontaminated before disposal (see above);	
3.2.5	Asbestos Abatement	20	Day	$3,000.00	$60,000		5 person crew (4 laborers, 1 supervisor) for 20 - 8 hr days plus travel and per diem	Texas Environmental Control Abatement Pricing
3.2.6	Transite Pressure Pipeline Excavations	300	BCY	$8.00	$2,400		Excavate to expose pipeline; stockpile material along trench for reuse	Task-based estimate
3.2.7	Transite Pipe Excavation Soils Disposal	330	CY	$183.61	$60,591		Assumes 10% conversion from bank to loose cy; nonhazardous disposal	CG Environmental Quote; excludes surcharges & tax
3.2.8	Field Screening Sample Analysis	440	EA	$59.78	$26,301		Colorimetric Test Kit for Explosives; includes 30% for secondary samples;	JJS Technical Services Internet Quote; 20 samples per kit
3.2.9	Field Screening Sample Collection	330	HR	$164.99	$54,446		0.75 hour per sample assumed; geologist	Task-based estimate
3.2.10	Confirmation Sample Analysis - Explosives	480	EA	$195.00	$93,600		48 hr TAT inc. 1.75 markup; no secondary samples; 2 sidewall 1 bottom every 30 lf; 20% for QC Samples	2022 Longhorn PDI work
	Subtotal					**$1,036,000**		
3.3 Cooling Water Pipeline Line Removal (NC-1)								
3.3.1	Cooling Water Pipeline Excavation	130	BCY	$8.00	$1,040		Excavate soil around pipeline; stockpile material above pipe along trench for reuse	Task-based estimate
3.3.2	Cooling Water Pipeline Removal	65	LF	$15.70	$1,021		Pipe Removal; Excludes excavation	Task-based estimate
3.3.3	Cooling Water Pipe and Soils Disposal	143	CY	$183.61	$26,256			CG Environmental Quote; excludes surcharges & tax
	Subtotal					**$28,000**		
3.4 Pipe Line Excavations Restoration								
3.4.1	Backfill	5,902	LCY	$11.26	$66,454		Placement, compaction of material stockpiled along trench	Task-based estimate
3.4.2	Import and Place Clean Backfill	1,850	LCY	$88.04	$162,836		Quote from A&T Sand & Gravel for purchase and haul, task-based estimate for place & compact.	Task-based estimate
3.4.3	Backfill Source Sampling	2.0	EA	$627.00	$1,254		1 sample per 1,000 cy	2022 Longhorn PDI work
3.4.4	Hydro Seed	0	MSF	$41.54	$0		Included above under Excavation Restoration	Task-based estimate
	Subtotal					**$231,000**		
3.5 Cooling Water Pipeline Inspection, Cleaning and Plugging/Abandonment								
3.5.1	Equipment and Crew Mobilization	1	LS	$10,000.00	$10,000			RSMeans Line Item 330130116120
3.5.2	Pipeline Video Inspection	10,400	LF	$1.50	$15,600		Pre- and post video inspection of all pipelines	RSMeans Line Item 330130119060
3.5.3	Pipe Jetting 4"-12"	10,400	LF	$0.75	$7,800		Light cleaning to flush residual solids;	Taken from 2021 MGA SSES study published online
3.5.4	Pipeline Filling	413	CY	$144.32	$59,548		Includes materials, labor and equipment	RSMeans Item 033113354350 & 033113700800
3.5.5	Manhole Demolition - Top 4 ft	48	VLF	$232.10	$11,141		Demo top 4-ft before filling with concrete	RSMeans 024113420100
3.5.6	Pipeline Line Excavation	30	BCY	$8.00	$240		NC-3 excavation	Task-based estimate
3.5.7	Pipeline Removal	65	LF	$15.70	$1,021		Pipe Removal; Excluds excavation	Task-based estimate
3.5.8	Frac Tank Delivery	1	LS	$1,500.00	$1,500			Based on past project experience
3.5.9	Frac Tank Rental	4	Week	$450.00	$1,800			Based on past project experience
3.5.10	Cooling Water Pipe and Soils Disposal	33	CY	$183.61	$6,059		Assumes 10% conversion from bank to loose cy; nonhazardous disposal	CG Environmental Quote; excludes surcharges & tax
3.5.11	Water Disposal	24,000	gal	$0.50	$12,000		Assumes 5 gpm flow rate for 10 - 8 hr days of cleaning; nonhazardous	Past project information
3.5.12	Slude Disposal (nonhazardous)	7	drum	$95.00	$665		Estimated volume based on 0.5% of pipeline volume	Based on past project experience
	Subtotal					**$127,000**		
					Subtotal for 3.0 Piping Clearing and Plugging Remedial Action	**$1,562,000**		
4.0 Monitored Natural Attenuation Implementation								
4.1 Baseline Groundwater Sampling								
4.1.1	Groundwater Sampling Labor	128	HR	$164.99	$21,118		2 person geologist crew; 2 hours per well; 8 hr days, assuming 6 hrs/day active sampling	Task-based estimate
4.1.2	Groundwater Sampling Equipment & Materials	8	Day	$700.00	$5,600		8 hr days; 6 hrs per day active sampling of 23 wells	Past project experience
4.1.3	Groundwater Samples Analysis	28	EA	$278.00	$7,673		Standard 10 day TAT; explosives, VOCs, perchlorate; 23 wells; 20% for QC Samples	2022 Longhorn PDI work
4.1.4	Groundwater Sampling Reporting	1	LS	$10,000.00	$10,000		Prepare summary report of results	
4.1.5	Drums for purge water	2	EA	$75.00	$150			Past project experience
4.1.6	Transport drums to 18/24 GWTP	1	LS	$500.00	$500			
						$45,000		
4.2 Groundwater Monitoring Well Installation								
4.2.1	Driller Mobilization/Demobilization	1	LS	$3,000.00	$3,000			2022 Longhorn PDI work
4.2.2	Drilling - Rotsonic Drill Rig	9	Day	$6,000.00	$51,000		Assumes 2 wells drilled per day;	2022 Longhorn PDI work
4.2.3	2-inch PVC Well Casing (Installed)	325	LF	$118.00	$38,350		14 wells installed between depths of 23 ft to 37 ft; 3 excavation wells	2022 Longhorn PDI work
4.2.4	2-inch PVC Screen - 10 ft (Installed)	170	LF	$140.00	$23,800		10-ft casings; 17 wells total	2022 Longhorn PDI work
4.2.5	Well Completion - Abovegrade with Guard Posts	17	EA	$600.00	$10,200			2022 Longhorn PDI work
4.2.6	Well Development - Driller	51	HR	$200.00	$10,200		3 hours per well for development	2022 Longhorn PDI work
4.2.7	Well Development - Field Geologist	51	HR	$164.99	$8,414		3 hours per well for development	
4.2.8	Drums for purge water	37	EA	$75.00	$2,782		Assumes 120 gallons generated per well	Past project experience
4.2.9	Transport drums to 18/24 GWTP	1	LS	$500.00	$500			
4.2.10	Decontamination	1	LS	$750.00	$750			2022 Longhorn PDI work
4.2.11	Field Documentation	1	LS	$3,000.00	$3,000			2022 Longhorn PDI work
						$152,000		
4.3 Post Well Installation Groundwater Sampling								
4.3.1	Groundwater Sampling Labor	288	HR	$164.99	$47,516		2 person crew; 2 hours per well; 8 hr days, assuming 6 hrs/day active sampling	Task-based estimate
4.3.2	Groundwater Sampling Equipment & Materials	18	Day	$700.00	$12,600		8 hr days; 6 hrs per day active sampling of 53 wells; 20% for QC Samples	Past project experience
4.3.3	Groundwater Samples Analysis	64	EA	$278.00	$17,681		Standard TAT; explosives, VOCs, perchlorate; 53 wells;	2022 PDI Work
4.3.4	Groundwater Sampling Reporting	1	LS	$10,000.00	$10,000		Prepare summary report of results	
4.3.5	Drums for purge water	7	EA	$75.00	$525			Past project experience
4.3.6	Transport drums to 18/24 GWTP	1	LS	$500.00	$500			
						$89,000		
					Subtotal for 4.0 Monitored Natural Attenuation	**$286,000**		
Total Costs								
					Subtotal for Remedial Actions:	**$10,473,000**		
					Contingency: 25%	$2,618,250		
					Subtotal for Remedial Actions:	**$13,091,000**		
					Construction Oversight: 6%	$628,000		
					Construction Management: 8%	$838,000		
					Total Costs:	**$14,557,000**		

LHAAP-29, Former TNT Production Area, Group 2

Task-Based Estimate Backup Calculations

Cost Items	Description	Type	Item	Total Rate	Unit	Bid Qty	Bid Unit	Prod	Prod Unit	Qty	±	Qty ±	Qty Unit	Task Cost	Direct Unit Cost	HOOH (6%)	JOOH (10%)	Profit (8%)	Bond (2%)	Total Unit Price
1.5.1	Excavation, Stockpiling, and Handling					14,644.0	BCY							$256,286.29	$17.50	$1.05	$1.75	$1.40	$0.35	$22.05
	Haul to Stockpile	Haul	Haul_Exc_Stock	$28.00	load	14,644.0	BCY	13.0	cy/load	1,126.5	1.0	1,127.0	load	$31,556.00	$2.15					
	Excavate and Stockpile Fill	Crew	EXC2	$1,003.26	hour	14,644.0	BCY	66.0	cy/hr	221.9	4.0	224.0	hour	$224,730.29	$15.35					
1.5.3	Load Fill into Trucks for Disposal					9,673.0	BCY							$58,160.27	$6.01	$0.36	$0.60	$0.48	$0.12	$7.58
	Load Fill into Trucks for Disposal	Crew	LOAD1	$660.91	hour	9,673.0	BCY	110.0	cy/hr	87.9	4.0	88.0	hour	$58,160.27	$6.01					
3.2.1 & 3.3.1	Excavate and Sidecast only					7,185.0	BCY							$45,621.12	$6.35	$0.38	$0.63	$0.51	$0.13	$8.00
& 3.2.6	Excavate and Sidecast only	Crew	EXC3	$495.88	hour	7,185.0	BCY	80.0	cy/hr	89.8	4.0	92.0	hour	$45,621.12	$6.35					
3.2.2	Load Pipe from Open Trench					5,730.0	LF							$71,406.97	$12.46	$0.75	$1.25	$1.00	$0.25	$15.70
	Load Pipe	Crew	EXC3	$495.88	hour	5,730.0	LF	40.0	lf/hr	143.3	4.0	144.0	hour	$71,406.97	$12.46					
1.3.1	Survey Crew per Day					4.0	DAY							$7,735.83	$1,933.96	$116.04	$193.40	$154.72	$38.68	$2,436.79
	Survey	Crew	Survey	$241.74	hour	4.0	DAY	8.00	hr/day	32.0	4.0	32.0	hour	$7,735.83	$1,933.96					
2.2.5	Security Guard					3,696.0	HR							$166,405.04	$45.02	$2.70	$4.50	$3.60	$0.90	$56.73
	Guard 1	Crew	Guard1	$45.02	hour	3,696.0	HR	1.00	HR	3,696.0	4.0	3,696.0	hour	$166,405.04	$45.02					
	Monitoring Costs (Exc)																			
1.4.1	Air Quality Monitor (DAY)	Crew	EnvMonitor	$108.84	hour	40.0	day	0.13	HR	320.0	4.0	320.0	hour	$34,828.88	$870.72	$52.24	$87.07	$69.66	$17.41	$1,097.11
1.4.2	Air Quality Monitor (WK)	Crew	EnvMonitor	$108.84	hour	8.0	wk	0.050	wk/hr	160.0	4.0	160.0	hour	$17,414.44	$2,176.81	$130.61	$217.68	$174.14	$43.54	$2,742.77
	Monitoring Costs (ISTD)																			
2.2.1	Air Quality Monitor (7-day WK)	Crew	EnvMonitor	$108.84	hour	44.0	wk	35.000	hr/wk	1,540.0	4.0	1,540.0	hour	$167,613.99	$3,809.41	$228.56	$380.94	$304.75	$76.19	$4,799.86
	Health and Safety																			
1.4.4 & 2.2.4	Health and Safety Officer	Crew	HSOfficer	$130.27	hour	440.0	hr	1.00	HR	440.0	4.0	440.0	hour	$57,320.94	$130.27	$7.82	$13.03	$10.42	$2.61	$164.15
2.2.2	Health and Safety Monitor (10 hr/wk)	Crew	HSMonitor	$84.37	hour	44.0	wk	0.10	wk/hr	440.0	4.0	440.0	hour	$37,123.31	$843.71	$50.62	$84.37	$67.50	$16.87	$1,063.08
1.3.2	Clearing and Grubbing (assume 6-in deep)					18,553.3	CCY							$1,085,337.44	$58.50	$3.51	$5.85	$4.68	$1.17	$73.71
						23.0	AC							$1,085,337.44	$47,188.58	$2,831.32	$4,718.86	$3,775.09	$943.77	$59,457.62
													No disposal	$64,361.44	$2,798.32	$167.90	$279.83	$223.87	$55.97	$3,525.89
	Excavate surface material	Crew	CG1	$342.35	hour	18,553.3	CCY	100.0	cy/hr	185.5	4.0	188.0	hour	$64,361.44	$3.47	$0.21	$0.35	$0.28	$0.07	$4.37
	Haul to disposal	Haul	Haul_Dispose_LA	$232.00	load	22,264.0	BCY	13.0	cy/load	1,712.6	1.0	1,713.0	load	$397,416.00	$17.85					
	Disposal Fee	MatFee	Fee_LA	$28.00	cy	22,264.0	BCY	n/a	n/a	22,264.0	10.0	22,270.0	cy	$623,560.00	$28.01					
1.3.10	Temporary Facilities Rentals					20	mo							$28,427.32	$1,421.37	$85.28	$142.14	$113.71	$28.43	$1,790.92
	Office Trailer	MatFee	OfficeTrailer_MO	$497.95	mo	20.0	mo	n/a	n/a	20.0	10.0	20.0	mo	$9,959.00	$497.95					
	Field Storage	MatFee	StorageBox_MO	$150.47	mo	20.0	mo	n/a	n/a	20.0	10.0	20.0	mo	$3,009.35	$150.47					
	Portable Toilet	MatFee	ToiletPortable_MO	$122.61	mo	40.0	mo	n/a	n/a	40.0	10.0	40.0	mo	$4,904.59	$122.61					
	Office Expenses	MatFee	FieldExpense_MO	$527.72	mo	20.0	mo	n/a	n/a	20.0	10.0	20.0	mo	$10,554.38	$527.72					

LHAAP-29, Former TNT Production Area, Group 2
Task-Based Estimate Backup Calculations

Cost Items	Description	Type	Item	Total Rate	Unit	Bid Qty	Bid Unit	Prod	Prod Unit	Qty	±	Qty ±	Qty Unit	Task Cost	Direct Unit Cost	HOOH (6%)	JOOH (10%)	Profit (8%)	Bond (2%)	Total Unit Price
1.7.2 & 3.4.2	Backfill from Commercial Source, A&T Sand & Gravel					13,457.3	CCY							$940,250.47	$69.87	$4.19	$6.99	$5.59	$1.40	$88.04
	Place, spread, and compact from borrow	Crew	FILL1	$896.11	hour	13,457.3	CCY	110.0	cy/hr	122.3	4.0	124.0	hour	$111,118.04	$8.26					
	Haul (11 CY/load)	MatFee	Fill_HaulLoad	$225.00	ea	1,224.0	ea	n/a	n/a	1,224.0	10.0	1,230.0	ea	$276,750.00	$226.10					
	Purchase Fee	MatFee	Fill_Import	$32.48	cy	16,821.6	LCY	n/a	n/a	16,821.6	10.0	16,830.0	cy	$546,554.25	$32.49					
	Water Fee	MatFee	Fee_Water	$0.43	cy	13,457.3	CCY	n/a	n/a	13,457.3	10.0	13,460.0	cy	$5,828.18	$0.43					
3.4.1	Backfill from Sidecast Material					5,901.9	CCY							$52,741.37	$8.94	$0.54	$0.89	$0.71	$0.18	$11.26
	Place, spread, and compact from borrow	Crew	FILL1	$896.11	hour	5,901.9	CCY	110.0	cy/hr	53.7	4.0	56.0	hour	$50,182.34	$8.50					
	Water Fee	MatFee	Fee_Water	$0.43	cy	5,901.9	CCY	n/a	n/a	5,901.9	10.0	5,910.0	cy	$2,559.03	$0.43					
1.7.1	Backfill from Stockpile					4,971.0	CCY							$107,365.65	$21.60	$1.30	$2.16	$1.73	$0.43	$27.21
	Load Fill into Trucks for Disposal	Crew	LOAD2	$321.69	hour	4,971.0	CCY	66.0	cy/hr	75.3	4.0	76.0	hour	$24,448.70	$4.92					
	Haul to Stockpile	Haul	Haul_Exc_Stock	$28.00	load	4,971.0	BCY	11.0	cy/load	451.9	1.0	452.0	load	$12,656.00	$2.55					
	Place, spread, and compact from borrow	Crew	FILL1	$896.11	hour	4,971.0	CCY	66.0	cy/hr	75.3	4.0	76.0	hour	$68,104.61	$13.70					
	Water Fee	MatFee	Fee_Water	$0.43	cy	4,971.0	CCY	n/a	n/a	4,971.0	10.0	4,980.0	cy	$2,156.34	$0.43					
1.3.4	2 Labor - General					1	HR							$171.48	$171.48	$10.29	$17.15	$13.72	$3.43	$216.07
	2 Laborers	Crew	2LAB	$171.48	hour	1.0	HR	n/a	n/a	1.0	1.0	1.0	hour	$171.48	$171.48					
1.5.8; 2.1.7; 2.1.12; 3.2.9; 4.1.1; 4.2.7; 4.3.1	Field Geologist					21	HR							$2,749.78	$130.94	$7.86	$13.09	$10.48	$2.62	$164.99
	Geologist	Crew	Geologist	$130.94	hour	21.0	HR	n/a	n/a	21.0	1.0	21.0	hour	$2,749.78	$130.94					
3.1.4	Pipe Cleaning					4,000	LF							$64,000.00	$16.00	$0.96	$1.60	$1.28	$0.32	$20.16
	Pipe Cleaning - Pig Method	MatFee	PipeClean_PigMethod	$16.00	lf	4,000.0	LF	n/a	n/a	4,000.0	10.0	4,000.0	lf	$64,000.00	$16.00					
2.1.3	4-in SS Casing					630	LF							$42,928.20	$68.14	$4.09	$6.81	$5.45	$1.36	$85.86
	Furnish and install casing	MatFee	4in_SS_Casing	$68.14	LF	630.0	LF	n/a	n/a	630.0	10.0	630.0	LF	$42,928.20	$68.14					
2.1.4	4-in SS Well Screen					70	LF							$5,626.60	$80.38	$4.82	$8.04	$6.43	$1.61	$101.28
	Furnish and install well screen	MatFee	4in_SS_WellScreen	$80.38	LF	70.0	LF	n/a	n/a	70.0	10.0	70.0	LF	$5,626.60	$80.38					
2.3.1	Power Drop					1	LS							$140,700.00	$140,700.00	$8,442.00	$14,070.00	$11,256.00	$2,814.00	$177,282.00
	Subbid for Power Drop from FS	MatFee	PowerDrop	$140,700.00	LS	1.0	LS	n/a	n/a	1.0	1.0	1.0	LS	$140,700.00	$140,700.00					
2.4.5	Abandon Well					1	EA							$13,671.27	$13,671.27	$820.28	$1,367.13	$1,093.70	$273.43	$17,225.80
	Demolition Existing Monitoring Well	MatFee	AbandonWell	$13,671.27	EA	1.0	EA	n/a	n/a	1.0	1.0	1.0	EA	$13,671.27	$13,671.27					
2.4.3	Chain Link Security Fence					890	LF							$17,830.26	$20.03	$1.20	$2.00	$1.60	$0.40	$25.24
	Furnish and Install Fence	MatFee	6ft_Fence	$20.03	LF	890.0	LF	n/a	n/a	890.0	1.0	890.0	LF	$17,830.26	$20.03					
1.7.4	Hydroseed					1,002	MSF							$33,032.77	$32.97	$1.98	$3.30	$2.64	$0.66	$41.54
	Seed	MatFee	Seed	$2.38	MSF	1,001.9	MSF	n/a	n/a	1,001.9	10.0	1,010.0	MSF	$2,403.80	$2.40					
	Hydroseeding Crew	Crew	SEED1	$317.62	hour	1,001.9	MSF	10.0	MSF/HR	100.2	4.0	104.0	hour	$33,032.77	$32.97					

HOOH	6%
JOOH	10%
Profit	8%
Bond	2%

LHAAP-29, Former TNT Production Area, Group 2

Summary of Task-Based Estimate Haul

Description	Segment	Distance	Speed	Time (min)	Haul (Min)	Haul (Hr)	Crew	Rate	Total Rate	Unit	Notes
Haul_Exc_Stock	Load	n/a	n/a	4.0	14	0.2	Haul1	$116.65	$28.00	load	Haul to nearby stockpile
	On site	0.5	10	3.0							
	Dump	n/a	n/a	4.0							
Haul_Dispose_LA	Load	n/a	n/a	12.0	119	2.0	Haul1	$116.65	$232.00	load	Non-hazardous disposal, Shreveport, LA
	Surface Road Haul	33.4	50	40.1							Landfill | Shreveport, LA - Official Website (shreveportla.gov)
	On site	0.5	5	6.0							10580 Woolworth Rd, Keithville, LA 71047
	Dump	n/a	n/a	15.0							

LHAAP-29, Former TNT Production Area, Group 2

Summary of Task-Based Estimate Crews

Crew	Eq & Labor	Category	Unit Rate	Unit	Num	Rate	Total Rate	Notes
CG1	Excavator_4.0cy	Equip	$232.35	hour	1	$232.35	$342.35	Hauling calculated separately.
	Operator4	Labor	$110.00	hour	1	$110.00		
	Teamster	Labor	$70.01	hour	0	$0.00		
	Laborer	Labor	$85.74	hour	0	$0.00		
Survey	Truck_Conventional	Equip	$54.49	hour	1	$54.49	$241.74	Survey crew, 1 chief + 2 aide + 2 technicians + work truck
	SurveyChief	Labor	$47.97	hour	1	$47.97		
	SurveyingAide	Labor	$29.37	hour	2	$58.74		
	SurveyingTechnician	Labor	$40.27	hour	2	$80.54		
Sampling	Truck_Conventional	Equip	$54.49	hour	1	$54.49	$140.24	Survey crew, 1 chief + 2 aide + 2 technicians + work truck
	Laborer	Labor	$85.74	hour	1	$85.74		
EnvMonitor	Truck_Conventional	Equip	$54.49	hour	1	$54.49	$108.84	Environmental monitor + truck
	EnviroTech	Labor	$54.35	hour	1	$54.35		
HSOfficer	HealthSafetyOfficer	Labor	$130.27	hour	1	$130.27	$130.27	
HSMonitor	HealthSafetyMonitor	Labor	$84.37	hour	1	$84.37	$84.37	
Guard1	Guard1	Labor	$45.02	hour	1	$45.02	$45.02	
Geologist	Geologist	Labor	$130.94	hour	1	$130.94	$130.94	
EXC2	Excavator_4.0cy	Equip	$232.35	hour	1	$232.35	$1,003.26	Excavator to dump material to be handled by dozer and loaded by loader, water truck for dust control. Dozer to also manage stockpile, clear haul routes, etc. Hauling calculated separately.
	Dozer_D6	Equip	$188.77	hour	1	$188.77		
	Loader_FE_3.5cy	Equip	$98.62	hour	1	$98.62		
	Truck_45klb_4x2	Equip	$71.52	hour	1	$71.52		
	WaterTank	Equip	$12.00	hour	1	$12.00		
	Operator4	Labor	$110.00	hour	3	$329.99		
	Teamster	Labor	$70.01	hour	1	$70.01		

LHAAP-29, Former TNT Production Area, Group 2

Summary of Task-Based Estimate Crews

Crew	Eq & Labor	Category	Unit Rate	Unit	Num	Rate	Total Rate	Notes
EXC3	Excavator_4.0cy	Equip	$232.35	hour	1	$232.35	$495.88	Excavator, remove material and sidecast
	Truck_45klb_4x2	Equip	$71.52	hour	1	$71.52		
	WaterTank	Equip	$12.00	hour	1	$12.00		
	Operator4	Labor	$110.00	hour	1	$110.00		
	Teamster	Labor	$70.01	hour	1	$70.01		
LOAD1	Excavator_4.0cy	Equip	$232.35	hour	0	$0.00	$660.91	Material handling - loader + dozer
	Dozer_D6	Equip	$188.77	hour	1	$188.77		
	Loader_FE_3.5cy	Equip	$98.62	hour	1	$98.62		
	Truck_45klb_4x2	Equip	$71.52	hour	1	$71.52		
	WaterTank	Equip	$12.00	hour	1	$12.00		
	Operator4	Labor	$110.00	hour	2	$219.99		
	Teamster	Labor	$70.01	hour	1	$70.01		
LOAD2	Excavator_4.0cy	Equip	$232.35	hour	0	$0.00	$321.69	Load pipe from open trench
	Dozer_D6	Equip	$188.77	hour	0	$0.00		
	Loader_FE_1cy	Equip	$40.22	hour	1	$40.22		
	Operator4	Labor	$110.00	hour	1	$110.00		
	Laborer	Labor	$85.74	hour	2	$171.48		
FILL1	Dozer_D6	Equip	$188.77	hour	1	$188.77	$896.11	Assume material dumped from import, dozer to push material in place for compactor, water truck included for dust control and moisture conditioning, water tank for water storage on site.
	Loader_FE_3.5cy	Equip	$98.62	hour	0	$0.00		
	Grader	Equip	$128.21	hour	0.1	$12.82		
	Roller_Vib_ShpFt_5.5ft	Equip	$55.98	hour	1	$55.98		
	Truck_45klb_4x2	Equip	$71.52	hour	1	$71.52		
	WaterTank	Equip	$12.00	hour	1	$12.00		
	Pump_Water_6in	Equip	$16.39	hour	1	$16.39		
	Tank_10kGal	Equip	$12.24	hour	1	$12.24		
	Truck_Pickup	Equip	$53.90	hour	1	$53.90		

LHAAP-29, Former TNT Production Area, Group 2

Summary of Task-Based Estimate Crews

Crew	Eq & Labor	Category	Unit Rate	Unit	Num	Rate	Total Rate	Notes
	Operator4	Labor	$110.00	hour	2.1	$230.99		
	Teamster	Labor	$70.01	hour	1	$70.01		
	Laborer	Labor	$85.74	hour	2	$171.48		
SEED1	Hydroseeder	Equip	$90.35	hour	1	$90.35	$317.62	
	Truck_45klb_4x2	Equip	$71.52	hour	1	$71.52		
	Teamster	Labor	$70.01	hour	1	$70.01		
	Laborer	Labor	$85.74	hour	1	$85.74		
2LAB	Laborer	Labor	$85.74	hour	2	$171.48	$171.48	
HAUL1	Dump_Highway	Equip	$46.63	hour	1	$46.63	$116.65	
	Teamster	Labor	$70.01	hour	1	$70.01		

LHAAP-29, Former TNT Production Area, Group 2

Summary of Labor Rates and Markups

Labor	Base Rate	Fringes	Payroll Tax	WCI	Overtime	Productivity	Escalation	Total Rate	Unit	Notes
Operator2	$49.81	$22.47	$9.93	$11.19	$5.67	$17.48	$16.03	$116.55	hour	Heavy, USACE 2021 National Labor Library, adjusted to TX, escalated to 2022 + 20% for HTRW
Operator4	$46.03	$22.47	$9.41	$10.34	$5.24	$16.50	$15.13	$110.00	hour	Medium, USACE 2021 National Labor Library, adjusted to TX, escalated to 2022 + 20% for HTRW
Teamster	$32.90	$9.63	$5.84	$7.39	$3.74	$10.50	$9.63	$70.01	hour	Heavy, USACE 2021 National Labor Library, adjusted to TX, escalated to 2022
Laborer	$39.86	$12.35	$7.17	$8.96	$4.53	$12.86	$11.79	$85.74	hour	Semi-skilled, USACE 2021 National Labor Library, adjusted to TX, escalated to 2022 + 20% for HTRW
SurveyChief	$22.44	$6.73	$4.01	$5.04	$2.55	$7.20	$0.00	$47.97	hour	SCA code 99830, present cost
SurveyingAide	$13.74	$4.12	$2.45	$3.09	$1.56	$4.41	$0.00	$29.37	hour	SCA code 99831, present cost
SurveyingTechnician	$18.84	$5.65	$3.36	$4.23	$2.14	$6.04	$0.00	$40.27	hour	SCA code 99832, present cost
EnviroTech	$25.42	$7.63	$4.54	$5.71	$2.89	$8.15	$0.00	$54.35	hour	SCA code 30090, present cost
HealthSafetyOfficer	$53.57	$16.07	$9.57	$12.04	$6.09	$17.18	$15.75	$130.27	hour	USACE 2021 National Labor Library, adjusted to TX, escalated to 2022
HealthSafetyMonitor	$34.69	$10.41	$6.20	$7.80	$3.95	$11.13	$10.20	$84.37	hour	USACE 2021 National Labor Library, adjusted to TX, escalated to 2022
Guard1	$21.06	$6.32	$3.76	$4.73	$2.40	$6.75	$0.00	$45.02	hour	SCA code 27131, present cost
Geologist	$61.25	$18.38	$10.94	$13.76	$6.97	$19.64	$18.01	$130.94	hour	MCACES, 2021 National Labor Library

Factors	Rate	
Payroll Tax	13.74%	
WCI Rate	22.47%	
Overtime	10.00%	Mon-Fri, 12 hours/day
Productivity	85.00%	
HTRW Adjustment	20.00%	Increase
Esc 2020 to 2022	24.86%	
Esc 2021 to 2022	13.75%	
State Adjustment Factor	81.48%	USACE National Labor Library adjustment from Seattle to TX

Note 1: payroll tax is calculated on base rate + fringe benefits, workmans comp insurance is calculated only on base rate, overtime markup applies to base rate + payroll tax

Note 2: service and professional labor assumes fringe = 30% of base rate

LHAAP-29, Former TNT Production Area, Group 2

Summary of Material Pricing

Material	Base Rate	Rate	Unit	
Fill_Import	$30.00	$32.48	cy	Quoted by A&T Sand and Gravel, 10 January 2023
Fill_HaulLoad	$225.00	$225.00	ea	11 CY loads. Quoted by A&T Sand and Gravel, 10 January 2023
Fee_LA	$28.00	$28.00	cy	Online rate for special handling waste
Fee_Water	$0.40	$0.43	cy	
OfficeTrailer_MO	$460.00	$497.95	mo	2022 MCACES Cost Book, 50' x 12' trailer
StorageBox_MO	$139.00	$150.47	mo	2022 MCACES Cost Book, 40' x 8' storage box
ToiletPortable_MO	$113.27	$122.61	mo	2022 MCACES Cost Book
FieldExpense_MO	$487.50	$527.72	mo	2022 MCACES Cost Book, office equipment, supplies, field office lights
TempPowerConnection	$305.00	$330.16	ea	2022 MCACES Cost Book
PipeClean_PigMethod	$16.00	$16.00	lf	Average price from 2022 MCACES Cost Book, escalated to 2023.
Seed	$2.38	$2.38	MSF	2022 MCACES Cost Book, 0.1 lb/ac
4in_SS_Casing	$68.14	$68.14	LF	2022 MCACES Cost Book, Casing, stainless steel, flush threaded, 4" diameter, 304 stainless steel
4in_SS_WellScreen	$80.38	$80.38	LF	2022 MCACES Cost Book, Stainless steel well screen, flush threaded, 5' sections, 4" diameter, no. 304 stainless steel
PowerDrop	$93,800.00	$140,700.00	LS	2015 Cost quote for Feasibility Study
AbandonWell	$12,658.58	$13,671.27	EA	2022 MCACES Cost Book, casing & gravel pack, 40' deep, 24-36" dia
6ft_Fence	$18.55	$20.03	LF	2022 MCACES Cost Book, Fence, chain link, residential, galvanized steel, 11 ga. wire, 1-5/8" post, 10' O.C., 1-3/8" top rail, 2" corner post, 6' high

Factors	Rate		
Sales Tax + Market Allowance	1.0825	Sales tax	
Escalation 2022 to 2023	1.08		USACE EM 1110-2-1304, September 2022 Update
Escalation 2015 to 2023	1.50		USACE EM 1110-2-1304, September 2022 Update

Non-hazardous disposal for selec items, Shreveport, LA
Landfill | Shreveport, LA - Official Website (shreveportla.gov)
10580 Woolworth Rd, Keithville, LA 71047

LHAAP-29, Former TNT Production Area, Group 2

Summary of Equipment Rates and Markups

Equipment	Model	Depreciation	FCCM	FCCM Discount	Operating Cost	Productivity	Subtotal	Total Rate	Unit	Notes
Loader_FE_3.5cy	930M	$19.61	$1.43	-$0.29	$63.07	$14.79	$98.62	$98.62	hour	
Loader_FE_1cy	416F	$9.28	$1.93	-$0.39	$23.36	$6.03	$40.22	$40.22	hour	LOADER / BACKHOE, WHEEL, 1.0 CY (0.76 M3) FRONT END BUCKET, 24" (61 CM) DIP, 6.2 CF (0.18 M3), 14.5' (4.4 M) DIGGING DEPTH, 4X2
Truck_Conventional	4X4 3/4 TON CONV GAS	$3.62	$0.45	-$0.09	$42.34	$8.17	$54.49	$54.49	hour	
Truck_45klb_4x2	4X2 37KGVW DSL	$4.31	$0.38	-$0.08	$56.18	$10.73	$71.52	$71.52	hour	
Dump_Highway	4X2 28KGVW DSL	$7.32	$1.41	-$0.28	$31.19	$6.99	$46.63	$46.63	hour	10wh Dump
Hydroseeder	T330	$19.80	$0.58	-$0.12	$56.53	$13.55	$90.35	$90.35	hour	3,000 gal truck mounted hydroseeder, add truck
WaterTank	DS 4000	$5.03	$0.31	-$0.06	$4.92	$1.80	$12.00	$12.00	hour	4,000 water tank, add truck
WaterTruck	740B & 8K TANK	$53.13	$4.61	-$0.92	$189.89	$43.54	$290.24	$290.24	hour	TRUCK, WATER, OFF-HIGHWAY, 8K GAL, W/CAT 740B TRUCK
Dozer_D6	D6N XW	$33.65	$2.82	-$0.56	$124.55	$28.32	$188.77	$188.77	hour	
Excavator_4.0cy	349E	$26.66	$6.75	-$1.35	$165.44	$34.85	$232.35	$232.35	hour	115.7k lb, 4.05 cy bucket
Grader	140-M3	$26.46	$2.91	-$0.58	$80.19	$19.23	$128.21	$128.21	hour	
Roller_Vib_ShpFt_5.5ft	TRU-PAC 915 B	$11.80	$0.62	-$0.12	$35.29	$8.40	$55.98	$55.98	hour	ROLLER, STATIC, SELF-PROPELLED, PNEUMATIC, 6-15 TON, 68" WIDE, 9 TIRES, ASPHALT/SOIL COMPACTOR
Pump_Water_6in	S6A1-E60 460/3	$2.50	$0.13	-$0.03	$11.33	$2.46	$16.39	$16.39	hour	PUMP, WATER, SUBMERSIBLE, ELECTRIC, 6" DIA, 1,950 GPM @ 40' HEAD (ADD HOSES)
Pump_Hose_20ft	C354-90	$0.15	$0.00	$0.00	$0.31	$0.08	$0.54	$0.54	hour	PUMP HOSE, SUCTION, 6" (153 MM) DIA x 20' (6.1 M) LENGTH, W/COUPLING/SECTION
Tank_10kGal	KPT-100	$3.73	$0.32	-$0.06	$6.42	$1.84	$12.24	$12.24	hour	WATER TANK, PORTABLE, TRAILER MTD, SELF ELEVATING, 10,000 GAL, 10" PIPE
Truck_Pickup	4x2	$3.38	$0.19	-$0.04	$42.28	$8.08	$53.90	$53.90	hour	TRUCK, HIGHWAY, CONVENTIONAL, 3/4 TON PICKUP, 4X2
Generator_30KW	30KW Trailer	$3.90	$0.19	-$0.04	$12.93	$3.00	$19.98	$19.98	hour	GENERATOR SET, SKID MTD, 30 KW

Factors	
Productivity	85.00%
Overtime FCCM Discount	-20.00%

Fuel Rates		
Diesel:	$4.60	/gal
Diesel Off-Road:	$4.16	/gal
Gasoline:	$3.20	/gal

Cost Estimate Back-up Documentation



HDR
Longhorn (LHAAP-29) Site

Longhorn, TX
Preliminary Site Evaluation
Revision 1

January 14, 2023

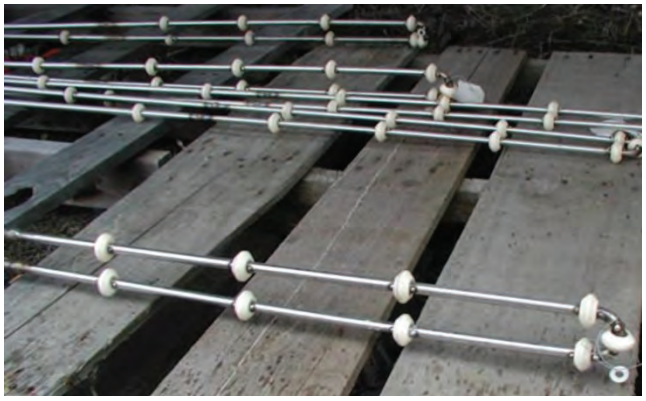
TERRATHERM
a Cascade Company
www.terratherm.com

About TerraTherm



- Based in MA and offering all major methods of subsurface heating
  - Thermal Conduction Heating (TCH)
  - Electric Resistance Heating (ERH)
  - Steam Enhanced Extraction (SEE)
- Over 20 years of experience implementing all three thermal technologies
- Our staff has played key roles in the technical development of TCH and ERH, and have an unparalleled knowledge about how to successfully deploy each technology
- TerraTherm has successfully completed more than:
  - 80 TCH projects
  - 55 ERH projects
  - 15 SEE projects
- 70 dedicated staff members with over 450 years of collective thermal experience
- First thermal company in the industry to gain UL electrical safety certification of heaters

Site Background







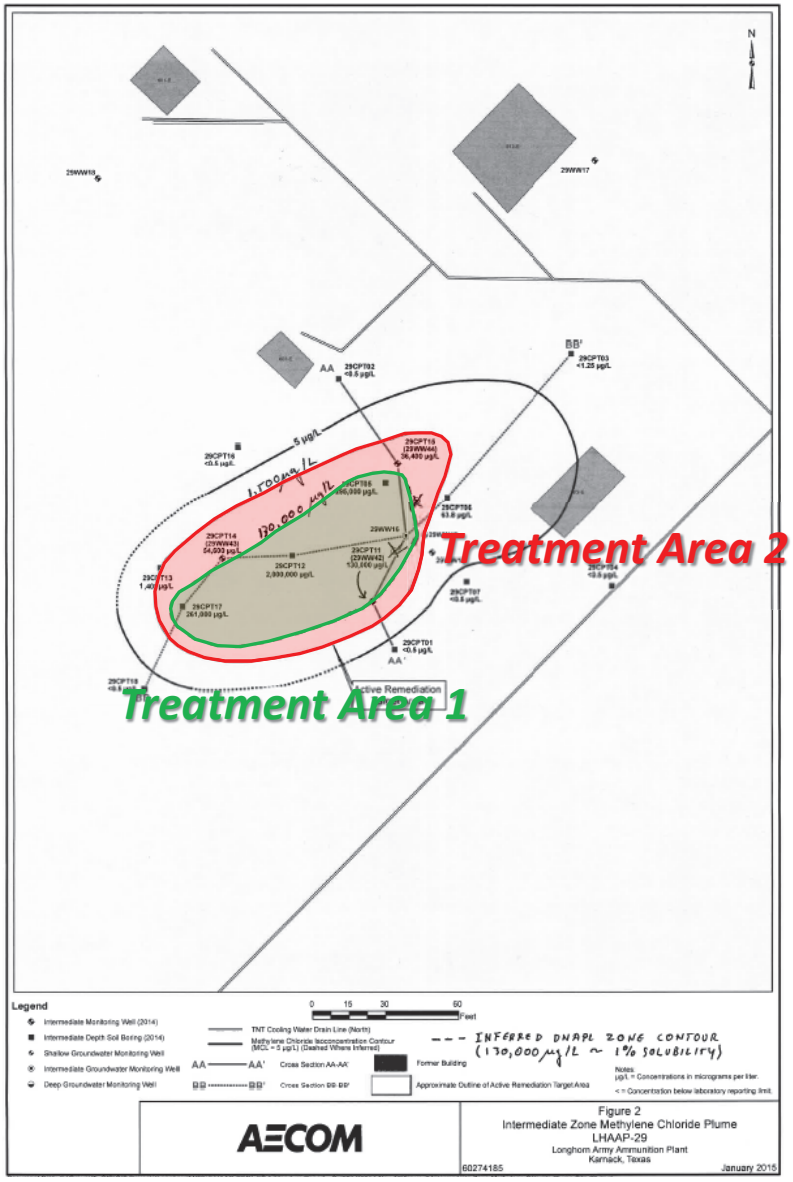
Site Name: Longhorn (LHAAP-29) Site

Site Location: Longhorn, Texas

Site/Environmental Consultant: HDR

Objective: Obtain a conceptual cost to implement thermal remediation at the site

Treatment Areas Map



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Geology and Hydrogeology

Geology:

- 0 to ~20 ft bgs: Fill Material
- ~20 to ~110 ft bgs: Mix of Sand and Silt

Hydrogeology:

- Per the information provided, water surface elevation is found at 48 ft bgs and was used for this evaluation.
- Per the information provided, hydraulic conductivity values varied between 1.1 x 10^{-4} cm/sec and 4.3 x 10^{-4} cm/sec .
- A representative hydraulic conductivity value of 1.0 x 10^{-4} cm/sec (2.84 ft/day) was used for this evaluation.
- No groundwater velocity information was provided for the treatment zone.

Hydraulic gradient:

- A representative hydraulic gradient value of 0.01 ft/ft was assumed and used for this evaluation.

Treatment Scenarios

Treatment Scenarios	Treatment Areas (ft^2)		Treatment Depth (ft bgs)	Treatment Volume (CY)
Treatment Scenario 1 (Smaller Option)	Treatment Area 1	6,600	48.0 – 95.0	11,489
Treatment Scenario 2 (Larger Option)	Treatment Area 2	7,200	75.0 – 90.0	4,000

Notes:

- Assumes full access to the site during construction and operation.



COCs, Mass Estimate and Remediation Goals

Contaminants of Concern (COC): Methylene chloride

Mass Estimate: Not provided. The following mass estimates were assumed for each of the evaluated treatment scenarios,

- T. Scenario 1: 3,900 lbs
- T. Scenario 2: 1,400 lbs

The estimated total mass present within the target treatment zone (TTZ) should be further evaluated at a later stage of the project.

Remediation Goals:

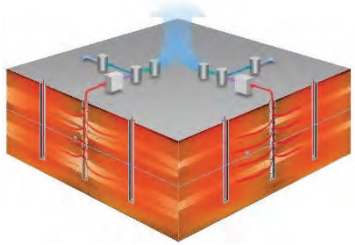
Chemical Name	Groundwater (µg/L)	
	Max Level Detected	Target Level
Methylene chloride		1,500





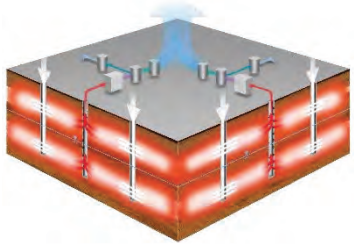
Thermal Technologies

Thermal Conduction Heating (TCH / ISTD)



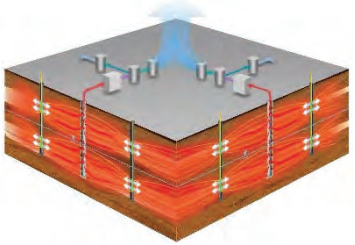
For all sites with low to moderate groundwater flow rates and either Volatile Organic Compounds (VOCs) or Semi-Volatile Organic Compounds (SVOCs).

Steam Enhanced Extraction (SEE)

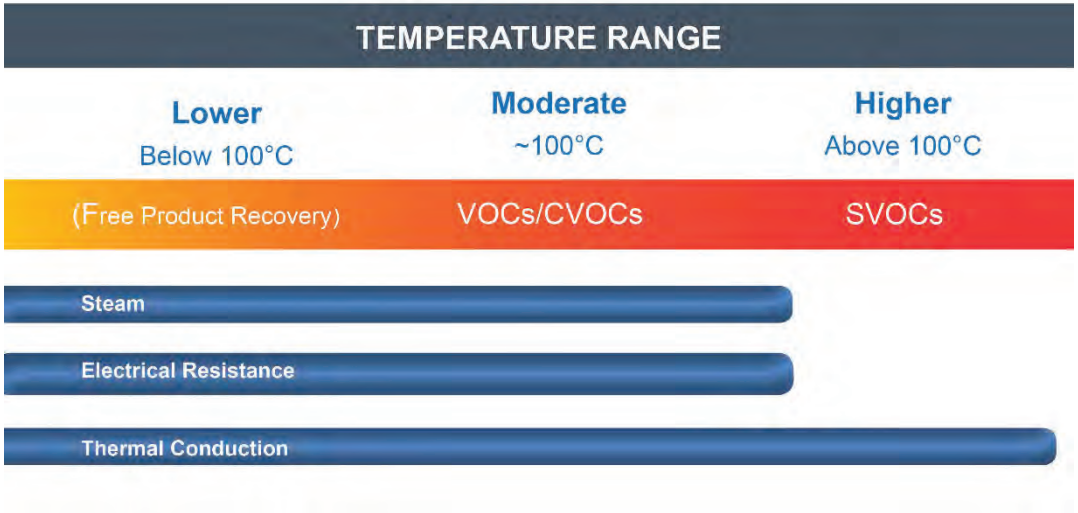


For permeable sites with significant groundwater flow rates and for sites with either volatile or moderately volatile contaminants.

Electrical Resistance Heating (ERH)



For all sites with low to moderate groundwater flow rates and either volatile or moderately volatile contaminants.



Thermal Technologies Evaluated

Characteristics	TCH	SEE	ERH
Heating Method	Conduction	Steam Injection, Convection	Electrical Resistance
Factors Governing Heating	• Thermal conductivity of the soil matrix. • Groundwater flow rate.	Injection rates and pressure are determined by the permeability of the soil matrix which can be too tight for SEE applications.	• Electrical resistivity of the soil matrix. • Groundwater flow rate. • Minimum electrode length is 10-feet
Maximum Temperature	• Low Temp TCH = 100°C (boiling point) • High Temp TCH = 325-400°C (once dewatered)	100°C (boiling point)	100°C (boiling point)
Sensitivity to Water Content and Flow	• Works in saturated and dry conditions. • High water flow can remove heat faster than it is added.	Not Sensitive	• Difficulty in dry Vadose Zone conditions. • High water flow can remove heat faster than it is added.
Sensitivity to Contrasts between Layers	Heating rates may be affected by differences in water content and flow rates between layers.	Aquitards not heated directly	Resistivity contrasts between layers require multi-element electrodes – long electrodes may be less efficient.
Sensitivity to Buried Objects	Not sensitive	Low-permeable layers may interfere with stream migration.	Metal debris and pipes may prevent uniform heating.
Heat Input Governed By	Soil thermal conductivity - which varies only by a factor of 1 to 3 between most common geologies.	Hydraulic conductivity of soil layers	Soil resistivity – which varies by large factors (over 200 X) between most common geologies.
Fluids Added to Ground	None	Steam	Water to keep electrodes saturated
General Safety Issues	High temperatures and steam	High temperatures and steam	• High temperatures and steam • Surface voltages

Note: Thermal Conductive Heating (TCH) has been selected as the preferred ISTR technology for this preliminary evaluation.

Conceptual Treatment Approach/Methodology

Conceptual Treatment Approach:

Treatment Scenarios 1 and 2

- TCH using a heater spacing of approximately 18-20 feet to target the boiling point of water.
- Soil vapor and steam extraction from co-located vertical and multi-phase extraction wells used to extract the vaporized contaminants and steam, and to maintain pneumatic and hydraulic control.
- Assuming most of the mass removal will be due to hydrolysis (limited mass removal in vapor phase).

Vapor and Liquid Treatment Approach:

Treatment Scenarios 1 and 2

- Extracted vapors and liquids (condensate) treated using Granular Activated Carbon (GAC).

Monitoring:

- Temperature and pressure monitoring to track subsurface heating, pneumatic, and hydraulic control.



Treatment Approach – Equipment (All Treatment Scenarios)

As this site meets the following conditions, TerraTherm is proposing to utilize our *Tier-One* pre-fabricated and containerized equipment:

- Small treatment zones
- Simple geology
- Modest chemical mass
- Limited groundwater flow considerations
- Well-defined remedial objectives
- Volatile contaminants (such as chlorinated solvents)

Tier 1 Systems - Efficient Cost-Effective Solutions:

- Pre-engineered components – ready for plug and play
- Standard heating systems
- Standard treatment systems
- Simplified design process
- Expedited permitting
- Simple heater and vapor extraction borings
- Simplified data collection and reporting
- Heating duration optimized based system monitoring



TerraTherm Tier-One Equipment container

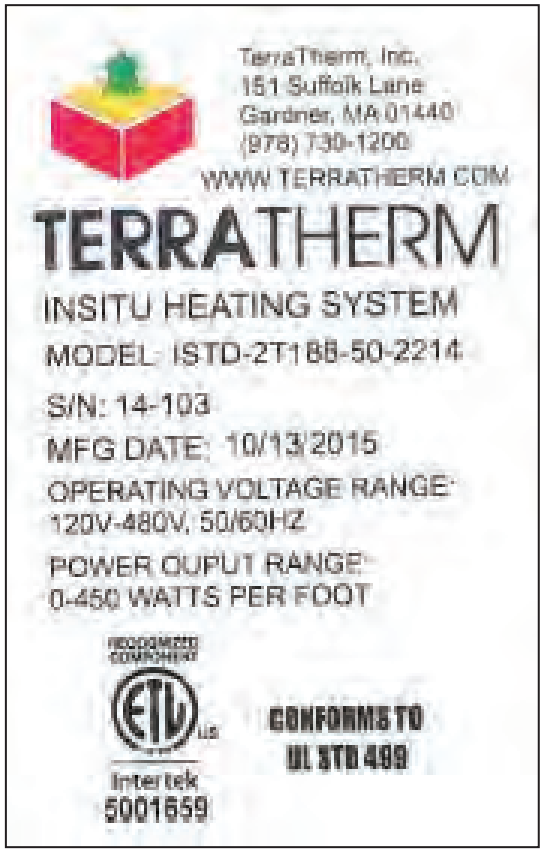


TerraTherm Site with Tier-One Equipment Installed

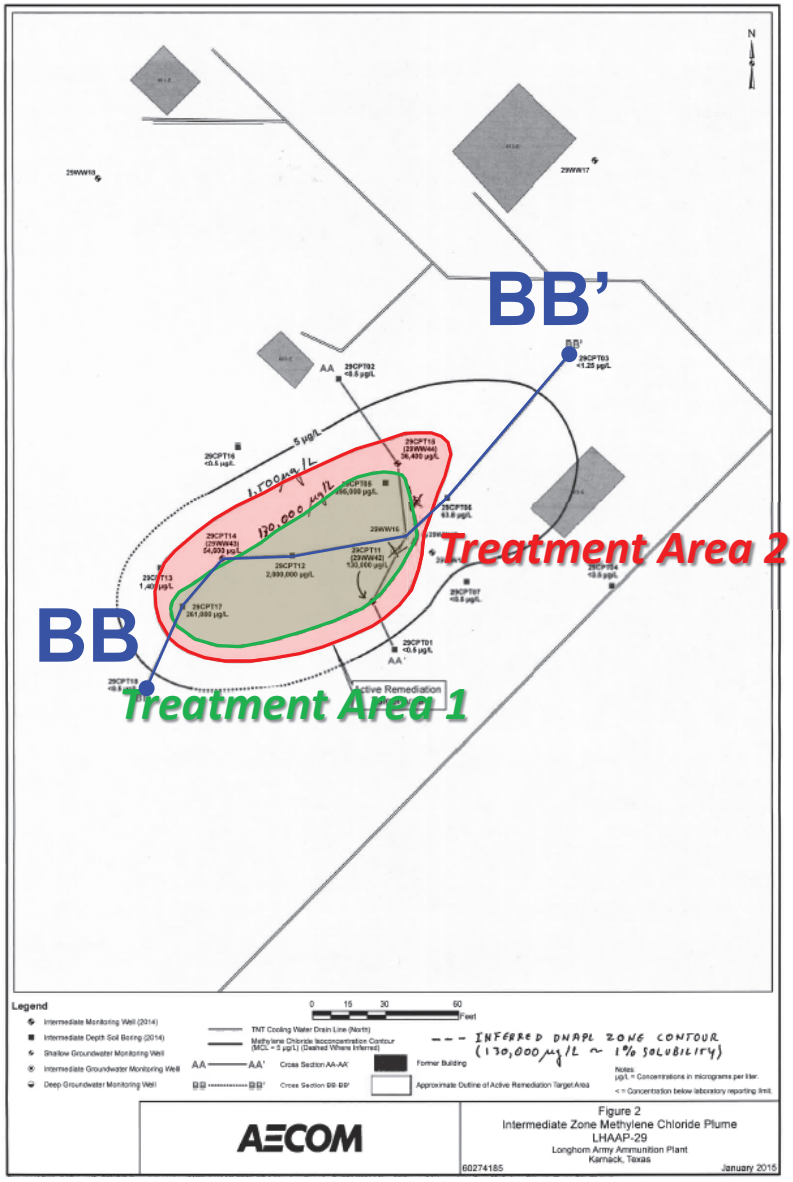
Safety Certification to UL Standard

Safety Certification to UL Standard

TerraTherm is the first thermal remediation company in the industry to gain certification of its thermal conduction heating element. Intertek, an OSHA-recognized Nationally Recognized Testing Laboratory, has granted our heating elements the ETL Mark, a symbol that verifies product compliance to North American Safety Standards. This certification demonstrates compliance with UL1030, exhibiting the highest standard of care for electrical safety within our industry. All electrical distribution equipment installed on-site by TerraTherm utilizes UL listed components and is installed in accordance with NFPA 70 (National Electrical Code).

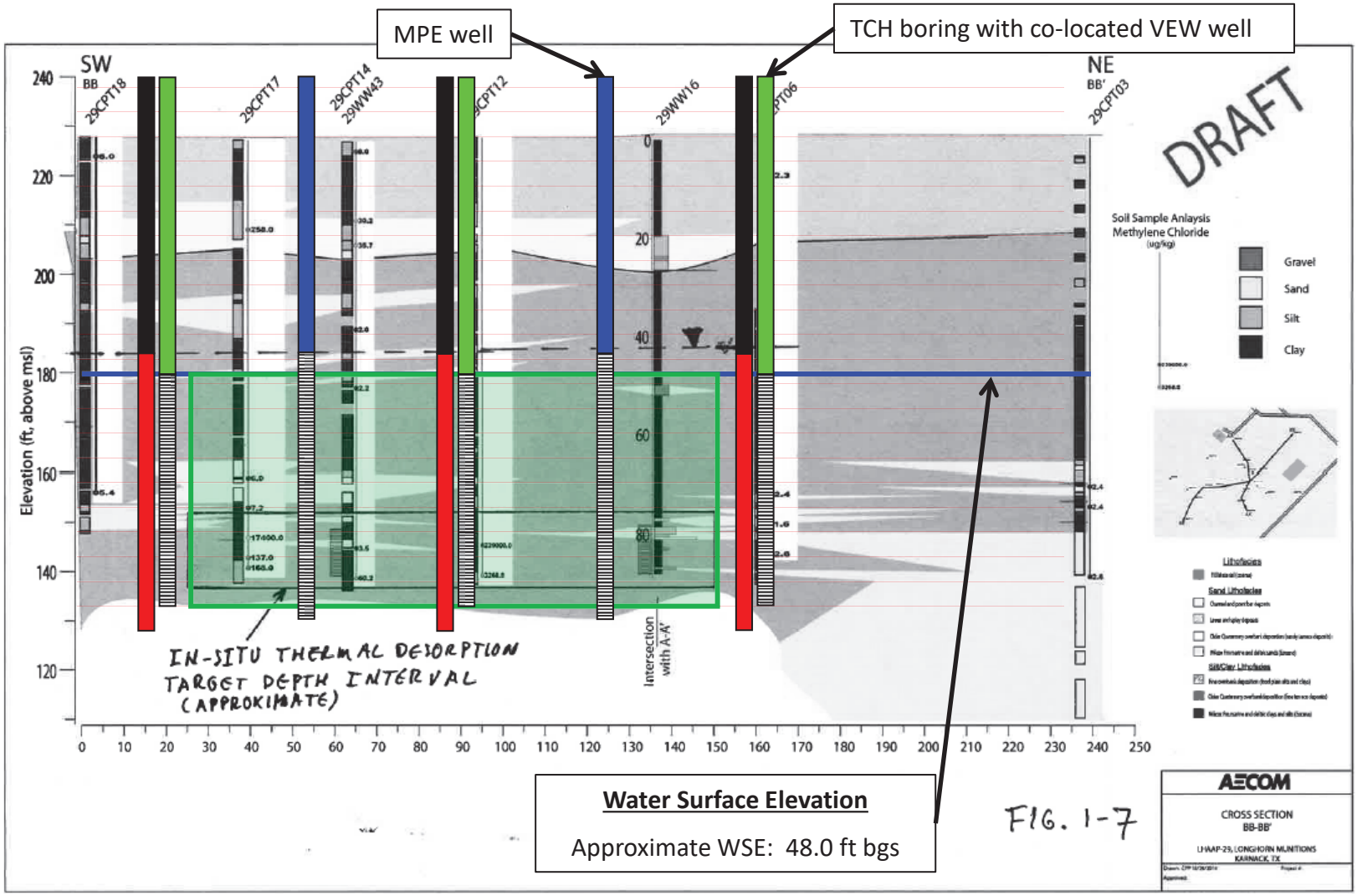


Treatment Area and Cross Section BB-BB’



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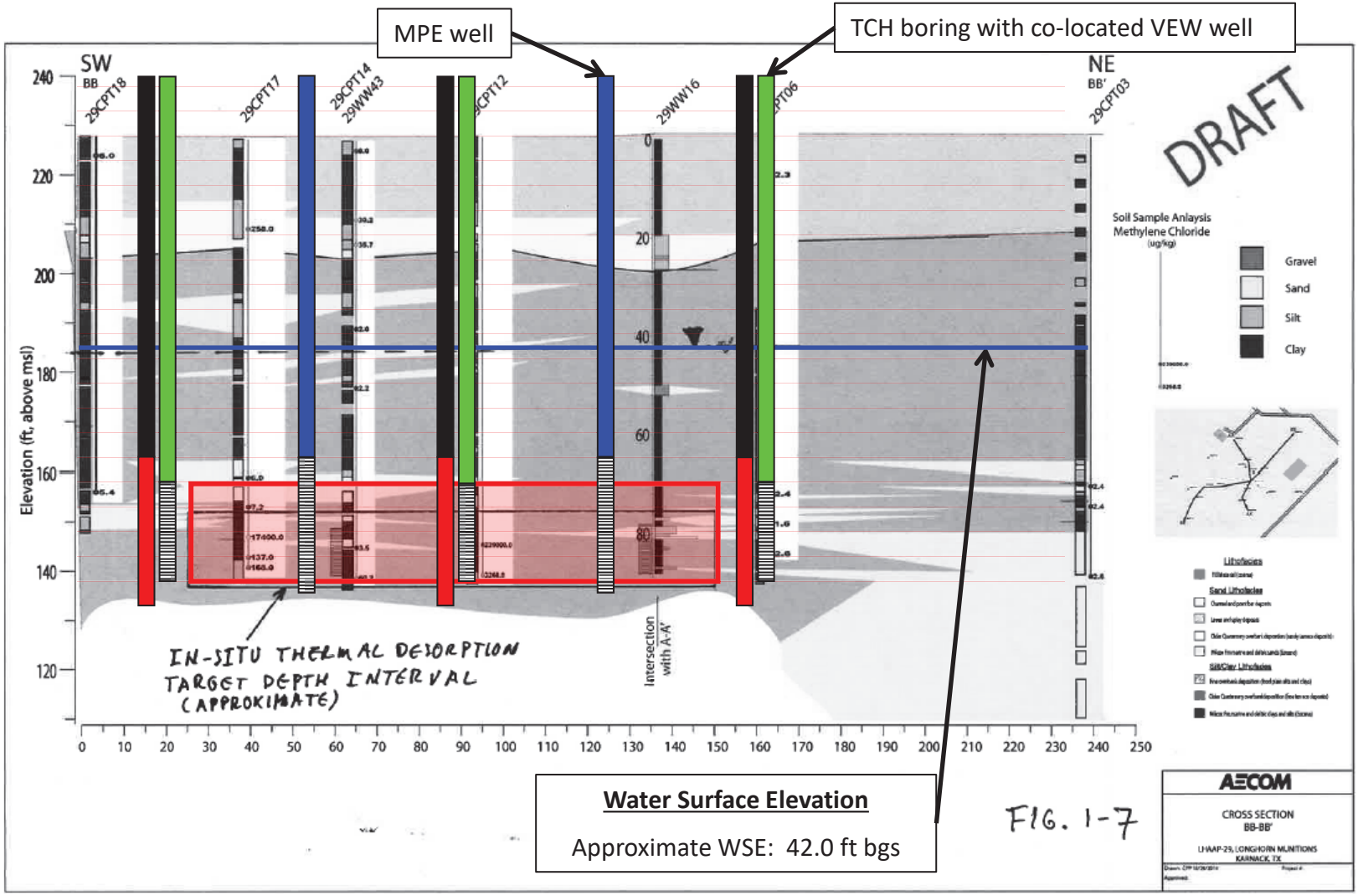
Conceptual Cross Section (BB-BB') (T. Scenario 1)



** 5 ft heater stick up and down.*

NOT TO SCALE

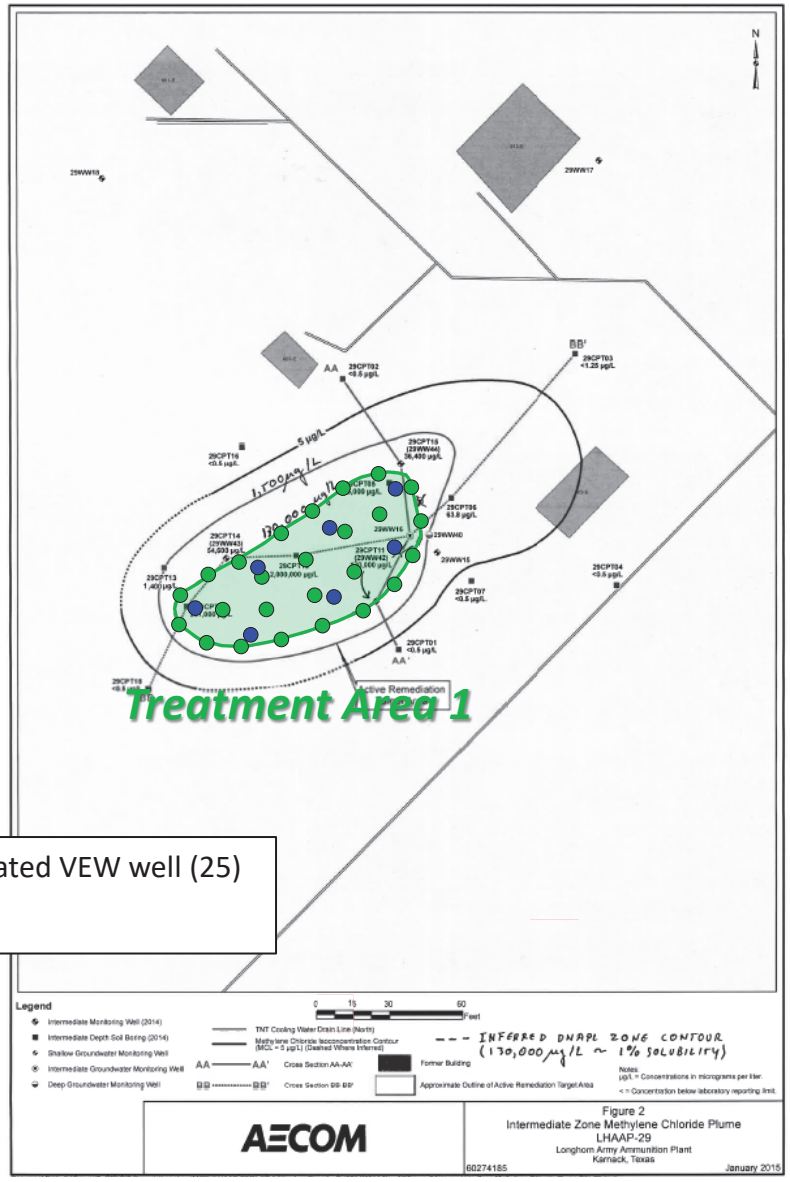
Conceptual Cross Section (BB-BB') (T. Scenario 2)



** 5 ft heater stick up and down.*

NOT TO SCALE

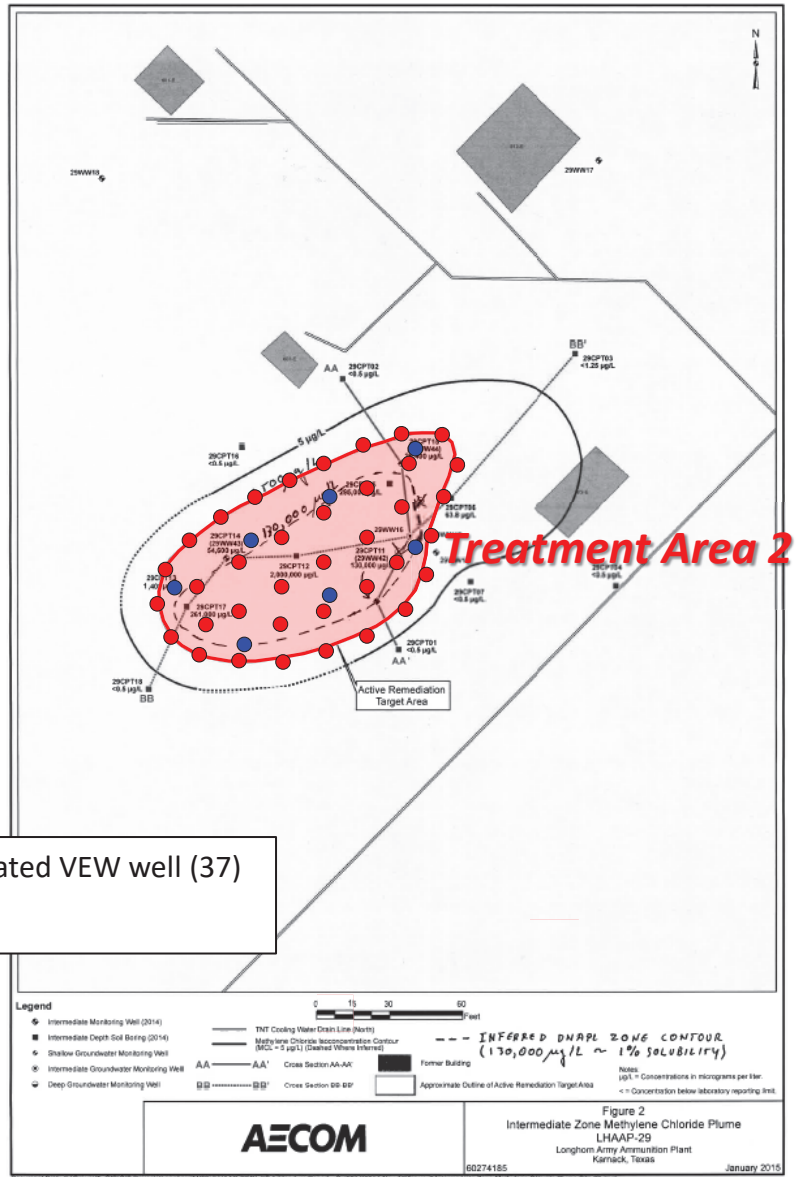
Conceptual Wellfield Layout (T. Scenario 1)



- TCH boring with co-located VEW well (25)
- MPE well (7)

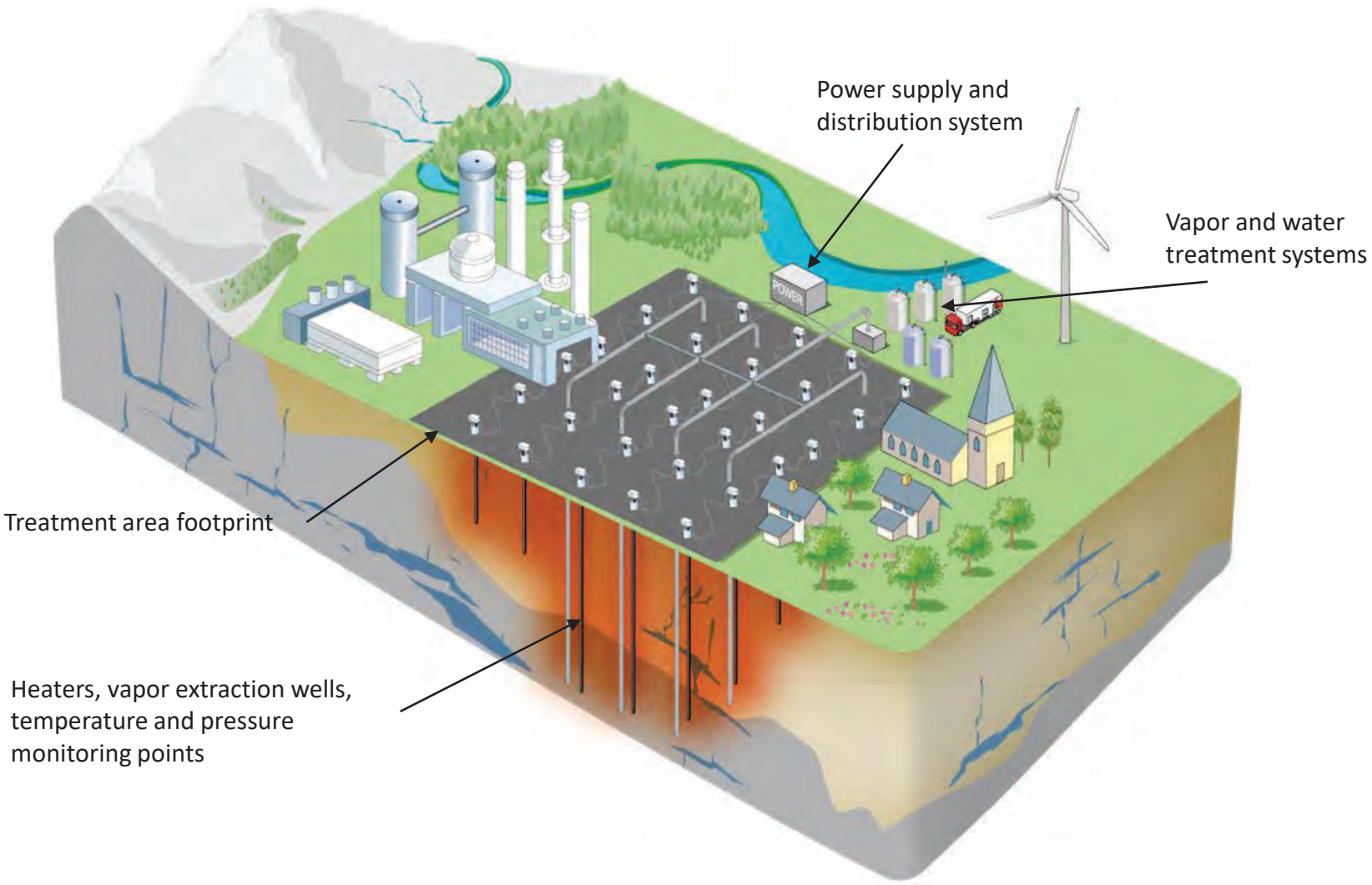
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Conceptual Wellfield Layout (T. Scenario 2)



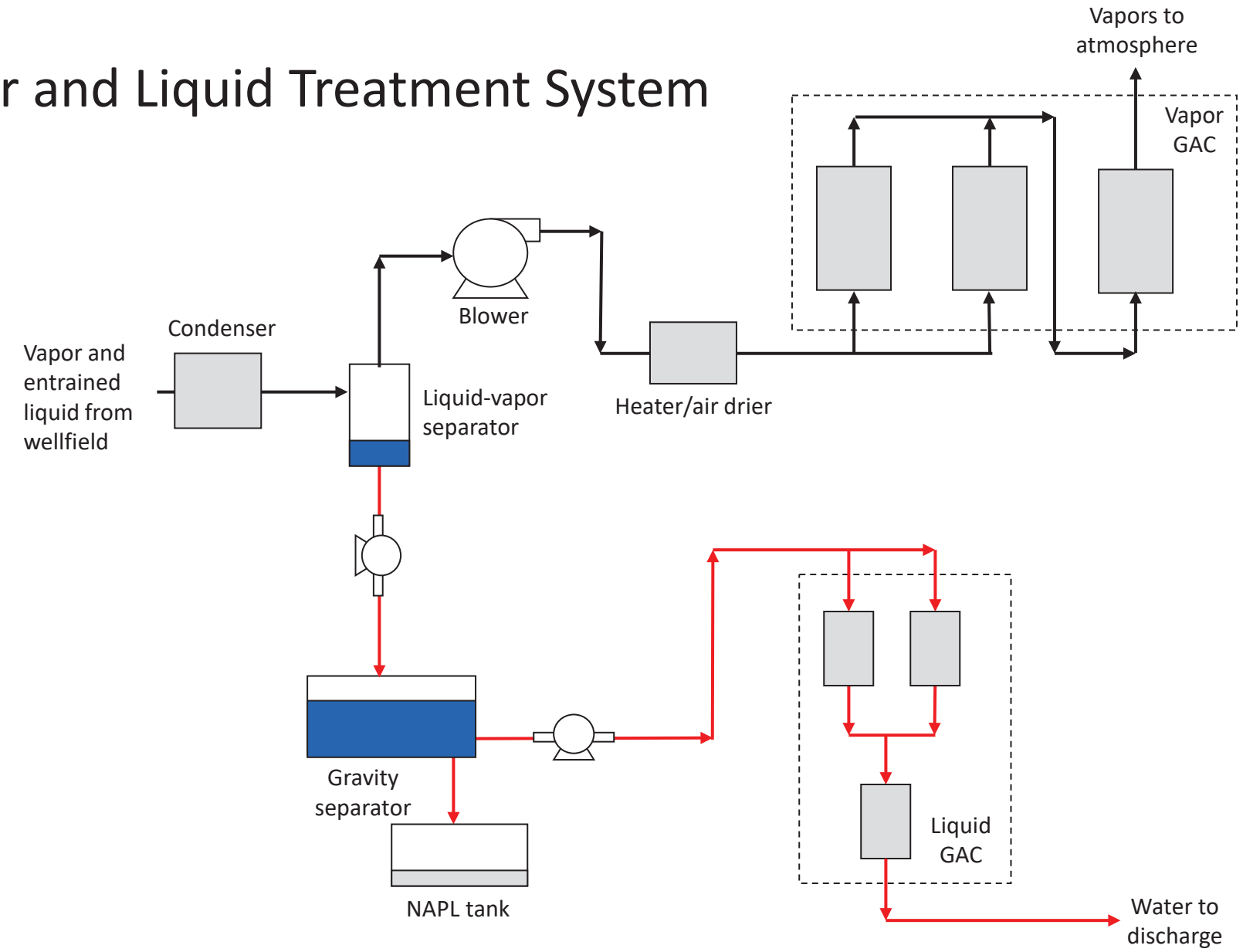
- TCH boring with co-located VEW well (37)
- MPE well (7)

Schematic of Typical TCH Site



Conceptual Process Flow Diagram (All Treatment Scenarios)

Vapor and Liquid Treatment System



TERRATHERM a Cascade Company

Treatment Scenario 1

(Smaller Option)

Conceptual Design Parameters

Longhorn (LHAAP-29) Site (T. Scenario 1)		HDR
Volume and heat capacity	***Treatment Area 1***	***Unit***
Treatment area	6,600	ft^2
Upper depth of treatment	48.0	ft bgs
Lower depth of treatment	95.0	ft bgs
Volume, TTZ	11,489	yd^3
Solids volume	7,468	yd^3
Porosity	0.35	-
Porosity volume	4,021	yd^3
Initial saturation	100	percent
Soil weight	33,345,931	lbs soil
Water weight	6,785,057	lbs water
Soil heat capacity	8,336,483	BTU/F
Water heat capacity	6,785,057	BTU/F
Total heat capacity, whole TTZ	15,121,540	BTU/F

Conceptual Design Parameters (Continued)

Longhorn (LHAAP-29) Site (T. Scenario 1)		HDR
Energy balance	***Treatment Area 1***	***Unit***
TCH power input rate	392	kW
Water extraction rate during heatup	1	gpm
Average extracted water temperature	190	F
Percent of injected energy extracted as steam	10	%
Steam extracted, average	138	lbs/hr
Energy flux into treatment volume	1,336,848	BTU/hr
Energy flux in extracted groundwater	56,605	BTU/hr
Energy flux in extracted steam	133,685	BTU/hr
Net energy flux into treatment volume	1,146,558	BTU/hr
Heating per day	2	F/day
Start temperature	61	F
Target temperature	194	F
Estimated heat loss, worst case	51	%
Operating time		
Heater ramp up	3	days
Heating to target temperature	125	days
Maintaining target temperature	73	days
Post treatment vapor extraction	7	days
Total operating time	208	days

Conceptual Design Parameters (Continued)

Longhorn (LHAAP-29) Site (T. Scenario 1)	HDR
Numbers of wells	***Treatment Area 1***
Heater borings, regular application	25
Vertical Vapor Extraction well (Co-located)	25
Multiphase extraction well, pumping	7
Temperature monitoring holes	4

Longhorn (LHAAP-29) Site (T. Scenario 1)	HDR	
Process equipment	***Value***	***Unit***
ISTD power supply	390	kW
Treatment system power supply	60	kW
Total power need to site	560	kW
Estimated total electric load	700	kVA
Estimated total amperage	800	Amps
Vapor extraction rate, total	250	scfm
Non-condensable vapor	200	scfm
Estimated steam extraction	50	scfm
Liquid extraction rate	0.81	gpm
Condensed liquid rate	0.28	gpm
Water treatment rate	1.08	gpm
Vapor treatment type	GAC w/ gas conditioning	-
Dominant contaminant of concern	Methylene Chloride	-
Estimated COC mass	3,917	lbs
Estimated COC mass treated by vapor system	1,958	lbs
Estimated COC mass treated by water system	78	lbs
Estimated COC mass destructed in-situ	1,880	lbs
Estimated max mass removal rate, vapor system	21	lbs/day

Conceptual Utility Requirements & Budgetary Costs

Longhorn (LHAAP-29) Site (T. Scenario 1)	HDR	
Utility estimates	***Value***	***Unit***
Power usage, in ground	1,876,000	kWh
Power usage, treatment system	319,000	kWh
Power usage, total	2,195,000	kWh

HDR Longhorn (LHAAP-29) Site (T. Scenario 1)	
Design and Procurement	$150,000
Construction and Operation	$1,970,000
Total	**$2,120,000**
Utilities, paid by client	$180,000
Total (with Utilities)	**$2,300,000**

THE ENVIRONMENTAL SOLUTION ™

CG Environmental Estimate Proposal Form

ACCOUNTS PAYABLE INFORMATION

HDR, INC.		
INVOICE TO COMPANY NAME	INVOICE TO- STREET ADDRESS	INVOICE TO- CITY, STATE, ZIP CODE
AP CONTACT FULL NAME	AP E-MAIL ADDRESS	AP PHONE NUMBER
	Due Upon Booking	
	PAYMENT TERMS	ISSUED PURCHASE ORDER (if applicable)

GENERATOR / PROJECT INFORMATION

HDR, INC.		KARNACK, TEXAS
GENERATOR NAME	PROJECT- STREET ADDRESS	PROJECT- CITY, STATE, ZIP CODE
SHANNON KLING	201.335.9385	NO
NAME OF PERSON WHO ORDERED WORK/ESTIMATE	PHONE NUMBER OF PERSON WHO ORDERED WORK/ESTIMATE	WILL INSURANCE BE INVOLVED IN THE PAYMENT OF THIS PROJECT?
		Shannon.Kling@hdrinc.com
ONSITE CONTACT NAME	ONSITE CONTACT PHONE NUMBER	ONSITE CONTACT EMAIL ADDRESS
		Thursday, July 1, 2021
	PROJECT ID	EXPECTED PROJECT DATE

ACCOUNT MANAGER INFORMATION

Robin.Barton@cleaningguys.com	737-990-9471	Robin Barton
E-MAIL ADDRESS	DIRECT PHONE NUMBER	REPRESENTATIVE NAME
San Antonio, TX	San Antonio	Wednesday, May 26, 2021
SUPPORT AREA	CG SALES TERRITORY	DATE PROPOSAL CREATED

SCOPE OF WORK RECAP — $2,285,621.62

Initial Scope:

CG will provide transportation and disposal of approximately 10,000 cubic yards of contaminated soil. This is only an estimate based on the information provided to CG. A site walk has not been conducted and the disposal fees are based on a nonhazardous classification. This estimate does not include fees for any testing required by the landfill for a disposal profile.

Clarifying Information:

This estimate is based on information provided by the generator to build scope of work. Scope of work includes items charged at our current rates, including, but not limited to: Transportation & Labor- Portal to Portal, Mobilization, Demobilization, Equipment, Incidentals, PPE, Tools, and Misc. Items needed to complete full scope of work.

Waste is based on pending profile approvals, signed and approved profiles, and volumes collected/generated. All profiles are subject to additional surcharges if waste is determined by disposal facility to be non-conforming. Actual quantities and profiles will be charged accordingly.

*See "Estimate Breakdown" for initial scope of work	Robin Barton
	Submitted by (CG Representative)

RESPONSIBLE PARTY ACCEPTANCE

Initial estimated quantities are based upon information provided to CG Environmental as detailed in "Estimate Breakdown". Quantities and rates may be subject to change based upon actual work performed. Customer agrees to all charges necessary to complete actual work performed.

Final invoice to reflect actual amount of hours worked, equipment and material used, accumulated waste charge for disposal, and an environmental compliance surcharge using our schedule of rates. Responsible party agrees to pay invoice within payment terms. If invoice is not paid within payment terms, responsible party agrees to pay all costs of collection and reasonable attorney fees with legal venue agreed to be CG headquarters of Tarrant County, Texas

Printed Name	Signature	/ /
Authorized Representative Printed Name & Signature (email acceptance of estimate will be considered same as signature)		**Acceptance Date**

CG v 12.03.2020

ESTIMATE BREAKDOWN

DURATION (If Applicable)	QTY	ER RATE	ITEM DESCRIPTION	UNIT PRICE	LINE TOTAL
Labor					
0.00	400.00	Standard	Disposal Coordinator	55.00	22000.00
0.00	500.00	Standard	Mobilization Fee	600.00	300000.00
Equipment					
0.00	5.00	Standard	1/2 Ton Pickup Truck	875.00	4375.00
Disposal					
0.00	10000.00	Standard	Disposal Fee - Per Yard per email increase to $300/cy for hazardous	150.00	1500000.00
0.00	1.00	Standard	Waste Coordination Fee	250.00	250.00
Additional Fees					
40.00	1.00	Standard	Pier Diem	35.00	1400.00
40.00	1.00	Standard	Disposal Coordinator Lodging	200.00	8000.00

THANK YOU FOR THE OPPORTUNITY TO SERVICE YOUR NEEDS

THESE PROPOSED COSTS FROM CLEANING GUYS LLC DBA CG ENVIRONMENTAL ARE **ESTIMATES ONLY** AND ARE SUBJECT TO CHANGE BASED ON ACTUAL WORK PERFORMED.

Sub-Total	$1,836,025.00
ECS Rate	15.00%
Environmental Compliance Surcharge	$275,403.75
TAX RATE	8.25%
TAX	$174,192.87
Estimated Total	**$2,285,621.62**

based on 10,000 cy and excluding Environmental compliance charge and tax unit rates are as follows:
-Nonhazardous = $183.60/cy
-hazardous = $336.60/cy

Telephone Record

Date:	Tuesday, January 10, 2023		
Project:	Longhorn LHAAP-29	Project No:	
Call to:	Shannon Kling	Phone No:	201-335-
Call from:	Chris Baxter	Phone No:	903-758-8939
Subject:	Quote for Clean Common Backfill		

Discussion, Agreement, and/or Action:

Reached out to A&T Sand and Gravel (A & T Sand & Gravel | Longview, TX (aandtsandngravel.com)) via website for cost for 11,000 cubic yards of clean backfill material.

Received a phone call from Chris Baxter who provided the following quote for clean fill and transportation for 11,000 cubic yards of material:

- $330,000 material cost
- $225,000 transportation cost: $225 per load for delivery assuming 1,000 trucks
- Total cost $555,000

A quote for end dump trucks was not provided.

Texas Environmental Control Inc.
4623 Steffani Lane, Houston, Texas 77041 (713)466-6717 (713)466-5160 FAX

HDR, INC.

May 25, 2021

Worker travel time by the hour	$43.00
SUPV travel time by the hour	$49.00
Worker hourly charge for 8 hr. day	$50.00 ($400/day)
Worker Hourly OT charge	$72.00
SUPV hourly charge for 8 hr day	$58.00 ($464/day)
SUPV hourly OT charge	$84.00
Worker Stand-by Charge per hour	$42.00
SUPV Stand-by Charge per hour	$48.00
Lodging & meals per person	$80.00
Fuel charge per mile each way	$ .75

When figuring a 10 hour day, add two hours @ $72.00 for each worker and two hours @ $84.00 for the supervisor.

Texas Environmental Control Inc.
4623 Steffani Lane, Houston, Texas 77041 (713)466-6717 (713)466-5160 FAX

Asbestos Transite Pipe Removal Work Plan

HDR, INC.

Karnack, TX Pipeline Project

TECI Work Plan

- TECI (Texas Environmental Control, Inc.) will post asbestos barrier tape and asbestos warning signs at work area.
- HDR, INC. will provide proper safety controls including ingress, egress and shore protection for all workers at job site that meet OSHA standards.
- HDR, INC. will be responsible for access to pipe and loading pipe lengths onto TECI trailer(s).
- Transite pipe must be off ground so TECI has access to cut in twelve (12) lengths.
- TECI workers will place 6 mil sheet poly under the exposed pipe.
- TECI workers will be asbestos trained, licensed, respirator fit tested and have required asbestos physicals.
- Workers will wear Tyvek type work uniforms, Nomex uniforms if required, 1/2 face respirators, hard hats, safety glasses, steel toe boots and gloves during abatement activities.
- TECI workers will sign Daily Log and attend Daily Safety Meeting.
- OSHA required personal air monitoring will be provided by TECI.
- After the abatement of the pipe, the 6-mil poly sheeting will be removed, the asbestos barrier tape and asbestos warning signs will also be removed from the project site.
- Asbestos containing Transite pipe will be loaded in TECI trailer, which has been lined with one layer of 6 mil poly for transport, with an asbestos manifest, to an EPA approved asbestos landfill by TECI.
- The **owner** of the asbestos or the **owner's representative** will receive a copy of the waste manifest from the landfill……**not** TECI or HDR, INC.
- TECI will coordinate all work activities with the pipeline contractor supervisor.
- TECI is a Texas licensed asbestos abatement contractor – license #800101.

Ron Van Gilder

Ron Van Gilder
Administrative VP
Texas Environmental Control, Inc.

01226908

Cost Proposal

Date	Proposal #
6/4/2020	12017

PO Box 1147
Foxworth, MS 39483

Name / Address	Re:
HDR INC 9781 S meridian Blvd, Ste 400 Englewood, CO 80112	Environmental Services Longhorn Army Ammunition Plant Karnack, TX

Description	Unit	Qty	Rate	Total
Mobilize/Demobilize DPT Rig & Crew	lump sum	1	800.00	800.00T
DPT Rig & Crew for (72) ~40' soil borings & (24) 1" PVC temporary wells	per day	30	2,050.00	61,500.00T
* Daily rate NTE 10 hr. workday; Additional hrs. @ $180.00 per hr.			0.00	0.00T
1" PVC Temporary Well Material	per ft.	960	4.00	3,840.00T
Mobilize/Demobilize Sonic Rig & Crew	lump sum	1	3,000.00	3,000.00T
Sonic Drill Rig & Crew for (6) 40' - 4" PVC well & (1) 80'- 4" PVC well	per day	6	6,000.00	36,000.00T
* Daily rate NTE 10 hr. workday; Additional hrs. @ $580.00 per hr.			0.00	0.00T
4" PVC Well Materials	per ft.	320	18.00	5,760.00T
Above Grade Surface Completion w/ Guard Post	per each	7	600.00	4,200.00T
Decontamination Pad	lump sum	1	750.00	750.00T
Well Development of (7) newly installed wells	per hr.	10	200.00	2,000.00T
55 Gallon Drums	per each	30	60.00	1,800.00T

Customer Acceptance of Cost Proposal

_____
Authorized Signature Date

*Payment Terms NTE 30 days upon project completion.
*1.5% Interest will be charged monthly to all overdue invoices.

Subtotal	$119,650.00
Tax (0.0%)	$0.00
Total	$119,650.00

Walker-Hill Environmental, Inc
Foxworth, MS Office
Phone: (601) 736-3500
Email: eric@whenv.com

Request for Quote
JBLM Tacoma, WA
November 13, 2017

Longhorn AAP, TX

REMEDIAL DESIGNS
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Parameter/Method	Matrix	Field Samples	No. of Dups	No. of MS	No. of MSD	Equipment Blanks	Trip Blanks	Total No. of Samples	Unit Price	Total Cost
Explosives (SW8330A)	Soil	192	20	10	10	10	0	242	**$ 110.00**	$ 26,620.00
VOCs 8260B	Water	31	4	2	2	4	5	48	**$ 55.00**	$ 2,640.00
1,4-Dioxane (need a 9.1 mg/L LOQ) **8260B SIM**	Water	1	1	1	1	1	1	6	**$ 55.00**	$ 330.00
Perchlorate (SW 6850)	Water	31	4	2	2	4	0	43	**$ 110.00**	$ 4,730.00
TCLP VOCs 1311/8260B **(includes cost for TCLP extraction at $35 per sample)**	Soil	1	0	0	0	0	0	1	**$ 90.00**	$ 90.00
TCLP SVOCs 1311/8270C/**D (includes cost for TCLP extraction at $35 per sample)**	Soil	1	0	0	0	0	0	1	**$ 150.00**	$ 150.00
TCLP **RCRA** Metals/Mercury 1311/6010C/7470A **(cost for TCLP extraction included with SVOCs above)**	Soil	1	0	0	0	0	0	1	**$ 69.00**	$ 69.00
TCLP Herbicides 1311/8151 **(cost for TCLP extraction included with SVOCs above)**	Soil	1	0	0	0	0	0	1	**$ 130.00**	$ 130.00
TCLP Pesticides 1311/8081A/B **(cost for TCLP extraction included with SVOCs above)**	Soil	1	0	0	0	0	0	1	**$ 81.00**	$ 81.00
Ignitability (flash point) **1030**	Soil	1	0	0	0	0	0	1	**$ 28.00**	$ 28.00
Corrosivity/ **pH 9045D**	Soil	1	0	0	0	0	0	1	**$ 10.00**	$ 10.00
Reactivity **as Total Cyanide/Sulfide by 9012B/9034**	Soil	1	0	0	0	0	0	1	**$ 64.00**	$ 64.00
Safe and Environmentally Responsible Waste Management (per sample)								262	**$ 2.50**	$ 655.00
If requested, % Moisture /Dry Weight reporting for Soil (cost/sample)								212	**$ 2.50**	$ 530.00
If requested, Perchlorate Filter/Syringe (cost per sample)								39	**$10.00**	$390.00
									Total cost	$36,517.00

Total cost	$36,517.00

Eurofins TestAmerica Quotation 28020808 is included in our submittal and is considered an integral part of our bid. It includes our technical approach, proposed deviations, clarifications, assumptions, and contract exceptions.

* Bids (unit costs) shall include supplying without additional charge all pre-preserved sampling containers, bubble bags, coolers, chain-of-custody forms, custody seals for coolers, and all shipping costs to the site.

* Required turnaround time (TAT) for complete analytical results will be standard.

* Standard PDF data packages shall include a laboratory narrative describing any analytical problems and usability of the data, results summary, and a summary of all QC performed including calibrations. This is typically known as a “Level III” deliverable. Deliverables will also include an Excel EDD and the Level IV raw data PDF SDG files.

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Modern Water EnSys TNT Explosives Soil Test Kit - 7002000

Item #: **7002000** Brand: **Modern Water**



$1,195.50

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Quantrol Peabody Gemini Round Dual Containment

RKI Instruments GX-2012 Confined Space Multi Gas

MSA 34L Econo-Cal Cylinder, 60 PPM CO, 20 PPM H2S,15%

Quantrol Peabody Gemini Round Dual Containment

Description

7002000 EnSys TNT Explosives Soil Test Kit by Modern Water

EnSys® explosives kits are rapid field or laboratory colourimetric tests for the analysis of explosives in soil. The kits are based on a method developed by Dr. Thomas Jenkins at the US Army Corps of Engineers - CRREL.

Features:

- Detects TNT, DNT and related explosives
- Convenient and rapid testing in the field or laboratory
- Extractions can be performed simultaneously with analysis in singlicate
- TNT extracts can be used with EnSys RDX test
- Training available
- EPA SW-846 Method #8515

Test result type

- Quantitative data

Samples per kit

- 20 soil samples

Assay range

- Soil: 1 ppm to 30 ppm total TNT
- Higher sample concentrations can be quantified by sample extract dilution

Sample preparation

- Soil samples require prior extraction using the included extraction components
- Soil samples should be dried prior to analysis
- Soil sample extracts may be saved for use with the RDXsoil test kit

Sampling time

- 'Dirt-to-Data' in approximately 30 minutes
- Typically about ten samples can be run in about 40 minutes
- Soil extraction time is typically 2 - 10 minutes per sample plus test run time of approximately 2 minutes

Specificity

The EnSys® TNT test is specific for TNT and related explosive compounds and exhibits the following sensitivities. The TNT test does not measure RDX or HMX.

Basic Test Procedure

- Clean cuvettes and set spectrophotometer
- Extract soil sample: Weigh 10 grams of soil sample, Add sample to extraction jar, Measure 50mL acetone into 50mL tube, Pour acetone into extraction jar and shake for three minutes, Allow to settle for five minutes
- Draw 25mL liquid into the syringe from above the sediment layer in extraction jar
- Attach filter tip to syringe and transfer 25mL of sample extract into a cuvette.
- Place cuvette in spectrophotometer and record initial absorbance
- Add one drop of developer solution, cap and shake for three seconds.
- Remove stopper and place the'sample' cuvette in cell holder and read sample absorbance.

- NOTE: For analysis of samples containing DNT,and/or where DNT concentration is of concern, samples must be allowed to develop for 10 minutes before reading sample absorbance. This will not affect colour development for other nitroaromatics.
- Record data and calculate results.

Test kit components

- 20 weigh boats and wooden spatulas
- 20 extraction jars
- One 50mL graduated tube
- 20 - 30cc syringes and syringe filters
- 1 bulb pipette
- 1 TNT control vial and ampoule cracker
- Developer solution
- Test kit instructions

Storage & precautions

- Shelf life is typically one year from date of manufacture, with specific kit expiration date information provided on product packaging.
- Store at ambient temperature 64° to 81°F (18° to 27°C)
- Operate the test at temperature greater than 40°F/4°C and less than 100°F/39°C (4°C)

Required test materials

- EnSys TNT explosives soil test kit (7002000)

Required test equipment

- EnSys TNT accessory kit (rental, includes HACH DR2800) (6999700)
- Acetone: hardware or laboratory grade (min 50mL per sample)

Other recommended materials

- Hach DR/2000, DR/2010 or DR/2800
- 2 matched hach cuvettes
- 2 cuvette stopper plugs
- Balance
- Tap or laboratory grade water for cuvette rinsing
- Marker pen, calculator
- Absorbent paper
- Liquid waste container
- PPE: Disposable gloves, eyewear

Specifications +

Datasheets & User Manuals +

Questions & Answers +

Reviews

+

Related Items



Modern Water EnSys RDX Explosives Soil Test Kit with Extraction Jars -...



RKI Instruments Sensor, Carbon Monoxide (CO) 0 - 300 PPM, Plug-In Type,...



Apera 201T-F Plastic 3-in-1 Combination pH Electrode



RAE Systems Combustible %LEL Sensor - 014-0212-00(

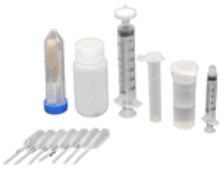
Related Items in This Section

Modern Water EnSys TNT Explosives Soil Test Kit - 7002000

Modern Water EnSys RDX Explosives Soil Test Kit with Extraction Jars - 7085000

Modern Water Alumina-A Cartidges - 6021200

Recently Viewed Items



Modern Water EnSys TNT Explosives Soil Test Kit - 7002000

JJS Technical Services 1900 East Golf Rd., Suite 950 Schaumburg, IL 60173

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Ask an Expert

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(1-866-455-7832)

8:30am - 5:00pm CST

Email Us

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C

Excavation Volume Calculations

Excavation Areas:

Area E-1 - B806A

Contaminated In-Place Volume		
perimeter	157	ft
Area	1522	sf
Depth	5	ft
Volume	7610	cf
Volume	282	cy

Calculated Civil3d Total Volume: 367 cy

Contaminated Volume	**282**	**cy**
Total Volume	**367**	**cy**

Area E-2 - B806D Area

Contaminated In-Place Volume		
Area	692	sf
Depth	1	ft
Volume	692	cf
Volume	26	cy

Calculated Civil3d Total Volume: NA cy

Total Volume	**26**	**cy**

Area E-3 - perchlorate excavation

Contaminated In-Place Volume		
perimeter	172	ft
Area	1668	sf
Depth	10	ft
Volume	16680	cf
Volume	618	cy

perimeter	168	ft
Area	1554	sf
Depth	14	ft
Volume	21756	cf
Volume	806	cy

Calculated Civil3d Total Volume: 2,107 cy

Contaminated Volume	**1,424**	**cy**
Total Volume	**2,107**	**cy**

Area E-4 - B812F

Contaminated In-Place Volume						**Calculated Civil3d Total Volume:**
perimeter	294 ft	perimeter	93 ft	perimeter	134 ft	3,631 cy
Area	3828 sf	Area	365 sf	Area	666 sf	
Depth	16 ft	Depth	8 ft	Depth	5 ft	
Volume	61248 cf	Volume	2920 cf	Volume	3330 cf	
Volume	2,268 cy	Volume	108 cy	Volume	123 cy	

Contaminated Volume:	**2,500**	**cy**	
Contingency-30%	**3,250**	**cy**	
Total Volume	**4,720**	**cy**	Includes 30% contingency on Civil3d Volume

Area E-5 - Cooling Water Outfall

Contaminated In-Place Volume						**Calculated Civil3d Total Volume:**
perimeter	94 ft	perimeter	135 ft	perimeter	154 ft	919 cy
Area	260 sf	Area	1100 sf	Area	1480 sf	
Depth	3 ft	Depth	4 ft	Depth	9 ft	
Volume	780 cf	Volume	4400 cf	Volume	13320 cf	
Volume	29 cy	Volume	163 cy	Volume	493 cy	

Contaminated Volume	**685**	**cy**
Total Volume	**919**	**cy**

Area E-6 - Drainage Ditch

Contaminated In-Place Volume				**Calculated Civil3d Total Volume:**
perimeter	150 ft	perimeter	170 ft	na cy
Area	1380 sf	Area	1770 sf	
Depth	1 ft	Depth	1 ft	
Volume	1380 cf	Volume	1770 cf	
Volume	51 cy	Volume	66 cy	

Total Volume	**117**	**cy**

Contaminated Volume	**5,790**	**cy**

Area NC-1- North Cooling Water Line

Contaminated In-Place Volume		
perimeter	295	ft
Area	5398	sf
Depth	13	ft
Volume	70174	cf
Volume	2,599	cy

Contaminated Volume	**2,599**	**cy**
Total Volume	**3,592**	**cy**

Calculated Civil3d Total Volume:
3,592 cy

Area NC-2- North Cooling Water Line

Contaminated In-Place Volume		
perimeter	252	ft
Area	3936	sf
Depth	14	ft
Volume	55104	cf
Volume	2,041	cy

Contaminated Volume	**2,041**	**cy**
Total Volume	**3,886**	**cy**

Calculated Civil3d Total Volume:
3,886 cy

Area NC-3- North Cooling Water Line

Contaminated In-Place Volume		
perimeter	152	ft
Area	656	sf
Depth	6	ft
Volume	3936	cf
Volume	146	cy

Contaminated Volume	**146**	**cy**
Total Volume	**-**	**cy**

Calculated Civil3d Total Volume:
na cy

D

ISTD Scope of Work



U.S. Army Corps of Engineers, Tulsa District

LHAAP-29
Final Performance Work Statement
for
In-Situ Thermal Treatment

Karnack, Texas
February 2024

This is a Performance Work Statement for site remediation using in-situ thermal desorption (ISTD). There are a variety of designs and approaches for the implementation of ISTD. This Performance Work Statement identifies the performance criteria for the implementation of ISTD for the above-noted project.

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TABLE OF CONTENTS

Section No. **Page No.**

1. Project Scope and Objectives 1-1
1.1 Summary Work 1-1
1.2 Description of Services/Introduction 1-1
1.3 Project Objectives 1-1
2. General Requirements 2-1
2.1 In-situ Thermal Desorption and Process Monitoring 2-1
2.1.1 Selection of Thermal Technology 2-1
2.1.2 Target Treatment Area Characteristics 2-1
2.1.3 Hours of Operation 2-2
2.1.4 Site Preparation 2-2
2.1.5 Heating Element Points/Wells and Monitoring Points Installation 2-3
2.1.6 Monitoring Well Installation 2-4
2.1.7 ISTD Wellfield, Liquid and Vapor Recovery and Treatment Equipment Installation 2-5
2.1.8 Performance Criteria 2-8
2.1.9 Process Monitoring Requirements 2-10
2.1.10 Effectiveness Monitoring 2-12
2.2 Site Security, Access, and Oversight 2-12
2.3 Environmental and Sensitive Receptor Protection 2-12
2.4 Temporary Facilities 2-13
2.5 Meetings 2-13
2.5.1 Project Kickoff and Pre-Construction Meetings 2-13
2.5.2 Project Progress Meetings 2-13
2.6 Regulatory Requirements 2-14
2.6.1 Well Drilling 2-14
2.6.2 Well Sealing and Abandonment 2-14
2.6.3 Air Emissions and Off-Gas Treatment 2-14
2.6.4 Soil Erosion and Sediment Control 2-15
2.6.5 Stormwater 2-15
2.6.6 Spill Plans 2-15

2.7 Utilities 2-15
2.8 Wells and Monitoring Points Abandonment and Project Survey 2-17
2.9 Site Restoration and Project Closeout 2-17
2.10 Demobilization 2-17
2.11 Residual Management 2-18
2.12 Health and Safety 2-18
2.13 Project Deliverables 2-18
2.13.1 Submittal Procedures 2-19
2.13.2 ISTD Work Plan 2-19
2.13.3 Contractor Quality Control Plan 2-20
2.13.4 UFP-Quality Assurance Project Plan 2-20
2.13.5 Chemical Data Final Report 2-21
2.13.6 Site Specific Health and Safety Plan 2-21
2.13.7 Daily Quality Control Reports 2-21
2.13.8 Process Monitoring Results 2-22
2.13.9 Effectiveness Monitoring Results 2-22
2.13.10 Field Change Requests 2-22
2.13.11 ISTD Completion Report 2-22
3. Quality Assurance/Quality Control 3-1
3.1 Quality Control System 3-1
3.2 Contractor Quality Control 3-1
3.2.1 Quality Control Organization 3-1
3.2.2 Definable Features of Work 3-1
3.2.3 Control 3-2
3.2.4 Technical Submittal Reviews 3-3
3.2.5 Field inspections 3-4
3.2.6 Documentation 3-4
3.3 Analytical Requirements 3-4
4. Period of Performance 4-1
5. Measurement and Payment 5-1
5.1 Payment Schedule 5-1
5.2 General Conditions (Bid Item 1) 5-1
5.2.1 Project Preparation, Site Preparation, and Temporary Facilities 5-1
5.2.2 Site Mobilization 5-1
5.2.3 Project Deliverables 5-1
5.3 Monitoring Well Installation and Baseline Sampling (Bid Item 2) 5-2
5.3.1 Monitoring Well Installation 5-2
5.3.2 Baseline Sampling 5-2

5.4 System Installation and Start-Up – Base Period (Bid Item 3) 5-2
5.4.1 Subsurface Heating Element and Monitoring Point Installation 5-2
5.4.2 Surface Equipment System Installation 5-2
5.4.3 Utility Service Installation, and Connection to Power Controls 5-3
5.4.4 System Start-Up 5-3
5.5 System Operation – Base Period (Bid Item 4) 5-3
5.5.1 Process and Effectiveness Monitoring/Sampling Events 5-4
5.5.2 Utility Costs 5-4
5.5.3 Off-Gas and Water Management 5-4
5.6 Groundwater Sampling (Bid Item 5) 5-4
5.7 ISTD System Demobilization/Decommissioning and Site Restoration (Bid Item 6) 5-5
5.8 ISTD Completion Report (Bid Item 7) 5-5
5.9 Optional Items 5-5
5.9.1 Optional Effectiveness Monitoring Post Treatment Phase (Bid Item 7) 5-5
5.9.2 Optional Continued ISTD Operation – 30 Days (Bid Item 8) 5-5
5.9.3 Optional Continued ISTD Operation – 30 Days (Bid Item 9) 5-5
5.9.4 Optional Continued ISTD Operation – 30 Days (Bid Item 10) 5-6
5.9.5 Optional ISTD Treatment Area – Up to 5,000 SF (Bid Item 11) 5-6
5.9.6 Optional ISTD Treatment Area – Additional 5,000 SF (Bid Item 12) 5-6
6. References 6-1

LIST OF TABLES

Tables

Table 2-1 ISTD Treatment Area
Table 2-2 Minimum Process Monitoring Reporting Requirements
Table 2-3 Project Meetings
Table 2-4 Deliverables Schedule

LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
amsl	above Mean Sea Level
ASTM	American Society for Testing and Materials
CDFR	Chemical Data Final Report
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COR	Contracting Officer's Representative
CQC	Contractor Quality Control
CQCP	Contractor Quality Control Plan
CY	Cubic Yard
DAR	Design Analysis Report
DESA	Division of Environmental Science and Assessment
DFW	Definable Features of Work
DOT	Department of Transportation
DQCR	Data Quality Control Report
DQO	Data Quality Objectives
DTG	Discharge to Groundwater
EDD	electronic data deliverable
EM	Engineering Manual
ER	Engineering Regulations
ERT	Environmental Response Team
FASTAC	Field and Analytical Services Teaming Advisory Committee
ft bgs	feet below ground surface
ft/day	feet per day
gpm	gallons per minute
GWP-IND	medium-specific concentration for industrial use based on groundwater protection
HASP	Health and Safety Plan
HSM	Health and Safety Manager
HSO	Health and Safety Officer
HTRW	Hazardous, Toxic, and Radioactive Waste
ISTD	In-Situ Thermal Desorption
mg/kg	milligram per kilogram
MIP	Membrane Interface Probe
NEC	National Electrical Code
NFG	National Functional Guidelines
NFPA	National Fire Protection Association
NTP	Notice to Proceed
OSHA	Occupational Safety and Health Association
PDT	Project Delivery Team
PVC	Polyvinyl Chloride
PWS	Performance Work Statement
QA/QC	Quality Assurance Quality Control
QAPP	Quality Assurance Project Plan
QCS	Quality Control System
RCRA	Resource Conservation and Recovery Act
RMS	Resident Management System
ROD	Record of Decision
RSCC	Regional Sample Control Coordinator
RSE	Remediation System Evaluation
TCEQ	Texas Commission on Environmental Quality
SAI-IND	Soil MSC for industrial use based on inhalation, ingestion, and dermal contact
SMO	Sample Management Officer
SOP	Standard Operating Procedure
SVE	Soil Vapor Extraction

UFP	Uniform Federal Policy
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

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1. Project Scope and Objectives

1.1 Summary Work

This is a Performance Work Statement (PWS) for site remediation using in-situ thermal desorption (ISTD). There are a variety of designs and approaches for the implementation of ISTD. This PWS identifies the performance criteria for the implementation of ISTD for the LHAAP-29, Former TNT Production Area Group 2, Longhorn Army Ammunition Plant Site (Site) located in Karnack, Texas, in accordance with the published Record of Decision (ROD) (HDR 2019). The ROD specified ISTD treatment for the dense nonaqueous phase liquid (DNAPL) methylene chloride (MC) plume identified in the intermediate groundwater zone to reduce concentrations to levels amenable to monitored natural attenuation (MNA). Other contaminants identified as chemicals of concern (COCs) in the intermediate groundwater zone include trichloroethene (TCE) and daughter products, 1,2-dichloroethane (1,2-DCA), and arsenic. In past sampling events, TCE has been detected at maximum concentrations of 28,100 ug/l at monitoring well 29WW16. As a result, ISTD shall be provided at sufficient temperatures to reduce concentrations of TCE in addition to treating MC.

1.2 Description of Services/Introduction

The Contractor shall provide all personnel, equipment, supplies, facilities, transportation, tools, materials, supervision, utility connections, and other items necessary to perform ISTD at the Site as defined in this PWS and associated specifications and design documents, except for those items specified as being furnished or completed by others. The area to be remediated using ISTD is depicted on Drawing Sheet 02C101.

1.3 Project Objectives

The groundwater remediation goal within the area defined on Drawing Sheet 02C101 is 8,000 micrograms per liter (µg/l) for MC, as stated in the United States Environmental Protection Agency (USEPA) 2019 Record of Decision (ROD) for the Site (HDR, 2019). There are no specified soil remediation goals for this ISTD project. In addition to meeting the cleanup level for MC, treatment for TCE in groundwater shall also be provided. The Contractor shall be responsible for design and implementation of their selected ISTD approach, associated means and methods (e.g., heating duration, temperature, equipment), and overall schedule suitable for achieving the above-noted groundwater remediation goal. The overall period of performance for the work shall be as specified in Section 5.

The Contractor shall monitor their selected ISTD process and equipment in accordance with the requirements specified in Section 4 and the United States Army Corps of Engineers (USACE) in consultation with the project delivery team (PDT). The COR and PDT will evaluate the Contractor's process and effectiveness monitoring results to determine whether the objectives of the ISTD have been achieved and/or to determine whether optional measures will be exercised (refer to Section 5.0). The remediation shall be performed in a way that protects human health and the environment.

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2. General Requirements

2.1 In-situ Thermal Desorption and Process Monitoring

2.1.1 Selection of Thermal Technology

There are a variety of designs and approaches for the implementation of ISTD. This PWS identifies the performance criteria for the implementation of ISTD for the Site. The Contractor shall be responsible for the selection and implementation of the ISTD technology (e.g., resistive heating, conductive heating) and specific means and methods that the Contractor believes is appropriate and cost-effective for the project, in accordance with the requirements of this PWS. The ISTD system shall be capable of providing the required minimum treatment temperature of 100 degrees Celsius.

2.1.2 Target Treatment Area Characteristics

The Contractor shall implement ISTD for the area/zones and depths bgs depicted on Drawing Sheets 02C101 and 02C103. The highest MC groundwater concentration detected in the treatment area during groundwater grab sampling was 2,350,000 µg/l at a depth of 85 ft below ground surface (bgs) from location 29CPT12. The highest MC groundwater concentration detected in a monitoring well was 8,260,000 µg/l at monitoring well 29WW16 collected in 2014. The greatest TCE groundwater grab sample concentration was 3,380 µg/l detected at a depth of 80 ft bgs at location 20CPT11.

The ISTD treatment area is defined by the estimated area of groundwater with MC concentrations greater than or equal to 8,000 µg/l. The treatment depth was estimated based on the groundwater grab samples and soil samples collected during the 2014 supplement RI and a correlation between the concentration in groundwater and soil based on the water octanol partitioning factor for MC. The thickness of the contaminated area is 20 ft and is between 70 to 90 ft bgs. Thermal treatment will be applied below and above the targeted treatment area to mitigate the potential for downward migration of DNAPL as it is heated and to reduce the potential of contaminating cooler zones above the thermal treatment area as a result of condensation of contaminant vapors. A summary of the target treatment area is summarized in Table 2-1.

Table 2-1
ISTD Treatment Area

Treatment Area	Contaminated Thickness	Heated Thickness	Contaminated Volume	Total Heated Volume	Approximate Target Heated Depth[1]
sf	ft	ft	cy	cy	ft bgs
6,600	20	55	4,450	13,444	40 to 95

Note:
1. The total saturated depth will be heated to prevent contaminated vapors from condensing in the cooler zones.

ISTD area will be implemented for the area and depths bgs provided in Table 3-3. ISTD treatment will be provided to the depth of contaminated saturated zone specified to ensure complete treatment of the contaminated zone. The total ISTD area encompasses approximately 6,600 sf and a total impacted volume of 4,450 cy.

Based on the 2014 supplemental RI investigation (AECOM, 2016), predominant features of the site's geology in the ISTD treatment area are identified as follows:

- Soils beneath the Project site consist of predominantly interlayered fine-grained soils (silts and clays) to about 90 ft bgs, with thin interlayered intervals of fine-grained sand interbedded among silt and clay. Often, sequences of clay/silt contain lamina of fine sand ranging in thickness from

0.04 inch (1 millimeter) to 0.4 inch (10 millimeter) thick. Occasionally, thin layers of black, hard lignite (a type of coal) were encountered in the subsurface.

- Depth to the water table in the intermediate zone is approximately 40 ft bgs. According to the boring log for monitoring well 29WW16, water saturated soils (silty sand to sand) were encountered from approximately 78.5 ft to 80.9 ft bgs, for a saturated thickness of 2.4 ft. Overlying the saturated soils was a thick layer of clay that extended from 78.5 to 27 ft bgs with an interlayer of silt (from 50 to 52 ft bgs) and sandy clay (from 38.5 to 38.9 ft bgs). With a thick layer of clay overlying the saturated zone and the static groundwater level occurring well above the saturated zone in 29WW16, groundwater in the intermediate zone occurs under confined conditions (AECOM 2016).
- Based on results of the 2014 pump test the aquifer has the following characteristics:
- Specific capacity of the pumping well: 0.004 to 0.032 gallons per minute/ft drawdown
- Aquifer transmissivity: between 5.6 and 45.7 gallons per day/ft drawdown
- Hydraulic conductivity: between 1.08E-04 cm/sec and 4.29E-04 cm/sec
- Aquifer storativity: ranged from 1.5×10^{-4} to 3.95×10^{-4} (unitless)
- Based on the results of the 2014 pump test, the maximum radius of influence was determined to be 102 ft at a constant pumping rate of 0.4 gallons per minute.
- There was no change in water levels in the deeper well assessed during the pump test indicating there is no vertical connectivity between the intermediate and deep zones.

Other available characterization information for the target treatment area is included in historical Site reports, listed in Section 6 and as provided to the Contractor. The Contractor shall be solely responsible for developing their own estimate of the VOC mass to be addressed by the ISTD project in their bid, for presenting the basis/rationale for their mass estimate calculations, and for appropriately designing, procuring, installing, and operating all required ISTD equipment based on their understanding of the target treatment area characteristics. The Contractor shall include an evaluation of the potential range in the mass estimate based on the degree of uncertainty in their calculations, and a discussion of the factors of safety incorporated into their process design (e.g., equipment sizing/selection) to accommodate the potential range in mass. In addition, the Contractor shall be responsible for providing all other equipment/operational measures required to address any other characteristics of the target treatment area (e.g., metals, soil total organic content, moisture content) and/or other relevant Site conditions (e.g., groundwater flow), as obtained through available site data/historical reports, that may affect their ISTD operations and/or compliance with associated air emissions/liquid discharge requirements. If the Contractor identifies any data gaps/additional data needs as part of their bid preparation, the Contractor shall identify the data collection requirements and associated costs in their bid.

2.1.3 Hours of Operation

Normal hours of operation during ISTD construction/installation shall be between 7:00 a.m. and 5:00 p.m., Monday through Friday, excluding federal holidays. The Contractor shall not conduct construction work outside these working hours without first obtaining written approval from the USACE. These working hours may be further modified based on local ordinances, as applicable.

ISTD operations will be on a 24-hour per day basis, from heating commencement through completion. The Contractor shall conduct the heating operations in compliance with all applicable local ordinances (e.g., noise, lighting).

2.1.4 Site Preparation

The following site features/infrastructure are present within or in the vicinity of the target treatment area (refer to Drawing Sheet 02C101):

- There are 7 monitoring wells (29WW15, 29WW16, 29WW40, 29WW41, 29WW42, 29WW43, and 29WW44), located in the vicinity of the ISTD area. Monitoring well 29WW41 is located

approximately 20-ft outside the ISTD area and is identified to be protected. Five of these monitoring wells were installed with stainless steel casing and screen and shall remain and be protected during the installation and implementation of ISTD. One monitoring well will require to be abandoned (29WW40) prior to implementing ISTD. Monitoring well 29WW41 is approximately 20-ft outside the ISTD area and was installed with a PVC casing. This well shall be protected if possible. If damage occurs during ISTD, the well shall be replaced. There is one well (29WW17) shown on Drawing Sheet 02C101 that is located outside the ISTD area and near the staging area that shall be protected. The Contractor shall be responsible for the replacement of any wells or other infrastructure that is unintentionally damaged or disturbed due to the Contractor's operations.

- The ground surface within the targeted treatment area is covered with grass/weeds and is wooded. The Contractor shall remove surface vegetation as required based on the Contractor's proposed ISTD implementation approach, with placement in a designated on-site location.

- The Contractor shall be responsible for the installation of security fencing (comprising minimum 6-foot-high chain link fence with visibility/privacy screening, appropriately anchored to the ground surface) to enclose the targeted treatment area and the Contractor's operations/equipment. The fencing shall be maintained by the Contractor throughout the construction and operations period, to prevent unauthorized access to the Contractor's work area(s) and equipment. The fencing shall be provided with appropriate gates to allow personnel/vehicles access to the work area(s).

The plan for addressing each of the above items should be included in the Contractor's ISTD Work Plan and shall be reviewed and approved by the USACE prior to implementation. The Contractor's ISTD Work Plan shall also include the details and approach for any other site preparation required based on the Contractor's proposed ISTD implementation approach (e.g., site re-grading for proper drainage, imported fill/materials requirements (if any) for vapor caps/insulating covers placed on the targeted treatment area surface).

2.1.5 Heating Element Points/Wells and Monitoring Points Installation

The Contractor shall provide the labor, equipment, materials, tools and supplies to install all required elements (subsurface and aboveground components) of the ISTD system which could include, but is not limited to: heating elements, temperature and pressure monitoring points, vapor recovery extraction wells, vapor recovery vacuum monitoring points, extraction wells (if needed), multi-phase extraction wells, soil vapor treatment and groundwater/process water treatment. For the purposes of this PWS, a "heating element" shall mean equipment that is used to deliver energy to the subsurface for the purpose of ISTD, such as a heater well or electrode. Heating elements, vapor extraction/monitoring wells, wells and monitoring points shall be suitable for the approved thermal technology, in accordance with this PWS and other applicable local, state, and federal regulations, statutes and codes. Local, state, or federal requirements or licenses required to perform the work shall be met or obtained prior to the commencement of drilling and well installation operations. The Contractor shall complete all required utility clearances prior to conducting invasive activities.

The Contractor shall supply the drill rig and other installation equipment inspection certificates prior to the start of drilling activities. It is the Contractor's responsibility to properly construct all heating elements and monitoring points / wells in accordance with the Contractor's approved ISTD Work Plan. Drill cuttings and other waste generated during installation shall be contained and disposed of in accordance with waste management procedures described in the in the Uniform Federal Policy for Quality Assurance Project Plan (UFP-QAPP). All equipment shall be decontaminated prior to leaving the site, in accordance with the UFP-QAPP.

Installation of heating elements and monitoring points / wells (including vapor extraction wells) shall be conducted in accordance with the Contractor's ISTD Work Plan approved by the USACE. Installation of heating elements and monitoring points / wells may require penetration through slabs and other materials. The Contractor shall complete a review of current site conditions, available utility maps, and other available site information prior to conducting invasive site activities. The Contractor shall provide drawings showing

details and locations of the electrodes and monitoring points in their ISTD Work Plan. Contractor shall survey locations for the heater elements and monitoring points / wells within each treatment area to verify correct placement of the required ISTD components within the treatment area. Survey shall be completed by a professional land surveyor licensed in the State of Texas, and all surveys shall be referenced to the Texas State Plane Grid. Horizontal datum shall be NAD 1983 (NA2011) Epoch 2010. Vertical datum shall be NAVD 1988 (GEOID 2012A). The Contractor shall submit both paper and electronic survey data (e.g., AutoCAD files and point databases) to the USACE.

Location, number and design of monitoring wells, extraction wells and monitoring points shall be provided by Contractor in site plan layouts included with their ISTD Work Plan. Capabilities shall be incorporated into the ISTD Work Plan to allow safe and effective monitoring of vapor concentrations, air pressures and vacuums, air flows, water flows, and subsurface temperatures over the course of the treatment and post-treatment periods. If the Contractor determines that extraction wells or other measures (e.g., hydraulic barriers) are needed in order to maintain hydraulic control of the targeted treatment area during the ISTD operations, the Contractor shall clearly indicate the proposed number, locations and depths of the extraction wells/barriers, and shall indicate the anticipated groundwater extraction rates required for maintaining hydraulic control throughout the operations period. The Contractor shall perform a pump test to verify existing aquifer characteristics for the hydraulic control design. Details of the pump test shall be provided in the Contractor's Work Plan. The Contractor shall also indicate the performance criteria (e.g., lack of downgradient COC detection, hydraulic gradients) used to evaluate whether sufficient hydraulic control is being maintained throughout the ISTD operations period, as well as the field parameters/measurements (e.g., groundwater analytical samples, water level measurements) collected in order to demonstrate that the performance criteria are being achieved. Existing monitoring wells located on the Site shall also be monitored to determine if they are impacted by the ISTD system.

2.1.6 Monitoring Well Installation

The Contractor shall provide the labor, equipment, materials, tools and supplies to install all required groundwater monitoring wells identified on Drawing Sheet 02C101. Installed monitoring wells shall be installed with heat resistance materials and shall be constructed using stainless steel casing and wire wrapped screen. Other temperature resistant well materials may also be used if approved by the USACE.

The monitoring wells will be installed using the rotosonic drilling method. The stainless-steel well screen for each well will be constructed with 0.01 inch slots and will be 10 feet in length. A threaded bottom cap will be secured to the bottom of the screen interval. Solid 4-inch diameter stainless-steel casing will be installed from the top of the screen interval to approximately 3 feet above surface grade. A filter pack consisting of clean silica sand (20 to 40 size) will be placed in the annular space from the well bottom to approximately 2 feet above the screen interval. A 3-feet thick bentonite seal (pellets or chips) will be placed above the sand filter pack and hydrated with potable water. The annular space from the top of the bentonite seal to the surface will be filled with a bentonite-cement grout.

Well surface completions will be constructed for each monitoring/compliance well installed. Surface completion will consist of protective steel casing, with a hinged, lockable lid set in a concrete pad. Concrete-filled steel bollards will be installed at the corners of the concrete pad.

The monitoring wells and surface completions will be installed in general accordance with USACE and the State of Texas requirements by a drilling subcontractor licensed in the State of Texas. Monitoring wells shall comply with applicable technical requirements of 16 Texas Administrative Code (TAC) Chapter 76. State of Texas Well Reports will be submitted to the Texas Department of Licensing and Regulation for each well.

The Contractor shall supply the drill rig and other installation equipment inspection certificates prior to the start of drilling activities. It is the Contractor's responsibility to properly construct all monitoring wells in accordance with the Contractor's approved ISTD Work Plan. Drill cuttings and other waste generated during installation shall be contained and disposed of in accordance with waste management procedures

described in the in the Uniform Federal Policy for Quality Assurance Project Plan (UFP-QAPP). All equipment shall be decontaminated prior to leaving the site, in accordance with the UFP-QAPP.

The newly installed monitoring wells shall be developed to remove drilling fines and enhance hydraulic communication between the well and the groundwater zone. The wells shall be developed no sooner than 48 hours, and no later than 7 days, after installation (grouting) of the well. Well development shall be performed by pumping and gentle surging of the screened interval using a rubber-lined surge block. A minimum of three well borehole volumes of water shall be removed. The volume of groundwater removed from each well shall be calculated from the static water level measurement referenced from the top-of-casing. An electronic interface probe shall be used to measure the water levels. As an alternative to pumping, a bottom filling bailer may be used to remove water from low-yielding wells. Water quality parameters (temperature, hydrogen ion concentration [pH], conductivity, and turbidity) of the development discharge water shall be monitored. Development shall continue until these parameters have stabilized (less than 0.2 pH units or a 10 percent change for the other parameters between four consecutive readings) and the water is clear and below 20 nephelometric turbidity units (NTU). If these parameters have not stabilized after 4 hours of continuous pumping, then the USACE shall be contacted for further direction. Well development shall be documented, and the Contractor shall collect at least 500 milliliters of the last water withdrawn from the well during development in a clear glass jar, labeling and immediately photographing it to document the clarity of the water. The photograph shall be suitably backlit (white background recommended), close-up that shows the clarity of the water. Once photographed the water can be disposed of with water purged during the well development.

A geologist provided by the Contractor shall supervise well development and document the development process and measurements on a Well Development Record specific to each well. Downhole development equipment will either be disposed after each use or will be decontaminated prior to and following use at each well location by cleaning in a detergent/water solution and multiple rinse stages in clean buckets. The development and decontamination wastewater will be placed in 55-gallon drums or other appropriate containers for disposal off site.

2.1.7 ISTD Wellfield, Liquid and Vapor Recovery and Treatment Equipment Installation

The minimum requirements of each component of the ISTD system are described separately, but it shall be the Contractor's responsibility to design, install, construct, operate, control and monitor the components of the ISTD system as one complete and compatible unit. The Contractor shall include any additional components and appurtenances not specified below which are required for a complete and operable system.

The minimum performance criteria to be met by the contractor's ISTD design will include the following:

- Minimum target heating temperature of 100 degrees Celsius.
- Installation of temperature monitoring probes along the edge of the treatment area at a frequency of one monitoring point every 80 lf along the perimeter of the treatment area and inside the ISTD area at a frequency of one probe every 1,200 sf for an estimated total of 10 temperature monitoring probe locations. Each probe location will provide temperature readings for every 4.5 ft interval (total of 12 sensors) across the specified heating depth.
- Installation of a minimum of two groundwater monitoring wells downgradient of the ISTD treatment area in the direction of groundwater flow to monitor temperature and hydraulic control of the plume. Additional wells, if deemed necessary, may be required based on groundwater flow direction. The wells will be installed approximately 20 ft downgradient of the treatment area and at a depth of 90 ft bgs with a 10 ft screen. The actual well depths and screened intervals will be determined in the field based on the lithology encountered during drilling.
- Provide hydraulic control to prevent the potential movement of mobilized MC DNAPL from migrating downward or laterally away from the treatment area during thermal treatment. Final method for

providing hydraulic control shall be determined by the contractor but could include the installation of extraction wells if it is determined to be necessary.

- Provide adequate measures to control all vapors generated during ISTD to prevent uncontrolled emissions of contaminants and/or discharges of steam. The system shall also be designed to prevent any condensation of contaminated vapors from entering and contaminating areas outside the target treatment zone.
- Capabilities will be incorporated into the Work Plan to allow safe and effective monitoring of vapor concentrations, air pressures and vacuums, air flows, water flows, and subsurface temperatures over the course of the treatment and post-treatment periods.
- The downgradient hydraulic control monitoring wells will be monitored monthly for VOCs and temperature during ISTD operations (specification for monitoring to be included in the Draft Final RD submittal), including a collection of baseline monitoring samples no more than one month prior to starting up the ISTD system. All results will be reported to the Corps. Results with elevated VOCs (for example, concentrations greater than 1 order of magnitude above baseline conditions) or elevated temperatures above baseline conditions may trigger additional action such as more frequent monitoring, adjustments of ISTD operations, or implementation of additional groundwater extraction or hydraulic control measures (that is, increasing flow rates from existing hydraulic control wells).

The Contractor shall describe the detailed installation procedure of the ISTD wellfield, liquid and vapor recovery equipment, and shall provide detailed site plan layouts/figures depicting the locations of all proposed equipment, in the ISTD Work Plan. Once approved by the USACE, the ISTD Work Plan shall be followed while installing the equipment. The Contractor shall clearly communicate what components are used and where they will be assembled. System off-loading shall be the Contractor's responsibility. The Contractor shall also be responsible to prepare the site for equipment installation prior to delivery. The equipment location, power requirements, acquiring new utility service during treatment, location of the heating elements, vapor extraction and monitoring points, wells and monitoring points, as well as any trenching, compaction, or construction requirements shall be included in the ISTD Work Plan and shall be the responsibility of the Contractor.

The Contractor shall indicate in their Work Plan whether any thermal insulating cap or cover is proposed for their ISTD implementation, and shall install any thermal insulating cap or cover with proper grading and sloping as necessary to prevent stormwater ponding on the cap. Stormwater collection and conveyance systems shall be designed to not interfere with the ISTD system operations or heating zones within the target treatment areas. Only clean site soil or clean certified fill shall be used as backfill material. See the following paragraph for further definition of these requirements. The Contractor shall compact each 10"-12" loose lift to achieve a minimum of 80% of the maximum dry density, as determined by ASTM D1557 (ASTM 2021). Any thermal insulating cap or cover installed shall also function as a vapor barrier.

During the installation of liquid and vapor recovery piping, the Contractor shall be responsible for any trenching required for pipe installation, if required. Only clean site soil or clean fill will be used as backfill material and the Contractor shall provide submittal to USACE certifying that the site soil and material imported from the off-site source are clean. The backfill material shall be coarse-grained soils classified by ASTM D2487as well-graded gravel (GW), poorly graded gravel (GP), silty gravel (GM), clayey gravel (GC), well graded sand (SW), poorly graded sand (SP) (ASTM, 2020), or combination, that is free of debris, roots, wood, scrap material, vegetation, refuse, soft unsound particles, and frozen, deleterious, or objectionable materials. The maximum particle diameter shall be no greater than 3 inches. Documentation of clean fill shall be in the form of a written certification provided by the supplier of the fill material that to the best of the affiant's knowledge and belief the fill material being imported does not contain constituents of concern in excess of the Texas Commission on Environmental Quality (TCEQ) Risk Reduction Standard No. 2 MSCs industrial use standards (GWP-IND or SAI-IND), and that the material originates from a natural environment without degradation caused by human influences. The Contractor shall also prepare and submit a written certification that on site soils reused for backfill are clean and meet the requirements for

clean fill material. The reused backfill and/or imported clean fill shall be sampled and analyzed in accordance with the requirements of the DAR. Licensed quarry / mine material shall be sampled and analyzed at least once per source, or data shall be provided if prior sampling and analysis was conducted within one calendar year from delivery to the Site.

The following equipment are common components of ISTD systems and have been included here with certain applicable requirements. If these components are not utilized in the Contractor's approach, or alternative approaches are employed, these shall be described in detail in the Contractor's ISTD Work Plan.

1. Knock-out tank and moisture separator with capabilities to separate, demist and condense significant moisture from the influent soil vapor being recovered. The separator shall have sufficient holding capacity to allow constant operation without shut-downs of the overall system. Equipment shall be constructed of suitable material for its intended purpose and incorporate the necessary gauges, piping, valves, sensors, and level control switches, or equivalent, to allow its effective and continuous functioning.

2. Vacuum blower(s) with motors properly sized and sheaved to accommodate sufficient vacuum and air flow rate (plus a safety factor) for recovering soil gas from the subsurface. The blower(s) shall be engineered for continuous long-life operation in an equivalent soil vapor extraction mode. The blower(s) shall be equipped with motor starters, variable speed drives, inlet filters, check valves, silencers, relief valves, or equivalent and other components recommended by the manufacturer for its intended use. Contractor shall provide soundproofing as necessary to comply with local or county noise ordinances.

3. Heat exchangers and cooling towers necessary to provide proper heat exchange, condensing and cooling needs for the recovered vapors and other process / treatment components of the ISTD system. System blowdown and any additives shall be adequately treated prior to discharge or re-use in order to comply with applicable wastewater discharge limitations, including temperature.

4. Liquid equalization, separation, handling and treatment equipment shall be properly sized to accommodate the range of expected flows and contaminants in order to meet applicable discharge limitations for the duration of the ISTD and post-treatment operating period. Contractor shall incorporate redundancy or provisions of spare equipment to avoid unplanned shutdown of the ISTD system due to equipment failure. Emergency contingency storage of 7 days shall be planned in the event of temporary shutdown of any equipment.

5. Vapor handling and treatment equipment shall be properly sized to accommodate the range of expected flows and contaminants in order to meet applicable vapor emission limitations for the duration of the ISTD and post-treatment operating period. Contractor shall incorporate redundancy or provisions of spare equipment to avoid unplanned shutdown of the ISTD system due to equipment failure. Discharge stacks shall be properly sized with sufficient height to meet applicable dispersion requirements and securing for stability.

6. Instrumentation (indicators, sensors, transmitters, recorders, alarms, auto-dialers, etc.) and controls necessary to monitor and operate the equipment continuously, remotely, and safely, allowing certain adjustments to be made. Such equipment shall sense, monitor, record, and control key operating parameters such as liquid levels, equipment and air temperatures, gas and liquid flow rates, pressures, etc.

The Contractor shall be responsible for furnishing and installing all necessary electric service to the system, in accordance with state, local, and National Electrical Codes (NEC) and requirements. All wiring, conduits, and interconnections necessary for a fully operable system shall be the responsibility of the Contractor. Power feed wiring and distribution cables, lighting, ventilation fans, heaters, disconnects, instrumentation, controls, and other requirements shall be furnished and installed by the Contractor. The Contractor shall also provide in the ISTD Work Plan the estimated amount of energy and fuel to operate the ISTD system during the duration of the treatment period. During operations, the Contractor shall be solely responsible

for all utility costs, including but not limited to usage, distribution, and other fees associated with energy or fuel to operate all equipment related to the ISTD system.

The system control panel shall contain all local control devices, circuit breakers, power control transformers, system disconnect switches, and alarm components, as necessary to operate the system effectively and safely. The control system shall provide all functions required for complete automatic and manual operation of the system, including the following:

- System shutdown and alarm on high liquid level conditions in moisture separator and other liquid handling equipment,
- Manual start/stop for blowers,
- System shutdown and alarm on low/no flow in system, and
- Automatic call-out and notification in the event of an alarm.

The control system shall also be furnished with a means to allow for remote, real-time access to monitoring data/data retrieval for the USACE.

All work outdoors and in wet conditions shall be weatherproof. All material, equipment, and incidentals in hazardous locations shall meet NEC, National Fire Protection Association (NFPA), UL, NEMA, and Occupational Safety and Health Association (OSHA) requirements for hazardous locations. Proper electrical grounding shall be installed for all equipment as applicable.

The Contractor shall ensure that all components of the system are constructed of materials that are acceptable and chemically inert and compatible to the contaminants expected to be present in the recovered soil gas at the concentrations expected based on the site data provided. All equipment shall be rated for the environment and location where it will be operating, to include the potential for hazardous locations, as per the Texas electrical code.

All piping and other lines shall be constructed in such a manner (sloped) to prevent any media from condensing or collecting where it would not be recovered or otherwise interfere with effective operations. When completed, the system construction details shall be submitted to the USACE as part of As-Built drawings. All piping and other materials of construction shall meet the anticipated temperatures and pH levels in that part of the system or those specified by manufacturers of component equipment, particularly those after the vacuum blower or oxidation/scrubber units, if present. Contractor shall ensure that the installed piping, hoses, and orifices are of sufficient size to transmit soil vapor, groundwater/process water, blow-down, treated air, and other media without any significant pressure drop or restriction to the system. All piping/connections shall be installed, properly supported, and maintained in a neat and workmanlike manner. No PVC piping shall be used for above-ground compressed air services as per OSHA policy and manufacturer's recommendations.

All liquid storage and treatment equipment shall be secondarily contained within impermeable surfaces suitable to contain a spill or release of liquid. Impermeable means having a maximum permeability for any hazardous substance that is being contained of 10^{-7} centimeters / second at the maximum anticipated hydrostatic pressure. The secondary containment system shall be capable of containing the volume of the largest container plus 6 inches of stormwater if the area is exposed to stormwater.

The Contractor shall provide adequate dust control and use proper methods and equipment to complete a clean and neat installation with minimal impact to other site activities and operations.

2.1.8 Performance Criteria

The following criteria provide objectives and goals for different aspects of the ISTD system at the site, as well as performance of individual components of the system during start-up, testing, operation, and maintenance phases of the project. It shall be the Contractor's responsibility to ensure that all of the system components operate in a manner compatible with one another while meeting their individual and collective objectives and the overall criteria.

The remediation goal within the area defined on Drawing Sheet 02C101 and is 8,000 µg/l of MC and 300 µg/l of TCE. There are no specified soil remediation goals for this ISTD project. The performance criteria that will be used to judge the point at which the ISTD system can be shut down for subsequent groundwater sampling for verification that the cleanup goals have been met shall be proposed by the Contractor. It will be up to the Contractor to determine when to shut down the system for groundwater sampling. The groundwater sampling that will be used to determine the cleanup objectives are met shall be collected 3-4 months after the ISTD system has been shut down. Prior to turning the system off the Contractor may decide to collect soil samples or hot groundwater samples to determine if cleanup levels have been met and that unacceptable rebound of contaminants will not occur. The collection of interim samples are described below.

Hot Soil Sampling:
If the Contractor opts to use soil sampling as a means to demonstrate attainment, samples shall be collected from soil borings (completed via direct-push or other drilling methods as selected by the Contractor) at locations and at depth intervals identified by the Contractor. It is recommended that samples be collected at the midpoint between heater elements and at locations of previous elevated MC and TCE concentrations. It is also recommended that samples collected be biased towards any indications of contamination based on field PID readings, visual and/or olfactory indications.

Samples shall be collected by a hot soil sampling protocol to be specified in the UFP-QAPP. The protocol shall be based on ISTD industry practices, such as methods documented in "Soil Core Characterization Strategy at DNAPL Sites Subjected to Strong Thermal or Chemical Remediation" by Gaberell et al, Battelle, May 2002, or equivalent (Gaberell et al, 2002). Soil samples shall be analyzed for VOCs via USEPA Method 8260 (USEPA, 2006).

Contractor shall temporarily de-energize the thermal treatment in the vicinity of the soil sampling pursuant to procedures identified in its HASP. All borings shall be properly grouted or otherwise abandoned in accordance with applicable agency requirements upon completion of sampling. The Contractor shall identify the anticipated/estimated timing of their sampling events (if used) in the UFP-QAPP.

Upon determining that the shutdown criteria have been met the Contractor shall then notify the USACE that the system will be shut down so that groundwater sampling can take place to verify treatment goals have been achieved.

Hot Groundwater Sampling:
The Contractor may cease applying further thermal treatment to target treatment areas upon receipt of preliminary analytical data demonstrating single-point attainment of samples collected from monitoring wells within the target treatment area (or portion thereof). Contractor shall submit results to the USACE for review and approval and will receive a shutdown determination within 72 hours. If sequential shut-down of portions of the targeted treatment area is proposed based on the results, the Contractor shall identify the strategy/approach for the sequential shut-down(s) in the ISTD Work Plan, with discussion of how effective heating conditions (e.g., temperatures, hydraulic/pneumatic control) will be maintained in adjacent portions of the area.

Interim Shutdown:
The Contractor may cease applying further thermal treatment to target treatment areas upon indication that performance criteria identified for system shutdown has been met. The Contractor shall submit all information indicating the performance criteria is met to the USACE for review and approval and will receive a shutdown determination within 72 hours. Following shutdown, the area will be allowed to cool to temperatures allowing the Contractor to perform hot groundwater sampling to verify groundwater concentrations are below the cleanup levels as described below.

Groundwater Sampling for Verification that Cleanup Objectives Are Met:
A groundwater sampling event shall be collected from the five existing monitoring wells and seven new monitoring wells installed in the interior and surrounding area of the MC plume. Samples shall be

collected 3-4 months following shut down of the ISTD system, to allow the subsurface to cool and assess whether rebound (if any) has caused concentrations to be greater than the cleanup objectives. If samples do not meet the cleanup objectives the system shall be turned back on to continue heating until cleanup objectives are met. If cleanup objectives are met the system can be decommissioned once approval to decommission the system is received from the USACE.

System Removal/Decommissioning:
The Contractor shall submit preliminary groundwater sample results to the USACE for review and approval and will receive a shutdown determination within 72 hours. Once all wells meet the cleanup criteria and results have been approved by the USACE, the Contractor can begin decommissioning and removal of the ISTD system and equipment from the Site.

Safety and Environmental Controls:
The Contractor shall ensure that no excessive steam pressure is created in the subsurface, shall operate the ISTD in a manner that minimizes migration of the impacted groundwater plume, and shall operate in a manner that effectively captures soil gas vapors within the Contractor's established heating area. If electric heating is used, then stray voltage shall remain below 15 Volts within the Site boundaries. The Contractor shall ensure that no surface expression of excessive heat, steam or electrical current is occurring at the site. There shall be no stray voltage outside the boundaries of the Site. Contractor shall meet the requirements of local and/or state noise ordinances.

VOC removal and emissions:
The vapor recovery shall be performed throughout the heating operations and as required during the additional operating period following the heating shutdown. Contractor shall continue to provide vapor recovery and treatment during the period between system shut down and receipt of the groundwater sample results and USACE approval for decommissioning the system. All recovered vapors shall be treated for removal and/or destruction of VOCs. The Contractor shall provide equipment to remove and/or destroy the VOCs to levels to meet the substantive requirements of applicable air regulations. Further details are discussed in Section 2.6. The Contractor's method of VOC treatment shall be provided in their ISTD Work Plan.

Emergency Backup:
Contractor shall provide emergency back-up power for operation of all extraction and treatment systems in the event of utility power interruption. Contractor shall operate in a back-up mode for a minimum period of 7 days or up to a duration identified by the Contractor as being necessary to ensure protection of downgradient receptors and to control migration of contaminants outside of the targeted thermal treatment area.

2.1.9 Process Monitoring Requirements

Process Monitoring shall be performed to monitor Contractor performance in meeting the Performance Criteria described in Section 2.1.8. Process monitoring shall be performed by the Contractor throughout the ISTD program (before, during, and immediately following shut-down). At a minimum, process monitoring shall include the following parameters. Parameters are to be monitored in real time and their recommended reporting frequencies during the remediation process are indicated in Table 2-2.

Temperature:
Contractor shall obtain sufficient temperature measurements on a continuous basis to verify the minimum temperature of 100 degrees Celsius is maintained in the treatment area. At a minimum of one monitoring location for every 1,200 SF of heating area footprint, and at the periphery of the ISTD targeted treatment area at a rate of one monitor per every 80 linear feet along the perimeter of the treatment area to document the changes in subsurface temperature of saturated and unsaturated soils. The locations and numbers of temperature monitoring locations may be adjusted based on the Contractor's review of the specific targeted heating area geometry and depth variations. These locations shall provide temperature monitoring across the horizontal treatment area and at regular and discrete intervals (minimum every 4.5 feet, or more

frequently as specified by the Contractor) with depth throughout the treatment zone volume, as described/depicted in the Contractor's Work Plan and associated plans/figures.

Heating Duration:
Contractor shall operate the system once minimum temperatures have been reached to ensure continuous up-time of all components for 24 hours per day, 7 days per week for the time period it identifies as sufficient to treat and remove VOCs from the subsurface. Individual components and total system up-time operations shall be tracked and documented.

The Contractor shall specify the means and methods used to monitor power consumption (both instantaneous and cumulative), as well as consumption rates for other required utilities/services (e.g., water service).

Recovered Vapor Flow:
Contractor shall operate vapor recovery system components to optimize removal of water vapor and volatilized VOCs from the subsurface based on its ISTD technology. Vacuum and flow rates shall be monitored and managed to maximize mass removal from the subsurface and control migration of contaminants outside of the targeted thermal treatment area. Measurements shall regularly be obtained and recorded to confirm mass removal, both at discrete times and cumulatively.

Safety and Environmental Controls:
Contractor shall operate the system and monitor key indicators to ensure that certain conditions are under control. These include monitoring of subsurface pressures and vapors to prevent enhanced migration of contaminants outside of the targeted thermal treatment area and to off-site to receptors. Stray voltage monitoring shall also be performed regularly to document safe conditions both on-site and off-site. The Contractor's Work Plan shall indicate the proposed locations and means and methods for collecting field measurements to evaluate pneumatic capture and stray current potential. Noise levels shall also be monitored to confirm compliance with safe levels. If monitoring of these last two parameters indicates exceedances, mitigation steps shall be necessary to ensure continued operation of the system.

VOC Vapor Destruction Efficiency:
Contractor shall provide appropriate treatment of recovered vapors and operate and monitor said system as required by this scope of work.

Groundwater/Process Water:
Contractor shall continuously monitor recovery of groundwater/process water and generation of process blowdown as indicators of water balance with groundwater in the area of the site. Contractor shall provide their required process water supply needs (e.g., flow rates, water quality) and all anticipated wastewater (e.g., extracted groundwater, blow-down, steam condensate) information (rate, quality, location, estimated volume, etc) in the Work Plan. Documentation of the ISTD groundwater/process water, blowdown, and drip irrigation stream flow (if applicable) and total volumes shall be provided during operation. The Contractor shall furnish, install, and operate all wastewater treatment equipment required to manage and treat all wastewater discharges to meet applicable standards required by the facility that will be receiving the water discharge. In addition, the Contractor shall be responsible for providing properly trained and licensed personnel for management of the wastewater treatment and discharge equipment. The Contractor shall provide storage capacity (including secondary containment) to handle groundwater/process water for a minimum duration of 7 days.

Table 2-2
Minimum Process Monitoring Reporting Requirements

Process Monitoring	Location	Matrix	Parameter	Frequency
Temperature	Temperature Monitoring Points	Soil and groundwater	Temperature	Daily
Heating Duration	Power Supply or Control Unit	Energy	Continuous operation	Continuous
Recovered Vapor Flow	Extraction Well	Vapor	Vacuum-flow	Daily
	Blower inlet			
	Blower outlet			
Safety and Environmental Control	Treatment area subsurface and periphery	Soil and groundwater	Stray voltage Pressure Noise	Minimum weekly
		Peripheral Groundwater	VOC concentrations (Analytical) Water Level	Minimum weekly
VOC Vapor Destruction Efficiency	Vapor Treatment Equipment influent/effluent	Vapor	VOC concentrations (Analytical)	Minimum weekly .
			VOC concentrations (PID)	Daily
Groundwater Extraction/ Process Water	Condenser, etc.	Groundwater/process water	Volume-flow rate	Continuous
			Quality	As required by receiving facility

2.1.10 Effectiveness Monitoring

The Contractor shall monitor the effectiveness of the ISTD process by specifically documenting the mass of VOC recovered and / or reduction of VOC concentrations in soil. Contractor shall provide one week notice to USACE prior to any effectiveness monitoring events.

2.2 Site Security, Access, and Oversight

As discussed in Section 2.1.5, the Contractor shall be responsible for the installation of security fencing to enclose the targeted treatment area and the Contractor's operations/equipment. The fencing shall be maintained by the Contractor throughout the construction, operations, and decommissioning of the ISTD, to prevent unauthorized access to the Contractor's work area(s) and equipment. The fencing shall be provided with appropriate gates to allow personnel/vehicles access to the work area(s). The Contractor shall be solely responsible for providing adequate oversight and on-site presence throughout the ISTD construction and operations phases to prevent unauthorized access to the Contractor's work area(s) and equipment. The Contractor's selected site security plan/measures shall be included in the ISTD Work Plan.

2.3 Environmental and Sensitive Receptor Protection

The Contractor shall perform the work in a manner that does not cause any environmental pollution and damage due to other site infrastructure or operations. The Contractor shall effectively prevent soil erosion and control sedimentation as well as cross-contamination through methods as defined in the Contractor's approved ISTD Work Plan. Wastewater derived from well construction, development, and decontamination activities shall be collected and properly stored, using secondary containment, pending characterization prior to disposal.

2.4 Temporary Facilities

The Contractor shall be responsible to provide all the temporary construction support facilities required for execution of the ISTD program and comply with the requirements specified in the Contract as well as local, state and federal regulations. Equipment storage area and a decontamination pad shall be constructed. Locations of the temporary facilities shall be included in the site layout, submitted with the Work Plan. The layout shall consist of the following information:

- General layouts of temporary facilities including trailers, temporary electricity, equipment storage area, decontamination area, and other staging areas.
- Water supply, contaminated groundwater/process water handling, and sanitary facilities.

General waste material as well as packaging materials shall be removed from the work site weekly. Any dirt or mud tracked onto paved surfaces shall be cleaned away at the end of the day. At the end of the work, the areas used by the Contractor shall be cleaned and restored to their original condition. The vehicles shall be parked in the designated location, within walking distance of the construction.

Contractor shall provide portable chemical type toilets for use of the site personnel during remedial construction and operations activities. The Contractor shall also provide the equipment and materials necessary to properly decontaminate the equipment that comes in contact with the contamination. If necessary, a decontamination pad shall be constructed using a plywood base, wood timber sides, and polyethylene sheeting for containment of the decontamination fluids and sediments. It shall include pressure washing and wire brushes. The Contractor shall provide the collection system for the equipment decontamination facility.

2.5 Meetings

2.5.1 Project Kickoff and Pre-Construction Meetings

The contractor shall meet with the USACE for a Pre-Construction Conference to discuss the contract clauses and project schedules within 5 calendar days after issuance of the Notice to Proceed (NTP).

Within 25 calendar days after the issuance of the NTP and prior to mobilization, a Pre-Work Conference shall be held between the Contractor and the USACE. Contractor's superintendent, quality control personnel, safety personnel, and any major subcontractor's representative shall attend this meeting. Submittals, safety, payrolls, labor relations, environmental protection, project schedule, and procurement materials shall be discussed in this meeting. Meetings shall be held at the site or by teleconference.

The Contractor and important subcontractors shall meet with the USACE for a Pre-Construction Safety and Pre-Construction Quality Control Conference before the start of construction. The Contractor shall combine the meetings as necessary. The Contractor shall record meeting minutes and submit it to the USACE. After USACE's approval, the Contractor shall distribute the meeting minutes to other parties affected by the decisions made during the meeting.

2.5.2 Project Progress Meetings

The Contractor shall schedule and administer project progress meetings at least once a week for the duration of the project. The Contractor or the USACE may require additional progress meeting when it is deemed necessary to raise any significant questions, establish new guidelines, introduce new aspect to the project, or address any issues. The Contractor and necessary personnel as determined by the USACE shall attend these meetings. The meetings shall take place at the site, or a location convenient for the Contractor as well as the USACE and include an option for those to attend via video conference. Meeting minutes shall be prepared and certified by the Contractor and submitted to the USACE within one business day. Virtual progress meetings will be offered to TCEQ and EPA at the beginning of the project, at the mid-point, and before shutdown.

Table 2-3
Project Meetings

Meetings	To be Held Within
Pre-Construction Conference	5 calendar days after notice to proceed
Pre-Work Conference	25 calendar days after notice to proceed
Pre-Construction Quality Control Conference	Before site mobilization
Pre-Construction Safety Conference	Before site mobilization
Progress Meetings	Weekly

2.6 Regulatory Requirements

The Contractor will not be required to obtain any permits for this work unless otherwise required by the USACE. The Contractor shall still prepare documents that would be required to obtain applicable permits and these documents shall meet the substantive requirements of the permit or applicable regulation. Prepared documents will be submitted and approved by the USACE.
All remedial activities shall comply with federal, state, and local regulations and patent requirements. The Contractor shall comply with any additional regulatory requirements not specifically stated below, if it is applicable to the remedial action being performed under this scope of work.

2.6.1 Well Drilling

All drilling shall be conducted in accordance with District Rules, Pineywoods Groundwater Conservation District, Revised January 13, 2011. These rules include all the requirements of 16 Texas Administrative Code §76.1000 (Technical Requirements – Location and Standards of Completion for Wells).

A State of Texas Well Report form (Form WWD001) shall be completed and submitted to the USACE within 60 days upon completion of each well. Well Reports will be prepared for each heating element, extraction well, monitoring point, or monitoring well. The form shall be submitted by the selected licensed Texas well drilling contractor.

2.6.2 Well Sealing and Abandonment

A Well Plugging Report (form WWD004) shall be prepared for the abandonment of all wells and submitted to the USACE. The Contractor shall follow the State of Texas and any other applicable requirements for abandoning or removing the wells.

2.6.3 Air Emissions and Off-Gas Treatment

The Contractor shall provide treatment equipment capable of meeting regulatory limits for air emissions. Although no permit will be obtained the system and design shall meet the substantive requirements of an air permit from the TCEQ for discharging off-gas from the vapor recovery system after treatment, and any other vents associated with the ISTD equipment. This includes support equipment such as emergency generators. The Contractor shall collect samples to verify air emissions do not exceed applicable air limits. At a minimum, air samples shall be collected weekly from the final discharge point of the system.

2.6.4 Soil Erosion and Sediment Control

Contractor shall provide soil and erosion controls in substantive requirements with all local and state requirements.

2.6.5 Stormwater

Contractor shall prepare a stormwater pollution prevent plan in substantive requirement with all local, state and federal requirements.

2.6.6 Spill Plans

Contractor shall evaluate applicability and prepare all necessary spill plans, such as a Spill Prevention, Control and Countermeasure Plan, if it determines that it will be storing quantities of petroleum products, oils, or hazardous substances in excess of threshold quantities that trigger such plans.

2.7 Utilities

Figure 1 shows the location of known utilities near the Site.

A 14.4 KV overhead electric line runs from Karnack, Texas to LHAAP Site 18/24 located along Avenue C. From the 18/24 Site to the intersection of Avenue C and Avenue Q (north corner of LHAAP Site 29) there is a 7200 volt overhead electric line. The electric service provider for the Site is SWEPCO. The Contractor shall be responsible for contacting the local power utility company and installing a separate service drop/meter as well as all utility costs, including but not limited to usage, distribution, and other fees associated with energy or fuel to operate all equipment related to the ISTD system.

A gas line exists near Site 29 and is shown on Figure 1 and runs along 18th Street.

There is no water service available on-site. The Caddo Lake Water Supply and Leigh Water Supply Districts can be contacted for possible use of water required during ISTD system operation.

There is no sewer service near the LHAAP Site 29 and the groundwater treatment plant at Site 18/24 is not an option for water discharge. The Contractor will be required to provide water treatment and collect extracted water from ISTD processes for transport to a water treatment facility or a public owned treatment works (POTW) for final discharge.

The Contractor shall provide the requirements and details for needed utility services as part of the ISTD Work Plan.

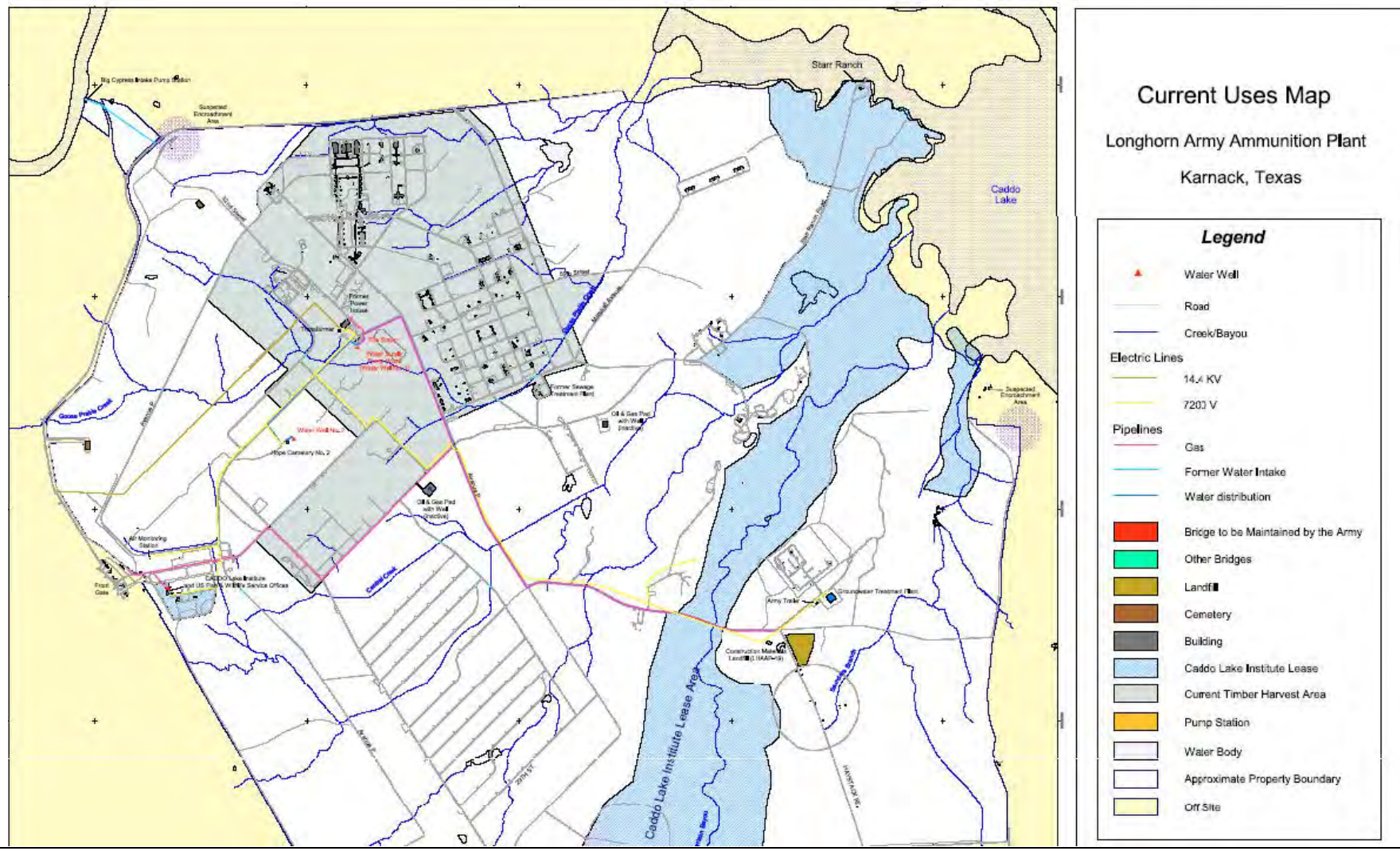


Figure 1. Utility Locations at Longhorn Ammunition Plant

2.8 Wells and Monitoring Points Abandonment and Project Survey

All heating elements/wells, temperature monitoring points, vapor recovery wells, vacuum monitoring points, and temporary injection wells shall be abandoned or removed at the completion of the accepted treatment. The USACE will determine when the treatment is complete (end of base treatment period or additional optional period[s]) based on the results of process and effectiveness monitoring. Some well abandonment may also be required prior to commencement of the ISTD.

The Contractor shall decommission/abandon any wells per the requirements of the State of Texas. In the decommissioning/abandonment of heating wells and monitoring points associated with the ISTD system the Contractor shall remove well materials down to a minimum depth of 4 feet below the ground surface before filling the well. The location of all heating wells and monitoring points with materials left in place shall be surveyed and included on a separate as-built with location information and a detail showing how these wells were abandoned and what materials remain after abandonment.

The Contractor shall maintain a well decommissioning/abandonment record for all abandoned wells. The Contractor shall also properly abandon all boreholes after completion of any soil sampling conducted as part of the ISTD system evaluation. The boreholes shall be grouted with a cement-bentonite mixture and shall be restored to pre-existing conditions. The location shall be clearly marked until the location is surveyed. As part of the as-built survey the following minimum items shall be shown:

- All monitoring well locations
- Limits of the thermal treatment area
- Locations of soil confirmation samples collected (if any)
- Existing aboveground structures and monitoring wells located outside the thermal treatment area but within the work area identified on Drawing Sheet 02C101.
- Final cover of all restored areas

Survey shall be completed by a professional land surveyor licensed in the State of Texas. Contractor shall submit the survey in electronic format (AutoCAD format or similar) in addition to providing a PDF version to the USACE.

2.9 Site Restoration and Project Closeout

Contractor shall use all reasonable precautions to prevent entrance of foreign material into the subsurface, except where specified in approved ISTD Work Plan. The Contractor shall be responsible for preserving, protecting, and preventing damage to all public and private property due to remedial construction and operation. Any damage to property resulting from any misuse or improper handling of equipment during the Contractor's operations shall be restored at the Contractor's expense. The final condition of the damaged property must be similar or equal to that which existed before the damage was done. The contractor shall maintain photos of the existing condition of the area that requires restoration.

Immediately upon determination by the USACE that no further treatment will be required, the Contractor shall remove all the equipment, material, temporary facilities, and supplies from the site and clean the entire area disturbed and used as part of the Contractor's work. If a thermal cap is used, the Contractor shall remove and dispose of it offsite in accordance with applicable local, state and federal requirements and other applicable aspects of waste disposal identified in this PWS. The site shall be restored to the condition that existed before commencement of the ISTD.

2.10 Demobilization

Once the remediation program is completed, the Contractor shall demobilize heavy equipment from the site. Upon completion of the remediation to satisfaction of the USACE, the Contractor shall remove all systems, equipment, material, and select subsurface structures from the site. Any equipment and materials that will not be taken off-site for disposal (piping, etc.) shall be decontaminated prior to leaving the Site.

2.11 Residual Management

The Contractor shall provide all labor, materials and equipment necessary for on-site storage of hazardous and non-hazardous waste material and off-site transportation and disposal of waste materials at an approved off-site disposal facility. Anticipated waste materials are drill cuttings, sediments from well development, purge water, soils and debris generated during trenching, spent carbon from water/vapor treatment, decontamination water, and water generated as groundwater/process water during the ISTD, as necessary. Wastewater treatment has been described previously.

The Contractor shall provide clean and approved 55-gallons drums or other suitable containers capable of securely containing solid or liquid wastes. The drum lids are required to be the type that can be fastened or unfastened using a clamp-type rim to produce a watertight seal. The drums shall be stored in a designated place pending disposal. The storage shall be secured to prevent unauthorized exposure. The waste shall be characterized in accordance with the sampling requirements included in the UFP-QAPP as required by the off-site disposal facilities.

The Contractor shall move drums and other containers as needed to staging areas, store them on wooden pallets and cover them with water resistant tarp. Secondary containment shall be provided for drums containing liquid waste.

The Contractor shall ensure that all operation and labeling are in compliance with federal and state Department of Transportation (DOT) regulations. The Contractor shall identify disposal facilities that are licensed to accept any on-site material in their ISTD Work Plan. The facilities accepting hazardous and/or non-hazardous wastes shall demonstrate proof of compliance with all appropriate Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements. The waste disposal facilities shall be reviewed and approved by the COR prior to removal of any waste.

All materials shall be transported for disposal in waste transportation vehicles that are properly placarded and permitted. Transportation of all hazardous wastes shall be done in a properly lined vehicle by the transporter registered with the Governing State. The manifest shall identify the USACE as the generator of all waste resulting from any operation under this contract. The Contractor shall be responsible for any action necessary to remediate any spill in transit.

2.12 Health and Safety

The Contractor shall comply with the applicable requirements of 29 CFR 1910, 29 CFR 1926.26, Engineering Manual (EM) 385-1-1 (November 2014), Safety and Occupational Health Requirements for Hazardous, Toxic, and Radioactive Waste (HTRW) Activities, USACE ER-385-1-1, and Engineering Regulation (ER)-385-1-92. The Contractor shall assign a Health and Safety Officer (HSO), who will develop, oversee and implement the Health and Safety Plan (HASP).

2.13 Project Deliverables

This section details the project deliverables that the Contractor shall submit for the USACE's approval or for information only. The USACE will collect comments and forward the comments to the Contractor.

The Contractor shall prepare and submit, at a minimum, the following project documents: ISTD Work Plan, Contractor Quality Control Plan, Uniform Facility Procedure Quality Assurance Project Plan (UFP-QAPP) for the collection and analysis of samples, HASP, and an ISTD Completion Report. The Contractor shall also submit Daily Quality Control Reports during times of active field work.

2.13.1 Submittal Procedures

The Contractor shall submit electronically and six (6) bound copies of the UFP-QAPP, Work Plan, Contractor Quality Control Plan (CQCP), HASP, and ISTD Completion Report for approval by the USACE. In addition to electronic submission, up to six (6) hard copies of each submittal may be requested by the USACE. Each of the deliverables shall be submitted in draft and final versions. All analytical laboratory results shall be submitted to the USACE as part of the ISTD Completion Report and as required for determining the shutdown criteria for the ISTD system has been met.

The Contractor shall ensure the subcontract laboratory submits electronic data deliverables (EDDs) meeting the EPA Region 6 EDD requirements for all environmental samples collected for the project.

The USACE's approval of submittals shall not be construed as a complete check but shall indicate only that the general method of construction, materials, details and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any errors which may exist. The Contractor, under the Contractor's Quality Control (CQC) requirements, is responsible for quantities, adequacies, and suitability of design, and the satisfactory construction and execution of all work. After submittals have been approved by the USACE, and prior to project implementation, the Contractor shall submit full justifications and obtain approval from the USACE for substituting of materials or equipment or changing of treatment methods from those indicated in the approved submittals.

If a submittal is disapproved, the Contractor shall make all corrections required by the USACE and promptly furnish a corrected submittal in the form and number of copies specified for the initial submittal at no additional cost to the Government. If the Contractor considers any corrections indicated on the submittals to constitute a change to the Contract, a notice shall be given promptly to the USACE.

The USACE may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the CQC representative, and each item shall be stamped, signed, and dated by the CQC representative indicating action taken. Proposed deviations from the contract requirements shall be clearly identified. Submittals requiring USACE approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby.

Transmittal Forms (ENG Form 4025) shall be used for submitting documents for USACE approval or information only in accordance with instructions on the reverse side of the form. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted.

2.13.2 ISTD Work Plan

The Contractor shall prepare and submit for approval a draft ISTD Work Plan after the notice to proceed has been issued. The Contractor shall submit responses to comments after the USACE has provided the Contractor with comments. The Contractor shall submit a final ISTD Work Plan incorporating the comments. The ISTD Work Plan shall provide a detailed description of the ISTD technology and all associated field activities. At a minimum, the ISTD Work Plan shall include all required items identified in this PWS and a project schedule.

The ISTD Work Plan shall include key components to include but not be limited to modeled estimates of energy needs for optimal temperature increase and duration necessary, equipment sizing, distribution of heater elements, process piping and instrumentation diagrams, electrical one-line diagrams, collection and treatment system layout plans, component process flow diagrams, and other information as required to describe the general intent of the system to execute the site remediation.

A project schedule, in MS Project or equivalent, shall be prepared and provided to include all major work breakdown structure tasks, milestones, anticipated task durations, sequencing of the work, and critical path items with long-lead times (including anticipated timeframes for the securing of all approvals as required

based on the Contractor's proposed ISTD implementation approach). The Contractor shall update the schedule using computer software capable of providing bar chart progress print-outs for use by the Government in interactions with the public and for discussions at progress meetings.

Based on the results of progress meetings, the Contractor shall submit schedule updates at a minimum of once per month. These submissions shall enable the USACE to assess the Contractor's progress.

2.13.3 Contractor Quality Control Plan

The Contractor shall prepare and submit for approval a draft CQCP after receipt of notice to proceed. The CQCP shall follow USACE Engineering Regulation (ER) 1110-1-12, Engineering and Design Quality Management (USACE 2006). The quality of all work shall be the responsibility of the Contractor. The Contractor shall provide and maintain an effective quality control program that complies with the Contract Document and the approved CQCP. The Plan shall meet all quality assurance and quality control requirements as specified in Section 4.2. Once reviewed and approved by the USACE, all Quality Assurance/Quality Control (QA/QC) activities shall follow the CQCP to monitor compliance with the approved ISTD Work Plan and UFP-QAPP.

Acceptance of the CQCP is required to start the remedial construction. The COR must approve the CQCP and reserves right to make changes in the CQCP and ask the Contractor to replace personnel, if required. After approval of the CQCP, the Contractor shall notify the COR in writing, of any proposed changes. The proposed changes are subject to acceptance by the COR.

2.13.4 UFP-Quality Assurance Project Plan

The Contractor shall prepare and submit for approval a UFP-QAPP prior to site mobilization. The UFP-QAPP shall define all procedures necessary to complete the process and effectiveness monitoring requirements related to the ISTD program (including but not limited to drilling, well installation, and sampling methods, etc.). The UFP-QAPP shall also describe the Contractor's interim sampling during baseline (pre-treatment), ISTD operations, and post-treatment monitoring, well and heating element installation, and sampling of all wastewaters prior to off-site disposal, and vapor phase VOCs before and after treatment. The UFP-QAPP shall be prepared and implemented in accordance with EPA-505-B-04-900A Uniform Federal Policy for Quality Assurance Project Plans Final Version 1, March 2005 (USEPA 2005).

In preparing the UFP-QAPP, the Contractor shall propose original approaches for chemical parameter measurements to allow cost reduction and remediation efficiency by abbreviated sampling, contingency sampling and/or contingency analysis, indicator or tracer analysis, onsite analytical services, and equivalency or screening methods, etc., while complying with the chemical data quality requirements stated in Section 4.3.

The UFP-QAPP shall also contain necessary technical detail and direction such that laboratory and field personnel understand all project sample analyses, QA/QC, and data reporting requirements. It shall contain sufficient direction and detail that analytical laboratory personnel understand analytical methods, method required detection limits, method QC requirements, data validation data quality objectives and reporting requirements. It shall also include all field work related forms, standard operating procedures (SOPs), or related material.

The UFP-QAPP shall contain necessary technical detail and direction such that field personnel understand all sampling and field measurement requirements. It shall contain sufficient direction and detail that on-site personnel can perform all on-site activities required to attain project Data Quality Objectives (DQOs), including: collection of samples for off-site chemical analysis, shipment of samples for off-site analyses, and performance of on-site instrumental parameter measurements, data documentation and reporting requirements. Drill cuttings and other waste generated during installation shall be contained and disposed

of in accordance with waste management procedures described in the in the Uniform Federal Policy for Quality Assurance Project Plan.

2.13.5 Chemical Data Final Report

The Chemical Data Final Report (CDFR) shall be provided with the ISTD Completion Report. The CDFR shall include a summary of quality control practices employed and all chemical parameter measurement activities conducted. The CDFR shall contain the following information:

- Project scope and description
- Any deviations from the UFP-QAPP
- Summary of chemical parameter measurements performed as contingent measurements
- Discussion of the resultant data including whether data reporting requirements were achieved
- Discussion of whether project DQOs were achieved
- Presentation and evaluation of the data to include an overall assessment on the quality of the data for each method and matrix and the usability of the data
- Internal QC data generated during the project, including tabular summaries correlating sample identifiers with all blank, matrix spikes, surrogates, duplicates, laboratory control samples, and batch identifiers
- A list of the affected sample results for each analyte (indexed by method and matrix) including the appropriate data qualifier flag (J, B, R, etc.), where sample results were negatively impacted by adverse quality control criteria
- Summary of field and laboratory oversight activities, providing a discussion of the reliability of the data, QC problems encountered, and a summary of the evaluation of data quality for each analysis and matrix as indicated by the laboratory QC data and any other relevant findings
- Conclusions and recommendations
- Data validation or usability assessment performed on data.
- Appendix containing chemistry data packages.

2.13.6 Site Specific Health and Safety Plan

The Contractor shall prepare and submit for approval a draft site-specific HASP prior to site mobilization. The Plan shall define all the components of site health and safety during construction, testing, and operation of the treatment system. The HASP shall be formatted as required in Appendix A of the EM 385-1-1. The Contractor shall submit responses to comments from the COR, and when approved, shall submit the final Plan.

Various physical or chemical hazards may be associated with the site remediation. Contractor's Health and Safety Manager (HSM) shall prepare and implement the HASP to adequately evaluate these hazards. The HASP shall incorporate elements required by OSHA, including Accident Prevention Plan as an appendix to the HASP.

In addition to describing how the exposure levels shall be maintained below maximum permissible concentrations (OSHA, American Conference of Governmental Industrial Hygienists (ACGIH), etc.), the HASP shall also address the health and safety hazards associated with each site task and operation to be performed during the remedial activities to minimize or eliminate risks.

2.13.7 Daily Quality Control Reports

The Contractor shall submit Daily Quality Control Reports to the COR during system installation and start-up and system operation. All Quality Control Reports shall be prepared in accordance with Section 4.2.

2.13.8 Process Monitoring Results

The Contractor shall submit a hard copy and an electronic version of the process monitoring result reports to the COR on a weekly basis during the Start-up and Testing Phase and Routine Operations Phase to document monitoring of the treatment process. The electronic data shall be submitted in a spreadsheet (e.g., Microsoft Excel). The process monitoring data to be included are specified in Section 3, and include the following parameters, with a short associated text description:

- Power and energy input during period,
- Temperatures at each measurement point and depth,
- Pressures at each measurement point and depth,
- Vacuums and flow rates from each vapor recovery well and through the entire system,
- Vapor VOC measurements at each location monitored,
- Mass (discrete and cumulative) of total VOCs removed,
- Running mass (discrete points and cumulative total) of VOC emissions,
- Running indication of vapor treatment removal efficiency,
- Amount of groundwater/process water generated during the period,
- Description of any wastes generated during reporting period and their disposition,
- System run-time hours, and down-time log with description of reasons and corrective actions, and
- Any other data (soil, groundwater, soil gas, etc) obtained during the period.

Additionally, the Contractor shall provide the USACE with on-line access to all monitoring data so issues can be raised and resolved in a timely fashion.

2.13.9 Effectiveness Monitoring Results

The Contractor shall submit a Technical Memorandum containing the effectiveness monitoring results and Contractor's evaluation/recommendation to the USACE after completion of the effectiveness monitoring events (baseline, operational, and post treatment phase). The electronic data shall be submitted in a spreadsheet (e.g., Microsoft Excel).

2.13.10 Field Change Requests

Field change requests shall be submitted to the USACE for approval.

2.13.11 ISTD Completion Report

Upon completion of ISTD, the Contractor shall prepare and submit for approval a draft ISTD Completion Report. The ISTD Completion Report shall include, but not be limited to the following:

- Project scope and description
- Any deviations from the originally approved ISTD Work Plan/UFP-QAPP
- Description of field operations including power and energy applied, duration of treatment, temperatures reached,
- Results of ISTD,
- All sampling results, process monitoring results, and interim monitoring results,
- Site restoration activities,
- As-built drawings,
- Wastes generated and disposition (including characterization analysis of wastes), and
- Summary of field and laboratory oversight activities, providing a discussion of the reliability of the data, QC problems encountered, and a summary of the evaluation of data quality for each analysis and matrix as indicated by the laboratory QC data and any other relevant findings
- Conclusions and recommendations based on process and effectiveness monitoring,
- Data validation or usability assessment performed on data, and
- all chemical data reports as an appendix.

The Contractor shall submit responses to comments from the USACE, and when approved, shall submit the final Plan.

Table 2-4
Deliverables Schedule

Project Deliverable	Submit Deliverable Within	Approximate time for COR Review	Type of Submittal (Approval – A; For Information Only – FIO)
Draft Work Plan and detailed schedule	30 calendar days after notice to proceed	30 calendar days	A
Draft CQCP	30 calendar days after notice to proceed	30 calendar days	A
Draft UFP-QAPP	30 calendar days after notice to proceed	30 calendar days	A
Draft HASP	30 calendar days after notice to proceed	30 calendar days	A
Final Work Plan and detailed schedule			A
Respond to Comments	14 calendar days after receiving comments	30 calendar days	
Submit Final Work Plan	14 calendar days after receipt of comments		
Final CQCP			A
Respond to Comments	14 calendar days after receiving comments	30 calendar days	
Submit Final CQCP	14 calendar days after receipt of comments		
Final UFP-QAPP			A
Respond to Comments	14 calendar days after receiving comments	30 calendar days	
Submit Final UFP-QAPP	14 calendar days after receipt of comments		
Final HASP			A
Respond to Comments	14 calendar days after receiving comments	30 calendar days	
Submit Final HASP	14 calendar days after receipt of comments		
Process Monitoring Data	weekly		FIO
Effectiveness Monitoring data (including data validation)	3 calendar days for preliminary data 60 calendar days for validated data		FIO
Daily Quality Control Reports	Daily during system installation and start-up and operations		FIO

Project Deliverable	Submit Deliverable Within	Approximate time for COR Review	Type of Submittal (Approval – A; For Information Only – FIO)
Meeting Minutes	5 calendar days after the meeting		A
Draft ISTD Completion Report	90 calendar days after site demobilization	30 calendar days	A
Respond to Comments	14 calendar days after receiving comments	30 calendar days	
Submit Final Remedial Action Completion Report	7 calendar days after comments are approved		

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3. Quality Assurance/Quality Control

3.1 Quality Control System

For ease and speed of communications, both the USACE and the Contractor shall, to the maximum extent feasible, exchange correspondence and other documents in electronic format. Correspondence, pay requests, and other documents comprising the official contract record shall also be provided in paper format, with signatures and dates where necessary. Paper documents will govern, in the event of discrepancy with the electronic version.

3.2 Contractor Quality Control

The Contractor shall be responsible for project quality control and shall establish and maintain an effective quality control system. The QC system shall include plans, procedures, and organization necessary to produce work products that comply with the project and contract requirements. The data collected during the project shall also meet the DQOs. The Contractor shall:

- Prepare CQCP that identifies the quality control areas and procedures that will be used on the project. See Section 3.
- Maintain documentation as required by the approved Work Plan
- Conduct internal QC review of the reports prior to submitting them to USACE.
- Notify the USACE of the quality problems and actions taken to correct them.
- Use professionally trained personnel throughout the project.
- Check all equipment for function and precision in accordance with the manufacturer's recommendation and maintain the records of checks. The Contractor shall make these check records available to the USACE upon request. Any equipment that doesn't work properly or cannot be calibrated shall not be used and shall be replaced promptly by the Contractor. The Contractor shall communicate with the USACE regarding failed equipment and replacement.
- Inspect all materials delivered on site to ensure the quality specified. Any damaged or unspecified materials shall not be used at the site.
- Perform audits to verify that the activities are performed in accordance with the approved ISTD Work Plan.
- Establish procedures for corrective actions when required and specify the personnel responsible for performing the corrective actions.

3.2.1 Quality Control Organization

The QC organization requires QC manager and enough qualified personnel to ensure contract compliance and is subject to approval by the USACE.

3.2.2 Definable Features of Work

A definable features of work (DFW) is a portion of work consisting of materials, equipment, supplies, and procedures which are closely related to each other, have the same controls, and shall be accomplished by the same work crew for completion. A DFW shall be sufficiently small so that the work is easily accomplished. Some examples are:

- Preparation of all Work Plans and Submittals
- Mobilization
- Utility clearance
- Well Installation and Baseline Sampling
- Trenching and piping

- Electrodes and temperature monitoring points installation
- Vapor recovery wells and vacuum monitoring points installation
- Thermal and vapor recovery system installation
- System startup
- Confirmation Groundwater Sampling
- Demobilization
- Site restoration
- Residual management
- Preparation of the ISTD Completion Report

3.2.3 Control

Contractor Quality Control is the means by which the Contractor ensures that the construction performed by the subcontractors, vendors, as well as his organization, complies with the requirements of the Contract. The controls shall be adequate to cover all operations, including both on-site and off-site activities as approved in the Work Plans.

3.2.3.1 Preparatory Phase

This phase shall be performed prior to beginning work on-site after all required plans/documents/materials are approved and after copies are available at the site. This phase shall include:

- A review of the applicable site plans (work plan, CQCP, HASP, etc.).
- A review of the contract drawings.
- A quality check to assure that all materials and equipment have been tested, submitted, and approved.
- Review of provisions that have been made to provide required control inspection and testing.
- Examination of the work area to assure that all required preliminary work has been completed and is in compliance with the Contract.
- A physical examination of the materials, equipment, and sample work to assure that they are available, conform to project specifications, and are properly stored.
- A review of HASP and applicable activity hazard analysis to assure safety requirements are met per EM 385-1-1, “Safety and Health Requirements Manual”.
- Discussion of procedures for controlling quality of the work including repetitive deficiencies, document construction tolerance, and workmanship standards for that feature of work.
- Qualities check to ensure that the portion of the plan for the work to be performed has been approved by the USACE.
- Discussion of the initial control phase.
- The USACE shall be notified at least 48 hours in advance of beginning the preparatory control phase meeting. This phase shall include a meeting conducted by the CQC Manager and attended by the superintendent, other QC personnel, and foreman responsible for the definable features. The results of this phase actions shall be documented by separate minutes prepared by the CQC Manager and attached to the document quality control report (DQCR). The Contractor shall clearly indicate its intent and plan for communication of the results of preparatory phase to applicable workers, to include materials, construction methods, workmanship standards, safety considerations and procedures, and preparatory phase meeting minutes.

3.2.3.2 Initial Phase

This phase shall be accomplished at the beginning of the remedial activities. The following shall be accomplished:

- A check of the portion of work done to ensure that it is in full compliance with contract requirements.
- Verify adequacy of controls to ensure full contract compliance. Verify required control inspection and testing.
- Establish level of workmanship and verify that it meets minimum acceptable workmanship standards.
- Resolve all differences.
- Check safety to include compliance with HASP and activity hazard analysis. Review the activity hazard analysis with each worker.
- The USACE shall be notified at least 48 hours in advance of beginning the initial phase meeting. This phase shall include a meeting conducted by the CQC Manager and attended by the superintendent, and other QC personnel, and the foreman responsible for the specific task or activity. Separate minutes of this phase shall be prepared by the manager and attached to the daily CQC report. Exact locations (i.e. CQC report number) of initial phase shall be indicated for future reference and comparison with follow-up phases.
- The initial phase shall be repeated for each new crew or when approved quality standards are not being met.

3.2.3.3 Follow-up Phase

Daily checks shall be performed to assure that control activities, including control testing, are providing continued compliance with contract requirements, until completion of the particular feature of work. The checks shall be recorded and included with the QC documentation. Final follow-up checks shall be conducted and all deficiencies shall be corrected prior to start of other tasks or activities that are affected by the deficient work. The Contractor shall not build upon or conceal non-conforming work.

3.2.3.4 Additional Phases

Additional preparatory and initial phases shall be conducted on the same definable features of work if the quality of on-going work is unacceptable, if there were changes in the applicable QC staff, onsite supervision or work crew, or if other problems develop.

3.2.4 Technical Submittal Reviews

The technical submittal review process shall be followed for all submittals that require approval prior to and during the remedial construction. A technical submittal implies that it is complete and in sufficient detail to allow ready determination of compliance with the Contract requirements. It also ensures that the requirements stated in the PWS are incorporated in the submittal.

The COR will review the technical document to determine general acceptance of the remedial approach and/or compliance with the PWS. Submitted documents are reviewed and approved under the established USACE procedure. The following are the action codes for submittals:

- “A” – Approve.
- “B” – Approved, except as noted. Resubmission not required.
- “C” – Approved, except as noted. Resubmission required.
- “D” – Will be returned by separate correspondence.
- “E” – Disapproved.
- “F” – Receipt acknowledged.
- “FX” – Receipt acknowledged, does not comply with contract requirements.

3.2.5 Field inspections

The Contractor shall be required to allow on-site audits/inspections by the USACE during the remedial construction and operation.

3.2.6 Documentation

The Contractor shall maintain and provide evidence that the required quality control activities and tests were performed as required by the Work Plan and UFP-QAPP. The records shall also include work performed by the subcontractor or vendors.

The DQCR shall be dated and signed by the CQC Manager. It shall also include weather information at the time of sampling, description of the field equipment used, health and safety inspections conducted, and any problem encountered. It shall include conforming and deficient features and a statement that equipment and material incorporated in the work. The original and one copy of these records shall be furnished to the USACE within 24 hours after the date covered in the report, except for the days when no work was performed. The DQCR shall include copies of any test reports. The Contractor shall generate all reports using QCS.

3.2.6.1 Notification of Noncompliance

The USACE will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the USACE may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor. Deficiencies cited and verbal instructions given to the Contractor by the USACE shall be entered into the DQCR.

3.3 Analytical Requirements

Samples shall be acquired, and chemical parameter measurements shall be performed in such a manner that the resulting data meets and supports data use requirements. Process monitoring, interim sampling, and air monitoring data may be of field screening quality as defined by EPA 540-R-93-071 (USEPA, 1993) and USACE EM 200-1-6 (USACE, 1997). The Contractor shall coordinate with the EPA Sample Management Office (SMO), the Regional Sample Control Coordinator (RSCC), and/or the Division of Environmental Science and Assessment (DESA) regarding analytical, data validation, and quality assurance Issues.

Field screening quality data are collected with portable field instruments (such as PIDs, pH meters, etc.). These data are used to identify the presence of a target compound or group of compounds, without actually identifying or quantifying the specific compound(s). Field screening quality is normally used for safety and health purposes but can also be used to identify media or samples that can be subject to further analysis or for relative changes over time in a comparative sense.

Process monitoring shall be performed in accordance with requirements and procedures specified by the Contractor or as otherwise required by the USACE. The results obtained by the Contractor shall be sufficient to assess operational adjustment needs for the treatment system, as well as worker health risks associated with site activities. The sampling objectives shall be included in the Contractor's UFP-QAPP and HASP.

Chemical data shall be acquired, documented, verified, and reported in a manner that assures that the precision, accuracy, and completeness requirements specified in the approved UFP-QAPP are met.

The Contractor shall perform data validation following the National Functional Guidelines (NFG) for all laboratory data used to make environmental decisions.

All chemical, survey, and GIS data are required to be submitted in the required Region 6 EDD format specified at the following website: Region 6 Superfund: Electronic Data Submission | US EPA. Other EDD formats will not be acceptable unless prior approval by the USACE is provided.

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4. Period of Performance

The period of performance for this contract (inclusive of ISTD pre-mobilization activities, construction, operation, demobilization, and restoration) is estimated as a base period of twenty-four (24) months and a six (6) month option period.

The Contractor shall prepare a Preliminary Project Schedule for all items covered in this PWS as part of the ISTD Work Plan. Start the schedule no earlier than the date on which the NTP was acknowledged. Completion of the last activity in the schedule shall be constrained by the contract completion date. The scheduling of construction shall be the responsibility of the Contractor. It is recommended, subcontractors and suppliers working on the project also contribute in developing and maintaining an accurate Project Schedule. The approved Project Schedule shall be used to measure the progress of the work, and to aid in evaluating time extensions.

After schedule approval, the contractor shall furnish the following, in writing, for a determination whether an extension of time is warranted: justification, project schedule data, and supporting evidence as the USACE may deem necessary. Submission of proof of delay, based on revised activity logic, duration, and costs (updated to the specific date that the delay occurred) shall also be provided.

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5. Measurement and Payment

Payment will be made on each bid item or sub item on a lump sum basis. The USACE has divided the bid items into base items and optional items. The USACE expects to exercise the optional bid items based on effectiveness monitoring results. Performance bonds shall be required for construction related activities (Bid Item 2).

5.1 Payment Schedule

The following sections present work items for which payment will be made at the lump sum bid price, unless otherwise noted, upon acceptance of the work by the USACE.

5.2 General Conditions (Bid Item 1)

The project administration items will be awarded together as one payment.

5.2.1 Project Preparation, Site Preparation, and Temporary Facilities

General Conditions shall include all items not covered under the other Bid items, including but not limited to the following: the Contractor's cost for insurance, bonds, fees, and other similar expenses directly related to and required by this PWS; project-dedicated supervisory staff and equipment; participation in meetings; compliance with regulatory requirements; coordination with utilities, municipalities, and subcontractors; Contractor quality control (including daily quality control reports); environmental protection and spill control; project photographs; and any other requirements or related miscellaneous items. Project management and subcontractor procurements shall be included under individual work items.

Preparation of temporary facilities shall include all labor, equipment, material and incidentals required to install and maintain all temporary facilities and the utilities servicing such facilities at the site during construction.

Measurement for Meetings shall include all labor, equipment, material and incidentals required to plan for and conduct pre-construction and weekly construction meetings in accordance with Section 3.

5.2.2 Site Mobilization

Measurement for Mobilization shall include all labor, equipment, material, and incidentals required to assemble all equipment and resources (staff, materials, etc) to the site in preparation for implementation.

5.2.3 Project Deliverables

Measurement for Project Deliverables shall include all labor, equipment, material, and incidentals required to prepare, reproduce and distribute the number of copies requested by the USACE of project deliverables as detailed in Section 3.

A lump sum payment will be made for all of the deliverables. At a minimum, Project Deliverables shall include a draft and a final version, and all required revisions of the following documents: ISTD Work Plan (including a project schedule), Contractor Quality Control Plan, Health and Safety Plan, and UFP-QAPP.

5.3 Monitoring Well Installation and Baseline Sampling (Bid Item 2)

5.3.1 Monitoring Well Installation

Measurement for installation of monitoring wells shall include all labor, equipment, materials, and incidentals required to install and develop the new monitoring wells identified for installation in the design. This effort also includes the collection and handling of waste generated during well installation and development.

Measurement for Waste Management shall include all labor, equipment, material and incidentals required for the provision, delivery, loading and sampling for the off-site transportation and disposal of uncontaminated and contaminated material, including waste generated from well construction and development. This work item shall also include disposal of all construction debris, and coordination with the appropriate disposal facilities.

5.3.2 Baseline Sampling

Measurement for baseline sampling event shall include all labor, equipment, materials, and incidentals required to collect a synoptic round of depth to water measurements and sample existing and newly installed monitoring wells in and surrounding the ISTD treatment area. Samples shall be analyzed for VOCs by an ELAP certified laboratory. Sample results shall be summarized in a memorandum and include figures and tables summarizes the depth to water measurements and analytical results. This effort also includes the collection and management of waste generated during the sampling event.

5.4 System Installation and Start-Up – Base Period (Bid Item 3)

5.4.1 Subsurface Heating Element and Monitoring Point Installation

Measurement for installation of ISTD heating elements and all associated monitoring points shall include all labor, equipment, materials, and incidentals required to install or provide heating elements (heater rods, wells, electrodes, antennae, or other) into the subsurface at depths and configured as designed by the Contractor in order to provide heat to perform the treatment. This bid item is for complete treatment of the proposed treatment area. This effort also includes the installation of temperature and pressure monitoring points, as well as groundwater wells resistant to heat effects for monitoring parameters during the remedial phases.

Measurement for Residuals Management shall include all labor, equipment, material and incidentals required for the provision, delivery, loading and sampling for the off-site transportation and disposal of uncontaminated and contaminated material, including waste generated from well construction and development and any generated from the ISTD process. This work item shall also include disposal of all construction debris, and coordination with the appropriate disposal facilities.

Progress payments will be made per a negotiated schedule between the COR and the Contractor. This item shall have a performance bond associated with it. Final payment of this bid item will be made based on receipt of the Certificate of Destruction from the disposal facility.

5.4.2 Surface Equipment System Installation

Measurement to include all labor, equipment, materials, and incidentals for the installation of vapor recovery system (co-located or separate recovery points or wells), vapor cap or cover, and vacuum blower to withdraw heated soil vapors from the subsurface. Measurement also includes any controls and appurtenances associated with vapor recovery to remove moisture and filter vapors during removal.

Measurement to include all labor, equipment, materials, and incidentals for the installation of component systems to store and treat recovered vapors and groundwater/process water prior to discharge or disposal.

Treatment of vapors may be via activated carbon, catalytic oxidation, thermal oxidation, or other. All discharged vapors and groundwater/process waters must be in compliance with regulatory limits. This item shall have a performance bond associated with it.

Measurement to include all labor, equipment, materials, and incidentals for the energizing of the entire ISTD system and all its components initially in a preliminary start-up mode to evaluate performance of each component and their interaction. Intermittent operation and testing shall continue until the target temperatures have been achieved, at which point all components shall be ready to operate fully (24 hours/day, 7 days/week) to achieve treatment conditions described in Section 3.

5.4.3 Utility Service Installation, and Connection to Power Controls

Measurement to include all labor, equipment, materials, and incidentals for the installation of an energy supply and distribution system to receive electrical, gaseous or liquid fuel to provide, meter, and control energy distribution to operate component systems and apply heat to the subsurface to achieve the treatment. Administration requirements, procurement and connection, including all fees, of an appropriate electrical or gas utility service to provide the necessary power for the ISTD system is also included in this item.

5.4.4 System Start-Up

Measurement to include all labor, equipment, materials, and incidentals for the operation of all components of an ISTD system designed and constructed to achieve the target minimum temperatures (see Section 3). Start-up will be considered complete after target minimum temperatures have been achieved in each monitoring point and at each depth interval.

Progress payments will be made per a negotiated schedule between the COR and the Contractor.

5.4.4.1 Utility Costs

Measurement to include all monthly operational utility costs such as usage, distribution, and all fees associated with the energy or fuel necessary to operate the ISTD system for the start-up period.

5.4.4.2 Off-Gas and Water Management

Measurement to include all labor, equipment, materials, and incidentals to monitor, manage, maintain, and document active handling of groundwater/process water. Also include necessary equipment and disposition of all necessary components for the treatment of vapor off-gases during operation of the system in compliance with regulatory limits. For water management costs for disposal of treated water shall be included. Water shall be tested to verify remaining concentrations of contaminants after treatment are in compliance with limits identified by the receiving water treatment or disposal facility.

5.5 System Operation – Base Period (Bid Item 4)

Measurement to include all labor, equipment, materials, and incidentals for the continuous operation, monitoring and maintenance of all components of an ISTD system designed and constructed to achieve the remedial goals. The Contractor shall demonstrate that the heat in the target area is sufficient to treat the contamination effectively based on its Work Plan and Project Schedule.

Progress payments will be made per a negotiated schedule between the COR and the Contractor.

5.5.1 Process and Effectiveness Monitoring/Sampling Events

Measurement shall include all labor, equipment, material, and incidentals required to perform measurements and monitoring on daily to weekly frequencies (depending on the parameter) to confirm on-going processes are optimized. Details of monitoring are described in Section 3.

This item shall also include all labor, equipment, materials and incidentals for any hot soil or groundwater interim sampling events opted to be completed by the Contractor as part of the Contractor's evaluation on whether the cleanup levels have been attained.

5.5.2 Utility Costs

Measurement to include all monthly operational utility costs such as usage, distribution, and all fees associated with the energy or fuel necessary to operate the ISTD system for the base project period.

5.5.3 Off-Gas and Water Management

Measurement to include all labor, equipment, materials, and incidentals to monitor, manage, maintain, and document active handling of groundwater/process water. Also include necessary equipment and disposition of all necessary components for the treatment of vapor off-gases during operation of the system in compliance with regulatory limits. For water management costs for disposal of treated water shall be included. Water shall be tested to verify remaining concentrations of contaminants after treatment are in compliance with limits identified by the receiving water treatment or disposal facility.

Off-gas and water management shall continue during the period between when the heating system is shut down and groundwater confirmation sample results are received and accepted by the USACE. Samples required for compliance with regulatory limits shall also continue during this period.

5.6 Groundwater Confirmation Sampling (Bid Item 5)

Approval for decommissioning the ISTD system will be based on groundwater sample results collected 3-4 months following shutdown of the ISTD for comparison to action levels. This item shall include all labor, equipment, materials, and incidentals to collect the groundwater samples that will be used to verify the cleanup objectives have been met for ISTD. Groundwaters samples will be collected from the five existing monitoring wells and seven new monitoring wells installed in the interior and surrounding area of the MC plume. Samples shall be analyzed for chlorinated VOC analysis with preliminary results available within 3 days after sample collection. These samples shall be collected once the Contractor determines cleanup levels have been met and shall be collected three to four months following system shut-down.

Hot soil sampling or any interim hot groundwater sampling that the Contractor may choose to complete as part of the Contractor's evaluation on whether cleanup levels are met before conducting the confirmation groundwater sampling are not included under this bid item and should be included as part of the System Operations Bid Item above. The system shall not be decommissioned until groundwater confirmation samples in the treatment area are below the cleanup levels and results are approved by the USACE.

This item shall also include the temporary storage, handling, and transportation of waste generated during the confirmation groundwater sampling event.

Following receipt of samples prepare a memorandum with figures summarizing the results of both the analytical results and temperature reading collected during the sampling event for review and acceptance by the USACE.

5.7 ISTD System Demobilization/Decommissioning and Site Restoration (Bid Item 6)

Measurement for abandonment of heating elements and wells, survey, and site restoration shall include all labor, equipment, material, and incidentals required to restore the site to pre-construction conditions. At a minimum this item shall include removal, grouting and sealing subsurface points, as well as replacement of crushed stone cover damaged during drilling operations and replacement of pavement and sidewalks damaged during construction. This work item shall also include demobilization of temporary facilities and removal of all equipment, materials, and supplies from the site.

5.8 ISTD Completion Report (Bid Item 7)

Measurement for the Remedial Action Completion Report shall include all labor, equipment, material, and incidentals required to prepare, reproduce, and distribute the number of copies requested by the COR of project deliverables as detailed in Section 3.

5.9 Optional Items

The option items will be awarded in combination or individually, based on the USACE's evaluation of process monitoring and effectiveness monitoring results. Optional items include increases to the baseline operation period of the ISTD system and performance monitoring for an increase to the baseline operation period and cost options in the event the ISTD treatment area increases over the RD treatment area based on baseline groundwater sample results or other information collected as part of the RA.

A second optional groundwater sampling event has also been included incase it is decided to collect two rounds of confirmation groundwater samples before decommissioning the system.

5.9.1 Optional Effectiveness Monitoring Post Treatment Phase (Bid Item 7)

Measurement to include all labor, utilities, equipment, materials, and incidentals required to perform a second Post-Treatment Phase groundwater sampling event. Groundwater samples shall be obtained three to four months following system shut-down, once the subsurface has cooled.

Groundwaters samples will be collected from the five existing monitoring wells and seven new monitoring wells installed in the interior and surrounding area of the MC plume. Samples shall be analyzed for chlorinated VOC analysis with preliminary results available within 3 days after sample collection.

5.9.2 Optional Continued ISTD Operation – 30 Days (Bid Item 8)

Contractor shall operate the ISTD system for 30 days. The Contractor shall assume that additional ISTD operations will involve the application of the same levels of power per heating unit as utilized for the base operational period. Measurement for added ISTD shall include all labor, equipment, material, energy costs and incidentals required for the execution of the approved treatment program proposed by the Contractor. This bid item shall include the same level of monitoring, maintenance, and documentation as utilized for the base operational period.

Payment will be made per a negotiated schedule between the USACE and the Contractor.

5.9.3 Optional Continued ISTD Operation – 30 Days (Bid Item 9)

Contractor shall operate the ISTD system for 30 days. The Contractor shall assume that additional ISTD operations will involve the application of the same levels of power per heating unit as utilized for the base operational period. Measurement for added ISTD shall include all labor, equipment, material, energy costs and incidentals required for the execution of the approved treatment program proposed by the Contractor.

This bid item shall include the same level of monitoring, maintenance, and documentation as utilized for the base operational period.

Payment will be made per a negotiated schedule between the USACE and the Contractor.

5.9.4 Optional Continued ISTD Operation – 30 Days (Bid Item 10)

Contractor shall operate the ISTD system for 30 days. The Contractor shall assume that additional ISTD operations will involve the application of the same levels of power per heating unit as utilized for the base operational period. Measurement for added ISTD shall include all labor, equipment, material, energy costs and incidentals required for the execution of the approved treatment program proposed by the Contractor. This bid item shall include the same level of monitoring, maintenance, and documentation as utilized for the base operational period.

Payment will be made per a negotiated schedule between the USACE and the Contractor.

5.9.5 Optional ISTD Treatment Area – Up to 5,000 SF (Bid Item 11)

Contractor shall provide labor, materials, and equipment to install and operate an ISTD system that encompasses an increased area from that indicated in Section 2.1.2. The increased area will be up to an additional 5,000 sf. Contractor shall also include all labor, materials, and equipment to include restoration of the larger treatment area. The overall treatment thickness shall remain unchanged from that identified in Section 2.1.2 and only the area shall increase under this option. The Contractor shall assume that additional ISTD operations will involve the application of the same levels of power per heating unit as utilized for the base operational period. Measurement for added ISTD shall include the increase in all labor, equipment, material, energy costs and incidentals required for the execution of the approved treatment program proposed by the Contractor. This bid item shall include the same level of monitoring, maintenance, and documentation as utilized for the base operational period and shall be provided as a unit based cost per square feet of additional treatment area up to 5,000 sf.

5.9.6 Optional ISTD Treatment Area – Additional 5,000 SF (Bid Item 12)

Contractor shall provide labor, materials, and equipment to install and operate an ISTD system that encompasses an increased area from that indicated in Section 2.1.2 and Bid Item 12. The increased area will be up to an additional 5,000 sf over what is covered under Bid Item 13. Contractor shall also include all labor, materials, and equipment to include restoration of the larger treatment area. The overall treatment thickness shall remain unchanged from that identified in Section 2.1.2 and only the area shall increase under this option. The Contractor shall assume that additional ISTD operations will involve the application of the same levels of power per heating unit as utilized for the base operational period. Measurement for added ISTD shall include the increase in all labor, equipment, material, energy costs and incidentals required for the execution of the approved treatment program proposed by the Contractor. This bid item shall include the same level of monitoring, maintenance, and documentation as utilized for the base operational period and shall be provided as a unit-based cost per square feet of additional treatment area.

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ASTM, 2020, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System), ASTM D2487-17. April.

ASTM, 2021, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft^3 (2,700 kN-m/m^3)), ASTM D1557-12. July.

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USEPA, 1993, Data Quality Objectives Process for Superfund, September.

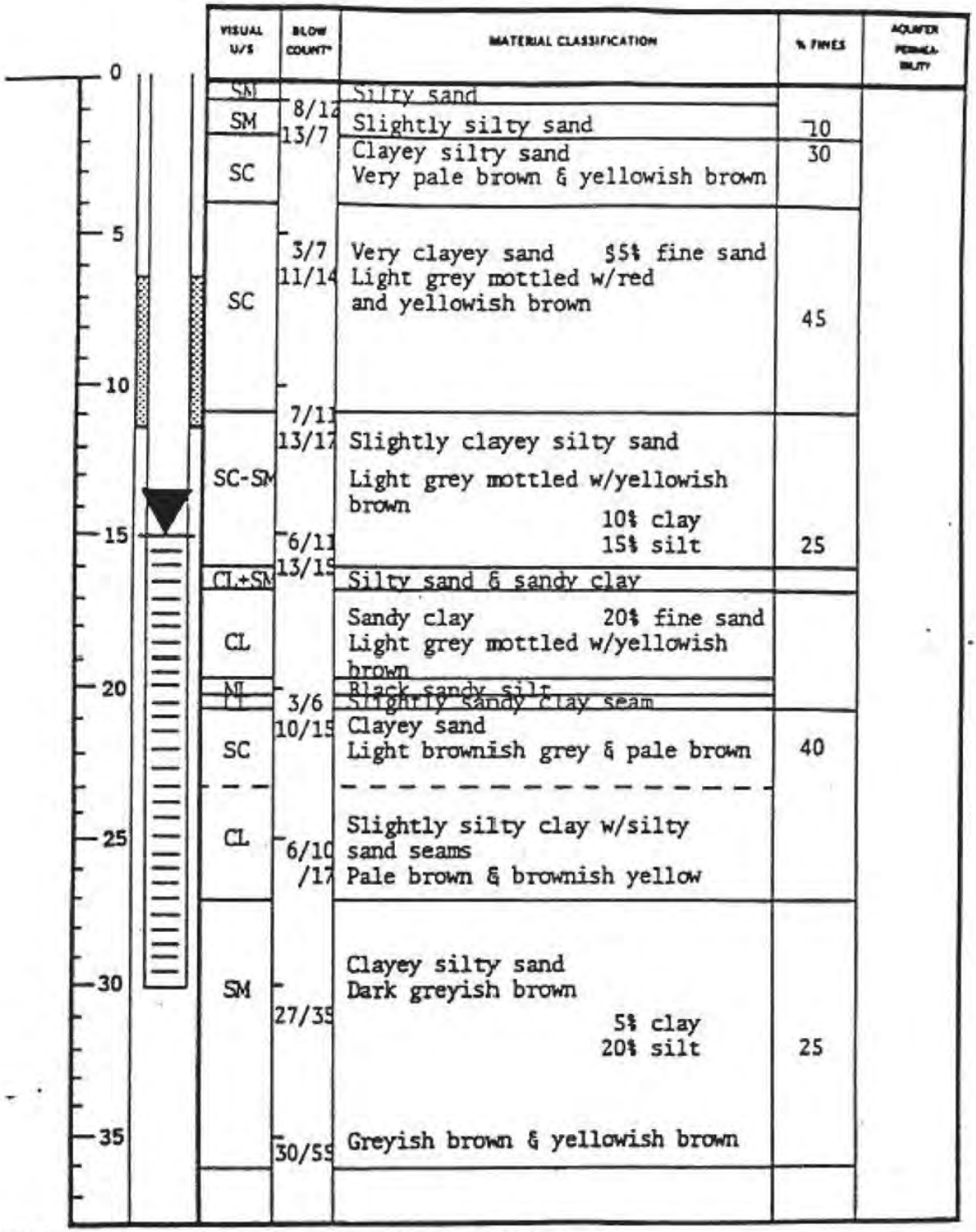
USEPA, 2005, Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, March.

USEPA, 2006, Method 8260D (SW-846): Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Revision 3.

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E

Boring and Well Construction Logs



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM		Silty sand		
SM	8/12 13/7	Slightly silty sand	10	
SC		Clayey silty sand Very pale brown & yellowish brown	30	
SC	3/7 11/14	Very clayey sand $5% fine sand Light grey mottled w/red and yellowish brown	45	
SC-SM	7/11 13/17 6/11 13/19	Slightly clayey silty sand Light grey mottled w/yellowish brown 10% clay 15% silt	25	
CL+SM		Silty sand & sandy clay		
CL		Sandy clay 20% fine sand Light grey mottled w/yellowish brown		
ML		Black sandy silt		
CL	3/6	Slightly sandy clay seam		
SC	10/15	Clayey sand Light brownish grey & pale brown	40	
CL	6/10 /17	Slightly silty clay w/silty sand seams Pale brown & brownish yellow		
SM	27/35	Clayey silty sand Dark greyish brown 5% clay 20% silt	25	
	30/55	Greyish brown & yellowish brown		

*BLOWS PER 6 INCH USING 18, 24 or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 114 DATE DRILLED 7/15/82

STUDY AREA Former TNT Production Area

ELEVATION TOP OF STEEL CASING = 243.96 ft

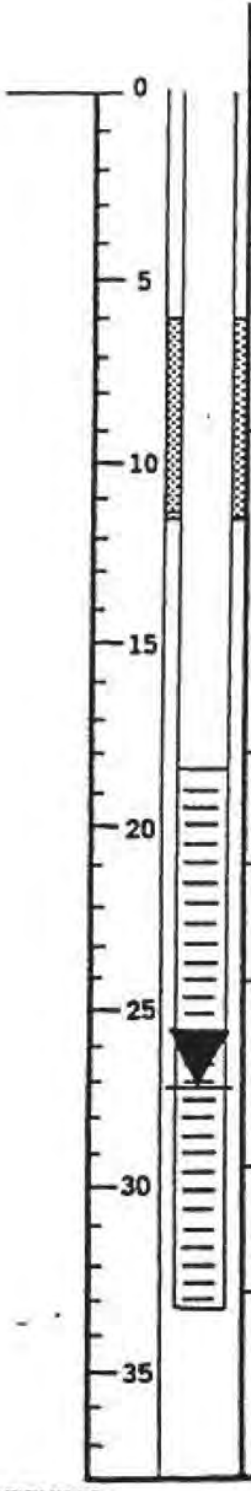
ELEVATION TOP OF PVC RISER = 242.88 ft

ELEVATION OF GROUND SURFACE = 241.13 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	8/15 /17	Silty sand Pale brown mottled w/yellowish brown	15	
CL	5/7 11/14	Sandy clay 30% fine sand Grey mottled w/yellowish red		
SC	7/12 15/18	Clayey sand 60% fine sand Light brownish grey mottled w/yellowish brown		
	5/11 15/19	Clayey sand Light brownish grey mottled w/yellowish brown		
SC+ SC-SP	6/9	Clayey sand w/seams of slightly clayey sand T1 brownish grey w/yellowish brown		
CL	14/18	Sandy clay 25% fine sand w/seam of dark grey clay		
SM-ML	18/20 22/25	Clayey silty sand Dark greyish brown 5% clay 30% silt	35	
SM+CL	27/41	Silty sand w/some clay layers 80% fine sand Olive brown 20% clay		

*BLOWS PER 6 INCH USING 18, 24 or 36 SPLIT SPOON

VERTICAL SCALE 1" = 5.0'

WELL 115 DATE DRILLED 7/14/82

STUDY AREA Former TNT Production Area

ELEVATION TOP OF STEEL CASING = 224.88 ft

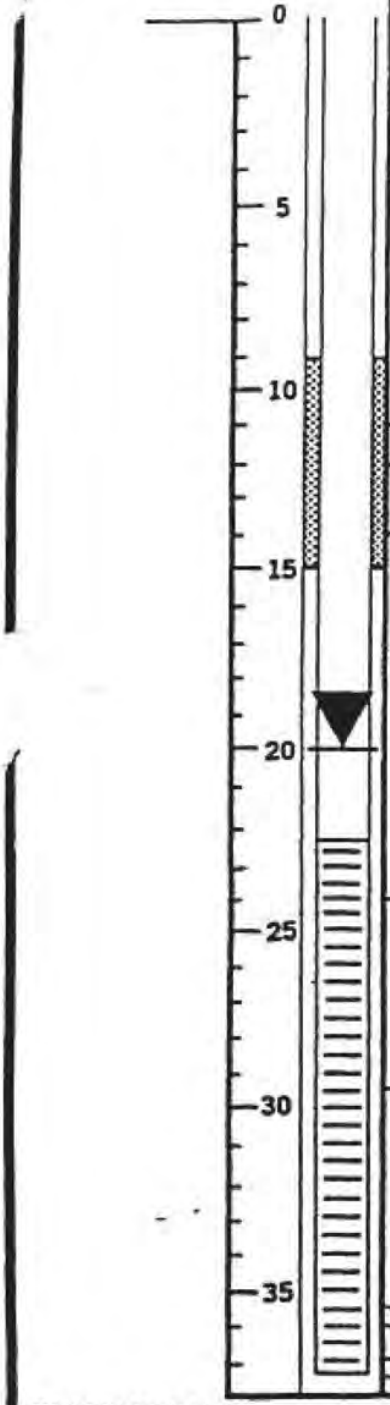
ELEVATION TOP OF PVC RISER = 224.38 ft

ELEVATION OF GROUND SURFACE = 221.90 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER FORMABILITY
SM	3/2 1/1	Silty sand Reddish brown	15	
SC	2/2	Clayey sand Light grey	30	
CL	3/7 12/19	Sandy clay 15% fine sand Light grey mottled w/red		
SC	16/19 6/10	Clayey silty sand 15% silt 15% clay Light grey mottled w/strong brown	30	
SM	14/17	Silty sand - lt. grey w/strong brn.	15	
SM+SC +CL	29/30	Thin layers of silty sand, clay sand and sandy clay		
ML-CL	7/11 12/17 19/23 10/12 13/15 22/27	Sandy clay & silt 20% fine sand Light grey mottled w/yellowish brown		
CL	11/17 23/37 42/52	Clay layers w/very thin seams of grey silty sand Very dark grey		
ML-SM	13/22 /45	Silty sand mixture Dark greyish brown 55% silt 45% sand	55	
SM-CL	12/19 /35	Transitional		
CL		Slightly sandy clay*10% fine sand		
N/A		Sandy lignite		

*BLOWS PER 6 INCH USING 18, 24 or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 116 DATE DRILLED 6/3/82

STUDY AREA Former TNT Production Area

ELEVATION TOP OF STEEL CASING = 216.32 ft

ELEVATION TOP OF PVC RISER = 216.21 ft

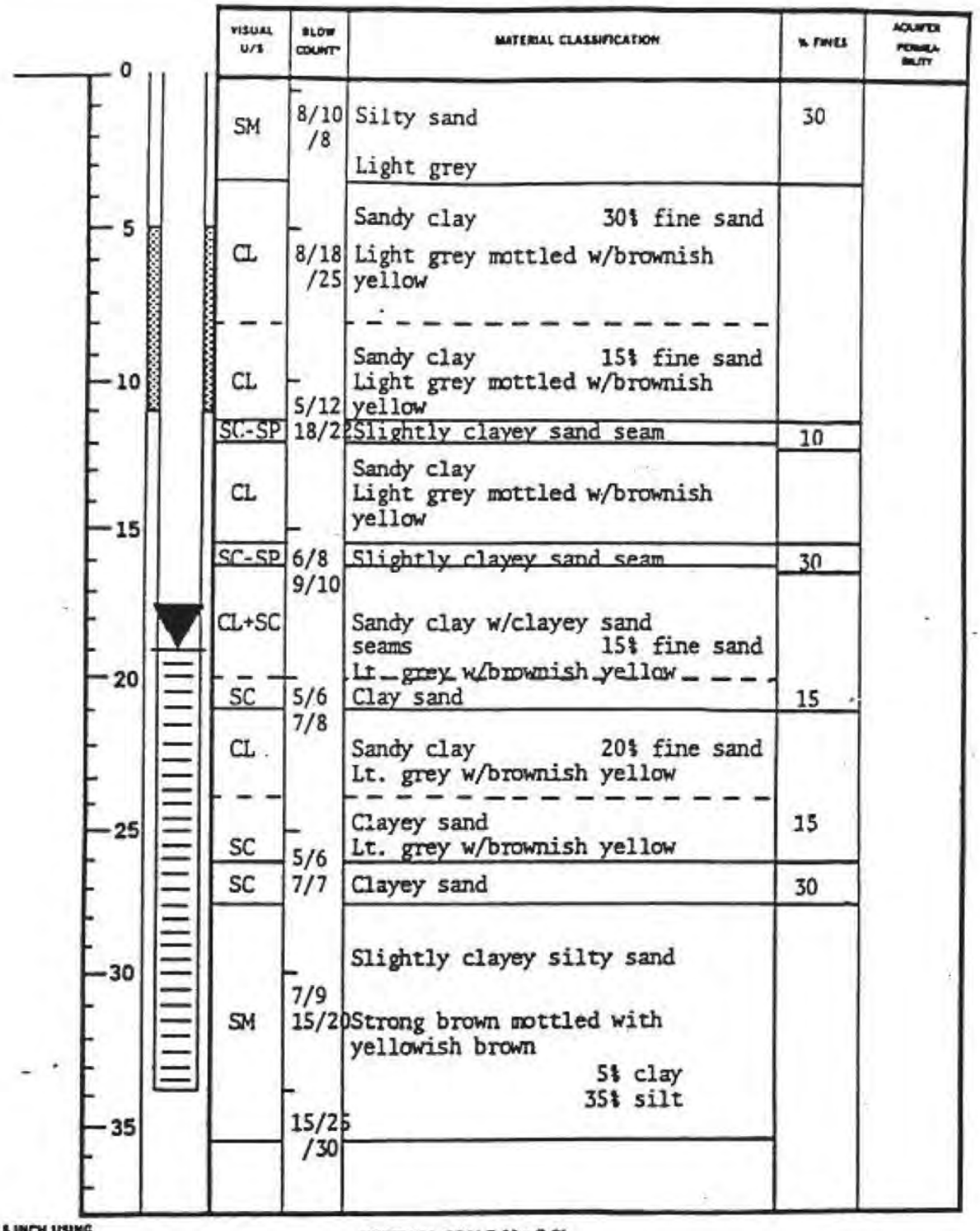
ELEVATION OF GROUND SURFACE = 213.47 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

026053



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	8/10 /8	Silty sand Light grey	30	
CL	8/18 /25	Sandy clay 30% fine sand Light grey mottled w/brownish yellow		
CL	5/12	Sandy clay 15% fine sand Light grey mottled w/brownish yellow		
SC-SP	18/2	Slightly clayey sand seam	10	
CL		Sandy clay Light grey mottled w/brownish yellow		
SC-SP	6/8	Slightly clayey sand seam	30	
CL+SC	9/10	Sandy clay w/clayey sand seams 15% fine sand Lt. grey w/brownish yellow		
SC	5/6	Clay sand	15	
CL	7/8	Sandy clay 20% fine sand Lt. grey w/brownish yellow		
SC	5/6	Clayey sand Lt. grey w/brownish yellow	15	
SC	7/7	Clayey sand	30	
SM	7/9 15/20	Slightly clayey silty sand Strong brown mottled with yellowish brown 5% clay 35% silt		
	15/25 /30			

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 117 DATE DRILLED 7/12/82

STUDY AREA Former TNT Production Area

ELEVATION TOP OF STEEL CASING = 213.72 ft

ELEVATION TOP OF PVC RISER = 213.38 ft

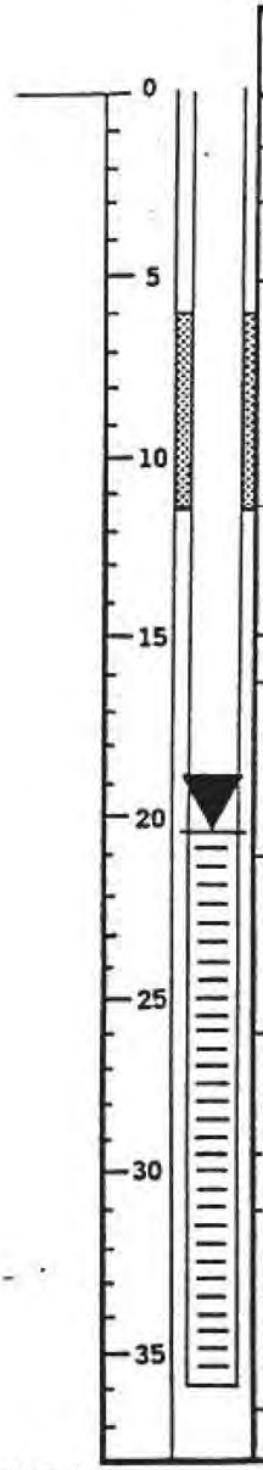
ELEVATION OF GROUND SURFACE = 210.92 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

026054



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SC-CL	5/6 /5	Clayey sand 55% fine sand Reddish grey & red mottled	45	
SM		Dry silty sand Light grey	20	
SC-CL		Clayey sand Reddish grey & red mottled	45	
SM-SC	8/16 20/27	Slightly clayey silty sand 5% clay 25% silt Light yellowish brown mottled yellowish brown	30	
SM-SC	8/15 15/20	Clayey sand 80% fine sand Light yellowish brown mottled w/yellowish brown		
SM	8/15	Silty sand seam	15	
SM-SC	19/25	Slightly clayey silty sand 5% clay 25% silt Light yellowish brown mottled w/yellowish brown	30	
SM	6/11 15/20	Silty sand Yellowish brown	25	
CL+SM		Thinly bedded clay & silty sand		
SM	15/15 18/20	Seam of slightly clayey silty sand		
CL+SC		Clay & clayey sand Dark grey to light grey		
	15/25 /30			

0 5 10 15 20 25 30 35

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 118 DATE DRILLED 7/13/82

STUDY AREA Former TNT Production Area

ELEVATION TOP OF STEEL CASING = 219.21 ft

ELEVATION TOP OF PVC RISER = 218.62 ft

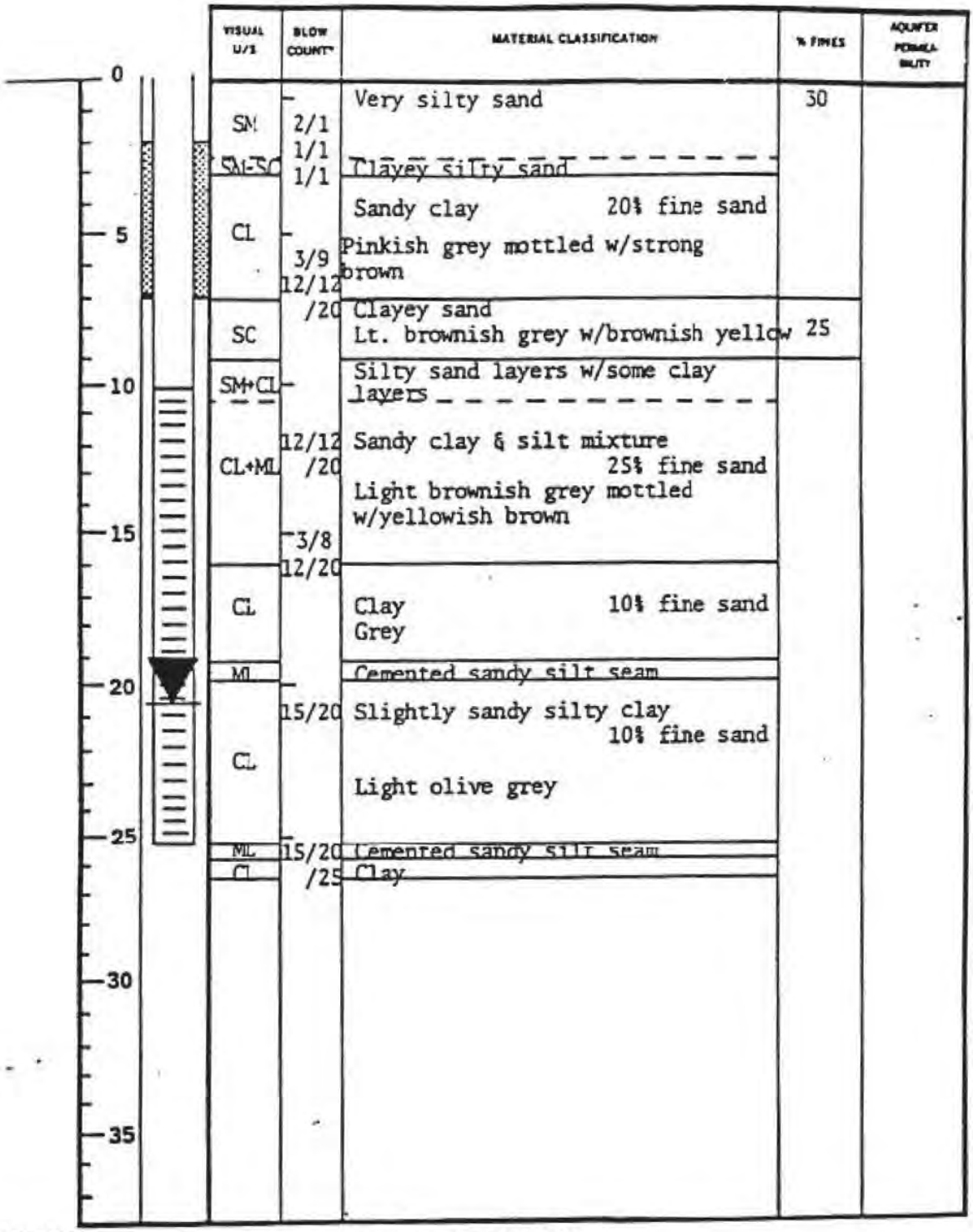
ELEVATION OF GROUND SURFACE = 216.28 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

026055



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	2/1 1/1	Very silty sand	30	
SM-SC	1/1	Clayey silty sand		
CL	3/9 12/12 /20	Sandy clay 20% fine sand Pinkish grey mottled w/strong brown		
SC		Clayey sand Lt. brownish grey w/brownish yellow	25	
SM+CL		Silty sand layers w/some clay layers		
CL+ML	12/12 /20 3/8	Sandy clay & silt mixture 25% fine sand Light brownish grey mottled w/yellowish brown		
CL	12/20	Clay 10% fine sand Grey		
ML		Cemented sandy silt seam		
CL	15/20	Slightly sandy silty clay 10% fine sand Light olive grey		
ML	15/20	Cemented sandy silt seam		
CL	/25	Clay		

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 119 DATE DRILLED 6/22/82

STUDY AREA Former TNT Production Area

ELEVATION TOP OF STEEL CASING = 222.95 ft

ELEVATION TOP OF PVC RISER = 222.16 ft

ELEVATION OF GROUND SURFACE = 219.84 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

026073

Sverdrup ENVIRONMENTAL

Site ID: 29WW08 Page 3 of 3

X Coordinate: 3306831.90 Y Coordinate: 6956127.60

Location: Longhorn Army Ammunition Plant Elevation: 209.87' Datum: NGVD

Date(s): 03/22/95 – 03/31/95 Total Depth: 140.00' Measuring Point: 212.32'

Logged By: D. Maloney Completed Depth: 140.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: −2.5' to: 130.00'

Drilling Method: Rotary Screens: type: Slotted size: .010in dia: 4.00in fm: 130.00' to: 140.00'

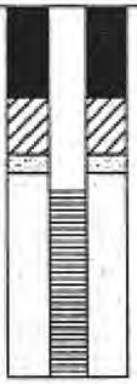
Remarks:

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 125.00'
type: Granular Bentonite Seal	fm: 125.00'	to: 128.00'
type: Secondary Sand Filter	fm: 128.00'	to: 129.00'
type: #20–40 Silica Filter Sand	fm: 129.00'	to: 140.00'
type:	fm:	to:

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-24			CL	– dark bluish gray, fine grained, moderate amount of silt and clay, wet CLAY– dark gray, some thin lenses of sandy clay, stiff, medium plasticity, dry to moist
	125		SS-25				– powder dry lignite
80	130		SS-26			SM	SAND– dark bluish gray, fine grained, some fines, wet to saturated
	135		SS-27				– some mica and thin lignite lenses
70	140					CL	– thinly laminated clay lenses, moist
	145						
60	150						
	155						
50	160						
	165						
	170						
	175						

Well Construction



026074

Sverdrup ENVIRONMENTAL	Site ID: 29WW09	Page 1 of 1
	X Coordinate: 3307426.30	Y Coordinate: 6956262.70
Location: Longhorn Army Ammunition Plant	Elevation: 208.11'	Datum: NGVD
Date(s): 03/27/95 – 03/27/95	Total Depth: 27.00'	Measuring Point: 211.02'
Logged By: K. Williams	Completed Depth: 27.00'	Static Water Level:
Contractor: Burlington Environmental Inc.	Well Casing: type: SS dia: 4.00in fm: −2.9' to: 17.00'	
Drilling Method: 6−1/4 in. I.D. Hollow Stem Auger	Screens: type: Slotted size: .010in dia: 4.00in fm: 17.00' to: 27.00'	
Remarks:	Annular Fill: type: Bentonite/Cement Grout fm: .00' to: 2.00' type: Bentonite Grout fm: 2.00' to: 9.00' type: Secondary Sand Filter fm: 9.00' to: 10.00' type: Granular Bentonite Seal fm: 10.00' to: 13.00' type: Secondary Sand Filter fm: 13.00' to: 14.00' type: #20−40 Silica Filter Sand fm: 14.00' to: 27.00'	

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
	0		SS-1			ML	CLAY– red, sit, low plasticity, moist, roots clayey SILT– gray with reddish brown mottling, low plasticity, moist
	5		SS-2				– increase rec mottling, dry to moist
	10		SS-3			CL	silty CLAY– light gray, stiff, low plasticity, dry to moist
	15		SS-4			ML	clayey SILT– light gray with black specks, stiff to very stiff, low plasticity, moist, organic matter
190	20		SS-5			SM/SC	silty SAND– light brown, minor clay, medium dense, moist
	25		SS-6			CH	silty CLAY– gray, hard, medium plasticity, moist, black organic matter
180	30						
	35						
170	40						
	45						
160	50						
	55						
150							

Well Construction

MP. EL. 211.02



026075

Sverdrup ENVIRONMENTAL

Site ID: **29WW10** Page 1 of 1

cation: Longhorn Army Ammunition Plant	X Coordinate: 3307649.40	Y Coordinate: 6956782.20
.te(s): 04/01/95 – 04/01/95	Elevation: 202.18'	Datum: NGVD
Logged By: K. Williams	Total Depth: 29.00'	Measuring Point: 204.95'
Contractor: Burlington Environmental Inc.	Completed Depth: 29.00'	Static Water Level:
Drilling Method: 6–1/4 in. I.D. Hollow Stem Auger	Well Casing: type: SS dia: 4.00in fm: –2.8' to: 19.00'	
Remarks:	Screens: type: Slotted size: .010in dia: 4.00in fm: 19.00' to: 29.00'	

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 2.00'
type: Bentonite Grout	fm: 2.00'	to: 11.00'
type: Secondary Sand Filter	fm: 11.00'	to: 12.00'
type: Granular Bentonite Seal	fm: 12.00'	to: 15.00'
type: Secondary Sand Filter	fm: 15.00'	to: 16.00'
type: #20–40 Silica Filter Sand	fm: 16.00'	to: 29.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
200	0		SS-1			SM/SC	clayey silty SAND– light brown, very fine grained, loose, wet, humus, roots
	5		SS-2			SC/SM	clayey SAND– brown, moist SAND– light brown with red and gray mottling, very fine grained, minor silt, dense, dry to moist, hematite gravel in bottom 2"
190	10		SS-3			ML	clayey SILT– gray with brown streaks, very stiff, low plasticity, moist
	15		SS-4			ML/SM	sandy SILT– light brown with light gray mottling, stiff, low plasticity, moist
180	20		SS-5			CH	silty CLAY– gray with light brown mottling, medium stiff, high plasticity, moist
	25		SS-6			SW	SAND– brown, loose, wet to saturated
			SS-7				– saturated
	30					CH	CLAY– gray with light brown mottling, medium stiff, high plasticity, moist
170	35						
	40						
160	45						
	50						
150	55						

Well Construction

MP. EL. 204.95



026076

Sverdrup ENVIRONMENTAL

	Site ID: **29WW11**	Page 1 of 1
	X Coordinate: 3307273.10	Y Coordinate: 6957154.30
Location: Longhorn Army Ammunition Plant	Elevation: 202.68'	Datum: NGVD
Date(s): 03/28/95 – 03/28/95	Total Depth: 27.00'	Measuring Point: 205.68'
Logged By: K. Williams	Completed Depth: 27.00'	Static Water Level:
Contractor: Burlington Environmental Inc.	Well Casing: type: SS dia: 4.00in fm: −3.0' to: 17.00'	
Drilling Method: 6−1/4 in. I.D. Hollow Stem Auger	Screens: type: Slotted size: .010in dia: 4.00in fm: 17.00' to: 27.00'	
Remarks:	Annular Fill:	
	type: Bentonite Grout	fm: .00' to: 9.00'
	type: Secondary Sand Filter	fm: 9.00' to: 10.00'
	type: Granular Bentonite Seal	fm: 10.00' to: 13.00'
	type: Secondary Sand Filter	fm: 13.00' to: 14.00'
	type: #20−40 Silica Filter Sand	fm: 14.00' to: 27.00'
	type:	fm: to:

Elevation (ft)	Depth (ft)	Recovery	Sample No	Blow Count	Graphic Log	USCS Code	Material Description
200	0		SS-1			ML/CL	clayey SILT– brown with red mottling, soft, slight plasticity, saturated
	5		SS-2				– light brown with light gray streaks, hard, dry to moist
	10		SS-3				
190	15		SS-4			ML	
	20		SS-5			PT	PEAT– dark brown to black, soft, saturated, roots clayey SILT– dark brown to gray, hard, slight plasticity, moist
180	25		SS-6				silty CLAY– dark gray, thin lenses of silt, medium stiff, low plasticity, moist
	30						
170	35						
	40						
160	45						
	50						
150	55						

Well Construction

MP. EL. 205.68



01226985

026077

Hole No. 29WW12

DRILLING LOG

DIVISION USACE - TRADOC

INSTALLATION LHAAP SITE 29

SHEET 1 OF 2 SHEETS

1. PROJECT LHAAP - GROUP 2 PHASE II

2. LOCATION (Coordinates or Station) SITE 29 LINE TWO TREES

3. DRILLING AGENCY GEOPROJECT INT.

4. HOLE NO. (As shown on drawing title and file number) 29WW12

5. NAME OF DRILLER JOSE HINAJOSA

6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ___ DEG. FROM VERT.

7. THICKNESS OF OVERBURDEN PENETRATED

8. DEPTH DRILLED INTO ROCK N/A

9. TOTAL DEPTH OF HOLE 20 FEET

10. SIZE AND TYPE OF BIT AUGER BIT 10" 3 3/4"

11. DATUM FOR ELEVATION SHOWN (GS or MSL)

12. MANUFACTURER'S DESIGNATION OF DRILL CME 75 3 3/4" ID AUGER 15' CME CONT. SAMPLER

13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED ___ UNDISTURBED ___

14. TOTAL NUMBER CORE BOXES N/A

15. ELEVATION GROUND WATER

16. DATE HOLE STARTED 3-18-98 COMPLETED 3-19-98

17. ELEVATION TOP OF HOLE

18. TOTAL CORE RECOVERY FOR BORING N/A %

19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1–2	FILL	SILTY CLAY, REDDISH BROWN WITH BLACK STREAKING & STAINS, ROOTS SOME SAND AND GRAVEL, DAMP (MED STIFF) SLIGHTLY PLASTIC FILL	3.5'	SAMPLE #1 0.0' to 4.0'	PID READING = 0.0 ppm IN SAMPLE
	3–4					PID READING = 0.0 ppm AT AUGER
	5–6	SM	SILTY SAND GRAY WITH BLACK AND BROWN STREAKS AND STAIN, FINE GRAINED, (MED DENSE) MOIST	5.0'	SAMPLE #2 4.0 to 9.0	PID READING = 0.0 PPM IN SAMPLE
	7	ML	SANDY SILT BROWN WITH REDDISH BROWN AND BLACK STREAKS, FINE GRAINED, MOIST TO WET (DENSE STIFF)			PID READING = 0.0 ppm AT AUGER
	8–9					
	10–11	CL-CH	SILTY CLAY BROWN WITH GRAY MOTTLING TRACE FINE SAND, MOIST, (VERY STIFF, HIGH PLASTIC)	5.0'	SAMPLE #3 9.0 to 14.0	PID READING = 0.0 ppm IN SAMPLE
	12–13					PID READING = 0.0 ppm AT AUGER
	14					
	15–16	CL	SILTY CLAY BROWN WITH GRAY STREAKING WITH TRACE FINE SAND LAYERS, MOIST (STIFF SLIGHTLY PLAS)	4.5	SAMPLE #4 14.0 to 19.0	PID READING = 0.0 ppm IN SAMPLE
	17–18					PID READING = 0.0 ppm AT AUGER
	19	CL-CH	SLIGHTLY SILTY CLAY LIGHT GRAY WITH BROWN MOTTLED TRACE FINE SAND DAMP (VERY STIFF PLASTIC)			
	19–20					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT

HOLE NO.

01226986

026078

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW12

PROJECT LHAAP GROUP 2 PHASE III | INSTALLATION LHAAP-SITE29 | SHEET 2 OF 2 SHEETS

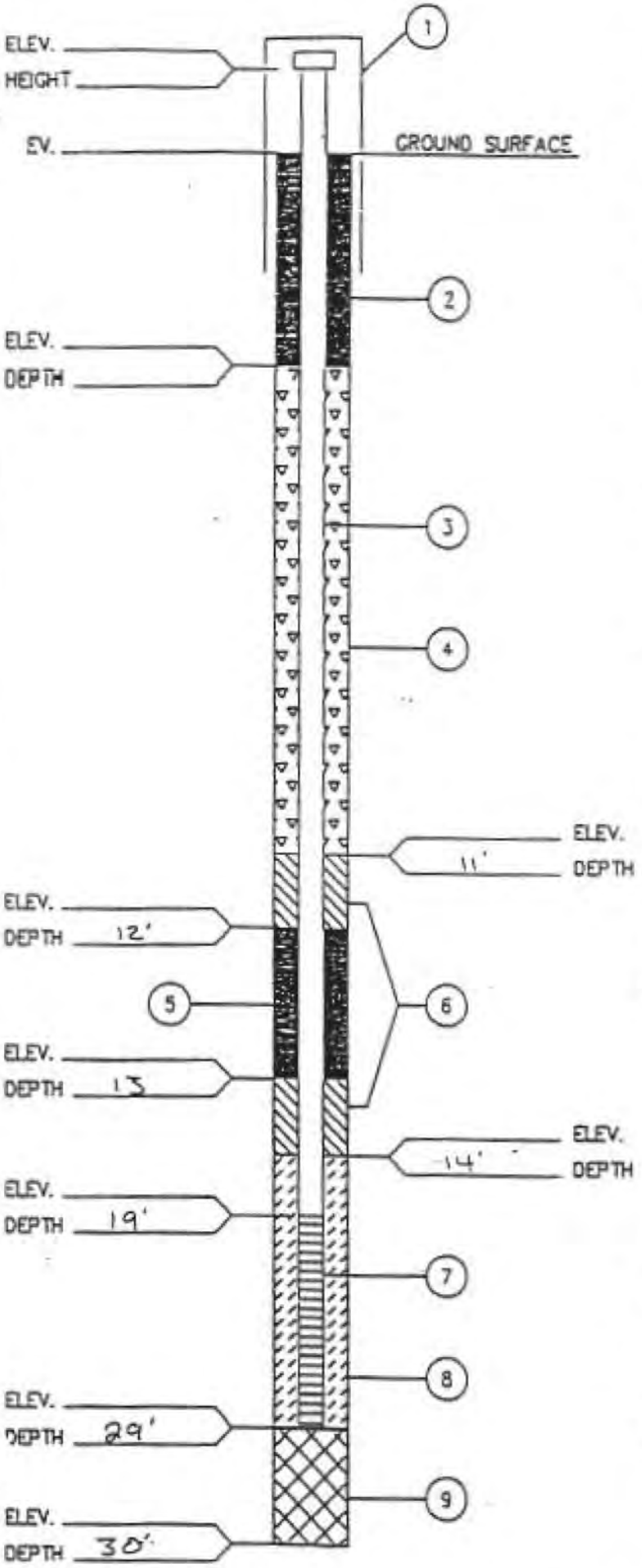
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	CL-CH	SANDY SILT BROWN WITH GRAY MOTTLING, FINE GRAINED, DAMP TO MOIST (MED STIFF, BRITTLE WHEN NOT CRUSHED)		SAMPLE	PID READING = 0.0 ppm IN SAMPLE
	22			3.75	#5	
	23	ML			19' to 24'	PID READING 0.0 ppm @ AUGER
	24					
	25	CL	SILTY CLAY, DARK BROWN WITH BLACK AND GRAY STREAKING AND STAINING, TRACE FINE SAND, SOFT TO MED STIFF, CRUMBLY PLASTIC) DAMP TO MOIST		SAMPLE #6	PID READING = 0.0 ppm IN SAMPLE
	26			4.0	24' to 29'	
	27					PID READING = 0.0 ppm @ AUGER
	28	CL-CH	SLIGHTLY SILTY CLAY DARK BROWN WITH GRAY MOTTLING TRACE FINE SAND, DRY TO DAMP (VERY STIFF, PLASTIC)			
	29	SM	SILTY SAND BROWN WITH GRAY MOTTLING F-VF GRAINED, LAMINATING, DRY TO DAMP DENSE		SAMPLE #7	PID READING = 0.0 ppm IN SAMPLE
	30			5.0	29' to 34'	
	31	CL	SANDY SILT AND CLAY DARK GRAY FINE GRAINED, LAYERED (1CM THICK) OF SILT SAND AND CLAY HORIZONTALLY 38' (STIFF VERY BRITTLE) PLASTIC DRY TO DAMP			PID READING = 0.0 ppm @ AUGER
	32					
	33					
	34		TD 34'			16:00 BOREHOLE WILL BE LEFT OPEN OVERNIGHT TO DETERMINE IF WATER WILL DEVELOP ▽ LEVEL AT 14"

WELL TO BE INSTALLED WITH FORM DEPTH 30'
BOTTOM SCREEN 29' to 19'
4" ID WIRE WOUND 304 STAINLESS STEEL #10 SLOT
PRIMARY FILTER PACK 30 to 14'
SUCCESSAND 14' to 13'
BENT. 13' to 12'
SUCCESSAND 12' to 11'
BENTONITE 11' to 8'
GROUT
SUCCESSAND 8 to 7'
GROUT 7' to SURFACE

END FORM (ER 1110-1-1803) | PROJECT | HOLE NO.

01226987

026079



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW12

DATE 3-19-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)

   NA

3. SOLID PIPE TYPE 304 S.S. Sch 40, 4" I.D

   SOLID PIPE LENGTH 19' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)

   Bentonite chip

6. TYPE OF SECONDARY FILTER PACK

   Silica Sand (30-70)

7. SCREEN TYPE Sch 40, 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 wire wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK

   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand (16-30)

10. DRILLING METHOD HSA

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

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Hole No. 29WW13

DRILLING LOG | DIVISION: HOTULSA - USACE | INSTALLATION | SHEET 1 OF 2 SHEETS

1. PROJECT: LHAAP - Group II Phase III
2. LOCATION (Coordinates or Station): Karnack, TX - Site 29
3. DRILLING AGENCY: GEO Projects
4. HOLE NO. (As shown on drawing title and file number)
5. NAME OF DRILLER: Amador Hinojosa
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: 62'
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 62'
10. SIZE AND TYPE OF BIT: 4" Tr. cone, Mud Rotary
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Mobile Drill B-61
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 3-26-98 | COMPLETED 3-31-98
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING
19. SIGNATURE OF INSPECTOR: Blanchard

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
		(1)	See boring log for shallow well 29WW12 for lithologic description from surface to 34'			This boring is located adjacent to shallow well 29WW12 installed 3-19-98. Total depth of 29WW12 was 34' screen was set from 29'-19'. No samples will be collected until 34'.
		(2)	These locations (shallow & Intermediate wells) were moved 200' North, 25' due to muddy conditions at original staked site. CME rig was stuck trying to access & moved to berm area.			
		(3)	No PID readings were measured above ambient from 0-34' samples			
	34	SM	See Silty Sand, med. gray, Hor: 2. laminated, sl. moist, tr. clay, v. dense	38/76/ 150 14"	SS-1 34'-36' Rec 20 inches	Begin drilling w/ Mud rotary 4" bit on 3-26-98 @ 0800. Collect sample from 34'-36' @ 1020
	35					
	36	CL	Silty clay, Med. gray, some sand, laminated, sl. moist			
		CL	As Above, Hor: 2. laminated w/ sand in partings, sl. moist v. stiff to stiff	17/42/ 56	SS-2 36'-38'	Note: Samples are collected using 3" Split Spoon. Driven 18" due to high blow counts.
	37					
	38	CL-CH	Silty Clay, Med Gray, v. Stiff, sl. moist	17"		
		SP	Sand, poorly sorted, sl. moist, med. gray v. fine sand, dense			
		SP	As Above	23/30/ 50	SS-3 38'-40'	
	39	CL	Silty Clay, Dk. Gray, laminated (Hor: 2.) w/ Sandy Partings (Lt. Gray), Med-Stiff, sl. moist			← Possible Confining Zone?
		CL-CH	Silty Clay Dk. Gray, v. stiff - Hard, sl. moist	18"		End Drilling @ 40' 3-26-98 1140 ←
	40	CL	Silty Clay, Med Gray, laminated, stiff, sl. moist, Sandy Partings (Lt. Gray)	17/23/ 37	SS-4 40'-42'	
	41	SM	Sandy Silt, Med Gray, sl. moist, tr. clay, dense	17"		Resume drilling w/ 4" bit 3-31-98 @ 0840 at 40'. Samples will be collected w/ a 2" S.S.
	42	SM	As Above	25/48/ 54	SS-5 42'-44'	
	43	CL	Silty Clay, Dk. Gray, v. stiff - Hard, sl. moist	18"		
		SM	Silty Sand, Med. Gray, fine sand, sl. moist, dense, laminated appear.			
	44	CL	Silty Clay, Dk. Gray, v. stiff - hard, sl. moist			
		SM	Silty Sand, Med Gray, wet, laminated appear., dense	21/40/ 50	SS-6 44'-46'	←
	45	CL	Silty Clay, some Sand, med gray, v. stiff, sl. moist, laminated	18"		
	46	SM	Sandy Silt, med gray, sl. moist silty, fr. clay, med. dense	21/30/ 46	SS-7 46'-48'	
	47	CL	Silty Clay, laminated alternating dk - lt. gray layers of sand impurities, hard, sl. moist	9"		

ENG FORM 1836 MAR 72 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE 29WW13

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DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW13

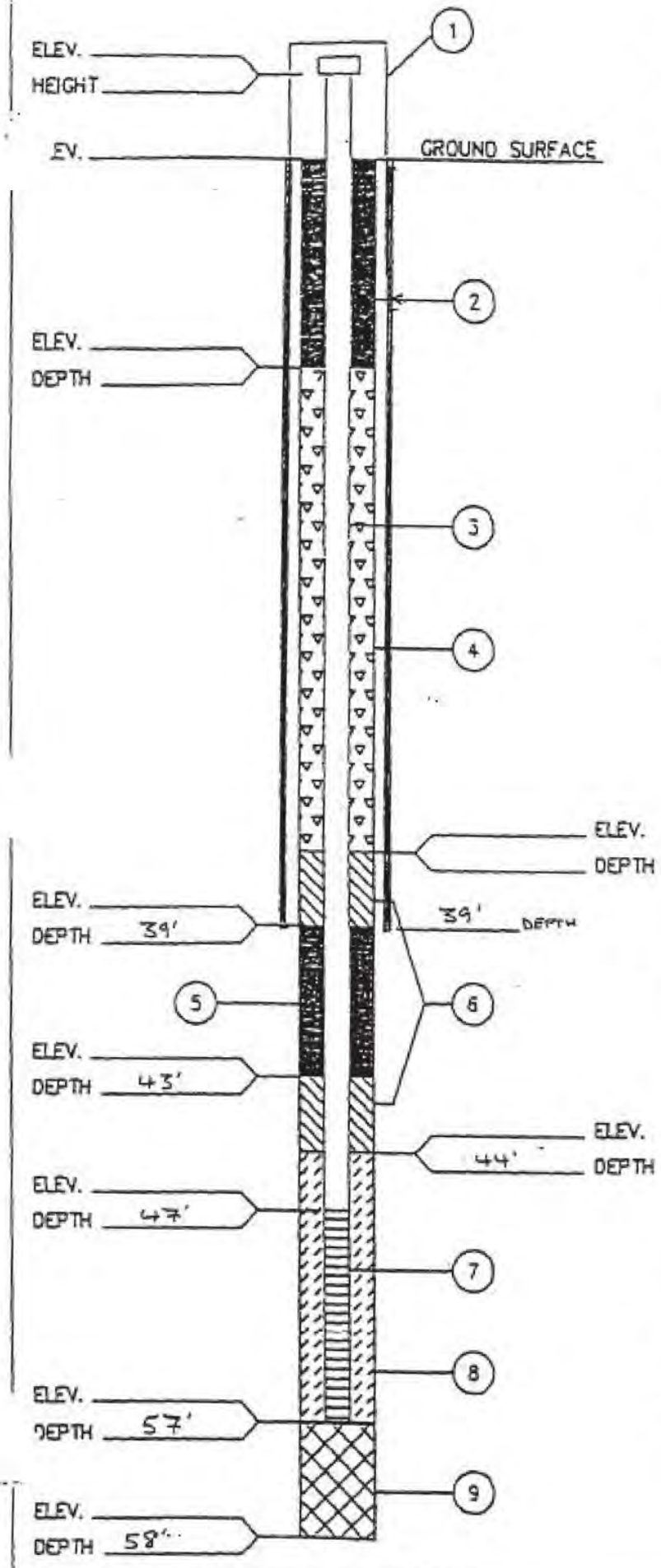
PROJECT LHAAP, Group II - Phase III | INSTALLATION | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	48	SM	Sandy silt, med-gray to Clay, moist, laminated appearance increasing clay w/depth (Logged in bottom of sample)	23/42/ 81	SS-8 48'-60'	
	49			8"	HNU = 0 ppm in spoon	
	50	CL	Silty Clay, med. gray, some f Sand, V. stiff, sl moist	29/73/ 140	SS-9 50'-52'	Laminated alternating Light - gray
	51	SM	Silty Sand, med gray, moist, med dense			
	52	CL	Silty Clay, med-gray, tr-some Sand, dry - sl moist, V. stiff	18"	HNU = 0 ppm in spoon	
		CL	As Above	34/53/ 77	SS-10 52-54	
	53	SM	Sandy silt, med-gray, sl moist, tr. Clay	18"	HNU = 0 ppm in spoon	
	54	SP	Sand, poorly sorted, tr silt, med-gray, fine grained, hard, dense	20/68/ 150	SP SS-11 54-56	
	55				HNU = 0 ppm in spoon	
		CL	Silty Clay, tr. sand, dk brown-gray mottled, V. stiff			
	56	SP	Sand, poorly sorted, tr silt, med-gray, fine grained hard, dense	38/91/ 86	SS-12 56-58	
	57			12"	HNU = 0 ppm in spoon	
	58	SP	As Above	39/72/ 77	SS-13 58-60	
	59					
	60	SP	As Above		SS-14 60-62'	
	61					
	62					
	63		T.D. @ 62' 3-31-98 @ 1500			Performed Gamma & Resistivity Log in Borehole on 3-31-98 @ 1530. Initial test was run incorrectly under file name 29WW13. The test was properly performed and should use data under file name 29WW13A.
	64					
	65					
		①	Borehole was grouted w/ tremie pipe on 3-31-98 from bottom to ground surface.			Proposed well construction 8" ø Steel casing 0-39' 4" 304 SS Screen (.010 slot) 57'-47' 16-30 Filter Sand 58'-44' 30-70 Sugar Sand 44'-43' Bentonite Seal 43'-40' ~~30-70 Sugar Sand 40'-39'~~ 4" 304 SS Riser 47'-3' Above
		②	8" ø steel casing set at 39' and grouted from 6 to Atom ft surface via tremie pipe on 4-2-98 @ 1230.			
		③	Monitoring well installed on 4-3-98 at 1230			

ENG FORM 1836-A (ER 1110-1-1801) OPO 1990 O-438-665 | PROJECT | HOLE NO. 29WW13

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MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29W013

DATE 3-31-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)
   8'ø steel casing

3. SOLID PIPE TYPE Sch 40, 304 S.S, 4"ID

   SOLID PIPE LENGTH 47 ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)
   Bentonite chip

6. TYPE OF SECONDARY FILTER PACK
   silica sand (30-70)

7. SCREEN TYPE Sch 40 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 wire wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK
   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD Mud Rotary

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

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Pilot Boring Hole No. 29WW14

DRILLING LOG | DIVISION | INSTALLATION | SHEET 1 OF 2 SHEETS

1. PROJECT: LHAAP-Site 29: Phase III RI
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY: GEO Projects'
4. HOLE NO. (As shown on drawing title and file number)
5. NAME OF DRILLER: Amador
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE 86'
10. SIZE AND TYPE OF BIT Mud rotary 4" Tricone
11. DATUM FOR ELEVATION SHOWN (MSL or USL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Mobile Drill B-61
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER 3-3-98 Gauged
16. DATE HOLE STARTED 2-25-98 COMPLETED 3-4-98
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: David W. Guy

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			see 29WW07, 29WW08 & log for 29SB52 for lithologic description from surface to 68'			Boring is located by well cluster 29WW07 & 29WW08. Based on boring logs for these wells and Gamma log for SB one 29SB52 we will drill to 68' and then begin continuous sampling. See Boring logs for these locations for lithologic description for surface to 68'. Begin set up @ 1530 2-25-98 - end at 10 day
	68	CL	Silty Clay, Dark Brown w/ some gray mottling, dry, very hard, tr. black deposits, tr. fine sand	43/82 75/130 2.0'	SS-1 (66-68')	Begin drilling 3-3-98 @ 0815
	69				Normally inserted	0920 - Informed Randy we will set casing @ 46' to seal off upper zone based on boring logs from 29WW07 & 29WW08. Informed Armador of casing depth. Armador advised to have equipment on hand to set 24'. Armador thanks me for info
	70		As Above slight increase in sand w/depth	43/104 100/150 2.0'	SS-2 (70-72') max=0 in sample	
	71					
	72	CL	Silty clay. Dark gray to black w/ some DK brown oxidation mottling, V. thin silt and fine sand layers - laminated to horizontal, V-plastic silty clay, some Fine sand in silty clay zones. Damp to moist (Very stiff)	73/133 100/150 2.0'	SS-3 (72-74') Normal	
	73					
	74			75/102 200/15" 1.2'	SS-4 (74-76') max=0 from in sample	1420 - Collect sample from 68'-70' & 70'-72'
	75					
	76	CL SP	Silty Clay - As Above 4" Sand, poorly sorted, gray, moist to wet, tr. black deposits, some silt, lam. of clay	49/199 300	SS-5 (76-78')	Hit sand @ 74.5
	77					END drilling @ 78' for day on 3-3-98, 1715
	78	SP	As Above, laminated black/ bedded layer @ bottom 5" tr. silt, tr. clay, moist to wet		max=50 from sample	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO. 29WW14

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DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW14

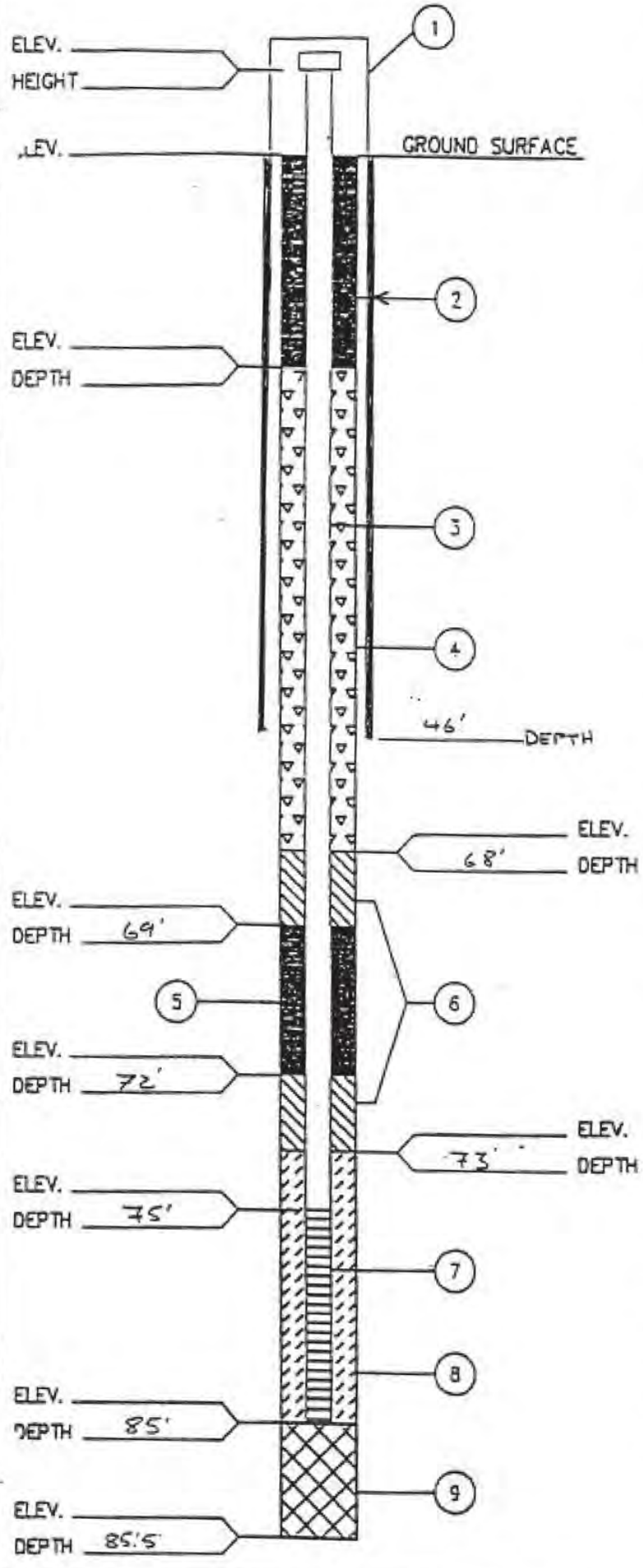
PROJECT: LHAAP-Sit 29: Phase III RI | INSTALLATION: Blow Counts | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	78	SP	Sand, poorly sorted gray, very fine grained, wet, some slag silt, dense	46/128/300 12"	SS-6	Begin drilling 0805 on 3-4-98 at a depth of 78'- Clean out boring before drilling.
	80 81	SP	As Above	70/123/180 8"	SS-7	
	82 83	SP	As Above	62/137/167 8"	SS-8	
	84 85	SP	As Above	70/127/223 7"	SS-9	
	86 87		TD. 86' 3/4/98 1200 This boring was grouted 3/4/98 w/ tremie pipe from bottom to surface.			29WW14 Last sample collected from 84'-86' in fine grained sand. Will grout boring and move rig to install well. Well construction details: (Proposed) TD 85.5 screen 85'-75' Primary Sand 85.5-72 Filter 72-70 Bentonite 70-68 Filter 68-67 Grout 67-surface Riser 75-3' above grade screen 4" 0.010 slot 304 SS Riser 4" 304 SS

ENG FORM 1836-A (ER 1110-1-1801) | PROJECT | HOLE NO. 29WW14

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MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW14

DATE 3-4-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)
   8"Ø Steel Casing

3. SOLID PIPE TYPE Sch 40, 304 S.S. 4" I.D.

   SOLID PIPE LENGTH 75' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement-bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)
   Bentonite chips

6. TYPE OF SECONDARY FILTER PACK
   Silica Sand (30-70)

7. SCREEN TYPE Sch 40, 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 Wire Wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK
   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD Mud Rotary

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

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Hole No. 29WMW15026086

DRILLING LOG | DIVISION | INSTALLATION | SHEET 1 OF 2 SHEETS

1. PROJECT: LHAAP-Site 29: Phase III RI
2. LOCATION (Coordinates or Stations)
3. DRILLING AGENCY: GEO Projects
4. HOLE NO. (As shown on drawing title and file number)
5. NAME OF DRILLER: Jose Landeros Gilbert Navarro Mike Rathbone
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 31'
10. SIZE AND TYPE OF BIT: 3¼" HSA ; 6 5/8 ID HSA - Well Install.
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 75
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 2-22-98 | COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: David W. Griggs

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0–4	CL	Silty Clay. Mod.-Brown mottled, roots - Iron stain, black stringers mod stiff sl moist, moist (bottom 6") tr gravel	3.8'	CS-1 *	Background HNU = 0 ppm CO 1310 Std Drift @ 1315 * CS = Continuous Sampler HNU = 0 ppm in spoon HNU = 0 ppm @ boring
	4–6	CL	Silty clay, mod. brown, moist, soft, lt. brown dense to wet	5.0'	CS-2	HNU = 0 ppm in spoon
	6–9	CL	Silty Clay, mod brown-gray mottled, lt/dark rock stringers very stiff, sl moist			
	9–14	CL	Silty Clay mod brown-gray mottled stiff - very stiff, dark brown dense sl moist, tr sand, tr roots (becomes)	5.0'	CS-3	HNU = 0 ppm in spoon HNU = 0 ppm @ boring
	14–16	CL	As above - moist w/ brown mod stiff stringers	5.0'	CS-4	HNU = 0 ppm in spoon HNU = 0 ppm @ boring
	16–18	CL	Silty Clay, Gray-brown, moist Lt brown dense, soft tr. black-brown deposits			
	18–19	CL	As Above but mod stiff & sl moist			
	19–20	SM	Silty Sand, med brown w/ gray layers moist, crumbles	3.1'	CS-5	HNU = 10 ppm in spoon w/ slow steady response

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

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LING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 2916W15

LHAAP - Site 29: Phase III RI | INSTALLATION | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	SM	Silty Sand, med brown w/gray layers, moist, crumbly		CS-5 (cont)	HNU = 10 ppm in 3 ppm (slow steady response) HNU = 20 ppm @ boring
	22					
	23					
	24	SM-SC	Silty Sand; sandy clay med. brown w/gray layers; wet, tr. roots	50'	CS-6	HNU = 250 ppm in spoon hole (slow steady response)
	25					
	26					
	27	GP CL	Sandy gravel w/sand & cobbles, Gray-brown wet Silty clay - med brown-gray layered cl. moist yellow brown layers			
	28	CL	Silty clay - med-dk gray striated very stiff thinly, slt moist			Poor chip
	29					
	30		As Above	Auger cuttings		Will drill to 31.0' T.D. Set screen 30'-20' Primary Filter 31-17' Secondary Filter 17'-16' Bentonite 16'-13' Secondary 13'-12' Grout 12'-surface Riser 20'-3' Above grade
	31		T.D. 31.0' 2-22-98 @ 1415			Well Materials SCREEN - 4" 304 SS 10 slot Riser 4" 304 SS

EM FORM [illegible] (ER 1110-1-1801) [illegible] | PROJECT | HOLE NO. 2916W15

01226996

Hole No. 29WW15 026088

DRILLING LOG	DIVISION: USACE Tulsa
PROJECT: LHAAP Phase III RI	INSTALLATION: LHAAP site 29
LOCATION (Coordinates or Station): Site 29 - Karnack, TX	SHEET 1 OF 6 SHEETS
DRILLING AGENCY: GPI	10. SIZE AND TYPE OF BIT: Auger Bit for 3 3/4
4. HOLE NO. (As shown on drawing title and file number): 29WW15	11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
5. NAME OF DRILLER: Joe Hinojosa	12. MANUFACTURER'S DESIGNATION OF DRILL: CME 75 3 3/4" I.D. augers / 5 sampler
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 6; UNDISTURBED 0
7. THICKNESS OF OVERBURDEN: Penetrated 31 ft.	14. TOTAL NUMBER CORE BOXES: N/A
8. DEPTH DRILLED INTO ROCK: N/A	15. ELEVATION GROUND WATER:
9. TOTAL DEPTH OF HOLE: 31.0 ft. below Grade	16. DATE HOLE: STARTED 2-22-98; COMPLETED 2-25-98
	17. ELEVATION TOP OF HOLE:
	18. TOTAL CORE RECOVERY FOR BORING: N/A %
	19. SIGNATURE OF INSPECTOR: CPG

ELEVATION a	DEPTH (Ft) b	LEGEND USC c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1	CL	- Silty clay. Same as Clayey silt, med. brown, gray, orange-brown, and rust-brown mottled, streaked, and stained, trace to some roots, trace fine sand, trace fine gravel - moist to sl. wet @ 4.0'	3.8'	Sample #1 0.0' to 4.0'	BIS commenced HSA & 6' cont. sampler PID Reading = 0ppm in sampler PID Reading @ auger = 0ppm
	5		- Silty clay, med. brown, some gray, trace to some roots, trace fine sand, moist to wet (soft) Becoming Damp to moist @ 6'			
	6		- Silty clay, med. gray, brown, tan, orange and rust brown, mottled, streaked, and stained, trace fine sand, very plastic - Damp to moist (Hard)	5.0'	Sample #2 4.0' to 9.0'	PID Reading = 0ppm in sampler
	9		- Silty clay, med. brown and tan, some orange-brown and rust coloring mottling, trace to some fine sand, trace roots - Damp to sl. moist (very stiff)	6.0'	Sample #3 9.0' to 14.0'	PID Reading = 0ppm
	14		- Silty clay, Lt. to med. gray, tan and orange brown mottled, trace to some fine sand - Damp to moist (stiff)			
	15		- Silty clay, Lt. gray-tan, and orange-brown mottled, trace to some fine sand - moist to sl. wet @ 15.5 ft	5.0'	Sample #4 14.0' to 19.0'	Sampler exterior wet when pulling Sample #4 PID Reading = 0ppm Water @ 19 ft. W.L. inside auger
	19		- Silty clay, Lt. gray, tan, and orange-brown mottled, streaked, and stained, some fine sand - Damp to moist			
	20	SM	- Sandy silt, Lt. brown/gray with some dk. gray		Sample #5	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: LHAAP - Site 29 HOLE NO. 29WW15

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LLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29 UW15

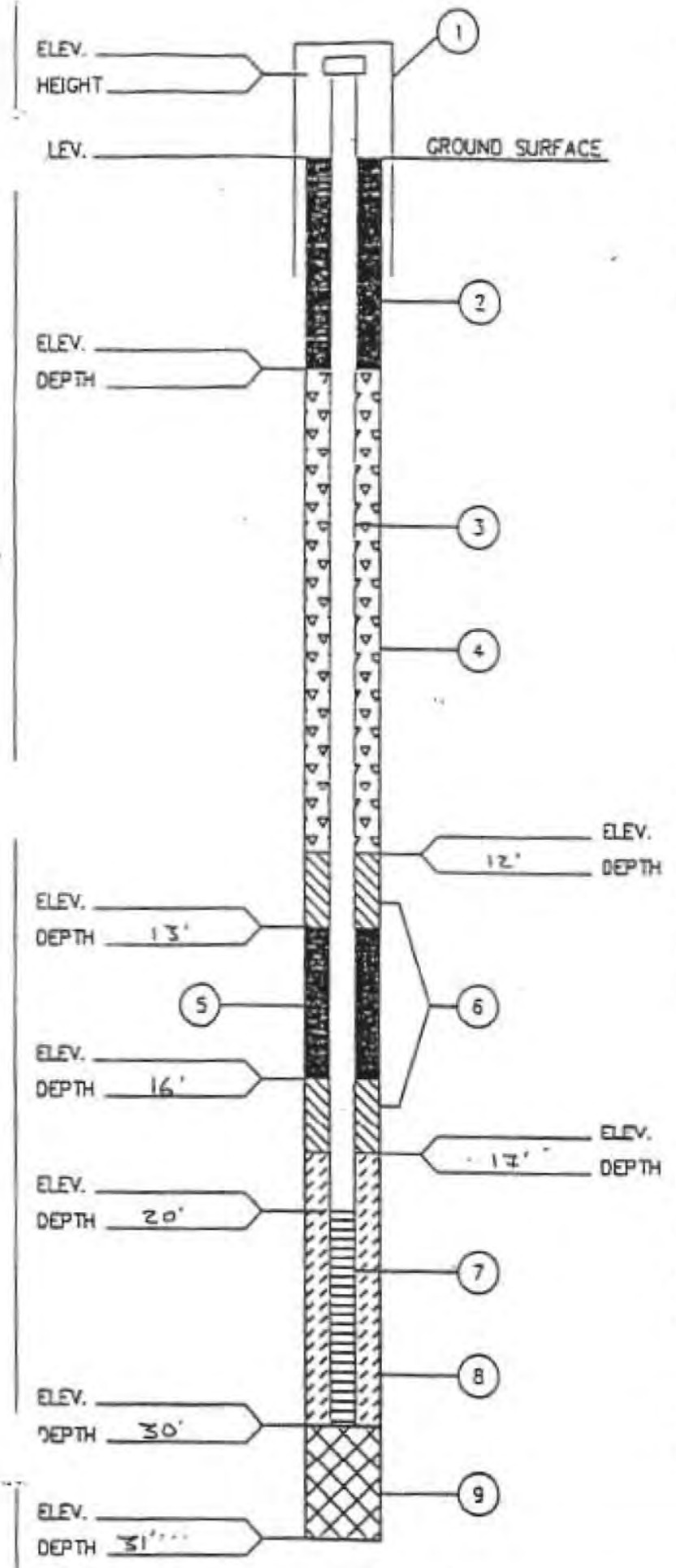
OJECT LHAAP Plus other Site 29 | INSTALLATION CHAAP | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH (Ft) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	SM	Mottling, Fine grained sand, some sl clayey - Moist to sl. wet (soft)	3.1'	19.0' to 24.0'	PID Reading = 10ppm+ in Sampler
	22		- Sandy silt, Lt. brown/gray with some gray streaks, fine grained sand, sl. plastic to occ plastic - moist to sl. wet			
	23					
	24	CL	- Clayey silt, med. brown/gray, some fine sand - moist (med. stiff) (trace roots)			
			- Sand content increasing			
	25	SM-SC	- Sandy silt interlaid with clayey sand, Lt. gray/brown to yellowish-orange, fine grained sand, sl. plastic in clayey beds - moist to wet (soft)		Sample # 6 24.0' to 29.0'	PID Reading = 250 ppm+ in Sampler
	26					
		GP	- Gravel, Lt. brown to yellowish and orange-brown, fine to coarse with some clay mixed throughout, subang. to subrounded - wet - Saturated!	5.0'		
	27	CL	- Silty clay, Lt. gray and brown (mottled) with some Lt. gray streaking, some layered, some fine sand - Damp (v. stiff)			
	28					
	29		- Silty clay, med. gray with some v. thin horizontal silt and fine sand lenses - Damp (v. stiff)	2.0'	Auger Sample	
	30					
	31		T.D. of hole is 31.0 Ft. below grade in med. gray silty clay			T.D. @ 1415 T.D. hole (31.0') Bottom Screen (30' to 20') (4" I.D., wirewound, 304 stainless, #10 slot) Primary filterpack (31' to 17') Auger sand (17' to 16') Bent. Seal (16' - 13') Auger Grout (13' - 12') Bent. Grout to within 3' of grade (Pilot hole was overdrilled with 11" O.D. augers and contempug to 31.0' For 4" SS well construction

PROJECT | HOLE NO.

01226998

026090



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW15

DATE 2-22-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)

   NA

3. SOLID PIPE TYPE Sch 40, 304 S.S. 4"ø

   SOLID PIPE LENGTH 20 ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/Bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)

   Bentonite Chip

6. TYPE OF SECONDARY FILTER PACK

   Silica Sand (30-70)

7. SCREEN TYPE Sch 40, 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 wire Wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK

   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD HSA

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

01226999

Hole No. 29WW16 026091

LLING LOG	DIVISION Tulsa USACE	INSTALLATION	SHEET 1 OF 3 SHEETS
ECT LHAAP - Group II Phase III		10. SIZE AND TYPE OF BIT 4" Tricone - Mud Rotary	
CATION (Coordinates or Station) Karnack TX Site 29		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
DRILLING AGENCY GEO Projects		12. MANUFACTURER'S DESIGNATION OF DRILL Mobile Drill B-61	
4. HOLE NO. (As shown on drawing title and file number)		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER Amador Hinahosa		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE STARTED 4-4-98 COMPLETED 4-6-98	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE 88'		18. TOTAL CORE RECOVERY FOR BORING %	
		19. SIGNATURE OF INSPECTOR David W. Bruce	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
			NOTE:			
			1) See boring log for shallow well 29WW15 for lithologic descript. from surface to 32'			Readings of 10 ppm (9'-21') and 250 ppm (24'-26'). The remaining samples were not above background
			2) Pilot boring is located 20' South of 29WW15			
			3) The screen for shallow well 29WW15 was set from 30'-20'			
			4) Soil samples from 29WW15 exhibited HNU			
	32	CL	Silty Clay, dk. gray and tan with abundant v. thin lt. gray and tan silt and sand lenses (horiz.), trace to some fine sand in silty clay matrix, plastic, damp	11"	SS-1 32-33.5	Begin drilling w/ 4" bit mud rotary on 4-4-98 @ 0900. NOTE Samples are collected using a 2" split spoon
	33					
	34	CL		18"	SS-2 34-35.5	
	35					
	36	CL	As Above	18"	SS-3 36-37.5	
	37					
	38	CL	As Above	16/22	SS-4 38-	
		SC	Sandy Clay, mottled brown + gray laminated (horiz.), sl. moist to moist, some silt, stiff,	31	39.5	
	39	CL/SC		12"		
			Silty clay, dk gray, sl. moist, some silt, some sand			
	40	CL	Silty Clay, some sand, laminated (horiz.), dk. gray, sl. moist to moist, sl. ft	24/24	SS-5 40-41.5	← potential NO! casing
	41			16"		
	42	CL	Silty clay, tr. sand, laminated (horiz), dk. gray, sl. moist v. stiff	13"	SS-6 42-43.5	
	43					
NO! X →	44	CL	As Above, laminations less prominent	7.5'	SS-7 44-	
	45					

PROJECT HOLE NO.

01227000

026092

LLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW16

JECT LHAAP: Group II - Phase III | INSTALLATION LHAAP - Karnack, TX | SHEET 2 OF 7 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	46	CL	As Above	15/24/ 33 14"	SS-8 46'-47.5	
	48	CL	As Above	23/36/ 81 18"	SS-9 48'-49.5	
	50	SM/ML	Clayey Silt, some sand, med gray, moist,	14/35/ 56 10"	SS-10 50'-51.5	
	52	CL-ML	Silty Clay, some sand, med gray, moist stiff, laminated	44/37/ 123 9"	SS-11 52'-53.5	
	54	PT	Lignite, blish, layered 2"			End Drilling @ 54' 4-4-98 1730
Yes casing	55	CL	Silty Clay, brown-gray mottled, w. fr. sand, sl. moist, v. stiff	25/35/ 43 12"	SS-12 54'-55.5	Begin Drilling @ 54' 4-5-98 @ 0900 All samples collected using a 2" split spoon.
	57	CH (OH)	Silty Clay, dk brown w/ black intermittent organic content, (seams of high) very hard, highly plastic, sl. moist, crumbles	28/59/ 79 18"	SS-13 56'-57.5 HNU = 100 ppm in spoon	
	59	CL	Silty Clay, med.-gray-brown, w/ some organic deposits within matrix, sl. moist, V. hard, plastic	31/53/ 75 18"	SS-14 58'-59.5 HNU = 0 ppm in spoon	
	61	CL	Silty Clay, med brown-gray, fr. sand, tr. organic dep., V. hard, plastic, sl. moist	29/53/ 90 18"	SS-15 60'-61.5 HNU = 0 ppm in spoon	
	62	CL	As Above	24/62/ 185 18"	SS-16 62'-63.5 HNU = 0 ppm in spoon	
	63	CL-CH	plasticity increases			
	64	CL-CH	As Above	85/130/ 19"	SS-17 64'-65.5 HNU = 0 ppm in spoon	double helix @ noon 1130 Traces of silty sand (ML) in bottom of spoon
	66	CL-CH	As Above	4 1"	SS-18 66'-67.5 HNU = 0 ppm in spoon	
	68	CL-CH		44/81/ 200 19"	68'-69.5 SS-19 HNU = ppm in spoon	

ENG FORM | PROJECT | HOLE NO.

01227001

026093

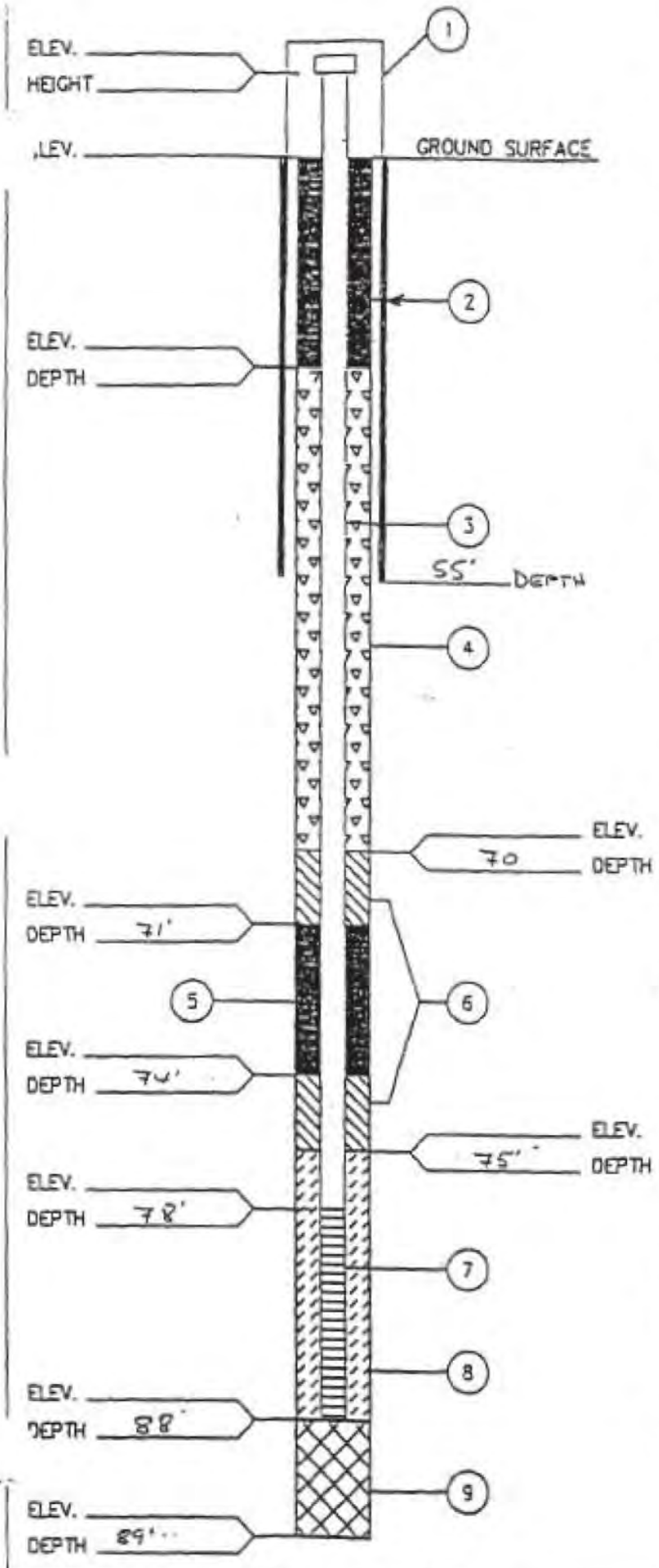
LLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW16

PROJECT LHAAP Group II - Phase III | INSTALLATION LHAAP - Karnack, TX | SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
5 →	70	CL-CH		49/57| 25D	SS-20	
3 →	71				70-71.5	
	72	CL-CH	Silty clay/clay - Dk gray and Dk brown with gray, trace fine sand - Damp (V. Stiff)	60/36| 120	SS-21 72-72.5	End sampling @ 72' Drill @ 70 446-784-3-98 1445
	73					Begin drilling @ 0830
5 →	74		Assumed CL-CH	See Note: No Recovery	SS-22 74-75.5	NOTE: No sample collected sampler driven only 1/10" after 300 blows.
1' →	75					* Apparent Drill Break (Drill off) @ 76.5 ft. No Hyd. Down Pressure
	74	CL-CH	As Above 4"			
	77	SM	Sandy Silt, med-gray, sl. moist, Dense 7"	90/83| 100 3" 11"	SS-23 76-77.5	
		CL-CH	Silty Clay, Dk. brown and Dk green gray, fr. sand, sl. moist			- No visual water/ moisture in sandy silt
2 →	78	CL-CH	As Above 1.5'			
	79	SM (NP)	Silty Sand, med gray, wet, Med Dense - Dense, fine gravel	24/47| 55#	SS-24 78-79.5	
	80	(ML?)	Sandy Silt, w/ clay, red-brown, moist 12"			
		SP	Sand, poorly graded, med gray, wet, dense 4"	54/48|	SS-25	
	81	SC	Sandy Clay w/ silty sand, gray, wet, laminated, moist 6"	57	80-81.5	
	82	CL	Silty Clay, med gray, sl. moist, V. Stiff	53/48| 85	SS-26 82-83.5	
	83	ML	Sandy Silt, med gray, sl. moist			
		CL	Silty Clay, med gray, fine sand, sl. moist, V. Stiff, laminated			
	84	CL	As Above	26/55	SS-27	1345
	85			75	84-85.5	
	86	CL	As Above	18"		
		SM	Silty Sand, Med brown, moist	32/36| 92	SS-28 86-87.5	
	87	CL	Silty Clay, Med brown, sl. moist			V. Stiff
		SC	Sandy Clay, Med brown, V. moist 5'	48"		
5 →	88					
Bottom →	89		T.D. @ 88' 6-9-98 1900			Proposed Well Construction
	90					8" ø Steel Casing 85'-Surface
						4" ø SS 304 Nickel screen 88'-78'
						Primary Sand (#-30) 89'-75'
						Sfy Sand (30-70) 75'-74'
						Bentonite 74'-71'
						Sec. Sand (30-70) 71'-70'
						Grout 70'-Surface
						4" 304SS Riser 78' + 3' Above Ground
						4 Pad 4 locking covers

01227002

026094



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW16

DATE 4-6-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)
   8"Ø Steel Casing

3. SOLID PIPE TYPE Sch 40, 304 S.S 4" I.D.

   SOLID PIPE LENGTH 78' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/Bentonite

   HOW INSTALLED - TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)
   Bentonite Chips

6. TYPE OF SECONDARY FILTER PACK
   Silica Sand (30-70)

7. SCREEN TYPE Sch 40, 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 wire Wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK
   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD Mud Rotary

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

01227003

026095

Hole No. 29WW17

DRILLING LOG | DIVISION: USACE - Tulsa | INSTALLATION: LHAAP - Karnack, TX | SHEET 1 OF 2 SHEETS

PROJECT: LHAAP - Karnack, TX Phase II Site 29 RI
2. LOCATION (Coordinates or Station): Site 29
3. DRILLING AGENCY: GPI - Austin, TX
4. HOLE NO. (As shown on drawing title and file number): 29WW17
5. NAME OF DRILLER: Jose Hinojosa
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Penetrated ft.
8. DEPTH DRILLED INTO ROCK: N/A
9. TOTAL DEPTH OF HOLE: Below Grade
10. SIZE AND TYPE OF BIT: 3¼" I.D. HSA Auger Bit
11. DATUM FOR ELEVATION SHOWN (MSL): Feet
12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75 — 3¼" I.D. HSA; Pilot Hole
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED: ; UNDISTURBED: 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 2-20-98 COMPLETED 2-21-98
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Cita CPG

ELEVATION (a)	DEPTH (ft) (b)	LEGEND (USC) (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	0	CL	Silty clay with some clayey silt, med. brown with some med. gray, rust brown, and orange-brown mottling and staining, trace to some fine sand - damp to moist (trace gravel)	1.6'	Sample #1 0.0' to 4.0'	3¼" I.D. HSA & 5' Sampler Started @ 1100 PID Reading = 1 ppm
	5		Silty clay, Med gray, tan, brown, orange-brown, and rust brown mottled, streaked, and stained, trace to some roots, trace fine sand, trace gravel - damp to moist (stiff)	5.0'	Sample #2 4.0' to 9.0'	PID Reading = 1 ppm
	10		Silty clay, med. gray, brown, tan and orange-brown mottled, streaked, and stained, occ. some black staining, trace to some fine sand, trace roots - damp to moist	5.0'	Sample #3 9.0' to 14.0'	PID Reading = 0 ppm
	15		Clayey silt, med. gray, tan, brown, gray-brown and rust brown mottled, streaked, and stained, some fine sand - moist	4.0'	Sample #4 14.0' to 19.0'	PID Reading = 0 ppm
	20		Silty clay, med. brown, med. gray and dark gray, v. thin layering with some v. thin silty lenses (horizontal layering) trace to some fine sand - Damp		Sample #5	

FOR FROM ... | PROJECT | HOLE NO.

01227004

026096

BORING ABANDONED

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW17

PROJECT LHAAP-Site 29: Phase III RI | INSTALLATION | SHEET 2 of 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	CL	Silty Clay, Dark gray w/ brown mottlings, dry, very stiff. to. iron stains? (orange-dk brown) (0.9')		CS-5 cont'd	50+ ppm in boring 1200: Cont Radio to SSW + inform of HNU readings will break for lunch & let vapors dissipate 1340 - Resume drilling @ 24' HNU = 0 ppm in boring. Personnel will don Level C if vapors return above 5ppm in breathing Zone
	22					
	23					
	24	CL	Silty Clay, Med - Dk. Gray, Dry, black stringers, silt laminations (6")	5.0'	CS-6	Headspace HNU in bag sample - 35ppm in spoon - 5 ppm (slow-steady response)
	25	CL	Silty Clay, brown-gray, Sand lenses, black deposits, irregular layering, slightly stiff (2.0')			
	26					
	27	SM	Silty Sand, blk-med brown, dry - slightly crumbly (2.5')			
	28					
	29	CL	Silty Clay, Med. Gray, dry irregular layering, black deposits, crumbly, some sand layers	5.0'	CS-7	HNU = 0 ppm in spoon ↳ 160 ppm headspace in baggie (slow-steady response on HNU)
	30					
	31					
	32					
	33					
	34	CL	As Above w/ intermittent crumbly thin Sand layers, dry, becomes stiff w/ depth	2.9'	CS-8	HNU > 40 ppm in spoon (slow-steady response) HNU = 6 ppm by boring/ augers 0 ppm - breathing Zone
	35					
	36					
	37					
	38					
	39	CL	As Above	3.8'	CS-9	HNU = 0 ppm in spoon
	40					
	41					
	42					
	43					
	44					

ENG FORM [illegible] (ER 1110-1-1801) | PROJECT LHAAP Site 29 Phase III RI | HOLE NO. 29WW17

01227005

026097

BORING ABANDONED

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29MW17

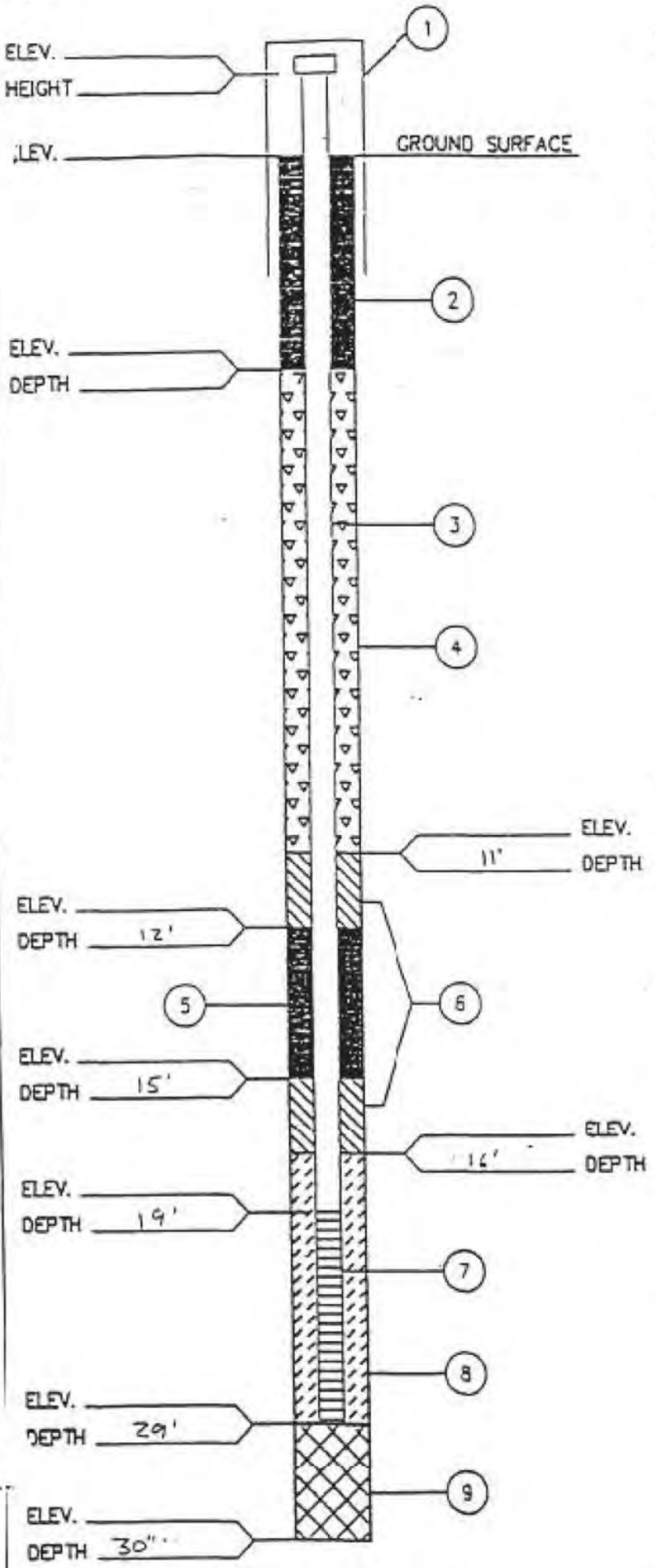
PROJECT: LHAAP Sit 29: Phase III RI | INSTALLATION | SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. ERT e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc. if significant) g
	45		As Above	5.0'	C5-10	HNU = 0 ppm in 5 ppm
	46		Small layer black organic material (topsoil -			
	47					J. Brooks + J. Nitthreyer Observe samples 44'-46' + 39'-44'
	48					Will pull augers & set it - water enters boring No water in boring
	49					Removed augers to 20' (3' Protect Above Ground) will let set overnight and measure W.L. tomorrow (2-21-98)
			T.D. 49' Boring 2-20-98 @ 1530			2-21-98
						1.) Measured water in boring @ 0815 - = 19' N.L. Total Depth = 29' (20" cased in materials) Water was observed seeping in below augers @ = 17'
						2.) Re drilled boring to 49' to remove soils in boring from 29' to 49'. No HNU readings were observed during drilling.
						3.) Grout boring to surface Will pull 5' augers & grout inside + then remove another 5' augers & grout well at surface.
						4.) Will offset and install Shallow well Screen to be set from 29'-19' Primary filter from 30'-16' Sump sand 16'-15' (See Drilling Log for well installation details
						backfill 15'-12' Grout 12'-11' Grout 11'-surface Screen 4" 304 SS 10 slot Riser 4" 304 SS to 1.5' Above ground

ENG FORM [illegible] | PROJECT LHAAP Sit 29: Phase III RI | HOLE NO. 29MW17

01227006

026098



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW17

DATE 2-21-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)
NA

3. SOLID PIPE TYPE Sch 40, 304 S.S 4" I.D.

SOLID PIPE LENGTH 19 ft.

JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/Bentonite

HOW INSTALLED – TREMIE

FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)
Bentonite chips

6. TYPE OF SECONDARY FILTER PACK
Silica Sand (30-70)

7. SCREEN TYPE Sch 40 304 S.S.

SCREEN LENGTH 10.' ft.

SLOT SIZE #10 Wire Wound in.

SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK
Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD HSA

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

01227007

S0

026099

Hole No. 29WW18

DRILLING LOG	DIVISION: USACE - TULSA	INSTALLATION: LHAAP SITE 29	SHEET: OF SHEETS
1. PROJECT: LHAAP PHASE II RI		10. SIZE AND TYPE OF BIT: AUGER BIT FOR 3¼"	
2. LOCATION (Coordinates or Station): SITE 29 KARNACK, TX		11. DATUM FOR ELEVATION SHOWN (TBM or MSL):	
3. DRILLING AGENCY: GPI		12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75 3¼" I.D. AUGERS / 5' SAMPLER	
4. HOLE NO. (As shown on drawing title and file number): 29WW18		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED: 6 UNDISTURBED: 0	
5. NAME OF DRILLER: JOSE HINNOJOSA		14. TOTAL NUMBER CORE BOXES: N/A	
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER:	
7. THICKNESS OF OVERBURDEN: PENETRATED 30 FT		16. DATE HOLE: STARTED 2-23-98 1320 COMPLETED 2-23-98 1615	
8. DEPTH DRILLED INTO ROCK: N/A		17. ELEVATION TOP OF HOLE:	
9. TOTAL DEPTH OF HOLE: 30 FT BELOW GRADE		18. TOTAL CORE RECOVERY FOR BORING: N/A %	
		19. SIGNATURE OF INSPECTOR:	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0–2	FILL	- SILTY SAND AND GRAVEL, FINE TO COARSE ROUNDED, LOOSE MOIST	2.0'	SAMPLE #1 0.0 to 4.0	PID READING = 0.0 ppm IN SAMPLE
	3–4	CL	SILTY CLAY, BROWN WITH GRAY AND REDDISH BROWN MOTTLING TRACE ROOTS MOIST (STIFF, PLASTIC)			PID READING @ AUGERS = 0.0 ppm
	5–6	CL	- SILTY CLAY, BROWN WITH GRAY MOTTLING WITH FINE SAND DAMPER SLIGHTLY MOIST (STIFF, MED PLASTIC)	5.0'	SAMPLE #2 4.0 to 6.0	PID READING = 90+ ppm IN SAMPLE
	7–9				9.0	PID READING @ AUGERS = 0.0 ppm
	9		IRON STAIN CHANNEL AT ~9.25' IN SAMPLE			
	9–10		- SILTY CLAY, BROWN WITH GRAY MOTTLING BLACK STAINING AND SATURATED TRACE FINE SAND, SLIGHTLY MOIST (VARY STIFF, PLASTIC)			PID READING = 40+ ppm IN SAMPLE
	10–11	CL		5.0'	SAMPLE #3 9.0 to 14.0	PID READING @ AUGERS = 0.0 ppm
	12–13					
	13				19.0	
	14					
	15				SAMPLE #4 14.0 to 19.0	PID READING = 100+ ppm IN SAMPLE
	16	CL	- SILTY CLAY, BROWN WITH GRAY MOTTLING BLACK STAINING AND SATURATED, TRACE FINE SAND, DAMP TO SLIGHTLY MOIST (STIFF TO VERY STIFF, PLASTIC	5.0'		
	17					PID READING = 0.0 ppm IN AUGERS
	18				19.0	
	19					
	20				SAMPLES	

ENG FORM 1836 — PREVIOUS EDITIONS ARE OBSOLETE — PROJECT — HOLE NO.

026100

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW18

PROJECT: GROUP 2 PHASE III | INSTALLATION: LHAAP - SITE 29 | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	ML	SLIGHTLY CLAYEY SILT WITH FINE SAND BROWNISH GRAY, SLIGHTLY MOIST (MED STIFF)		SAMPLE #5	MOISTURE NOTED ON SAMPLER PID READING = 200+ ppm
	22	SM	- SANDY SILT, FINE GRAINED, BROWN TO GRAY DENSE SLIGHTLY MOIST (MED STIFF TO STIFF)	4.0	19.0	PID READING @ CUTTERS = 0.0 ppm
	23				to 24.0	
	24	CL	- SILTY CLAY BROWN TO MAGENTA STREAKING AND BLACK STAINS WITH FINE SAND, MOIST TO SATURATED		SAMPLE #6	WATER NOTED, 24 HRS 27' PID READING = 210+ ppm
	25	SM	(SOFT, MED PLASTIC)		24.0	
			25.0 - 25.25		to	
	26	SP	SILTY SAND, REDDISH BROWN FINE GRAINED MED DENSE TO LOOSE MOIST		29.0	PID READING @ AUGER = 0.0 ppm
	27					
	28		SILTY SAND, BROWN WITH REDDISH BROWN STREAKS, MED DENSE TO DENSE MOIST			
		SM-SC	- SILTY SAND REDDISH BROWN FINE GRAINED VERY DENSE DRY TO DAMP			
	29	CL	28.5 - SILTY CLAY GRAY WITH BLACK AND DARK BROWN INCLUSIONS, TRACE FINE SAND DRY TO DAMP (STIFF, PLASTIC)		AUGER SAMPLE	
	30					

TD @ 10:25

T. D HOLE (30.0')

BOTTOM SCREEN (29' to 19')

SCREEN (4" ID WIRE WOUND 304 STAINLESS #10 SLOT)

PRIMARY FILTER PACK (30' to 16')

SLAGGE SAND (16' to 15')

BENT SEAL (15' to 12')

SLAGGE SAND (12' to 11')

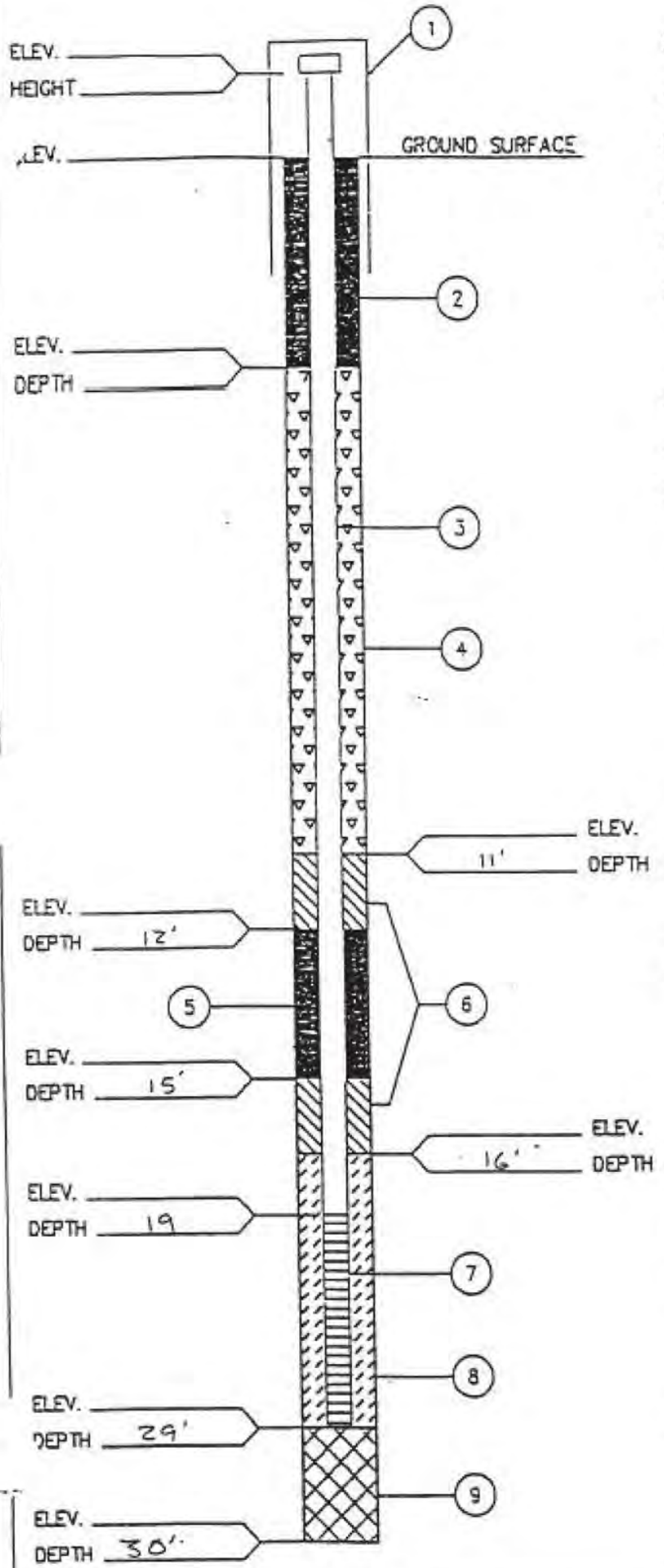
BENTONITE 11' TO 3' OF GROUT

(PILOT HOLE WAS OVERDRILLED WITH 11" O.D. AUGERS AND CASED PLUG TO 30' FOR 4" STAINLESS STEEL RISER DOWN

ENG FORM [illegible] | PROJECT | HOLE NO.

01227009

026101



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW18

DATE 2-23-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)

   NA

3. SOLID PIPE TYPE Sch 40, 304 S.S, 4" I.D

   SOLID PIPE LENGTH 19 ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)

   Bentonite chip

6. TYPE OF SECONDARY FILTER PACK

   Silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 wire wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK

   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD HSA

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

01227010

026102

Hole No. 29WW19

DRILLING LOG	DIVISION: USACE - Tulsa	INSTALLATION: LHAAP	SHEET 1 OF 2 SHEETS
1. PROJECT: LHAAP - Karnack, TX Site 29 - Phase III RI		10. SIZE AND TYPE OF BIT: Auger Bit	
2. LOCATION (Coordinates or Station): Site 29		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY: GPI - Austin, TX		12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75 3¾" I.D. HSA / 5' CME Cont. Sampler	
4. HOLE NO. (As shown on drawing title and file number): 29WW19		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 7 / UNDISTURBED 0	
5. NAME OF DRILLER: Jose Hinojosa		14. TOTAL NUMBER CORE BOXES: N/A	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN: Pegetrated 33ft		16. DATE HOLE: STARTED 3-05-98 / COMPLETED 3-05-98	
8. DEPTH DRILLED INTO ROCK: N/A		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE: 33 ft. Below Gate		18. TOTAL CORE RECOVERY FOR BORING: N/A %	
		19. SIGNATURE OF INSPECTOR: [signature] CPG	

ELEVATION (ft)	DEPTH (ft)	LEGEND (USC)	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	1	F:11 / CL	6" of fine to coarse gravelly topsoil fill (wet) over - Silty clay, Lt. gray, tan, orange-brown, yellowish-brown, and Dk. gray mottled, streaked, and stained, trace to some fine sand, trace gravel - Moist to Damp @ 3.0' (Med. stiff) (trace roots)	3.0'	Sample #1 0.0' to 3.0'	0815 commenced HSA 3¾" I.D. HSA / 5' cont. sampler PID Reading = 1ppm (10.2eV Hnu) sampler
	4		- Silty clay, Lt. gray-brown, yellowish-orange, and Dk. gray mottled streaked, and stained, some fine sand, trace gravel and roots - Dry to Damp (stiff)	5.0'	Sample #2 3.0' to 8.0'	PID Reading @ Augers = 0ppm PID Reading: 1ppm in sampler
	8		- Clayey silt, Lt. gray and Med. brown mottled, some yellowish-orange staining, trace to some fine sand, some apparent layering - Dry to Damp (soft to Med. stiff)	5.0'	Sample #3 8.0' to 13.0'	PID Reading: 4ppm in sample
	12		- Silty clay Lt. gray, Lt. brown, and yellowish-brown layered horizontally in V. thin laminations, abundant V. thin silt and fine sand lenses, trace to some fine sand in silty clays - Moist (Med. stiff)			
	16		- Silty clay / clayey silt, Lt. gray, Med. gray, Lt. brown, and yellowish-orange layered horizontally in V. thin laminations, abundant V. thin horiz. silt and fine sand lenses, some fine sand in silty clays and clayey silts - Damp to Moist (Med. stiff)	2.3'	Sample #4 13.0' to 18.0'	PID Reading = 6 ppm in sample
	18	SM	- Silty sand, Pred. Lt. gray with some yellowish-brown and rust-brown mottling, fine grained sand, some apparent layering - Damp (Med. Dense)	4.8'	Sample #5 18.0' to	PID Reading: 9ppm in sample
	20					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: LHAAP - site 29 HOLE NO. 29WW19

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DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW19

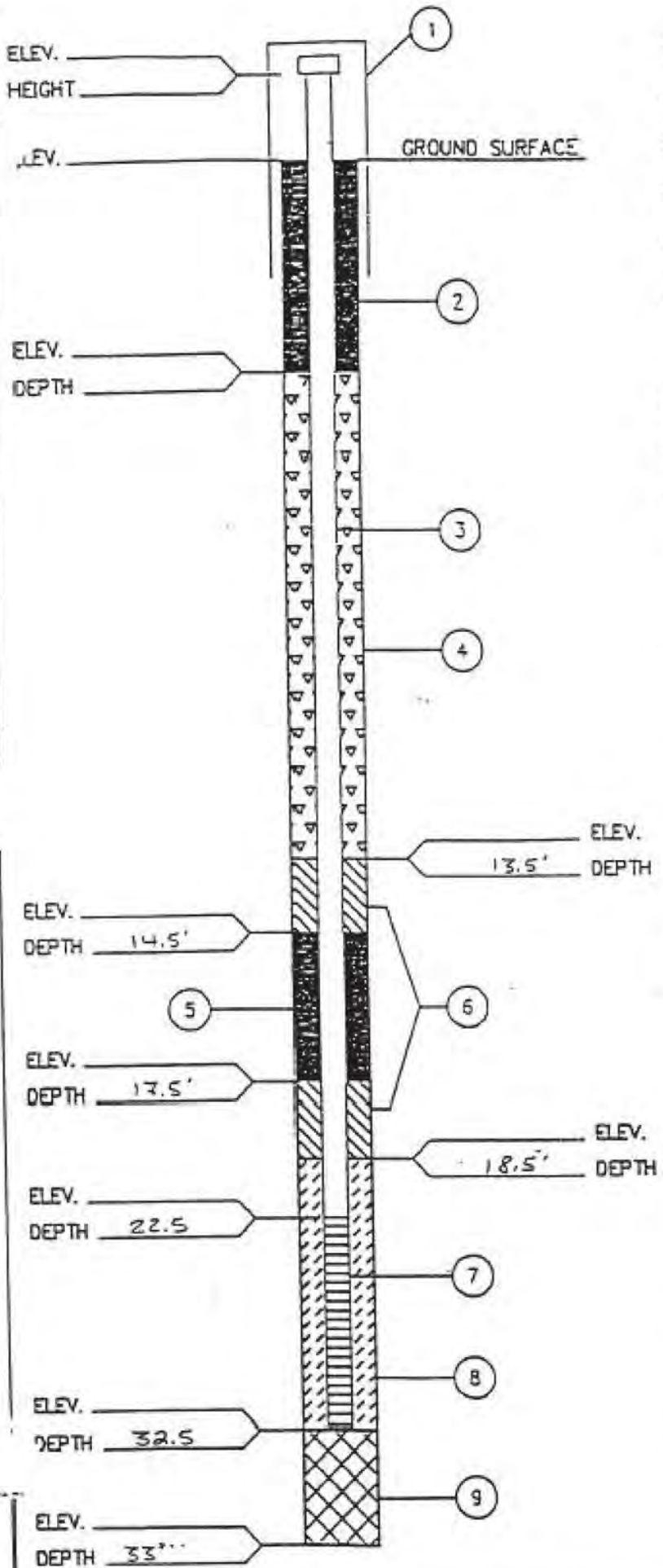
PROJECT LHAAP - Karnack, TX Site 29 Phase II RI | INSTALLATION LHAAP | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH (Ft.) b	LEGEND USC c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	CL	- Silty clay / Clayey silt, LA. to mod. gray, tan, and orange-brown mottled, stratified w/ stained, some irregular layering, some fine sand - Damp to moist - (RSTIH)			
	22					
	23					
	24		- Silty clay (with lignite frag.) Dk gray to black, some rust colored staining, silty clay are plastic, lignite is easily frac., some fine sand - moist	4.1'	Sample #6 23.0' to 28.0'	
	25					
	26	SM	- Sandy silt. Mod. greenish-gray, fine grained sand, some apparent layering - Moist (mod. dense to loose)			PID Reading = 220ppm+ in sample
	27					
	28		- Sandy silt. LA. gray to mod. greenish-gray, fine grained sand, some v. thin to thin layering, occ. sl. clayey layers (v. thin to thin) - moist to wet (Saturated @ 28.5') (Dense)	5.0'	Sample #7 28.0' to 33.0'	PID Reading @ Augers = 0ppm
	29					
	30					PID Reading = 130ppm+ in sample
	31					
	32	CL	- Silty clay, mod. to dark gray with abundant horiz. and irregular v. thin silt and fine sand lenses, some fine sand, silty clay - Moist (stiff)			
	33		T.D. @ 33 ft. below existing grade in Dk gray laminated silty clay * W.L. @ 28.5 ft. below grade in new augers @ T.D.			T.D. 29WW19 @ 0900 - 11" O.D. HSA was advanced to 23.0 ft. - 4" SS (304) w/ screwed #10 slot screen (10 ft) was set @ 32.5 - (Trip screen @ 22.5') - Primary filterpack (16-30) 33 ft. to 18.5 ft. - Seam sand (30-70) 18.5 ft. to 15' - Bent seal 15 ft. to 14' - Sump sand (30-70) 14.5' 13.5 ft. - Bent. grout 13.5 ft to within 3 ft. of grade

ENG FORM 1836-A (ER 1110-1-1801) GPO 1990 OF - 655 - 661 | PROJECT LHAAP Site 29 | HOLE NO 29WW19

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MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW19

DATE 3-5-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)

NA

3. SOLID PIPE TYPE Sch 40, 304 S.S, 4" I.D.

SOLID PIPE LENGTH 22.5 ft.

JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

HOW INSTALLED - TREMIE

FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)

Bentonite Chip

6. TYPE OF SECONDARY FILTER PACK

Silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

SCREEN LENGTH 10' ft.

SLOT SIZE # 10 Wire Wound in.

SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK

Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD HSA

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

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Hole No. 29WW20

DRILLING LOG | DIVISION: USACE - TULSA | INSTALLATION: LHAAP SITE 29 | SHEET 1 OF 2 SHEETS

1. PROJECT: LHAAP GROUP 2 PHASE III
2. LOCATION (Coordinates or Station): SITE 29 KARNACK TEXAS
3. DRILLING AGENCY: GEOPROBE INT.
4. HOLE NO. (As shown on drawing title and file number): 29WW20
5. NAME OF DRILLER: JOE HINAJOSA
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: PENETRATED 34 ft
8. DEPTH DRILLED INTO ROCK: N/A
9. TOTAL DEPTH OF HOLE: 34 ft BELOW GRADE
10. SIZE AND TYPE OF BIT: AUGER BIT FOR 3¼
11. DATUM FOR ELEVATION SHOWN (USM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: CME 75 3¼" ID AUGER 15' SAMPLER, CME CONT.
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 7, UNDISTURBED 8
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 2-24-98 9.23 COMPLETED 2-24-98
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: N/A
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1	FILL	CLAYEY SILT DARK BROWN ORGANICS MOIST (SOFT TO MED STIFF)		SAMPLE #1	
	2	ML	CLAYEY SILT, BROWN WITH REDISH BROWN MOTTLING AND BLACK STAINING WITH FINE SAND MOIST (MED SOFT TO STIFF)	2.0	0.0' to 4.0'	PID READING = 32.0 ppm IN SAMPLE
	3					PID READING = 0.0 ppm IN AUGER
	4					
	5	CL	SILTY CLAY BROWN WITH GRAY MOTTLING AND REDISH BROWN STREAKS WITH FINE SAND DAMP (STIFF, LOW PLASTIC)		SAMPLE #2	BREATHING ZONE 0.0 ppm PID READING = 15 ft ppm 7-eleven IN SAMPLE
	6			5.0	4.0 to 9.0	
	7					PID READING = 0.0 ppm IN AUGER
	8	CL-CH	SILTY CLAY BROWN WITH REDISH BROWN AND GRAY MOTTLING DAMP (STIFF VERY PLASTIC)			
	9					
	10	CL	SILTY CLAY BROWN WITH GRAY MOTTLING AND BLACK STAINS/ STREAKS TRACE FINE SAND DRY TO DAMP (MED STIFF, LOW PLASTIC)		SAMPLE #3	PID READING = 191 - 13' ppm IN SAMPLE
	11			5.0	9.0' to 14.0'	PID READING OVER MAX OF ALL SCALES WITH ALARM FROM ZONE
	12					PID READING = 0.0 PPM IN AUGER/ BREATHING ZONE
	13					
	14	CL	SILTY CLAY GRAY WITH BLACK STREAKS WITH FINE SAND DRY TO DAMP (MED STIFF, MED PLASTIC)			MOISTURE ON SAMPLING TUBE AT 15.5'
	15					
	16	SM	SILTY SAND BROWN WITH GRAY MOTTLING FINE GRAINED MOIST TO SLIGHTLY WET (SOFT)	5.0	SAMPLE #4 14.0' to 19.0'	PID READING = 200 CL ppm IN SAMPLE
	17					PID READING = 0.0 ppm IN AUGER/ BREATHING ZONE
	18					
	19					
	20				SAMPLE #5	

END COPY

PROJECT | HOLE NO.

01227014

026106

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW20

PROJECT LHAAP GROUP 2 PHASE III | INSTALLATION LHAAP - SITE 29 | SHEET 2 OF 2 SHEETS

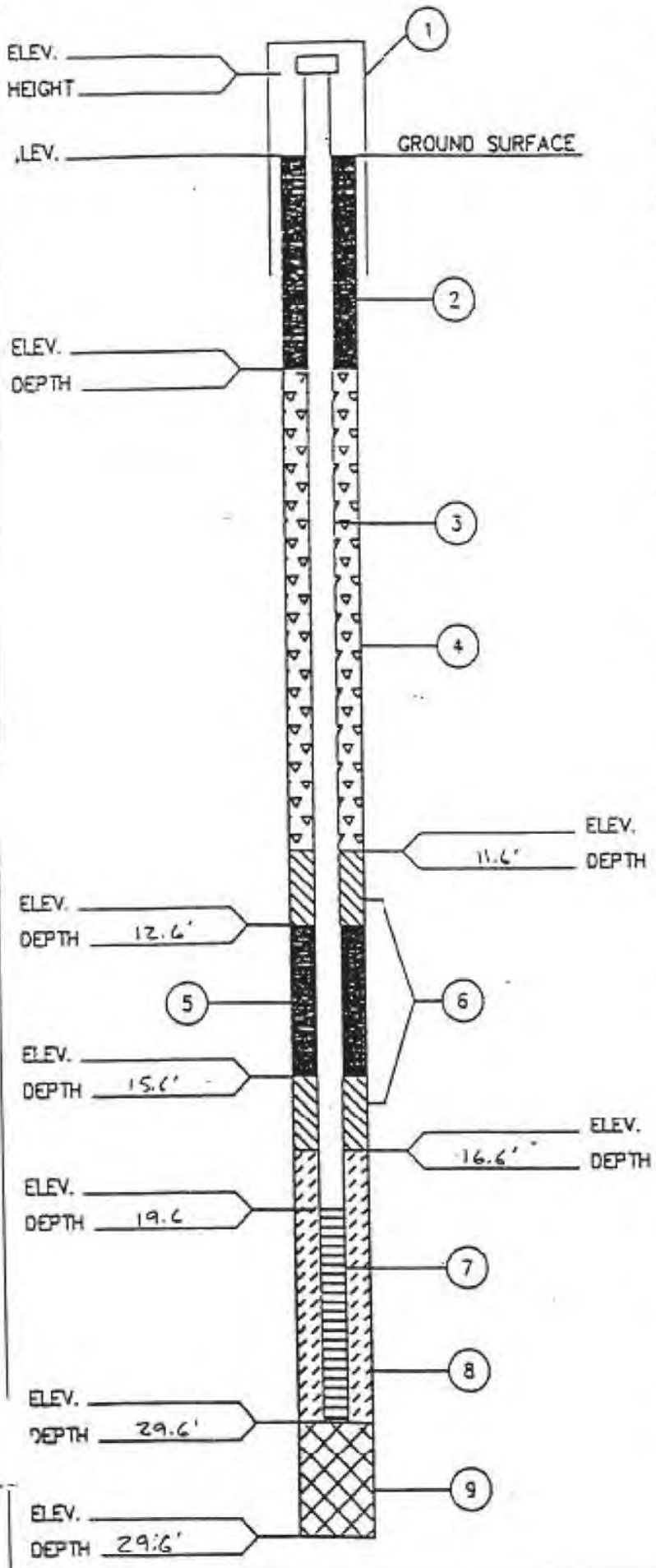
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	SM	SILTY SAND BROWN WITH GRAY MOTTLING, FINE GRAINED SOME SLIGHTLY CLAYEY - MOIST TO SLIGHTLY WET (SOFT)		SAMPLE # 5, 19, 6, 24'	16@ -5m 7D Bore PID READING = 40 PPM IN SAMPLE
	22			5.0		
	23	SM	SILTY SAND GRAYISH BROWN WITH DARK BROWN STREAKS FINE GRAINED MOIST TO SLIGHTLY WET (SOFT TO MED DENSE)			PID READING = 0.0 ppm @ Augers
	24	SM-SP	SILTY SAND GRAY FINE GRAINED MOIST TO SLIGHTLY WET (MED DENSE)		SAMPLE # 6, 24'	
	25					PID READING = 240 PPM IN Sample
	26	SM	SILTY SAND BROWN WITH LT BROWN AND GRAY MOTTLING FINE GRAINED MOIST TO SLIGHTLY WET (SOFT TO MED DENSE)	5.0		
	27					PID READING = 0.0 ppm @ Augers
	28	ML	SANDY SILT BROWN & GRAY FINE GRAINED WITH SLIGHTY CLAYEY ZONES MOIST (MED STIFF)		29'	
	29					
	30	CL-CH	SILTY CLAY GRAY WITH BLACK AND DARK BROWN INCLUSIONS TRACE FINE SAND. DAMP TO SLIGHTLY MOIST (MED STIFF TO STIFF)		SAMPLE #7, 29, W, 34	PID READING = 0.0 ppm IN SAMPLE
	31			5.0		
	32	CL-CH	SILTY CLAY GRAY W/ SOME BLACK MOTTLING INCLUSIONS TRACE FINE SAND, DRY VERY STIFF PLASTIC			PID READING = 0.0 ppm @ Auger
	33					
	34		TD @ 34'			10:20 TD TD @ 34'

BENTONITE SEAL IN 3¼" ID AUGER TO @ 29.6'
11" AUGER TO @ 29.6'
BOTTOM SCREEN 29.6'
4" ID WIRE WOUND SCH STAINLESS #10 SLOT
PRIMARY FILTER PACK (29 to 16')
SILICA SAND 16.6' to 15.6'
BENT. 15.6 to 12.6'
SILICA SAND 12.6' to 11.6
BENTONITE GROUT 1.1' to WITHIN 3' of GROUND SURFACE

ENG FORM [illegible] (EER 1110-1-1801) AND 1400 OF - 439 - 993 | PROJECT | HOLE NO. [illegible]

01227015

026107



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW20

DATE 2-24-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)

   NA

3. SOLID PIPE TYPE Sch40, 304 S.S 4" I.D

   SOLID PIPE LENGTH 19.6' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)

   Bentonite Chips

6. TYPE OF SECONDARY FILTER PACK

   Silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 wire wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK

   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD HSA

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

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026108

Hole No. 29WW22 (I) Date 3-31-98

DRILLING LOG | DIVISION Tulsa USACE | INSTALLATION | SHEET 1 OF 3 SHEETS

1. PROJECT LHAAP Group II Phase III
2. LOCATION (Coordinates or Station) Site 29
3. DRILLING AGENCY GEO Projects (Date 7-21-98)
4. HOLE NO. (As shown on drawing title and file number) 29WW 22 (I) 21
5. NAME OF DRILLER Amador
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE 78'
10. SIZE AND TYPE OF BIT Mud Rotary - 4" Bit
11. DATUM FOR ELEVATION SHOWN (FSM or MSL) (Plot Hole)
12. MANUFACTURER'S DESIGNATION OF DRILL Mobile B-11 B-61
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 3-19-98 COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR David W Berger

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS
			NOTE: This location is adjacent to Shallow monitoring well 29WW21. Installed on 3-12-98. See boring log 29WW21 (S) for lithologic description from surface to 34 ft. Mud Rotary rig will begin sampling at 34'.			Only PID reading above appm during shallow well was 5PPM in spoon from 0-4'. Remaining intervals were appm from 5' to 34'. Screen for shallow well 29WW21 is 3433'-23' Begin drilling w/ mud @ 1615 and 4" bit @ 1330, 3-19-98 No sampling till 34'
		Gray	slate layers encountered from ≈25' to 26.2'		Mud Rotary	Background Head Space @ 15
					SS-1 34'-36'	Collect Sample in 2½" spoon only drive 8" due to HARD layer cuttings
34	CL		Silty Clay, med. gray, dry to sl moist, stiff to very stiff, some layering, tr. fine sand, crumbly	32/50/66 18"	HNU? 0 ppm	0 spoon
36	CL		As Above, slight mottled appearance med-dk gray	25/9/75 16"	SS-2 36'-38' HNU=0 ppm	0 spoon
38	CL		As Above, laminated w/ very fine sand in partings sl moist, stiff, crumbly	36/70/85 16"	SS-3 38'-40' HNU=0 ppm	0 spoon
40	CL		As Above; crumbly laminations	78/100/100 16"	SS-4 40'-42' HNU=0 ppm	0 spoon
41						End Sampling 3-19-98 @ 1810
42	CL		Silty Clay, laminated w/ fine sand partings, med-dk gray, mottled (dk gray), sl moist, stiff, crumbly	75/101/ 300 11"	SS-5 42'-44'	Begin drilling @ 40' on 3-20-98, 0815 on 4" bit and mud rotary
43	CL		Silty Clay w very fine sand in partings med-DK gray, mottled (lt gray) laminated (crosbed pattern), sl moist, stiff, crumbly			NOTE: HNU not functioning properly - Fan Broken. No readings in samples during PID scanning from 34'-40' (3-20-98)
44	CL		Silty Clay, med-dk gray, laminated, sand in partings decreases w depth Below 3" little sand in partings Below 4" - some sand - lite gray, sl moist, crumbly, med	75/112/ 101 17"	SS-6 44'-46'	
45						
46	CL		As Above 0.2	70/101/ 300 0.9'	SS-7 46'-48'	
	PT		Humic - Coal like layer 0.7			
	SM		Silty Sand, med gray, fine sand, sl moist, very dense			
47	CL		Silty Clay, dk gray w/ lignite in partings laminated (crosbed pattern), tr. sand sl moist, very stiff to stiff, (0.5')			Date 3-31-98

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE PROJECT HOLE NO. 29WW22(I)

026109

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW22(2)

PROJECT: LHAAP-Group II Phase III - Sik 29 | INSTALLATION | SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. / RQD e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
		CL	Silty Clay, dk. gray w/ light tan partings, hard moist (crumbled pattern), fr. sand (gray), sl. moist, stiff to very stiff			(casing (?) No. possible
	48	ML	Silt, fr. sand, lite gray, dry to slightly moist, sl. plastic to non plastic (can barely be rolled), low dry strength	12/12 / 28 / 17"	SS-8 48'-50'	NOTE: switched to 3½ Spoon (SS-8)
	49					
	50	ML	Silt, fr clay, med. to lite gray, dry to sl. moist, sl to non-plastic, becomes mottled in appearance w/ depth, moisture decreases	60/60 / 65 / 14"	SS-9 50'-52'	
	51					
	52	ML	As Above fr sand (4")	24/24 / 150	SS-10 52'-54'	
	53	ML CH	Silt w/ organic inclusions (lignite), fr sand, med. gray, sl. moist, v. stiff (1")			
		PT (3")	Lignite, peat, laminated, dk brown-black	18"		
	54	ML	Clayey Silt w/ organic inclusions (lignite), med-dk gray, sl. moist, v. stiff		SS-11	
	55			23/24 / 61 / 12"	54'-56'	
	56	CL	Silty clay, med-dk gray, fr sand, sl. moist, very stiff, some organic deposits (black)	23/24 / 79 / 17"	SS-12 56'-58'	
	57					
	58	CL	As Above	33/36 / 96 / 17"	SS-13 58'-60'	
	59					
	60	CL	As Above	25/48 / 49 / 18"	SS-14 60'-62'	
	61					
	62	CL	As Above		SS-15 62'-64'	
	63	MC SM	Silty Sand, med. gray, moist, dense to v. dense, fr. clay	14"		Auger refusal at 63' bgs. Moved well location 10' to the west (63'-75')
	64	MC SM	As Above, very dense	20/45 / 71 / 6"	SS-16 64'-66'	Catcher broke in spoon lost sample on removal
	65					
	66	ML SM	As Above	23/31 / 53 / 12"	SS-17 66'-68'	← END DRILLING 3-20-98 1710 Catcher broke some samples lost on removal
	67	SM				Begin drilling @ 66' on 3-21-98 @ 0830 Samples collected using 1½" O.D. S.S. Split spoon HNU utilized for borehole, No samples recovered
	68	SP	Sand, poorly sorted, fine sand, some to little silt (silt content decreases w/ depth), med. gray, moist, wet, dense (increases w/ depth)	35/90 / 200 / 9"	SS-18 68'-70'	
	69					
	70	SP	As Above, poorly sorted,	40/90 / 150 / 10"	SS-19 70'-72'	

END FORM ... (IRR 7120-1, 88011) ... PROJECT ... HOLE NO. 29WW22

01227018

DRILLING LOG [Cont Sheet] ELEVATION TOP OF HOLE Hole No. 29WW22 026110

PROJECT LHAAP - Group II, Phase III - Site 29 INSTALLATION SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	71	SP	Sand, poorly sorted, fine grained, tr silt, med. gray, wet, dense		SS-9A (cont.)	
	72	SP	As Above, incr. silt (5")	30/75/90	SS-20 72'-74'	← Last Sample
	73	SP	As Above, less silt, incr. wet	14"		← Prelim. Pipe bottom of screen
	74					
	75		? will review formation & possibly for lithology Most likely SP			No samples collected to drilled to allow downhole logging to cover entire proposed screen interval from 64'-74', 65'-75'
	77					
	78					Drilled contin. from 74' to 78' to allow coverage for down hole log

T.D 78', 3-21-98 @ 1040

Grouted boring w/tremie pipe from bottom to surface on 3-21-98

Will attempt downhole E-log of this pilot boring on 3-21-98

Steve B. + Dave G. performed downhole Gamma + Resistance Survey in boring from 1330 to 1510 in this boring on 3-21-98. Recorded data going down top boring from surface to 78'. Data appeared to be good viewing on laptop screen.

Began drilling 8" ALW boring on 3-22-98 @ 0920. Moved rig ≈ 6' West of pilot boring and closer to the previously installed shallow well 29WW22. Steel casing will be set @ 56' to isolate shallow zone. Prelim. Well construction for intermediate well 29WW31 is as follows:

Prelim. Well Construction Details

Used 4" bit to drill from 7' to 56'

Drill through plaster plug after grout sets

8" Bit from 56'-76'

Mud Rot

8" Steel Casing 56' to surface (plastic plug in bottom of)

4" 304SS screen (10 slot) 75'-65'

16-30 Prim. Filter Sand 76'-63'

30-70 Sugar Sand 63'-62'

Bentonite Seal 62'-59'

30-70 Sugar Sand 59'-58'

Grout 58'-surface

4" 304SS Riser 65'-3' above ground

+ locking well cover

bumper posts (4)

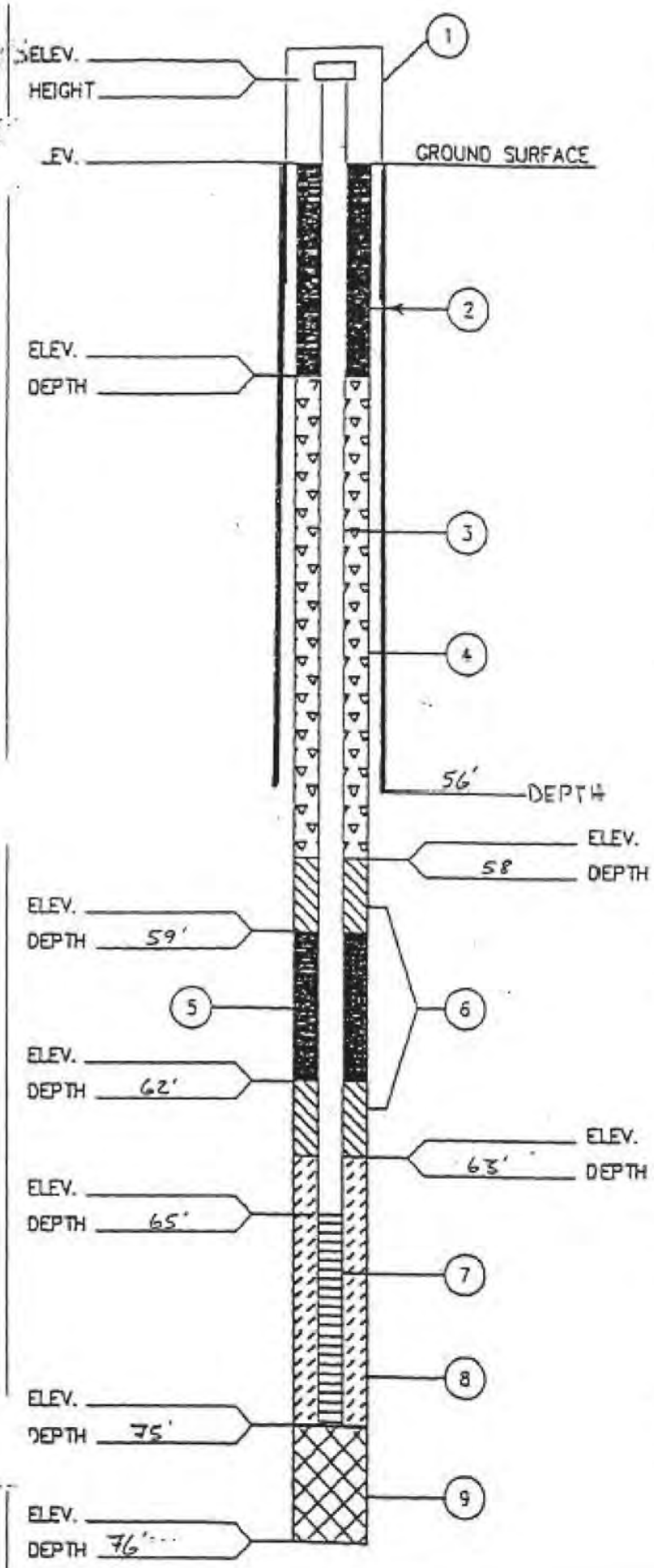
Well Pad

3-22-98	Drilled to 57' w/ 4"
	Drilled to 18 w/12" reamer
3-23-98	Drilled to 55' w/12" Reamer
3-24-98	Drilled to 56' w/12" Reamer then set casing (8")

PROJECT HOLE NO.

01227019

026111



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW21

DATE 3-22-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)
   8" ø steel casing

3. SOLID PIPE TYPE Sch40, 304 S.S., 4" I.D.

   SOLID PIPE LENGTH 65' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)
   Bentonite chip

6. TYPE OF SECONDARY FILTER PACK
   silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 wire wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK
   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD Mud Rotary

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

01227020

026112

Hole No. 29WW22(S)

DRILLING LOG — DIVISION: USACE - Tulsa — INSTALLATION: LHAAP - Karnack TX — SHEET 1 OF 2 SHEETS

1. PROJECT: LHAAP - Karnack TX — Phase III Site 29
2. LOCATION (Coordinates or Station): Site 29
3. DRILLING AGENCY: GPI - Austin TX
4. HOLE NO. (As shown on drawing title and file number): 29WW22(S)
5. NAME OF DRILLER: Jose Landeros
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Penetrated 34 Ft
8. DEPTH DRILLED INTO ROCK: N/A
9. TOTAL DEPTH OF HOLE: 34 Ft. below grade
10. SIZE AND TYPE OF BIT: Auger 8"ø
11. DATUM FOR ELEVATION SHOWN (MSL or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75 & 3¼" I.D. HSAs / CME 5' cont sampler
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 7 / UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 3-11-98 / COMPLETED 3-12-98
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: CMG

ELEVATION	DEPTH (Ft)	USC LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	1–2	FILL	Fill - Dark to med. gray topsoil overlying reddish-brown silty clay with some fine to coarse gravel. Fill - Wet	3.9'	Sample #1 0.0 to 4.0'	1345 Commenced HSA & 3¼" I.D. HSAs and CME 5' cont sampler
	2–3	CL	- Silty clay/clay - Lt. gray, yellowish-orange and reddish-brown (mottled) some dark gray streaking and staining, trace fine sand, trace roots - Damp to Moist (U. Stiff)			PID Reading = 5 ppm+ in sampler (10.2 ev PID - HNu)
	4–9		- Silty clay - Lt. gray, tan, Lt. brown, and yellowish orange (mottled) - some rust-brown streaks and staining, trace to some fine sand, trace gravel and roots - Damp	5.0'	Sample #2 4.0' to 9.0'	PID Reading @ Augers = 0 ppm PID Reading = 0 ppm in sampler
	9–14	SM	- Sandy silt - Lt. gray, tan, Lt. brown, and yellowish-brown (mottled), some med. gray streaking and staining, some apparent layering, fine grained sand, occ. Gl. clayey - Dry to Damp (Med. Dense)	5.0'	Sample #3 9.0' to 14.0'	PID Reading = 0 ppm in sampler PID Reading @ Augers = 0 ppm
	14–15	CL	- Clayey silt - Lt. gray, tan, Lt. brown, and yellowish-brown, some silty clay, some fine sand - Dry to Prev. Damp (Med. Stiff)			
	15–19	SM-SP CL	- Silty sand and sand - Yellowish-brown and orange-brown, fine grained sand, occ. gravel, subang. to subrounded, poorly sorted - Damp to Sl. moist	5.0'	Sample #4 14.0' to 19.0'	PID Reading = 0 ppm in sampler PID Reading @ Augers = 0 ppm
	19–20				Sample #5	

ENG FORM 1836 MAR 71 — PREVIOUS EDITIONS ARE OBSOLETE. — PROJECT: LHAAP - Site 29 — HOLE NO. 29WW22(S)

026113

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW22(S)

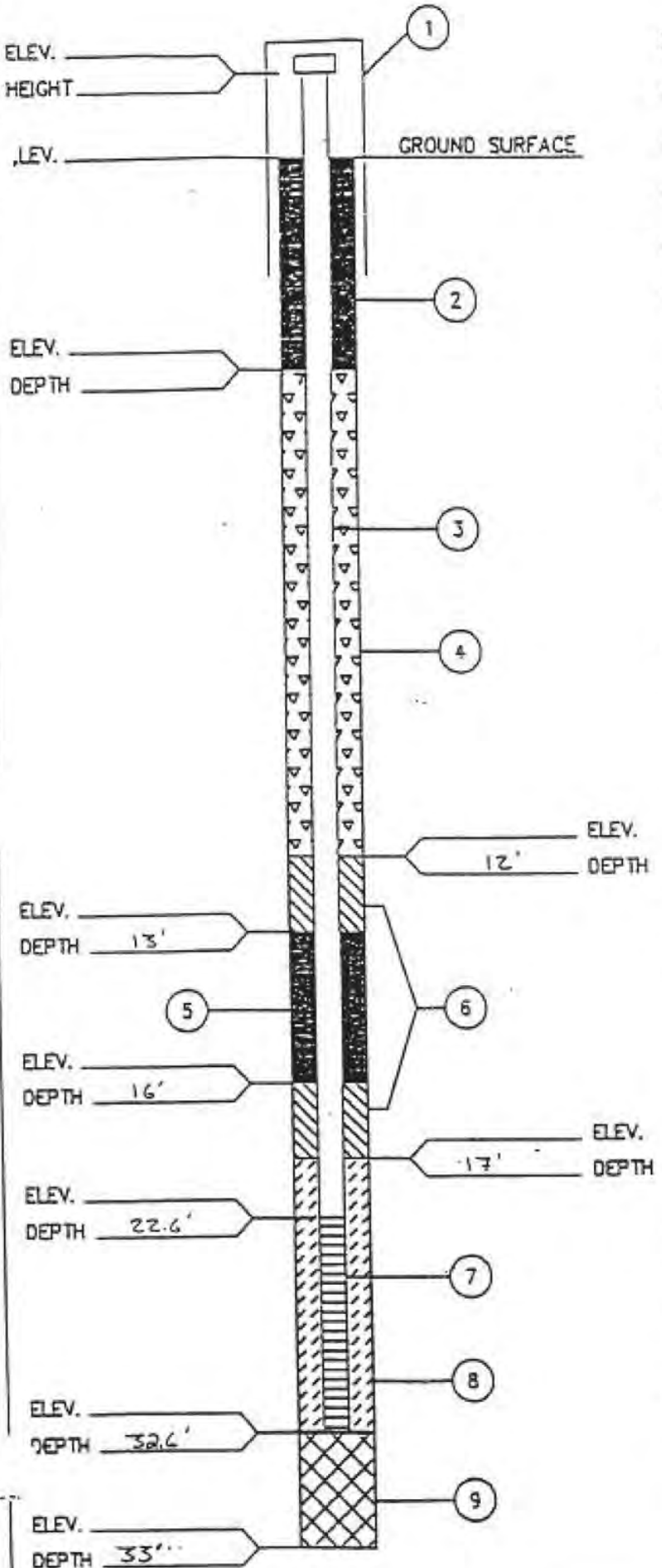
PROJECT: LHAAP - Karnack, TX | INSTALLATION: LHAAP - Karnack, TX | SHEET 2 OF 2 SHEETS

ELEVATION (a)	DEPTH (ft) (b)	USC LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOV-ERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	21	CL	- Silty clay/clayey silt - Lt. to med. gray, Lt. brown, some greenish-gray (mottled), abundant V. thin horiz. Lt. gray fine sand and silt lenses throughout, some fine sand in silty clay and clayey silt matrices, becoming less plastic with depth - Damp	5.0'	19.0' to 24.0'	PID Reading = 0 ppm in sampler PID Reading @ Auger = 0 ppm
	24		- Clayey silt - Lt. to med brown and brown/gray, some fine sand - Dry to Damp (V. stiff)	5.0'	Sample #6 24.0' to 29.0'	PID reading = 0 ppm in sampler PID Reading @ Auger = 0 ppm
	25	(SH) CL	- Lt. gray and brown clay shale (Competent) from 24.7 ft to 25.1 ft.			
	26		- Silty clay/clayey silt - med. brown/gray to Dark gray @ 26.8 ft., abundant V. thin horiz. and irregular Lt. gray fine sand and silt lenses, some fine sand in silty clay and clayey silt matrices - Dry to Damp (V. stiff to Hard)			
	30		- Silty clay/clayey silt - med. to dark gray, some dark greenish-gray, abundant V. thin horiz. and irregular Lt. gray fine sand and silt lenses (horizontal) - Dry to Damp (common) (V. stiff to Hard)	5.0'	Sample #7 29.0 ft. to 34.0 ft.	PID Reading = 0 ppm in sampler
	34		T.D. @ 34 ft. below grade in Dry to Damp silty clay * Hole Dry @ T.D. * No visible water in 5' cont. sampler * Pulled augers up approx. 1.5 ft. from bottom - will let set overnite 3/11/98 * Ckd inside 3 1/4" I.D. augers (pilot-hole for 29WW21(S)) @ 0750 * Water @ 32.0 ft. below grade - audible "dripping" sound of water dripping from bottom of augers into base of hole 3/17/98 - 15.86 water level RECEIVED FROM CONTRACTOR			T.D. @ 1450 034 ft (3/11/98) 3/12/98 - 11" O.D. HSAs were advanced to 36.8 ft below grade - 4" SS (Type 304) wire wound, #10 slot screen (10.0 ft.) was set @ 32.6 ft. below grade - Primary filterpack (16-30) 33.0 ft to 17.0 ft - Sump sand (30-70) 17.0 ft. to 16.0 ft - Bent seal 16.0 ft to 13.0 ft - Sump sand (30-70) 13.0 ft. to 12.0 ft - Bent. grout mix 12.0 ft to within 3 ft. of grade

PROJECT | HOLE NO.

01227022

026114



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW22

DATE 3-12-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)
NA

3. SOLID PIPE TYPE Sch40, 304 S.S., 4" I.D.

SOLID PIPE LENGTH 22.6' ft.

JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

HOW INSTALLED – TREMIE

FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)
Bentonite Chip

6. TYPE OF SECONDARY FILTER PACK
silica sand (30-70)

7. SCREEN TYPE 304 S.S.

SCREEN LENGTH 10' ft.

SLOT SIZE #10 Wire Wound in.

SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK
Filter sand (16-30)

9. TYPE OF BACKFILL Filter sand

10. DRILLING METHOD

WATER LEVEL DATE

*ALL DEPTHS MEASURED FROM GROUND SURFACE

01227023

026115

Hole No. 29WW23(S)

DRILLING LOG	DIVISION USACE - Tulsa	INSTALLATION LHAAP - Karnack, TX	SHEET 1 OF 2 SHEETS
1. PROJECT LHAAP - Karnack, TX Phase III Site 29 RI		10. SIZE AND TYPE OF BIT Auger 4" b	
2. LOCATION (Coordinates or Station) Site 29		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY GPI - Austin, TX		12. MANUFACTURER'S DESIGNATION OF DRILL CME-75 3¾" ID HSA / 5' Ent. sampler	
4. HOLE NO. (As shown on drawing title and file number) 29WW23(S)		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 7	UNDISTURBED 0
5. NAME OF DRILLER Jose Hinojosa		14. TOTAL NUMBER CORE BOXES N/A	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN Penetrated 36 ft.		16. DATE HOLE STARTED 3-5-98	COMPLETED 3-6-98
8. DEPTH DRILLED INTO ROCK N/A		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE 36 ft. below grade		18. TOTAL CORE RECOVERY FOR BORING N/A %	
		19. SIGNATURE OF INSPECTOR [signature] CPG	

ELEVATION (a)	DEPTH (ft) (b)	USC LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	0	CL	- silty clay, Lt. gray, tan, brown, orange-brown, and yellowish-orange mottled, streaked and stained, very plastic, some apparent layering, trace to some fine sand, trace roots - Moist - (V. stiff)	3.9'	Sample #1 0.0' to 4.0'	1600 commenced HSA & 5' cont. Sampler on 3-5-98. PID Reading = 20ppm + in sampler
	4		- Silty clay, Lt. gray, tan and yellowish-brown mottled, some rust brown staining and trace "iron stone" gravel-coarse, trace to some fine sand, v. plastic - Moist - (V. stiff)	5.0'	Sample #2 4.0' to 9.0'	PID Reading = 0ppm @augers PID Reading = 300ppm + in sampler
	8		- Clayey silt, Lt. gray, Lt. brown, tan, yellowish-brown, and rust brown mottled, some orange-brown streaking and staining, V. thin horiz. laminations from 12' to 14', some fine sand - Damp to Moist (>stiff)	4.8'	Sample #3 9.0' to 14.0'	PID Reading = 0ppm @augers PID Reading = 150ppm + in sampler
	12		- Clayey silt / silty clay, Lt. to med. gray, some blk gray thin horiz. layers @ 17ft, some rust brown streaking and staining, occ. v. thin horizontal laminated bedding, some fine sand - Damp to Moist (Med. stiff)	2.8'	Sample #4 14.0' to 19.0'	PID Reading 300ppm + in sampler
	16				Sample #5	
	20	SM	becoming moist to wet @ 20' in sampler			

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT [illegible] Site 29 HOLE NO. 29WW23(S)

026116

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW23(S)

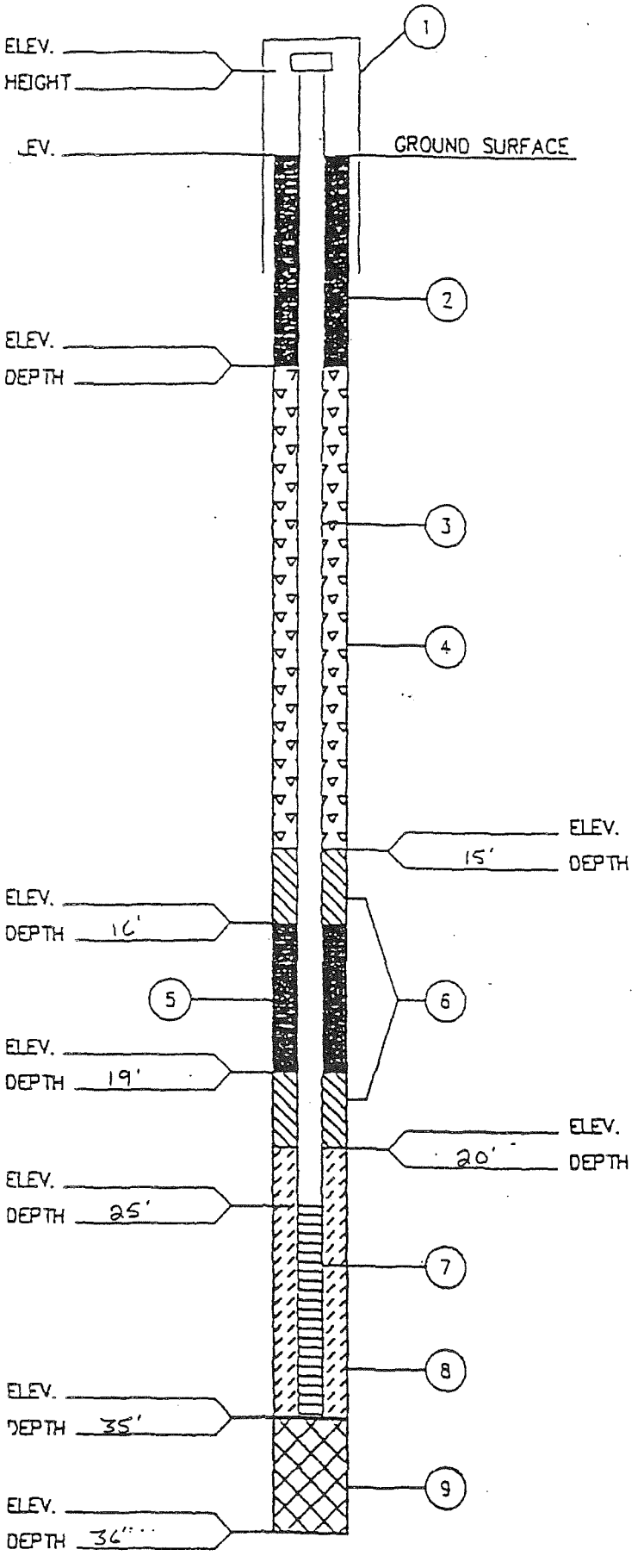
PROJECT LHAAP- Kunnard, TX Site 29 phase III RI | INSTALLATION LHAAP | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH (Ft) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	SM	- Sandy silt, lt. to dark gray with some v. thin horiz. layering/laminated; fine grained sand, some rust brown staining - Moist (med. dense).	4.9'	17.0 to 24.0'	
	22					
	23	CL	- Silty clay, Med. to dark gray, some lt. gray mottling, some fine sand seams & clayey silt - Damp to moist			
	24	COAL	- "Lignite" coal seam (Damp)		Sample #6	
		SM				
		CL				
	25	SM	- Sandy silt, DK gray, some med. gray v. thin layers (horiz.) fine grained sand, occ. cl. clayey - Moist (med dense)	3.1'	24.0' to 29.0'	PID Reading 190ppm+ in sampler
	26					
	27		(No vis. water W.D. in samples)			PID Reading @ Augco = 0ppm
	28					
	29		- Sandy silt, Pred. med. gray, some Dark gray with apparent v. thin to thin layering, fine grained sand - Moist		Sample #7	
	30				29.0' to 34.0'	PID Reading = 500ppm+ in sample
	31			5.0'		
	32	CL	- Silty clay, Med. to dark gray, some lt. gray v. thin horiz. and irregular layering and lenses of silt and fine sand, trace to some fine sand in silty clay matrix - Dry (HARD)			
	33					
	34					
	35			2.0'	Auger Sample	
	36		T. D. @ 36 ft. bgbg existing grade in Med. to DK gray laminated Dry silty clay			T. D. @ 29WW23 @ 1650 3/6/98 - 11" O.D. HSA were advanced to 36.0 ft - 4" SS (304) wire-wound #10 slot screen (10 ft.) was set @ 36.0' - Primary filterpack (16-30) 36' to 20' - Sugar Sand (30-70) 20' to 19' - Bent. Seal 19' to 16' - Sugar Sand (30-70) 16' - 15' - Bent. grout 15' to within 3 ft of grade

ENG FORM (FB 1110-1-1801) PREVIOUS EDITIONS ARE OBSOLETE

PROJECT LHAAP-Site 29 | HOLE NO. 29WW23(S)

026117



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29NW23

DATE 3-6-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)

   NA

3. SOLID PIPE TYPE Sch 40, 304 S.S. 4" I.D.

   SOLID PIPE LENGTH 25' ft.

   JOINT TYPE SUP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED - TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)

   Bentonite chip

6. TYPE OF SECONDARY FILTER PACK

   Silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 wire Wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK

   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD HSA

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

911350

Hole No. 29WW24(+)

026118

DRILLING LOG	DIVISION USACE - TULSA	INSTALLATION LHAAP - KARNACK TX	SHEET OF SHEETS
PROJECT LHAAP - KARNACK TX GROUP 2 PHASE III		10. SIZE AND TYPE OF BIT 11"	
2. LOCATION (Coordinates or Station) SITE 29		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY GEOPROTECT INTERNATIONAL		12. MANUFACTURER'S DESIGNATION OF DRILL CME-75	
4. HOLE NO. (As shown on drawing title and file number) 29WW24		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED	UNDISTURBED N/A
5. NAME OF DRILLER JOSE LANDEROS		14. TOTAL NUMBER CORE BOXES N/A	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN PENETRATED		16. DATE HOLE STARTED 4-15-98	COMPLETED
8. DEPTH DRILLED INTO ROCK N/A		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE PLEASE GRADE		18. TOTAL CORE RECOVERY FOR BORING N/A %	
		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
	36					GEOPROBE FROM 0-36' DRILLING 12:00-13:19
	37	CL	SILTY CLAY DARK BROWNISH GRAY, BLACK STREAKS TRACE FINE SAND DRY TO DAMP (VERY STIFF) PLASTIC	12.0	SAMPLE #1 36.0 to 38.0	PID READING = 0.0 ppm IN SAMPLE 10:32
	38					PID READING = 0.0 ppm IN WORK ZONE
	39	CL	SILTY CLAY DARK BROWNISH GRAY BLACK STREAK TRACE FINE SAND DRY TO DAMP (VERY STIFF) HIGH PLASTIC	2.0	SAMPLE #2 38.0 to 40.0	PID READING = 0.0 ppm IN SAMPLE 10:55
	40					PID READING = 0.0 ppm IN WORK ZONE
	41	CL	SILTY CLAY DARK BROWNISH GRAY BLACK STREAKS, LT GRAY MOTTLING TRACE FINE SAND AND LIGNITE FRAGMENTS DRY TO DAMP (VERY STIFF) HIGH PLASTIC	2.0	SAMPLE #3 40.0 to 42.0	PID READING = 0.0 ppm IN SAMPLE 11:18
	42					PID READING = 0.0 ppm IN WORK ZONE
	43	CL	SILTY CLAY DARK BROWNISH GRAY BLACK STREAKS, LT GRAY MOTTLING TRACE FINE SAND AND LIGNITE FRAGMENTS DRY TO DAMP (VERY STIFF) HIGH PLASTIC	2.0	SAMPLE #4 42.0 to 44.0	PID READING = 0.0 ppm IN SAMPLE 11:34
	44					PID READING = 0.0 ppm IN WORK ZONE
	45	CL	SILTY CLAY DARK BROWN OR CHOCOLATE WITH BLACK STREAKS AND LT GRAY MOTTLING TRACE FINE SAND AND LIGNITE FRAGMENTS DRY TO DAMP (VERY STIFF) HIGH PLASTIC	2.0	SAMPLE #5 44.0 to 46.0	PID READING = 0.0 ppm IN SAMPLE 11:58
	46					PID READING = 0.0 ppm 12:00 STOPPED DRILLING IN WORK ZONE RESUMED 13:19 DRILLING COMMENCES
	47	CL	SILTY CLAY DARK BROWNISH GRAY WITH BLACK STREAKS WITH THIN LT GRAY FINE SAND ENTERING TRACE LIGNITE FRAG. DRY TO DAMP (STIFF) PLASTIC	2.0	SAMPLE #6 46.0 to 48.0	PID READING = 0.0 ppm IN SAMPLE 13:30
	48					PID READING = 0.0 ppm IN WORK ZONE
	49	CL	SILTY CLAY DARK BROWNISH GRAY WITH BLACK STREAKS THIN LT GRAY FINE STRINGERS TRACE LIGNITE FRAG. DRY TO DAMP (VERY STIFF) PLASTIC 1/4" LIGNITE SEAM	2.0	SAMPLE #7 48.0 to 50.0	PID READING = 0.0 ppm IN SAMPLE 13:50
	50	CL				PID READING = 0.0 ppm IN WORK ZONE
	51	CL	SILTY CLAY DARK BROWNISH GRAY WITH BLACK STREAKS AND THIN LT GRAY SILTY SAND ENTERING TRACE LIGNITE FRAG. DRY TO DAMP (VERY STIFF) PLASTIC	2.0	SAMPLE #8 50.0 to 52.0	PID READING = 0.0 ppm IN SAMPLE 14:10
	52	CL				PID READING = 0.0 ppm IN WORK ZONE
	53	SM	CLAYEY AND SILTY SAND DARK BROWNISH GRAY WITH HORIZONTAL THIN LAYERS OF LT GRAY SILTY SAND AND DARK BROWN CLAYEY FINE SAND DRY TO DAMP (VERY DENSE)	2.0	SAMPLE #9 52.0 to 54.0	PID READING = 0.0 ppm IN SAMPLE 14:49
76	54					PID READING = 0.0 ppm IN WORK ZONE
	55	SM	SILTY AND CLAYEY SAND DARK GRAY, FINE GRAINED MOIST TO WET (VERY DENSE)	1.2	SAMPLE #10 54.0 to 56.0	PID READING = 0.0 ppm IN SAMPLE 15:15
	56					PID READING = 0.0 ppm IN WORK ZONE

PROJECT HOLE NO.

026119

PILOT HOLE

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW24(2)

PROJECT GROUP 2 PHASE III SITE 29 | INSTALLATION LHAAP-KANSAS IX | SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	56	SM/SP	SLIGHTLY SILTY AND CLAYEY SAND MED TO DARK GRAY, FINE GRAINED, MOIST WET (DENSE)	1.0	SAMPLE #11 56 to 58	PID READING = 0.0 PPM IN SAMPLE 15:45
	57					PID READING = 0.0 PPM IN WATER ZONE
	58	SP	SAND MED TO DARK GRAY SOME SILT AND CLAY, FINE GRAINED TRACE MED TO COARSE SAND MOIST/WET (DENSE)	1.0	SAMPLE #12 58 to 60	PID READING = 0.0 PPM IN SAMPLE 16:12
	59					PID READING = 0.0 PPM IN WATER ZONE
	60	SP	SAND MED TO DARK GREENISH GRAY SOME SILT FINE GRAINED MOIST/WET (DENSE)	1.1	SAMPLE #13 60 to 62	PID READING = 0.0 PPM IN SAMPLE 16:47
	61					PID READING = 0.0 PPM IN WATER ZONE
	62	SP	SAND MED TO DARK GREENISH GRAY SOME SILT FINE GRAINED MOIST/WET (VERY DENSE)	1.0	SAMPLE #14 62 to 64	PID READING = 0.0 PPM IN SAMPLE 17:09
	63					PID READING = 0.0 PPM IN WATER ZONE
	64			1.4	SAMPLE #15 64 to 66	PID READING = 0.0 PPM IN SAMPLE 17:41
	65		- DARK BROWN LIGNITE WITH WOOD FRAGMENTS FAIRLY LARGE FROM 64.5 TO 66 WITHIN THE FINE GRAINED SAND			PID READING = 0.0 PPM IN WATER ZONE
	66	SM/SP	CLAYEY AND SILTY SAND FINE LT GRAY WITH MED GRAY THIN LAYERS OF SILTY/CLAYEY FINE SAND, FINE GRAINED MOIST/WET DENSE)	0.5 BECOMES 0.8	SAMPLE #16 66 to 68	PID READING = 0.0 PPM IN SAMPLE 18:10
	67					PID READING = 0.0 PPM IN WATER ZONE
	68			3.4		BEGIN CORE DRILLING STARTED FOR 4-15-98
	69	SP	SAND MED TO DARK GREENISH GRAY SOME SILT AND CLAY, FINE GRAINED MOIST/WET (DENSE)	1.4 SPOON SECTION 0.5	SAMPLE #17 68 to 70	CONTINUED DRILLING 4-16-98 PID READING = 0.0 PPM IN SAMPLE 9:07
	70					PID READING = 0.0 PPM IN WATER ZONE
	71	SP	SAND MED TO DARK GREENISH GRAY SOME SILT AND CLAY FINE GRAINED MOIST/WET (DENSE)	1.4	SAMPLE #18 70 to 72	PID READING = 0.0 PPM IN SAMPLE 9:39
	72					PID READING = 0.0 PPM IN WATER ZONE
	73	SP	SAND MED TO DARK GREENISH GRAY SOME SILT AND CLAY FINE GRAINED WET (MED DENSE)	1.5	SAMPLE #19 72 to 74	PID READING = 0.0 PPM IN SAMPLE 10:38
	74					PID READING = 0.0 PPM IN WATER ZONE
	75	SP	SAND MED TO DARK GRAY TRACE SILT AND CLAY FINE GRAINED WET (MED DENSE)	0.75	SAMPLE #20 74 to 76	PID READING = 0.0 PPM 11:03
	76					PID READING = 0.0 PPM IN SAMPLE
	77	SP	SAND MED TO DARK GRAY TRACE SILT AND CLAY FINE GRAINED WET (MED DENSE)	1.2	SAMPLE #21 76 to 78	PID READING = 0.0 PPM IN SAMPLE 11:52
	78					PID READING = 0.0 PPM IN WATER ZONE
	79	SP	SAND MED TO DARK GRAY TRACE SILT AND CLAY FINE TO MEDIUM GRAINED WET (MED DENSE)	1.0	SAMPLE #22 78 to 80	PID READING = 0.0 PPM IN SAMPLE 13:40
	80					PID READING = 0.0 PPM IN WATER ZONE

PROJECT | HOLE NO.

026120

PILOT HOLE

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW24(I)

PROJECT: GROUP PHASE III SITE 29 | INSTALLATION: LHAAP - KARNACK TX | SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	80					
	81	SP	SAND MIXED TO DARK GREENISH GRAY TRACE SILT AND CLAY, SOME LIGNITE FAIRLY MOIST/WET (MED DENSE)	1.2	SAMPLE #24 80.0 to 82.0'	PID READING = 0.6 ppm IN SAMPLE 14:08
	82					PID READING = 0.0 ppm IN WORKZONE
	83		SAND MIXED TO DARK GREENISH GRAY TRACE SILT AND CLAY MOIST/WET (MED DENSE)	1.2	SAMPLE #25 82.0 to 84.0	PID READING = 0.0 ppm IN SAMPLE 15:22
	84		TD@84 4-16-98			PID READING = 0.0 ppm IN WORKZONE

GEOPHYSIC DOWNHOLE EQUIPMENT USED TO RUN RESIST. GAMMA SURVEY

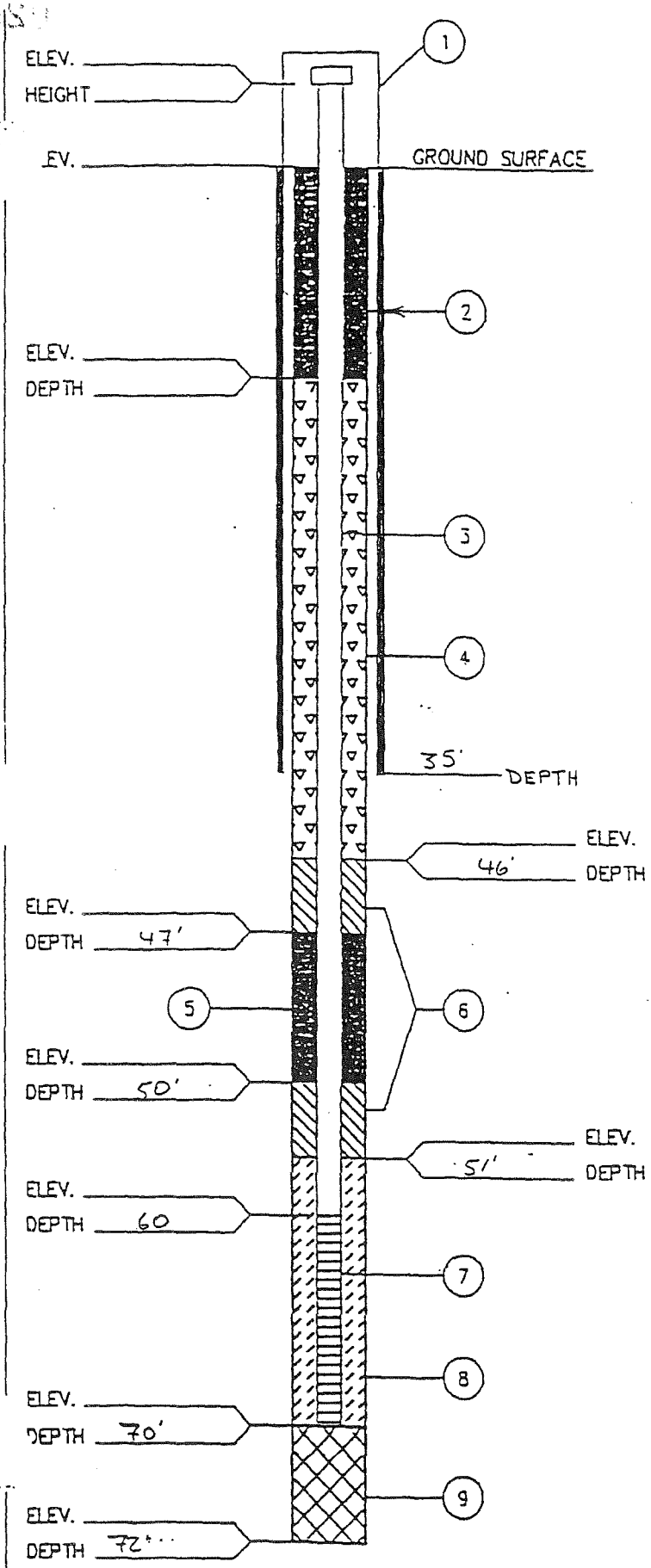
BOREHOLE GROUTED 4-16-98

See Aw's field book → Drilled offset hole (12') with 7/8" Rotary Bit on 4/30/98 (Jose Lorono and CME-75)

Drilled with CME-75 Mobile-68 Drill

Drilled to T.D. of 72' @ 29WW24(I) on 4/30/98 - circ. hole w/ tri-pelect bit. Set 10' of #10 slot 4" I.D. SS screen @ 70 ft. below grade. Primary sand from 72' upto 51' Sugar sand from 51' to 50' Bentseal from: 50' to 47' Sugar sand from: 48' to 46' Bent/cement grout from: 46' to grade thru easy

026121



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW24

DATE 4-30-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)
   8" ø steel casing

3. SOLID PIPE TYPE Sch 40, 304 S.S., 4" I.D.

   SOLID PIPE LENGTH 60' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)
   Bentonite chips

6. TYPE OF SECONDARY FILTER PACK
   silica sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 Wire Wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK
   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter sand

10. DRILLING METHOD Mud Rotary

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

Hole No. 29WW25(P)

026122

DRILLING LOG	DIVISION USACE – Tulsa	INSTALLATION LHAAP	SHEET 1 OF 2 SHEETS
1. PROJECT LHAAP – Karnack, TX Phase III Site 29 RI		10. SIZE AND TYPE OF BIT Auger BH	
2. LOCATION (Coordinates or Station) Site 29		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY GPT – Austin, TX		12. MANUFACTURER'S DESIGNATION OF DRILL CME-75 3¼" I.D. HSA / 5' CME Cont. Sampler	
4. HOLE NO. (As shown on drawing title and file number) 29WW275		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 7	UNDISTURBED 0
5. NAME OF DRILLER Jose Hinojosa		14. TOTAL NUMBER CORE BOXES N/A	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 3-4-98	COMPLETED 3-4-98
7. THICKNESS OF OVERBURDEN Penetrated 34.0ft.		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK N/A		18. TOTAL CORE RECOVERY FOR BORING N/A %	
9. TOTAL DEPTH OF HOLE 34.0 ft. Bebu Grade		19. SIGNATURE OF INSPECTOR [signature] CPG	

ELEVATION a	DEPTH (Ft) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1	CL	- Silty clay/clayey silt Lt. gray, tan, orange-brown, and yellowish-orange mottled, streaked and stained, some fine sand, occ rust colored staining, trace to some roots - Damp to Moist (stiff)	3.4'	Sample #1 0.0' to 4.0'	0945 commenced HSA & 3¼" I.D. HSA ÷ 5' CME cont sampler
	2					PID Reading = 40 ppm+ in sampler (10.2 eV Hnu)
	3					
	4		- Silty clay, Lt. gray, brown, orange-brown, yellowish-orange, tan mottled, streaked and stained, some apparent layering, occ rust colored staining and some gravel (ironstone), some fine sand Dry to Damp (v. stiff)	5.0'	Sample #2 4.0' to 9.0'	PID Reading = 70 ppm+ in sampler
	5					
	6					
	7					
	8					PID Reading @ Auger = 0 ppm
	9		- Silty clay, Lt. gray, tan, and med. gray mottled, some dark gray staining, trace to some fine sand, trace gravel, trace roots - Dry to Primarily Damp (v. stiff)	5.0'	Sample #3 9.0' to 14.0'	PID Reading = 30 ppm+ in sampler
	10					
	11					
	12					
	13					
	14		- Silty clay, Lt. gray, brown, tan, orange-brown, and yellowish-orange mottled, streaked and stained, some layering (Horiz.) from 14.6 ft. to 19.0 ft, some fine sand, trace gravel - Damp to Moist (stiff)	6.0'	Sample #4 14.0' to 19.0'	PID Reading = 520 ppm+ in sampler
	15					
	16					
	17					
	18					
	19		Some black irregular staining and staining from 19.5 ft. to 19.0 ft.		Sample #5	
	20					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT LHAAP Phase III Site 29 HOLE NO. 29WW25

026123

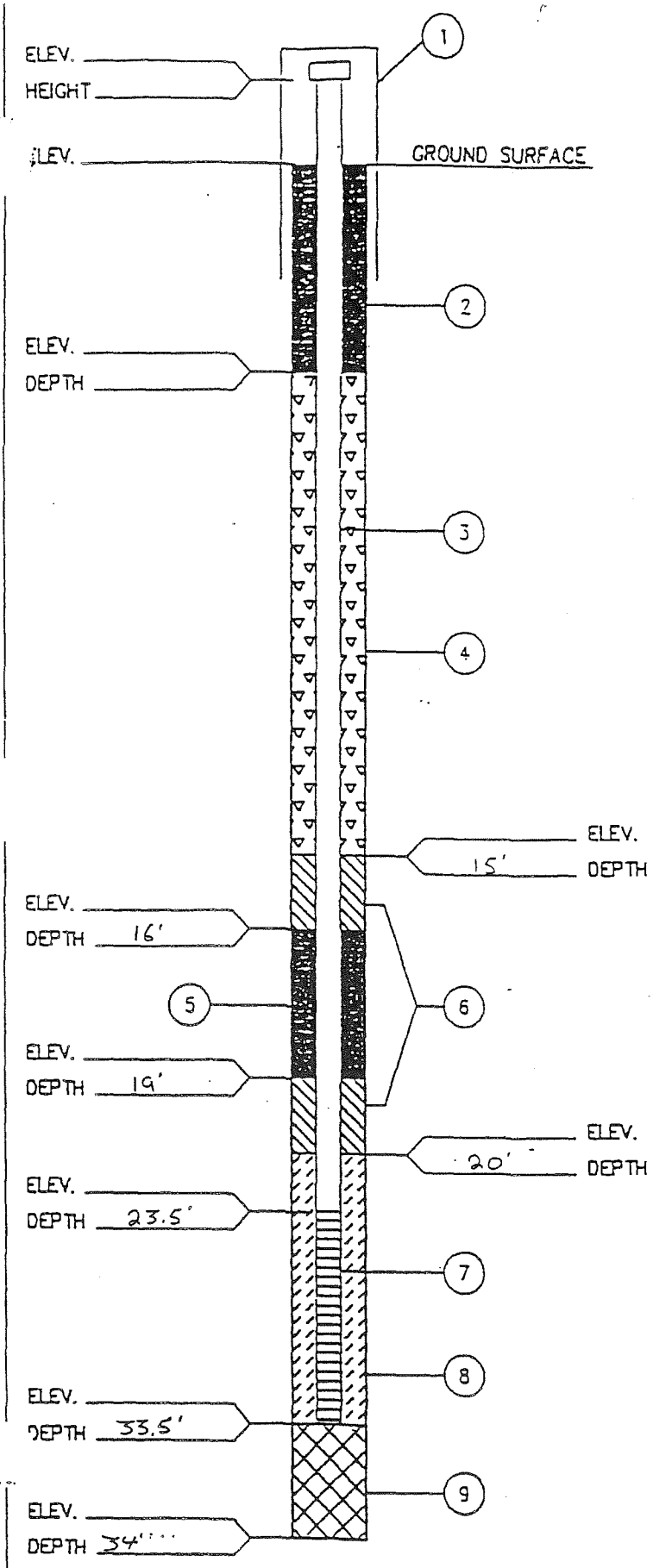
DRILLING LOG (Cont Sheet) — ELEVATION TOP OF HOLE — Hole No. 29WW25(2)

PROJECT LHAAP - Phase III Site 29 — INSTALLATION LHAAP — SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH (Ft.) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	CL	- Silty clay / Sandy clayey silt, Lt. gray, tan, orange-brown, Yellowish-brown mottled, streaked and stained, some rust colored stained, some black iron staining, and black streaks and veins, some fine sand - Moist (V. stiff)	5.0'	19.0' to 24.0'	PID Reading = 240ppm+ in sample
	22					
	23					
	24	SM	- stony content & sandy silt @ 23.7 ft. (moist)			
	25		- Sandy silt / with some clayey silt (V. thin to thin layering) Lt. gray, tan, yellowish orange and brown mottled, streaked and stained, some sl. plastic, sand & fine grained - Damp to sl. moist (Dense)	5.0'	Sample #6 24.0' to 29.0'	PID Reading = 15ppm+ in sample
	26					
	27		Becoming med. gray @ 27 ft.			
	28		* No visible water - in SM material W.D.			PID Reading @ Augers = ppm
	29		- Sandy silt - some sl. clayey, Lt. brown, tan, and yellowish orange, & brown mottled, streaked and stained, fine-grained sand, some apparent layering - clayey zones "slightly" plastic, Moist (Med. Dense)			
	30				Sample #7 29.0' to 34.0'	
	31			5.0'		PID Reading = 2ppm+ in sample
	32					
	33		- Silty clay med. to dark gray with abundant very thin horiz. fine sand and silt lenses, some sand in clay & silt - Damp (V. stiff)			
	34	CL				
	35		T.D. @ 34 ft. below grade in med gray layered clay Hole dry (inside augers) @ T.D. * W.L. @ 19.4 ft below grade inside well after 24 hours			T.D. 29WW25 @ 1040 - 11" O.D. HSA were advanced to 34.0 ft - 4" SS (304) Wirewound #10 slot screen was set @ 33.5 ft. (10 ft screen) - Primary filterpack (16-30) 34 ft. to 20 ft - Sump sand (20-40) 20 ft. to 19 ft - Bent. seal 19 ft. to 16 ft - Sump sand (30-40) 16 ft to 15 ft - Bent grout 15 ft to within 3 ft. of grade

ENG FORM 1836-A (ER 1110-1-1801) GPO 1980 OF-626-603 — PROJECT LHAAP Phase III Site 29 — HOLE NO. 29WW25

026124



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW25

DATE 3-4-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)

   NA

3. SOLID PIPE TYPE Sch 40, 304 S.S., 4" I.D.

   SOLID PIPE LENGTH 23.5' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)

   Bentonite chip

6. TYPE OF SECONDARY FILTER PACK

   Silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 wire wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK

   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD HSA

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

01227033

026125

Hole No. 29WWZ6(S)

DRILLING LOG	DIVISION USACE - TULSA	INSTALLATION LHAAP SITE 29	SHEET 1 OF 2 SHEETS
1. PROJECT LHAAP GROUP 2 PHASE III		10. SIZE AND TYPE OF BIT AUGER BIT FOR 3 3/4	
2. LOCATION (Coordinates or Station) SITE 29 KARNACK TEXAS		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY GEOPROTECT INT.		12. MANUFACTURER'S DESIGNATION OF DRILL CME CONTINUOUS CME-75 3 3/4" I.D. AUGER 15' SAMPLER	
4. HOLE NO. (As shown on drawing title and file number) 29WWZ6		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED / UNDISTURBED
5. NAME OF DRILLER JOSI.		14. TOTAL NUMBER CORE BOXES N/A	
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 10:45 2-25-98 COMPLETED 2-25-98	
7. THICKNESS OF OVERBURDEN PENETRATED 34 ft		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK NA		18. TOTAL CORE RECOVERY FOR BORING %	
9. TOTAL DEPTH OF HOLE 34 ft BELOW GRADE		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1	SM	SILTY SAND, BROWN WITH REDDISH BROWN MOTTLING FINE GRAINED SOME CLAYEY, MOIST (DENSE)	3'	SAMPLE #1 0.0' to 4.0'	START DRILLING 10:45 PID READING = 0.2 / 0.0 ppm IN SAMPLER PID READING = 0.0 ppm @ AUGER
	2	CL	SILTY CLAY, BROWN WITH REDDISH BROWN AND GREY MOTTLING, WITH FINE SAND, MOIST (SOFT TO MEDIUM STIFF) SLIGHTLY PLASTIC			
	3					
	4					
	5	CL-CH	SILTY CLAY, REDDISH BROWN AND GREY MOTTLED WITH FINE SAND DAMP TO MOIST (STIFF TO VERY STIFF) PLASTIC.	5.0'	SAMPLE #2 4.0' to 9.0'	PID READING = 300 / 5 ppm BETTER IN SAMPLER PID READING = 0.0 ppm @ AUGER
	6					
	7					
	8					
	9					
	10	CL	SILTY CLAY GRAYISH BROWN WITH FINE SAND WITH FINE SAND DAMP TO MOIST (MED STIFF) LOW TO MED PLASTIC	5.0'	SAMPLE #3 9.0' to 14.0'	PID READING = 6.0 / 230 ppm IN SAMPLER PID READING = 0.0 ppm @ Auger
	11					
	12					
	13		AREAS OF INCREASE SAND CONTENT WITH DEPTH			
	14					
	15			3.5'	SAMPLE #4 14.0' to 19.0'	PID READING = 18.2 / 520 ppm IN SAMPLE PID READING = 0.0 ppm @ Auger
	16		SILTY CLAY, GRAYISH BROWN DRY TO DAMP (STIFF TO VERY STIFF) PLASTIC FRACTURED AT TOP OF SPOON BECOMING VERY DENSE AT 18'			
	17					
	18					
	19				SAMPLE #5	
	20					

01227034

026126

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW26(3)

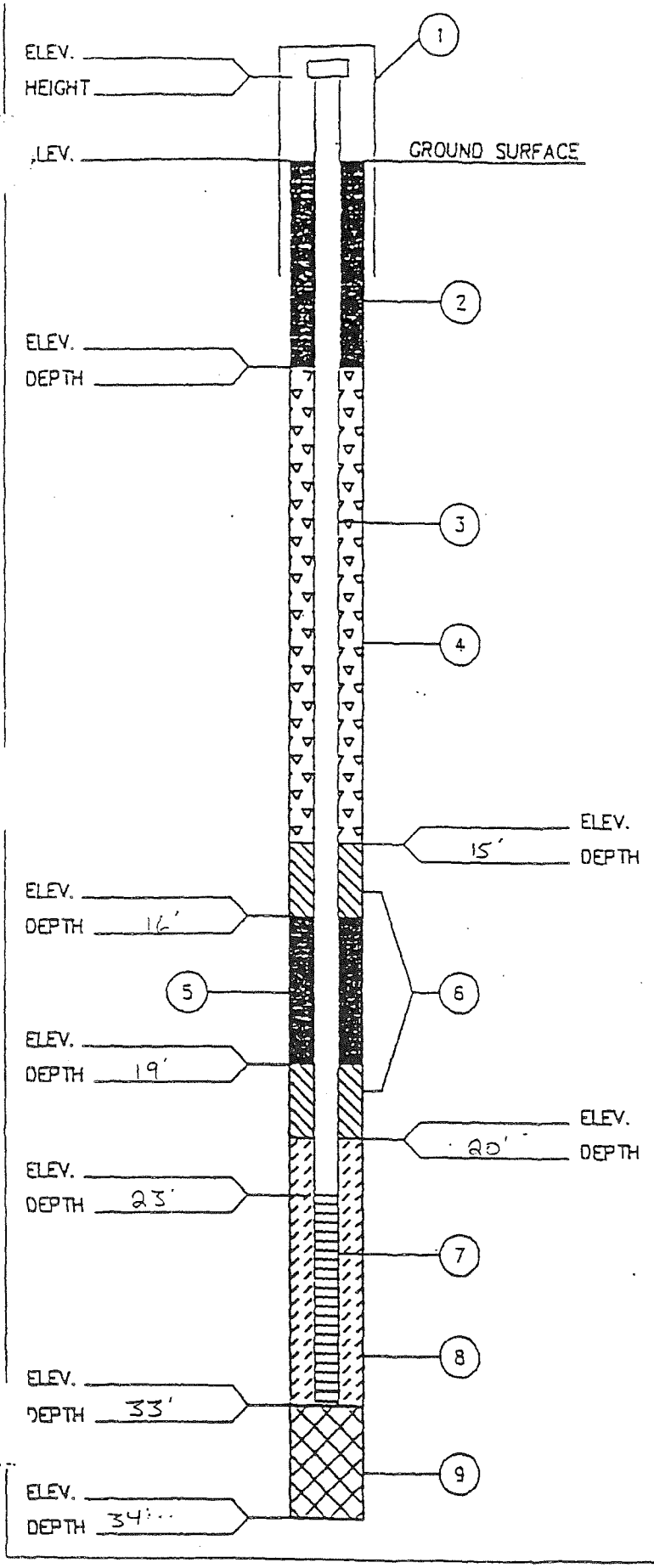
PROJECT LHAAP GROUP 2 PHASE III | INSTALLATION LHAAP - SITE 29 | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	CH-CL	SILTY CLAY GRAY WITH GRAYISH BROWN MOTTLING, DRY TO DAMP (VERY STIFF) PLASTIC	4.0'	SAMPLE #5 19' to 24'	PID READING = 13.2 / 4.0 PPM IN SAMPLE
	22					
	23	SM	SILTY SAND BROWN WITH GRAY MOTTLING FINE TO MED GRAINED, MOIST (DENSE)			PID READING = 0.0 ppm @ AUGER
	24					
	25			3.0	SAMPLE #6 24' to 29'	PID READING = 48.0 TIP / 16.4 PPM CORR. IN SAMPLE
	26					
	27					PID READING = 0.0 ppm @ AUGER
	28	CL	SILTY CLAY BROWN WITH LT. BROWN AND GRAY STREAKS SOME FINE SAND, DRY TO DAMP (VERY STIFF) MED PLASTIC			
	29	SM	SILTY SAND BROWN FINE TO MED GRAINED MOIST TO WET (DENSE)		SAMPLE #7 29' to 34'	SAMPLE TAPE MOISTURE NOTED ON LOGS 13.2 TO 20.4 PERT. PID READING = 20.4 PPM IN SAMPLE
	30					
	31					PID READING = 0.0 PPM @ AUGER
	32					
	33	CL	SILTY CLAY DARK GRAY WITH BROWN STREAKS SOME FINE SAND DRY TO DAMP (STIFF TO VERY STIFF) PLASTIC SOME SAND LAYERS WITHIN SILTY CLAY			TDQ 11:45
	34			TOTAL	DEPTH 34'	11" AUGERS FROM 0 TO 34'

SCREEN BOTTOM 33'-23'
4" ID WIRE WOUND 304 STAINLESS STEEL #10 SLOT
PRIMARY FILTER 34' TO 20'
SLUFF 20' TO 29'
SAND
BENT. 19' TO 16'
SLUFF SAND 16' TO 15'
BENTONITE GRANITE 15' TO WITHIN 3' OF GROUND SURFACE

PROJECT | HOLE NO.

026127



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW26

DATE 2-25-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)

   NA

3. SOLID PIPE TYPE Sch 40 304 S.S. 4" I.D

   SOLID PIPE LENGTH 23' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)

   Bentonite chip

6. TYPE OF SECONDARY FILTER PACK

   Silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 Wire Wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK

   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD HSA

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

01227036

026128

Hole No. 29WW27(7)

DRILLING LOG	DIVISION: USACE-Tulsa	INSTALLATION: LHAAP	SHEET 1 OF 2 SHEETS
1. PROJECT: LHAAP-Karnack, TX Phase III Site 29 RI		10. SIZE AND TYPE OF BIT: Auger Bit	
2. LOCATION (Coordinates or Station): Site 29		11. DATUM FOR ELEVATION SHOWN (TBM or MSL):	
3. DRILLING AGENCY: GPI - Austin, TX		12. MANUFACTURER'S DESIGNATION OF DRILL: CME CME-75 3¼ I.D HSA / 5' cont Sampler	
4. HOLE NO. (As shown on drawing title and file number): 29WW27		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 8	UNDISTURBED 0
5. NAME OF DRILLER: Jose Hinohosa		14. TOTAL NUMBER CORE BOXES: N/A	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER:	
7. THICKNESS OF OVERBURDEN: Penetrated 34 ft		16. DATE HOLE: STARTED 3-3-98	COMPLETED 3-3-98
8. DEPTH DRILLED INTO ROCK: N/A		17. ELEVATION TOP OF HOLE:	
9. TOTAL DEPTH OF HOLE: 34 Ft. Below Grade		18. TOTAL CORE RECOVERY FOR BORING: N/A %	
		19. SIGNATURE OF INSPECTOR: CPG	

ELEVATION (a)	DEPTH (ft) (b)	LEGEND (Use) (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	0	OL	5" Dark brown topsoil with some gravel fill and roots (Wet) overlying	3.0'	Sample #1 0.0' to 4.0'	0910 Commenced HSA & 5' CME cont. sampler
	1	CL	- Silty clay, Lt. brown, gray, and orange-brown mottling, streaking and staining, trace to some fine sand, becoming more plastic with depth - Dump to Moist (St:H) (Some Roots)			PID Reading = 300ppm+ in sampler
	2					
	3	CL-CH				
	4					
	5	CL	- Silty clay, Lt. gray-brown, and tan (mottled) with some clayey silt layering, some fine sand - Dry to Damp (V. St:H)	4.8'	Sample #2 4.0' to 9.0'	PID Reading = 500ppm+ in sampler
	6					PID Reading @ Augers = 0ppm
	7					
	8					
	9		- Silty clay, same as thin clayey silt zones with fine sands, Lt. to med. gray, some tan, brown, and rust brown mottling, low to med. plasticity, some layering of clayey silt zones - Dry to Damp	3.4'	Sample #3 9.0' to 14.0'	PID Reading = 100ppm+ in sampler
	10					
	11					
	12					PID Reading @ Aug
	13					
	14					
	15		- Silty clay, Lt. gray, brown, tan, Orange and yellowish brown mottled, streaked, and stained, some rust-brown and black streaks and stains, occ as clayey silt, some fine sand - Moist (St:H)	5.0'	Sample #4 14.0' to 19.0'	PID Reading = 600ppm+ in sampler
	16					
	17					
	18	CL	v. thin silty sand layer (moist) @ 18'			PID Reading @ Augers = 0ppm
	19		- Silty clay, Lt. to med. gray, some yellowish-orange, v. thin layered, some fine sand			
	20	SM			Sample #5	

ENG FORM 1836 — PREVIOUS EDITIONS ARE OBSOLETE — PROJECT LHAAP OU III Site — HOLE NO. 29WW27

026129

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW27(S)

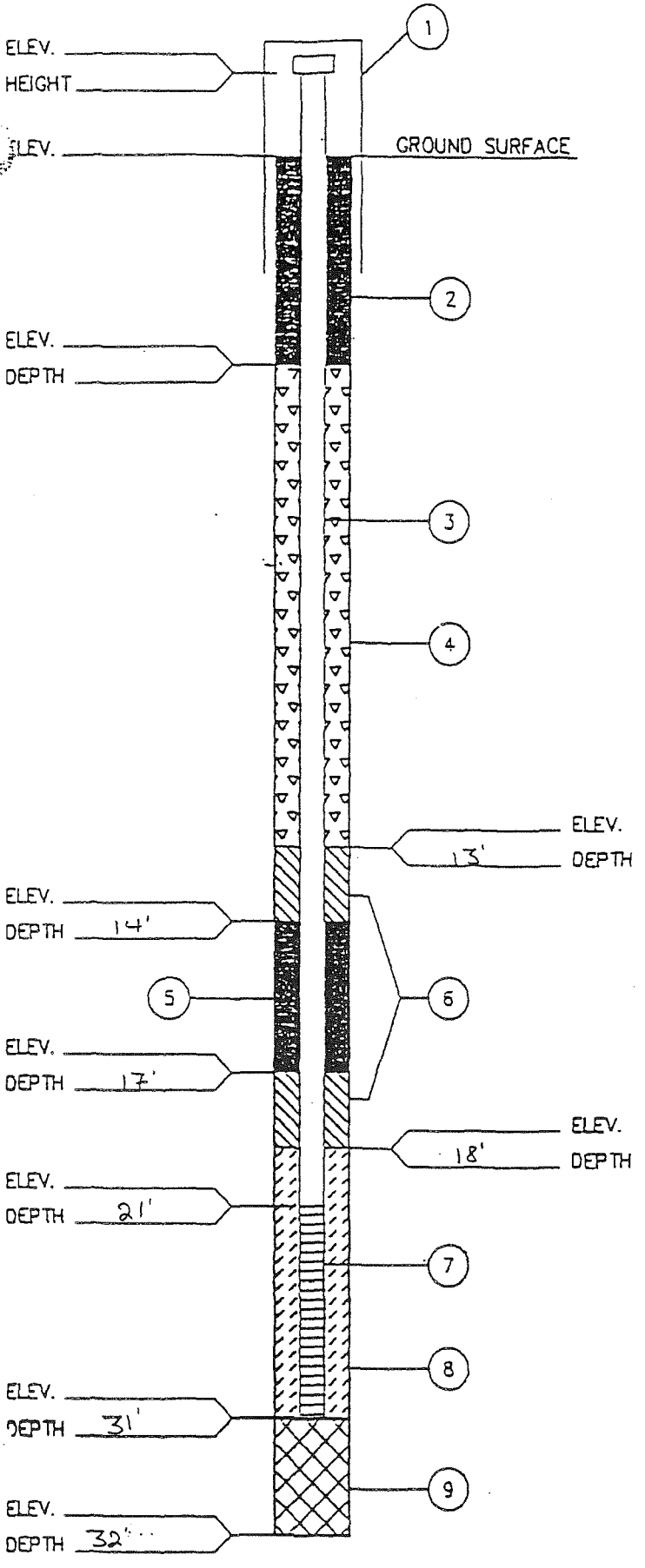
PROJECT LHAAP- Phase III Site 29 | INSTALLATION LHAAP | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH (Ft) b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	SM	- Sandy silt, med. gray/brown, fine grained sand, some cl clayey - Damp to moist	5.0'	19.0' to 24.0'	PID Reading = 7ppmt in sample
	22		- Silty Sand - med gray/brown, fine grained sand, trace med. grains - moist (Med. Dense)			PID Reading = 0ppm @ Auger
	23	CL	- silty clay - Lt. tomed. gray, tan, brown, and yellowish-brown (mottled) some rust brown staining, some fine sand - Dry to Damp (V. stiff)			
	24					
	25	SM	- Sandy silt, Lt. to med. browned gray (mottled), fine grained sand - moist	3.0'	Sample # 6, 24.0' to 27.0'	PID Reading = 329 ppmt in sampler
	26					
	27	CL	- clayey silt, Lt. gray, some layering, some fine sand - DRY (HARD)			Premature sampler Refusal @ 27.0'
	28	SM	- Sandy silt, med. gray/brown (mottled), fine grained sand, some as silty fine sand - Moist to sl. Wet (med. Dense)	2.0'	Sample #7 27.0' to 29.0'	PID Reading = 90 ppmt in sampler PID Reading = 0ppm @ Augers
	29					
	30		- Sandy silt, med. brown, orange-brown, yellowish-brown, and rust brown (mottled), some sl. clayey.	5.0'	Sample #8 29.0' to 34.0'	
	31	CL	- silty clay/clay, dk gray, abundant V. thin and irregular fine sand and silt layers / laminated, trace to some fine sand in silty clay matrix - DRY (Hard)			PID Reading = 2ppmt in sampler
	32					
	33					
	34		T.D. @ 34.0 ft. BEG. @ 1120 in Dark gray silty clay f.c.			T.D. @ 1120

- 11" O.D. HSA advanced to 32 ft. → 4" wire-wound SS (304) #10 slot screen set @ 31 ft. (10 ft. screen)
- Primary filterpack (16-30) 32 ft. to 18 ft.
- Sugar sand (30-10) 18 ft. to 17 ft.
- Bent. seal 17 ft. to 14 ft.
- Sugar sand (30-70) 14 ft. to 13 ft.
- Bent grout 13 ft. to within 3 ft. of grade

PROJECT / Phase III | HOLE NO.

026130



MONITORING WELL CONSTRUCTION INFORMATION

JOB. NO. 000187

BORING/WELL NO. 29WW27

DATE 3-3-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)
   N/A

3. SOLID PIPE TYPE Sch 40, 304 S.S. 4" I.D.

   SOLID PIPE LENGTH 21' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)
   Bentonite Chips

6. TYPE OF SECONDARY FILTER PACK
   Silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 wire wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK
   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD HSA

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

01227039

026131

Pilot Hole — Hole No. 29WW28(P)

DRILLING LOG	DIVISION	INSTALLATION	SHEET 1 OF 3 SHEETS
1. PROJECT: LHAAP: Site 29 - Phase III RI		10. SIZE AND TYPE OF BIT: Mud Rotary - 4" Tricone	
2. LOCATION (Coordinates or Station): Group II		11. DATUM FOR ELEVATION SHOWN (TBM or MSL):	
3. DRILLING AGENCY: GEO Projects		12. MANUFACTURER'S DESIGNATION OF DRILL: Mobile Drill: B-61	
4. HOLE NO. (As shown on drawing title and file number):		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED	
5. NAME OF DRILLER: Amador		14. TOTAL NUMBER CORE BOXES	
6. DIRECTION OF HOLE: ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED Pilot Hole 3/8/98 COMPLETED Pilot Hole 3/10/98 Grouted	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE	
9. TOTAL DEPTH OF HOLE: 76'		18. TOTAL CORE RECOVERY FOR BORING: %	
		19. SIGNATURE OF INSPECTOR: BLOW CNT — David W. Guzzo	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			This boring is located adjacent to existing shallow well 29 WW 02. see boring log 29 ww02 for lithologic description from surface to 35'.			
	34	CL	Silty clay, med gray, sl. moist, fine sand in very partings, laminated, stiff to hard, tr. black organic deposits	10/20/45 12"	SS-1	Begin drilling w/ 4" tricone @ 1020 - 3/8/98 - No samples till 35'.
	35					
	36	CL	As Above	52/63/75 17"	SS-2	NOTE: 3" Split spoon is only being driven 18" due to high blow counts. Samples are started at even depth intervals (ie 42', 44', 46', etc)
	37					
	38	CL	As Above	31/42/53/65 4"	SS-3	
	39					
	40	CL	As Above, sl. increase in moisture	34/74/75 15"	SS-4	
	41					
	42	CL	As Above	67/76/91 13"	SS-5 HNU = 0 @ Split Spoon	
	43					
	44	CL	As Above 8"	41/100/250	SS-6 HNU = 0	
	45	ML	Sit Sandy Silt, med. gray, tr. clay, moist (8")	11"		End 3/9/98 @ 1730
	46	ML	As Above	33/42/300 12"	SS-7 HNU = 0 in Spoon	Start drilling on 3-9-98 @ 0825 depth - 46'
	47					
	48	CL	Sr Clayey Silt, tr fine Sand, med. gray, laminated, moist	40/100/515 10"	SS-8 HNU = 0 ppm in Spoon	Beginning of Zone of Confining for shallow aquifer (?)
	49					
	50					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO. 29WW28

01227040

026132

ILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW28(F)

PROJECT GROUP II / LHAAP: Site 29 - Phase III | INSTALLATION | SHEET 2 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
		OL	Organic Soil, Black (coal like) crumbly, sl. moist 4"	77/90	SS-9	
	51	CL	Silty Clay, Dk gray, very stiff, sl. moist 4"	120 / 8"	HNU = 0 ppm in spoon	
	52	CL	Silty Clay, Dk gray-blue w/black deposits, laminated, sl. moist to moist, stiff	93/75/ 113	SS-10	
	53			8"	HNU = 0 ppm in spoon	
	54	CL	As Above, very stiff to hard	22/30/	SS-11	
	55			126 / 7"	HNU = 0 ppm in spoon	
	56	CL	As Above, increasing black deposits	70/83/	SS-12	
	57		~~Organic Soil, Black w/ Clay~~	150		
		CL	BR Silty Clay, Dk gray w/ blk deposits, laminated, very stiff to hard, ~~moist~~ sl. moist	16"	HNU = 0 ppm in spoon	
	58	CL	As Above	65/95/	SS-13	
	59			131 / 18"	HNU = 0 ppm in spoon	
	60	CL	As Above	110/141/	SS-14	
	61			177 / 18"	HNU = 0 ppm in spoon	
	62	CL	As Above	55/115/	SS-15	
	63			200 / 18"	HNU = 0 ppm in spoon	
	64	CL	As Above, increased sand in partings, brown-black	45/65/ 120	SS-16	
	65				HNU = ppm	
				14"	in spoon	← Begin of intermediate zone 66'
	66	SM	Silty Sand, med-dk gray, moist, very dense	70/30/ 600	SS-17	
	67				HNU = ppm	
				7"	in spoon	← End sampling on 3-7-98 @ 1730
	68	SM	As Above	50/30/ 200	SS-18	Begin drilling @ 0830 2-10-98
	69			12"	HNU = 0 ppm in spoon	
	70	SM	As Above (larger sand size)	40/75/ 300	SS-19	
	71			9"	HNU = 0 ppm in spoon	
	72	SM-SP	Silty Sand to Poorly Sorted Sand, med-dk gray; increased sand size, decreasing silt, increased moisture (moist to very moist)	35/90/ 235	SS-20	
	73			4"	HNU = 0 ppm in spoon	

ENG FORM 1836-A (ER 1110-1-1801) DRO 1990 01-020-003 | PROJECT | HOLE NO. 29WW28

01227041

026133

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW28(I)

PROJECT LHAAP Sit 29 Group II - Phase II | INSTALLATION | SHEET 3 OF 3 SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV-ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	75	SM-SP	As Above	75/145/250 7"	SS-21	Headspace 0 ppm in spoon
	76		T.D @ 76.0' 3-10-98 Boring grouted w/ tremie pipe 3-10-98 to surface			
	77					
	78					
	79					
	80		Well Installed 3-18-98			Attempted to run down hole resistivity in boring on 3-10-98. Instrument was not functioning properly and no data was collected. Boring for monitoring well is located approximately 6' west of pilot boring and 10' east of existing well 29WW02 (shallow). Drilling for this intermediate well (29WW28) began on 3-11-98 @ 0830 Proposed construction of well

8" Steel Casing surface to 51'

4" 304 SS Screen (0.01 slot) 66' - 76'

16-30 Primary Sand 76 - 64'

30-70 Filter Sand Bentonite 64 - 63', 63 - 60'

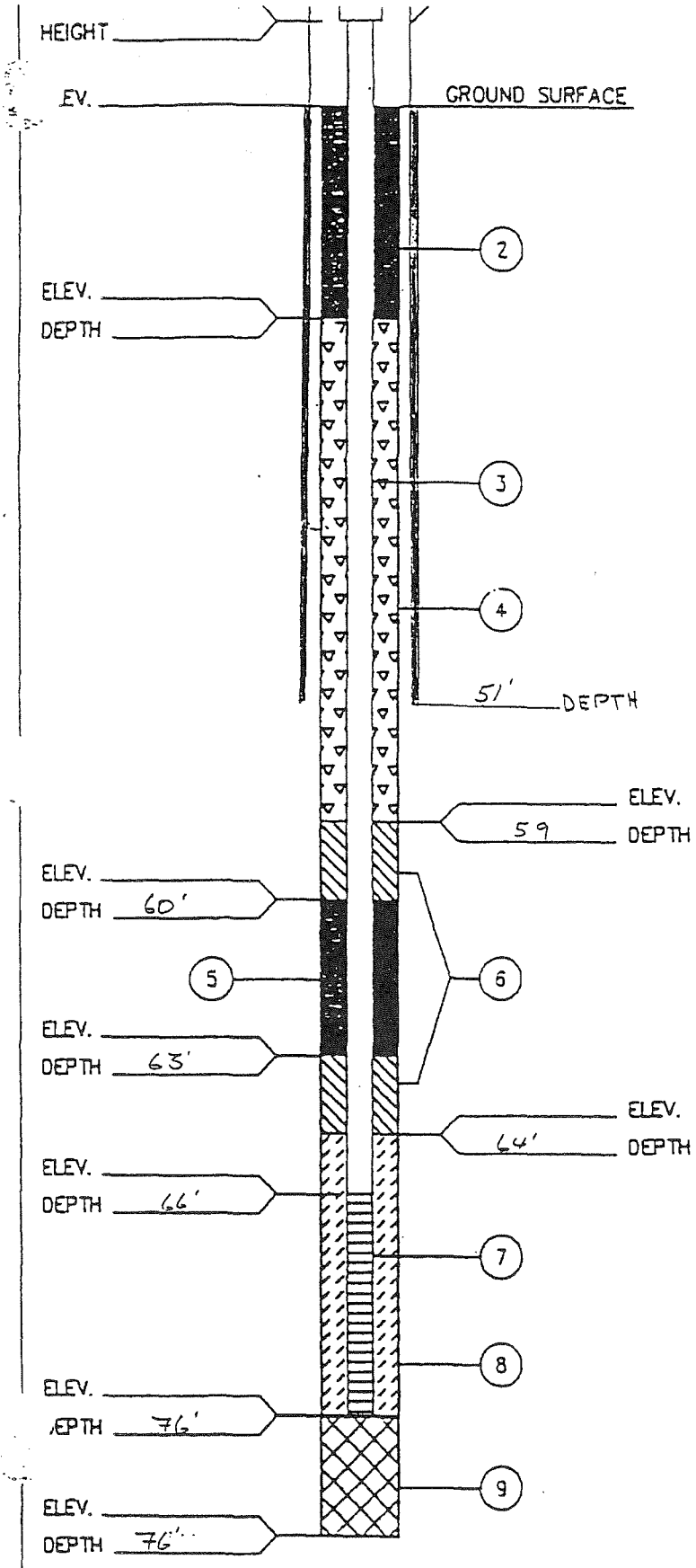
30-70 Filter Sand 60 - 54'

Grout 54 - surface

Riser 4" 304 SS 66 - surface 3' Above grade

PROJECT | HOLE NO.

026134



JOB. NO. 000187

BORING/WELL NO. 29WW28

DATE 3-11-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)
   8"Ø steel casing

3. SOLID PIPE TYPE Sch 40, 304 S.S. 4"I.D.

   SOLID PIPE LENGTH 66' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)
   Bentonite chips

6. TYPE OF SECONDARY FILTER PACK
   Silica sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 wire wound in.

   SCREEN DIAMETER 4"I.D. in.

8. TYPE OF PRIMARY FILTER PACK
   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD Mud Rotary

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

026135

Hole No. 29WW29(S)

DRILLING LOG	DIVISION USACE - Tulsa	INSTALLATION LHAAP - Karnack, TX	SHEET 1 OF 2 SHEETS
1. PROJECT LHAAP - Karnack, TX Phase II Site 29		10. SIZE AND TYPE OF BIT Auger Bits	
2. LOCATION (Coordinates or Station) Site 29		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY GPT - Austin, TX		12. MANUFACTURER'S DESIGNATION OF DRILL CME 75 3¾" I.D. HSA / 5' Cont. Sampler	
4. HOLE NO. (As shown on drawing title and file number) 29WW29(S)		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 8	UNDISTURBED 0
5. NAME OF DRILLER Jose Hinojosa		14. TOTAL NUMBER CORE BOXES N/A	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 3-6-98	COMPLETED 3-7-98
7. THICKNESS OF OVERBURDEN Penetrated 39 ft.		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK N/A		18. TOTAL CORE RECOVERY FOR BORING N/A %	
9. TOTAL DEPTH OF HOLE 39 ft. below grade		19. SIGNATURE OF INSPECTOR Clka CDG	

ELEVATION (a)	DEPTH (ft) (b)	USC LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	1	FILL	- Fill - silty clay overlying fine grained sand fill = moist		Sample #1 0.0' to 4.0'	1615 Commenced HSA & 5' Cont. Sampler
	2			2.8'		PID Reading = 4 ppm in sample (from Fill)
	3					
	4		Apparent end of fill @ 4.2 ft. below existing grade			PID Reading = 0 ppm @ Augers
	5	CL	- Silty clay Lt. gray and tan with abundant reddish-brown mottling, some fine sand, trace gravel & pliastre - moist (Stiff)		Sample #2 4.0' to 9.0'	
	6			5.0'		PID Reading = 0 ppm in sample
	7		- Silty clay Lt. gray, brown and tan mottled, trace to some fine sand, trace roots - moist (V. Stiff)			
	8					
	9					
	10		- Silty clay, Lt. to med. gray and tan mottling, some apparent layering, trace fine sand - Damp (Stiff)		Sample #3 9.0' to 14.0'	
	11			5.0'		PID Reading = 30 ppm in sample
	12					
	13					
	14					PID Reading = 0 ppm @ Augers
	15		- Silty clay Lt. gray, tan, Lt. brown and some yellowish-brown mottled, streaked and stained, some apparent layering from 18.5' To 19.0', trace to some fine sand, trace roots - Damp (Stiff)		Sample #4 14.0' to 19.0'	
	16			5.0'		PID Reading = 70 ppm in sample
	17					
	18	SM/CL	- Silty clay to clayey silt @ 20 ft. below grade			
	19					
	20				Sample #5	

ENG FORM ... PROJECT / L... HOLE NO.

026136

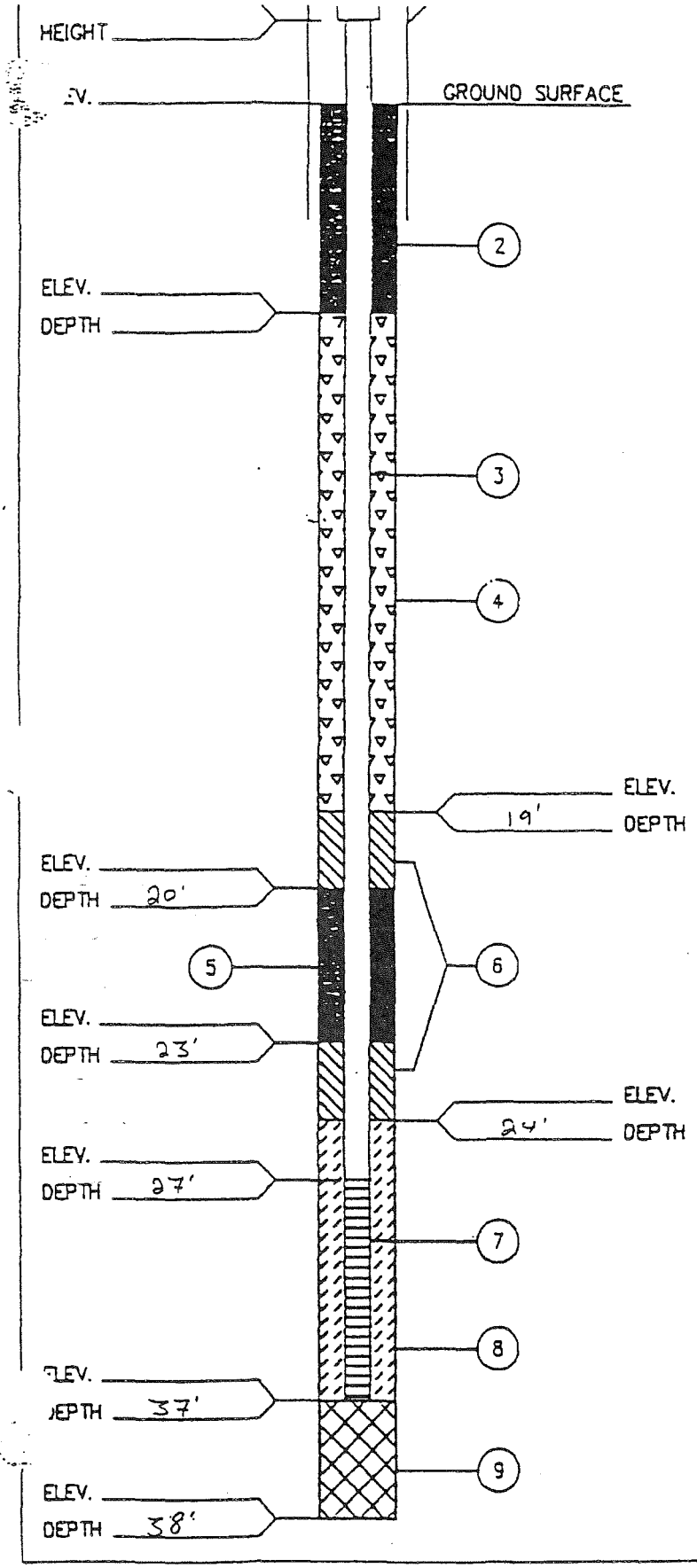
DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW29 (S)

PROJECT LHAAP - Karnack, TX Phase III Site 29 | INSTALLATION LHAAP | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH (ft) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	CL	- Clayey silt, some c-c silty clay, Lt. tan, Lt. gray, and Lt. brown mottled, streaks and stains, some apparent layering, some fine sand, plastic, trace roots - Damp to Moist	4.7'	A1.0' to 24.0'	PID Reading = 300 ppm in Sample
	22					
	23	SM	- Sandy silt, Lt. brown and tan, fine grained sand, some sl. clayey - Moist (med. Dense)			
	24					
	25		- Silty sand, Lt. gray/brown, fine grained sand some sl. clayey, some DK. gray staining - Moist To Wet	5.0'	Sample A6 24.0' to 29.0'	PID Reading = 300+ ppm in Sample
	26					
	27					
	28		Sample becoming saturated @ 28.0' while logging			PID Reading = 0 ppm @ A6 @ 29'
	29		/ Clayey silt, Lt gray mottled (mottled), some to abundant fine sand @ 29.4' = Moist			
	30	CL SM	- Silty sand, Lt. to med. gray/brown, mottled, fine grained sand, some V. thin to thin apparent layering - moist to wet (Dense)	5.0'	Sample #7 29.0' to 34.0'	PID Reading = 300+ ppm in sample
	31					PID Reading @ hole = 0 ppm
	32					
	33					
	34		Silty sand to sand, sl. silty gradational contact zone @ 34.6'			
	35	SP	- Sand, Pred. Med. gray, fine grained, trace to some med. grained, occ very silty in layers, subang to subrounded poorly sorted - Wet/Saturated	5.0'	Sample #8 34.0' to 39.0'	PID reading = 900+ ppm in Sample
	36					
	37	CL	- Silty clay Med. to Dark gray silty clay with abundant V. thin horiz. laminated and irregular silt/fine sand leads - Dry to Damp			
	38					
	39		T.D. 3¼" HSA Drill hole @ 39.0 ft. to below grade in gray silty clay			T.D. @ 1715 3/7/19 11"O.D. HSA were advanced to 38.0 ft. -4" SS (3m) Wirewound #10 slot screen (10') was set @ 37.0' - Primary filter pack (16/30) 38' to 24.0' - Sugar sand (20-70) 24' to 23' - Bent. seal 23' to 20' - Sugar sand 20' to 19' - Bent. grout 19' to within 3' of grade
	40					

ENG FORM 1836-A (ER 1110-1-1801) 0PO 1980 OP-326-803 | PROJECT / LHAAP - Site 29 | HOLE NO. 29WW29(S)

026137



JOB. NO. 000187

BORING/WELL NO. 29WW29

DATE 3-7-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)

   NA

3. SOLID PIPE TYPE Sch 40, 304 S.S. 4" I.D.

   SOLID PIPE LENGTH 27' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)

   Bentonite Chips

6. TYPE OF SECONDARY FILTER PACK

   Silica sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 Wire Wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK

   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD HSA

WATER LEVEL _____ DATE _____

•ALL DEPTHS MEASURED FROM GROUND SURFACE

Hole No. 29WW30(s)

026138

DRILLING LOG | DIVISION: USACE - Tulsa | INSTALLATION: LHAAP - Karnack, TX | SHEET 1 OF 2 SHEETS

1. PROJECT: LHAAP - Karnack, TX Phase III site 29
2. LOCATION (Coordinates or Station): Site 29
3. DRILLING AGENCY: GPI - Austin, TX
4. HOLE NO. (As shown on drawing title and file number): 29WW30(s)
5. NAME OF DRILLER: Jose Landeros
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Penetrated 34.0ft.
8. DEPTH DRILLED INTO ROCK: N/A
9. TOTAL DEPTH OF HOLE: 34.0ft. below grade
10. SIZE AND TYPE OF BIT: Auger Bits
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75 ; 3¼" I.D. HSA / 5' CME cont. sample
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 7 ; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 3-10-98 ; COMPLETED 3-11-98
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: [signature] CPG

ELEVATION (a)	DEPTH (ft.) (b)	USC LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	1	CL	3" of Dark reddish-brown clayey topsoil, some roots - Wet overlying -	4.0'	Sample #1 0.0' to 4.0'	1605 Commenced HSA & 3¼" I.D. HSAs and 5' CME cont. sampler
	2		- Silty clay, Lt. gray, reddish-brown, yellowish-brown, brown and yellowish-orange (mottled) some as thin layering, trace to some fine sand, trace roots - Damp to moist (stiff)			PID Reading = 0 ppm (10.2 eV HNu)
	3					
	4					
	5		- Clayey silt, Lt. gray, reddish-brown, yellowish-orange, brown, and yellowish-brown (mottled), some apparent layering, some as silty clay from 8.2 ft. to 9 ft., some fine sand - Damp to moist (stiff to V. stiff) (trace gravel @ 8.4 Ft)	5.0'	Sample #2 4.0' to 9.0'	Headspace PID Reading = 3 ppm
	6					
	7					
	8					
	9		- Silty clay/clayey silt, Lt. gray, tan and brown (mottled), some purple-gray streaking and staining, some apparent layering, some fine sand throughout, trace rock - Dry to Damp (stiff)	5.0'	Sample #3 9.0' to 14.0'	Headspace PID Reading = 3 ppm
	10					
	11					
	12					
	13					
	14		- Silty clay/clayey silt, Lt. gray, tan and Lt-brown mottled, streaked, and stained, some occ Dk gray streaking and staining, some fine sand, trace rock and gravel - Dry to Damp (stiff to V. stiff)	3.4'	Sample #4 14.0' to 19.0'	Headspace PID Reading = 1 ppm
	15					
	16					
	17					
	18		1" of Dark brown and rust-brown "ironstone" - competent rock @ 18.6 ft.			
	19					
	20				Sample #5	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: LHAAP - site 29 | HOLE NO. 29WW30(s)

026139

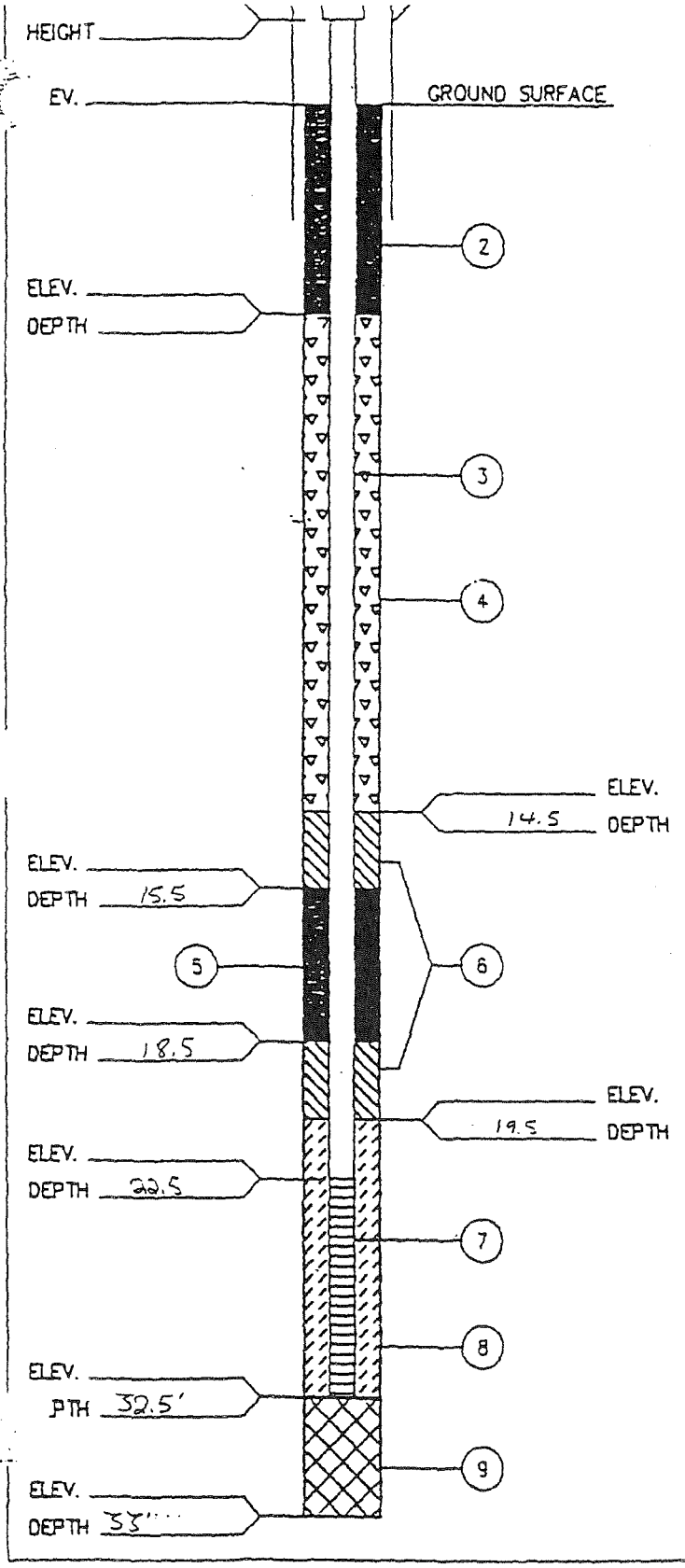
DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW30(S)

PROJECT LHAAP - Karnack, TX | INSTALLATION LHAAP | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH (Ft.) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20	CL	- Silty clay/clayey silt, Lt. gray, tan, and Lt. brown, (mottled) some apparent layering some V. thin fine sand and silt lenses, some fine sand in silty clays and clayey silt matrices - Damp to Sl. moist (med. stiff to stiff)	5.0'	19.0' to 24.0'	Headspace PID Reading = 1 ppm+
	23	SM	- Moist @ 23.2' in fine sandy silt			
	24		Sandy silt, Lt. gray-brown, some Lt. gray V. thin layering, fine grained sand, some Sl. clayey - Damp to moist (med. dense)		Sample #6 24.0' to 29.0'	
	25			4.2'		Headspace PID Reading = 1 ppm+
	27		- silty sand, Lt. to med. gray-brown, fine grained sand - moist to Sl. wet (med. dense sand) (Wet @ 29.0ft. - bottom of sampler W.D.)			
	29		- silty sand, Lt. tomed. brown/gray, fine grained sand - wet / saturated (med. dense)		Sample #7 29.0' to 34.0'	
	31	CL	silty clay, Med. to dark gray, some V. thin horizontal irregular Lt. gray fine sand and silt lenses, trace lignite coal becoming somewhat light-gray with depth, trace to some fine sand in silty clay matrix - Dry to Damp (V. stiff)	5.0'		Headspace PID Reading = 1 ppm+
	34		T.D. @ 34.0ft. below grade in dry to damp silty clay			T.D. @ 34.0 Ft. @ 1700
	35					3/11/98.
	36					- 11" O.D. HSA were advanced to 33ft. below grade
	37					- 4" SS (Type 304) wire wound #10 slot screen (10ft.) was set @ 32.5ft. below grade
						- Primary filterpack (16-30) 33ft. to 18.5ft.
						- Sugar sand from (30-10) 19.5ft. to 18.5ft.
						- Bent. seal from 18.5ft. to 16.5ft.
						- Sugar sand from (30-10) 16.5ft. to 14.5ft.
						- Bent. grout 14.5 ft. to within 3ft. of grade

ENG FORM 1836, 8 (RR 1110-1-1801) GPO 1980 OF - 626-601 | PROJECT LHAAD - Site 29 | HOLE NO. 29WW30(S)

026140



JOB. NO. 000187

BORING/WELL NO. 29WW30

DATE 3-11-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)

   NA

3. SOLID PIPE TYPE Sch 40 304 S.S. 4" I.D.

   SOLID PIPE LENGTH 22.5' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)

   Bentonite Chip

6. TYPE OF SECONDARY FILTER PACK

   silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 Wire Wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK

   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand.

10. DRILLING METHOD

WATER LEVEL ____ DATE ____

•ALL DEPTHS MEASURED FROM GROUND SURFACE

01227049

026141

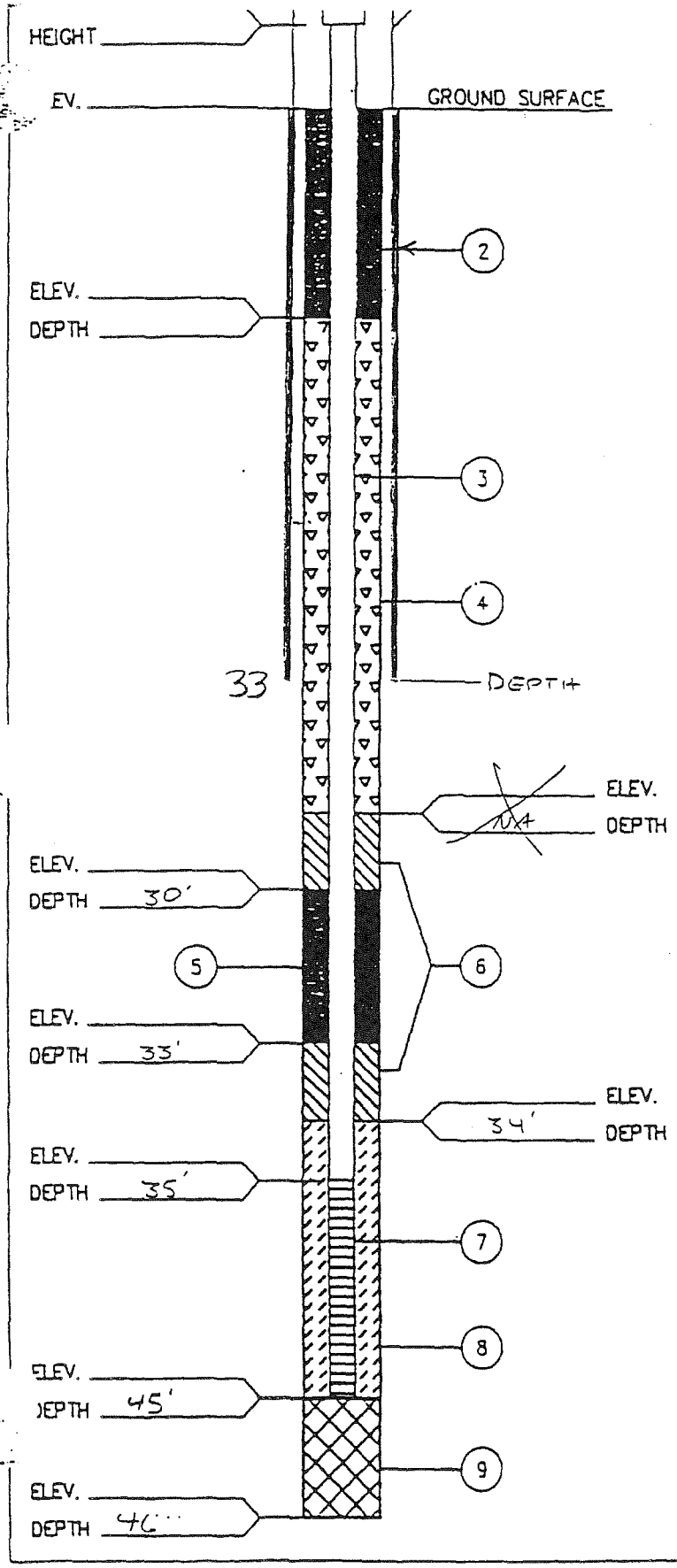
Hole No. 29NW31 (I) PILOT HOLE

DRILLING LOG	DIVISION USACE - TULSA	INSTALLATION LHAAP - KARNACK, TX	SHEET 1 OF 1 SHEETS
1. PROJECT LHAAP - KARNACK TX PHASE III GROUP 2		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station) SITE 29		11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
3. DRILLING AGENCY CROSS PROJECT INTERNATIONAL		12. MANUFACTURER'S DESIGNATION OF DRILL CME-75	
4. HOLE NO. (As shown on drawing title and file number) 29NW31 (I)		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 6	UNDISTURBED N/A
5. NAME OF DRILLER JOSE LANDEROS		14. TOTAL NUMBER CORE BOXES N/A	
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE STARTED 4-14-98	COMPLETED 4-14-98
7. THICKNESS OF OVERBURDEN 46 PENETRATED		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK N/A		18. TOTAL CORE RECOVERY FOR BORING N/A %	
9. TOTAL DEPTH OF HOLE 46 ft. BELOW GRADE		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	34	CL	SILTY CLAY, DARK GRAY WITH LT GRAY MOTTLING SOME FINE SAND TRACE LIGNITE, ONLY TO DAMP (STIFF)	2.0	SAMPLE #1 34.0 to 36.0	PID READING = 0.0 ppm IN SAMPLE PID READING = 0.0 ppm IN WORK ZONE 13:36
	35	CL	SILTY CLAY BROWN WITH LT GRAY AND RED/BROWN MOTTLING WITH FINE SAND, THIN LAYERING DAMP (MED STIFF) LIGNITE			
	36	SM	SILTY SAND GRAYISH DARK BROWN FINE GRAINED DAMP TO MOIST (DENSE)	1.2	SAMPLE #2 36.0 to 38.0	PID READING = 0.0 ppm IN SAMPLE 13:52 PID READING = 0.0 ppm IN WORK ZONE
	37	SM	SILTY SAND GRAYISH DARK BROWN FINE GRAINED TRACE CLAY, MOIST TO WET (DENSE)			
	38	SM	SILTY AND CLAYEY SAND GRAYISH DARK BROWN FINE GRAINED, WET (DENSE)	0.5	SAMPLE #3 38.0 to 40.0	PID READING = 0.0 ppm IN SAMPLE 14:22 PID READING = 0.0 ppm IN WORK ZONE
	39	SM	- DENSE SAND BECOMES HARD AT DRILLER AT 39'			
	40	SM VERY DENSE	- VERY DENSE SAND "CEMENTED" FROM 39 - 40.7'			
	41	SM	SILTY AND CLAYEY SAND GRAYISH DARK BROWN FINE TO MED GRAINED MOIST TO WET (DENSE)	1.0	SAMPLE #4 40.7 to 42.0	PID READING = 0.0 ppm 300 BLOWS/FT TO DRIVE SAMPLE 15:00 PID READING = 0.0 ppm IN WORK ZONE
	42					
	43	CL	SILTY CLAY DARK GRAY WITH LT GRAY AND BLACK STREAKS, FINE GRAINED SAND SEAMS (1mm) LIGNITE FROM DRY (VERY STIFF) PLASTIC	2.0	SAMPLE #5 42 to 44	PID READING = 0.0 ppm IN SAMPLE 15:18 PID READING = 0.0 ppm IN WORK ZONE
	44					
	45	CL	SILTY CLAY DARK GRAY WITH BLACK STREAKS, LIGNITE SOME FINE SAND, HARD DRY TO DAMP (STIFF) PLASTIC	2.0	SAMPLE #6 44 to 46	PID READING = 0.0 ppm IN SAMPLE 15:55 PID READING = 0.0 ppm IN WORK ZONE
	46		T.D. @ 46' 15:55			PILOT HOLE COMPLETE 4-14-98
	47		DOWN HOLE GEOPHYSICS RUN 4-14-98			Offset hole for 29NW31I was drilled to 46'. Set 10' #10 SS screen @ 45'. Primary sand from 46' to 34'. Sump sand from 34' to 33'. Bent seal from 33' to 30'. Cement in casing to surface
	48					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

026142



JOB. NO. 000187

BORING/WELL NO. 29WW31

DATE 4-14-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)
   8"Ø Steel Casing

3. SOLID PIPE TYPE Sch 40, 304 S.S, 4" I.D.

   SOLID PIPE LENGTH 35' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED - TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)
   Bentonite chip

6. TYPE OF SECONDARY FILTER PACK
   Silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 Wire Wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK
   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD _____

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

026143

Hole No. 29WW32(S)

DRILLING LOG

DIVISION: USACE - Tulsa

INSTALLATION: LHAAP - Karnack, TX

SHEET 1 OF 2 SHEETS

1. PROJECT: LHAAP - Karnack, TX Phase III Site 29
2. LOCATION (Coordinates or Station): Site 29
3. DRILLING AGENCY: GPI - Austin, TX
4. HOLE NO. (As shown on drawing title and file number): 29WW 32 (S)
5. NAME OF DRILLER: Joce Hinahosa
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN: Penetrated 34.0 ft.
8. DEPTH DRILLED INTO ROCK: N/A
9. TOTAL DEPTH OF HOLE: 34.0 ft. below grade (3½" HSA)
10. SIZE AND TYPE OF BIT: Auger Bit
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): CME-75-3¼" I.D. HSA / 5' CME cont. Sample
12. MANUFACTURER'S DESIGNATION OF DRILL:
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 7; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 3-8-98; COMPLETED 3-10-98
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: [signature] CPG

ELEVATION (a)	DEPTH (ft.) (b)	USC LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	1	CL	3" Dark gray and brown Topsoil - Wet over	4.0'	Sample #1 0.0' to 4.0'	1000 commenced HSA & 5' Cont. sampler
	2		- Silty clay, Lt. gray and tan with abundant reddish-brown and rust brown mottling, some fine sand, trace gravel, U. plastic - Moist (Stiff)			PID Reading = 0 ppm in sample
	3		- Becoming Lt. gray and tan (no mottling) - Damp			(10.2 eV, PID - HNu) (Rain & Drizzle! While Drilling/Sampling 55°F, humid
	4		- Silty clay, Lt. gray, Lt. brown and tan (no mottling) some occ. mod. to dark gray streaking and staining, trace to some fine sand, trace roots - Damp to moist (U, stiff)	5.0'	Sample #2 4.0' to 9.0'	PID Reading = 50 ppm+ in sample
	5					
	6					
	7					
	8					
	7		- Silty clay / some sandy layers silt, Lt. brown, Lt. gray, and tan mottled and some occ. U. thin horiz. laminations, some fine sand - Damp (Stiff)	4.3'	Sample #3 9.0' to 14.0'	PID Reading = 30 ppm+ in sample
	10					
	11					
	12					
	13					
	14		- Silty clay Lt. to med gray, tan, and brown mottled and layered - U. thin to thin horiz laminations, trace to some fine sand, trace gravel, and roots - Damp to Moist	4.8'	Sample #4 14.0' to 19.0'	PID Reading = 0 ppm @ Augers
	15					
	16					PID Reading = 1100! ppm+ ! in sample
	17		clayey silt @ 17 ft. to 18 ft			
	18		Becoming Dark gray and more laminated @ 18.0' to 19.0'			PID Reading = 0 ppm @ Augers
	19				Sample #5	
	20					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT: LHAAD - Site 29

HOLE NO. 29WW32(S)

026144

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW32(S)

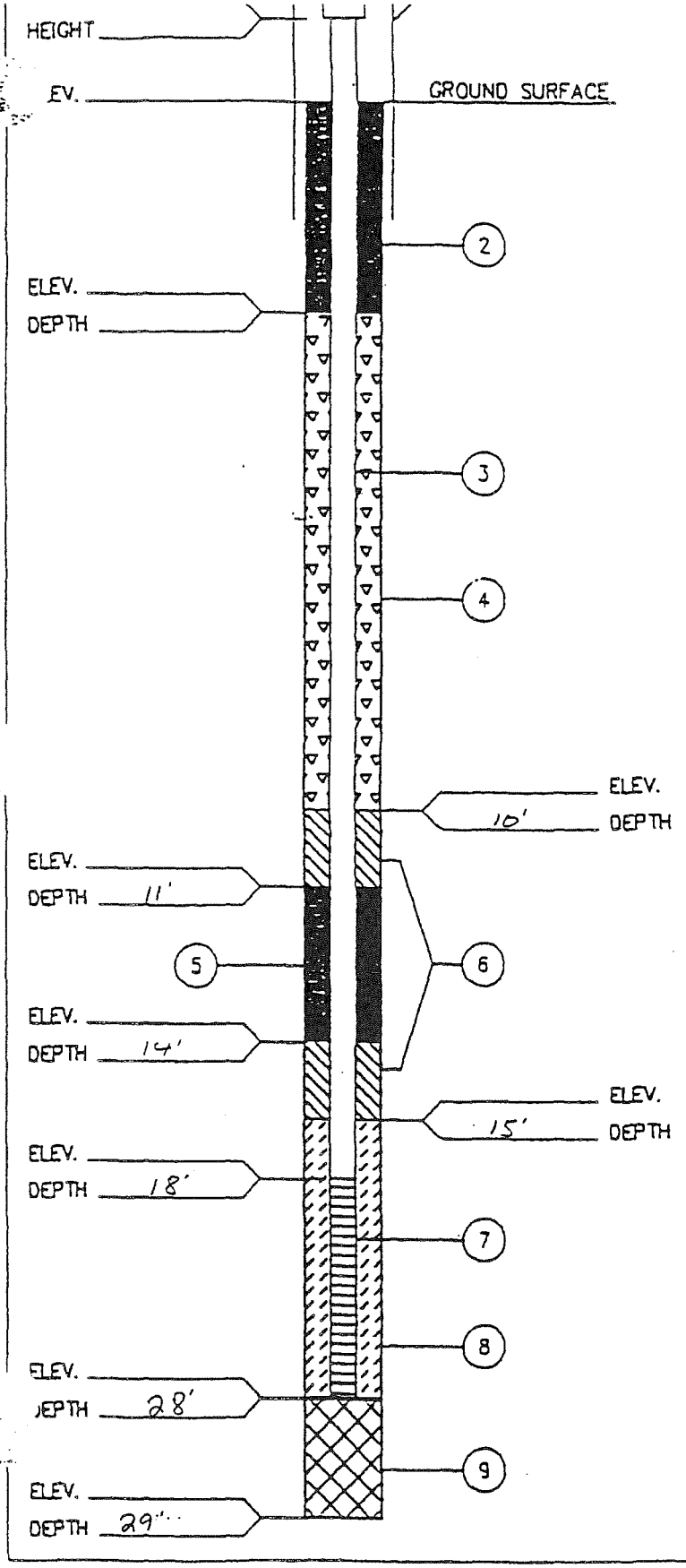
PROJECT LHAAP - Karnack TK Site 29 | Phase III | INSTALLATION LHAAP | SHEET 2 OF 2 SHEETS

ELEVATION a	DEPTH (Ft.) b	USC LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	21	CL	- Silty clay, Dark gray with within horiz. Lt-gray silted fine sand lenses, silty clay is plastic, some fine sand in silty clay matrix, trace to some Dk greenish-gray staining - Damp to Moist (Stiff)	3.8'	19.0' to 24.0'	PID Reading = 380 ppm+ in sample.
	22					
	23					
	24					PID Reading = 0 ppm @ Auger
	25	SM	- Sandy silt (Sl. Wet @ 24.4' in sample - W.L.), Med. grey to greenish gray hue, fine grained sand, occ Sl clayey - Damp to moist	6.0'	Sample #6 24.0' to 29.0'	PID Reading = 800 ppm+ in sample
	26					
	27					
	28	CL	- silty clay, med to dark greenish-gray, abundant within Lt. gray fine sand and silt lenses (horiz.) trace to some fine sand in silty clay matrix - Damp to Dry (Hard)			
	29				Sample #7 29.0' to 34.0'	
	30					
	31			5.0'		PID Reading = 800 ppm+ in sample
	32		- silty clay, med. to dark gray, v. thin silt and sand lenses (horiz.) - Dry (Hard)			
	33					
	34					
	35		T.D. @ 34.0' below grade in Dry, hard silty clay * Drill hole Dry @ T.D. * No visual water in samples * Bottom of hole wet inside augers @ 1125 *3/12/98 W.L. @ 1210 23.4 ft. (Below grade) inside screen w.l. (rising very slowly!)			T.D. 1110 @ 34.0' - 11" O.D. HSA were advanced to 29.0' on 3/10/98 - 4" SS (80%) vice wound #10 slot screen (10 ft.) was set @ 28.0' - Primary filter pack from 29.0' to 18.0' - Sogrout seal from 15' to 14' - Bent. seal from 14' to 11' - Sogrout seal from 11' to 10' - Bent. grout 10' to within 3.0' of grade

FORM ... (EP 1110-1-1801) ... PROJECT LHAAP - Site 29 HOLE NO. 29WW32(S)

01227053

026145



JOB. NO. 000187

BORING/WELL NO. 29WW32

DATE 3-10-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)

   NA

3. SOLID PIPE TYPE Sch40, 304 S.S. 4" I.D.

   SOLID PIPE LENGTH 18' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)

   Bentonite Chip

6. TYPE OF SECONDARY FILTER PACK

   Silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 Wire Wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK

   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD

WATER LEVEL , DATE

*ALL DEPTHS MEASURED FROM GROUND SURFACE

Hole No. 29WW33(I)

026146

DRILLING LOG	DIVISION	INSTALLATION: LHAAP	SHEET 1 OF 1 SHEETS

1. PROJECT: LHAAP, Group 2, Phase III
2. LOCATION (Coordinates or Station): Site 29
3. DRILLING AGENCY: Geo Projects
4. HOLE NO. (As shown on drawing title and file number): 29WW33
5. NAME OF DRILLER: Ameter
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT: Mud Rotary w/ 4" tricone
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Mobil Drill B-61
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 2-21-98 / COMPLETED
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Jon B. Uffenegger

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1	CL	Silty CLAY, with fine sand, light Brown/gray mottled, Med. Stiff, Med. plastic, moist	1.9'	SS-1 Push	Drill Mud rotary w/ 4" tricone. Drilling fluid - fresh water
	2			2.0	SS-2 Push	-Sample continuously w/ 2" ID (2.5" OD) split spoon - Sampler pushed 2'
	3	SC	clayey SAND, gray, loose moist to wet			
	4	CL	Silty CLAY, with little fine sand light brown/gray mottled med. stiff to stiff, Med Plastic moist to dry	1.8	SS-3 Push	
	5					
	6			2.0	SS-4 Push	
	7					
	8	CL	Silty CLAY w/ trace fine sand gray/lt. brown mottled w/ black streaks (organics) stiff, Med. Plastic. Dry	2.0	SS-5 Push	
	9					
	10			2.0	SS-6 Push	
	11					
	12	SM	Silty fine SAND w/ some clay gray/lt. brown mottled med. dense, dry to moist	2.0	SS-7 Push	
	13					
	14			2.0	SS-8 Push	
	15	CL	Silty CLAY w/ fine sand gray/lt. brown mottled Med stiff, low plastic Dry			
	16					
	17			2	SS-9 Push	
	18	SM	Silty fine SAND w/ some clay lenses, Gray/lt. brown medium Dense, dry to moist	1.7	SS-10 Push	
	19		Silty fine SAND, lt. brown Med Dense, Moist			

026147

Pilot Hole

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29WW33 (I)

PROJECT: Group 2, Phase III | INSTALLATION: LHAAP | SHEET 2 OF SHEETS

ELEVATION a	DEPTH b	LEGEND USCS c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOV. ERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	20	SM	Silty fine SAND, lt. Brown, Medium Dense, moist	1.8	SS-11 Push	Note: could not push sample SS-11, drive sampler w/ 140# safety hammer
↑ ground	21	SP	fine SAND, little silt, lt. Brown, Dense moist to wet			
	22		fine SAND, trace mit to coarse sand, Poorly sorted, Dense Wet	1.7	SS-12 14/27 25/29	
↓ ↑ fine sand	23					
	24		- wet	1.9	SS-13 15/20 20/45	
	25	CL	Silty CLAY w/ trace fine sand occ. thin fine sand laminations gray, very stiff, low plastic Dry			
Bentonite Seal	26			2.0	SS-14 Push	note: resume pushing sampler
Bottom of steel casing ↓	27					
f. Sand	28		Silty CLAY w/ some fine sand gray to dark gray, very stiff, plastic, Dry	2.0	SS-15 Push	
sand	29					
Top of screen →	30		- increasing sand content at depth	2.0	SS-16 4/25 44/100	note: drive sampler w/ 140# safety hammer
	31		Sandy CLAY, dark gray, very stiff, low plastic, Dry to moist			
	32	SM	Silty fine SAND w/ little clay, dark gray, Very Dense, Moist	2.0	SS-17 18/22 43/112	
	33					
	34		Silty fine SAND, dark gray Very Dense, moist	2.0	SS-18 26/51 41/100+	
	35					
	36	SC	clayey fine SAND, lt. brown Med. Dense, Moist	1.8	SS-19 3/30 40/57	
	37	SM	Silty fine SAND, dark gray Very Dense, moist			
	38			2.0	SS-20 20/45 50/115	
	39	CL	Silty CLAY w/ trace fine sand, dark gray, Hard med. plastic, Dry			- Break for day @ 1745
Bottom of screen →	40			2.0	SS-21 Push/ 43/146	Resume drilling @ 9:00. - add bentonite to natural mud - Rig Break down @ 10:45
	41					
	42			2.0	SS-22	- Resume drilling @ 14:10
	43		Silty CLAY w/ lite sand laminations, dark gray Hard, med Plastic, Dry			
	44					

ENG FORM 1836-A (ER 1110-1-1801) OMB 1980 OF - 620 - 602 | PROJECT | HOLE NO.

026148

Pilot Hole

DRILLING LOG (Cont Sheet) | ELEVATION TOP OF HOLE | Hole No. 29S/W37(I)

PROJECT: Group 2, Phase III | INSTALLATION: LHAAP | SHEET 3 OF SHEETS

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	44	CL	Silty CLAY w/ little fine sand, laminated, some fine sand in partings (lamination spacing ~1/16") dark gray, medium plastic very hard, dry	2.0	SS-23 43/11 76/100+	
	45					
	46			2.0	SS-24 32/47 39/57	
	47					
	48			2.0	SS-25 37/51 67/95	
	49					
	50			1.9	SS-26 27/50 76/20	
	51					
	52			1.5	SS-27 22/47/32	Switch to 1" ϕ split spoon
	53					
	54					
				1.8'	SS-28 41/100+ 14/100+	- Break for day @ 17:30 2/22/98 - 2" ϕ split spoon
	55	SP	Silty fine SAND, dark gray, medium dense, wet			
	56	CL	Silty CLAY, w/ little fine sand laminated, dark gray, med plastic, very hard, dry	2.0'	SS-29 63/100+ 100+/100+	Resume Drilling @ 08:00 2/23/98
	57		occ thin (~0.1") fine sand lenses			- 0 recovery on spoon, retrieve hole to recover sample
	58		- less laminated at depth	2.0'	SS-30 39/59 80/100+	
	59					
		OL	lignite, dk brown to black			
	60	CL/SC	Sandy CLAY, containing fine silty sand, dark gray; low plastic, hard, moist	1.5'	SS-31 61/100+ 200+	- break rope on safety hammer
	61					- replace w/ new rope
	62					
				1.4'	SS-32 83/152 200+	
	63	CL	Silty CLAY, w/ little fine sand laminated, dark gray, med. plastic, very hard, dry			note: very hard to drive sampler
	64		Lignite, black, hard, dry		SS-33 150/1'	
	65					
						- very hard drilling @ ~65'
	66	CL	Silty CLAY w/ trace fine sand, dark gray, laminated, very little sand between partings, medium plastic, very hard dry.	1.5'	SS-34 51/115 105	terminate boring @ 66' sample to 67.5'
	67					- grout boring w/ cement/ bentonite grout to surface
	68	TD				

ENG FORM (ER 1110-1-1801) | PROJECT | HOLE NO.

01227057

Hole No. 29NW53(D) 026149

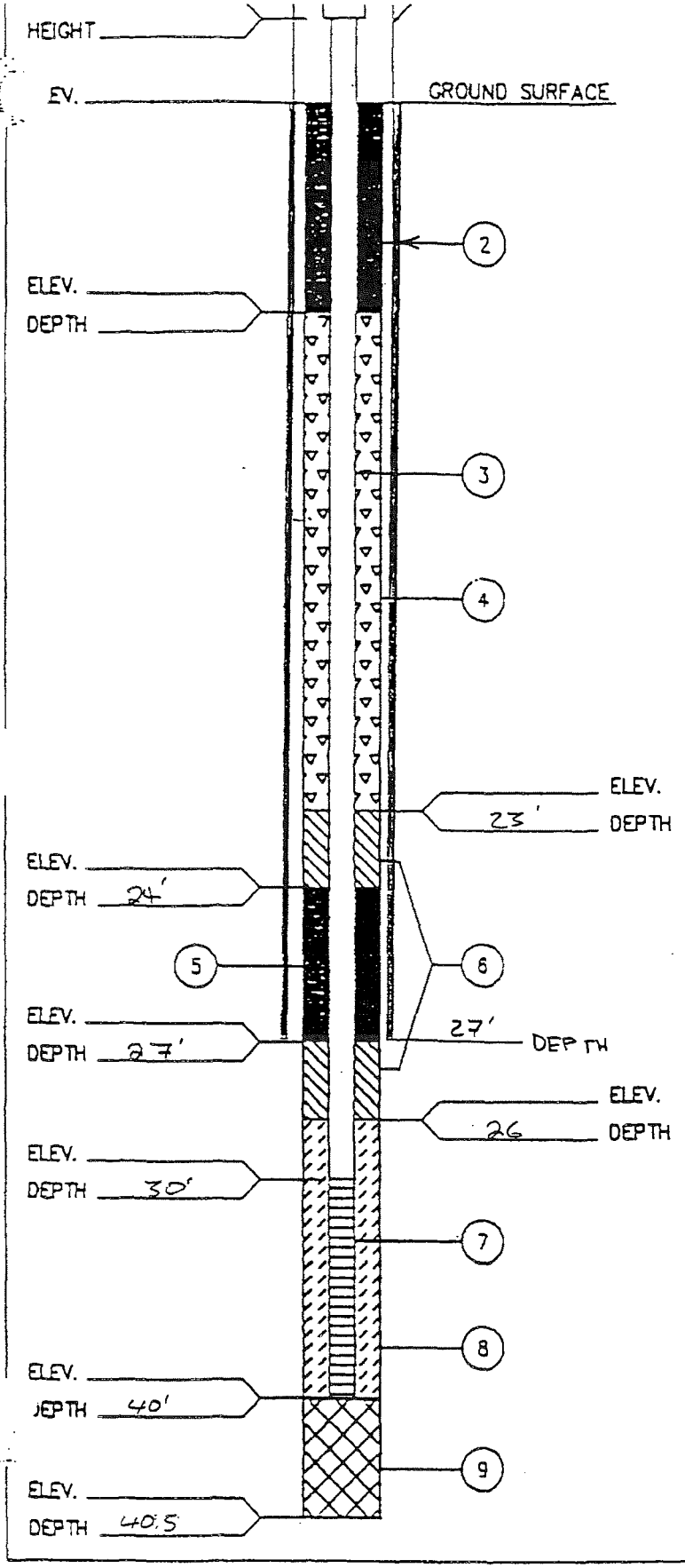
DRILLING LOG | DIVISION | INSTALLATION | SHEET 1 OF SHEETS

1. PROJECT: LHAAP - Site 29 Phase III - RI
2. LOCATION (Coordinates or Station)
3. DRILLING AGENCY: GEO Projects
4. HOLE NO. (As shown on drawing title and file number)
5. NAME OF DRILLER: Armadur
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 40.5'
10. SIZE AND TYPE OF BIT: Mud Rotary - 12"
11. DATUM FOR ELEVATION SHOWN (USM — MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: Mobil Drill
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE STARTED: 2-23-98 | COMPLETED: 2-25-98
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: David W Bruya

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1		1340 Begin adding grout between boring + casing. Drillers mixed up 70 gallons of cement-bentonite. Grout came to ± 8' below grade (inside drive pipe + pumped out boring annulus) until grout returned. (* see back)	2-24-98:		0800 - Resume drilling w/ 12" Bit @ 4' depth. 0900 - Drilling has proceeded to a depth of 11' 1000 - Drilling has proceeded to a depth of 18.5' 1020 - Drilling @ 20'
2/25/98			0810 Arrived @ 29NW33. Drillers begin w/ 7 7/8" bit @ 27' Hit a hard zone from 29'-30' during drilling.			Add 10' pipe Tom delivered 8" ø casing w/ fork lift.
			0845 Electrical short on rig.			1120 - Completed drilling to 27' w/ 12" bit.
			0900 Resume drilling			Removed bit from boring + begin flushing boring w/ water to remove cuttings/ mud.
			0920 Encountered hard layer from 38'-39'			
			0950 Reached T.D. @ 40.5'. Flush out cuttings in boring by raising + lowering bit in boring		8"	1230 - Returned to site. Redrill to remove cuttings and add casing into boring. Total length of pipe is 30.85'. Marked ground level + top of mudpit on pipe to set @ correct depth.
			1000 Begin well installation. Drillers wear clean gloves while handling casing.			
			1010 Begin adding primary sand at 40.5' + set screen to 40'			
			1120 Sugar sand @ 28' 27' Begin adding bentonite seal @ to 24'			1300 Add water inside casing for weight. Bottom end of casing has a plastic plug.

PROJECT | HOLE NO.

026150



JOB. NO. 00187

BORING/WELL NO. 29WW33

DATE 2-25-98

CHIEF UNIT Wilcox

1. PROTECTIVE CASING YES NO

   LOCKING YES NO

2. TYPE OF SURFACE SEAL (IF INSTALLED)
   8" Ø Steel Casing

3. SOLID PIPE TYPE Sch 40, 304 S.S. 4" I.D.

   SOLID PIPE LENGTH 30' ft.

   JOINT TYPE SLIP/GLUED/THREADED

4. TYPE OF BACKFILL Cement/bentonite

   HOW INSTALLED – TREMIE

   FROM SURFACE

5. TYPE OF LOWER SEAL (IF INSTALLED)
   Bentonite chip

6. TYPE OF SECONDARY FILTER PACK
   Silica Sand (30-70)

7. SCREEN TYPE 304 S.S.

   SCREEN LENGTH 10' ft.

   SLOT SIZE #10 Wire Wound in.

   SCREEN DIAMETER 4" I.D. in.

8. TYPE OF PRIMARY FILTER PACK
   Filter Sand (16-30)

9. TYPE OF BACKFILL Filter Sand

10. DRILLING METHOD _____

WATER LEVEL _____ DATE _____

*ALL DEPTHS MEASURED FROM GROUND SURFACE

00044943

Drilling Log

Monitoring Well 29WW34

Project: Longhorn Army Ammunition Plant | Owner: Shaw E&I, Inc.
Location: Kamack, Texas | Proj. No.: 845714
Surface Elev.: 211.9 ft. | Total Hole Depth: 87.0 ft. | North: 6956567.583 ft. | East: 3307436.941 ft.
Top of Casing: 214.54 ft. | Water Level Initial: ▽ 13.0 ft. | Static: ▼ 25.0 ft. | Diameter: 10 in.
Screen: Dia: 4 in. | Length: 10 ft. | Type/Size: PVC/0.01 in.
Casing: Dia: 4 in. | Length: 79.67 ft. | Type: Sch. 40 PVC
Fill Material: 20/40 Sand, Bentonite Grout | Rig/Core: Foremost 5500/5' Core Barrel
Drill Co.: ETTL | Method: Hollow Stem Auger w/Mud Rotary Capabilities
Driller: Doug Hines | Log By: Dale Jayne | Date: 4/28/04 | Driller #: NA
Checked By: Kay Everett | License No.: NA

COMMENTS
12" CARBON STEEL CASING SET AT 44.5'.
APPROXIMATE DIAMETER OF SECTION 2 BOREHOLE IS 9"
APPROXIMATE DIAMETER OF SECTION 1 BOREHOLE IS 16"

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) — Geologic Descriptions are Based on the USCS.	Elevation (ft.)
0						4'x4'x6" Conc. Pad w/ 4" diameter bollards	
0		0.0	NA 75%		CL	CLAY, PALE BROWN, MOIST, SOFT	211.87
2		0.0	NA 100%			REDDISH-YELLOW, STIFF	210
4							208
6		0.0	NA 100%			-BECOMES LIGHT BLUISH GRAY SANDY CLAY, REDDISH-YELLOW TO LIGHT BLUISH-GRAY	206
8							204
10		0.0	NA 80%			-BECOMES BLUISH-GRAY AND YELLOW, SOFT, MOIST	202
12	▽						200
14		0.0	NA 100%		ML	CLAYEY SILT, YELLOW, MOIST SOFT	198
16							196
18					CL	SILTY CLAY, PALE YELLOW,STIFF, MOIST	194
20		0.0	NA 100%		ML	CLAYEY SILT, PALE YELLOW, SOFT, LOOSE, MOIST	192
22							190
24	▼						188
26		0.0	NA 100%		CL	SILTY CLAY, PALE YELLOW, LIGHT BLUISH-GRAY, LOW PLASTICITY, STIFF, FISSILE, MOIST	186
28							184
30		0 0	NA 100%				182

Continued Next Page

00044944

Drilling Log

Monitoring Well **29WW34**

Project *Longhorn Army Ammunition Plant* Owner *Shaw E&I, Inc.*

Location *Kamack, Texas* Proj. No. *845714*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.	Elevation (ft.)
						Continued	
30							
32		0.0	NA 100%		CL		180
34		0.0	NA 100%		ML	CLAYEY SILT, BLUISH-GRAY, FISSILE, LOOSE, DRY	178
36							176
38		0.0	NA 100%			-BECOMES SOFT (BREAKS EASILY), DRY	174
40							172
42		0.0	NA 100%			CLAY, BLUISH-BLACK, SOFT, SATURATED	170
44							168
46		0.0	NA 100%				166
48		0.0	NA 100%			-BECOMES DARK BLUISH GRAY IN COLOR, STIFF	164
50							162
52		0.0	NA 100%				160
54							158
56		0.0	NA 100%		CL		156
58							154
60		0.0	NA 100%				152
62							150
64		0.0	NA 100%				148
66							146
68		0.0					144
70							142

Continued Next Page

MANCHACA Rev: 10/25/04 SITES 32 50 67 BORING LOGS.GPJ 12/2/04

00044945

Drilling Log

Monitoring Well **29WW34**

Project *Longhorn Army Ammunition Plant* Owner *Shaw E&I, Inc.*

Location *Karnack, Texas* Proj. No. *845714*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.	Elevation (ft.)
70						*Continued*	
72		0.0	NA 100%		CL		140
74							138
76		0.0	NA 100%		SP	-NO RECOVERY, MOST LIKELY SAND BASED ON DRILLING RESPONSE SAND, GREENISH-GRAY, LOOSE, SATURATED	136
78							134
80							132
82							130
84						TOTAL DEPTH OF WELL	128
86							126
88							124
90							122
92							120
94							118
96							116
98							114
100							112
102							110
104							108
106							106
108							104
110							102

MANCHACA Rev: 10/25/04 SITES 32 50 67 BORING LOGS.GPJ 12/2/04

00091606

Drilling Log

Monitoring Well **29WW35**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*

Surface Elev. *225.2 ft.* Total Hole Depth *95.0 ft.* North *6956393.466 ft* East *3306421.223 ft.*

Top of Casing *228.19* Water Level Initial ▽ *79.0 ft.* Static *NA* Diameter *8 in.*

Screen: Dia *4 in.* Length *10 ft.* Type/Size *Sch. 40 PVC/.01 in.*

Casing: Dia *4 in.* Length *88 (incl. ~3' of riser) ft.* Type *Sch. 40 PVC*

Fill Material *NA* Rig/Core *Mobil B5500*

Drill Co. *ETTL* Method *Mud Rotary*

Driller *T. Cook* Log By *A. Willmore/B. Hardmant* Date *9/14/06* Driller # *NA*

Checked By *K. Everett* License No. *Texas 379*

COMMENTS

Hand augered 0 to 5 feet bgs.

Shallow Zone 12" Isolation Casing set at 49' bgs.

13:05-Began drilling

8/24/06-Borehole was dry to 49' bgs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0					SC	TOPSOIL, GRASS, ROOTING
2		0.0			SC	SAND, CLAYEY, LOOSE, MEDIUM-SORT, DRY, NO ODOR, RED, IRON STAINING
4						-BECOMES MORE CLAYEY
6		0.0				CLAY, SANDY, MEDIUM TO HIGH PLASTICITY, SOFT, BROWN, SLIGHTLY DAMP
8						-BECOMES MORE SILTY, ORGANIC
10						-BECOMES BROWN TO GRAY, HARD, DRY
12		58.1				-BECOMES SANDY, MORE ORGANIC, GRAY IN COLOR
14						-BECOMES VERY SANDY, LOW PLASTICITY, ALTERNATING GRAY TO REDDISH-BROWN COLOR
16		38.4				-MODERATELY STIFF, LOW TO NO PLASTICITY
18					CL	-BECOMES STIFF TO HARD
20						
22		48.4				
24						
26		41.2				
28						
30		209				

Continued Next Page

00091607

Drilling Log

Monitoring Well **29WW35**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Kamack, Texas* Proj. No. *117591*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) — Geologic Descriptions are Based on the USCS.
						Continued
30					PT	LIGNITE, LAYERED, ORGANIC, BLACK, BRITTLE, DRY
32		209				CLAY, SILTY, HARD NO PLASTICITY, ORGANIC, DARK GRAY, DRY, NO ODOR
34						
36		36.2				
38						
40						
42		6.8				
44						
46		19.8				
48					CL	*(ALLEN WILLMORE LOGS HOLE FROM 0 TO 49' BGS, BILL HARDMANT LOGS HOLE FROM 49' BGS TO TOTAL DEPTH)*
50		0.3				12" ISOLATION CASING SET AT 49' BGS -TRACES OF LIGNITE
52						
54						
56						
58						DRY
60		0.5				-IRON NODULES
62						
64						-BECOMES SILTY WITH SAND AND CLAY LENSES INTERMIXED
66						
68					SM	SAND WITH SILT, SB 5/1, DRY, HARD
70		2.1				

Continued Next Page

00091608

Drilling Log

Monitoring Well **29WW35**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
						Continued
70						
72					SM	
74					PT	LIGNITE BED
						SAND WITH SILT
76						
78						
		0.5				-SAND WITH SILT, SLIGHTLY DAMP, 10 GY, 5/1
80						
82						
84					SM	
86						
88						
		2.1				-5 GY 4/1, SLIGHTLY MOIST
90						
92						
94		0.5				
						END OF BORING
96						
98						
100						
102						
104						
106						
108						
110						

7-11 Rev: 7/20/06 SITE 29.GPJ 11/13/07

00091609

Drilling Log

Monitoring Well **29WW36**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*

Surface Elev. *231.01998* Total Hole Depth *34.0 ft.* North *6956665.96 ft.* East *3305879.737 ft.*

Top of Casing *234.02* Water Level Initial ▽ *28.0 ft.* Static *NA* Diameter *8 in.*

Screen: Dia *4 in.* Length *10 ft.* Type/Size *Sch. 40 PVC/.01 in.*

Casing: Dia *4 in.* Length *27 ft.* Type *Sch. 40 PVC*

Fill Material *NA* Rig/Core *Mayhew 500*

Drill Co. *ETTL* Method *Hollow Stem*

Driller *T. Cook* Log By *A. Willmore* Date *8/25/06* Driller.# *NA*

Checked By *K. Everett* License No. *Texas 379*

COMMENTS
Hand augered 0 to 5 feet bgs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0						
2		0.0			CL	CLAY, SANDY, LOW TO NO PLASTICITY, DAMP (DUE TO RAIN), NO ODOR, BROWN
4						-BECOMES SILTY, HARD, NO PLASTICITY, IRON STAINING, REDDISH-BROWN, RED TO BROWN MOTTLING, SOME ORGANICS
6		0.0				
8						
10						
12		0.0				
14						-BECOMES LIGHT BROWN TO GRAY
16		0.0			SC	SAND, CLAYEY, DAMP, BROWN, DENSE, NO ODOR
18						CLAY, SILTY, HARD, LOW TO NO PLASTICITY, BROWN TO LIGHT BROWN, NO ODOR, DRY
20						
22		0.0			CL	
24						
26		0.0			SC	SAND, CLAYEY, DENSE, MOIST, MEDIUM-SORTED, GRAY, FINE-GRAINED, GRAY
					PT	LIGNITE TO ORGANIC CLAY, DRY, BLACK, NO ODOR
28 ▽					SC	SAND, CLAYEY, DENSE, MOIST, MEDIUM-SORTED, FINE GRAINED, BROWN TO GRAY
					CL	CLAY, SANDY, STIFF, NO PLASTICITY, BROWN TO GRAY, DAMP, NO ODOR
30		0.0				

Continued Next Page

00091610

Drilling Log

Monitoring Well **29WW36**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
30						*Continued*
32		0.0			CL	-BECOMES DRY
34						END OF BORING
36						
38						
40						
42						
44						
46						
48						
50						
52						
54						
56						
58						
60						
62						
64						
66						
68						
70						

00091611

Drilling Log

Monitoring Well **29WW37**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Kamack, Texas* Proj. No. *117591*

Surface Elev. *231.58386* Total Hole Depth *91.0 ft.* North *6956663.149 ft* East *3305871.659 ft.*

Top of Casing *234.91* Water Level Initial ▽ *86.0 ft.* Static *NA* Diameter *8 in.*

Screen: Dia *4 in.* Length *10 ft.* Type/Size *Sch. 40 PVC/.01 in.*

Casing: Dia *4 in.* Length *84 ft.* Type *Sch. 40 PVC*

Fill Material *NA* Rig/Core *Mobil B5500*

Drill Co. *ETTL* Method *Mud Rotary*

Driller *T. Cook* Log By *A. Willmore* Date *9/8/06* Driller # *NA*

Checked By *K. Everett* License No. *Texas 379*

COMMENTS
Hand augered 0 to 5 feet bgs.

Shallow Zone 12" Isolation Casing set at 34' bgs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) — Geologic Descriptions are Based on the USCS.
0						CLAY, SANDY, LOW TO NO PLASTICITY, DAMP (DUE TO RAIN), NO ODOR, BROWN
2		0.0				
4						-BECOMES SILTY, HARD, NO PLASTICITY, IRON STAINING, REDDISH-BROWN, RED TO BROWN MOTTLING, SOME ORGANICS
6		0.0				
8					CL	
10						
12		0.0				
14						-BECOMES LIGHT BROWN TO GRAY
16		0.0			SC	SAND, CLAYEY, DAMP, BROWN, DENSE, NO ODOR
18						CLAY, SILTY, HARD, LOW TO NO PLASTICITY, BROWN, NO ODOR, DRY
20						
22		0.0			CL	
24						
26		0.0			SC	SAND, CLAYEY, DENSE, MOIST, MEDIUM-SORTED, GRAY, FINE-GRAINED, GRAY
					PT	LIGNITE TO ORGANIC CLAY, DRY, BLACK, NO ODOR
28					SC	SAND, CLAYEY, DENSE, MOIST, MEDIUM-SORTED, FINE GRAINED, BROWN TO GRAY
					CL	CLAY, SANDY, STIFF, NO PLASTICITY, BROWN TO GRAY, DAMP, NO ODOR
30		0.0				

Continued Next Page

00091612

Drilling Log

Monitoring Well **29WW37**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) — Geologic Descriptions are Based on the USCS.
						Continued
30						-BECOMES DRY
32		0.0				
34						12" ISOLATION CASING SET AT 34' BGS
36		0.0				
38					CL	
40						
42		0.0				
44						
46		0.0				
48						
50					PT	LIGNITE, BLACK, ORGANIC, HARD IN NORMAL DIRECTION, FLAKY IN COMPRESSED DIRECTION
					SM	SAND, SILTY, GRAY, SLIGHTLY MOIST, DENSE
52		0.0			ML	SILT, SANDY, SLIGHTLY MOIST, DENSE
54						CLAY, SILTY, HARD, NO PLASTICITY, GRAY TO DARK GRAY, SLIGHTLY DAMP
56						
58						
60		0.0			CL	
62						
64						
66						
68						
70		0.0				

Continued Next Page

7-11 Rev: 7/20/06 SITE 29.GPJ 11/13/07

00091613

Drilling Log

Monitoring Well **29WW37**

Page: 3 of 3

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Kamack, Texas* Proj. No. *117591*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
						Continued
70						
72						
74						
76					CL	
78						
80		0.0				SILT, SANDY, POORLY-SORTED, DENSE, MOIST
82					ML	
84						
86 ▽						SAND, CLAYEY, POORLY-SORTED, DENSE, GRAY, WET
88					SC	
90		0.0				CLAY, SILTY, DAMP, GRAY, LOW TO NO PLASTICITY
		0.0			CL	END OF BORING
92						
94						
96						
98						
100						
102						
104						
106						
108						
110						

7-11 Rev: 7/20/06 SITE 29.GPJ 11/13/07

00091614

Drilling Log

Monitoring Well **29WW38**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Kamack, Texas* Proj. No. *117591*

Surface Elev. *218.33704* Total Hole Depth *49.0 ft.* North *6955376.315 ft* East *3307030.402 ft.*

Top of Casing *220.99* Water Level Initial ▽ *31.0 ft.* Static *NA* Diameter *8 in.*

Screen: Dia *4 in.* Length *10 ft.* Type/Size *Sch. 40 PVC/.01 in.*

Casing: Dia *4 in.* Length *37 ft.* Type *Sch. 40 PVC*

Fill Material *NA* Rig/Core *Mayhew 500*

Drill Co. *ETTL* Method *Hollow Stem*

Driller *T. Cook* Log By *S. Oller/ A. Willmore* Date *8/25/06* Driller # *NA*

Checked By *K. Everett* License No. *Texas 379*

COMMENTS

Hand augered 0 to 5 feet bgs.

Backfilled with bentonite to 44' bgs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
0						TOPSOIL, SANDY, ROOTED
2		0.0			CL	CLAY, SANDY, LOW PLASTICITY, DENSE, DRY, BROWN TO GRAY
4						
6		0.0				
8						
10					SC	SAND, CLAYEY, LOW PLASTICITY, DAMP, LIGHT BROWN
12		0.0			CL	CLAY, SANDY, DENSE, HIGH PLASTICITY, DAMP, BROWN
14						SAND, CLAYEY, FINE-GRAINED, MEDIUM- TO WELL-SORTED, DAMP, BROWN
16		0.0			SC	
18						CLAY, SANDY, LOW PLASTICITY, DAMP, BROWN, DENSE
20						
22		0.0			CL	
24						-BECOMES MORE CLAYEY -BECOMES MORE SANDY
26		0.0				SAND, CLAYEY, FINE GRAINED, WELL-SORTED, DAMP, BROWN, SOME IRON STAINING
28					SC	
30		0.0				

Continued Next Page

00091615

Drilling Log

Monitoring Well **29WW38**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
						Continued
30						-BECOMES MORE SANDY
	▽					-BECOMES MOIST
32		0.0				
34						
36		0.0				
38						
40					SC	
42		0.0				-BECOMES SATURATED
44						
46		0.0				WELL SET AT 44' BGS; BORING BACKFILLED WITH BENTONITE FROM 44' BGS TO 49' BGS
48						
50						END OF BORING
52						
54						
56						
58						
60						
62						
64						
66						
68						
70						

7-11 Rev: 7/20/06 SITE 29.GPJ 11/13/07

00091616

Drilling Log

Monitoring Well **29WW39**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*

Surface Elev. *218.25497* Total Hole Depth *87.0 ft.* North *6955363.733 ft* East *3307033.519 ft.*

Top of Casing *221.13* Water Level Initial ▽ *78.0 ft.* Static *NA* Diameter *8 in.*

Screen: Dia *4 in.* Length *10 ft.* Type/Size *Sch. 40 PVC/.01 in.*

Casing: Dia *4 in.* Length *80 ft.* Type *Sch. 40 PVC*

Fill Material *NA* Rig/Core *Mobil B5500*

Drill Co. *ETTL* Method *Mud Rotary*

Driller *J. Sartain* Log By *A. Willmore /D. Tibbals* Date *9/14/06* Driller # *NA*

Checked By *K. Everett* License No. *Texas 379*

COMMENTS

Hand augered 0 to 5 feet bgs.

No isolation casing set. No discernable lithologic separation of shallow and intermediate water-bearing zones

Backfilled with bentonite to 84' bgs.

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) — Geologic Descriptions are Based on the USCS.
0						TOPSOIL, SANDY, ROOTED
2		0.0			CL	CLAY, SANDY, LOW PLASTICITY, DENSE, DRY, BROWN TO GRAY
4						
6		0.0				
8						
10					SC	SAND, CLAYEY, LOW PLASTICITY, DAMP, LIGHT BROWN
12		0.0			CL	CLAY, SANDY, DENSE, HIGH PLASTICITY, DAMP, BROWN
14					SC	SAND, CLAYEY, FINE-GRAINED, MEDIUM- TO WELL-SORTED, DAMP, BROWN
16		0.0				
18					CL	CLAY, SANDY, LOW PLASTICITY, DAMP, BROWN, DENSE
20						
22		0.0				-BECOMES MORE CLAYEY
24						-BECOMES MORE SANDY
26		0.0			SC	SAND, CLAYEY, FINE GRAINED, WELL-SORTED, DAMP, BROWN, SOME IRON STAINING
28						
30		0.0				

Continued Next Page

00091617

Drilling Log

Monitoring Well **29WW39**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Kamack, Texas* Proj. No. *117591*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
						Continued
30						-BECOMES MORE SANDY
32		0.0				-BECOMES MOIST
34						
36		0.0				
38						
40						
42		0.0				-BECOMES SATURATED
44					SC	
46		0.0				
48						
50						
52		0.0				
54						
56						
58						SAND, SILTY, SAND, GRAY, MOIST, FINE-GRAINED, WELL-GRADED
60		0.0				
62					SM	-SOME LAYERING
64						
66						
68					CL	CLAY, SILTY, GRAY, DRY, LOW PLASTICITY, HARD
					SM	SAND, SILTY, SAND, GRAY, MOIST, FINE-GRAINED, WELL-GRADED
70		0.0				
						Continued Next Page

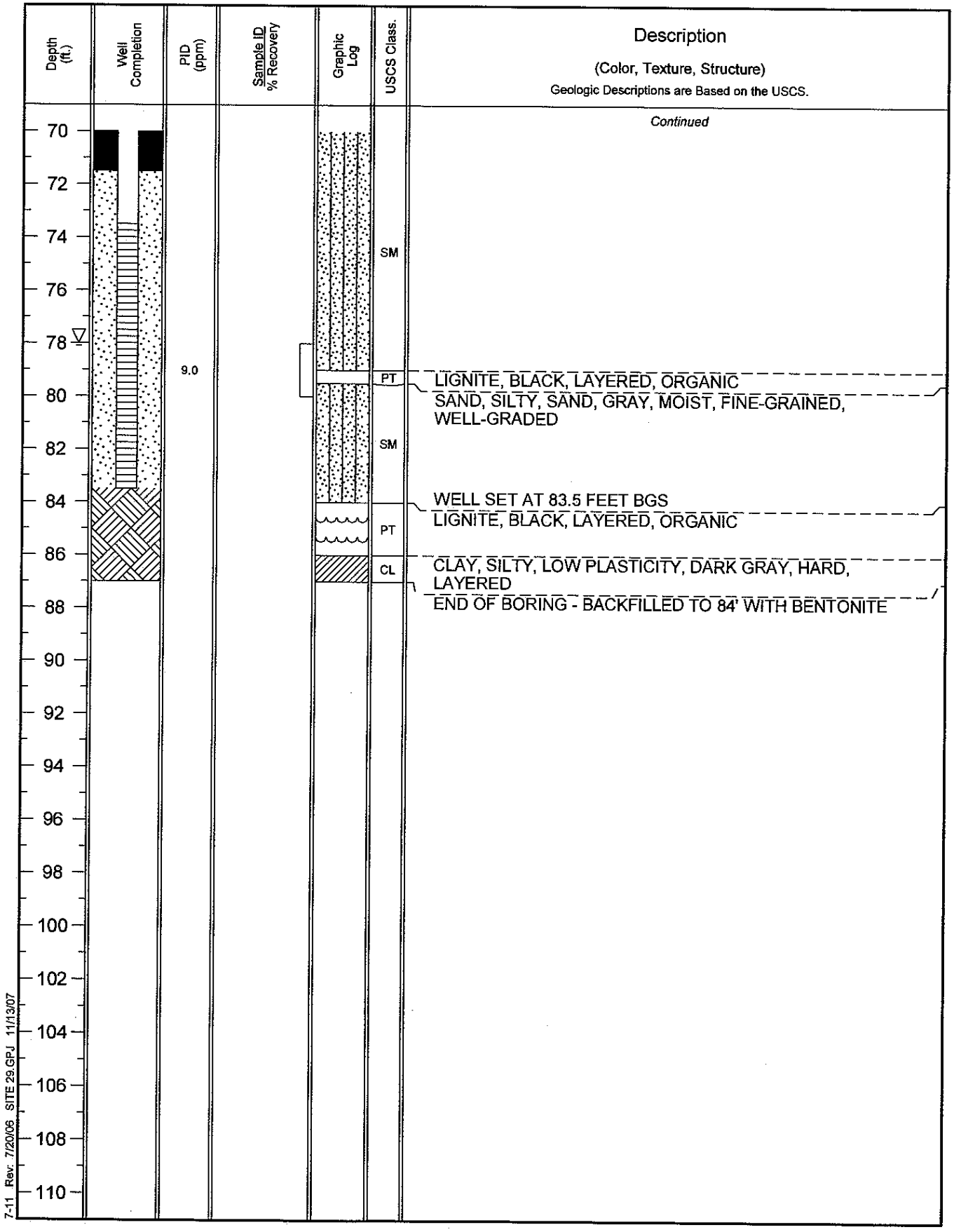
00091618

Drilling Log

Monitoring Well **29WW39**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Kamack, Texas* Proj. No. *117591*



7-11 Rev: 7/20/06 SITE 29.GPJ 11/13/07

00091619

Drilling Log

Monitoring Well 29WW40

Project Longhorn Army Ammunition Plant Owner USACE

Location Karnack, Texas Proj. No. 117591

Surface Elev. 229.65548 Total Hole Depth 159.0 ft. North 6955855.435 ft East 3306143.65 ft.

Top of Casing 232.49 Water Level Initial ▽ 110.0 ft. Static NA Diameter 6 in.

Screen: Dia 2 in. Length 10 ft. Type/Size Sch. 40 PVC/.01 in.

Casing: Dia 2 in. Length 152 ft. Type Sch. 40 PVC

Fill Material NA Rig/Core Mayhew 500/ Mobil B5500

Drill Co. ETTL Method Mud Rotary

Driller J. Sartain Log By A. Willmore/ D. Tibbals Date 9/18/06 Driller # NA

Checked By K. Everett License No. Texas 379

COMMENTS

Hand augered 0 to 5 feet bgs.

16" Shallow Zone Isolation Casing set at 50' bgs.

8" Intermediate Zone Isolation Casing set at 90' bgs

(Note: 12" Casing stuck at 82' bgs.)

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
						0' - 31' Description taken from log 29WW15, Appendix II of the Draft Site Characterization Summary Report for the Phase III Group 2 Sites Remedial Investigation (RI) and Feasibility Study (FS), Sverdrup, January 2000.
0						CLAY, SILTY, MEDIUM BROWN, MOTTLED, ROOTS, IRON STAINING, BLACK STRIATION, MEDIUM STIFF, SLIGHTLY MOIST TO MOIST, TRACE GRAVEL
4						-BECOMES SOFT AND WET
6					CL	-BECOMES VERY STIFF WITH RED STRIATION, SLIGHTLY MOIST
10					CL	-BECOMES MEDIUM-BROWN TO GRAY WITH TRACE SAND AND ROOTS
20					SM	SAND, SILTY, MEDIUM BROWN WITH GRAY LAYERS, MOIST, MEDIUM DENSE TO LOOSE
26					GP	GRAVEL, POORLY-GRADED, BROWN, WET
28					CL	CLAY, SILTY, MEDIUM-BROWN TO GRAY, LAYERED, SLIGHTLY MOIST, GOLDEN BROWN LAYERS
30						

Continued Next Page

00091620

Drilling Log

Monitoring Well **29WW40**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Kamack, Texas* Proj. No. *117591*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
						Continued
30						31' - 88' Description taken from log 29WW16, Appendix II of the Draft Site Characterization Summary Report for the Phase III Group 2 Sites RI/FS, Sverdrup, January 2000.
32						
34					CL	
36						
38						
					SC	CLAY, SANDY, MEDIUM BROWN TO GRAY, LAMINATED, SLIGHTLY MOIST TO MOIST, SOME SILT, STIFF
40						CLAY, SILTY, DARK GRAY, VERY STIFF, TRACE SAND, SLIGHTLY MOIST TO MOIST
42						
44					CL	
46						
48						
50						- 16" SHALLOW ZONE ISOLATION CASING SET AT 50' BGS
					ML	SILT, CLAYEY, SOME SAND, MEDIUM GRAY, MOIST
52					CL ML	CLAY, SILTY, SOME SAND, MEDIUM GRAY, MOIST, STIFF, LAMINATED
54					PT	LIGNITE, BLACK, LAYERED
						CLAY, SILTY, DARK BROWN WITH BLACK INTERMITTENT ORGANIC CONTENT, VERY HARD, HIGH PLASTICITY, SLIGHTLY MOIST
56						
58						
60						
62					CL	
64						-PLASTICITY INCREASES
66						
68						
70						

Continued Next Page

00091621

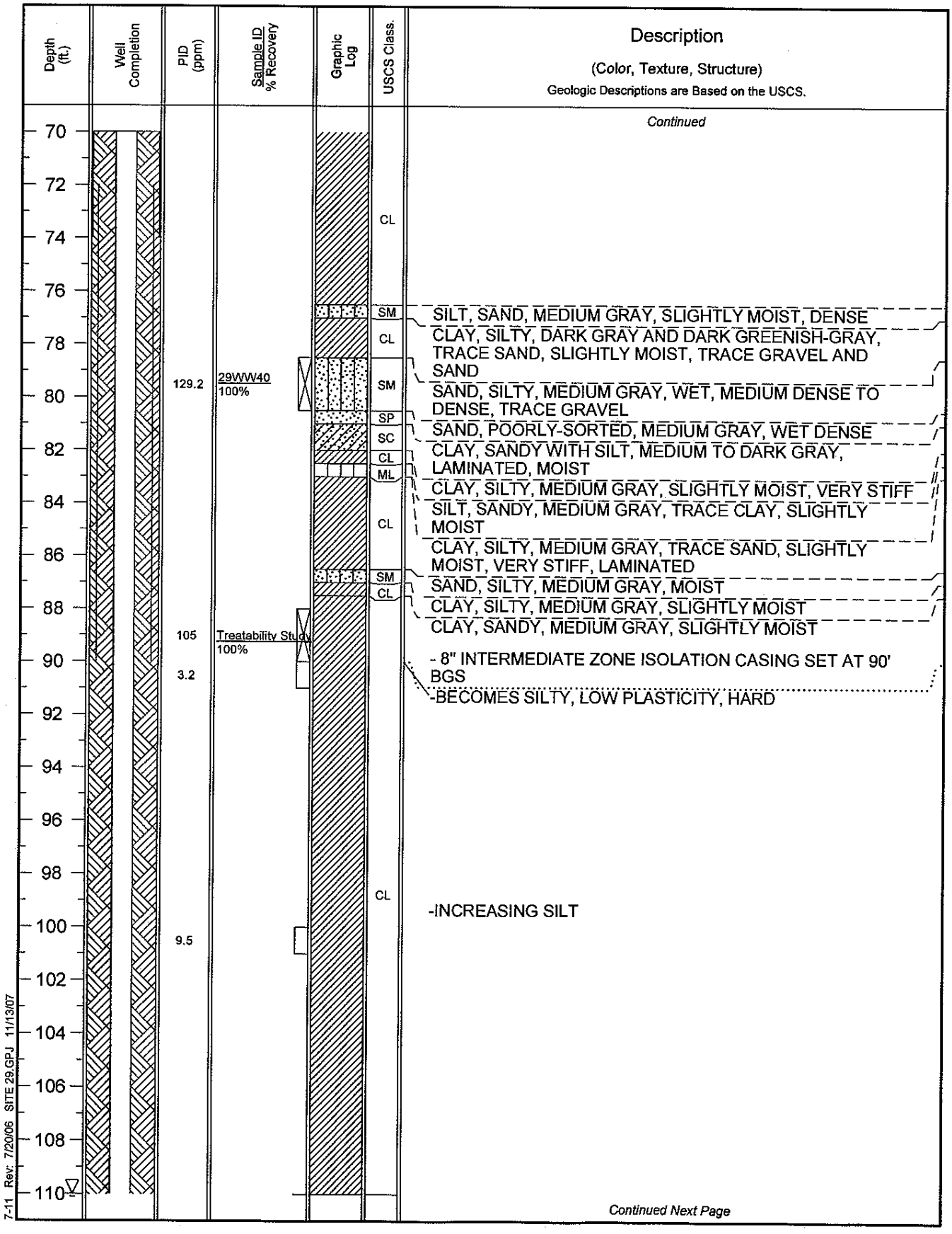
Drilling Log

Monitoring Well **29WW40**

Page: 3 of 5

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*



7-11 Rev: 7/20/06 SITE 29.GPJ 11/13/07

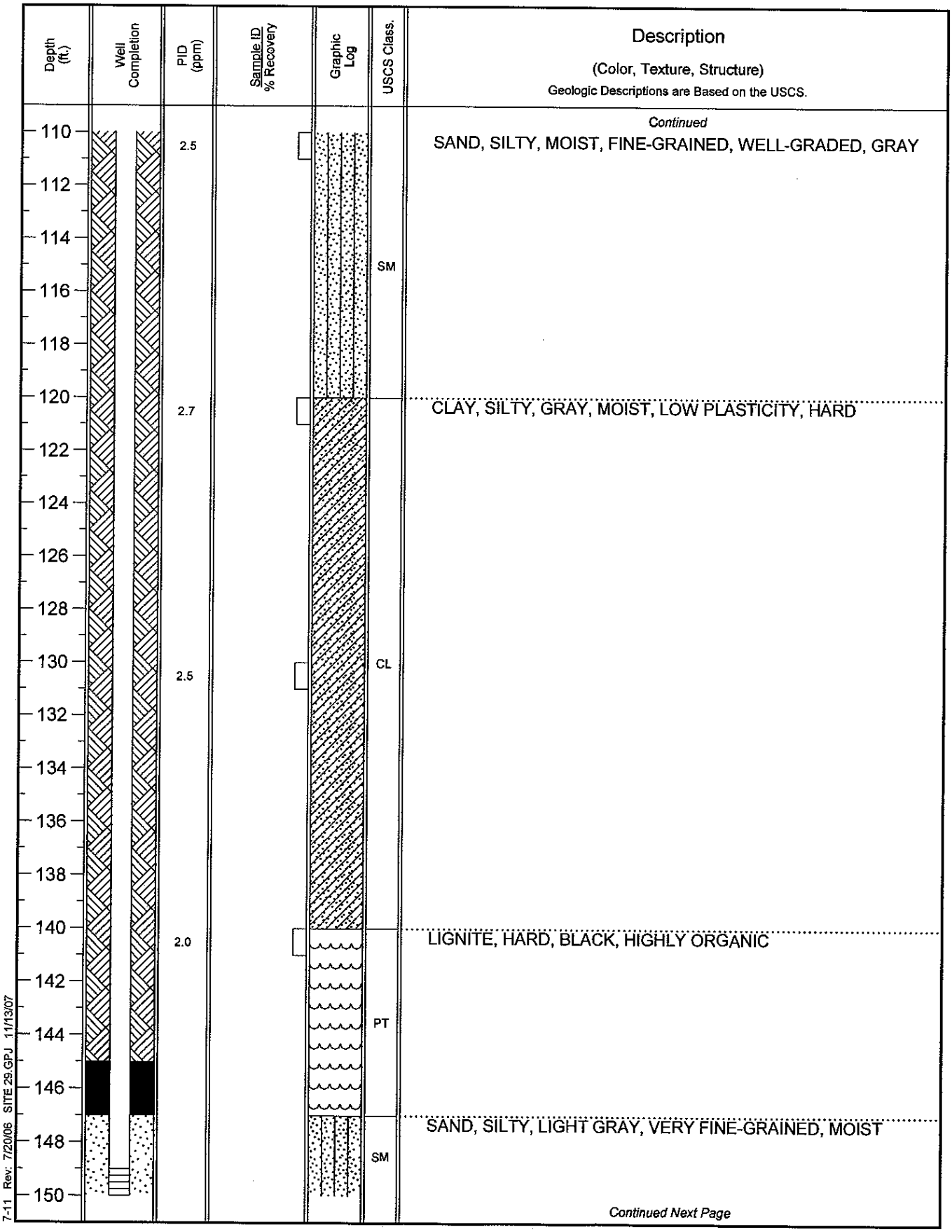
00091622

Drilling Log

Monitoring Well **29WW40**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*



00091623

Drilling Log

Monitoring Well **29WW40**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
150						*Continued*
152						
154					SM	
156						
158						
160					CL	CLAY, SILTY, GRAY, DRY, LOW PLASTICITY, HARD
162						END OF BORING
164						
166						
168						
170						
172						
174						
176						
178						
180						
182						
184						
186						
188						
190						

7-11_Rev: 7/20/06 SITE 29.GPJ 11/13/07

00096590

Drilling Log

Monitoring Well 29WW41

Project Longhorn Army Ammunition Plant Owner USACE

Location Karnack, Texas Proj. No. 117591

Surface Elev. NA Total Hole Depth 120.0 ft. North ____ East ____

Top of Casing NA Water Level Initial NA Static ▼ 46.0 ft. Diameter 6 in.

Screen: Dia 2 in. Length 15 ft. Type/Size Sch. 40 PVC/.01 in.

Casing: Dia 2 in. Length 103 ft. Type Sch. 40 PVC

Fill Material NA Rig/Core Gardner-Denver

Drill Co. Walker-Hill Method Wet Rotary

Driller Timmy Beach Log By A. Willmore Date 6/9/09 Driller # NA

Checked By A. Willmore License No. Tennessee 5456

COMMENTS

Hand augered 0 to 5 feet bgs.

12" Shallow Zone Isolation Casing set at 50' bgs.

8" Intermediate Zone Isolation Casing set at 90' bgs

Depth (ft.)	Well Completion	PID (ppm)	Sample ID % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
						Lithologic description verified with borings 29WW15, 29WW16, and 29WW40
0						CLAY, SILTY, MEDIUM BROWN, MOTTLED, ROOTS, IRON STAINING, BLACK STRIATION, MEDIUM STIFF, SLIGHTLY MOIST TO MOIST, TRACE GRAVEL
2		0.0	100%			
4						-BECOMES SOFT AND WET
6		0.0	100%		CL	-BECOMES VERY STIFF WITH RED STRIATION, SLIGHTLY MOIST
8						
10		0.0	100%		CL	-BECOMES MEDIUM-BROWN TO GRAY WITH TRACE SAND AND ROOTS
12						
14		0.0	100%			
16						
18		0.0	100%			
20					SM	SAND, SILTY, MEDIUM BROWN WITH GRAY LAYERS, MOIST, MEDIUM DENSE TO LOOSE
22		0.2	100%			CLAY, SILTY, MEDIUM-BROWN TO GRAY, LAYERED, SLIGHTLY MOIST, GOLDEN BROWN LAYERS
24						
26		0.5	100%		CL	
28		0.0	75%			
30						

Continued Next Page

MANCHACA Rev: 10/25/04 SITE 29.GPJ 7/1/09

00096591

Drilling Log

Monitoring Well **29WW41**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) — Geologic Descriptions are Based on the USCS.
						Continued
30						31' - 88' Description taken from log 29WW16, Appendix II of the Draft Site Characterization Summary Report for the Phase III Group 2 Sites RI/FS, Sverdrup, January 2000.
32		4.2	75%			
34		3.6	75%		CL	
36		5.7	85%			
38		6.2	85%			
40		2.1	85%		SC	CLAY, SANDY, MEDIUM BROWN TO GRAY, LAMINATED, SLIGHTLY MOIST TO MOIST, SOME SILT, STIFF
42		6.3	90%			CLAY, SILTY, DARK GRAY, VERY STIFF, TRACE SAND, SLIGHTLY MOIST TO MOIST
44		4.3	85%			
46		2.1	85%		CL	
48		4.1	85%			
50		2.3	85%			- 12" SHALLOW ZONE ISOLATION CASING SET AT 50' BGS
52		3.2	90%		ML	SILT, CLAYEY, SOME SAND, MEDIUM GRAY, MOIST
54		2.1	100%		CL ML	CLAY, SILTY, SOME SAND, MEDIUM GRAY, MOIST, STIFF, LAMINATED
56		3.4	100%		PT	LIGNITE, BLACK, LAYERED
58		4.1	100%			CLAY, SILTY, DARK BROWN WITH BLACK INTERMITTENT ORGANIC CONTENT, VERY HARD, HIGH PLASTICITY, SLIGHTLY MOIST
60		2.2	100%			
62		6.2	100%		CL	
64		6.7	90%			-PLASTICITY INCREASES
66		6.3	100%			
68		6.8	75%			
70		8.2	50%			

Continued Next Page

00096592

Drilling Log

Monitoring Well **29WW41**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Kamack, Texas* Proj. No. *117591*

Depth (ft.)	PID (ppm)	Sample ID % Recovery	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
				Continued
70	10.2	75%	CL	
72	13.2	100%		
74	14.8	75%	SM	SILT, SAND, MEDIUM GRAY, SLIGHTLY MOIST, DENSE
76	15.6	100%	CL	CLAY, SILTY, DARK GRAY AND DARK GREENISH-GRAY, TRACE SAND, SLIGHTLY MOIST, TRACE GRAVEL AND SAND
78	19.8	90%	SM	SAND, SILTY, MEDIUM GRAY, WET, MEDIUM DENSE TO DENSE, TRACE GRAVEL
80	20.1	85%	SP	SAND, POORLY-SORTED, MEDIUM GRAY, WET DENSE
82	25.6	85%	SC	CLAY, SANDY WITH SILT, MEDIUM TO DARK GRAY, LAMINATED, MOIST
84	26.3	85%	CL	CLAY, SILTY, MEDIUM GRAY, SLIGHTLY MOIST, VERY STIFF
86	26.2	85%	ML	SILT, SANDY, MEDIUM GRAY, TRACE CLAY, SLIGHTLY MOIST
88	22.1	90%	CL	CLAY, SILTY, MEDIUM GRAY, TRACE SAND, SLIGHTLY MOIST, VERY STIFF, LAMINATED
90	32.1	100%	SM	SAND, SILTY, MEDIUM GRAY, MOIST
92	40.1	85%	CL	CLAY, SILTY, MEDIUM GRAY, SLIGHTLY MOIST
94	47.5	100%		CLAY, SANDY, MEDIUM GRAY, SLIGHTLY MOIST
96	23.1	85%		- 8" INTERMEDIATE ZONE ISOLATION CASING SET AT 90' BGS
98	15.6	100%		-BECOMES SILTY, LOW PLASTICITY, HARD
100	12.1	100%		
102	13.4	90%		
104	14.5	90%		-INCREASING SILT
106	16.5	90%	PT	LIGNITE, HARD, BLACK, HIGHLY ORGANIC
108	2.3	85%	SM	SAND, SILTY, MOIST, FINE-GRAINED, WELL-GRADED, GRAY
110				

Continued Next Page

00096593

Drilling Log

Monitoring Well **29WW41**

Project *Longhorn Army Ammunition Plant* Owner *USACE*

Location *Karnack, Texas* Proj. No. *117591*

Depth (ft.)	Well Completion	PID (ppm)	Sample ID / % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Geologic Descriptions are Based on the USCS.
110						*Continued*
112		2.5	85%		SM	
114		2.5	90%			
116		3.2	90%			
118		3.6	100%		CL	CLAY, SILTY, GRAY, MOIST, LOW PLASTICITY, HARD
120		1.2	100%			END OF BORING
122						
124						
126						
128						
130						
132						
134						
136						
138						
140						
142						
144						
146						
148						
150						

MANCHACA Rev: 10/25/04 SITE 29.GPJ 7/1/09

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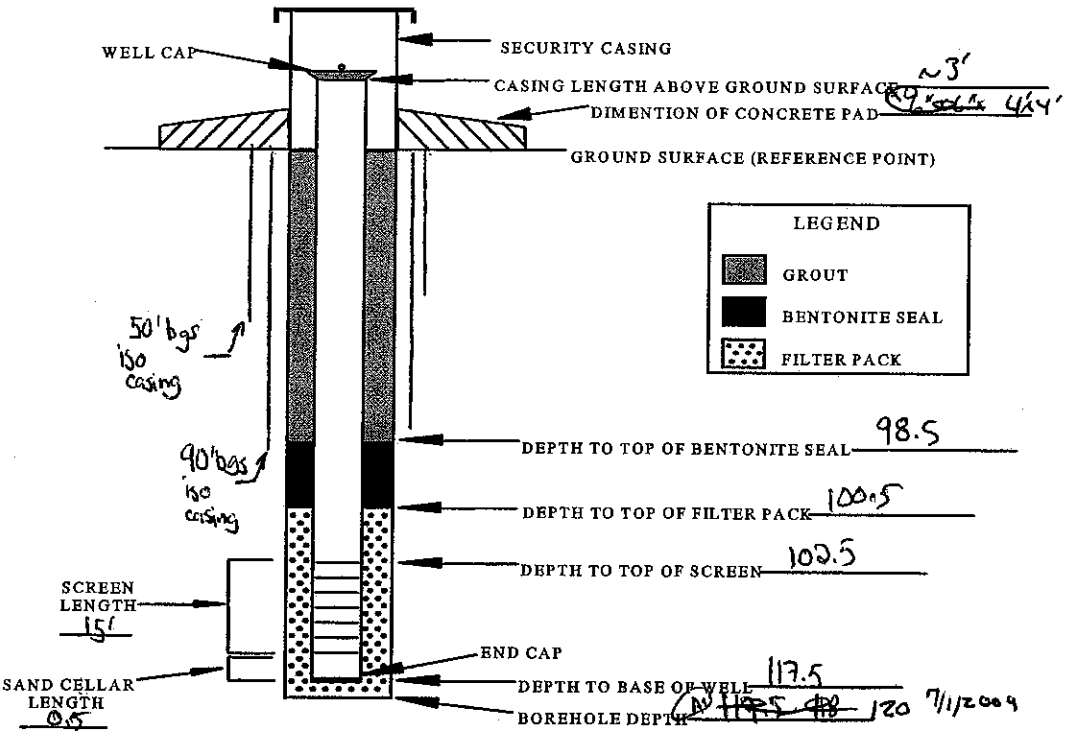
29WW41

WELL COMPLETION FORM (Stickup or Above Grade Completion Well)

FIELD REPRESENTATIVE: A. Willmore
DRILLING CONTRACTOR: WDC
DRILLING TECHNIQUE: Mud rotary
AUGER SIZE AND TYPE: 16"Ø; 10"Ø; 8"Ø
BOREHOLE IDENTIFICATION: 29WW41
BOREHOLE DIAMETER: 6"
WELL IDENTIFICATION: 29WW9
WELL CONSTRUCTION START DATE: 6-1-09
WELL CONSTRUCTION COMPLETE DATE: 6-10-09
SCREEN MATERIAL: PVC
SCREEN DIAMETER: 2"
STRATUM-SCREENED INTERVAL (FT): 15'
CASING MATERIAL: PVC
CASING DIAMETER: 8"

TYPE OF FILTER PACK: Silica sand
GRADIATION: 20/40
AMOUNT OF FILTER PACK USED: 9 bags
TYPE OF BENTONITE: portland cement
AMOUNT BENTONITE USED: 1-50 lb bg
TYPE OF CEMENT: portland
AMOUNT CEMENT USED: 4- bags
GROUT MATERIALS USED: bentonite
DIMENSIONS OF SECURITY CASING: 6"x6"
TYPE OF WELL CAP: Plugging Cap
TYPE OF END CAP: PVC
COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



NOT TO SCALE

INSTALLED BY: Timmy WDC
INSTALLATION OBSERVED BY: A. Willmore
DISCREPANCIES: 12" casing (PVC) set at 50' bgs; 8" casing (PVC) 90' bgs.

F

EnSys TNT Soil Field Testing Fact Sheet

EnSys™

MODERN WATER
A Deepverge Company

TNT Soil Test System

Ensys® explosives kits are rapid field or laboratory colourimetric tests for the analysis of explosives in soil. The kits are based on a method developed by Dr. Thomas Jenkins at the US Army Corps of Engineers - CRREL.

Test result type

- Quantitative data

Samples per kit

- 20 soil samples

Assay range

- Soil: 1 ppm to 30 ppm total TNT
- Higher sample concentrations can be quantified by sample extract dilution

Sampling preparation

- Soil samples require prior extraction using the included extraction components
- Soil samples should be dried prior to analysis
- Soil sample extracts may be saved for use with the RDX soil test kit

Sampling time

- 'Dirt-to-Data' in approximately 30 minutes
- Typically about ten samples can be run in about 40 minutes
- Soil extraction time is typically 2 - 10 minutes per sample plus test run time of approximately 2 minutes

- » Detects TNT, DNT and related explosives
- » Convenient and rapid testing in the field or laboratory
- » Extractions can be performed simultaneously with analysis in singlicate
- » TNT extracts can be used with Ensys RDX test
- » Training available
- » EPA SW-846 Method #8515

Specificity

The Ensys® TNT test is specific for TNT and related explosive compounds and exhibits the following sensitivities. The TNT test does not measure RDX or HMX.

MDL SOIL (PPM)

Compound	MDL
2, 4, 6 trinitrotoluene	0.7
2, 4 dinitrotoluene	0.5
2, 6 dinitrotoluene	2.1
1, 3, 5 trinitrobenzene	0.5
Tetryl	0.9
2 nitrotoluene	>100
3 nitrotoluene	>100
4 nitrotoluene	>100
4 amino 2, 6 dinitrotoluene	>100
Nitrobenzene	>100



Basic Test Procedure

- Clean cuvettes and set spectrophotometer
- Extract soil sample:
  - Weigh 10 grams of soil sample
  - Add sample to extraction jar
  - Measure 50ml acetone into 50ml tube
  - Pour acetone into extraction jar and shake for three minutes
  - Allow to settle for five minutes
- Draw 25ml liquid into the syringe from above the sediment layer in extraction jar
- Attach filter tip to syringe and transfer 25ml of sample extract into a cuvette.
- Place cuvette in spectrophotometer and record initial absorbance
- Add one drop of developer solution, cap and shake for three seconds.
- Remove stopper and place the 'sample' cuvette in cell holder and read sample absorbance.
- NOTE: For analysis of samples containing DNT, and/or where DNT concentration is of concern, samples must be allowed to develop for 10 minutes before reading sample absorbance. This will not affect colour development for other nitroaromatics.
- Record data and calculate results.

Test kit components

» 20 weigh boats and wooden spatulas
» 20 extraction jars
» One 50ml graduated tube
» 20 - 30cc syringes and syringe filters
» 1 bulb pipette
» 1 TNT control vial and ampoule cracker
» Developer solution
» Test kit instructions

Storage & precautions

» Shelf life is typically one year from date of manufacture, with specific kit expiration date information provided on product packaging
» Store at ambient temperature 64° to 81°F (18° to 27°C)
» Operate the test at temperature greater than 40°F /4°C and less than 100°F/ 39°C (4°C)

Required test materials	Part #
» EnSys TNT explosives soil test kit	7002000

Required test equipment

» Ensys TNT accessory kit (rental, includes HACH DR2800)	6999700
» Acetone: hardware or laboratory grade (min 50ml per sample)	

Other recommended materials

» Hach DR/2000, DR/2010 or DR/2800
» 2 matched hach cuvettes
» 2 cuvette stopper plugs
» Balance
» Tap or laboratory grade water for cuvette rinsing
» Marker pen, calculator
» Absorbent paper
» Liquid waste container
» PPE: Disposable gloves, eyewear

G

Scope of Work for TV Inspection of Pipelines

UFGS

Scope of Work

TV INSPECTION OF PIPELINES
11/21

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 CCTV Video

CD or DVD storage media containing the recorded video.

1.1.2 Cleaning

To remove soil or solid deposited materials from a pipe segment when the pipe is less than half full of deposited materials.

1.1.3 Defects

Defects in the pipe, manholes, structures, and services include cracks, separation of joints, collapsed pipe, grade irregularities, leaks, roots, grease buildup, offset joints, reverse grades, obstructions, delamination, missing pipe, restrictions, fractures and similar structural irregularities.

1.1.4 Entry Point

The leading edge of the access point or the manhole or structure wall where the pipe segment begins. Only the pipe is video inspected from manhole or structure wall to manhole or structure wall and does not include any portion of the manhole or structure.

1.1.5 Exit Point

The point where the downstream access manhole or structure wall is encountered. Only the pipe is video inspected from manhole or structure wall to manhole or structure wall and does not include any portion of the manhole or structure.

1.1.6 Heavy Cleaning

To remove soil or solid deposited materials from a pipe segment when the materials in the pipe are between half full to full.

1.1.7 Hydraulically Propelled Cleaning Tools

Tools that depend upon water pressure to provide their cleaning force.

1.1.8 National Association of Sewer Service Companies (NASSCO)

National Association of Sewer Service Companies (NASSCO) identifies the generally accepted industry standards for CCTV inspection, observation coding, and certification.

1.1.9 Pipe Segment

The length of pipe from entry point to exit point along the main or service.

1.1.10 Pipeline Assessment and Certification Program (PACP)

A CCTV Inspection standardization certification and observation coding system sponsored by NASSCO.

1.1.11 Pre-Installation CCTV (Pre-TV)

Pre-TV inspection is a video inspection of existing sewer lines to confirm cleaning activities, locations of service connections, and identify defects in the existing sewer system infrastructure prior to any work being performed.

1.1.12 Re-TV Inspection

Upon the completion of repairs made after performing a Post-TV Inspection or Warranty TV inspection, the mains or services are re-inspected by performing a Re-TV inspection. Also, refers to rework for a TV-Inspection that has video interruptions, gaps, or is not continuous.

1.1.13 TV Inspection Log

Information collected and recorded by the CCTV operator for each CCTV inspection effort and includes pertinent information for the respective inspection section; such as, date of inspection, location of site, CCTV technician, direction of CCTV inspection with manhole or structure identifiers, weather conditions, pipe size(s), pipe materials, conditions found, locations where the conditions were found.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Disposal Plan

Submit a disposal plan prior to performing any work that might generate waste materials. Include a complete description of the materials that are expected to be encountered and their proposed disposal sites. No changes to the disposal plan will be made without prior written acceptance by the Contracting Officer.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval.

SD-01 Preconstruction Submittals

Disposal Plan; G

List of Equipment

SD-06 Test Reports

Calibration Test

SD-07 Certificates

Qualifications; G

CCTV Technician's Qualifications; G

Pre-TV Inspection; G

Post-TV Inspection; G

RE-TV Inspection; G

SD-11 Closeout Submittals

Verification of Measurement

Records of Disposals

1.5 QUALITY CONTROL

1.5.1 CCTV Technician's Qualifications

Provide a CCTV technician with three years of total experience with the CCTV technology. Submit a current PACP Operator certification for personnel performing closed circuit television inspection and pipeline assessments.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

TV inspection of pipelines encompasses cleaning, heavy cleaning, CCTV inspection and video recording of the existing pipelines included in the design documents. This work includes inspection logs, video requirements, permits, and the legal disposal of materials removed from the mains.

It includes the mechanical equipment used to clean and dispose of the materials found in pipes and structures, CCTV cameras and recording devices used to record the internal conditions of non-pressurized piping.

2.2 EQUIPMENT

2.2.1 Cleaning Equipment

Utilize mechanically powered equipment necessary for the proper rodding, bucketing, brushing, root cutting, and flushing of the sewers, including a heavy duty power rodding machine that is compatible with the cleaning to be performed.

2.2.1.1 Rodding

Provide rodding equipment capable of rodding distances of up to 1000 feet in one set-up and having the following capabilities:

a. The ability to spin the rod either clockwise or counter-clockwise, and be able to be pushed straight out or pulled back without rotating the machine.

b. The capability of pulling pipe-size swabs or brushes back through the pipeline for cleaning and flushing purposes.

2.2.1.2 Bucket Machine

Provide heavy-duty bucket machines for use on dragline work to clean the pipeline with buckets, brushes, scrapers, swabs or other similar devices in order to effectively remove debris and provide a clean pipe for the CCTV inspection activities.

2.2.1.3 Hydraulic Flusher

Provide hydraulic high-pressure sewer cleaners used for sewer cleaning, specifically designed and constructed for such cleaning, that have a minimum usable water capacity of 600 gallon) and a pump capable of delivering at least 30 gallons per minute (gpm) at 100 psi and having the following capabilities:

a. Pressure regulator nozzle capable of adjustment from 1 psi to 1500 psi.

b. Constructed for ease of use and safety of operation with two or more high-velocity nozzles capable of producing a scouring action from 15 to 45 degrees in lines designated to be cleaned.

c. A high-velocity gun for washing and scouring the manhole or structure walls and floor capable of producing flows from a fine spray to a solid stream.

d. Carry its own water tank, auxiliary engines, pumps, and hydraulically driven hose reel.

2.2.2 CCTV Equipment

Provide a video system capable of producing a sharply focused, well-lit and color balanced picture in accordance with the following requirements:

2.2.2.1 Pipe Inspection Camera and Associated Equipment

a. Provide a pipe inspection camera system that produces a video using a pan and tilt, radial viewing, that pans a minimum of 275 degrees and rotates 360 degrees. Illumination sensitivity of 3 Lux or less and a minimum of 460 lines of resolution is required.

b. Utilize video cameras specifically designed and constructed for CCTV inspection.

c. Provide a camera that is operative in 100 percent humidity conditions.

d. Provide a camera with an accurate footage counter that displays on the monitor the exact distance of the camera to the nearest 1/10 of a foot.

e. Provide a camera with a height adjustment so that the camera lens is typically centered in the pipe, or higher depending on water levels in the pipe.

f. Provide equipment that will produce digital color images and allows the CCTV technician to remotely balance the iris and color to produce a clear and true video of the pipeline.

g. Provide lighting for the camera that is suitable to provide a clear color picture of the entire periphery of the pipe.

h. Provide a reflector in front of the camera as necessary to enhance the lighting on dark or large diameter pipes.

i. Provide an accompanying computer and recording device capable of projecting and recording the facility location, project name, Contractor's name, date, line size, material type, line identification, manhole or structure ID numbers and ongoing footage counter onto the video screen.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Sewer Line Cleaning

Immediately prior to conducting CCTV activities, thoroughly clean the segment of sewer pipe to be video inspected. Clean the segments using hydraulically propelled, high-velocity jet, or mechanically powered equipment.

a. During cleaning and preparation operations, undertake precautions to protect the pipelines from damage.

b. During the course of normal cleaning operations immediately report pre-existing damage such as broken or missing pipe to the Contracting Officer.

c. If cleaning of an entire sewer section cannot be successfully performed from one manhole or structure, set up the equipment on the other entry or exit point and attempt cleaning again.

d. If successful cleaning cannot be performed from the opposite end or the equipment fails to traverse the entire pipeline section, cease cleaning those specific sections, notify the Contracting Officer and CCTV inspect both sides of the pipeline section to determine the cause of the blockage.

3.1.2 Manhole or Structure Cleaning

Clean concrete and masonry surfaces prior to CCTV inspection. Completely remove grease, laitance, loose bricks, mortar, unsound concrete, loose or damaged wall mounted steps (cut flush with wall), and other materials.

Utilize water blasting (minimum 1200 psi) with compatible nozzles as the primary method of cleaning. It is acceptable to use other methods of cleaning such as concrete cleaners or mechanical means to clean the surfaces. Thoroughly rinse, scrub, and neutralize the surfaces in order to remove cleaning agents and their reactant products. Do not allow material to pass to pipeline sections, which could adversely affect water quality.

3.1.5 Flow Control

Reduce the flow depth to allow a minimum of 80 percent of the pipe wall to be displayed at all times during inspection so that defects, features, and other notable information can be collected.

3.1.5.1 Flow Reduction

Flow depth reduction can be accomplished by:

a. Providing bypass pumping.

b. High-pressure jet nozzle.

c. Plugging or by pulling the camera with a swab.

d. Performing the CCTV inspection during periods of minimal flow.

3.1.5.2 Floating the Camera

Video inspection performed while floating the camera is not acceptable. Lower water levels as indicated in paragraph FLOW CONTROL.

3.1.6 Root Removal

Remove roots in the designated pipe sections and manholes or structures. Ensure complete removal of roots to the joints. Use mechanical equipment that can be operated remotely, such as rodding machines, bucket machines, winches using root cutters and porcupines, and equipment such as high-velocity jet cleaners. Capture and remove roots from the pipeline at the downstream manhole or structure.

3.1.7 Material Removal and Disposal

Remove sludge, dirt, roots, grease, and other solid or semi-solid material resulting from cleaning operations at the downstream manhole or structure of the section being cleaned.

3.1.7.1 Dams or Weirs

When hydraulic cleaning equipment is used, place dam or weir in the downstream manhole or structure to trap such materials. Do not allow material to pass from pipeline section to pipeline section, which could cause stoppages, accumulations of sand in wet wells, or damage to pumping equipment.

3.1.7.2 Sludge and Debris Storage

Under no circumstances is sludge or other debris removed during these operations to be stored, dumped or spilled into ditches, storm drains, or other piping systems.

a. Dispose of solids and semi-solids resulting from the cleaning operations in accordance with the approved Disposal Plan.

b. Under no circumstances will debris be allowed to accumulate on the work site beyond the end of each week, except in totally enclosed containers and as acceptable by the Contracting Officer.

c. Continuously maintain the haul route and work areas neat, clean, and reasonably free of odor. Cleanup any spill which occurs during the transport of cleaning or surface preparation by-products. Perform the cleanup of any such material pursuant to this Contract and in accordance with applicable law and environmental regulations.

d. Immediately notify the Contracting Officer of any spill and begin cleaning up any such spill or waste. This will include any material leaking from pipelines during cleaning activities (e.g., pipe ruptures in a weak spot during cleaning).

e. The Government will charge to the Contractor for any costs incurred or penalties imposed upon the Government as a result of the spill, dump or discard.

f. Under no circumstances is this material to be discharged into the waterways or any place other than where authorized to do so in accordance with the approved Disposal Plan.

3.1.7.3 Hauling of Waste Material

Provide vehicles hauling such waste material that meet the following requirements:

a. Provide transport vehicles of the type(s) approved for this application by the jurisdictions where those vehicles will be operated in the performance of activities associated with this Contract.

b. Provide transport vehicles with watertight bodies equipped and fitted with seals and covers to prohibit material spillage or drainage.

c. Clean vehicles to prevent deposits of material on roadways.

d. Load vehicles within legal weight limits and operate safely within traffic speed regulations.

e. The routes used for the conveyance of this material on a regular basis is subject to approval by the local governing bodies having jurisdiction over such routes.

3.2 APPLICATION

3.2.1 Inspection of Pipelines

Inspection of sewer lines applies to Pre-TV inspection, Post-TV inspection, and RE-TV inspection. Perform inspections of pipelines in the presence of the Contracting Officer or their designated representative.

3.2.2.1 Communication

Set up hand operated radios, telephones, or other means of communication between the entry and exit points being inspected to ensure uninterrupted

communication between members of the CCTV crew when manually operated winches are used to pull the television camera through the line.

3.2.2.2 Flush Main

Introduce a minimum of 1000 gallons of clear, potable water into the upstream manhole or structure or access structure of the mains to be CCTV inspected just prior to inserting the camera. The Contractor is responsible for collecting and disposing of the water in accordance with the approved disposal plan.

3.2.2.3 Camera Operation

Set counter to 0.00 feet at the entry point, which is the beginning manhole or access point. Move the camera through the line in either direction at a moderate speed, stopping to permit proper documentation of the pipe condition or service connection locations. In no case will the camera be operated at a speed greater than 30 feet per minute. Slowly pan and tilt the camera at the beginning and ending manhole, structure connections, service connections, joints, visible defects, and pipe arterial transitions. Provide a full 360 degree view of the pipe, joints, and service connections.

Utilize manual winches, power winches, cable, powered rewinds or other devices that do not obstruct the camera view or interfere with camera operation or CCTV inspection of the pipe conditions as the camera is moved through the pipeline.

3.2.2.3.1 Recording Defects

During CCTV inspection, temporarily stop the camera at each defect or feature along the line.

3.2.2.4 Documentation of CCTV Inspection

Documentation of CCTV inspection applies to Pre-TV inspection, Post-TV inspection, and RE-TV inspection.

Utilize a data logger and reporting system that is PACP compliant to make a video and audio recording of the CCTV inspections. Submit video recordings, inspection logs, and digital photographs as indicated in the following sub-paragraphs.

3.2.2.4.1 Video Recordings

Provide a color video showing the completed work and document the inspection on a digital recorder. Capture inspection video in either MPEG-4 or Windows Media Video (WMV) format with a minimum resolution of 352 x 240 pixels and an interlaced frame rate at a minimum of 24 frames per second. Save video on CD or DVD. However, the CCTV inspection video of a segment must be wholly contained on a single CD or DVD. The video recording must meet the following requirements:

a. Provide a continuous and uninterrupted recorded video for the pipe segment being examined. Include the official project title, Contracting party, Contractor's name, street name, manhole or structure ID numbers, direction of video and flow, date and time video was recorded, continuous counter text, pipe size and material, material

changes in the pipe segment, audio and text call outs of laterals, fixtures and problem areas in the recorded video.

b. Include an audio track recorded by the CCTV technician during the actual inspection work with a description of the parameters of the line being inspected on the video recordings.

c. Include the location, pipe diameter, pipe material, defects, service lateral locations and any unusual conditions found in PACP format.

d. Submit labeled CDs or DVDs of the video inspections.

e. Without exception, CCTV inspections must be continuous without video interruption or gaps for pipe segments.

f. Clean, flush, and RE-TV pipe segments with video interruptions or gaps.

3.2.2.4.2 TV Inspection Logs

Submit computer generated records that clearly show the location and orientation in relation to an adjacent manhole or structure of each infiltration point observed during the inspection.

Record other points of significance such as locations and orientations of service connections, missing or broken pipe, roots, the presence of grease, scale or corrosion, bellies, fractures, cracks, and other discernible features using PACP designations.

3.2.2.4.3 Digital Photographs

Submit JPEG images at a minimum resolution of 640 x 480 pixels. Save digital photographs in JPEG file format on CD or DVD. Document noted defects and lateral connections as color digital files and hard copy print-outs. Photo logs are to accompany each photo submitted.

3.2.3 Pre-TV Inspection

Immediately after cleaning has been performed, complete a Pre-TV inspection, in accordance with paragraph INSPECTION OF PIPELINES. Submit Pre-TV inspection documentation in accordance with paragraph DOCUMENTATION OF CCTV INSPECTION.

3.2.4 Post-TV Inspection

Immediately after cleaning is complete on a pipe segment, complete Post-TV inspection accordance with paragraph INSPECTION OF PIPELINES to verify all wastes have been removed and the pipe is visually clean. Submit Post-TV inspection documentation in accordance with paragraph DOCUMENTATION OF CCTV INSPECTION.

3.2.4.1 Post-TV Defects

If defects are found in the mains or services during the Post-TV inspection mark these locations in the field with stakes or other methods.

3.2.6 RE-TV Inspection

After additional cleaning measures are made to a main or service, complete RE-TV inspection accordance with paragraph INSPECTION OF SEWER LINES and DOCUMENTATION OF CCTV INSPECTION.

3.3 CLOSEOUT ACTIVITIES

3.3.1 Pipeline Cleaning

Submit copies of Records of Disposals indicating the disposal site, date, amount, and a brief description of the materials disposed.

-- End of Section --

H

Annual LUC Compliance Documentation and Inspection Checklist Forms

Annual Land Use Control Compliance Inspection Form

In accordance with the Remedial Design dated _____ for LHAAP-29 an inspection of the site was conducted by _____ [indicate transferee] on _____.

The land use control mechanisms are:

- Groundwater restrictions - prohibit groundwater use (except for environmental monitoring and testing) until the levels of COCs in soil and groundwater allow for unlimited use and unrestricted exposure.
- Land use restrictions – restrict land use to nonresidential;
- The integrity of any current or future remedial or monitoring systems shall remain in place

No unauthorized activities or uses have occurred. Compliance with land use controls and restrictions is as follows:

- No use of groundwater (other than environmental testing and monitoring), installation of new groundwater wells, or tampering with existing monitoring wells;
- No land use other than nonresidential; and
- No activities that would compromise the integrity of the remedial or monitoring systems.

I, the undersigned, do document that the inspection was conducted as indicated above, and that the above information is true and correct to the best of my knowledge, information, and belief.

Date: _____

Name/Title: _____

Signature: _____

Annual compliance certification forms shall be completed no later than March 1 of each year for the previous calendar year, retained in the file and provided to Army, EPA and TCEQ upon request.

RAO Inspection and Maintenance Checklist

General Information	
Project Name	RAO Inspection and Maintenance, LHAAP-29, Former Longhorn Army Ammunition Plant, Karnack, TX
Contractor	
Inspector's Name	
Inspector's Title	
Inspector's Signature	
Inspector's Contact Number	
Inspection Date	
Type of Inspection	☐ Quarterly ☐ Semiannual ☐ Annual ☐ Prior to forecast rain ☐ After a rain event ☐ Other ----------

Description		Yes	No	N/A	**Comments** (Attach photos/location sketches)	**Corrective Action** (Attach photos)
A. Groundwater Monitoring Wells						
A.1	Are the installed groundwater monitoring wells in poor condition?					
A.2	Are there any signs of damage, unusual wear, rust and corrosion, vandalism, unauthorized entry/use, or settlement?					
A.3	Is well cap and/or locking mechanism not properly functioning?					
A.4	Are the well heads and protective casings damaged?					
A.5	Is the well cleared of vegetation and accessible?					
A.6	Any other relevant observations?					

Description		Yes	No	N/A	**Comments** (Attach photos/location sketches)	**Corrective Action** (Attach photos)
B. Site Access Features						
B.1	Are the perimeter fence and gates damaged?					
B.2	Gate(s) damaged?					
B.3	Litter encountered within the area?					
B.4	Are the gate locks missing?					
B.4	Are signs to prevent unauthorized entry missing?					
B.5	Are the access roads in unusable or poor condition?					
B.6	Any other relevant observations?					
C. Concrete Aprons and Bollards						
C.1	Are there any significant cracks present?					
C.2	Are there any damaged areas?					
C.3	Any other relevant observations?					

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
US ARMY ENVIRONMENTAL COMMAND
2455 REYNOLDS ROAD
JOINT BASE SAN ANTONIO FORT SAM HOUSTON, TX 78234-7588

March 1, 2024

SUBJECT: Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition, Plant, Karnack, Texas

Mr. Brian Follin
U.S. Environmental Protection Agency
1201 Elm Street, Suite 500
Dallas, TX 75270-2002

Dear Mr. Follin,

An electronic copy of the 100% Design Analysis Report, Remedial Design for LHAAP – 18/24 Burning Ground No. 3 and Unlined Evaporation Pond, Former Longhorn Army Ammunition Plant (LHAAP) has been transmitted via DOD SAFE and is awaiting download for your records. A notice of availability has been generated and sent via email with the instructions and dates for download. The document includes revisions based on Texas Commission on Environmental Quality (TCEQ) comments received by the Army on 8 January 2024 on the second submittal of the Final 100% Remedial Design. The Army did not receive any comments from the Environmental Protection Agency (EPA) on the second submittal. Tables of the Army responses to all EPA and TCEQ comments (30% - 100%) are included with the document.

The document was prepared by HDR Environmental, Operations and Construction, Inc. (HDR) on behalf of the Army as part of HDR's contract for the facility. I ask that Phil Werner, HDR's Project Manager, be copied on any communications related to the project.

The point of contact for this action is the undersigned. I may be contacted at (726) 999-0505, or by email at lena.j.sierocinski.civ@army.mil.

Sincerely,

Lena Sierocinski

Lena Sierocinski
LHAAP Environmental Support Manager
U.S. Army Environmental Command

cc:
A. Palmie, TCEQ Austin, TX
E. Duerkop, USFWS, Caddo Lake NWR, TX (1 CD)
C. Montoya USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
K. Russell, BRAC, Huntsville, AL
P. Srivastav, APTIM, Houston, TX

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
US ARMY ENVIRONMENTAL COMMAND
2455 REYNOLDS ROAD
JOINT BASE SAN ANTONIO FORT SAM HOUSTON, TX 78234-7588

March 1, 2024

SUBJECT: Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant, Karnack, Texas

Ms. April Palmie
Texas Commission on Environmental Quality
Superfund Section, MC-136
12100 Park 35 Circle, Bldg D
Austin, TX 78753

Dear Ms. Palmie,

An electronic copy of the 100% Design Analysis Report, Remedial Design for LHAAP – 18/24 Burning Ground No. 3 and Unlined Evaporation Pond, Former Longhorn Army Ammunition Plant (LHAAP) has been transmitted via DOD SAFE and is awaiting download for your records. A notice of availability has been generated and sent via email with the instructions and dates for download. The document includes revisions based on Texas Commission on Environmental Quality (TCEQ) comments received by the Army on 8 January 2024 on the second submittal of the Final 100% Remedial Design. The Army did not receive any comments from the Environmental Protection Agency (EPA) on the second submittal. Tables of the Army responses to all EPA and TCEQ comments (30% - 100%) are included with the document.

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Sincerely,

Lena Sierocinski

Lena Sierocinski
LHAAP Environmental Support Manager
U.S. Army Environmental Command

cc:
B. Follin, USEPA Region 6, Dallas, TX
E. Duerkop, USFWS, Caddo Lake NWR, TX (1 CD)
C. Montoya USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
K. Russell, BRAC, Huntsville, AL
P. Srivastav, APTIM, Houston, TX

Comments Response Matrixes

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond Karnack, Texas

Comments Response Matrix
FINAL (100%) Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant Karnack, Texas
Submitted: June 28, 2023

Submitted by: Brian Follin, U.S. Environmental Protection Agency Responded by: Army
Date Responded: 10/04/23

1. Respondent concurs (C) or does not concur (D)
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1:						
1	1.5, p. 1-5	2nd paragraph, 1st sentence	"Figures B-3" and "B-6" should be bolded.	C	Text was revised as suggested.	
2	1.6.1, p. 1-6	3rd paragraph, 4th sentence	A comma is missing in "7100."	C	Text was revised as suggested.	
3	1.7, p. 1-8	3rd complete paragraph, last sentence	The word "the" before "**Sections 3** and **4**" is extraneous.	C	Text was revised to read, "These fluctuations are discussed in **Sections 3** and **4**…"	
4	1.7.1, p. 1-9	Last paragraph, last sentence	The portion of the sentence "at the clay/sand interface occupying pore space" is awkwardly phrased and unclear. Should indicate the TCE and perchlorate contamination is in the interface/interval between the shallow zone (alluvium) and Wilcox clay instead of the "clay/sand interface."	C	Text was revised to read, "….the greatest contamination of TCE and perchlorate detected in the saturated soil was attributed to the residual DNAPL and existence of very high levels of perchlorate contamination in the interface/interval between the shallow alluvium and Wilcox clay in the saturated zone."	
5	1.10, p. 1-11	2nd open bullet under 4th solid bullet (begins with "A phased reactivation")	The word "COCs" should be singular (i.e., "… until COC concentrations…")	C	Text was revised as suggested.	
6	1.12, p. 1-12	2nd solid bullet	As is done elsewhere in report, should indicate the soil sample will be collected from interface/interval between the shallow zone (alluvium) and Wilcox clay (instead of the "sand/clay interface").	C	Text was revised to read, "Collection of one soil sample for perchlorate and VOC analyses from the interface/interval between the shallow alluvium and Wilcox clay…"	

Comments Response Matrix
FINAL (100%) Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant Karnack, Texas
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Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
7	1.12, p. 1-13	4th open bullet on page (3rd open bullet under "Groundwater" subsection)	1) In 2nd sentence, the word "VOCs" should be singular (i.e., should be "…and VOC contamination in the groundwater"). 2) In 4th sentence, "1824DPT29A/29" should be relocated after "nested well pair." 3) In 4th sentence, "ug/L" is missing after "193". 4) Period is missing at end of 4th sentence (after "containment area"). 5) In 5th sentence, believe "east" should be "northeast." 6) In 5th sentence, should remove the word "the" before "well" and delete the comma before "18WW17" (i.e., "Much farther to the east of well 18WW17, "). 7) 5th sentence is awkwardly constructed — strongly suggest revising sentence to improve clarity and readability.	C	1. Text was revised to read, "continuing source of perchlorates and VOC contamination in the groundwater." 2. In 4th sentence, "1824DPT29A/29" was relocated after "nested well pair." 3. Text was revised as per comment #1 submitted by TCEQ. No further change is required as per response to this comment. 4. Text was revised as per comment #1 submitted by TCEQ. No further change is required as per response to this comment. 5. In 5th sentence, "east" was revised to read "northeast." 6. Text was revised to read, "Much farther to the northeast of well 18WW17, the lower perchlorate and VOC concentrations..." 7. Text under 3rd open bullet under groundwater subsection was revised to improve clarity and readability.	

8	1.12, p. 1-13	5th open bullet on page (4th open bullet under "Groundwater" subsection)	Comparison made near end of sentence is incomplete — perchlorate and TCE are exhibiting higher concentrations than what (other compounds), specifically?		Text under 3rd open bullet under groundwater subsection was revised as follows to improve clarity and readability: o Groundwater and soil samples were collected at the nested well pair 1824DPT29A/29 (see **Figure 1-5**), located near ICT-14B to investigate additional source area between the ICT boundary and northeast of well 18WW17. Higher concentrations of perchlorate and TCE were observed in the deeper well of nested well pair 1824DPT29A/29, located near ICT-14B. At the shallower well 1824DPT29A, perchlorate and TCE were detected at 5,450 ug/L and 182 ug/L, respectively. In contrast, perchlorate and TCE were detected at 41,000 ug/L and 273 ug/L, respectively, in the deeper well 1824DPT29, where the well screen extends into the clay separating the shallow alluvium and the Wilcox Formation. The low-permeable clay layer may potentially be the continuing source of contamination within the containment area. o Groundwater and soil samples were also collected at the nested well pair 1824DPT27/1824DPT27A (see **Figure 1-5**), located much farther northeast of 18WW17, for delineating perchlorate and VOC contamination at the shallow alluvium and Wilcox Clay contact interval. The interval between the shallow alluvium and Wilcox clay is believed to be a continuing source of perchlorates and VOCs contamination in the groundwater. The sandy units of shallow alluvium – Wilcox clay contact interval generally was observed between	

Comments Response Matrix
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Submitted: June 28, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
					27 and 42 ft bgs in the northeast area. While overall lower perchlorate and VOCs concentrations were observed in this nested well pair, much lower concentrations were observed in the shallower of the well pair (1824DPT27A), indicating that the shallow alluvium – Wilcox clay contact is not a source in this area.	
9	1.13, p. 1-14	2nd open bullet on page (2nd open bullet under "Phase 1")	Would be helpful to specify what is meant by "secondary TCE sources."		The primary source of TCE contamination is identified as the areas with DNAPL in the feasibility study. Based on the PDI, the secondary source of TCE is identified as the areas with TCE concentrations greater than ~ 10,000 ug/L, which is defined in the text. For clarity, "secondary" was replaced with "additional".	
10	1.13, p. 1-14	4th open bullet on page (4th open bullet under "Phase 1")	In 2nd sentence, the word "COCs" should be singular (i.e., "… until COC concentrations…")	C	Text was revised as suggested.	
11	2.1, p. 2-2	1st paragraph, 2nd sentence	"Table 2-1" should be bolded.	C	Text was revised as suggested.	
12	2.1, p. 2-2	Last black bullet on page	A period is missing at end of bullet (after "LHAAP-18/24").	C	Text was revised as suggested.	
13	3.2, p. 3-3	1st paragraph, 2nd sentence	The word "level" should be pluralized (i.e., "… elevated levels of TCE…").	C	Text was revised to read "elevated levels of TCE were detected in..."	
14	4, p. 4-1	1st paragraph, 5th sentence	The word "the" needs to be added before "saturated zone" (i.e., "… with applications in the saturated zone…").	C	Text was revised to read "with applications in the saturated zone..."	
15	4, p. 4-1	1st paragraph, last sentence	"Table 1-1" should be bolded.	C	Text was revised as suggested.	

Comments Response Matrix
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Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
16	Table 1-1		1) Upper left corner of table indicates" "total porosity" was used for groundwater velocity calculations — is this correct? Groundwater velocity calculations typically are computed using effective porosity. 2) "ft", "ft/ft", and "ft/day" are not defined below table body. 3) Because of changes to rounding made in response to comments made on the 90% report, the groundwater seepage velocity values for EISB Biobarrier 2 were changed to "0.00." Believe it would be more appropriate to report these values as "<0.01 ft/day" (note: this change would affect the corresponding sentence describing groundwater velocities in the body of the report (in the sentence described in the next comment).	C	Text was revised as suggested. 1. An average value of effective porosity presented in Table 3-8 of the Post-Screening Investigation Report was used to estimate groundwater velocity. The Post-Screening Investigation Report states that porosity was estimated by ASTM D2434, which measures the effective porosity of a granular soil media. Table 1-1 will be revised to read, "effective porosity". 2. Acronyms have been defined below Table 1-1. 3. The groundwater seepage velocity for EISB Biobarrier 2 – towards West have been revised to report <0.01 ft/day.	
17	4, p. 4-4	1st paragraph, last sentence	1) Both groundwater velocity values need to be rounded to fewer decimal places to reflect rounding changes made to table 1-1 (note: see table 1-1 comments made in previous comment [comment #16]). 2) Should indicate if "porosity" was total porosity or effective porosity (see first table 1-1 comment made in previous comment [comment #16]).	C	1. Text was revised as suggested. 2. Please see response to comment # 16-1. Text was revised to read, "was determined based on the available hydraulic conductivity, effective porosity, and horizontal gradient data."	
18	4.3, p. 4-3	1st paragraph, 1st sentence	The word "the" before "**Table 4-1**" is extraneous.	C	Text was revised as suggested.	

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Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
19	4.3, p. 4-4	1st paragraph, last sentence	1) Should add a comma after "Wilcox clay" 2) Suggest several revisions to this sentence: adding "downward" between "potential" and "leakage", changing "vertically" into "into" and adding, "underlying" before "Wilcox Formation". After these revisions are made, this part of the sentence would be revised as follows: "… is mainly held in the Wilcox clay, but potential downward leakage of TCE into the underlying Wilcox Formation was implied…".	C	1. Text was revised as suggested. 2. Text was revised to read, "DNAPL at 18CPT27 in ISTD Area 2 is mainly held in the Wilcox clay, but potential downward leakage of TCE into the underlying Wilcox Formation was implied based on the analytical results (AECOM, 2013)."	
20	4.4, p. 4-4	Solid bullets	Many of the bulleted subsection names do not match the subsection names that follow. In addition, one or more subsection names appear to be missing from the bulleted list presented here.	C	Text was revised as suggested.	
21	4.4.3, p. 4-7	1st paragraph, 2nd sentence	A comma is missing in "7200."	C	Text was revised as suggested.	
22	4.4.5.1, p. 4-8	Last solid black bullet	A period is missing after the last bullet (after "Soil vapor treatment").	C	Text was revised as suggested.	
23	4.4.7, p. 4-12	1st paragraph, 6th sentence	1) "VOCs" should be singular (i.e., "any VOC impacts"). 2) Should clarify what is meant by "The contractor will be responsible for addressing any "VOC impacts"— suggest revising sentence to identify the potential "VOC impacts."	C D	1. Text was revised as suggested. 2. The potential VOC impacts may include existing VOC contaminations not identified during the RI or PDI or potentially due to the implementation of the ISTD. Therefore, a general sentence is included for the Contractor to address any VOC impacts as part of the performance matrix. No change to the text is proposed in response to this comment.	
24	4.4.13.1, p. 4-14	1st paragraph, last sentence	"Section 4.4.6.3" should be bolded.	C	Text was revised as suggested.	

Comments Response Matrix
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Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
25	4.4.13.2, p. 4-15	1st paragraph, 1st sentence	There is an extra space after "evaluation."	C	Text was revised as suggested.	
26	5, p. 5-1	1st paragraph after second 4 solid bullets (begins with "The treatability test"	1) Should change "accounted the" to "account for the" (i.e., "…or account for the heterogeneity…") to maintain parallel construction. 2) Sentence indicates heterogeneity is a potential limitation without specifying the corresponding media being referenced.	C	1. Text was revised to read, "or account for the heterogeneity..." 2. Text was revised to read, "…..account for the heterogeneity in site geology and …..	
27	5.1, p. 5-2	1st black bullet	The word "Oxidation" in ""Oxidation-reduction" should be lowercase.	C	Text was revised to read, "oxygen/oxidation-reduction...."	
28	5.1.1, p. 5-2	1st paragraph, 3rd sentence	The word "condition" should be pluralized (i.e., "…bio-geochemical conditions…").	C	Text was revised to read, "bio-geochemical conditions..."	
29	5.1.1, p. 5-2	1st solid bullet, last sentence	The comma between "Existing well" and "MW-23" is unneeded.	C	Text was revised to read, "Existing well MW-23..."	
30	5.1.1, p. 5-3	1st solid bullet, 3rd sentence	The word "time" should be pluralized (i.e., "… at certain times of the year…").	C	Text was revised to read "...at certain times of the year."	
31	5.1.1, p. 5-3	2nd solid bullet, last sentence	The word "wells" should be pluralized In the comma after "well" should be removed (i.e., "… Existing wells MW-14 and 120…").	C	Text was revised to read "Existing wells MW-14 and 120..."	
32	5.3, p. 5-4	1st paragraph, 2nd sentence	To improve readability, suggest replacing "subsequent sections 5.4" with "section 5.4" (i.e., "The specific details for each EISB system are provided in section 5.4.").	C	Text was revised to read, "The specific design details for each EISB system are provided in **Section 5.4**"	
33	5.4, p. 5-7	1st black bullet, 1st sentence	"Figures D-5" and "D-6" should be bolded.	C	Text was revised as suggested.	
34	5.4.1.2, p. 5-9	1st open bullet	90% RD indicated wells AWD-3 and 1824DPTMW05 also were to be monitored at EISB Grid 1 — why were these 2 monitoring locations removed or replaced?		Monitoring wells AWD-3 and 1824DPTMW05 were removed by mistake in the 100% RD. Text was revised to reflect existing monitoring wells. AWD-3 and 1824DPTMW05, to be used for EISB performance.	
35	5.4.1.3, p. 5-9	1st paragraph, 2nd sentence	The "ESTCP, 2010" citation is missing from the references section.		References was revised to include "ESTCP, 2010."	
36	5.4.2.1, p. 5-10	1st paragraph, 1st sentence	The word "the" is unneeded before "Caddo Lake."	C	Text was revised to read, "towards Caddo Lake..."	

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Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
37	5.4.2.2, p. 5-10	1st paragraph, 4th sentence	Believe the comma after "then" should be relocated to after "remediated."	C	Text was revised as suggested.	
38	5.4.2.2, p. 5-11	2nd paragraph, 1st sentence	1) Suggest adding a comma after "observations." 2) There is an extra space after "Wilcox clay." 3) The word "the" should be added before "Shallow Zone."	C	1. Text was revised as suggested. 2. Text was revised as requested. 3. Text was revised to read, "the Wilcox clay layer separating the Shallow Zone and Wilcox Formation..."	
39	5.4.2.3, p. 5-12	2nd open bullet	A comma needs added after the word "biobarrier" in "located upgradient from the biobarrier."	C	Text was revised as suggested (assuming this refers to third open bullet).	
40	5.4.2.3, p. 5-12	4th open bullet	A comma needs added after the word "biobarrier" in "located downgradient from the biobarrier."	C	Text was revised as suggested (assuming this refers to fifth open bullet).	
41	5.4.2.3, p. 5-12	7th open bullet	A comma needs added after the word "biobarrier" in "located upgradient from the biobarrier."	C	Text was revised as suggested (assuming this refers to eighth open bullet).	
42	5.5, p. 5-13	1st solid bullet	The comma after "geochemistry" should be replaced with an "and".	C	Text was revised as suggested.	
43	5.5.4, p. 5-16	2nd paragraph, 1st sentence	Believe it would be preferable to change "evaluating impact from groundwater" to "evaluating potential impacts from groundwater" or "evaluating potential impacts from groundwater COCs"?	C	Text was revised to read, "the purpose of evaluating potential impacts from groundwater COC" (assuming this is referring to 3rd paragraph).	
44	Table 1-2	Notes section underlying table body	The word "concentrations" in "Medium-Specific Concentrations" should be singular.		Table 1-2 was revised to remove "Medium-Specific Concentrations."	
44	Table 1-4	Notes section underlying table body	TRRP$^{GW}GW_{Ing}$ and PCL are not defined in the Notes section.	C	Text was revised to define TRRP $^{GW}GW_{Ing}$ PCL in the Notes section.	
44	Table 3-1	Notes section underlying table body	"bgs" is not defined in in the Notes section.	D	Notes section defines "bgs" as below ground surface. No changes are required as a result of this comment.	
45	Table 4-2		1) "Down-gradient" should not be hyphenated. 2) Several abbreviations/acronyms are undefined below table: VOC, NAPL, and PID	C	1. Table was revised to say "(two new downgradient wells)." 2. Table 4-2 was revised to define VOC, NAPL, and PID.	
46	Table 5-1		Would be helpful to add a column (or footnotes), indicating which groundwater zone is being targeted in each test area.	C	Table 5-1 was revised to include groundwater target zone for each test area in Column 1.	

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Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
47	Fig. 1-4		1) Perchlorate in VOC comparison levels for soil are not provided. Could add a Notes "box" similar to the one used in the upper left corner of fig. 1-5 or add levels to the legend. 2) Several abbreviations are not defined in either the notes portion of the legend or the notes portion of the Alternative 5 Activities "box" in the lower right corner of figure body: DNAPL, ICT, and DPT.		1. Notes "box" similar to upper left corner of figure 1-5 was added to figure 1-4. 2. Abbreviations were defined in the notes portion of the legend.	
48	Fig. 1-5		1) Would be helpful to increase font size of text in Notes box in upper left corner of figure body. 2) In Notes box in upper left corner of figure body, unclear why the numerals 1 and 2 have been added after the various comparison levels (presumably, these are missing footnotes that have not been superscripted?); if intended to be footnotes, need to add the 2 missing footnotes. 3) Several abbreviations are not defined in the notes portion of the legend, Alternative 5 Activities box in the lower right corner of figure body, or comparison level box in the upper left corner of fig. body: DNAPL, ICT, DPT, TRRP, and PCL. 4) "Boxes" for 2 sampling locations have footnotes after the word "shallow" (18CPTMW18 and 18 WW17), even though footnotes are not provided in the various figure components.		1. Font size was enlarged. 2. Footnotes have been reformatted. 3. Abbreviations have been defined in the notes portion of the legend. 4. It is a typographical error from previous figure set, therefore, "1" after word "shallow" will be removed from the PDI figures.	

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Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
49	Fig. 1-6		1) In Notes box in lower left corner of figure body, unclear why the numerals 1 and 2 have been added after the various comparison levels (missing footnotes that have not been superscripted?); if intended to be footnotes, need to add the 2 missing footnotes. 2) Several abbreviations are not defined in the notes portion of the legend, Alternative 5 Activities box in the lower right corner of figure body, or comparison level box in the upper left corner of fig. body: DNAPL, DPT, TRRP, and PCL.		1. Footnotes were added and reformatted. 2. Abbreviations have been defined in the notes portion of the legend.	
50	Figs. 1-7 and 1-8		1) Roads, buildings, and site boundary are very difficult to see on printed hard copy — lines representing these features need to be darkened. 2) Need to identify stream (Harrison Bayou). 3) 3rd data range for each constituent is missing a greater than symbol (“>”) — specifically, a “>” needs to be added before “100-500” for TCE, before “500-1,000” for perchlorate, and before “100-500” for methylene chloride.		1. Figures 1-7 and 1-8 were revised to show darkened features. 2. Harrison Bayou Stream was identified in the figures. 3. Comment acknowledged. The data ranges are a range and do not warrant a greater than symbol. No changes have been made as a result of this comment.	
51	Fig. 7-1		Abbreviations/acronyms used in left side of figure are not defined. Could add them to the upper right corner of fig. body.		Abbreviations/acronyms are added in the top right corner of Figure 7-1.	
52	Various Appendix A sheets	Comment regarding location of performance monitoring wells at EISB Pilot Test Area 3	Fig. B-6 in appendix C indicates groundwater at EISB Pilot Test Area 3 flows radially away from well MW-14 in all directions. If intent is to locate performance monitoring wells downgradient of test area, it should be noted there are no existing or proposed performance monitoring wells located to the southeast of the test area, an area which is clearly downgradient of the site as indicated by fig. B-6.		An additional new monitoring well (PMW-18D) is added to the southeast of the Pilot Test Area 3 and text/tables/drawings were revised accordingly.	

Comments Response Matrix
Final Design Analysis Report (100%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: June 28, 2023

Submitted by: April Palmie, TCEQ
Responded by: Army
Date Responded: 10/04/2023

1. **Respondent concurs (C) or does not concur (D)**
2. **Commenter agrees (A) or does not agree (D) with response.**

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1: April Palmie (TCEQ PM) and Midori Campbell (TCEQ Engineering Support)						
1.	RTC	General	We accept the responses to comments, except for the notes below.	C	Comment acknowledged.	

2.	Comment 11	1.12	Please revise the 3rd bullet under groundwater. We appreciate the revisions, but the narrative is confusing. We propose two options: Either split this into two bullets that discuss the purpose and observations from each nested well pair, or streamline the bullet, as mentioned previously in the 90% design document comments. Two bullet version: • Groundwater and soil samples were collected at the nested well pair 1824DPT29A/29, located near ICT-14B to investigate additional source area between the ICT boundary and east of well 18WW17. Higher concentrations of perchlorate and TCE were observed in the deeper well of nested well pair 1824DPT29A/29, located near ICT-14B. At the shallower well 1824DPT29A, perchlorate and TCE were detected at 5,450 ug/L and 182 ug/L, respectively. In contrast, perchlorate and TCE were detected at 41,000 ug/L and 273 ug/L, respectively, in the deeper well 1824DPT29, where the well screen extends into the clay separating the shallow alluvium and the Wilcox Formation. The low-permeable clay layer may potentially be the continuing source of contamination within the containment area. • Groundwater and soil samples were also collected at the nested well pair	C	Text was revised to include two bullet version as requested. o Groundwater and soil samples were collected at the nested well pair 1824DPT29A/29 (see **Figure 1-5**), located near ICT-14B to investigate additional source area between the ICT boundary and east of well 18WW17. Higher concentrations of perchlorate and TCE were observed in the deeper well of nested well pair 1824DPT29A/29, located near ICT-14B. At the shallower well 1824DPT29A, perchlorate and TCE were detected at 5,450 ug/L and 182 ug/L, respectively. In contrast, perchlorate and TCE were detected at 41,000 ug/L and 273 ug/L, respectively, in the deeper well 1824DPT29, where the well screen extends into the clay separating the shallow alluvium and the Wilcox Formation. The low-permeable clay layer may potentially be the continuing source of contamination within the containment area. o Groundwater and soil samples were also collected at the nested well pair 1824DPT27/1824DPT27A (see **Figure 1-5**), located much	

			1824DPT27/1824DPT27A, located much farther east of 18WW17, for delineating perchlorate and VOC contamination at the shallow alluvium and Wilcox Clay contact interval. The interval between the shallow alluvium and Wilcox clay is believed to be a continuing source of perchlorates and VOCs contamination in the groundwater. The sandy units of shallow alluvium – Wilcox clay contact interval generally was observed between 27 and 42 ft bgs in the northeast area. While overall lower perchlorate and VOCs concentrations were observed in this nested well pair, much lower concentrations were observed in the shallower of the well pair (1824DPT27A), indicating that the shallow alluvium – Wilcox clay contact is not a source in this area. Streamlined version: • Groundwater and soil samples were collected at nested well pairs to further investigate for additional source area in the containment area and to delineate perchlorate and VOC contamination in the shallow alluvium and Wilcox Clay contact interval. Within the containment area, higher concentrations of perchlorate and TCE were observed in the deeper well of nested well pair 1824DPT29A/29, located near ICT-14B, indicating that low-permeable clay layer may potentially be the continuing source of contamination within the containment area. Outside the		farther east of 18WW17, for delineating perchlorate and VOC contamination at the shallow alluvium and Wilcox Clay contact interval. The interval between the shallow alluvium and Wilcox clay is believed to be a continuing source of perchlorates and VOCs contamination in the groundwater. The sandy units of shallow alluvium – Wilcox clay contact interval generally was observed between 27 and 42 ft bgs in the northeast area. While overall lower perchlorate and VOCs concentrations were observed in this nested well pair, much lower concentrations were observed in the shallower of the well pair (1824DPT27A), indicating that the shallow alluvium – Wilcox clay contact is not a source in this area.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
			containment area, much farther east of 18WW17, lower concentrations were observed in the shallower well of the well pair (1824DPT27A/1824DPT27), indicating that the shallow alluvium – Wilcox clay contact is not a source in this area. Overall, lower perchlorate and VOCs groundwater concentrations were observed in this nested well pair than inside the containment area.			
3.	Comment 19	4.4.6.3/4-11	Safety and Environmental Controls Several changes are requested to the RTC revised text: 1. Strike out "need to" from "will also need to" and "will need to". Using "will" is more definitive. 2. Revise this sentence as shown below. "These measures may include site preparation with proper grading and drainage to minimize water accumulation and the potential runoff; weather monitoring; erosion and sediment ~~control to prevent soil erosion and sediment runoff during heavy rainfall or storms~~; containment measures to prevent contaminants from migration; and adequate safety measures ~~to protect workers during inclement weather~~." 3. In the last sentence, change "enabling" to "to enable."		1. The text was revised as suggested. 2. The text was revised to "These measures may include site preparation with proper grading and drainage to minimize water accumulation and the potential runoff; weather monitoring; erosion and sediment controls, necessary containment measures to prevent contaminants from migrating, and adequate safety measures." 3. The text was revised as suggested.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
4.	Comment 20	4.4.6.3/4-11	Heating Duration - The revised text in the RTC is unclear. Consider this alternate text: "The Contractor will operate the system continuously, 24 hours a day, 7 days a week. Once minimum temperatures have been reached, the Contractor will continue operating the system for the duration needed to allow monitored natural attenuation to take over as the primary mechanism for DNAPL and VOCs removal from the subsurface."		The text was revised as suggested.	
5.	Comment 21	4.4.7/4-12	The explanation for not sampling the 0-20 ft bgs depth interval is not provided.		The target treatment depth for in-situ treatment (ISTD) in the specified areas is deeper than 20 feet below ground surface (bgs). ISTD treatment is not applied within the 0-20 feet bgs range, and therefore, soil sampling confirmation is not proposed within this depth range. Text was revised to include a sentence stating "Confirmatory soil sampling from depth shallower than 20 feet is excluded since the target treatment depth for ISTD is deeper than 20 ft bgs."	
6.	Comment 23	4.4.8/4-12	The RTC does not match the redline version. Consider this alternate text: "Contractor may perform an initial shutdown based on their assessment that preliminary results meet the performance criterion; however, final shutdown is contingent upon the U.S. Army and regulatory review and subsequent approval, requiring up to 10 business days."		The text was revised as suggested.	
7.	Comment 25	4.4.13.3	Strike out "as necessary" from "Photo documentation of any deficiencies and their resolutions will be provided, as necessary."		The text was revised as suggested.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
8.	Comment 32	7.1/7-1 and G002 Remedial Action Activities	Under Remedial Action Phase I Activities, the first paragraph should clarify that Site Preparation will be completed first. "The Contractor to complete the following activities under Phase I RA. Step 1, Site Preparation, will be completed first. Steps 2 through 4 will be completed concurrently as feasible."		The text and Design Drawing sheet G002 was revised as suggested.	
9.	Comment 37	Table 1-2 notes	Remove the words "Medium-Specific Concentrations" in the note		The table was revised as suggested.	
10.	Comment 38	Table 1-4	Why did you remove note 1 about PCL change for bromodichloromethane?		Note 1 was accidentally removed. Table 1-4 was revised to include note 1 about PCL change for bromodichloromethane.	
11.	Comment 41	Tables 5-10 and 5-13	Correct random bold borders on Table 5-10 (PMW-16 description) and Table 5-13 (location descriptions).		The tables were revised as suggested.	
12.	General	RLSO file	The RLSO file was very helpful. Please include a similar file with future submittals.		Comment Acknowledged.	
13.	General		For consistency, please do a global search to be sure that "Contractor" is capitalized in all occurrences.		The contract documents were revised as suggested.	
14.	Tables 5-2 and 5-3		Tables 5-2 and 5-3 - please remove the bold borders between each row and adjust row height. The bold borders and narrow rows make the text and numbers much harder to read. See the tables in 90% RD, which were more legible. Table 5-3 - remove the Wilcox table, which is a duplicate of Table 5-4		Tables 5-2 and 5-3 were revised for readability. Table 5-3 was revised to remove the Wilcox Table.	

Comments Response Matrix
Final Design Analysis Report (100%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: June 28, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
15.	Figure 7-1		Figure 7-1 - Why is there an empty year in the schedule? The schedule for RD work should start day 1 year 1. Row 67, 3.0 Performance Monitoring - according to Section 7.1 there is EISB performance monitoring in Phase II. What is this performance monitoring indicated as Phase 3?	C	Figure 7-1, empty year was included by mistake, the RD work will start at day 1, year 1. Row 67, 3.0 Performance monitoring representants site wide LTM events; title of the Row 67 will be revised to say Long-Term Monitoring.	
16.	Sheet 14		Sheet 14 EISB Areas Site Plan – Sheet 3 is missing		Sheet 14 (Sheet 3) is included in Final RD Submittal.	
17.	Appendix E		Add bookmarks to Appendix E		Appendix E was revised to include bookmarks.	
18.	Appendix H		Correct Appendix H cover page and table of contents bookmark names. Move the EISB Injection and Surface Water Monitoring Logs to the end of Section 02 53 17. Section 31 23 00, 3.2, end of sentence, change this back to “making due allowance” or revise to “making allowance”.		1. Appendix H bookmarks were revised. 2. EISB Injection and Surface Water Monitoring Logs were moved to the end of Section 02 53 17 for Final RD Submittal. 3. Section 31 23 00, 3.2 was revised and changed to “making allowance.”	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
19.	Appendix H	Section 31 23 10 Excavation and Handling of Contaminated Materials	Noting this specification was added for 100% draft final– not part of the 90% package. 1.2.A.1.a. - Under the Code of Federal Regulations references, add 5) 40 CFR 268 Land Disposal Restrictions. 3.10.B.2. – The first sentence is incomplete. 3.11.A. – 2nd sentence revise to “one composite sample per 1,000 square feet”. 3.12.B. – Does LHAAP have a RCRA Contingency Plan?		1. Section 31 23 10 was revised to include a reference for 40 CFR 268. 2. Sentence will be corrected to say, “Each stockpile shall be covered with a polyethylene cover free of holes or other damage to prevent precipitation from entering the stockpile.” 3. 3.11.A. – 2nd sentence was revised to “one composite sample per 1,000 square feet. 4. The 2018 IWWP, Health and Safety Plan, section 9.s was referenced for Spill Prevention and Control instead of the RCRA Contingency Plan.	
20.	Appendix H	Section 31 23 20 Transportation and Disposal of Contaminated Material	1.2. b – remove the “e” before CFR 3.3.D.1. – There are two “if required” statements in this sentence which is confusing. I propose this rewrite: Contact water may be generated during wet weather and shall be collected from excavations and ~~from~~ stockpiles with saturated soil.~~, if required,~~ The contact water shall be temporarily stored in frac tanks, sampled, and treated at the on-site GWTP, if required.		1. Section 31 23 20 was revised as suggested. 2. Section 31 23 20, 3.4.D.1 was revised as suggested.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Submitted by: Brian Follin, U.S. Environmental Protection Agency
Responded by: Army
Date Responded: 6/28/2023

1. Respondent concurs (C), does not concur (D), or takes exception (E).
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
Reviewer #1:						
1	1.5, p. 1-4	1st paragraph, only sentence	1) The word "site" should be before "LHAAP-18/24" (or alternatively, add the word "The" before "LHAAP-18/24.) 2) The "Texas Bureau of Economic Geology, 1992" reference is missing from the REFERENCES section.	C	1) "The" was added. 2) Reference was added to Section 9 - REFERENCES	
2	1.5, p. 1-4	2nd, 1st sentence	Age of alluvium (Quaternary) is provided in previous paragraph, but no age is provided for the Wilcox Formation.	C	The text was revised to say, "….mantling Tertiary Age formations of the Wilcox Formation and Midway Groups…."	
3	1.5, p. 1-4	2nd, 5th sentence, line 6 in paragraph	The word "cyprus" needs capitalized in "Big cypress Bayou alluvium…".	C	The text was revised as suggested.	
4	1.5, p. 1-4	3rd, 2nd sentence, line 4 in paragraph	The "Texas Bureau of Economic Geology, 1975" reference is missing from the REFERENCES section.	C	Reference was added to Section 9 - REFERENCES.	
5	1.5, p. 1-4	4th, 2nd sentence, line 3 in paragraph	The word "the" is missing between "with" and "underlying Wilcox.".	C	The text was revised as suggested.	
6	1.5, p. 1-4	4th, 4th sentence, line 4 in paragraph	The word "with" is missing between "flowpaths," and "horizontal gradients...".	C	The text was revised as suggested.	
7	1.5, p. 1-5	2nd complete paragraph, 1st sentence, line 1 in paragraph	Can understand the desire to keep things as short as possible, but should indicate at least at beginning of the paragraph that these values are **horizontal** hydraulic conductivities. Could do this at 1st mention by adding "horizontal" before "hydraulic conductivity" at beginning of sentence (i.e., "Horizontal hydraulic conductivity at site 18/24…".	C	The text was revised as suggested.	

Comments Response Matrix
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Submitted: February 7, 2023

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8	1.5, p. 1-5	2nd complete paragraph, 2nd sentence, line 4 in paragraph	The word "ranging" should be "range" (i.e., "… for the shallow zone, range from…").	C	The text was revised as suggested.	
9	1.5, p. 1-5	3rd complete paragraph	Should indicate that these are horizontal **hydraulic** gradients, not simply "horizontal gradients".	C	The text was revised as suggested.	
10	1.7, p. 1-8	1st complete paragraph, 3rd sentence, line 7 of paragraph	Sentence cites table 1-2 as source of info indicating contamination at the site; however, table 1-2 only lists metals.	C	The text was revised to include a reference to Table 1-4.	
11	1.7, p. 1-8	4th complete paragraph, 1st and 2nd sentences	Paragraph utilizes "deep groundwater zone" even though this LHAAP-18/24 report has transitioned to referring to the former "deep zone" as the "Wilcox Formation."	C	The text was revised as suggested.	
12	1.7.1, p. 1-9	4th complete paragraph, 1st sentence	The word "clay" in "Wilcox Clay" should be lowercase because "Wilcox clay" is not a formal stratigraphic unit. Comment applies to entire report.	C	The report was revised as suggested.	
13	1.7.1, p. 1-9	4th complete paragraph, 3rd sentence	The "Wilcox clay" has already been introduced/defined by this point in report, so in this sentence it would be much clearer to simply indicate these two units are separated by the Wilcox clay rather than a "mostly contiguous clay layer," unless this sentence is referring to a different clay layer. If that is the case, additional explanation is warranted.	C	The text was revised to refer to the Wilcox clay.	
14	1.7.1, p. 1-9	4th paragraph, 2nd to last sentence	This sentence indicates "localized influence of groundwater extraction" can be observed in the shallow zone, but it does not specify as to how that conclusion was reached (e.g., lower [deeper] groundwater-level elevations, changes the horizontal and/or vertical hydraulic gradients, extent and location of contaminants in groundwater, etc.).	E	Details on the existing extraction system are not well known, except that it influences groundwater flow locally. There are no existing data (i.e., pump testing) to determine the specifics on the influences on the groundwater flow. Text associated with comment was not revised.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
15	1.7.1, p. 1-9 & 1-10	6th paragraph, 1st sentence	Unclear how it is possible that a PSI published in 2013 was conducted to fill data gaps identified in a future (2017) FS. Additionally, should use either "attributed" or "due" in later part of sentence, but not both words.	C	1. The sentence was revised to, "The PSI (AECOM, 2013) was conducted to fill data gaps identified during the 2010 FS at the LHAAP-18/24 site (Shaw, 2010),…." 2. "Due" was deleted.	
16	1.10, p. 1-11	4th solid bullet on top of page	The comma after "Monitored Natural Attenuation" should be after the parenthetical "(MNA)".	C	The text was revised as suggested.	
17	1.10, p. 1-12	1st complete paragraph (after 4 open bullets), last sentence	The word "a" between "includes" and "maintenance" is extraneous.	C	The text was revised as suggested.	
18	1.12, p. 1-13	Open bullet below solid "Soil" bullet	1st sentence in bullet indicates the "critical mass of contaminant was at the clay/sand interface"—unclear if this is referring to the interface between the shallow zone and Wilcox clay? If so, should clearly state this.	C	The text was revised to, "….indicating a critical mass of contaminant in groundwater media at the clay/sand interface (i.e., sandy units of shallow alluvium – Wilcox Clay contact interface) occupying pore space in the saturated zone."	
19	1.12, p. 1-13	3rd open bullet below solid "Groundwater" bullet, 1st sentence	Paragraph utilizes "Shallow Alluvium" even though this report typically refers to this as the "shallow zone." Additionally, it is unclear why "shallow zone" is capitalized in report — it is an informal term (and capitalization is also not applied consistently, as it is capitalized in some but not all locations in the report).	C	The final RD was revised for consistency in response to the comments received on the intermediate design, as follows: "Shallow Zone" in upper case to identify shallow groundwater (saturated) zone "shallow alluvium" in lower case to identify shallow subsurface soil.	
20	1.12, p. 1-13	3rd open bullet below solid "Groundwater" bullet, 3rd sentence	The word "were" is missing between "since they" and "believed to be".	C	The subject phrasing was deleted, and therefore the comment is no longer applicable.	
21	1.12, p. 1-13	3rd open bullet below solid "Groundwater" bullet, 4th sentence	1) The word "the" is extraneous between "At" and 1824DPT29/29A." 2) The part of the sentence "at depth 40 ft bgs" should be "at **a** depth **of** 40 ft bgs"—note the addition of the needed words, "a," and "of".	C	The text was revised as suggested.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
22	1.12, p. 1-13	4th open bullet below solid "Groundwater" bullet, 1st sentence	Sentence indicates perchlorate and TCE are "exhibiting higher concentrations" but does specify what the perchlorate and TCE concentrations ("higher concentrations") are higher than to complete comparison.	C	The text was revised to include perchlorate and TCE concentrations as a reference to indicate "higher concentrations".	
23	1.12, p. 1-13	7th open bullet (last one) below solid "Groundwater" bullet, 1st sentence	Sentence mistakenly indicates the 37.3 TCE value was J qualified— per fig. 1-6, the J value is for perchlorate, not TCE. Additionally, the word "Near" in the beginning part of the sentence should be lowercase and "Figure 1-6" at end of sentence should be bolded.	C	The text was corrected to identify perchlorate and revised as suggested.	
24	1.13, p. 1-15	Last paragraph, last sentence on page	The phrase "in the phase" should be changed to "in phases"—note deletion of the "the" and pluralization of "phase" (i.e., should be "… components included in phases I, II, and III…").	C	Text was revised as suggested.	
25	2.1, p. 2-1	Last paragraph, 1st sentence	This is the 1st use of "ARARs" abbreviation in report, so it should be spelled out here (and move "ARARs" into a parenthetical located after the spelled-out word).	C	Text was revised as suggested.	
26	3.2, p. 3-2	3rd paragraph (1st paragraph of Excavation Areas section), last sentence	The "IWWP" abbreviation is missing from the list of acronyms and abbreviations section in the back of the report.	C	"IWWP" was added to list of acronyms and abbreviations.	
27	3.2, p. 3-2	1st paragraph, 2nd complete sentence	The phrase "the fact that elevated level of TCE was detected in" should be changed to "the fact that elevated level**s** of TCE **were** detected in" because the later part of sentence is referring to TCE contamination in two depth intervals.	C	Text was revised as suggested.	
28	3.7.1, p. 3-5	1st solid black bullet	"**Site Safety and Health:**" is repeated at beginning of bullet.	C	The repeated text was deleted.	
29	3.7.1, p. 3-6	5th solid black bullet (**Debris Removal**)	The word "Miscellaneous" is misspelled.	C	The text was revised.	
30	4, p. 4-1	1st paragraph, 3rd sentence	The word "subsurface" typically is not spelled with a hyphen between "sub" and "surface".	C	The text was revised.	

Comments Response Matrix
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Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
31	4, p. 4-1	1st paragraph, 4th, 5th, and 6th sentences	This is the 1st use of "ft/day" abbreviation in report, so it should be spelled out here (and move "ft/day" into a parenthetical located after the spelled-out word). After this is done, then can use "ft/day" instead of "foot per day" and "feet per day" in next 2 sentences (and anywhere else in the main body [text] of the report).	C	The text was revised as suggested.	
32	4, p. 4-1	3rd paragraph, 3rd sentence	The word "that" is used twice between "resistivity tests determined" and "the soil". Additionally, the word "value" should be pluralized to "values" because the sentence is referring to a range of resistivity values.	C	The text was revised as suggested.	
33	4, p. 4-1	3rd paragraph, 4th sentence	The word "a" is missing between "also" and "viable".	C	The text was revised as suggested.	
34	4.2, p. 4-2	3rd paragraph (Former ACD Area), 1st sentence	Unclear if "The results" are referring to sampling conducted in 2013 or 2014 (or both years).	C	The text was revised to clarify that the results are from both 2013 and 2014.	
35	4.2, p. 4-2	3rd paragraph (Former ACD Area), 2nd sentence	Units are missing after 414,476 and 404,008. Additionally, it would be helpful to add a comma after "bgs" earlier in the sentence.	C	The text was revised as suggested.	
36	4.2, p. 4-2	4th paragraph (Former UEP Area), 2nd sentence	Sentence indicates extent of DNAPL at 18CPT21 would remain confined primarily beneath the former UEP area—unclear what led to this conclusion (presume it a conclusion of the PSI?).	C	Yes, the text was revised to add, "….based on the findings from the PSI".	
37	4.2, p. 4-3	1st paragraph, 1st sentence	Sentence is unclear and somewhat "awkwardly" phrased—suggest revision to improve clarity.	C	The text was revised as suggested.	
38	4.3, p. 4-3	2nd paragraph, solid bullet and 2nd open bullets	Bullets refer to "shallow alluvium" instead of "shallow zone".	E	The text was revised to replace "shallow alluvium" with "Shallow Zone"	
39	4.3, p. 4-4	1st paragraph, 1st and only complete sentence	Unclear what is meant by "potential leakage of TCE vertically to the Wilcox Formation **was implied based on analytical results**".	E	The language implied here is from the conclusions section of the 2013 PSI report, which was to indicate that there is potential for vertical migration based on assessment conducted during the PSI. The text associated with this comment was not revised.	

Comments Response Matrix
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Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
40	4.3, p. 4-4	2nd paragraph, 2nd sentence	Should replace "feet/day" with "ft/day" abbreviation introduced previously.	C	Text was revised as suggested.	
41	4.4.1, p. 4-4	4th paragraph, 1st sentence	The "USACE, 2014" citation at the end of the sentence is missing from the References section in the back of the report. The only USACE citation in the References section is from 1993. However, there is a U.S. Army reference from 2014 in the references section—perhaps that is what was intended to be cited here?	C	The reference has been revised to (U.S. Army, 2014).	
42	5, p. 5-1	2nd solid bullet after 1st paragraph	The "AECOM, 2016c" citation is missing from the References section in the back of the report. There are only 2 AECOM references in that section: "AECOM, 2016a" and "AECOM, 2016b."	C	Typographical error was corrected to reference "AECOM, 2016b."	
43	5.1, p. 5-2	2nd black bullet	The word "versus" is misspelled ("verses" should be "versus").	C	The text was revised as suggested.	
44	5.1, p. 5-2	2nd paragraph, 1st sentence, 1st line	The word "the" is extraneous between "during" and "Phase 1," and the word "is" between "and" and "anticipated" should be changed to "are" because the sentence is referring to 3 tests.	C	The text was revised as suggested.	
44	5.1, p. 5-2 & 5-3	1st sentence of each bullet	Sentences are unclear as constructed—believe this is largely due to the use of "representing" in the sentences. Would be helpful to restructure/revise these 3 sentences for clarity.	C	This text was revised as suggested.	
44	5.1.1, p. 5-3	1st black bullet, 5th sentence, 11th line of bullet	The word "permanent" should be added between "5" and "injection wells" ("Up to 5 *permanent* injection wells and 5 new monitoring wells…").	C	The text was revised as suggested.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
45	5.4, p. 5-7	Last black bullet, 2nd sentence	Because it has been introduced and discussed in different report sections, should equate the "aquitard separating the shallow zone and Wilcox Formation" with the Wilcox clay—could do this by simply replacing "aquitard" with "Wilcox clay", "aquitard (Wilcox clay)", or "Wilcox clay (aquitard)".	C	The text was revised to refer the aquitard as "Wilcox Clay"	
46	5.4.1.1, p. 5-8	1st/only paragraph, last sentence	The maximum depth of 50 ft BGS is off by 1 ft—table 5-2 indicates 51 ft BGS.	C	The text was corrected.	
47	5.4.1.2, p. 5-8	Last (3rd) open bullet, 1st sentence	Sentence as written is confusing. Assuming intent/meaning of sentence was understood correctly, the word "wells" in "one new monitoring wells" should be singular; the word "well" in "three new well that" should be plural; the word "that" in "three new well that" is extraneous; and the phrase "and will be used" after "Shallow Zone" is extraneous. Therefore, revised sentence would be: "In addition to one new monitoring well installed during the implementation of pilot tests, three new wells will be installed within EISB Grid 1 in the Shallow Zone to monitor EISB performance."	C	The text was revised as suggested.	
48	5.4.1.4, p. 5-9	1st paragraph, 1st sentence	The word "liter" in "1.5 liter" should be pluralized.	C	The text was revised as suggested.	
49	5.4.2, p. 5-10	1st (and only) paragraph in section, last sentence	The word "details" at the end of sentence should be singular (i.e., "Each biobarrier is described below in detail.").	C	The text was revised as suggested.	
50	5.4.2.2, p. 5-10	4th complete paragraph on page, 4th sentence (begins with "It is…")	The word "the" needs added before "groundwater flow pattern".	C	The text was revised as suggested.	
51	5.4.2.2, p. 5-10	4th complete paragraph on page, 6th sentence (begins with "Ninety-two…")	The word "injections" near beginning of sentence should be singular (i.e., should be "Ninety-two injection wells…").	C	The text was revised as suggested.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
52	5.4.2.2, p. 5-11	1st paragraph, 1st (and only) sentence in paragraph	1) Because it has been introduced and discussed in different report sections, should equate the "clay layer" separating the shallow zone and Wilcox Formation" with the Wilcox clay The word "shallow" should be followed by the word "zone"—should be "shallow zone"	C	The text was revised to refer the clay layer to the "Wilcox Clay" and the "Shallow Zone".	
53	5.4.2.5, p. 5-12	1st paragraph, 2nd sentence	1) The word "liter" in "Two liter" should be pluralized. 2) The word "and" is missing before "25 locations."	C	The text was revised as suggested.	
54	10	N/A	1) As noted previously, IWWP (1st introduce on page 3-2) and ARARs (1st introduced on page 2-1) are missing from list of Acronyms and Abbreviations. 2) For PVC, there should be space between "Polyvinyl" and "chloride"	C	1) "IWWP" and "ARARs" have been added to section 10. 2) The text was revised as suggested.	
55	Table 1-1	N/A	2) Many of the values presented in table indicate much more accuracy than is typically reported for these types of measurements in hydrogeology — i.e., reporting 4 numerals to the right of the decimal point is meaningless for most (all?) of these measurements.	C	The table was revised to report 2 numerals to the right, where appropriate.	
56	Table 1-2	N/A	1) CAS is not defined in the Notes section below table MCL is identified as maximum contaminant *limit* instead of maximum contaminant *level*	C	Table 1-2 was revised to define CAS and MCL in the Notes Section.	
57	Table 5-4	N/A	2) Inclusion of "DPT" in the Notes section below table and discussion in text indicates "DPT" should be inserted before "Injection Points" in 3rd table column heading. If not added to column heading, would have to remove from the Notes section below table.	C	Table 5-4 was revised to include "DPT Injection Points" in the 3rd column heading.	
58	fig. 1	N/A	Should add Karnack to fig. 1	C	Location of Karnack was added in Figure 1.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
59	fig. 1-7	N/A	Some “nested” symbols within solid red symbols (and some solid green symbols) are very hard to read, especially on hardcopy.	D	Comment acknowledged. Figures include all three COCs (perchlorate, TCE and methylene chloride) making it relatively congested and hard to read. The soft copy viewed at 100% zoom appears to be clearer. No changes to the Figures 1-7 were made in response to this comment.	
60	General		Discussion about GWTP contingency to address 1,4 dioxane treatment through advance oxidation is listed as both a contingency for this OU and to be considered during the FYR. During the remedial action process if dioxane levels increase at the GWTP is there an interim action to handle the dioxane in place? This could become an issue before the next FYR in 2028.	E	No, the ROD does not provide for an interim action for 1,4 dioxane in place. However, based on the low concentrations observed at LHAAP-18/24, with just two exceedances at MW14 and 120 in December 2022 sampling inside the fence line with concentrations of 63 and 26 ug/L, respectively, and GWTP effluent consistently being well below discharge criteria for 1,4 Dioxane, it is not anticipated that a contingency will be required for the contaminant.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Submitted by: April Palmie, TCEQ
Responded by: Army
Date Responded: 6/28/2023

1. Respondent concurs (C), does not concur (D), or takes exception (E).
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
Reviewer #1: April Palmie (TCEQ PM) and Midori Campbell (TCEQ Engineering Support)						
1.	General	RLSO file	The RLSO file was very helpful. Please include a similar file with future submittals.	C	Comment acknowledged.	
2.	General		The terms Shallow Zone, shallow alluvium, and Shallow EISB Biobarriers are not consistent throughout the document. For consistency, identify Shallow Zone in upper case and shallow alluvium in lower case. Biobarriers should be identified as either "Shallow Zone EISB Biobarrier" or "shallow EISB Biobarrier", but not both.	C	The final RD was revised for consistency as follows: "Shallow Zone" in upper case "shallow alluvium" in lower case "Shallow Zone EISB Biobarrier" as identified.	
3.	General		Add the trademark symbol to all trademarked amendment names.	C	The final RD was revised to include trademark symbol to all trademarked amendment names.	
4.	General		Replacement of off-site with outside the containment area: When you replaced most instances of the term "off-site", there were instances that should not have been changed. Sentences related to waste disposal should state "the Contractor will remove and dispose of the waste off-site in accordance with applicable local, state, and federal requirements and other applicable aspects of waste disposal identified in the contract documents" (copied from 4.4.11). Please revise: 3.7.1 Debris Removal, last sentence should be off-site 4.4.5.1 Sentence beginning "Drill cuttings and other waste generated" should be off-site.	C	The final RD was revised as suggested in the comment and checked for consistency. "the Contractor will remove and dispose of the waste off-site in accordance with applicable local, state, and federal requirements and other applicable aspects of waste disposal identified in the contract documents" (copied from 4.4.11). 3.7.1 Debris Removal, last sentence was revised to be off-site. 4.4.5.1 Sentence beginning "Drill cuttings and other waste generated" was revised to be off-site.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
5.	General		For the RD, it is acceptable for proposed well locations to be identified as PMW-##. Please add a general instruction that when the wells are included in work plans and installed, the well names must include characters to identify the site and work phase (such as 18RA). In the work plan phase, we will need to develop a naming convention that makes sense.	C	General instruction that when the wells are included in work plans and installed, the well names must include characters to identify the site and work phase (such as 1824RA) was added in Section 5.3.	
6.	General	Appendices	The file including drawing and appendices was not searchable. I was also not able to convert the files to make the drawings searchable. Please submit searchable files in the future. For example, reader/reviewer should be able to type a MW# in find and search for all occurrences. None of the well labels are searchable on the drawings, which makes review and use difficult.	C	Searchable files of the drawings and appendices are included in the Final RD.	
7.	1.5/1-5	Last/last	Define first occurrence of ISTD and EISB and use the same terminology for Shallow EISB Biobarrier 1 and 2, as presented later in the document.	C	ISTD and EISB have been defined.	
8.	1.7/1-8	Last/2	If Harrison Bayou is located north-northwest of 18/24, how does groundwater in the upper deep zone move in a southeast direction toward Harrison Bayou?	C	Typographical error. The sentence was revised to, “The groundwater flow direction is north-northeast toward Harrison Bayou in both the Shallow Zone and Wilcox Formation. Overall, the groundwater flow is toward Caddo Lake.” The rest of the text in last paragraph was also determined to be a typographical error and was deleted from the last paragraph of Section 1.7.	
9.	1.7/1-8	Last/4	Denote -3 as superscript.	C	The subject text was deleted, and the comment is no longer relevant.	
10.	1.7.1/1-9	1st bullet/3	Add “the Texas Risk Reduction Program (TRRP) Tier 1 Residential” before “protective concentration levels:	C	“The Texas Risk Reduction Program (TRRP) Tier 1 Residential” was added.	

11.	1.12/1-13	3rd bullet under Groundwater	The comparison of these two nested pairs is not useful. There were samples from many borings collected to evaluate the contact interval. These two pairs were not intended to compare to each other. One pair is inside the containment area, while the other is 1500' to the east. The purpose of these two pairs was not the same. One looked for source, while the other was intended to delineate. Consider rewriting this bullet to streamline the message or implement changes as noted below. This sentence is unclear "This contact between sandy units and underlying clay was targeted since they believed to be the continuing sources of perchlorates and VOCs." Consider revising 3rd and 4th sentences as follows (or similar): The contact between sandy units and underlying clay was targeted because the contact interval between the Shallow Alluvium and Wilcox clay are believed to be the continuing sources of perchlorates and VOCs in the groundwater. At the 1824DPT29A/29 nested well pair near ICT-14B, higher perchlorate and VOC concentrations were detected in the deeper well (1824DPT29) at 40 feet bgs, where the well screen extended into the clay separating the Shallow Alluvium from the Wilcox Formation, indicating the low-permeable clay layer potentially being the continuing source of contamination within the containment area. For the last sentence, I think the conclusion is that the residual source does not extend that far but there are closer soil borings that make the same demonstration. During the PDI, the remote wells were intended to delineate the extent.	C	The text was revised to, "Of the 17 DPT borings advanced outside the Northeast ICT Boundary between the ICT boundary and east of well, 18WW17, groundwater and soil samples were collected at two collocated borings; at 1824DPT29/29A to investigate for additional source area and 1824DPT27/27A to delineate perchlorate and VOC contamination at the shallow alluvium and Wilcox clay contact interval. The contact between sandy units and underlying clay was targeted because the interval between the shallow alluvium and Wilcox clay is believed to be the continuing source of perchlorates and VOCs contamination in the groundwater. The sandy units of shallow alluvium – Wilcox clay contact interval generally was observed between 27 and 42 ft bgs in the northeast area. At the 1824DPT29A/29 nested well pair near ICT-14B, higher perchlorate (41,000 µg/L at 1824DPT29 vs. 5,450 µg/L at 1824DPT29A) and VOC (273 µg/L TCE at 1824DPT29 vs. 193 TCE at 1824DPT29A) concentrations were detected in the deeper well (1824DPT29) at 40 feet bgs, where the well screen extended into the clay separating the shallow alluvium from the Wilcox Formation, indicating the low-permeable clay layer potentially being the continuing source of contamination within the containment area Much farther to the east of the well, 18WW17, the lower perchlorate and VOC concentrations, albeit much lower, were found in the shallower (1824DPT27A) of the nested wells 1824DPT27 and 1824DPT27A indicating otherwise (**Figure 1-5**)."	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
12.	2.2/2-2	3/8	Strike out "of" before 1,4-dioxane.	C	The text was revised as suggested.	
13.	3.2/3-3	1st bullet/1	Strike out "well" to eliminate confusing the adjective for a noun.	C	The text was revised as suggested.	
14.	3.3/3-4	2/1	Will the horizontal piping runs for future EISB be installed preemptively "in case" of contamination in the lower permeable soil? If the installation is not pre-emptive, replace "In case" with "If".	C	"In case" was replaced with "if"	
15.	3.5/3-4	1	The fill will have to meet clean-up criteria. Also add reference to location of the criteria in the specification and contract documents.	C	Language that the fill will meet clean-up criteria and reference to Section 1.2B of Specification 31 23 00 Backfill, Compaction, and Grading were added.	
16.	4/4-1	2/2	Consider rewording the ERH half of this sentence as follows: "ERH generates heat when subsurface media resists an electrode-induced electrical current flowing through pore water only under saturated conditions."	C	The text was revised as suggested.	
17.	4/4-1	2/6	Add "or higher" after "boiling point of water".	C	The text was revised as suggested.	
18.	4.4-1	2/last sentence	Consider revising the last sentence as follows: "Second, high temperatures solubilize contaminants out of DNAPL into the groundwater matrix, making the contaminants biological available when concentrations are not toxic to the microorganisms.	C	The text was revised as suggested.	
19.	4.4.6.1/4-10	Safety and Environmental Controls	Consider adding shutdown or damage mitigation procedures in case of inclement weather.	C	The requirement for including necessary safety and environmental protection measures during inclement weather was added to the Section 4.4.6.3.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
20.	4.4.6.3/4-11	Heating Duration/4	It is unlikely that complete treatment and removal of DNAPL and VOCs from the subsurface can be achieved in a reasonable amount of time. Add some type of criteria for identifying a sufficient time period. Consider adding "to the extent that monitored natural attenuation can take over as the primary decontamination process" after "remove DNAPL and VOCs from the surface."	C	The text was revised to, The contractor will operate the system continuously, 24 hours a day, 7 days a week, once minimum temperatures have been reached, for the duration it determines to be sufficient to treat and remove DNAPL and VOCs from the subsurface. The Contractor will operate the system to the extent allowing monitored natural attenuation to take over as the concentrations of contaminants in soil and groundwater naturally decrease or attenuate. after "remove DNAPL and VOCs from the subsurface"	
21.	4.4.7/4-12	1/8	Add "saturated" before "soil column" and explain why the 0-20 ft. bgs depth interval will not be sampled (e.g., unsaturated soil column).	C	"saturated" was added.	
22.	4.4.7/4-12	3	SSHP is not defined	C	The term SSHP is no longer used and was replaced with APP/HASP, which is defined at its first mention.	
23.	4.4.8/4-12	1/1-3	The timing of the system shutdown is unclear. Does the Contractor need approval from the agencies for shutdown, or can the Contractor shut down the system based on their own assessment?	C	The timing of the system was clarified in Section 4.4.8 as follows: The Contractor may shut down once the performance goals are met but the final approval is contingent upon U.S. Army and regulatory review of final results and approval.	
24.	4.4.10/4-13	1/3-4	The referenced Section 4.4.9 does not specify which heating elements will be abandoned in-place. Are the heating elements meant to be the wells or rods used for heating?	C	Yes, the heating elements and monitoring points refers to the boring location used for installing heating elements/monitoring points. The text was clarified to include boreholes for installing heating elements and monitoring points.	
25.	4.4.13.3	1/5	Include a statement that photo documentation of any deficiencies and their resolutions will be provided as necessary. Also note these submittals could be digital and would not require original/copies.	C	Text was revised as suggested.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
26.	5.3.1/5-5	1 /2	The immediately preceding paragraph states that injections for the entire Shallow EISB Biobarrier 1 will be achieved through DPT, instead of through injection wells. Please clarify.	C	Permanent injection wells will be used to inject substrate for the Shallow Zone EISB Biobarrier 1. Text will be revised to remove Shallow Zone EISB Biobarrier 1 under the DPT paragraph.	
27.	5.4.2.2/5-10	1/last sentence	Add “spaced 20 feet apart” after “injection points”.	C	The text was revised as suggested.	
28.	5.5.3.4/5-15	1/last sentence	Please specify whether any or all of the criteria conditions must be observed before reinjection will be conducted.		The Section 5.5.3.4 was revised to clarify the requirement of re-injection if any one of the listed three criteria is met.	
29.	5.5.4/5-16	2/5	The RTC for the 60% indicated that surface water samples would be analyzed for other parameters besides COCs. Please list these parameters.	C	The text was revised as suggested.	
30.	6.1/6-2	1st bullet	Please revise sentence to revise/remove highlighted words “The LUC boundary presented in this RD is not subject to change ~~as~~ because the limits of groundwater contamination ~~is~~ are well defined ~~within the~~ outside of the containment area.”	C	The text was revised as suggested.	
31.	6.2/6-2	1st bullet	COCs here instead of Chemicals of Concern	C	The text was revised as suggested.	
32.	7.1/7-1 And G002 Remedial Action Activities		Phase I and II both indicate the work will be completed concurrently. Pleas expand these statements and clarify. In Phase I, site prep is first, then remainder of the numbered work is concurrent (as it is feasible). There will be logistical limitations (health/safety, equipment protection) that may prevent all tasks from proceeding at the same time. Within each numbered item, the lettered tasks are generally sequential. 1 Site Prep a. and b. both have sentences missing capitalization of first word. In Phase II, 2. Performance monitoring - of what? Also fix the numbering (j,k).	C	The text was revised as suggested.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
33.	7.1/7-1	2/under Site Preparation	Add "Set up traffic controls" as an activity under Site Preparation	C	The text was revised as suggested.	
34.	8.3.1/8-1	1 /2	Typo in url – correct url is www.dol.gov.	C	The text was corrected.	
35.	8.3.2/8-2	1/1	The current Federal COM rate is closer to 5%.	C	The text was revised as suggested.	
36.	8.3.3/8-2	# 3	Correct "waster liner" to "waste liner"	C	The text was revised as suggested.	
37.	Table 1-2	Notes	Remove reference to MSC, should be MCL and PCL MCL is Maximum Contaminant Level * note – remove perchlorate and 1,4-dioxane	C	The table was revised as suggested.	
38.	Table 1-4	PCL	Fix sub and superscript – should be TRRP $^{GW}GW_{Ing}$ PCL	C	The table was revised as suggested.	
39.	Table 2-1	Frequency of Inspection	Clarify the required frequency of inspection is annual. Additional inspections may occur between annual events. As written, it looks like annual is optional.	C	The table was revised as suggested.	
40.	Table 5-6		<u>Biobarrier #1</u> Add PMW-15 or 16 Are PMW-12 and PMW-13 sufficient for baseline? They will be a baseline from an area that was pre-treated by the pilot test. Another data point from within Biobarrier #1 would provide useful baseline information with PMW-12 or PMW-13 (not both). I propose northwest of PMW-13. <u>Biobarrier #3</u> 18CPTMW26 should be identified as 18CPTMW26SW. It will need to be corrected on figures, tables, drawings, and in text. 18CPTMW26SW is not sufficient as downgradient well for Biobarrier #3. A new well will be needed south of the corner in similar lithology as 18CPTMW22SW. Additional wells noted here should be added to Tables 5-9 through 5-12.	C	Biobarrier #1 1. PMW-16 was included as a downgradient well to Shallow Zone EISB Biobarrier 1. 2. A new performance monitoring well (PMW-28) was included to replace PMW-13 in the baseline for Biobarrier #1. Biobarrier #3: 1. Contract documents will be revised to replace 18CPTMW26 with 18CPTMW26SW. 2. A new performance monitoring well (PMW-13D) was included downgradient of PMW-11D. 18CPTMW26SW was removed from Wilcox Biobarrier #3 and instead was included as another data point for Shallow Biobarrier #2. 3. Tables 5-9 through 5-12 have been revised accordingly.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
41.	Tables 5-9 through 5-12		Note a – this note is incomplete, and it is unclear what it goes with. Note ü - it is unclear what this note goes with. I think it is supposed to be the check mark.	C	1. Tables have been revised for clarity. 2. Tables have been revised as suggested.	
42.	Table 5-13		Add a column with general location of the well (which part of the site) Add reference note to 04C100 and 04C101 where MNA and LTM locations are identified. No wells are identified with superscript e MW-2-R and 18CPTMW03SW-R add note to explain the R (replaced after ISTD activities). [Also add note on Tables 5-8 and 5-12 for MW-2-R]	C	1. Table 5-13 was revised to include a column with the general location of the well. 2. A reference was included as requested. 3. Superscript e was removed. 4. A note was included as requested.	
43.	Figure 1-3, Figure 6-1		The legend indicates that a single line represents roads. Is there a distinction between the single gray lines and the double gray lines, i.e., do the single gray lines represent undeveloped roads while the double gray lines represent developed roads?	C	A note was added in the Figures to clarify that single gray line represent un-paved access path while the double gray line represent paved access road.	
44.	Sheet G001		Under Environmental Notes, Item 7: Add statement that water used for monitoring well development will be tested to determine appropriate management method. Under injection notes: Add that injection activities must be coordinated with TCEQ to meet the substantive requirements of the Underground Injection Control authorization (permit equivalent).	C	Sheet G001 was revised to include the following notes: 1. Note 7: Water used for monitoring well development shall be tested to determine an appropriate management method. 2. Note 2: The Contractor shall coordinate injection activities with the Texas Commission on Environmental Quality (TCEQ) to meet the substantive requirements of the Underground Injection Control authorization (permit equivalent).	
45.	Sheet G002		Under Remedial Action Phase I Activities, Item #1: Add I. Set up traffic control	C	Sheet G002 was revised as requested.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
46.	Sheet G002		Under 4. In-Situ Thermal Desorption for DNAPL Treatment, Item G: the performance monitoring schedule is not consistent with the schedule noted in Table 5-10.	E	The Performance monitoring included in Table 5-10 is for the EISB while under 4, Item G is for listing the requirement for the performance monitoring for ISTD. No changes are anticipated in response to this comment.	
47.	Sheet 01C101		The symbol for the excavation area is identical to the symbol for excavation top of slope in the legend. Please correct.	C	Sheet 01C101 was revised to improve clarity and readability of the symbology for the excavation top of slope.	
48.	Sheet 02C100		The boundaries for EISB Grid 1 and Grid 1A appear to be discontinuous because of labels dissecting the boundaries. Consider revising the labels so that the boundaries can be seen through them and appear continuous. On this sheet and the series, consider changing EISB Grid labels (such as EISB Grid 1A) so they are all larger and/or a different color than the well labels. The labels are especially difficult to distinguish in EISB Grid 1.	C	Labels were repositioned so that the boundary appears continuous. In certain instances, repositioning the label was not feasible, therefore, background mask was removed from the label.	
49.	Sheet 01D100		Are the specifications for the construction details based on runoff calculations?	E	No, the details are shown based on the typical BMPs used for Erosion and Sediment Control measures.	
50.	Appendix B	Phase 1-1/1.1.6.4	This cost assumes hazardous waste meets universal treatment standards for land disposal; cost could be higher.	C	Comment acknowledged on cost being higher if the waste does not meet treatment standard for land disposal; however, the cost assumption is based on the available data and vendor quotes received from waste disposal facility. No change was made in response to this comment.	

Comments Response Matrix
Draft Design Analysis Report (90%) Pre-Final Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: February 7, 2023

Number	Section/Page	Paragraph/Line	Comment	C,D,E	Response	A,D
51.	Appendix H	01 03 45	1.3 Should this sentence say “regulators” instead of “state”? USACE will approve in consultation with the state, where appropriate. [If revised, edit other specifications, such as 31 23 00 Section1.3.] Also correct page number for Tables 01 35 45-1A and B Table 01 35 45-1B PCL - Fix sub and superscript – should be TRRP $^{GW}GW_{Ing}$ PCL	C	The subject sentence was removed. However, the following standard language is used instead: “Approval from the Contracting Officer's Representative, in consultation with the regulators is required...” Page numbers for Tables 01 35 45 – 1A and 1B were corrected. PCL - Fix sub and superscript were fixed.	
52.	Appendix H	31 23 00	2.1.A.4 – Fill must also be sampled for metals.	C	Text was revised as requested.	
53.	Appendix H	31 23 20	3.6 Confirm – Did you mean to include EPA Region II? Somewhere in this specification, you may want to add (or similar): The Contractor will be responsible for reporting waste shipments to the TCEQ One-Time Waste Shipment Program.	C	Typographical error. EPA Region II was corrected to the USACE. Text, “The Contractor will be responsible for reporting waste shipments to the TCEQ One-Time Waste Shipment Program.” was added to Section 3.5 under Shipping Documents.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Submitted by: Brian Follin, EPA Region 6
Responded by: Army
Date Responded: 02/07/2023

1. Respondent concurs (C) or does not concur (D)
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1:						
1	1.5 Geology and Hydrogeology section, page 1-4	1st paragraph	Usage of "Surficial soils" in the first sentence as currently constructed can be interpreted to refer to 1) actual "soils," or 2) unconsolidated sediments from land surface to some unspecified depth. First reading of the sentence seems to imply that it is the former, but after reading the next sentence, the 1st sentence seems to be referring to the clay layer (i.e., "clay stratum") separating the shallow zone from the underlying Wilcox Formation. Consequently, both sentences should be revised to clarify.	C	The language used in the Report under Section 1.5 is from the 2020 ROD, which refers to the unconsolidated sediments from land surface to the clay layer separating the shallow zone and Wilcox Formation as "surficial soils." For clarity, the paragraph was revised to include geology in reference to shallow alluvium and Wilcox Formation.	
2	1.5 Geology and Hydrogeology section, page 1-4	1st paragraph, 2nd sentence	Stratigraphic rank of the "Wilcox" lithostratigraphic unit used throughout subsequent parts of the report is at the formation level/rank, so it is unclear why the unit is identified using group rank here. A review of the literature indicates the "Wilcox" is elevated to group rank in Texas, but it would be preferable to use consistent stratigraphic rank for the unit (Wilcox Formation) throughout the report.	C	Text was revised to "Wilcox Formation" throughout the report.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
3	1.5 Geology and Hydrogeology section, page 1-4,	2nd paragraph	The first sentence refers to the "shallow alluvial zone," but the remainder of the report refers to the "Shallow Zone." It is unclear if the two zones are equivalent. If not equivalent, it should be clearly stated as such and each zone should be defined. If they are equivalent, the phrase "shallow alluvial zone" should be replaced with "shallow zone" because that is how the zone above the Wilcox Formation is identified throughout subsequent parts of the report — this would eliminate any potential confusion and promote consistent internal identification of this "unit/zone" within the report. The next sentence refers to thickness of the "shallow alluvium." Once again, it is unclear if this sentence is referring to the "shallow alluvial zone" or "the shallow zone (or perhaps neither?)." Consequently, this sentence (and the next two sentences) should be revised as well to clarify. Additionally, thickness of this zone is indicated to range from 10 to 40 ft; however, pages 1-7 and 4-3 indicate the shallow zone can be as deep as 45 ft BGS — thus, revise, as necessary, this sentence and/or the other sentences on pages 1-7 and 4-3 to eliminate this apparent discrepancy.	C	The phrase "shallow alluvial zone" was replaced with "shallow zone," since that is how the zone above the Wilcox Formation is identified throughout subsequent parts of the report. Shallow Alluvium refers to the site geology and the Shallow Zone refers to the groundwater zone. This was clarified in the report text Section 1.5 to eliminate the apparent discrepancy.	
4	1.5 Geology and Hydrogeology section, page 1-4	2nd paragraph, 2nd to last sentence	Unclear what is meant by part of the sentence: "…flowpaths, gradients depending on where sandy channel deposits intersect." Thus, sentence needs revised for clarity. In addition, it would be helpful to add the word "groundwater" before "flow paths" (only needed at 1st time use of "flowpaths"), and the type of gradient being referred to should be specified— presumably horizontal hydraulic gradient or vertical hydraulic gradient, or both.	C	The sentence was revised as per the comment to clarify the groundwater flow paths and their complexity due to the heterogeneity characteristics of the geology of shallow alluvium.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
5	1.5 Geology and Hydrogeology section, page 1-4	3rd paragraph, 3rd sentence	Suggest revising the sentence "Many of the channel fill sand bodies include a percentage of silt" to "Many of the channel fill sand bodies include silt," or alternatively, "Many of the channel fill sand bodies are silty."	C	Text was revised as follows, "Many of the channel fill sand bodies include silt."	
6	1.5 Geology and Hydrogeology section, page 1-4	4th paragraph, 2nd sentence	This sentence indicates the clay layer is missing in the *northwestern* corner of the site, but page 1-7 indicates the clay layer is present across the entire site with the exception of the area to the *west and northwest* towards Harrison Bayou. Reconcile the discrepancy.	C	The sentence was revised to reconcile the discrepancy and clarify the relevant locations where the clay layer thins out (i.e., whether within or outside of the containment area).	
7	1.5 Geology and Hydrogeology section, page 1-4	2nd paragraph, 2nd to last sentence	Unclear what is meant by part of the sentence: "…flowpaths, gradients depending on where sandy channel deposits intersect." Thus, sentence needs revised for clarity. In addition, it would be helpful to add the word "groundwater" before "flow paths" (only needed at 1st time use of "flowpaths"), and the type of gradient being referred to should be specified—presumably horizontal hydraulic gradient or vertical hydraulic gradient, or both.	C	Text was revised to clarify the groundwater flow paths and reference to horizontal or vertical gradient depending on the location.	
8	1.5 Geology and Hydrogeology section, page 1-4	3rd paragraph, 3rd sentence	Suggest revising the sentence "Many of the channel fill sand bodies include a percentage of silt" to "Many of the channel fill sand bodies include silt," or alternatively, "Many of the channel fill sand bodies are silty."	C	Comment#5 is repeated as Comment # 8. Please see response to comment # 5.	

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Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
9	1.5 Geology and Hydrogeology section, page 1-4	4th paragraph, 2nd sentence	This sentence indicates the clay layer is missing in the *northwestern* corner of the site, but page 1-7 indicates the clay layer is present across the entire site with the exception of the area to the *west and northwest* towards Harrison Bayou. Reconcile the discrepancy.	C	Comment#6 is repeated as Comment # 9. Please see response to comment # 6.	
10	1.5 Geology and Hydrogeology section, page 1-4	4th paragraph, last sentence	The first half of this sentence indicates the sands of the Wilcox Formation are homogenous, but it is unclear if this is referring to grain composition, or some other physical characteristic. The second half of the sentence indicates the Wilcox Formation sands range in grain size from medium to fine silty sands — note that "silty sands" is not a grain size. Thus, as currently constructed, the sentence is improperly equating sediment grain size with sorting. Consequently, this sentence needs revised.	C	The sentence was revised to clarify that the sands of the Wilcox Formation are homogenous, which refers to its physical characteristics (unlike shallow alluvium sands which is surrounded by silts and clays). The text was revised clarify the grain size of the Wilcox Formation sands.	

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Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
11	1.5 Geology and Hydrogeology section, page 1-4		Seasonal/annual water-table fluctuations are not discussed/described in this report section (and minimally in the remainder of the report). Because removal of contaminated materials and certain treatments discussed in the report will be limited to contaminated soil/sediment in the unsaturated zone, at least some description of the range of these fluctuations should be provided. The water-table depth at the time contaminated materials are removed will determine the volume of materials to be removed. Similarly, the water-table depth will affect the depths to which certain treatments will be applied and treatment systems will be installed. Thus, water-table fluctuations should be at least broadly discussed/summarized/characterized in this report section, and the potential effects of different water-table depths on the various treatment sections described in subsequent parts of the report warrants at least some mention/discussion.	C	Discussion on the seasonal/annual water-table fluctuations was included in this report section based on the Bhate's groundwater data collected for the year 2021. Along with the water-table fluctuations, the potential effects of different water-table depths on the various remediation methods are discussed in the appropriate sections.	
12	1.5 Geology and Hydrogeology section, page 1-4	5th paragraph, 4th sentence	The sentence indicates groundwater extraction affects groundwater in the shallow zone, but it does not specify the type of extraction or how the extraction affects the zone.	C	Details on the existing extraction system are not well known, except that it influences groundwater flow locally.	

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
13	1.5 Geology and Hydrogeology section, page 1-4	5th paragraph, 5th sentence	Should specify this is referring to horizontal hydraulic gradient. In addition, sentence should be revised by adding "hydraulic" before gradient, "that of" between "similar to" and "the Shallow Zone," and "which is" before "towards Harrison Bayou" (i.e., "The horizontal hydraulic gradient and direction of groundwater flow in the Wilcox Formation in the northern portion of the site is similar to that of the Shallow Zone, which is towards Harrison Bayou.").	C	Sentences were revised per the comment.	
14	1.5 Geology and Hydrogeology section, page 1-4	6th paragraph, 2nd and 3rd sentences	A citation should be provided for the Bower and Rice slug test method. In addition, it is unclear what is meant by "included for the shallow saturated zone." Presumably, this is referring to the "Shallow Zone"? Similarly, it is unclear what is meant by "intermediate saturated zone" of the shallow zone in the next sentence. Need to revise sentences to clarify.	C	Citations, including these results from the remedial investigation report (Jacobs, 2001), were added to the text. The reference to the "shallow saturated zone" was revised to "shallow zone." At the time of preparing the RI, three zones were identified, including an intermediate saturated zone. At a later date, based on additional investigation, it was concluded that only two zones are present at the site. This is why "also within the Shallow Zone" is stated in the text. The sentence was further revised to clarify.	
15	1.6.3 Current and Future Groundwater Uses section, page 1-6	1st paragraph, 1st sentence	Sentence indicates the aquifer is near LHAAP, but doesn't the same aquifer underlie all of LHAAP? In addition, can the aquifer be identified (named)?	C	Yes, it is the same aquifer underlies all of LHAAP. Text was revised to clarify.	
16	1.6.3	1st paragraph, 2nd sentence	Should add a comma after "Wilcox Formation" and delete the immediately following "or" (i.e., "… should not be confused with the Wilcox Formation, also referred to as deep zone groundwater in previous investigations, which extends…"). Additionally, it would be helpful to provide a citation for the information provided in this sentence, especially the depth of the bottom of the Wilcox Formation/deep zone groundwater (151 ft bgs).	C	Sentence was revised per the comment. Citation of the report from which this information was obtained was added to the text.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
17	1.6.3	1st paragraph, last sentence	Because a depth range was provided for the drinking-water aquifer in the first sentence of the paragraph, it would be helpful to also provide a depth range for the "contaminated zone" in this sentence to facilitate comparison of depths, preferably as a parenthetical after "drinking water aquifer" at the end of sentence.	C	Depth range for the contaminated zone was added to facilitate comparison of depths.	
18	1.6.3	2nd paragraph, 9th sentence	Sentence indicates water removal is not expected to affect groundwater flow, but it does not specify in what manner (for example, horizontal and/or vertical direction of groundwater flow, quantity of groundwater flowing beyond or towards a specific location [for example, discharge to a surface water body], etc.).	E	The language used in Section 1.6.3 is from the 2020 ROD, which states that the water removal is not expected to affect groundwater flow, as the nearby wells are completed deeper than the deepest zone of contamination at LHAAP and there is considerable distance between these wells and LHAAP. Text associated with comment was not revised.	
19	1.7 Conceptual Site Model section, page 1-7	3rd paragraph, 4th sentence	Beginning of sentence should be revised because VOCs and perchlorate were detected in wells, not concentrations of VOCs and perchlorate (i.e., "VOCs and perchlorate were detected in wells screened in the Shallow Zone…").	C	Sentence was revised to, "VOCs and perchlorate were detected in wells screened in the Shallow Zone…"	
20	1.7.1	3rd paragraph, 2nd sentence	To maintain parallel construction, the phrase "is characterized primarily" should be replaced with "is composed of" and then "by" should be replaced with "of" (i.e., "… whereas the Wilcox Formation is composed primarily of fine-grained sand."). Also note that "while" was replaced with "whereas."	C	Sentence was revised as per the comment.	
21	1.7.1	4th paragraph, last sentence	Unclear what is meant by "other VOCs and metals concentrations in groundwater are intermittent" in this sentence. The word "concentrations" should be removed, and the sentence should be revised to provide clarity.	C	Sentence was revised to, "other VOCs and metals detections in groundwater are intermittent and their distribution is generally not contiguous across the site."	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
22	4 In-Situ Thermal Desorption Design for DNAPL Treatment section		In several locations in this report section, the text indicates VOCs are treated "effectively" by ERH and TCH. However, no quantitative metrics are provided to indicate VOCs have been "effectively" treated by a given method.	E	The remedial design for the in-situ thermal desorption will be performance-based, and the Contractor will be responsible for identifying the quantitative metrics to indicate that VOCs are being treated by the proposed method. A reference to a white paper (CDM, Smith 2018) indicating ERH and TCH can be effective in treating the VOCs at multiple sites like the Site 18/24 has been included in Section 4. Text associated with comment was not revised.	
23	4 In-Situ Thermal Desorption Design for DNAPL Treatment section, page 4-1,	1st paragraph, 5th sentence	Sentence indicates TCH is applicable to sites with "low to moderate groundwater flow rates." However, no information (i.e., estimated groundwater flow rates at the site) is provided in the report indicating the site meets this criteria. In addition, it would be more appropriate to use "unsaturated conditions" instead of "dry conditions" at the end of sentence.	C	The estimated groundwater flow rates calculated based on the available information was added to the document including in Section 4.0. The sentence was revised appropriately to use "unsaturated conditions" instead of "dry conditions" at the end of sentence.	
24	4 In-Situ Thermal Desorption Design for DNAPL Treatment section, page 4-1	, 2nd paragraph, last sentence	Sentence indicates groundwater extraction will be temporarily stopped to reduce groundwater inflow. It would be helpful to briefly describe the potential effects of stopping extraction.	C	Based on the estimated groundwater flow rates and extraction rates of the ICT located near the proposed ISTD areas, the potential effects of stopping extraction were evaluated and included in the Section 4.0.	
25	4.3 ISTD Area Characteristics section, page 4-4	2nd paragraph, 1st sentence	Need to explain what is meant by "regional groundwater."	C	In this sentence, "regional groundwater" referred to groundwater within the ISTD area. The sentence was revised to clarify the meaning of localized groundwater depths for each ISTD area.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
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Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
26	5 Enhanced In-Situ Bioremediation Design section, page 5-1	2nd paragraph, 2nd sentence	Unclear what is meant by "groundwater material."	C	This was a typographical error. The sentence was revised to say, "The testing was conducted on soil material received from the area of MW21 and groundwater from well MW21…"	
27	5 Enhanced In-Situ Bioremediation Design section, page 5-1	paragraph after last bullet	Another key limitation of the treatability test that should be noted is that it could not account for site hydrogeologic conditions and characteristics.	C	Text was revised to include the additional key limitations, including the difference in site hydrogeologic conditions and characteristics.	
28	5.3.4 EISB Design section, 5.3.4.1 EISB Grid Areas section, page 5-6		Unclear why concentration measurement units have suddenly switch to parts per billion, instead of previously used micrograms per liter previously used throughout the report. Suggest using micrograms per liter for internal consistency.	C	The report text was revised to include consistent unit for concentration measurement (micrograms per liter).	
29	5.3.4.1 EISB Grid Areas section, page 5-7	last sentence	Per table 5-2, saturated thickness range is 7 to 20 vertical ft—saturated thickness at 1824DPT42 in EISB Area 1 is 7 ft.	E	Saturated thickness range was kept as 8 to 20 vertical ft, as Table 5-2 was updated.	
30	6.2 Maintenance and Monitoring Requirements, page 6-2	1st bullet	COCs are defined as "Contaminants of Concern" here, but were defined as "Chemicals of Concern" in earlier parts of the report. Thus, there are two different definitions for COCs in the report (also note they are defined as "Chemicals of Concern" in the List of Acronyms and Abbreviations section at the end of the report).	C	The report text was revised to include consistent definition of "COCs," which will be Chemicals of Concern, as defined in the 2020 ROD.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Submitted by: April Palmie, TCEQ
Responded by: Army
Date Responded: 02/07/2023

1. Respondent concurs (C) or does not concur (D)
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
Reviewer #1: April Palmie and Midori Campbell (engineering support)						
1.	General	Formatting	Include bookmarks for imbedded tables OR add the tables to section bookmarks. Example: 1.11 Site Cleanup Levels and Table 1-1 Note the design report uses cy while design sheets use yd^3 In comments below, copied text may be highlighted for emphasis. **<u>Search for these terms and replace/correct:</u>** regulator to regulators ppb to unit of measure (i.e., µg/L) barrier wall to permeable reactive barrier [Because groundwater will be moving through the line of injections, "permeable reactive barrier" is a more appropriate term to describe the configuration of permanent injection wells.]	C	Bookmarks for imbedded tables were included in the pdf document. Consistent with the design report, the design sheets now use cy instead of yd^3 "regulator" was replaced with "regulators" "ppb" was replaced with "µg/L" "barrier wall" was replaced with "biobarrier" (because permeable reactive barrier usually refers to the wall created by trenching and placing with reactive material.)	

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Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
2.	General		The RD introduces concept of on- and off-site contamination. At 18/24 this is described as inside and outside of the containment area. Please revise throughout the document. Replace usage of on-site and off-site area with inside or within and outside of the containment area. Figures in report and Figures in Appendices – Please consider including all figures that aren't design drawings together. Next iteration please send a red-line strike-out or track-changes version to streamline review. For sections that are completely new, you could highlight the heading to draw attention. You are probably working on those sections while we are reviewing 60% and highlight of heading would be easy to do after the fact.	C E C	On-site and off-site were replaced with within and outside of containment area Figures from the Bhate reports were maintained as an Appendix separate from the DAR figures. These figures were created for work performed by Bhate and are included in Appendix C for reference. Draft final design includes a red-line strike-out version of the report to streamline review.	
3.	General		Lesson learned from LHAAP-17: Consider adding MEC explanation somewhere for the future bidders. You could explain that Army does not expect to encounter MEC, however if encountered work will stop and specialists will be brought in. Note if there is any location at 18/24 that processed these materials historically. Lesson learned from LHAAP-16: Injection wells - Consider adding information about the failed wells at LHAAP-16. There will be some comparable completions at 18/24 in high saturation/high COC areas. Should those wells be completed with a different grout mix/slurry, longer curing time, or something else to avoid whole well extruding once injections start?	C C	Lesson learned from LHAAP-17 regarding MEC was included in the report under section 3. SOIL EXCAVATION REMEDIAL DESIGN Lesson learned from LHAAP-16 for injection wells was added to the report.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
4.	1	Introduction	Last sentence – the last clause of this sentence relates to the PDI, not all documents. "…to refine the extent of groundwater impacted by perchlorate and volatile organic compounds (VOCs), and soil impacted by the VOCs." Revise sentence to clarify	C	It is a typographical error. The sentence was revised to, "The design report was prepared based on the nature and extent of contamination determined during the pre-design investigation (PDI) conducted in 2021 (HDR, 2022), Final Revised Feasibility Study (FS) (AECOM, 2017) and its supporting documents, including Post-Screening Investigation Reports (AECOM, 2013 & 2016), and Remedial Investigation Report for the Group 2 Sites Remedial Investigation (Sites 12, 17, 18/24, 29, and 32) (Jacobs, 2001).	
5.	1.1	1st paragraph (P)	Reference Figure 1-1	C	Figure reference was revised from 1-2 to 1-1.	
6.	1.1	2nd P	Replace braces {} with parentheses () in 2nd sentence.	C	Text was revised to correct the typographical error.	
7.	1.2	1st P	Last sentence, remove "over the past 35 years"	C	Text was revised to remove "over the past 35 years"	
8.	1.2.1		The GWTP is not shown on Figure 1-3. Please add to the design drawing and add reference in this paragraph.	C	GWTP was added to the design drawings, and a reference to the drawings was added to the text.	
9.	1.3		Second bullet add "I"– Should be "1980 to 1987: Pre-Phase I Investigations" 2002 bullet first sentence– replace "conducted", revise to "were completed using data from the investigations…"	C	Second bullet was revised as commented. Text was revised to, "were completed using data from the investigations…"	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
10.	1.7		General comment about extent of contamination in soils - the thickness of the vadose zone (i.e., depth to groundwater) is not discussed in this section and is not mentioned until later in the document. Please include a discussion of the range of thickness of the vadose zone in their respective locations. Last P - Please describe where groundwater seepage to surface water occurs, and whether injections of emulsified oil or other amendments could result in a DO deficiency in the surface water.	C	Text was revised to include depth to groundwater, as well as discussion of the range of thickness of the vadose zone in their respective locations. General discussion of the estimated groundwater flow velocity and distance to surface water was included in the text. Performance monitoring for surface water was included as part of the detailed design to determine if injections of emulsified oil or other amendments would result in a DO deficiency in the surface water.	
11.	1.7.1		Excavation areas – Reference a figure or drawing G004. Define first use of MSC consistent with the ROD - TCEQ soil medium-specific concentration (MSC) for industrial use based on groundwater protection (GWP-Ind). 3rd P – last sentence regarding UEP contingency remedy, add "(e.g., depending on the results of the Five-Year Review of the groundwater remedy)." Or similar.	C	References to drawings 01C100 and 01C101 were added to the text per the comment. First use of MSC consistent with the ROD - TCEQ soil medium-specific concentration (MSC) for industrial use based on groundwater protection (GWP-Ind) was defined as per the comment. Text, "(e.g., depending on the results of the Five-Year Review of the groundwater remedy)" was added per the comment.	
12.	1.9	Last P	First sentence, replace "is to return" with "will be returned"	C	Text was revised to, "groundwater will be returned to its beneficial use."	
13.	1.10/1-9		3rd bullet on 1-9 - SVE is not mentioned until Section 4, but it is required for mass removal of COCs in conjunction with ISTD. Add the following statement (or similar) to this bullet: "SVE will be implemented as a component of ISTD for the removal of COCs volatilized from the DNAPL."	C	Text was revised to include, "SVE will be implemented as a component of ISTD for the removal of COCs volatilized from the DNAPL."	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
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Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
14.	1.10/1-10		Components first bullet, TCEQ and MSC are already defined. MSC should be defined in 1.7.1. FYR Contingency bullet should also note this will require an update to decision document (probably ESD). There are several contingency statements in this section, either add an overall statement that any contingency remedies will require an update to the decision document (probably ESD) OR note in each bullet. Would 1,4-dioxane advanced oxidation perhaps be evaluated at the same time (FYR)? The bullet about 1,4-dioxane is vague on implementation. MNA bullet – Should "(after evaluation of ESIB)" be revised to "(after completion of EISB)"?	C	Text was revised per the comment. Text was revised to include a note for requiring an update to decision document (probably ESD) in the FYR contingency bullet. A general note was added that any contingency remedies will require an update to the decision document (probably ESD). Specific treatment for 1,4-dioxane such as advanced oxidation process shall be evaluated during the FYR. Text was revised to clarify the contingency remedy. MNA bullet text was revised per the comment.	
15.	1.10/1-11		1st bullet - Cap maintenance will be required to prevent surface water infiltration and leaching of COCs from the UEP soils into the groundwater. Revise the second sentence to read, "The protectiveness of the cap will be evaluated at five-year intervals."	C	The second sentence was revised to read, "The protectiveness of the cap will be evaluated at five-year intervals."	
16.	1.10/1-11		LUC objectives – nonresidential land use is missing from the list. Also missing in Section 6.	C	The LUC restricting land use to nonresidential was included in Section 1.10 and in Section 6 as per the comment.	
17.	Table 1-2/ 1-12		Note - The PCL for Bromodichloromethane has changed (increased) in the TRRP 2021 tables due to an update in the reference dose. I think we would address that update in FYR since these tables are from the ROD.	C	Now Table 1-4, A note was added to the table stating that the PCL for Bromodichloromethane will be updated for the FYR.	

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Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
18.	1.12/1-13		PDI components 3rd bullet – I suggest this rewording to clarify. I moved the location description: Installation of 5 Shallow Zone monitoring wells to a depth of 40 ft bgs, and 1 monitoring well northwest of well MW-14 in the Wilcox Formation to a depth of 51 ft bgs, and Findings bullets: Soil – remove "being" in this clause "indicating a critical mass of contaminant being in groundwater media" Groundwater 1st bullet – at the end of sentence, replace "high soil levels that were detected." with "high soil sample results." Groundwater 3rd bullet – How does this comparison inform the design? I'm not sure the nested pairs should be compared in one bullet as a summary finding. I recall we looked at 27/27A to better understand the area to the south and north of that location, not as a comparison to 29. Whereas 29/29A data informs the clay as source hypothesis and other fate and transport issues. Groundwater 4th bullet - The solubility of TCE is generally higher than 10,000 µg/L; literature reports TCE solubility on the order of 1000 mg/L. Unless DNAPL has been observed, change "indicates" to "suggests."	C	PDI components 3rd bullet, text was revised to, "Installation of 5 Shallow Zone monitoring wells to a depth of 40 ft bgs, and 1 monitoring well northwest of well MW-14 in the Wilcox Formation to a depth of 51 ft bgs, and" per the comment. Findings bullets: Soil – text was revised to, "indicating a critical mass of contaminant in groundwater media…." Groundwater 1st bullet – at the end of sentence, "high soil levels that were detected" was replaced with "high soil sample results." Groundwater 3rd bullet was revised to clarify the clay as source hypothesis and other fate and transport issues instead of just stating the data. Text was revised to "suggests" instead of "indicates."	
19.	1.13/1-14		Phase 1 3rd bullet – add some location information for the EISB pilot tests and reference Sheet G004.	C	Location information of the pilot tests and a reference to sheets 01C100 and 01C301 was included in the Phase I 3rd bullet.	
20.	1.13/1-15		Contingency remedy statement – also note this will require an update to decision document (probably ESD).	C	A note for requiring an update to decision document (probably ESD) was added to the text as per the comment.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
21.	2.2/2-1		A brief description of the GWTP would provide background information on how advanced oxidation might be integrated into the system should 1,4-dioxane need to be addressed.	C	A brief description of the GWTP to provide background information on how advanced oxidation might be integrated into the system should 1,4-dioxane need to be addressed was added to the text.	
22.	3/3-1		1st P - Reference sheets G004 and 01C101 Bullets 1 and 2 – Add “Includes” before one location and two locations Last P, next to last sentence – Correct UFP typo	C	Sheets 01C100 and 01C101 were referenced in the text as per the comment. Word “Includes” was added to the bullets 1 and 2 as per the comment. Typographical error was corrected from UFP to UEP.	
23.	3.1/3-2		In this sentence: “The design for soils” revise to include “as determined by confirmation sampling” or similar.	C	Text was revised to, “The design for soil includes excavation of the contaminated soil until the cleanup levels are attained based on the confirmatory sampling results or groundwater is encountered.”	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
24.	3.2/3-2		1st P and Table 3-1 - The volumes of contaminated soils reported in this section are not the same as the volumes reported on Sheet 01C101. In addition, the soil volumes in this paragraph do not account for soils removed from benching of the excavation face. Table 3-1 should clarify that the volumes reflect only impacted soil removal. Table 3-1 – Add note to indicate excavate to these depths or depth groundwater is encountered. P below Table 3-1 – Does not explain when Area 3 was excavated or why it isn't necessary to dispose top 4 feet. Add discussion of Area 3. 2nd P – 2nd sentence is a repeat. And repeated as 5th sentence. Last P of 3.2 is repetitive compared to 1st and 2nd P of 3.3.	C	1st P and Table 3-1 - The volumes of contaminated soils underwent quality control in the DAR text and drawings. A note was added below Table 3-1 to say, "The soil volumes do not account for soils removed from benching of the excavation face." Volumes required to bench the excavation will be estimated as part of the cost estimate. A note was added for Table 3-1 clarifying that the volumes reflect only impacted soil removal. Table 3-1 – a note to require excavation to these depths or depth groundwater is encountered was added. Discussion related to previous excavations in Excavation Area 3 was included as per the comment. 2nd P and Last P of 3.2 is repetitive compared to 1st and 2nd P of 3.3 – the repeated sentences were removed from the text.	
25.	3.3/3-4		1st P - Provide a break-down of the number of bottom and sidewall confirmation samples per excavation area.	C	A break-down of the number of bottom and sidewall confirmation samples per excavation area was provided in the text per the comment.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
26.	3.4/3-3		General – clarify here and elsewhere if soils excavated from benching the excavation faces will be treated as excavated impacted soil or as potential fill. Either way, these soils will need to be characterized and should be included in the sample counts. Soils should also be included in the volume estimates. 1st P, 3rd sentence – should be "three samples" 2nd P, 1st sentence – Add "soil" between No. 2 and MSCs. Same edit in 3.5. 2nd sentence – should be "excavation area"	C	Text was revised to clarify that soils excavated from benching the excavation faces will be treated as excavated impacted soil and will need to be characterized prior to disposal. Soils excavated for benching will be estimated and included in the Cost Estimate. Sampling shown in the design drawings are estimated and contractor will need to follow the guidance for collecting and analyzing the samples. Typographical error in 1st P, 3rd sentence was corrected and is now "nine samples". 2nd P, 1st sentence – word "soil" was added between No. 2 and MSCs. And in Section 3.5. Typographical error in 2nd sentence was corrected to "excavation area"	
27.	3.7/3-4		1st P, last sentence – should be "described in detail"	C	Typographical error was corrected to "described in detail"	
28.	3.7.2/3-5		1st sentence – correct this statement "will be surveyed preliminary using…"	C	Typographical error was corrected to "will be preliminary surveyed using..."	
29.	3.7.3/3-6		Correct the permit reference – TCEQ Construction General Permit (TXR150000)	C	Text was revised to correct the permit reference to "TCEQ Construction General Permit (TXR 150000)"	
30.	3.7.4/3-7		3rd P 1st sentence - confirmation samples, for consistency revise to "2 to 5 feet laterally and 1 foot vertically"	C	Text was revised for consistency.	
31.	3.7.5/3-7		Specifications for backfill placement and compaction should be included in the draft final design to ensure that the fill properties are equal to those of the surrounding soil.	C	The draft final design includes specifications for backfill placement and compaction.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
32.	4/4-1	1st P	TCH sentence should also include a general description. Please add something like "technology that makes use of steam injection and possibly electrical resistance heating" In this sentence, does "electrical resistance" mean ISTD or only ERH? Revise to clarify. "The heat generated by electrical resistance typically can raise subsurface temperatures to around the boiling point of water." After "increase hydrolysis of chlorinated solvents", reference TCE and MC.	C	Text was revised to include a description of TCH as well. Text was revised to clarify the different mechanism used for both ERH and TCH, primary thermal heating technologies. Text was revised to reference TCE and MC after "increase hydrolysis of chlorinated solvents."	
33.	4.2/4-1		Include figures to show the MC plume for ISTD Area 1. Noting Figures 1-7 and 1-8 don't include MC and those are already busy. Suggest bringing MC GW plume figures from GWTP reports and referencing those figures in the Former UEP area discussion.	C	Additional Figures showing MC plume were added in the report. MC GW plume figures from GWTP reports were included and referenced when discussing the Former UEP area.	
34.	4.2/4-2		Former ACD P - Which table is being referenced?	C	Information was provided under Former ACP P is from the from the 2017 Final Revised Feasibility Study, which references the following text: "TCE concentration was reported at 2,670,000 µg/kg in the sample at 26 to 28 ft bgs exceeding the theoretical solubility limit for TCE presented in the table above." Based on the detailed review of the provided information, multiple typographical errors in the text provided in the 2017 FS were observed. Based on the detailed review of the PSI data, the text was revised as follows, "TCE concentration was reported at 2,830,000 µg/kg in the sample at 26 to 27 ft bgs exceeding the calculated soil saturation limits of 414,476 for TCE in fine-grained soil to 404,008 for TCE in coarse-grained soil" (AECOM, 2017).	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
35.	4.3/4-4	1st P	After "DNAPL at 18CPT21", add "in ISTD Area 1" and after "DNAPL at 18CPT 27" add "in ISTD Area 2".	C	Text was revised to, "DNAPL at 18CPT21 in ISTD Area 1" and "DNAPL at 18CPT27 in ISTD Area 2."	
36.	4.4.1/4-4		Include mobilization and site preparation as bulleted items.	C	Text was revised to include a bullet for "Mobilization and Site Preparation."	
37.	4.4.1.2/4-5	3rd P	Rather than specifying a minimum number of new well installations downgradient of the ISTD boundaries, I suggest specifying a minimum number of monitoring wells (existing and new) per ISTD area to monitor the effectiveness of the system. Given the relatively large size of Area 1 and Area 3, a minimum of three downgradient wells (existing and new) are recommended.	C	Text was revised to specify a minimum number (three) monitoring wells (new and existing) per area downgradient of the ISTD boundaries as per the comment.	
38.	4.4.2/4-6	Utility mark-outs	Area 1 and 3 bullets suggest a general note to utility clear all extraction lines within and near the area.	C	A general note was added to clear all extraction lines within and near the area.	
39.	4.4.2/4-7		Utility protection – revise this sentence to add "is" "However, the location where ISTD will be implemented is relatively far from ICTs and direct impact is not anticipated." Other than an obvious leak, how will we know if the HDPE piping is compromised within ISTD areas? Would it be feasible to route HDPE at surface around these areas during this phase of work?	C	Typographical error was corrected to "the location where ISTD will be implemented is relatively far..." Rerouting of HDPE piping is not required, as the ISTD vendor clarified that horizontal utilities within 0-5 ft bgs will be unaffected by the heating.	
40.	4.4.4.1/4-7 & 4-8		Approvals – Please add Underground Injection Control here and in EISB. 1st P on 4-7 – revise the first statement and clarify the sentence "A complete a review of current site conditions, available utility maps, utilities associated with the GWTP, and other available site information will be provided for review prior to conducting invasive site activities." Is Contractor reviewing or providing for review?	C	Text was revised to include Underground Injection Control in Section 4 and in Section 5. Text was revised to clarify that the Contractor will be required to review the current site conditions, available utility maps, utilities associated with the GWTP, and other available site information prior to submitting the ISTD work plan when proposing invasive site activities.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
41.	4.4.4.2/4-8		1st P last sentence – add "include" before "additional safe"	C	Now 4.4.5.2, Text was revised to "Existing access roads within the site boundary can be used to access the ISTD areas; however, if required, include additional safe..."	
42.	4.4.5.1/4-9		Provide an explanation of how the 50-foot spacing for the shallow vacuum monitoring points was determined.	C	Now 4.4.6.1, Basis of design for estimating the 50-foot interval which is based on the typical soil type was included in the text.	
43.	5	General	In Section 5 there are a couple references to Sheets 04C101 to 01C104. Should this be to 04C105?	C	Yes, the text was revised to, "Sheets 02C101 through 02C105" to reflect the current drawing numbering.	
44.	5.2/5-4		Last paragraph - The criteria for demonstrating that MNA is an effective remedy should be stated here and in 5.4.3.2. Detailed explanation in one location and summary in the other.	C	Text was revised to include an explanation of the criteria for demonstrating that MNA is an effective remedy.	
45.	5.3.1/5-5	Injection wells	Correct this sentence: "Injection wells will be used to inject substrate for the northeast to southwest portion of the EISB Barrier Wall 1 and for the EISB Barrier Wall 1 EISB."	C	Text was revised to "Injection wells will be used to inject substrate for the northeast to southwest portion of the Biobarrier 2 and for the Biobarrier 1."	
46.	5.3.4/5-6		EISB design narrative should include MC. MC is included in the table but not discussed.	C	Now 5.4, EISB design narrative was revised to discuss the MC.	
47.	5.3.4.1/5-7		EISB Grid 4 – replace "flank" with "is near". Table 5-2 paragraph add MC.		Text was revised as per comment. MC was added to Table 5-2.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
48.	5.3.4.2/5-11		Shallow Zone EISB Barrier Wall #2 is less than 100 feet upgradient of Harrison Bayou. What measures will be taken to prevent injected amendments from seeping into the bayou and causing anoxic conditions in the surface water?	C	The RD now includes surface water monitoring requirements where applicable, prior to start-up, during injections, and at a frequency determined to be protective and to ensure no detrimental changes in the surface water body are occurring. Frequency of monitoring was determined based on the distance to water body, localized soil permeability, ground water flow velocity, and the mobility of assumed injected material. Monitoring of the surface water may include visual inspection, field measurements such as dissolved oxygen, conductivity, turbidity, pH, ORP, and temperature, and/or water sample analysis specific to the COCs and injection solution. Requirement for an evaluation of data collected during the monitoring event was included as part of the monitoring requirement.	
49.	5.4.2/5-14		Hydraulic conductivities within the containment area vary from 10^{-5} cm/sec to 10^{-2} cm/sec, with equally varying sediment porosities. For areas with hydraulic conductivities on the order of 10^{-5} cm/sec, will two months provide sufficient time for injectate to be distributed and achieve observable mass reduction?	C	The proposed pilot test will provide better estimate on the sampling period for evaluating effectiveness of injectate distribution and the occurrence of geochemical changes around the EISB areas. The RD includes language for modifying the sampling frequencies based on the pilot test results.	
50.	Table 5-2		Area 1 - target depth varies – can you give general range of depth, perhaps in different parts of that area? MC in thousands, remove decimal for consistency.	C	Area 1 was further divided into sub-areas and general ranges of depth were proposed for each sub-area based on the variance in target depths. Text was revised to maintain MC in thousands for consistency purposes.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
51.	Table 5-3		Two rows for Shallow EISB Barrier Wall 2 – Note "Wal" typo and should MW-7 be the only noted nearby well? Notes – add IW – Injection well	C	Typographical error was corrected to "Shallow EISB Biobarrier 2." Nearby wells were updated. Notes were revised to include injection well.	
52.	6 and 6.2		Both sections should include nonresidential land use.	C	Text was revised to include nonresidential land use in Section 6 and 6.2.	
53.	10	List of acronyms	See the 18/24 ROD acronym list for correct language and correct or add these acronyms: $^{GW}GW_{Ing}$, GWP-Ind, PCL, TRRP, and TRRP Residential Groundwater PCL.	C	List of acronyms was revised to use the correct language in 18/24 ROD.	
54.	Appendices file(s)		Include a useable set of adobe bookmarks. Bookmark each appendix and include bookmarks for each drawing.	C	Bookmarks for each appendix and drawing were included in the pdf document.	
55.	Drawings	General	Add the GWTP to drawings.	C	Drawings, where applicable, were revised to include a general GWTP footprint.	
56.	G003		Topographic contours outside of the site (ICT) boundaries would be helpful. Do they exist to add to the drawing? Or was the survey only within the 4 corners?	C	Based on the available online GIS information, the topographic contours outside of the site (ICT) boundaries were added to all the drawings.	
57.	G004, G005 and others		EISB Pilot injection points – the light green symbols are difficult to see and to distinguish between, especially between shallow and Wilcox DPT (circle and square). The squares look very similar to circles. Please revise color (suggest darker green) and symbols on all relevant sheets. EISB full-scale– consider using a different color for shallow and Wilcox. If circle or square symbol is revised on EISB pilot, make similar revision for these data points on all relevant sheets.	C	Drawings were revised to improve clarity and readability of EISB Pilot injection points. Drawings were revised to change the color for shallow and Wilcox. The design drawings underwent quality control to ensure all changes made were consistent across the drawings.	

Comments Response Matrix
Draft Design Analysis Report (60%) Intermediate Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: August 25, 2022

Number	Section/Page	Paragraph/Line	Comment	C,D	Response	A,D
58.	G005		Add 1824DPT22 EISB legend is missing shallow permanent injection well symbol. Also missing in 04C series.	C	Drawings were revised to include location 1824DPT22. The EISB legend and O4C series were revised to include a symbol for permanent injection wells.	
59.	03C101		Inset map – revise (shift display area) so 1824DPTMW01 is included in the top right corner.	C	Drawing was revised to shift the display area as requested.	
60.	Cost Estimate		When updating the costs for Phase I and Phase II in the draft final design, please include the source for developing the cost estimates (e.g., RSMEANS, RACER, etc.). All occurrences of "Coordinate with TCEQ/Approvals" – Should this be "Coordinate with Regulators/Approvals"?	C	The Cost Estimate for Phase I and Phase II will be revised to include the source for developing the cost estimates. All occurrences of "Coordinate with TCEQ/Approvals" – will be revised to "Coordinate with Regulators/Approvals"	

Comments Response Matrix
Preliminary (30%) Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 25, 2022

Submitted by: Brian Follin, EPA Region 6
Responded by: Rose Zeiler, Longhorn AAP Site Manager
Date Responded: 08/25/2022

1. **Respondent concurs (C) or does not concur (D)**
2. **Commenter agrees (A) or does not agree (D) with response.**

Number	Section/Page	Paragraph/ Line	Comment	C, D	Response	A,D
Reviewer #1:						
1	2.4.2/6	2/3-5	If unequivocal statements such as the following are going to be made; they need to be supported by one or more references …"The deep zone groundwater and the drinking water aquifer are distinct from each other **and there is no connectivity** between the contaminated zone and the drinking water aquifer."	C	Now Section 1.6.3. Reference to the conclusive statements such as …"The deep zone groundwater and the drinking water aquifer are distinct from each other **and there is no connectivity** between the contaminated zone and the drinking water aquifer." are provided in the60% RD submittal.	
2	3/7	Discussion of phased reactivation of existing ICTs	Maybe should consider reactivating ICT-6 (and possibly ICT-5 and ICT-1 as well) in response to TCE and perchlorate detections in groundwater at18CPTMW04 and MW-1 as well as the potential for cross-media transfer from soil in Open Burning Pan 157, which had very high concentrations of TCE and MC in soil from boring 8A-940	C	A phased reactivation of existing ICTs such as ICT-6, 5 & 1 will be evaluated based on the historical data as well as existing conditions of infrastructure of these ICT systems. Additional text associated with reactivation added to Section 1.13.	
3	5.1/10		Excavation Area 2 is identified as having "two locations to the south of the former UEP," but I'm only seeing one area designated as "Excavation Area 2" on Sheet 01C101	C	Now Section 3.2. Excavation Area 2 is one area and has been revised for clarity and is inclusive of two locations 18-SB02 and 8A-911. Soil boring locations pertinent to the RD were added on Sheet 01C101 for reference.	

Number	Section/Page	Paragraph/ Line	Comment	C, D	Response	A,D
4	5.1/11	Table 2 and subsequent paragraph	Based on the following volume calculation…" The estimated extent of excavation in the Excavation Area 1 with location 8A-975 conducted in 1996 is 50 ft by 50 ft for a total area of 2,500 square ft and potential total volume of 16,250 cubic ft or 602 cy." The excavation depth would have to be 6.5 ft, but the notes associated with table 2 suggest that only the top 4ft of soil were previously excavated as an IRM. Which is correct?	C	Now Section 3.2. As-builts or an accurate description of the IRM conducted in 1996 is not available. The quantity/depth presented in the report are from the FS/ROD documents. The text subsequent to the Table 2 (Now Table 3-1) was revised to state "approximate" when referring to depth. A conservative approach will be taken: that is, the RD will consider that the top 4 feet of soil as previously excavated soil and backfilled with clean material.	
5	5.2/12	4/3-4	Is there published evidence (not associated with a vendor) of TCH providing the extraction efficiency referred to in the following statement? If so, it would be a good idea to include one or more references to those investigations…"Thermal treatment and extraction will remove at least 99.9% of residual DNAPL mass, according to thermal vendors, even within low permeability zones."	C	Now Section 4. Published evidence of thermal treatment removing up to 99.9% of residual DNAPL mass is added to the text accordingly.	
6	5.2/12	4/6-9	In the following sentence, it is unclear if the phrase "up to approximately 25 °C " refers to an increase in temperature of 25 °C or a final temperature of 25 °C. The latter seems more likely, and if that is the case…this could be a moot point depending on when the TCH will take place considering that ambient soil temperatures in Texas are likely at or near 25 °C during a large proportion of the year already. "Additionally, higher ambient soil temperature imposed by the thermal treatment process during startup and cool down periods will increase the biodegradation rate by a factor of 2 for every 10 °C increase in ambient soil temperature up to approximately 25 °C above which bacterial activity would decrease."	Check and Resolve	Now Section 4. The RD includes citation/evidence on thermal treatment assisting the biodegradation and the general range of temperature rise in the area.	

Number	Section/Page	Paragraph/ Line	Comment	C, D	Response	A,D
7	5.2/12	4	Less detail is provided about the TCH method, the preferred ISTD technology, than is provided about ERH, which is not intended for use. Specifically…it would be interesting to know how the treatment depths will vary from 50 feet bgs at ISTD Area 1 to 30 feet bgs at the four remaining ISTD areas.	C	Now Section 4. Selection of the specific type of the thermal treatment is not required to be specified in the RD; however, implementation in the ISTD areas selected for the active remedy are defined in the 60% RD submittal.	
8	5.3/13	1/7-9	In the following sentence, what levels of perchlorate and TCE would be considered "amenable to MNA?" If those concentration levels are known (and they should be if statements like this are going to be made), they should be included and one or more references should be provided that support them…"The active treatment phase will be terminated once concentrations within the high concentration areas are reduced to levels amenable to MNA, after which MNA will be used to treat the on-site and off-site areas that contain site COCs greater than the cleanup levels."	C	Now Section 5.3.4. The feasibility study did not include known concentrations that would be considered amenable to MNA in their evaluation; however, the period of active remedy was estimated to be 5 years and MNA was assumed to be from 5 to 20 years. The 5-year review will be required to demonstrate that natural attenuation is acting at a greater pace than contaminant migration. The 1000 ppb for Perchlorate and 500 ppb for TCE within the containment area was evaluated and RD has been prepared based on these concentrations at which the active treatment phase can be terminated. Details on the performance monitoring requirements will be included in the Draft Final RD submittal. The concentrations amenable to MNA with respect to the point of compliance has not been conducted yet but will be discussed in the Draft Final RD submittal.	
9	5.3/14	2/6-8	The following statement seems to imply that the injection points will remain open to enable future injections …"These transects will consist of individual well points that will allow multiple dosing of organic substrate as needed." Which would seem to contradict the statement in line 7 that states that "injection points will be constructed temporarily."	C	Now Section 5.3.4.2. Rationale for selecting the combinations of permanent injection well points for the Northeast area EISB Barrier Wall and temporary points for the rest of the Barrier Walls and grid systems are included in the 60% RD submittal. Contradicting statement has been revised.	
10	5.3.1/14	3	The authors should specify which of the EISB areas are targeting the shallow groundwater and which are targeting the Wilcox Formation.	C	The EISB areas specified for the shallow and Wilcox formation treatment zone are clearly distinguished in the Design Drawings using the legends and defined in the Section 5.3 of the 60% RD submittal.	

Number	Section/Page	Paragraph/ Line	Comment	C, D	Response	A,D
11	5.3.2/16	1/10-11	The following statement should be corrected to indicate that Wilcox Wall 2 is in the western corner of the site, and Wilcox Wall 3 is on the southern corner of the site…"Wilcox Wall 1 in the northern corner of the site; Wilcox Wall 2 in the northern corner of the site; and Wilcox Wall 3 in the northern corner of the site"	C	Now Section 5.3.4.2. Text was corrected as suggested.	
12	N/A - general	N/A - general	Has any though been given to how the TCH and EISB will react or interfere with one another and how this might impact the effectiveness of each treatment process considering that all but one of the ISTD areas overlap EISB areas.	C	Based on our discussion with the vendors and past experience with each of the technologies, a low temperature thermal process (such as TCH or ERH) capable of reaching up to 100 degree C is compatible with the bioremediation implementation as the phased process. However, evidence supported by case studies and further discussion with the subject matter experts are yet to be conducted and will be included in the Draft Final RD submittal to support the proposed remedy.	
13	N/A - general	N/A - general	Why don't the EISB walls in the shallow zone surround more of the site? Should Shallow EISB Barrier Walls 1 and 2 be connected?	C	Based on the recent discussion after the MMM meeting held 21 June 2022, the extent of EISB implementation of the grid and wall configuration was re-evaluated to optimize the treatment zones to shorten the duration of the remedial action. This will be implemented to eliminate the need for the operation and upgrade of the existing water treatment plant.	
14	N/A - general	N/A - general	Why are the EISB walls in the Wilcox Formation only located along three corners of the site and why are there large gaps between the three?	C	The proposed EISB walls in the Wilcox Formation along three corners as shown on the drawings are based on the groundwater flow direction and the preferential flow path in the Wilcox Formation from the previous investigation reports. The RD includes groundwater contours as backup as the supportive documents.	

Comments Response Matrix
Preliminary (30%) Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 25, 2022

Number	Section/Page	Paragraph/ Line	Comment	C, D	Response	A,D
15	N/A - general	N/A - general	It would be helpful if a commentary was provided on the anticipated duration of the effectiveness of the EISB, particularly with respect to the EISB Wall System, which would seemingly need to have the ELS Microemulsion replenished often due to a constant flux of water across these barriers during which the ELS Microemulsion (if the wall is functioning at a reasonably high level) is being continuously consumed.	C	Now Section 7. An overall RD schedule, sequence of RD components and implementation would be determined based on the groundwater flow and vertical/horizontal extent of contamination, and travel time. This information will be provided in the Draft Final RD submittal.	
16	N/A - general	N/A - general	In order to review the MNA portion of the remedy, we will need to see more information in the RD addressing estimated timelines, performance monitoring program, and evaluation criteria.	C	Now Section 5, 6 & 7. Additional information will be included in the Draft Final RD submittal that will address estimated timelines, a performance monitoring program, and evaluation criteria for terminating the active remedy.	

Comments Response Matrix
Preliminary (30%) Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 25, 2022

Submitted by: April Palmie, TCEQ
Responded by: Rose Zeiler, Longhorn AAP Site Manager
Date Responded: 08/24/2022

1. Respondent concurs (C) or does not concur (D)
2. Commenter agrees (A) or does not agree (D) with response.

Number	Section/Page	Paragraph/ Line	Comment	C,D	Response	A,D
Reviewer #1: April Palmie						
1)	General		a. Please make sure future submittals have page numbers. b. The technical memo references numerous sources but no reference list is included. c. For this report, please remove all caps - QUARTERLY EVALUATION REPORT, 2ND QUARTER (APRIL-JUNE)	C	a. The 60% RD includes the page numbers as suggested. b. Reference list and citation are included in the 60% RD submittal. c. Proper citation and format are used when referencing the previous reports as suggested.	
2)	Acronyms		Define first use of acronyms. I noticed ICTs, TCE, and MC specifically, but there may be others.	C	A list of acronyms are included in the 60% RD submittal	
3)	2.1		For this sentence, add note that Harrison Bayou is close to Western corner (about 200') - There are no surface water bodies or watercourses running through LHAAP-18/24.	C	Now Section 1.4. A note that Harrison Bayou is close to Western corner (about 200') - There are no surface water bodies or watercourses running through LHAAP-18/24 is added to the text.	

Number	Section/Page	Paragraph/ Line	Comment	C,D	Response	A,D
4)	2.4.1		a. Please correct this sentence: Most of the contaminated soil (approximately 32,000 cubic yards) was remediated during the IRA (Attachment 1, Figure 2-7); however, remaining residual contaminants in the unsaturated soil may present an ongoing source of groundwater contamination. The areas mentioned in the ROD are listed below. b. Before the bullet about the areas beneath the UEP, please add something like "In addition to the areas listed above, there are". Also briefly note what triggers the contingency remedy for these areas.	C	a. Now Section 1.7.1. Sentence was corrected as follows: Most of the contaminated soil (approximately 32,000 cubic yards) was remediated during the IRA (Attachment 1, Figure 2-7); however, remaining residual contaminants in the unsaturated soil may present an ongoing source of groundwater contamination. The areas mentioned in the ROD are listed below. b. Now Section 1.7.1. Before the bullet about the areas beneath the UEP, sentence was added as follows "In addition to the areas listed above, the following area……". Note in Now Section 3 was added for triggering the contingency remedy as follows: "Development and specific description of the contingency remedy are not part of this RD; however, the RD addresses the triggering criteria (groundwater cleanup levels listed in **Table 1-1**) for evaluating whether a contingent remedy is needed in future design submittal. Groundwater beneath the UFP will be monitored continuously as part of the groundwater RA performance monitoring program and results will be evaluated against the criteria listed in **Table 1-1**."	
5)	2.4.3		Look for the terms "deep zone aquifer" and "deep zone groundwater" and consistently revise "deep" to Wilcox where appropriate. Document should include shallow zone, Wilcox Formation, and drinking water aquifer.	C	Text was revised as suggested.	
6)	4		a. Add title for the table and note that it is from the ROD. b. In general, please don't insert tables as images.	C	a. Now Section 1.11. Title and reference for the table were added. b. Comment acknowledged.	

Comments Response Matrix
Preliminary (30%) Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 25, 2022

Number	Section/Page	Paragraph/ Line	Comment	C,D	Response	A,D
7)	5.1		a. Last sentence before Table 2 - For excavation areas, also reference G004. b. Suggestions for first sentences of this paragraph below Table 2: The shallow soil (0-4 ft bgs) in Excavation Areas 1 and 2 was previously excavated in 1996. The estimated extent in Excavation Area 1, with location 8A-975, was 50 ft by 50 ft for a total area of 2,500 square ft and potential total volume of 16,250 cubic ft or 602 cy. The estimated extent in Excavation Area 2, with locations 18SB02 and 8A-911, was 40 ft by 70 ft for a total area of 2,800 square ft and potential total volume of 11,200 cubic ft or 414 cy. Soil in these areas was excavated to a depth of 4 ft and replaced with clean backfill. When these areas are excavated for the remedial action, shallow soil (0-4 ft bgs) will be removed and stockpiled for possible use as backfill.	C	a. Last sentence before the old Table 2 (Now Table 3-1) - For excavation areas, G004 was referenced. c. Now Section 3.2. Text was revised as suggested.	
8)	5.2		a. First partial sentence – remove “via ERH”. I suggest also referencing the ROD which did not select the type of ISTD. b. In this section, add a description of the TCH process. The ROD said the specific process would be selected during the design phase. The current narrative has a detailed explanation for ERH, none for TCH, then states that TCH has been selected for primary evaluation.	C	a. Now Section 4. ERH was removed from the sentence as the specific ISTD technology will not be included in the RD. b. As discussed during the RD meeting, for the ISTD treatment, the RD will leave the heating method open to allow maximum flexibility by the ISTR contractor/bidders and to increase the bidding pool to get more competition.	
9)	5.3		In first paragraph, correct “high-concertation” typo. Second paragraph, second sentence, add “with” - ELS (mixed with dehalorespiring bacteria…	C	Now Section 5. Text was revised as suggested.	

Comments Response Matrix
Preliminary (30%) Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 25, 2022

Number	Section/Page	Paragraph/ Line	Comment	C,D	Response	A,D
10)	Attachment 1		a. Cover page - Include the source information for the figures included; which report each figure was extracted from. b. Some of the figures included in the Tech Memo portion aren't good quality (such as Figure 2 and the PDI figure). Please correct with next revision.	C	a. Source information for the figures were included. b. Original figures with high resolution format are included in the 60% RD submittal.	
11)	Figure 4		Please include the full data set of Wilcox wells, wells are missing.	C	Figure 4 (Now Figure 1-8) was revised to include full data set of the Wilcox Well.	
12)	Figure from PDI		a. If you include figures from the PDI, please include the final figures from the report. The figure you included is low image quality and seems to be an earlier draft. b. Figures 4, 8, 9, 11, and 12 from PDI would be the most useful or comprehensive if figures from the PDI are included going forward.	C	a. Final high-resolution figures from PDI are included in the 60% RD submittal. b. Comment acknowledged.	
13)	Drawings	General	a. Thank you for sending a set of high image-quality figures for review (drawings). b. Label the site boundary between 18/24 and 17 c. Cover page – suggest you remove the wells as site features in the image on cover page. d. All sheets – Note 1 should reference G001 Abbreviations and G002 General Notes and Legend. e. Sheets with Key Maps – Can the Key Maps be bigger? There is a big white space around some of these maps. Larger key maps (when possible) would be helpful. f. The sheets included were sufficient for 30% review.	C	a. Comment acknowledged. b. The site boundary between 18/24 and 17 were labeled. c. Cover page –The wells as site features in the image on cover page will be removed in the Draft Final submittal. d. All sheets – Note 1 references G001 Abbreviations and G002 General Notes and Legend. e. Sheets with Key Maps – Larger key maps (when possible) were included. f. Comment acknowledged.	
14)	Drawing	01C101	Table inset, revise column heading to "Area ID (Sample ID)"	C	Table inset, column heading was revised to "Area ID (Sample ID)"	

Comments Response Matrix
Preliminary (30%) Remedial Design for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond Longhorn Army Ammunition Plant Karnack, Texas
Submitted: April 25, 2022

Number	Section/Page	Paragraph/ Line	Comment	C,D	Response	A,D
15)	Drawing	03C101	For the EISB barrier walls, while these are technically feasible, there will be installation constraints depending on soil moisture and surface water. For areas that tend to be boggy, the design and cost will need to include the mats or other bridging methods that have been tested in the past. If the RD includes lessons learned from previous efforts, that will help the next phase. Some of these areas have been very difficult for installation of wells/borings.	C	Comment acknowledged. The Draft Final RD submittal will include approximate boundary, details and notes on the design drawings for site constraints for the “boggy areas”. The cost includes the swamp mats.	
16)	Conceptual		During this review, confirmed the location of the excavation, shallow EISB, Wilcox EISB, and ISTD treatment areas compared to the ROD and PSI. The conceptual placement of the treatment areas is consistent with those documents, known distribution of COCs, and the long-term goal of GWTP shut-down.	C	Comment acknowledged.	

100% Design Analysis Report
Remedial Design
for
LHAAP – 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Former Longhorn Army Ammunition Plant (LHAAP)
Karnack, Texas

Prepared for:

U.S. Army Corps of Engineers, Tulsa District
Contract No. W912BV 15 D 0014
Task Order

Prepared by:

HDR
2650 Park Tower Drive, Suite 400 Vienna, VA 22180

February 2024



TABLE OF CONTENTS

1 INTRODUCTION 1-1
1.1 Longhorn Army Ammunition Plant (LHAAP) Background 1-1
1.2 LHAAP-18/24 Site Description and Background 1-1
1.2.1 LHAAP-18/24 Site History 1-2
1.3 History of Investigative Activities 1-2
1.4 Surface Water Hydrology 1-3
1.5 Geology and Hydrogeology 1-4
1.6 Current and Future Land and Resource Uses 1-6
1.6.1 Current and Future Land Uses 1-6
1.6.2 Current and Future Surface Water Uses 1-6
1.6.3 Current and Future Groundwater Uses 1-6
1.7 Conceptual Site Model 1-7
1.7.1 Nature and Extent of Contamination 1-8
1.8 Basis of Action 1-10
1.9 Remedial Action Objectives 1-10
1.10 Selected Remedy 1-10
1.11 Site Cleanup Levels 1-12
1.12 Pre-Design Investigation 1-12
1.13 Planned Remedial Action 1-14
2 OPERATION AND MAINTENANCE PROCEDURES 2-1
2.1 UEP Cap Maintenance 2-1
2.2 Maintenance of Existing Extraction System and GWTP 2-2
2.3 Maintenance of the Current or Future Groundwater Monitoring System 2-3
2.4 Maintenance of Site Access Features 2-3
3 SOIL EXCAVATION REMEDIAL DESIGN 3-1
3.1 Design Criteria 3-2
3.2 Excavation Areas 3-2
3.3 Post-Excavation Confirmatory Sampling 3-3
3.4 Waste Characterization and Disposal 3-4
3.5 Backfill and Site Restoration 3-4
3.6 Other Design Considerations 3-5

3.7 Implementation of Soil Excavation Remedial Design 3-5
3.7.1 Mobilization and Site Preparation 3-5
3.7.2 Surveying 3-6
3.7.3 Soil Excavation and Disposal 3-7
3.7.3.1 Area Preparation 3-7
3.7.3.2 Soil Excavation and Disposal 3-7
3.7.4 Confirmation Soil Sampling 3-8
3.7.5 Backfilling and Site Restoration 3-8
3.7.6 Reporting 3-8
3.7.7 As-Built Survey 3-9
4 IN-SITU THERMAL DESORPTION DESIGN FOR DNAPL TREATMENT 4-1
4.1 Design Criteria 4-1
4.2 ISTD Treatment Areas 4-2
4.3 ISTD Area Characteristics 4-3
4.4 Implementation of ISTD 4-4
4.4.1 Preparation of ISTD Treatment Work Plan 4-4
4.4.1.1 ISTD Design Calculations 4-5
4.4.1.2 ISTD Design 4-5
4.4.2 Mobilization and Site Preparation 4-6
4.4.3 New Utilities 4-7
4.4.4 Surveying 4-8
4.4.5 ISTD Treatment System Installation 4-8
4.4.5.1 ISTD Well-Field Installation 4-8
4.4.5.2 Liquid And Vapor Recovery and Treatment Systems Installation 4-9
4.4.6 System Operation 4-10
4.4.6.1 Safety and Environmental Controls 4-10
4.4.6.2 VOC Removal and Emissions 4-10
4.4.6.3 Process Monitoring Requirements 4-11
4.4.7 Confirmatory Sampling and System Shut Down 4-12
4.4.8 Shutdown 4-13
4.4.9 System Decommissioning 4-13
4.4.10 Demobilization 4-13
4.4.11 Site Restoration and Project Closeout 4-14

4.4.12 Residual Management 4-14
4.4.13 Reporting 4-14
4.4.13.1 Weekly Operational Progress Reports 4-14
4.4.13.2 Effectiveness Monitoring Results 4-15
4.4.13.3 Daily Contractor Quality Control (CQC) Reports 4-15
4.4.13.4 Safety Data Sheet (SDS) 4-15
4.4.13.5 Maintenance Manuals 4-15
4.4.13.6 Chemical Data Final Report (CDFR) 4-15
4.4.13.7 ISTD Completion Report 4-16
5 ENHANCED IN-SITU BIOREMEDIATION DESIGN 5-1
5.1 Field Pilot Test 5-2
5.1.1 Pilot Field Test Design 5-2
5.2 Full-Scale EISB Remedial Design 5-3
5.3 EISB Design Parameters 5-4
5.3.1 General Substrate Injection Strategies 5-4
5.3.2 Radius of Influence and Injection Point Spacing 5-5
5.3.3 Substrate Selection 5-6
5.3.3.1 Pilot Tests 5-6
5.3.3.2 EISB Grid Areas and Biobarriers 5-6
5.3.4 Bioaugmentation Culture Selection and Injection 5-7
5.4 EISB Design 5-7
5.4.1 EISB Grid Areas 5-8
5.4.1.1 EISB Grid Area Design 5-8
5.4.1.2 Injection Point and Monitoring Well Placement and Design 5-8
5.4.1.3 Substrate Loading and Injection 5-9
5.4.1.4 Bioaugmentation Culture Injection 5-10
5.4.2 Biobarriers 5-10
5.4.2.1 Shallow Zone EISB Biobarrier 1 5-10
5.4.2.2 Shallow Zone EISB Biobarrier 2 5-10
5.4.2.3 Wilcox Formation EISB Biobarriers 5-11
5.4.2.4 Substrate Loading and Injection 5-12
5.4.2.5 Bioaugmentation Culture Injection 5-12
5.5 Performance Monitoring 5-13
5.5.1 Pre-EISB Implementation Groundwater Sampling 5-13

5.5.2 Evaluation of Design Effectiveness 5-14
5.5.3 Performance Monitoring – Years 1 and 2....5-14
5.5.3.1 EISB Performance Monitoring....5-14
5.5.3.2 MNA Performance Monitoring....5-14
5.5.3.3 Contingency Action for MNA Areas 5-15
5.5.3.4 Follow-up Injections in Biobarriers 5-15
5.5.4 Surface Water Monitoring 5-15
5.5.5 Performance Monitoring – Year 3 through Five-Year Review....5-16
5.5.6 Performance Monitoring Following Five-Year Review 5-16
6 LAND USE CONTROL REMEDIAL DESIGN 6-1
6.1 LUC Implementation....6-1
6.2 Maintenance and Monitoring Requirements 6-2
6.3 Reporting of LUC Inspection and Monitoring 6-3
6.3.1 Notice of Planned Property Conveyances....6-3
6.3.2 Opportunity to Review Text of Intended Land Use Controls 6-4
6.3.3 Notification Should Action(s) which Interfere with land Use Control Effectiveness be Discovered Subsequent to Conveyance....6-4
6.3.4 Land Use Control Enforcement 6-4
6.3.5 Modification or Termination of Land Use Controls 6-4
7 REMEDIAL CONSTRUCTION SCHEDULE....7-1
7.1 Construction Sequence 7-1
7.2 Preliminary Schedule 7-2
8 SUMMARY OF PROJECT COSTS 8-1
8.1 Summary of Project Costs....8-1
8.2 Estimating Method....8-1
8.3 Task-Based Estimates....8-1
8.3.1 Labor Rates....8-1
8.3.2 Equipment Rates 8-1
8.3.3 Earthwork....8-2
8.3.4 Monitoring Wells 8-2
8.3.5 Indirect Cost Markups....8-2
8.4 Subcontractor Quotes....8-3
8.5 Project-level Markups....8-3

8.5.1 Contingency 8-3
9 REFERENCES 9-1
10 LIST OF ACRONYMS AND ABBREVIATIONS 10-1

LIST OF FIGURES

Figure 1-1 Site Location Map
Figure 1-2 Site Vicinity Map
Figure 1-3 Cumulative Sampling and IRA Excavation Locations (Pre-PDI)
Figure 1-4 DPT Soil Sample Results Perchlorate and VOCs Outside the Northeast ICT Boundary
Figure 1-5 DPT Groundwater Sample Results Perchlorate and VOCs Outside the Northeast ICT Boundary
Figure 1-6 Groundwater Sample Results Perchlorate and VOCs Shallow Zone EISB Grids
Figure 1-7 Summary of Shallow Zone Groundwater Perchlorate and TCE Analytical Results
Figure 1-8 Summary of Wilcox Formation Groundwater Perchlorate and TCE Analytical Results
Figure 6-1 Preliminary Land Use Control Boundary
Figure 7-1 General Remedial Action Construction Schedule

LIST OF TABLES

Table 1-1 Groundwater Seepage Velocity and Travel Time
Table 1-2 Wells with Metal Concentrations above Cleanup Levels
Table 1-3 Soil Cleanup Levels at LHAAP-18/24
Table 1-4 Groundwater Cleanup Levels at LHAAP-18/24
Table 2-1 Landfill Inspection Schedule
Table 3-1 Excavation Areas
Table 4-1 ISTD Treatment Areas
Table 4-2 ISTD Treatment System – Minimum Process Monitoring Reporting Requirements
Table 5-1 EISB Pilot Test Areas
Table 5-2 EISB Grid Areas
Table 5-3 Shallow Zone EISB Biobarrier Areas
Table 5-4 Wilcox Formation EISB Biobarrier Areas
Table 5-5 Baseline Sampling Plan for Pilot Test Areas
Table 5-6 Baseline Sampling Plan for Shallow Zone EISB Biobarriers
Table 5-7 Baseline Sampling Plan for Wilcox Formation EISB Biobarriers
Table 5-8 Baseline Sampling Plan for EISB Grid Areas
Table 5-9 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the Pilot Test Areas
Table 5-10 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the Shallow Zone Biobarriers
Table 5-11 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the Wilcox Formation Biobarriers
Table 5-12 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the EISB Grid Areas
Table 5-13 MNA and LTM Performance Monitoring Plan

LIST OF APPENDICES

Appendix A Final Remedial Design Drawings
Appendix B Final Remedial Design Cost Estimate
Appendix C Figures from Bhate GWTP Quarterly Evaluation Reports
Appendix D RAO Inspection and Maintenance Checklist
Appendix E Existing Monitoring Well and Soil Boring Logs
Appendix F EISB Substrate Calculation Sheets
Appendix G Annual LUC Compliance Documentation Form
Appendix H Specifications

1 INTRODUCTION

This design report presents technical basis, design methodologies, and supporting documents for a final (100%) remedial design (RD) to achieve the Remedial Action Objectives (RAOs) specified in the Final LHAAP-18/24 Record of Decision (ROD) (U.S. Army, 2020) at the former Longhorn Army Ammunition Plant (LHAAP) Site 18/24 - Burning Ground No. 3 and Unlined Evaporation Pond (UEP) (collectively named "LHAAP-18/24") located in Karnack, Texas (**Figure 1-1**). The RD documents were prepared under the U.S. Army Corps of Engineers (U.S. Army) Tulsa District Contract Number W912BV19D0016 Task Order No. W912BV20F0096.

Tables, figures, and appendices included in this design report provide additional information, summarize relevant data, and serve as the basis for design decisions. In addition, the design report references design drawings and a cost estimate for the remedial action (RA), which are included in **Appendix A** and **B**, respectively.

The design report was prepared based on the nature and extent of contamination determined during the pre-design investigation (PDI) conducted in 2021 (HDR, 2022), Final Revised Feasibility Study (FS) (AECOM, 2017) and its supporting documents, including Post-Screening Investigation Reports (AECOM, 2013 & 2016), and Remedial Investigation Report for the Group 2 Sites Remedial Investigation (Sites 12, 17, 18/24, 29, and 32) (Jacobs, 2001).

1.1 Longhorn Army Ammunition Plant (LHAAP) Background

The former LHAAP is an inactive, government-owned, formerly contractor operated and maintained, Department of Defense facility located in central east Texas (see **Figure 1-1**) in the northeast corner of Harrison County. LHAAP is approximately 14 miles northeast of Marshall, Texas, and approximately 40 miles west of Shreveport, Louisiana. The former U.S. Army installation occupied 8,416 acres between State Highway 43 at Karnack, Texas, and the southwestern shore of Caddo Lake. The facility can be accessed via State Highways 43 and 134.

LHAAP was placed on the Superfund National Priorities List (NPL) on August 9, 1990. Activities to remediate contamination began in 1990. After its listing on the NPL, the U.S. Army, the U.S. Environmental Protection Agency (USEPA), and the Texas Water Commission [currently known as the Texas Commission on Environmental Quality (TCEQ)] entered into a CERCLA §120 FFA for remedial activities at LHAAP. The FFA became effective December 30, 1991. LHAAP operated until 1997 when it was placed on inactive status and classified by the U.S. Army Armament, Munitions, and Chemical Command as excess property. The majority of LHAAP, excluding LHAAP-18/24, has been transferred by the U.S. Army to the U.S. Fish and Wildlife Service (USFWS) for management as the Caddo Lake National Wildlife Refuge.

1.2 LHAAP-18/24 Site Description and Background

LHAAP-18/24 is a 34.5-acre cleared area within a heavily wooded section of LHAAP (**Figure 1-2**). The area is vegetated primarily with grass and has asphalt-paved roads. It is situated on a natural topographic high slightly west of the crest of a small topographic divide between Harrison Bayou and Saunders Branch. Topography of the Site has been altered by operations.

The burning ground area is mostly level with more relief near the western corner and near the northern corner that contains the mounded surface of the former UEP. There are no surface water bodies or watercourses running through LHAAP-18/24. Surface drainage occurs in all directions, but flow is

generally directed to the north and west by both natural and manmade ditches and drainage swales towards Harrison Bayou. Harrison Bayou drains into Caddo Lake which is located approximately 2.5-miles northeast of LHAAP-18/24 (Jacobs, 2001). A Site map with topographic elevation contours is included as **Sheet G0003** in **Appendix A**.

1.2.1 LHAAP-18/24 Site History

LHAAP-18/24 is comprised of the former Burning Ground No. 3 (LHAAP-18) and UEP (LHAAP-24). LHAAP-18 Burning Ground No. 3 operated between 1955 and 1998, while LHAAP-24 UEP was operational from 1963 to 1984. The area was used for the treatment, storage, and disposal of solid and liquid explosive, pyrotechnic, and combustible solvent waste by open burning/open detonation, incineration, evaporation, and burial (Jacobs, 2001). The UEP was constructed at the burning ground in 1963 as a holding pond to store explosive wastes resulting from the washout of rocket motor casings. In 1973, the pond also began receiving wastewater containing solvent residues and solids. An air curtain destructor (ACD) was built in 1979 for the purpose of disposing of explosive and explosive-contaminated wastes by burning. Sludge from the UEP was removed in 1986 and the impoundment was capped. The majority of impacts to the soil were remediated during the 1997 LHAAP-18/24 Interim Remedial Action (IRA) when approximately 32,000 cubic yards (cy) of soil was removed. A groundwater extraction system incorporating approximately 5,000 feet (ft) of interceptor-collection trenches (ICTs) and a groundwater treatment plant (GWTP) was installed in 1997 to control the migration of contaminated groundwater and to protect surface water (**Figure 1-3** and **Sheet G003** in **Appendix A**) (AECOM, 2017). The area within the ICTs is considered the containment area. Harrison Bayou is located adjacent to the Site and drains to Caddo Lake, a drinking water supply.

1.3 History of Investigative Activities

A brief history of the investigative activities conducted at the LHAAP-18/24 is provided below.

- 1976: As part of the Installation Restoration Program, the U.S. Army began an environmental investigation at LHAAP followed by installation-wide assessments/investigations.
- 1980 to 1987: Pre-Phase I Investigations were conducted. Findings from previous investigations were summarized by the U.S. Army in A Data Summary Report of Investigation Results from 1976 through 1992 for Burning Ground 3 and the Unlined Evaporation Pond (USACE, 1993).
    - 1980: the United States Army Environmental Hygiene Agency (USAEHA) installed monitoring wells and collected groundwater samples for laboratory analyses of anions, explosive compounds, metals, phenols, and physical/chemical characteristics (USAEHA, 1980).
    - 1982: Environmental Protection Systems (EPS) investigated the Site for the United States Army Toxic and Hazardous Materials Agency (USATHAMA) (EPS, 1984). An additional nine groundwater monitoring wells were installed, and twenty-two groundwater samples were collected.
    - 1986: As part of the Groundwater Quality Assessment (GWQA) investigations, Camp, Dresser & McKee (CDM) installed ten monitoring wells and groundwater samples were collected and analyzed for metals, total organic carbon (TOC), selected anions, volatile organic compound (VOCs), and explosive compounds (CDM, 1986). CDM concluded that the UEP was a source of groundwater contamination, but not the primary source for all of the contaminants identified, including nitrate and organic contamination in the groundwater (along the western edge of the burning ground) and barium (south of the burning ground boundary).

  - 1987: EPS performed a site investigation and published a report in May 1988 (EPS, 1988). Groundwater samples were collected from three existing monitoring wells and analyzed for explosive compounds.
- 1993 to 1999: Numerous remedial investigations to determine the nature and extent of contamination in the soil, groundwater, surface water, and sediments were conducted during Phase I, Phase II, and Phase III investigations in 1993, 1995, and 1998, respectively (Sverdrup Environmental, Inc., 1993, 1996a, 1996b, 1999). The Phase I, Phase II, and Phase III investigations at LHAAP-18/24 are documented in the Group 2 Sites RI (Jacobs, 2001).
- 2000 to 2002: Groundwater investigation was conducted to delineate perchlorate contamination (Solutions to Environmental Problems, Inc. [STEP], 2005).
- 2002: Baseline Human Health Risk Assessment and Screening Ecological Risk Assessment were completed using data from the investigations conducted through 2001 (Jacobs, 2002). The report concluded that the soil at Site posed a non-carcinogenic hazard and the groundwater posed unacceptable carcinogenic risk and non-carcinogenic hazard to the hypothetical future maintenance worker. The Ecological Risk Assessment did not identify potential risk to ecological receptors at the Site.
- 2007: Baseline Ecological Risk Assessment (Shaw, 2007a) identified chemicals of potential ecological concern (COPECs) for the Industrial Sub-Area.
- 2013 to 2016: Post-Screening Investigations were conducted in 2013, 2014, and 2016 in an attempt to improve the Conceptual Site Model (CSM) and assess for the presence of source areas (unsaturated soil and Dense Non-aqueous Phase Liquid (DNAPL) in the saturated Shallow Zone). These investigations are documented in the Final Post-Screening Investigation Report for LHAAP-18/24 (AECOM, 2013), the Final Updated Post-Screening Investigation Report – LHAAP-18/24 (AECOM, 2016a) and the Draft Final Supplemental to the Updated Post-Screening Investigation Report, LHAAP-18/24 (AECOM, 2016b).
- 2014: Baseline Ecological Risk Assessment Addendum was prepared in 2014, the BERA Addendum did not change the conclusion of the 2007 BERA (AGEISS, 2014).
- 2017: A preliminary evaluation was conducted to determine the occurrence of natural attenuation (NA) of VOCs including methylene chloride (MC) and trichloroethene (TCE), and perchlorate in the Shallow Zone and Wilcox Formation groundwater at LHAAP-18/24 (AECOM, 2017; Appendix A).
- 2017: The Revised FS was prepared based on data from previous investigations through 2016 (AECOM, 2017).
- 2019: The Proposed Plan (PP) (U.S. Army, 2019) for LHAAP-18/24 was issued in February 2019.
- 2020: The ROD following PP and requirements for detailed RD was signed on February 6, 2020 (U.S. Army, 2020).
- 2021: A pre-design investigation (PDI) was conducted to gather additional Site data to support development of the RD by refining the extent of groundwater contaminated by perchlorate, and/or VOCs in three specific areas: one area located outside the northeast site boundary and two areas inside the containment area (one in southwest corner, and the other in northwest corner).

1.4 Surface Water Hydrology

Harrison Bayou flows within approximately 200 ft of the western corner of LHAAP-18/24. There are no surface water bodies or watercourses running through the Site, however, minor drainage paths have been observed in the northwestern part of the Site, associated with intermittent ponding in low areas after heavy rainfall events. Surface drainage occurs in all directions, but flow is generally directed toward Harrison Bayou to the west and by both natural and manmade ditches and drainage swales to the north. Harrison Bayou drains into Caddo Lake, which is located approximately one mile northeast of LHAAP-18/24.

1.5 Geology and Hydrogeology

The LHAAP-18/24 site falls completely within the area mapped as undifferentiated Quaternary alluvium mantling Tertiary Age formations of the Wilcox Formation and Midway Groups in the geologic maps compiled by Virgil Barnes (Texas Bureau of Economic Geology, 1992).

Site stratigraphy consists of a relatively thin (10 to approximately 45 feet) cover of unconsolidated shallow alluvium atop semi-consolidated sandstones (sands) and shales (clays and silts) of the Wilcox Formation. Structurally, the Site is located on the northwest edge of the Sabine uplift, a roughly circular dome-like geologic structure. Due to this feature, the Wilcox Formation locally dips gently toward the northwest. The shallow alluvial deposits that cover the Site were generated by two main fluvial systems: the Big Cypress Bayou and the Harrison Bayou fluvial systems. Big Cypress Bayou alluvium comprises the majority of the Site's shallow alluvium. Its thickness ranges from 20 to 50 ft (USACE, 1993) and thins toward the west, away from Caddo Lake and the modern alluvial valley. A smaller portion of the alluvium at the Site owes its origins to the Harrison Bayou. The Harrison Bayou occupies a small valley on the immediate northwestern border of the Site. It locally incises into the older portions of the shallow alluvium and, upstream, it likely cuts into any exposed or thinly covered Wilcox Formation. In general, shallow alluvium is characterized by laterally heterogeneous deposits of clays, silts, and sands with isolated sandy zones of higher permeability surrounded by silts and clays. Sand, silty sands, silts, and clays are generally orange, light brown/grey, yellow and light brown, respectively.

The underlying Wilcox Formation consists of semi-consolidated sands and clays with sands broadly lenticular in morphology and more massive and homogeneous than the overlying alluvium sands. Sands tend to be grey, greenish grey fine sands, though they weather to a variety of colors including red, yellow, and brown (Texas Bureau of Economic Geology, 1975). Locally, the top of the Wilcox Formation was identified as dark grey or blue grey clay (USACE, 1993).

The Shallow Zone at LHAAP-18/24 is very heterogeneous, consisting of discrete sand channels encapsulated in lower permeability silt/clay floodplain sediments. The thickness of the shallow alluvium geology is variable, because of the irregular contact with the underlying Wilcox. Thickness ranges from 10 to 45 ft. The zone is characterized by potentially complex groundwater flow paths, with horizontal gradients depending on where sandy channel deposits intersect and/or diverge. In general, the axes of channel deposits trend toward the north and northeast (AECOM, 2015).

The permeable intervals (i.e., sands and silty sands) associated with individual channel fill or point bar sediment packages range in thickness from 10 to 20 ft thick generally. Sands are typically fine to medium grained. Many of the channel fill sand bodies include silt. Levee or overbank sand bodies were identified where possible. Typically, the fine levee sands display an abrupt coarsening upward grain size trend, are 5 to 10 ft in thickness, and may have some evidence of root or soil formation in the form of noted "mottling" of the sediments (AECOM, 2015).

A clay unit separating the shallow alluvium from the Wilcox sands occurs at the top of the Wilcox Formation throughout most of the containment area. However, this clay thins in the northwestern corner of the containment area and also to the west and to the north of the containment area. The clay layer is thinner where fluvial incision has occurred during both the deposition of the shallow Wilcox (incision indicated by a well-defined gravel lag deposit at 18WW06 as well as later incision by the Harrison Bayou). The thickness and extent of the "Wilcox clay" layer varies in thickness from 0 to 20 ft and may be in contact with overlying floodplain silts and clays or incised by overlying channel sands.

The sands of the Wilcox Formation are homogenous, which refers to its physical characteristics (unlike the shallow alluvium sands that are surrounded by silts and clays) and vary in grain size from medium to fine silty sands (AECOM, 2015).

Figures B-3 and **B-6** provided in **Appendix C** show the well locations and groundwater elevations from December 2021 data (Bhate, 2022) for the Shallow Zone and Wilcox Formation, respectively. The groundwater in the Shallow Zone flows radially outward in a complex pattern from the Site. Shallow groundwater flow in the northwest area of the Site is towards Harrison Bayou, located approximately 200 ft from the western corner of the Site. Localized influence of groundwater extraction can be observed in the Shallow Zone. The horizontal hydraulic gradient and direction of flow in the Wilcox Formation in the northern portion of the Site is similar to that of the Shallow Zone, which is towards Harrison Bayou. The groundwater flow pattern and gradient direction in the Wilcox Formation prior to installation of the groundwater extraction system was similar to what is observed today. Slight downward vertical gradients were measured across the Site during previous investigations (AECOM, 2017). Based on groundwater elevation data from the 2021 4th Quarter Evaluation Report (Bhate, 2021), groundwater elevations fluctuate seasonally, with maximum elevations generally observed in June and minimum elevations generally observed in December. Elevations fluctuate by approximately 1.6 ft (MW-22) up to 5.3 ft (MW-20) in the Shallow Zone and 1.8 ft (18CPTMW01DW) up to 3.5 ft (18WW09) in the Wilcox Formation. These fluctuations are discussed in **Sections 3** and **4**, as they pertain to remediation in the unsaturated zone.

Horizontal hydraulic conductivity at Site 18/24 was estimated through slug tests conducted on several of the Pre-Phase I wells and results were reported in the remedial investigation report (Jacobs, 2001). Hydraulic conductivity values, calculated from the slug test data using the Bouwer-Rice method (Bouwer, H. and R.C. Rice, 1976), included for the Shallow Zone, range from 4.94E-05 centimeter per second (cm/sec) at well MW-18, located in the southwestern portion of the Site, to 1.09E-03 cm/sec at monitoring well 18WW20, located on the far northern side of the Site. For the Wilcox Formation, hydraulic conductivity values ranged from 2.05E-06 cm/sec at monitoring well C-4A, located in the northeast comer of the Site, to a maximum value of 3.13E-03 cm/sec at well 18WW03, located at the southeastern comer of the Site. These hydraulic conductivity values are within the expected range of values for silts, sandy silts, and silty sands and were utilized to prepare the basis of design for the active remedial treatments (Jacobs, 2001).

The groundwater flow rates (i.e., seepage velocity) were estimated by multiplying hydraulic conductivity by the horizontal hydraulic gradient and dividing by the total soil porosity. Horizontal hydraulic gradient was determined based on the water elevations data from Quarterly Evaluation Report, 2nd Quarter (April-June) 2021, Groundwater Treatment Plant (Bhate, 2021). Hydraulic conductivity at the Site was estimated through slug tests conducted on several of the Pre-Phase I wells and results reported in the remedial investigation report (Jacobs, 2001) were utilized for estimating the seepage velocity for each area. The porosity is estimated at 39.6% based on the average value reported in the 2017 FS (AECOM, 2017). **Table 1-1** represents the estimated seepage velocities for Shallow Zone Enhanced In-situ Bioremediation (EISB) Biobarrier 1 and 2 located outside of the containment area and In-Situ Thermal Desorption (ISTD) areas/EISB grids located within the containment area.

1.6 Current and Future Land and Resource Uses

1.6.1 Current and Future Land Uses

LHAAP is located near the unincorporated community of Karnack, Texas. Karnack is a rural community with a population of 775 people. The incorporated community of Uncertain, Texas, population of 205, is located to the northeast of LHAAP on the edge of Caddo Lake and is a resort area and an access point to Caddo Lake. The industries in the surrounding area consist of agriculture, timber, oil and natural gas production, and recreation.

LHAAP has been an industrial facility since 1942. Production activities and associated waste management activities continued until the facility was determined to be in excess of the U.S. Army's needs in 1997. The plant area has been relatively dormant since that time. LHAAP is surrounded by a fence (except on the border with Caddo Lake), and current security measures at the LHAAP preclude unlimited public access to areas within the fence. The fence now represents the National Wildlife Refuge boundary. Approved access for hunters is very limited.

The reasonably anticipated future use of LHAAP-18/24 is as part of a national wildlife refuge. This anticipated future use is based on a Memorandum of Agreement (MOA) (U.S. Army, 2004) between the USFWS and the U.S. Army. That MOA documents the transfer process of the LHAAP acreage to USFWS to become the Caddo Lake National Wildlife Refuge and will be used to facilitate a future transfer of LHAAP-18/24. Presently the Caddo Lake National Wildlife Refuge occupies a little more than 7,100 acres of the 8,416-acre former installation. In accordance with the National Wildlife Refuge System Administration Act of 1966 and its amendments (16 USC 668dd), the land will remain as a national wildlife refuge unless there is a change brought about by an act of Congress, or the land is part of an exchange authorized by the Secretary of the Interior.

1.6.2 Current and Future Surface Water Uses

Streams on LHAAP currently support wildlife and aquatic life. While humans may have limited access to some streams during annual hunts, there is no routine human use of streams on LHAAP. The streams do not carry adequate numbers and size of fish to support either sport or subsistence fishing. During the summer months, the streams cease flowing and/or dry up. When flowing, the streams flow into Caddo Lake, a large recreational area that covers 51 square miles and has a mean depth of 6 ft. The watershed of the lake encompasses approximately 2,700 square miles. It is used extensively for fishing and boating. Caddo Lake is a drinking water supply for multiple cities in Louisiana including Vivian, Oil City, Mooringsport, South Shore, Blanchard, Shreveport, and Bossier City.

The anticipated future uses of the streams and lake are the same as the current uses.

1.6.3 Current and Future Groundwater Uses

Groundwater in the aquifer (approximately 250 to 430 ft bgs) underlying all of LHAAP is currently used as a drinking water source. The drinking water aquifer should not be confused with the Wilcox Formation, also referred to as deep zone groundwater in previous investigations, which extends only to a depth of approximately 151 ft bgs (U.S. Army, 2020). The deep zone groundwater and the drinking water aquifer are distinct from each other and there is no connectivity between the contaminated zone (to a depth of approximately 60 ft bgs) and the drinking water aquifer (approximately 250 to 430 ft bgs) (U.S. Army, 2020).

There are five active water supply wells near LHAAP that are completed in the drinking water aquifer (**Figure 1-2**). One well is located in and owned by Caddo Lake State Park. The well is completed to a depth of 315 ft bgs and has been in use since 1935. A second well owned by the Karnack Water Supply Corporation services the town of Karnack and is located approximately 0.3 miles northwest of town. This well is completed to approximately 430 ft bgs and has been in use since 1942. The Caddo Lake Water Supply Corporation has three wells located both north and northwest of LHAAP. These wells are identified as Caddo Lake Water Supply Corporation Wells 1, 2, and 3, and all are hydraulically upgradient of LHAAP (Jacobs, 2001). These wells are completed deeper than the deepest zone of contamination at LHAAP-18/24 (which occurs at a maximum depth of approximately 67 feet bgs within the Wilcox Formation). Furthermore, because of this and the large distance between these wells and LHAAP, water removal from these wells is not expected to affect groundwater flow at the Site. There are also several livestock and domestic wells located in the vicinity of LHAAP with depths averaging approximately 250 ft bgs.

Three water supply wells are located within the boundary of LHAAP itself. One well is located at the Fire Station; the second well is located approximately 0.35 miles southwest of the Fire Station. The third well is located north of the USFWS administration building for the Caddo Lake National Wildlife Refuge, near the main entrance to LHAAP. The distances from these water supply wells to LHAAP-18/24 are approximately 2.16 miles, 2.25 miles, and 2.78 miles, respectively (**Figure 1-2**). The three water supply wells were completed at a depth much greater than the zone of contamination described at LHAAP-18/24. None of these three wells are currently used for drinking water at LHAAP, although they may supply water for non-potable uses. Two additional wells previously supplied water to the installation, but these have been plugged and abandoned.

Although the anticipated future use of the facility as a wildlife refuge does not include the use of the groundwater at LHAAP-18/24 as a drinking water source, the State of Texas designates all groundwater as potential drinking water, unless otherwise classified, and consistent with 30 TAC 335.563(h)(1). To be conservative, a hypothetical industrial use scenario was evaluated for risk. The future industrial scenario for LHAAP assumes limited use of groundwater as a drinking water source.

1.7 Conceptual Site Model

VOCs, perchlorate, 1,4-dioxane, and metals releases associated with past operations of the former burn pits, burial trenches, the ACD, and the UEP were identified as the contamination sources in soil at LHAAP-18/24. An IRA performed in 1997 removed approximately 32,000 cy of contaminated source area soil and treated it using low-temperature thermal desorption. The majority of the contaminated soil was remediated during the IRA; however, some residual contaminants remain in the unsaturated soil. Based on the results of the BHHRA (Jacobs, 2002), the soil at LHAAP-18/24 does not pose an unacceptable carcinogenic risk or non-cancer hazard; however, the concentrations of contaminants in unsaturated soil could be an ongoing source of groundwater contamination.

Unsaturated soil known to contain residual contamination posing a low-level threat to groundwater is isolated to locations south of the former UEP, west of the UEP, and underneath the UEP. Therefore, the potential leaching of contaminants from the unsaturated soil at these locations to groundwater is considered a complete transport pathway that will be addressed during the remedial action.

Other than the unsaturated soil locations with residual contamination, the medium of concern at LHAAP-18/24 is groundwater. The contaminants in the saturated zone occur as dissolved plumes

within the containment area and outside the containment area where contaminants have migrated outside the containment area before the installation of the ICTs and GWTP. Additionally, residual DNAPL is also present in the UEP and former ACD areas.

Contamination from historical activities at LHAAP-18/24 have impacted two groundwater zones: the Shallow Zone extending from the surface to a depth of approximately 10 to 45 ft below ground surface (bgs), and the Wilcox Formation below the Shallow Zone. These two units are separated by a mostly contiguous clay layer which is believed to be present across most of the containment area but does thin out in the northwestern corner of the containment area and to the west and to the north of the containment area towards Harrison Bayou. Groundwater contamination in the form of VOCs, 1,4-dioxane, metals, and perchlorate in the Shallow Zone and the Wilcox Formation (**Table 1-2** and **Table 1-4**) poses a potential risk to the hypothetical future maintenance worker at LHAAP-18/24. VOCs and perchlorate were detected in wells screened in the Shallow Zone and in localized areas in the Wilcox Formation, though Shallow Zone contamination is more widespread. Since the groundwater at LHAAP-18/24 may pose a risk for the hypothetical future maintenance worker, the pathways considered for remediation include future industrial groundwater use.

The contaminants in the Shallow Zone groundwater migrate toward surface water and may discharge via seepage. Although this transport pathway is currently mostly mitigated by the operation of a groundwater extraction system, the seepage of groundwater to surface water represents a pathway that is addressed by the selected remedial action.

Based on groundwater elevation data from the 2021 4th Quarter Evaluation Report (Bhate, 2021), groundwater elevations fluctuate seasonally, with maximum elevations generally observed in June and minimum elevations generally observed in December. Elevations fluctuate by approximately 1.6 ft (MW-22) up to 5.3 ft (MW-20) in the Shallow Zone and 1.8 ft (18CPTMW01DW) up to 3.5 ft (18WW09) in the Wilcox Formation. These fluctuations are discussed in **Sections 3** and **4**, as they pertain to remediation in the unsaturated zone.

The groundwater flow direction is north-northeast toward Harrison Bayou in both the Shallow Zone and Wilcox Formation. Overall, the groundwater flow is toward Caddo Lake.

1.7.1 Nature and Extent of Contamination

Soil has not been identified as a medium of concern for protection of human health and ecological risk; however, it was identified as a medium of potential concern for the protection of groundwater from potential cross-media transfer. Most of the contaminated soil (approximately 32,000 cy) was remediated during the IRA (**Figure 1-3)**; however, remaining residual contaminants in the unsaturated soil may present an ongoing source of groundwater contamination. The areas mentioned in the 2020 ROD are listed below and are also shown on **Sheets 01C100** and **01C101** in **Appendix A**.

- Unsaturated soil in two areas south of the former UEP contain TCE and MC, as well as Tetrachloroethene (PCE), at concentrations that exceed their respective GWP-Ind values and could leach to groundwater at concentrations exceeding the maximum contaminant levels (MCLs).
- Unsaturated soil in the area west of the UEP within the former Burn Burial Area contains TCE and MC, as well as some perchlorate, which could leach to groundwater at concentrations

exceeding the MCLs or the Texas Risk Reduction Program (TRRP) Tier 1 Residential protective concentration levels (PCLs).

The leaching of contaminants from the unsaturated soil to groundwater in the above areas is considered a complete transport pathway that is being addressed in this RD.

In addition to the areas listed above, there are two soil areas beneath the UEP which had concentrations of TCE and/or MC that exceeded the TCEQ soil medium-specific concentration (MSCs) for industrial use based on groundwater protection (GWP-Ind). The first area is in the vicinity of 18CPT21, and the second area is in the vicinity of 18CPT25. A conservative extent was estimated at 280 ft by 110 ft and a thickness of approximately 10 ft. Thus, the estimated in-place soil volume was estimated at 11,400 cy. These two areas will be considered for remediation in the future as a contingency remedy depending on the results of the Five-Year Review of the groundwater remedy.

The collective investigative results at LHAAP-18/24 identified groundwater contamination present at concentrations that pose an unacceptable risk to human health or the environment that require RA. TCE, MC, and perchlorate present the vast majority of the human health risk in groundwater. The concentrations of TCE and MC in some portions of the Site are sufficiently high to indicate the possible presence of DNAPL within the saturated zone. Historic data suggest that contaminants in the saturated zone occur as dissolved plumes within the containment area and outside the containment area where contaminants may have migrated outside the containment area. Additionally, residual DNAPL is present in the UEP and former ACD areas.

Contamination from historical activities at LHAAP-18/24 has impacted two groundwater zones: the Shallow Zone extending from the surface to a depth of approximately 10 to 45 ft below ground surface (bgs) and the Wilcox Formation below the Wilcox clay to a depth of approximately 60 ft bgs. The Shallow Zone is heterogeneous, composed of discrete layers of fine-grained and coarse-grained soils, whereas the Wilcox Formation is composed of fine-grained sand. These two units are separated by the Wilcox clay which is believed to be present across the entire site, except for the area to the west and northwest near Harrison Bayou. The groundwater in the Shallow Zone flows radially outward from the northwestern portion of the Site. Localized influence of groundwater extraction can be observed in the Shallow Zone. The groundwater flow pattern and gradient direction in the Wilcox Formation is similar to what is observed in the Shallow Zone.

VOCs and perchlorate were detected in wells screened in the Shallow Zone and in localized areas of the Wilcox Formation, though Shallow Zone contamination is more widespread. Perchlorate was detected in groundwater in 1999, and in 2001 a fluidized bed reactor treatment system was installed at the GWTP. The compound 1,4-dioxane was added as a chemical of concern (COC) in 2017 after completion of a Supplement to the Updated Post Screening Investigation (PSI) Report (AECOM, 2016). 1,4-dioxane is present as isolated plumes, while other VOCs and metals detections in groundwater are intermittent and their distribution is generally not contiguous across the Site.

The PSI (AECOM, 2013) was conducted to fill data gaps identified during the 2010 FS at the LHAAP-18/24 site (Shaw, 2010), and determined that inside the contained area, the greatest contamination of TCE and perchlorate detected in the saturated soil was attributed to the residual DNAPL and existence of very high levels of perchlorate in the interface/interval between the shallow alluvium and Wilcox clay in the saturated zone.

1.8 Basis of Action

The remedial action selected in the 2020 ROD was to protect the public health and welfare and the environment from actual or threatened releases of hazardous substances, pollutants, or contaminants into the environment. Actions for the groundwater are required to address the potential for human health risks in the unlikely event there is an attempt to use groundwater as a potable water source.

Actions for soil are to address human health risk including the pathway from soil to groundwater. **Tables 1-3** and **1-4** presents the COCs and the final cleanup levels for both soil and groundwater, with groundwater COCs for the Shallow Zone and the Wilcox Formation listed separately.

1.9 Remedial Action Objectives

The RAOs for LHAAP-18/24 presented in the 2020 ROD for the selected remedy and contingency remedies address contamination associated with the media at the Site and take into account the future uses of LHAAP surface waters, land, and groundwater.

The RAOs for groundwater:

- Protection of human health by preventing human exposure to the groundwater contaminated with COCs,
- Protection of human health and the environment by preventing groundwater contaminated with COCs from migrating into nearby surface water, and
- Returning groundwater to its beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the Site (40 C.F.R. § 300.430(a)((1)(iii)(F)).

The RAOs for soil:

- Protection of human health and the environment by preventing the migration of contaminants to groundwater from potential sources in the soil.

The above RAOs recognize USEPA's policy to return all groundwater to beneficial uses, based on non-binding programmatic expectation in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and is consistent with the NCP regulations requiring the lead agency, the U.S. Army in this case, to establish RAOs specifying contaminants and media of concern, potential exposure pathways, and remediation goals.

Per these RAOs, and consistent with the NCP, groundwater will be returned to its beneficial use. In the absence of federal drinking water standards, the groundwater clean-up level at the Site is the Texas Risk Reduction Program (TRRP) Tier 1 Residential Groundwater PCL and is protective of human health and the environment.

1.10 Selected Remedy

As described in the 2020 ROD, the final selected remedy for LHAAP-18/24 includes:

- Enhancement of the existing groundwater extraction and treatment system
- EISB in Shallow Zone and Wilcox Formation groundwater, both inside and outside the containment area
- Thermal treatment to remove DNAPL (Soil Vapor Extraction (SVE) will be implemented as a component of thermal treatment for the removal of COC volatilized from the DNAPL)
- Unsaturated soil excavation and off-site disposal

- Maintenance of the existing cap over the UEP
- Land Use Controls (LUCs), Monitored Natural Attenuation (MNA), and long-term monitoring (LTM)

The final selected remedy for LHAAP-18/24 protects human health and the environment by preventing human and ecological receptors from being exposed to contaminated soil and contaminated groundwater. The human health risk assessment scenarios evaluated were based on the hypothetical future maintenance worker.

The components of the selected active remedy are summarized below:

- Excavation of unsaturated soil exceeding the TCEQ MSC for industrial use based on groundwater protection (GWP-Ind). Additional confirmation soil sampling during the RA will be conducted to define the final excavation extent and volume of soil contaminated in the two areas south of the UEP and area west of the UEP.
    - If during the Five-Year Review the results of the groundwater remedy indicate that vadose zone soil under the UEP constitutes a continuing source that requires a response, a contingency remedy to excavate soil beneath the UEP would be developed. Development and specific description of the contingency remedy is not included in this RD but would be presented in a Remedial Design/Remedial Action Work Plan (RD/RAWP) that would be prepared in the future if response for soil under UEP is determined to be required. If the contingency remedy is required, it will require an update to the decision document (likely an Explanation of Significant Difference [ESD]).
- Continued use of the existing groundwater extraction system, as needed, with the following enhancements:
    - A phased reactivation of two existing ICTs (ICT 3 and 9) until COC concentrations are low enough that MNA can address remaining contamination within the containment area.
    - Continued operation of the current GWTP, or potentially a new GWTP as needed, will be determined during this RD. Specific treatment for 1,4-dioxane, such as an advanced oxidation process, shall be evaluated during the FYR. Development and specific description of the contingency remedy is not included in this RD but would be presented in a RD/RAWP that would be prepared in the future if treatment for 1,4-dioxane is determined to be required.
- Implementation of ISTD, using either Electrical Resistance Heating (ERH) or Thermal Conduction Heating (TCH), to remove DNAPL in two distinct areas inside the containment area.
- Implementation of EISB of Shallow Zone groundwater outside the containment area at several locations; in the Wilcox Formation at three or more locations, and inside the containment at five or more locations or as needed.
- MNA for both Shallow Zone and Wilcox Formation groundwater for areas outside the influence of the treatment areas and for areas inside the influence of the treatment areas (after completion of EISB) to reduce contaminant levels to confirm protection of human health and the environment by documenting that the contaminated groundwater remains localized with minimal migration and that COCs are being reduced to cleanup levels.
    - Performance objectives to be evaluated after two years of MNA. During those two years, monitoring will be quarterly. If MNA is found to be effective, it will be continued, and LTM will be semiannual for three years. In subsequent years, LTM will be annual until the next Five-Year Review and annually thereafter until recommended otherwise by the Five-Year Review. The monitoring and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue until recommended otherwise at the Five-Year Review.

    - If MNA is found to be ineffective, a contingency remedy to enhance MNA will be developed. The contingency remedy would consist of injection of bioremediation amendments to enhance degradation of the groundwater contaminants at selected locations based on data available at the time it is determined MNA is not successful. Development and specific description of the contingency remedy is not included in this RD but would be presented in a RD/RAWP that would be prepared in the future if MNA is determined unsuccessful.
- Groundwater monitoring to be conducted to evaluate inorganic COCs. The need to continue groundwater monitoring for this purpose will be evaluated at five-year intervals.
- Maintenance of the existing cap over the former UEP. The protectiveness of the cap will be evaluated at five-year intervals.
- LTM and reporting will be continued until the cleanup levels are achieved.
- The LUC's objectives include:
    - Maintaining the integrity of any current or future remedial or monitoring systems.
    - Preserving the integrity of the surface impoundment cap over the UEP and to restrict intrusive activities (e.g., digging) that would degrade or alter the cap.
    - Preventing the use of groundwater contaminated above cleanup levels as a potable water source.
    - Restricting land use to nonresidential until it is demonstrated that surface and subsurface soil and groundwater COCs (i.e., including all hazardous substances, pollutants, and contaminants found at the Site at cleanup levels) are at levels that allow for unlimited use and restricted exposure.

The groundwater treatment and MNA remedial components include a groundwater monitoring system that will be used to characterize the condition of the groundwater during the period the groundwater remedy is in place until the groundwater remediation goals are achieved, and to demonstrate achievement of the groundwater remediation goals when the groundwater remedy is complete. As a part of this groundwater remedy, the RD includes maintenance of the remedial and monitoring systems associated with the groundwater remedies until these components of the remedy are no longer needed to achieve cleanup levels.

1.11 Site Cleanup Levels

From the 2020 ROD, site cleanup levels for the soil, Shallow Zone groundwater and Wilcox Formation groundwater are listed in **Tables 1-3** and **1-4** (U.S. Army, 2020).

1.12 Pre-Design Investigation

A PDI was conducted to gather additional site data to support development of the RD by refining the extent of groundwater contaminated by perchlorate and/or VOCs outside the northeast site boundary (Northeast ICTs Boundary), adjacent to 18CPT03 and 18CPTMW03SW (within the EISB grids identified in the 2020 ROD), and near well MW-14. In addition, soil samples were collected outside the Northeast ICTs Boundary to investigate levels of perchlorate and VOC soil contamination at the contact interval between the clay and sand and included both soil types.

The PDI included the following components:

- Advancement of 44 boreholes, and installation of temporary wells at each borehole location for collection and analysis of groundwater samples for perchlorate and VOCs,
- Collection of one soil sample for perchlorate and VOC analyses from the interface/interval between the shallow alluvium and Wilcox clay at each borehole located outside the Northeast ICTs Boundary (17 total),

- Installation of 5 Shallow Zone monitoring wells to a depth of 40 ft bgs, and 1 monitoring well northwest of well MW-14 in the Wilcox Formation to a depth of 51 ft bgs, and
- Groundwater sampling at six newly installed monitoring wells.

Below is a summary of key investigation findings from the PDI.

- Soil:
    - The saturated soil and groundwater contamination detected were generally collocated in the northeast area (**Figure 1-4**), indicating a critical mass of contaminant in groundwater media at the clay/sand interface (i.e., sandy units of shallow alluvium – Wilcox clay contact interface) occupying pore space in the saturated zone. Similar observations were made during the PSI, in which elevated levels of VOCs/perchlorate were detected at the clay/sand interface in the saturated zone.
- Groundwater:
    - VOC and perchlorate groundwater contamination were observed to be more widespread when compared to the soil contamination, but largely the higher concentrations were detected along the northeast boundary corresponding well to the location of high soil sample results.
    - The highest levels of perchlorate in groundwater were detected outside the ICTs in the area around extraction well 18WW17 (see **Figure 1-5**). To the northeast of this area, concentrations rapidly decreased with distance (one to two orders of magnitude lower).
    - Groundwater and soil samples were collected at the nested well pair 1824DPT29A/29 (see **Figure 1-5**), located near ICT-14B to investigate additional source area between the ICT boundary and northeast of well 18WW17. Higher concentrations of perchlorate and TCE were observed in the deeper well of nested well pair 1824DPT29A/29, located near ICT-14B. At the shallower well 1824DPT29A, perchlorate and TCE were detected at 5,450 ug/L and 182 ug/L, respectively. In contrast, perchlorate and TCE were detected at 41,000 ug/L and 273 ug/L, respectively, in the deeper well 1824DPT29, where the well screen extends into the clay separating the shallow alluvium and the Wilcox Formation. The low-permeable clay layer may potentially be the continuing source of contamination within the containment area.
    - Groundwater and soil samples were also collected at the nested well pair 1824DPT27/1824DPT27A (see **Figure 1-5**), located much farther northeast of 18WW17, for delineating perchlorate and VOC contamination at the shallow alluvium and Wilcox Clay contact interval. The interval/interface between the shallow alluvium and Wilcox clay is believed to be the continuing source of perchlorates and VOC contamination in the groundwater. The sandy units of shallow alluvium – Wilcox clay contact interval generally was observed between 27 and 42 ft bgs in the northeast area. While overall lower perchlorate and VOCs concentrations were observed in this nested well pair, much lower concentrations were observed in the shallower of the well pair (1824DPT27A), indicating that the shallow alluvium – Wilcox clay contact is not a source in this area.
    - In the southwest corner of the containment area (**Figure 1-6**), perchlorate and VOC groundwater contamination was observed to be widespread with perchlorate and TCE exhibiting higher concentrations. TCE concentrations in several temporary direct push technology (DPT) wells (1824DPT5, 1824DPT6, 1824DPT7, 1824DPT32, 1824DPT40, and 1824DPT41) suggests the presence of residual DNAPL (assumed when the concentration of TCE is greater than 10,000 µg/L). Perchlorate was detected at 576,000 µg/L in permanent monitoring well 1824DPTMW05, located within the southwest portion of the Site.
    - Based on the PDI results, the spatial extent of contamination in the Shallow Zone extends beyond the limits of EISB grid proposed in the 2020 ROD.

- Contamination was detected at the clay sand/silt contact separating the Shallow Zone and Wilcox Formation.
- Within the northwest corner near MW-14, perchlorate was detected at an estimated concentration of 37.3 J µg/L in permanent monitoring well 1824DPTMW06, installed northwest of well MW-14 (**Figure 1-6**).

Groundwater contaminants evaluated for this RD include perchlorate and TCE in the Shallow Zone and in the Wilcox Formation. Summary of the Shallow Zone groundwater analytical data (perchlorate and TCE) from the Quarterly Evaluation Report, 2nd quarter (April-June) 2021 (Bhate, 2021) along with the 2021 PDI data is presented in **Figure 1-7**. Similarly, summary of the Wilcox Formation groundwater analytical data (Perchlorate and TCE) is presented in **Figure 1-8**. Groundwater analytical results from the June 2021 sampling event were evaluated for this RD since it is the most recent event that included the comprehensive well network.

1.13 Planned Remedial Action

The planned remedial action (RA) will be implemented in multiple phases, as the criteria for each phase of the remedial action will depend on the evaluation of monitoring and performance results of Ras from the previous phase. The planned RA at LHAAP-18/24 based on a three-phase construction process is comprised of several design elements as listed below.

- Phase I:
  - Excavation of unsaturated soil in three areas exceeding GWP-Ind.
  - Implementation of ISTD treatment to remove DNAPL and additional TCE sources within the containment area identified with TCE concentrations greater than approximately 10,000 µg/L.
  - Implementation of three EISB field pilot tests in the following areas: Pilot Test Area 1 in the southern portion of the containment area, Pilot Test Area 2 to the northeast of the containment area, and Pilot Test Area 3 in the northwest corner of the containment area, as shown on **Sheets 01C100** and **01C301** in **Appendix A**.
  - Continued operation of the existing groundwater extraction system and GWTP. The 2020 ROD indicated a phased reactivation of two existing ICTs (ICT 3 and 9) until COC concentrations are low enough that MNA can address remaining contamination within the containment area. The ICT 3 and 9 are located outside of the proposed ISTD or EISB treatment areas and may not be able to enhance the existing system. However, the reactivation of existing ICTs including 3 and 9 located within the containment area will be evaluated during the field pilot tests to determine if any ICTs inside the containment area can enhance either contaminated groundwater extraction or assist in substrate distribution for EISB implementation.
  - Implementation of LUCs:
    - To prohibit access to the contaminated groundwater except for environmental monitoring and testing only.
    - To preserve the integrity of the of the surface impoundment cap over the UEP and to restrict intrusive activities (e.g., digging) that would degrade or alter the cap.
    - To restrict land use to nonresidential.
    - To maintain the integrity of any current or future remedial or monitoring systems.

- Phase II:
    - EISB in the most contaminated portion of the Shallow Zone and Wilcox Formation inside the containment area and in the northeast area outside the containment area in a grid configuration.
    - EISB inside the containment area in a grid configuration where ISTD was performed, if required.
    - EISB inside and outside the containment area in a biobarrier configuration
    - Performance monitoring and reapplication of bio-amendments.
- Phase III will consist of:
    - Phased shutdown of the existing groundwater extraction system.
    - MNA of both the Shallow Zone and Wilcox Formation groundwater zones to ensure continued degradation of COCs and daughter products and that surface water in Harrison Bayou is not adversely affected by groundwater such that it fails to meet surface water standards for COCs and daughter products. MNA includes:
        - Evaluation of MNA based on performance objectives after 2 years of quarterly monitoring.
        - LTM semiannually for 3 years, then annually thereafter, until recommended otherwise by the Five-Year Review. LTM will not be initiated until MNA performance monitoring establishes the effectiveness of MNA.

The contingency remedy for LHAAP-18/24 includes the below design elements. Development and specific description of the contingency remedy are not included in this RD. If the contingency remedy is required, it will require an update to the decision document (probably the ESD).

- Injection of bioremediation amendments to enhance degradation of the groundwater contaminants at selected locations based on data available at the time it is determined MNA is not successful.
- Evaluation and implementation of enhancements related to the existing groundwater extraction system.
- Evaluation and implementation of advanced oxidation process for treatment of 1,4-dioxane in the existing GWTP, if data evaluation during the Five-Year Review indicates it is necessary.
- Excavation of soil beneath the UEP if, during the Five-Year Review, the results of the groundwater remedy indicate that vadose zone soil under the UEP constitutes a continuing source that requires a response.

The focus of this RD is remedial components included in phases I, II, and III of the multi-phase construction process approach described above.

Prior to implementing any of the construction activities, the Contractor will be required to submit a Remedial Action Work Plan (RAWP). This work plan shall be submitted, reviewed, and approved by the U.S. Army and regulators prior to mobilization. The RAWP shall be prepared in accordance with the requirements of this design report and the approved Installation Wide Work Plan (Bhate, 2018). The RAWP may need to be revised if a supplemental remediation effort is required for the ISTD and/or EISB mitigation areas. The RAWP shall include but not limited to the following information:

- Health and Safety Plan/Accident Prevention Plan including decontamination procedures meeting the requirements of the USACE Safety and Health Manual (EM-385-1-1) (U.S. Army, 2014b).

- Proposed schedule and sequence of operations.
- Locations for proposed staging and equipment areas, layout for access roads, stormwater and erosion control measures, temporary facilities, and the location of decontamination stations.
- Borrow sources and haul routes.
- Soil Erosion and Sediment Control Plan.
- Excavation and Handling Plan.
- Waste Management and Transportation Plan.
- In Situ Thermal Desorption Plan, referencing EM 200-1-21 (U.S. Army, 2014a).
- EISB Field Pilot Test Plan.
- EISB Treatment Plan (for Affected Areas and derived from pilot study).
- Associated Sampling Plans.
- Associated Monitoring Plans (for ISTD, EISB, and MNA areas).
- Comprehensive Land Use Management Plan.
- Waste management activities and identification of disposal facilities.
- Spill contingency measures that will be implemented in the event of a spill.
- Quality Assurance Project Plan (QAPP) for samples collected as part of the remedial action. A separate QAPP is anticipated to be prepared and included as part of the ISTD Work Plan.
- Separate RAWPs that will be provided by vendors or subcontractors who will provide support to the Contractor. This includes but is not limited to, the ISTD and EISB contractors.

2 OPERATION AND MAINTENANCE PROCEDURES

Maintenance of existing UEP cap and of the current or future groundwater monitoring system, and MNA components of the final remedy at LHAAP-18/24 require operation and maintenance (O&M) as described in this section, along with routine maintenance activities currently being conducted at the Site. The remedy components that require O&M include:

- Maintenance of the existing UEP cap, which includes signage.
- Maintenance of the existing extraction system and GWTP.
- Maintenance of the current or future groundwater monitoring system which will include all wells that serve some purpose, including bioremediation injection and performance monitoring, MNA, background, water levels, and cap performance.

Other routine maintenance activities include maintenance and repair of site access features, such as roads, gates, and fencing, as needed. These activities will be conducted annually unless recommended otherwise during a Five-Year Review.

2.1 UEP Cap Maintenance

The former UEP was closed under Resource Conservation and Recovery Act (RCRA) in 1986 and capped by 1987. The UEP cap design consisted of removing the sludge, filling the UEP with common fill, covering the common fill with 4 ft of compacted clay, then applying 1 foot of sand, covered by 1 foot of topsoil. The surface of the cap has an average slope of three percent on top while the sides have a vertical to horizontal ratio of 1:4. It is graded and equipped with a sand drainage layer to promote sheet flow runoff to minimize erosion.

This cap will continue to be monitored, maintained, and repaired, as necessary, to ensure long-term effectiveness. This includes inspections of the cap to check for erosion, settlement, and deep-rooted vegetation, and implementation of necessary repairs. Routine maintenance and repair of the cap would include actions needed to ensure that the integrity of the cap is maintained (e.g., mowing, seeding, and settlement/erosion repair).

The importance of maintaining the cap is to prevent contaminants present in the unsaturated soil from leaching to groundwater. Three locations within the UEP identified the presence of contaminants within the unsaturated zone above the water table (18CPT21, 18CPT25, and 18CPTUEP05). The highest contamination was reported in 18CPT21. This area is included in the DNAPL impact zone that will be addressed under this alternative via ISTD treatment. However, the other two locations are outside the DNAPL zone. Nonetheless, the presence of the cap provides a significant protection.

Per the 2020 Final ROD, the substantive post-closure requirements at 40 CFR Sections 264.228 (b)(1), (3), and (4); 264.117-120; and 30 TAC 335.174 are Applicable or Relevant or Appropriate Requirements (ARARs) for UEP cap maintenance and monitoring. The substantive requirements of these post-closure ARARs relevant to LHAAP-18/24 include the following:

- Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events (e.g., deep-rooted vegetation and burrowing animals).
- Maintain and monitor the groundwater monitoring system.
- Prevent run-on and run-off from eroding or otherwise damaging the final cover.

In order to comply with above requirements, annual inspections will be conducted for the UEP cap. Inspections will include examining each component of the cap to determine maintenance needs. **Table 2-1** summarizes the UEP cap inspection schedule. Inspection and maintenance of the signs will be conducted as part of the UEP cap inspection and maintenance activities. The area will be checked for proper signage to ensure that required signs are posted and are legible. If missing or no longer legible, the signs will be replaced. An RAO Inspection and Maintenance Checklist is presented in **Appendix D**.

2.2 Maintenance of Existing Extraction System and GWTP

The operation of the existing GWTP is part of the IRA at LHAAP-18/24. A historical pilot test for nearby landfill LHAAP-16 resulted in the installation of eight extraction wells which also contributed groundwater to the GWTP but ceased after implementation of the final remedy at LHAAP-16 in September 2019. Also, water extracted from two wells located at LHAAP-17 currently contribute groundwater to the GWTP but is anticipated to cease extractions in February 2024.

The groundwater remediation process at the existing GWTP includes the following operable systems:

- Equalization tank (water storage) pretreatment system (metals removal)
- Air stripper system
- Sludge treatment system (thickening, devolatilization, and belt filter press)
- Perchlorate treatment system (fluidized bed reactor [FBR] and ion exchange [IX] vessels)
- Various pumps, meters, piping, and valves tying the treatment systems together
- Programmable Logic Controller (PLC) that communicates the status of the operable systems, including the extraction wells, to a central computer that can then notify the operators of shutdowns and similar issues remotely.

Contaminated water from the extraction wells and ICTs is pumped into the GWTP and stored in the equalization storage tank. The contaminated water is then pumped to the pretreatment system for precipitation of metals. The sludge from the pretreatment system is delivered to the sludge treatment system to be thickened, air stripped of VOCs, and filter pressed for burial in a landfill. The water from the pretreatment system is delivered to the air stripper system for air stripping of VOCs. Water from the air stripper is stored in the effluent storage tank for further treatment by the perchlorate system, which consists of a FBR and IX vessels. Evaluation and implementation of an advanced oxidation process to treat 1,4-dioxane in the existing GWTP will be conducted if data evaluation during the Five-Year Review indicates it is necessary. If this contingency remedy is deemed necessary, it will require an update to the decision document (probably the ESD). Groundwater extraction, treatment, discharge, and monitoring activities consist of:

- Continuous extraction of groundwater from multiple ICTs and extraction wells at LHAAP-18/24
- Treatment of extracted groundwater for heavy metals, chlorinated compounds, and perchlorate using precipitation, air stripping, and biological methods, respectively
- Evaluation of the hydraulic effectiveness of the extraction system by groundwater monitoring
- Monitoring and analysis of treated groundwater to ensure compliance with the discharge limits
- Discharge of treated water to Harrison Bayou or to a holding pond (INF Pond), or the treated water may be released as irrigation water on LHAAP-18/24.

Based on the quarterly evaluation report (Bhate, 2022), the typical discharge flowrate from the GWTP was estimated as 136 gallons per minute (gpm) during the 4th Quarter of 2021.

Maintenance of the existing extraction system and GWTP will be continued while the plant remains operational.

2.3 Maintenance of the Current or Future Groundwater Monitoring System

The groundwater monitoring system is comprised of a network of monitoring wells used to implement EISB (Details provided in Section 5), monitor progress of the remedial activities, evaluate the performance of the cap, and determine the magnitude and extent of COCs. This system of wells will be inspected and maintained as part of the annual inspection and maintenance program discussed for the UEP cap. The monitoring wells will be inspected for the integrity of the pad, bollards, surface casing, and well markings, the presence and accumulation of silt in the well screen, the presence and integrity of a locking mechanism, the presence of encroaching vegetation, such as tree roots and weeds, and the presence of biological hazards, such as ant mounds and bee nests. Maintenance activities will be performed as needed and could include replacement of the pads and well markings, resurfacing/painting the well casing and bollards, and redevelopment of the wells.

2.4 Maintenance of Site Access Features

LHAAP-18/24 is accessed by roads and through a gate in a perimeter fence. The roads, perimeter fence and a gate will be visually inspected annually, or as needed, to ensure that the roads remain accessible, and the perimeter fence and the gate are intact and undamaged. Maintenance will be conducted as needed.

Any fence posts that are not securely anchored in the ground and/or metallic parts that are excessively corroded, will be repaired or replaced. If evidence of unauthorized entry through, over, or under the fence is observed, these sections of the fence will be reinforced.

3 SOIL EXCAVATION REMEDIAL DESIGN

The basis of the soil excavation remedial design as well as the implementation of the design are provided in this section and in **Sheets 01C100** and **01C101** in **Appendix A**. The leaching of contaminants from the unsaturated soil to groundwater was considered a complete transport pathway that needs to be addressed during the RA. The ROD identified unsaturated soil in the following areas containing TCE and MC at concentrations that exceeded their respective GWP-Ind values, which have the potential to leach to groundwater at concentrations exceeding the MCLs:

1. Excavation Area 1: Includes one location to the south of the former UEP identified with TCE and MC exceedances in soil between the depths of 5.5 and 12 ft bgs around location 8A-975.
2. Excavation Area 2: Includes two locations to the south of the former UEP identified with TCE and MC exceedances in soil between the depths of 8 and 12 ft bgs around locations 18-SB02 and 8A-911.
3. Excavation Area 3: An area in the former burn pit area to the west of the former UEP identified with soil exceedances of TCE, MC, and perchlorate at depths ranging from 4 to 14 ft bgs around locations 8A-940, 18CPTBB02, and 18-SB04.

Soil samples collected during the 2021 PDI did not identify any additional areas with unsaturated soil contamination. Therefore, the extent of areas for soil excavation were estimated based on the data provided in the Final Revised FS (AECOM, 2017).

Two additional soil areas identified beneath the UEP had concentrations of TCE and/or MC that exceeded the GWP-Ind. The first area is in the vicinity of 18CPT21, and the second area is in the vicinity of 18CPT25. A conservative extent was estimated at 280 ft by 110 ft area with a thickness of approximately 10 ft and the estimated in-place soil volume of 11,400 cy. These two areas are not considered for remediation as an active remedy under the RD since the existing cap effectively prevents human contact with contaminated soil and minimizes infiltration of precipitation/runoff that potentially mobilizes COCs in the waste and impact shallow groundwater. The cap is regularly maintained and inspected and will be continued to ensure its continuing effectiveness. If during the Five-Year Review, the results of the groundwater remedy indicate that vadose zone soil under the UEP constitutes a continuing source that requires a response, a contingency remedy to excavate soil beneath the UEP will be developed. Development and specific description of the contingency remedy are not part of this RD; however, the RD addresses the triggering criteria (groundwater cleanup levels listed in **Table 1-4**) for evaluating whether a contingent remedy is needed in future design submittal. Groundwater beneath the UEP will be monitored continuously as part of the groundwater RA performance monitoring program and results will be evaluated against the criteria listed in **Table 1-4**. Also note that an overlapping area where DNAPL exists will be remediated using the ISTD.

Since the burning ground area (LHAAP 18) of the Site was historically used for the treatment, storage, and disposal of solid and liquid explosive by open burning/open detonation, incineration, evaporation, and burial (Jacobs, 2001), there is a possibility of encountering the munitions and explosives of concern (MEC) during excavation. Therefore, if any MEC is discovered during the removal of contaminated soil as per the requirement of the 2020 ROD, all work must be stopped, and the U.S. Army should be notified immediately.

3.1 Design Criteria

The soil design criteria define the goals to be achieved and are based on the RAO of protection of human health and the environment by preventing the migration of contaminants to groundwater from potential sources in the soil. The soil cleanup levels included in the 2020 ROD are listed in **Table 1-3,** as well as provided below:

- Methylene Chloride 0.5 mg/kg
- Trichloroethylene 0.5 mg/kg
- Perchlorate 7.2 mg/kg
- Tetrachloroethene 0.5 mg/kg

The design for soil includes excavation of the contaminated soil until the cleanup levels are attained based on the confirmatory sampling results or groundwater is encountered. If the contamination is present at or below groundwater level, excavation will be terminated at the depth where saturated conditions are encountered.

3.2 Excavation Areas

Contaminated soil has been identified in three areas totaling an area of approximately 108,800 cubic ft. The excavation areas are not fully delineated, but approximately in-place volume of 4,040 cy of soil will be excavated. The locations of the excavation areas are shown on **Sheet 01C100** in **Appendix A**; areal extents and excavation depth intervals and volumes for each area are provided in **Table 3-1**. A summary of excavation areas is also provided in **Sheet 01C101** in **Appendix A.** In all three areas, the excavation walls will be benched since the sidewall height of each excavation area would be greater than 4 ft. Soils excavated below 4 ft from benching the excavation faces will be treated as excavated impacted soil and will need to be characterized prior to disposal. The estimated additional volume of excavated soil from benching activities is included in the cost estimate. Side slopes are assumed to be 1:2 vertical to horizontal, which, in the absence of additional soil analysis, satisfies the maximum 1:1.5 slope stated in the Final Installation-Wide Work Plan for Longhorn Army Ammunition Plant (IWWP) Health and Safety Plan (HASP) Attachment 1 (Bhate, 2018).

The shallow soil (0-4 ft bgs) in Excavation Areas 1 and 2 was previously excavated in 1996. The estimated extent in Excavation Area 1, with location 8A-975, was 50 ft by 50 ft for a total area of approximately 2,500 square ft and potential total volume of approximately 16,250 cubic ft or 602 cy. The estimated extent in Excavation Area 2, with locations 18SB02 and 8A-911, was 40 ft by 70 ft for a total area of approximately 2,800 square ft and potential total volume of approximately 11,200 cubic ft or 414 cy. Soil in these areas was excavated to a depth of 4 ft and replaced with clean backfill.

In Area 3, historical samples at locations 8A-940 and 8A-984 to the west of the former UEP indicated the potential presence of TCE and MC soil sources at a depth of up to 14 ft bgs. Initially, these samples were not considered further as they appeared to be located within the former excavation depth of 16 ft bgs that was supposedly backfilled with clean material. To confirm that these exceedance soil areas were excavated, two soil borings 18CPTBB01 and 18CPTBB02 were driven in 2014 in the vicinity of borings 8A-940 and 8A-984 and soil samples collected at depths deeper than 4.5 ft (Final Updated PSI Report, 2016). One sample at 18CPTBB02 at a depth of 4.5 to 5.5 ft bgs exhibited perchlorate at concentration exceeding the GWP-Ind concentration of 7,200 micrograms per kilograms (µg/kg). Neither MC nor TCE soil sources were identified in the unsaturated soil at soil boring locations conducted during the PSI. However, the impacted soil at 4 ft bgs at 8A-940 and at 4.5 to 5.5 ft bgs at

18CPTBB02 was determined to be a threat to groundwater and was proposed for remediation in the 2020 ROD. The RD assumes excavation in Area 3 to the indicated depths, or the depth groundwater is encountered, as a conservative approach since as-builts or an accurate description of the excavation conducted in 1996 is not available. This approach also is supported by the fact that elevated levels of TCE were detected in 18SB04 collected in August 2011 (i.e., after soil excavation had taken place) at depths of 10 to 12 ft bgs and 13 to 14 ft bgs. Based on available data from the 2021 4th Quarter Evaluation Reports (Bhate, 2021), localized depths to groundwater in the Shallow Zone fluctuate as follows:

- In the vicinity of Excavation Areas 1 and 2: from 23.35 (MW-2) to 27.25 (MW-22) ft bgs (below the proposed excavation depth of 10 ft bgs).
- In the vicinity of Excavation Area 3: from 11.59 (AWD-2) to 24.21 (18CPTMW04) ft bgs (compared to the proposed excavation depth of 12 ft bgs).

The quantity/depth provided above are based on the 2020 ROD and when calculating the potential depth of excavation based on the volume and area provided, a discrepancy was noted (4 ft versus 6.5 ft in Area 1). As-builts or an accurate description of the excavation conducted in 1996 is not available. Therefore, as a conservative approach, the RD assumes that the top 4 ft of soil as previously excavated soil.

When these areas are excavated for the remedial action, shallow soil (0-4 ft bgs) will be removed and stockpiled for possible use as backfill. The backfill soil will be characterized before reuse. The contaminated soil will be excavated, stockpiled, sampled for characterization, and then hauled off-site for disposal. Contaminated soils will be excavated starting with the Area 3, then Area 2, and lastly Area 1. Shallow soils from the surface to 4 ft will be excavated and stockpiled separately. Soils deeper than 4 ft will be excavated until cleanup levels are attained or until groundwater is encountered. Based upon the most recent groundwater elevation data, the average groundwater is found from approximately 24 ft bgs in Area 1 and 2, and approximately 12 ft bgs in Area 3.

3.3 Post-Excavation Confirmatory Sampling

Post-excavation confirmatory samples will be collected from each excavation area to confirm contamination has been removed before backfilling with clean soil. Additional (i.e., secondary) excavations will be conducted if contaminants are detected in the confirmatory samples above the cleanup levels. Confirmatory sampling for each excavation will consist of one 5-point composite bottom sample per 1,000 square ft of the excavation bottom and one 5-point composite sidewall sample per 1,000 sq ft of vertical sidewall. Each bottom sample will be composited from 0 to 3 inches at five points at the bottom of the excavation. The five points for each composite sidewall sample will be selected to represent the full height of the sidewall. Based on the primary excavation limits shown in **Sheet 01C101** in **Appendix A**, totals of approximately 11 bottom confirmation samples and 14 sidewall confirmation samples will be collected:

- Excavation Area 1: Approximately 3 composite bottom samples and 4 composite sidewall samples.
- Excavation Area 2: Approximately 3 composite bottom samples and 4 composite sidewall samples.
- Excavation Area 3: Approximately 5 composite bottom samples and 6 composite sidewall samples.

The results of the samples collected will be reviewed to verify the cleanup levels have been met. If a confirmation sample is above the cleanup level, additional soil will be removed (2 to 5 feet laterally and 1 foot vertically). After each secondary excavation, additional confirmation samples will be collected from the excavation bottom and/or wall(s) as needed. This process of excavations and collection of additional confirmation samples will continue until the cleanup levels are attained or until groundwater is encountered.

If contamination in low permeable soil at the soil/water interface is observed, then horizontal piping runs for future EISB injections will be installed at the bottom of the excavation to address potential groundwater contamination. # 2 stone shall be used for constructing the gravel bed for the piping runs. These piping runs will be used for future EISB injections to address potential groundwater contamination remaining after the implementation of the soil remedy in each area. Each piping run shall consist of a required horizontal length of 4-inch HDPE Schedule PVC, perforated with 0.25-inch slot spacing, glued at 90-degree joints to two upright sections of solid PVC, one at each end of the perforated section of PVC. The piping run shall be configured in the subsurface such that the perforated section was set horizontally with the solid uprights extending upwards to the surface where they will be covered with a protective cap secured with bolts.

Piping runs shall be installed in trenches excavated 4 to 6 inches deep into the low permeable soil layer and horizontal section of the pipes shall be installed on top of a gravel bed placed at the bottom of the trenches. The gravel bed is used as a conductive layer surrounding the perforated PVC pipe to promote migration of the EISB reagents into the low permeable layer. The trenches shall be backfilled with gravel first, surrounding the perforated PVC pipes, and then backfilled to the surface using clean fill.

3.4 Waste Characterization and Disposal

The excavated material will be transported and disposed of off-site at approved disposal facilities, in compliance with all federal, state, and local regulations. Waste characterization samples will be collected at a rate of one sample for every 250 cy of excavated soil to characterize the waste. Based on the estimated volume, four samples from Area 1, five from Area 2, and nine samples from Area 3 are anticipated to characterize the excavated materials. It is anticipated that soil will be classified as non-hazardous. Samples will be analyzed for the analytes required by the selected waste disposal facility.

Soils excavated below 4 ft from benching the excavation faces will be managed as excavated impacted soil and will need to be characterized prior to disposal. Shallow soils excavated from depths 0 to 4 ft and stockpiled separately will also be sampled to confirm that it meets the TCEQ Risk Reduction Standard No. 2 Soil MSCs for industrial use criteria for VOCs, explosives, and perchlorate. One sample from each excavation area will be collected to determine if the shallow soil can be reused for backfill.

3.5 Backfill and Site Restoration

Following the receipt of clean confirmation samples for a given excavation area, clean fill dirt meeting the clean-up criteria will be placed in the excavation and compacted with the backhoe/excavator bucket to prevent settling. The backfill will be suitable for future vegetation growth. Borrow source material will be considered clean if it meets the criteria for the satisfactory materials as listed in Section

1.2.B of Specification 31 23 00 Backfill, Compaction, and Grading (**Appendix H**) and the contract documents. Approximately 5,000 loose cy of clean backfill will be brought on site. Borrow source samples will be collected at a rate of one per 1,000 cy of borrow soil. The Site will be reseeded with a native grass and wildflower mix with guidance from USFWS.

3.6 Other Design Considerations

Several of the bridges at LHAAP have weight limits. Routes for trucks filled with excavated soil as well as for trucks bringing clean backfill from borrow sources will be selected with coordination from USFWS. Additional gates may need to be unlocked to allow access to and from LHAAP from another gate besides the main gate in Karnack to avoid bridges where weight limits may be exceeded with loaded trucks.

3.7 Implementation of Soil Excavation Remedial Design

This section describes the remedial action field activities planned at the Site for the unsaturated soil excavation. A RAWP for the unsaturated soil excavation and outside the containment area for disposal will be prepared and implemented. Prior to initiation of the field activities performed as part of the RAWP, the regulators will be notified at least 10 days in advance. Site-specific activities are described in associated subsections. The construction sequence for soil excavation is outlined below and described in detail in the following subsections:

- Mobilization and Site Preparation
- Surveying
- Soil Excavation and Disposal
- Confirmation Soil Sampling
- Backfilling and Site Restoration
- Reporting
- As-built Survey

3.7.1 Mobilization and Site Preparation

The following field activities will be conducted as part of the mobilization and site preparation activity.

- **Site Safety and Health:** The responsibility for the development, implementation, and enforcement of the Accident Prevention Plan (APP) and Health and Safety Plan (HASP) lies with the Contractor and its health and safety personnel. APP/HASP will be developed by the Contractor including programs for accident prevention, personnel protection, medical surveillance, site control/decontamination, emergency response/contingency planning, and air monitoring. The Contractor's APP/HASP will be submitted to the regulators for approval prior to the commencement of any Site activities.
- **Mobilization:** Appropriate personnel, subcontractors, and equipment necessary to perform excavation and disposal will be mobilized to the Site.
- **Site Access**: U.S. Army will be responsible for providing site access needed to complete the work. Improvement of the Site access road using geotextile and additional gravel may be performed to allow trucks and heavy equipment to enter and exit the Site safely. USFWS will be consulted regarding any improvements to minimize impact to the surrounding terrain to the degree possible.

- **Pre-Construction Documentation**: Prior to the start of any site preparation activities, a pre-construction video/photographic recording of the excavation areas will be conducted. This recording will document the existing conditions of the Site, and any other features of interest on and adjacent to the Site. The Contractor will enlist the services of a qualified surveyor, licensed in the State of Texas, to field verify the existing site conditions. This pre-construction survey will identify and mark-out the limits of construction, limits of excavation, existing site topography, property boundaries, and capture any and all structures and other existing physical features of the Site.
- **Clearing**: Prior to the mobilization, work locations for overhead and ground level accessibility will be evaluated. In areas that have excessive vegetation and/or tree growth, a backhoe or other appropriate earthmoving equipment will be used to clear the areas to allow equipment access. Grubbing is not anticipated. Clearing shall consist of the felling, trimming, and cutting of trees and other vegetation, as required to perform the work.
- **Utility Mark-outs**: After coordinating with underground utility locators for utility clearances, excavation locations and areas that require surface soil removal will be located and staked. Additionally, existing utilities associated with the GWTP as listed below but not limited to will need to be located based on the available information and soft dig methods to confirm that the excavation areas can be accessed for the purpose of excavating the contaminated soils.
    - ICT-8 and extraction line from ICT-8 near Excavation Area 1 & 2.
    - Injection lines from ICT-2 & 3 near Excavation Area 3.
- **Soil erosion and sedimentation controls (SESCs):** SESCs will be installed at the Site where necessary to prevent the migration of sediment into non-contaminated areas. The controls anticipated for use include but are not limited to the installation of silt fence around the area of disturbance, and hay bales and diversion berms to control storm water flow. Additional controls to prevent the migration of sediment may be employed if necessary.
- **Decontamination:** Equipment and personnel decontamination procedures should be included and detailed in the Site Safety and Health Plan. A permanent decontamination station is located inside the containment area LHAAP-18/24 GWTP and can accommodate large equipment. Temporary decontamination pads will be constructed or as needed at approved on-site locations to decontaminate equipment and prevent cross-contamination between the excavation areas. Wash water will be contained and transported to the GWTP for disposal when necessary.
- **Debris Removal**: Miscellaneous debris such as empty drums, pallets, polyvinyl chloride (PVC) pipes, small plastic water storage tanks, generators, concrete, and metal debris are present at three isolated locations (Open Burning Cage 003 Area, Open Burning Plan 155 Area, and from southern corner of the containment area) as shown on **Sheet G003** in **Appendix A**. These debris are required to be disposed off-site at an approved facility.

3.7.2 Surveying

The limits of excavation and locations of soil confirmation samples will be preliminary surveyed using global positioning system (GPS) equipment. A professional land surveyor licensed in the State of Texas will survey the final horizontal excavation limits, bottom of the excavation surface, and restored surface to the nearest 0.01 foot.

3.7.3 Soil Excavation and Disposal

The limits and plans for excavation are described in **Section 3.2**. Excavation of the soil will consist of preparing each excavation area, excavating the shallow soil and stockpiling it separately, excavating soil deeper than 4 ft, transporting and disposing of the soil, collecting confirmation samples, surveying the excavation limits, backfilling, and restoring the Site. Excavations performed under this remedial action are expected to be less than one acre in size and are not subject to the storm water pollution prevention requirements of Chapter 26 of the Texas Water Code and TCEQ General Permit (TXR150000). However, best practices (silt fencing, berms, etc.) will be used where appropriate to prevent excess runoff of sediment from the excavation and stockpile areas.

3.7.3.1 Area Preparation

The areas to initially be excavated, as shown on the design drawings, will be first established using the GPS and excavation limits will be physically marked with survey stakes, pin flags, paint, or other appropriate marking. Clearing of the vegetation in the excavation area will largely be conducted using conventional equipment. A temporary decontamination station will be constructed near the area of excavation as needed. Most of the Site is an open field with low vegetations and will be used for construction staging. However, if required, a portion of the Site near each excavation area will be cleared for construction of a temporary soil staging/stockpile area. A temporary area consisting of berm with polyethylene sheeting will be constructed for stockpiling soil prior to collecting waste characterization and off-site transport and disposal.

3.7.3.2 Soil Excavation and Disposal

Excavation in each area will be initiated after the preliminary excavation limits are established. Since the excavation depths will exceed 4 ft, each side of the excavation will either be benched, or shoring (sheet piling) will be installed for safety reasons for the persons entering the excavation area. Vertical excavation will stop if groundwater is encountered.

A selected disposal facility will require sample collection and/or evaluation of existing soil data for characterization of the waste and provide pre-excavation acceptance of the soil from these select areas. If possible, pre-excavation acceptance will allow direct loading of contaminated soil and avoid staging and double- handling of material. In these instances, the soil will be removed from the excavation and placed directly in transport trailers or dump trucks for immediate transport to the disposal facility. Licensed transporters will be used to haul the excavated soil to the pre-approved landfill for non-hazardous disposal.

If the direct loading is not implemented, then, the excavated soil will be staged on plastic sheeting adjacent to the excavation while awaiting loading. The excavated soil stockpile will be protected from rainfall runoff and erosion by covering it with plastic sheeting.

Composite samples will be collected from the stockpiled material at a rate of 1 sample per 250 cy and analyzed for the necessary analytes to obtain acceptance at the selected disposal facility. Each composite sample will consist of equal parts of five samples collected at evenly spaced locations within the stockpile. The fully characterized excavation stockpile soil will be loaded onto dump trucks and removed from the Site for proper disposal in accordance with state and federal regulations. Loading of trucks will be coordinated with USFWS to ensure that load ratings for bridges along the haul route out of the refuge are not exceeded.

3.7.4 Confirmation Soil Sampling

Confirmation soil sampling will be conducted concurrently with excavation and will document that the remaining soil meets the established cleanup levels as shown in **Table 1-3**. After the initial excavation, confirmation samples will be collected from the sidewalls and floor of the excavation. Excavation will continue until concentrations in the soil are less than the soil cleanup levels. The Contractor shall be responsible for selecting appropriate confirmation sample locations based on the design requirements stated on **Sheet 01C101** in **Appendix A**.

GPS coordinates of each discrete sample location will be recorded. Vertical wall height will be manually measured and recorded. Each sample location will be numbered sequentially in order of collection, labelled on a map, and identified using the nomenclature provided in the approved RAWP.

If contaminants are detected above their cleanup levels during the confirmation sampling, secondary excavation will be performed 2 to 5 feet laterally and 1 foot vertically. The extent of the secondary excavation (2 to 5 ft) will consider the concentrations detected in the sidewall sample, and the bottom sample will consider the anticipated depth to groundwater. This will continue until confirmation samples demonstrate the contaminants remaining in the soil are below their cleanup level or until groundwater is encountered.

In the event that groundwater is encountered, and a bottom sample cannot be collected, only sidewall samples will be collected from each excavation sidewall just above the groundwater interface to represent the bottom sample above the groundwater. If the sidewall sample is above the cleanup level, then additional excavation of the sidewall will be conducted to the groundwater interface depth, and additional excavation step outs and confirmation sampling would continue until the confirmation sample results are below the cleanup levels. The confirmation samples will confirm that the vadose zone soil identified as exceeding the cleanup levels would be removed.

3.7.5 Backfilling and Site Restoration

The backfill operations will proceed after excavation confirmation samples are clean for a definable area. The excavation areas will be backfilled with the shallow clean soil excavated from each respective area and with fill material that is certified to meet the Site-specific cleanup levels. If the soil is saturated from rain events, the bottom of the excavation will be stabilized with an appropriate product that will not adversely impact the soil pH prior to placing the backfill. The backfill will be placed in 1-foot lifts to allow proper compaction with a backhoe/excavator bucket. After backfilling is complete, the area will be graded, with a mound approximately one foot above finished grade to allow for settling without creating a depression and positive drainage. The top six inches will have a soil that will be suitable for vegetative growth. The surface will be reseeded with a native grass and wildflower seed mixture selected in coordination with USFWS.

3.7.6 Reporting

After the soil excavation remedial action has been completed, a removal action completion report will be prepared to document the implementation of the remedial action. The removal action completion report will include a description of the remedy as constructed, a discussion of any problems encountered during construction along with their resolution, a description of any changes to the design, and quantities and concentrations of contaminants removed. The report will also include documentation of all waste manifests or waste disposal tickets and results of all analysis.

3.7.7 As-Built Survey

Final restoration will be documented by an as-built drawing. The drawing will include the location of all soils removed indicating the surveyed limits of the excavation and location of all documentation samples. Information will be certified by a State of Texas licensed Engineer.

4 IN-SITU THERMAL DESORPTION DESIGN FOR DNAPL TREATMENT

The installation and operation of ISTD will follow the completion of the excavation activities described in Section 3. The PSI and Final Revised FS delineated the extent of areas with DNAPL for implementing ISTD. The ISTD treatment consists of the application of heat to the subsurface to mobilize COCs. The ISTD treatment is applicable to sites with low to moderate groundwater flow rates [less than 1 foot per day (ft/day)] and treats VOCs effectively in both saturated and in unsaturated conditions. The main concern with applications in the saturated zone is groundwater velocity of greater than 1 ft/day, which results in heat losses that need to be controlled. As shown in **Table 1-1**, the estimated groundwater velocity for the Site including within and outside of the containment area vary between <0.01 and 0.33 ft/day which is well below the threshold limit of 1 ft/day for implementing the ISTD treatment at the Site.

A variety of methods may be applied to generate heat, including ERH and TCH. While TCH achieves heating by simple thermal conduction, ERH generates heat when subsurface media resists an electrode-induced electrical current flowing through pore water only under saturated conditions. The presence of metal debris and pipes may prevent uniform heating under the ERH application. The heat generated by either electrical resistance or thermal conduction typically can raise subsurface temperatures to around the boiling point of water or higher. The steam produced from pore-water serves as a medium to carry out volatilized VOCs for capture via SVE and subsequent ex-situ treatment of extracted vapors. In addition, the applied heat can increase hydrolysis of chlorinated solvents, such as TCE and MC and promote in-situ biological activity in two ways. First, biological activity is boosted by moderately high temperatures (30 °C) found at the periphery of the heated area during active thermal treatment, and throughout the heated area as it cools. Second, high temperatures solubilize contaminants out of DNAPL into the groundwater matrix, making the contaminants biological available when concentrations are not toxic to the microorganisms.

Either ERH or TCH is a viable technology at the Site and will be evaluated by the Contractor prior to final technology selection. TRS Group conducted soil resistivity testing of the Site soil as per ASTM Method G187-12a in 2014 (AECOM, 2017). The resistivity tests determined that the soil with resistivity values in the range of 15 to 35 ohm-m was amenable to ERH. However, TCH is also a viable technology based on the preliminary evaluation of site-specific parameters conducted by the industry professionals. According to the white paper published on thermal remediation technologies for treatment of chlorinated solvents, thermal treatment and extraction can remove up to 99.9% of residual DNAPL mass, even within low permeability zones including fractured bedrock (CDM Smith, 2018). Thermal treatment can also enhance mobilization of organic matter from the soil to groundwater, which will act to enhance biodegradation of the COCs. Additionally, research has shown that slightly higher ambient soil temperature imposed by the thermal treatment process during startup and cool down periods during the winter months will potentially increase the biodegradation in ambient soil temperature up to approximately 30 to 35°C above which bacterial activity would decrease (USEPA, 2015). Groundwater extraction near the thermally treated areas will be temporarily stopped to reduce the groundwater flux through the area, which requires additional heating capacity. New power supply is included for implementing the ISTD system.

4.1 Design Criteria

Site cleanup levels for the Shallow Zone groundwater and Wilcox Formation groundwater are listed in **Table 1-4**. The performance goal for the ISTD treatment to meet is listed below:

- Saturated Soil
    - Methylene Chloride 0.5 mg/kg
    - Trichloroethylene 0.5 mg/kg
- Groundwater
    - Methylene Chloride 100 µg/L
    - Trichloroethylene 100 µg/L

4.2 ISTD Treatment Areas

Soil sampling conducted in the spring of 2013 identified the presence of elevated MC and TCE indicating DNAPL at 18CPT21 between approximately 48 and 51 ft bgs and at 18CPT27 between approximately 23 and 35 ft bgs [see Appendix F of the Updated PSI Report (AECOM, 2016a) for estimation of soil concentrations above which DNAPL might be implied; and Appendix A of the same Report for membrane interface probe (MIP) logs indicating the presence of VOCs in the intervals indicated]. Location 18CPT21 is located beneath the former UEP and 18CPT27 is located within the former ACD area. Figures D-5 and D-6 of **Appendix C** show the MC plume based on June 2021 data for ISTD Area 1 in the Shallow Zone and Wilcox Formation, respectively.

Further delineation of the potential presence of DNAPL was conducted between April and September 2014 in the former ACD area surrounding location 18CPT27 and in the UEP area location 18CPT21. Cone penetrometer test (CPT)/MIP was driven at 11 locations surrounding 18CPT27 in the vicinity of the ACD area and 18 locations surrounding 18CPT21 to determine the presence and potential extent of DNAPL in the saturated zone.

Former ACD Area: The results from the 2013 and 2014 PSI Investigation indicated the presence of DNAPL in another location (18CPTACD03) approximately 50 ft to the southwest of 18CPT27 and in the same general interval of approximately 23 and 35 ft bgs. TCE concentration was reported at 2,830,000 µg/kg in the sample at 26 to 27 ft bgs, exceeding the calculated soil saturation limit of 414,476 µg/kg for TCE in fine-grained soil to 404,008 µg/kg for TCE in coarse-grained soil (AECOM, 2017).

Former UEP Area: The results from the 2013 and 2014 PSI Investigation did not identify the potential presence of DNAPL in any other location near former UEP area, except at previously identified location 18CPT21. Additionally, potential migration pattern of DNAPL from the 18CPT21 area was evaluated and it was concluded based on the findings from the PSI, that the extent of DNAPL at 18CPT21 would remain confined primarily beneath the former UEP area. At 18CPT21, the sample collected at 27 to 28 ft bgs from a coarse- to fine-grained soil indicated the presence of high concentrations of VOCs (no perchlorate detected) but much lower (two orders of magnitude) than the concentrations at 48 to 49 ft bgs (Wilcox clay) where DNAPL was identified.

Based on the findings from the PSI, the extent of DNAPL is identified as ISTD Area 1 in the UEP area and ISTD Area 2 in the former ACD area, as shown on **Sheet 01C201** in **Appendix A**. The DNAPL extent in ISTD Area 1 was governed by the results identified in 18CPT21 and the high concentration of MC in MW-2, implying presence of DNAPL in the vicinity of MW-2. The DNAPL impacted soil depth interval is characterized by fine-grained soil (i.e., Wilcox clay) as the investigation concluded that DNAPL has migrated into the fine-grained soil, but none was observed in the overlying coarse-grained soil. Furthermore, the extraction of groundwater in this area of the Site has most likely resulted in the

removal of the majority of DNAPL from the coarse-grained soils via physical extraction, and via enhanced dissolution and volatilization.

The removal of DNAPL within the lower permeability zones (fine-grained soil) is required to prevent potential impediments of remediating the Site. The presence of the majority of DNAPL/residual mass in lower permeability zones would hinder contaminant extraction or distribution of substrates for in-situ treatments. Therefore, ISTD treatment will be implemented in these areas, ISTD Area 1 and 2 in the source area, where residual DNAPL has been identified during the multiple PSI conducted in 2013/2014.

As listed in **Table 4-1**, ISTD will be implemented to remove residual DNAPL in ISTD Area 1 and 2 as shown on **Sheets 01C201**, **01C202**, and **01C203** in **Appendix A**. In Area 1 near the former UEP, ISTD will be performed over 40,000 square ft at an approximate target depth from 48 to 51 ft bgs. In Area 2, near the former ACD, ISTD will be performed over 7,500 square ft at an approximate target depth from 23 to 35 ft bgs. The remaining ISTD areas will be treated to a depth from approximately 28 to 40 ft bgs in the ISTD Area 3 near former Open Burning Pans 155 and 156, near the center of the Site's southwestern edge. The total ISTD area encompasses approximately 103,500 square ft and a total impacted volume of 32,680 cy.

It is anticipated that system installation and start up will take approximately 6 months. The system will then operate for the period of time required to reach the groundwater cleanup levels. It is estimated that system operation and decommissioning will take approximately 9 months. Prior to decommissioning the system confirmatory samples will be collected to verify cleanup levels have been achieved. The Site will then be restored to its original condition.

4.3 ISTD Area Characteristics

ISTD areas will be implemented for the area/zones and depths bgs provided in **Table 4-1** and as depicted on **Sheet 01C201** in **Appendix A**. ISTD treatment will be provided to the depth of contaminated saturated zone specified to ensure complete treatment of the contaminated zone. The total ISTD area encompasses approximately 103,500 square ft and a total impacted volume of 32,680 cy.

Predominant features of the Site's geology based on the 2013 PSI are identified as follows:

- Two main hydrogeologic zones are present at the Site: A Shallow Zone between the ground surface and a depth of 10 to 45 ft bgs, which is underlain by the Wilcox Formation.
    - The alluvium is comprised of intermixed depositional environment of fine-grained soil (e.g., silt and clay) and coarse-grained soil (primarily fine sand). The coarse-grained soil created by levee deposits and channel deposits create a network of pathways for contaminant migration. The thickness of the Shallow Zone becomes smaller closer to Harrison Bayou to the northwest of the Site.
    - A Wilcox clay layer (0 to 20 ft thick) is identified across the majority of the containment area, separating the Shallow Zone from the Wilcox Formation. The Wilcox clay thins out in the northwestern corner of the containment area and to the west and to the north of the containment area. In these areas, there is a vertical communication between the Shallow Zone and the Wilcox Formation. The Wilcox clay unit is present over the majority of the areas of proposed active remediation.
    - The Wilcox Formation is comprised primarily of silty fine sands and fine sands, although clay deposits have also been observed within the Wilcox Formation.

DNAPL at 18CPT21 in ISTD Area 1 was located at the top of Wilcox clay layer at a depth of 48 to 51 ft bgs in the silty clayey sand to silty clay zone. Assessment of potential migration of DNAPL at this location determined that the DNAPL at 18CPT21 will remain confined primarily beneath the former UEP. DNAPL at 18CPT27 in ISTD Area 2 is mainly held in the Wilcox clay, but potential downward leakage of TCE into the underlying Wilcox Formation was implied based on the analytical results (AECOM, 2013).

Localized groundwater within each ISTD area is first encountered in the Shallow Zone at a depth ranging from 24 to 26 ft bgs in ISTD Area 1 & 3 and 8 to 10 ft bgs in ISTD Area 2. As shown in **Table 1-1**, an estimated groundwater flow velocity of 0.01 ft/day for ISTD Area 1 and 0.02 ft/day for ISTD Area 2 was determined based on the available hydraulic conductivity, effective porosity, and horizontal gradient data.

4.4 Implementation of ISTD

This section describes the remedial action field activities planned at the Site for the ISTD treatment implementation. The Contractor will be responsible for the selection and implementation of the ISTD treatment technology (e.g., resistive heating [ERH] or conductive heating [TCH]) and specific means and methods appropriate for the Site and cost-effective for the project, in accordance with the requirements of this Section. A RAWP for the implementation of the selected ISTD treatment will be prepared and implemented. Prior to initiation of the field activities performed as part of the RAWP, the regulators will be notified at least two weeks in advance. Site-specific activities are described in associated subsections. The construction sequence for the ISTD treatment is outlined below and described in detailed in the following subsections:

- Preparation of the ISTD Treatment Work Plan
- Mobilization And Site Preparation
- New Utilities
- Surveying
- ISTD Treatment System Installation
- System Operation
- Confirmatory Sampling and System Shut Down
- Shutdown
- System Decommissioning
- Demobilization
- Site Restoration and Project Closeout
- Residual Management
- Reporting

4.4.1 Preparation of ISTD Treatment Work Plan

As part of the RAWP, the Contractor will prepare and submit for approval an ISTD Treatment Work Plan in accordance with applicable sections of EM 200-1-21, Design: In Situ Thermal Remediation (U.S. Army, 2014). The Contractor will submit for an approval a draft ISTD Treatment Work Plan. The Contractor shall submit a final Work Plan incorporating comments. The Work Plan will provide a detailed description of the selected ISTD technology equipment, construction procedures, and operations, as well as all associated field activities. The ISTD Work Plan will address all items specified in this section as listed below and other relevant information including detailed information to verify

that it meets substantive requirements and a project schedule. The ISTD Treatment Work Plan will need to include the following information:

- A basis of design for its selected ISTD equipment and approach, including mass calculation, targeted design temperature, heating element layout/spacing, and design approach/basis for vapor/liquid treatment equipment.
- Modeled estimates of energy need for optimal temperature increase and duration necessary
- Equipment sizing
- Mobilization and site preparation
- Well-field layout (number, spacing, depths of heating elements/wells, all other wells)
- Process piping and instrumentation diagrams
- Electrical one-line diagrams
- Vapor/liquid collection and treatment system layout plans
- Component process flow diagrams
- The estimated amount of energy, water, fuel, and other consumable materials (e.g., granular activated carbon) to operate the ISTD system during the duration of the treatment period
- Other information as required to describe the design, construction, and operations approach of the system to implement the remediation in accordance with the ISTD Contract Documents

4.4.1.1 ISTD Design Calculations

An estimate of the DNAPL and VOC mass to be addressed by the ISTD treatment will be developed by the Contractor and the basis/rationale for their mass estimate calculations will be included in their ISTD design provided in the Work Plan. The Contractor will be responsible for appropriately designing, procuring, installing, and operating all required ISTD treatment equipment based on their understanding of the ISTD areas and other site characteristics. The Work Plan will include an evaluation of the potential range in the mass estimate based on the degree of uncertainty in the calculations, and a discussion of the factors of safety incorporated into the process design (e.g., equipment sizing/selection) to accommodate the potential range in mass. In addition, the Contractor will be providing all other equipment/operational measures required to address any other characteristics of the ISTD areas (e.g., metals, soil total organic content, moisture content) and/or other relevant Site conditions (e.g., groundwater flow), as obtained through available site data/historical reports, that may affect their ISTD treatment operations and/or compliance with associated air emissions/liquid discharge requirements. If the Contractor identifies any data gaps/additional data needs as part of their bid preparation, then they will need to identify the data collection requirements and associated costs in their bid.

4.4.1.2 ISTD Design

Location, number and design of monitoring wells, extraction wells and monitoring points will be provided by Contractor in site plan layouts included with their ISTD Treatment Work Plan. Capabilities will be incorporated into the Work Plan to allow safe and effective monitoring of vapor concentrations, air pressures and vacuums, air flows, water flows, and subsurface temperatures over the course of the treatment and post-treatment periods.

If the Contractor determines that either existing ICT, extraction wells or other measures (e.g., hydraulic barriers) are needed in order to maintain hydraulic control of the ISTD area during the ISTD operations, the Contractor will need to clearly indicate the proposed number, locations, and depths of the

extraction wells, and indicate the anticipated groundwater extraction rates required for maintaining hydraulic control throughout the operations period.

The Contractor will need to perform performance monitoring at a minimum of three monitoring wells (existing and/or new) per each ISTD area to determine the effectiveness of the system. If required, the Contractor will install new downgradient monitoring wells approximately 30 ft downgradient from the ISTD boundary and screened appropriately for each area. The new and/or existing monitoring wells will be monitored monthly for VOCs and temperature during ISTD operations, including once prior to commencement of ISTD operations to establish baseline conditions. Results with elevated VOCs (e.g., concentrations greater than 1 order of magnitude above baseline conditions) or elevated temperatures above baseline conditions may trigger additional action such as more frequent monitoring, adjustment of ISTD operations, or implementation of additional groundwater extraction or hydraulic control measures.

4.4.2 Mobilization and Site Preparation

The following field activities will be conducted as part of the mobilization and site preparation activity.

- **Site Safety and Health:** The responsibility for the development, implementation, and enforcement of the APP and HASP lies with the Contractor and its health and safety personnel. The APP/HASP will be developed by the Contractor including programs for accident prevention, personnel protection, medical surveillance, site control/decontamination, emergency response/contingency planning, and air monitoring. The Contractor's APP/HASP will be submitted to the regulators for approval prior to the commencement of any on-site activities.
- **Pre-Mobilization Activities:** Prior to commencing field work, a pre-construction meeting will be held. USEPA, TCEQ, and USFWS will be notified of the meeting at least two weeks prior. Prior to mobilization for any field activities, the Contractor will secure any applicable approvals and notifications, which can include federal, state, and local requirements (i.e., underground injection control, notification of Texas 811). The Contractor will also secure utility clearance, where applicable, for water, sewer, gas, electric, and communication.
- **Site Access:** U.S. Army will be responsible for providing site access needed to complete the work. Improvement of the Site access road using geotextile and additional gravel may be performed to allow drilling and heavy equipment to enter and exit the Site safely.
- **Mobilization:** Appropriate personnel, subcontractors, and equipment necessary to install and operate ISTD treatment system, including the ISTD well-field installation and liquid and vapor recovery and treatment systems, will be mobilized to the Site.
- **Pre-Construction Documentation:** Prior to the start of any site preparation activities, a pre-construction video/photographic recording of the ISTD areas will be conducted. This recording will document the existing conditions of the Site, and any other features of interest on and adjacent to the Site. The Contractor will enlist the services of a qualified surveyor, licensed in the State of Texas, to field verify the existing site conditions. This pre-construction survey will identify and mark-out the limits of ISTD areas, existing site topography, site features, property boundaries, and capture any and all structures and other existing physical features of the Site.
- **Clearing:** Prior to the mobilization, work locations for overhead and ground level accessibility will be evaluated. In areas that have excessive vegetation and/or tree growth, a backhoe or other appropriate earthmoving equipment will be used to clear the areas to allow equipment

access. Grubbing is not anticipated. Clearing shall consist of the felling, trimming, and cutting of trees and other vegetation, as required to perform the work.

- **Utility Mark-Outs:** After coordinating with underground utility locators for utility clearances, excavation locations and areas that require ISTD treatment installation will be located and staked. Additionally, existing utilities associated with the GWTP as listed below but not limited to will need to be located based on the available information and soft dig methods to confirm that the ISTD areas can be accessed for the purpose of installing the systems.
    - ICT-8, EW-1, and extraction line from ICT-8 in ISTD Area 1.
    - Well AWD-1 located near ISTD Area 2.
    - ICT-4 line to the header pipe, ICT-12C and well 18CPRMW03SW in ISTD Area 3.
    - All extraction lines within or near the ISTD areas.
- **Decontamination:** Equipment and personnel decontamination procedures should be included and detailed in the Site Safety and Health Plan. A permanent decontamination station is located at the on-site LHAAP-18/24 GWTP and can accommodate large equipment. Temporary decontamination pads shall be shown on drawings included as part of the RAWP and shall be constructed at approved on-site locations to decontaminate equipment and prevent cross-contamination between the drilling locations. Wash water will be contained and transported to the GWTP for disposal when necessary.
- **Utility Protection:** Existing features including ICT-8, EW-1, Well AWD-1, ICT-12C and well 18CPRMW03SW will require protection during the thermal treatment period since it may compromise these features. However, the location where ISTD will be implemented is relatively far from ICTs and direct impact is not anticipated. In addition, the existing horizontal high-density polyethylene (HDPE) conveyance piping is located within the first five feet from the ground surface and will not be affected by ISTD heating.

4.4.3 New Utilities

Overhead power lines are located along the access road located along the northeast site boundary within the containment area. The capacity of the existing overhead lines at the LHAAP-18/24 site is about 240 volts, 420 volts at the existing GWTP and approximately 7,200 volts coming in the LHAAP.

The Contractor will be responsible for the design, procurement, and installation of the primary power service drop to supply all required power for the Contractor's selected operations, including all required coordination with/submittals to the local power utility company. The Contractor's power service design will need to include all coordination required with local power utility representatives and engineering support required to confirm the adequacy of the existing overhead service at the Site along the containment area boundary for supporting the Contractor's power needs, based on the Contractor's selected ISTD technology and operations approach. The power service drop installation will include all infrastructure required to connect to the existing overhead power service at the main transformer located on the LHAAP facility, and to bring the required power to the Contractor's ISTD infrastructure, including furnishing and installation of all conductors, conduits, trenching work, transformers, metering equipment, primary and secondary power distribution equipment, and grounding, fencing, or other safety and security measures. The power service drop will include separate service metering as required to allow for tracking of the Contractor's power usage/costs. The Contractor is advised that the design, coordination with regulators and approvals, procurement, and installation of the power service drop may require an extended time period, and that the scheduling for these activities shall be incorporated into the pre-construction period in the Contractor's project schedule. The Contractor

shall notify the U.S. Army if additional submittal reviews are needed prior to Work Plan approval in order to facilitate power drop coordination.

During the ISTD operations, the Contractor will be responsible for all utility costs associated with energy, water, fuel, and other consumable materials to operate all equipment related to the ISTD treatment system. The Contractor will also be designing, coordinating with the regulators for approvals, furnishing, and installing all utilities required to support the selected operations, as listed below:

- Process Water Supply – treated water from the nearby existing GWTP is available at the Site and will be provided to the Contractor.
- Water Discharges – Wastewater generated from the ISTD operations will be contained and transported to the GWTP for treatment when necessary.
- Secondary Containment – All liquid storage and treatment equipment shall be secondarily contained within impermeable surfaces suitable to contain a spill or release of liquid. Impermeable means having a maximum permeability for any hazardous substance that is being contained of 10^{-7} centimeters/second at the maximum anticipated hydrostatic pressure. The secondary containment system shall be capable of containing the volume of the largest container plus 6 inches of stormwater if the area is exposed to stormwater.

4.4.4 Surveying

The limits of ISTD areas and locations of well points will be surveyed preliminarily using GPS equipment. A professional land surveyor licensed in the State of Texas will survey the performance borehole/well locations to the nearest 0.01 foot.

4.4.5 ISTD Treatment System Installation

4.4.5.1 ISTD Well-Field Installation

Two separate ISTD treatment systems, one for ISTD Area 1 and the other for ISTD Area 2 and 3 will be installed based on the selected thermal technology. The following elements (subsurface and aboveground components) of the each ISTD treatment system will be installed as part of the well-field installation:

- Heating elements
- Temperature and pressure monitoring points
- Vapor recovery extraction wells
- Vapor recovery vacuum monitoring points
- Groundwater monitoring and extraction wells
- Soil vapor treatment.

Heating elements, wells and monitoring points will be suitable for the selected thermal technology and will be constructed and installed in accordance with 16 TAC 76.1000 and other applicable local, state, and federal regulations, statutes, and codes. Contractor will secure any applicable approvals and notifications, which can include federal, state, and local requirements (i.e., Section 76.1000 for well installation, underground injection control, and notification of Texas 811) prior to the commencement

of drilling and well installation operations. All required utility clearances will be completed prior to conducting invasive activities.

All heating elements and monitoring points/wells will be installed in accordance with the approved Work Plan. Drill cuttings and other waste generated during installation will be containerized and disposed off-site. Installation of heating elements and monitoring points/wells may require penetration through slabs and other materials. The Contractor will be required to review the current site conditions, available utility maps, utilities associated with the GWTP, and other available site information prior to submitting the ISTD work plan when proposing intrusive site activities. Drawings showing details and locations of the electrodes and monitoring points will be provided as part of the Work Plan. Locations for the heater elements and monitoring points/wells within each treatment area will be surveyed to verify correct placement of the required ISTD treatment components within each ISTD area. Existing monitoring wells, extraction wells and ICTs located within the containment area, but outside the ISTD area will also be monitored by the Contractor to determine if they are impacted by the ISTD system.

4.4.5.2 Liquid And Vapor Recovery and Treatment Systems Installation

A detailed installation procedure of the ISTD treatment liquid and vapor recovery equipment, and site plan layouts/figures depicting the locations of all proposed equipment will be included in the ISTD Treatment Work Plan prepared for the Site. All the components to be used and where they will be assembled will be communicated prior to the installation. Site preparation for recovery system equipment installation prior to delivery may include preparing staging area and secondary containment. The equipment location, power requirements, acquiring new utility service during treatment, location of the heating elements, wells, and monitoring points, as well as any trenching, compaction, or construction requirements will be included in the ISTD Treatment Work Plan. Existing access roads within the Site boundary can be used to access the ISTD areas; however, if required, include additional safe and stable access for sampling equipment (e.g., drilling rigs) to enter the ISTD wellfield for purposes of collecting soil/groundwater samples for demonstrating attainment with the performance objectives identified in **Section 4.1**.

The ISTD Treatment Work Plan will indicate whether any thermal insulating cap or cover is required for the selected ISTD treatment implementation, and any thermal insulating cap(s) or cover(s) with proper grading and sloping will be installed as necessary to prevent stormwater ponding on the cap. At a minimum, the cap/cover will include a low-permeability vapor barrier (e.g., geomembrane) to mitigate the potential for fugitive emissions from the well-field surface during ISTD operations. Any backfill required during the installation of liquid and vapor recovery piping, will meet the definitions of certified clean fill requirements in accordance with **Section 3.7.5**.

All necessary electric service to the system will be installed in accordance with state, local, and National Electrical Codes and requirements. All wiring, conduits, and interconnections will be installed appropriately for a fully operable system. Power feed wiring and distribution cables, lighting, ventilation fans, heaters, disconnects, instrumentation, controls, and other requirements will be required to be furnished and installed as necessary.

A suitably sized source of back-up/secondary power (e.g., generator) to allow the ISTD vapor/liquid recovery and treatment equipment and all monitoring systems and controls will be included to continue uninterrupted operation in the event of a loss in utility power (back-up power for the well-field heating elements is not required). The back-up power source will need to allow for a minimum of 24 hours of

operation without the need for re-fueling. A back-up mode will last up to the same duration it identifies as the operational period after shutdown, if necessary, to control migration of contaminants outside of the ISTD areas.

All electrical work for the installing and operating the ISTD treatment system will be required to meet National Electrical Code (NEC), National Fire Protection Association (NFPA), and Occupational Safety and Health Association (OSHA) requirements for hazardous locations. Proper electrical grounding will be installed for all equipment as applicable.

All piping and other lines will be constructed in such a manner (sloped) to prevent any media from condensing or collecting where it would not be recovered or otherwise interfere with effective operations. The use of PVC piping in any part of the system that will store/transport compressed gases is not recommended. When completed, the system construction details will be submitted as part of As-Built drawings. All piping and other materials of construction will meet the anticipated temperatures, pressures exhibited from compressed gases, and pH levels in that part of the system or those specified by manufacturers of component equipment, particularly those after the vacuum blower or oxidation/scrubber units, if present. Piping, hoses, and orifices to be installed are of sufficient size to transmit soil vapor, groundwater/process water, blow-down, treated air, and other media without any significant over-pressure, pressure drop or restriction to the system. All piping/connections will be installed, properly supported, and maintained in a neat and workmanlike manner.

4.4.6 System Operation

ISTD treatment system operations will be on a 24-hour per day basis, from heating commencement through completion.

4.4.6.1 Safety and Environmental Controls

The Contractor will be required to ensure that no excessive steam pressure is created in the subsurface that can create hazardous site condition. The ISTD will be operated in a manner that minimizes migration of the impacted groundwater plume, and effectively captures soil gas vapors within the established heating area. If electric heating is used, then stray voltage will need to remain below 15 Volts within the Site boundaries. It will be ensured that no surface expression of excessive heat, steam or electrical current is occurring at the Site. Shallow vacuum monitoring points will need to be installed every 50 ft around the perimeter of the ISTD areas and weekly monitoring will be conducted to ensure negative pressure at these locations. Fifty-foot spacing between the vacuum monitoring points is typical for the Site with silty sand geological condition. Weekly monitoring will be conducted to ensure negative pressure at these locations (proposed by the Contractor) as specified in **Table 4-2**.

4.4.6.2 VOC Removal and Emissions

The vapor recovery will be performed throughout the heating operations and as required during the additional operating period following the heating shutdown. All recovered vapors will be treated for removal and/or destruction of VOCs. Emission rates and monitoring/reporting requirements will be consistent with the Air Contaminants – General Nuisance Rules (30 TAC 101.4). The method of VOC treatment will be provided in the approved Work Plan. The Contractor will provide emergency back-up power for operation of all extraction and treatment systems in the event of utility power interruption.

4.4.6.3 Process Monitoring Requirements

Process Monitoring will be required to monitor Contractor performance toward meeting the Performance Criteria. Process monitoring shall be performed by the Contractor throughout the ISTD treatment program (before, during, and immediately following shut-down). At a minimum, process monitoring will include the following parameters. Parameters are to be monitored in real time and their recommended reporting frequencies during the remediation process are indicated in **Table 4-2**.

- **Temperature:** Contractor will obtain temperature measurements on a continuous basis at a minimum of one monitoring location for every 2,500 square feet of heating area footprint, and at the periphery of each ISTD area, to document the changes in subsurface temperature of saturated soils. The locations and numbers of temperature monitoring locations may be adjusted based on the Contractor's review of the specific targeted heating area geometry and depth variations. These locations will provide temperature monitoring across the horizontal extents of the treatment area and at regular and discrete vertical intervals (minimum every 5 feet, or more frequently as specified by the Contractor) throughout the treatment zone volume, as described/depicted in the Contractor's ISTD Treatment Work Plan and associated plans/figures.
- **Heating Duration:** The Contractor will operate the system continuously, 24 hours a day, 7 days a week. Once minimum temperatures have been reached, the Contractor will continue operating the system for the duration needed to allow monitored natural attenuation to take over as the primary mechanism for DNAPL and VOCs removal from subsurface. Individual components and total system up-time operations shall be tracked and documented. The Contractor shall specify the means and methods used to monitor power consumption (both instantaneous and cumulative), as well as consumption rates for other required utilities/services (e.g., water service).
- **Recovered Vapor Flow:** Contractor will operate vapor recovery system components to optimize removal of water vapor and volatilized VOCs from the subsurface based on its selected ISTD technology. Vacuum and flow rates shall be monitored and managed to maximize mass removal from the subsurface and control migration of contaminants outside of the targeted ISTD areas. Measurements shall regularly be obtained and recorded to confirm mass removal, both at discrete times and cumulatively.
- **Safety and Environmental Controls:** Contractor will operate the system and monitor key indicators to ensure that certain conditions are under control. These include monitoring of subsurface pressures and vapors to prevent enhanced migration of contaminants outside of the targeted ISTD areas and to outside of containment area. Stray voltage monitoring shall also be performed regularly to document safe conditions both within and outside containment areas. The Contractor's ISTD Treatment Work Plan will indicate the proposed locations and means and methods for collecting field measurements to evaluate pneumatic capture and stray current potential. If monitoring of these last two parameters indicates exceedances, mitigation steps shall be necessary to ensure continued operation of the system. The Contractor's ISTD Treatment Work Plan will also include required safety and environmental controls to ensure effective and safe operation of the system during inclement weather. These measures may include site preparation with proper grading and drainage to minimize water accumulation and the potential for runoff, weather monitoring, erosion, and sediment controls, necessary containment measures to prevent contaminants from migrating, and adequate worker safety measures. The Work Plan will need to outline procedures for system monitoring (i.e.,

emergency shutdown), maintenance, and damage mitigation during/after adverse weather conditions, to enable the identification of potential issues or malfunctions.

- **VOC Vapor Destruction Efficiency:** Contractor will need to provide appropriate collection and treatment of recovered vapors and operate and monitor the vapor collection and treatment system in compliance with the Air Contaminants – General Nuisance Rules (30 TAC 101.4), based on their selected ISTD implementation approach and associated air emissions control equipment.
- **Process Water:** Contractor shall continuously monitor recovery of process water and generation of process blowdown as indicators of water balance with groundwater in the area of the Site. Contractor will need to provide their required process water supply needs (e.g., flow rates, water quality) and all anticipated wastewater (e.g., extracted groundwater, blow-down, steam condensate) information (rate, quality, location, estimated volume, etc.) in the ISTD Treatment Work Plan. Documentation of the ISTD process water, blowdown, and drip irrigation stream flow (if applicable) and total volumes shall be provided during operation. Wastewater generated from the ISTD operations will be contained and transported to the GWTP for treatment when necessary. The Contractor will be solely responsible for any discharge violations resulting from their operations. The Contractor will provide emergency contingency storage capacity (including secondary containment) to allow for temporary accumulation of untreated process wastewater for a minimum duration of one day, in the event of temporary shut-down of the existing GWTP. The Contractor shall include all equipment necessary for on-site water treatment as a contingency measure.

4.4.7 Confirmatory Sampling and System Shut Down

Contractor will need to demonstrate attainment of the Site cleanup levels for saturated soil and groundwater through sampling and analysis of soils and groundwater from the ISTD area(s). Samples will be collected from soil borings (completed via direct-push or other drilling methods as selected by the Contractor) that are generally located on a 30-ft x 30-ft grid pattern across the entire ISTD area. The grid nodes shall be adjusted to ensure representative samples are collected at the midpoint between heater elements and at locations of previous elevated VOC concentrations, or as otherwise directed. Soil samples will be collected from within each 5-ft vertical interval (or portion thereof) throughout the saturated soil column of the ISTD area, with the exception of the 0-20 ft bgs depth interval. Confirmatory soil sampling from depth shallower than 20 feet is excluded since the target treatment depth for ISTD is deeper than 20 ft bgs. One groundwater grab sample will be collected from each boring. The Contractor will be responsible for addressing any VOC impacts identified at concentrations greater than the Site cleanup levels within each interval sampled. Specific sample locations from within each 5-ft vertical interval will be based on field PID readings, visual, and / or olfactory indications of soil impacts. If no indications of impact are identified, the sample location will be randomly selected from within the 5-ft interval.

Soil samples will be collected by a hot soil sampling protocol to be specified in the ISTD Treatment Work Plan. The protocol shall be based on ISTD industry practices, such as methods documented in “Soil Core Characterization Strategy at DNAPL Sites Subjected to Strong Thermal or Chemical Remediation” by Gaberell et al, Battelle, May 2002, or equivalent. Soil samples shall be analyzed for VOCs via EPA Method 8260.

The Contractor will identify the appropriate time to collect samples upon sufficient ISTD treatment based on the Contractor's analysis of time, temperature, vapor characterization, or other performance monitoring criteria specific to its ISTD technology. The Contractor may elect to collect samples prior to its projected completion of the full ISTD treatment timeframe at its sole cost and discretion for purposes such as adjusting its operations to meet the numeric soil cleanup levels. U.S. Army may identify the locations of the 10 additional borings contemporaneously when the Contractor elects to collect final post-treatment samples ISTD area. The Contractor will temporarily de-energize the thermal treatment in the vicinity of the soil sampling pursuant to procedures identified in its APP/HASP. The Contractor will use a licensed driller and obtain approvals for the soil boring work as required. All borings shall be properly grouted or otherwise abandoned in accordance with applicable agency requirements upon completion of sampling. The Contractor shall identify the anticipated/estimated timing of their sampling events in the ISTD Treatment Work Plan.

4.4.8 Shutdown

The Contractor may cease applying further thermal treatment to ISTD area(s) upon receipt of preliminary analytical data demonstrating single-point attainment of each soil sample collected within the ISTD area (or portion thereof). The Contractor may perform an initial shutdown based on their assessment that preliminary results meet the performance criterion; however, final shutdown is contingent upon the U.S. Army and regulatory review, and subsequent approval, requiring up to 10 business days. If sequential/expedited shut-down of portions of the ISTD area is proposed, the Contractor shall identify the strategy/approach for the sequential shut-down(s) in the ISTD Treatment Work Plan, with discussion of how effective heating conditions (e.g., temperatures, hydraulic/pneumatic control) will be maintained in adjacent portions of the area.

4.4.9 System Decommissioning

All heating elements/wells, temperature monitoring points, vapor recovery wells, and vacuum monitoring points will be abandoned or removed at the completion of the accepted treatment. The Contractor shall decommission/abandon any points/wells in accordance with 16 TAC 76.104, as applicable, by a Texas-licensed driller. Removal of the well materials will be implemented by over-drilling the well casing. Well abandonment reports and notices required by the Texas Water Development Board and Texas Department of Licensing and Regulation will be submitted upon abandonment.

Several goals should be met while conducting well abandonment activities. These include the prevention of vertical migration of fluids in the borehole and prevention of intermixing of waters from different water-bearing zones. In addition, any physical hazards that may be present, such as an open borehole, should be eliminated after conducting well abandonment procedures. Lastly, well abandonment activities shall be conducted in such a way to preserve aquifer properties. Additional guidance is provided in SOP A16-Soil Boring/Monitoring Well Abandonment, of **Appendix A** of the IWWP (Bhate, 2018).

4.4.10 Demobilization

Once areas have achieved the cleanup level and approval is received, the Contractor will demobilize all equipment and materials from the Site. All equipment and materials shall be removed from the

property. Nothing shall be abandoned in place except for the boreholes used for installing heating elements and monitoring points abandoned in accordance with **Section 4.4.9**.

4.4.11 Site Restoration and Project Closeout

Upon determination that no further treatment will be required, the Contractor will remove all the equipment, material, temporary facilities, and supplies from the Site and clean the area. If a thermal cap is used, the Contractor will remove and dispose of the waste off-site in accordance with applicable local, state, and federal requirements and other applicable aspects of waste disposal identified in the contract documents. The Site shall be restored to the condition that existed before commencement of the ISTD. Any impacted GWTP pipes that are shown on the Design Drawings to remain shall be restored to full working condition at the end of ISTD operations.

If the Contractor elects to protect existing infrastructure from elevated temperatures in the ISTD zone, then these means, and methods shall be outlined in their Work Plan and testing shall be conducted during restoration to document restored conditions match or exceed baseline conditions. In the event the ICT piping is damaged during ISTD operation, the Contractor will need to replace damaged piping in-kind.

4.4.12 Residual Management

The Contractor will provide all labor, materials, and equipment necessary for on-site storage of hazardous and non-hazardous waste material and off-site transportation and disposal of waste materials at an approved off-site disposal facility. Anticipated waste materials are drill cuttings, sediments from well development, purge water, personal protective equipment (PPE), soils and debris generated during trenching, decontamination water, and water generated as process water during the ISTD, as necessary. Wastewater generated from the ISTD operations will be contained and transported to the GWTP for treatment when necessary.

4.4.13 Reporting

4.4.13.1 Weekly Operational Progress Reports

The Contractor will need to submit an electronic version of the process monitoring result reports on a weekly basis during the ISTD treatment system start-up, testing, operation, and maintenance phases of the project to document monitoring of the treatment process. The electronic data will need to be submitted in a spreadsheet (e.g., Microsoft Excel). The process monitoring data to be included are specified in **Section 4.4.6.3**, and include the following parameters, tabulated, when possible, with a short-associated text description:

a. Power and energy input during period,
b. Temperatures at each measurement point and depth,
c. Pressures at each measurement point and depth,
d. Vacuums and flow rates from each vapor recovery well and through the entire system,
e. Vapor VOC measurements at each location monitored,
f. Mass (discrete and cumulative) of total VOCs removed,
g. Running mass (discrete points and cumulative total) of VOC emissions from the well-field,
h. Running indication of vapor treatment removal efficiency,
i. Amount of groundwater/process water generated during the period,

j. Description of any wastes generated during reporting period and their disposition,
k. System run-time hours, and down-time log with description of reasons and corrective actions, and
l. Any other data (soil, groundwater, soil gas, etc.) obtained during the period.

Sampling results shall be generated and submitted in accordance with the procedures/scheduling as detailed in the ISTD Treatment Work Plan.

4.4.13.2 Effectiveness Monitoring Results

The Contractor will submit a Technical Memorandum containing the effectiveness monitoring results and the Contractor's evaluation/recommendations regarding the ISTD progress after completion of the effectiveness monitoring events (e.g., baseline, operational, and post treatment phase). The electronic data will be submitted in a spreadsheet (e.g., Microsoft Excel). Preliminary results will be submitted 10 days following completion of the effectiveness monitoring event followed by submission of final results 30 days after the monitoring event.

4.4.13.3 Daily Contractor Quality Control (CQC) Reports

The Contractor will submit daily CQC reports during ISTD system installation, start-up, and operation. The daily CQC reports will be dated and signed by the CQC Manager. It shall also include weather information at the time of sampling, description of the field equipment used, health and safety inspections conducted, and any problem encountered. It shall include conforming and deficient features and a statement that equipment and materials were properly incorporated in the work. Photo documentation of any deficiencies and their resolutions will be provided. The original and one copy of these records shall be furnished within 24 hours after the date covered in the report, except for the days when no work was performed. Submittals may be provided digitally and would not require the original or hard copies. The daily CQC reports shall include copies of any test reports.

4.4.13.4 Safety Data Sheet (SDS)

The Contractor will maintain a complete compilation of all SDSs on-site for the chemicals/substances used as part of the Contractor's operations. SDSs will be submitted and/or available for review upon request.

4.4.13.5 Maintenance Manuals

ISTD Operations and Maintenance (O&M) manual will be submitted at least 30 days prior to commencement of ISTD system operations. The O&M manual will include procedures for operations and maintenance of all ISTD equipment/components, including the vapor/liquid treatment systems.

4.4.13.6 Chemical Data Final Report (CDFR)

The CDFR will include the quality control practices employed and all chemical parameter measurement activities conducted as discussed in this Section. The CDFR will be submitted within 30 days of completing the ISTD work, before final payment of the ISTD portion of the work.

4.4.13.7 ISTD Completion Report

Upon completion of ISTD treatment, the Contractor will prepare and submit for approval an ISTD Completion Report. The ISTD Completion Report will include, but not be limited to the following:

a. Summary of field operations including power and energy applied, duration of treatment, temperatures reached,
b. Evaluation of ISTD effectiveness relative to treatment objectives,
c. All sampling results, process monitoring results, and interim monitoring results,
d. Any deviations from the approved Work Plan, and rationale/justification for each,
e. Wastes generated and disposition (including characterization analysis of wastes),
f. Chemical data final report (if interim samples are collected), and
g. Summary of Project Cost as an appendix

5 ENHANCED IN-SITU BIOREMEDIATION DESIGN

EISB will be implemented at the LHAAP-18/24 site to remediate groundwater impacted with elevated concentrations of TCE, MC, and perchlorate. The following supportive documents included in the Final Revised FS (AECOM, 2017) were reviewed and existing data were evaluated to determine the efficacy of the EISB treatment to remediate the Site COCs.

- An evaluation of natural attenuation (NA) of groundwater contaminants at LHAAP-18/24 presented as Appendix A.
- The Draft Final Supplemental to the Updated PSI Report (AECOM, 2016b) presented as Appendix B.
- The treatability study results presented as Appendix C.

During the previous investigation, a treatability study was conducted to assess effectiveness of microbial degradation of VOCs and perchlorate under anaerobic conditions at SiRem® (Ontario, CA, 2014) (Appendix C) (AECOM, 2017). The testing was conducted on soil material received from the area of MW21 and groundwater from well MW21, representing moderately impacted areas within the dissolved plume migration zones. The results indicated that:

- Enhanced biodegradation was effective with the addition of lactate or emulsified oil as an electron donor to remediate TCE, perchlorate, and MC.
- Subsurface media conditions had to be adjusted including buffering to improve the pH to near neutral and bioaugmenting with substrate such as KB-1 Plus® to enhance biodegradation of TCE and its daughter products. The process suffered from the need to adjust the pH on multiple occasions and bioaugmenting at least on two occasions to enhance bacterial population and degrade cis-1,2-DCE.
- Complete degradation of MC occurred without the addition of organic substrate under strict anaerobic conditions, implying that native microorganisms capable of fermenting MC were readily available in the subsurface but it is hindered by the lack of strict anaerobic conditions and likely the low ambient pH levels.
- Perchlorate degradation occurred very rapidly once organic substrate was added under the presence of native microbial populations.

The treatability test was conducted in the laboratory under the controlled environment; however, it did not evaluate the limitations imposed by the presence of contaminants in fine-grained soils or account for the heterogeneity in site geology and different bio-geochemical and/or area-specific accessibility constraints/conditions of the Site. An additional key limitation of the treatability test is that it could not account for site-specific hydrogeologic conditions and characteristics.

Prior to mobilization for any field activities, the Contractor will secure any applicable approvals and notifications, which can include federal, state, and local requirements (i.e., Section 76.1000 for well installation, underground injection control, and notification of Texas 811) prior to the commencement of drilling and well installation operations. All required utility clearances will be completed prior to conducting invasive activities.

5.1 Field Pilot Test

There is insufficient information available from previous investigations to determine that the EISB approach will work in both the Shallow Zone and the Wilcox Formation. Therefore, the RD includes field pilot testing prior to implementing full-scale remedy in three areas, as shown on **Sheet 01C301** in **Appendix A**. These areas are identified to determine the design parameters for the EISB remedy that accounts for the variability in treatment depth zone and bio-geochemical conditions, and limitations imposed by heterogeneity in site geological condition as well as installation constraints depending on seasonal soil moisture and ponding of the surface water within the northeast area outside of the containment area. The pilot tests will be conducted to determine:

- The efficacy of EISB (particularly for TCE and MC) given different bio-geochemical conditions such as low pH in the Shallow Zone and higher pH in the Wilcox Formation, and high dissolved oxygen/oxidation-reduction potential (DO/ORP).
- The contaminant distribution in the Shallow Zone soils (i.e., shallow alluvium) and top of the Wilcox clay versus in the Wilcox Formation.
- The means and methods for delivering the amendments effectively into the depth intervals that have the most contamination in the Shallow Zone and in the Wilcox Formation.
- How different hydrogeologic parameters affect amendment injection spacing and the need of using injection/recirculation delivery method.

All three pilot tests will be conducted during Phase I of the remedial action and are anticipated to be completed in 12 to 18 months. After the completion of these pilot tests, the Contractor will submit a Field Pilot Test report documenting the implementation, findings, results, and recommendation for implementing the full-scale remedy for EISB during Phase II RA. Sections below outline the pilot test design approach, design parameters, substrate selection requirements, injection plan, and monitoring and performance sampling requirement for the three EISB field pilot tests.

5.1.1 Pilot Field Test Design

The EISB field pilot tests design was developed based on the Site hydrogeological conceptual model provided in the Final Revised FS (AECOM, 2017), the groundwater data from the Quarterly Evaluation Report (Bhate, 2021), and the PDI data (HDR, 2022). Available monitoring well/boring logs evaluated to develop design parameters for each pilot test are provided in **Appendix E**. The purpose of conducting three pilot tests is not only to determine efficacy of EISB for the TCE, MC, and perchlorate, but also to determine how different hydrogeologic parameters affect substrate distribution and bio-geochemical conditions affect amendment selection given the heterogeneity of the Site. Pilot tests will be conducted in the three areas as follows:

- EISB Pilot Test Area 1: was identified based on the elevated concentrations of TCE and perchlorate in the Shallow Zone. The grid system configuration within the southern portion of the site represents the area where the substrate will be injected in a grid configuration using DPT. Design parameters estimated for the EISB Pilot Test Area 1 are provided in **Table 5-1**. Up to 24 injection points to a maximum depth of 40 ft will be installed using the DPT in the EISB Pilot Test Area 1. Nine new monitoring wells in the Shallow Zone will be installed for the purpose of performance monitoring and to collect required field parameters to determine design parameters for the full-scale remedy implementation. Existing well MW-23 will also be used for collecting performance monitoring data.

- EISB Pilot Test Area 2: was identified based on the elevated concentrations of perchlorate and moderate concentrations of TCE in the Shallow Zone. This area represents the biobarrier system configuration within the northeast area outside of the containment area where the substrate will be injected using permanent injection wells. The seasonal soil moisture and ponding of surface water in the northeast area outside of the containment area makes the working area too wet and muddy for the installation of wells/boring at certain times of the year. Therefore, for the northeast area, which tends to be boggy, the pilot test design includes permanent injection wells instead of the temporary points allowing flexibility in conducting multiple injection events with easier access. The design costs include the swamp mats when installing permanent wells in this area. Design parameters estimated for the EISB Pilot Test Area 2 are provided in **Table 5-1**. Up to 5 permanent injection wells and 5 new monitoring wells to a maximum depth of 38 ft will be installed in the EISB Pilot Test Area 2. New monitoring wells will be installed for the purpose of performance monitoring and to collect required field parameters to determine design parameters for the full-scale remedy implementation. Existing well 18WW17 will also be used for collecting performance monitoring data.
- EISB Pilot Test Area 3: was identified based on the elevated concentrations of TCE and perchlorate in the Wilcox Formation. This area represents the grid system configuration within the northwest corner of the Site where the substrate will be injected using DPT. Design parameters estimated for the EISB Pilot Test Area 3 are provided in **Table 5-1**. Up to 9 injection points to a maximum depth of 50 ft will be installed using the DPT in the EISB Pilot Test Area 3. Five new monitoring wells in the Wilcox Formation will be installed for the purpose of performance monitoring and to collect required field parameters to determine design parameters for the full-scale remedy implementation. Existing wells MW-14 and 120 will also be used for collecting performance monitoring data.

5.2 Full-Scale EISB Remedial Design

Per the Final ROD (U.S. Army, 2020), the following EISB systems will be designed and implemented to remediate groundwater impacted with elevated levels of TCE, MC and perchlorate:

- EISB in the most contaminated areas of the Shallow Zone and Wilcox Formation groundwater (hereinafter referred to as EISB Grid 1 to 4)
- Biobarrier in the Shallow Zone groundwater near Northeast Area (hereinafter referred to as Shallow Zone EISB Biobarrier 1)
- Biobarrier in the Shallow Zone groundwater near Harrison Bayou (hereinafter referred to as Shallow Zone EISB Biobarrier 2)
- Biobarriers in the Wilcox Formation groundwater (hereinafter referred to as Wilcox Formation EISB Biobarriers 1 to 3)

The summary of locations in these EISB grid and biobarrier systems are presented in **Sheet 02C101** in **Appendix A**. The 2020 ROD provided preliminary design concepts but stated that the details of the EISB implementation would be established during the remedial design phase. The design and implementation details of the EISB systems are summarized in the subsections below. Available monitoring well/boring logs evaluated to develop design parameters for EISB system are provided in **Appendix E**.

In general, implementation of EISB Biobarriers and EISB Grids will include injection of an electron donor/substrate, and a microbial consortium capable of biodegrading primary chlorinated COCs (perchlorate, TCE, and MC) in the subsurface. The indigenous and augmented microorganisms will

grow and multiply using injected substrate as a carbon and energy source, thereby degrading perchlorate, TCE, and MC.

A groundwater extraction system incorporating approximately 5,000 ft of ICTs and a GWTP was installed in 1997 to control the migration of contaminated groundwater. The groundwater extraction system is comprised of ICTs surrounding the western, northern, and eastern site boundaries in the Shallow Zone. The existing Shallow Zone ICTs closer to the area where EISB is implemented will be shut down prior to implementation of the remedy. The existing extraction wells including 18WW17 will continue to be pumped during implementation of EISB and will be shut down immediately after injection is complete to prevent extraction of the injected substrate. Multiple rounds of injection will be continued until the criteria for MNA are met (i.e., MNA is demonstrated to be an effective remedy). **Section 5.5.3.2** provides the criteria for demonstrating that MNA is an effective remedy.

5.3 EISB Design Parameters

This section presents the general EISB design parameters common to the pilot test areas and to the EISB grid areas and biobarriers. The specific design details for each EISB system are provided in **Section 5.4**. The details of the field implementation procedures will be included in the Remedial Action Work Plan. Well identification for any wells planned and installed at the Site will include characters to identify the Site and work phase (such as 1824RA).

5.3.1 General Substrate Injection Strategies

The substrate for the EISB Grid 1 through 4, the northern portion of Shallow Zone EISB Biobarrier 2 and three Wilcox Formation EISB Biobarrier will be injected using DPT. Permanent injection wells will be used to inject substrate for the northeast to southwest portion of the Shallow Zone EISB Biobarrier 2 and for the Shallow Zone EISB Biobarrier 1 as shown on **Sheet 02C100** in **Appendix A**.

Direct Push Technology

Substrate for the Shallow Zone within EISB Grids 1, 2, 3, and 4 and Wilcox Formation within Grid 4, the northern segment of Shallow Zone EISB Biobarrier 2, and Wilcox Formation EISB Biobarriers 1, 2, and 3 will be injected using DPT. The temporary DPT injection points injected with substrate over a longer period of treatment will be a passive system and will provide flexibility in targeting the elevated areas and allow for reducing the number of points for subsequent injection events. DPT will be used to inject substrate at 2- to 3-foot intervals to cover the entire Shallow Zone and Wilcox Formation groundwater treatment depth intervals provided in the **Table 5-1 through 5-4** using a “top-down” approach at each proposed injection point. Using this approach, the injection tool string is advanced to the top of the injection interval and the substrate is pumped through the probe rods. The tools are then advanced to the next injection depth and the substrate is again pumped through the rods. This cycle is repeated to provide coverage across the entire injection interval. The top-down injection approach is expected to be effective since it will prevent backflow of injected material up through the tool string and reduces preferential flow of substrate.

Several direct push injection points may be manifolded for simultaneous injection to maximize delivery efficiency. The substrate will be injected at relatively low pressures (less than 200 psi) to avoid development of preferential flow pathways within the formation. The injection pressure must be adjusted based on the pilot test results and recommendations. The injection pressure at each DPT

location will be dictated by the formation back pressure on the pumping system but will be controlled by use of pressure relief valves.

Injection Wells

Injection wells will be used to inject substrate for the northeast to southwest portion of the Shallow Zone Biobarrier 2 and for the entire Shallow Zone Biobarrier 1. During previous injections performed at LHAAP-16, several injection wells failed (extruded) due to pressure fluctuations during injections. Although the cause of this failure was not definitively determined, it is possible the well grout was not fully cured prior to injections. Therefore, the Contractor shall take care to ensure injection well grout is fully cured prior to injections, by either reducing the amount of bentonite or water in the grout mixture or increasing the amount of Portland cement. If, in the course of injections, any injection wells do not perform properly (e.g., the pressure of injections causes the well to extrude), then those wells shall be abandoned, and injections shall continue via offset temporary DPT injection points.

The substrate will be gravity fed or injected into wells using pumps operated at relatively low pressures to avoid development of preferential flow pathways within the formation. If required, based on the field pilot test results, the injection and distribution of substrate within the subsurface may be hydraulically controlled by extracting groundwater from nearby wells during injection to enhance distribution of substrate away from the injection well.

If required, groundwater will be extracted from wells located adjacent to or near the injection wells using submersible pumps. The extracted groundwater will be used as dilution water for substrate at a central dosing unit. Diluted substrate will be injected into wells through a multi-channel manifold with simultaneous groundwater extraction from nearby wells. Following injection of substrate, chase water may be injected, if required, to enhance substrate distribution and flush the wells to limit biological growth and/or plugging of injection wells screens.

5.3.2 Radius of Influence and Injection Point Spacing

Direct Push Technology

Based on the 10-foot radius of influence (ROI) presented in the ROD (U.S. Army, 2020), a spacing of 20 ft between injection locations is estimated for each DPT injection point for the pilot tests as well as for the EISB Grid and Biobarrier system. Based on the results of the field pilot test in Area 1 and 3, the DPT injection point spacing will be adjusted for the full-scale remedy implementation. Groundwater monitoring will be conducted to evaluate if adequate zone of influence has been attained to create an effective EISB biobarrier and to remediate the most contaminated groundwater within the extent of the EISB Grid in the Shallow Zone and Wilcox Formation.

Injection Wells

A conservative spacing of 25 ft between each injection well is estimated for the injection for the northeast to southwest portion of the EISB Biobarrier 1 and for the EISB Biobarrier 2. Based on the results of the field pilot test in Area 2, the injection well spacing will be adjusted and a need for installing extraction wells will be evaluated for the full-scale remedy implementation.

5.3.3 Substrate Selection

Emulsified vegetable oil (EVO) is selected as the substrate for conducting all three pilot tests as well as for the installation of biobarriers and EISB grid area remediation per the 2020 ROD. Sufficient EVO mass will be injected such that replenishment would not be required for 3 to 5 years; therefore, the use of EVO is expected to be cost-effective since it would eliminate the need for continuous or more frequent injection of substrate into the subsurface. There are various formulations of EVO commercially available in the market for groundwater remediation. Most of these EVOs are vegetable oil-based products and are expected to have similar long-term performance for bioremediation.

In addition to the EVO, fast-acting soluble nutrient blend such as TersOx™ Nutrients-QR available from Tersus Environmental or comparable and sodium bicarbonate will be added to the EVO mix. Contaminated matrices are usually deficient in nitrogen and phosphorus content, key elements in biological activities during microbial destruction of organic contaminant destruction. Using TersOx™ Nutrients can provide limiting nutrients in a mixture of environmentally compatible salts for maximizing the biodegradation rates. TersOx™ Nutrients is a specialty blend of nitrogen, phosphorus, and microbial growth enhancers to stimulate biological activity. Sodium bicarbonate is available commercially and is used for buffering the pH.

5.3.3.1 Pilot Tests

The specific formulation of EVO evaluated for pilot tests is Electron Donor Solution – Extended Release (EDS-ER™) available from Tersus Environmental (**Appendix F**). EDS-ER™ is a water-mixable oil formulated with at least 92 percent natural seed oils. EDS-ER™ is a food-grade carbon and is made from renewable crop-based oils. EDS-ER™ is provided by the vendor as water-mixable oil that contains no water as shipped; therefore, it will be mixed with water in the field. This will reduce the cost and environmental footprint associated with transportation of higher volumes of more dilute substrate to the Site. The product mixes easily with water and does not require high energy mixers. It formulates a completely miscible product when mixed with water (it does not create emulsions or particles in water), thus preventing clogging effects when injected in groundwater. A mixing tank will be located adjacent to the location of the pilot test areas to mix the product with water. The product will be added to the tank in the volume desired, followed by pumping treated water from the GWTP into the tank to produce the mixture with the design concentration for injection. No mixers will be required due to the nature of the EDS-ER™ oil. The same procedure will be followed for the each of the pilot tests. The manufacturer's product information sheets are provided in **Appendix F**.

5.3.3.2 EISB Grid Areas and Biobarriers

The specific formulation of EVO evaluated for EISB grid areas and biobarriers is soybean oil mixed with the TASK™ MicroEVO™ Self-Emulsifier available from Tersus Environmental (**Appendix F**). TASK™ MicroEVO™ Self-Emulsifier is an optimized surfactant blend that makes stable vegetable oil-water emulsions. This self-emulsifier is designed to spontaneously phase-invert into soybean oil for easy field mixing. Sourcing soybean oil locally will reduce the cost and environmental footprint associated with transportation of higher volumes of more dilute substrate to the Site. Upon contact with water, this field prepared soluble oil (EDS-ER™) will spontaneously form a stable oil in water emulsion with a mean droplet size of less than one micron. Once the EDS-ER™ solution is prepared in the field, it will be further mixed with water following the procedure outlined for the pilot tests.

5.3.4 Bioaugmentation Culture Selection and Injection

In addition to the EVO, implementation of EISB in pilot test areas, biobarriers and grid areas will include injection of a microbial consortium capable of biodegrading chlorinated COCs (perchlorate, TCE, cis-1,2-DCE; and Vinyl Chloride (VC)) in the subsurface. Based on vendor recommendations, volume of dechlorinating culture KB-1® Plus ranging from one to two liters will be injected at each of the injection well and DPT point to facilitate a more rapid onset of complete reductive dechlorination of TCE to ethene. KB-1® Plus is a custom-blended microbial culture formulation for bioaugmentation of sites with inhibitory concentrations of chlorinated ethanes and chlorinated methanes, which are often comingled with chlorinated ethenes.

The injection of KB-1® Plus will be conducted in conjunction with the injection of EDS-ER™ and KB-1® Primer at each DPT and IW points. KB-1® Primer is used to prepare anaerobic water to disperse electron donors and protect anaerobic bioaugmentation cultures during injection into aquifers. Fifty percent of the target volume of EDS-ER™ will be injected into each injection location before the introduction of KB-1® Plus. To provide conducive conditions for KB-1® Plus in situ, about 60 gallon of anaerobic water (KB-1® Primer) will be injected before and after the KB-1® Plus injection. After the addition of the anaerobic water, required volume KB-1® Plus will be delivered to the middle of the injection interval. Following KB-1® Plus injection, an additional 62 gallons of anaerobic water will be injected into each injection point before proceeding with the injection of the remaining EDS-ER™ solution.

The anaerobic water used during the KB-1® Plus injection will be generated on-site in bladder tanks or equivalent, using potable water. The potable water will be mixed with soluble electron donor such as high fructose corn syrup (HFCS) and seeded with groundwater containing indigenous bacteria and/or KB-1® Plus. The water will be ready for injection once the anaerobic condition in the tank is confirmed (DO less than 0.5 mg/L and oxidation-reduction potential [ORP] less than -75 millivolts [mV]). Multiple tanks will be used to generate anaerobic water to ensure a constant supply of anaerobic water needed during the KB-1® Plus injections.

5.4 EISB Design

The EISB design for the full-scale EISB systems was developed based on the Site hydrogeological conceptual model that was developed in the Final Revised FS (AECOM, 2017), the groundwater data from the Quarterly Evaluation Report (Bhate, 2021), and the PDI (HDR, 2022). The relevant features of the Site hydrogeologic conceptual model that impact the design of the source and plume treatment/containment system include the following:

- The distribution of TCE and Perchlorate contamination (**Figures 1-7** and **1-8**) and MC contamination (**Figures D-5** and **D-6** in **Appendix C**) within the containment area, including the likely presence of residual DNAPL in the areas identified for ISTD.
- The predominant groundwater flow directions in the Shallow Zone, as it is affected by the continued operation of the current GWTP, groundwater flow directions in the Shallow Zone prior to the existing extraction system installation, and between the Shallow Zone and Wilcox Formation, as indicated by groundwater elevation contours, and vertical head differences between hydrogeologic units (AECOM, 2017).
- Spatial and/or temporal variability in the plume migration pathways, hydraulic gradients, hydraulic conductivities, and soil heterogeneity. For example, the lateral extent and continuity of the Wilcox clay separating the Shallow Zone and Wilcox Formation saturated zones at site

is highly variable due to the heterogeneity associated with the depositional environment of the Wilcox Formation. This, in turn, affects the degree of hydraulic communication between these two water-bearing units.

The remediation approach for implementing the EISB treatment system consists of two distinct methods: EISB Grid configuration for the areas estimated to have perchlorate concentrations greater than approximately 1,000 µg/L and/or TCE concentrations greater than 500 µg/L within the containment area and northeast area outside of the containment area and the EISB Biobarrier for the dissolved plume treatment at the property boundary and in the northeast area as the contaminated groundwater passes through. The following sections outline the design approach for the EISB Grid and Biobarrier system for the full-scale remedy implementation.

5.4.1 EISB Grid Areas

5.4.1.1 EISB Grid Area Design

EISB Grid Areas in the most contaminated portion of the Shallow Zone and Wilcox Formation groundwater will consist of four treatment grids to address inside and outside of containment areas with elevated levels of perchlorate and/or TCE in groundwater (perchlorate above approximately 1,000 µg/L and/or TCE above 500 µg/L). Each treatment grid will be comprised of DPT injection locations spaced 20 ft apart. The grids will cover a total area of approximately 926,000 square ft and will include a total of approximately 2,315 injection points (see **Sheets 02C101** through **02C105** in **Appendix A**). **Table 5-2** shows the elevated perchlorate and TCE groundwater concentrations within each EISB area, as well as the areal extent and target depth zones for each area. The EISB Grid will target a saturated thickness ranging from 8 to 20 vertical ft to a maximum depth of 51 ft bgs, based on the depth of elevated perchlorate and/or TCE levels detected in the nearby existing monitoring wells provided in **Table 5-2**.

5.4.1.2 Injection Point and Monitoring Well Placement and Design

The DPT injection points will be staggered to provide good distribution of injected chemicals. The 20-foot spacing between the injection points will need to be verified and may be modified based on pilot tests results. The injection depths may be modified during field implementation activities based on field observations including depth to groundwater. The number of estimated injection points, approximate target depths and size of each EISB grid areas are as follows:

- **EISB Grid 1**
  - EISB Grid 1, the largest area, overlaps ISTD Area 1 and 3 and is in the southern portion of the Site.
  - EISB Grid 1 area was further divided into four subareas (see **Sheets 02C101** through **02C105** in **Appendix A**) and general range of treatment depths were determined based on the variance in saturated depths. EISB Grid 1 will cover a total area of approximately 517,600 square ft and will include a total of approximately 1,294 DPT injection points as listed below:
    - EISB Grid 1A will cover approximately 329,900 square feet with a total of 825 points with a target depth of approximately 23 to 43 ft below ground surface.
    - EISB Grid 1B will cover approximately 174,900 square feet with a total of 437 points with a target depth of approximately 18 to 41 ft below ground surface.
    - EISB Grid 1C and 1D within Grid 1A will cover approximately 6,400 square feet with a total of 16 points each with a target depth of approximately 18 to 41 ft below ground surface.

  - In addition to one new monitoring well installed during the implementation of pilot tests, three new wells will be installed within EISB Grid 1 in the Shallow Zone to monitor EISB performance. Existing monitoring wells, AWD-3, MW-2-R, and 1824DPTMW05, located within EISB Grid 1 in the Shallow Zone will also be used to monitor EISB performance.
- **EISB Grid 2**
  - EISB Grid 2, the second largest area covers the northeast boundary of the Site and the outside of the containment area to the northeast.
  - EISB Grid 2 will cover a total area of approximately 364,800 square ft and will include a total of 912 DPT injection points with a target depth of approximately 25 to 37 ft below ground surface.
  - Existing monitoring wells, MW-3, 1824DPTMW-02 and MW-21 located within the EISB Grid 2 in the Shallow Zone will be used to monitor EISB performance.
- **EISB Grid 3**
  - EISB Grid 3 is in area just north of the former UEP along the northern site boundary.
  - EISB Grid 3 will cover a total area of approximately 27,200 square ft and will include a total of 68 DPT injection points with a target depth of approximately 25 to 33 ft below ground surface.
  - Existing monitoring wells, MW-5 and MW-6 located within the EISB Grid 3 in the Shallow Zone will be used to monitor EISB performance.
- **EISB Grid 4 Shallow Zone and Wilcox Formation**
  - EISB Grid 4 is located near the former ADC area in the western corner of the Site.
  - EISB Grid 4 Shallow Zone will cover a total area of approximately 10,000 square ft and will include a total of 25 DPT injection points with a target depth of approximately 13 to 25 ft below ground surface.
  - EISB Grid 4 Wilcox Formation will cover a total area of approximately 6,400 square ft and will include a total of 16 DPT injection points with a target depth of approximately 30 to 50 ft below ground surface. EISB Grid 4 covers the remaining area not injected during the pilot test in the EISB Pilot Test Area 3.
  - New monitoring wells installed during the implementation of pilot tests, PMW-02D and PMW-03D in the Wilcox Formation located within the EISB Grid 4 will be used to monitor EISB performance.

5.4.1.3 Substrate Loading and Injection

The mass of EVO required for each grid areas was calculated based on the stochiometric demand exerted by the native (e.g., dissolved oxygen [DO], nitrate, and sulfate) and anthropogenic (COCs) electron acceptors. These calculations were performed using the ESTCP spreadsheet-based Substrate Estimating Tool (ESTCP, 2010). **Appendix F** provides the summary of calculated mass of required EVO and example of the input and output calculations spreadsheets for Pilot Test Area 1.

The specific formulation of EVO proposed for the implementing the EISB in grid areas is soybean oil mixed with the TASK™ MicroEVO™ Self-Emulsifier. Based on the stochiometric demand, the total estimated weight of soybean oil (1,968,000 pounds) and the TASK™ MicroEVO™ Self-Emulsifier (148,350 pounds) as well as the dosage of nutrients (49,200 pounds) and sodium bicarbonate (245,950 pounds) is proposed for all grid areas injection. The estimated weight of all these amendments for each grid area are provided in **Appendix F**. The concentrated solution of EDS-ER™ will be diluted by mixing 1 part of EDS-ER™ with 10 parts of water. During mixing, nutrients and sodium bicarbonate will be added to the solution at the required dose provided in **Appendix F.** The diluted EDS-ER™ solution will be injected into DPT injection points. The details of the substrate injection using DPT are discussed in **Section 5.3.1**.

5.4.1.4 Bioaugmentation Culture Injection

Based on vendor recommendations, 1.5 liters of dechlorinating culture KB-1® Plus will be injected at each of the 1,294 locations within the EISB Grid 1A to 1D to facilitate a more rapid onset of complete reductive dechlorination of TCE to ethene. One liter of KB-1® Plus will be injected at each of the 912 locations in EISB Grid 2, 68 locations in EISB Grid 3, 16 locations in EISB Grid 4 Wilcox Formation, and 25 locations in EISB Grid 4 Shallow Zone. Injection of dechlorinating culture KB-1® Plus as well as KB-1® Primer will be conducted during the substrate injection as per the details provided in **Section 5.3.4.**

5.4.2 Biobarriers

The EISB system for the dissolved plume treatment will consist of five inside and outside of containment area biobarriers running roughly parallel to the Site boundaries to treat contaminated groundwater as it migrates downgradient from the Site (see **Sheet 02C100** in **Appendix A**). Each biobarrier is described below in detail.

5.4.2.1 Shallow Zone EISB Biobarrier 1

The purpose of the Shallow Zone EISB Biobarrier 1 is to remediate the Shallow Zone groundwater as it flows through the northeast area towards Caddo Lake, which is located approximately one mile northeast of the Site. EISB Biobarrier 1 will consist of injection locations spaced 25 ft apart, which will be injected at target depths ranging from 26 to 38 ft bgs (as listed in **Table 5-3**) with amendment via permanent injection wells. Approximately 37 additional injection wells will be installed to create 925 ft of the treatment biobarrier in the northeast area downgradient of well, 18WW17. These injection/screen intervals are intended to target the treatment of Shallow Zone groundwater. The injection depths and monitoring well screen intervals and lengths may be modified based on the pilot test results and initial field observations including depth of clay layer separating shallow and Wilcox Formation and depth to groundwater.

In addition to the 2 new monitoring wells to be installed during the pilot test, three new wells will be installed in the Shallow Zone downgradient from the Biobarrier 1 and one new well will be installed within Biobarrier 1 to monitor EISB performance. Existing monitoring well, 18WW17, located upgradient from the Biobarrier 2 in the Shallow Zone will be used to monitor EISB performance as well.

5.4.2.2 Shallow Zone EISB Biobarrier 2

The purpose of the Shallow Zone EISB Biobarrier 2 is to remediate the Shallow Zone groundwater as it flows radially outward in a complex pattern from the Site, especially towards north to Harrison Bayou (approximately 200 ft of the western corner of the Site). The injection approach for creating treatment wall in the Shallow Zone EISB Biobarrier 2 area consists of two distinct methods: via DPT injection points and permanent injection wells. In the EISB Biobarrier 2 area, the complex radial groundwater flow pattern in the Shallow Zone prior to installation of the groundwater extraction system was similar to what is observed today. It is anticipated that once the groundwater contamination within the containment area is remediated, then the existing extraction system will be shut down and the groundwater flow pattern will return to its original condition. Therefore, to account for the complexity of the groundwater flow direction and anticipated shutdown of the extraction system, approximately 2,300 ft of the wall segment surrounding the western half of the property boundary will consist of permanent injection wells spaced 25 ft apart as shown on **Sheet 02C100** in **Appendix A**. Ninety-two

injection wells will be installed at target depths ranging from 16 to 27 ft bgs (as listed in **Table 5-3**). The remaining 680 ft of the Shallow Zone EISB Biobarrier segment will consist of approximately 34 DPT injection points spaced 20 feet apart at target depths ranging from 16 to 27 ft bgs.

The injection depths and monitoring well screen intervals and lengths may be modified based on the pilot test results and initial field observations, including depth of the Wilcox clay layer separating the Shallow Zone and Wilcox Formation and depth to groundwater.

Along the northern portion of Biobarrier 2 near Harrison Bayou, one new monitoring well within the biobarrier and two downgradient from the Biobarrier 2 will be installed in the Shallow Zone to monitor EISB performance. Existing monitoring wells in the Shallow Zone, 18CPTMW23 and 18CPTMW15 located upgradient from the Biobarrier 2 will be used to monitor EISB performance as well.

Along the western/southwestern portion of Biobarrier 2, one new monitoring well within the biobarrier and four wells downgradient from the Biobarrier 2 will be installed in the Shallow Zone to monitor EISB performance. Existing monitoring wells in the Shallow Zone, MW-9 and MW-7 located upgradient from the Biobarrier 2 and existing well 18CPTMW26SW located downgradient from the Biobarrier 2 will be used to monitor EISB performance as well.

5.4.2.3 Wilcox Formation EISB Biobarriers

The purpose of the Wilcox Formation EISB Biobarriers 1 to 3 is to remediate the Wilcox Formation groundwater as follows:

- Wilcox Formation EISB Biobarrier 1 for remediating groundwater in the vicinity of monitoring well 18CPTMW08SW as it flows towards Harrison Bayou through the northern corner of the Site.
- Wilcox Formation EISB Biobarrier 2 for remediating groundwater in the vicinity of monitoring well MW-14 as it flows towards Harrison Bayou through the western corner of the Site.
- Wilcox Formation EISB Biobarrier 3 for remediating groundwater in the vicinity of monitoring well 18CPTMW22SW as it flows through the southern corner of the Site.

As shown on **Sheets 02C101** through **02C105** in **Appendix A,** each Wilcox Formation EISB Biobarrier will consist of injection locations spaced 20 ft apart, which will be injected at varying target depths (as listed in **Table 5-4**) with amendment via temporary DPT points. The DPT injection points will be staggered to provide a good distribution of injected chemicals. The 20-foot spacing between the injection points will need to be verified and may be modified based on pilot tests results. The injection depths may be modified during field implementation activities based on field observations including depth to groundwater. The three shorter biobarriers will target contamination in the deeper Wilcox Formation and will total 1,640 ft in length: **Table 5-4** includes the elevated perchlorate and TCE groundwater concentrations upgradient from each Wilcox Formation EISB Biobarrier, as well as the length and target depth zones for each biobarrier. The number of estimated injection points, approximate target depths and size of each Wilcox Formation biobarrier are as follows:

- **Wilcox Formation EISB Biobarrier 1**
    - 31 DPT locations with a target depth of 45 to 65 ft bgs will be used to inject amendments traverse to the direction of groundwater flow to establish approximately 620 feet long Wilcox Formation EISB Biobarrier 1.

  - Two new monitoring wells within the biobarrier and four wells downgradient from the Wilcox Formation Biobarrier 1 will be installed in the Wilcox Formation to monitor EISB performance.
  - The existing monitoring wells in the Shallow Zone, 18CPTMW19 located downgradient from the biobarrier and AWD-4 and 125 located upgradient from the biobarrier, will be used to monitor EISB performance.
- **Wilcox Formation EISB Biobarrier 2**
  - 26 DPT locations with a target depth of 30 to 50 ft bgs will be used to inject amendments traverse to the direction of groundwater flow to establish approximately 520 feet long Wilcox Formation EISB Biobarrier 2.
  - The existing monitoring wells in the Wilcox Formation, 1824DPTMW06 located within the biobarrier, and 18WW06 located downgradient from the biobarrier, will be used to monitor EISB performance. The existing monitoring well in the Shallow Zone MW-12, located within the biobarrier, will be used to monitor EISB performance.
  - Two new monitoring wells in the Wilcox Formation to be installed during the pilot test will be used to monitor EISB performance upgradient from the biobarrier.
- **Wilcox Formation EISB Biobarrier 3**
  - 25 DPT locations with a target depth of 40 to 60 ft bgs will be used to inject amendments traverse to the direction of groundwater flow to establish approximately 500 feet long Wilcox Formation EISB Biobarrier 3.
  - Two new monitoring wells will be installed in the Wilcox Formation within the biobarrier, and one new monitoring well will be installed in the Wilcox Formation located downgradient from the biobarrier will be used to monitor EISB performance. The existing monitoring wells in the Wilcox Formation and Shallow Zone, 18CPTMW22SW and MW-20 located upgradient from the biobarrier, will be used to monitor EISB performance.

5.4.2.4 Substrate Loading and Injection

The mass of EVO required for biobarriers was calculated based on the stochiometric demand exerted by the native (e.g., dissolved oxygen [DO], nitrate, and sulfate) and anthropogenic (COCs) electron acceptors. These calculations were performed using the ESTCP spreadsheet-based Substrate Estimating Tool (ESTCP, 2010). **Appendix F** provides the summary of calculated mass of required EVO for biobarriers and example of the input and output calculations spreadsheets for Pilot Test Area 1.

The specific formulation of EVO proposed for the implementing the EISB in biobarriers is soybean oil mixed with the TASK™ MicroEVO™ Self-Emulsifier. Based on the stochiometric demand, the total estimated weight of soybean oil (144,000 pounds) and the TASK™ MicroEVO™ Self-Emulsifier (10,725 pounds) as well as the dosage of nutrients (3,000 pounds) and sodium bicarbonate (15,000 pounds) is proposed for all biobarrier injection. The estimated weight of all these amendments for each biobarrier are provided in **Appendix F**. The concentrated solution of field mixed EDS-ER™ will be diluted by mixing 1 part of EDS-ER™ with 10 parts of water. During mixing, nutrients and sodium bicarbonate will be added to the solution at the required dose provided in **Appendix F.** The diluted EDS-ER™ solution will be injected into DPT injection points. The details of the substrate injection using DPT are discussed in **Section 5.3.1**.

5.4.2.5 Bioaugmentation Culture Injection

Based on vendor recommendations, one liter of dechlorinating culture KB-1® Plus will be injected at each of the 37 locations in Shallow Zone EISB Biobarrier 1 and 92 locations in Shallow Zone Biobarrier

2-IW to facilitate a more rapid onset of complete reductive dechlorination of TCE to ethene. Two liters of KB-1® Plus will be injected at each of the 31 locations in Wilcox Formation EISB Biobarrier 1, 26 locations in Wilcox Formation EISB Biobarrier 2, and 25 locations in Wilcox Formation EISB Biobarrier 3. Injection of dechlorinating culture KB-1® Plus as well as the KB-1® Primer will be conducted during the substrate injection as per the details provided in **Section 5.3.4.**

5.5 Performance Monitoring

Performance monitoring conducted as part of the Phase II of RA for the Site will include the following:

- Groundwater monitoring in the areas of active EISB to evaluate its effectiveness, and to assess changes in groundwater geochemistry and concentrations of COCs and their degradation products.
- Groundwater monitoring to evaluate changes in concentrations of COCs and their degradation products in the areas outside the influence of active EISB.

In the short-term (1-3 months), monitoring of groundwater conditions will be conducted to evaluate design effectiveness associated with the distribution of the injectate in the Shallow Zone and Wilcox Formation.

Per the ROD (U.S. Army, 2020), the performance evaluation for MNA will be conducted after the collection of eight quarters of EISB performance data. If MNA is determined to be effective, a baseline will be established from the data to this point in time. Monitoring will be conducted to evaluate the remedy performance and determine if the plume conditions remain constant, improve, or worsen after the baseline is established. If after eight quarters of EISB performance data collection, MNA is determined to be ineffective according to **Section 5.4.3.2** criteria, a contingency action will be initiated as described in **Section 5.4.3.3**.

The LTM will be implemented at a semiannual frequency for three years, then annually until the next Five-Year Review.

5.5.1 Pre-EISB Implementation Groundwater Sampling

The pre-EISB implementation groundwater sampling will be performed as a single event to characterize the COC concentrations and geochemical conditions in the Shallow Zone and Wilcox Formation after the Phase I RA is completed and prior to emplacement of bioremediation substrate. The wells selected for the pre-EISB groundwater sampling include wells inside and outside of the contaminant areas, and wells located upgradient, within, and downgradient of EISB Grid and Biobarrier areas. New monitoring wells in both the Shallow Zone and Wilcox Formation will be installed to supplement existing wells and provide a comprehensive well network for pre- and post-EISB implementation and MNA/LTM sampling events. The pre-EISB groundwater sampling results will be used to optimize the locations of DPT injection points for the EISB Biobarriers. In addition, the baseline groundwater sampling results will be compared with monitoring results following substrate emplacement to assess the performance of EISB systems. The baseline sampling plan is summarized in **Table 5-5** to **5-8** for the pilot tests, each of the EISB grid areas, and EISB biobarriers**.**

5.5.2 Evaluation of Design Effectiveness

Within the first two months after the EISB remedy implementation, groundwater data will be collected from the various monitoring points in the treatment areas to evaluate effectiveness of injectate distribution and the occurrence of geochemical changes. Up to two sets of groundwater samples will be collected before the first quarterly sampling is implemented. The EISB performance monitoring plans for the pilot tests, each of the EISB grid areas, and EISB biobarriers are presented in **Tables 5-9 to 5-12.** These tables present the proposed monitoring locations along with the rationale for the selection of each monitoring location.

5.5.3 Performance Monitoring – Years 1 and 2

Performance monitoring will be conducted at the Site during Years 1 and 2 in accordance with the monitoring plans summarized in the subsections below. After each monitoring round, the data will be reviewed to evaluate progress towards attainment of remedial action objectives/cleanup levels. Optimization/changes of the monitoring plans presented below will be conducted as warranted by the results of the data reviews. The optimizations/changes will be presented to the regulatory agencies prior to implementation.

5.5.3.1 EISB Performance Monitoring

When a bioremediation substrate such as emulsified vegetable oil (EVO) and ABC+ is injected into the subsurface, the naturally occurring bacteria are stimulated and degrade the injected organic substrate. Biodegradation of substrate depletes the DO and other terminal electron acceptors (e.g., nitrate or sulfate), and lowers the ORP of groundwater, thereby creating conditions conducive to the anaerobic COC degradation processes. The EISB performance monitoring will be conducted to assess changes in geochemical conditions and perchlorate concentrations due to biodegradation reactions.

The performance monitoring plans for the pilot tests, each of the EISB grid areas, and EISB biobarriers, are presented in **Tables 5-9** through **5-12**. These tables present the proposed monitoring locations along with the rationale for the selection of each monitoring location.

5.5.3.2 MNA Performance Monitoring

MNA is the component of the selected remedy for the LHAAP-18/24 to reduce COC concentrations and to return groundwater to its potential beneficial use, wherever practical. A preliminary evaluation of the occurrence of NA of MC, TCE, and perchlorate present in the Shallow Zone and Wilcox Formation groundwater at the LHAAP-18/24 was performed (AECOM, 2017). This analysis is important in evaluating the concentrations at which the active treatment phase can be terminated and MNA can be implemented to both the Shallow Zone and Wilcox Formation to ensure continued degradation of COCs and daughter products and that surface water in Harrison Bayou is not adversely affected by groundwater such that it fails to meet surface water standards for COCs and daughter products.

Twenty-two (22) new groundwater monitoring wells installed as part of either the performance and/or MNA/LTM monitoring along with the existing well network of 41 wells will be used to implement MNA at the Site. The performance monitoring plan for MNA for the Shallow Zone and Wilcox Formation is presented in **Table 5-13** and shown in the design drawings.

Per the Final ROD (U.S. Army, 2020), the performance evaluation for MNA will be based on data from eight quarters of monitoring combined with historical data to evaluate the effectiveness of various natural physical, chemical, and biological processes in reducing contaminant concentrations. Per the Final ROD, the following performance objectives will be used to evaluate MNA performance after two years:

- Plume stability (i.e., the plume concentrations are decreasing in the majority of performance wells, and the plume is not expanding in area as demonstrated with compliance wells).
- MNA potential based on evaluation of biodegradation screening scores using USEPA guidance.
- MNA process evaluation, based on an attenuation rate calculated with empirical performance monitoring data, and MNA process demonstration based on the presence of daughter products and bacterial culture counts.

5.5.3.3 Contingency Action for MNA Areas

Per the 2020 ROD, a contingency remedy would be implemented if the MNA criteria are not met for the passive MNA areas (i.e., MNA areas outside the active remediation areas). The contingency remedy includes a second application of EISB using the temporary injection points to address the ineffective aspects of MNA. The area and the elements of the contingency remedy will be determined based on the magnitude of deviation from the MNA performance criteria and the remedy area(s) with observed deviations. Therefore, the contingency remedy will evaluate any deficiencies in MNA performance and will attempt to address those deficiencies. If the contingency remedy is required, it will be documented in the ESD.

5.5.3.4 Follow-up Injections in Biobarriers

As specified in the 2020 ROD, follow-up injections for the biobarriers using injection wells will be implemented based on EISB performance groundwater monitoring results. The emulsified vegetable oil for the grid areas and biobarriers is specified to last between 3 and 5 years. Nonetheless, the decision for reapplication of organic carbon will be made based on groundwater monitoring results. Three criteria for determining the need to reinject are:

- Depletion of the organic carbon to below 20 mg/L;
- ORP increases above -50 mV; or
- Contaminant concentrations in groundwater downgradient of EISB Shallow Zone Biobarriers 1 & 2 and in surface water remain above the cleanup standards.

If any of these conditions occur, then reinjection of organic carbon would be conducted, but only in those specific areas that meet any of the above criteria.

5.5.4 Surface Water Monitoring

Surface water monitoring will be conducted to confirm that surface water standards for the contaminants and by-product contaminants are not exceeded in Harrison Bayou, which flows into Caddo Lake. The surface water sampling events will be conducted concurrently with the groundwater sampling events for performance monitoring. Harrison Bayou is classified as an intermittent stream with perennial pools. Therefore, it is not expected that Harrison Bayou would be dry. However, as a contingency, if surface water samples could not be collected from Harrison Bayou during the quarterly sampling events, samples from Harrison Bayou would be collected outside the routine quarterly

sampling events following significant rain events. The goal is to collect four surface water samples every monitoring year.

During each monitoring round, surface water samples will be collected at four locations in Harrison Bayou: upgradient, downgradient and immediately adjacent to LHAAP-18/24 (**Sheet 02C100** in **Appendix A**). Surface water samples will be collected following the protocols included in Section 3.7 of the Final Installation-Wide Work Plan (IWWP) for LHAAP (Bhate, 2018). These surface water samples will be analyzed for the COCs, and the sample concentrations will be compared to the Texas surface water quality standards set forth in 30 TAC 307.6(d)(1) for TCE (5 µg/L), 1,2-DCA (5 µg/L), 1,1-DCE (7 µg/L), and VC (2 µg/L) for LHAAP-18/24 as per the 2020 ROD. Monitoring of the surface water may include visual inspection, field measurements such as dissolved oxygen, conductivity, turbidity, pH, ORP, and temperature, and/or water sample analysis specific to the COCs and injection solution.

Surface water samples are collected for the purpose of evaluating potential impacts from groundwater COC. Therefore, at these locations and during surface water sampling, the groundwater elevations in wells 18WW07, 18WW24, 18WW25 and new monitoring well, PMW-21 will be gauged and compared to the bottom elevation of the creek to determine whether there is groundwater contribution to surface water.

5.5.5 Performance Monitoring – Year 3 through Five-Year Review

If MNA is determined to be effective based on the first two years of performance monitoring data, LTM will be initiated. Per the 2020 ROD, LTM will be implemented at a semiannual frequency for three years, then annually until the next Five-Year Review. For LTM, the performance monitoring plan presented in **Table 5-13** will be modified as appropriate based on the review of first two years of data.

If MNA is found to be ineffective, a contingency remedy will be implemented to include application of bio-amendments to address the ineffective aspects of MNA. If the bio-amendments are reapplied, the EISB and MNA performance monitoring plans presented in **Tables 5-9 to 5-13** and the frequency of monitoring will be modified as appropriate based on the review of first two years of data. Groundwater monitoring will be conducted also to evaluate inorganic COCs.

The selected remedy in the 2020 ROD indicates monitoring for metals will be evaluated at the first Five-Year Review to determine if any further monitoring for metals is warranted (U.S. Army, 2020). **Table 1-2** provides a summary of the wells that were sampled for the metals COCs and had detected concentrations above the cleanup levels. As part of the next Five-Year Review after remedy implementation, groundwater samples will be collected. All the wells listed on **Table 1-2** will be analyzed for TAL metals. The sampling will be conducted using low flow sampling as described in Section 3.4 of the IWWP (Bhate, 2018). The monitoring results and evaluation will be included in the next Five-Year Review report.

5.5.6 Performance Monitoring Following Five-Year Review

Per the 2020 ROD, the results from performance monitoring will be reviewed during the Five-Year Review. Unless otherwise indicated by the data, the well locations will then be sampled during each Five-Year Review.

6 LAND USE CONTROL REMEDIAL DESIGN

This section describes the LUC RD for LHAAP-18/24. In accordance with the 2020 ROD, the LUC RD will be finalized as the land use component of the Remedial Design. Per the 2020 ROD, LUCs' performance objectives are to:

- Maintaining the integrity of any current or future remedial or monitoring systems.
- Preserving the integrity of the surface impoundment cap over the UEP and to restrict intrusive activities (e.g., digging) that would degrade or alter the cap.
- Preventing the use of groundwater contaminated above cleanup levels as a potable water source.
- Restricting land use to nonresidential until it is demonstrated that surface and subsurface soil and groundwater COCs (i.e., including all hazardous substances, pollutants, and contaminants found at the Site at cleanup levels) are at levels that allow for unlimited use and restricted exposure.

The implementation, maintenance, and inspection requirements associated with each of the performance objectives that comprise this LUC RD are described below. The actions taken to implement the LUC objectives during the RA phase, as well as ongoing maintenance, monitoring and reporting requirements will be presented in the Remedial Action Completion Report (RACR), as the final LUC RD. Upon regulatory review and concurrence with the final LUC RD, it will be distributed as part of the Comprehensive LUC Management Plan.

For portions of the Site subject to land use controls that are not owned by the U.S. Army, the U.S. Army will monitor and report on the implementation, maintenance, and enforcement of land use controls, and coordinate with federal, state, and local governments and owners and occupants of properties subject to land use controls. The Army remains responsible for ensuring that the remedy remains protective of human health and the environment.

6.1 LUC Implementation

The actions required to implement the LUCs for LHAAP-18/24 are described below. The first of these, the initial notice of LUCs, was completed, and a figure depicting the preliminary LUC boundaries as presented in the 2020 ROD is provided as **Figure 6-1**. The following actions either were completed or will be undertaken to implement the LUCs for LHAAP-18/24:

- Provide initial notice of the LUCs before remedial action is implemented.
    - Develop the initial notice of the groundwater and soil (surface and subsurface) contamination and any land use restrictions referenced in the 2020 ROD. The notice will consist of a brief description of the contaminants present in groundwater and soil, a written description of the LUCS and a figure depicting the preliminary LUC boundaries presented in **Figure 6-1**.
- The notice to federal, state, and local governments involved at this site and the owners and occupants of the properties subject to those use restrictions and land use controls were transmitted within 90 days of ROD signature, on March 16, 2020. The notices were sent to federal, state, and local officials including U.S. Senator Ted Cruz, U.S. Senator John Cornyn, U.S. Congressman Louie Gohmert, State Senator Bryan Hughes, State Representative Chris Paddie, Harrison County Judge Chad Sims, Harrison County Commissioner Precinct 1 William

D. Hatfield, and City of Uncertain Mayor Sam Canup. Notice was also sent to the Caddo Lake National Wildlife Refuge Manager Erik Duerkop, the Leigh Water Supply Corporation Board of Directors, and Caddo Lake Water Supply Corporation Board of Directors.

- Finalize the Boundaries for the LUCs as a part of the remedial action.
    - Revise the boundaries if necessary. The LUC boundary presented in this RD is not subject to change because the limits of groundwater contamination are well defined outside of the containment area. However, the final boundaries of the groundwater LUCs (prevent the use of groundwater contaminated above cleanup levels as a potable water source and prohibit access to the contaminated groundwater except for environmental monitoring and testing only); the UEP LUCs (preserve the surface impoundment cap over the UEP, and to restrict intrusive activities (e.g., digging) that would degrade or alter the cap); and the remedial or monitoring system LUCs (maintain the integrity of any current or future remedial or monitoring systems); will be reviewed during remedial action activities after an evaluation of new data has been completed and revised if necessary.
    - Survey the LUC Boundaries. The boundaries will be finalized after concurrence by USEPA and TCEQ, and the LUC boundaries will be surveyed by a State-licensed surveyor. A legal description of the surveyed areas will be appended to the survey plat.
- Record the LUCs in Harrison County. The LUC plat, legal description and LUC restriction language will be recorded in the Harrison County Courthouse in accordance with TAC Title 30, §335.566.
- Notify the Texas Department of Licensing and Regulation of the groundwater LUCs. The Texas Department of Licensing and Regulation will be notified of the groundwater restrictions, which include the prohibition of water well installation for any purpose other than environmental monitoring and testing without prior approval from the U.S. Army, the USEPA, and the TCEQ. The survey plat, legal boundary, and description of the groundwater restriction LUCs, in conjunction with a locator map, will be provided in hard and electronic copy.

6.2 Maintenance and Monitoring Requirements

The LUCs will be maintained in place as follows:

- The UEP LUCs will remain in place as long as the former UEP remains at the Site or until the levels of COCs (i.e., including all hazardous substances, pollutants, and contaminants found at the Site at cleanup levels as listed in the 2020 ROD) allow for unlimited use and unrestricted exposure.
- The LUCs restricting the use of groundwater to environmental monitoring and testing only will remain in place until the levels of COCs (i.e., including all hazardous substances, pollutants, and contaminants found at the Site at cleanup levels as listed in the 2020 ROD) in groundwater allow for unlimited use and unrestricted exposure.
- The LUC to maintain the integrity of any current or future remedial or monitoring systems will remain in place until groundwater cleanup levels of COCs (i.e., including all hazardous substances, pollutants and contaminants found at the Site at cleanup levels as listed in the 2020 ROD) are met; and,
- The LUC prohibiting groundwater use (except for environmental monitoring and testing) as a potable source will remain in place until the levels of COCs (i.e., all hazardous substances,

pollutants, and contaminants found at the Site at cleanup levels as listed in the 2020 ROD) in soil and groundwater allow for unlimited use and unrestricted exposure.
- The LUC will restrict land use to nonresidential until it is demonstrated that surface and subsurface soil and groundwater COCs (i.e., including all hazardous substances, pollutants, and contaminants found at the Site at cleanup levels) are at levels that allow for unlimited use and restricted exposure.

Remedial or Monitoring System LUCs include physical components that require repair and maintenance. These are described in Section 2.0.

The administrative maintenance required to ensure the four LUCs remain in place and effective until the cleanup levels of the COCs are at levels that allow unrestricted use and unlimited exposure are:

- Annual field inspections of the Site to confirm that no violations of the LUCs have occurred. Documentation of the inspection will be included in the Inspection and Maintenance Checklist (**Appendix D**).
- Annual certifications that no LUC-restricted activities have been authorized and that site conditions and use are consistent with the LUCs (**Appendix G**).
- Periodic transmittal of a LUC Notice to federal, state, and local authorities and to owners and occupants of LHAAP-18/24. The notice will include the groundwater and soil (surface and subsurface) contamination and any land use restrictions referenced in the 2020 ROD, a written description of the LUCs and a figure depicting the LUC boundaries. The transmittal will coincide with each Five-Year Review and will be documented in the report.
- The final LUC RD appendix of the RACR will be added to the Comprehensive LUC Management Plan and the plan will be provided to the owner or occupant of LHAAP-18/24.

The U.S. Army will address LUC problems within its control that are likely to impact remedy integrity and shall address problems as soon as practicable.

6.3 Reporting of LUC Inspection and Monitoring

Beginning with finalization of this RD and approval of the Inspection and Maintenance forms and the Annual Certification Form, the U.S. Army will undertake inspections and certify continued compliance with the LUC objectives. The U.S. Army, or the transferee after transfer, will retain the LUC Inspection and Certification documents in the project files for incorporation into the Five-Year Review reports, and these documents will be made available to USEPA and TCEQ upon request. In addition, should any violations be found during the certification, the U.S. Army will provide to USEPA and TCEQ, along with the document, a separate written explanation indicating the specific violations found and what efforts or measures have or will be taken to correct those violations. The need to continue inspections and certifications will be revisited at Five-Year Reviews.

6.3.1 Notice of Planned Property Conveyances

Upon transfer of Army-owned property, the Army will provide written notice to the transferee of the LHAAP-18/24 groundwater and soil (surface and subsurface) contamination and any land use restrictions. Within 15 days of transfer, the U.S. Army will provide written notice to USEPA and TCEQ of the division of implementation, maintenance, and enforcement responsibilities unless the information has already been provided in the LUC RD. The notice will describe the mechanism by which the LUC will continue to be implemented, maintained, inspected, reported, and enforced. Upon

transfer, such responsibilities may shift to the transferee via appropriate provisions placed in the Environmental Condition of Property (ECP) or other environmental document for transfer. Although the U.S. Army may transfer responsibility for various implementation actions, the U.S. Army will also retain ultimate responsibility for the remedy integrity. This means that the U.S. Army is responsible for addressing substantive violations of the LUC performance objectives that would undermine the U.S. Army's CERCLA remedy. The U.S. Army also will be responsible for incorporating RD information and outlining the transferee's LUC obligations into property transfer documentation. In the event property is transferred out of Federal control, the land use controls relating to property and groundwater restrictions shall be recorded in the deed and shall be enforceable by the United States and the state of Texas.

6.3.2 Opportunity to Review Text of Intended Land Use Controls

The U.S. Army will provide a copy of the groundwater and land use restriction notification to TCEQ for review and approval prior to its recordation in Harrison County. USEPA will also receive a copy for review. The U.S. Army will produce an ECP or other environmental document for transfer of LHAAP-18/24, but before executing transfer, the U.S. Army will provide USEPA and TCEQ with a copy of the ECP or other environmental document for transfer so that they may have reasonable opportunity, before transfer, to review all LUC-related provisions.

6.3.3 Notification Should Action(s) which Interfere with land Use Control Effectiveness be Discovered Subsequent to Conveyance

Should the U.S. Army discover after conveyance of the Site any activity on the property inconsistent with the LUC performance objectives, the U.S. Army shall notify USEPA and TCEQ within 72 hours of such discovery. Consistent with **Section 6.3.5** below, the U.S. Army will then work with USEPA, TCEQ and the transferee to correct the problem(s) discovered. This reporting requirement does not preclude the U.S. Army from taking immediate action pursuant to its CERCLA authorities to prevent any perceived risk(s) to human health or the environment.

6.3.4 Land Use Control Enforcement

Should the LUC remedy reflected in this RD fail, the U.S. Army will coordinate with USEPA and TCEQ to ensure that appropriate actions are taken to reestablish its protectiveness. These actions are taken to reestablish its protectiveness. These actions may range from informal resolutions with the USFWS or its lessee, to the institution of judicial action against non-federal third parties. Alternatively, should the circumstances warrant such, the U.S. Army could choose to exercise its response authorities under CERCLA. Should the U.S. Army become aware that any future owner or user of the property has violated any LUC requirement over which a local agency may have independent jurisdiction, the U.S. Army may notify those agencies of such violation(s) and work cooperatively with them to re-achieve owner/user compliance with the LUC.

6.3.5 Modification or Termination of Land Use Controls

The LUCs shall remain in effect until such time as the U.S. Army and USEPA agree that the concentrations of COCs in groundwater have met cleanup levels in groundwater and that surface and subsurface soil concentrations allow unrestricted use. When this occurs, the LUC will be terminated as needed. The decision to terminate the LUC will be documented consistent with the NCP process for post-ROD changes, potentially including an explanation of significant differences or a remedial

action complete report. If the property has been transferred and a determination by the U.S. Army and USEPA has been made to terminate the LUC, the U.S. Army shall provide to the owner of the property an appropriate release for recordation pertaining to the Site and will also timely advise other local stakeholders of the action.

7 REMEDIAL CONSTRUCTION SCHEDULE

This section provides a preliminary schedule for the activities necessary to complete Phase I, II and III of the RD. The actual sequence will be determined by the Contractor and shall be included in the individual work plan that will be submitted prior to commencing the work.

7.1 Construction Sequence

A preliminary sequence of the activities necessary to implement the remedial action (RA) is below. The RA is proposed to be performed in two phases. The Contractor shall include the sequence in the RAWP that will be submitted for approval prior to commencing their work.

Remedial Action Phase I Activities

The Contractor to complete the following activities under Phase I RA. Step 1, Site Preparation, will be completed first. Steps 2 through 4 will be completed concurrently as feasible.

1. Site Preparation
    a. Locate and mark all underground utilities and verify existing site conditions in the vicinity of the work areas. The Contractor shall use a third-party location service if required.
    b. Mobilize equipment and trailers to the Site. Set up staging areas.
    c. Conduct pre-construction photographic and video documentation.
    d. Identify and clearly mark all monitoring wells in the vicinity of the work areas for protection.
    e. Set up air monitoring stations.
    f. Perform site clearing as needed to access/perform the work.
    g. Conduct preliminary survey using global positioning system equipment.
    h. Construct decontamination facilities and stockpiling area.
    i. Set up traffic controls.
2. Soil excavation and disposal
    a. Install erosion control measures.
    b. Construct access roads, as required, for soil excavation.
    c. Excavate areas to primary excavation limits as defined.
    d. Visually inspect excavation and if no impacts are observed, collect sidewall and bottom confirmation samples.
    e. Based on results, proceed with secondary excavations, if required.
    f. If results are less than the cleanup levels, with the approval of the contracting officer's representative, perform backfill and compaction.
    g. Following backfill, restore with topsoil and seed.
    h. Transport and dispose of contaminated material.
    i. Demobilize.
    j. Remove temporary erosion control measures.
3. EISB Field Pilot Tests
    a. Clear injection and monitoring well locations required for conducting all three pilot tests.
    b. Mobilize materials, equipment, and labor for installing injection wells and new monitoring wells to be used for performance monitoring.
    c. Mobilize materials, equipment, mixing tanks, and labor for injections for the pilot tests.
    d. Layout injection locations and clear DPT injection points.

e. Core concrete/asphalt at injection points, if needed, and adjust any points if obstructions are found and push rods to the desired injection interval.
f. Setup amendment, equipment, and materials onsite.
g. Begin preparing amendment solution for injection a day before planned injections. preparation of amendment solution will be a continual activity.
h. Inject amendments.
i. Record injection intervals and volumes during injections.
j. Once injection is complete at a DPT injection point, abandon point.
k. Record injection wells and DPT injection point locations with GPS.
l. Record field measurements from the observation wells.
m. Submit a field pilot test report documenting the implementation, findings, results, and recommendation for implementing the full-scale remedy for the full scale EISB to be implemented in phase II.

4. ISTD for DNAPL treatment:
    a. Clear areas required for the implementation of the ISTD treatment.
    b. Secure power drop.
    c. Install construction access roads, as required.
    d. Install heater wells, vapor extraction wells, and infrastructure for the ISTD treatment system.
    e. Start the ISTD system.
    f. Operate system until performance criteria for the ISTD treatment have been met.
    g. Perform two rounds of groundwater sampling. the first round shall be at a point when groundwater temperatures have dropped below 100 deg. Celsius. the second sampling event shall take place within 12 to 16 weeks after the first sampling event.
    h. Following receipt of groundwater samples achieving the performance criteria and with the approval of the contracting officer's representative, decommission the ISTD system.
    i. Restore the area to pre-existing conditions to the extent practicable following removal and demobilization of all equipment and materials from the Site.

Remedial Action Phase II Activities

The Contractor to complete the following activities under phase II RA concurrently.

1. Full scale EISB implementation:
    a. Provide site clearing.
    b. Please see **Section 7.1.3** above.
2. Conduct EISB performance monitoring.

7.2 Preliminary Schedule

Please see **Figure 7-1** for preliminary RA schedule.

8 SUMMARY OF PROJECT COSTS

8.1 Summary of Project Costs

A cost estimate for the proposed RA was developed as part of the RD and provided in **Appendix B**. The total estimated cost is $45.60 M. Additional investigation data collected in the PDI has resulted in changes to the remedial project including the larger area requiring remedial treatment. A detailed basis for the cost estimate is also provided in the **Appendix B**.

8.2 Estimating Method

The cost estimate combines task-based estimates for major construction items, quotes for materials and subsurface thermal treatment, and historical unit pricing for incidental and minor costs. Task-based estimates were developed for approximately 80% of construction costs for unsaturated soil excavation and 50% of construction costs for EISB pilot testing. A vendor quote from Terra Therm comprises approximately 90% of construction costs for ISTD. Details regarding these methods are discussed below.

8.3 Task-Based Estimates

Task-based estimating considers a work breakdown by task, construction method, production rates, equipment types, labor classifications, and material pricing appropriate for the scope of work, site properties, and level of design detail to calculate project costs. Assumptions made within the task-based estimates may be revised as needed as design progresses. Task-based estimates follow the requirements of the United States Army Corps of Engineers (USACE) regulations for civil works projects. The USACE software Micro-Computer Aided Cost Estimating System, Generation II, Version 4.4.3 (MII) was used for some calculations of equipment operating costs and production rates. The basis for these costs is described below followed by a discussion of major task-based estimates.

8.3.1 Labor Rates

All labor rates and fringes are based on Davis Bacon Act (DBA) and Service Contract Act (SCA) wage determinations, as available online at www.dol.gov. Typically, rates for the county where work is located would be used; however, the DBA rates for Karnack County were far out of date, as well as rates for larger nearby counties such as Shreveport, LA, and Houston, TX. Therefore, the estimate considered the national DBA rates published by USACE, which reflect a 2021 cost basis and local Seattle labor pricing. These costs were adjusted to Texas and escalated to 2024 (the expected midpoint of construction) per USACE Engineering Manual (EM) 1110-2-1304, September 2022 release. SCA rates were available and recently updated for Karnack County and were used for any non-construction labor. SCA rates were based on wage determination 2015-5191, revision 20, released December 27, 2022. Fringe benefits were assumed to be 30% of the base rate for SCA labor. Texas payroll tax (13.74%), workman's compensation insurance (WCI, 22.47%), and overtime (10%) were applied to all labor rates. The overtime markup assumes five 10-hour days per week. Note that payroll tax is calculated on the base rate plus fringe benefits, WCI is calculated only on the base rate, and the overtime markup applies to the base rate and payroll tax increase. A 20% markup was applied to DBA labor for HTRW work.

8.3.2 Equipment Rates

Equipment rates are based on the 2020 Region 6 MII equipment library which considers USACE Engineering Pamphlet (EP) 1110-1-8 rates. Operating costs were calculated in MII to account for

current fuel prices in the project area, and a Federal cost-of-money (COM) rate of 5.0%. The estimate includes fuel rates of $4.60/gallon for on-road diesel, $4.16 for off-road diesel, and $3.20 for gasoline. The overtime FCCM discount markup is applied to the total equipment rate after calculating operating costs.

8.3.3 Earthwork

Production rates for earthwork follow an assumed earthwork handling plan, which considers three classifications of soil, clean reusable soil in the upper four ft of the Site, and hazardous and non-hazardous soil from deeper than four feet below ground surface to be disposed of. The earthwork handling plan is as follows:

1. Excavation: All material will be excavated and stockpiled on-site. Costs assume an excavator to remove material and a dozer to manage stockpiles, plus a water truck for dust control.
2. Material Characterization: Samples from the excavations or stockpiles will classify the material as 1) reusable as backfill (for soils excavated from 0 to 4 feet below ground surface), 2) non-hazardous disposal, or 3) hazardous disposal.
3. Offhaul of Contaminated Soils: Costs for offhaul include hauling and disposal fees. Hauling assumes on-highway trucks hauling 11 cy/load and includes an allowance for a waste liner for each load. Quotes were obtained for disposal fees for non-hazardous and hazardous material:
    3.1. Non-hazardous material is assumed to be disposed of at the Woolworth Road Landfill at 10580 Woolworth Rd, Keithville, LA 71047. A disposal price of $28/cy was quoted by the facility.
    3.2. Hazardous material is assumed to be disposed of at the Waste Management CWM Lake Charles facility which accepts hazardous soil. It is located at 36964 Alabama Highway 17 N, Emelle, AL 35459. A quote of $140/TN from a recent remediation project was used for disposal costs.
4. Backfill: Backfill costs include purchase, placement, compaction, and grading of certified clean material from 2 sources:
    4.1. Material from the upper four ft of excavation deemed suitable for reuse assumes material will be pushed into place by a dozer and compacted.
    4.2. Imported material assumed purchase from A&T Sand and Gravel in Longview, Texas. A purchase and hauling quote were received by phone on January 10, 2023.

8.3.4 Monitoring Wells

Monitoring well costs are mostly based on the 2022 MII Cost Book, which is a cost database maintained by the USACE. Material pricing and equipment crews and productions rates from the cost book and MII software were used in excel-based calculations of total costs.

8.3.5 Indirect Cost Markups

The above discussion calculates a direct cost to the Contractor. To advance these costs to representative bid item costs, the following indirect markups are applied:

- Home Office Overhead (HOOH): 6%
- Job Office Overhead (JOOH): 10%
- Contractor Profit: 8%
- Contractor Bond: 2%

8.4 Subcontractor Quotes

Costs for the ISTD treatment system are based on an estimate provided by Terra Therm, a leading thermal treatment vendor. Design parameters and assumptions used to develop the ISTD cost estimate are included in **Appendix B**. Costs for EISB substrates and amendments are based on quotes provided by Tersus and SiREM Lab. Supporting calculations and vendor quotes for EISB injection materials are included in **Appendix F**.

8.5 Project-level Markups

The estimate includes the following “below-the-line" cost markups:

8.5.1 Contingency

A 30% contingency is applied to all project costs. The contingency accounts for possible price fluctuations, the reliance on an outside quote for the ISTD portion of the remedy, and other unknowns, such as possible secondary excavations based on post-excavation confirmatory sampling results.

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10 LIST OF ACRONYMS AND ABBREVIATIONS

ACD	Air curtain destructor
AECOM	AECOM Technical Services, Inc.
APP	Accident Prevention Plan
ARARs	Applicable or Relevant or Appropriate Requirements
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
CDM	Camp, Dresser & McKee
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COCs	Chemicals of Concern
COPECs	Chemicals of Potential Ecological Concern
CPT	Cone Penetrometer Test
CSM	Conceptual Site Model
cy	Cubic Yards
DNAPL	Dense Non-aqueous Phase Liquid
DO/ORP	Dissolved Oxygen/Oxidation-reduction potential
DPT	Direct Push Technology
ECP	Environmental Condition of Property
EISB	Enhanced In-situ Bioremediation
EPS	Environmental Protection Systems
ERH	Electrical Resistance Heating
ESD	Explanation of Significant Difference
EVO	emulsified vegetable oil
FS	Feasibility Study
ft	Feet
GPS	Global Positioning System
GWP-Ind	TCEQ soil MSCs for industrial use based on groundwater protection
GWQA	Groundwater Quality Assessment
GWTP	groundwater treatment plant
HASP	Health and Safety Plan
HDPE	High-density Polyethylene
HDR	HDR Environmental, Operations and Construction, Inc.
ICTs	Interceptor-collection trenches
IRA	Interim Remedial Action
ISTD	In-situ Thermal Desorption
IWWP	Installation-Wide Work Plan
LHAAP	Longhorn Army Ammunition Plant

LTM	Long-term monitoring
LUCs	Land Use Controls
MC	Methylene chloride
MCL	Maximum Contaminant Level
MIP	Membrane Interface Probe
MNA	Monitored Natural Attenuation
MOA	Memorandum of Agreement
MSCs	Medium-Specific Concentration
NA	Natural Attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEC	National Electrical Code
NFPA	National Fire Protection Association
NPL	National Priorities List
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Association
PCE	Tetrachloroethene
PCL	Protective Concentration Level
PDI	Pre-Design Investigation
PSI	Post-Screening Investigation
PVC	Polyvinyl chloride
RA	Remedial Action
RACR	Remedial Action Completion Report
RAOs	Remedial Action Objectives
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
ROD	Record of Decision
ROI	Radius of Influence
SESCs	Soil Erosion and Sedimentation Controls
STEP	Solutions to Environmental Problems, Inc.
SVE	Soil Vapor Extraction
TCE	trichloroethylene
TCEQ	Texas Commission on Environmental Quality
TCH	Thermal Conduction Heating
TOC	Total Organic Carbon
TRRP	Texas Risk Reduction Program
TRRP Residential Groundwater PCL	Texas Risk Reduction Program Tier 1 Residential Groundwater Protective Concentration Level
U.S. Army	U.S. Army Corps of Engineers

TABLES

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Table 1-1 Groundwater Seepage Velocity and Travel Time
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Calculate groundwater seepage velocity and travel time:

Effective Porosity *0.396* Average Porosity from Post-Screening Investigation Report (Table 3-8)

Well ID	Water Elevations - June 2021*	Well ID	Water Elevations - June 2021*	Horizontal Distance between Wells	Hydraulic Gradient	Assumes Hydraulic conductivity of **	Assumes Hydraulic conductivity of **	Reference Monitoring Well ID	Groundwater Seepage Velocity	Groundwater Seepage Velocity	Average Seepage Velocity
	ft amsl		ft amsl	ft	ft/ft	cm/sec	ft/day		ft/day	ft/year	ft/year
EISB Biobarrier 1 - Northeast area towards Harrison Bayou											
18WW22	172.42	18CPTMW18	169.03	710	0.0048	3.47E-03	9.84	18WW17	0.12	43.29	43.1
Iso Line 172	172	Isoline 171	171	211	0.0047	3.47E-03	9.84	18WW17	0.12	42.97	
EISB Biobarrier 2 - North/North West towards ICTs											
120	175.11	MW12	172.14	150	0.0198	2.34E-03	6.63	18WW08	0.33	121.05	95.5
Iso Line 175	175.00	Iso Line 172	172.00	176	0.0170	2.34E-03	6.63	18WW08	0.29	104.21	
123	176.56	18WW25	170.22	634	0.0100	2.34E-03	6.63	18WW08	0.17	61.14	
EISB Biobarrier 2 - North/North West towards Harrison Bayou											
18CPTMW15	171.79	18WW25	170.22	355	0.0044	2.34E-03	6.63	18WW08	0.07	27.04	30.4
18CPTMW23	171.68	18WW24	170.54	206	0.0055	2.34E-03	6.63	18WW08	0.09	33.83	
EISB Biobarrier 2 - towards West											
MW-9	173.28	MW-18	172.70	403	0.0014	1.52E-04	0.43	MW-20	<0.01	0.57	0.4
129	172.78	MW-8	172.68	225	0.0004	1.52E-04	0.43	MW-20	<0.01	0.18	
Within Containment Area - Southwest Corner											
AWD-3	175.09	MW-23	172.89	291	0.0076	1.52E-04	0.43	MW-20	0.01	3.00	
Within Containment Area - ISTD Area 1											
Iso Line 175	175.00	Iso Line 172	172.00	240	0.0125	1.52E-04	0.43	MW-20	0.01	4.96	
Within Containment Area - ISTD Area 2											
Iso Line 176	176.00	Iso Line 175	175.00	50	0.0200	1.52E-04	0.43	MW-20	0.02	7.94	

* Water elevations are from Quarterly Evaluation Report, 2nd Quarter (April-June) 2021, Groundwater Treatment Plant (Bhate, 2021)
** Hydraulic conductivity at Site 18/24 was estimated through slug tests conducted on several of the Pre-Phase I wells and results were reported in the remedial investigation report (Jacobs, 2001)
ft asml - feet above mean sea level
cm/sec - centimeters per second
ft - feet
ft/ft - feet per feet
ft/day - feet per day

Table 1-2 Wells with Metal Concentrations above Cleanup Levels
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

		Analyte	Arsenic	Barium	Chromium	Manganese	Nickel
		CAS No.	7440-38-2	7440-39-3	7440-47-3	7439-96-5	7440-02-0
		MCL/PCL	0.01	2	0.1	1.1	0.49
		UNITS	mg/L	mg/L	mg/L	mg/L	mg/L
Well ID	**Aquifer Zone**	**Date**					
AWD-1	Shallow	12/9/2021	0.0127	0.298	0.0181	0.242	0.032
C-08	Shallow	12/14/2021	0.00112 J	5.42	0.00143 J	1.18	0.00775
18CPTMW14	Shallow	12/9/2021	0.00205 J	3.95	0.0213	0.285	0.00476 J
18CPTMW15	Shallow	12/8/2021	NA	NA	NA	NA	NA
18CPTMW16	Shallow	12/15/2021	NA	NA	NA	NA	NA
18CPTMW19	Shallow	12/13/2021	NA	NA	NA	NA	NA
18CPTMW22R	Shallow	12/7/2021	0.00351 J	0.171	0.00922	0.112	0.0089
18CPTMW23	Shallow	12/15/2021	NA	NA	NA	NA	NA
18CPTMW24	Shallow	12/14/2021	0.00718	10.6	0.00229 J	0.483	0.00758
1824DPTMW01	Shallow	12/20/2021	NA	NA	NA	NA	NA
1824DPTMW02	Shallow	12/20/2021	NA	NA	NA	NA	NA
1824DPTMW03	Shallow	12/20/2021	NA	NA	NA	NA	NA
1824DPTMW03	Shallow	12/20/2021	NA	NA	NA	NA	NA
1824DPTMW04	Shallow	12/14/2021	NA	NA	NA	NA	NA
1824DPTMW05	Shallow	12/13/2021	NA	NA	NA	NA	NA
18WW08	Shallow	12/13/2021	NA	NA	NA	NA	NA
18WW10	Shallow	12/9/2021	NA	NA	NA	NA	NA
18WW22	Shallow	12/15/2021	0.00206 J	0.0919	0.0251	0.00243 J	<0.000600
18WW24	Shallow	12/15/2021	0.000899 J	0.0464	0.00165 J	7.16	0.178 J
MW-2	Shallow	12/9/2021	0.0259	2.68	0.218	7.69	0.396
MW-2	Shallow	12/9/2021	0.0265	3.06	0.252	8.83	0.408
MW-3	Shallow	12/9/2021	0.000461 J	0.551	0.00305 J	2.39	0.00722
MW-5	Shallow	12/6/2021	< 0.00100	0.698	0.0771	0.0644	0.0599
MW-7	Shallow	12/6/2021	NA	NA	NA	NA	NA
MW-8	Shallow	12/20/2021	NA	NA	NA	NA	NA
MW-9	Shallow	12/15/2021	< 0.00100	0.105	0.147	0.147	0.0476
MW-16	Shallow	12/15/2021	NA	NA	NA	NA	NA
MW-17	Shallow	12/9/2021	NA	NA	NA	NA	NA
MW-18	Shallow	12/7/2021	NA	NA	NA	NA	NA
MW-18	Shallow	12/7/2021	NA	NA	NA	NA	NA
MW-19	Shallow	12/7/2021	0.00328 J	0.323	0.0517	2.71	0.0433
MW-21	Shallow	12/13/2021	0.000799 J	4.09	0.623	1.14	0.478
MW-22	Shallow	12/8/2021	0.00153 J	1.02	1.25	0.288	0.93
MW-22	Shallow	12/8/2021	0.00143 J	0.972	1	0.267	0.865
MW-23	Shallow	12/6/2021	NA	NA	NA	NA	NA
109	Shallow	12/14/2021	NA	NA	NA	NA	NA
120	Shallow	12/7/2021	NA	NA	NA	NA	NA
125	Shallow	12/14/2021	0.0129	0.139	0.011	0.0581	0.00696
126	Shallow	12/14/2021	0.0233	10.5	0.00180 J	0.398	0.0204
C-03	Wilcox	12/20/2021	NA	NA	NA	NA	NA
18CPTMW01SW	Wilcox	12/9/2021	0.0108	1.13	0.00254 J	0.576	0.00192 J
18CPTMW03SW	Wilcox	12/13/2021	0.00479 J	0.607	0.00571	0.674	0.00314 J
18CPTMW04SW	Wilcox	12/8/2021	0.00684	0.925	0.0111	0.561	0.00606
18CPTMW04	Wilcox	12/8/2021	NA	NA	NA	NA	NA
18CPTMW06	Wilcox	12/8/2021	NA	NA	NA	NA	NA
18CPTMW07	Wilcox	12/14/2021	NA	NA	NA	NA	NA

Table 1-2 Wells with Metal Concentrations above Cleanup Levels
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

		Analyte	Arsenic	Barium	Chromium	Manganese	Nickel
		CAS No.	7440-38-2	7440-39-3	7440-47-3	7439-96-5	7440-02-0
		MCL/PCL	0.01	2	0.1	1.1	0.49
		UNITS	mg/L	mg/L	mg/L	mg/L	mg/L
Well ID	**Aquifer Zone**	**Date**					
18CPTMW08DW	Wilcox	12/6/2021	NA	NA	NA	NA	NA
18CPTMW08SW	Wilcox	12/6/2021	NA	NA	NA	NA	NA
18CPTMW10DW	Wilcox	12/13/2021	0.00276 J	0.208	0.00517	0.185	0.00201 J
18CPTMW10DW	Wilcox	12/13/2021	0.00255 J	0.202	0.00525	0.186	0.00161 J
18CPTMW10SW	Wilcox	12/13/2021	NA	NA	NA	NA	NA
18CPTMW12SW	Wilcox	12/6/2021	0.000813 J	0.901	0.00295 J	1.46	0.0132
18CPTMW12DW	Wilcox	12/6/2021	0.00264 J	0.327	0.00329 J	0.201	0.000774 J
18CPTMW22SW	Wilcox	12/7/2021	0.00211 J	0.11	0.0188	0.00737	< 0.00100
1824DPTMW06	Wilcox	12/7/2021	NA	NA	NA	NA	NA
1824DPTMW06	Wilcox	12/7/2021	NA	NA	NA	NA	NA
18WW02	Wilcox	12/8/2021	0.000528 J	0.0445	0.0151	0.0803	0.00942
18WW06	Wilcox	12/8/2021	NA	NA	NA	NA	NA
18WW17	Wilcox	12/15/2021	0.000746 J	3.45	0.0272	0.03	0.0531
MW-14	Wilcox	12/7/2021	0.00422 J	0.341	0.211	3.11	0.465

Notes:
Blue highlighting indicates concentrations above the MCL/PCL
MCL/PCL - Maximum Contaminant Level/Protective Concentration Level
NA - Not Analyzed
mg/L - milligrams per liter
J - Estimated: The analyte was positively identified, the quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria.
*Manganese and nickel compared to the PCL
PCL – Texas Risk Reduction Program (TRRP) Tier 1 Groundwater Residential Protective Concentration Level
< - non-detect
CAS - Chemical Abstracts Services

Table 1-3 Soil Cleanup Levels at LHAAP-18/24
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Chemical of Concerns (COCs)	GWP-Ind MSC* (mg/kg)
Methylene Chloride	0.5
Trichloroethylene	0.5
Perchlorate	7.2
Tetrachloroethene	0.5

Notes:
*GWP-Ind MSC - Texas Commission on Environmental Quality soil medium-specific concentration (MSC) for industrial use based on groundwater protection
mg/kg – milligrams per kilogram

Table 1-4 Groundwater Cleanup Levels at LHAAP-18/24
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Medium	Chemical of Concern	Cleanup Level
Shallow Zone Groundwater		**MCL (µg/L)**
	Methylene chloride	5
	Trichloroethylene	5
	cis-1,2-Dichloroethene*	70
	Tetrachloroethene	5
	Benzene	5
	1,1,2-Trichloroethane	5
	Vinyl chloride*	2
	Arsenic	10
	Barium	2,000
	Chromium	100
		TRRP $^{GW}GW_{Ing}$ PCL (µg/L)
	Bromodichloromethane	15
	1,3,5-trinitrobenzene	730
	1,4-Dioxane	9.1
	Cobalt	240
	Nickel	490
	Perchlorate	17
Wilcox Formation Groundwater		**MCL (µg/L)**
	Methylene chloride	5
	Trichloroethylene	5
	cis-1,2-Dichloroethene*	70
	Tetrachloroethene	5
	Benzene	5
	Vinyl chloride*	2
	Arsenic	10
	Barium	2,000
		TRRP $^{GW}GW_{Ing}$ PCL (µg/L)
	Bromodichloromethane	15
	1,3,5-trinitrobenzene	730
	1,4-Dioxane	9.1
	Perchlorate	17

Notes:
1. The PCL for Bromodichloromethane was increased in the 2021 TRRP tables, and this change should be addressed in the Five-Year Review.
* Trichloroethene daughter products
**TRRP $^{GW}GW_{Ing}$ PCL from April 2018, https://www.tceq.texas.gov/remediation/trrp/trrppcls.html
µg/L – micrograms per liter
MCL – Safe Drinking Water Act (SDWA) maximum contaminant level
TRRP $^{GW}GW_{Ing}$ PCL – Texas Risk Reduction Program (TRRP) Tier 1 Groundwater Residential Protective Concentration Level (PCL)

Table 2-1 Landfill Inspection Schedule
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Landfill Feature	Frequency of Inspection
Existing Landfill Cap	Annually. Additional inspections may occur between annual events or after a major event[a]
- Vegetative Cover	
- Erosion and Settlement	
- Drainage System	
Current and Future Groundwater Monitoring Systems	Annually. Additional inspections may occur between annual events or after a major event[a]
Site Access Features*	Annually. Additional inspections may occur between annual events.

Notes:
[a] A major event is defined as a storm event that causes major local flooding, a seismic event greater than a magnitude of 4, or other events such as wildfires that may affect the cover.
* This is not a ROD requirement.

Table 3-1 Excavation Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Area ID	Length	Width	Area	Depth Interval		Depth	Volume	
	feet	feet	square feet	Feet bgs	Feet bgs	feet	cubic feet	cubic yards
Excavation Area 1	50	50	2,500	4	14	10	25,000	930
Excavation Area 2	70	40	2,800	4	14	10	28,000	1,040
Excavation Area 3	155	30	4,650	4	16	12	55,800	2,070
						TOTAL	108,800	4,040

Notes:
* Depth interval 0-4 ft bgs was previously excavated as part of the IRA. Excavation areas will be excavated to the indicated depths or to the depth groundwater is encountered.
**The soil volumes do not account for soils removed from benching of the excavation face. The soil volumes reflect only impacted soil removal.
bgs – below ground surface

Table 4-1 ISTD Treatment Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Area ID	Area	Thickness*	Volume	Volume	Approximate Target Depth
	square feet	feet	cubic feet	cubic yards	feet bgs
ISTD Area 1*	40,000	3	120,000	4,450	48 to 51
ISTD Area 2*	7,500	12	90,000	3,340	23 to 35
ISTD Area 3	56,000	12	672,000	24,890	28 to 40
TOTAL	103,500	3 to 15 ft	882,000	32,680	

Notes:

* Thickness of treatment is based on the estimate provided in Table 2-7: Estimate of DNAPL Mass for MC and TCE in the Shallow Zone, of Final Revised Feasibility Study Lhaap-18/24, Burning Ground No. 3 And Unlined Evaporation Pond, Longhorn Army Ammunition Plant, Karnack, Texas (AECOM, 2017).

bgs - below ground surface

Table 4-2 ISTD Treatment System - Minimum Process Monitoring Reporting Requirements
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Process Monitoring	Location	Matrix	Parameter	Frequency
Temperature	Temperature Monitoring Points	Soil and groundwater	Temperature	Daily
Heating Duration	Power Supply or Control Unit	Energy	Continuous operation	Continuous
Recovered Vapor Flow	Well-field Vapor Influent Manifold	Vapor	Vacuum-flow	Daily
	Blower inlet			
	Blower outlet			
Safety and Environmental Control	Treatment area subsurface and periphery	Soil and groundwater	Stray voltage	Minimum weekly
			Pressure	
			Noise	
		Peripheral Groundwater (two new downgradient wells)	VOC concentrations (Analytical) and	Minimum monthly
			temperature measurements	
VOC Vapor Destruction Efficiency	Vapor Treatment Equipment influent/effluent	Vapor	VOC concentrations (Analytical)	Minimum weekly and in accordance with permit equivalent(s)
			VOC concentrations (PID)	Daily and in accordance with permit equivalent(s)
Shallow Vacuum Monitoring	Perimeter vacuum monitoring points	Vapor	Pressure	Minimum weekly
NAPL Analysis for VOCs	NAPL collection equipment	Liquid	VOC concentrations (Analytical)	As needed (additional analyses may be required for disposal)

VOC - Volatile Organic Compounds
NAPL - Nonaqueous phase liquid
PID - Photoionization Detector

Table 5-1 EISB Pilot Test Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Area ID	Area	Injection Points	ROI	Target Depth Interval	Saturated Thickness	Nearby Existing Well ID	Perchlorate	TCE	MC
	square feet	no.	feet	feet bgs	feet		µg/L	µg/L	µg/L
Pilot Test Area 1 (Shallow Zone)	9,600	Up to 24 DPT Points in a Grid Configuration	10	28-40	12	1824DPT13	71,300	5,550	1
						1824DPT14	36,700	3,810	1
						MW-23	76,800	2,200	10
Pilot Test Area 2 (Shallow Zone)	Wall Length 125 feet	Up to 5 Permanent Injection Well Points	12.5	26-38	12	18WW17	47,500	13	1
						1824DPT22	76,800	42	2
Pilot Test Area 3 (Wilcox Formation)	3,600	Up to 9 DPT Points ina Grid Configuration	10	30-50	20	MW-14	198,000	9,000	20

Note:
ID – Identification
ROI – Radius of Influence
EISB – Enhanced In-Situ Bioremediation
bgs – below ground surface
µg/L – micrograms per liter
DPT – Direct Push Technology
TCE – trichloroethene
MC – methylene chloride

Table 5-2 EISB Grid Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Area ID	Area	Injection Points	ROI	Target Depth Interval	Saturated Thickness	Nearby Existing Well ID	Perchlorate	TCE	MC	Screen Depth	Total Depth	Depth to Clay	Depth to Water
	square feet	no.	feet	feet bgs	feet		µg/L	µg/L	µg/L	ft	ft	ft	ft bgs
EISB Grid 1	517,600	1,294	10	Varies across the area	17	1824DPT01	2,350	7,530	4.9	32-42	42	41	21.79
					15	1824DPT02	32,400	6,340	0.8	28-38	38	37	19.63
					14	1824DPT03	214,000	2,810	10.0	32-42	42	41	24.12
					16	1824DPT04	85,000	5,620	1.5	33-43	43	42	23.16
					15	1824DPT05	35,600	**12700***	4.3	32-42	42	41	24.00
					15	1824DPT06	26,200	**13100***	4.6	33-43	43	42	24.51
					14	1824DPT07	137,000	**11200***	2.2	32-42	42	41	24.08
					16	1824DPT08	87,300	3,540	4.9	32-42	42	41	22.79
					15	1824DPT09	56,900	4,260	10.0	33-43	43	42	24.34
					15	1824DPT10	42,000	5,380	1.5	33-43	43	42	24.96
					14	1824DPT11	65,900	2,930	4.6	32-42	42	41	24.14
					16	1824DPT12	59,500	3,040	2.2	33-43	43	42	23.21
					16	1824DPT13	71,300	5,550	1.4	33-43	43	42	23.65
					15	1824DPT14	36,700	3,810	1.2	34-44	44	43	25.09
					13	1824DPT15	51,300	4,400	1.1	33-43	43	42	26.29
					15	1824DPT16	47,900	2,890	0.6	33-43	43	42	24.37
					15	1824DPT32	26,200	**13400***	4.5	32-42	42	41	23.06
					16	1824DPT33	51,500	6,470	1.7	32-42	42	41	22.67
					14	1824DPT34	29,500	4,940	1.0	32-42	42	41	24.90
					17	1824DPT35	40,600	1,150	0.3	32-42	42	41	21.35
					17	1824DPT39	89,000	4,940	1.1	30-40	40	39	19.77
					14	1824DPT40	495,000	**14000***	3.5	31-41	41	40	23.03
					17	1824DPT41	124,000	**38400***	7.3	28-38	38	37	17.72
					9	1824DPT42	3,500	6,860	6,980.0	21-31	31	30	20.58
					16	1824DPTMW05	576,000	8,890	25.0	30-40	40	39	22.76
					17	MW-1	1,820	**15000***	20.0	31-36	38	41	23.10
					14	MW-2	0.124	6,200	6,400.0	33-38	40	27	23.35
					10	129	7,780	770	2.0	25-35	36	36	25.95
Average					***15***		***89,152***	***4,682***	***482.2***				

**** TCE concentration will be reduced to approximately 100 ppb by ISTD treatment at this location***

Table 5-2 EISB Grid Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Area ID	Area	Injection Points	ROI	Target Depth Interval	Saturated Thickness	Nearby Existing Well ID	Perchlorate	TCE	MC	Screen Depth	Total Depth	Depth to Clay	Depth to Water
	square feet	no.	feet	feet bgs	feet		µg/L	µg/L	µg/L	ft	ft	ft	ft bgs
EISB Grid 2	364,800	912	10	25-37	12	1824DPT17	6,410	229	1.0				
						1824DPT18	148,000	135	0.5				
						1824DPT19	16,200	100	1.0				
						1824DPT20	39,200	695	2.5	32-42	42	41	30
						1824DPT29	41,000	273	0.3	34-44	44	39	24
						1824DPT30	35,400	29	0.6	28-38	38	37	22
						1824DPTMW02	112,000	466	2.5	30-40	40	39	26
						MW-3	16,400	430	2				
						MW-21	10,600	3,900	10				
						109	20,400	240	2				
EISB Grid 3	27,200	68	10	25-33	8	MW-5	22,300	40	2	34-39	41	41	27
						MW-6	3,440	16	2				
EISB Grid 4 - Wilcox	6,400	16	10	30-50	20	MW-14	198,000	9,000	20	43-48	51	26 - 27.8	5
ESIB Grid 4 - Shallow	10,000	25	10	13-25	12	120	12,000	7,600	20	9-12	24	26	12
TOTAL	**926,000**	**2,315**											

Notes:
ID – Identification
ROI – Radius of Influence
EISB – Enhanced In-Situ Bioremediation
bgs – below ground surface
µg/L – micrograms per liter
DPT – Direct Push Technology
TCE – trichloroethene
MC – methylene chloride

Table 5-3 Shallow EISB Biobarrier Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Area ID	Area	Injection Points	ROI	Target Depth Interval	Saturated Thickness	Nearby Existing Well ID	Perchlorate	TCE	MC
	square feet	no.	feet	feet bgs	feet		µg/L	µg/L	µg/L
Shallow EISB Biobarrier 1 - IW	925	37	12.5	26-38	12	18WW17	47,500	13	0.5
						1824DPT22	76,800	42	2
Shallow EISB Biobarrier 2 - IW	2300	92	12.5	16-27	11	MW-7	13,100	2,000	10
						18CPTMW23	253	2,000	10
						MW-9	897	1,200	2
						MW-16	0.05	960	2
						129	7,780	770	2
						MW-12	0.71	260	2
						MW-8	2,500	120	2
						MW-10	0.05	15	2
Shallow EISB Biobarrier 2 - DPT	680	34	10	16-27	11	18CPTMW15	199	2.5	2
						MW-7	13,100	2,000	10
TOTAL	**3,905**	**163**							

Notes:
ID – Identification
ROI – Radius of Influence
EISB – Enhanced In-Situ Bioremediation
bgs – below ground surface
µg/L – micrograms per liter
DPT – Direct Push Technology
TCE – trichloroethene
MC – methylene chloride
IW – injection well

Table 5-4 Wilcox EISB Biobarrier Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Area ID	Area	DPT Injection Points	ROI	Target Depth Interval	Saturated Thickness	Nearby Existing Well ID	Perchlorate	TCE	MC
	square feet	no.	feet	feet bgs	feet		µg/L	µg/L	µg/L
Wilcox EISB Biobarrier 1	620	31	10	45-65	20	18CPTMW08SW	17,300	35	2
Wilcox EISB Biobarrier 2	520	26	10	30-50	20	MW-14	198,000	9,000	20
Wilcox EISB Biobarrier 3	500	25	10	40-60	20	18CPTMW22SW	4,050	1	2
TOTAL	**1,640**	**82**							

Notes:
ID – Identification
ROI – Radius of Influence
EISB – Enhanced In-Situ Bioremediation
bgs – below ground surface
µg/L – micrograms per liter
DPT – Direct Push Technology
TCE – trichloroethene
MC – methylene chloride

Table 5-5 Baseline Sampling Plan for Pilot Test Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	Proposed Analyses								
		VOCs [a] (SW8260B)	Perchlorate (6850)	Anions [b] (E300.0)	Dissolved Gases [c] (RSK-175)	Alkalinity (2320B)	TOC (SW9060)	DHC (qPCR)	Bromide (E300.0)	Field Parameters [d]
PMW-04	Downgradient to Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-05	Downgradient to Pilot Test Area #1	✓	✓							✓
PMW-06	Downgradient to Pilot Test Area #1	✓	✓							✓
PMW-07	Downgradient to Pilot Test Area #1	✓	✓							✓
PMW-08	Downgradient to Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-09	Downgradient to Pilot Test Area #1	✓	✓							✓
PMW-02	Upgradient to Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-03	Upgradient to Pilot Test Area #1	✓	✓							✓
PMW-01	Performance Data within Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-23	Performance Data within Pilot Test Area #1	✓	✓							✓
PMW-14	Downgradient to Pilot Test Area #2	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-15	Downgradient to Pilot Test Area #2	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-16	Downgradient to Pilot Test Area #2	✓	✓							✓
18WW17	Upgradient to Pilot Test Area #2	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-12	Performance Data within Pilot Test Area #2	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-13	Performance Data within Pilot Test Area #2	✓	✓							✓
PMW-03D	Downgradient to Pilot Test Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-04D	Downgradient to Pilot Test Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-01D	Upgradient to Pilot Test Area #3	✓	✓							✓

Table 5-5 Baseline Sampling Plan for Pilot Test Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	Proposed Analyses								
		VOCs [a] (SW8260B)	Perchlorate (6850)	Anions [b] (E300.0)	Dissolved Gases [c] (RSK-175)	Alkalinity (2320B)	TOC (SW9060)	DHC (qPCR)	Bromide (E300.0)	Field Parameters [d]
PMW-02D	Upgradient to Pilot Test Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-18D	Upgradient to Pilot Test Area #3	✓	✓							✓
MW-14	Performance Data within Pilot Test Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓
120	Performance Data within Pilot Test Area #3	✓	✓							✓

Notes:

[a] VOCs include TCE; cis-1,2-DCE; 1,1-DCE; 1,2-DCA; 1,1,2-TCA; VC; and methylene chloride.

[b] Anions include nitrate and sulfate.

[c] Dissolved gasses include ethene, ethane, and methane.

[d] Field Parameters include dissolved oxygen, oxidation reduction potential, and pH.

[e] Upper deep monitoring well

✓ Indicates that sample will be collected and analyzed for the listed analyte.

DHC - Dehalococcoides (microbial analysis)

TOC - total organic carbon

VOCs - volatile organic compounds

Table 5-6 Baseline Sampling Plan for Shallow Zone EISB Biobarriers
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	Proposed Analyses								
		VOCs [a] (SW8260B)	Perchlorate (6850)	Anions [b] (E300.0)	Dissolved Gases [c] (RSK-175)	Alkalinity (2320B)	TOC (SW9060)	DHC (qPCR)	Bromide (E300.0)	Field Parameters [d]
PMW-16	Downgradient to Shallow Zone EISB Biobarrier #1	✓	✓							✓
PMW-17	Downgradient to Shallow Zone EISB Biobarrier #1	✓	✓							✓
PMW-18	Downgradient to Shallow Zone EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-19	Downgradient to Shallow Zone EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
18WW17	Upgradient to Shallow Zone EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-12	Performance Data within Shallow Zone EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-28	Performance Data within Shallow Zone EISB Biobarrier #1	✓	✓							✓
PMW-21	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓							✓
PMW-22	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-24	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓							✓
PMW-25	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-26	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓							✓
PMW-27	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓							✓
18CPTMW26SW	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓							✓
18CPTMW23	Upgradient to Shallow Zone EISB Biobarrier #2	✓	✓							✓
MW-7	Upgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-9	Upgradient to Shallow Zone EISB Biobarrier #2	✓	✓							✓
18CPTMW15	Upgradient to Shallow Zone EISB Biobarrier #2	✓	✓							✓
PMW-20	Performance Data within Shallow Zone EISB Biobarrier #2	✓	✓							✓
PMW-23	Performance Data within Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes:

[a] VOCs include TCE; cis-1,2-DCE; 1,1-DCE; 1,2-DCA; 1,1,2-TCA; VC; and methylene chloride.

[b] Anions include nitrate and sulfate.

[c] Dissolved gasses include ethene, ethane, and methane.

[d] Field Parameters include dissolved oxygen, oxidation reduction potential, and pH.

[e] Upper deep monitoring well

✓ Indicates that sample will be collected and analyzed for the listed analyte.

DHC - Dehalococcoides (microbial analysis)

TOC - total organic carbon

VOCs - volatile organic compounds

Table 5-7 Baseline Sampling Plan for Wilcox Formation EISB Biobarriers
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	Proposed Analyses								
		VOCs [a] (SW8260B)	Perchlorate (6850)	Anions [b] (E300.0)	Dissolved Gases [c] (RSK-175)	Alkalinity (2320B)	TOC (SW9060)	DHC (qPCR)	Bromide (E300.0)	Field Parameters [d]
PMW-07D	Downgradient to Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-08D	Downgradient to Wilcox Formation EISB Biobarrier #1	✓	✓							✓
PMW-09D	Downgradient to Wilcox Formation EISB Biobarrier #1	✓	✓							✓
PMW-10D	Downgradient to Wilcox Formation EISB Biobarrier #1	✓	✓							✓
18CPTMW19	Downgradient to Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
AWD-4	Upgradient to Wilcox Formation EISB Biobarrier #1	✓	✓							✓
125	Upgradient to Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-05D	Performance Data within Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-06D	Performance Data within Wilcox Formation EISB Biobarrier #1	✓	✓							✓
18WW06	Downgradient to Wilcox Formation EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-03D	Upgradient to Wilcox Formation EISB Biobarrier #2	✓	✓							✓
PMW-04D	Upgradient to Wilcox Formation EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓
1824DPTMW06	Performance Data within Wilcox Formation EISB Biobarrier #2	✓	✓							✓
MW-12	Performance Data within Wilcox Formation EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-13D	Downgradient to Wilcox Formation EISB Biobarrier #3	✓	✓	✓	✓	✓	✓	✓	✓	✓
18CPTMW22SW	Upgradient to Wilcox Formation EISB Biobarrier #3	✓	✓							✓
MW-20	Upgradient to Wilcox Formation EISB Biobarrier #3	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-11D	Performance Data within Wilcox Formation EISB Biobarrier #3	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-12D	Performance Data within Wilcox Formation EISB Biobarrier #3	✓	✓							✓

Notes:

[a] VOCs include TCE; cis-1,2-DCE; 1,1-DCE; 1,2-DCA; 1,1,2-TCA; VC; and methylene chloride.

[b] Anions include nitrate and sulfate.

[c] Dissolved gasses include ethene, ethane, and methane.

[d] Field Parameters include dissolved oxygen, oxidation reduction potential, and pH.

[e] Upper deep monitoring well

✓ Indicates that sample will be collected and analyzed for the listed analyte.

DHC - Dehalococcoides (microbial analysis)
TOC - total organic carbon
VOCs - volatile organic compounds

Table 5-8 Baseline Sampling Plan for EISB Grid Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	Proposed Analyses								
		VOCs [a] (SW8260B)	Perchlorate (6850)	Anions [b] (E300.0)	Dissolved Gases [c] (RSK-175)	Alkalinity (2320B)	TOC (SW9060)	DHC (qPCR)	Bromide (E300.0)	Field Parameters [d]
AWD-3	Performance Data within EISB Grid Area #1	✓	✓							✓
1824DPTMW05	Performance Data within EISB Grid Area #1	✓	✓							✓
MW-2-R	Performance Data within EISB Grid Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-09	Performance Data within EISB Grid Area #1	✓	✓							✓
PMW-10	Performance Data within EISB Grid Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-11	Performance Data within EISB Grid Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-3	Performance Data within EISB Grid Area #2	✓	✓							✓
MW-21	Performance Data within EISB Grid Area #2	✓	✓							✓
1824DPTMW02	Performance Data within EISB Grid Area #2	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-5	Performance Data within EISB Grid Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-6	Performance Data within EISB Grid Area #3	✓	✓							✓
PMW-03D	Performance Data within EISB Grid Area #4	✓	✓							✓
PMW-02D	Performance Data within EISB Grid Area #4	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes:

[a] VOCs include TCE; cis-1,2-DCE; 1,1-DCE; 1,2-DCA; 1,1,2-TCA; VC; and methylene chloride.

[b] Anions include nitrate and sulfate.

[c] Dissolved gasses include ethene, ethane, and methane.

[d] Field Parameters include dissolved oxygen, oxidation reduction potential, and pH.

[e] Upper deep monitoring well

✓ Indicates that sample will be collected and analyzed for the listed analyte.

DHC - Dehalococcoides (microbial analysis)

TOC - total organic carbon

VOCs - volatile organic compounds

-R - Replaced after ISTD activities.

Table 5-9 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the Pilot Test Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	First Two Months (Up to Two Events[a])					Year 1 (Quarterly)												Year 2 (Quarterly)											
		DO (field reading)	ORP (field reading)	pH (field reading)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	DHC (qPCR)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	Bromide (E300.0)	TOC (SW9060)
PMW-04	Downgradient to Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-05	Downgradient to Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-06	Downgradient to Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-07	Downgradient to Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-08	Downgradient to Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-09	Downgradient to Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-02	Upgradient to Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
PMW-03	Upgradient to Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
PMW-01	Performance Data within Pilot Test Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-23	Performance Data within Pilot Test Area #1	✓	✓	✓	✓	✓																									
PMW-14	Downgradient to Pilot Test Area #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓

Table 5-9 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the Pilot Test Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	First Two Months (Up to Two Events[a])					Year 1 (Quarterly)												Year 2 (Quarterly)											
		DO (field reading)	ORP (field reading)	pH (field reading)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	DHC (qPCR)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	Bromide (E300.0)	TOC (SW9060)
PMW-15	Downgradient to Pilot Test Area #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-16	Downgradient to Pilot Test Area #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
18WW17	Upgradient to Pilot Test Area #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
PMW-12	Performance Data within Pilot Test Area #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-13	Performance Data within Pilot Test Area #2	✓	✓	✓	✓	✓																									
PMW-03D	Downgradient to Pilot Test Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-04D	Downgradient to Pilot Test Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
PMW-01D	Upgradient to Pilot Test Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
PMW-02D	Upgradient to Pilot Test Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
PMW-18D	Upgradient to Pilot Test Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							

Table 5-9 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the Pilot Test Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	First Two Months (Up to Two Events[a])					Year 1 (Quarterly)												Year 2 (Quarterly)											
		DO (field reading)	ORP (field reading)	pH (field reading)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	DHC (qPCR)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	Bromide (E300.0)	TOC (SW9060)
MW-14	Performance Data within Pilot Test Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
120	Performance Data within Pilot Test Area #3	✓	✓	✓	✓	✓																									

Notes:

[a] To be conducted within 15 to 30 days of the completion of substrate injection. A second event will be collected between 45 and 60 days if the results from the first event were inconclusive.

[b] VOCs include TCE; cis-1,2-DCE; 1,1-DCE; 1,2-DCA; 1,1,2-TCA; VC; and methylene chloride.

[c] Anions include nitrate and sulfate.

✓ Indicates that sample will be collected and analyzed for the listed analyte.

EISB - enhanced in-situ bioremediation

Table 5-10 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the Shallow Zone Biobarriers
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	First Two Months (Up to Two Events[a])					Year 1 (Quarterly)												Year 2 (Quarterly)										
		DO (field reading)	ORP (field reading)	pH (field reading)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	DHC (qPCR)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	Bromide (E300.0)	TOC (SW9060)
PMW-16	Downgradient to Shallow Zone EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-17	Downgradient to Shallow Zone EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-18	Downgradient to Shallow Zone EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-19	Downgradient to Shallow Zone EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
18WW17	Upgradient to Shallow Zone EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
PMW-12	Performance Data within Shallow Zone EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-28	Performance Data within Shallow Zone EISB Biobarrier #1	✓	✓	✓	✓	✓																									
PMW-21	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-22	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-24	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-25	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-26	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-27	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
18CPTMW26SW	Downgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓

Table 5-10 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the Shallow Zone Biobarriers
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	First Two Months (Up to Two Events[a])					Year 1 (Quarterly)												Year 2 (Quarterly)											
		DO (field reading)	ORP (field reading)	pH (field reading)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	DHC (qPCR)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	Bromide (E300.0)	TOC (SW9060)
18CPTMW23	Upgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
MW-7	Upgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
MW-9	Upgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
18CPTMW15	Upgradient to Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
PMW-20	Performance Data within Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓																									
PMW-23	Performance Data within Shallow Zone EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes:

[a] To be conducted within 15 to 30 days of the completion of substrate injection. A second event will be collected between 45 and 60 days if the results from the first event were inconclusive.

[b] VOCs include TCE; cis-1,2-DCE; 1,1-DCE; 1,2-DCA; 1,1,2-TCA; VC; and methylene chloride.

[c] Anions include nitrate and sulfate.

✓ Indicates that sample will be collected and analyzed for the listed analyte.

EISB - enhanced in-situ bioremediation

Table 5-11 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the Wilcox Formation Biobarriers
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	First Two Months (Up to Two Events[a])					Year 1 (Quarterly)											Year 2 (Quarterly)										
		DO (field reading)	ORP (field reading)	pH (field reading)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs[b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions[c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	DHC (qPCR)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs[b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions[c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	Bromide (E300.0)	TOC (SW9060)
PMW-07D	Downgradient to Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-08D	Downgradient to Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-09D	Downgradient to Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-10D	Downgradient to Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
18CPTMW19	Downgradient to Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
AWD-4	Upgradient to Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
125	Upgradient to Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
PMW-05D	Performance Data within Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-06D	Performance Data within Wilcox Formation EISB Biobarrier #1	✓	✓	✓	✓	✓																									
18WW06	Downgradient to Wilcox Formation EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
PMW-03D	Upgradient to Wilcox Formation EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
PMW-04D	Upgradient to Wilcox Formation EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
1824DPTMW06	Performance Data within Wilcox Formation EISB Biobarrier #2	✓	✓	✓	✓	✓																									
MW-12	Performance Data within Wilcox Formation EISB Biobarrier #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 5-11 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the Wilcox Formation Biobarriers
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	First Two Months (Up to Two Events[a])					Year 1 (Quarterly)												Year 2 (Quarterly)											
		DO (field reading)	ORP (field reading)	pH (field reading)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	DHC (qPCR)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	Bromide (E300.0)	TOC (SW9060)
PMW-13D	Downgradient to Wilcox Formation EISB Biobarrier #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓
18CPTMW22SW	Upgradient to Wilcox Formation EISB Biobarrier #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
MW-20	Upgradient to Wilcox Formation EISB Biobarrier #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓									✓	✓	✓	✓	✓							
PMW-11D	Performance Data within Wilcox Formation EISB Biobarrier #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-12D	Performance Data within Wilcox Formation EISB Biobarrier #3	✓	✓	✓	✓	✓																									

Notes:

[a] To be conducted within 15 to 30 days of the completion of substrate injection. A second event will be collected between 45 and 60 days if the results from the first event were inconclusive.

[b] VOCs include TCE; cis-1,2-DCE; 1,1-DCE; 1,2-DCA; 1,1,2-TCA; VC; and methylene chloride.

[c] Anions include nitrate and sulfate.

✓ Indicates that sample will be collected and analyzed for the listed analyte.

EISB - enhanced in-situ bioremediation

Table 5-12 EISB Performance Monitoring Sampling Plan (Years 1 and 2) in the EISB Grid Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	EISB Area	First Two Months (Up to Two Events[a])					Year 1 (Quarterly)												Year 2 (Quarterly)											
		DO (field reading)	ORP (field reading)	pH (field reading)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	DHC (qPCR)	Bromide (E300.0)	TOC (SW9060)	Perchlorate (6850)	VOCs [b] (SW8260B)	DO (field reading)	ORP (field reading)	pH (field reading)	Alkalinity (2320B)	Anions [c] (E300.0)	Ethene (RSK-175)	Ethane (RSK-175)	Methane (RSK-175)	Bromide (E300.0)	TOC (SW9060)
AWD-3	Performance Data within EISB Grid Area #1	✓	✓	✓	✓	✓																									
1824DPTMW05	Performance Data within EISB Grid Area #1	✓	✓	✓	✓	✓																									
MW-2-R	Performance Data within EISB Grid Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-09	Performance Data within EISB Grid Area #1	✓	✓	✓	✓	✓																									
PMW-10	Performance Data within EISB Grid Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-11	Performance Data within EISB Grid Area #1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-3	Performance Data within EISB Grid Area #2	✓	✓	✓	✓	✓																									
MW-21	Performance Data within EISB Grid Area #2	✓	✓	✓	✓	✓																									
1824DPTMW02	Performance Data within EISB Grid Area #2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-5	Performance Data within EISB Grid Area #3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-6	Performance Data within EISB Grid Area #3	✓	✓	✓	✓	✓																									
PMW-03D	Performance Data within EISB Grid Area #4	✓	✓	✓	✓	✓																									
PMW-02D	Performance Data within EISB Grid Area #4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes:

[a] To be conducted within 15 to 30 days of the completion of substrate injection. A second event will be collected between 45 and 60 days if the results from the first event were inconclusive.

[b] VOCs include TCE; cis-1,2-DCE; 1,1-DCE; 1,2-DCA; 1,1,2-TCA; VC; and methylene chloride.

[c] Anions include nitrate and sulfate.

✓ Indicates that sample will be collected and analyzed for the listed analyte.

EISB - enhanced in-situ bioremediation

-R - Replaced after ISTD activities.

Table 5-13 MNA and LTM Performance Monitoring Plan
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	Location of Well[a]	Groundwater Zone	Proposed Analyses									
			VOCs[b] (SW8260B)	Perchlorate (6850)	TAL Metals (EPA Method 6020A)	Anions[c] (E300.0)	Dissolved Gases[d] (RSK-175)	Alkalinity (2320B)	TOC (SW9060)	DHC (qPCR)	Bromide (E300.0)	Field Parameters[e]
18CPTMW18	Outside the containment area to the northeast; downgradient from Shallow Zone EISB Biobarrier #1	Shallow Zone	✓	✓	✓							✓
18CPTMW19	Outside the northern corner of the containment area; downgradient from Wilcox Formation EISB Biobarrier #1	Shallow Zone	✓	✓	✓							✓
18CPTMW24	Along site boundary just outside the eastern corner of the containment area	Shallow Zone	✓	✓	✓							✓
1824DPTMW01	Outside the containment area to the northeast; downgradient from Shallow Zone EISB Biobarrier #1	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1824DPTMW02	Outside the containment area to the northeast; within EISB Grid Area #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1824DPTMW03	Outside the containment area to the north-northeast; downgradient from EISB Grid Area #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1824DPTMW04	Outside the containment area to the east-northeast; downgradient from EISB Grid Area #2	Shallow Zone	✓	✓	✓							✓
PMW-18	Outside the containment area to the northeast; downgradient from Shallow Zone EISB Biobarrier #1	Shallow Zone	✓	✓	✓							✓
PMW-19	Outside the containment area to the northeast; downgradient of Shallow Zone EISB Biobarrier #1	Shallow Zone	✓	✓	✓							✓
18WW17	Outside the containment area to the northeast; upgradient from Shallow Zone EISB Biobarrier #1	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18WW10	Outside the containment area to the west; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓							✓
109	Just outside the northeastern edge of containment; within EISB Grid #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-1	Within the containment area and upgradient from UEP; within EISB Grid #1A	Shallow Zone	✓	✓	✓							✓
MW-5	Within the containment area and downgradient from UEP; within EISB Grid #3	Shallow Zone	✓	✓	✓							✓
MW-6	Within the containment area and downgradient from UEP; within EISB Grid #3	Shallow Zone	✓	✓	✓							✓
MW-8	Outside the containment area to the southwest; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓							✓
MW-9	Just outside the southwestern edge of containment; upgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 5-13 MNA and LTM Performance Monitoring Plan
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	Location of Well[a]	Groundwater Zone	Proposed Analyses									
			VOCs[b] (SW8260B)	Perchlorate (6850)	TAL Metals (EPA Method 6020A)	Anions[c] (E300.0)	Dissolved Gases[d] (RSK-175)	Alkalinity (2320B)	TOC (SW9060)	DHC (qPCR)	Bromide (E300.0)	Field Parameters[e]
MW-10	Outside the containment area to the west; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓							✓
MW-12	At the western corner of containment; within Wilcox Formation EISB Biobarrier #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-17	Outside the containment area to the southwest; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓							✓
MW-18	Outside the containment area to the southwest; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MW-19	Outside the containment area to the southwest; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓							✓
MW-21	Just outside the northeastern edge of containment; within EISB Grid #2	Shallow Zone	✓	✓	✓							✓
18CPTMW14	Along the southeastern edge of the containment area	Shallow Zone	✓	✓	✓							✓
PMW-10	Inside the southeastern edge of the containment area; within EISB Grid #1A	Shallow Zone	✓	✓	✓							✓
MW-2-R	Within the containment area, near the UEP; within EISB Grid #1A	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AWD-3	Within the containment area, near Open Burning Cage 003; within EISB Grid #1A	Shallow Zone	✓	✓	✓							✓
PMW-01	Within the containment area; within EISB Grid #1A	Shallow Zone	✓	✓	✓							✓
PMW-08	Inside the southeastern edge of the containment area; within EISB Grid #1A	Shallow Zone	✓	✓	✓							✓
PMW-09	Inside the southern portion of the containment area; within EISB Grid #1A	Shallow Zone	✓	✓	✓							✓
1824DPTMW05	Inside the southwestern edge of the containment area; within EISB Grid #1B	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AWD-4	Just outside the northwestern edge of containment; upgradient from Wilcox Formation EISB Biobarrier #1	Shallow Zone	✓	✓	✓							✓
18CPTMW15	Outside the northwestern edge of containment; upgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓							✓
PMW-27	Outside the southeastern edge of containment; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-23	Outside the southwestern edge of containment; within Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PMW-24	Outside the southwestern edge of containment; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 5-13 MNA and LTM Performance Monitoring Plan
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	Location of Well[a]	Groundwater Zone	Proposed Analyses									
			VOCs[b] (SW8260B)	Perchlorate (6850)	TAL Metals (EPA Method 6020A)	Anions[c] (E300.0)	Dissolved Gases[d] (RSK-175)	Alkalinity (2320B)	TOC (SW9060)	DHC (qPCR)	Bromide (E300.0)	Field Parameters[e]
18CPTMW22R	South of the southern corner of containment; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓							✓
PMW-21	Outside the western corner of containment; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
120	Inside the western corner of containment; within EISB Grid #4	Shallow Zone	✓	✓	✓							✓
18CPTMW23	Outside the northwestern edge of containment; upgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18WW24	Outside the northwestern edge of containment; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18WW25	Outside the northwestern edge of containment; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓							✓
18WW08	Outside the northwestern edge of containment; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18CPTMW16	Outside the northwestern edge of containment; downgradient from Shallow Zone EISB Biobarrier #2	Shallow Zone	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18WW20	Outside the containment area to the north	Shallow Zone	✓	✓	✓							✓
PMW-29	Northeast of the ICT-14D	Shallow Zone	✓	✓	✓							✓
PWM-30	North of the ICT-14B	Shallow Zone	✓	✓	✓							✓
PWM-31	Near the Burning Ground #3	Shallow Zone	✓	✓	✓							✓
PWM-32	West of ICT-3	Shallow Zone	✓	✓	✓							✓
PWM-33	Inside of containment area; West of ICT-14D	Shallow Zone	✓	✓	✓							✓
PMW-08D	Outside the northern corner of the containment area; downgradient from Wilcox Formation EISB Biobarrier #1	Wilcox Formation	✓	✓	✓							✓
18CPTMW08SW	Inside the northern corner of the containment area; within EISB Grid #3	Wilcox Formation	✓	✓	✓							✓
18WW06	Just outside the western corner of containment; downgradient from Wilcox Formation EISB Biobarrier #2	Wilcox Formation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1824DPTMW06	At the western corner of containment; within Wilcox Formation EISB Biobarrier #2	Wilcox Formation	✓	✓	✓							✓
MW-14	Inside the western corner of containment; within EISB Grid #4	Wilcox Formation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18CPTMW03SW-R	Inside the containment area near Open Burning Pan 156; within EISB Grid #1A	Wilcox Formation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
18CPTMW22SW	Inside the containment area near Open Burning Pan 156; within EISB Grid #1A	Wilcox Formation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 5-13 MNA and LTM Performance Monitoring Plan
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Monitoring Locations	Location of Well[a]	Groundwater Zone	Proposed Analyses									
			VOCs[b] (SW8260B)	Perchlorate (6850)	TAL Metals (EPA Method 6020A)	Anions[c] (E300.0)	Dissolved Gases[d] (RSK-175)	Alkalinity (2320B)	TOC (SW9060)	DHC (qPCR)	Bromide (E300.0)	Field Parameters[e]
PMW-11D	Outside the southern corner of containment; within Wilcox Formation Biobarrier #3	Wilcox Formation	✓	✓	✓							✓
PMW-13D	West of ICT-14D	Wilcox Formation	✓	✓	✓							✓
PMW-14D	West of ICT-9	Wilcox Formation	✓	✓	✓							✓
PMW-15D	East of ICT-13F	Wilcox Formation	✓	✓	✓							✓
PMW-16D	Northwest of ICT-13D	Wilcox Formation	✓	✓	✓							✓
PMW-17D	Near ICT-3	Wilcox Formation	✓	✓	✓							✓

Wilcox Formation

[a] The MNA and LTM Sampling Plan for the Shallow Zone and Wilcox Formation are provided in Appendix A Sheets 04C100 and 04C101, respectively.

[b] VOCs include TCE; cis-1,2-DCE; 1,1-DCE; 1,2-DCA; 1,1,2-TCA; VC; and methylene chloride.

[c] Anions include nitrate and sulfate.

[d] Dissolved gasses include ethene, ethane, and methane.

[e] Field Parameters include dissolved oxygen, oxidation reduction potential, and pH.

✓ Indicates that sample will be collected and analyzed for the listed analyte.

DHC - Dehalococcoides (microbial analysis)

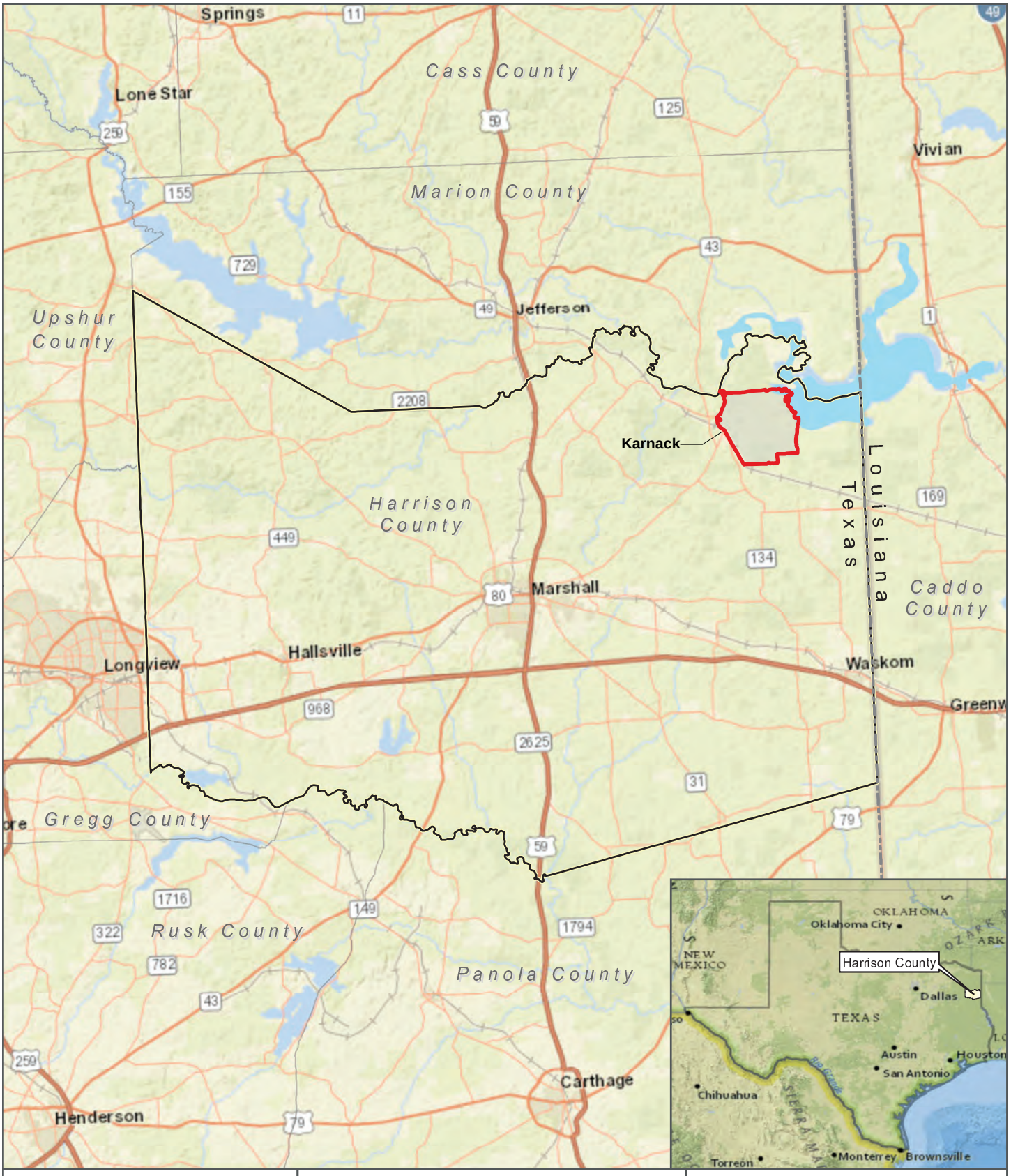
TOC - total organic carbon

VOCs - volatile organic compounds

-R - Replaced after ISTD activities.

FIGURES

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas



N

0 5 10
MILES

LEGEND

- LHAAP Installation Boundary
- Harrison County
- State Boundary

SITE LOCATION

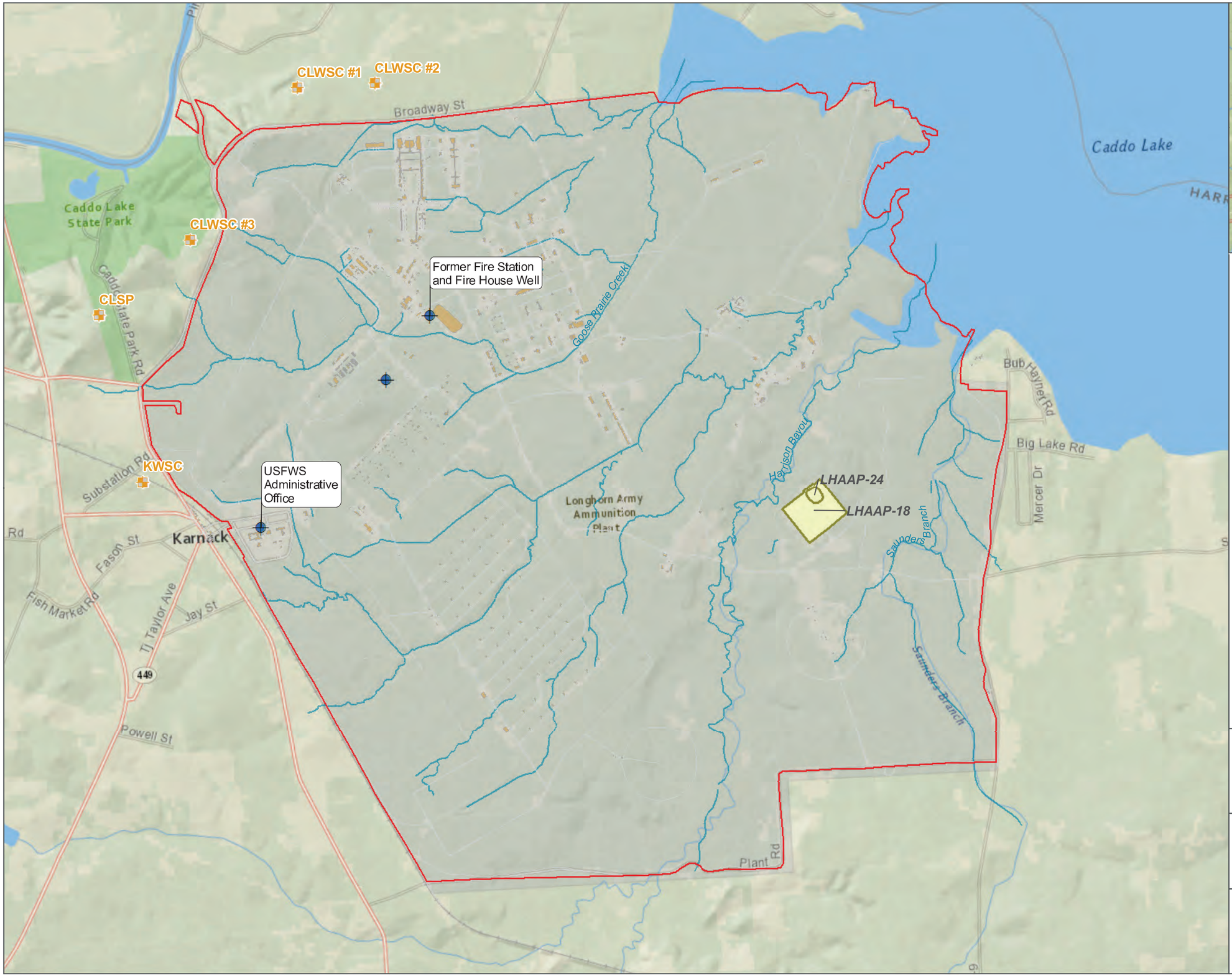
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

DATA SOURCES: AECOM, ESRI, LHAAP

DISCLAIMER: Map information was compiled from the best available sources.
No warranty is made for its accuracy or completeness.

FIGURE 1-1

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP29\LHAAP_29_ROD_LHAAP_SITE_LOCATION.MXD - USER: EBOWLIN - DATE: 7/24/2019





LEGEND

- Public Water Supply Well Locations
- Potable Water Wells
- Roads
- Building
- Site
- LHAAP Installation Boundary

CLWSC – Caddo Lake Water Supply Corporation
KWSC – Karnack Water Supply Corporation

DATA SOURCES: AECOM, 2017. Final Revised Feasibility Study for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant, Karnack, Texas, January.

DISCLAIMER: Map information was compiled from the best available sources. No warranty is made for its accuracy or completeness.

SITE VICINITY

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

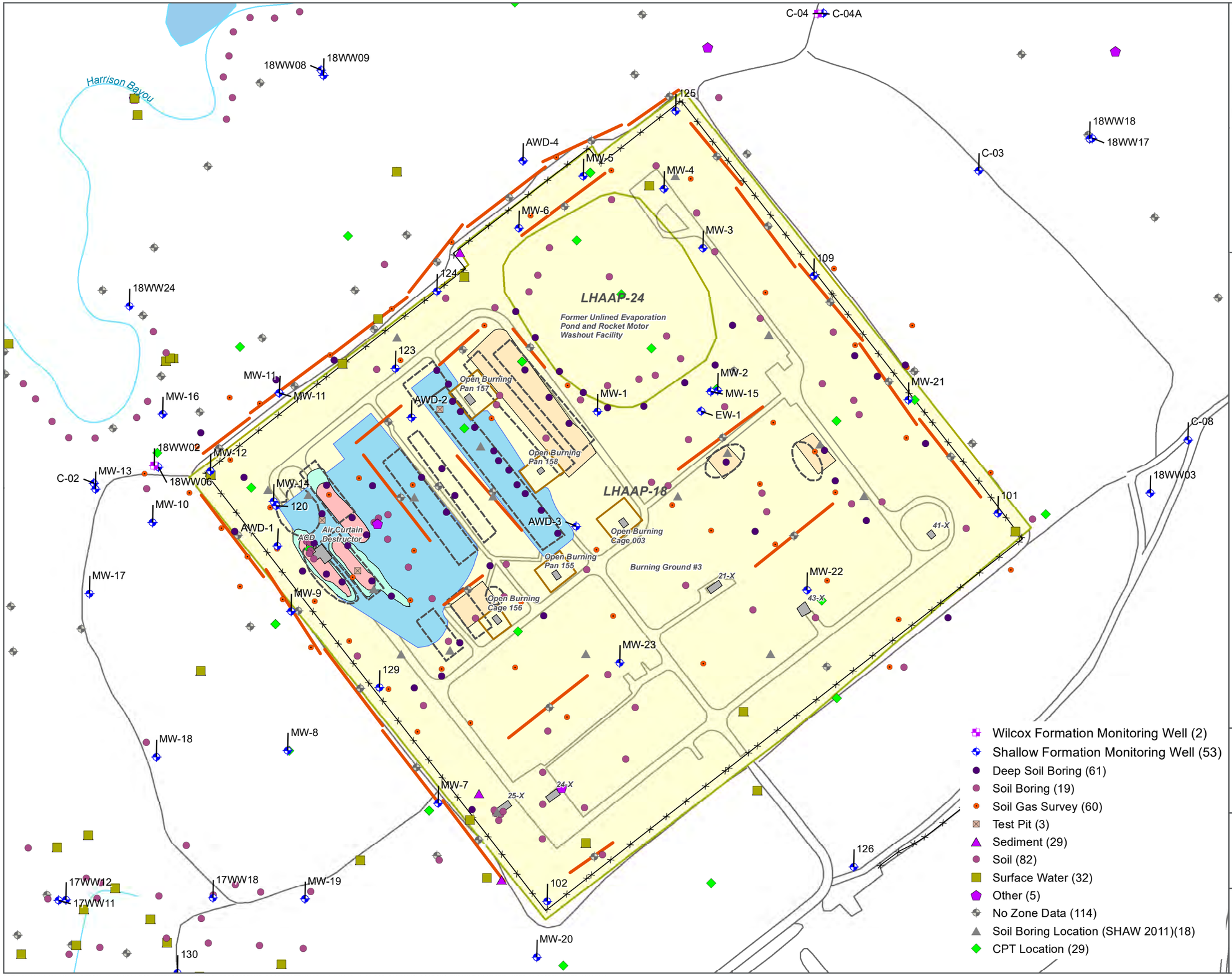
N

0 0.5 1
MILES

FIGURE 1-2

1-1

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\I7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP18_24\LHAAP_18_24_ROD_SITE_VICINITY.MXD - USER: KLOFGREN - DATE: 11/21/2019





LEGEND

- Source Units (USACE, 1993)
- Burning Cage
- Excavated Area - 4 Feet
- Excavated Area - 15 Feet
- Trench Limits
- Berm Limits
- ICT Trench
- Fence
- Roads
- Buildings
- Streams
- Ponded Area
- Site

- Wilcox Formation Monitoring Well (2)
- Shallow Formation Monitoring Well (53)
- Deep Soil Boring (61)
- Soil Boring (19)
- Soil Gas Survey (60)
- Test Pit (3)
- Sediment (29)
- Soil (82)
- Surface Water (32)
- Other (5)
- No Zone Data (114)
- Soil Boring Location (SHAW 2011)(18)
- CPT Location (29)

IRA - Interim Remedial Action
ACD - Air Curtain Destructor

DATA SOURCES: AECOM, 2017. Final Revised Feasibility Study for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant, Karnack, Texas, January.

DISCLAIMER: Map information was compiled from the best available sources. No warranty is made for its accuracy or completeness.

CUMULATIVE SAMPLING AND IRA EXCAVATION LOCATIONS
LHAAP 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

N

0 250 500
FEET

FIGURE 1-3

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP18_24\LHAAP_18_24_ROD_SAMPLINGLOCATIONS_EXCAVATION_V2.MXD - USER: KLOFGREN - DATE: 12/26/2019

Notes:
Bold - Exceeds Screening Level
1 = Safe Drinking Water Act (SDWA) maximum contaminant level (MCL)
2 = TRRP PCL
ug/L = micrograms per liter

Comparison Levels:

Perchlorate - 17 ug/L[2]

1,1,2-Trichloroethane - 5 ug/L[1]

1,4-Dioxane - 9.1 ug/L[2]

cis-1,2-Dichloroethene- 70 ug/L[1]

Benzene - 5 ug/L[1]

Methylene Chloride - 5 ug/L[1]

Tetrachloroethene - 5 ug/L[1]

Trichloroethene - 5 ug/L[1]

Vinyl Chloride - 2 ug/L[1]

1824DPT31 - 36' bgs
Perchlorate - 783 J ug/kg
Methylene Chloride - 2.16 J ug/kg
Trichloroethene - 0.732 J ug/kg

1824DPT30 - 37' bgs
Perchlorate - 5,830 ug/kg
Methylene Chloride - 2.63 J ug/kg
Trichloroethene - 1.23 J ug/kg

1824DPT29 - 40' bgs
Perchlorate - **10,200 ug/kg**
Methylene Chloride 1.43 J ug/kg
Trichloroethene - 16.8 ug/kg

1824DPT29A - 30' bgs
Perchlorate - 1,090 ug/kg
Methylene Chloride - 1.08 J ug/kg
Trichloroethene - 21 ug/kg

1824DPT18 - 24' bgs
Perchlorate - 23,900 ug/kg
Trichloroethene - 31.7 ug/kg

1824DPT17 - 29' bgs
Perchlorate - **11,000 ug/kg**
Tetrachloroethene - 0.850 ug/kg
Trichloroethene - 933 ug/kg

1824DPT25 - 28' bgs
Non-detects

1824DPT26 - 38' bgs
Perchlorate - 53.7 ug/kg
Methylene Chloride - 1.23 J ug/kg

1824DPT27 - 39' bgs
Perchlorate - 3.21 J ug/kg
Methylene Chloride - 1.13 J ug/kg

1824DPT27A - 30' bgs
Perchlorate - 8.22 ug/kg
Methylene Chloride - 1.97 J ug/kg

1824DPT23 - 38' bgs
Perchlorate - 1.38 J ug/kg

1824DPT22 - 38' bgs
Perchlorate - 2,720 ug/kg

1824DPT21 - 38' bgs
Perchlorate - 4.57 J ug/kg

1824DPT24 - 27.5' bgs
Perchlorate - 6.69 ug/kg
Methylene chloride - 20 ug/kg

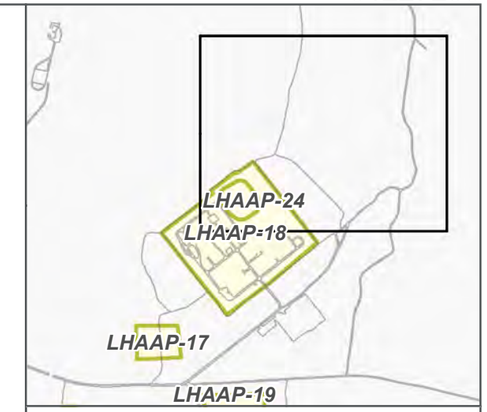
1824DPT28 - 40' bgs
Perchlorate - 2.05 J ug/kg
Methylene Chloride - 2.02 J ug/kg

1824DPT19 - 42' bgs
Perchlorate - 307 ug/kg

1824DPT20 - 41' bgs
Perchlorate - 2,800 ug/kg
Trichloroethene - 12.3 J ug/kg

C-06
18CPTMW18
1824DPTMW01
1824DPTMW03
1824DPTMW02
1824DPTMW04
18WW17
1824DPT31
1824DPT30
1824DPT29
1824DPT18
1824DPT17
1824DPT25
1824DPT26
1824DPT27
1824DPT23
1824DPT22
1824DPT21
1824DPT24
1824DPT28
1824DPT19
1824DPT20
AWD-4
18CPTMW08SW
MW-5
MW-2
MW-21
109
ICT-14A
ICT-14B
ICT-14C
ICT-14D
ICT-14E

LHAAP-24
LHAAP-18
LHAAP-17
LHAAP-19
Former Unlined Evaporation Pond and Rocket Motor Washout Facility
Open Burning Pan 157
Open Burning Pan 158



LEGEND
- New Monitoring Well Locations
- New DPT Locations
- Extraction Location
- ICT Locations
- Road
- Stream
- Site
- Former Building or Concrete Slab
- Shallow Zone Monitoring Well
- Wilcox Formation Monitoring Well
- Soil Boring - May 2013

Note: A single gray line represents unpaved access paths, while a double gray line represents paved access roads

Notes:
ug/kg = micrograms per kilogram
J = estimated value
DNAPL = dense non-aqueous phase liquid
DPT = direct push technology
ICT = interceptor-collection trenches
PDI data collected from New DPT and Monitoring Wells March - June 2021.

DATA SOURCES: AECOM, 2017. Final Revised Feasibility Study for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant, Karnack, Texas, January.

Alternative 5 Activities
- Shallow Zone ISB
- Wilcox ISB
- Shallow Zone ISB Grid
- Shallow Zone ISB Grid after DNAPL Removal

Notes
ISB In-Situ Bioremediation
ACD – Air Curtain Destructor
Barriers, grids and other remedy component features shown in this figure were used to facilitate comparison of alternatives including costs. The locations, number and layout may change during Remedial Design phase.

DPT SOIL SAMPLE RESULTS
PERCHLORATE AND VOCS
OUTSIDE THE NORTHEAST ICT BOUNDARY
LHAAP-18/24 PDI REPORT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

N
0 250 500
FEET

FIGURE 1-4

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP18_24\PDI_2021\LHAAP_18_24_PDI_OUTSIDE_ICT_SOIL_SAMPLE_RESULTS_TCE_FIG4.MXD - USER: KLOFGREN - DATE: 2/21/2022

Notes:
Bold - Exceeds Screening Level
1 = Safe Drinking Water Act (SDWA) maximum contaminant level (MCL)
2 = TRRP PCL
ug/L = micrograms per liter

Comparison Levels:

Perchlorate - 17 ug/L[2]
1,1,2-Trichloroethane - 5 ug/L[1]
1,4-Dioxane - 9.1 ug/L[2]
cis-1,2-Dichloroethene- 70 ug/L[1]
Benzene - 5 ug/L[1]
Methylene Chloride - 5 ug/L[1]
Tetrachloroethene - 5 ug/L[1]
Trichloroethene - 5 ug/L[1]
Vinyl Chloride - 2 ug/L[1]

1824DPT30
Perchlorate - **35,400 ug/L**
cis-1,2-Dichloroethene - 4.54 ug/L
Methylene Chloride - 0.59 ug/L
Trichloroethene - **28.8 ug/L**
Vinyl Chloride - 1.28 ug/L

1824DPT31
Perchlorate - **11,400 ug/L**
cis-1,2-Dichloroethene - 7.82 ug/L
Methylene Chloride - 0.34 ug/L
Trichloroethene - **56.4 ug/L**
Vinyl Chloride - **3.99 ug/L**

1824DPT29
Perchlorate - **41,000 ug/L**
cis-1,2-Dichloroethene - 48.8 ug/L
Methylene Chloride - 0.25 ug/L
Tetrachloroethene - 0.43 ug/L
Trichloroethene - **273 ug/L**
Vinyl Chloride - **21.5 ug/L**

1824DPT29A
Perchlorate - **5,450 ug/L**
cis-1,2-Dichloroethene - 35.5 ug/L
Benzene - 0.21 ug/L
Methylene Chloride - 0.32 ug/L
Tetrachloroethene - 0.62 ug/L
Trichloroethene - **193 ug/L**
Vinyl Chloride - **10.3 ug/L**

18CPTMW18 - Shallow
Perchlorate - 0.0 ug/L
Trichloroethene - 0.0 ug/L

1824DPT18
Perchlorate - **148,000 ug/L**
cis-1,2-Dichloroethene - 14.4 ug/L
Tetrachloroethene - 0.26 ug/L J
Trichloroethene - **135.0 ug/L**
Vinyl Chloride - 0.66 ug/L J

1824DPTMW03
Perchlorate - 4.61 J ug/L
Bromodichloromethane - 1.58 ug/L
Trichloroethene - 0.88 J ug/L

Perchlorate = Nondetect June, 2020

1824DPT26
Perchlorate - 95.6 ug/L
Trichloroethene - 0.379 ug/L

1824DPT25
Perchlorate - **41.7 ug/L**

1824DPT27
Perchlorate - 1.19 ug/L

1824DPT27A
Perchlorate - 9.08 ug/L
Trichloroethene - 0.253 ug/L

1824DPTMW01
Perchlorate - **321 J ug/L**
Bromodichloromethane - 0.51 J ug/L

1824DPT23
Perchlorate - **65.9 ug/L**

1824DPT22
Perchlorate - **47,500 ug/L**
cis-1,2-Dichloroethene - 1.37 ug/L
Trichloroethene - **12.5 ug/L**

18WW17 - Shallow
Perchlorate - **76,800 ug/L**
Trichloroethene - **42 ug/L**

1824DPT24
Perchlorate - 9.82 ug/L

1824DPT28
Perchlorate - 10.6 ug/L

1824DPT21
Perchlorate - **33.6 ug/L**

1824DPTMW02
Perchlorate - **112,000 ug/L**
cis-1,2-Dichloroethene - 26 ug/L
Trichloroethene - **466 ug/L**

1824DPT19
Perchlorate - **16,200 ug/L**
cis-1,2-Dichloroethene - 0.78 J ug/L
Trichloroethene - **99.5 ug/L**

1824DPT20
Perchlorate - **39,200 ug/L**
cis-1,2-Dichloroethene - 10.3 ug/L
Trichloroethene - **695.0 ug/L**

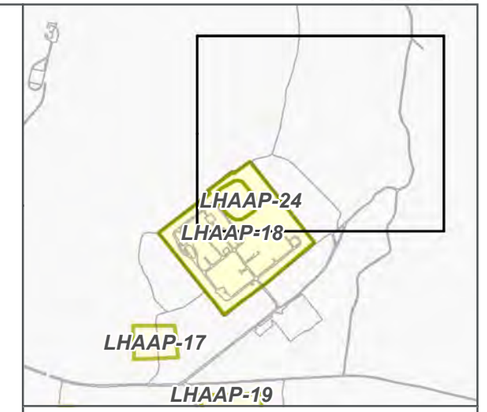
1824DPTMW04
Perchlorate - **274 J ug/L**
Trichloroethene - 1.21 ug/L

109
Perchlorate - **20,400 ug/L**
cis-1,2-Dichloroethene - **83.0 ug/L**
Trichloroethene - **240.0 ug/L**

MW-21
Perchlorate - **10,600 ug/L**
1,1,2-Trichloroethane - **5.2 ug/L**
1,2-Dichloroethene - **16.0 ug/L**
cis-1,2-Dichloroethene - **210.0 ug/L**
Trichloroethene - **3,900 ug/L**
Vinyl Chloride - **13 ug/L**

1824DPT17
Perchlorate - **6,410 ug/L**
cis-1,2-Dichloroethene - **135.0 ug/L**
Trichloroethene - **229 ug/kg**
Vinyl Chloride - 0.52 ug/L J

C-06
1824DPT31
1824DPT30
1824DPT18
1824DPT29
1824DPT22
18WW17
1824DPT21
1824DPTMW02
1824DPT19
1824DPT20
1824DPT17
1824DPTMW04
1824DPTMW01
1824DPT23
1824DPT24
1824DPT28
1824DPT26
1824DPT25
1824DPT27
18CPTMW18
1824DPTMW03
AWD-4
18CPTMW08SW
MW-5
ICT-14A
ICT-14B
ICT-14C
ICT-14D
ICT-14E
109
MW-21
MW-2
LHAAP-18
LHAAP-24
Open Burning Pan 157



LEGEND
- Extraction Location
- New Shallow Monitoring Well Locations
- New DPT Locations
- ICT Locations
- Road
- Stream
- Site
- Former Building or Concrete Slab
- Shallow Zone Monitoring Well
- Wilcox Formation Monitoring Well
- Soil Boring - May 2013

Note: A single gray line represents unpaved access paths, while a double gray line represents paved access roads

Notes:
ug/kg = micrograms per kilogram
J = estimated value
TRRP = Texas Risk Reduction Program
PCL = protective concentration levels
DNAPL = dense non-aqueous phase liquid
DPT = direct push technology
ICT = interceptor-collection trenches

PDI data collected from New DPT and Monitoring Wells March - June 2021. Other sample data was collected in June 2021 (Bhate, 2021).

DATA SOURCES: AECOM, 2017. Final Revised Feasibility Study for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant, Karnack, Texas, January.

Alternative 5 Activities
- Shallow Zone ISB
- Wilcox ISB
- Shallow Zone ISB Grid
- Shallow Zone ISB Grid after DNAPL Removal

Notes
ISB In-Situ Bioremediation
ACD – Air Curtain Destructor
Barriers, grids and other remedy component features shown in this figure were used to facilitate comparison of alternatives including costs. The locations, number and layout may change during Remedial Design phase.

DPT GROUNDWATER SAMPLE RESULTS PERCHLORATE AND VOCS OUTSIDE THE NORTHEAST ICT BOUNDARY
LHAAP-18/24 PDI REPORT
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

N
0 250 500
FEET

FIGURE 1-5

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP18_24\PDI_2021\LHAAP_18_24_PDI_OUTSIDE_ICT_DPT_MW_SAMPLE_RESULTS_PERCH_VOC_FIG7.MXD - USER: KLOFGREN - DATE: 2/17/2022

1824DPTMW06
Perchlorate - 0.327 J ug/L
Trichloroethene - **37.3 ug/L**
1,4-Dioxane - 6.13 J ug/L

1824DPTMW06

MW-14
Perchlorate - **198,000 ug/L**
TCE - **9,000 ug/L**

MW-14

120

1824DPT42
Perchlorate - **3,500 ug/L**
cis-1,2-Dichloroethene - **8,730 ug/L**
Methylene Chloride - **6,980 ug/L**
Tetrachloroethene - **15.1 ug/L**
Trichloroethene - **6,860 ug/L**
Vinyl Chloride - **648 ug/L**

ACD
Air Curtain Destructor

1824DPT02
Perchlorate - **32,400 ug/L**
1,1,2-Trichloroethane - 0.548 ug/L
Benzene - 4.26 ug/L
cis-1,2-Dichloroethene* - **122 ug/L**
Methylene chloride - 0.757 ug/L
Tetrachloroethene - 2.83 ug/L
Trichloroethene - **6,340 ug/L**

1824DPT42

1824DPT07
Perchlorate - **137,000 ug/L**
1,1,2-Trichloroethane - 1.65 ug/L
Benzene - **8.62 ug/L**
cis-1,2-Dichloroethene* - **317 ug/L**
Methylene chloride - 2.21 ug/L
Tetrachloroethene - 3.57 ug/L
Trichloroethene - **11,200 ug/L**
Vinyl chloride* - **5.11 ug/L**

1824DPT41
Perchlorate - **124,000 ug/L**
1,1,2-Trichloroethane - **14.2 ug/L**
cis-1,2-Dichloroethene - **202 ug/L**
Methylene Chloride - **7.27 ug/L**
Tetrachloroethene - **15.9 ug/L**
Trichloroethene - **38,400 ug/L**
Vinyl CHloride - **18.3 ug/L**

1824DPT41

129
Perchlorate - **7,780 ug/L**
Trrichloroethene - **770 ug/L**

129

1824DPT08
Perchlorate - **87,300 ug/L**
1,1,2-Trichloroethane - 0.823 ug/L
Benzene - 2.52 ug/L
cis-1,2-Dichloroethene* - 44.1 ug/L
Methylene chloride - 1.13 ug/L
Tetrachloroethene - 1.30 ug/L
Trichloroethene - **3,540 ug/L**
Vinyl chloride* - 1.34 ug/L

1824DPTMW05
Perchlorate - **576,000 ug/L**
Benzene - **26.5 ug/L**
Trichloroethene - **8,890 ug/L**

1824DPTMW05

1824DPT40

1824DPT40
Perchlorate - **495,000 ug/L**
cis-1,2-Dichloroethene - **118 ug/L**
Benzene - **31.9 ug/L**
Tetrachloroethene - **8.94 ug/L**
Trichloroethene - **14,000 ug/L**

MW-8

MW-8
Perchlorate - **2,500 ug/L**
cis-1,2-Dichloroethene - 18 ug/L
Trichloroethene - **120 ug/L**

1824DPT03
Perchlorate - **214,000 ug/L**
Benzene - **7.73 ug/L**
cis-1,2-Dichloroethene* - 19.6 ug/L
Trichloroethene - **2,810 ug/L**

MW-7

MW-7
Perchlorate - **13,100 ug/L**
cis-1,2-Dichloroethene - 18 ug/L
Trichloroethene - **2,000 ug/L**

1824DPT06
Perchlorate - **26,200 ug/L**
1,1,2-Trichloroethane - 2.81 ug/L
Benzene - **7.72 ug/L**
cis-1,2-Dichloroethene* - **2,150 ug/L**
Methylene chloride - 4.57 ug/L
Tetrachloroethene - 4.0 ug/L
Trichloroethene - **13,100 ug/L**
Vinyl chloride* - **18.7 ug/L**

18CPTMW03SW (Wilcox)
Perchlorate - 0.65 ug/L
cis-1,2-Dichloroethene - 6.3
Trichloroethene - **18 ug/L**

1824DPT05
Perchlorate - **35600 ug/L**
1,1,2-Trichloroethane - 2.35 ug/L
Benzene - **6.51 ug/L**
cis-1,2-Dichloroethene* - **1570 ug/L**
Methylene chloride - 4.29 ug/L
Tetrachloroethene - 3.30 ug/L
Trichloroethene - **12,700 ug/L**
Vinyl chloride* - **26.6 ug/L**

1824DPT04
Perchlorate - **85,000 ug/L**
1,1,2-Trichloroethane - 1.81 ug/L
Benzene - 4.31 ug/L
cis-1,2-Dichloroethene* - **74.5 ug/L**
Methylene chloride - 1.45 ug/L
Tetrachloroethene - 3.18 ug/L
Trichloroethene - **5,620 ug/L**
Vinyl chloride* - **3.73 ug/L**

1824DPT01
Perchlorate - **2,350 ug/L**
1,1,2-Trichloroethane - **5.5 ug/L**
Benzene - **11.3 ug/L**
cis-1,2-Dichloroethene* - **16,100 ug/L**
Methylene chloride - 4.88 ug/L
Tetrachloroethene - 1.85 ug/L
Trichloroethene - **7,530 ug/L**
Vinyl chloride* - **445 ug/L**

1824DPT01

Open Burning Pan 155

1824DPT05

Open Burning Cage 156

1824DPT06

1824DPT02

18CPTMW03SW

18CPT03

1824DPT04

1824DPT08

1824DPT07

1824DPT41

1824DPT03

MW-23
Perchlorate - **76,800 ug/L**
Trichloroethene - **2,200 ug/L**

1824DPT37

1824DPT37
Perchlorate - **17,400 ug/L**
Trichloroethene - **279 ug/L**

1824DPT36

1824DPT36
Perchlorate - **19,100 ug/L**
Trichloroethene - **2,530 ug/L**

1824DPT39

1824DPT39
Perchlorate - **89,000 ug/L**
Trichloroethene - **4,940 ug/L**

25-X

1824DPT38

1824DPT38
Perchlorate - **13,300 ug/L**
Trichloroethene - **217 ug/L**

1824DPT12
Perchlorate - **59,500 ug/L**
1,1,2-Trichloroethane - 0.573 ug/L
Benzene - 1.54 ug/L
cis-1,2-Dichloroethene* - 18.6 ug/L
Methylene chloride - 0.886 ug/L
Tetrachloroethene - 1.14 ug/L
Trichloroethene - 3,040 ug/L
Vinyl chloride* - **0.969 ug/L**

1824DPT32
Perchlorate - **26,200 ug/L**
1,1,2-Trichloroethane - **5.19 ug/L**
cis-1,2-Dichloroethene - **8,800 ug/L**
Benzene - **10.8 ug/L**
Trichloroethene - **13,400 ug/L**
Vinyl Chloride - **94.6 ug/L**

Open Burning Cage 003

Burning Ground #3

1824DPT32

1824DPT09

1824DPT33

1824DPT09
Perchlorate - **56,900 ug/L**
1,1,2-Trichloroethane - 1.20 ug/L
Benzene - **5.60 ug/L**
cis-1,2-Dichloroethene* - **231 ug/L**
Methylene chloride - 3.78 ug/L
Tetrachloroethene - **7.62 ug/L**
Trichloroethene - **4,260 ug/L**
Vinyl chloride* - **3.98 ug/L**

1824DPT33
Perchlorate - **51,500 ug/L**
cis-1,2-Dichloroethene - **140 ug/L**
Benzene - **6.79 ug/L**
Tetrachloroethene - **13.9 ug/L**
Trichloroethene - **6,470 ug/L**
Vinyl Chloride - **2.4 ug/L**

1824DPT34
Perchlorate - **29,500 ug/L**
cis-1,2-Dichloroethene - **230 ug/L**
Benzene - **20.1 ug/L**
Tetrachloroethene - **10.2 ug/L**
Trichloroethene - **4,940 ug/L**
Vnyl Chloride - **4.68 ug/L**

21-X

1824DPT34

MW-22

43-X

1824DPT13

1824DPT13
Perchlorate - **71,300 ug/L**
1,1,2-Trichloroethane - 1.58 ug/L
Benzene - 3.63 ug/L
cis-1,2-Dichloroethene* - **94.1 ug/L**
Methylene chloride - 1.42 ug/L
Tetrachloroethene - 3.44 ug/L
Trichloroethene - **5,550 ug/L**
Vinyl chloride* - **2.04 ug/L**

1824DPT14

MW-23

1824DPT16

1824DPT10

1824DPT15

1824DPT14
Perchlorate - **36,700 ug/L**
1,1,2-Trichloroethane - 0.909 ug/L
Benzene - 3.25 ug/L
cis-1,2-Dichloroethene* - **120 ug/L**
Methylene chloride - 1.19 ug/L
Tetrachloroethene - **5.26 ug/L**
Trichloroethene - **3,810 ug/L**
Vinyl chloride* - 1.93 ug/L

1824DPT11

1824DPT10
Perchlorate - **42,000 ug/L**
1,1,2-Trichloroethane - 0.650 ug/L
Benzene - **9.04 ug/L**
cis-1,2-Dichloroethene* - 51.5 ug/L
Methylene chloride - 1.13 ug/L
Tetrachloroethene - 3.55 ug/L
Trichloroethene - **5,380 ug/L**
Vinyl chloride* - 1.52 ug/L

1824DPT35

1824DPT35
Perchlorate - **40,600 ug/L**
Trichloroethene - **1,150 ug/L**

24-X

1824DPT15
Perchlorate - **51,300 ug/L**
1,1,2-Trichloroethane - 0.967 ug/L
Benzene - 2.98 ug/L
cis-1,2-Dichloroethene* - 37.1 ug/L
Methylene chloride - 1.13 ug/L
Tetrachloroethene - 4.40 ug/L
Trichloroethene - **4,400 ug/L**
Vinyl chloride* - 1.07 ug/L

1824DPT11
Perchlorate - **65,900 ug/L**
1,1,2-Trichloroethane - 0.328 ug/L
Benzene - 1.26 ug/L
cis-1,2-Dichloroethene* - 11.0 ug/L
Methylene chloride - 0.407 ug/L
Tetrachloroethene - 0.940 ug/L
Trichloroethene - **2,930 ug/L**
Vinyl chloride* - 0.647 ug/L

1824DPT16
Perchlorate - **47,900 ug/L**
1,1,2-Trichloroethane - 0.409 ug/L
Benzene - 1.49 ug/L
cis-1,2-Dichloroethene* - 15.9 ug/L
Methylene chloride - 0.611 ug/L
Tetrachloroethene - 1.22 ug/L
Trichloroethene - **2,890 ug/L**
Vinyl chloride* - 0.787 ug/L

LHAAP-18

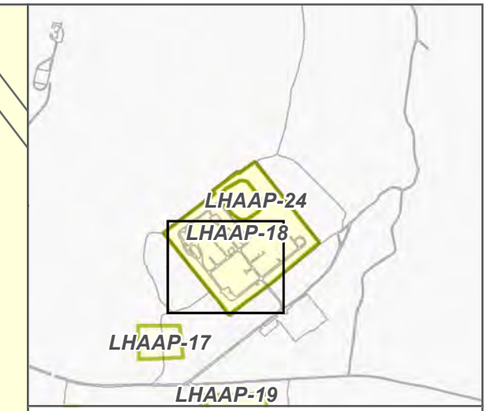
Notes:
Bold - Exceeds Screening Level
1 = Safe Drinking Water Act (SDWA) maximum contaminant level (MCL)
2 = TRRP PCL
ug/L = micrograms per liter

Comparison Levels:

Perchlorate - 17 ug/L[2]
1,1,2-Trichloroethane - 5 ug/L[1]
1,4-Dioxane - 9.1 ug/L[2]
cis-1,2-Dichloroethene- 70 ug/L[1]
Benzene - 5 ug/L[1]
Methylene Chloride - 5 ug/L[1]
Tetrachloroethene - 5 ug/L[1]
Trichloroethene - 5 ug/L[1]
Vinyl Chloride - 2 ug/L[1]

Alternative 5 Activities
- Shallow Zone ISB
- Wilcox ISB
- Shallow Zone ISB Grid
- Shallow Zone ISB Grid after DNAPL Removal

Notes
ISB In-Situ Bioremediation
ACD – Air Curtain Destructor
Barriers, grids and other remedy component features shown in this figure were used to facilitate comparison of alternatives including costs. The locations, number and layout may change during Remedial Design phase.



LEGEND
- New Shallow Monitoring Well Locations
- New DPT Locations
- Road
- Stream
- Site
- Former Building or Concrete Slab
- Shallow Zone Monitoring Well
- Wilcox Formation Monitoring Well
- Soil Boring - May 2013

Note: A single gray line represents unpaved access paths, while a double gray line represents paved access roads

Notes:
ug/kg = micrograms per kilogram
J = estimated value
TRRP = Texas Risk Reduction Program
DNAPL = dense non-aqueous phase liquid
DPT = direct push technology
PCL = protective concentration levels

Notes: PDI data collected from New DPT and Monitoring Wells March - June 2021. Other sample data was collected in June 2021 (Bhate, 2021).

DATA SOURCES: AECOM, 2017. Final Revised Feasibility Study for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant, Karnack, Texas, January.

GROUNDWATER SAMPLE RESULTS PERCHLORATE AND VOCS SHALLOW ZONE EISB GRIDS FORMER LONGHORN ARMY AMMUNITION PLANT KARNACK, TEXAS

N
0 100 200
FEET

FIGURE 1-6

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP18_24\PDI_2021\LHAAP_18_24_PDI_ISB_DPT_MW_SAMPLE_RESULTS_PERCH_VOCS_FIG10.MXD - USER: KLOFGREN - DATE: 2/17/2022

Harrison Bayou

18WW20
18CPTMW16
18WW07
18CPTMW19
18WW08
18WW25
18CPTMW15
18WW24
18CPTMW23
MW-16
MW-11
123
18CPTMW04
MW-1
MW-2
AWD-2
MW-12
C-02
120
MW-10
18WW10
AWD-1
MW-17
MW-9
MW-18
MW-8
MW-7
MW-19
130
18CPTMW26
MW-20
18CPTMW22R
102
1824DPT36
1824DPT39
1824DPT40
1824DPTMW05
129
1824DPT41
1824DPT07
1824DPT42
1824DPT02
1824DPT05
AWD-3
1824DPT01
1824DPT06
1824DPT32
1824DPT04
1824DPT09
1824DPT34
MW-22
1824DPT33
1824DPT13
1824DPT10
1824DPT08
MW-23
1824DPT16
1824DPT37
1824DPT03
1824DPT11
1824DPT12
1824DPT35
1824DPT38
126
18CPTMW14
101
18CPTMW24
C-08
1824DPT17
1824DPT20
1824DPTMW04
MW-21
18WW22
1824DPTMW03
1824DPT31
125
AWD-4
MW-5
MW-4
MW-6
MW-3
109
1824DPT29
1824DPT30
1824DPT18
1824DPTMW02
1824DPT19
1824DPT22
18WW17
1824DPT21
18CPTMW18
1824DPTMW01
1824DPT23
1824DPT27A
1824DPT27
1824DPT24
1824DPT28

LEGEND

01227299

Trichloroethene (Bhate, 6/21 & PDI 3/21)
- < 5 ug/L
- 5-100 ug/L
- 100-500 ug/L
- > 500 ug/L

Perchlorate (Bhate, 6/21 & PDI 3/21)
- < 17 ug/L
- 17-500 ug/L
- 500-1,000 ug/L
- > 1,000 ug/L

Methylene Chloride (Bhate, 6/21 & PDI 3/21)
- < 5 ug/L
- 5 - 100 ug/L
- 100 - 500 ug/L
- >500 ug/L

- Streams
- Roads
- Buildings
- Site Boundary

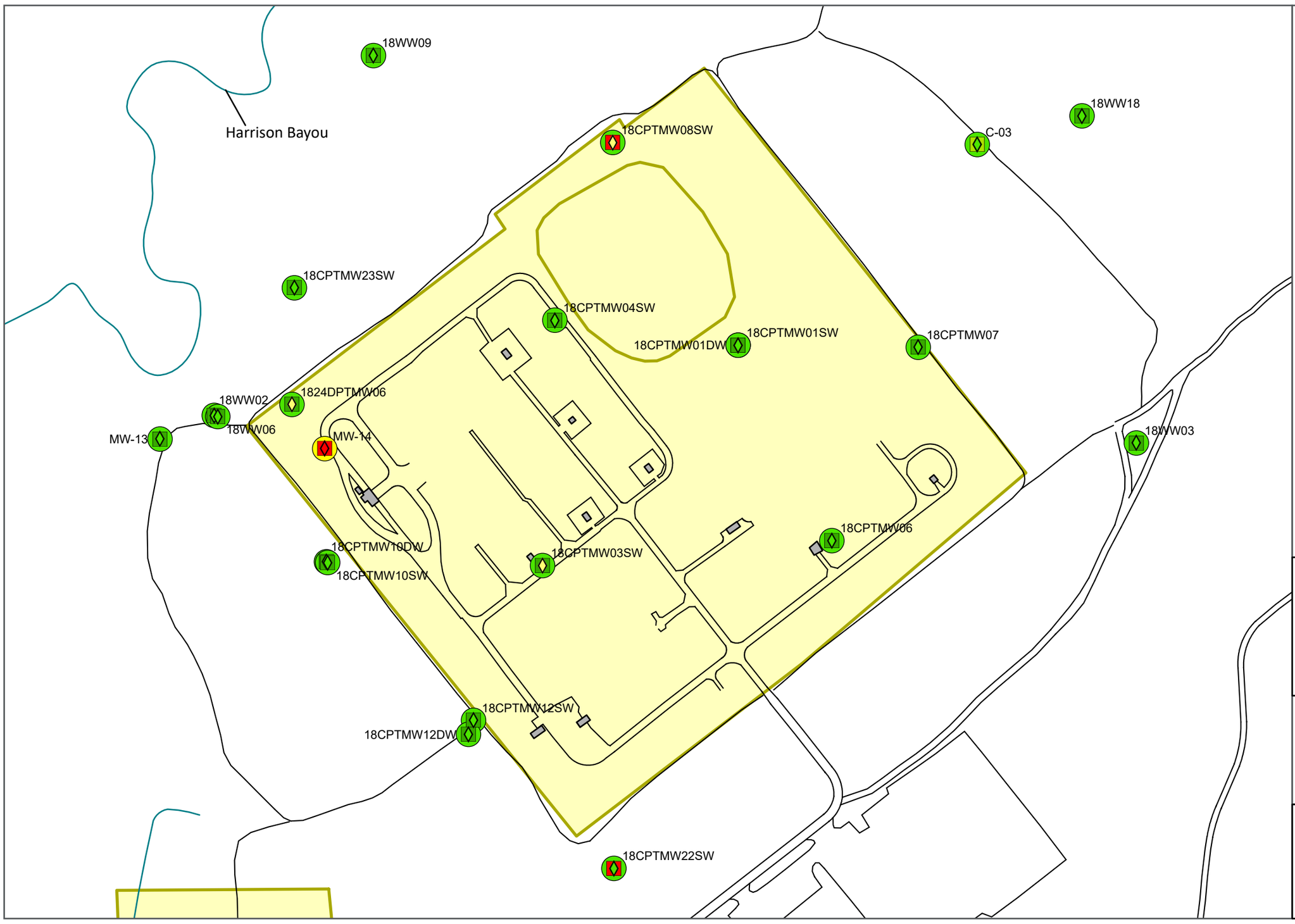
SUMMARY OF SHALLOW ZONE GROUNDWATER TCE, PERCHLORATE, AND METHYLENE CHLORIDE ANALYTICAL RESULTS

LONGHORN ARMY AMMUNITION PLANT SITE 18/24

N

0 250 500
FEET

FIGURE 1-7



LEGEND

01227300

- Streams
- Roads
- Buildings
- Site Boundary

Trichloroethene (Bhate, 6/21 & PDI, 3/21)

- < 5 ug/L
- 5-100 ug/L
- 100-500 ug/L
- > 500 ug/L
- 20220216_PDI_Results

Perchlorate (Bhate, 6/21 & PDI, 3/21)

- < 17 ug/L
- 17-500 ug/L
- 500-1,000 ug/L
- > 1,000 ug/L

Methylene Chloride

- < 5 ug/L
- 5-100 ug/L
- 100-500 ug/L
- > 500 ug/L

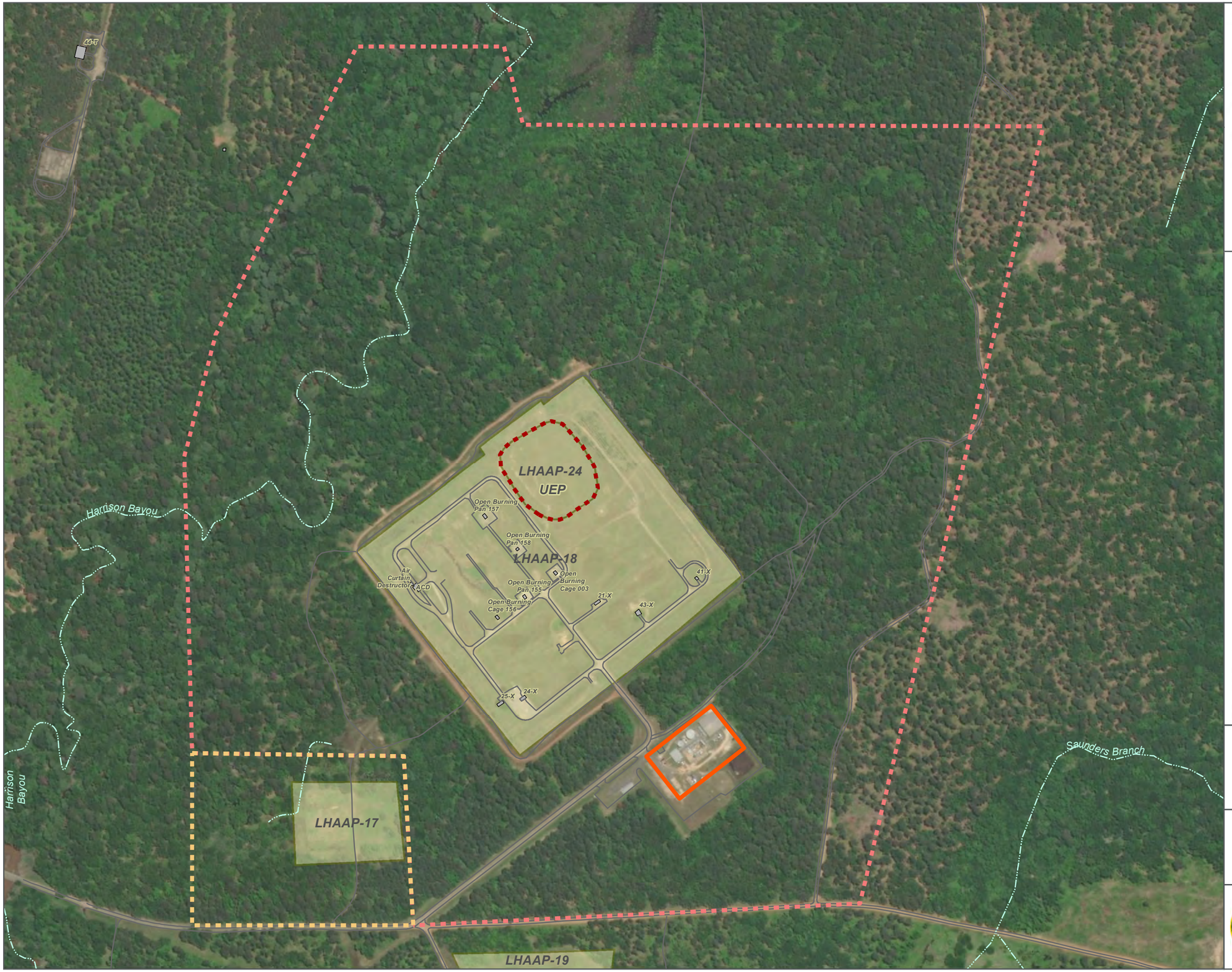
SUMMARY OF WILCOX FORMATION GROUNDWATER TCE, PERCHLORATE AND METHYLENE CHLORIDE

LONGHORN ARMY AMMUNITION PLANT SITE 18/24

N

0 250 500
FEET

FIGURE 1-8





LEGEND

Preliminary Land Use Control Boundary

- LUC 17
- LUC 18
- LUC 24 (UEP)
- GWTP – Groundwater Treatment Plant
- Roads
- Streams
- Buildings
- Site

ACD – Air Curtain Destructor, UEP – Unlined Evaporation Pond

DATA SOURCES: AECOM, 2017. Final Revised Feasibility Study for LHAAP-18/24, Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant, Karnack, Texas, January.

DISCLAIMER: Map information was compiled from the best available sources. No warranty is made for its accuracy or completeness.

PRELIMINARY LAND USE CONTROL BOUNDARY

LHAAP 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

N

0 250 500
FEET

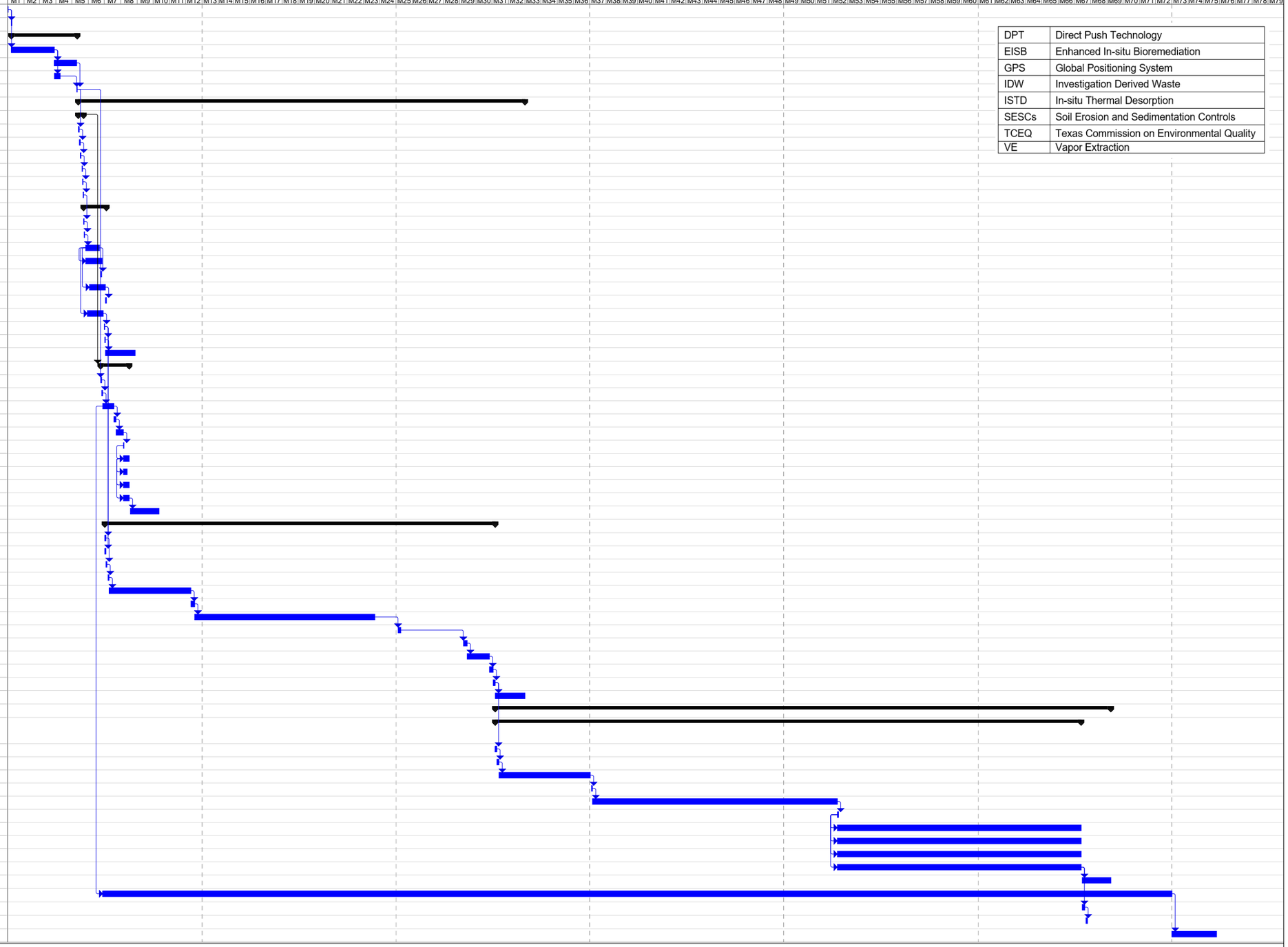
FIGURE 6-1

PATH: J:\2018\18-025_LHAAP_SITES29_47_18AND24_ROD_(WERNER)\7.2_WORK_IN_PROGRESS\MAP_DOCS\DRAFT\LHAAP18_24\LHAAP_18_24_ROD_LUC.MXD - USER: KLOFGREN - DATE: 12/26/2019

Figure 7-1 General Remedial Action Construction Schedule

Former Longhorn Army Ammunition Plant (LHAAP) 18/24, Burning Ground No. 3 and Unlined Evaporation Pond

ID	Task Name	Duration
1	**Contractor Bid Review and Approval**	**1 day**
2	**Notice to Proceed**	**1 day**
3	**Pre-Construction Activities**	**90 days**
4	Contractor Project Plans Preparation and Submittal	59 days
5	Contractor Project Plans Review and Approval	30 days
6	Coordination with TCEQ	7 days
7	Pre-Construction Meeting	1 day
8	**1.0 Phase I Remedial Action**	**601 days**
9	**1.1 Site Preparation**	**8 days**
10	Mobilization	2 days
11	Utilities Mark Out and Pre-Construction Surveys	2 days
12	Clearing and Grubbing	1 day
13	Air Monitoring Setup	1 day
14	Staging Area Set Up	1 day
15	Setting up Traffic Control	1 day
16	**1.2A Soil Excavation and Disposal**	**43 days**
17	Installation of SESC Measures	1 day
18	Access Road Construction	1 day
19	Excavation and Handling of Contaminated Material	20 days
20	Post-Excavation Confirmatory Sampling	23 days
21	Secondary Excavations (as required)	2 days
22	Backfill and Compaction (based on confirmatory sampling results)	22 days
23	Restoration of Backfilled Areas	2 days
24	Transportation and Disposal of Contaminated Material	22 days
25	Demobilization	1 day
26	Removal of SESC Measures	1 day
27	**1.2B Reporting**	**40 days**
28	**1.3A Enhanced In-Situ Bioremediation (EISB) Field Pilot Tests**	**54 days**
29	Site Clearing for Pilot Tests	2 days
30	Mobilization for Injection and Monitoring Well Installations	2 days
31	Install/Develop Injection and Monitoring Wells	15 days
32	Mobilization for Pilot Test Injections	2 days
33	Selection/Coring of DPT Injection Points	10 days
34	EISB Injection System Setup	1 day
35	Preparation and Injection of EISB Material	9 days
36	Abandonment of DPT Points Following Injection	5 days
37	Recording of Injection Locations with GPS	9 days
38	IDW Management, Transportation, and Disposal	9 days
39	**1.3B Preparation of Field Pilot Test Report**	**40 days**
40	**1.4A ISTD DNAPL Treatment**	**525 days**
41	Site Clearing for ISTD	2 days
42	Securing Power Drop	2 days
43	Access Road Construction (as needed)	2 days
44	Mobilization for ISTD and VE System	2 days
45	Installation of ISTD and VE System Components	110 days
46	ISTD and VE System Startup	5 days
47	ISTD and VE System Operation	243 days
48	Groundwater Sampling Round 1	5 days
49	Groundwater Sampling Round 2	5 days
50	Decommissioning of ISTD and VE Systems	30 days
51	Restoration of the ISTD Areas	5 days
52	Demobilization	2 days
53	**1.4B ISTD Reporting**	**40 days**
54	**2.0 Phase 2 Remedial Action**	**829 days**
55	**2.1A Enhanced In-Situ Bioremediation (EISB) Full-Scale Implementation**	**789 days**
56	Site Clearing for Full-Scale EISB	3 days
57	Mobilization for Injection and Monitoring Well Installations	2 days
58	Install/Develop Injection and Monitoring Wells	124 days
59	Mobilization for Full-Scale Injections	2 days
60	Selection/Coring of DPT Injection Points	329 days
61	EISB Injection System Setup	2 days
62	Preparation and Injection of EISB Material - Round 1	329 days
63	Abandonment of DPT Points Following Injection	329 days
64	Recording of Injection Locations with GPS	329 days
65	IDW Management, Transportation, and Disposal	329 days
66	**2.1B EISB Full-Scale Reporting**	**40 days**
67	**3.0 Long-Term Monitoring**	**2013 days**
68	**Post-Construction Surveys**	**5 days**
69	**Final Inspection**	**3 days**
70	**Contractor's Final Submittals**	**60 days**



DPT	Direct Push Technology
EISB	Enhanced In-situ Bioremediation
GPS	Global Positioning System
IDW	Investigation Derived Waste
ISTD	In-situ Thermal Desorption
SESCs	Soil Erosion and Sedimentation Controls
TCEQ	Texas Commission on Environmental Quality
VE	Vapor Extraction

Project: Raritan Bay Slag Site - Seawall Sector
General Remedial Action Construction Schedule
Date: Tue 10/3/23

Task | Milestone | Project Summary | External Milestone | Inactive Milestone | Manual Task | Manual Summary Rollup | Start-only | Progress
Split | Summary | External Tasks | Inactive Task | Inactive Summary | Duration-only | Manual Summary | Finish-only | Deadline

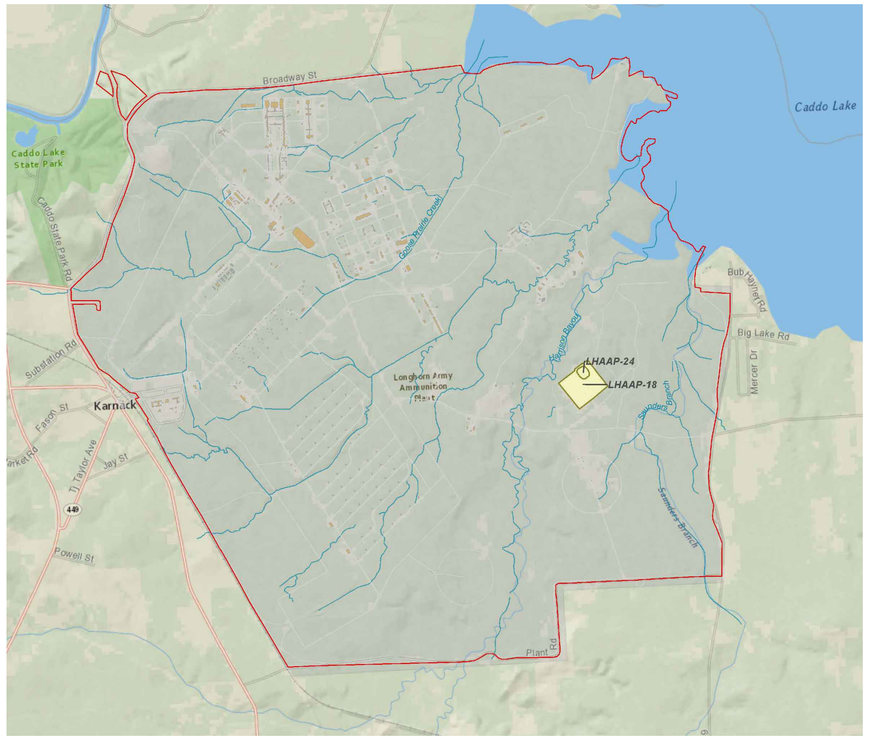
APPENDIX A

Final Remedial Design Drawings

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

01227304

US ARMY CORPS
OF ENGINEERS
USACE TULSA DISTRICT



0 0.5 MILES 1 MILE
SCALE: 1" = 0.5 MILES

Contract Drawings For

LHAAP - 18 / 24

BURNING GROUND NO. 3 AND UNLINED EVAPORATION POND

FINAL DESIGN

REMEDIAL ACTION DESIGN

CONTRACT NO. W912BV 19 D0016
TASK ORDER NO. W912BV20F0096

KARNACK, TEXAS
FEBRUARY 2024

STATE OF TEXAS
MICHAEL J. VECCHIO
147480
LICENSED
PROFESSIONAL ENGINEER

INDEX OF DRAWINGS

GENERAL (G)

G000	COVER SHEET AND SHEET INDEX
G001	GENERAL NOTES
G002	LEGEND AND CONSTRUCTION SEQUENCE
G003	SITE PLAN

REMEDIAL ACTION - PHASE I (C)

01C100	REMEDIAL ACTION SITE PLAN - PHASE I
01C101	EXCAVATION AREAS SITE PLAN
01C201	ISTD AREAS SITE PLAN
01C202	ISTD PROFILE VIEWS - SHEET 1
01C203	ISTD PROFILE VIEWS - SHEET 2
01C204	SVE SCHEMATIC
01C301	EISB PILOT TEST AREAS SITE PLAN

REMEDIAL ACTION - PHASE II (C)

02C100	REMEDIAL ACTION SITE PLAN - PHASE II
02C101	EISB AREAS SITE PLAN - SHEET 1
02C102	EISB AREAS SITE PLAN - SHEET 2
02C103	EISB AREAS SITE PLAN - SHEET 3
02C104	EISB AREAS SITE PLAN - SHEET 4
02C105	EISB AREAS SITE PLAN - SHEET 5
02C106	COORDINATE TABLES FOR EISB AND BIOBARRIERS
02C107	EISB INJECTIONS SCHEMATIC

RESTORATION (C)

03C100	RESTORATION SITE PLAN - SHEET 1
03C101	RESTORATION SITE PLAN - SHEET 2

LONG-TERM MONITORING (C)

04C100	LTM SAMPLING PLAN - SHALLOW ZONE
04C101	LTM SAMPLING PLAN - WILCOX FORMATION

DETAILS (D)

01D100	DETAILS - SHEET 1
01D101	DETAILS - SHEET 2

GENERAL NOTES:

1. ALL WORK SHALL BE PERFORMED IN STRICT ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL CODES AND REGULATIONS.
2. THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMIT EQUIVALENCY BEFORE BEGINNING WORK.
3. THE CONTRACTOR SHALL NOTIFY TEXAS COMMISSION ON ENVIRONMENTAL QUALITY (TCEQ) AND THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (USEPA) TWO WEEKS IN ADVANCE OF COMMENCEMENT OF FIELDWORK ACTIVITIES.
4. SITE IS LOCATED AT THE LONGHORN ARMY AMMUNITION PLANT (LHAAP) SITE 18/24 IN KARNACK, TEXAS.
5. U.S. ARMY CORPS OF ENGINEERS (U.S. ARMY) WILL PROVIDE ACCESS TO THE SITE NECESSARY TO PERFORM WORK.
6. AFTER AWARD OF CONTRACT, ELECTRONIC SITE SURVEY FILES WILL BE MADE AVAILABLE TO THE CONTRACTOR FOR USE IN LAYING OUT THE WORK AREA, EXCAVATION, IN-SITU THERMAL DESORPTION (ISTD) AREAS, AND ENHANCED IN-SITU BIOREMEDIATION (EISB) AREAS INCLUDING THE PILOT AND FULL SCALE EISB IMPLEMENTATION AREAS. A TOPOGRAPHIC SURVEY SHALL BE COMPLETED IN THESE AREAS PRIOR TO INITIATING THE CONSTRUCTION. LAYOUT TO BE PROVIDED IN ELECTRONIC SITE SURVEY FILES ARE FOR STAKE OUT AND BASED ON STATE PLANE DATUM, ESTIMATED TO THE NEAREST HUNDREDTH OF A FOOT ±.
7. THE CONTRACTOR SHALL ESTABLISH LINES AND LEVELS AND LOCATE AND LAY OUT BY INSTRUMENTATION AND SIMILAR APPROPRIATE MEANS, ALL SITE FEATURES TO BE CONSTRUCTED OR EXECUTED. THESE INCLUDE, BUT ARE NOT LIMITED TO, THE FOLLOWING:
   A. DECONTAMINATION, STOCKPILE AND LOAD OUT AREA (AS PER SHEET 01C101)
   B. ACCESS ROAD (AS PER SHEET 01C101)
   C. SILT FENCE (AS PER SHEET 01C101)
   D. EXCAVATION DEPTHS AND LIMITS (AS PER SHEET 01C101)
   E. LIMITS OF ISTD AREAS (AS PER SHEET 01C201)
   F. LIMITS OF EISB PILOT TEST AREAS (AS PER SHEET 01C301)
   G. LIMITS OF FULL SCALE EISB IMPLEMENTATION AREAS (AS PER SHEET 02C100)
8. THE CONTRACTOR SHALL RE-VERIFY LAYOUTS PERIODICALLY DURING CONSTRUCTION BY SAME MEANS.
9. ALL SITE FEATURES SHALL BE FIELD VERIFIED BY CONTRACTOR PRIOR TO CONSTRUCTION. ANY DISCREPANCIES NOTED SHALL BE IMMEDIATELY BROUGHT TO THE ATTENTION OF THE CONTRACTING OFFICER'S REPRESENTATIVE.
10. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO HAVE A GEOPHYSICAL SURVEY COMPLETED TO LOCATE ALL UNDERGROUND UTILITIES AND STRUCTURES, WHETHER SHOWN ON THE PLAN OR NOT, AND TO PROTECT THEM FROM DAMAGE. THE UNDERGROUND UTILITIES INCLUDE, BUT ARE NOT LIMITED TO, EXISTING INFRASTRUCTURE FOR THE GROUNDWATER TREATMENT PLANT (GWTP) LOCATED OUTSIDE OF THE CONTAINMENT AREA.
11. IN THE EVENT THE CONTRACTOR DAMAGES ANY EXISTING UTILITIES CAUSING SERVICE INTERRUPTION, THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE CONTRACTING OFFICER'S REPRESENTATIVE.
12. PROVISIONS SHALL BE TAKEN TO MINIMIZE DUST AND NOISE.
13. DURING THE PROGRESS OF CONSTRUCTION, TRUCKS ENTERING OR LEAVING THE SITE SHALL USE ONLY ROADS THAT PERMIT TRUCK TRAVEL AS GOVERNED BY ANY AGENCY HAVING JURISDICTION.
14. ALL ROADWAYS AFFECTED BY CONSTRUCTION OF THIS PROJECT SHALL BE RESTORED TO PRE-CONSTRUCTION CONDITIONS.
15. FLAGMEN MAY BE USED FOR VEHICLES ENTERING AND LEAVING THE SITE, AS WELL AS OTHER INSTANCES WHEN REQUIRED FOR THE SAFETY OF THE PUBLIC OR WORKERS.
16. THE CONTRACTOR IS RESPONSIBLE FOR ENSURING UNAUTHORIZED PERSONS DO NOT ENTER THE EXCLUSION ZONE. PROVIDE TEMPORARY FENCING OR OTHER ACCEPTABLE MEANS AROUND THE HAZARDOUS WORK ZONES TO RESTRICT ACCESS.
17. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE SECURITY OF THE SITE. ANY REPAIRS RESULTING FROM DAMAGE CAUSED BY TRESPASSERS SHALL BE AT THE EXPENSE OF THE CONTRACTOR.
18. ALL AREAS DISTURBED BY THE CONTRACTOR SHALL BE RESTORED TO THEIR ORIGINAL CONDITIONS OR AS OTHERWISE SHOWN ON THE DRAWINGS OR INDICATED IN THE SPECIFICATIONS, AND TO THE SATISFACTION OF THE CONTRACTING OFFICER'S REPRESENTATIVE.
19. THE CONTRACTOR SHALL PREPARE A REMEDIAL ACTION WORK PLAN (RAWP) WHICH SHALL INCLUDE A HEALTH AND SAFETY PLAN AND ACCIDENT PREVENTION PLAN PREPARED IN ACCORDANCE WITH THE USACE SAFETY AND HEALTH MANUAL (EM-385-1-1) AND SHALL INCLUDE ALL DECONTAMINATION MEASURES THAT WILL BE IMPLEMENTED TO PREVENT CONTAMINATION FROM SPREADING TO UNCONTAMINATED AREAS OF THE SITE. THE RAWP SHALL BE PREPARED IN ACCORDANCE WITH THE USACE APPROVED INSTALLATION WIDE WORK PLAN (IWWP) (LATEST VERSION AVAILABLE IS FROM MAY 2018) AND ALL OTHER APPLICABLE LAWS AND REGULATIONS. THE REMEDIAL ACTION WORK PLAN SHALL BE REVIEWED AND APPROVED BY THE CONTRACTING OFFICER'S REPRESENTATIVE AND REGULATORS.

WASTE DISPOSAL NOTES:

1. THE CONTRACTOR MUST TAKE EVERY EFFORT TO REDUCE THE AMOUNT OF WASTE THAT IS GENERATED, TO REUSE MATERIALS WITH THE CONCURRENCE OF THE CONTRACTING OFFICER'S REPRESENTATIVE, AND TO SEGREGATE WASTE MATERIALS FOR WASTE DISPOSAL.
2. ALL WASTE MATERIALS MUST BE PROPERLY TRANSPORTED, STORED, HANDLED, AND CONTAINED TO PREVENT SPILLS, LEAKAGE, DISCHARGE OR RELEASE TO THE ENVIRONMENT. WASTE CONTAINERS MUST BE PROPERLY LABELED TO IDENTIFY CONTENTS.
3. CONTRACTOR MUST NOT DISCHARGE OR DISPOSE OF ANY WASTE INTO ANY WATER BODY OR DRAINAGE SYSTEM.
4. CONTRACTOR MUST DISPOSE OF ALL WASTE MATERIALS ACCORDING TO ALL LOCAL, STATE AND FEDERAL REGULATIONS.
5. ALL WASTE MANIFESTS REQUIRED FOR THE PROJECT SHALL BE PREPARED BY THE CONTRACTOR AND SIGNED BY THE CONTRACTING OFFICER'S REPRESENTATIVE.

EXCAVATION NOTES:

1. EXCAVATION EQUIPMENT AND WORK SHALL COMPLY WITH ALL FEDERAL, STATE, AND LOCAL CODES AND REGULATIONS INCLUDING BUT NOT LIMITED TO OSHA 29 CFR 1926, SUBPARTS M, O, AND P.
2. THE CONTRACTOR SHALL PERFORM THE EXCAVATIONS AT THE MINIMUM DEPTHS SHOWN ON THE PLANS. THE EXCAVATION LIMITS SHOWN MAY BE ENLARGED BASED ON THE RESULTS OF THE POST EXCAVATION CONFIRMATION SAMPLES. ALL EXCAVATIONS BEYOND THE DEPTHS OR LIMITS SHOWN SHALL BE APPROVED BY THE CONTRACTING OFFICER'S REPRESENTATIVE PRIOR TO COMMENCING.
3. ESTIMATED VOLUME OF SOIL TO BE REMOVED IS NOT NECESSARILY EQUAL TO THE ACTUAL VOLUME THAT WILL BE REMOVED. THE CONTRACTOR SHALL SLOPE AND/OR SHORE EXCAVATIONS TO PROTECT EXISTING STRUCTURES AND UTILITIES THAT ARE TO REMAIN. MAXIMUM ALLOWABLE SLOPES FOR EXCAVATIONS SHALL BE 2H:1V.
4. METHODS USED FOR PROTECTING INDIVIDUALS WITHIN AN EXCAVATION SHALL MEET THE REQUIREMENTS OF 29 CFR 1926.625. STRUCTURAL METHODS, IF NOT DESIGNED USING TABULATED DATA SHALL BE DESIGNED AND CERTIFIED BY A TEXAS LICENSED PROFESSIONAL ENGINEER.
5. PROVIDE BARRICADES, COVERINGS, OR OTHER TYPES OF PROTECTION NECESSARY TO PREVENT DAMAGE TO EXISTING STRUCTURES AND UTILITIES TO REMAIN IN PLACE.
6. CONTRACTOR MUST PROVIDE LADDERS, STAIRWAYS, RAMPS, OR OTHER SAFE MEANS OF EGRESS IN ALL EXCAVATIONS THAT ARE FOUR FEET DEEP OR MORE SO THAT A WORKER DOES NOT NEED TO TRAVEL MORE THAN 25 FEET IN ANY DIRECTION BEFORE BEING ABLE TO EXIT THE EXCAVATION.
7. DIRT, DEBRIS, AND OTHER MATERIAL MUST BE EFFECTIVELY STORED AND RETAINED AT LEAST TWO FEET FROM THE EDGE OF EXCAVATIONS THAT PERSONNEL MAY BE REQUIRED TO ENTER.
8. THE CONTRACTOR SHALL CONTINUALLY INSPECT, EVALUATE, AND MAINTAIN THE EXCAVATION SLOPE TO PREVENT CRACKS, BULGES, SLOUGHS, OR FAILURES.

LAND GRADING NOTES:

1. PROVISIONS SHALL BE MADE TO DIVERT SURFACE RUNOFF AWAY FROM EXPOSED AREAS AND OPEN EXCAVATIONS. RUNOFF THAT COMES IN CONTACT WITH IMPACTED SOILS SHALL BE COLLECTED AND TRANSPORTED TO THE EXISTING GROUNDWATER TREATMENT PLANT OR DISPOSED OFF-SITE TO AN APPROVED FACILITY.
2. ALL GRADED OR DISTURBED AREAS, INCLUDING SLOPES, SHALL BE PROPERLY PROTECTED DURING CLEARING AND CONSTRUCTION IN ACCORDANCE WITH THE EROSION AND SEDIMENT CONTROL PLAN UNTIL THEY ARE ADEQUATELY STABILIZED.
3. ALL EROSION AND SEDIMENT CONTROL PRACTICES AND MEASURES SHALL BE CONSTRUCTED, APPLIED, AND MAINTAINED IN ACCORDANCE WITH THE SEDIMENT CONTROL PLAN AND THE TEXAS EROSION CONTROL STANDARDS.
4. AREAS THAT ARE TO BE TOPSOILED SHALL BE SCARIFIED TO A MINIMUM DEPTH OF FOUR INCHES PRIOR TO PLACEMENT OF TOPSOIL.
5. ALL FILL SHALL BE COMPACTED AS REQUIRED TO REDUCE EROSION, SLIPPAGE, SETTLEMENT, SUBSIDENCE, OR OTHER RELATED PROBLEMS. FILL INTENDED TO SUPPORT BUILDINGS, STRUCTURES, AND CONDUITS, ETC., SHALL BE COMPACTED IN ACCORDANCE WITH LOCAL REQUIREMENTS OR CODES.
6. ALL FILL SHALL BE PLACED AND COMPACTED IN LAYERS NOT TO EXCEED 12 INCHES IN THICKNESS.
7. FILL MATERIAL SHALL BE FREE OF BRUSH, ROOTS, SOD, OR OTHER FOREIGN OBJECTIONABLE MATERIALS THAT WOULD INTERFERE WITH, OR PREVENT, CONSTRUCTION OF SATISFACTORY FILLS. FILL MATERIAL MUST MEET THE TEXAS RISK REDUCTION PROGRAM (TRRP) TIER 1 STANDARDS FOR COMMERCIAL/INDUSTRIAL SOIL PCLS.
8. FILL SHALL NOT BE PLACED ON SATURATED SURFACES.
9. ALL GRADED AREAS SHALL BE PERMANENTLY STABILIZED IMMEDIATELY FOLLOWING FINISHED GRADING.
10. STOCKPILES, BORROW AREAS, AND SPOIL AREAS SHALL BE PROTECTED AS REQUIRED BY THE CONTACT DOCUMENTS. STOCKPILES SHALL NOT BE STORED WITHIN 50 FEET OF A WATER BODY OR IN ANY DRAINAGE PATHS. ALL MATERIALS SHALL BE ENCIRCLED WITH SILT FENCE AND COVERED WHEN NOT IN USE.

ENVIRONMENTAL NOTES:

1. THE CONTRACTOR SHALL REDUCE VEHICLE IDLING. ALL VEHICLES, BOTH ON AND OFF ROAD (INCLUDING CONSTRUCTION EQUIPMENT) SHALL BE SHUT OFF WHEN NOT IN USE FOR MORE THAN 5 MINUTES.
2. CONTRACTORS MUST NOT SPILL, DISCHARGE, OR RELEASE ANY HAZARDOUS MATERIAL OR CHEMICAL UPON OR FROM THE SITE. A RELEASE IS DEFINED AS ANY UNPLANNED RELEASE, LEAKING, PUMPING, POURING, EMITTING, DUMPING, DISCHARGING, EMPTYING, OR DISPOSING OF A HAZARDOUS MATERIAL OR CHEMICAL (INCLUDING WASTEWATER OR CHEMICALLY TREATED WATER) FROM A PRIMARY CONTAINMENT.
3. CONTRACTOR EQUIPMENT MUST BE PROPERLY MAINTAINED AND IS SUBJECT TO INSPECTION BY THE CONTRACTING OFFICER. IF EQUIPMENT IS FOUND LEAKING, IT MUST IMMEDIATELY BE CONTAINED, STOPPED, AND REPAIRED.
4. UNREPORTED SPILLS, DISCHARGES, AND RELEASES ARE A VIOLATION OF FEDERAL, STATE, AND LOCAL LAWS. IF A CHEMICAL OR UNKNOWN LIQUID IS SPILLED, DISCHARGED, OR RELEASED TO THE PROPERTY, THE CONTRACTOR MUST IMMEDIATELY NOTIFY THE CONTRACTING OFFICER.
5. WHEN A SPILL, DISCHARGE, OR RELEASE IS DIRECTLY ATTRIBUTABLE TO A CONTRACTOR, THEIR SUBCONTRACTOR OR SUPPLIER, THE CONTRACTOR MUST PROVIDE ANY ASSISTANCE REQUIRED TO IDENTIFY THE CAUSE OF THE RELEASE AND TO CLEAN UP THE RELEASE. HOWEVER, CONTRACTORS MUST NOT BEGIN CLEAN UP UNTIL AUTHORIZED TO DO SO BY THE CONTRACTING OFFICER.
6. ANY CHEMICAL SPILL, DISCHARGE, OR RELEASE CAUSED BY THE CONTRACTOR MUST BE CLEANED TO THE CONTRACTING OFFICER'S SATISFACTION.
7. WATER USED FOR MONITORING WELL DEVELOPMENT SHALL BE TESTED TO DETERMINE AN APPROPRIATE MANAGEMENT METHOD.

WELL NOTES:

1. THE FOLLOWING REQUIREMENTS SHALL BE USED FOR THE INSTALLATION OF GROUNDWATER MONITORING WELLS. THE CONTRACTOR SHALL OBTAIN WRITTEN APPROVAL FROM THE CONTRACTING OFFICER'S REPRESENTATIVE PRIOR TO WELL INSTALLATION IF EQUIVALENT ALTERNATIVES TO THESE REQUIREMENTS ARE BE USED.
2. DRILLING:
   A. MONITORING WELLS SHALL BE DRILLED BY A TEXAS-LICENSED DRILLER WHO IS QUALIFIED TO DRILL AND INSTALL MONITORING WELLS. THE INSTALLATION AND DEVELOPMENT SHALL BE SUPERVISED BY A LICENSED PROFESSIONAL GEOSCIENTIST OR ENGINEER WHO IS FAMILIAR WITH THE GEOLOGY OF THE AREA.
   B. THE WELL SHALL BE DRILLED BY A METHOD THAT WILL ALLOW INSTALLATION OF THE CASING, SCREEN, ETC., AND THAT WILL NOT INTRODUCE CONTAMINANTS INTO THE BOREHOLE OR CASING. DRILLING TECHNIQUES USED FOR BORING SHALL CONSIDER THE MATERIALS TO BE DRILLED, DEPTH TO GROUNDWATER, TOTAL DEPTH OF THE HOLE, ADEQUATE SOIL SAMPLING, AND OTHER SUCH FACTORS THAT AFFECT THE SELECTION OF THE DRILLING METHOD. IF ANY FLUIDS ARE NECESSARY IN DRILLING OR INSTALLATION, THEN CLEAN, TREATED WATER FROM EXISTING GWTP SHALL BE USED; OTHER FLUIDS SHALL BE APPROVED IN WRITING BY THE CONTRACTING OFFICER'S REPRESENTATIVE BEFORE USE. IF TREATED WATER FROM EXISTING GWTP IS USED, A CURRENT CHEMICAL ANALYSIS OF THE GWTP EFFLUENT WATER SHALL BE PROVIDED WITH THE MONITOR-WELL REPORT.
   C. THE DIAMETER OF THE BORING SHALL BE AT LEAST FOUR INCHES LARGER THAN THE DIAMETER OF THE CASING.
   D. A LOG OF THE BORING SHALL BE MADE BY OR UNDER THE SUPERVISION OF A LICENSED PROFESSIONAL GEOSCIENTIST OR ENGINEER WHO IS FAMILIAR WITH THE GEOLOGY OF THE AREA, AND SHALL BE SEALED, SIGNED, AND DATED BY THE LICENSED PROFESSIONAL.
3. CASING, SCREEN, FILTER PACK, AND SEALS:
   A. THE WELL CASING SHALL BE AT MINIMUM TWO INCHES IN DIAMETER; NATIONAL SCIENCE FOUNDATION-CERTIFIED POLYVINYL CHLORIDE (PVC) SCHEDULE 40 OR 80 PIPE, FLUSH-THREAD, SCREW JOINT (NO GLUE OR SOLVENTS); POLYTETRAFLUOROETHYLENE (PTFE, SUCH AS TEFLON) TAPE OR O-RINGS IN THE JOINTS; NO COLLAR COUPLINGS. THE TOP OF THE PVC RISER AT INJECTION WELL LOCATIONS SHALL BE THREADED TO SUPPORT FUTURE INJECTIONS.
   B. THE TOP OF THE PVC CASING SHALL BE 6 INCHES TO 2 FEET ABOVE GROUND LEVEL FOR INJECTION WELLS. THE TOP OF THE OUTER PROTECTIVE CASING SHALL BE 2-3 FEET ABOVE GROUND LEVEL FOR MONITORING WELLS.
   C. WHERE HIGH LEVELS OF VOLATILE ORGANIC COMPOUNDS OR CORROSIVE COMPOUNDS ARE ANTICIPATED, STAINLESS STEEL OR PTFE CASING AND SCREEN MAY BE USED, SUBJECT TO APPROVAL BY THE CONTRACTING OFFICER'S REPRESENTATIVE.
   D. THE CASING SHALL BE CLEANED AND PACKAGED AT THE PLACE OF MANUFACTURE; THE PACKAGING SHALL INCLUDE A PVC WRAPPING ON EACH SECTION OF CASING TO KEEP IT FROM BEING CONTAMINATED PRIOR TO INSTALLATION. THE CASING SHALL BE FREE OF INK, LABELS, OR OTHER MARKINGS. THE CASING (AND SCREEN) SHALL BE CENTERED IN THE HOLE TO ALLOW INSTALLATION OF A GOOD FILTER PACK AND ANNULAR SEAL. CENTRALIZERS ARE RECOMMENDED ON WELLS OVER SIX METERS (20 FEET) IN LENGTH BUT MAY NOT BE NEEDED IF THE WELLS ARE INSTALLED THROUGH HOLLOW-STEM AUGERS. THE TOP OF THE CASING SHALL BE PROTECTED BY A THREADED (FOR INJECTION WELLS) OR A THREADED OR SLIP-ON TOP CAP OR BY A SEALING CAP OR SCREW-PLUG SEAL INSERTED INTO THE TOP OF THE CASING (FOR MONITORING WELLS). THE CAP SHALL BE VENTED TO PREVENT BUILDUP OF ANY GASES AND SHALL BE DESIGNED TO PREVENT MOISTURE FROM ENTERING THE WELL.
   E. THE SCREEN SHALL BE COMPATIBLE WITH THE CASING AND SHOULD GENERALLY BE OF THE SAME MATERIAL. THE SCREEN SHALL NOT INVOLVE THE USE OF ANY GLUES OR SOLVENTS FOR CONSTRUCTION. FIELD-CUT SLOTS ARE NOT PERMITTED FOR WELL SCREEN. FILTER CLOTH SHALL NOT BE USED. A BLANK-PIPE SEDIMENT TRAP, TYPICALLY 4 TO 6 INCHES, SHOULD BE INSTALLED BELOW THE SCREEN. A BOTTOM CAP IS TYPICALLY PLACED ON THE BOTTOM OF THE SEDIMENT TRAP. THE SEDIMENT TRAP SHALL NOT EXTEND THROUGH THE LOWER CONFINING LAYER OF THE WATER-BEARING ZONE BEING TESTED. SCREEN STERILIZATION METHODS ARE THE SAME AS THOSE FOR CASING. SELECTION OF THE SIZE OF THE SCREEN OPENING SHOULD BE DONE BY A PERSON EXPERIENCED WITH SUCH WORK AND SHALL INCLUDE CONSIDERATION OF THE DISTRIBUTION OF PARTICLE SIZES BOTH IN THE WATER-BEARING ZONE AND IN THE FILTER PACK SURROUNDING THE SCREEN. THE SCREEN OPENING SHALL NOT BE LARGER THAN THE SMALLEST FRACTION OF THE FILTER PACK.
   F. THE FILTER PACK, PLACED BETWEEN THE SCREEN AND THE WELL BORE, SHALL CONSIST OF PREPACKAGED, INERT, CLEAN SILICA SAND OR GLASS BEADS; IT SHALL EXTEND TO TWO FEET ABOVE THE TOP OF THE SCREEN. OPEN STOCKPILE SOURCES OF SAND OR GRAVEL ARE NOT PERMITTED. THE FILTER PACK USUALLY HAS A 30% FINER GRAIN SIZE THAT IS ABOUT FOUR TO TEN TIMES LARGER THAN THE 30% FINER GRAIN SIZE OF THE WATER-BEARING ZONE; THE FILTER PACK SHOULD HAVE A UNIFORMITY COEFFICIENT LESS THAN 2.5. THE FILTER PACK SHOULD BE PLACED WITH A TREMIE PIPE TO ENSURE THAT THE MATERIAL COMPLETELY SURROUNDS THE SCREEN AND CASING WITHOUT BRIDGING. THE TREMIE PIPE SHALL BE STEAM CLEANED PRIOR TO THE FIRST WELL AND BEFORE EACH SUBSEQUENT WELL.
   G. THE ANNULAR SEAL SHALL BE PLACED ON TOP OF THE FILTER PACK AND SHALL BE AT LEAST THREE FEET THICK. IT SHOULD BE PLACED IN THE ZONE OF SATURATION TO MAINTAIN HYDRATION. THE SEAL SHOULD BE COMPOSED OF COARSE-GRAIN SODIUM BENTONITE, COARSE-GRIT SODIUM BENTONITE, OR BENTONITE GROUT. SPECIAL CARE SHOULD BE TAKEN TO ENSURE THAT FINE MATERIAL OR GROUT DOES NOT PLUG THE UNDERLYING FILTER PACK. PLACEMENT OF A FEW INCHES OF PREPACKAGED CLEAN FINE SAND ON TOP OF THE FILTER PACK WILL HELP TO PREVENT MIGRATION OF THE ANNULAR SEAL MATERIAL INTO THE FILTER PACK. THE SEAL SHOULD BE PLACED ON TOP OF THE FILTER PACK WITH A STEAM-CLEANED TREMIE PIPE TO ENSURE GOOD DISTRIBUTION AND SHOULD BE TAMPED WITH A STEAM-CLEANED ROD TO DETERMINE THAT THE SEAL IS THICK ENOUGH. THE BENTONITE SHALL BE HYDRATED WITH CLEAN WATER PRIOR TO ANY FURTHER ACTIVITIES ON THE WELL AND LEFT TO STAND UNTIL HYDRATION IS COMPLETE (EIGHT TO 12 HOURS, DEPENDING ON THE GRAIN SIZE OF THE BENTONITE). IF A BENTONITE-GROUT (WITHOUT CEMENT) CASING SEAL IS USED IN THE WELL BORE, THEN IT MAY REPLACE THE ANNULAR SEAL DESCRIBED IN THIS PARAGRAPH.
   H. A CASING SEAL SHALL BE PLACED ON TOP OF THE ANNULAR SEAL TO PREVENT FLUIDS AND CONTAMINANTS FROM ENTERING THE BOREHOLE FROM THE SURFACE. THE CASING SEAL SHALL CONSIST OF A COMMERCIAL BENTONITE GROUT OR A CEMENT-BENTONITE MIXTURE. DRILLING SPOIL, CUTTINGS, OR OTHER NATIVE MATERIALS ARE NOT PERMITTED FOR USE AS A CASING SEAL. QUICK-SETTING CEMENTS ARE NOT PERMITTED FOR USE BECAUSE CONTAMINANTS MAY LEACH FROM THEM INTO THE GROUNDWATER. THE TOP OF THE CASING SEAL SHALL BE BETWEEN FIVE AND TWO FEET FROM THE SURFACE.
   I. CONCRETE PAD. HIGH-QUALITY STRUCTURAL-TYPE CONCRETE SHALL BE PLACED FROM THE TOP OF THE CASING SEAL (TWO TO FIVE FEET BELOW THE SURFACE) CONTINUOUSLY TO THE TOP OF THE GROUND TO FORM A PAD AT THE SURFACE. THIS FORMED SURFACE PAD SHALL BE AT LEAST SIX INCHES THICK AND NOT LESS THAN FOUR (PREFERABLY SIX) FEET SQUARE OR FIVE (PREFERABLY SIX) FEET IN DIAMETER. THE PAD SHALL CONTAIN SUFFICIENT REINFORCING STEEL TO ENSURE ITS STRUCTURAL INTEGRITY IN THE EVENT THAT SOIL SUPPORT IS LOST. THE TOP OF THE PAD SHALL SLOPE AWAY FROM THE WELL BORE TO THE EDGES TO PREVENT PONDING OF WATER AROUND THE CASING OR COLLAR.
4. PROTECTIVE COLLAR. A STEEL PROTECTIVE PIPE COLLAR SHALL BE PLACED AROUND THE CASING "STICKUP" TO PROTECT IT FROM DAMAGE AND UNWANTED ENTRY. THE COLLAR SHALL BE SET AT LEAST ONE FOOT INTO THE SURFACE PAD DURING ITS CONSTRUCTION. THE WELL NUMBER OR OTHER DESIGNATION SHALL BE MARKED PERMANENTLY ON THE PROTECTIVE STEEL COLLAR; IT IS USEFUL TO MARK THE TOTAL DEPTH OF THE WELL AND ITS ELEVATION ON THE COLLAR.
   A. INJECTION WELLS: THE COLLAR SHOULD EXTEND SIX INCHES TO TWO FEET ABOVE GRADE, WITH THE PVC WELL CASING PROTRUDING THROUGH A COLLAR TO SIX INCHES ABOVE THE TOP OF THE COLLAR.
   B. MONITORING WELLS: THE COLLAR SHOULD EXTEND AT LEAST THREE INCHES ABOVE THE TOP OF THE WELL CASING (AND TOP CAP, IF PRESENT). THE TOP OF THE COLLAR SHALL HAVE A LOCKABLE HINGED TOP FLAP OR COVER. A STURDY LOCK SHALL BE INSTALLED, MAINTAINED IN WORKING ORDER, AND KEPT LOCKED WHEN THE WELL IS NOT BEING BAILED/PURGED OR SAMPLED.
5. PROTECTIVE BARRIER. WHERE MONITORING WELLS ARE LIKELY TO BE DAMAGED BY MOVING EQUIPMENT OR ARE LOCATED IN HEAVILY TRAVELED AREAS, A PROTECTIVE BARRIER SHALL BE INSTALLED. A TYPICAL BARRIER IS THREE OR FOUR 6- TO 12-INCH DIAMETER PIPES SET IN CONCRETE JUST OFF THE PROTECTIVE PAD. THE PIPES CAN BE JOINED BY PIPES WELDED BETWEEN THEM, BUT CONSIDERATION SHALL BE GIVEN TO WELL ACCESS FOR SAMPLING AND OTHER ACTIVITIES. SEPARATION OF SUCH A PIPE BARRIER FROM THE PAD MEANS THAT THE BARRIER CAN BE DAMAGED WITHOUT RISK TO THE PAD AND WELL.
6. UNUSUAL CONDITIONS. WHERE MONITORING WELLS ARE INSTALLED IN UNUSUAL CONDITIONS, ALL ASPECTS OF THE INSTALLATION SHALL BE APPROVED IN WRITING IN ADVANCE BY THE CONTRACTING OFFICER'S REPRESENTATIVE. SUCH ASPECTS INCLUDE, FOR EXAMPLE, THE USE OF CELLAR-TYPE ENCLOSURES FOR THE TOP-WELL EQUIPMENT OR MULTIPLE COMPLETIONS IN A SINGLE HOLE.
7. DEVELOPMENT. AFTER A MONITORING WELL IS INSTALLED, IT SHALL BE DEVELOPED TO REMOVE ARTIFACTS OF DRILLING (CLAY FILMS, BENTONITE PELLETS IN THE CASING, ETC.) AND TO OPEN THE WATER-BEARING ZONE FOR MAXIMUM FLOW INTO THE WELL. DEVELOPMENT SHOULD CONTINUE UNTIL ALL OF THE WATER USED OR AFFECTED DURING DRILLING ACTIVITIES HAS BEEN REMOVED AND FIELD MEASUREMENTS OF PH, SPECIFIC CONDUCTANCE, AND TEMPERATURE HAVE STABILIZED. FAILURE TO DEVELOP A WELL PROPERLY MAY MEAN THAT IT IS NOT PROPERLY MONITORING THE WATER-BEARING ZONE OR MAY NOT YIELD ADEQUATE WATER FOR SAMPLING EVEN THOUGH THE WATER-BEARING ZONE IS PROLIFIC.
8. LOCATION AND ELEVATION. UPON COMPLETION OF A MONITORING WELL, THE LOCATION OF THE WELL AND ALL APPROPRIATE ELEVATIONS ASSOCIATED WITH THE TOP-WELL EQUIPMENT SHALL BE SURVEYED BY A REGISTERED PROFESSIONAL SURVEYOR. THE ELEVATION SHALL BE SURVEYED TO THE NEAREST 0.01 FOOT ABOVE MEAN SEA LEVEL (WITH YEAR OF THE SEA-LEVEL DATUM SHOWN). THE POINT ON THE WELL CASING FOR WHICH THE ELEVATION WAS DETERMINED SHALL BE PERMANENTLY MARKED ON THE CASING. THE LOCATION SHALL BE GIVEN IN TERMS OF THE LATITUDE AND LONGITUDE AT LEAST TO THE NEAREST TENTH OF A SECOND.
9. REPORTING. MONITORING WELL INSTALLATION AND CONSTRUCTION DETAILS SHALL BE SUBMITTED ON FORMS AVAILABLE FROM THE COMMISSION AND SHALL BE COMPLETED AND SUBMITTED WITHIN 60 DAYS OF WELL COMPLETION. A COPY OF THE DETAILED GEOLOGIC LOG OF THE BORING, A DESCRIPTION OF DEVELOPMENT PROCEDURES, ANY PARTICLE SIZE OR OTHER SAMPLE DATA FROM THE WELL, AND A SITE MAP DRAWN TO SCALE SHOWING THE LOCATION OF ALL MONITORING WELLS AND THE POINT OF COMPLIANCE SHALL BE SUBMITTED TO THE EXECUTIVE DIRECTOR AT THE SAME TIME. THE LICENSED DRILLER SHOULD BE FAMILIAR WITH THE FORMS REQUIRED BY OTHER AGENCIES; A COPY OF THOSE FORMS SHALL ALSO BE SUBMITTED TO THE COMMISSION.
10. DAMAGED WELLS. ANY MONITORING WELL THAT IS DAMAGED TO THE EXTENT THAT IT IS NO LONGER SUITABLE FOR SAMPLING SHALL BE REPORTED TO THE CONTRACTING OFFICER'S REPRESENTATIVE, WHO MAY MAKE A DETERMINATION ABOUT WHETHER TO REPAIR OR REPLACE THE WELL.
11. PLUGGING AND ABANDONMENT. ANY MONITORING WELL THAT IS NO LONGER USED SHALL BE PROPERLY ABANDONED AND PLUGGED-IN ACCORDANCE WITH 16 TAC §76.702 (RELATING TO RESPONSIBILITIES OF THE LICENSEE AND LANDOWNER--WELL DRILLING, COMPLETION, CAPPING AND PLUGGING) AND §76.1004 (RELATING TO TECHNICAL REQUIREMENTS--STANDARDS FOR CAPPING AND PLUGGING OF WELLS AND PLUGGING WELLS THAT PENETRATE UNDESIRABLE WATER OR CONSTITUENT ZONES). NO ABANDONMENT SHALL TAKE PLACE WITHOUT PRIOR AUTHORIZATION IN WRITING BY THE CONTRACTING OFFICER'S REPRESENTATIVE.

INJECTION NOTES:

1. THE POTABLE WATER REQUIRED FOR MIXING SHALL BE OBTAINED FROM THE GROUNDWATER TREATMENT PLANT (GWTP) OR FROM AN OFF-BASE FIRE HYDRANT AND TRANSPORTED TO THE MIXING TANK LOCATED ON SITE IN A WATER TRUCK.
2. THE CONTRACTOR SHALL COORDINATE INJECTION ACTIVITIES WITH THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY (TCEQ) TO MEET THE SUBSTANTIVE REQUIREMENTS OF THE UNDERGROUND INJECTION CONTROL AUTHORIZATION (PERMIT EQUIVALENT).

US Army Corps of Engineers®
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STATE OF TEXAS — MICHAEL A. VECCHIO — 147480 — LICENSED PROFESSIONAL ENGINEER

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DESIGNED BY: AP
DWN BY: JP
CKD BY: TC
SUBMITTED BY:
DATE: 02/29/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE:
FILE NUMBER: 102645371
SIZE: ANSI D
FILE NAME:

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LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

GENERAL NOTES

SHEET IDENTIFICATION
G001
SHEET 1 OF 24

CONSTRUCTION SEQUENCE:

A PRELIMINARY SEQUENCE OF THE ACTIVITIES NECESSARY TO IMPLEMENT THE REMEDIAL ACTION (RA) IS BELOW. THE RA IS PROPOSED TO BE PERFORMED IN TWO PHASES. THE CONTRACTOR SHALL INCLUDE THE SEQUENCE IN THE REMEDIAL ACTION WORK PLAN (RAWP) THAT WILL BE SUBMITTED FOR APPROVAL PRIOR TO COMMENCING THEIR WORK.

REMEDIAL ACTION PHASE I ACTIVITIES

THE CONTRACTOR TO COMPLETE THE FOLLOWING ACTIVITIES UNDER PHASE I RA. STEP 1, SITE PREPARATION, WILL BE COMPLETED FIRST. STEPS 2 THROUGH 4 WILL BE COMPLETED CONCURRENTLY AS FEASIBLE.

1. SITE PREPARATION

   A. LOCATE AND MARK ALL UNDERGROUND UTILITIES AND VERIFY EXISTING SITE CONDITIONS IN THE VICINITY OF THE WORK AREAS. THE CONTRACTOR SHALL USE A THIRD–PARTY LOCATION SERVICE IF REQUIRED.
   B. MOBILIZE EQUIPMENT AND TRAILERS TO THE SITE. SET UP STAGING AREAS.
   C. CONDUCT PRE–CONSTRUCTION PHOTOGRAPHIC AND VIDEO DOCUMENTATION.
   D. IDENTIFY AND CLEARLY MARK ALL MONITORING WELLS IN THE VICINITY OF THE WORK AREAS FOR PROTECTION.
   E. SET UP AIR MONITORING STATIONS.
   F. PERFORM SITE CLEARING AS NEEDED TO ACCESS/PERFORM THE WORK.
   G. CONDUCT PRELIMINARY SURVEY USING GLOBAL POSITIONING SYSTEM EQUIPMENT.
   H. CONSTRUCT DECONTAMINATION FACILITIES AND STOCKPILING AREA.
   I. SET UP TRAFFIC CONTROL.

2. SOIL EXCAVATION AND DISPOSAL

   A. INSTALL EROSION CONTROL MEASURES.
   B. CONSTRUCT ACCESS ROADS, AS REQUIRED, FOR SOIL EXCAVATION.
   C. EXCAVATE AREAS TO PRIMARY EXCAVATION LIMITS AS DEFINED.
   D. VISUALLY INSPECT EXCAVATION AND IF NO IMPACTS ARE OBSERVED, COLLECT SIDEWALL AND BOTTOM CONFIRMATION SAMPLES.
   E. BASED ON RESULTS, PROCEED WITH SECONDARY EXCAVATIONS, IF REQUIRED.
   F. IF RESULTS ARE LESS THAN THE CLEANUP LEVELS, WITH THE APPROVAL OF THE CONTRACTING OFFICER'S REPRESENTATIVE, PERFORM BACKFILL AND COMPACTION.
   G. FOLLOWING BACKFILL, RESTORE WITH TOPSOIL AND SEED.
   H. TRANSPORT AND DISPOSE OF CONTAMINATED MATERIAL.
   I. DEMOBILIZE.
   J. REMOVE TEMPORARY EROSION CONTROL MEASURES.

3. ENHANCED IN–SITU BIOREMEDIATION (EISB) FIELD PILOT TESTS

   A. CLEAR INJECTION AND MONITORING WELL LOCATIONS REQUIRED FOR CONDUCTING ALL THREE PILOT TESTS.
   B. MOBILIZE MATERIALS, EQUIPMENT AND LABOR FOR INSTALLING INJECTION WELLS AND NEW MONITORING WELLS TO BE USED FOR PERFORMANCE MONITORING.
   C. MOBILIZE MATERIALS, EQUIPMENT, MIXING TANKS, AND LABOR FOR INJECTIONS FOR THE PILOT TESTS.
   D. LAYOUT INJECTION LOCATIONS AND CLEAR DPT INJECTION POINTS.
   E. CORE CONCRETE/ASPHALT AT INJECTION POINTS, IF NEEDED, AND ADJUST ANY POINTS IF OBSTRUCTIONS ARE FOUND AND PUSH RODS TO THE DESIRED INJECTION INTERVAL.
   F. SETUP AMENDMENT, EQUIPMENT, AND MATERIALS ONSITE.
   G. BEGIN PREPARING AMENDMENT SOLUTION FOR INJECTION A DAY BEFORE PLANNED INJECTIONS. PREPARATION OF AMENDMENT SOLUTION WILL BE A CONTINUAL ACTIVITY.
   H. INJECT AMENDMENTS FOLLOWING THE SEQUENCING DESCRIBED AS PER SPECIFICATION SECTION 02 53 17 – INJECTION PROCEDURES AND MONITORING.
   I. RECORD INJECTION INTERVALS AND VOLUMES DURING INJECTIONS.
   J. ONCE INJECTION IS COMPLETE AT A DPT INJECTION POINT, ABANDON POINT.
   K. RECORD INJECTION WELLS AND DPT INJECTION POINT LOCATIONS WITH GLOBAL POSITIONING SYSTEM (GPS).
   L. RECORD FIELD MEASUREMENTS FROM THE OBSERVATION WELLS FOLLOWING THE LIST PROVIDED IN SPECIFICATION SECTION 02 53 17 – INJECTION PROCEDURES AND MONITORING.
   M. SUBMIT A FIELD PILOT TEST REPORT DOCUMENTING THE IMPLEMENTATION, FINDINGS, RESULTS, AND RECOMMENDATION FOR IMPLEMENTING THE FULL–SCALE REMEDY FOR THE FULL SCALE EISB TO BE IMPLEMENTED IN PHASE II.

4. IN–SITU THERMAL DESORPTION FOR DNAPL TREATMENT:

   A. CLEAR AREAS REQUIRED FOR THE IMPLEMENTATION OF THE ISTD TREATMENT.
   B. SECURE POWER DROP.
   C. INSTALL CONSTRUCTION ACCESS ROADS, AS REQUIRED.
   D. INSTALL HEATER WELLS, VAPOR EXTRACTION WELLS, AND INFRASTRUCTURE FOR THE ISTD TREATMENT SYSTEM.
   E. START THE ISTD SYSTEM.
   F. OPERATE SYSTEM UNTIL PERFORMANCE CRITERIA FOR THE ISTD TREATMENT HAVE BEEN MET.
   G. PERFORM TWO ROUNDS OF GROUNDWATER SAMPLING. THE FIRST ROUND SHALL BE AT A POINT WHEN GROUNDWATER TEMPERATURES HAVE DROPPED BELOW 100 DEG. CELSIUS. THE SECOND SAMPLING EVENT SHALL TAKE PLACE WITHIN 12 TO 16 WEEKS AFTER THE FIRST SAMPLING EVENT.
   H. FOLLOWING RECEIPT OF GROUNDWATER SAMPLES ACHIEVING THE PERFORMANCE CRITERIA AND WITH THE APPROVAL OF THE CONTRACTING OFFICER'S REPRESENTATIVE, DECOMMISSION THE ISTD SYSTEM.
   I. RESTORE THE AREA TO PRE–EXISTING CONDITIONS TO THE EXTENT PRACTICABLE FOLLOWING REMOVAL AND DEMOBILIZATION OF ALL EQUIPMENT AND MATERIALS FROM THE SITE.

REMEDIAL ACTION PHASE II ACTIVITIES

THE CONTRACTOR TO COMPLETE THE FOLLOWING ACTIVITIES UNDER PHASE II RA CONCURRENTLY.

1. FULL SCALE EISB IMPLEMENTATION:

   A. PROVIDE SITE CLEARING.
   B. PLEASE SEE SECTION 3 ABOVE.

2. CONDUCT PERFORMANCE MONITORING

ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
BGS	–	BELOW GROUND SURFACE
CPT/MIP	–	CONE PENETRATION TEST / MEMBRANE INTERFACE PROBE
CF	–	CUBIC FEET
CY	–	CUBIC YARDS
DNAPL	–	DENSE NON–AQUEOUS PHASE LIQUID
DPT	–	DIRECT PUSH TECHNOLOGY
EISB	–	ENHANCED IN–SITU BIOREMEDIATION
FIPS	–	FEDERAL INFORMATION PROCESSING STANDARD
FT	–	FEET
HDPE	–	HIGH–DENSITY POLYETHYLENE
ICT	–	INTERCEPTOR COLLECTION TRENCH
ISTD	–	IN–SITU THERMAL DESORPTION
LB/FT^2	–	POUND PER SQUARE FOOT
LB/IN^2	–	POUND PER SQUARE INCH
MW	–	MONITORING WELL
NAD	–	NORTH AMERICAN DATUM
NAVD	–	NORTH AMERICAN VERTICAL DATUM
OZ/YD	–	OUNCE PER YARD
OZ/YD^2	–	OUNCE PER SQUARE YARD
PMW	–	PERFORMANCE MONITORING WELL
PVC	–	POLYVINYL CHLORIDE
ROI	–	RADIUS OF INFLUENCE
SF	–	SQUARE FEET
TCEQ	–	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
USEPA	–	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

GENERAL LEGEND:

- AREA VERTEX
- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- POWER POLE
- OHE — OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

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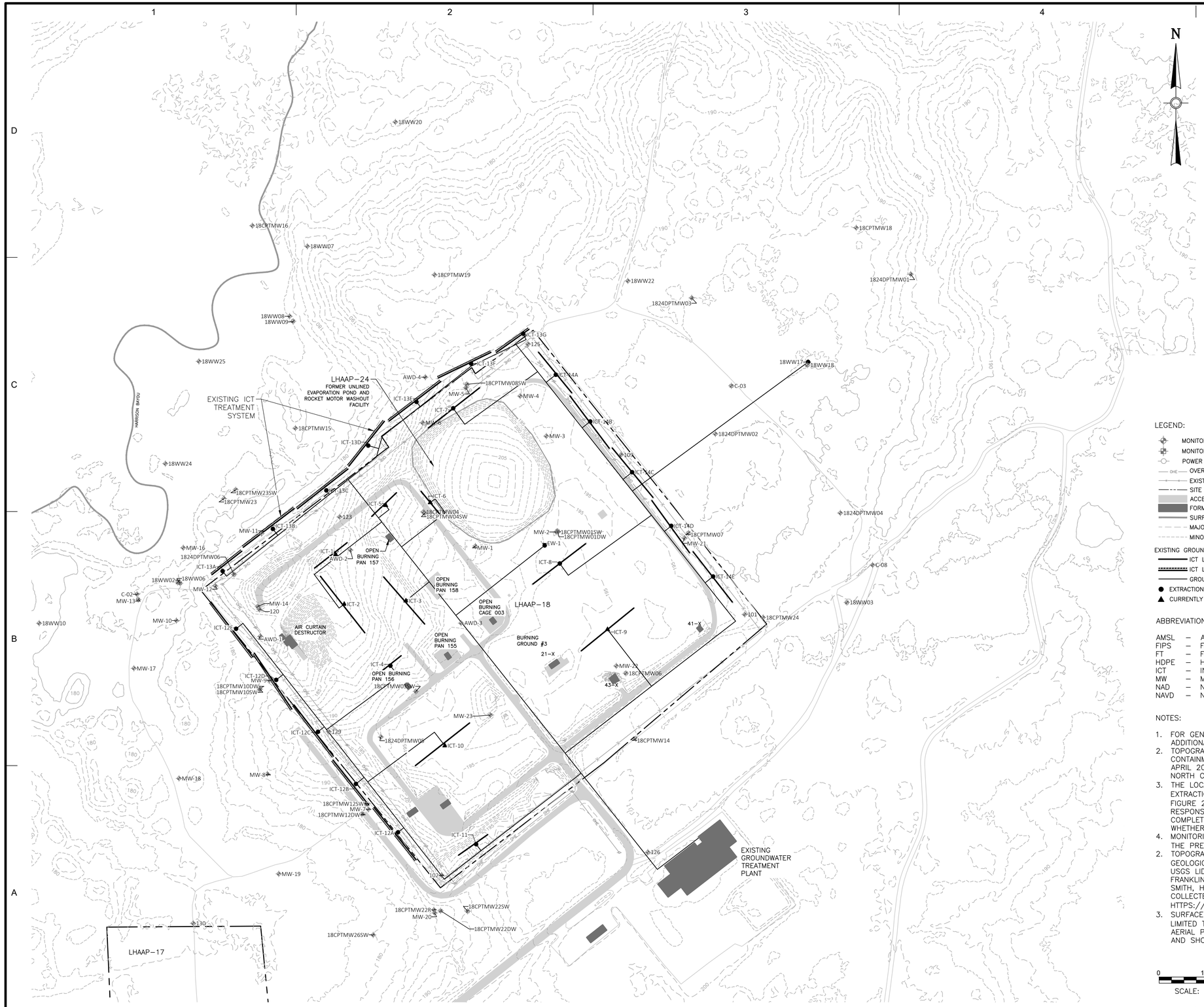
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LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

LEGEND AND CONSTRUCTION SEQUENCE

SHEET IDENTIFICATION
G002
SHEET 2 OF 24



LEGEND:

- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- POWER POLE
- OHE — OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

ABBREVIATIONS:

AMSL – ABOVE MEAN SEA LEVEL
FIPS – FEDERAL INFORMATION PROCESSING STANDARD
FT – FEET
HDPE – HIGH–DENSITY POLYETHYLENE
ICT – INTERCEPTOR COLLECTION TRENCH
MW – MONITORING WELL
NAD – NORTH AMERICAN DATUM
NAVD – NORTH AMERICAN VERTICAL DATUM

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. TOPOGRAPHY AND LOCATIONS OF EXISTING SURFACE FEATURES WITHIN THE CONTAINMENT AREA ARE FROM A SURVEY COMPLETED BY MTX SURVEYING IN APRIL 2021. SURVEY IS WITH REFERENCE TO NAD 83 STATE PLANE TEXAS NORTH CENTRAL FIPS 4202 AND NAVD 88.
3. THE LOCATIONS OF EXISTING ICT SYSTEM COMPONENTS (I.E., ICTS, LINERS, EXTRACTION LOCATIONS, AND SUMPS) ARE APPROXIMATE AND BASED ON FIGURE 2–16 OF THE ROD (U.S. ARMY, 2020). 1. IT SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR TO HAVE A GEOPHYSICAL SURVEY COMPLETED TO LOCATE ALL UNDERGROUND UTILITIES AND STRUCTURES, WHETHER SHOWN PLAN OR NOT, AND TO PROTECT THEM FROM DAMAGE.
4. MONITORING WELL LOCATIONS ARE BASED ON A SURVEY CONDUCTED DURING THE PRE–DESIGN INVESTIGATION (HDR, 2021).
2. TOPOGRAPHY OUTSIDE THE CONTAINMENT AREA ARE FROM UNITED STATES GEOLOGICAL SURVEY (USGS) RED RIVER LIDAR, DATED MARCH 1, 1, 2017. THIS USGS LIDAR COLLECTION COVERS PORTIONS OF LAMAR, RED RIVER, BOWIE, FRANKLIN, TITUS, MORRIS, CASS, CAMP, WOOD, UPSHUR, MARION, GREGG, SMITH, HARRISON, RUSK, PANOLA, AND HOPKINS COUNTIES, TEXAS. DATA WAS COLLECTED AND PROCESSED BY DEWBERRY & DAVIS LLC. ACCESSED FROM HTTPS://DATA.TNRIS.ORG/ ON NOVEMBER 29, 2022.
3. SURFACE FEATURES OUTSIDE THE CONTAINMENT AREA (INCLUDING BUT NOT LIMITED TO ROADS AND THE EXISTING TREATMENT PLANT) ARE BASED ON AERIAL PHOTOS ACCESSED FROM GOOGLE MAPS ON NOVEMBER 28, 2022, AND SHOULD BE CONSIDERED APPROXIMATE.

0 150' 300'
SCALE: 1" = 150'

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DATE: 02/29/2024
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CONTRACT NO.: W912BV19D0016
FILE NUMBER: 102436.37
PLOT SCALE: AS NOTED
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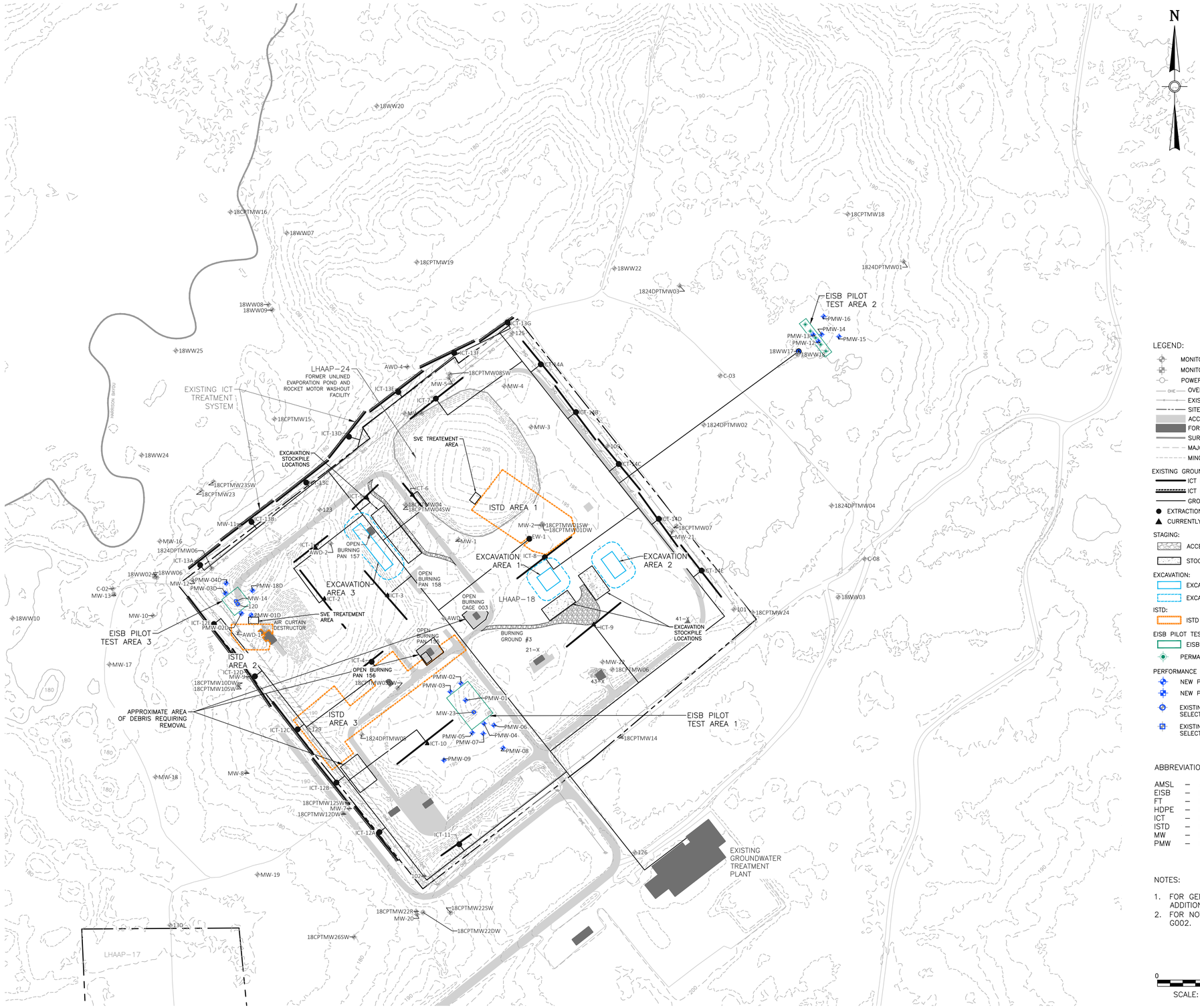
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LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

SITE PLAN

SHEET IDENTIFICATION
G003
SHEET 3 OF 24



LEGEND:

- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- POWER POLE
- OHE — OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

STAGING:

- ACCESS ROAD
- STOCKPILE LOCATION

EXCAVATION:

- EXCAVATION AREA
- EXCAVATION TOP OF SLOPE

ISTD:

- ISTD AREA

EISB PILOT TEST:

- EISB PILOT TEST AREA
- PERMANENT INJECTION WELL LOCATION – SHALLOW ZONE

PERFORMANCE MONITORING:

- NEW PERFORMANCE MONITORING WELL LOCATION – SHALLOW ZONE
- NEW PERFORMANCE MONITORING WELL LOCATION – WILCOX FORMATION
- EXISTING MONITORING WELL LOCATION – SHALLOW ZONE SELECTED FOR PERFORMANCE MONITORING
- EXISTING MONITORING WELL LOCATION – WILCOX FORMATION SELECTED FOR PERFORMANCE MONITORING

ABBREVIATIONS:

AMSL – ABOVE MEAN SEA LEVEL
EISB – ENHANCED IN-SITU BIOREMEDIATION
FT – FEET
HDPE – HIGH-DENSITY POLYETHYLENE
ICT – INTERCEPTOR COLLECTION TRENCH
ISTD – IN-SITU THERMAL DESORPTION
MW – MONITORING WELL
PMW – PERFORMANCE MONITORING WELL

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. FOR NOTES ON SOURCES OF SURVEY/LOCATION DATA, REFER TO SHEET G002.

0 150' 300'
SCALE: 1" = 150'

US Army Corps of Engineers
TULSA DISTRICT

STATE OF TEXAS · MICHAEL J. VECCHIO · 147460 · LICENSED PROFESSIONAL ENGINEER · 01/31/2025

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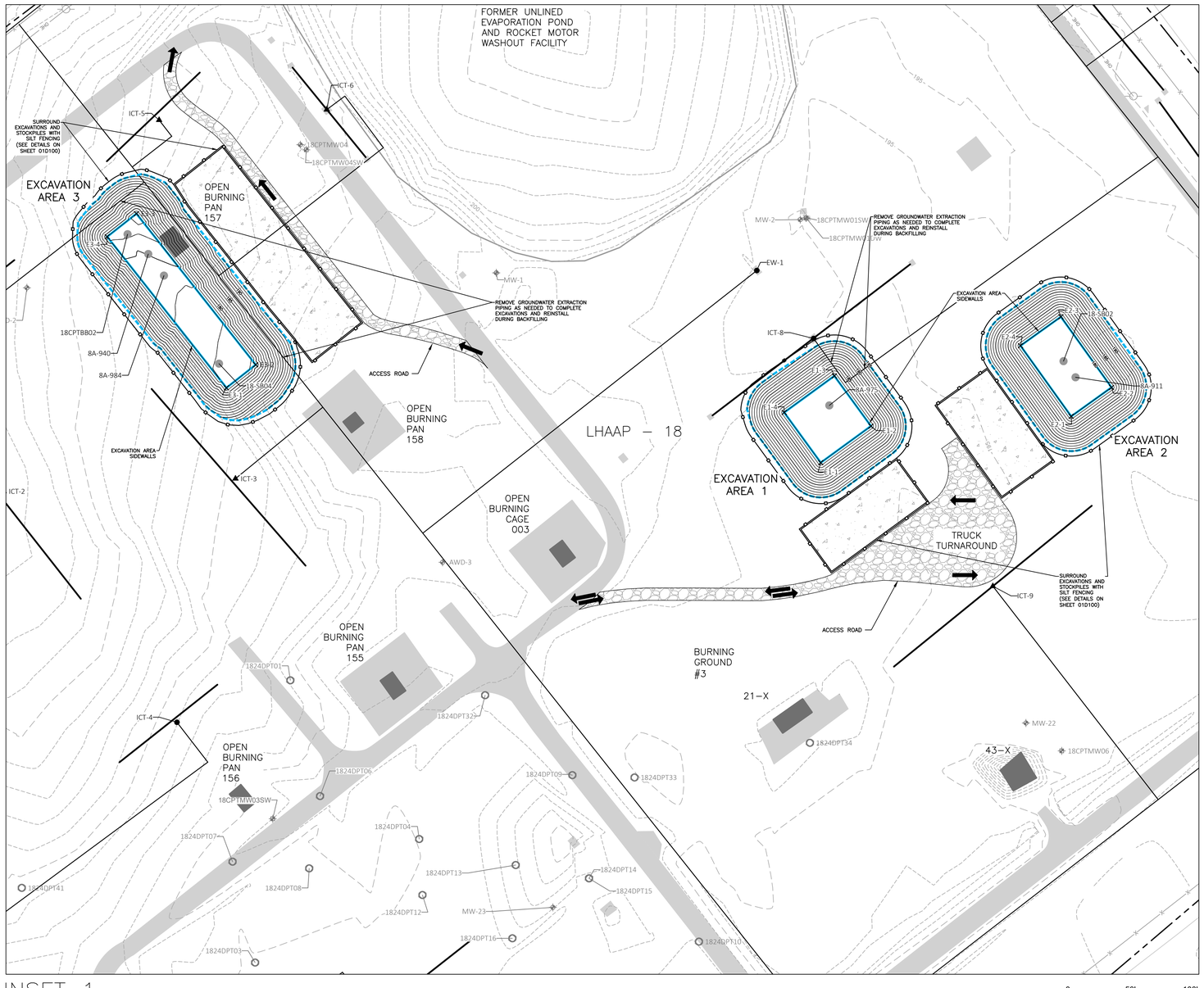
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LONGHORN ARMY AMMUNITION PLANT
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REMEDIAL ACTION SITE PLAN - PHASE I

SHEET IDENTIFICATION
01C100
SHEET 4 OF 24



INSET 1

0 50' 100'

SCALE: 1" = 50'

Excavation Area Vertices		
Location ID	Easting	Northing
E1-1	3316929.58	6953812.34
E1-2	3316969.99	6953841.78
E1-3	3316940.55	6953882.19
E1-4	3316900.14	6953852.75
E2-1	3317131.20	6953849.64
E2-2	3317163.71	6953872.95
E2-3	3317122.93	6953929.84
E2-4	3317090.42	6953906.54
E3-1	3316451.04	6953872.61
E3-2	3316474.60	6953891.19
E3-3	3316378.61	6954012.90
E3-4	3316355.06	6953994.32



KEY MAP

0 600' 1200'

SCALE: 1" = 600'

LEGEND:

- SOIL BORING LOCATION
- PDI DPT SAMPLE LOCATION
- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- POWER POLE
- OHE — OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

STAGING:

- ACCESS ROAD
- TRUCK TRAFFIC DIRECTION
- STOCKPILE LOCATION
- SILT FENCE

EXCAVATION:

- EXCAVATION AREA
- EXCAVATION TOP OF SLOPE
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR

ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
BGS	–	BELOW GROUND SURFACE
CF	–	CUBIC FEET
CY	–	CUBIC YARDS
DNAPL	–	DENSE NON–AQUEOUS PHASE LIQUID
FIPS	–	FEDERAL INFORMATION PROCESSING STANDARD
FT	–	FEET
HDPE	–	HIGH–DENSITY POLYETHYLENE
ICT	–	INTERCEPTOR COLLECTION TRENCH
MW	–	MONITORING WELL
NAD	–	NORTH AMERICAN DATUM
NAVD	–	NORTH AMERICAN VERTICAL DATUM
SF	–	SQUARE FEET

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. PREVIOUS SOIL BORING LOCATIONS WERE APPROXIMATED BASED ON FIGURES PROVIDED IN THE FINAL REVISED FEASIBILITY STUDY REPORT (AECOM, 2017) AND ITS SUPPORTING DOCUMENTS, INCLUDING POST–SCREENING INVESTIGATION REPORTS (AECOM, 2013 & 2016)
3. PDI DPT SAMPLE LOCATIONS ARE BASED ON THE SURVEY CONDUCTED DURING THE PRE–DESIGN INVESTIGATION (HDR, 2021).
4. FOR NOTES ON SOURCES OF SURVEY DATA AND OTHER LOCATION DATA, REFER TO SHEET G002.

Excavation Areas						Excavation Area Calculations					Post-Excavation Confirmatory Sampling	
Area ID	Length	Width	Depth Interval		Depth	Bottom Area	Sidewall Area (Length)	Sidewall Area (Width)	Volume[1]		Composite Bottom Samples[2]	Composite Sidewall Samples[3]
	ft	ft	ft bgs	ft bgs	ft	sf	sf	sf	cf	cy	no.	no.
Excavation Area 1	50	50	4	14	10	2,500	500	500	25,000	930	3	4
Excavation Area 2	70	40	4	14	10	2,800	700	400	28,000	1,040	3	4
Excavation Area 3	155	30	4	16	12	4,650	1860	360	55,800	2,070	5	6
								TOTAL	108,800	4,040	11	14

Notes:
1. Volume of impacted material does not include overlying non-impacted material or slope material.
2. One 5-point composite bottom sample per 1,000 square ft of the excavation bottom.
3. One 5-point composite sidewall sample per 1,000 square ft of vertical sidewall.

EXCAVATION NOTES:

1. THE CONTRACTOR SHALL PERFORM PRIMARY EXCAVATIONS TO THE LIMITS SHOWN ON THIS PLAN AND IN ACCORDANCE WITH SPECIFICATION SECTION 31 23 10 – EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS AND OSHA REQUIREMENTS. PERMISSIBLE SLOPES USED TO COMPLETE EXCAVATIONS SHALL BE 2H:1V.
2. THE CONTRACTOR SHALL USE SOFT DIGGING METHODS WHEN EXCAVATING AROUND THE EXISTING GROUNDWATER EXTRACTION SYSTEM. THE CONTRACTOR SHALL REMOVE PORTIONS OF INACTIVE GROUNDWATER EXTRACTION PIPING EXPOSED DURING EXCAVATIONS AND REINSTALL THEM DURING BACKFILLING AS INDICATED IN THIS PLAN AND IN CONSULTATION WITH THE CONTRACTING OFFICER'S REPRESENTATIVE.
3. THE CONTRACTOR SHALL COLLECT CONFIRMATION SAMPLES IN ACCORDANCE WITH SPECIFICATION SECTION 31 23 10 – EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS AT A FREQUENCY OF:
   - 3.1. ONE 5–POINT COMPOSITE BOTTOM SAMPLE PER 1,000 SQUARE FT OF THE EXCAVATION BOTTOM.
   - 3.2. ONE 5–POINT COMPOSITE SIDEWALL SAMPLE PER 1,000 SQ FT OF VERTICAL SIDEWALL. THE POINTS FOR EACH COMPOSITE WILL BE SELECTED TO REPRESENT THE FULL HEIGHT OF THE SIDEWALL.
4. RESULTS OF CONFIRMATION SAMPLES WILL BE REVIEWED BY THE CONTRACTING OFFICER'S REPRESENTATIVE TO VERIFY SITE CLEANUP LEVELS FOR SOIL ARE ACHIEVED BEFORE THE CONTRACTOR MAY BACKFILL THE EXCAVATIONS. IF CONFIRMATION SAMPLING RESULTS EXCEED THE CLEANUP LEVELS, THEN THE CONTRACTOR SHALL EXCAVATE 2 TO 5 FEET LATERALLY AND 1 FOOT VERTICALLY IN THE DIRECTION OF EXCEEDANCES AND THEN COLLECT ADDITIONAL CONFIRMATION SAMPLES FOR ANALYSIS.
5. THE CONTRACTOR SHALL STOCKPILE EXCAVATED MATERIAL IN ACCORDANCE WITH SPECIFICATION SECTION 31 23 10 – EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS. THE CONTRACTOR SHALL STOCKPILE EXCAVATED SOILS FROM NON–IMPACTED INTERVALS (0–4 FT BELOW GROUND SURFACE BOTH WITHIN THE EXCAVATION AREA AND SIDE SLOPES) SEPARATELY FROM IMPACTED MATERIAL FOR REUSE AS BACKFILL ONCE EXCAVATIONS ARE COMPLETED. SOILS EXCAVATED DEEPER THAN 4 FT BGS FROM SIDE SLOPES ARE POTENTIALLY CONTAMINATED AND SHALL BE HANDLED AS CONTAMINATED MATERIAL.

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TULSA DISTRICT

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SUBMITTED BY:
DATE: 02/29/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
FILE NUMBER: 1084437
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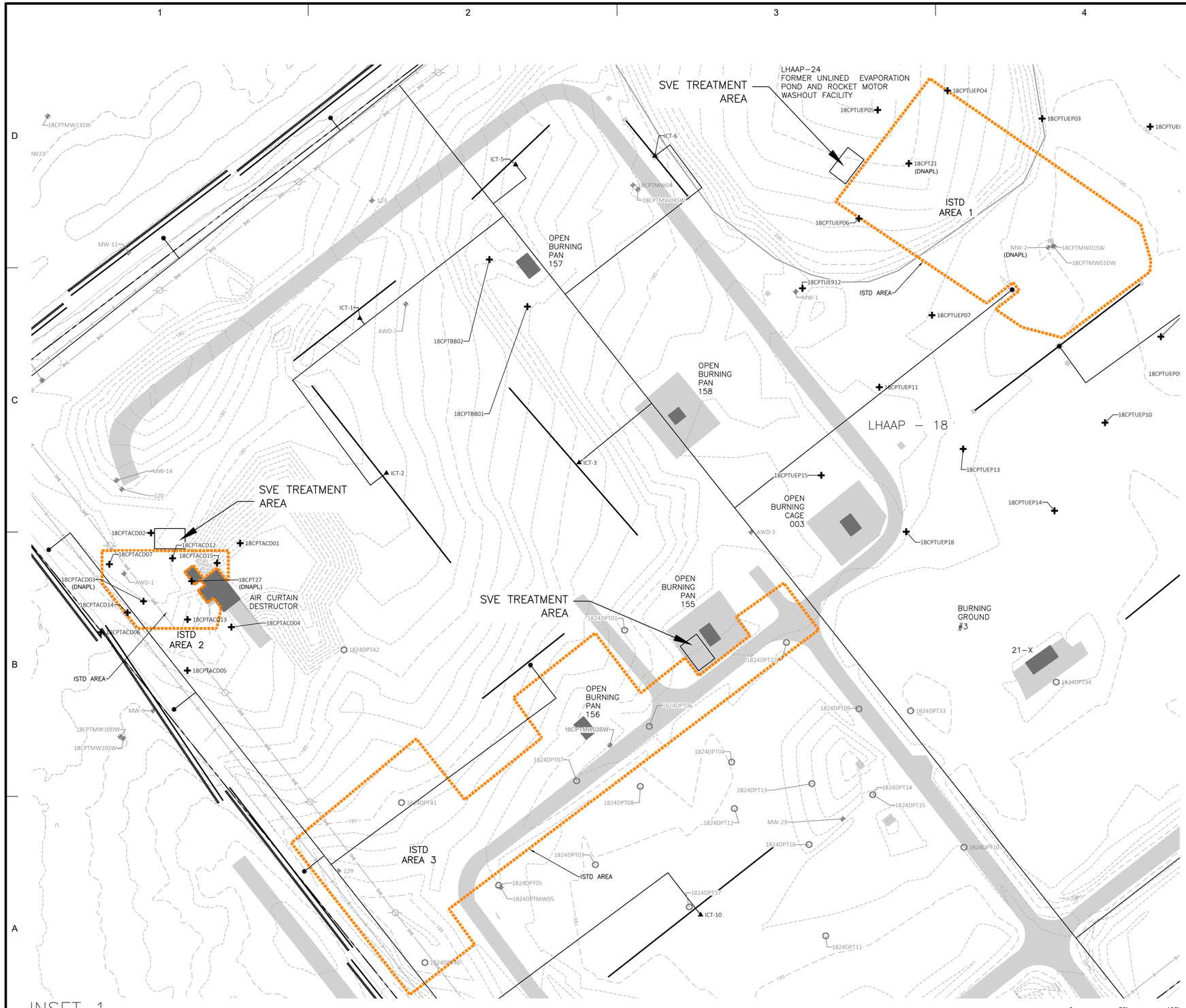
U.S. ARMY ENGINEER DIVISION
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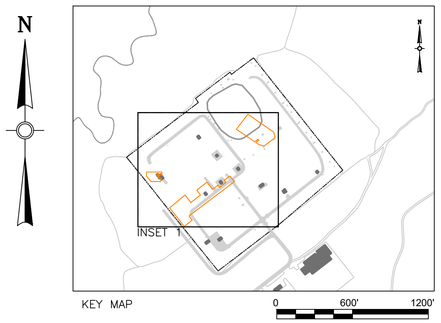
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LHAAP - 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

EXCAVATION AREAS SITE PLAN

SHEET IDENTIFICATION
01C101
SHEET 5 OF 24





LEGEND:

- PDI DPT SAMPLE LOCATION
- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- CPT/MIP LOCATION
- (DNAPL) HISTORICAL PRESENCE OF DNAPL
- POWER POLE
- OHE OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

ISTD:

- ISTD AREA

ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
CPT/MIP	–	CONE PENETRATION TEST / MEMBRANE INTERFACE PROBE
DNAPL	–	DENSE NON–AQUEOUS PHASE LIQUID
FIPS	–	FEDERAL INFORMATION PROCESSING STANDARD
FT	–	FEET
HDPE	–	HIGH–DENSITY POLYETHYLENE
ICT	–	INTERCEPTOR COLLECTION TRENCH
ISTD	–	IN–SITU THERMAL DESORPTION
MW	–	MONITORING WELL
PMW	–	PERFORMANCE MONITORING WELL

ISTD NOTES:

1. THE CONTRACTOR SHALL PERFORM ISTD IN THE AREAS SHOWN ON THIS PLAN AND SHEETS 01C202 AND 01C203 AND IN ACCORDANCE WITH DAR SECTION 4 IN–SITU THERMAL DESORPTION DESIGN FOR DNAPL TREATMENT.
2. WELLS WITHIN ISTD AREAS TO BE ABANDONED: MW–2 IN ISTD AREA 1, AWD–1 IN ISTD AREA 2, AND 18CPTMW03SW AND 129 IN ISTD AREA 3. THESE WELLS ARE TO BE REPLACED DURING THE PHASE II RA, PRIOR TO COMMENCING INJECTIONS.

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. PREVIOUS CPT/MIP LOCATIONS WERE APPROXIMATED BASED ON FIGURES PROVIDED IN THE FINAL REVISED FEASIBILITY STUDY REPORT (AECOM, 2017) AND ITS SUPPORTING DOCUMENTS, INCLUDING POST–SCREENING INVESTIGATION REPORTS (AECOM, 2013 & 2016)
3. PDI DPT SAMPLE LOCATIONS ARE BASED ON THE SURVEY CONDUCTED DURING THE PRE–DESIGN INVESTIGATION (HDR, 2021).
4. FOR NOTES ON SOURCES OF SURVEY DATA AND OTHER LOCATION DATA, REFER TO SHEET G002.

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MARK	DESCRIPTION	DATE
1	PRELIMINARY DESIGN	03/2022
2	INTERMEDIATE DESIGN	09/2022
3	PRE–FINAL DESIGN	02/2023
4	DRAFT FINAL DESIGN	10/2023
5	FINAL DESIGN	02/2024
6		13
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DESIGNED BY: AP
DWN BY: JP
CKD BY: TC
SUBMITTED BY:
DATE: 02/29/2024
SOLICITATION NO.: W912BV20F0086
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE:
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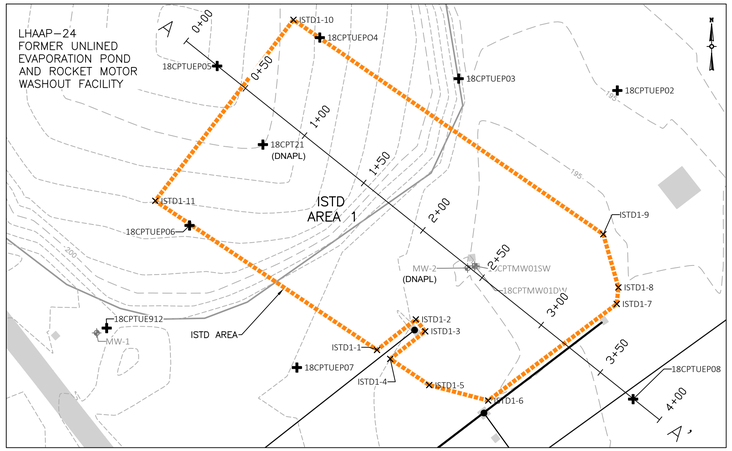
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LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

ISTD AREAS SITE PLAN

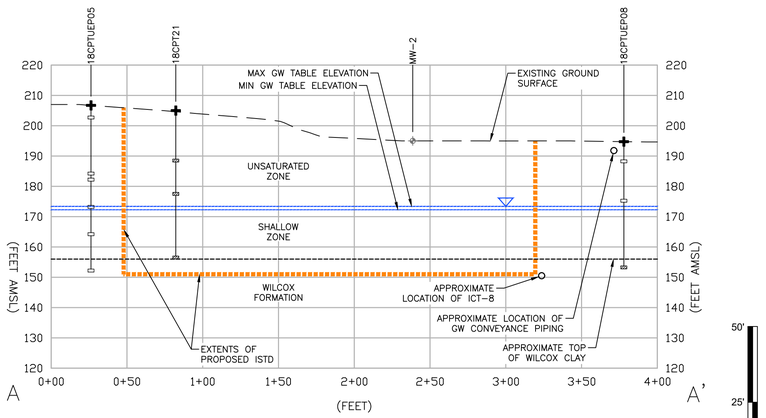
SHEET IDENTIFICATION
01C201
SHEET 6 OF 24



INSET 1

0 50' 100'

SCALE: 1" = 50'



PROFILE A-A' - ISTD AREA 1

0 50' 100'

0 25' 50'

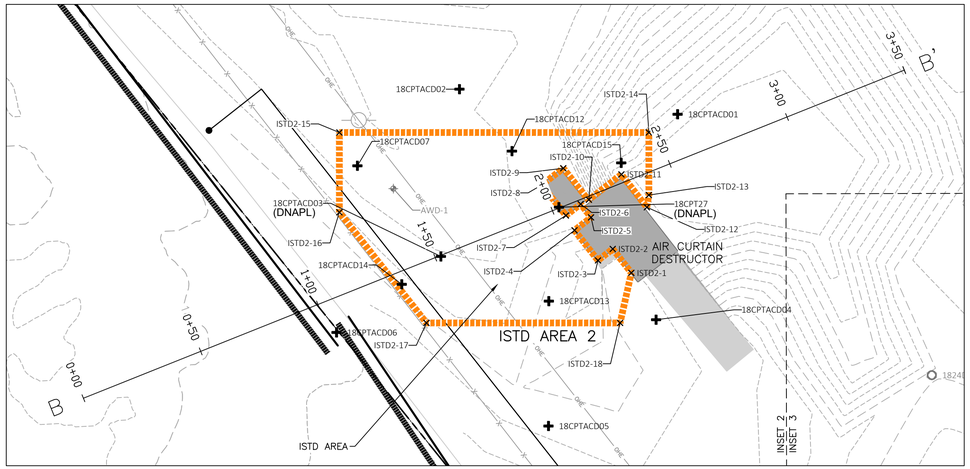
HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 25'



KEY MAP

0 600' 1200'

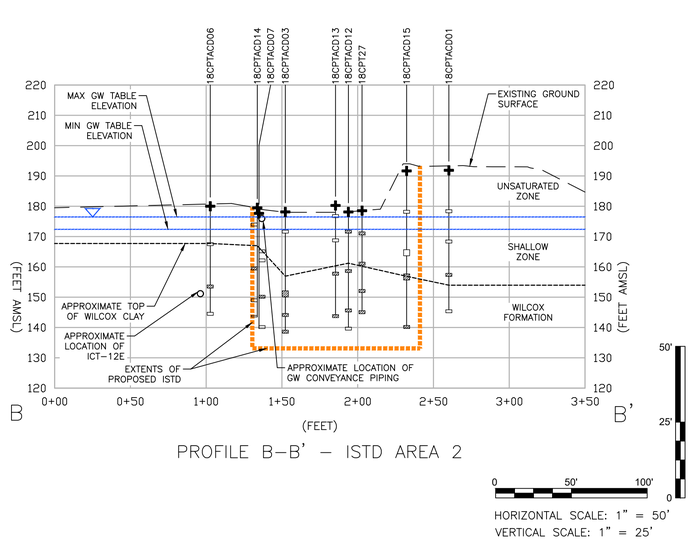
SCALE: 1" = 600'



INSET 2

0 30' 60'

SCALE: 1" = 30'



PROFILE B-B' - ISTD AREA 2

0 50' 100'

0 25' 50'

HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 25'

ISTD Area 1 Vertices		
Location ID	Easting	Northing
ISTD1-1	3316853.29	6953953.96
ISTD1-2	3316878.91	6953974.12
ISTD1-3	3316885.09	6953966.26
ISTD1-4	3316862.01	6953948.09
ISTD1-5	3316887.74	6953930.79
ISTD1-6	3316926.66	6953920.58
ISTD1-7	3317011.49	6953984.34
ISTD1-8	3317012.58	6953995.25
ISTD1-9	3317002.61	6954030.33
ISTD1-10	3316798.15	6954171.82
ISTD1-11	3316706.95	6954052.37

ISTD Area 2 Vertices		
Location ID	Easting	Northing
ISTD2-1	3316111.51	6953658.56
ISTD2-2	3316104.15	6953668.04
ISTD2-3	3316098.30	6953663.49
ISTD2-4	3316089.02	6953675.42
ISTD2-5	3316095.57	6953680.51
ISTD2-6	3316091.45	6953685.81
ISTD2-7	3316085.61	6953681.26
ISTD2-8	3316076.03	6953693.35
ISTD2-9	3316084.56	6953700.00
ISTD2-10	3316094.70	6953687.52
ISTD2-11	3316107.57	6953697.54
ISTD2-12	3316117.64	6953684.52
ISTD2-13	3316118.44	6953689.37
ISTD2-14	3316118.44	6953714.14
ISTD2-15	3315995.91	6953714.14
ISTD2-16	3315995.91	6953682.55
ISTD2-17	3316030.40	6953636.74
ISTD2-18	3316107.06	6953638.74

LEGEND:

- PDI DPT SAMPLE LOCATION
- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- CPT/MIP LOCATION
- (DNAPL) HISTORICAL PRESENCE OF DNAPL
- POWER POLE
- OHE OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

ISTD:

- ISTD AREA

- SOIL SAMPLE INTERVAL
- SOIL SAMPLE WITH VOC CONCENTRATIONS INDICATING THE POTENTIAL PRESENCE OF DNAPL IN THE SATURATED ZONE

ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
CPT/MIP	–	CONE PENETRATION TEST / MEMBRANE INTERFACE PROBE
DNAPL	–	DENSE NON-AQUEOUS PHASE LIQUID
FIPS	–	FEDERAL INFORMATION PROCESSING STANDARD
FT	–	FEET
HDPE	–	HIGH-DENSITY POLYETHYLENE
ICT	–	INTERCEPTOR COLLECTION TRENCH
ISTD	–	IN-SITU THERMAL DESORPTION
MW	–	MONITORING WELL
NAD	–	NORTH AMERICAN DATUM
NAVD	–	NORTH AMERICAN VERTICAL DATUM
PMW	–	PERFORMANCE MONITORING WELL

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. PREVIOUS CPT/MIP LOCATIONS WERE APPROXIMATED BASED ON FIGURES PROVIDED IN THE FINAL REVISED FEASIBILITY STUDY REPORT (AECOM, 2017) AND ITS SUPPORTING DOCUMENTS, INCLUDING POST-SCREENING INVESTIGATION REPORTS (AECOM, 2013 & 2016).
3. TEMPORARY DPT SAMPLE LOCATIONS ARE BASED ON THE SURVEY CONDUCTED DURING THE PRE-DESIGN INVESTIGATION (HDR, 2021).
4. FOR NOTES ON SOURCES OF SURVEY DATA AND OTHER LOCATION DATA, REFER TO SHEET G002.
5. MAX AND MIN GROUNDWATER TABLE ELEVATIONS ARE BASED ON SYNOPTIC DEPTH TO WATER MEASUREMENTS COLLECTED BY BHATE ENVIRONMENTAL ASSOCIATES, INC. [BHATE] IN JUNE 2021 AND DECEMBER 2021, RESPECTIVELY.
6. THE TOP OF THE WILCOX CLAY IS INTERPRETED BASED ON THE PRE-DESIGN INVESTIGATION (PDI) CONDUCTED IN 2021 (HDR, 2022); THE FINAL REVISED FEASIBILITY STUDY (FS) (AECOM, 2017) AND ITS SUPPORTING DOCUMENTS, INCLUDING POST-SCREENING INVESTIGATION REPORTS (AECOM, 2013 & 2016); AND THE REMEDIAL INVESTIGATION REPORT FOR THE GROUP 2 SITES (SITES 12, 17, 18/24, 29, AND 32; JACOBS, 2001).
7. SOIL AND GROUNDWATER ANALYTICAL RESULTS ARE FROM THE QUARTERLY EVALUATION REPORT, 2ND QUARTER (APRIL-JUNE) 2021 (BHATE), AND THE PRE-DESIGN INVESTIGATION (PDI) CONDUCTED IN 2021 (HDR, 2022),
8. ICT DEPTHS ARE BASED ON THE QUARTERLY EVALUATION REPORT, 2ND QUARTER (APRIL-JUNE) 2021 (BHATE), TABLE A-1 – ICT COMPLETION DEPTHS. CONVEYANCE PIPING DEPTHS ARE APPROXIMATE AND SHALL BE VERIFIED AS PART OF THE UTILITY CLEARANCE ACTIVITY.

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MARK	DESCRIPTION	DATE
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2	DRAFT FINAL DESIGN	10/2023
3	FINAL DESIGN	02/2024
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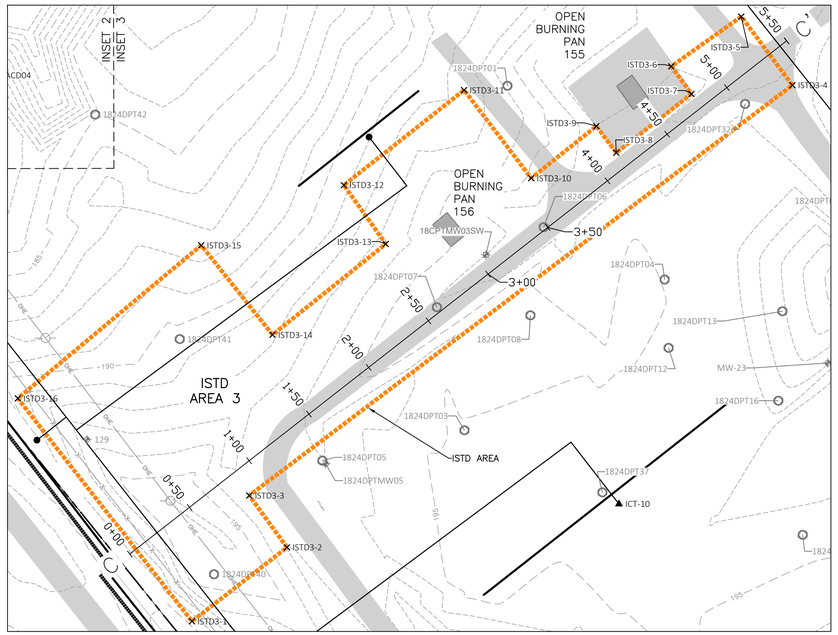
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DWN BY: JP
CKD BY: TC
SUBMITTED BY:
DATE: 02/29/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE:
FILE NUMBER: 112043537
SIZE: ANSI D
FILE NAME:

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(402) 399-1000

LHAAP - 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

ISTD PROFILE VIEWS SHEET 1

SHEET IDENTIFICATION
01C202
SHEET 7 OF 24



INSET 3

0 50' 100'

SCALE: 1" = 50'

ISTD Area 3 Vertices		
Location ID	Easting	Northing
ISTD3-1	3316294.35	6953283.68
ISTD3-2	3316357.05	6953332.45
ISTD3-3	3316332.13	6953366.68
ISTD3-4	3316690.56	6953637.43
ISTD3-5	3316656.80	6953682.69
ISTD3-6	3316610.58	6953649.84
ISTD3-7	3316623.95	6953631.66
ISTD3-8	3316574.35	6953592.86
ISTD3-9	3316561.19	6953610.40
ISTD3-10	3316518.20	6953576.06
ISTD3-11	3316473.91	6953634.19
ISTD3-12	3316394.57	6953571.45
ISTD3-13	3316422.25	6953532.70
ISTD3-14	3316347.51	6953472.73
ISTD3-15	3316300.46	6953531.78



KEY MAP

0 600' 1200'

SCALE: 1" = 600'

LEGEND:

- PDI DPT SAMPLE LOCATION
- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- CPT/MIP LOCATION
- (DNAPL) HISTORICAL PRESENCE OF DNAPL
- POWER POLE
- OHE OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

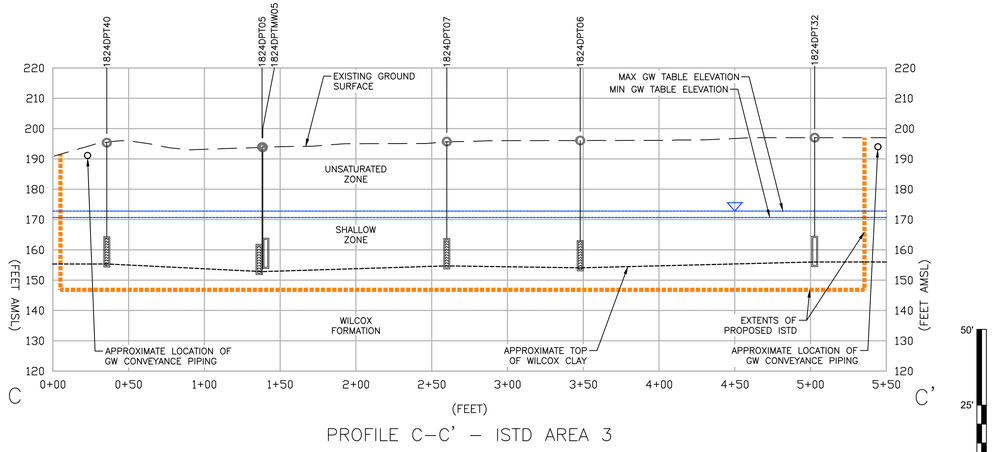
EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

ISTD:

- ISTD AREA

- GROUDWATER SAMPLE INTERVAL
- 2000 GROUNDWATER SAMPLE WITH VOC CONCENTRATIONS INDICATING POTENTIAL PRESENCE OF RESIDUAL SOIL SOURCE



PROFILE C–C' – ISTD AREA 3

0 50' 100'

50'
25'
0

HORIZONTAL SCALE: 1" = 50'
VERTICAL SCALE: 1" = 25'

ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
CPT/MIP	–	CONE PENETRATION TEST / MEMBRANE INTERFACE PROBE
DNAPL	–	DENSE NON–AQUEOUS PHASE LIQUID
FIPS	–	FEDERAL INFORMATION PROCESSING STANDARD
FT	–	FEET
HDPE	–	HIGH–DENSITY POLYETHYLENE
ICT	–	INTERCEPTOR COLLECTION TRENCH
ISTD	–	IN–SITU THERMAL DESORPTION
MW	–	MONITORING WELL
NAD	–	NORTH AMERICAN DATUM
NAVD	–	NORTH AMERICAN VERTICAL DATUM
PMW	–	PERFORMANCE MONITORING WELL

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. FOR SOURCES OF LOCATION AND ELEVATION DATA, REFER TO NOTES ON SHEET 01C202.

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STATE OF TEXAS · MICHAEL L. VECCHIO · 147486 · LICENSED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
1	PRE–FINAL DESIGN	03/2023
2	DRAFT FINAL DESIGN	10/2023
3	FINAL DESIGN	02/2024
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DESIGNED BY: AP
DWN BY: JP
CKD BY: TC
SUBMITTED BY:
DATE: 02/29/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
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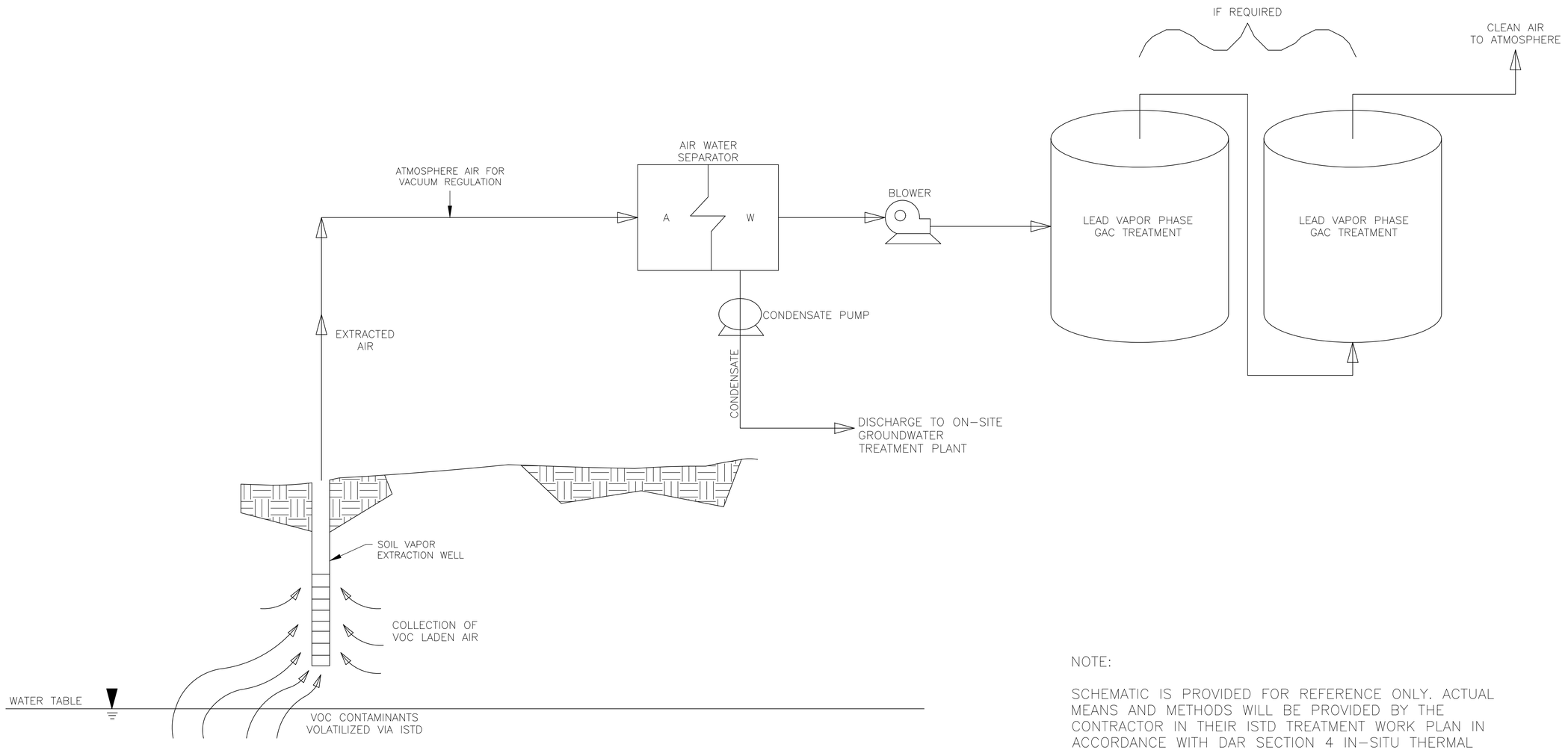
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ISTD PROFILE VIEWS SHEET 2

SHEET IDENTIFICATION
01C203
SHEET 8 OF 24



NOTE:

SCHEMATIC IS PROVIDED FOR REFERENCE ONLY. ACTUAL MEANS AND METHODS WILL BE PROVIDED BY THE CONTRACTOR IN THEIR ISTD TREATMENT WORK PLAN IN ACCORDANCE WITH DAR SECTION 4 IN-SITU THERMAL DESORPTION DESIGN FOR DNAPL TREATMENT AND REVIEWED AND APPROVED BY THE CONTRACTING OFFICER'S REPRESENTATIVE PRIOR TO INSTALLING AND PERFORMING SVE SYSTEM.

SCALE: NOT TO SCALE

US Army Corps of Engineers
TULSA DISTRICT

STATE OF TEXAS · MICHAEL L. VICCHIO · 147486 · REGISTERED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
1	PRE-FINAL DESIGN	12/2022
2	DRAFT FINAL DESIGN	10/2023
3	FINAL DESIGN	02/2024
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DESIGNED BY: AP
DWN BY: JP
CKD BY: TC
SUBMITTED BY:
DATE: 02/29/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
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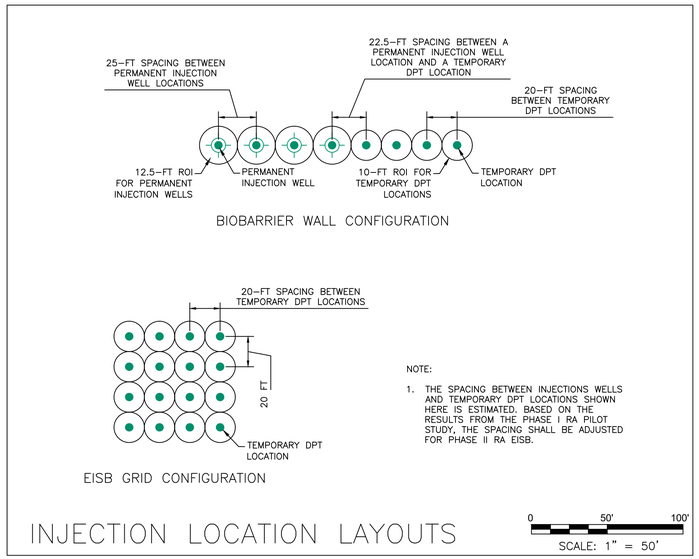
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SVE SCHEMATIC

SHEET IDENTIFICATION
01C204
SHEET 9 OF 24

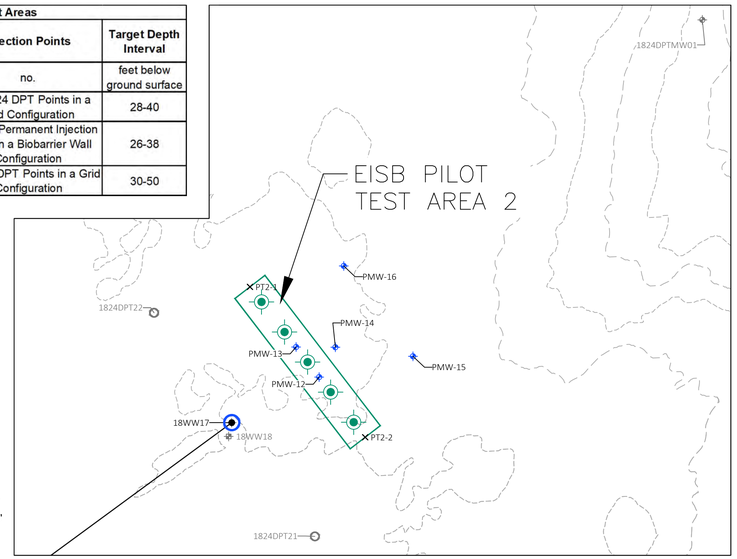


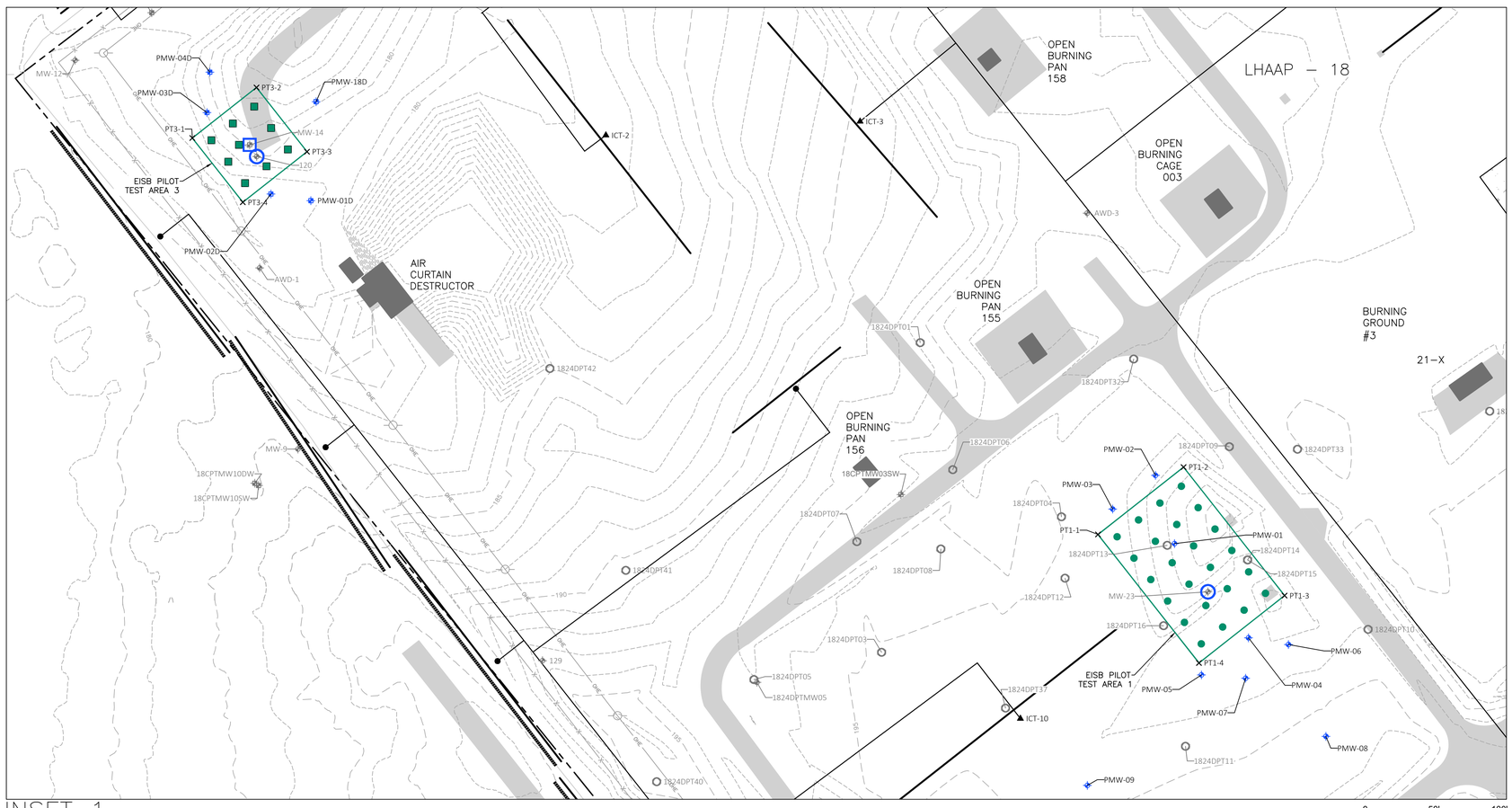
EISB Pilot Test Areas

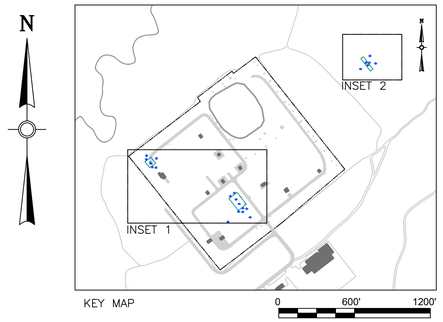
Area ID	Size	Injection Points	Target Depth Interval
		no.	feet below ground surface
Pilot Test Area 1	9,600 square feet	Up to 24 DPT Points in a Grid Configuration	28-40
Pilot Test Area 2	125 linear feet	Up to 5 Permanent Injection Wells in a Biobarrier Wall Configuration	26-38
Pilot Test Area 3	3,600 square feet	Up to 9 DPT Points in a Grid Configuration	30-50

Pilot Test Area Vertices

Location ID	Easting	Northing
PT1-1	3316633.10	6953496.22
PT1-2	3316695.99	6953545.66
PT1-3	3316770.16	6953451.33
PT1-4	3316707.27	6953401.88
PT2-1	3317687.05	6954611.58
PT2-2	3317763.09	6954512.37
PT3-1	3315967.82	6953787.29
PT3-2	3316014.99	6953824.38
PT3-3	3316052.08	6953777.21
PT3-4	3316004.91	6953740.12







LEGEND:

- PDI DPT SAMPLE LOCATION
- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- POWER POLE
- OHE — OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

EISB PILOT TEST:

- EISB PILOT TEST AREA
- TEMPORARY DPT INJECTION LOCATION – SHALLOW ZONE
- TEMPORARY DPT INJECTION LOCATION – WILCOX FORMATION
- PERMANENT INJECTION WELL LOCATION – SHALLOW ZONE

PERFORMANCE MONITORING:

- NEW PERFORMANCE MONITORING WELL LOCATION – SHALLOW ZONE
- NEW PERFORMANCE MONITORING WELL LOCATION – WILCOX FORMATION
- EXISTING MONITORING WELL LOCATION – SHALLOW ZONE SELECTED FOR PERFORMANCE MONITORING
- EXISTING MONITORING WELL LOCATION – WILCOX FORMATION SELECTED FOR PERFORMANCE MONITORING
- PERFORMANCE MONITORING SURFACE WATER LOCATION

ABBREVIATIONS:

AMSL – ABOVE MEAN SEA LEVEL
DNAPL – DENSE NON–AQUEOUS PHASE LIQUID
EISB – ENHANCED IN–SITU BIOREMEDIATION
FIPS – FEDERAL INFORMATION PROCESSING STANDARD
FT – FEET
HDPE – HIGH–DENSITY POLYETHYLENE
ICT – IN–SITU COLLECTION TRENCH
MW – MONITORING WELL
PMW – PERFORMANCE MONITORING WELL
ROI – RADIUS OF INFLUENCE

EISB PILOT STUDY NOTES:

1. THE CONTRACTOR SHALL INSTALL PERFORMANCE MONITORING WELLS AND PERMANENT INJECTION WELLS AT THE LOCATIONS INDICATED IN THIS PLAN AND IN ACCORDANCE WITH SPECIFICATION SECTION 33 51 39 – WELL INSTALLATION.
2. THE CONTRACTOR SHALL PERFORM EISB INJECTIONS AT THE PERMANENT INJECTION WELL LOCATIONS AND TEMPORARY DPT LOCATIONS INDICATED IN THIS PLAN AND IN ACCORDANCE WITH SPECIFICATION SECTION 02 53 17 – INJECTION PROCEDURES AND MONITORING.
3. THE CONTRACTOR SHALL MONITOR AREAS OF ACTIVE INJECTION FOR SIGNS OF SUBSTRATE SURFACING AND SHALL ADJUST INJECTION FLOW RATES TO REDUCE SURFACING. IN THE EVENT OF EXCESSIVE SURFACING, THE CONTRACTOR SHALL PAUSE INJECTIONS AT PROBLEM LOCATIONS AND CONSULT WITH THE CONTRACTING OFFICER'S REPRESENTATIVE REGARDING POTENTIAL MODIFICATIONS TO THE INJECTION APPROACH.
4. THE CONTRACTOR MAY OFFSET MONITORING WELLS, PERMANENT INJECTION WELLS, AND TEMPORARY DPT LOCATIONS FROM THE LOCATIONS SHOWN IN THIS PLAN TO AVOID THE GROUNDWATER EXTRACTION SYSTEM TRENCHES AND PIPING, OBSTRUCTIONS, AND UNSUITABLE AREAS IN CONSULTATION WITH THE CONTRACTING OFFICER'S REPRESENTATIVE.
5. THE CONTRACTOR SHALL CONDUCT PERFORMANCE MONITORING AT THE LOCATIONS INDICATED IN THIS PLAN AND IN ACCORDANCE WITH SPECIFICATION SECTION 02 53 17 – INJECTION PROCEDURES AND MONITORING.

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. PDI DPT SAMPLE LOCATIONS ARE BASED ON THE SURVEY CONDUCTED DURING THE PRE–DESIGN INVESTIGATION (HDR, 2021).
3. FOR NOTES ON SOURCES OF SURVEY DATA AND OTHER LOCATION DATA, REFER TO SHEET G002.

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TULSA DISTRICT

STATE OF TEXAS – MICHAEL J. VECCHIO – 147486 – LICENSED PROFESSIONAL ENGINEER

MARK	DESCRIPTION	DATE
1	PRELIMINARY DESIGN	03/2022
2	INTERMEDIATE DESIGN	06/2022
3	PRE–FINAL DESIGN	02/2023
4	DRAFT FINAL DESIGN	10/2023
5	FINAL DESIGN	02/2024
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14		

DESIGNED BY: AP
DRWN BY: JP
CKD BY: TC
SUBMITTED BY:
DATE: 02/29/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE:
FILE NUMBER: 10245537
SIZE: ANSI D
FILE NAME:

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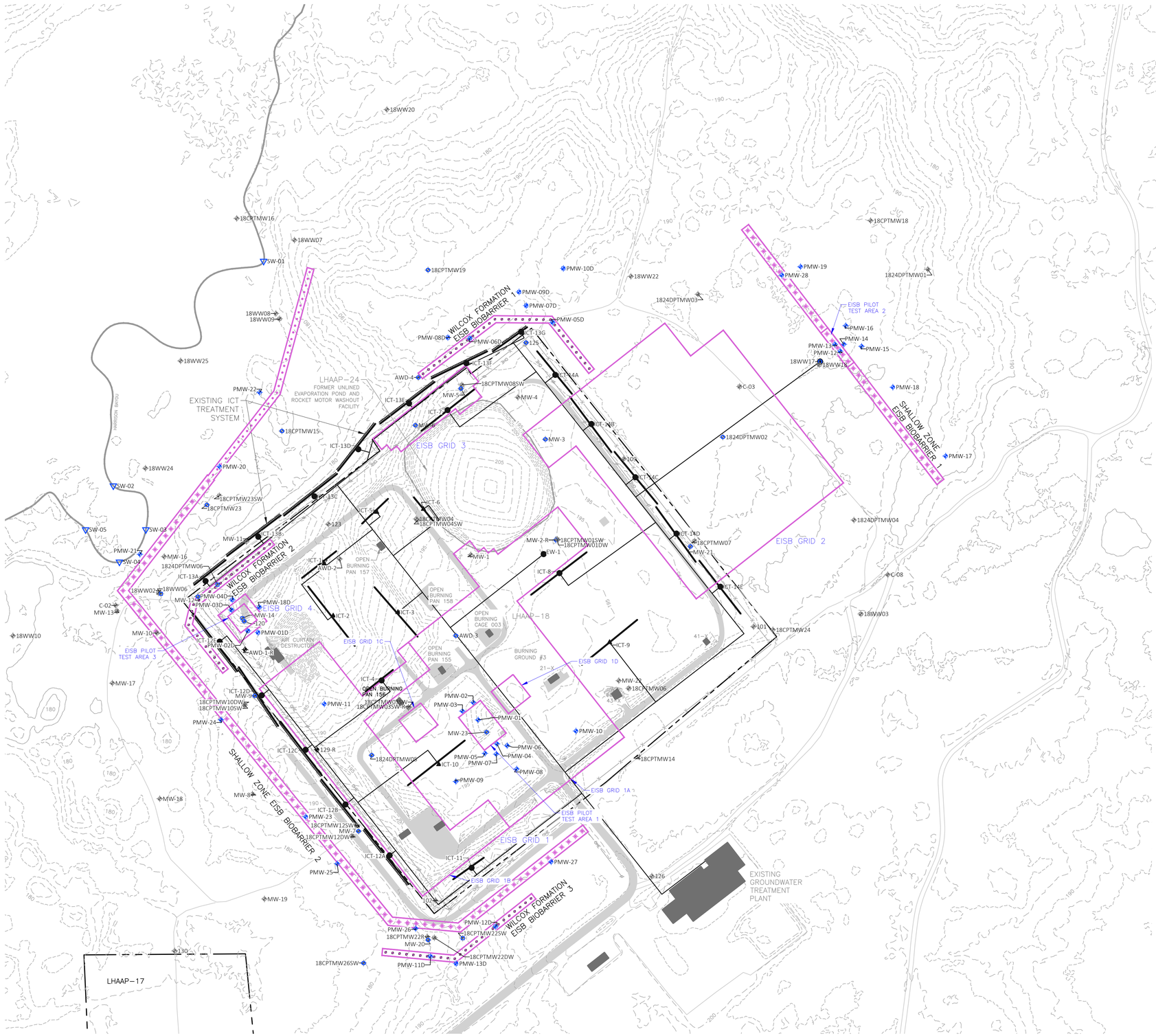
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LHAAP - 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

EISB PILOT TEST AREAS SITE PLAN

SHEET IDENTIFICATION
01C301
SHEET 10 OF 24

01227315



ABBREVIATIONS:

AMSL – ABOVE MEAN SEA LEVEL
EISB – ENHANCED IN-SITU BIOREMEDIATION
FT – FEET
HDPE – HIGH-DENSITY POLYETHYLENE
ICT – INTERCEPTOR COLLECTION TRENCH
ISTD – IN-SITU THERMAL DESORPTION
MW – MONITORING WELL
PMW – PERFORMANCE MONITORING WELL

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. FOR NOTES ON SOURCES OF SURVEY/LOCATION DATA, REFER TO SHEET G002.
3. WELLS ENDING IN "-R" ARE REPLACEMENTS FOR WELLS ABANDONED DURING ISTD IMPLEMENTATION IN PHASE I.
4. TEMPORARY DPT INJECTION LOCATIONS NOT SHOWN WITHIN EISB GRID AREAS.

1	PRELIMINARY DESIGN	03/2022	8
2	INTERMEDIATE DESIGN	06/2022	9
3	PRE-FINAL DESIGN	02/2023	10
4	DRAFT FINAL DESIGN	10/2023	11
5	FINAL DESIGN	02/2024	12
6			13
7			14

MARK	DESCRIPTION	DATE

US Army Corps of Engineers
TULSA DISTRICT

STATE OF TEXAS · MICHAEL A. VECCHIO · 147480 · LICENSED PROFESSIONAL ENGINEER

DESIGNED BY: AP
DWN BY: JP
CKD BY: TC
SUBMITTED BY:
DATE: 02/29/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE:
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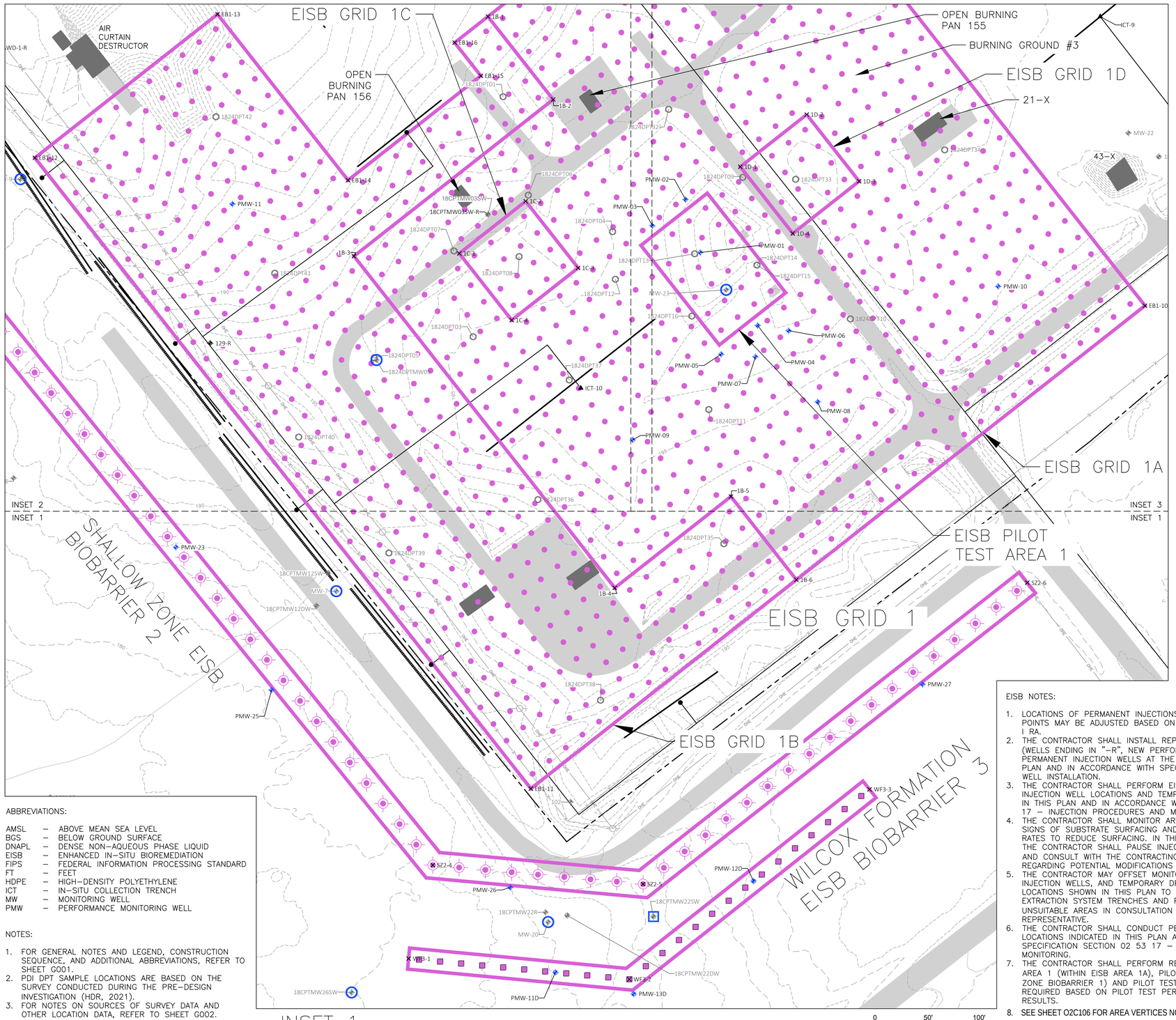
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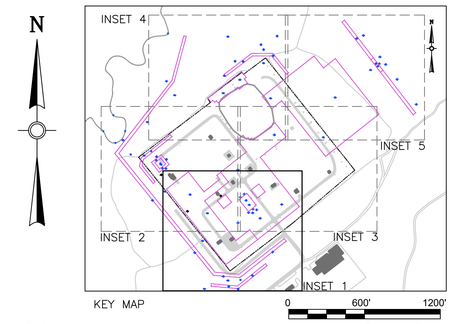
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LHAAP - 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

REMEDIAL ACTION
SITE PLAN - PHASE II

SHEET IDENTIFICATION
02C100
SHEET 11 OF 24





LEGEND:

- PDI DPT SAMPLE LOCATION
- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- POWER POLE
- OHE — OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

PERFORMANCE MONITORING:

- NEW PERFORMANCE MONITORING WELL LOCATION – SHALLOW ZONE
- NEW PERFORMANCE MONITORING WELL LOCATION – WILCOX FORMATION
- EXISTING MONITORING WELL LOCATION – SHALLOW ZONE SELECTED FOR PERFORMANCE MONITORING
- EXISTING MONITORING WELL LOCATION – WILCOX FORMATION SELECTED FOR PERFORMANCE MONITORING
- PERFORMANCE MONITORING SURFACE WATER LOCATION

EISB:

- EISB AREA
- TEMPORARY DPT INJECTION LOCATION – SHALLOW ZONE
- TEMPORARY DPT INJECTION LOCATION – WILCOX FORMATION
- PERMANENT INJECTION WELL LOCATION – SHALLOW ZONE

REPLACEMENT MONITORING WELLS:

- REPLACEMENT MONITORING WELL LOCATION – SHALLOW ZONE
- REPLACEMENT MONITORING WELL LOCATION – WILCOX FORMATION

ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
BGS	–	BELOW GROUND SURFACE
DNAPL	–	DENSE NON–AQUEOUS PHASE LIQUID
EISB	–	ENHANCED IN–SITU BIOREMEDIATION
FIPS	–	FEDERAL INFORMATION PROCESSING STANDARD
FT	–	FEET
HDPE	–	HIGH–DENSITY POLYETHYLENE
ICT	–	IN–SITU COLLECTION TRENCH
MW	–	MONITORING WELL
PMW	–	PERFORMANCE MONITORING WELL

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. PDI DPT SAMPLE LOCATIONS ARE BASED ON THE SURVEY CONDUCTED DURING THE PRE–DESIGN INVESTIGATION (HDR, 2021).
3. FOR NOTES ON SOURCES OF SURVEY DATA AND OTHER LOCATION DATA, REFER TO SHEET G002.

EISB NOTES:

1. LOCATIONS OF PERMANENT INJECTIONS WELLS AND TEMPORARY DPT POINTS MAY BE ADJUSTED BASED ON PILOT TEST RESULTS FROM PHASE I RA.
2. THE CONTRACTOR SHALL INSTALL REPLACEMENT MONITORING WELLS (WELLS ENDING IN "–R", NEW PERFORMANCE MONITORING WELLS, AND PERMANENT INJECTION WELLS AT THE LOCATIONS INDICATED IN THIS PLAN AND IN ACCORDANCE WITH SPECIFICATION SECTION 33 51 39 – WELL INSTALLATION.
3. THE CONTRACTOR SHALL PERFORM EISB INJECTIONS AT THE PERMANENT INJECTION WELL LOCATIONS AND TEMPORARY DPT LOCATIONS INDICATED IN THIS PLAN AND IN ACCORDANCE WITH SPECIFICATION SECTION 02 53 17 – INJECTION PROCEDURES AND MONITORING.
4. THE CONTRACTOR SHALL MONITOR AREAS OF ACTIVE INJECTION FOR SIGNS OF SUBSTRATE SURFACING AND SHALL ADJUST INJECTION FLOW RATES TO REDUCE SURFACING. IN THE EVENT OF EXCESSIVE SURFACING, THE CONTRACTOR SHALL PAUSE INJECTIONS AT PROBLEM LOCATIONS AND CONSULT WITH THE CONTRACTING OFFICER'S REPRESENTATIVE REGARDING POTENTIAL MODIFICATIONS TO THE INJECTION APPROACH.
5. THE CONTRACTOR MAY OFFSET MONITORING WELLS, PERMANENT INJECTION WELLS, AND TEMPORARY DPT LOCATIONS FROM THE LOCATIONS SHOWN IN THIS PLAN TO AVOID THE GROUNDWATER EXTRACTION SYSTEM TRENCHES AND PIPING, OBSTRUCTIONS, AND UNSUITABLE AREAS IN CONSULTATION WITH THE CONTRACTING OFFICER'S REPRESENTATIVE.
6. THE CONTRACTOR SHALL CONDUCT PERFORMANCE MONITORING AT THE LOCATIONS INDICATED IN THIS PLAN AND IN ACCORDANCE WITH SPECIFICATION SECTION 02 53 17 – INJECTION PROCEDURES AND MONITORING.
7. THE CONTRACTOR SHALL PERFORM RE–INJECTIONS IN EISB PILOT TEST AREA 1 (WITHIN EISB AREA 1A), PILOT TEST AREA 2 (WITHIN SHALLOW ZONE BIOBARRIER 1) AND PILOT TEST AREA 3 (WITHIN EISB GRID 4), AS REQUIRED BASED ON PILOT TEST PERFORMANCE MONITORING TEST RESULTS.
8. SEE SHEET O2C106 FOR AREA VERTICES NORTHING AND EASTING COORDINATES.

EISB Grids

Area ID	Area	DPT Locations	Target Depth Interval
	square ft	no.	ft bgs
EISB Grid 1	517,600	1,294	Varies
EISB Grid 1A	*(329,900)*	*(825)*	*(23-43)*
EISB Grid 1B	*(174,900)*	*(437)*	*(18-41)*
EISB Grid 1C	*(6,400)*	*(16)*	*(18-41)*
EISB Grid 1D	*(6,400)*	*(16)*	*(18-41)*
EISB Grid 2	364,800	912	25-37
EISB Grid 3	27,200	68	25-33
EISB Grid 4 - Wilcox Formation	6,400	16	30-50
EISB Grid 4 - Shallow Zone	10,000	25	13-25
TOTAL	**926,000**	**2,315**	**NA**

EISB Biobarriers - Shallow Zone

Area ID	Length	Injection Locations	Target Depth Interval
	ft	no./type	ft bgs
Shallow Zone EISB Biobarrier 1	925	37 IWs	26-38
Shallow Zone EISB Biobarrier 2(IW)	2,300	92 IWs	16-27
Shallow Zone EISB Biobarrier 2(DPT)	680	34 DPTs	16-27
TOTAL	**3,905**	**129 IWs & 34 DPTs**	**NA**

EISB Biobarriers - Wilcox Formation

Area ID	Length	DPT Locations	Target Depth Interval
	ft	no.	ft bgs
Wilcox Formation EISB Biobarrier 1	620	31	45-65
Wilcox Formation EISB Biobarrier 2	520	26	30-50
Wilcox Formation EISB Biobarrier 3	500	25	40-60
TOTAL	**1,640**	**82**	**NA**

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DRN BY: JP
CKD BY: TC
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CONTRACT NO.: W912BV19D0016
FILE NUMBER: 702643537
PLOT SCALE: AS NOTED
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FILE NAME:
SIZE: ANSI D

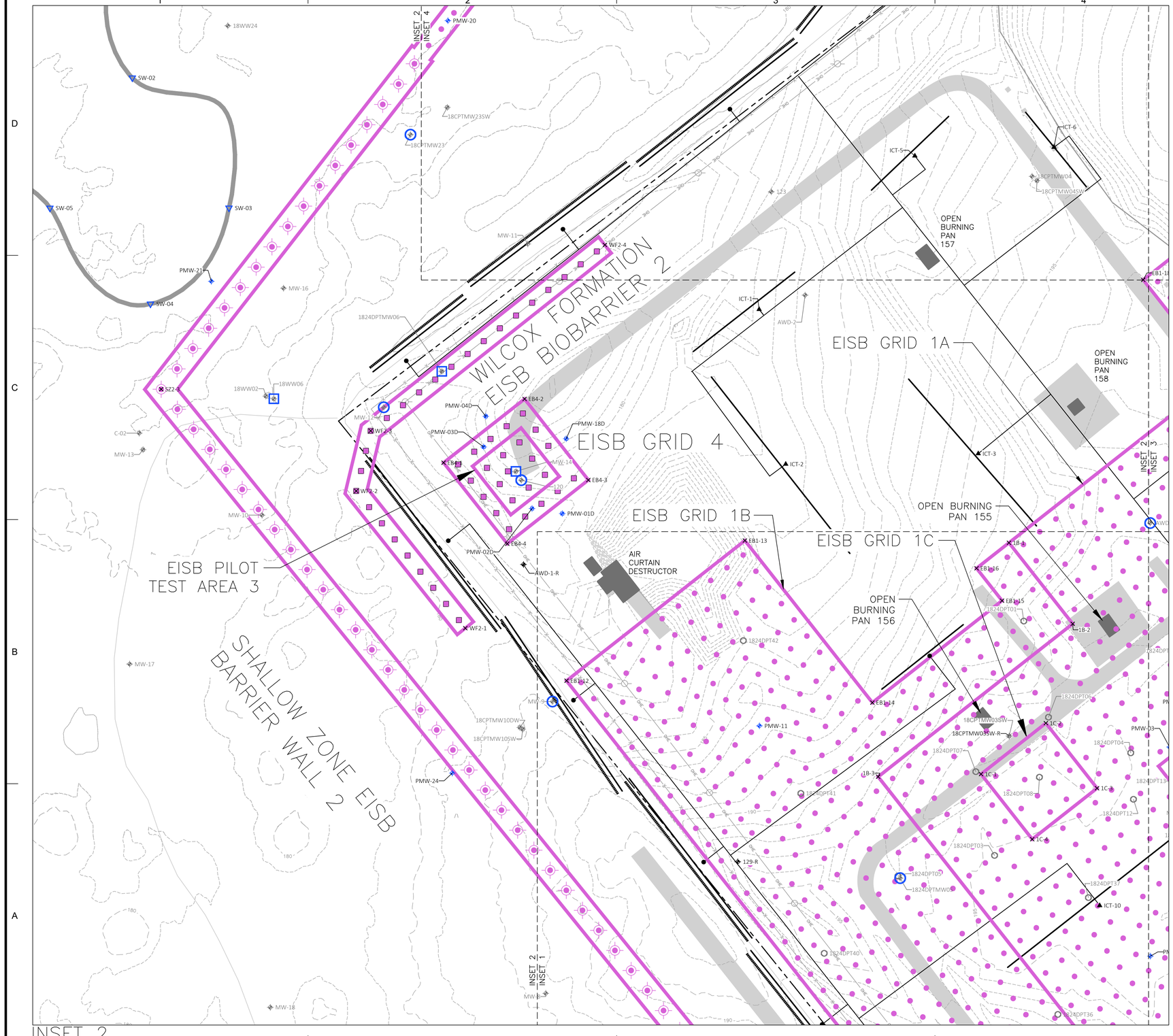
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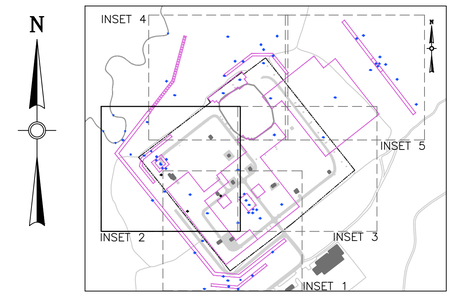
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LHAAP - 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

EISB AREAS SITE PLAN SHEET 1

SHEET IDENTIFICATION
02C101
SHEET 12 OF 24





LEGEND:

- PDI DPT SAMPLE LOCATION
- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- POWER POLE
- OHE — OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

PERFORMANCE MONITORING:

- NEW PERFORMANCE MONITORING WELL LOCATION – SHALLOW ZONE
- NEW PERFORMANCE MONITORING WELL LOCATION – WILCOX FORMATION
- EXISTING MONITORING WELL LOCATION – SHALLOW ZONE SELECTED FOR PERFORMANCE MONITORING
- EXISTING MONITORING WELL LOCATION – WILCOX FORMATION SELECTED FOR PERFORMANCE MONITORING
- PERFORMANCE MONITORING SURFACE WATER LOCATION

EISB:

- EISB AREA
- TEMPORARY DPT INJECTION LOCATION – SHALLOW ZONE
- TEMPORARY DPT INJECTION LOCATION – WILCOX FORMATION
- PERMANENT INJECTION WELL LOCATION – SHALLOW ZONE

REPLACEMENT MONITORING WELLS:

- REPLACEMENT MONITORING WELL LOCATION – SHALLOW ZONE
- REPLACEMENT MONITORING WELL LOCATION – WILCOX FORMATION

ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
DNAPL	–	DENSE NON-AQUEOUS PHASE LIQUID
EISB	–	ENHANCED IN-SITU BIOREMEDIATION
FIPS	–	FEDERAL INFORMATION PROCESSING STANDARD
FT	–	FEET
HDPE	–	HIGH-DENSITY POLYETHYLENE
ICT	–	IN-SITU COLLECTION TRENCH
MW	–	MONITORING WELL
PMW	–	PERFORMANCE MONITORING WELL

NOTES:

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3. FOR NOTES ON SOURCES OF SURVEY DATA AND OTHER LOCATION DATA, REFER TO SHEET G002.
4. FOR EISB NOTES, REFER TO SHEET 02C101.
5. SEE SHEET 02C106 FOR AREA VERTICES NORTHING AND EASTING COORDINATES.

0 50' 100'
SCALE: 1" = 50'

US Army Corps of Engineers
TULSA DISTRICT

STATE OF TEXAS · MICHAEL J. VECCHIO · 147460 · LICENSED PROFESSIONAL ENGINEER · 03/29/2024

MARK	DESCRIPTION	DATE
1	PRELIMINARY DESIGN	03/2022
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DESIGNED BY: AP	CKD BY: TC	SOLICITATION NO.: W912BV20F0086	DATE: 02/29/2024
DWN BY: JP	SUBMITTED BY:	CONTRACT NO.: W912BV19D0016	PLOT SCALE: AS NOTED
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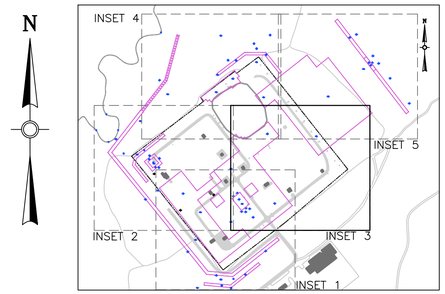
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LHAAP - 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

EISB AREAS SITE PLAN SHEET 2

SHEET IDENTIFICATION
02C102
SHEET 13 OF 24





LEGEND:

- PDI DPT SAMPLE LOCATION
- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- POWER POLE
- OHE — OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

PERFORMANCE MONITORING:

- NEW PERFORMANCE MONITORING WELL LOCATION – SHALLOW ZONE
- NEW PERFORMANCE MONITORING WELL LOCATION – WILCOX FORMATION
- EXISTING MONITORING WELL LOCATION – SHALLOW ZONE SELECTED FOR PERFORMANCE MONITORING
- EXISTING MONITORING WELL LOCATION – WILCOX FORMATION SELECTED FOR PERFORMANCE MONITORING
- PERFORMANCE MONITORING SURFACE WATER LOCATION

EISB:

- EISB AREA
- TEMPORARY DPT INJECTION LOCATION – SHALLOW ZONE
- TEMPORARY DPT INJECTION LOCATION – WILCOX FORMATION
- PERMANENT INJECTION WELL LOCATION – SHALLOW ZONE

ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
DNAPL	–	DENSE NON–AQUEOUS PHASE LIQUID
EISB	–	ENHANCED IN–SITU BIOREMEDIATION
FIPS	–	FEDERAL INFORMATION PROCESSING STANDARD
FT	–	FEET
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ICT	–	IN–SITU COLLECTION TRENCH
MW	–	MONITORING WELL
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4. FOR EISB NOTES, REFER TO SHEET 02C101.
5. SEE SHEET 02C106 FOR AREA VERTICES NORTHING AND EASTING COORDINATES.

0 50' 100'

SCALE: 1" = 50'

US Army Corps of Engineers
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SOLICITATION NO.: W912BV20F0096
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FILE NAME:

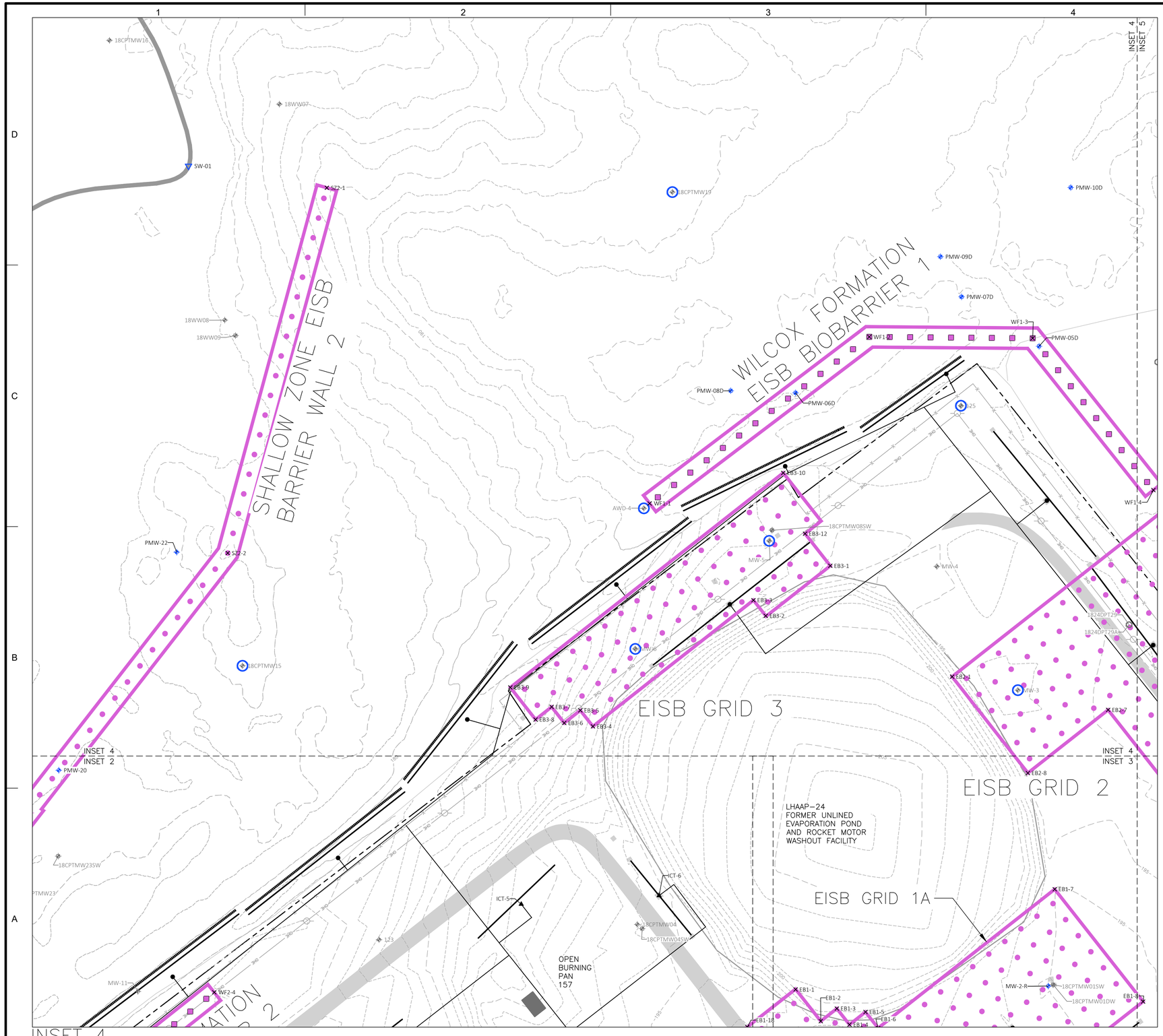
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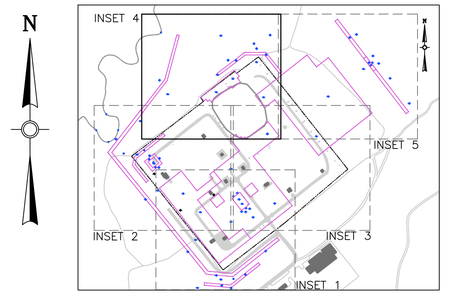
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LHAAP - 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

EISB AREAS SITE PLAN SHEET 3

SHEET IDENTIFICATION
02C103
SHEET 14 OF 24





KEY MAP

0 600' 1200'

SCALE: 1" = 600'

LEGEND:

- PDI DPT SAMPLE LOCATION
- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- POWER POLE
- OHE — OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

PERFORMANCE MONITORING:

- NEW PERFORMANCE MONITORING WELL LOCATION – SHALLOW ZONE
- NEW PERFORMANCE MONITORING WELL LOCATION – WILCOX FORMATION
- EXISTING MONITORING WELL LOCATION – SHALLOW ZONE SELECTED FOR PERFORMANCE MONITORING
- EXISTING MONITORING WELL LOCATION – WILCOX FORMATION SELECTED FOR PERFORMANCE MONITORING
- PERFORMANCE MONITORING SURFACE WATER LOCATION

EISB:

- EISB AREA
- TEMPORARY DPT INJECTION LOCATION – SHALLOW ZONE
- TEMPORARY DPT INJECTION LOCATION – WILCOX FORMATION
- PERMANENT INJECTION WELL LOCATION – SHALLOW ZONE

ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
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0 50' 100'

SCALE: 1" = 50'

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MARK	DESCRIPTION	DATE
1	PRELIMINARY DESIGN	03/2022
2	INTERMEDIATE DESIGN	09/2022
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5	FINAL DESIGN	02/2024
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DESIGNED BY: AP
DWN BY: JP
CKD BY: TC
SUBMITTED BY:
DATE: 02/29/2024
SOLICITATION NO.: W912BV20F0096
CONTRACT NO.: W912BV19D0016
PLOT SCALE: AS NOTED
PLOT DATE:
FILE NUMBER: 10244537
SIZE: ANSI D
FILE NAME:

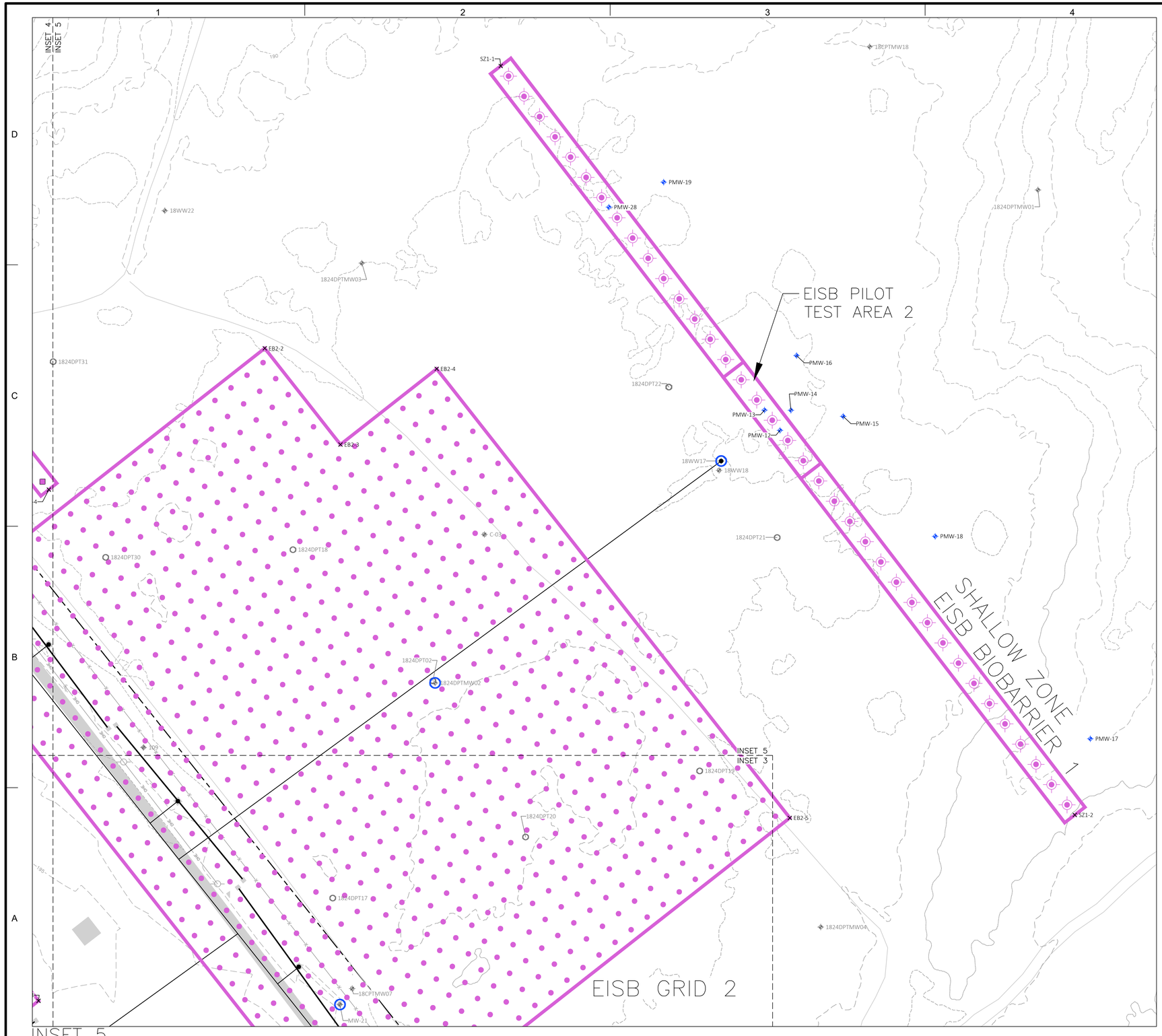
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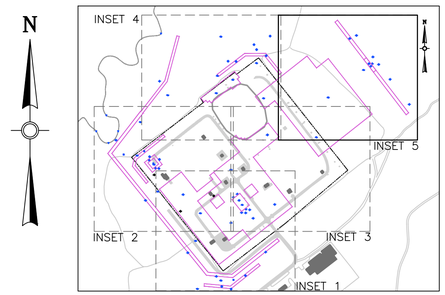
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LHAAP - 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

EISB AREAS SITE PLAN SHEET 4

SHEET IDENTIFICATION
02C104
SHEET 15 OF 24





KEY MAP

0 600' 1200'

SCALE: 1" = 600'

LEGEND:

- PDI DPT SAMPLE LOCATION
- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- POWER POLE
- OHE OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

PERFORMANCE MONITORING:

- NEW PERFORMANCE MONITORING WELL LOCATION – SHALLOW ZONE
- NEW PERFORMANCE MONITORING WELL LOCATION – WILCOX FORMATION
- EXISTING MONITORING WELL LOCATION – SHALLOW ZONE SELECTED FOR PERFORMANCE MONITORING
- EXISTING MONITORING WELL LOCATION – WILCOX FORMATION SELECTED FOR PERFORMANCE MONITORING
- PERFORMANCE MONITORING SURFACE WATER LOCATION

EISB:

- EISB AREA
- TEMPORARY DPT INJECTION LOCATION – SHALLOW ZONE
- TEMPORARY DPT INJECTION LOCATION – WILCOX FORMATION
- PERMANENT INJECTION WELL LOCATION – SHALLOW ZONE

ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
DNAPL	–	DENSE NON–AQUEOUS PHASE LIQUID
EISB	–	ENHANCED IN–SITU BIOREMEDIATION
FIPS	–	FEDERAL INFORMATION PROCESSING STANDARD
FT	–	FEET
HDPE	–	HIGH–DENSITY POLYETHYLENE
ICT	–	IN–SITU COLLECTION TRENCH
MW	–	MONITORING WELL
PMW	–	PERFORMANCE MONITORING WELL

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. PDI DPT SAMPLE LOCATIONS ARE BASED ON THE SURVEY CONDUCTED DURING THE PRE–DESIGN INVESTIGATION (HDR, 2021).
3. FOR NOTES ON SOURCES OF SURVEY DATA AND OTHER LOCATION DATA, REFER TO SHEET G002.
4. FOR EISB NOTES, REFER TO SHEET 02C101.
5. SEE SHEET O2C106 FOR AREA VERTICES NORTHING AND EASTING COORDINATES.

0 50' 100'

SCALE: 1" = 50'

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KARNACK, TEXAS

EISB AREAS SITE PLAN SHEET 5

SHEET IDENTIFICATION
02C105
SHEET 16 OF 24

ISTD Area 1 Vertices		
Location ID	Easting	Northing
ISTD1-1	3316853.29	6953953.96
ISTD1-2	3316878.91	6953974.12
ISTD1-3	3316885.09	6953966.26
ISTD1-4	3316862.01	6953948.09
ISTD1-5	3316887.74	6953930.79
ISTD1-6	3316926.68	6953920.58
ISTD1-7	3317011.49	6953984.34
ISTD1-8	3317012.58	6953995.25
ISTD1-9	3317002.61	6954030.33
ISTD1-10	3316798.15	6954171.82
ISTD1-11	3316706.95	6954052.37

NOTE: SEE SHEET 01C202 FOR ISTD AREA 1 PLAN.

ISTD Area 2 Vertices		
Location ID	Easting	Northing
ISTD2-1	3316111.51	6953658.56
ISTD2-2	3316104.15	6953668.04
ISTD2-3	3316098.30	6953663.49
ISTD2-4	3316089.02	6953675.42
ISTD2-5	3316095.57	6953680.51
ISTD2-6	3316091.45	6953685.81
ISTD2-7	3316623.95	6953631.66
ISTD2-7	3316085.61	6953681.26
ISTD2-8	3316076.03	6953693.35
ISTD2-9	3316084.56	6953700.00
ISTD2-10	3316094.70	6953687.52
ISTD2-11	3316107.57	6953697.54
ISTD2-12	3316117.64	6953684.52
ISTD2-13	3316118.44	6953689.37
ISTD2-14	3316118.44	6953714.14
ISTD2-15	3315995.91	6953714.14
ISTD2-16	3315995.91	6953682.55
ISTD2-17	3316030.40	6953638.74
ISTD2-18	3316107.06	6953638.74

NOTE: SEE SHEET 01C202 FOR ISTD AREA 2 PLAN.

ISTD Area 3 Vertices		
Location ID	Easting	Northing
ISTD3-1	3316294.35	6953283.68
ISTD3-2	3316357.05	6953332.45
ISTD3-3	3316332.13	6953366.68
ISTD3-4	3316690.56	6953637.43
ISTD3-5	3316656.80	6953682.69
ISTD3-6	3316610.58	6953649.84
ISTD3-8	3316574.35	6953592.86
ISTD3-9	3316561.19	6953610.40
ISTD3-10	3316518.20	6953576.06
ISTD3-11	3316473.91	6953634.19
ISTD3-12	3316394.57	6953571.45
ISTD3-13	3316422.25	6953532.70
ISTD3-14	3316347.51	6953472.73
ISTD3-15	3316300.46	6953531.78
ISTD3-16	3316179.41	6953430.77

NOTE: SEE SHEET 01C203 FOR ISTD AREA 3 PLAN.

Shallow Zone Area Vertices		
Location ID	Easting	Northing
SZ1-1	3317458.94	6954909.22
SZ1-2	3318021.63	6954175.05
SZ2-1	3316206.47	6954790.10
SZ2-2	3316109.42	6954432.25
SZ2-3	3315665.88	6953861.91
SZ2-4	3316435.95	6952909.22
SZ2-5	3316635.14	6952891.31
SZ2-6	3316999.05	6953176.75

NOTE: SEE SHEET 02C105 FOR SHALLOW ZONE EISB BIOBARRIER 1 PLAN. SEE SHEETS 02C101, 02C102 AND 02C104 FOR SHALLOW ZONE EISB BIOBARRIER 2 PLAN.

Wilcox Formation Area Vertices		
Location ID	Easting	Northing
WF1-1	3316522.65	6954480.84
WF1-2	3316737.75	6954644.02
WF1-3	3316897.75	6954642.68
WF1-4	3317015.99	6954493.96
WF2-1	3315960.85	6953630.14
WF2-2	3315855.06	6953763.20
WF2-3	3315869.04	6953821.55
WF2-4	3316096.21	6954001.94
WF3-1	3316413.00	6952820.77
WF3-2	3316622.08	6952801.14
WF3-3	3316849.59	6952980.97

NOTE: SEE SHEET 02C104 FOR WILCOX FORMATION EISB BIOBARRIER 1 PLAN. SEE SHEET 02C102 FOR WILCOX FORMATION EISB BIOBARRIER 2 PLAN. SEE SHEET 02C101 FOR WILCOX FORMATION EISB BIOBARRIER 3 PLAN.

EISB Grid 1B-1D Area Vertices		
Location ID	Easting	Northing
1B-1	3316488.12	6953712.97
1B-2	3316549.93	6953634.36
1B-3	3316361.26	6953486.02
1B-4	3316608.28	6953171.85
1B-5	3316718.33	6953258.38
1B-6	3316780.35	6953179.49
1C-1	3316461.02	6953488.57
1C-2	3316523.91	6953538.02
1C-3	3316573.57	6953474.86
1C-4	3316510.68	6953425.41
1D-1	3316727.22	6953570.66
1D-2	3316790.11	6953620.11
1D-3	3316839.77	6953556.94
1D-4	3316776.88	6953507.50

NOTE: SEE SHEETS 02C101, 02C102 AND 02C103 FOR EISB GRID 1B–1D PLANS.

EISB Grid 1 Area Vertices		
Location ID	Easting	Northing
EB1-1	3316665.61	6954004.74
EB1-2	3316690.23	6953973.64
EB1-3	3316705.96	6953986.01
EB1-4	3316718.32	6953970.28
EB1-5	3316734.04	6953982.64
EB1-6	3316746.40	6953966.92
EB1-7	3316919.35	6954102.90
EB1-8	3317005.88	6953992.84
EB1-9	3316801.49	6953832.14
EB1-10	3317110.52	6953439.08
EB1-11	3316528.80	6952981.71
EB1-12	3316059.06	6953579.16
EB1-13	3316232.01	6953715.14
EB1-14	3316355.62	6953557.91
EB1-15	3316481.40	6953656.80
EB1-16	3316456.68	6953688.25
EB1-17	3316692.51	6953873.67
EB1-18	3316618.34	6953968.00

NOTE: SEE SHEETS 02C101, 02C102 AND 02C103 FOR EISB GRID 1 PLAN.

EISB Grid 2 Area Vertices		
Location ID	Easting	Northing
EB2-1	3316818.87	6954311.12
EB2-2	3317227.65	6954632.52
EB2-3	3317301.82	6954538.19
EB2-4	3317396.16	6954612.36
EB2-5	3317742.28	6954172.13
EB2-6	3317317.77	6953838.37
EB2-7	3316971.65	6954278.60
EB2-8	3316893.04	6954216.79

NOTE: SEE SHEETS 02C103, 02C104 AND 02C105 FOR EISB GRID 2 PLAN.

EISB Grid 3 Area Vertices		
Location ID	Easting	Northing
EB3-1	3316699.55	6954419.78
EB3-2	3316636.35	6954370.74
EB3-3	3316624.30	6954386.06
EB3-4	3316467.08	6954262.44
EB3-5	3316454.72	6954278.16
EB3-6	3316439.00	6954265.80
EB3-7	3316426.63	6954281.52
EB3-8	3316410.91	6954269.16
EB3-9	3316386.19	6954300.61
EB3-10	3316653.47	6954510.75
EB3-11	3316690.55	6954463.59
EB3-12	3316674.83	6954451.22

NOTE: SEE SHEET 02C104 FOR EISB GRID 3 PLAN.

EISB Grid 4 Area Vertices		
Location ID	Easting	Northing
EB4-1	3315939.74	6953790.65
EB4-2	3316018.35	6953852.46
EB4-3	3316080.16	6953773.85
EB4-4	3316001.55	6953712.04

NOTE: SEE SHEET 02C102 FOR EISB GRID 4 PLAN.

NOTE:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.

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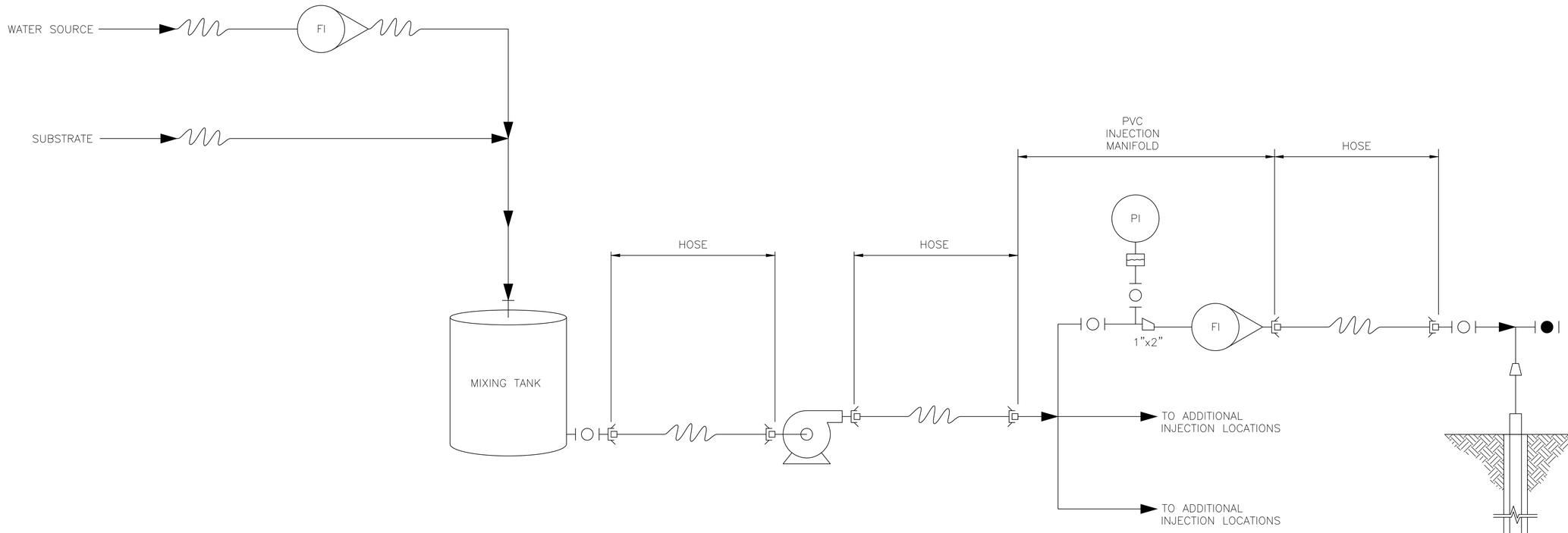
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LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

COORDINATE TABLES FOR EISB & BIOBARRIERS

SHEET IDENTIFICATION
02C106
SHEET 17 OF 24



LEGEND:

- OPEN BALL VALVE
- CLOSED BALL VALVE
- ECCENTRIC REDUCER
- CONCENTRIC REDUCER
- CAMLOCK QUICK DISCONNECT
- BALL LOCK QUICK DISCONNECT
- PNEUMATIC ACTUATOR
- SEAL
- FLEXHOSE
- MAIN PROCESS LINE
- PI — PRESSURE INDICATOR
- FI — FLOW INDICATOR

ABBREVIATIONS:

EISB – ENHANCED IN-SITU BIOREMEDIATION
PVC – POLYVINYL CHLORIDE

NOTE:

SCHEMATIC IS PROVIDED FOR INFORMATION ONLY. ACTUAL MEANS AND METHODS WILL BE PROVIDED BY THE CONTRACTOR AND REVIEWED AND APPROVED BY THE CONTRACTING OFFICER'S REPRESENTATIVE PRIOR TO PERFORMING INJECTIONS.

SCALE: NOT TO SCALE

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STATE OF TEXAS · MICHAEL L. VECCHIO · 147486 · REGISTERED PROFESSIONAL ENGINEER

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LHAAP-18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

EISB INJECTIONS SCHEMATIC

SHEET IDENTIFICATION
02C107
SHEET 18 OF 24

LHAAP–24
FORMER UNLINED
EVAPORATION POND
AND ROCKET MOTOR
WASHOUT FACILITY

OPEN BURNING PAN 157

OPEN BURNING PAN 158

OPEN BURNING CAGE 003

OPEN BURNING PAN 155

OPEN BURNING PAN 156

BURNING GROUND #3

LHAAP – 18

RESEED BACKFILLED EXCAVATION AREAS

RESEED ISTD AREAS

RESTORE PORTIONS OF ACCESS ROAD DAMAGED BY ISTD

ICT-1 ICT-2 ICT-3 ICT-4 ICT-5 ICT-6 ICT-8 ICT-9 ICT-10 ICT-14C

MW-1 MW-2-R MW-22 MW-23

18CPTMW03 18CPTMW04SW 18CPTMW03SW 18CPTMW03SW-R 18CPTMW01SW 18CPTMW01DW 18CPTMW06 18CPTMW14

1824DPTMW05

AWD-2 AWD-3

PMW-01 PMW-02 PMW-03 PMW-04 PMW-05 PMW-06 PMW-07 PMW-08 PMW-09 PMW-10 PMW-11

123 129-R 21–X 43–X

INSET 1

INSET 2

INSET 1

INSET 2

0 50' 100'
SCALE: 1" = 50'

N

KEY MAP

0 600' 1200'
SCALE: 1" = 600'

LEGEND:

- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- NEW MONITORING WELL LOCATION – SHALLOW ZONE
- NEW MONITORING WELL LOCATION – WILCOX FORMATION
- POWER POLE
- OHE OVERHEAD ELECTRIC
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- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

RESTORATION:

- FINAL GRADE MAJOR CONTOUR (ELEVATION IN FT AMSL)
- FINAL GRADE MINOR CONTOUR
- NATIVE SEEDING MIX
- ACCESS ROAD RESTORATION

ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
FIPS	–	FEDERAL INFORMATION PROCESSING STANDARD
FT	–	FEET
ICT	–	INTERCEPTOR COLLECTION TRENCH
MW	–	MONITORING WELL

RESTORATION NOTES:

1. THE CONTRACTOR SHALL RESTORE PORTIONS OF THE ACCESS ROAD DISTURBED IN THE COURSE OF THE REMEDIAL ACTION TO EXISTING CONDITIONS, AS SHOWN IN THIS PLAN.
2. FOR NOTES ON BACKFILLING EXCAVATION AREAS, REFER TO SHEET 01C101.
3. THE CONTRACTOR SHALL RESTORE EXCAVATION AREAS AND ANY OTHER DISTURBED AREAS, AS SHOWN IN THIS PLAN, BY RESEEDING WITH A NATIVE GRASS AND WILDFLOWER SEED MIXTURE SELECTED IN COORDINATION WITH THE U.S. FISH AND WILD LIFE SERVICES (USFWS).
4. UPON THE CONCLUSION OF THE REMEDIAL ACTION, THE CONTRACTOR SHALL REMOVE ALL TEMPORARY FACILITIES, INCLUDING FIELD OFFICE TRAILERS AND CONSTRUCTION ACCESS ROADS.

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. FOR NOTES ON SOURCES OF SURVEY DATA AND OTHER LOCATION DATA, REFER TO SHEET G002.

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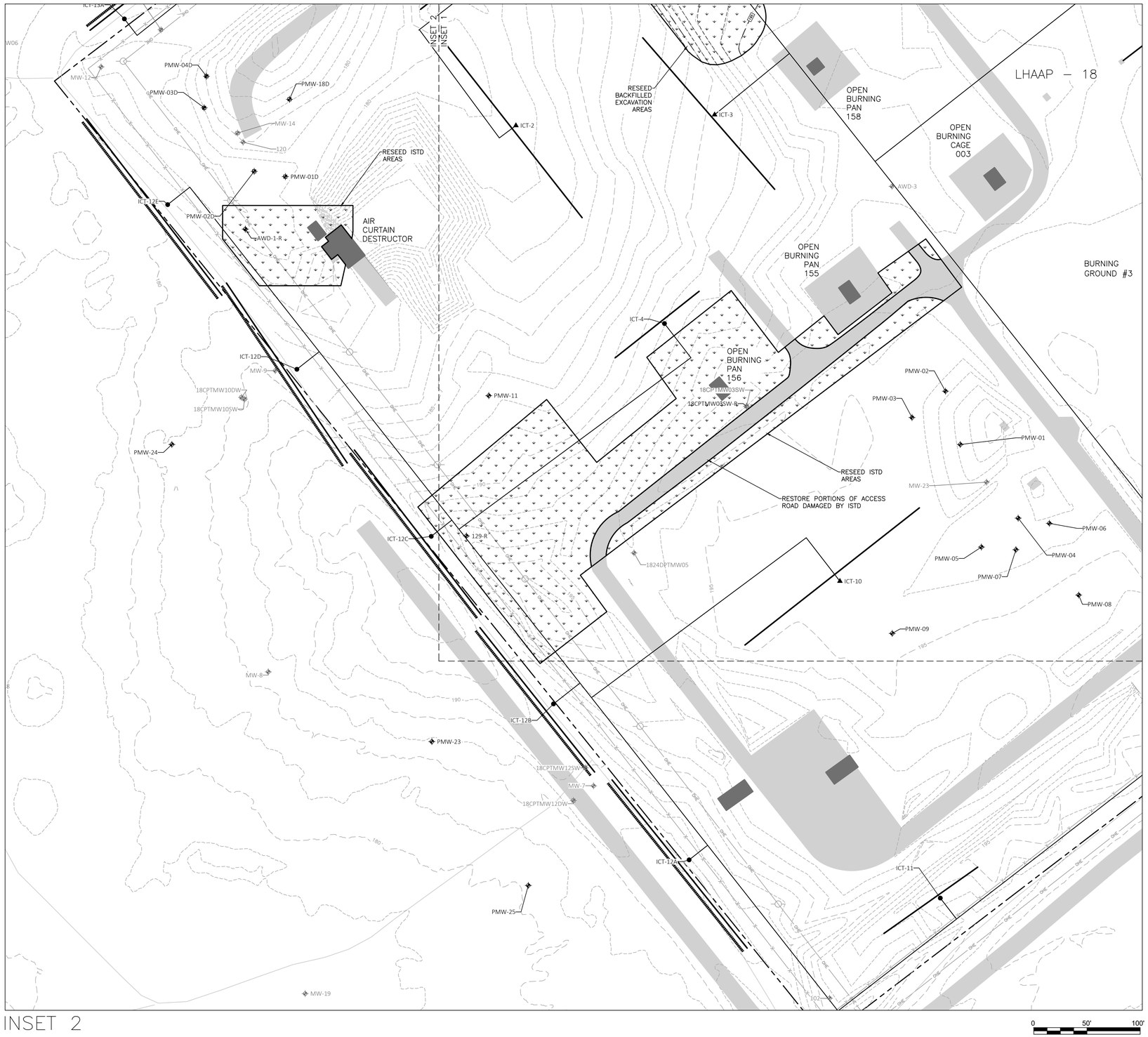
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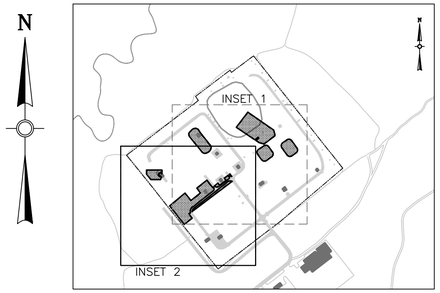
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LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RESTORATION SITE PLAN - SHEET 1

SHEET IDENTIFICATION
03C100
SHEET 19 OF 24





LEGEND:

- MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – WILCOX FORMATION
- NEW MONITORING WELL LOCATION – SHALLOW ZONE
- NEW MONITORING WELL LOCATION – WILCOX FORMATION
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- OHE — OVERHEAD ELECTRIC
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- MINOR CONTOUR

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- ICT LOCATION WITH HDPE LINER
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- CURRENTLY DEACTIVATED SUMP

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- FINAL GRADE MAJOR CONTOUR (ELEVATION IN FT AMSL)
- FINAL GRADE MINOR CONTOUR
- NATIVE SEEDING MIX
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ABBREVIATIONS:

AMSL	–	ABOVE MEAN SEA LEVEL
FIPS	–	FEDERAL INFORMATION PROCESSING STANDARD
FT	–	FEET
ICT	–	INTERCEPTOR COLLECTION TRENCH
MW	–	MONITORING WELL

NOTES:

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2. FOR NOTES ON SOURCES OF SURVEY DATA AND OTHER LOCATION DATA, REFER TO SHEET G002.
3. FOR RESTORATION NOTES, REFER TO SHEET 03C100.

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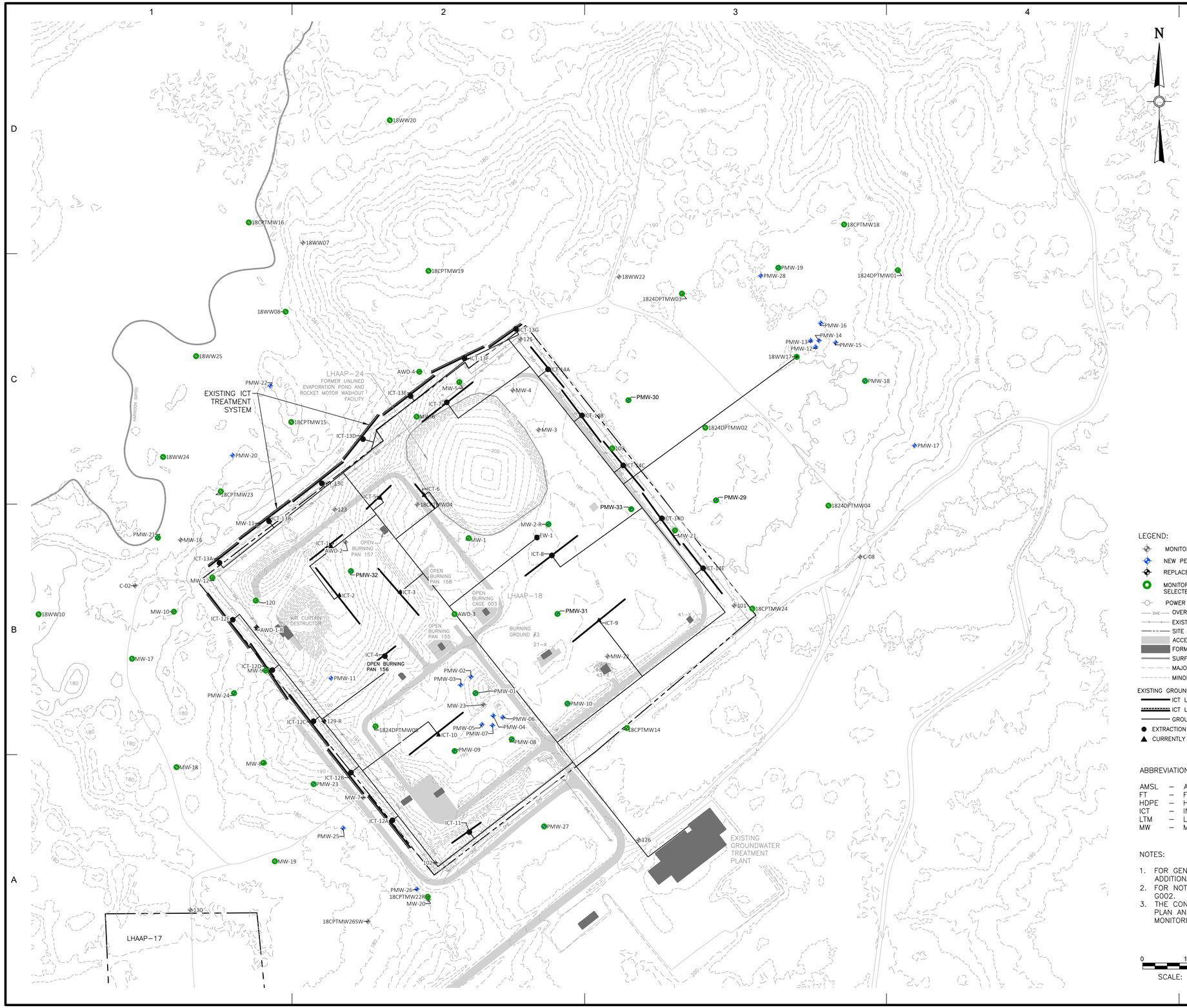
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DWN BY: JP
CKD BY: TC
SUBMITTED BY:
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CONTRACT NO.: W912BV19D0016
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LHAAP - 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

RESTORATION SITE PLAN - SHEET 2

SHEET IDENTIFICATION
03C101
SHEET 20 OF 24



LEGEND:

- MONITORING WELL LOCATION – SHALLOW ZONE
- NEW PERFORMANCE MONITORING WELL LOCATION – SHALLOW ZONE
- REPLACEMENT MONITORING WELL LOCATION – SHALLOW ZONE
- MONITORING WELL LOCATION – SHALLOW ZONE SELECTED FOR LTM
- POWER POLE
- OHE — OVERHEAD ELECTRIC
- EXISTING FENCE
- SITE BOUNDARY
- ACCESS ROAD
- FORMER BUILDING OR CONCRETE SLAB
- SURFACE WATER
- MAJOR CONTOUR (ELEVATION IN FT AMSL)
- MINOR CONTOUR

EXISTING GROUNDWATER EXTRACTION SYSTEM:

- ICT LOCATION
- ICT LOCATION WITH HDPE LINER
- GROUNDWATER PIPELINE
- EXTRACTION LOCATION
- CURRENTLY DEACTIVATED SUMP

ABBREVIATIONS:

AMSL – ABOVE MEAN SEA LEVEL
FT – FEET
HDPE – HIGH–DENSITY POLYETHYLENE
ICT – INTERCEPTOR COLLECTION TRENCH
LTM – LONG–TERM MONITORING
MW – MONITORING WELL

NOTES:

1. FOR GENERAL NOTES AND LEGEND, CONSTRUCTION SEQUENCE, AND ADDITIONAL ABBREVIATIONS, REFER TO SHEET G001.
2. FOR NOTES ON SOURCES OF SURVEY/LOCATION DATA, REFER TO SHEET G002.
3. THE CONTRACTOR SHALL CONDUCT LTM AT THE LOCATIONS SHOWN IN THIS PLAN AND IN ACCORDANCE WITH DAR SECTION 5.4 PERFORMANCE MONITORING.

0 150' 300'
SCALE: 1" = 150'

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4	DRAFT FINAL DESIGN	10/2023
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SOLICITATION NO.: W912BV20F0096
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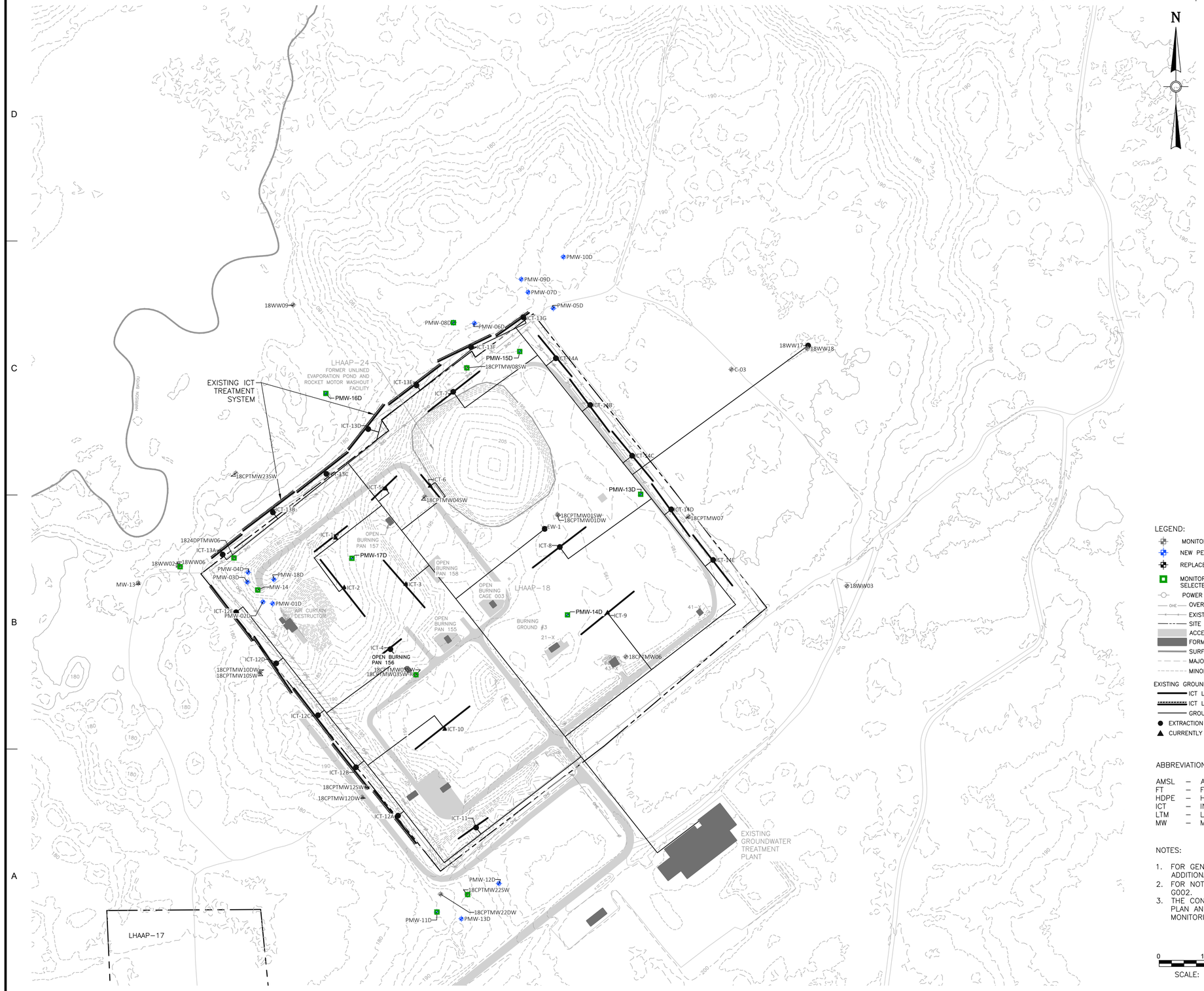
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LONGHORN ARMY AMMUNITION PLANT
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LTM SAMPLING PLAN SHALLOW ZONE

SHEET IDENTIFICATION
04C100
SHEET 21 OF 24



LEGEND:

- MONITORING WELL LOCATION – WILCOX FORMATION
- NEW PERFORMANCE MONITORING WELL LOCATION – WILCOX FORMATION
- REPLACEMENT MONITORING WELL LOCATION – WILCOX FORMATION
- MONITORING WELL LOCATION – WILCOX FORMATION SELECTED FOR LTM
- POWER POLE
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0 150' 300'
SCALE: 1" = 150'

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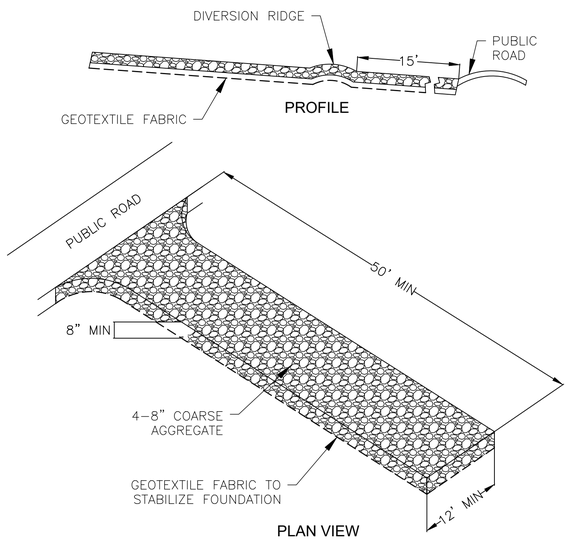
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LHAAP - 18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

LTM SAMPLING PLAN WILCOX FORMATION

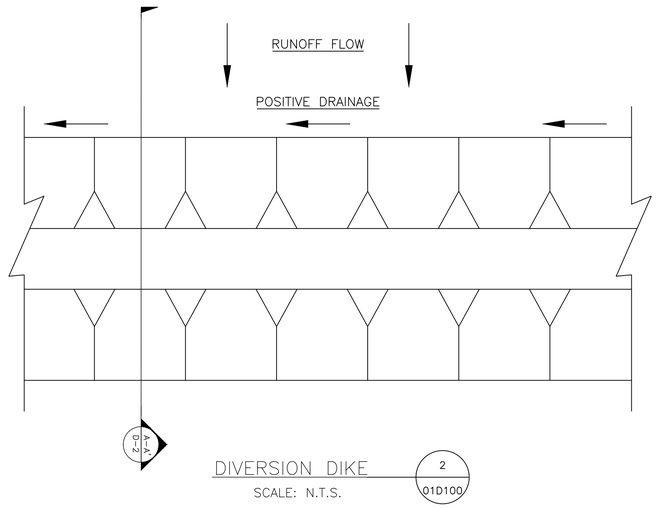
SHEET IDENTIFICATION
04C101
SHEET 22 OF 24



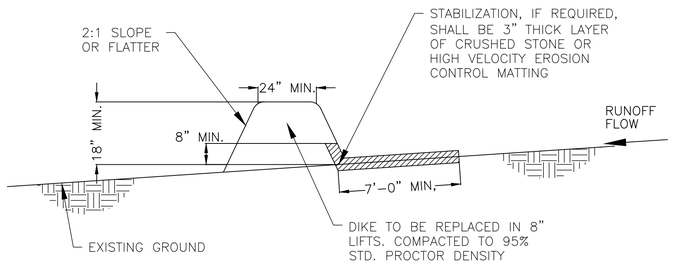
CONSTRUCTION SPECIFICATIONS:

1. THE AGGREGATE SHOULD CONSIST OF 4 TO 8 INCH WASHED STONE OVER A STABLE FOUNDATION AS SPECIFIED IN THE PLAN.
2. THE AGGREGATE SHOULD BE PLACED WITH A MINIMUM THICKNESS OF 8 INCHES.
3. THE GEOTEXTILE FABRIC SHOULD BE DESIGNED SPECIFICALLY FOR USE AS A SOIL FILTRATION MEDIA WITH AN APPROXIMATE WEIGHT OF 6 OZ/YD^2, A MULLEN BURST RATING OF 140 LB/IN^2, AND AN EQUIVALENT OPENING SIZE GREATER THAN A NUMBER 50 SIEVE.
4. IF A WASHING FACILITY IS REQUIRED, A LEVEL AREA WITH A MINIMUM OF 4 INCH DIAMETER WASHED STONE OR COMMERCIAL RACK SHOULD BE INCLUDED IN THE PLANS. DIVERT WASTEWATER TO A SEDIMENT TRAP OR BASIN.
5. AVOID CURVES ON PUBLIC ROADS AND STEEP SLOPES. REMOVE VEGETATION AND OTHER OBJECTIONABLE MATERIAL FROM THE FOUNDATION AREA. GRADE CROWN FOUNDATION FOR POSITIVE DRAINAGE.
6. THE MINIMUM WIDTH OF THE ENTRANCE/EXIT SHOULD BE 12 FEET OR THE FULL WIDTH OF EXIT ROADWAY, WHICHEVER IS GREATER.
7. THE CONSTRUCTION ENTRANCE SHOULD BE AT LEAST 50 FEET LONG.
8. IF THE SLOPE TOWARD THE ROAD EXCEEDS 2%, CONSTRUCT A RIDGE, 6 TO 8 INCHES HIGH WITH 3:1 (H:V) SIDE SLOPES, ACROSS THE FOUNDATION APPROXIMATELY 15 FEET FROM THE ENTRANCE TO DIVERT RUNOFF AWAY FROM THE PUBLIC ROAD.
9. PLACE GEOTEXTILE FABRIC AND GRADE FOUNDATION TO IMPROVE STABILITY, ESPECIALLY WHERE WET CONDITIONS ARE ANTICIPATED.
10. PLACE STONE TO DIMENSIONS AND GRADE SHOWN ON PLANS. LEAVE SURFACE SMOOTH AND SLOPE FOR DRAINAGE.
11. DIVERT ALL SURFACE RUNOFF AND DRAINAGE FROM THE STONE PAD TO A SEDIMENT TRAP OR BASIN.

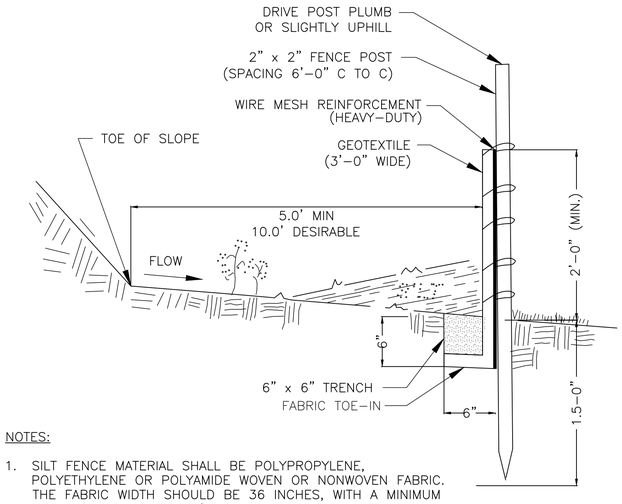
STABILIZED CONSTRUCTION ENTRANCE — 1 / 01D100
SCALE: N.T.S.



DIVERSION DIKE — 2 / 01D100
SCALE: N.T.S.



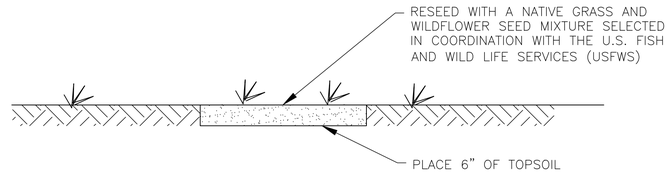
CROSS SECTION — A–A' / 01D100
SCALE: N.T.S.



NOTES:

1. SILT FENCE MATERIAL SHALL BE POLYPROPYLENE, POLYETHYLENE OR POLYAMIDE WOVEN OR NONWOVEN FABRIC. THE FABRIC WIDTH SHOULD BE 36 INCHES, WITH A MINIMUM UNIT WEIGHT OF 4.5 OZ/YD, MULLEN BURST STRENGTH EXCEEDING 190 LB/IN^2, ULTRAVIOLET STABILITY EXCEEDING 70%, AND MINIMUM APPARENT OPENING SIZE OF U.S. SIEVE NO. 30.
2. FENCE POSTS SHOULD BE MADE OF HOT ROLLED STEEL, AT LEAST 4 FT LONG WITH TEE OR YBAR CROSS SECTION, SURFACE PAINTED OR GALVANIZED, MINIMUM NOMINAL WEIGHT 1.25 LB/FT2, AND BRINDELL HARDNESS EXCEEDING 140.
3. WOVEN WIRE BACKING TO SUPPORT THE FABRIC SHOULD BE GALVANIZED 2" X 4" WELDED WIRE, 12 GAUGE MINIMUM.

SILT FENCE (NJ) — 3 / 01D100
SCALE: N.T.S.



VEGETATED AREA RESTORATION DETAIL — 4 / 01D100
SCALE: N.T.S.

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CKD BY: TC
SUBMITTED BY:
DATE: 02/29/2024
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CONTRACT NO.: W912BV19D0016
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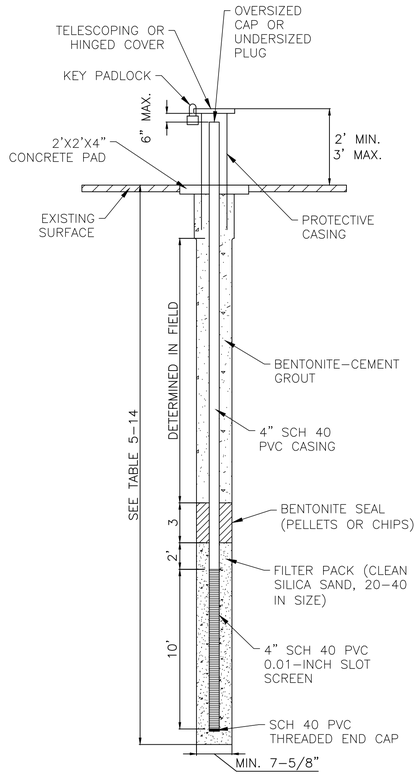
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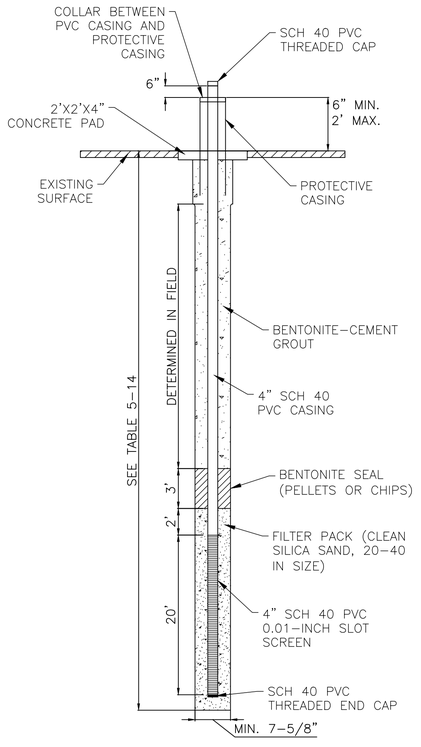
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LHAAP-18/24
LONGHORN ARMY AMMUNITION PLANT
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DETAILS SHEET 1

SHEET IDENTIFICATION
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SHEET 23 OF 24



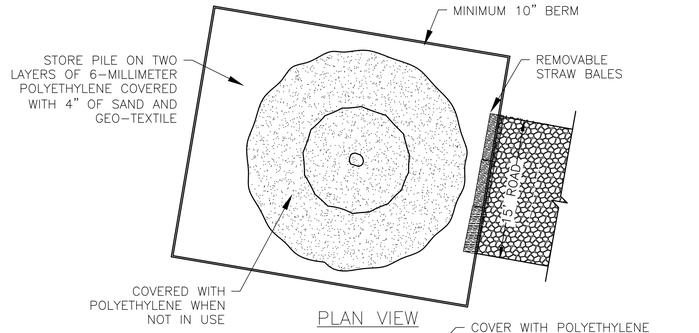


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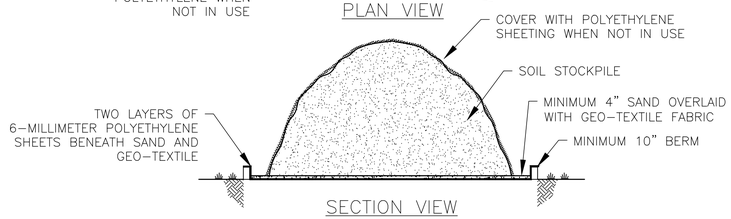
1. SEE SHEET G001 FOR NOTES ON WELL INSTALLATION, DEVELOPMENT, AND ABANDONMENT.

MONITORING WELL DETAIL — 1 / 01D101
SCALE: N.T.S.

INJECTION WELL DETAIL — 2 / 01D101
SCALE: N.T.S.



PLAN VIEW

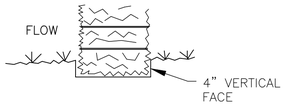


SECTION VIEW

NOTES:

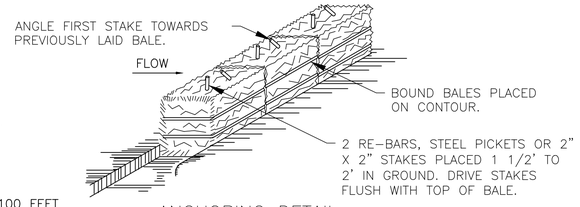
1. CONTAMINATED SOIL STOCKPILES MUST BE PLACED ON TWO LAYERS OF 6-MILLIMETER POLYETHYLENE SHEETS COVERED WITH A 4 INCH LAYER OF SAND AND GEO-TEXTILE FILTER FABRIC.
2. A BERM SHALL BE INSTALLED AROUND THE STOCKPILED SOIL TO PREVENT THE MIGRATION OF CONTAMINANTS.
3. STOCKPILES SHALL BE COVERED WITH POLYETHYLENE SHEETING TO PREVENT RAIN OR SURFACE WATER FROM COMING INTO CONTACT WITH THE CONTAMINATED SOIL.
4. THE COVER SHALL BE ANCHORED WITH SANDBAGS TO PREVENT IT FROM BEING BLOWN AWAY.

CONTAMINATED SOIL STOCKPILE DETAIL — 3 / 01D101
SCALE: N.T.S.



BEDDING DETAIL

DRAINAGE AREA NO MORE THAN 1/4 ACRE PER 100 FEET OF STRAW BALE DIKE FOR SLOPES LESS THAN 25%.



ANCHORING DETAIL

STRAW BALE DIKE — 4 / 01D101
SCALE: N.T.S.

CONSTRUCTION SPECIFICATIONS:

1. BALES SHALL BE PLACED AT THE TOE OF A SLOPE OR ON THE CONTOUR AND IN A ROW WITH ENDS TIGHTLY ABUTTING THE ADJACENT BALES.
2. EACH BALE SHALL BE EMBEDDED IN THE SOIL A MINIMUM OF (4) INCHES, AND PLACED SO THE BINDINGS ARE HORIZONTAL.
3. BALES SHALL BE SECURELY ANCHORED IN PLACE BY EITHER TWO STAKES OR RE-BARS DRIVEN THROUGH THE BALE. THE FIRST STAKE IN EACH BALE SHALL BE DRIVEN TOWARD THE PREVIOUSLY LAID BALE AT AN ANGLE TO FORCE THE BALES TOGETHER. STAKES SHALL BE DRIVEN FLUSH WITH THE BALE.
4. INSPECTION SHALL BE FREQUENT AND REPAIR REPLACEMENT SHALL BE MADE PROMPTLY AS NEEDED.
5. BALES SHALL BE REMOVED WHEN THEY HAVE SERVED THEIR USEFULNESS SO AS NOT TO BLOCK OR IMPEDE STORM FLOW OR DRAINAGE.

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1		PRE-FINAL DESIGN
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SUBMITTED BY:
CKD BY: TC
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SOLICITATION NO.: W912BV20F0096
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PLOT SCALE: AS NOTED
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LHAAP-18/24
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

DETAILS SHEET 2

SHEET IDENTIFICATION
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SHEET 24 OF 24

APPENDIX B

Final Remedial Design Cost Estimate

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

CONSTRUCTION COST ESTIMATE

Site: LHAAP-18/24 - Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant
Location: Karnack, Texas
Phase: Pre-Final Remedial Design
Base Year: 2023
Date: February 7, 2023

RA costs include:
• Phase I - Excavation of unsaturated soil, implementation of ISTD treatment to remove DNAPL, implementation of three EISB field pilot tests, and implementation of LUCs.
• Phase II - EISB treatment in grids and biobarriers.
RA costs for Phase III MNA and LTM activities are not provided in this cost estimate.

	Item	Quantity	Unit	Unit Cost	Estimated Cost	Subtotal	Note
Phase 1-1: Unsaturated Soil Excavation Remedial Action							
1.1.1 General							
1.1.1.1	Submittals/Implementation Plans	1	LS	$80,000	$80,000		Work Plan, QAPP, HASP, CQCP, Air Monitoring Plan, and Waste Mgmt Plan; Based on experience on similar projects.
1.1.1.2	Coordinate with Regulators/Approvals	1	LS	$15,000	$15,000		Based on experience on similar projects.
1.1.1.3	Pre-construction Meetings	1	LS	$15,000	$15,000		Based on experience on similar projects.
1.1.1.4	Post-Construction Submittals	1	LS	$80,000	$80,000		Manifests, as-builts, air monitoring results, verification sample results, boring logs, etc.; Based on experience on similar projects.
	Subtotal					**$190,000**	
1.1.2 Mobilization/Demobilization for Excavation							
1.1.2.1	General Mobilization/Demobilization	1	LS	$152,000	$152,000		Excavators, loader, dozer, etc.; Assume 4% of direct costs (based on experience on similar projects).
	Subtotal					**$152,000**	
1.1.3 Site Preparation for Excavation							
1.1.3.1	Pre-Construction Survey	1	acre	$2,000	$2,000		Existing conditions survey and stakeout; Based on experience on similar projects.
1.1.3.2	Clearing and grubbing	1	acre	$4,730	$4,730		Based on task-based estimate.
1.1.3.3	Debris Removal & Disposal	980	CY	$60	$58,800		Removal of misc. debris; Based on experience on similar projects.
1.1.3.4	Silt Fence	1,000	LF	$1.70	$1,700		Assume silt fence around excavation perimeters; Based on experience on similar projects.
1.1.3.5	Erosion Control Measures	1	LS	$10,000	$10,000		Based on experience on similar projects.
1.1.3.6	Access Roads	500	SY	$11	$5,500		8" Gravel depth, 20-ft wide; Based on experience on similar projects.
1.1.3.7	Equipment Staging Areas	1	EA	$13,100	$13,100		Based on experience on similar projects.
1.1.3.8	Decontamination Pad	1	EA	$17,800	$17,800		Lined stone decon pad with sump; Based on experience on similar projects.
1.1.3.9	Truck Loading Area	3	EA	$800	$2,400		Bermed loading area with geo-membrane liner; Based on experience on similar projects.
1.1.3.10	Utility Mark-Out	3	EA	$1,800	$5,400		Based on experience on similar projects.
1.1.3.11	Temporary Facilities Rentals	3	Mo	$600	$1,800		Based on experience on similar projects.
1.1.3.12	Construction Fence	1,000	LF	$1.80	$1,800		Orange construction fence to signify excavation area; Based on experience on similar projects.
	Subtotal					**$125,000**	
1.1.4 Health and Safety for Excavation							
1.1.4.1	Perimeter Air Monitoring	30	Day	$1,180	$35,400		Based on task-based estimate.
1.1.4.2	H&S Monitoring	6	Week	$1,070	$6,420		Based on task-based estimate.
1.1.4.3	PPE and Field Supplies	6	Week	$200	$1,200		Based on experience on similar projects.
1.1.4.4	H&S Superintendent	300	Hr	$170	$51,000		Based on task-based estimate.
	Subtotal					**$94,000**	
1.1.5 Excavation							
1.1.5.1	Excavation, Stockpiling, & Handling	13,900	BCY	$24	$333,600		Excavate soil and loading of trucks for off-site disposal;Based on task-based estimate.
1.1.5.2	Survey Work	30	1/2 Day	$1,260	$37,800		1/2 day field during excavations; 3 days office; Based on task-based estimate.
1.1.5.3	Confirmation Sample Collection	240	HR	$190	$45,600		VOCs and perchlorate analysis; Based on task-based estimate.
1.1.5.4	Confirmation Sample Analysis - Perchlorate	25	EA	$260	$6,500		48 hr TAT (primary excavations); Based on experience on similar projects.
1.1.5.5	Confirmation Sample Analysis - VOCs	25	EA	$470	$11,800		48 hr TAT (primary excavations); Based on experience on similar projects.
	Subtotal					**$435,000**	
1.1.6 Waste Disposal for Excavation							
1.1.6.1	Non-Hazardous Waste Transport	9,500	LCY	$28.08	$266,717		Assumes 1.5 conversion from LCY to tons; Based on task-based estimate.
1.1.6.2	Non-Hazardous Waste Disposal	9,500	LCY	$35.28	$335,160		Assumes 1.25 conversion from BCY to LCY; Based on task-based estimate.
1.1.6.3	Hazardous Waste Transport	3,200	LCY	$127.07	$406,626		Assumes 1.5 conversion from LCY to tons; Based on task-based estimate.
1.1.6.4	Hazardous Waste Disposal	4,800	TN	$195.80	$939,859		Assumes 1.25 conversion from BCY to LCY; Based on task-based estimate.
1.1.6.5	Truck Liners	1,155	EA	$60	$69,300		Based on experience on similar projects.
1.1.6.6	Waste Characterization Samples	56	EA	$1,880	$105,280		1 test per 250 CY; Based on experience on similar projects.
	Subtotal					**$2,123,000**	

CONSTRUCTION COST ESTIMATE

Site: LHAAP-18/24 - Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant
Location: Karnack, Texas
Phase: Pre-Final Remedial Design
Base Year: 2023
Date: February 7, 2023

RA costs include:
• Phase I - Excavation of unsaturated soil, implementation of ISTD treatment to remove DNAPL, implementation of three EISB field pilot tests, and implementation of LUCs.
• Phase II - EISB treatment in grids and biobarriers.
RA costs for Phase III MNA and LTM activities are not provided in this cost estimate.

	Item	Quantity	Unit	Unit Cost	Estimated Cost	Subtotal	Note
1.1.7 Post-Excavation Restoration							
1.1.7.1	Backfill (Reused Shallow Soil)	3,500	CCY	$12	$42,000		Assumes use of excavated shallow soil; includes placement, hauling, compaction. Also 10% loss between BCY and CCY; Based on task-based estimate.
1.1.7.2	Backfill (Imported Common Fill)	10,400	CCY	$89	$925,600		Importing certified clean soil; includes placement, hauling, compaction; Based on task-based estimate.
1.1.7.3	Backfill Source Sampling	56	EA	$520	$29,120		1 sample per 250 cy (for both reused shallow soil and imported common fill); Based on experience on similar projects.
1.1.7.4	Seeding	9,950	SF	$0.20	$1,990		Based on experience on similar projects.
	Subtotal					**$999,000**	
	Subtotal for Phase 1-1: Unsaturated Soil Excavation Remedial Action					**$4,118,000**	
Phase 1-2: In-Situ Thermal Desorption (ISTD) Remedial Action							
1.2.1 Pre-Construction							
1.2.1.1	Submittals/Implementation Plans	1	LS	$163,800	$163,800		QAPP, HASP, shop drawings, and work plans; Based on experience on similar projects.
1.2.1.2	Coordinate with Regulators/Approvals	1	LS	$14,400	$14,400		Based on experience on similar projects.
1.2.1.3	Pre-construction Meetings	1	LS	$5,000	$5,000		Based on experience on similar projects.
1.2.1.4	Post-Construction Submittals	1	LS	$50,000	$50,000		ISTD Completion Report; Based on experience on similar projects.
	Subtotal					**$233,200**	
1.2.2 Mobilization/Demobilization for ISTD							
1.2.2.1	General Mobilization	1	LS	$3,000	$3,000		General Mobilization for oversight sampling; Based on experience on similar projects.
	Subtotal					**$3,000**	
1.2.3 Site Preparation for ISTD							
1.2.3.1	Perimeter Fence	2,950	LF	$40	$118,825		Perimeter fence around the ISTD areas.
1.2.3.2	Clearing and grubbing	1	acre	$6,400	$6,400		Based on experience on similar projects.
1.2.3.3	Erosion Control Measures	1	LS	$10,000	$10,000		Based on experience on similar projects.
1.2.3.4	Equipment Staging Area	1	EA	$13,100	$13,100		Based on experience on similar projects.
1.2.3.5	Utility Protection	1	LS	$2,000	$2,000		No access road assumed; Based on experience on similar projects.
1.2.3.6	Utility Mark-Out	1	LS	$1,800	$1,800		Based on experience on similar projects.
1.2.3.7	New Well Installation - Mob/Demob	1	LS	$10,780	$10,780		Based on task-based estimate. Based on task-based estimate.
1.2.3.8	New Well Installation (up to 40 ft)	3	EA	$10,103	$30,309		Well Installation + Development; Based on task-based estimate.
1.2.3.9	Temporary Facilities Rentals	9	Mo	$600	$5,400		Based on experience on similar projects.
	Subtotal					**$199,000**	
1.2.4 Health and Safety for ISTD							
1.2.4.1	Perimeter Air Monitoring	35	Week	$5,880	$205,800		VOCs monitoring; Based on task-based estimate.
1.2.4.2	H&S Monitoring	35	Week	$1,070	$37,450		VOCs monitoring; Based on task-based estimate.
1.2.4.3	PPE and Field Supplies	35	Week	$200	$7,000		Based on experience on similar projects.
1.2.4.4	H&S Superintendent	350	Hr	$166	$58,100		Based on task-based estimate.
1.2.4.5	ISTD System Security	3,024	HR	$57	$172,368		Security guard during non-working hours; 12 hrs./day; 30 days per mo. Based on task-based estimate.
	Subtotal					**$481,000**	
1.2.5 Power Drop for ISTD							
1.2.5.1	Power Drop and Transformer Installation	1	LS	$150,000	$150,000		Requires actual quote when RA is being implemented; Based on experience on similar projects.
	Subtotal					**$150,000**	
1.2.6 ISTD - System Installations and Operations							
1.2.6.1	ISTD Construction and Operations	1	LS	$9,740,000	$9,740,000		Quote from TerraTherm.
1.2.6.2	Electricity Usage	1	LS	$2,530,000	$2,530,000		Quote from TerraTherm.
1.2.6.3	Performance Monitoring	1	LS	$78,700	$78,700		
1.2.6.4	Reporting	1	LS	$25,000	$25,000		Based on experience on similar projects.
	Subtotal					**$12,374,000**	
1.2.7 Post-ISTD Restoration							
1.2.7.1	Hydro Seed	100,000	SF	$0.20	$20,000		Based on experience on similar projects.
1.2.7.2	ICT Infrastructure Protection/Replacement	1	LS	$20,000	$20,000		Replacement of Infrastructure associated with ICTs; Based on experience on similar projects.
	Subtotal					**$40,000**	
	Subtotal for Phase 1-2: In-Situ Thermal Desorption (ISTD) Remedial Action					**$13,480,000**	

CONSTRUCTION COST ESTIMATE

Site: LHAAP-18/24 - Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant
Location: Karnack, Texas
Phase: Pre-Final Remedial Design
Base Year: 2023
Date: February 7, 2023

RA costs include:
• Phase I - Excavation of unsaturated soil, implementation of ISTD treatment to remove DNAPL, implementation of three EISB field pilot tests, and implementation of LUCs.
• Phase II - EISB treatment in grids and biobarriers.
RA costs for Phase III MNA and LTM activities are not provided in this cost estimate.

	Item	Quantity	Unit	Unit Cost	Estimated Cost	Subtotal	Note
Phase 1-3: Enhanced In-Situ Bioremediation (EISB) Pilot Tests							
1.3.1 Pre-Pilot Tests							
1.3.1.1	Submittals/Implementation Plans	1	LS	$49,140	$49,140		QAPP, HASP, shop drawings, and work plans; Based on experience on similar projects.
1.3.1.2	Coordinate with Regulators/Approvals	1	LS	$14,400	$14,400		Based on experience on similar projects.
1.3.1.3	Pre-Pilot Tests Meetings	1	LS	$5,000	$5,000		Based on experience on similar projects.
1.3.1.4	Post Pilot Tests Submittals	1	LS	$50,000	$50,000		EISB Pilot Test and Recommendation Report; Based on experience on similar projects.
1.3.1.5	Pre-Test and Performance Monitoring Sampling	56	Day	$2,370	$132,720		Assumes two-person crew & 8 days for each sampling event; total 7 events; Based on task-based estimate.
1.3.1.6	Pre-Test and Performance Monitoring Sampling Analysis	1	LS	$51,920	$51,920		
1.3.1.7	Field Parameters Monitoring Labor and Equipment	9	Day	$1,190	$10,710		Field Parameters Monitoring; Based on task-based estimate.
	Subtotal					**$313,890**	
1.3.2 Mobilization/Demobilization for EISB Pilot Tests							
3.2.1	General Mobilization/Demobilization	1	LS	$23,000	$23,000		Drill Rig and Organic Substrate Materials Mobilization, 4% of direct costs (based on experience on similar projects).
	Subtotal					**$23,000**	
1.3.3 Site Preparation for ESIB Pilot Tests							
1.3.3.1	Clearing and grubbing	0.4	acre	$4,730	$1,773		Based on task-based estimate.
1.3.3.2	Equipment Staging Area	1	EA	$5,000	$5,000		Based on experience on similar projects.
1.3.3.3	Utility Mark-Out	1	LS	$2,520	$2,520		Assume 8 hours survey crew; Based on task-based estimate.
1.3.3.4	New Well Installation - Mob/Demob	1	LS	$10,780	$10,780		Based on task-based estimate.
1.3.3.5	New Well Installation (up to 40 ft)	18	EA	$10,103	$181,855		Well Installation + Development; Based on task-based estimate.
1.3.3.6	Swamp Mats	6,400	SF	$10	$64,000		Based on experience on similar projects.
1.3.3.7	Temporary Facilities Rentals	12	Mo	$2,860	$34,320		Based on task-based estimate.
	Subtotal					**$300,000**	
1.3.4 Health and Safety for ESIB							
1.3.4.1	Perimeter Air Monitoring	3	Week	$5,880	$17,640		VOCs monitoring; Based on task-based estimate.
1.3.4.2	H&S Monitoring	3	Week	$1,070	$3,210		VOCs monitoring; Based on task-based estimate.
1.3.4.3	PPE and Field Supplies	3	Week	$200	$600		Based on experience on similar projects.
1.3.4.4	H&S Superintendent	120	Hr	$165	$19,810		Based on task-based estimate.
	Subtotal					**$41,000**	
1.3.5 EISB Pilot Tests 1, 2, & 3 Substrate Material and Delivery							
1.3.5.1	EISB Substrate Material and Delivery	1	LS	$73,700	$73,700		Material cost plus estimated freight + Tax; from Tersus and SiREM quotes.
	Subtotal					**$74,000**	
1.3.6 EISB Pilot Tests 1 & 3 DPT Drilling and Injections							
1.3.6.1	DPT Drilling for Temporary Injections	11	Day	$2,590	$28,490		Probe/Drill Rig Daily Rental W/ Operator; Based on task-based estimate.
1.3.6.2	Decontamination Equipment	11	Day	$220	$2,420		Based on experience on similar projects.
1.3.6.3	Injection Labor and Equipment	7	Day	$2,354	$16,479		Based on task-based estimate.
1.3.6.4	IDW Management	1	LS	$10,000	$10,000		Based on experience on similar projects.
	Subtotal					**$57,000**	
1.3.7 EISB Pilot Tests 2 - IW Installation and Injections							
1.3.7.1	IW Well Installation Mob/Demob	1	LS	$10,780	$10,780		Probe/Drill Rig Daily Rental W/ Operator; Based on task-based estimate.
1.3.7.2	IW Well Installation	5	EA	$10,103	$50,515		Well Installation + Development; Based on task-based estimate.
1.3.7.3	Decontamination Equipment	5	Day	$220	$1,100		
1.3.7.4	Decontamination of Drilling Equipment	5	Day	$110	$550		Based on experience on similar projects.
1.3.7.5	Injection Labor and Equipment	3	Day	$2,354	$7,062		Based on task-based estimate.
1.3.7.6	IDW Management	1	LS	$10,000	$10,000		Based on experience on similar projects.
	Subtotal					**$80,000**	
	Subtotal for Phase 1-3: Enhanced In-Situ Bioremediation (EISB) Pilot Tests					**$889,000**	

CONSTRUCTION COST ESTIMATE

Site: LHAAP-18/24 - Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant
Location: Karnack, Texas
Phase: Pre-Final Remedial Design
Base Year: 2023
Date: February 7, 2023

RA costs include:
• Phase I - Excavation of unsaturated soil, implementation of ISTD treatment to remove DNAPL, implementation of three EISB field pilot tests, and implementation of LUCs.
• Phase II - EISB treatment in grids and biobarriers.
RA costs for Phase III MNA and LTM activities are not provided in this cost estimate.

	Item	Quantity	Unit	Unit Cost	Estimated Cost	Subtotal	Note
Phase 1-4: Implementation of LUCs							
1.4.1 Implementation of LUCs							
1.4.1.1	Preliminary LUCs Review	1	LS	$10,000	$10,000		Based on experience on similar projects.
1.4.1.2	LUCs updates and Revision	1	LS	$15,000	$15,000		Based on experience on similar projects.
1.4.1.3	LUCs Submittals	1	LS	$5,000	$5,000		Based on experience on similar projects.
	Subtotal					**$30,000**	
	Subtotal for 1.4.1 Implementation of LUCs					**$30,000**	
	Subtotal for Phase I Remedial Actions:					**$18,517,000**	
	Contingency:				30%	$5,555,100	
	Subtotal for Remedial Actions:					**$24,072,000**	
	Construction Oversight:				6%	$1,111,000	
	Construction Management:				8%	$1,481,000	
TOTAL PHASE I - REMEDIAL ACTION COST						**$ 26,664,000**	
Phase 2: Enhanced In-Situ Bioremediation Remedial Action Grids and Barrier Walls							
2.1 Pre-Construction							
2.1.1	Submittals/Implementation Plans	1	LS	$114,660	$114,660		QAPP, HASP, shop drawings, and work plans; Based on experience on similar projects.
2.1.2	Coordinate with Regulators/Approvals	1	LS	$14,400	$14,400		Based on experience on similar projects.
2.1.3	Pre-construction Meetings	1	LS	$5,000	$5,000		Based on experience on similar projects.
2.1.4	Post-Construction Submittals	1	LS	$75,000	$75,000		EISB Completion Report; Based on experience on similar projects.
	Subtotal					**$209,060**	
2.2 Mobilization/Demobilization for EISB							
2.2.1	General Mobilization/Demobilization	1	LS	$29,000	$29,000		Drill Rigs & Organic Substrate Materials Mobilization; Based on experience on similar projects.
	Subtotal					**$29,000**	
2.3 Site Preparation for EISB							
2.3.1	Clearing and grubbing	24.2	acre	$6,400	$155,100		Based on experience on similar projects.
2.3.2	Equipment Staging Area	1	EA	$10,000	$10,000		Based on experience on similar projects.
2.3.3	Utility Mark-Out	1	LS	$7,560	$7,560		
2.3.4	New Well Installation - Mob/Demob	1	LS	$10,780	$10,780		
2.3.5	New Well Installation (up to 40 ft)	22	EA	$10,103	$222,267		Well Installation + Development.
2.3.6	Swamp Mats	6,400	SF	$10	$64,000		Based on experience on similar projects.
2.3.7	Temporary Facilities Rentals	12	Mo	$1,000	$12,000		Based on experience on similar projects.
	Subtotal					**$482,000**	
2.4 Health and Safety for EISB							
2.4.1	Perimeter Air Monitoring	65	Week	$2,500	$162,500		VOCs monitoring; Based on experience on similar projects.
2.4.2	H&S Monitoring	65	Week	$1,200	$78,000		VOCs monitoring; Based on experience on similar projects.
2.4.3	PPE and Field Supplies	65	Week	$200	$13,000		Based on experience on similar projects.
2.4.4	H&S Superintendent	2,600	Hr	$120	$312,000		Based on experience on similar projects.
	Subtotal					**$566,000**	
2.5 EISB Injections Substrate Material and Delivery - 1st Event							
2.5.1	EISB Substrate Material and Delivery	1	LS	$4,818,000	$4,818,000		Material cost plus estimated fright + Tax.
	Subtotal					**$4,818,000**	
2.6 EISB Grid System DPT Installation & Injections - 1st Event							
2.6.1	DPT Drilling for Temporary Injections	389	Day	$2,590	$1,007,510		Probe/Drill Rig Daily Rental W/ Operator.
2.6.2	Decontamination Equipment	389	Day	$220	$85,580		Based on experience on similar projects.
2.6.3	Decontamination of Drilling Equipment	389	Day	$110	$42,790		Based on experience on similar projects.
2.6.4	Injection Labor and Equipment	285	Day	$2,354	$670,921		
2.6.5	IDW Management	1	LS	$14,000	$14,000		
	Subtotal					**$1,821,000**	
	Subtotal					**$1,821,000**	
2.7 EISB Shallow/Wilcox Barrier Wall IW Injection - 1st Event							
2.7.1	IW Well Installation Mob/Demob	1	LS	$10,780	$10,780		Probe/Drill Rig Daily Rental W/ Operator.
2.7.2	IW Well Installation	124	EA	$10,103	$1,252,778		Well Installation + Development.
2.7.3	Decontamination Equipment	124	Day	$220	$27,280		Based on experience on similar projects.
2.7.4	Decontamination of Drilling Equipment	124	Day	$110	$13,640		Based on experience on similar projects.
2.7.5	Injection Labor and Equipment	25	Day	$2,354	$58,853		
2.7.6	IDW Management	1	LS	$1,000	$1,000		
	Subtotal					**$1,364,000**	

CONSTRUCTION COST ESTIMATE

Site: LHAAP-18/24 - Burning Ground No. 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant
Location: Karnack, Texas
Phase: Pre-Final Remedial Design
Base Year: 2023
Date: February 7, 2023

RA costs include:
• Phase I - Excavation of unsaturated soil, implementation of ISTD treatment to remove DNAPL, implementation of three EISB field pilot tests, and implementation of LUCs.
• Phase II - EISB treatment in grids and biobarriers.
RA costs for Phase III MNA and LTM activities are not provided in this cost estimate.

Item		Quantity	Unit	Unit Cost	Estimated Cost	Subtotal	Note
2.8 EISB Barrier Wall DPT Injections - 1st Event							
2.8.1	DPT Drilling for Temporary Injections	33	Day	$2,590	$85,470		Probe/Drill Rig Daily Rental W/ Operator.
2.8.2	Decontamination Equipment	33	Day	$220	$7,260		Based on experience on similar projects.
2.8.3	Decontamination of Drilling Equipment	33	Day	$110	$3,630		Based on experience on similar projects.
2.8.4	Injection Labor and Equipment	19	Day	$2,354	$44,728		
2.8.5	IDW Management	1	LS	$2,000	$2,000		
	Subtotal					**$143,000**	
2.9 EISB Injections Substrate Material and Delivery - 2nd Event (Assumes 33% of 1st Event)							
2.9.1	EISB Substrate Material and Delivery	1	LS	$1,606,000	$1,606,000		Material cost plus estimated fright + Tax; from Tersus and SiREM quotes.
	Subtotal					**$1,606,000**	
2.10 EISB Grid System DPT Installation & Injections - 2nd Event (Assumes 33% of the 1st Event)							
2.10.1	DPT Drilling for Temporary Injections	127	Day	$2,590	$328,930		Probe/Drill Rig Daily Rental W/ Operator.
2.10.2	Decontamination Equipment	127	Day	$220	$27,940		Based on experience on similar projects.
2.10.3	Decontamination of Drilling Equipment	127	Day	$110	$13,970		Based on experience on similar projects.
2.10.4	Injection Labor and Equipment	95	Day	$2,354	$223,640		
2.10.5	IDW Management	1	LS	$5,000	$5,000		
	Subtotal					**$599,000**	
2.11 EISB Shallow/Wilcox Barrier Wall IW Injection - 2nd Event							
2.11.1	Decontamination Equipment	25	Day	$220	$5,500		Based on experience on similar projects.
2.11.2	Decontamination of Injection Equipment	25	Day	$110	$2,750		Based on experience on similar projects.
2.11.3	Injection Labor and Equipment	25	Day	$2,354	$58,853		
	Subtotal					**$67,000**	
2.12 Post-EISB Restoration							
2.12.1	Field Parameters Monitoring	1	LS	$521,833	$521,833		Field Parameters Monitoring.
2.12.2	Evaluation Of Design Effectiveness Sampling	120	Day	$2,370	$284,400		Assumes two-person crew & 15 days for each sampling event; total 8 events as Quarterly for Year 1 & 2.
2.12.3	Evaluation Of Design Effectiveness Sample Analyses	1	LS	$134,000	$134,000		
2.12.4	Pre-Remedy and Performance Monitoring Sampling	60	Day	$2,370	$142,200		Assumes two-person crew & 15 days for each sampling event; total 4 events.
2.12.5	Pre-Remedy and Performance Monitoring Sampling Analysis	1	LS	$29,260	$29,260		
2.12.6	Reporting	4	EA	$25,000	$100,000		
2.12.7	Hydro Seed	1,055,025	SF	$0.20	$211,005		Based on experience on similar projects.
2.12.8	Demobilization	1	LS	$20,000	$20,000		Labor, equipment and disposal; Based on experience on similar projects.
	Subtotal					**$1,443,000**	
	Subtotal for Phase II Remedial Actions:					**$13,147,060**	
	Contingency:			30%		$3,944,118	
	Subtotal for Remedial Actions:					**$17,091,000**	
	Construction Oversight:			6%		$789,000	
	Construction Management:			8%		$1,052,000	
TOTAL PHASE II - REMEDIAL ACTION COST						**$ 18,932,000**	
	TOTAL COST					**$ 45,596,000**	

Longhorn 18-24

Task-Based Estimate Backup Calculations

Description	Type	Item	Total Rate	Unit	Bid Qty	Bid Unit	Prod	Prod Unit	Qty	±	Qty ±	Qty Unit	Task Cost	Direct Unit Cost	HOOH (6%)	JOOH (10%)	Profit (8%)	Bond (2%)	Total Unit Price
Excavation, Stockpiling, and Handling					13,900.0	BCY							$255,278.20	$18.37	$1.10	$1.84	$1.47	$0.37	$23.14
Excavate and Stockpile Fill	Crew	EXC1	$865.74	hour	13,900.0	BCY	100.0	cy/hr	139.0	4.0	140.0	hour	$121,203.53	$8.72					
Load Fill into Trucks for Disposal	Crew	LOAD1	$713.16	hour	10,200.0	BCY	55.0	cy/hr	185.5	4.0	188.0	hour	$134,074.67	$13.14					
Haul Disposal, Non-Hazardous					9,500.0	CCY							$211,680.00	$22.28	$1.34	$2.23	$1.78	$0.45	$28.08
Haul to disposal	Haul	Haul_Dispose_LA	$245.00	load	9,500.0	BCY	11.0	cy/load	863.6	1.0	864.0	load	$211,680.00	$22.28					
Disposal Fee, Non-Hazardous					9,500.0	CCY							$266,000.00	$28.00	$1.68	$2.80	$2.24	$0.56	$35.28
Disposal Fee	MatFee	Fee_LA	$28.00	cy	9,500.0	BCY	n/a	n/a	9,500.0	10.0	9,500.0	cy	$266,000.00	$28.00					
Haul Disposal, Hazardous					3,200.0	CCY							$322,719.00	$100.85	$6.05	$10.08	$8.07	$2.02	$127.07
Haul to disposal	Haul	Haul_Dispose_WM	$1,109.00	load	3,200.0	BCY	11.0	cy/load	290.9	1.0	291.0	load	$322,719.00	$100.85					
Disposal Fee, Hazardous					4,800.0	TON							$745,920.00	$155.40	$9.32	$15.54	$12.43	$3.11	$195.80
Disposal Fee	MatFee	Fee_WM	$155.40	tn	4,800.0	TON	n/a	n/a	4,800.0	10.0	4,800.0	tn	$745,920.00	$155.40					
Survey Crew 1/2 Day					30.0	HALFDAY							$29,930.59	$997.69	$59.86	$99.77	$79.81	$19.95	$1,257.08
Survey	Crew	Survey	$249.42	hour	30.0	HALFDAY	0.25	hr/halfday	120.0	4.0	120.0	hour	$29,930.59	$997.69					
Sampling					8.0	HR							$1,183.29	$147.91	$8.87	$14.79	$11.83	$2.96	$186.37
Collect and Log Samples	Crew	Sampling	$147.91	hour	8.0	HR	1.00	HR	8.0	4.0	8.0	hour	$1,183.29	$147.91					
Injection Well Eq and Labor					3.0	DAY							$5,605.02	$1,868.34	$112.10	$186.83	$149.47	$37.37	$2,354.11
Injection Well Crew	Crew	InjWell	$186.83	hour	3.0	DAY	0.10	HR	30.0	1.0	30.0	hour	$5,605.02	$1,868.34					
Security Guard					3,024.0	HR							$136,149.58	$45.02	$2.70	$4.50	$3.60	$0.90	$56.73
Guard 1	Crew	Guard1	$45.02	hour	3,024.0	HR	1.00	HR	3,024.0	4.0	3,024.0	hour	$136,149.58	$45.02					
Monitoring Costs																			
Air Quality Monitor (DAY)	Crew	EnvMonitor	$116.52	hour	30.0	day	0.13	HR	240.0	4.0	240.0	hour	$27,964.08	$932.14	$55.93	$93.21	$74.57	$18.64	$1,174.49
Air Quality Monitor (WK)	Crew	EnvMonitor	$116.52	hour	3.0	wk	0.03	wk/hr	120.0	4.0	120.0	hour	$13,982.04	$4,660.68	$279.64	$466.07	$372.85	$93.21	$5,872.46
Health and Safety																			
Health and Safety Officer	Crew	HSOfficer	$130.27	hour	350.0	hr	1.00	HR	350.0	4.0	352.0	hour	$45,856.75	$131.02	$7.86	$13.10	$10.48	$2.62	$165.08
Health and Safety Monitor (10 hr/wk)	Crew	HSMonitor	$84.37	hour	35.0	wk	0.10	wk/hr	350.0	4.0	352.0	hour	$29,698.65	$848.53	$50.91	$84.85	$67.88	$16.97	$1,069.15
Dispose Excavation					9,500.0	tn							$1,476,300.00	$155.40	$9.32	$15.54	$12.43	$3.11	$195.80
Disposal at Charles Lake CWM	MatFee	FEE_WM	$155.40	tn	9,500.0	tn	n/a	n/a	9,500.0	10.0	9,500.0	tn	$1,476,300.00	$155.40					
DPT Drilling					11.0	day							$22,552.20	$2,050.20	$123.01	$205.02	$164.02	$41.00	$2,583.25
Direct Push Rig, Labor, Decon, Sampling	MatFee	DirectPushRig	$2,050.20	day	11.0	day	n/a	n/a	11.0	1.0	11.0	day	$22,552.20	$2,050.20					
Clearing and Grubbing (assume 6-in deep)					1,613.3	CCY							$98,326.61	$60.95	$3.66	$6.09	$4.88	$1.22	$76.79
					2.0	AC							$98,326.61	$49,163.30	$2,949.80	$4,916.33	$3,933.06	$983.27	$61,945.76
												No disposal	$7,501.61	$3,750.80	$225.05	$375.08	$300.06	$75.02	$4,726.01
Excavate surface material	Crew	CG1	$375.08	hour	1,613.3	CCY	100.0	cy/hr	16.1	4.0	20.0	hour	$7,501.61	$4.65	$0.28	$0.46	$0.37	$0.09	$5.86
Haul to disposal	Haul	Haul_Dispose_LA	$245.00	load	1,936.0	BCY	13.0	cy/load	148.9	1.0	149.0	load	$36,505.00	$18.86					
Disposal Fee	MatFee	Fee_LA	$28.00	cy	1,936.0	BCY	n/a	n/a	1,936.0	10.0	1,940.0	cy	$54,320.00	$28.06					

Longhorn 18-24

Task-Based Estimate Backup Calculations

Description	Type	Item	Total Rate	Unit	Bid Qty	Bid Unit	Prod	Prod Unit	Qty	±	Qty ±	Qty Unit	Task Cost	Direct Unit Cost	HOOH (6%)	JOOH (10%)	Profit (8%)	Bond (2%)	Total Unit Price
Drill MW + Development					14	ea							$112,256.06	$8,018.29	$481.10	$801.83	$641.46	$160.37	$10,103.05
					560.0	LF							$112,256.06	$200.46	$12.03	$20.05	$16.04	$4.01	$252.58
Drill Well	Crew	Drilling	$534.47	hour	560.0	LF	20.0	lf/hr	28.0	4.0	28.0	hour	$14,965.29	$26.72					
Casing	MatFee	MW_Casing	$5.00	lf	560.0	lf	n/a	n/a	560.0	10.0	560.0	lf	$2,800.64	$5.00					
Well Screen	MatFee	MW_Screen	$44.18	lf	560.0	lf	n/a	n/a	560.0	10.0	560.0	lf	$24,739.02	$44.18					
Gravel Filter	MatFee	MW_GravelPack	$123.32	lf	560.0	lf	n/a	n/a	560.0	10.0	560.0	lf	$69,058.30	$123.32					
Well Cap	MatFee	MW_Cap	$34.64	ea	14.0	ea	n/a	n/a	14.0	10.0	20.0	ea	$692.80	$49.49					
Drill MW - Mob/Demob					1	ls							$8,551.59	$8,551.59	$513.10	$855.16	$684.13	$171.03	$10,775.01
Drill Well	Crew	Drilling	$534.47	hour	1.0	ls	16.0	hr/ea	16.0	4.0	16.0	hour	$8,551.59	$8,551.59					
Temporary Facilities Rentals					12	mo							$27,201.17	$2,266.76	$136.01	$226.68	$181.34	$45.34	$2,856.12
Office Trailer	MatFee	OfficeTrailer_MO	$497.95	mo	12.0	mo	n/a	n/a	12.0	10.0	20.0	mo	$9,959.00	$829.92					
Field Storage	MatFee	StorageBox_MO	$150.47	mo	12.0	mo	n/a	n/a	12.0	10.0	20.0	mo	$3,009.35	$250.78					
Portable Toilet	MatFee	ToiletPortable_MO	$122.61	mo	24.0	mo	n/a	n/a	24.0	10.0	30.0	mo	$3,678.44	$153.27					
Office Expenses	MatFee	FieldExpense_MO	$527.72	mo	12.0	mo	n/a	n/a	12.0	10.0	20.0	mo	$10,554.38	$879.53					
Backfill from Commercial Source, A&T Sand & Gravel					10,400.0	CCY							$732,184.14	$70.40	$4.22	$7.04	$5.63	$1.41	$88.71
Place, spread, and compact from borrow	Crew	FILL1	$955.79	hour	10,400.0	CCY	110.0	cy/hr	94.5	4.0	96.0	hour	$91,755.94	$8.82					
Haul (11 CY/load)	MatFee	Fill_HaulLoad	$225.00	ea	946.0	ea	n/a	n/a	946.0	10.0	950.0	ea	$213,750.00	$225.95					
Purchase Fee	MatFee	Fill_Import	$32.48	cy	13,000.0	LCY	n/a	n/a	13,000.0	10.0	13,000.0	cy	$422,175.00	$32.48					
Water Fee	MatFee	Fee_Water	$0.43	cy	10,400.0	CCY	n/a	n/a	10,400.0	10.0	10,400.0	cy	$4,503.20	$0.43					
Backfill from Onsite Stockpile					3,500.0	CCY							$32,100.81	$9.17	$0.55	$0.92	$0.73	$0.18	$11.56
Place, spread, and compact from borrow	Crew	FILL1	$955.79	hour	3,500.0	CCY	110.0	cy/hr	31.8	4.0	32.0	hour	$30,585.31	$8.74					
Water Fee	MatFee	Fee_Water	$0.43	cy	3,500.0	CCY	n/a	n/a	3,500.0	10.0	3,500.0	cy	$1,515.50	$0.43					

Markups	
HOOH	6%
JOOH	10%
Profit	8%
Bond	2%

Longhorn 18-24

Summary of Task-Based Estimate Haul

Description	Segment	Distance	Speed	Time (min)	Haul (Min)	Haul (Hr)	Crew	Rate	Total Rate	Unit	Notes
Haul_Commercial	Load	n/a	n/a	4.5	99	1.7	Haul2	$154.55	$256.00	load	20-ft flatbed, haul from commercial supplier
	Assumed haul	n/a	n/a	45.0							
	Dump	n/a	n/a	4.5							
Haul_Exc_Stock	Load	n/a	n/a	4.0	22	0.4	Haul1	$123.22	$47.00	load	Haul to nearby disposal areas northeast of site.
	Surface Road Haul	0.5	25	1.2							
	On site	0.5	5	6.0							
	Dump	n/a	n/a	4.0							
Haul_Dispose_WM	Load	n/a	n/a	30.0	540	9.0	Haul1	$123.22	$1,109.00	load	Hazardous Disposal to CWM Lake Charles (Waste Management)
	180-mi 1-way haul	n/a	n/a	240.0							CWM Lake Charles | Management Facility (Disposal) | WMSolutions.com
	Dump	n/a	n/a	30.0							7170 John Brannon Rd, Sulphur, LA 70665
Haul_Dispose_LA	Load	n/a	n/a	12.0	119	2.0	Haul1	$123.22	$245.00	load	Non-hazardous disposal, Shreveport, LA
	Surface Road Haul	33.4	50	40.1							Landfill | Shreveport, LA - Official Website (shreveportla.gov)
	On site	0.5	5	6.0							10580 Woolworth Rd, Keithville, LA 71047
	Dump	n/a	n/a	15.0							

Longhorn 18-24

Summary of Task-Based Estimate Crews

Crew	Eq & Labor	Category	Unit Rate	Unit	Num	Rate	Total Rate	Notes
CG1	Excavator_4.0cy	Equip	$265.09	hour	1	$265.09	$375.08	Hauling calculated separately.
	Operator4	Labor	$110.00	hour	1	$110.00		
	Teamster	Labor	$70.01	hour	0	$0.00		
	Laborer	Labor	$85.74	hour	0	$0.00		
Survey	Truck_Conventional	Equip	$62.17	hour	1	$62.17	$249.42	Survey crew, 1 chief + 2 aide + 2 technicians + work truck
	SurveyChief	Labor	$47.97	hour	1	$47.97		
	SurveyingAide	Labor	$29.37	hour	2	$58.74		
	SurveyingTechnician	Labor	$40.27	hour	2	$80.54		
InjWell	6inPump	Equip	$14.77	hour	1	$14.77	$186.83	IW labor, pump + 2 lab + truck
	6inPumpHose40ft	Equip	$0.59	hour	1	$0.59		
	Laborer	Labor	$85.74	hour	2	$171.48		
Sampling	Truck_Conventional	Equip	$62.17	hour	1	$62.17	$147.91	Survey crew, 1 chief + 2 aide + 2 technicians + work truck
	Laborer	Labor	$85.74	hour	1	$85.74		
EnvMonitor	Truck_Conventional	Equip	$62.17	hour	1	$62.17	$116.52	Environmental monitor + truck
	EnviroTech	Labor	$54.35	hour	1	$54.35		
HSOfficer	HealthSafetyOfficer	Labor	$130.27	hour	1	$130.27	$130.27	
HSMonitor	HealthSafetyMonitor	Labor	$84.37	hour	1	$84.37	$84.37	
Guard1	Guard1	Labor	$45.02	hour	1	$45.02	$45.02	
EXC1	Excavator_4.0cy	Equip	$265.09	hour	1	$265.09	$865.74	Excavator to dump material to be pushed to sotckpile by dozer.
	Dozer_D6	Equip	$215.36	hour	1	$215.36		
	Truck_45klb_4x2	Equip	$81.60	hour	1	$81.60		
	WaterTank	Equip	$13.69	hour	1	$13.69		
	Operator4	Labor	$110.00	hour	2	$219.99		
	Teamster	Labor	$70.01	hour	1	$70.01		
EXC2	Excavator_4.0cy	Equip	$265.09	hour	1	$265.09	$1,088.24	Excavator to dump material to be handled by dozer and loaded by loader, water truck for dust control. Dozer to also manage stockpile, clear haul routes, etc. Hauling calculated separately.
	Dozer_D6	Equip	$215.36	hour	1	$215.36		
	Loader_FE_3.5cy	Equip	$112.51	hour	1	$112.51		
	Truck_45klb_4x2	Equip	$81.60	hour	1	$81.60		
	WaterTank	Equip	$13.69	hour	1	$13.69		
	Operator4	Labor	$110.00	hour	3	$329.99		
	Teamster	Labor	$70.01	hour	1	$70.01		
LOAD1	Excavator_4.0cy	Equip	$265.09	hour	0	$0.00	$713.16	Material handling - loader + dozer
	Dozer_D6	Equip	$215.36	hour	1	$215.36		
	Loader_FE_3.5cy	Equip	$112.51	hour	1	$112.51		
	Truck_45klb_4x2	Equip	$81.60	hour	1	$81.60		
	WaterTank	Equip	$13.69	hour	1	$13.69		
	Operator4	Labor	$110.00	hour	2	$219.99		
	Teamster	Labor	$70.01	hour	1	$70.01		

Longhorn 18-24

Summary of Task-Based Estimate Crews

Crew	Eq & Labor	Category	Unit Rate	Unit	Num	Rate	Total Rate	Notes
FILL1	Dozer_D6	Equip	$215.36	hour	1	$215.36	$955.79	Assume material dumped from import, dozer to push material in place for compactor, water truck included for dust control and moisture conditioning, water tank for water storage on site.
	Loader_FE_3.5cy	Equip	$112.51	hour	0	$0.00		
	Grader	Equip	$146.27	hour	0.1	$14.63		
	Roller_Vib_ShpFt_5.5ft	Equip	$63.87	hour	1	$63.87		
	Truck_45klb_4x2	Equip	$81.60	hour	1	$81.60		
	WaterTank	Equip	$13.69	hour	1	$13.69		
	Pump_Water_6in	Equip	$18.70	hour	1	$18.70		
	Tank_10kGal	Equip	$13.97	hour	1	$13.97		
	Truck_Pickup	Equip	$61.49	hour	1	$61.49		
	Operator4	Labor	$110.00	hour	2.1	$230.99		
	Teamster	Labor	$70.01	hour	1	$70.01		
	Laborer	Labor	$85.74	hour	2	$171.48		
Drilling	8inAuger	Equip	$129.34	hour	1	$129.34	$534.47	8-in auger
	Truck_Conventional	Equip	$62.17	hour	1	$62.17		
	Laborer	Labor	$85.74	hour	4	$342.96		
SEED1	Hydroseeder	Equip	$103.07	hour	1	$103.07	$340.43	
	Truck_45klb_4x2	Equip	$81.60	hour	1	$81.60		
	Teamster	Labor	$70.01	hour	1	$70.01		
	Laborer	Labor	$85.74	hour	1	$85.74		
HAUL1	Dump_Highway	Equip	$53.20	hour	1	$53.20	$123.22	
	Teamster	Labor	$70.01	hour	1	$70.01		
HAUL2	Flatbed	Equip	$2.94	hour	1	$2.94	$154.55	
	Truck_45klb_4x2	Equip	$81.60	hour	1	$81.60		
	Teamster	Labor	$70.01	hour	1	$70.01		

Longhorn 18-24

Summary of Labor Rates and Markups

Labor	Base Rate	Fringes	Payroll Tax	WCI	Overtime	Productivity	Escalation	Total Rate	Unit	Notes
Operator2	$49.81	$22.47	$9.93	$11.19	$5.67	$17.48	$16.03	$116.55	hour	Heavy, USACE 2021 National Labor Library, adjusted to TX, escalated to 2022 + 20% for HTRW
Operator4	$46.03	$22.47	$9.41	$10.34	$5.24	$16.50	$15.13	$110.00	hour	Medium, USACE 2021 National Labor Library, adjusted to TX, escalated to 2022 + 20% for HTRW
Teamster	$32.90	$9.63	$5.84	$7.39	$3.74	$10.50	$9.63	$70.01	hour	Heavy, USACE 2021 National Labor Library, adjusted to TX, escalated to 2022
Laborer	$39.86	$12.35	$7.17	$8.96	$4.53	$12.86	$11.79	$85.74	hour	Semi-skilled, USACE 2021 National Labor Library, adjusted to TX, escalated to 2022 + 20% for HTRW
SurveyChief	$22.44	$6.73	$4.01	$5.04	$2.55	$7.20	$0.00	$47.97	hour	SCA code 99830, present cost
SurveyingAide	$13.74	$4.12	$2.45	$3.09	$1.56	$4.41	$0.00	$29.37	hour	SCA code 99831, present cost
SurveyingTechnician	$18.84	$5.65	$3.36	$4.23	$2.14	$6.04	$0.00	$40.27	hour	SCA code 99832, present cost
EnviroTech	$25.42	$7.63	$4.54	$5.71	$2.89	$8.15	$0.00	$54.35	hour	SCA code 30090, present cost
HealthSafetyOfficer	$53.57	$16.07	$9.57	$12.04	$6.09	$17.18	$15.75	$130.27	hour	USACE 2021 National Labor Library, adjusted to TX, escalated to 2022
HealthSafetyMonitor	$34.69	$10.41	$6.20	$7.80	$3.95	$11.13	$10.20	$84.37	hour	USACE 2021 National Labor Library, adjusted to TX, escalated to 2022
Guard1	$21.06	$6.32	$3.76	$4.73	$2.40	$6.75	$0.00	$45.02	hour	SCA code 27131, present cost

Factors	Rate	
Payroll Tax	13.74%	
WCI Rate	22.47%	
Overtime	10.00%	Mon-Fri, 12 hours/day
Productivity	85.00%	
HTRW Adjustment	20.00%	Increase
Esc 2020 to 2022	24.86%	
Esc 2021 to 2022	13.75%	
State Adjustment Factor	81.48%	USACE National Labor Library adjustment from Seattle to TX

Note 1: payroll tax is calculated on base rate + fringe benefits, workmans comp insurance is calculated only on base rate, overtime markup applies to base rate + payroll tax

Note 2: service and professional labor assumes fringe = 30% of base rate

Longhorn 18-24

Summary of Material Pricing

Material	Base Rate	Rate	Unit	
Fill_Import	$30.00	$32.48	cy	Quoted by A&T Sand and Gravel, 10 January 2023
Fill_HaulLoad	$225.00	$225.00	ea	11 CY loads. Quoted by A&T Sand and Gravel, 10 January 2023
Fee_LA	$28.00	$28.00	cy	Online rate for special handling waste
Fee_WM	$140.00	$155.40	tn	Hazardous disposal at Charles Lake CWM; note, awaiting updated hazardous disposal costs
Fee_Water	$0.40	$0.43	cy	
MW_Casing	$4.62	$5.00	lf	2022 MCACES Cost Book, 4-in DIA well casing
MW_Screen	$40.81	$44.18	lf	2022 MCACES Cost Book, 4-in DIA well casing
MW_GravelPack	$113.92	$123.32	lf	2022 MCACES Cost Book, 4-in DIA well casing
MW_Cap	$32.00	$34.64	ea	2022 MCACES Cost Book, 4-in DIA well casing
OfficeTrailer_MO	$460.00	$497.95	mo	2022 MCACES Cost Book, 50' x 12' trailer
StorageBox_MO	$139.00	$150.47	mo	2022 MCACES Cost Book, 40' x 8' storage box
ToiletPortable_MO	$113.27	$122.61	mo	2022 MCACES Cost Book
FieldExpense_MO	$487.50	$527.72	mo	2022 MCACES Cost Book, office equipment, supplies, field office lights
TempPowerConnection	$305.00	$330.16	ea	2022 MCACES Cost Book
DirectPushRig	$2,050.20	$2,050.20	day	Vendor quote from 2022 MCACES Cost Book, Direct Push Rig, Truck Mounted, non Hydraulic, Incl. Labor, Sampling, Decon

Factors	Rate		
Sales Tax + Market Allowance	1.0825	Sales tax	
Escalation 2022 to 2024	1.11		USACE EM 1110-2-1304, September 2022 Update

Non-hazardous disposal, Shreveport, LA
Landfill | Shreveport, LA - Official Website (shreveportla.gov)
10580 Woolworth Rd, Keithville, LA 71047

Hazardous Disposal to CWM Lake Charles (Waste Management)
CWM Lake Charles | Management Facility (Disposal) | WMSolutions.com
7170 John Brannon Rd, Sulphur, LA 70665

Longhorn 18-24
Summary of Equipment Rates and Markups

Equipment	Model	Depreciation	FCCM	FCCM Discount	Operating Cost	Productivity	Subtotal	Escalation FY20 to FY22	Total Rate	Unit	Notes
Loader_FE_3.5cy	930M	$19.61	$1.43	-$0.29	$63.07	$14.79	$98.62	$13.89	$112.51	hour	
Truck_Conventional	4X4 3/4 TON CONV GAS	$3.62	$0.45	-$0.09	$42.34	$8.17	$54.49	$7.68	$62.17	hour	
Truck_45klb_4x2	4X2 37KGVW DSL	$4.31	$0.38	-$0.08	$56.18	$10.73	$71.52	$10.08	$81.60	hour	
Dump_Highway	4X2 28KGVW DSL	$7.32	$1.41	-$0.28	$31.19	$6.99	$46.63	$6.57	$53.20	hour	10wh Dump
Flatbed	PVMXT-203C	$1.12	$0.14	-$0.03	$0.96	$0.39	$2.58	$0.36	$2.94	hour	20-ft
Hydroseeder	T330	$19.80	$0.58	-$0.12	$56.53	$13.55	$90.35	$12.73	$103.07	hour	3,000 gal truck mounted hydroseeder, add truck
WaterTank	DS 4000	$5.03	$0.31	-$0.06	$4.92	$1.80	$12.00	$1.69	$13.69	hour	4,000 water tank, add truck
WaterTruck	740B & 8K TANK	$53.13	$4.61	-$0.92	$189.89	$43.54	$290.24	$40.89	$331.13	hour	TRUCK, WATER, OFF-HIGHWAY, 8K GAL, W/CAT 740B TRUCK
Dozer_D6	D6N XW	$33.65	$2.82	-$0.56	$124.55	$28.32	$188.77	$26.59	$215.36	hour	
Excavator_4.0cy	349E	$26.66	$6.75	-$1.35	$165.44	$34.85	$232.35	$32.73	$265.09	hour	115.7k lb, 4.05 cy bucket
Grader	140-M3	$26.46	$2.91	-$0.58	$80.19	$19.23	$128.21	$18.06	$146.27	hour	
Roller_Vib_ShpFt_5.5ft	TRU-PAC 915 B	$11.80	$0.62	-$0.12	$35.29	$8.40	$55.98	$7.89	$63.87	hour	ROLLER, STATIC, SELF-PROPELLED, PNEUMATIC, 6-15 TON, 68" WIDE, 9 TIRES, ASPHALT/SOIL COMPACTOR
Pump_Water_6in	S6A1-E60 460/3	$2.50	$0.13	-$0.03	$11.33	$2.46	$16.39	$2.31	$18.70	hour	PUMP, WATER, SUBMERSIBLE, ELECTRIC, 6" DIA, 1,950 GPM @ 40' HEAD (ADD HOSES)
Pump_Hose_20ft	C354-90	$0.15	$0.00	$0.00	$0.31	$0.08	$0.54	$0.08	$0.62	hour	PUMP HOSE, SUCTION, 6" (153 MM) DIA x 20' (6.1 M) LENGTH, W/COUPLING/SECTION
Tank_10kGal	KPT-100	$3.73	$0.32	-$0.06	$6.42	$1.84	$12.24	$1.72	$13.97	hour	WATER TANK, PORTABLE, TRAILER MTD, SELF ELEVATING, 10,000 GAL, 10" PIPE
Truck_Pickup	4x2	$3.38	$0.19	-$0.04	$42.28	$8.08	$53.90	$7.59	$61.49	hour	TRUCK, HIGHWAY, CONVENTIONAL, 3/4 TON PICKUP, 4X2
Dump_740	740GC	$46.49	$3.96	-$0.79	$156.38	$36.36	$242.40	$34.15	$276.54	hour	TRUCK, OFF-HIGHWAY, ARTICULATED FRAME, 31.4 CY, 43.5 TON, 6X6, REAR DUMP
Generator_30KW	30KW Trailer	$3.90	$0.19	-$0.04	$12.93	$3.00	$19.98	$2.81	$22.79	hour	GENERATOR SET, SKID MTD, 30 KW
8inAuger	B-60 Truck	$29.47	$6.03	-$1.21	$62.07	$17.01	$113.37	$15.97	$129.34	hour	DRILL, EARTH / AUGER, MULTI-PURPOSE, 8" (20CM) DIA, 250' (76.2M) DEPTH, 7,000 FT-LBS (9.5KNM) TORQUE W/45KGVW (20.4MT) TRUCK (ADD COST FOR DRILL STEEL AND CUTTING EDGE WEAR)
6inPump	04MH & 250HPND	$2.86	$0.44	-$0.09	$7.79	$1.94	$12.94	$1.82	$14.77	hour	PUMP, WATER, SUBMERSIBLE, 4"(10 CM) DIA, 455 GPM (1.7 M3M) MAX FLOW, 59' (18 M) MAX HEAD (INCLUDES TRAILER MTD POWER UNIT MODEL 250)(ADD HOSES)
6inPumpHose40ft	C357-90	$0.16	$0.02	$0.00	$0.26	$0.08	$0.51	$0.07	$0.59	hour	2X PUMP HOSE, SUCTION, 4" (102 MM) DIA x 20' (6.1 M)LENGTH, W/COUPLING/SECTION

Factors	
Escalation	14.09%
Productivity	85.00%
Overtime FCCM Discount	-20.00%

Fuel (via internet search, Shell Station on Lafayette, taken 12 May 2022)

Diesel:	$6.90	/gal
Regular:	$6.30	/gal
Intermediate:	$6.50	/gal
Premium:	$6.70	/gal

Cost Estimate Backup Information

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond Karnack, Texas



HDR

Longhorn Army Ammunition Plant (LHAAP) – 18/24 Site

Karnack, TX

Preliminary Site Evaluation

Revision 2

December 23, 2022

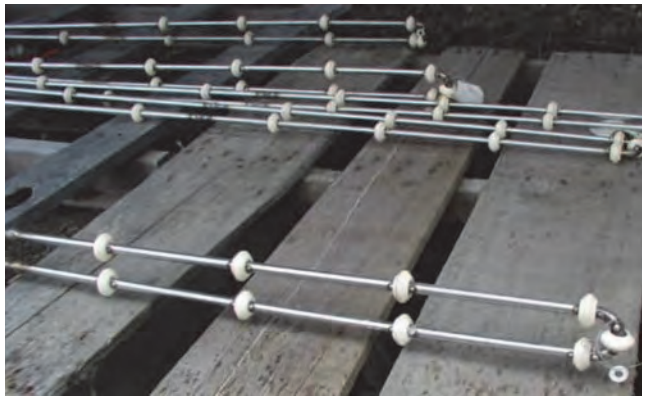
TERRATHERM
a Cascade Company
www.terratherm.com

About TerraTherm



- Based in MA and offering all major methods of subsurface heating
  - Thermal Conduction Heating (TCH)
  - Electric Resistance Heating (ERH)
  - Steam Enhanced Extraction (SEE)
- Over 20 years of experience implementing all three thermal technologies
- Our staff has played key roles in the technical development of TCH and ERH, and have an unparalleled knowledge about how to successfully deploy each technology
- TerraTherm has successfully completed more than:
  - 75 TCH projects
  - 55 ERH projects
  - 15 SEE projects
- 70 dedicated staff members with over 450 years of collective thermal experience
- First thermal company in the industry to gain UL electrical safety certification of heaters

Site Background







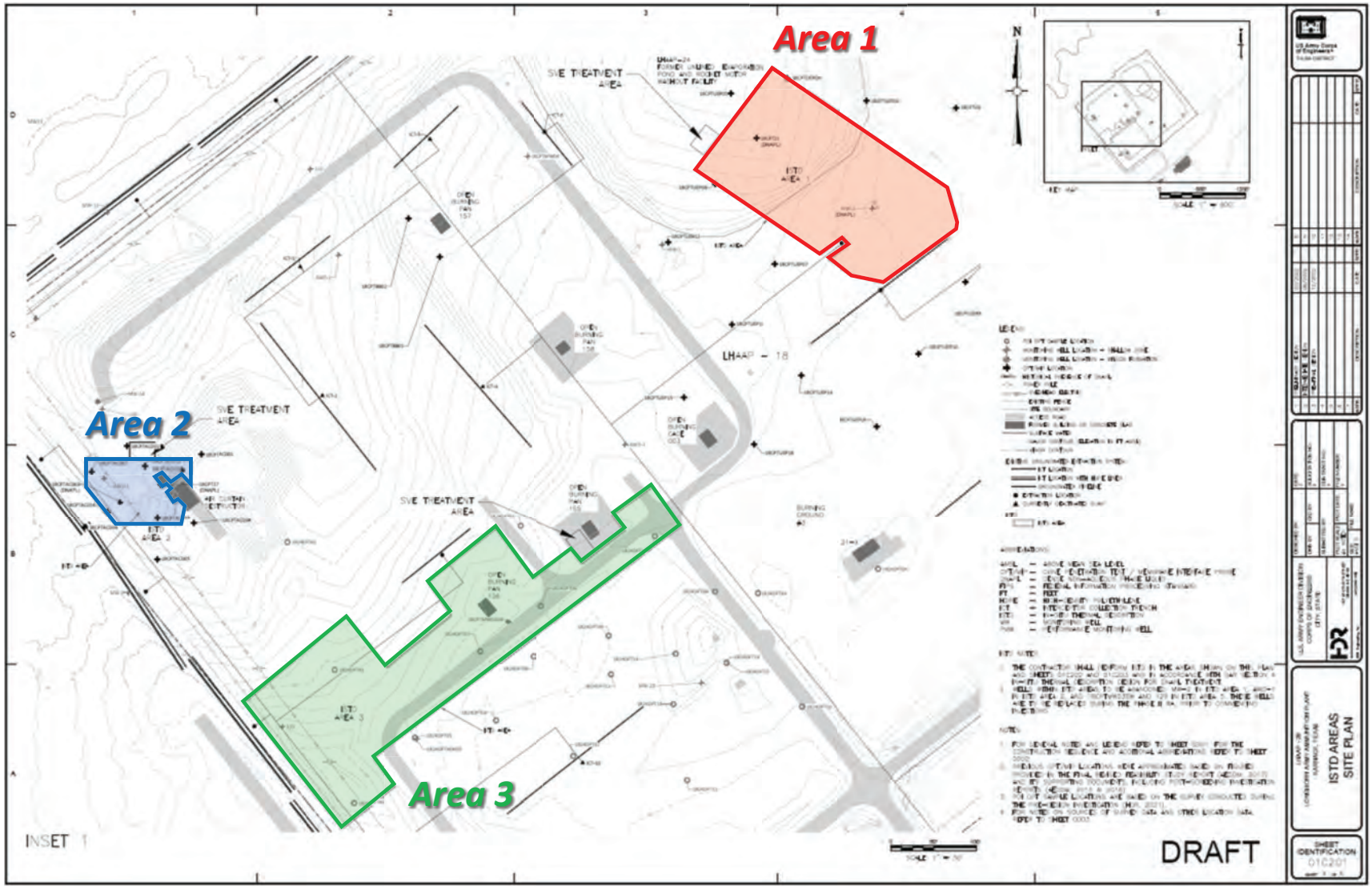
Site Name: Longhorn Army Ammunition Plant (LHAAP) – 18/24 Site

Site Location: Karnack, Texas

Site/Environmental Consultant: HDR

Objective: Obtain a conceptual cost to implement thermal remediation at the site

Treatment Areas Map



Geology and Hydrogeology

Geology:

- 0 to ~30 ft bgs: Flood plain silts and clays
- ~30 to ~50 ft bgs: Wilcox marine and deltaic clays and silts

Hydrogeology:

- Per the information provided, water surface elevation is found at approximately 20 ft bgs and was used for this evaluation.
- The hydraulic conductivity values varies between 1.52×10^{-4} and 3.86×10^{-3} cm/sec.
- A representative hydraulic conductivity value of 2.01×10^{-3} cm/sec (5.69 ft/day) was used for this evaluation.
- Per the information provided, groundwater velocity varied between 0.0082 ft/day and 0.4267 ft/day.

Hydraulic gradient:

- A provided hydraulic gradient varied between 0.0009 ft/ft and 0.01 ft/ft. A representative hydraulic gradient value of 0.0047 ft/ft was used for this evaluation.

Treatment Scenario

Treatment Areas (ft^2)				Impacted Depth (ft bgs)	Treatment Depth (ft bgs)	Treatment Volume (CY)		
Treatment Area 1 (DNAPL, TCE & MC)	40,000		103,500	48.0 – 51.0	20.0 – 51.0	45,926		91,574
Treatment Area 2 (DNAPL, TCE & MC)	7,500	63,500		23.0 – 35.0	20.0 – 35.0	4,167	45,648	
Treatment Area 3 (TCE)	56,000			28.0 – 40.0	20.0 – 40.0	41,481		

Notes:

- Existing in situ collection trench (ICT) system, consisting of collection trenches, sumps, and extraction piping network
- Mostly flat terrain with some concrete pads
- No current site operations
- Full access to the site during construction and operation



COCs, Mass Estimate and Remediation Goals

Contaminants of Concern (COC): Methylene Chloride and Trichloroethene

Mass Estimate: Not provided. A total mass estimate of approximately 39,400 lbs was assumed and used for this evaluation.

The estimated total mass present within the target treatment zone (TTZ) should be further evaluated at a later stage of the project.

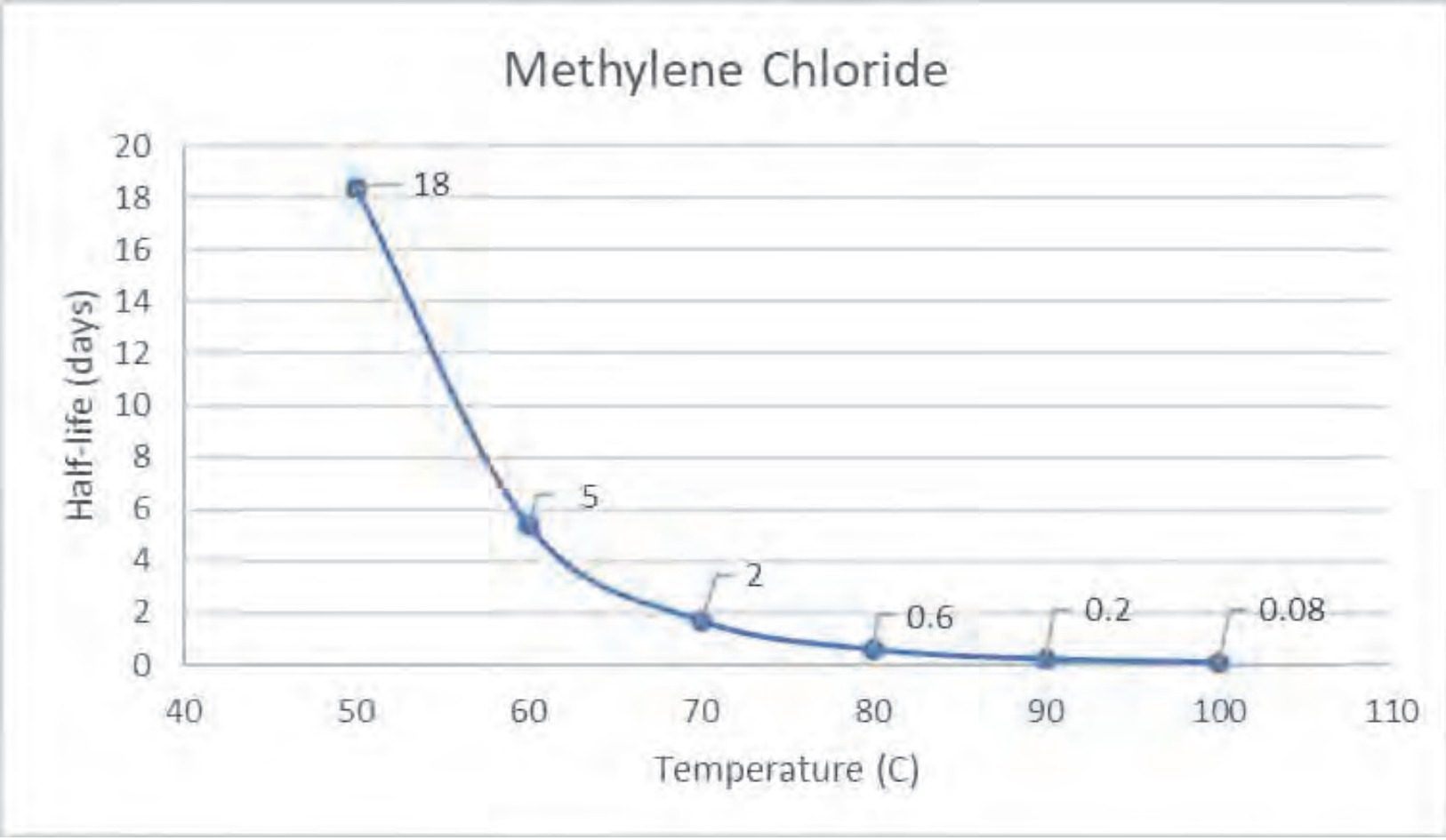
Remediation Goals: *Per the ROD – "The remedy selection was based on documentation available in the Administrative Record for the site, including the remedial investigation (RI) (Jacobs Engineering Group, Inc. [Jacobs], 2001), baseline human health risk assessment (BHHRA) report (Jacobs, 2002), installation-wide baseline ecological risk assessment (BERA) report (Shaw Environmental, Inc. [Shaw], 2007), baseline ecological risk assessment addendum (BERA) report (AGEISS, 2014), feasibility study (FS) (AECOM, 2017), post-screening investigation (PSI) (AECOM, 2013), updated PSI (AECOM, 2016a), and supplemental to updated PSI (AECOM, 2016b) and proposed plan (PP) (U.S. Department of the Army [U.S. Army], 2019).*



Chemical Name	Groundwater (µg/L)		Soil (mg/kg)	
	Max Level Detected	Target Level	Max Level Detected	Target Level
Methylene Chloride	1,050,000	100	-	0.5
Trichloroethene	68,400	100	-	0.5

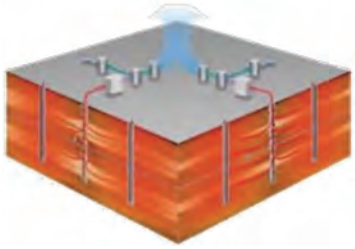
Hydrolysis of Methylene Chloride

Hydrolysis rate of methylene chloride with temperature (more than 500 days at ambient temperature):



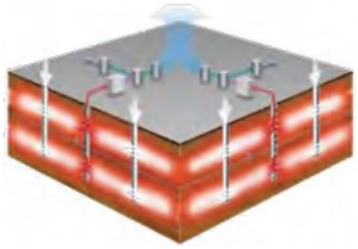
Thermal Technologies

Thermal Conduction Heating (TCH / ISTD)



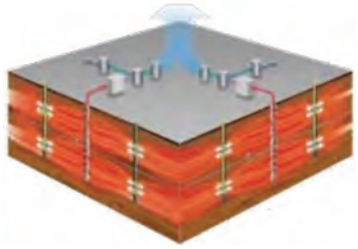
For all sites with low to moderate groundwater flow rates and either Volatile Organic Compounds (VOCs) or Semi-Volatile Organic Compounds (SVOCs).

Steam Enhanced Extraction (SEE)

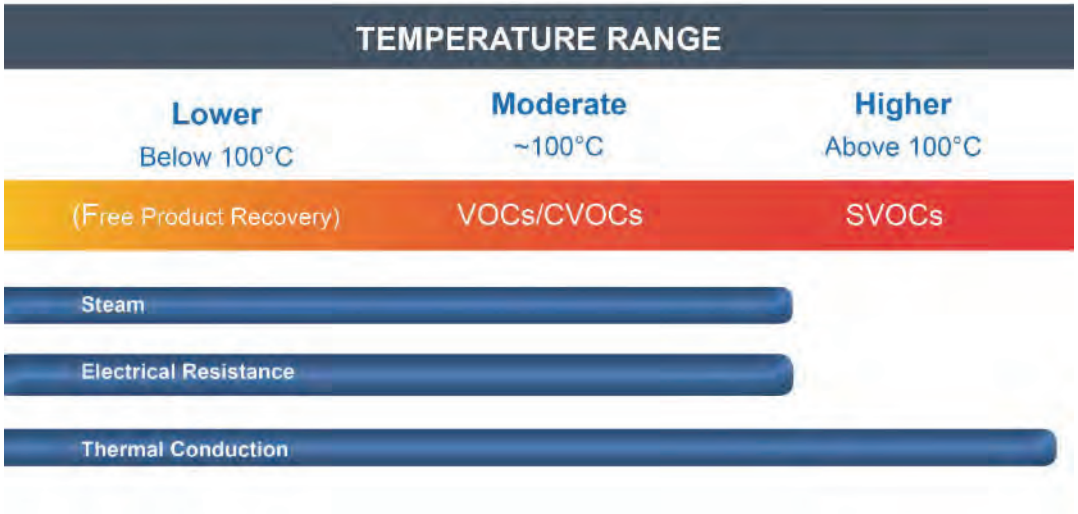


For permeable sites with significant groundwater flow rates and for sites with either volatile or moderately volatile contaminants.

Electrical Resistance Heating (ERH)



For all sites with low to moderate groundwater flow rates and either volatile or moderately volatile contaminants.



Thermal Technologies Evaluated

Characteristics	TCH	SEE	ERH
Heating Method	Conduction	Steam Injection, Convection	Electrical Resistance
Factors Governing Heating	• Thermal conductivity of the soil matrix. • Groundwater flow rate.	Injection rates and pressure are determined by the permeability of the soil matrix which can be too tight for SEE applications.	• Electrical resistivity of the soil matrix. • Groundwater flow rate. • Minimum electrode length is 10-feet
Maximum Temperature	• Low Temp TCH = 100°C (boiling point) • High Temp TCH = 325-400°C (once dewatered)	100°C (boiling point)	100°C (boiling point)
Sensitivity to Water Content and Flow	• Works in saturated and dry conditions. • High water flow can remove heat faster than it is added.	Not Sensitive	• Difficulty in dry Vadose Zone conditions. • High water flow can remove heat faster than it is added.
Sensitivity to Contrasts between Layers	Heating rates may be affected by differences in water content and flow rates between layers.	Aquitards not heated directly	Resistivity contrasts between layers require multi-element electrodes – long electrodes may be less efficient.
Sensitivity to Buried Objects	Not sensitive	Low-permeable layers may interfere with stream migration.	Metal debris and pipes may prevent uniform heating.
Heat Input Governed By	Soil thermal conductivity - which varies only by a factor of 1 to 3 between most common geologies.	Hydraulic conductivity of soil layers	Soil resistivity – which varies by large factors (over 200 X) between most common geologies.
Fluids Added to Ground	None	Steam	Water to keep electrodes saturated
General Safety Issues	High temperatures and steam	High temperatures and steam	• High temperatures and steam • Surface voltages

Note: Thermal Conductive Heating (TCH) has been selected as the preferred ISTR technology for this preliminary evaluation. ERH may also be a viable technology at the site, and should be evaluated prior to final technology selection.

Conceptual Treatment Approach/Methodology

Conceptual Treatment Approach:

- TCH using a heater spacing of approximately 17 feet to target the boiling point of water.
- Soil vapor and steam extraction from vertical extraction wells used to extract the vaporized contaminants and steam, and to maintain pneumatic and hydraulic control.

Vapor and Liquid Treatment Approach:

- Vapor treated using a thermal oxidizer system, due to the high mass present at the site.
- Extracted liquids (condensate) treated using Granular Activated Carbon (GAC).

Monitoring:

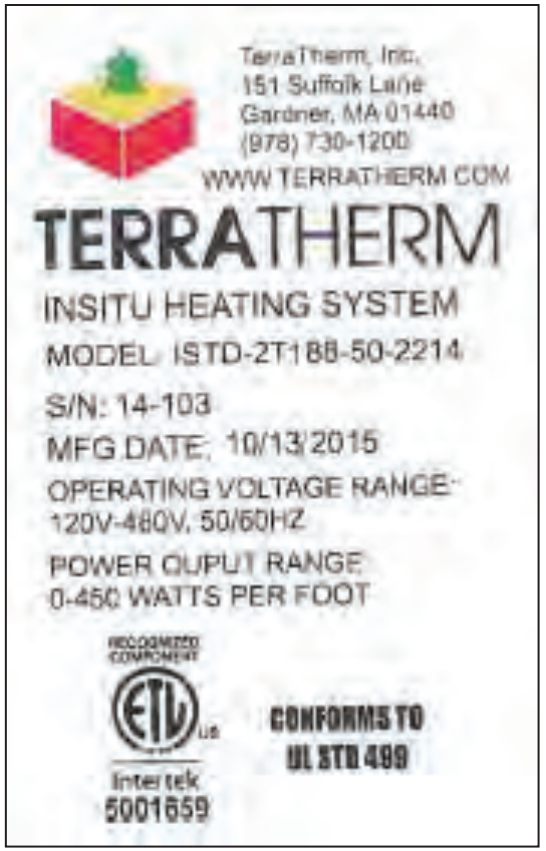
- Temperature and pressure monitoring to track subsurface heating, pneumatic, and hydraulic control.
- Vapor and liquid treatment system monitoring for mass removal and discharge compliance.



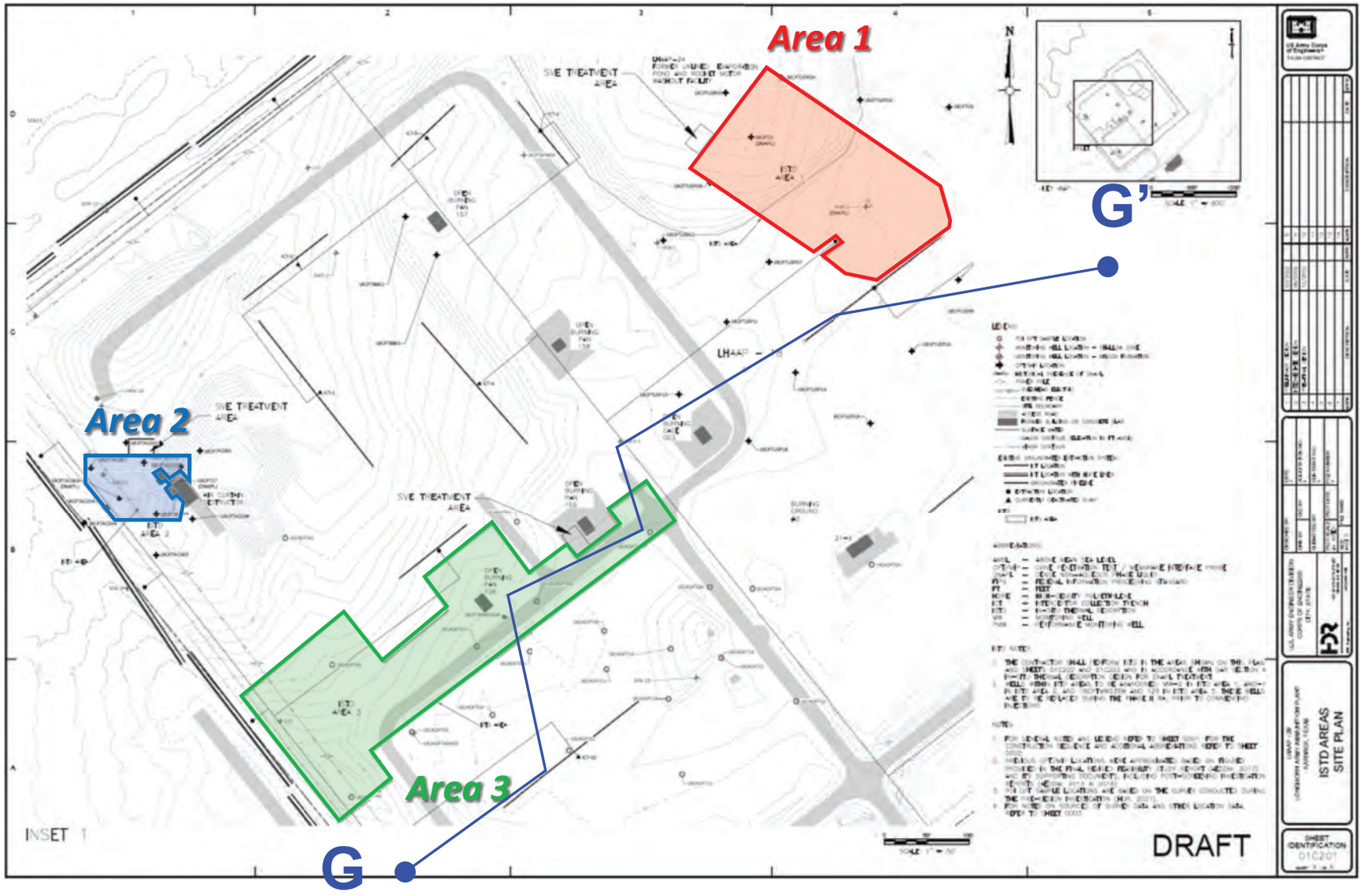
UL Safety Certification

UL Safety Certification

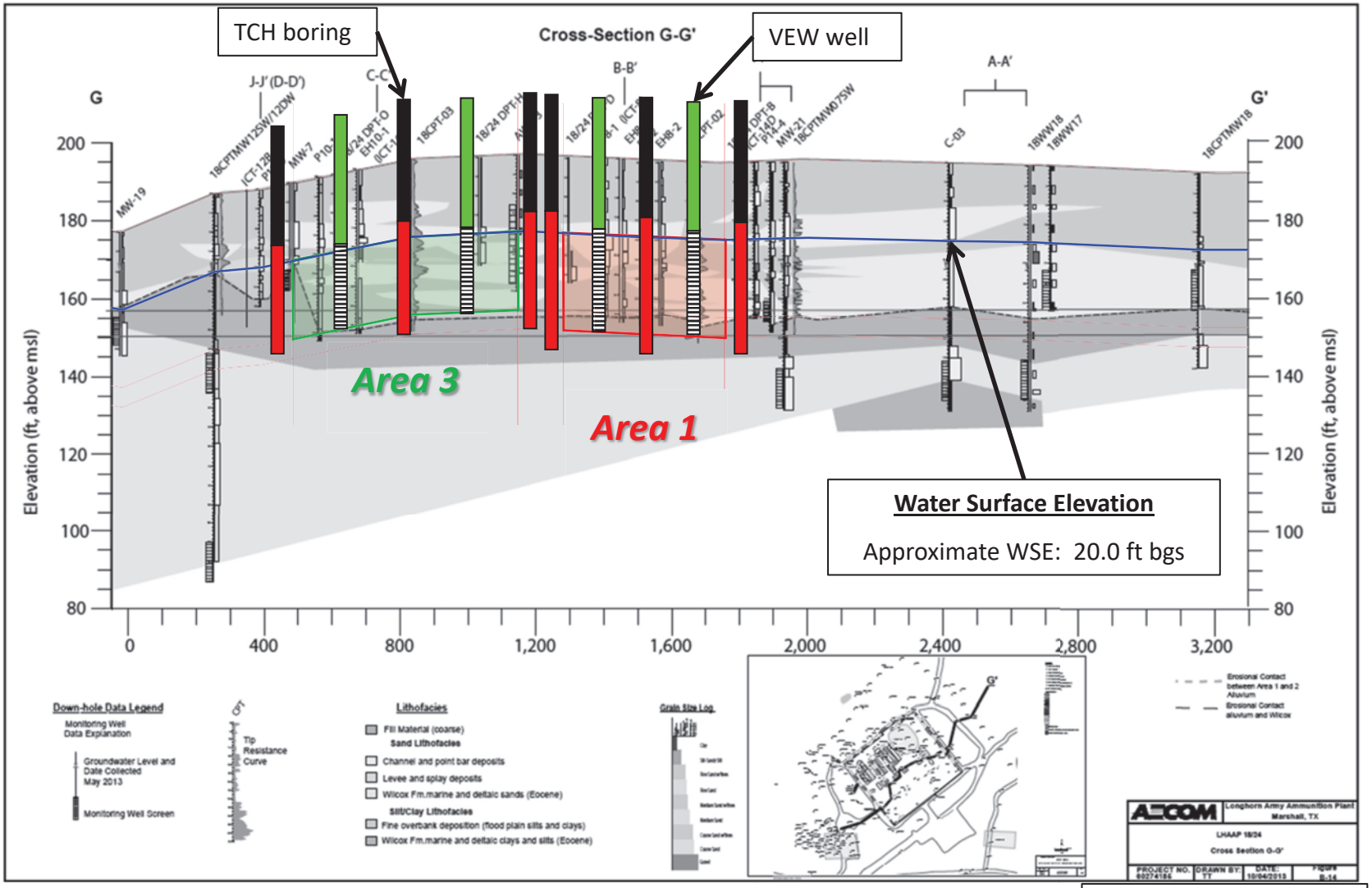
TerraTherm was the first and thermal remediation company in the industry to gain certification of its heating system and heating components. Intertek, an Occupational Safety and Health Administration (OSHA) Nationally Recognized Testing Laboratory, has granted our heating system the ETL Mark, a symbol that verifies product compliance to North American Safety Standards. This certification demonstrates compliance with UL499 and UL1030 **exhibiting the highest standard of care for electrical safety within our industry**.



Treatment Areas and Cross Section G-G’



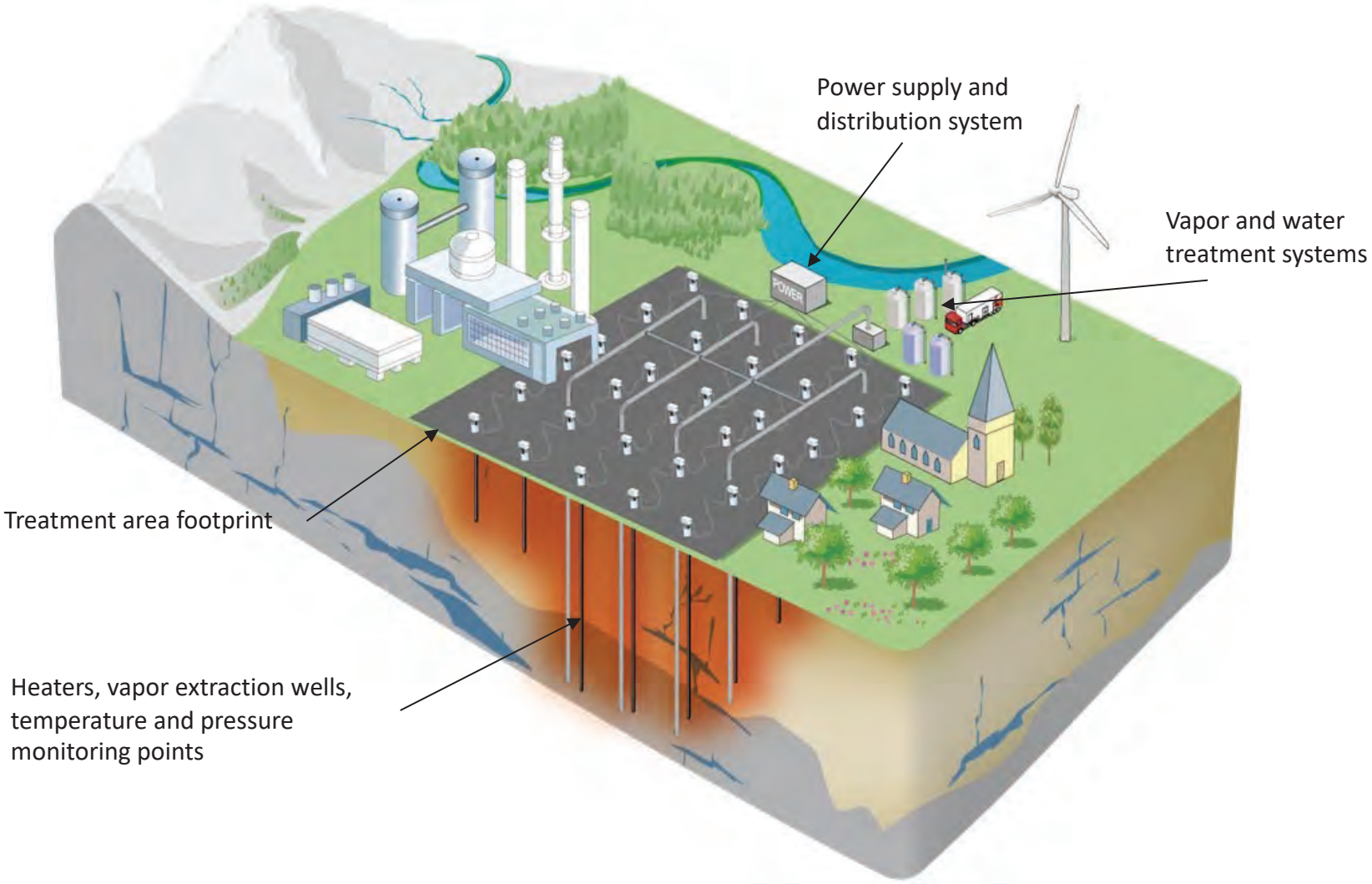
Conceptual Cross Section (G-G')



** 5 ft heater stick up and down.*

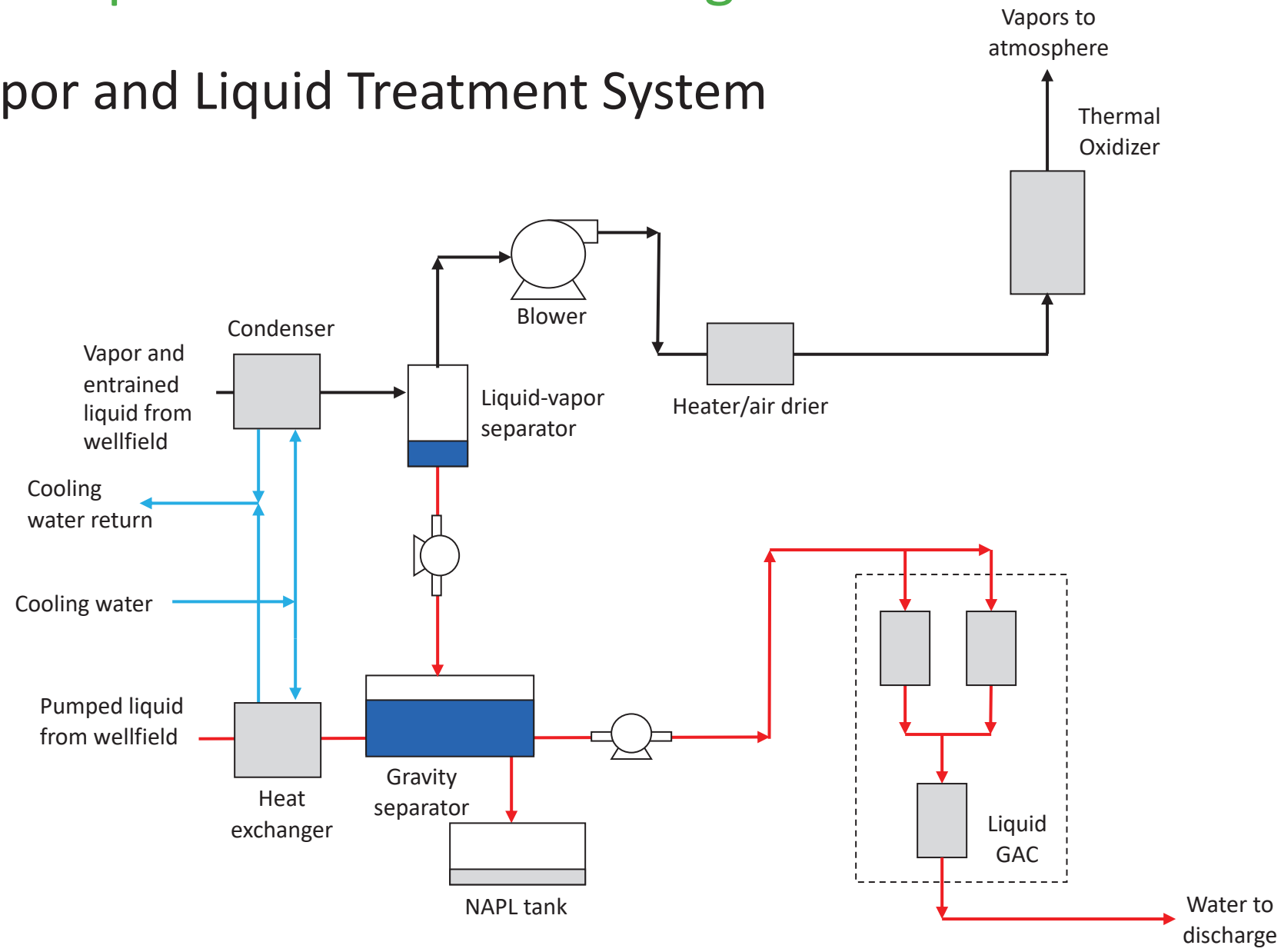
NOT TO SCALE

Schematic of Typical TCH Site



Conceptual Process Flow Diagram

Vapor and Liquid Treatment System



Conceptual Design Parameters

Longhorn Army Ammunition Plant (LHAAP) – 18/24 Site					HDR
Volume and heat capacity	***Area 1***	***Area 2***	***Area 3***	***Total***	***Unit***
Treatment area	40,000	7,500	56,000	103,500	ft^2
Upper depth of treatment	20.0	20.0	20.0		ft bgs
Lower depth of treatment	51.0	35.0	40.0		ft bgs
Volume, TTZ	45,926	4,167	41,481	91,574	yd^3
Solids volume	29,852	2,708	26,963	59,523	yd^3
Porosity	0.35	0.35	0.35		-
Porosity volume	16,074	1,458	14,519	32,051	yd^3
Initial saturation	88	83	85		percent
Soil weight	133,297,724	12,093,544	120,397,944	265,789,212	lbs soil
Water weight	23,931,820	2,038,892	20,823,257	46,793,969	lbs water
Soil heat capacity	33,324,431	3,023,386	30,099,486	66,447,303	BTU/F
Water heat capacity	23,931,820	2,038,892	20,823,257	46,793,969	BTU/F
Total heat capacity, whole TTZ	57,256,251	5,062,278	50,922,743	113,241,272	BTU/F

Conceptual Design Parameters (Continued)

Longhorn Army Ammunition Plant (LHAAP) – 18/24 Site					HDR
Energy balance	***Area 1***	***Area 2***	***Area 3***	***Total***	***Unit***
TCH power input rate	2,120	250	2,170	4,539	kW
Average extracted water temperature	190	190	190		F
Percent of injected energy extracted as steam	30	30	30		%
Steam extracted, average	2,234	263	2,287	4,785	lbs/hr
Energy flux into treatment volume	7,231,172	852,853	7,401,914	15,485,939	BTU/hr
Energy flux in extracted groundwater	81,092	32,911	58,539	172,542	BTU/hr
Energy flux in extracted steam	2,169,352	255,856	2,220,574	4,645,782	BTU/hr
Net energy flux into treatment volume	4,980,729	564,086	5,122,800	10,667,616	BTU/hr
Heating per day	2	3	2		F/day
Start temperature	50	50	50		F
Target temperature	236	224	228		F
Estimated heat loss, worst case	46	91	72		%
Operating time					
Heater ramp up	3	3	3		days
Heating to target temperature	114	116	115		days
Maintaining target temperature	116	111	114		days
Sampling/analysis phase	3	3	3		days
Post treatment vapor extraction	7	7	7		days
Total operating time		243			days

Conceptual Design Parameters (Continued)

Longhorn Army Ammunition Plant (LHAAP) – 18/24 Site	HDR			
Numbers of wells	*Area 1*	*Area 2*	*Area 3*	*Total*
Heater borings, regular application	188	40	263	491
Vertical Vapor Extraction well, regular application	56	11	77	144
Temperature monitoring holes	11	4	15	30

Longhorn Army Ammunition Plant (LHAAP) – 18/24 Site		HDR
Process equipment	*Value*	*Unit*
ISTD power supply	4,540	kW
Treatment system power supply	250	kW
Total power need to site	5,990	kW
Estimated total electric load	7,500	kVA
Estimated total amperage	9,000	Amps
Vapor extraction rate, total	3,440	scfm
Non-condensable vapor	1,730	scfm
Estimated steam extraction	1,710	scfm
Liquid extraction rate	2.46	gpm
Condensed liquid rate	9.58	gpm
Water treatment rate	12.04	gpm
Vapor treatment type	Thermal Oxidizer w/ heat recovery	-
Dominant contaminant of concern	Trichloroethene (TCE)	-
Estimated COC mass	39,368	lbs
Estimated COC mass treated by vapor system	38,581	lbs
Estimated COC mass treated by water system	787	lbs
Estimated max mass removal rate, vapor system	361	lbs/day

Conceptual Utility Requirements & Budgetary Costs

Longhorn Army Ammunition Plant (LHAAP) – 18/24 Site		HDR
Utility estimates	***Value***	***Unit***
Power usage, in ground	25,400,000	kWh
Power usage, treatment system	1,452,000	kWh
Power usage, total	26,852,000	kWh
Gas usage, total	40,064	MM BTU

HDR Longhorn Army Ammunition Plant (LHAAP) – 18/24 Site	
Design and Procurement	$250,000
Construction and Operation	$9,490,000
Total	**$9,740,000**
Utilities, paid by client	$2,530,000
Total (with Utilities)	**$12,270,000**

Unit cost
Without utilities: 106 $/cy
With utilities: 134 $/cy

Assumptions

Price:

- +/- 30% price accuracy based on current understanding of preliminary Conceptual Site Model (CSM) as stated in this treatment concept
- Unit power cost assumed: $0.08/kWh (Source: https://www.eia.gov/electricity/state/)
- Evaluation assumes: (a) full access to the site during construction and operation; (b) that all utilities will be protected at the boundary of the Treatment Area; and (c) that all electrical and mechanical connections to be done above grade.

Turn-Key services:

- Design/procurement/permitting (permitting managed by HDR, TerraTherm supports the process)
- Construction
- Operations (site and office support)
- Demobilization
- Reporting

Construction:

- 150 ft/day drilling production assumed
- Electrical and mechanical connections above grade

Operations

- Standard:
  - Field Crew (3 persons on average) housed within a 30-minute drive to the site
  - Office support: Project Management and Engineering

Demobilization

- Bringing site back to as near to starting conditions as possible:
  - Grouting up wells
  - Removal of all equipment
  - Overdrilling of wells is excluded

Possible Next Steps (If Applicable)

Basis of Design Report (BODR):

TerraTherm would be pleased to provide a proposal for preparation of the BODR (or alternatively for preparation of the detailed design effort) as described below for the project.

The BODR includes the following:

- Site visit and meeting
- Thermal modeling and refinement of thermal treatment concept(s)
- Evaluation of data gaps
- Risk/uncertainty evaluation
- Definition of exact scope of work for key project tasks (responsibility matrix)
- Comparison of multiple treatment scenarios (if applicable)
- Updated cost estimate

The price for this deliverable can range from $20,000 to $25,000.

For further information, please contact **Jeff Brink** at (720) 940-4885.

From: Michelle Prelow <Michelle.Prelow@shreveportla.gov>
Sent on: Wednesday, January 11, 2023 7:19:11 PM
To: Giordano, Thomas <Thomas.Giordano@hdrinc.com>
Subject: RE: Disposal Quote for LHAAP

CAUTION: [EXTERNAL] This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Thomas,

The Woolworth Road Landfill is strictly a disposal facility owned by the City of Shreveport and therefore, do not provide transportation services. You would need to contact a transportation provider. Due to a conflict of interest, I am not at liberty to refer or recommend you to a transportation servicer but do suggest conducting a search for local providers.

Should you decide to utilize our facility the rate for industrial non-hazardous waste is $28.00 per yardage.

I regret not being able to better assist you but hope this information has been helpful. Please feel free to contact me should you have any other questions or concerns.

Best regards,

Michelle Prelow, Landfill Supervisor
COS Solid Waste Dept.
Woolworth Road Landfill
10580 Woolworth Rd.
Keithville, LA 71047
PH. 318.925.3500
michelle.prelow@shreveportla.gov

City of Shreveport
DEPARTMENT OF PUBLIC WORKS

From: Giordano, Thomas <Thomas.Giordano@hdrinc.com>
Sent: Wednesday, January 11, 2023 12:03 PM
To: Michelle Prelow <Michelle.Prelow@shreveportla.gov>
Subject: Disposal Quote for LHAAP

Hello Michelle,

I am following up on our phone conversation. Would you be able to provide transportation and disposal pricing for the below waste?

- 10,060 cy (approximately 15,090 tons) of industrial non-hazardous soil generated within a 1-month period.
- This waste will be generated at the Site 18/24 Former Longhorn Army Ammunition Plant (LHAAP) in Karnack, Texas. In 2011, your facility accepted similar non-hazardous soil waste from Site 4 of the LHAAP.
- I have provided some representative contaminant concentrations from historical samples in the below table.

If you could, please provide transportation and disposal costs per ton. Please let me know if you need any additional information to prepare a quote. I appreciate your help.

Representative Contaminant Concentrations

Boring ID	Soil Interval	TCE	MC	Perchlorate
	ft bgs	ug/kg	ug/kg	ug/kg
18CPTBB02	4.5-5.5	-	-	18,700
8A-940	4	430,000	22,000	-
8A-940	10	150,000	420,000	-
8A-940	14	2,200,000	600,000	-
8A-984	10-11	<5	16	-
8A-984	14	210,000	600,000	-
8A-975	5.5-7.5	<30	820	-
8A-975	10-12	58	2,900	-
18SB02	10-12	11,800	-	-
18CPTPB17	16-17	531	-	-
8A-911	8	3,228	4,318	-

Thank you,

Tom Giordano, EIT
Environmental Engineer in Training

HDR
50 Tice Boulevard, Suite 210
Woodcliff Lake, NJ 07677
D 201.335.9460 **M** 201.786.8474
thomas.giordano@hdrinc.com

hdrinc.com/follow-us

From: Rhyne, John <jrhyne@wm.com>
Sent on: Monday, May 23, 2022 7:10:03 PM
To: Giordano, Thomas <Thomas.Giordano@hdrinc.com>
CC: Heinke, Simone <sheinke@wm.com>; Yelverton, Allison <ayelvert@wm.com>
Subject: Raritan Bay Slag Site - Seawall Sector Waste Disposal

CAUTION: [EXTERNAL] This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hello Tom

-

RE: Budget T&D 2023 quotation from CWM Emelle RCRA Haz Metas soil and the RCRA Metals Haz Slag material seawall removal action

Waste approval will be contingent upon WM (CWM Emelle) Review of a waste profile, and certified analysis, this rough order of magnitude (ROM) quotation is based upon the tables provided, however waste approval and hard number unit rates will be based on review of WM waste profile and certified analysis/treatability samples (if necessary).

RCRA Hazardous Metals Soil from the Seawall area - $355.00 per Ton
or
RCRA Hazardous Metals Slag from the Seawall - $395.00 per Ton

Terms and Conditions

- ADEM waste approval fee $ 360.00 per profile (one-time Agency approval fee)
- $11.00 per ton Disposal tax CWM Emelle, AL
- $4.50 per ton NJ Haz Tax
- Fuel Surcharge is included in the above rate, its set at today's rate, subject to change if fuel increases.
- 100 net ton minimum per gondola Rail Car, 110 ton max per Railcar
- 25 net ton min per Tri-axle Truck loaded from the project site, one hour free loading time, $120.00 per hour thereafter
- $25.00 / load (EPA e-Manifest Fee)
- Estimate inclusive of Front end trucking, railcar mobilization, transload, all packaging, railcar utilization, rail logistics, destination truck drayage, Treatment and Disposal at CWM Emelle
- Estimate Valid for 30 days
- Debris to be sized to < 18 inches in any dimension with no protruding rebar.

Thanks

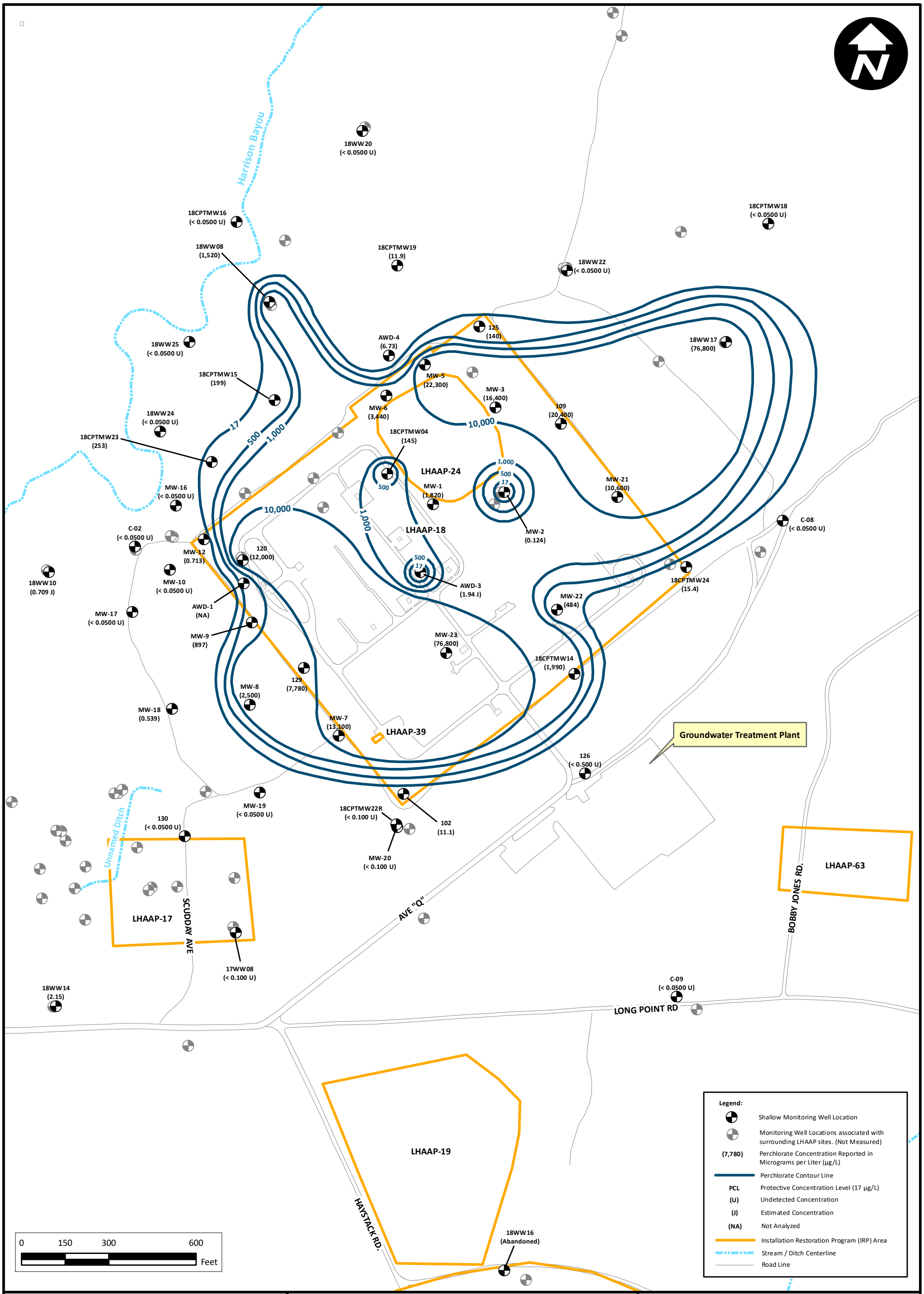
John Rhyne
SME Hazardous Waste & Waste by Rail
(404)-402-5732
jrhyne@wm.com

Chemical Waste Management - Emelle, AL
Chemical Waste Management - Lake Charles, LA

APPENDIX C

Figures from Bhate GWTP Quarterly Evaluation Reports

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas



bhate

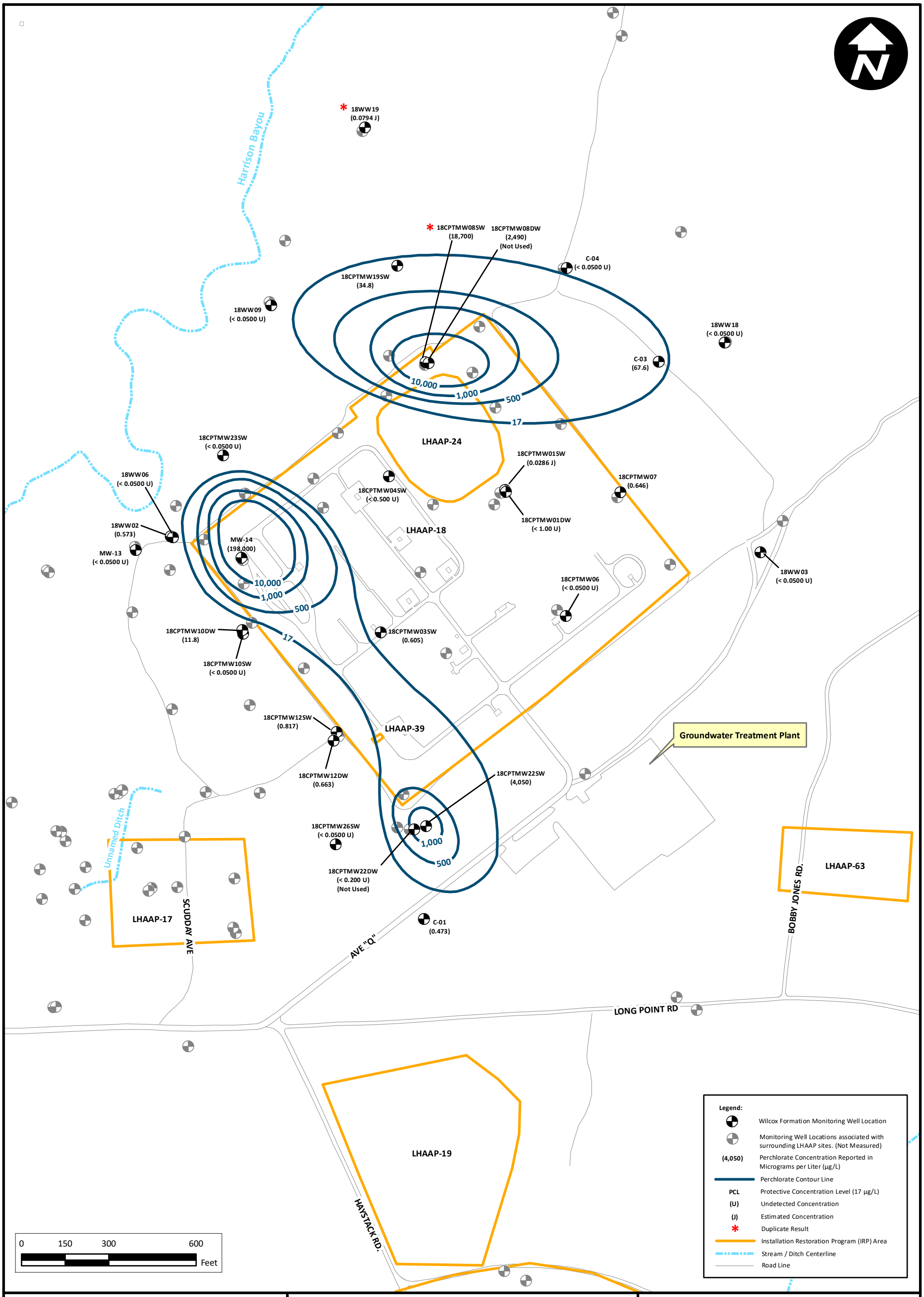
www.bhate.com

Quarterly Evaluation Report 2nd Quarter (April – June) 2021
Groundwater Treatment Plant
Longhorn Army Ammunition Plant, Karnack, Texas

PROJECT NO:	SCALE:	DATE:	DRAWN BY:
NWO1312.0150	As Shown	7/27/2021	MRM

Perchlorate Isopleth Contours in Shallow Zone (June 2021)

Figure D-1



bhate

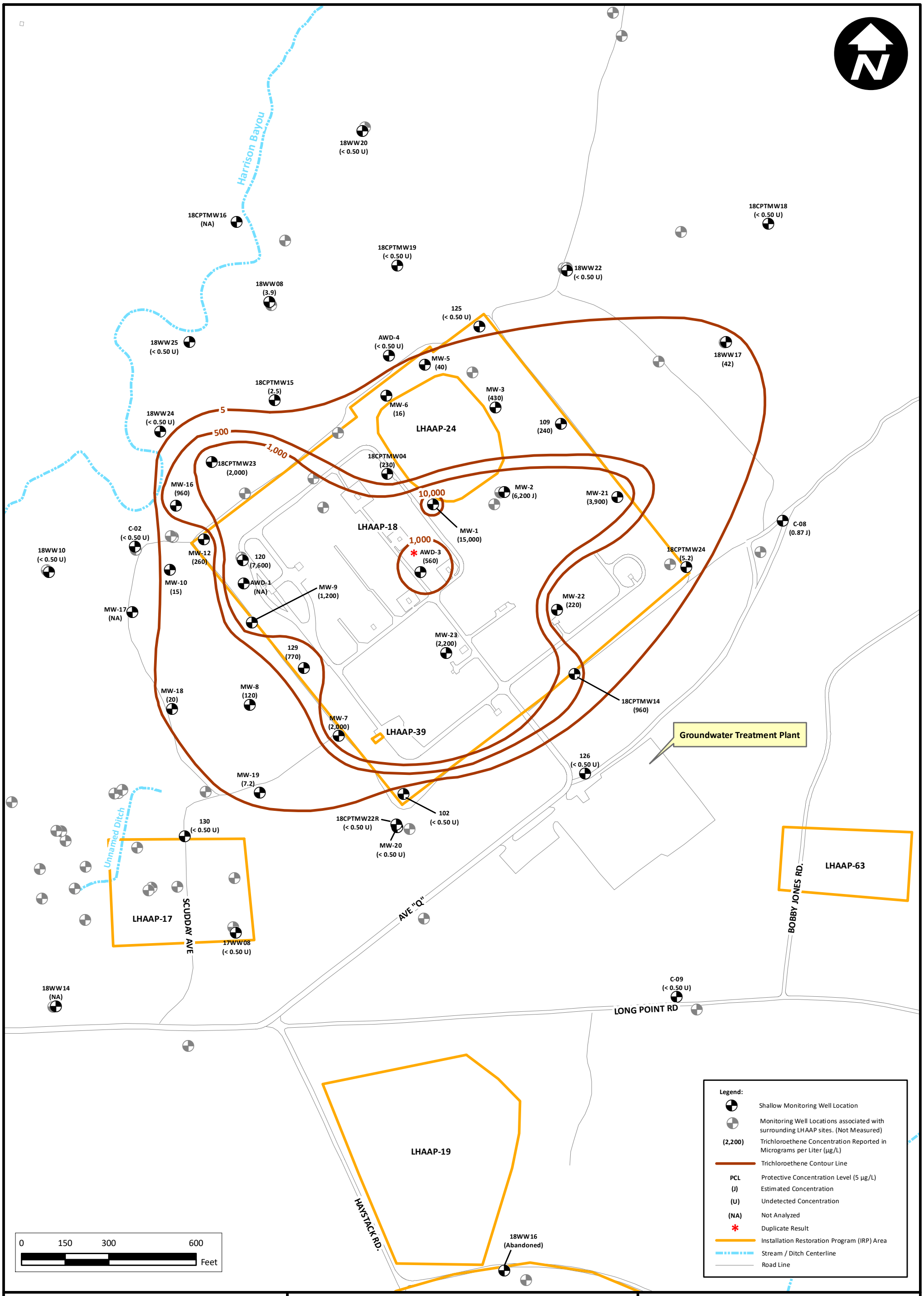
www.bhate.com

Quarterly Evaluation Report 2nd Quarter (April – June) 2021
Groundwater Treatment Plant
Longhorn Army Ammunition Plant, Karnack, Texas

PROJECT NO:	SCALE:	DATE:	DRAWN BY:
NWO1312.0150	As Shown	7/27/2021	MRM

Perchlorate Isopleth Contours in Wilcox Formation (June 2021)

Figure D-2



bhate

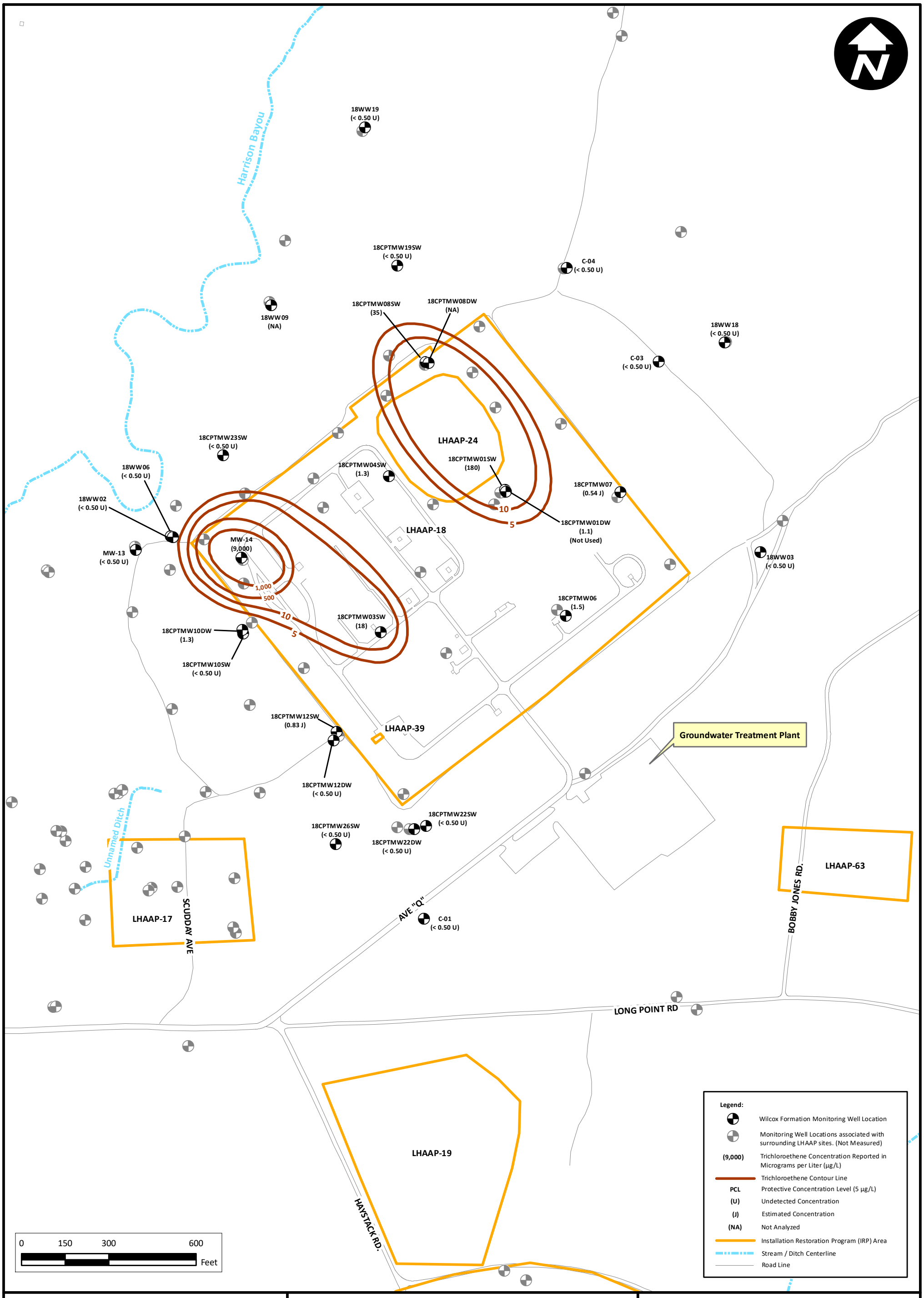
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Quarterly Evaluation Report 2nd Quarter (April – June) 2021
Groundwater Treatment Plant
Longhorn Army Ammunition Plant, Karnack, Texas

PROJECT NO:	SCALE:	DATE:	DRAWN BY:
NWO1312.0150	As Shown	7/27/2021	MRM

Trichloroethene Isopleth Contours in Shallow Zone (June 2021)

Figure D-3



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Quarterly Evaluation Report 2nd Quarter (April – June) 2021
Groundwater Treatment Plant
Longhorn Army Ammunition Plant, Karnack, Texas

PROJECT NO:	SCALE:	DATE:	DRAWN BY:
NWO1312.0150	As Shown	7/27/2021	MRM

Trichloroethene Isopleth Contours in Wilcox Formation (June 2021)

Figure D-4

Harrison Bayou
18WW20 (< 2.0 U)
18CPTMW16 (NA)
18CPTMW19 (< 2.0 U)
18CPTMW18 (< 2.0 U)
18WW22 (< 2.0 U)
18WW08 (< 2.0 U)
18WW25 (< 2.0 U)
AWD-4 (< 2.0 U)
125 (< 2.0 U)
MW-5 (< 2.0 UJ)
18WW17 (< 2.0 U)
18CPTMW15 (< 2.0 U)
MW-6 (< 2.0 U)
MW-3 (< 2.0 U)
109 (< 2.0 U)
LHAAP-24
18WW24 (< 2.0 U)
18CPTMW23 (< 10 U)
18CPTMW04 (< 2.0 U)
MW-2 (6,400 J)
MW-21 (< 10 U)
MW-16 (< 2.0 U)
MW-1 (< 20 U)
LHAAP-18
C-02 (< 2.0 U)
MW-12 (< 2.0 U)
C-08 (< 2.0 U)
1,000
500
5
18WW10 (< 2.0 U)
MW-10 (< 2.0 U)
120 (< 20 U)
AWD-3 (< 10 U)
18CPTMW24 (< 2.0 U)
AWD-1 (NA)
MW-22 (< 2.0 U)
MW-17 (NA)
MW-9 (< 2.0 U)
MW-23 (< 10 U)
129 (< 2.0 U)
18CPTMW14 (< 2.0 U)
MW-8 (< 2.0 U)
MW-18 (< 2.0 U)
MW-7 (< 10 U)
LHAAP-39
Groundwater Treatment Plant
126 (< 2.0 U)
102 (< 2.0 U)
MW-19 (< 2.0 U)
18CPTMW22R (< 2.0 U)
MW-20 (< 2.0 U)
Unnamed Ditch
130 (< 2.0 U)
LHAAP-63
BOBBY JONES RD.
LHAAP-17
SCUDDAY AVE
17WW08 (< 2.0 U)
AVE "Q"
18WW14 (NA)
C-09 (< 2.0 U)
LONG POINT RD
LHAAP-19
HAYSTACK RD.
18WW16 (Abandoned)

0 150 300 600 Feet

Legend:

- Shallow Monitoring Well Location
- Monitoring Well Locations associated with surrounding LHAAP sites. (Not Measured)
- (6,400 J) Methylene Chloride Concentration Reported in Micrograms per Liter (µg/L)
- Methylene Chloride Contour Line
- PCL Protective Concentration Level (5 µg/L)
- (J) Estimated Concentration
- (U) Undetected Concentration
- (NA) Not Analyzed
- Installation Restoration Program (IRP) Area
- Stream / Ditch Centerline
- Road Line

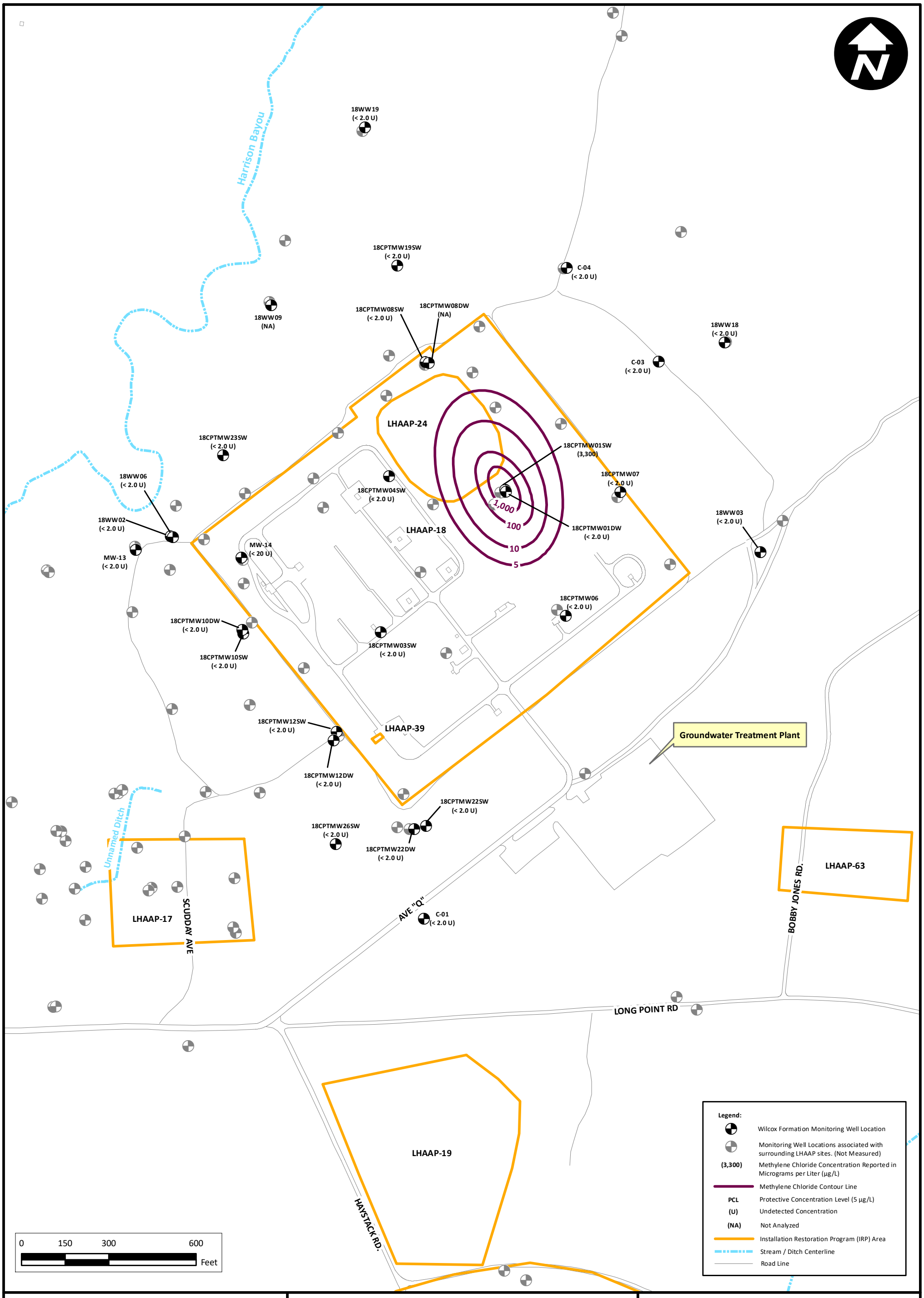
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Quarterly Evaluation Report 2nd Quarter (April – June) 2021
Groundwater Treatment Plant
Longhorn Army Ammunition Plant, Karnack, Texas

PROJECT NO:	SCALE:	DATE:	DRAWN BY:
NWO1312.0150	As Shown	7/27/2021	MRM

Methylene Chloride Isopleth Contours in Shallow Zone (June 2021)

Figure D-5



bhate

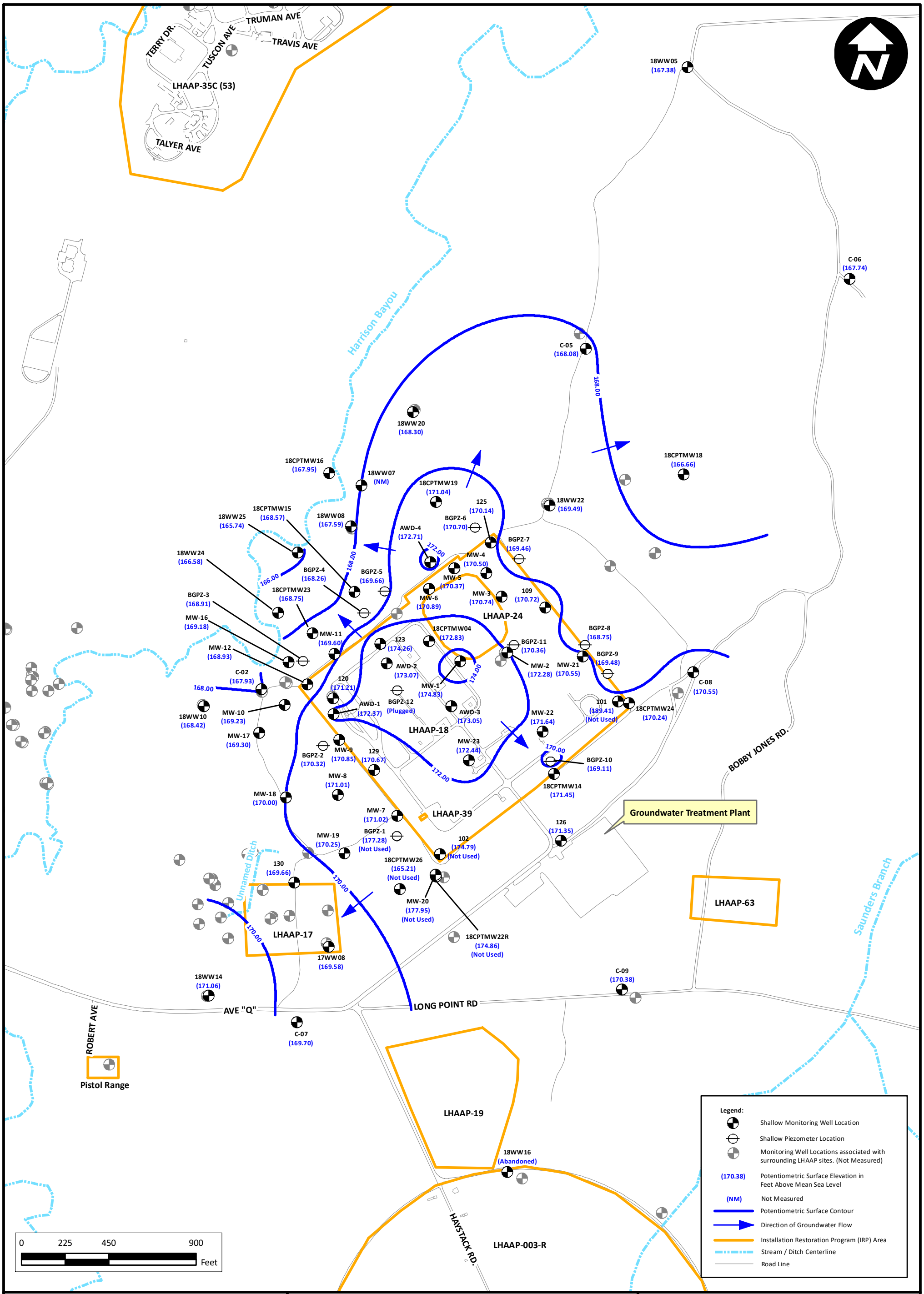
www.bhate.com

Quarterly Evaluation Report 2nd Quarter (April – June) 2021
Groundwater Treatment Plant
Longhorn Army Ammunition Plant, Karnack, Texas

PROJECT NO:	SCALE:	DATE:	DRAWN BY:
NWO1312.0150	As Shown	7/27/2021	MRM

Methylene Chloride Isopleth Contours in Wilcox Formation (June 2021)

Figure D-6



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Quarterly Evaluation Report 4nd Quarter (October – December) 2021
Groundwater Treatment Plant
Longhorn Army Ammunition Plant, Karnack, Texas

PROJECT NO:	SCALE:	DATE:	DRAWN BY:
NWO1312.0150	As Shown	2/17/2022	MRM

Groundwater Potentiometric Surface Map
Shallow Zone (December 22, 2021) LHAAP-18/24

Figure B-3

TALYER AVE
LHAAP-35C (53)
Harrison Bayou
18WW04 (167.03)
18WW19 (167.91)
168.00
18WW21 (168.93)
C-04A (170.56)
18CPTMW19SW (170.10)
C-04 (170.44)
169.00
18WW09 (168.33)
18CPTMW08DW (169.47)
C-03 (170.16)
18WW18 (169.62)
18CPTMW08SW (169.96)
18CPTMW01SW (173.40)
LHAAP-24
18WW06 (169.45)
18CPTMW23SW (168.76)
18CPTMW04SW (169.82)
173
18CPTMW07 (169.94)
18WW02 (169.75)
172.00
18WW11 (168.12)
MW-14 (173.09)
MW-13 (168.80)
18CPTMW01DW (170.99) (Not Used)
18WW03 (168.31)
171.00
171.00
18CPTMW03SW (169.90)
LHAAP-18
BOBBY JONES RD.
18CPTMW10DW (169.53)
170.00
18CPTMW06 (171.00)
18CPTMW10SW (169.98)
169.00
18CPTMW12SW (170.17)
Groundwater Treatment Plant
LHAAP-39
18CPTMW12DW (169.93)
Unnamed Ditch
18CPTMW22SW (170.04)
18CPTMW26SW (169.35)
LHAAP-63
18CPTMW22DW (169.51)
Saunders Branch
LHAAP-17
170.00
C-01 (170.44)
18WW15 (171.29)
171.00
AVE "Q"
LONG POINT RD
170.00
C-10 (169.57)
ROBERT AVE
Pistol Range
LHAAP-19
18WW01 (Abandoned)
HAYSTACK RD.
LHAAP-003-R

0 225 450 900 Feet

Legend:
- Wilcox Zone Monitoring Well Location
- Monitoring Well Locations associated with surrounding LHAAP sites. (Not Measured)
- (169.57) Potentiometric Surface Elevation in Feet Above Mean Sea Level
- Potentiometric Surface Contour
- Direction of Groundwater Flow
- Installation Restoration Program (IRP) Area
- Stream / Ditch Centerline
- Road Line

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Quarterly Evaluation Report 4nd Quarter (October – December) 2021
Groundwater Treatment Plant
Longhorn Army Ammunition Plant, Karnack, Texas

PROJECT NO:	SCALE:	DATE:	DRAWN BY:
NWO1312.0150	As Shown	2/17/2022	MRM

Groundwater Potentiometric Surface Map
Wilcox Zone (December 22, 2021) LHAAP-18/24

Figure B-6

APPENDIX D

RAO Inspection and Maintenance Checklist

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

RAO Inspection and Maintenance Checklist

General Information	
Project Name	RAO Inspection and Maintenance, LHAAP-18/24 UEP Cap, Former Longhorn Army Ammunition Plant, Karnack, TX
Contractor	
Inspector's Name	
Inspector's Title	
Inspector's Signature	
Inspector's Contact Number	
Inspection Date	
Type of Inspection	☐ Quarterly ☐ Semiannual ☐ Annual ☐ Prior to forecast rain ☐ After a rain event ☐ Other ----------

Description		Yes	No	N/A	**Comments** (Attach photos/location sketches)	**Corrective Action** (Attach photos)
A. CAP Cover Surface						
A.1	Are there any significant cracks present?					
A.2.	Are there any damaged areas?					
A.3	Is there any ponded water present?					
A.4	Any other relevant observations?					
B. CAP Vegetation and Animal Burrows						
B.1	Are there signs of stressed/ dead vegetation?					
B.2	Are there any significant bare spots?					
B.3	Are deep-rooted plants present?					
B.4	Are there signs of animal burrows?					
B. 5	Any other relevant observations?					

Description		Yes	No	N/A	**Comments** (Attach photos/location sketches)	**Corrective Action** (Attach photos)
C. CAP Erosion and Drainage System						
C.1	Is there any evidence of significant/ clearly visible erosion, settlement, or other deterioration?					
C.2	Are the drainage systems in poor condition?					
C.3	Is there excessive silting or debris clogging?					
C.4	Is there erosion of banks and slopes?					
C.5	Are there areas of choking by overgrown vegetation?					
C.7	Is there pooling of water in or along side a channel or berm?					
C.8	Any other relevant observations?					
D. Groundwater Monitoring Wells						
D.1	Are the installed groundwater monitoring wells in poor condition?					
D.2	Are there any signs of damage, unusual wear, rust and corrosion, vandalism, unauthorized entry/use, or settlement?					
D.3	Is well cap and/or locking mechanism not properly functioning?					
D.4	Are the well heads and protective casings damaged?					
D.5	Is the well cleared of vegetation and accessible?					
D.6	Any other relevant observations?					

Description		Yes	No	N/A	**Comments** (Attach photos/location sketches)	**Corrective Action** (Attach photos)
E. Site Access Features						
E.1	Are the perimeter fence and gates damaged?					
E.2	Gate(s) damaged?					
E.3	Litter encountered within the area?					
E.4	Are the gate locks missing?					
E.4	Are signs to prevent unauthorized entry missing?					
E.5	Are the access roads in unusable or poor condition?					
E.6	Any other relevant observations?					
F. Concrete Aprons and Bollards						
F.1	Are there any significant cracks present?					
F.2	Are there any damaged areas?					
F.3	Any other relevant observations?					

APPENDIX E

Existing Monitoring Well and Soil Boring Logs

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

025945

Monitor Well Installation

Client: Cons Dresser & McKee Job No.: 385-874 Date Drilled: 7/1/86 Well No.: C-7

Site: LHAAP Elevation: GL ____ Top of PVC Casing ____

Total Depth: 36 feet Casing Size & Type: 4-inch Schedule 40 Flush-joint Threaded PVC Screen Size: .010 PVC

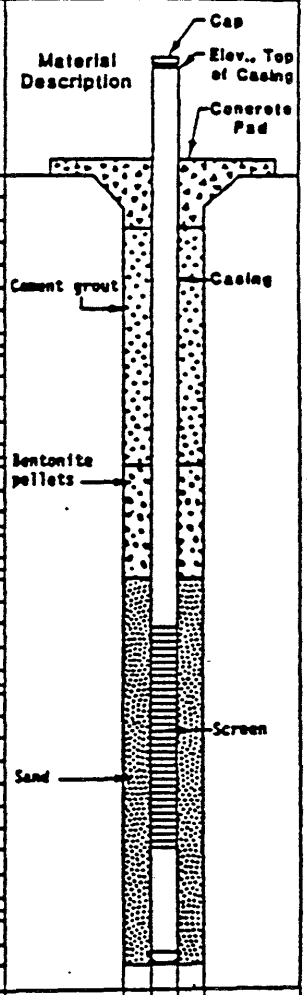
Comments: ____

Depth	Symbol	Stratigraphy	Sample Description
0	CH		SANDY CLAY, 10-20% very fine sand, stiff, moist, tan and red mottled, roots, iron nodules.
10	SP/SM		SAND, uniform fine, compact, wet, iron stains, 3-5% silt.
15	MH		SILT, highly plastic, stiff, wet, gray, mottled with iron stains.
	SM		SILTY SAND, 70-80% fine to medium sand, wet, dark red, some 1/4" mud clasts (rounded).
20	MH		CLAYEY SILT, highly plastic, stiff, moist, gray, slight iron mottling.
25	SM		SILTY SAND, 20-30% silt, very fine, saturated, tan and red.
30	SM		SILTY SAND, 60-70% fine sand, compact, wet, red and gray laminated.
35	ML		SILT, moderate plasticity, stiff, moist, tan and red mottled, 10-20% very fine sand.
40			
45			
50			

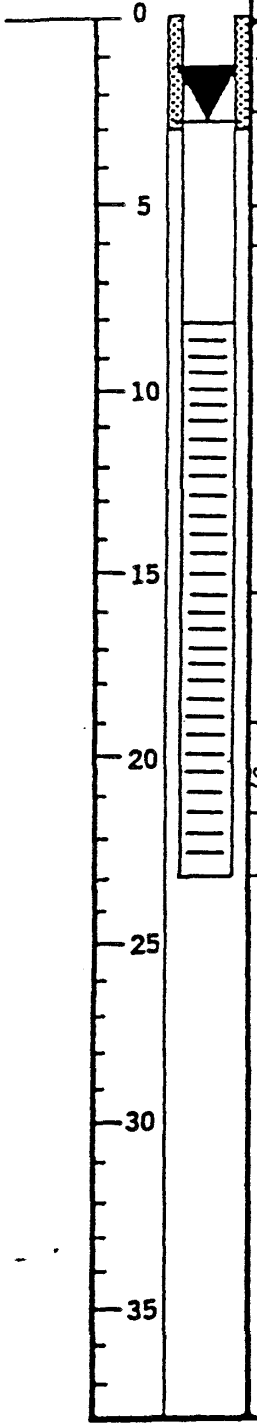
Completion Data

Material Setting

Material Description



Underground Resource Management, Inc.
Austin, Texas



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	8/7	Silty sand		
SM	6/4	Silty sand		
— —	5/6	Lt. brownish grey w/yellowish red		
CL-ML		Sandy silty clay 20% fine sand Reddish grey mottled w/yellowish red		
SC	2/3	Clayey sand		
	4/8			
	1/12			
		Silty sand		
		Grey mottled w/reddish brown	38.8	
SM	6/6			
	7/7			
	6/6			
SM	4/6	Silty sand		
	6/6	Grey w/some reddish brown	30	
SM+CL	2/4	Silty sand w/clay seams Grey mottled w/reddish brown		
	5/12			
CL	9/10	Sandy clay 25% sand Grey mottled w/reddish brown		

*BLOWS PER 6 INCH USING 18, 24 or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 130 DATE DRILLED 6/7/82

STUDY AREA Flashing Area

ELEVATION TOP OF STEEL CASING = 177.36 ft

ELEVATION TOP OF PVC RISER = 176.71 ft

ELEVATION OF GROUND SURFACE = 174.44 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

01227384

025947

Hole No. MW-18

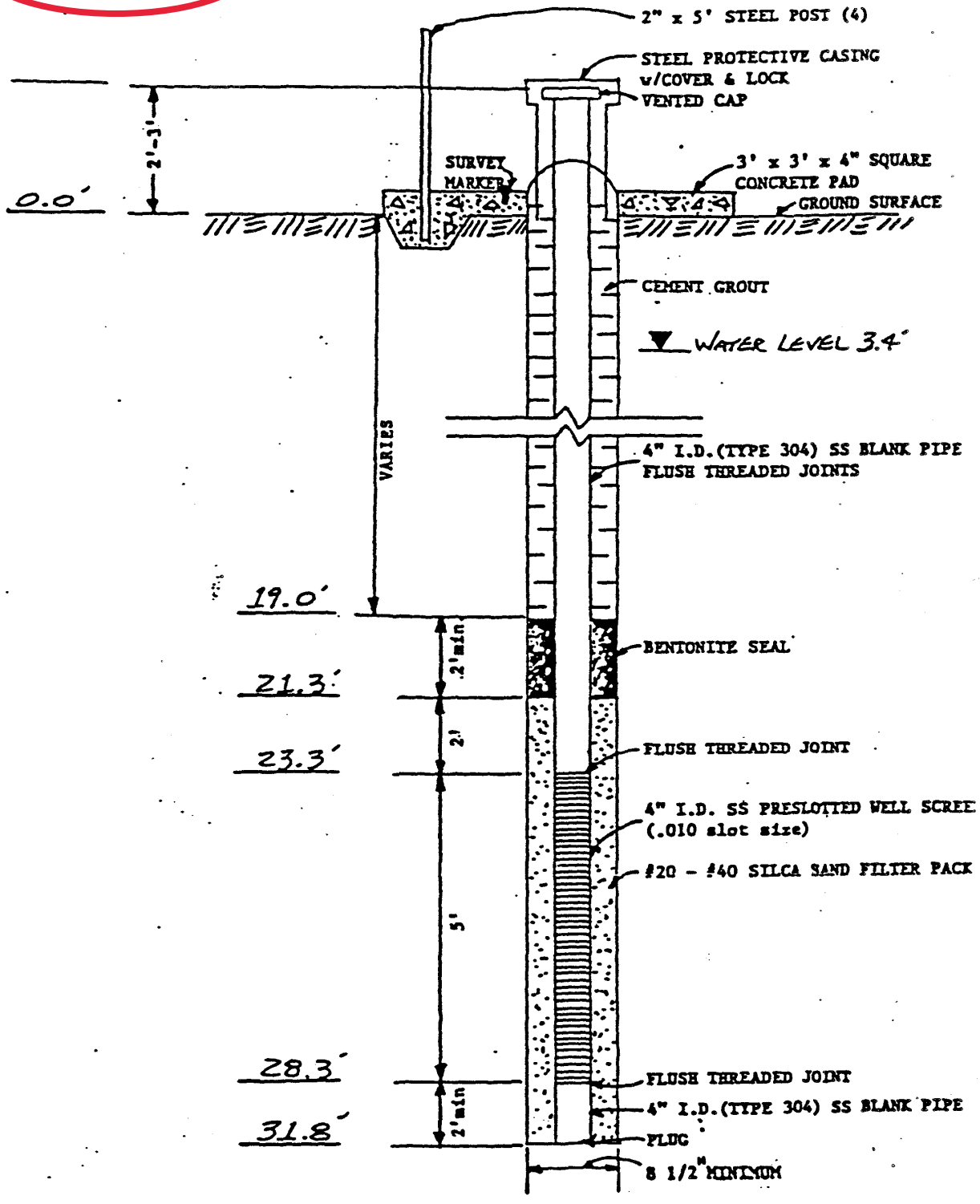
DRILLING LOG | DIVISION: SWD | INSTALLATION: SWF | SHEET 1 OF 1 SHEETS

1. PROJECT: LONGHORN AAP IRET-PHASE II-MONITOR WELLS)
2. LOCATION (Coordinates or Station): SEE LAYOUT
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): MW-18
5. NAME OF DRILLER: T. SILVIS
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 31.8'
10. SIZE AND TYPE OF BIT: 10" AUGER
11. DATUM FOR ELEVATION SHOWN (MSL or Other):
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 9; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 9 AUG '89; COMPLETED 10 AUG '89
17. ELEVATION TOP OF HOLE: 177.09'
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R. Bolen

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS
	0.0		0.0' TO 2.5' SILT: LOW PLASTICITY: LIGHT GRAY WITH YELLOWISH BROWN: STIFF: DAMP: SANDY 2.5' TO 3.3' CLAY: MEDIUM PLASTICITY: LIGHT GRAY WITH YELLOWISH BROWN: STIFF: DAMP-MOIST: VERY SILTY: SANDY 3.3' TO 9.0' SILT: LOW PLASTICITY: LIGHT GRAY WITH YELLOWISH BROWN: MEDIUM: VERY MOIST TO WET FROM 5.0': VERY SANDY (BORDERS A SILTY SAND FROM 5.0') 9.0' TO 31.8' T.D. SAND: FINE GRAINED: LIGHT BLUE GRAY WITH YELLOWISH BROWN: LOOSE-MEDIUM: WET TO SATURATED: MODERATELY SILTY TO VERY SILTY: WITH ABUNDANT BLACK CARBON MATTER FROM 24.0'-31.8' 14.0'-19.0': WET: VERY SILTY (BORDERS A SANDY SILT)		A	1. WATER LEVEL: NOTE: SOME FREE WATER ENTERED BORING DURING DRILLING FROM 3.3'. 24 HR. OBSERVATION: FREE WATER LEVEL WAS AT 3.4': AFTER DEVELOPING WELL ON 11 AUG. BORING WAS BAILED TO 33.0' ON 14 AUG. AT 0825 HRS. LEVEL WAS 26.8' AT 0850 HRS., 22.4' AT 0930 HRS., 17.5' AT 1037 HRS., 11.0' AT 1299 HRS., 9.0' AT 1408 HRS., 6.0' AT 1655 HRS. & 3.4' AT 0822 HRS. on 15 AUG.
					B	
					C	
					D	
					E	
					F	2. JAR SAMPLES: A: 0.0' - 2.5' B: 2.5' - 3.3' C: 3.3' - 5.0' D: 5.0' - 9.0' E: 9.0' - 14.0' F: 14.0' - 19.0' G: 19.0' - 24.0' H: 24.0' - 29.0' I: 29.0' - 31.8'
	20				G	3. DRILLING: 10" FLIGHT AUGER: 0.0' - 31.0' NOTE: SET 8" STEEL CASING TO 31.0' 8" FLIGHT AUGER: 31.0' - 31.8' NOTE: WELL PIPE, SCREEN, FILTER & SEAL WERE PLACED AS CASING WAS REMOVED.
					H	
					I	4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BORENOLE ADVANCEMENT. No MEASURABLE AMOUNTS WERE PRESENT. No ODORS WERE DETECTED IN DRILLING.
	31.8		T.D. 31.8'			5. NOTE: BORING WAS DRILLED AS STAKED.
	40					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT: LONGHORN AAP. | HOLE NO. MW-18

LONGHORN AAP
Well No. MW-18
Date 10 AUG 89



Construction Detail for Shallow Monitoring Well

025949

Hole No. MW-19

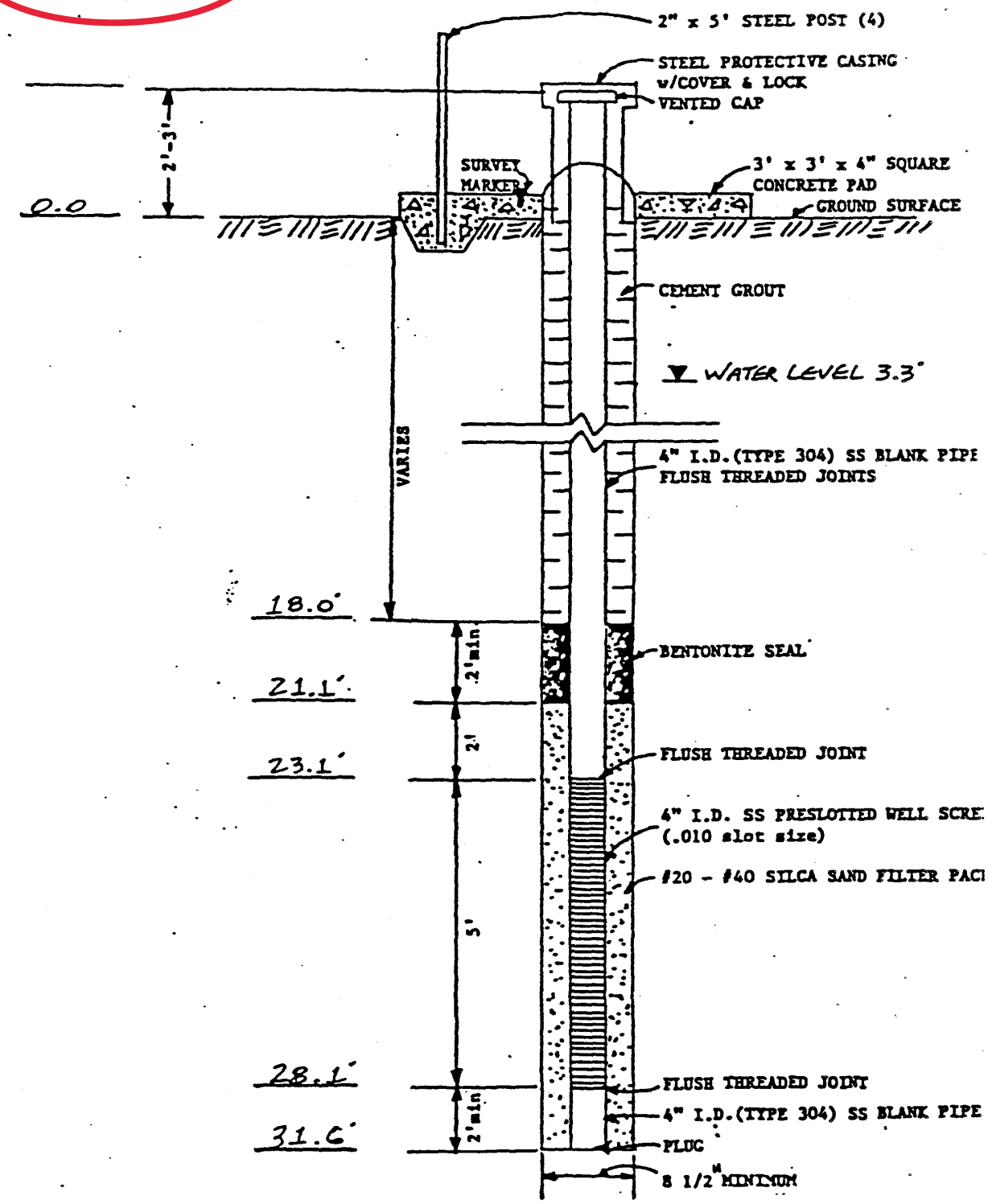
DRILLING LOG | DIVISION SWD | INSTALLATION SWF | SHEET 1 OF 1 SHEETS

1. PROJECT: LONGHORN AAP (RFI-PHASE II-MONITOR WELLS)
2. LOCATION: SEE REMARKS COLUMN
3. DRILLING AGENCY: USCE
4. HOLE NO.: MW-19
5. NAME OF DRILLER: T. SILITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 31.0'
10. SIZE AND TYPE OF BIT: 10" AUGER
11. DATUM FOR ELEVATION SHOWN (MSL or MLW)
12. MANUFACTURER'S DESIGNATION OF DRILL: FALCON 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 13; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 3 AUG. 89; COMPLETED 3 AUG. 89
17. ELEVATION TOP OF HOLE: 176.59'
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jack R. Stokes

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if appropriate)
	0.0		0.0' TO 0.8' SILT: LOW PLASTICITY; GRAY BROWN; STIFF; DAMP; VERY SANDY		A	1. WATER LEVEL: NOTE: FREE WATER ENTERED BORING DURING DRILLING FROM 10.0'-10.9' & 15.0'-18.5' & 23.0'-31.6'.
			0.8' TO 4.0' CLAY: MEDIUM-HIGH PLASTICITY; GRAYISH BROWN; STIFF-VERY STIFF; DAMP-MOIST; MOD. SILTY		B	
			4.0' TO 7.0' SILT: MEDIUM PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; MEDIUM-STIFF; MOIST-VERY MOIST; SLIGHTLY SANDY		C	24 HR. OBSERVATION: FREE WATER LEVEL IN WELL CASING WAS AT 3.3'; WELL WAS DEVELOPED on 7 AUG. & LEVEL WAS 30.5' AFTER BAILING AT 1325 HRS. LEVEL at 18.0' AT 1355 HRS. & 5.9' AT 1515 HRS. & 3.3' AT 0810 HRS. on 8 AUG.
			7.0' TO 7.8' CLAY: MEDIUM-HIGH PLASTICITY; GRAY BROWN-YELLOWISH BROWN; VERY STIFF-HARD; DAMP		D	
			7.8' TO 15.0' SILT: LOW-MEDIUM PLASTICITY; GRAY WITH YELLOWISH BROWN, WITH LIGHT BLUE GRAY, FROM 10.9'; MEDIUM-STIFF; MOIST-VERY MOIST & WET FROM 10.0'-10.9'; SANDY TO VERY SANDY FROM 10.0'-10.9'		E	
					F	
					G	2. JAR SAMPLES: A: 0.0' - 0.8'; B: 0.8' - 4.0'; C: 4.0' - 7.0'; D: 7.0' - 7.8'; E: 7.8' - 10.0'; F: 10.0' - 10.9'; G: 10.9' - 15.0'; H: 15.0' - 18.5'; I: 18.5' - 20.5'; J: 20.5' - 20.7'; K: 20.7' - 23.0'; L: 23.0' - 28.0'; M: 28.0' - 31.6'
			15.0' TO 18.5' SAND: FINE GRAINED; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM; SILTY; SATURATED		H	
	20				I	
			18.5' TO 20.5' SILT: LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM; VERY MOIST; VERY SANDY		J	
			20.5' TO 20.7' CLAY: MEDIUM-HIGH PLASTICITY; GRAY & BROWN; MEDIUM; VERY MOIST; WITH TRACE of SILT & SAND		K	3. DRILLING: 10" FLIGHT AUGER: 0.0' - 31.0'. NOTE: SET 8" STEEL CASING TO 31.0'. 8" FLIGHT AUGER: 31.0' - 31.6'. NOTE: WELL PIPE & SCREEN WITH FILTER & SEAL WERE SET AS CASING WAS REMOVED.
			20.7' TO 23.0' SILT: LOW PLASTICITY; LIGHT BLUE GRAY & YELLOWISH BROWN; MEDIUM-STIFF; VERY MOIST-WET; VERY SANDY; WITH FERRUGINOUS STAINS		L	
	31.6		23.0' TO 31.6' T.D. SAND: FINE GRAINED; LIGHT BLUE GRAY WITH YELLOWISH BROWN; MEDIUM; SATURATED; SILTY; WITH ABUNDANT CARBON MATTER		M	4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' of BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODORS WERE DETECTED IN DRILLING.
			T.D. 31.6'			5. NOTE: BORING OFFSET 15' S52°E of HUB AT SAME ELEVATION.
	40					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT LONGHORN AAP. | HOLE NO. MW-19

LONGHORN AAP
Well No. MW-19
Date 4 AUG 89



Construction Detail for Shallow Monitoring Well
and Well C-4A

01227388

025982

Hole No. MW-1

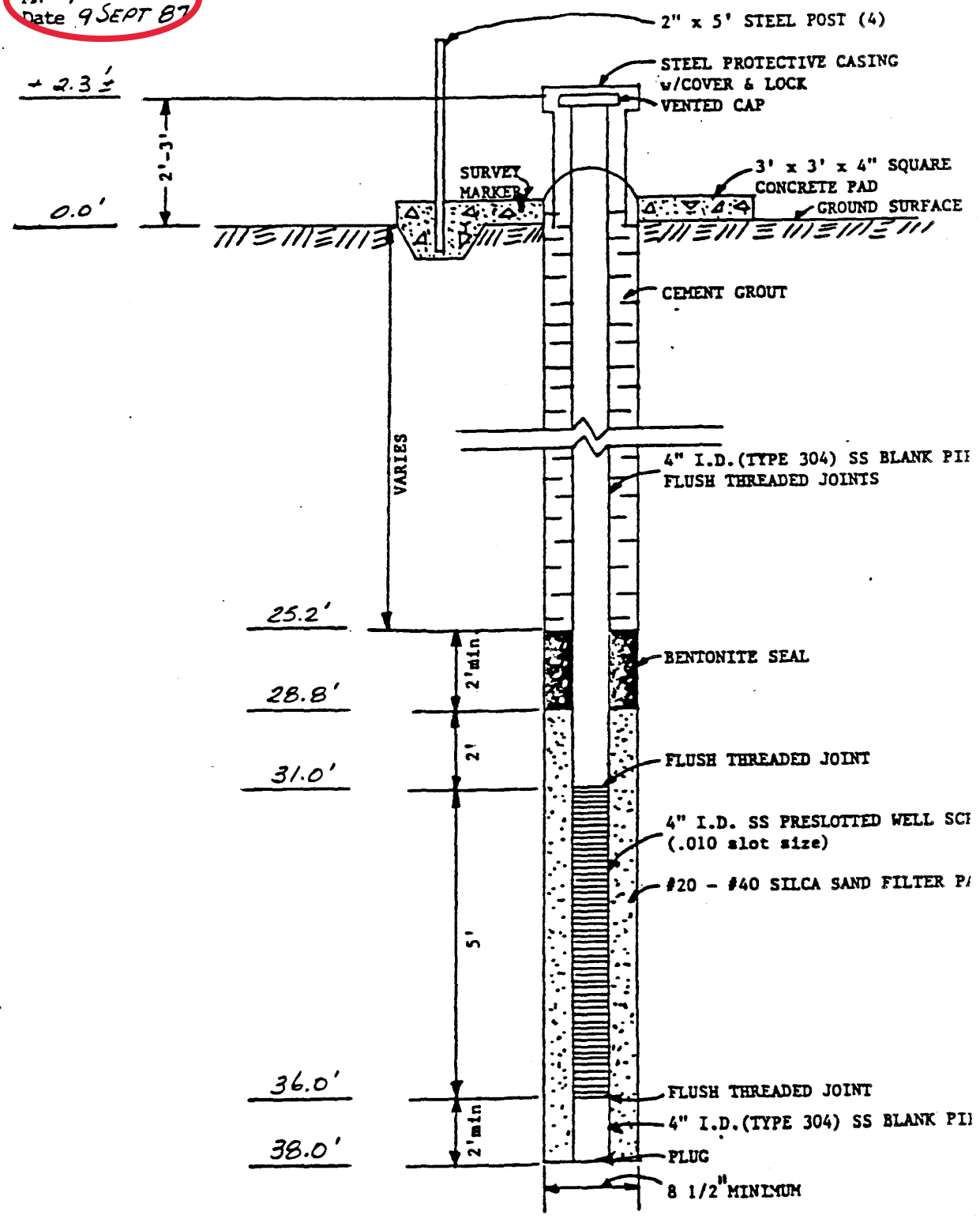
DRILLING LOG | DIVISION: SWD | INSTALLATION: FWD | SHEET 1 OF 1 SHEETS

1. PROJECT: GROUND-WATER MONITORING WELLS
2. LOCATION (Coordinates or Station): LONGHORN AAP
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): MW-1
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 38.0'
10. SIZE AND TYPE OF BIT: 10" AUGER
11. DATUM FOR ELEVATION SHOWN (MSL or Other): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 17; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 2 SEPT. 87; COMPLETED 3 SEPT. 87
17. ELEVATION TOP OF HOLE: 199.73
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Joshua L. Stubbs

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	0.0		0.0' To 3.0' SAND: FINE GRAINED; REDDISH BROWN; MEDIUM DRY; SILTY; CLAYEY FROM 2.0'-3.0' 3.0' To 8.0' CLAY: 3.0'-6.0': MEDIUM-HIGH PLASTICITY; RED & LIGHT GRAY TO RED FROM 4.0'; VERY STIFF - HARD; DAMP; TRACE of SILTY SAND To 4.0'± 6.0'-8.0': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; STIFF; DAMP; VERY SILTY; SANDY 8.0' To 24.2' SILT: 8.0'-20.0': LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM MOIST; SANDY; VERY CLAYEY WITH THIN SILTY CLAY LAMINATIONS 20.0'-24.2': LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; VERY MOIST-WET; SANDY		A B C D E F G H I J K L M	1. WATER LEVEL: NOTE: FREE WATER BEGAN ENTERING BORING AT 22.0'±; LEVEL WAS AT 23.0' AFTER 24 HRS 2. JAR SAMPLES: A: 0.0' - 2.0' B: 2.0' - 3.0' C: 3.0' - 4.0' D: 4.0' - 6.0' E: 6.0' - 8.0' F: 8.0' - 10.0' G: 10.0' - 15.0' H: 15.0' - 20.0' I: 20.0' - 24.2' J: 24.2' - 26.5' K: 26.5' - 31.5' L: 31.5' - 34.4' M: 34.4' - 38.0' 3. JAR SAMPLES: (CHEMICAL TESTS) CH-1 & 1A: 2.0' CH-2 & 2A: 10.0' 4. DRILLING: 10" FLIGHT AUGER: 0.0' - 37.0' NOTE: BORING BEGAN SQUEEZING IN FROM 21.0'± NOTE: SET 8" STEEL CASING TO 37.0' 8" FLIGHT AUGER: 37.0' - 38.0' 5. NOTE: MONITORING WELL WAS COMPLETED & DEVELOPED 10 SEPT. 87; REFER TO CONSTRUCTION DETAIL SHEET. 6. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLORO ETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT; NO MEASURABLE AMOUNTS WERE PRESENT.
	20					
	38.0		24.2' To 26.5' SAND: FINE GRAINED; YELLOWISH BROWN; SATURATED; VERY SILTY 26.5' To 34.4' CLAY: MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; VERY STIFF; DAMP; WITH SCATTERED SILTY SAND LAMINATIONS 34.4' To 38.0' T.D. SILT: LOW-MEDIUM PLASTICITY; YELLOWISH BROWN; SATURATED; SANDY; MODERATELY CLAYEY T.D. 38.0'			
	40					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT: LONGHORN AAP | HOLE NO. MW-1

LONGHORN AAP
MW - 1
Date 9 SEPT 87



TYPICAL CONSTRUCTION DETAIL FOR MONITORING WELI

01227390

025984

Hole No. MW-2

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 2 SHEETS
1. PROJECT: GROUND-WATER MONITORING WELLS		10. SIZE AND TYPE OF BIT: 8" AUGER	
2. LOCATION (Coordinates or Station): LONGHORN AAP		11. DATUM FOR ELEVATION SHOWN (TBM or MSL):	
3. DRILLING AGENCY: USCE		12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500	
4. HOLE NO. (As shown on drawing title and title number): MW-2		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 18 / UNDISTURBED 0	
5. NAME OF DRILLER: T. SUITS		14. TOTAL NUMBER CORE BOXES: N/A	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: SEE REMARKS COLUMN	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED 27 AUG. 87 / COMPLETED 28 AUG. 87	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE: 195.18	
9. TOTAL DEPTH OF HOLE: 40.4'		18. TOTAL CORE RECOVERY FOR BORING: N/A %	
		19. SIGNATURE OF INSPECTOR: Jackie R. Stobbe	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIAL (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0		0.0' TO 2.0' SAND: FINE GRAINED; REDDISH BROWN; MEDIUM; DRY; VERY SILTY		A	1. WATER LEVEL: NOTE: FREE WATER BEGAN ENTERING BORING AT 20.8' I; LEVEL WAS AT 20.7' AFTER 24 HRS.
			2.0' TO 19.2' CLAY: 2.0'-6.0': MEDIUM-HIGH PLASTICITY; RED WITH LIGHT GRAY TO REDDISH BROWN FROM 4.0' I; VERY STIFF-HARD DOWN TO VERY STIFF FROM 4.0' I; DAMP; TRACE OF SILTY SAND TO NO SAND FROM 4.0' I		B	
					C	
					D	
					E	2. JAR SAMPLES: A: 0.0' - 2.0' B: 2.0' - 4.0' C: 4.0' - 6.0' D: 6.0' - 8.0' E: 8.0' - 10.0'
			6.0'-14.2': MEDIUM PLASTICITY; REDDISH BROWN, YELLOWISH BROWN & LIGHT GRAY; STIFF; MOIST; VERY SILTY; SLIGHTLY SANDY		F	F: 10.0' - 14.2' G: 14.2' - 19.2' H: 19.2' - 20.4'
			14.2'-19.2': LOW-MEDIUM PLASTICITY; REDDISH BROWN WITH LIGHT GRAY; MEDIUM; VERY MOIST; VERY SANDY WITH LAMINATIONS OF FINE SAND		G	I: 20.4' - 26.0' J: 26.0' - 27.0' K: 27.0' - 34.0' L: 34.0' - 38.0' M: 38.0' - 39.9' N: 39.9' - 40.4'
	20		19.2' TO 27.0' SILT: LOW PLASTICITY; YELLOWISH BROWN; MEDIUM; WET TO SATURATED FROM 20.4' TO VERY MOIST FROM 26.0'; SANDY TO VERY SANDY		H	3. JAR SAMPLES (CHEMICAL TESTS): CH-1 & 1A: 2.0' CH-2 & 2A: 10.0'
					I	4. DRILLING: 10" FLIGHT AUGER: 0.0' - 40.0' NOTE: BORING BEGAN SQUEEZING IN FROM 20.0' I
					J	NOTE: SET 8" STEEL CASING TO 40.0' 8" FLIGHT AUGER: 40.0' - 40.4'
			27.0' TO 34.0' CLAY: MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF; MOIST; SLIGHTLY SILTY		K	5. NOTE: MONITORING WELL WAS COMPLETED & DEVELOPED ON 1 SEPT. 87; REFER TO CONSTRUCTION DETAIL SHEET.
			34.0' TO 39.9' SILT: LOW TO MEDIUM PLASTICITY FROM 38.0'; YELLOWISH BROWN WITH LIGHT GRAY TO YELLOWISH BROWN & REDDISH BROWN FROM 38.0'; MEDIUM; VERY MOIST; VERY SANDY; CLAYEY FROM 38.0'; WITH ABUNDANT		L	6. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLORODETHYLENE EVERY 10.0'
	40				M	

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PROJECT: LONGHORN AAP | HOLE NO.: MW-2

01227391

025985

Hole No. MW-2

DRILLING LOG

Division

Installation

Sheet 1 of 2 Sheets

1. Project: GROUND-WATER MONITORING WELLS
2. Location (Coordinates or Station): LONGHORN AAP
3. Drilling Agency
4. Hole No. (As shown on drawing title and file number): MW-2
5. Name of Driller
6. Direction of Hole: ☐ Vertical ☐ Inclined _____ Deg. From Vert.
7. Thickness of Overburden
8. Depth Drilled into Rock
9. Total Depth of Hole
10. Size and Type of Bit
11. Datum for Elevation Shown (MSL or Mean)
12. Manufacturer's Designation of Drill
13. Total No. of Overburden Samples Taken: Disturbed | Undisturbed
14. Total Number Core Boxes
15. Elevation Ground Water
16. Date Hole: Started 27 AUG. 87 | Completed 28 AUG. 87
17. Elevation Top of Hole
18. Total Core Recovery for Boring
19. Signature of Inspector: Jackie R. Stalker

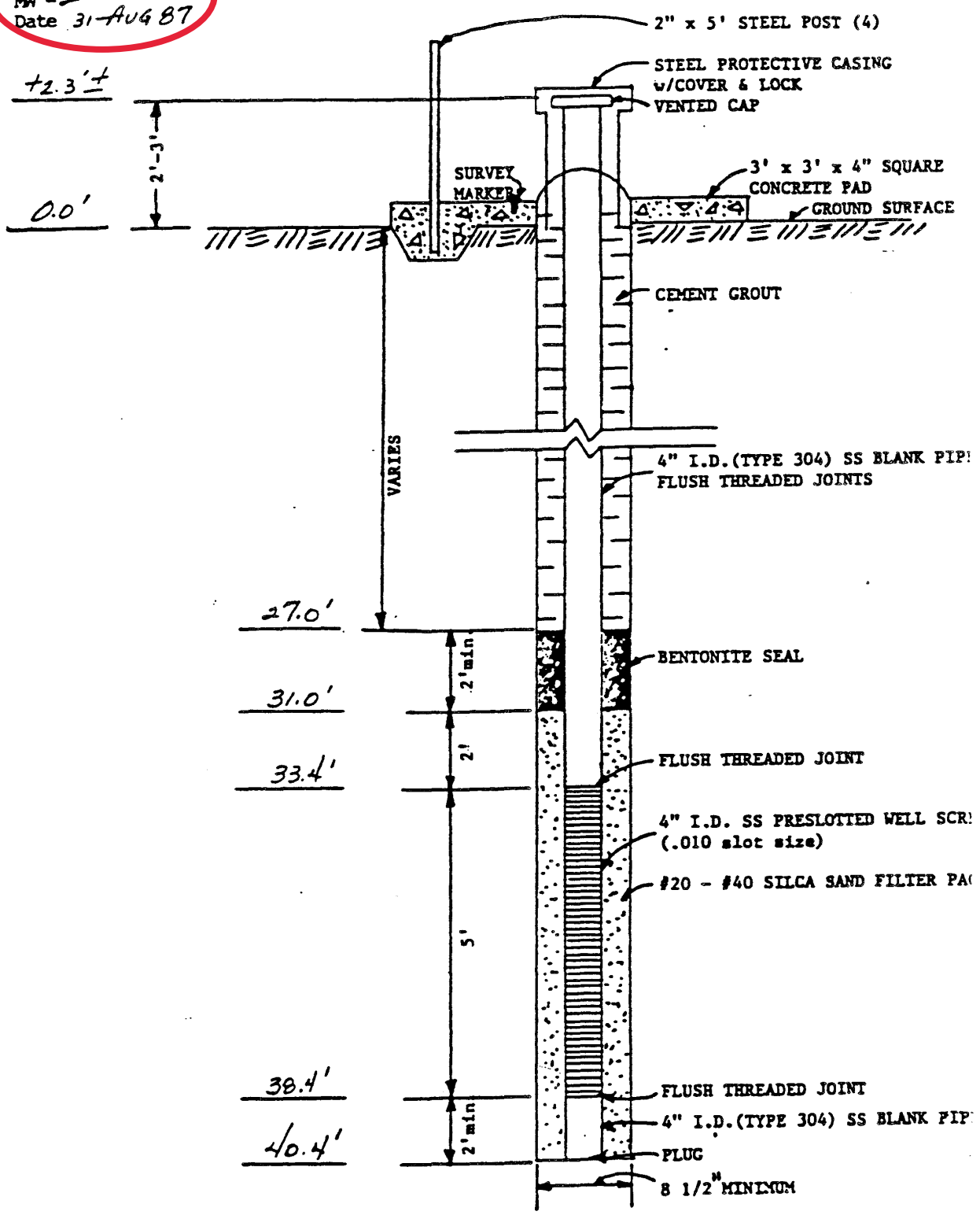
Elevation a	Depth b	Legend c	Classification of Material (Description) d	% Core Recovery e	Box or Sample No. f	Remarks (Drilling time, water loss, depth of weathering, etc.; if significant) g
	40.4		FERRUGINOUS STAINING FROM 38.0' 39.9' TO 40.4' T.D. CLAY: HIGH PLASTICITY; GRAY WITH YELLOWISH BROWN; VERY STIFF; DAMP 40.4' T.D.		N	OF BOREHOLE ADVANCEMENT; NO MEASURABLE AMOUNTS WERE PRESENT.
	60					
	80					

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Project [illegible] AAP

Hole No. AA-MW-2

LONGHORN AAP
MW -2
Date 31-AUG 87



TYPICAL CONSTRUCTION DETAIL FOR MONITORING WELL

01227393

025987

Hole No. MW-14

DRILLING LOG	DIVISION SWD	INSTALLATION FWD	SHEET 1 OF 2 SHEETS
1. PROJECT: LONGHORN AAP		10. SIZE AND TYPE OF BIT: 10" AUGER	
2. LOCATION: GROUND-WATER MONITORING WELLS		11. DATUM FOR ELEVATION SHOWN (MSL or MLW):	
3. DRILLING AGENCY: USCE		12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500	
4. HOLE NO. (As shown on drawing title and file number): MW-14		13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 21; UNDISTURBED 0	
5. NAME OF DRILLER: T. SUITS		14. TOTAL NUMBER CORE BOXES: N/A	
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER: SEE REMARKS COLUMN	
7. THICKNESS OF OVERBURDEN		16. DATE HOLE: STARTED 2 AUG 88; COMPLETED 9 AUG 88	
8. DEPTH DRILLED INTO ROCK		17. ELEVATION TOP OF HOLE: 180.93	
9. TOTAL DEPTH OF HOLE: 51.0'		18. TOTAL CORE RECOVERY FOR BORING: N/A %	
		19. SIGNATURE OF INSPECTOR: Jackie P. Hudson	

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	0.0		0.0' TO 1.9' SILT FILL: LOW PLASTICITY; LIGHT REDDISH BROWN; HARD; DRY; VERY SANDY; WITH FERRUGINOUS NODULES & CONCRETIONS		A	1. WATER LEVEL: NOTE: FREE WATER ENTERED BORING DURING DRILLING FROM 11.0'±. LEVEL IN WELL AFTER 24HRS. WAS AT 10.0'
			1.9' TO 7.0' SILT: 1.9'-5.0': LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM-STIFF; MOIST; VERY SANDY (BORDERS A SILTY SAND); CONTAINS A VERY WEAK ODOR. 5.0'-7.0': LOW PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF; DAMP; CLAYEY; SANDY; CONTAINS A VERY WEAK ODOR		B C D E F	
			7.0' TO 20.0' SAND: 7.0'-11.0': FINE GRAINED; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM; VERY MOIST TO WET FROM 9.0'±; VERY SILTY TO SLIGHTLY SILTY FROM 9.0'; CONTAINS A VERY WEAK ODOR		G H	2. JAR SAMPLES: (SOIL CLASSIFICATION) A: 0.0' - 1.9' B: 1.9' - 3.9' C: 3.9' - 5.0' D: 5.0' - 7.0' E: 7.0' - 9.0' F: 9.0' - 11.0' G: 11.0' - 16.0' H: 16.0' - 20.0' I: 20.0' - 22.5' J: 22.5' - 23.8' K: 23.8' - 26.0' L: 26.0' - 27.8' M: 27.8' - 32.8' N: 32.8' - 37.8' O: 37.8' - 42.8' P: 42.8' - 47.8' Q: 47.8' - 51.0'
	20		11.0'-20.0': FINE GRAINED; YELLOW, YELLOWISH BROWN & LIGHT GRAY; MEDIUM; WET-SATURATED; VERY SILTY; CONTAINS A WEAK ODOR		I	(CHEMICAL SAMPLES) C-1&1A: 2.0' C-2&2A: 10.0'
			20.0' TO 23.8' SILT: 20.0'-22.5': LOW PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; MEDIUM; WET; VERY SANDY (BORDERS A SILTY SAND); CONTAINS A VERY WEAK ODOR. 22.5'-23.8': LOW-MEDIUM PLASTICITY; LIGHT BLUE GRAY; MEDIUM-STIFF; VERY MOIST; CLAYEY; SANDY; CONTAINS A VERY WEAK ODOR		J K L M	3. DRILLING: 10" FLIGHT AUGER: 0.0' - 28.0' NOTE: SET 8" PVC CASING TO 28.0' & CEMENTED IN PLACE; NOTE: CEMENT PLUG WAS ROCKBITTED OUT. 8" FLIGHT AUGER 28.0' - 50.0' NOTE: BENTONITE DRILL MUD WAS USED & BORING WAS "MUDDED OFF" & 7 7/8" ROCK-BIT WAS USED FROM 50.0' - 51.0' MONITOR WELL WAS SET & SAND FILTER WAS PLACED AFTER DRILL MUD WAS FLUSHED OUT. THE BENTONITE SEAL WAS PLACED & BORING WAS GROUTED TO SURFACE. NOTE: REFER TO CONSTRUCTION
			23.8' TO 26.0' SAND: FINE GRAINED; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM; VERY MOIST-WET; VERY SILTY; CONTAINS A VERY WEAK ODOR		N	
			26.0' TO 27.8' CLAY: LOW PLASTICITY;		O	
	40					

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PROJECT: LONGHORN AAP. HOLE NO.: MW-14

01227394

025988

Hole No. MW-14

DRILLING LOG | DIVISION | INSTALLATION | SHEET 2 of 7 sheets

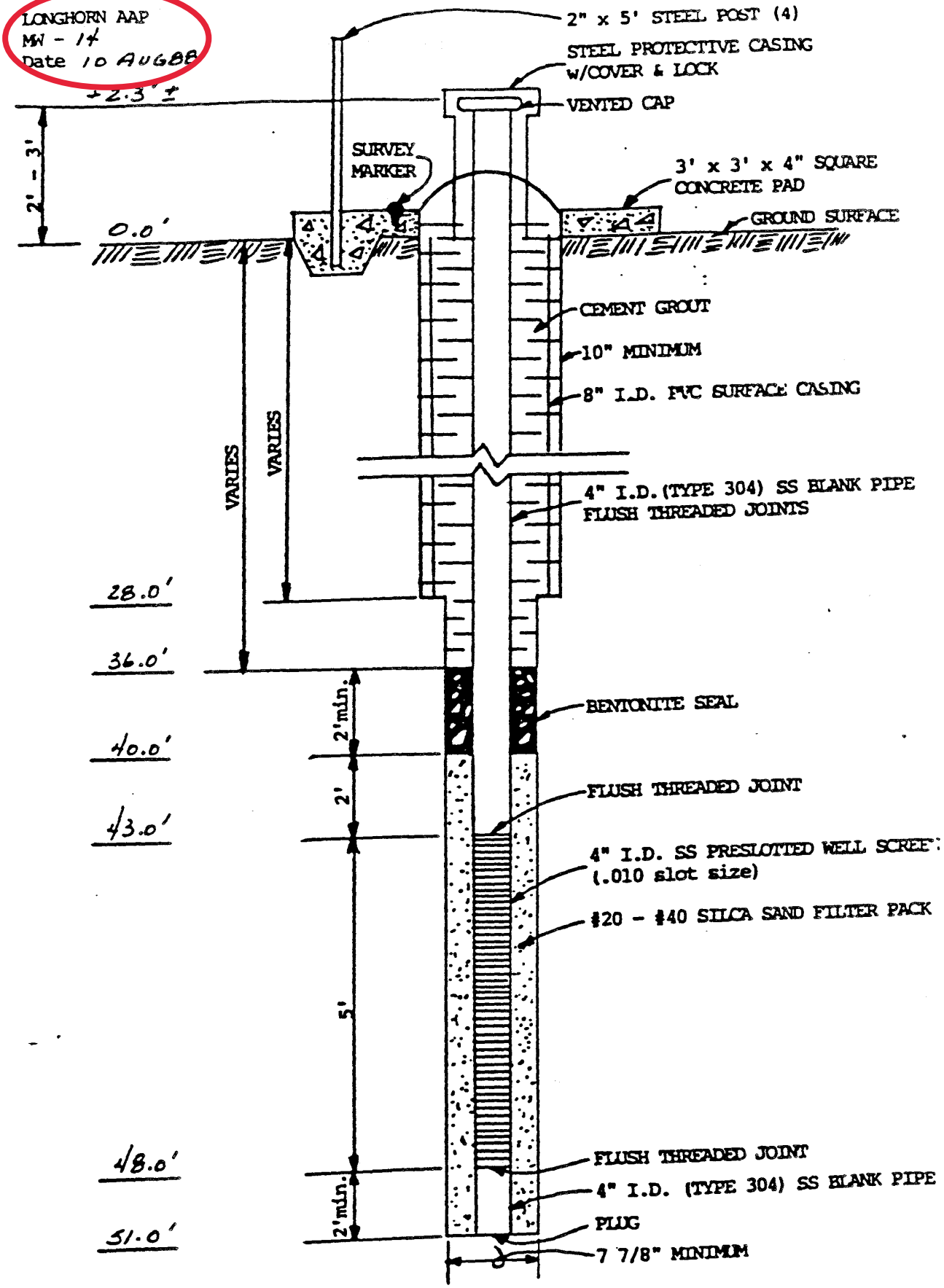
1. PROJECT: LONGHORN AAP.
2. LOCATION (Coordinates or Station): GROUND-WATER MONITORING WELLS
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): MW-14
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED: 2 AUG '88 COMPLETED: 9 AUG '88
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Jackie R Stokes

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Descriptions) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling rate, water loss, depth of weathering, etc., if significant) g
			LIGHT BLUE GRAY & YELLOWISH BROWN; MEDIUM-STIFF; VERY MOIST; VERY SILTY; SANDY; CONTAINS A VERY WEAK ODOR.			DETAIL SHEET.
			27.8' TO 51.0' T.D.			4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NOTE: A WEAK ODOR WAS DETECTED IN SOIL SAMPLES TO 32.8'
			SAND:			
			27.8'-32.8': FINE GRAINED; LIGHT BLUE GRAY & YELLOWISH BROWN; MEDIUM; SATURATED; SILTY; CONTAINS A WEAK ODOR		P	
			32.8'-51.0': FINE-MEDIUM GRAINED; LIGHT BLUE GRAY & YELLOWISH BROWN TO LIGHT GRAY WITH CHOCOLATE BROWN FROM 47.8'; MEDIUM-DENSE; SATURATED; SLIGHTLY SILTY; WITH CARBON MATTER.		Q	
	51.0		T.D. 51.0'			
	60					

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PROJECT LONGHORN AAP. HOLE NO. MW-14

LONGHORN AAP
MW - 14
Date 10 AUG88



TYPICAL CONSTRUCTION DETAIL FOR DEEP MONITORING WELL

025990

Sverdrup ENVIRONMENTAL

Site Id: **18SB01** Page 1 of 2

Location: Longhorn Army Ammunition Plant	X Coordinate: 3316725.84	Y Coordinate: 6952152.32
Date(s): 02/03/95 – 02/17/95	Elevation: .00'	Datum: NGVD
Logged By: T. Nelson	Total Depth: 127.00'	Completed Depth: 127.00'
Contractor: Burlington Environmental Inc.	Remarks:	
Drilling Method: Rotary		

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1	1 1 1		CL	CLAY– light brown, some very fine grained sand, saturated, roots
	5		SS-2	1 17 21 22			– mottled gray and reddish brown, some silt, stiff, moist, 2" lens of iron/manganese nodules
-10	10		SS-3	12 17 18 22		ML	SILT– light gray, moderate amount of very fine grained sand, some clay, low plasticity, moist
	15		SS-4	12 17 18 22			– gray, some very fine grained sand, black dendrites
-20	20		SS-5	5 6 14 18		CH	CLAY– light brown, trace silt, medium to high plasticity, moist, iron staining
	25		SS-6	15 7 37		SM	SAND– light gray, very fine grained, moderate amount of silt, moist to saturated
-30	30		SS-7	5 7 14 17		CL	CLAY– mottled orange and brown, stiff, dry to moist
	35		SS-8	10 12 21 30			– grayish brown, some very fine grained sand and silt, iron staining
-40	40		SS-9	8 10 20 22		SM	SAND– very dark gray, some silt, low plasticity, moist, iron staining
	45		SS-10	10 12 30 32			– dark gray, very fine grained, thinly laminated
-50	50		SS-11	7 17 28 31			– very fine to fine grained, thin laminations of silt, lignite lens
	55		SS-12	7 31 51 R/4"		ML SM	SILT– some very fine grained sand, stiff, low plasticity, dry to moist SAND– dark gray, moderate amount of silt, finely laminated, stiff
	60		SS-13				
	65		SS-14				– light greenish gray, very fine to fine grained, low plasticity, wet to saturated, thin lignite lenses

Sverdrup
ENVIRONMENTAL

Site Id: 18SB01 Page 2 of 2

tion: Longhorn Army Ammunition Plant	X Coordinate: 3316725.84 / Y Coordinate: 6952152.32
Date(s): 02/03/95 – 02/17/95	Elevation: .00' / Datum: NGVD
Logged By: T. Nelson	Total Depth: 127.00' / Completed Depth: 127.00'
Contractor: Burlington Environmental Inc.	Remarks:
Drilling Method: Rotary	

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-15	25 47 51 R/2"			– moist
	75		SS-16	27 47 51 R/4"			– some thin lenses of stiff gray clay
-80	80		SS-17	17 35 51 R/5"			– light bluish gray, fine grained, moderate amount of silt and clay, medium plasticity, moist to wet
	85		SS-18	17 35 51 R/5"		CL	CLAY– bluish gray, moderate amount of sand, stiff, medium plasticity, dry to moist – dark gray – thin sand lenses – light gray, thin dark gray clay lenses, alternating lenses of sandy clay
-90	90		SS-19	20 48 51 R/4"			
	95		SS-20	17 38 51 R/5"			– dark gray, fine sandy clay lenses, very stiff, dry
-100	100		SS-21	17 28 32 42		SM	SAND– greenish gray, very fine to fine grained, moderate amount of silt, low plasticity, moist to wet
	105		SS-22	19 51 R/6"			– moist
-110	110		SS-23	28 80 R/6"		CL	CLAY SHALE– dark gray, fine grained sand in partings, hard, dry
	115		SS-24	15 87 88 88			
-120	120		SS-25	38 51 R/2"			
	125		SS-26	32 88 88 88			
	130						
	135						

025992

Sverdrup ENVIRONMENTAL

Site ID: 18WW01 — Page 1 of 2

X Coordinate: [illegible].10 — Y Coordinate: 6951297.80

Location: Longhorn Army Ammunition Plant — Elevation: 198.87' — Datum: NGVD

(s): 02/05/95 - 03/22/95 — Total Depth: 109.00' — Measuring Point: 201.31'

Logged By: K. Williams — Completed Depth: 109.00' — Static Water Level:

Contractor: Burlington Environmental Inc. — Well Casing: type: SS dia: 4.00in fm: -2.4' to: 97.00'

Drilling Method: Rotary — Screens: type: Slotted size: .010in dia: 4.00in fm: 97.00' to: 107.00'

Remarks:

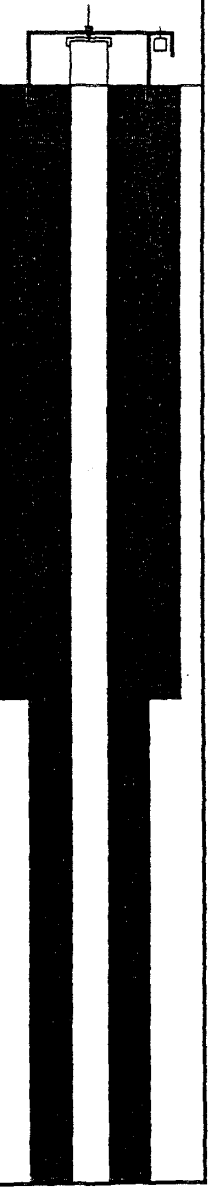
Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 87.50'
type: Secondary Sand Filter	fm: 87.50'	to: 89.00'
type: Granular Bentonite Seal	fm: 89.00'	to: 92.50'
type: Secondary Sand Filter	fm: 92.50'	to: 93.50'
type: #20-40 Silica Filter Sand	fm: 93.50'	to: 109.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1	1 1 1		CL	CLAY- light brown, some very fine grained sand, saturated, roots
	5		SS-2	1 17 21 22			- mottled gray and reddish brown, some silt, stiff, moist, 2" lens of iron/manganese nodules
	10		SS-3	12 17 18 22		ML	SILT- light gray, moderate amount of very fine grained sand, some clay, low plasticity, moist
	15		SS-4	12 17 18 22			- gray, some very fine grained sand, black dendrites
180	20		SS-5	5 6 14 18		CH	CLAY- light brown, trace silt, medium to high plasticity, moist, iron staining
	25		SS-6	15 7 37		SM	SAND- light gray, very fine grained, moderate amount of silt, moist to saturated
170	30		SS-7	9 14 17		CL	CLAY- mottled orange and brown, stiff, dry to moist
	35		SS-8	9 10 12 21 30			- grayish brown, some very fine grained sand and silt, iron staining
160	40		SS-9	8 19 20 22		SM	SAND- very dark gray, some silt, low plasticity, moist, iron staining
	45		SS-10	19 12 30 32			- dark gray, very fine grained, thinly laminated
	50		SS-11	7 17 28 31			- very fine to fine grained, thin laminations of silt, lignite lens
	55		SS-12	7 31 31 8/4"		ML SM	SILT- some very fine grained sand, stiff, low plasticity, dry to moist SAND- dark gray, moderate amount of silt, finely laminated, stiff
140							

Well Construction

MP. EL. 201.31



025993

Sverdrup ENVIRONMENTAL

Site ID: 18WW01 Page 2 of 2

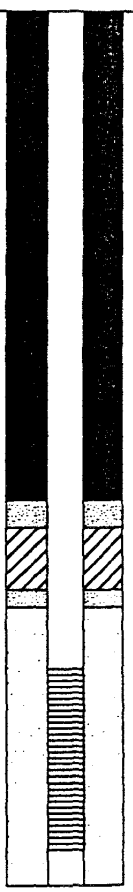
Location: Longhorn Army Ammunition Plant	X Coordinate: [illegible].10	Y Coordinate: 6951297.80
Date(s): 02/05/95 – 03/22/95	Elevation: 198.87'	Datum: NGVD
Logged By: K. Williams	Total Depth: 109.00'	Measuring Point: 201.31'
Contractor: Burlington Environmental Inc.	Completed Depth: 109.00'	Static Water Level:
Drilling Method: Rotary	Well Casing: type: SS dia: 4.00in fm: −2.4' to: 97.00'	
Remarks:	Screens: type: Slotted size: .010in dia: 4.00in fm: 97.00' to: 107.00'	

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 87.50'
type: Secondary Sand Filter	fm: 87.50'	to: 89.00'
type: Granular Bentonite Seal	fm: 89.00'	to: 92.50'
type: Secondary Sand Filter	fm: 92.50'	to: 93.50'
type: #20–40 Silica Filter Sand	fm: 93.50'	to: 109.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-13				
	65		SS-14				– light greenish gray, very fine to fine grained, low plasticity, wet to saturated, thin lignite lenses
	70		SS-15	25 47 51 R/2"			– moist
	75		SS-16	27 47 51 R/4"			– some thin lenses of stiff gray clay
120	80		SS-17	17 35 51 R/5"			– light bluish gray, fine grained, moderate amount of silt and clay, medium plasticity, moist to wet
	85		SS-18	17 33 51 R/5"		CL	CLAY– bluish gray, moderate amount of sand, stiff, medium plasticity, dry to moist
110	90		SS-19	20 48 51 R/4"			– dark gray – thin sand lenses – light gray, thin dark gray clay lenses, alternating lenses of sandy clay
	95		SS-20	17 38 51 R/5"			– dark gray, fine sandy clay lenses, very stiff, dry
100	100		SS-21	17 28 32 42		SM	SAND– greenish gray, very fine to fine grained, moderate amount of silt, low plasticity, moist to wet
	105		SS-22	15 51 R/6"			– moist
	110					CL	CLAY SHALE– dark gray, fine sand in partings, hard dry
	115						
80							

Well Construction



025994

Sverdrup ENVIRONMENTAL

Site Id: 18SB02 | Page 1 of 4

X Coordinate: 3315712.11 | Y Coordinate: 6954011.74

ation: Longhorn Army Ammunition Plant | Elevation: 176.00' | Datum: NGVD

Date(s): 03/29/95 – 04/03/95 | Total Depth: 222.00' | Completed Depth: 222.00'

Logged By: S. Brunton | Remarks:

Contractor: Burlington Environmental Inc.

Drilling Method: Rotary

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
						SC/SM	
170	5		SS-1	3 5 7 11			clayey silty SAND– light gray, fine grained, soft, slight plasticity, wet, iron nodules and iron staining
	10		SS-2	14 32 32 40		SP	SAND– gray, fine grained, poorly sorted, medium dense, wet to saturated, some iron staining
	15		SS-3	7 14 20 18			– light brownish gray
	20		SS-4	12 12 16 20		SM SP	silty SAND– gray to reddish brown, fine grained, poorly sorted, dense, moist to wet SAND– dark gray, fine grained, poorly sorted, some fines, dense, wet to saturated
150	25		SS-5	10 12 28 24			– gray, slightly larger grain size
	30		SS-6	8 28 48 42			– decreased fines, some lignite lenses
140	35		SS-7	12 51 R/1"			– fine to medium grained, medium dense – light gray, medium grained, saturated
	40		SS-8	20 32 42 45			– gray – dark gray, some fine and coarse grains, some fines, wet to saturated
130	45		SS-9	22 42			–dark gray, clean – grayish brown, fine grained, saturated
	50		SS-10	24 34 22 24		SW	sandy CLAY– gray, some coarse sand to fine gravel, soft, medium plasticity, moist SAND– brown, well graded, fines to medium gravel, medium dense, wet to saturated, lignite lenses
120	55		SS-11	99 R/2"		GM	– coarse grained, some gravel, loose, saturated
	60		SS-12	9 28 51 R/3"		SP	– gray, fine grained, poorly graded, medium dense, some stained black lenses
110	65		SS-13	4 4 48 51 R/3"			– fine to medium grained, wet to saturated

025995

Sverdrup ENVIRONMENTAL	Site Id 18SB02	Page 2 of 4
	X Coordinate: 3315712.11	Y Coordinate: 6954011.74
ɪtion: Longhorn Army Ammunition Plant	Elevation: 176.00'	Datum: NGVD
Date(s): 03/29/95 – 04/03/95	Total Depth: 222.00'	Completed Depth: 222.00'
Logged By: S. Brunton	Remarks:	
Contractor: Burlington Environmental Inc.		
Drilling Method: Rotary		

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-14	28 50 51 R/3"		SM	clayey silty SAND– bluish gray, very dense, slight plasticity, moist
100	75		SS-15	30 51 R/4"			– moist to wet
	80		SS-16	50 51 R/3"			– increased clay content, moist
90	85		SS-17	40 51 R/4"			
	90		SS-18	42 51 R/4"			– increased fine sand content, decreased clay content
80	95		SS-19	42 51 R/4"			– wet to saturated
	100		SS-20	51 R/4"			– moist
70	105		SS-21	41 51 R/4"			– increased fine sand content, moist to wet
	110		SS-22	18 51 R/3"			– moist
60	115		SS-23	40 51 R/3"			
	120		SS-24	50 51 R/2"		SM/SP	– increased fine sand content, poorly graded, medium dense, wet to saturated
50	125		SS-25	47 51 R/3"			
	130		SS-26	15 30 51 R/1"			
40	135		SS-27	15 30 51 R/3"			

025990

Sverdrup ENVIRONMENTAL

Site Id: 18SB02 | Page 3 of 4

X Coordinate: 3515712.11	Y Coordinate: 6954011.74
Location: Longhorn Army Ammunition Plant	Elevation: 176.00' / Datum: NGVD
Date(s): 03/29/95 – 04/03/95	Total Depth: 222.00' / Completed Depth: 222.00'
Logged By: S. Brunton	Remarks:
Contractor: Burlington Environmental Inc.	
Drilling Method: Rotary	

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-28	50 51 R/5"			
30	145		SS-29	30 48 50 51 R/4"		SM	– decreased fine sand content, increased fines content, some black organic laminations, moist
	150		SS-30	23 51 R/4"			– thin dark gray clay lenses
	155		SS-31	32 51 R/4"			
	160		SS-32	32 51 R/3"			– increased fine sand content, wet
10	165		SS-33	35 51 R/4"			
	170		SS-34	34 51 R/3"			silty SAND– greenish gray, fine grained, medium dense, slight plasticity, moist
0	175		SS-35	48 51 R/3"		SM/SP	– increased sand content, poorly graded
	180		SS-36	50 51 R/3"			– medium dense to dense, moist to wet
-10	185		SS-37	42 51 R/4"			– dense
	190		SS-38	50 51 R/3"		CH	CLAY– dark greenish gray, some fine silt laminations, very stiff, medium plasticity, dry
-20	195		SS-39	99 R/1"			
	200		SS-40	99 R/1"			– very dark gray, fine dark greenish gray silt lenses, medium to high plasticity
-30	205		SS-41	99 R/3"			

01227403

025997

Sverdrup
ENVIRONMENTAL

Site Id: 18SB02 — Page 4 of 4

X Coordinate: 3315712.71 — Y Coordinate: 6954011.74

Location: Longhorn Army Ammunition Plant — Elevation: 176.00' — Datum: NGVD

Date(s): 03/29/95 – 04/03/95 — Total Depth: 222.00' — Completed Depth: 222.00'

Logged By: S. Brunton — Remarks:

Contractor: Burlington Environmental Inc.

Drilling Method: Rotary

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-42	99 R/1"			
-40	215		SS-43	99 R/1"			– some fine sand laminations
	220						
-60	225						
	230						
	235						
-70	240						
	245						
-80	250						
	255						
-90	260						
	265						
-100	270						
	275						

01227404

025998

Sverdrup
ENVIRONMENTAL

Site ID: 18WW02 Page 1 of 4

X Coordinate: [illegible] Y Coordinate: 6953855.00

Location: Longhorn Army Ammunition Plant Elevation: 176.00' Datum: NGVD

Date(s): 04/05/95 – 04/15/95 Total Depth: 188.00' Measuring Point: 179.30'

Logged By: S. Brunton Completed Depth: 188.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: –3.3' to: 175.00'

Drilling Method: Rotary Screens: type: Slotted size: .010in dia: 4.00in fm: 175.00' to: 185.00'

Remarks:

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 165.50'
type: Secondary Sand Filter	fm: 165.50'	to: 167.70'
type: Granular Bentonite Seal	fm: 167.70'	to: 171.00'
type: Secondary Sand Filter	fm: 171.00'	to: 172.00'
type: #20–40 Silica Filter Sand	fm: 172.00'	to: 188.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
	5		SS-1	3 5 7 11		SC/SM	clayey silty SAND– light gray, fine grained, soft, slight plasticity, wet, iron nodules and iron staining
	10		SS-2	14 32 32 40		SP	SAND– gray, fine grained, poorly sorted, medium dense, wet to saturated, some iron staining
160	15		SS-3	7 14 20 18			– light brownish gray
	20		SS-4	12 12 18 20		SM SP	silty SAND– gray to reddish brown, fine grained, poorly sorted, dense, moist to wet SAND– dark gray, fine grained, poorly sorted, some fines, dense, wet to saturated
150	25		SS-5	10 12 28 24			– gray, slightly larger grain size
	30		SS-6	8 28 48 42			– decreased fines, some lignite lenses
140	35		SS-7	51 12 6/1"			– fine to medium grained, medium dense – light gray, medium grained, saturated
	40		SS-8	20 32 42 45			– gray – dark gray, some fine and coarse grains, some fines, wet to saturated
130	45		SS-9	22 42			–dark gray, clean – grayish brown, fine grained, saturated
	50		SS-10	24 34 22 24		SW	sandy CLAY– gray, some coarse sand to fine gravel, soft, medium plasticity, moist SAND– brown, well graded, fines to medium gravel, medium dense, wet to saturated, lignite lenses
120	55		SS-11	99 8/2"		GM	– coarse grained, some gravel, loose, saturated
			SS-12	9 [illegible]		SP	– gray, fine grained, poorly graded, medium dense,

Well Construction

MP. EL. 179.30

Sverdrup ENVIRONMENTAL

Site ID: 18WW02 Page 2 of 4

ıtion: Longhorn Army Ammunition Plant	Elevation: 176.00'	Datum: NGVD
Date(s): 04/05/95 – 04/15/95	Total Depth: 188.00'	Measuring Point: 179.30'
Logged By: S. Brunton	Completed Depth: 188.00'	Static Water Level:
Contractor: Burlington Environmental Inc.	Well Casing: type: SS dia: 4.00in fm: −3.3' to: 175.00'	
Drilling Method: Rotary	Screens: type: Slotted size: .010in dia: 4.00in fm: 175.00' to: 185.00'	
Remarks:	Annular Fill:	

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 165.50'
type: Secondary Sand Filter	fm: 165.50'	to: 167.70'
type: Granular Bentonite Seal	fm: 167.70'	to: 171.00'
type: Secondary Sand Filter	fm: 171.00'	to: 172.00'
type: #20–40 Silica Filter Sand	fm: 172.00'	to: 188.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
				51 R/3"			some stained black lenses
	65		SS-13	4 4 49 51 R/3"			– fine to medium grained, wet to saturated
	70		SS-14	28 50 51 R/3"		SM	clayey silty SAND– bluish gray, very dense, slight plasticity, moist
100	75		SS-15	30 51 R/4"			– moist to wet
	80		SS-16	50 51 R/3"			– increased clay content, moist
90	85		SS-17	40 51 R/4"			
	90		SS-18	40 51 R/4"			– increased fine sand content, decreased clay content
80	95		SS-19	42 51 R/4"			– wet to saturated
	100		SS-20	51 R/4"			– moist
70	105		SS-21	41 51 R/4"			– increased fine sand content, moist to wet
	110		SS-22	18 51 R/3"			– moist
60	115		SS-23	40 51 R/3"			

Well Construction

025945

Monitor Well Installation

Client: Camp Dresser & McKee Job No.: 385-874 Date Drilled: 2/1/86 Well No.: C-3

Site: LHAAP Elevation: GL ____ Top of PVC Casing ____

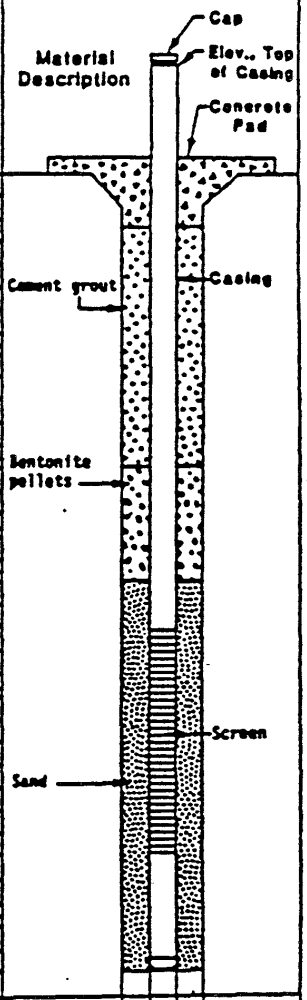
Total Depth: 36 feet Casing Size & Type: 4-inch Schedule 40 Flush-joint Threaded PVC Screen Size: .010 PVC

Comments: ____

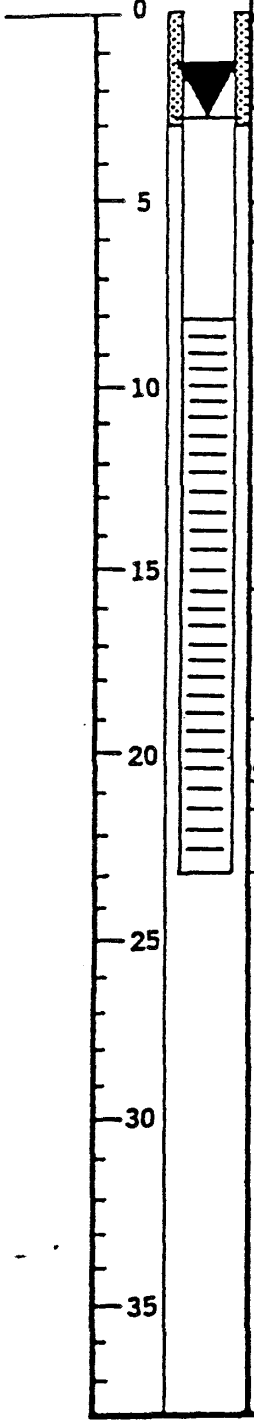
Depth	Symbol	Stratigraphy	Sample Description
0	CH		SANDY CLAY, 10-20% very fine sand, stiff, moist, tan and red mottled, roots, iron nodules.
10	SP/SM		SAND, uniform fine, compact, wet, iron stains, 3-5% silt.
15	MH		SILT, highly plastic, stiff, wet, gray, mottled with iron stains.
	SM		SILTY SAND, 70-80% fine to medium sand, wet, dark red, some 1/4" mud clasts (rounded).
20	MH		CLAYEY SILT, highly plastic, stiff, moist, gray, slight iron mottling.
25	SM		SILTY SAND, 20-30% silt, very fine, saturated, tan and red.
30	SM		SILTY SAND, 60-70% fine sand, compact, wet, red and gray laminated.
35	ML		SILT, moderate plasticity, stiff, moist, tan and red mottled, 10-20% very fine sand.
40			
45			
50			

Material Setting

Completion Data



Underground Resource Management, Inc.
Austin, Texas



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	8/7	Silty sand		
SM	6/4	Silty sand		
	5/6	Lt. brownish grey w/yellowish red		
CL-ML		Sandy silty clay 20% fine sand Reddish grey mottled w/yellowish red		
SC	2/3	Clayey sand		
	4/8			
	1/12			
		Silty sand		
		Grey mottled w/reddish brown	38.8	
SM	6/6			
	7/7			
	6/6			
SM	4/6	Silty sand		
	6/6	Grey w/some reddish brown	30	
SM+CL	2/4	Silty sand w/clay seams Grey mottled w/reddish brown		
	5/12			
CL	9/10	Sandy clay 25% sand Grey mottled w/reddish brown		

*BLOWS PER 6 INCH USING [illegible] SPLIT SPOON

VERTICAL SCALE 1" = 5.0'

WELL 130 DATE DRILLED 6/7/82

STUDY AREA Flashing Area

ELEVATION TOP OF STEEL CASING = 177.36 ft

ELEVATION TOP OF PVC RISER = 176.71 ft

ELEVATION OF GROUND SURFACE = 174.44 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

01227408

025947

Hole No. MW-18

DRILLING LOG | DIVISION: SWD | INSTALLATION: SWF | SHEET 1 OF 1 SHEETS

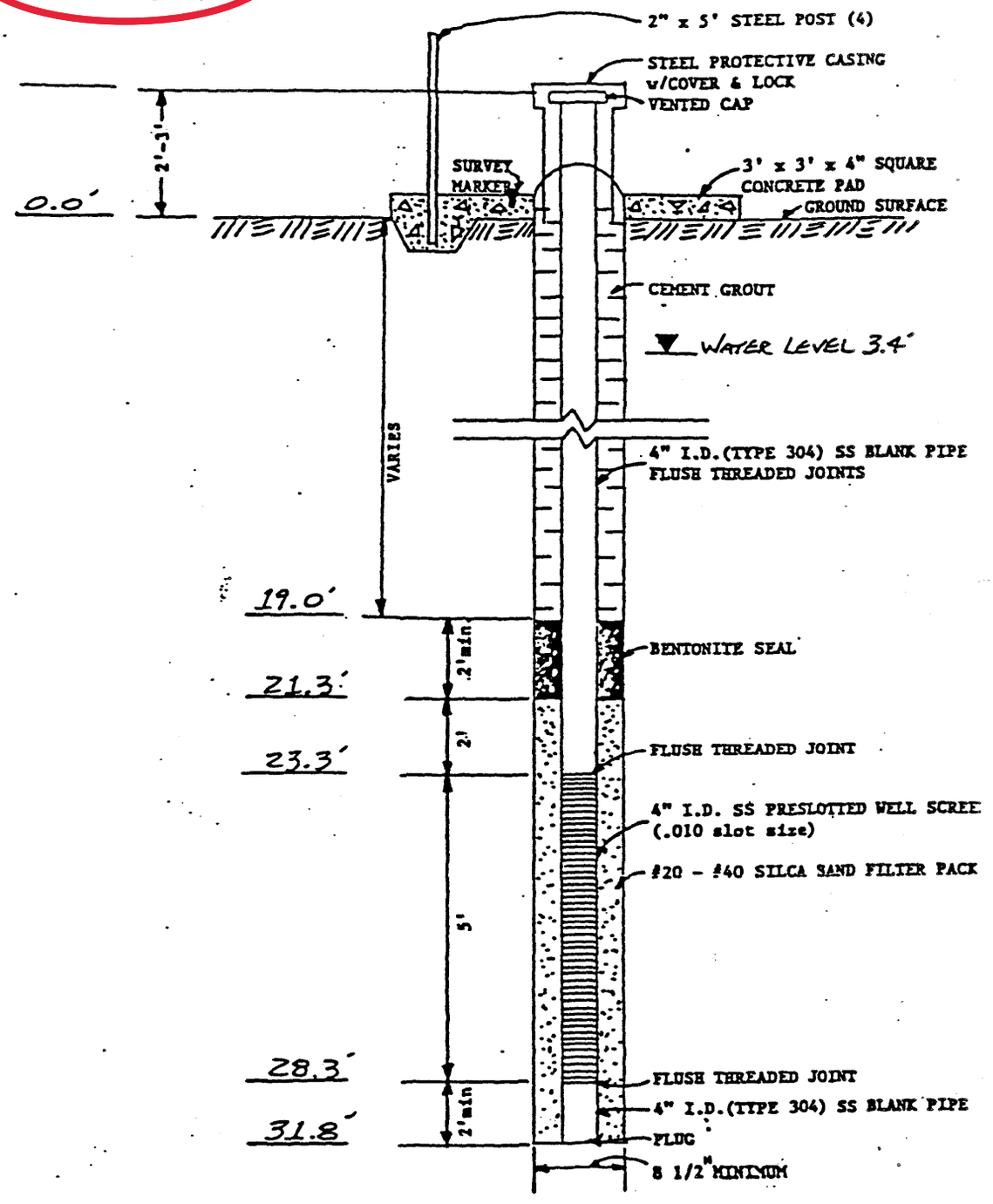
1. PROJECT: LONGHORN AAP IRET-PHASE II-MONITOR WELLS)
2. LOCATION: SEE LAYOUT
3. DRILLING AGENCY: USCE
4. HOLE NO.: MW-18
5. NAME OF DRILLER: T. SILVIS
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 31.8'
10. SIZE AND TYPE OF BIT: 10" AUGER
11. DATUM FOR ELEVATION SHOWN: (MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 9; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 9 AUG '89; COMPLETED 10 AUG '89
17. ELEVATION TOP OF HOLE: 177.09'
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R. Bolen

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS
	0.0		0.0' TO 2.5' SILT: LOW PLASTICITY: LIGHT GRAY WITH YELLOWISH BROWN: STIFF: DAMP: SANDY 2.5' TO 3.3' CLAY: MEDIUM PLASTICITY: LIGHT GRAY WITH YELLOWISH BROWN: STIFF: DAMP-MOIST: VERY SILTY: SANDY 3.3' TO 9.0' SILT: LOW PLASTICITY: LIGHT GRAY WITH YELLOWISH BROWN: MEDIUM: VERY MOIST TO WET FROM 5.0': VERY SANDY (BORDERS A SILTY SAND FROM 5.0') 9.0' TO 31.8' T.D. SAND: FINE GRAINED: LIGHT BLUE GRAY WITH YELLOWISH BROWN: LOOSE-MEDIUM: WET TO SATURATED: MODERATELY SILTY TO VERY SILTY: WITH ABUNDANT BLACK CARBON MATTER FROM 24.0'-31.8' 14.0'-19.0': WET: VERY SILTY (BORDERS A SANDY SILT)		A	1. WATER LEVEL: NOTE: SOME FREE WATER ENTERED BORING DURING DRILLING FROM 3.3'. 24 HR. OBSERVATION: FREE WATER LEVEL WAS AT 3.4': AFTER DEVELOPING WELL ON 11 AUG. BORING WAS BAILED TO 33.0' ON 14 AUG. AT 0925 HRS. LEVEL WAS 26.8' AT 0850 HRS., 22.4' AT 0930 HRS., 17.5' AT 1037 HRS., 11.0' AT 1299 HRS., 9.0' AT 1408 HRS., 6.0' AT 1655 HRS. & 3.4' AT 0822 HRS. on 15 AUG.
					B	
					C	
					D	
					E	
	20				F	2. JAR SAMPLES: A: 0.0' - 2.5' B: 2.5' - 3.3' C: 3.3' - 5.0' D: 5.0' - 9.0' E: 9.0' - 14.0' F: 14.0' - 19.0' G: 19.0' - 24.0' H: 24.0' - 29.0' I: 29.0' - 31.8'
					G	3. DRILLING: 10" FLIGHT AUGER: 0.0' - 31.0' NOTE: SET 8" STEEL CASING TO 31.0' 8" FLIGHT AUGER: 31.0' - 31.8' NOTE: WELL PIPE, SCREEN, FILTER & SEAL WERE PLACED AS CASING WAS REMOVED.
					H	
	31.8		T.D. 31.8'		I	4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. No MEASURABLE AMOUNTS WERE PRESENT. No ODORS WERE DETECTED IN DRILLING.
						5. NOTE: BORING WAS DRILLED AS STAKED.
	40					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT: LONGHORN AAP. | HOLE NO. MW-18

025948

LONGHORN AAP
Well No. MW-18
Date 10 AUG 89



Construction Detail for Shallow Monitoring Well

01227410

025949

Hole No. MW-19

DRILLING LOG | DIVISION SWD | INSTALLATION SWF | SHEET 1 of 1 SHEETS

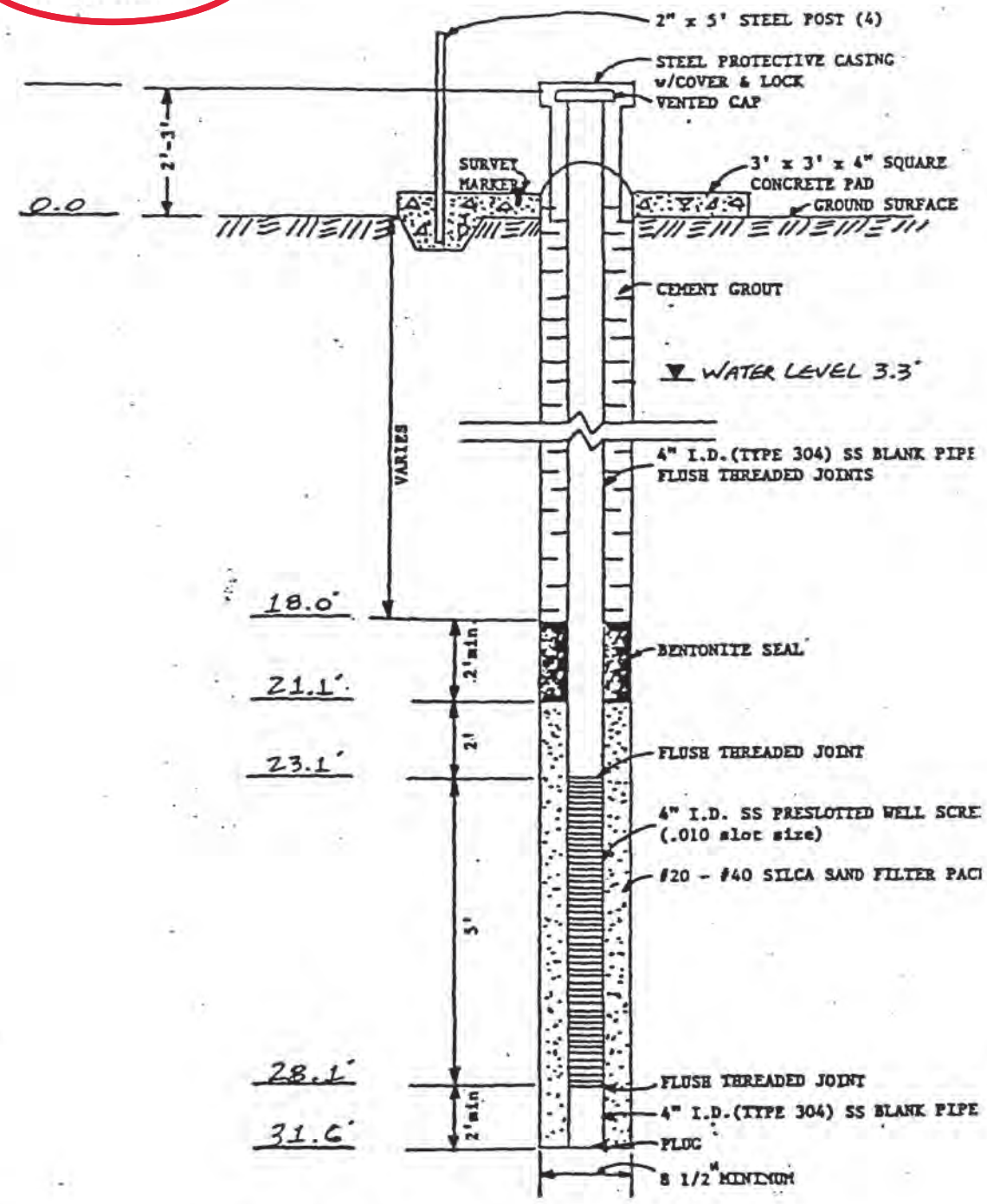
1. PROJECT: LONGHORN AAP (RFI-PHASE II-MONITOR WELL)
2. LOCATION: SEE REMARKS COLUMN
3. DRILLING AGENCY: USCE
4. HOLE NO.: MW-19
5. NAME OF DRILLER: T. SILITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 31.0'
10. SIZE AND TYPE OF BIT: 10" AUGER
11. DATUM FOR ELEVATION SHOWN (MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 13; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 3 AUG. 89; COMPLETED 3 AUG. 89
17. ELEVATION TOP OF HOLE: 176.59'
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R. Stokes

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIAL (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	0.0		0.0' TO 0.8' SILT: LOW PLASTICITY: GRAY BROWN: STIFF: DAMP: VERY SANDY		A	1. WATER LEVEL: NOTE: FREE WATER ENTERED BORING DURING DRILLING FROM 10.0'-10.9' & 15.0'-18.5' & 23.0'-31.6'. 24 HR. OBSERVATION: FREE WATER LEVEL IN WELL CASING WAS AT 3.3'; WELL WAS DEVELOPED on 7 AUG. & LEVEL WAS 30.5' AFTER BAILING AT 1325 HRS. LEVEL AT 18.0' AT 1355 HRS. & 5.9' AT 1515 HRS. & 3.3' AT 0810 HRS. on 8 AUG.
			0.8' TO 4.0' CLAY: MEDIUM-HIGH PLASTICITY: GRAYISH BROWN: STIFF-VERY STIFF: DAMP-MOIST: MOD. SILTY		B	
			4.0' TO 7.0' SILT: MEDIUM PLASTICITY: YELLOWISH BROWN & LIGHT GRAY: MEDIUM-STIFF: MOIST-VERY MOIST: SLIGHTLY SANDY		C	
			7.0' TO 7.8' CLAY: MEDIUM-HIGH PLASTICITY: GRAY BROWN-YELLOWISH BROWN: VERY STIFF-HARD: DAMP		D	
			7.8' TO 15.0' SILT: LOW-MEDIUM PLASTICITY: GRAY WITH YELLOWISH BROWN, WITH LIGHT BLUE GRAY FROM 10.9': MEDIUM-STIFF: MOIST-VERY MOIST & WET FROM 10.0'-10.9': SANDY TO VERY SANDY FROM 10.0'-10.9'		E	
			15.0' TO 18.5' SAND: FINE GRAINED: YELLOWISH BROWN WITH LIGHT GRAY: MEDIUM: SILTY: SATURATED		F	
	20		18.5' TO 20.5' SILT: LOW PLASTICITY: YELLOWISH BROWN WITH LIGHT GRAY: MEDIUM: VERY MOIST: VERY SANDY		G	2. JAR SAMPLES: A: 0.0' - 0.8' B: 0.8' - 4.0' C: 4.0' - 7.0' D: 7.0' - 7.8' E: 7.8' - 10.0' F: 10.0' - 10.9' G: 10.9' - 15.0' H: 15.0' - 18.5' I: 18.5' - 20.5' J: 20.5' - 20.7' K: 20.7' - 23.0' L: 23.0' - 28.0' M: 28.0' - 31.6'
			20.5' TO 20.7' CLAY: MEDIUM-HIGH PLASTICITY: GRAY & BROWN: MEDIUM: VERY MOIST: WITH TRACE of SILT & SAND		H	
			20.7' TO 23.0' SILT: LOW PLASTICITY: LIGHT BLUE GRAY & YELLOWISH BROWN: MEDIUM-STIFF: VERY MOIST-WET: VERY SANDY: WITH FERRUGINOUS STAINS		I	
	31.6		23.0' TO 31.6' T.D. SAND: FINE GRAINED: LIGHT BLUE GRAY WITH YELLOWISH BROWN: MEDIUM: SATURATED: SILTY: WITH ABUNDANT CARBON MATTER		J	
			T.D. 31.6'		K	
					L	3. DRILLING: 10" FLIGHT AUGER: 0.0' - 31.0' NOTE: SET 8" STEEL CASING TO 31.0' 8" FLIGHT AUGER: 31.0' - 31.6' NOTE: WELL PIPE & SCREEN WITH FILTER & SEAL WERE SET AS CASING WAS REMOVED.
					M	4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT. NO ODORS WERE DETECTED IN DRILLINGS.
	40					5. NOTE: BORING OFFSET 15' S52°E OF HUB AT SAME ELEVATION.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT LONGHORN AAP. | HOLE NO. MW-19

025950

LONGHORN AAP
Well No. MW-19
Date 4 AUG 89



Construction Detail for Shallow Monitoring Well
and Well C-4A

01227412

025982

Hole No. MW-1

DRILLING LOG | DIVISION: SWD | INSTALLATION: FWD | SHEET 1 OF 1 SHEETS

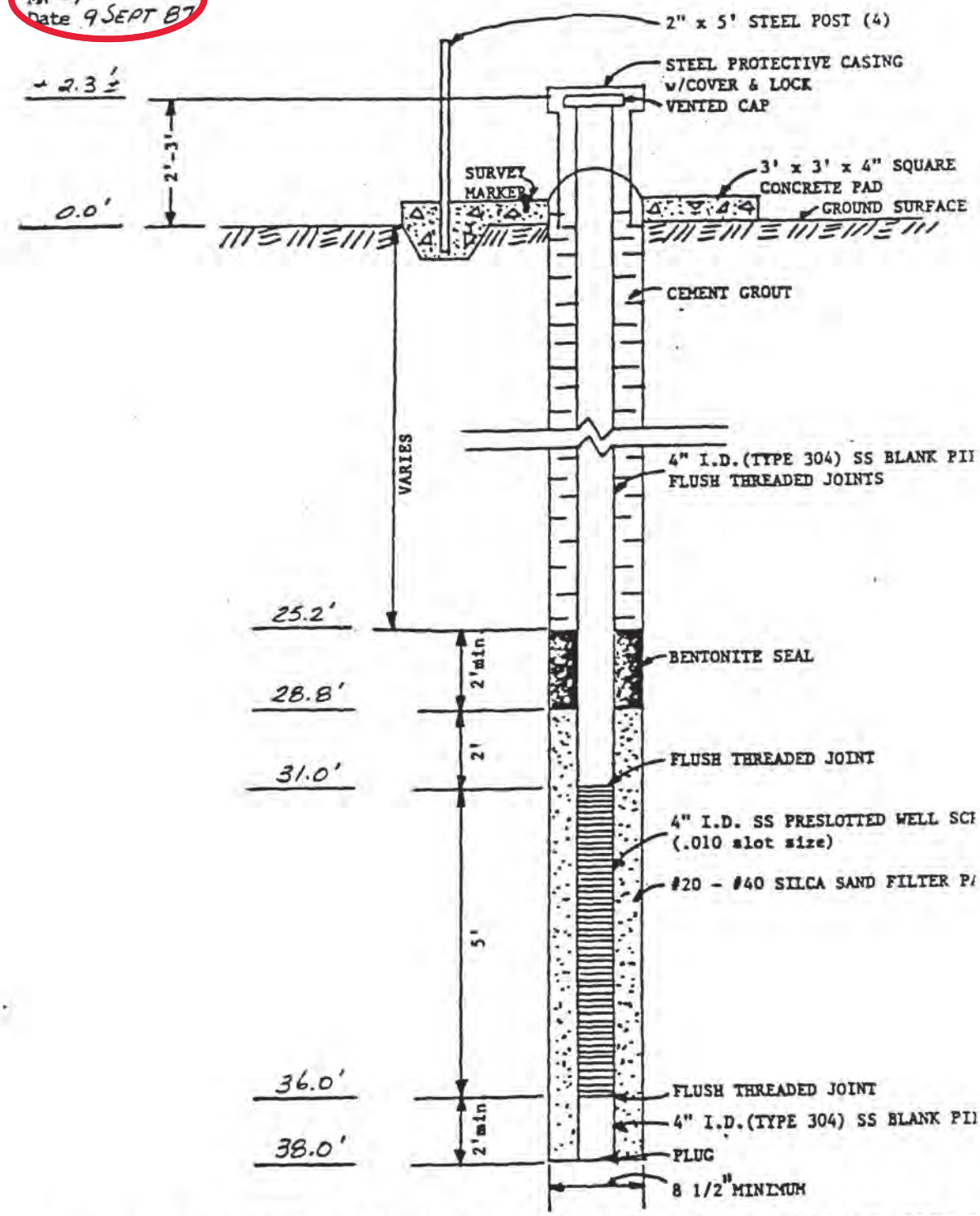
1. PROJECT: GROUND-WATER MONITORING WELLS
2. LOCATION: LONGHORN AAP
3. DRILLING AGENCY: USCE
4. HOLE NO.: MW-1
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 38.0'
10. SIZE AND TYPE OF BIT: 10" AUGER
11. DATUM FOR ELEVATION SHOWN: MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 2500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 17; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 2 SEPT. 87; COMPLETED 3 SEPT. 87
17. ELEVATION TOP OF HOLE: 197.73
18. TOTAL CORE RECOVERY FOR BORING: N/A
19. SIGNATURE OF INSPECTOR: Jackie L. Stokes

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc.) g
	0.0		0.0' To 3.0' SAND: FINE GRAINED; REDDISH BROWN; MEDIUM DRY; SILTY; CLAYEY FROM 2.0'-3.0'.		A B C	1. WATER LEVEL: NOTE: FREE WATER BEGAN ENTERING BORING AT 22.0'±; LEVEL WAS AT 23.0' AFTER 24 HRS
			3.0' To 8.0' CLAY: 3.0'-6.0': MEDIUM-HIGH PLASTICITY; RED & LIGHT GRAY To RED FROM 4.0'; VERY STIFF - HARD; DAMP; TRACE of SILTY SAND To 4.0'± 6.0'-8.0': LOW-MEDIUM PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; STIFF; DAMP; VERY SILTY; SANDY		D E F G	2. JAR SAMPLES: A: 0.0' - 2.0' B: 2.0' - 3.0' C: 3.0' - 4.0' D: 4.0' - 6.0' E: 6.0' - 8.0' F: 8.0' - 10.0' G: 10.0' - 15.0' H: 15.0' - 20.0' I: 20.0' - 24.2' J: 24.2' - 26.5' K: 26.5' - 31.5' L: 31.5' - 34.4' M: 34.4' - 38.0'
			8.0' To 24.2' SILT: 8.0'-20.0': LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM MOIST; SANDY; VERY CLAYEY WITH THIN SILTY CLAY LAMINATIONS 20.0'-24.2': LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; VERY MOIST-WET; SANDY		H I	3. JAR SAMPLES: (CHEMICAL TESTS) CH-1 & 1A: 2.0' CH-2 & 2A: 10.0'
	20		24.2' To 26.5' SAND: FINE GRAINED; YELLOWISH BROWN; SATURATED; VERY SILTY		J	4. DRILLING: 10" FLIGHT AUGER: 0.0' - 37.0' NOTE: BORING BEGAN SQUEEZING IN FROM 21.0'± NOTE: SET 8" STEEL CASING TO 37.0' 8" FLIGHT AUGER: 37.0' - 38.0'
			26.5' To 34.4' CLAY: MEDIUM-HIGH PLASTICITY; LIGHT GRAY WITH YELLOWISH BROWN; VERY STIFF; DAMP; WITH SCATTERED SILTY SAND LAMINATIONS		K L	5. NOTE: MONITORING WELL WAS COMPLETED & DEVELOPED 10 SEPT. 87; REFER To CONSTRUCTION DETAIL SHEET.
			34.4' To 38.0' T.D. SILT: LOW-MEDIUM PLASTICITY; YELLOWISH BROWN; SATURATED; SANDY; MODERATELY CLAYEY		M	6. NOTE: GAS DETECTOR TUBES WERE USED To MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT; NO MEASURABLE AMOUNTS WERE PRESENT.
	38.0		T.D. 38.0'			
	40					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT: LONGHORN AAP | HOLE NO. MW-1

025983

LONGHORN AAP
MW - 1
Date 9 SEPT 87



TYPICAL CONSTRUCTION DETAIL FOR MONITORING WELL

025984

Hole No. MW-2

DRILLING LOG | DIVISION: SWD | INSTALLATION: FWD | SHEET 1 OF 2 SHEETS

1. PROJECT: GROUND-WATER MONITORING WELLS
2. LOCATION (Coordinates or Station): LONGHORN AAP
3. DRILLING AGENCY: USCE
4. HOLE NO. (As shown on drawing title and file number): MW-2
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 40.4'
10. SIZE AND TYPE OF BIT: 8" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVERBURDEN SAMPLES TAKEN: DISTURBED 18; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 27 AUG. 87; COMPLETED 28 AUG. 87
17. ELEVATION TOP OF HOLE: 195.18
18. TOTAL CORE RECOVERY FOR BORING: N/A
19. SIGNATURE OF INSPECTOR: Jack R. Stobbe

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	0.0		0.0' TO 2.0' SAND: FINE GRAINED; REDDISH BROWN; MEDIUM; DRY; VERY SILTY		A	1. WATER LEVEL: NOTE: FREE WATER BEGAN ENTERING BORING AT 20.8'; LEVEL WAS AT 20.7' AFTER 24 HRS.
			2.0' TO 19.2' CLAY: 2.0'-6.0': MEDIUM-HIGH PLASTICITY; RED WITH LIGHT GRAY TO REDDISH BROWN FROM 4.0'; VERY STIFF-HARD DOWN TO VERY STIFF FROM 4.0'; DAMP; TRACE OF SILTY SAND TO NO SAND FROM 4.0'		B	
					C	
					D	
					E	2. JAR SAMPLES: A: 0.0' - 2.0' B: 2.0' - 4.0' C: 4.0' - 6.0' D: 6.0' - 8.0' E: 8.0' - 10.0' F: 10.0' - 14.2' G: 14.2' - 19.2' H: 19.2' - 20.4' I: 20.4' - 26.0' J: 26.0' - 27.0' K: 27.0' - 34.0' L: 34.0' - 38.0' M: 38.0' - 39.9' N: 39.9' - 40.4'
			6.0'-14.2': MEDIUM PLASTICITY; REDDISH BROWN, YELLOWISH BROWN & LIGHT GRAY; STIFF; MOIST; VERY SILTY; SLIGHTLY SANDY		F	
			14.2'-19.2': LOW-MEDIUM PLASTICITY; REDDISH BROWN WITH LIGHT GRAY; MEDIUM; VERY MOIST; VERY SANDY; WITH LAMINATIONS OF FINE SAND		G	
	20		19.2' TO 27.0' SILT: LOW PLASTICITY; YELLOWISH BROWN; MEDIUM; WET TO SATURATED FROM 20.4' TO VERY MOIST FROM 26.0'; SANDY TO VERY SANDY		H	3. JAR SAMPLES (CHEMICAL TESTS): CH-1 & 1A: 2.0' CH-2 & 2A: 10.0'
					I	4. DRILLING: 10" FLIGHT AUGER: 0.0' - 40.0' NOTE: BORING BEGAN SQUEEZING IN FROM 20.0'
			27.0' TO 34.0' CLAY: MEDIUM-HIGH PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF; MOIST; SLIGHTLY SILTY		J	NOTE: SET 8" STEEL CASING TO 40.0' 8" FLIGHT AUGER: 40.0' - 40.4'
					K	5. NOTE: MONITORING WELL WAS COMPLETED & DEVELOPED ON 1 SEPT. 87; REFER TO CONSTUCTION DETAIL SHEET.
			34.0' TO 39.9' SILT: LOW TO MEDIUM PLASTICITY FROM 38.0'; YELLOWISH BROWN WITH LIGHT GRAY TO YELLOWISH BROWN & REDDISH BROWN FROM 38.0'; MEDIUM; VERY MOIST; VERY SANDY; CLAYEY FROM 38.0'; WITH ABUNDANT		L	6. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0'
	40				M	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT: LONGHORN AAP. | HOLE NO. MW-2

01227415

025985

Hole No. MW-2

DRILLING LOG | DIVISION | INSTALLATION | SHEET 2 OF 2 SHEETS

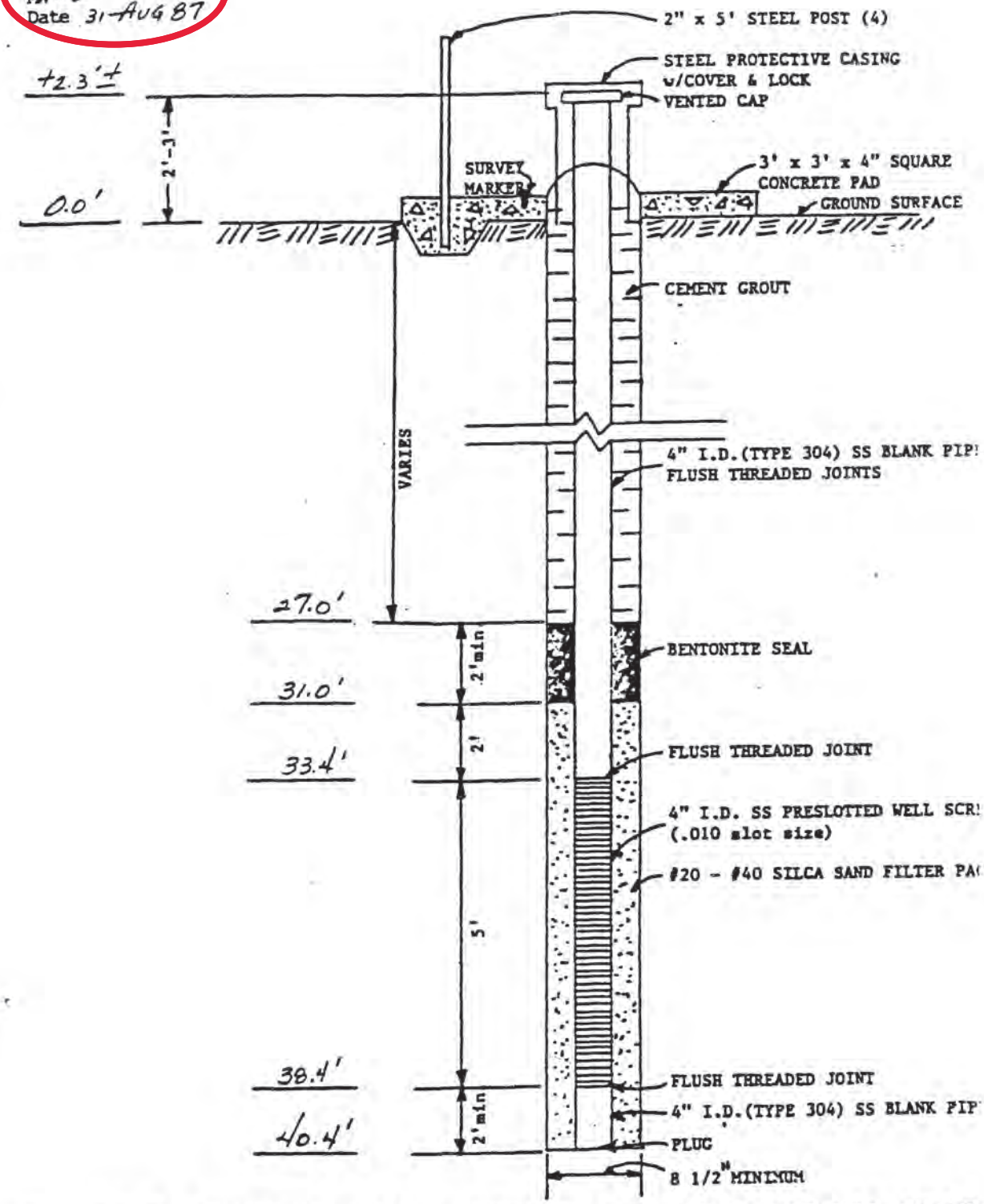
1. PROJECT: GROUND-WATER MONITORING WELLS
2. LOCATION (Coordinates or Station): LONGHORN AAP
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): MW-2
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM — MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED 27 AUG. 87 | COMPLETED 28 AUG. 87
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Joshua R. Stokes

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIAL (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	40.4		FERRUGINOUS STAINING FROM 38.0' 39.9' TO 40.4' T.D. CLAY: HIGH PLASTICITY; GRAY WITH YELLOWISH BROWN; VERY STIFF; DAMP 40.4' T.D.		N	OF BOREHOLE ADVANCEMENT; NO MEASURABLE AMOUNTS WERE PRESENT.
	60					
	80					

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT [illegible] AAP | HOLE NO MW-2

025986

LONGHORN AAP
MW -2
Date 31 AUG 87



TYPICAL CONSTRUCTION DETAIL FOR MONITORING WELL

Hole No. MW-14

DRILLING LOG | DIVISION SWD | INSTALLATION FWD | SHEET 1 OF 2 SHEETS

1. PROJECT: LONGHORN AAP
2. LOCATION: GROUND-WATER MONITORING WELLS
3. DRILLING AGENCY: USCE
4. HOLE NO.: MW-14
5. NAME OF DRILLER: T. SUITS
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE: 51.0'
10. SIZE AND TYPE OF BIT: 10" AUGER
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 21; UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES: N/A
15. ELEVATION GROUND WATER: SEE REMARKS COLUMN
16. DATE HOLE: STARTED 2 AUG. 88; COMPLETED 9 AUG. 88
17. ELEVATION TOP OF HOLE: 180.93
18. TOTAL CORE RECOVERY FOR BORING: N/A %
19. SIGNATURE OF INSPECTOR: Jackie R. Stokes

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
	0.0		0.0' TO 1.9' SILT FILL: LOW PLASTICITY; LIGHT REDDISH BROWN; HARD; DRY; VERY SANDY; WITH FERRUGINOUS NODULES & CONCRETIONS		A	1. WATER LEVEL: NOTE: FREE WATER ENTERED BORING DURING DRILLING FROM 11.0' LEVEL IN WELL AFTER 24HRS. WAS AT 10.0'
			1.9' TO 7.0' SILT: 1.9'-5.0': LOW PLASTICITY; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM-STIFF; MOIST; VERY SANDY (BORDERS A SILTY SAND); CONTAINS A VERY WEAK ODOR.		B	
			5.0'-7.0': LOW PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; STIFF; DAMP; CLAYEY-SANDY; CONTAINS A VERY WEAK ODOR		C	
			7.0' TO 20.0' SAND: 7.0'-11.0': FINE GRAINED; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM; VERY MOIST TO WET FROM 9.0'±; VERY SILTY TO SLIGHTLY SILTY FROM 9.0'; CONTAINS A VERY WEAK ODOR		D	
	20		11.0'-20.0': FINE GRAINED; YELLOW, YELLOWISH BROWN & LIGHT GRAY; MEDIUM; WET-SATURATED; VERY SILTY; CONTAINS A WEAK ODOR		E	2. JAR SAMPLES: (Soil Classification) A: 0.0' - 1.9' B: 1.9' - 3.9' C: 3.9' - 5.0'
			20.0' TO 23.8' SILT: 20.0'-22.5': LOW PLASTICITY; YELLOWISH BROWN & LIGHT GRAY; MEDIUM; WET; VERY SANDY (BORDERS A SILTY SAND); CONTAINS A VERY WEAK ODOR.		F	D: 5.0' - 7.0' E: 7.0' - 9.0' F: 9.0' - 11.0'
			22.5'-23.8': LOW-MEDIUM PLASTICITY; LIGHT BLUE GRAY; MEDIUM-STIFF; VERY MOIST; CLAYEY; SANDY; CONTAINS A VERY WEAK ODOR		G	G: 11.0' - 16.0' H: 16.0' - 20.0' I: 20.0' - 22.5' J: 22.5' - 23.8' K: 23.8' - 26.0' L: 26.0' - 27.8'
			23.8' TO 26.0' SAND: FINE GRAINED; YELLOWISH BROWN WITH LIGHT GRAY; MEDIUM; VERY MOIST-WET; VERY SILTY; CONTAINS A VERY WEAK ODOR		H	M: 27.8' - 32.8' N: 32.8' - 37.8' O: 37.8' - 42.8' P: 42.8' - 47.8' Q: 47.8' - 51.0' (CHEMICAL SAMPLES) C-141A: 2.0' C-242A: 10.0'
			26.0' TO 27.8' CLAY: LOW PLASTICITY;		I	
	40				J	3. DRILLING: 10" FLIGHT AUGER: 0.0' - 28.0'
					K	NOTE: SET 8" PVC CASING TO 28.0' & CEMENTED IN PLACE.
					L	NOTE: CEMENT PLUG WAS ROCKBITTED OUT.
					M	8" FLIGHT AUGER 28.0' - 50.0' NOTE: BENTONITE DRILL MUD WAS USED & BORING WAS "MUDDED OFF" & 7 7/8" ROCK-BIT WAS USED FROM 50.0' - 51.0'
					N	MONITOR WELL WAS SET & SAND FILTER WAS PLACED AFTER DRILL MUD WAS FLUSHED OUT. THE BENTONITE SEAL WAS PLACED & BORING WAS GROUTED TO SURFACE. NOTE: REFER TO CONSTRUCTION
					O	

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT: LONGHORN AAP. HOLE NO.: MW-14

01227418

025988

Hole No. MW-14

DRILLING LOG | DIVISION | INSTALLATION | SHEET 2 OF 7 SHEETS

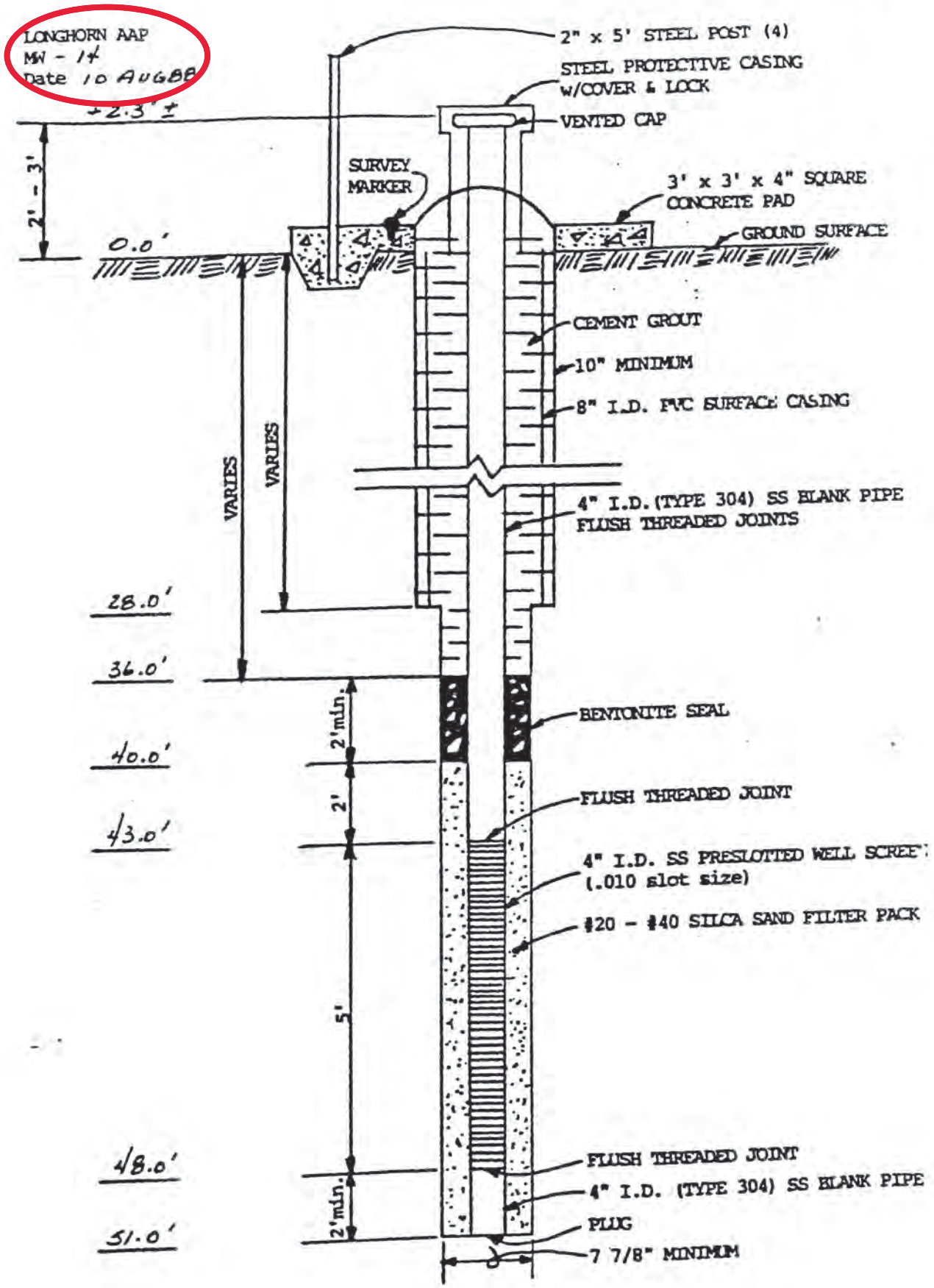
1. PROJECT: LONGHORN AAP
2. LOCATION (Coordinates or Station): GROUND-WATER MONITORING WELLS
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number): MW-14
5. NAME OF DRILLER
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED _____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED 2 AUG. 88 | COMPLETED 9 AUG. 88
17. ELEVATION TOP OF HOLE
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
			LIGHT BLUE GRAY & YELLOWISH BROWN; MEDIUM-STIFF; VERY MOIST; VERY SILTY; SANDY; CONTAINS A VERY WEAK ODOR.			DETAIL SHEET.
			27.8' TO 51.0' T.D.			
			SAND:			
			27.8'-32.8': FINE GRAINED; LIGHT BLUE GRAY & YELLOWISH BROWN; MEDIUM; SATURATED; SILTY; CONTAINS A WEAK ODOR		P	4. NOTE: GAS DETECTOR TUBES WERE USED TO MONITOR METHYLENE CHLORIDE & TRICHLOROETHYLENE EVERY 10.0' OF BOREHOLE ADVANCEMENT. NO MEASURABLE AMOUNTS WERE PRESENT.
			32.8'-51.0': FINE-MEDIUM GRAINED; LIGHT BLUE GRAY & YELLOWISH BROWN TO LIGHT GRAY WITH CHOCOLATE BROWN FROM 47.8'; MEDIUM-DENSE; SATURATED; SLIGHTLY SILTY; WITH CARBON MATTER.		Q	NOTE: A WEAK ODOR WAS DETECTED IN SOIL SAMPLES TO 32.8'
	51.0		T.D. 51.0'			
	60					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE

PROJECT LONGHORN AAP. HOLE NO. MW-14

025989



TYPICAL CONSTRUCTION DETAIL FOR DEEP MONITORING WELL

025990

Sverdrup
ENVIRONMENTAL

Site Id: **18SB01**

ıtion: Longhorn Army Ammunition Plant	X Coordinate: 3316725.84	Y Coordinate: 6952152.32
Date(s): 02/03/95 – 02/17/95	Elevation: .00'	Datum: NGVD
Logged By: T. Nelson	Total Depth: 127.00'	Completed Depth: 127.00'
Contractor: Burlington Environmental Inc.	Remarks:	
Drilling Method: Rotary		

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1	1 1 1		CL	CLAY– light brown, some very fine grained sand, saturated, roots
	5		SS-2	17 21 22			– mottled gray and reddish brown, some silt, stiff, moist, 2" lens of iron/manganese nodules
-10	10		SS-3	12 17 22		ML	SILT– light gray, moderate amount of very fine grained sand, some clay, low plasticity, moist
	15		SS-4	12 17 22			– gray, some very fine grained sand, black dendrites
-20	20		SS-5	5 8 18		CH	CLAY– light brown, trace silt, medium to high plasticity, moist, iron staining
	25		SS-6	15 17 37		SM	SAND– light gray, very fine grained, moderate amount of silt, moist to saturated
-30	30		SS-7	5 7 14 17		CL	CLAY– mottled orange and brown, stiff, dry to moist
	35		SS-8	10 15 21 30			– grayish brown, some very fine grained sand and silt, iron staining
-40	40		SS-9	8 10 20 22		SM	SAND– very dark gray, some silt, low plasticity, moist, iron staining
	45		SS-10	10 12 25 32			– dark gray, very fine grained, thinly laminated
-50	50		SS-11	7 17 28 31			– very fine to fine grained, thin laminations of silt, lignite lens
	55		SS-12	7 31 51 N/C		ML SM	SILT– some very fine grained sand, stiff, low plasticity, dry to moist SAND– dark gray, moderate amount of silt, finely laminated, stiff
	60		SS-13				
	65		SS-14				– light greenish gray, very fine to fine grained, low plasticity, wet to saturated, thin lignite lenses

025991

Sverdrup ENVIRONMENTAL

Site Id: **18SB01** Page 2 of 2

X Coordinate: 5516725.84 | Y Coordinate: 6952152.32

tion: Longhorn Army Ammunition Plant | Elevation: .00' | Datum: NGVD

Date(s): 02/03/95 - 02/17/95 | Total Depth: 127.00' | Completed Depth: 127.00'

Logged By: T. Nelson | Remarks:

Contractor: Burlington Environmental Inc.

Drilling Method: Rotary

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-15	45 47 51 R/2"			– moist
	75		SS-16	27 47 51 R/4"			– some thin lenses of stiff gray clay
-80	80		SS-17	17 35 51 R/5"			– light bluish gray, fine grained, moderate amount of silt and clay, medium plasticity, moist to wet
	85		SS-18	17 35 51 R/5"		CL	CLAY– bluish gray, moderate amount of sand, stiff, medium plasticity, dry to moist – dark gray – thin sand lenses – light gray, thin dark gray clay lenses, alternating lenses of sandy clay
	90		SS-19	20 48 51 R/4"			
	95		SS-20	17 38 51 R/5"			– dark gray, fine sandy clay lenses, very stiff, dry
-100	100		SS-21	17 28 32 42		SM	SAND– greenish gray, very fine to fine grained, moderate amount of silt, low plasticity, moist to wet
	105		SS-22	15 R/6"			– moist
-110	110		SS-23	28 80 R/6"		CL	CLAY SHALE– dark gray, fine grained sand in partings, hard, dry
	115		SS-24	15 37 80 50			
-120	120		SS-25	38 51 R/2"			
	125		SS-26	32 80 80 80			
	130						
	135						

025992

Sverdrup ENVIRONMENTAL

Site ID: 18WW01 Page 1 of 2

Location: Longhorn Army Ammunition Plant	X Coordinate: [illegible].10	Y Coordinate: 6951297.80
(s): 02/05/95 – 03/22/95	Elevation: 198.87'	Datum: NGVD
Logged By: K. Williams	Total Depth: 109.00'	Measuring Point: 201.31'
Contractor: Burlington Environmental Inc.	Completed Depth: 109.00'	Static Water Level:
Drilling Method: Rotary	Well Casing: type: SS dia: 4.00in fm: −2.4' to: 97.00'	
Remarks:	Screens: type: Slotted size: .010in dia: 4.00in fm: 97.00' to: 107.00'	

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 87.50'
type: Secondary Sand Filter	fm: 87.50'	to: 89.00'
type: Granular Bentonite Seal	fm: 89.00'	to: 92.50'
type: Secondary Sand Filter	fm: 92.50'	to: 93.50'
type: #20–40 Silica Filter Sand	fm: 93.50'	to: 109.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1	1 1 1		CL	CLAY– light brown, some very fine grained sand, saturated, roots
	5		SS-2	1 17 21 22			– mottled gray and reddish brown, some silt, stiff, moist, 2" lens of iron/manganese nodules
	10		SS-3	12 17 19 22		ML	SILT– light gray, moderate amount of very fine grained sand, some clay, low plasticity, moist
	15		SS-4	12 17 19 22			– gray, some very fine grained sand, black dendrites
180	20		SS-5	5 14 14 18		CH	CLAY– light brown, trace silt, medium to high plasticity, moist, iron staining
	25		SS-6	13 17 37		SM	SAND– light gray, very fine grained, moderate amount of silt, moist to saturated
170	30		SS-7	9 14 17		CL	CLAY– mottled orange and brown, stiff, dry to moist
	35		SS-8	10 12 21 30			– grayish brown, some very fine grained sand and silt, iron staining
160	40		SS-9	8 19 28 32		SM	SAND– very dark gray, some silt, low plasticity, moist, iron staining
	45		SS-10	10 12 30 32			– dark gray, very fine grained, thinly laminated
	50		SS-11	7 17 28 31			– very fine to fine grained, thin laminations of silt, lignite lens
	55		SS-12	7 31 51 8/4"		ML SM	SILT– some very fine grained sand, stiff, low plasticity, dry to moist SAND– dark gray, moderate amount of silt, finely laminated, stiff
140							

Well Construction

MP. EL. 201.31



025993

Sverdrup ENVIRONMENTAL

Site ID: 18WW01 Page 2 of 2

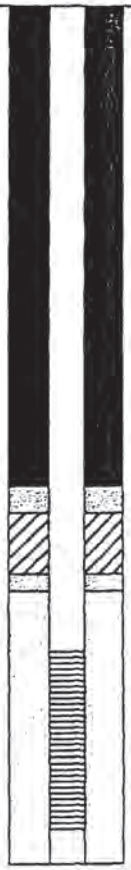
Location: Longhorn Army Ammunition Plant	X Coordinate: 3316988.10	Y Coordinate: 6951297.80
Date(s): 02/05/95 – 03/22/95	Elevation: 198.87'	Datum: NGVD
Logged By: K. Williams	Total Depth: 109.00'	Measuring Point: 201.31'
Contractor: Burlington Environmental Inc.	Completed Depth: 109.00'	Static Water Level:
Drilling Method: Rotary	Well Casing: type: SS dia: 4.00in fm: −2.4' to: 97.00'	
Remarks:	Screens: type: Slotted size: .010in dia: 4.00in fm: 97.00' to: 107.00'	

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 87.50'
type: Secondary Sand Filter	fm: 87.50'	to: 89.00'
type: Granular Bentonite Seal	fm: 89.00'	to: 92.50'
type: Secondary Sand Filter	fm: 92.50'	to: 93.50'
type: #20–40 Silica Filter Sand	fm: 93.50'	to: 109.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-13				
	65		SS-14				– light greenish gray, very fine to fine grained, low plasticity, wet to saturated, thin lignite lenses
	70		SS-15	25 47 50 8/2"			– moist
	75		SS-16	27 47 50 8/4"			– some thin lenses of stiff gray clay
120	80		SS-17	17 35 50 8/5"			– light bluish gray, fine grained, moderate amount of silt and clay, medium plasticity, moist to wet
	85		SS-18	17 35 50 8/5"		CL	CLAY– bluish gray, moderate amount of sand, stiff, medium plasticity, dry to moist
110	90		SS-19	20 40 50 8/4"			– dark gray – thin sand lenses – light gray, thin dark gray clay lenses, alternating lenses of sandy clay
	95		SS-20	17 38 50 8/5"			– dark gray, fine sandy clay lenses, very stiff, dry
100	100		SS-21	17 28 33 42		SM	SAND– greenish gray, very fine to fine grained, moderate amount of silt, low plasticity, moist to wet
	105		SS-22	15 8/6"			– moist
	110					CL	CLAY SHALE– dark gray, fine sand in partings, hard dry
	115						
80							

Well Construction



025994

Sverdrup ENVIRONMENTAL

Site Id: 18SB02 Page 1 of 4

X Coordinate: 3315712.11 Y Coordinate: 6954011.74

ation: Longhorn Army Ammunition Plant Elevation: 176.00' Datum: NGVD

Date(s): 03/29/95 – 04/03/95 Total Depth: 222.00' Completed Depth: 222.00'

Logged By: S. Brunton Remarks:

Contractor: Burlington Environmental Inc.

Drilling Method: Rotary

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
						SC/SM	
170	5		SS-1	3 5 7 11			clayey silty SAND– light gray, fine grained, soft, slight plasticity, wet, iron nodules and iron staining
	10		SS-2	14 32 42 50		SP	SAND– gray, fine grained, poorly sorted, medium dense, wet to saturated, some iron staining
	15		SS-3	7 14 20 16			– light brownish gray
	20		SS-4	12 12 16 20		SM SP	silty SAND– gray to reddish brown, fine grained, poorly sorted, dense, moist to wet SAND– dark gray, fine grained, poorly sorted, some fines, dense, wet to saturated
150	25		SS-5	10 12 28 24			– gray, slightly larger grain size
	30		SS-6	8 28 48 42			– decreased fines, some lignite lenses
140	35		SS-7	51 12 6/1"			– fine to medium grained, medium dense – light gray, medium grained, saturated
	40		SS-8	30 32 42 46			– gray – dark gray, some fine and coarse grains, some fines, wet to saturated
130	45		SS-9	22 42			–dark gray, clean – grayish brown, fine grained, saturated
	50		SS-10	24 34 32 24		SW	sandy CLAY– gray, some coarse sand to fine gravel, soft, medium plasticity, moist SAND– brown, well graded, fines to medium gravel, medium dense, wet to saturated, lignite lenses
120	55		SS-11	50/2" 6/2"		GM	– coarse grained, some gravel, loose, saturated
	60		SS-12	51 9 28 6/3"		SP	– gray, fine grained, poorly graded, medium dense, some stained black lenses
110	65		SS-13	51 6/3"			– fine to medium grained, wet to saturated

025995

Sverdrup ENVIRONMENTAL

Site Id: 18SB02 Page 2 of 4

X Coordinate: 3315712.11 Y Coordinate: 6954011.74

Location: Longhorn Army Ammunition Plant Elevation: 176.00' Datum: NGVD

Date(s): 03/29/95 – 04/03/95 Total Depth: 222.00' Completed Depth: 222.00'

Logged By: S. Brunton Remarks:

Contractor: Burlington Environmental Inc.

Drilling Method: Rotary

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-14	28 50 51 R/3"		SM	clayey silty SAND– bluish gray, very dense, slight plasticity, moist
100	75		SS-15	30 51 R/4"			– moist to wet
	80		SS-16	50 51 R/3"			– increased clay content, moist
90	85		SS-17	40 51 R/4"			
	90		SS-18	42 51 R/4"			– increased fine sand content, decreased clay content
80	95		SS-19	42 51 R/4"			– wet to saturated
	100		SS-20	51 R/4"			– moist
70	105		SS-21	41 51 R/4"			– increased fine sand content, moist to wet
	110		SS-22	18 51 R/3"			– moist
60	115		SS-23	* 40 51 R/3"			
	120		SS-24	50 51 R/2"		SM/SP	– increased fine sand content, poorly graded, medium dense, wet to saturated
50	125		SS-25	47 51 R/3"			
	130		SS-26	15 30 51 R/1"			
40	135		SS-27	15 30 51 R/3"			

025998

Sverdrup ENVIRONMENTAL

Site Id: 18SB02 Page 3 of 4

X Coordinate: 3315712.11 Y Coordinate: 6954011.74

Location: Longhorn Army Ammunition Plant Elevation: 176.00' Datum: NGVD

Date(s): 03/29/95 – 04/03/95 Total Depth: 222.00' Completed Depth: 222.00'

Logged By: S. Brunton Remarks:

Contractor: Burlington Environmental Inc.

Drilling Method: Rotary

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-28	30 51 R/5"			
30	145		SS-29	30 48 50 51 R/4"		SM	– decreased fine sand content, increased fines content, some black organic laminations, moist
	150		SS-30	23 51 R/4"			– thin dark gray clay lenses
	155		SS-31	32 51 R/4"			
	160		SS-32	32 51 R/3"			– increased fine sand content, wet
10	165		SS-33	38 51 R/4"			
	170		SS-34	34 51 R/3"			silty SAND– greenish gray, fine grained, medium dense, slight plasticity, moist
0	175		SS-35	48 51 R/3"		SM/SP	– increased sand content, poorly graded
	180		SS-36	50 51 R/3"			– medium dense to dense, moist to wet
-10	185		SS-37	42 51 R/4"			– dense
	190		SS-38	50 51 R/3"		CH	CLAY– dark greenish gray, some fine silt laminations, very stiff, medium plasticity, dry
-20	195		SS-39	99 R/1"			
	200		SS-40	99 R/1"			– very dark gray, fine dark greenish gray silt lenses, medium to high plasticity
-30	205		SS-41	99 R/3"			

025997

Sverdrup ENVIRONMENTAL

Site Id: 18SB02 Page 4 of 4

X Coordinate: 1315712.11 Y Coordinate: 6954011.74

Location: Longhorn Army Ammunition Plant Elevation: 176.00' Datum: NGVD

Date(s): 03/29/95 – 04/03/95 Total Depth: 222.00' Completed Depth: 222.00'

Logged By: S. Brunton Remarks:

Contractor: Burlington Environmental Inc.

Drilling Method: Rotary

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-42	99 R/1"			
-40	215		SS-43	99 R/1"			– some fine sand laminations
	220						
	225						
	230						
-60	235						
	240						
-70	245						
	250						
-80	255						
	260						
-90	265						
	270						
-100	275						

025998

Sverdrup ENVIRONMENTAL

Site ID: 18WW02 Page 1 of 4

X Coordinate: 3315769.10 Y Coordinate: 6953855.00

Location: Longhorn Army Ammunition Plant Elevation: 176.00' Datum: NGVD

Date(s): 04/05/95 – 04/15/95 Total Depth: 188.00' Measuring Point: 179.30'

Logged By: S. Brunton Completed Depth: 188.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: –3.3' to: 175.00'

Drilling Method: Rotary Screens: type: Slotted size: .010in dia: 4.00in fm: 175.00' to: 185.00'

Remarks:

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 165.50'
type: Secondary Sand Filter	fm: 165.50'	to: 167.70'
type: Granular Bentonite Seal	fm: 167.70'	to: 171.00'
type: Secondary Sand Filter	fm: 171.00'	to: 172.00'
type: #20–40 Silica Filter Sand	fm: 172.00'	to: 188.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
	5		SS-1	3 5 7 11		SC/SM	clayey silty SAND– light gray, fine grained, soft, slight plasticity, wet, iron nodules and iron staining
	10		SS-2	14 32 32 40		SP	SAND– gray, fine grained, poorly sorted, medium dense, wet to saturated, some iron staining
160	15		SS-3	7 14 20 18			– light brownish gray
	20		SS-4	12 22 18 30		SM SP	silty SAND– gray to reddish brown, fine grained, poorly sorted, dense, moist to wet SAND– dark gray, fine grained, poorly sorted, some fines, dense, wet to saturated
150	25		SS-5	10 32 28 24			– gray, slightly larger grain size
	30		SS-6	8 28 48 42			– decreased fines, some lignite lenses
140	35		SS-7	12 8/1"			– fine to medium grained, medium dense – light gray, medium grained, saturated
	40		SS-8	28 32 45			– gray – dark gray, some fine and coarse grains, some fines, wet to saturated
130	45		SS-9	22 42			–dark gray, clean – grayish brown, fine grained, saturated
	50		SS-10	24 34 22 24		SW	sandy CLAY– gray, some coarse sand to fine gravel, soft, medium plasticity, moist SAND– brown, well graded, fines to medium gravel, medium dense, wet to saturated, lignite lenses
120	55		SS-11	99 8/3"		GM	– coarse grained, some gravel, loose, saturated
			SS-12	9		SP	– gray, fine grained, poorly graded, medium dense,

Well Construction

MP. EL. 179.30

Sverdrup ENVIRONMENTAL

Site ID: 18WW02 Page 2 of 4

ıtion: Longhorn Army Ammunition Plant	X Coordinate: 3315769.10	Y Coordinate: 6953855.00
Date(s): 04/05/95 – 04/15/95	Elevation: 176.00'	Datum: NGVD
Logged By: S. Brunton	Total Depth: 188.00'	Measuring Point: 179.30'
Contractor: Burlington Environmental Inc.	Completed Depth: 188.00'	Static Water Level: .
Drilling Method: Rotary	Well Casing: type: SS dia: 4.00in fm: –3.3' to: 175.00'	
Remarks:	Screens: type: Slotted size: .010in dia: 4.00in fm: 175.00' to: 185.00'	
	Annular Fill:	
	type: Bentonite/Cement Grout	fm: .00' to: 3.00'
	type: Bentonite Grout	fm: 3.00' to: 165.50'
	type: Secondary Sand Filter	fm: 165.50' to: 167.70'
	type: Granular Bentonite Seal	fm: 167.70' to: 171.00'
	type: Secondary Sand Filter	fm: 171.00' to: 172.00'
	type: #20–40 Silica Filter Sand	fm: 172.00' to: 188.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description	Well Construction
							some stained black lenses	
	65		SS-13				– fine to medium grained, wet to saturated	
	70		SS-14			SM	clayey silty SAND– bluish gray, very dense, slight plasticity, moist	
100	75		SS-15				– moist to wet	
	80		SS-16				– increased clay content, moist	
90	85		SS-17					
	90		SS-18				– increased fine sand content, decreased clay content	
80	95		SS-19				– wet to saturated	
	100		SS-20				– moist	
70	105		SS-21				– increased fine sand content, moist to wet	
	110		SS-22				– moist	
60	115		SS-23					

026000

Sverdrup ENVIRONMENTAL

Site ID: 18WW02 Page 3 of 4

ɔtion: Longhorn Army Ammunition Plant	Elevation: 176.00'	Datum: NGVD
ɒate(s): 04/05/95 – 04/15/95	Total Depth: 188.00'	Measuring Point: 179.30'
Logged By: S. Brunton	Completed Depth: 188.00'	Static Water Level:
Contractor: Burlington Environmental Inc.	Well Casing: type: SS dia: 4.00in fm: –3.3' to: 175.00'	
Drilling Method: Rotary	Screens: type: Slotted size: .010in dia: 4.00in fm: 175.00' to: 185.00'	
Remarks:	Annular Fill: type: Bentonite/Cement Grout fm: .00' to: 3.00'; type: Bentonite Grout fm: 3.00' to: 165.50'; type: Secondary Sand Filter fm: 165.50' to: 167.70'; type: Granular Bentonite Seal fm: 167.70' to: 171.00'; type: Secondary Sand Filter fm: 171.00' to: 172.00'; type: #20–40 Silica Filter Sand fm: 172.00' to: 188.00'	

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-24	50 S1 6/5"		SM/SP	– increased fine sand content, poorly graded, medium dense, wet to saturated
	125		SS-25	47 S1 8/5"			
	130		SS-26	15 30 S1 8/1"			
40	135		SS-27	13 30 S1 8/5"			
	140		SS-28	50 S1 6/5"			
30	145		SS-29	30 48 50 S1 6/4"		SM	– decreased fine sand content, increased fines content, some black organic laminations, moist
	150		SS-30	23 S1 6/4"			– thin dark gray clay lenses
20	155		SS-31	32 S1 6/5"			
	160		SS-32	32 S1 8/5"			– increased fine sand content, wet
10	165		SS-33	38 S1 6/4"			
	170		SS-34	34 S1 8/5"			silty SAND– greenish gray, fine grained, medium dense, slight plasticity, moist
0	175		SS-35	48 S1 8/5"		SM/SP	– increased sand content, poorly graded

Well Construction



026000

Sverdrup ENVIRONMENTAL

Site ID: 18WW02 Page 3 of 4

X Coordinate: [illegible] Y Coordinate: 6953855.00

ɔtion: Longhorn Army Ammunition Plant Elevation: 176.00' Datum: NGVD

ɒate(s): 04/05/95 – 04/15/95 Total Depth: 188.00' Measuring Point: 179.30'

Logged By: S. Brunton Completed Depth: 188.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: −3.3' to: 175.00'

Drilling Method: Rotary Screens: type: Slotted size: .010in dia: 4.00in fm: 175.00' to: 185.00'

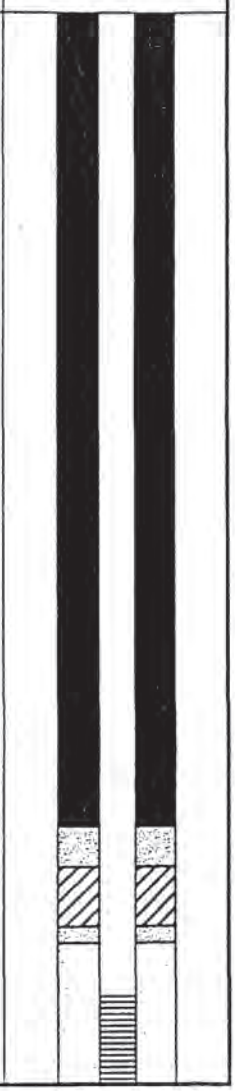
Remarks:

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 165.50'
type: Secondary Sand Filter	fm: 165.50'	to: 167.70'
type: Granular Bentonite Seal	fm: 167.70'	to: 171.00'
type: Secondary Sand Filter	fm: 171.00'	to: 172.00'
type: #20–40 Silica Filter Sand	fm: 172.00'	to: 188.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-24	50 S1 6/5"		SM/SP	– increased fine sand content, poorly graded, medium dense, wet to saturated
	125		SS-25	47 S1 8/5"			
	130		SS-26	15 30 S1 8/1"			
40	135		SS-27	13 30 S1 8/5"			
	140		SS-28	50 S1 8/5"			
30	145		SS-29	30 48 50 S1 8/4"		SM	– decreased fine sand content, increased fines content, some black organic laminations, moist
	150		SS-30	23 S1 8/4"			– thin dark gray clay lenses
20	155		SS-31	32 S1 8/5"			
	160		SS-32	32 S1 8/5"			– increased fine sand content, wet
10	165		SS-33	38 S1 8/4"			
	170		SS-34	34 S1 8/5"			silty SAND– greenish gray, fine grained, medium dense, slight plasticity, moist
0	175		SS-35	48 S1 8/5"		SM/SP	– increased sand content, poorly graded

Well Construction



026001

Sverdrup ENVIRONMENTAL

Site ID: 18WW02 Page 4 of 4

X Coordinate: 3315765.10 Y Coordinate: 6953855.00

ation: Longhorn Army Ammunition Plant Elevation: 176.00' Datum: NGVD

e(s): 04/05/95 - 04/15/95 Total Depth: 188.00' Measuring Point: 179.30'

Logged By: S. Brunton Completed Depth: 188.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: -3.3' to: 175.00'

Drilling Method: Rotary Screens: type: Slotted size: .010in dia: 4.00in fm: 175.00' to: 185.00'

Remarks:

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 165.50'
type: Secondary Sand Filter	fm: 165.50'	to: 167.70'
type: Granular Bentonite Seal	fm: 167.70'	to: 171.00'
type: Secondary Sand Filter	fm: 171.00'	to: 172.00'
type: #20-40 Silica Filter Sand	fm: 172.00'	to: 188.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description	Well Construction
		SS-36		50/5"			- medium dense to dense, moist to wet	
0	185	SS-37		42/6"			- dense	
	190						CLAY- dark greenish gray, some fine silt laminations, very stiff, medium plasticity, dry	
-20	195							
	200							
-30	205							
	210							
-40	215							
	220							
-50	225							
	230							
-60	235							

026002

Sverdrup ENVIRONMENTAL

Site Id: 18SB03 Page 1 of 2

ation: Longhorn Army Ammunition Plant	Elevation: 173.00'	Datum: NGVD
Date(s): 02/22/95 – 02/28/95	Total Depth: 107.00'	Completed Depth: 107.00'
Logged By: K. Williams	Remarks:	
Contractor: Burlington Environmental Inc.		
Drilling Method: Rotary		

X Coordinate: 3317957.46 Y Coordinate: 6953882.12

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
170	5		SS-1	20 50		CL	CLAY– tan with mottled yellowish orange, some very fine grained sand and silt, hard
	10		SS-2	5 10 21 20		ML	SILT– yellowish orange, some fines, medium stiff, dry
	15		SS-3	3 3 4 8			– yellowish orange to gray, increased clay content
	20		SS-4	2 3 5 10		SM/SC	SAND– yellowish orange with mottled gray, very fine grained, some clay, moist – gray, saturated
150	25		SS-5	3 4 7 8		SC	– gray with mottled yellowish orange, increased fines
	30		SS-6	8 9 11 11			
140	35		SS-7	4 8 8 10		CL	CLAY– gray with orange streaks, dry
	40		SS-8	2 3 7 9		SW	SAND– light gray, trace fines, moist
130	45		SS-9	2 7 9 9		SP	– brown, wet to saturated
	50		SS-10	8 10 20 18			– saturated
120	55		SS-11	1 3 3 5			– dark brown, gravel stringers
	60		SS-12	2 7 27 18			
110	65		SS-13	2 11 15 13		SC	– clay stringers

026003

Sverdrup ENVIRONMENTAL

Site Id: 18SB03 Page 2 of 2

X Coordinate: 3317957.46 Y Coordinate: 6953882.12

:tion: Longhorn Army Ammunition Plant Elevation: 173.00' Datum: NGVD

Date(s): 02/22/95 – 02/28/95 Total Depth: 107.00' Completed Depth: 107.00'

Logged By: K. Williams Remarks:

Contractor: Burlington Environmental Inc.

Drilling Method: Rotary

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
100	75		SS-14			PT OL	– dark brown PEAT
			SS-15			CL	CLAY– dark gray, hard, low plasticity, dry – some fine grained sand and silt in partings
90	80		SS-16				
	85		SS-17				
80	90		SS-18				
	95		SS-19				
70	100		SS-20	50			
	105		SS-21	60			
60	110						
	115						
50	120						
	125						
40	130						
	135						

026004

Sverdrup ENVIRONMENTAL

Site ID: 18WW03 Page 1 of 2

...ation: Longhorn Army Ammunition Plant	Elevation: 192.46'	Datum: NGVD
...e(s): 03/01/95 – 03/20/95	Total Depth: 73.00'	Measuring Point: 195.59'
Logged By: K. Williams	Completed Depth: 73.00'	Static Water Level:
Contractor: Burlington Environmental Inc.	Well Casing: type: SS dia: 4.00in fm: −3.1' to: 62.00'	
Drilling Method: Rotary	Screens: type: Slotted size: .010in dia: 4.00in fm: 62.00' to: 72.00'	
Remarks:	Annular Fill:	

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 54.30'
type: Secondary Sand Filter	fm: 54.30'	to: 55.00'
type: Granular Bentonite Seal	fm: 55.00'	to: 58.30'
type: Secondary Sand Filter	fm: 58.30'	to: 58.80'
type: #20–40 Silica Filter Sand	fm: 58.80'	to: 73.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No	Blow Count	Graphic Log	USCS Code	Material Description
						CL	CLAY– tan with mottled yellowish orange, some very fine grained sand and silt, hard
	5		SS-1	20 50			
						ML	SILT– yellowish orange, some fines, medium stiff, dry
	10		SS-2	3 10 20			
180							
	15		SS-3	3 6 8			– yellowish orange to gray, increased clay content
	20		SS-4	2 3 10		SM/SC	SAND– yellowish orange with mottled gray, very fine grained, some clay, moist
170							– gray, saturated
	25		SS-5	3 7 8		SC	– gray with mottled yellowish orange, increased fines
	30		SS-6	9 11 11			
160							
	35		SS-7	4 8 10		CL	CLAY– gray with orange streaks, dry
	40		SS-8	2 3 7		SW	SAND– light gray, trace fines, moist
150							
	45		SS-9	2 7 9		SP	– brown, wet to saturated
	50		SS-10	6 10 20 10			– saturated
140							
	55		SS-11	1 3 1			– dark brown, gravel stringers

Well Construction

MP. EL. 195.59



026005

Sverdrup ENVIRONMENTAL

Site ID: 18WW03 Page 2 of 2

X Coordinate: [illegible] Y Coordinate: 6953799.70

ation: Longhorn Army Ammunition Plant Elevation: 192.46' Datum: NGVD

Date(s): 03/01/95 – 03/20/95 Total Depth: 73.00' Measuring Point: 195.59'

Logged By: K. Williams Completed Depth: 73.00' Static Water Level:

Contractor: Burlington Environmental Inc.

Well Casing: type: SS dia: 4.00in fm: -3.1' to: 62.00'

Drilling Method: Rotary

Screens: type: Slotted size: .010in dia: 4.00in fm: 62.00' to: 72.00'

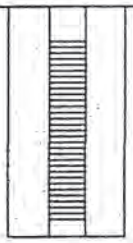
Remarks:

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 54.30'
type: Secondary Sand Filter	fm: 54.30'	to: 55.00'
type: Granular Bentonite Seal	fm: 55.00'	to: 58.30'
type: Secondary Sand Filter	fm: 58.30'	to: 58.80'
type: #20-40 Silica Filter Sand	fm: 58.80'	to: 73.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
130			SS-12	7 17 27 18			
	65		SS-13	2 11 13 13		SC	– dark gray, clay stringers
	70		SS-14	3 11 17 18			– dark brown
120						PT	PEAT
	75					CL	CLAY– dark gray, hard, low plasticity, dry
	80						
110							
	85						
	90						
100							
	95						
	100						
90							
	105						
	110						
80							
	115						

Well Construction



026006

Sverdrup ENVIRONMENTAL

Site Id: 18SB04 Page 1 of 2

ɪtion: Longhorn Army Ammunition Plant	X Coordinate: 3317137.52	Y Coordinate: 6954713.34
Date(s): 03/06/95 – 03/08/95	Elevation: 180.17'	Datum: NGVD
Logged By: S. Brunton	Total Depth: 85.75'	Completed Depth: 85.75'
Contractor: Burlington Environmental Inc.	Remarks:	
Drilling Method: Rotary		

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
180			SS-1	7 4 80 R/2"		SP	SAND– brown, fine grained, poorly graded, some silt and clay, medium dense, moist to wet, roots and decomposing plant material in upper 1'
	5		SS-2	3 5 6 8		SM	silty SAND– gray, fine grained, medium dense, moist, iron staining
170	10		SS-3	10 14 20 34		SC	clayey SAND– gray, fine grained, increased fines content, medium dense, slight plasticity, some iron staining
	15		SS-4	8 14 20 20		CL	sandy CLAY– brownish gray, fine grained sand, alternating lenses of sand and soft clay, dry to moist
160	20		SS-5	8 10 14 24		CH SM	CLAY– light gray, silt inclusions, stiff, high plasticity, dry, some iron staining silty SAND– light gray, fine grained, medium dense, wet to saturated
	25		SS-6	51 R/5"			
150	30		SS-7	7 8 16 18		SP	SAND– gray to dark yellowish brown, fine grained, poorly graded, loose, saturated
	35		SS-8	5 17 13 20			– gray, some fines
140	40		SS-9	8 12 20 24		SP	CLAY– gray to dark yellowish brown, fine grained sand, medium stiff, medium plasticity, dry SAND– gray, fine grained, some fines, loose, saturated
	45		SS-10	12 49 51 R/4"		SP	silty CLAY– dark gray, stiff, medium plasticity, dry SAND– gray, fine grained, some fines, loose, saturated
130	50		SS-11	38 51 R/5"		CL	– medium dense, wet silty CLAY– dark gray, very stiff, medium plasticity, dry
	55		SS-12	14 51 R/1"		SP/CL	– alternating lenses of gray, wet fine sand
	60		SS-13	32 51 R/1"		SM/SC	clayey silty SAND– bluish gray, stiff, slight plasticity, moist
			SS-14	48 51 R/4"			– increased sand content
	65		SS-15	20 50 51 R/2"		SC	silty clayey SAND– bluish gray, increased sand content, stiff, low plasticity, moist

Sverdrup
ENVIRONMENTAL

Site Id: 18SB04 Page 2 of 2

ation: Longhorn Army Ammunition Plant

Date(s): 03/06/95 – 03/08/95

Logged By: S. Brunton

Contractor: Burlington Environmental Inc.

Drilling Method: Rotary

X Coordinate: 3317137.52	Y Coordinate: 6954713.34
Elevation: 180.17'	Datum: NGVD
Total Depth: 85.75'	Completed Depth: 85.75'

Remarks:

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
110			SS-16	51 8/4"			
	75		SS-17			CH	CLAY– dark gray, gray silt laminations, very stiff, medium to high plasticity, dry
100	80		SS-18				
	85		SS-19				
90	90						
	95						
80	100						
	105						
70	110						
	115						
60	120						
	125						
	130						
	135						

026008

Sverdrup ENVIRONMENTAL

Site ID: 18WW04 Page 1 of 2

cation: Longhorn Army Ammunition Plant	Elevation: 180.17'	Datum: NGVD
.e(s): 03/09/95 – 03/17/95	Total Depth: 76.00'	Measuring Point: 183.74'
Logged By: S. Brunton	Completed Depth: 76.00'	Static Water Level:
Contractor: Burlington Environmental Inc.	Well Casing: type: SS dia: 4.00in fm: –3.6' to: 64.60'	
Drilling Method: Rotary	Screens: type: Slotted size: .010in dia: 4.00in fm: 64.60' to: 74.60'	
Remarks:	Annular Fill:	

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 52.50'
type: Secondary Sand Filter	fm: 52.50'	to: 54.20'
type: Granular Bentonite Seal	fm: 54.20'	to: 59.30'
type: Secondary Sand Filter	fm: 59.30'	to: 61.30'
type: #20–40 Silica Filter Sand	fm: 61.30'	to: 76.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
180			SS-1	7 4 4 50 6/2"		SP	SAND– brown, fine grained, poorly graded, some silt and clay, medium dense, moist to wet, roots and decomposing plant material in upper 1'
	5		SS-2	3 5 6 8		SM	silty SAND– gray, fine grained, medium dense, moist, iron staining
170	10		SS-3	10 14 20 24		SC	clayey SAND– gray, fine grained, increased fines content, medium dense, slight plasticity, some iron staining
	15		SS-4	8 14 20 20		CL	sandy CLAY– brownish gray, fine grained sand, alternating lenses of sand and soft clay, dry to moist
160	20		SS-5	8 10 14 24		CH SM	CLAY– light gray, silt inclusions, stiff, high plasticity, dry, some iron staining silty SAND– light gray, fine grained, medium dense, wet to saturated
	25		SS-6	51 6/5"			
150	30		SS-7	7 8 16 16		SP	SAND– gray to dark yellowish brown, fine grained, poorly graded, loose, saturated
	35		SS-8	5 17 15 20			– gray, some fines
140	40		SS-9	8 12 20 24		SP	CLAY– gray to dark yellowish brown, fine grained sand, medium stiff, medium plasticity, dry SAND– gray, fine grained, some fines, loose, saturated
	45		SS-10	12 49 51 6/4"		SP	silty CLAY– dark gray, stiff, medium plasticity, dry SAND– gray, fine grained, some fines, loose, saturated
	50		SS-11	38 51 6/5"		CL	– medium dense, wet silty CLAY– dark gray, very stiff, medium plasticity, dry
	55		SS-12	16 51 6/1"		SP/CL	– alternating lenses of gray, wet fine sand

Well Construction

MP. EL. 183.74



026009

Sverdrup ENVIRONMENTAL

Site ID: 18WW04 Page 2 of 2

X Coordinate: 3317286.00 Y Coordinate: 6955654.80

Location: Longhorn Army Ammunition Plant Elevation: 180.17' Datum: NGVD

Date(s): 03/09/95 – 03/17/95 Total Depth: 76.00' Measuring Point: 183.74'

Logged By: S. Brunton Completed Depth: 76.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: −3.6' to: 64.60'

Drilling Method: Rotary Screens: type: Slotted size: .010in dia: 4.00in fm: 64.60' to: 74.60'

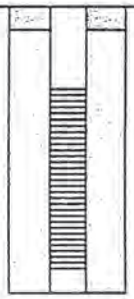
Remarks:

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 52.50'
type: Secondary Sand Filter	fm: 52.50'	to: 54.20'
type: Granular Bentonite Seal	fm: 54.20'	to: 59.30'
type: Secondary Sand Filter	fm: 59.30'	to: 61.30'
type: #20–40 Silica Filter Sand	fm: 61.30'	to: 76.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
120			SS-13	32 51 6/1'		SM/SC	clayey silty SAND– bluish gray, stiff, slight plasticity, moist
			SS-14	48 51 6/4'			– increased sand content
	65		SS-15	28 38 51 8/1'		SC	silty clayey SAND– bluish gray, increased sand content, stiff, low plasticity, moist
110	70		SS-16	28 44 51 8/4'			
	75		SS-17	14 44		CH	CLAY– dark gray, gray silt laminations, very stiff, medium to high plasticity, dry
100	80						
	85						
90	90						
	95						
80	100						
	105						
	110						
	115						

Well Construction



026010

Sverdrup ENVIRONMENTAL

Site Id: **18SB05** Page 1 of 2

X Coordinate: 3317650.65 Y Coordinate: 6956490.29

Location: Longhorn Army Ammunition Plant Elevation: 186.80' Datum: NGVD

Date(s): 02/17/95 – 02/21/95 Total Depth: 116.10' Completed Depth: 116.10'

Logged By: S. Brunton Remarks:

Contractor: Burlington Environmental Inc.

Drilling Method: Rotary

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1			FILL	
180	5		SS-2				silty CLAY– strong brown, soft, low to medium plasticity, dry
	10		SS-3			SP	sandy silty CLAY– light gray to yellowish brown, soft, medium to high plasticity, dry, roots SAND– yellowish brown, fine grained, trace fines, medium dense, wet
	15		SS-4			SM CL	silty SAND– mottled light gray to yellowish brown, fine grained, medium dense, wet sandy silty CLAY– mottled light gray to yellowish brown, soft, medium plasticity, moist
	20		SS-5			ML SP	clayey SILT– light yellowish brown with mottled light gray, some fine grained sand, soft, low plasticity, moist, iron staining SAND– light yellowish brown, fine grained, some silt, medium dense, wet to saturated
160	25		SS-6			CH	CLAY– olive yellow with mottled light gray, soft, high plasticity, dry, iron nodules
	30		SS-7			CH/SM SP	– grading downward into a light brownish gray silty sand, moist to wet SAND– light yellowish brown, some fines, medium dense, wet to saturated
150	35		SS-8				– brownish yellow, trace fines
	40		SS-9				– olive yellow, fine grained, trace fines
140	45		SS-10	51 R/T			– yellowish brown, slightly larger grain size, trace fines
	50		SS-11				– brown, fine grained, – dark gray, trace fines, layer of lignite
130	55		SS-12				– light yellowish brown to grayish brown, fine to medium grained, lignite lens at 55.5'
	60		SS-13			CL	silty CLAY– gray, medium stiff, medium plasticity, dry, plant roots, wood fibers
			SS-14			CH	CLAY– mottled gray to dark gray, medium stiff, high plasticity, dry, large wood fragments at 63.5'
120	65		SS-15			CL ML/SP	– dark gray to light brownish gray, some silt, fine sand inclusions, soft, medium to high plasticity, dry, some plant material sandy SILT– dark gray, some clay, grading to a silty sand, soft, low plasticity, dry to wet

Sverdrup ENVIRONMENTAL

Site Id: 18SB05 Page 2 of 2

X Coordinate: 3317650.65 Y Coordinate: 6956490.29

tion: Longhorn Army Ammunition Plant Elevation: 186.80' Datum: NGVD

Date(s): 02/17/95 - 02/21/95 Total Depth: 116.10' Completed Depth: 116.10'

Logged By: S. Brunton Remarks:

Contractor: Burlington Environmental Inc.

Drilling Method: Rotary

Elev. (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-16			ML	– bluish gray, some clay, stiff, slight to low plasticity, moist
110	75		SS-17				– some wet silty fine sand lenses
	80		SS-18	51 40 R/6"			– increased sand content
	85		SS-19	51 44 R/6"			
100							
	90		SS-20	51 28 R/6"		SM	silty SAND– bluish gray, fine grained, medium dense, slight plasticity, wet
90	95		SS-21			ML	sandy SILT– bluish gray, fine grained, stiff, slight to low plasticity, moist
	100		SS-22	51 R/1"		CH	CLAY– very dark gray, light gray silt laminations, hard, high plasticity, dry
80	105		SS-23				– some sand inclusions/nodules
	110		SS-24	51 24 R/6"			– very fine sand/coarse silt lens
70	115		SS-25	*			
	120						
60	125						
	130						
50	135						

026012

Sverdrup ENVIRONMENTAL

Site ID: 18WW05 Page 1 of 2

Location: Longhorn Army Ammunition Plant | X Coordinate: 3517840.90 | Y Coordinate: 6957027.00

Date(s): 02/22/95 – 03/03/95 | Elevation: 186.80' | Datum: NGVD

Logged By: S. Brunton | Total Depth: 98.00' | Measuring Point: 189.59'

Contractor: Burlington Environmental Inc. | Completed Depth: 98.00' | Static Water Level:

Drilling Method: Rotary | Well Casing: type: SS dia: 4.00in fm: -2.8' to: 88.00'

Remarks:

Screens: type: Slotted size: .010in dia: 4.00in fm: 88.00' to: 98.00'

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 77.00'
type: Secondary Sand Filter	fm: 77.00'	to: 78.10'
type: Granular Bentonite Seal	fm: 78.10'	to: 81.30'
type: Secondary Sand Filter	fm: 81.30'	to: 84.30'
type: #20-40 Silica Filter Sand	fm: 84.30'	to: 98.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1				
	5		SS-2			CL	silty CLAY- strong brown, soft, low to medium plasticity, dry
	10		SS-3			SP	sandy silty CLAY- light gray to yellowish brown, soft, medium to high plasticity, dry, roots SAND- yellowish brown, fine grained, trace fines, medium dense, wet
170	15		SS-4			SM CL	silty SAND- mottled light gray to yellowish brown, fine grained, medium dense, wet sandy silty CLAY- mottled light gray to yellowish brown, soft, medium plasticity, moist
	20		SS-5			ML SP	clayey SILT- light yellowish brown with mottled light gray, some fine grained sand, soft, low plasticity, moist, iron staining SAND- yellowish brown, fine grained, some silt, medium dense, wet to saturated
160	25		SS-6			CH	CLAY- olive yellow with mottled light gray, soft, high plasticity, dry, iron nodules
	30		SS-7			CH/SM SP	- grading downward into a light brownish gray silty sand, moist to wet SAND- light yellowish brown, some fines, medium dense, wet to saturated
150	35		SS-8				- brownish yellow, trace fines
	40		SS-9				- olive yellow, fine grained, few fines
140	45		SS-10				- yellowish brown, slightly larger grain size, trace fines
	50		SS-11				- brown, fine grained, - dark gray, trace fines, layer of lignite
130	55		SS-12				- light yellowish brown to grayish brown, fine to medium grained, lignite lens at 55.5'

Well Construction

MP. EL. 189.59



026013

Sverdrup ENVIRONMENTAL

Site ID: 18WW05 — Page 2 of 2

Location: Longhorn Army Ammunition Plant	X Coordinate: [illegible] Y Coordinate: 6957027.00
Date(s): 02/22/95 – 03/03/95	Elevation: 186.80' Datum: NGVD
Logged By: S. Brunton	Total Depth: 98.00' Measuring Point: 189.59'
Contractor: Burlington Environmental Inc.	Completed Depth: 98.00' Static Water Level:
Drilling Method: Rotary	Well Casing: type: SS dia: 4.00in fm: −2.8' to: 88.00'
Remarks:	Screens: type: Slotted size: .010in dia: 4.00in fm: 88.00' to: 98.00'

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Bentonite Grout	fm: 3.00'	to: 77.00'
type: Secondary Sand Filter	fm: 77.00'	to: 78.10'
type: Granular Bentonite Seal	fm: 78.10'	to: 81.30'
type: Secondary Sand Filter	fm: 81.30'	to: 84.30'
type: #20–40 Silica Filter Sand	fm: 84.30'	to: 98.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-13			CL	silty CLAY– gray, medium stiff, medium plasticity, dry, plant roots, wood fibers
			SS-14			CH	CLAY– mottled gray to dark gray, medium stiff, high plasticity, dry, large wood fragments at 63.5'
	65		SS-15			CL	– dark gray to light brownish gray, some silt, fine sand inclusions,
70						ML/SP	soft, medium to high plasticity, dry, some plant material sandy SILT– dark gray, some clay, grading to a silty sand, soft, low plasticity, dry to wet
	70		SS-16			ML	– bluish gray, some clay, stiff, slight to low plasticity, moist
	75		SS-17				– some wet silty fine sand lenses
110							
	80		SS-18	51 40 8/6			– increased sand content
	85		SS-19	51 44 8/6			
100							
	90		SS-20	51 28 8/6		SM	silty SAND– bluish gray, fine grained, medium dense, slight plasticity, wet
	95		SS-21			ML	sandy SILT– bluish gray, fine grained, stiff, slight to low plasticity, moist
90							
	100						CLAY– very dark gray, light gray silt laminations, hard, high plasticity, dry
	105						
80							
	110						
	115						
70							

Well Construction



026014

Sverdrup
ENVIRONMENTAL

Site ID: 18WW06 Page 1 of 2

Location: Longhorn Army Ammunition Plant	X Coordinate: 3315776.60	Y Coordinate: 6953852.50
Date(s): 04/20/95 – 04/20/95	Elevation: 176.00'	Datum: NGVD
Logged By: Brunton/William	Total Depth: 67.00'	Measuring Point: 179.70'
Contractor: Burlington Environmental Inc.	Completed Depth: 67.00'	Static Water Level:
Drilling Method: Rotary to 50'/HSA from 50'–67'	Well Casing: type: SS dia: 4.00in fm: –3.7' to: 57.00'	
Remarks:	Screens: type: Slotted size: .010in dia: 4.00in fm: 57.00' to: 67.00'	

Annular Fill:

type: Bentonite Grout	fm: .00'	to: 49.00'
type: Secondary Sand Filter	fm: 49.00'	to: 50.00'
type: Bentonite	fm: 50.00'	to: 53.00'
type: Secondary Sand Filter	fm: 53.00'	to: 54.00'
type: #20–40 Silica Filter Sand	fm: 54.00'	to: 67.00'
type:	fm:	to:

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
	5					SC/SM	clayey silty SAND– light gray, fine grained, soft, slight plasticity, wet, iron nodules and iron staining
	10					SP	SAND– gray, fine grained, poorly sorted, medium dense, wet to saturated, some iron staining
160	15						– light brownish gray
	20					SM SP	silty SAND– gray to reddish brown, fine grained, poorly sorted, dense, moist to wet SAND– dark gray, fine grained, poorly sorted, some fines, dense, wet to saturated
150	25						– gray, slightly larger grain size
	30						– decreased fines, some lignite lenses
140	35						– fine to medium grained, medium dense – light gray, medium grained, saturated
	40						– gray – dark gray, some fine and coarse grains, some fines, wet to saturated
130	45						–dark gray, clean – grayish brown, fine grained, saturated
	50					SW	sandy CLAY– gray, some coarse sand to fine gravel, soft, medium plasticity, moist SAND– brown, well graded, fines to medium gravel, medium dense, wet to saturated, lignite lenses
120	55						– coarse grained, some gravel, loose, saturated
						GM	– gray, fine grained, poorly graded, medium dense, some stained black lenses
						SP	

Well Construction



026015

Sverdrup ENVIRONMENTAL

Site ID: 18WW06 Page 2 of 2

X Coordinate: [illegible] Y Coordinate: 6953852.50

Location: Longhorn Army Ammunition Plant Elevation: 176.00' Datum: NGVD

Date(s): 04/20/95 – 04/20/95 Total Depth: 67.00' Measuring Point: 179.70'

Logged By: Brunton/William Completed Depth: 67.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: –3.7' to: 57.00'

Drilling Method: Rotary to 50'/HSA from 50'–67' Screens: type: Slotted size: .010in dia: 4.00in fm: 57.00' to: 67.00'

Remarks:

Annular Fill:

type: Bentonite Grout	fm: .00'	to: 49.00'
type: Secondary Sand Filter	fm: 49.00'	to: 50.00'
type: Bentonite	fm: 50.00'	to: 53.00'
type: Secondary Sand Filter	fm: 53.00'	to: 54.00'
type: #20–40 Silica Filter Sand	fm: 54.00'	to: 67.00'
type:	fm:	to:

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description	Well Construction
110	65						– fine to medium grained, wet to saturated	
	70							
100	75							
	80							
90	85							
	90							
80	95							
	100							
70	105							
	110							
60	115							

026016

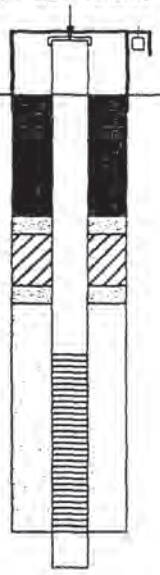
Sverdrup ENVIRONMENTAL

Site ID: 18WW07 Page 1 of 1

ation: Longhorn Army Ammunition Plant	Elevation: 180.55'	Datum: NGVD
ate(s): 04/29/95 – 04/29/95	Total Depth: 27.00'	Measuring Point: 183.67'
Logged By: A. Passanise	Completed Depth: 27.00'	Static Water Level:
Contractor: Burlington Environmental Inc.	Well Casing: type: SS dia: 4.00in fm: -3.1' to: 15.00'	
Drilling Method: 6-1/4 in. I.D. Hollow Stem Auger	Screens: type: Slotted size: .010in dia: 4.00in fm: 15.00' to: 25.00'	
Remarks:	Annular Fill: type: Bentonite/Cement Grout fm: .00' to: 2.00'; type: Bentonite Grout fm: 2.00' to: 7.00'; type: Secondary Sand Filter fm: 7.00' to: 8.00'; type: Granular Bentonite Seal fm: 8.00' to: 11.00'; type: Secondary Sand Filter fm: 11.00' to: 12.00'; type: #20-40 Silica Filter Sand fm: 12.00' to: 25.00'	

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
180	0		SS-1	2 3 5		SM CL	silty SAND- light brown, fine grained, cohesive, dry silty CLAY- light brown, hard, low plasticity, dry, iron staining
	5		SS-2	3 4 6			sandy silty CLAY- light brown to light gray, fine grained sand, medium stiff, low to medium plasticity, dry to moist
170	10		SS-3	3 5 7			- increased silt content, decreased sand content, black veins - moist to wet
	15		SS-4	3 5 8		CL/ML	- light brownish gray, stiff to hard, low plasticity, dry to moist, iron staining
160	20		SS-5	3 5 8		SC/CL	clayey SAND- light gray, fine grained, cohesive, wet to saturated
	25		SS-6	3 5 11		ML/CL	sandy clayey SILT- mottled light gray with light brown, fine grained sand, stiff to hard, low plasticity, moist
150	30						
	35						
140	40						
	45						
	50						
	55						

Well Construction



026017

Sverdrup ENVIRONMENTAL

Site ID: 18WW08 Page 1 of 1

X Coordinate: [illegible] Y Coordinate: 6954660.20

Location: Longhorn Army Ammunition Plant Elevation: 174.59' Datum: NGVD

Date(s): 04/30/95 – 04/30/95 Total Depth: 20.00' Measuring Point: 177.77'

Logged By: A. Passanise Completed Depth: 20.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: -3.2' to: 9.00'

Drilling Method: 6-1/4 in. I.D. Hollow Stem Auger Screens: type: Slotted size: .010in dia: 4.00in fm: 9.00' to: 19.00'

Remarks:

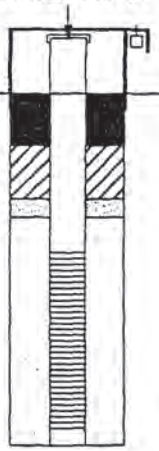
Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 3.00'
type: Granular Bentonite Seal	fm: 3.00'	to: 6.00'
type: Secondary Sand Filter	fm: 6.00'	to: 7.00'
type: #20-40 Silica Filter Sand	fm: 7.00'	to: 20.00'
type:	fm:	to:
type:	fm:	to:

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1	1 2 1		CL	silty CLAY- brown, low to medium stiff, low plasticity, dry
170	5		SS-2	2 4 9 12		SC/SM	clayey silty SAND- light gray with yellowish orange, fine grained, cohesive, moist
	10		SS-3	6 10 12 13		SC	clayey SAND- light gray to yellowish orange, fine grained, cohesive, moist to wet
160	15		SS-4	2 3 7 10		SM/SP	clayey silty SAND- light gray to yellowish orange, fine grained, cohesive, moist to wet
			SS-5	3 7 10 12		CL	silty SAND- yellowish orange, fine to medium grained, slightly cohesive, wet to saturated
	20						silty CLAY- light gray to yellowish orange, fine grained, hard, low plasticity, dry, lignite
150	25						
	30						
140	35						
	40						
130	45						
	50						
120	55						

Well Construction

MP. EL. 177.77



Sverdrup ENVIRONMENTAL

Site ID: 18WW09 Page 1 of 1

X Coordinate: [illegible] Y Coordinate: 6954648.80

Location: Longhorn Army Ammunition Plant Elevation: 174.36' Datum: NGVD

Date(s): 05/10/95 – 05/12/95 Total Depth: 59.00' Measuring Point: 177.51'

Logged By: P. Sazama Completed Depth: 59.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: –3.2' to: 49.00'

Drilling Method: 6–1/4 in. I.D. Hollow Stem Auger Screens: type: Slotted size: .010in dia: 4.00in fm: 49.00' to: 59.00'

Remarks:

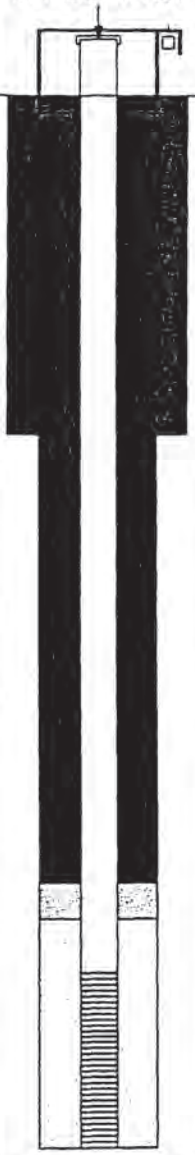
Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 1.00'
type: Bentonite Grout	fm: 1.00'	to: 38.00'
type: Bentonite	fm: 38.00'	to: 44.00'
type: Secondary Sand Filter	fm: 44.00'	to: 46.00'
type: #20–40 Silica Filter Sand	fm: 46.00'	to: 59.00'
type:	fm:	to:

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1	1 2 3		CL	silty CLAY– brown, low to medium stiff, low plasticity, dry
	5		SS-2	2 4 9 12		SC/SM	clayey silty SAND– light gray with yellowish orange, fine grained, cohesive, moist
	10		SS-3	6 10 12 13		SC	clayey SAND– light gray to yellowish orange, fine grained, cohesive, moist to wet
160	15		SS-4	2 3 7 10		SM/SP	clayey silty SAND– light gray to yellowish orange, fine grained, cohesive, moist to wet
			SS-5	5 7 10 12		CL	silty SAND– yellowish orange, fine to medium grained, slightly cohesive, wet to saturated
	20						silty CLAY– light gray to yellowish orange, fine grained, hard, l ow plasticity, dry, lignite
150	25		SS-6	3 6 8 9			CLAY– light gray, some sand, stiff to very stiff, high plasticity, moist, iron staining
			SS-7	4 5 6 9			silty CLAY– light to olive gray, trace of fine grained sand, stiff, high plasticity, moist, iron staining
	30		SS-8	2 3 10 11		SC	silty clayey SAND– dark gray, fine grained, low plasticity, saturated, trace of wood fragments
140	35		SS-9	2 5 8 18			– olive gray, soft
	40					SM	silty SAND– gray, fine to medium grained, loose, saturated
			SS-10	10 12 13 17		SP	SAND– gray, fine to medium grained, loose, saturated
130	45		SS-11	5 10 18 35		SM	silty SAND– gray to yellowish brown, fine grained, loose, saturated
	50		SS-12	9 16 21 20			– olive gray
120	55		SS-13	9 16 20 32		CL SC CH	silty CLAY– gray to brown, trace of fine grained sand, stiff, moist SAND– grayish brown, fine grained, interbedded with clay lenses, very loose, saturated CLAY– dark brown, some sand layers, very stiff, dry to moist

Well Construction

MP. EL. 177.51



Sverdrup ENVIRONMENTAL

Site ID: 18WW10 Page 1 of 1

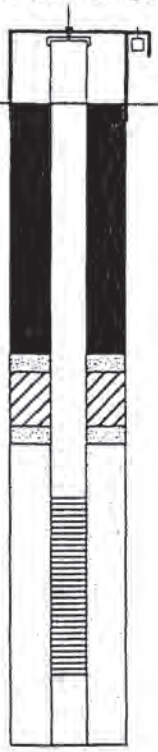
Location: Longhorn Army Ammunition Plant	X Coordinate: 3315348.30	Y Coordinate: 6953732.50
Date(s): 05/01/95 – 05/02/95	Elevation: 178.78'	Datum: NGVD
Logged By: A. Passanise	Total Depth: 36.00'	Measuring Point: 182.26'
Contractor: Burlington Environmental Inc.	Completed Depth: 36.00'	Static Water Level:
Drilling Method: 6–1/4 in. I.D. Hollow Stem Auger	Well Casing: type: SS dia: 4.00in fm: –3.5' to: 22.00'	
Remarks: PID measured in airspace above sample = 0 ppm.	Screens: type: Slotted size: .010in dia: 4.00in fm: 22.00' to: 32.00'	

Annular Fill:

type: Bentonite Grout	fm: .00'	to: 14.00'
type: Secondary Sand Filter	fm: 14.00'	to: 15.00'
type: Granular Bentonite Seal	fm: 15.00'	to: 18.00'
type: Secondary Sand Filter	fm: 18.00'	to: 19.00'
type: #20–40 Silica Filter Sand	fm: 19.00'	to: 36.00'
type:	fm:	to:

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1	1 1 2		SM	silty SAND– dark brown, fine grained, cohesive, moist
	5		SS-2	4 8 13 14		SC	clayey SAND– light gray, fine grained, cohesive, moist, iron staining
0	10		SS-3	3 7 11 17			– some silt lenses
	15		SS-4	WH WH 11 13		SM	silty SAND– light gray to yellowish orange, fine grained, cohesive, saturated
160	20		SS-5	2 3 7 9			– decreased silt content, wet
	25		SS-6	WH 2 3 4			– wet
150	30		SS-7	1 1 3 3			– olive gray, lignite, wood fragments
			SS-8	3 2 3 3		CL/SC	clayey silty SAND– olive gray, fine grained, cohesive, low to medium plasticity, moist
	35		SS-9	5 12 15 15		SM	silty SAND– olive gray, fine grained, cohesive, moist
140	40						
	45						
30	50						
	55						
120							

Well Construction



026020

Sverdrup ENVIRONMENTAL

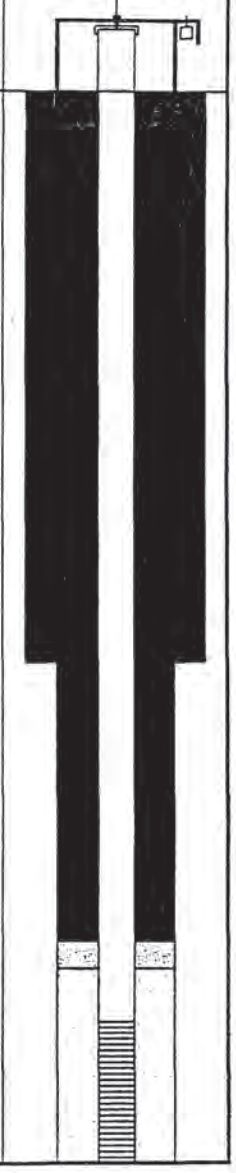
Site ID: 18WW11 Page 1 of 2

Location: Longhorn Army Ammunition Plant	X Coordinate: 3315341.20	Y Coordinate: 6953739.50
Date(s): 05/14/95 – 05/16/95	Elevation: 178.83'	Datum: NGVD
Logged By: P. Sazama	Total Depth: 64.50'	Measuring Point: 182.29'
Contractor: Burlington Environmental Inc.	Completed Depth: 64.50'	Static Water Level:
Drilling Method: 6–1/4 in. I.D. Hollow Stem Auger	Well Casing: type: SS dia: 4.00in fm: –3.5' to: 52.00'	
Remarks: PID measured in airspace above sample = 0 ppm.	Screens: type: Slotted size: .010in dia: 4.00in fm: 52.00' to: 62.00'	
	Annular Fill:	
	type: Bentonite/Cement Grout fm: .00' to: 2.00'	
	type: Bentonite fm: 2.00' to: 47.50'	
	type: Secondary Sand Filter fm: 47.50' to: 49.00'	
	type: #20–40 Silica Filter Sand fm: 49.00' to: 64.50'	
	type: fm: to:	
	type: fm: to:	

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1	1 1 2		SM	silty SAND– dark brown, fine grained, cohesive, moist
	5		SS-2	4 8 13 14		SC	clayey SAND– light gray, fine grained, cohesive, moist, iron staining
/0	10		SS-3	9 11 17			– some silt lenses
	15		SS-4	WH WH 11 15		SM	silty SAND– light gray to yellowish orange, fine grained, cohesive, saturated
160	20		SS-5	2 5 7 9			– decreased silt content, wet
	25		SS-6	WH 2 3 4			– wet
150	30		SS-7	1 1 1 2			– olive gray, lignite, wood fragments
			SS-8	1 2 3 3		CL/SC	clayey silty SAND– olive gray, fine grained, cohesive, low to medium plasticity, moist
	35		SS-9	4 12 25 35		SM	silty SAND– olive gray, fine grained, cohesive, moist
140	40		SS-10	6 8 9 12			– light to olive gray, very loose, wet to saturated
			SS-11	14 10 7 8		SP	SAND– light gray, fine grained, poorly graded, trace silt, medium dense, saturated
	45					CL	silty sandy CLAY– dark gray, medium stiff, medium plasticity, moist, trace lignite
			SS-12	5 10 7 7		SM	silty SAND– greenish gray, fine grained, poorly graded, medium dense, wet to saturated
	50						
			SS-13	8 12 14 16		GC SM	sandy clayey GRAVEL– brown, fine grained, well graded, loose to medium dense, wet to saturated
	55						silty SAND– light gray, fine grained, loose, wet
120			SS-14	7 10 17 26		SM/SC CL	– olive gray, poorly graded, trace clay, moist silty CLAY– gray, some sand, stiff, medium plasticity, moist

Well Construction

MP. EL. 182.29



026021

Sverdrup ENVIRONMENTAL

Site ID: 18WW11 Page 2 of 2

Location: Longhorn Army Ammunition Plant	X Coordinate: 3315341.20	Y Coordinate: 6953739.50
Date(s): 05/14/95 – 05/16/95	Elevation: 178.83'	Datum: NGVD
Logged By: P. Sazama	Total Depth: 64.50'	Measuring Point: 182.29'
Contractor: Burlington Environmental Inc.	Completed Depth: 64.50'	Static Water Level:
Drilling Method: 6–1/4 in. I.D. Hollow Stem Auger	Well Casing: type: SS dia: 4.00in fm: –3.5' to: 52.00'	
Remarks: PID measured in airspace above sample = 0 ppm.	Screens: type: Slotted size: .010in dia: 4.00in fm: 52.00' to: 62.00'	
	Annular Fill:	
	type: Bentonite/Cement Grout fm: .00' to: 2.00'	
	type: Bentonite fm: 2.00' to: 47.50'	
	type: Secondary Sand Filter fm: 47.50' to: 49.00'	
	type: #20–40 Silica Filter Sand fm: 49.00' to: 64.50'	
	type: fm: to:	
	type: fm: to:	

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description	Well Construction
	65		SS-15	17 23 32 51 8/2"		SC	silty clayey SAND– light gray, poorly graded, stiff to very stiff, medium plasticity, wet	
	70							
	75							
100	80							
	85							
90	90							
	95							
80	100							
	105							
	110							
	115							
60								

026022

Sverdrup ENVIRONMENTAL

Site ID: 18WW14 Page 1 of 1

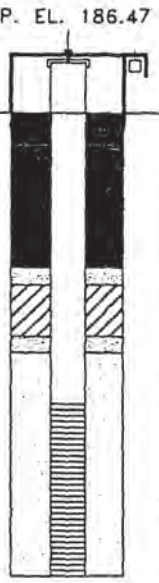
Location: Longhorn Army Ammunition Plant	X Coordinate: 3315372.10	Y Coordinate: 6952240.50
Date(s): 04/12/95 – 04/12/95	Elevation: 183.61'	Datum: NGVD
Logged By: K. Williams	Total Depth: 27.00'	Measuring Point: 186.47'
Contractor: Burlington Environmental Inc.	Completed Depth: 27.00'	Static Water Level:
Drilling Method: 6–1/4 in. I.D. Hollow Stem Auger	Well Casing: type: SS dia: 4.00in fm: –2.9' to: 17.00'	
Remarks: PID measured in airspace above sample = 0 ppm.	Screens: type: Slotted size: .010in dia: 4.00in fm: 17.00' to: 27.00'	

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 2.00'
type: Bentonite Grout	fm: 2.00'	to: 9.00'
type: Secondary Sand Filter	fm: 9.00'	to: 10.00'
type: Granular Bentonite Seal	fm: 10.00'	to: 13.00'
type: Secondary Sand Filter	fm: 13.00'	to: 14.00'
type: #20–40 Silica Filter Sand	fm: 14.00'	to: 27.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No	Blow Count	Graphic Log	USCS Code	Material Description
	0		SS-1	3 3 2		ML	clayey SILT– reddish brown, soft, moist to wet
	5		SS-2	3 3 3			
						CL	sandy CLAY– reddish brown, medium stiff, low plasticity, moist
	10		SS-3	3 3 3			
170						SM	silty SAND– light brown, medium dense, moist
	15		SS-4	3 4 4		SW	SAND– light grayish brown, loose, saturated
							– light gray
	20		SS-5	3 3 3			
160							
	25		SS-6	3 3 4			
	30						
150							
	35						
	40						
140							
	45						
	50						
130							
	55						

Well Construction



026023

Sverdrup ENVIRONMENTAL

Site ID: 18WW15 Page 1 of 1

X Coordinate: 3315363.60 Y Coordinate: 6952238.70

Location: Longhorn Army Ammuntion Plant Elevation: 183.58' Datum: NGVD

Date(s): 04/05/95 – 04/13/95 Total Depth: 56.00' Measuring Point: 186.24'

Logged By: K. Williams Completed Depth: 56.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: −2.6' to: 44.00'

Drilling Method: 6−1/4 in. I.D. Hollow Stem Auger Screens: type: Slotted size: .010in dia: 4.00in fm: 44.00' to: 54.00'

Remarks:
PID measured in airspace above sample = 0 ppm.

Annular Fill:

type: Bentonite Grout	fm: .00'	to: 36.00'
type: Secondary Sand Filter	fm: 36.00'	to: 37.00'
type: Granular Bentonite Seal	fm: 37.00'	to: 40.00'
type: Secondary Sand Filter	fm: 40.00'	to: 41.00'
type: #20−40 Silica Filter Sand	fm: 41.00'	to: 56.00'
type:	fm:	to:

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1			SM/SC	clayey silty SAND− reddish brown, very loose to loose, wet
180	5		SS-2			CL	sandy CLAY− light gray with red streaks, stiff, low plasticity, dry to moist
	10		SS-3				− moist
170	15		SS-4			SM SW	silty SAND− light brown with red streaks, medium dense, wet SAND− light gray, loose, saturated
	20		SS-5			SM/SC	silty clayey SAND− reddish brown, medium dense, wet
160	25		SS-6			ML	clayey SILT− gray with brown laminations, medium stiff, low plasticity, moist
	30		SS-7			SM/SC	clayey SAND− light gray with brown laminations in upper 6−8", very fine to fine grained, medium dense, moist
150	35		SS-8			SM	− light gray, decreased fines
	40		SS-9			SC	− light gray with dark gray laminations in lower 6", moist to wet
140	45		SS-10			SW	SAND− medium gray, very fine grained, trace fines, loose, wet to saturated
	50		SS-11				− saturated
			SS-12				sandy CLAY− dark gray to black, very stiff, dry to moist SAND− medium gray, very fine grained, loose, saturated
130	55		SS-13			ML	clayey SILT− dark gray, very stiff, low plasticity, dry to moist

Well Construction



026024

Sverdrup
ENVIRONMENTAL

Site ID: 18WW16 Page 1 of 1

X Coordinate: 3316913.30	Y Coordinate: 6951331.30
Elevation: 199.24'	Datum: NGVD
Total Depth: 32.00'	Measuring Point: 201.88'
Completed Depth: 32.00'	Static Water Level:

-cation: Longhorn Army Ammunition Plant
..e(s): 03/02/95 - 03/02/95
Logged By: K. Williams
Contractor: Burlington Environmental Inc.
Drilling Method: 6-1/4 in. I.D. Hollow Stem Auger

Remarks:
PID measured in airspace above sample = 0 ppm.

Well Casing: type: SS dia: 4.00in fm: -2.6' to: 21.00'

Screens:
type: Slotted size: .010in dia: 4.00in fm: 21.00' to: 31.00'

Annular Fill:

type: Bentonite Grout	fm: .00'	to: 13.00'
type: Secondary Sand Filter	fm: 13.00'	to: 14.00'
type: Granular Bentonite Seal	fm: 14.00'	to: 17.00'
type: Secondary Sand Filter	fm: 17.00'	to: 18.00'
type: #20-40 Silica Filter Sand	fm: 18.00'	to: 32.00'
type:	fm:	to:

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
	0		SS-1	2 2 3		CL	silty CLAY- light brown, some fine grained sand, wet to saturated, roots
	5		SS-2	6 9 11 14			- brown to gray mottled, medium plasticity, saturated at 5.5'
190	10		SS-3	2 4 6 7			
	15		SS-4	6 13 18 23		ML	SILT- gray to brown mottled, some clay, moist
180	20		SS-5	6 10 12		SM	silty SAND- gray, very fine grained, moist
						CL	silty CLAY- brown gray, medium plasticity, moist, black streaks
	25		SS-6	8 12 19 24		SC	clayey SAND- gray, moist
170						CL	silty CLAY- brown to gray, fat, moist to saturated, black streaks
	30		SS-7	9 17 23		CL	silty CLAY- gray, medium plasticity, moist
	35						
160	40						
	45						
	50						
	55						
140							

Well Construction



01227456

026025

Sverdrup ENVIRONMENTAL

Site ID: 18WW17 Page 1 of 1

X Coordinate: 3317664.80 Y Coordinate: 6954531.10

Location: Longhorn Army Ammunition Plant Elevation: .00' Datum: NGVD

Date(s): 05/02/95 – 05/04/95 Total Depth: 37.00' Measuring Point: 196.97'

Logged By: A. Passanise Completed Depth: 37.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: -3.0' to: 25.00'

Drilling Method: 6-1/4 in. I.D. Hollow Stem Auger Screens: type: Slotted size: .010in dia: 4.00in fm: 25.00' to: 35.00'

Remarks:
PID measured in airspace above sample = 0 ppm.

Annular Fill:

type: Bentonite Grout	fm: .00'	to: 17.00'
type: Secondary Sand Filter	fm: 17.00'	to: 18.00'
type: Granular Bentonite Seal	fm: 18.00'	to: 21.00'
type: Secondary Sand Filter	fm: 21.00'	to: 22.00'
type: #20-40 Silica Filter Sand	fm: 22.00'	to: 37.00'
type:	fm:	to:

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1	1 1		CL	sandy CLAY- yellowish orange to dark brown, fine grained sand, medium stiff, low plasticity, dry to moist
	5		SS-2	3 8 11 14		ML	sandy SILT- light gray and yellowish orange, fine grained sand, clay lenses, stiff, low plasticity, dry, black veins
-10	10		SS-3	3 5 7 9		SC/SM	silty clayey SAND- light gray and yellowish orange, fine grained, cohesive, moist to dry
	15		SS-4	4 8 12 18		CL/ML SC	silty CLAY- mottled light gray and yellowish orange, hard, low plasticity, dry to moist, black veins clayey SAND- light gray and yellowish orange, fine grained, cohesive, dry to moist
-20	20		SS-5	3 6 12 16		SM	silty SAND- yellowish orange, fine grained, cohesive, wet to saturated
	25		SS-6	3 4 10 20		SC SM	- light brown, decreased silt content, moist to wet clayey SAND- light gray, fine grained, cohesive, moist silty SAND- yellowish orange to light gray, fine grained, cohesive, moist to wet
-30	30		SS-7	12 20 14 11			- increased silt content, wet
	35		SS-8	3 7 10 8		CL SC/SM CL	sandy silty CLAY- light gray and yellowish orange, stiff, low plasticity, moist clayey silty SAND- light gray and yellowish orange, cohesive, moist to wet sandy silty CLAY- light gray and yellowish orange, hard, low plasticity, moist, black veins
-40	40						
	45						
0	50						
	55						

Well Construction



026026

Sverdrup ENVIRONMENTAL

Site ID: 18WW18 Page 1 of 2

X Coordinate: [illegible] Y Coordinate: 6954523.00

ation: Longhorn Army Ammunition Plant Elevation: .00' Datum: NGVD

ate(s): 05/22/95 – 05/25/95 Total Depth: 63.00' Measuring Point: 196.82'

Logged By: P. Sazama Completed Depth: 63.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: –3.0' to: 51.00'

Drilling Method: 6–1/4 in. I.D. Hollow Stem Auger Screens: type: Slotted size: .010in dia: 4.00in fm: 51.00' to: 61.00'

Remarks:
PID measured in airspace above sample = 0 ppm.

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 1.00'
type: Bentonite	fm: 1.00'	to: 47.00'
type: Secondary Sand Filter	fm: 47.00'	to: 48.00'
type: #20–40 Silica Filter Sand	fm: 48.00'	to: 63.00'
type:	fm:	to:
type:	fm:	to:

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1	1 1		CL	sandy CLAY– yellowish orange to dark brown, fine grained sand, medium stiff, low plasticity, dry to moist
	5		SS-2	5 8 11 14		ML	sandy SILT– light gray and yellowish orange, fine grained sand, clay lenses, stiff, low plasticity, dry, black veins
–10	10		SS-3	3 5 7 9		SC/SM	silty clayey SAND– light gray and yellowish orange, fine grained, cohesive, moist to dry
	15		SS-4	4 8 12 16		CL/ML SC	silty CLAY– mottled light gray and yellowish orange, hard, low plasticity, dry to moist, black veins clayey SAND– light gray and yellowish orange, fine grained, cohesive, dry to moist
–20	20		SS-5	3 8 12 16		SM	silty SAND– yellowish orange, fine grained, cohesive, wet to saturated
	25		SS-6	2 4 16 20		SC SM	– light brown, decreased silt content, moist to wet clayey SAND– light gray, fine grained, cohesive, moist silty SAND– yellowish orange to light gray, fine grained, cohesive, moist to wet
–30	30		SS-7	12 20 14 11			– increased silt content, wet
	35		SS-8	3 7 10 8		CL SC/SM CL	sandy silty CLAY– light gray and yellowish orange, stiff, low plasticity, moist clayey silty SAND– light gray and yellowish orange, cohesive, moist to wet sandy silty CLAY– light gray and yellowish orange, hard, low plasticity, moist, black veins
–40	40						
			SS-9	4 8 9 9		CH	silty CLAY– light gray, little sand, very stiff, high plasticity, wet, iron staining
	45		SS-10	1 3 5 5		CL	silty sandy CLAY– greenish gray, higher sand content at 48.5', medium stiff, medium plasticity, moist, iron staining
	50		SS-11	1 3 5 5		SM/SC SM	silty clayey SAND– greenish gray, fine grained, poorly sorted, loose, low to medium plasticity, wet silty SAND– dark gray to black, fine to medium grained, poorly sorted, trace clay, very loose, saturated, gun powder odor
	55		SS-12	13 14 16 16		SP	SAND– light gray, fine to medium grained, poorly graded, very loose, saturated

Well Construction



026027

Sverdrup ENVIRONMENTAL

Site ID: **18WW18** Page 2 of 2

X Coordinate: 3317675.70	Y Coordinate: 6954523.00
Elevation: .00'	Datum: NGVD
Total Depth: 63.00'	Measuring Point: 196.82'
Completed Depth: 63.00'	Static Water Level:

-ation: Longhorn Army Ammunition Plant

e(s): 05/22/95 – 05/25/95

Logged By: P. Sazama

Contractor: Burlington Environmental Inc.

Drilling Method: 6–1/4 in. I.D. Hollow Stem Auger

Remarks:
PID measured in airspace above sample = 0 ppm.

Well Casing: type: SS dia: 4.00in fm: –3.0' to: 51.00'

Screens:
type: Slotted size: .010in dia: 4.00in fm: 51.00' to: 61.00'

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 1.00'
type: Bentonite	fm: 1.00'	to: 47.00'
type: Secondary Sand Filter	fm: 47.00'	to: 48.00'
type: #20–40 Silica Filter Sand	fm: 48.00'	to: 63.00'
type:	fm:	to:
type:	fm:	to:

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description	Well Construction
	65		SS-13	14 21 41 51 9/4"		CL	clayey SILT– light to greenish gray, interbedded with dark gray clay, stiff, low plasticity, dry	
–70	70							
	75							
–80	80							
	85							
–90	90							
	95							
–100	100							
	105							
10	110							
	115							

026028

Sverdrup ENVIRONMENTAL

Site ID: 18WW19 Page 1 of 2

X Coordinate: 3316435.70 Y Coordinate: 6955260.90

Location: Longhorn Army Ammunition Plant Elevation: 176.53' Datum: NGVD

Date(s): 05/01/95 – 05/03/95 Total Depth: 71.00' Measuring Point: 179.56'

Logged By: P. Sazama Completed Depth: 71.00' Static Water Level:

Contractor: Burlington Environmental Inc. Well Casing: type: SS dia: 4.00in fm: −3.0' to: 45.00'

Drilling Method: 6−1/4 in. I.D. Hollow Stem Auger

Screens: type: Slotted size: .010in dia: 4.00in fm: 45.00' to: 55.00'

Remarks:
PID measured in airspace above sample = 0 ppm.
Clay layer not encountered. Surface casing was not installed.

Annular Fill:

type: Bentonite/Cement Grout	fm: .00'	to: 5.00'
type: Bentonite Grout	fm: 5.00'	to: 33.50'
type: Secondary Sand Filter	fm: 33.50'	to: 35.50'
type: Granular Bentonite Seal	fm: 35.50'	to: 39.00'
type: Secondary Sand Filter	fm: 39.00'	to: 42.00'
type: #20−40 Silica Filter Sand	fm: 42.00'	to: 71.00'

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1			ML	sandy clayey SILT− brown, very loose, medium plasticity, moist, some roots
	5		SS-2			SM	silty clayey SAND− light brown to gray, fine grained, poorly graded, medium dense, slight plasticity, moist, iron staining from 5−6'
	10		SS-3				silty SAND− light gray, fine grained, poorly graded, some clay, loose to medium dense, low plasticity, moist
160	15		SS-4				− light to yellowish brown, loose, wet
	20		SS-5			SM/SP	− light gray, loose to medium dense, iron staining SAND− light gray, poorly graded
	25		SS-6			CL SP	silty clayey SAND− light gray, medium dense, medium plasticity, wet, iron staining SAND− light gray, poorly graded, loose, wet
150	30		SS-7				− gray to greenish gray, fine grained, trace silt
	35		SS-8				− gray, loose to medium dense
140	40		SS-9				− light gray to gray, fine to medium grained, medium dense
	45		SS-10				− light to greenish gray, medium dense to dense, saturated
130	50		SS-11				− loose to medium dense
	55		SS-12	25 51 6/5"		SM	SILT− greenish gray, fine grained sand, interbedded with thin lenses of gray silty clay, hard, slight plasticity, moist
120			SS-13				− light to greenish gray

Well Construction

MP. EL. 179.56



026029

Sverdrup ENVIRONMENTAL	Site ID: 18WW19	Page 2 of 2
	X Coordinate: 3316455.70	Y Coordinate: 6955260.90
...ation: Longhorn Army Ammunition Plant	Elevation: 176.53'	Datum: NGVD
...e(s): 05/01/95 – 05/03/95	Total Depth: 71.00'	Measuring Point: 179.56'
Logged By: P. Sazama	Completed Depth: 71.00'	Static Water Level:
Contractor: Burlington Environmental Inc.	Well Casing: type: SS dia: 4.00in fm: -3.0' to: 45.00'	
Drilling Method: 6-1/4 in. I.D. Hollow Stem Auger	Screens: type: Slotted size: .010in dia: 4.00in fm: 45.00' to: 55.00'	
Remarks: PID measured in airspace above sample = 0 ppm. Clay layer not encountered. Surface casing was not installed.	Annular Fill: type: Bentonite/Cement Grout fm: .00' to: 5.00'; type: Bentonite Grout fm: 5.00' to: 33.50'; type: Secondary Sand Filter fm: 33.50' to: 35.50'; type: Granular Bentonite Seal fm: 35.50' to: 39.00'; type: Secondary Sand Filter fm: 39.00' to: 42.00'; type: #20-40 Silica Filter Sand fm: 42.00' to: 71.00'	

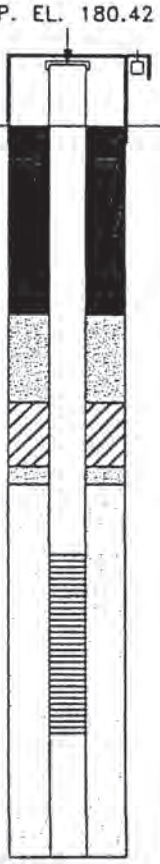
Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description	Well Construction
	65		SS-14	50 25/4"			silty SAND- light gray, fine grained, poorly graded, saturated	
	70		SS-15	50 24/4"			SILT- light to olive gray, fine grained sand, increased sand content at 70.5", some silty clay layers, dense to hard, moist	
100	75							
	80							
90	85							
	90							
80	95							
	100							
70	105							
	110							
60	115							

Sverdrup ENVIRONMENTAL

	Site ID: 18WW20	Page 1 of 1
	X Coordinate: 3316426.30	Y Coordinate: 6955248.00
ıtion: Longhorn Army Ammunition Plant	Elevation: 176.98'	Datum: NGVD
oate(s): 04/28/95 – 04/28/95	Total Depth: 41.00'	Measuring Point: 180.42'
Logged By: P. Sazama	Completed Depth: 41.00'	Static Water Level:
Contractor: Burlington Environmental Inc.	Well Casing: type: SS dia: 4.00in fm: –3.4' to: 24.00'	
Drilling Method: 6–1/4 in. I.D. Hollow Stem Auger	Screens: type: Slotted size: .010in dia: 4.00in fm: 24.00' to: 34.00'	
Remarks: PID measured in airspace above sample = 0 ppm.	Annular Fill: type: Bentonite/Cement Grout fm: .00' to: 2.00'; type: Bentonite Grout fm: 2.00' to: 10.50'; type: Secondary Sand Filter fm: 10.50' to: 15.50'; type: Granular Bentonite Seal fm: 15.50' to: 19.10'; type: Secondary Sand Filter fm: 19.10' to: 20.10'; type: #20–40 Silica Filter Sand fm: 20.10' to: 41.00'	

Elevation (ft)	Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	USCS Code	Material Description
			SS-1			ML	sandy clayey SILT– brown, very loose, medium plasticity, moist, some roots
	5		SS-2			SM	silty clayey SAND– light brown to gray, fine grained, poorly graded, medium dense, slight plasticity, moist, iron staining from 5–6'
	10		SS-3				silty SAND– light gray, fine grained, poorly graded, some clay, loose to medium dense, low plasticity, moist
160	15		SS-4				– light to yellowish brown, loose, wet
	20		SS-5			SM/SP	– light gray, loose to medium dense, iron staining SAND– light gray, poorly graded
150	25		SS-6			CL SP	silty clayey SAND– light gray, medium dense, medium plasticity, wet, iron staining SAND– light gray, poorly graded, loose, wet
	30		SS-7				– gray to greenish gray, fine grained, trace silt
140	35		SS-8				– gray, loose to medium dense
	40		SS-9				– light gray to gray, fine to medium grained, medium dense
	45						
	50						
120	55						

Well Construction



026261

000088

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 24 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kraftner

DRILL RIG Acker II BORE HOLE 1

Page 1 of 4

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
	BS	Medium brown silty sand, fine in grain size.	Hit stone.
		Stone	Possible backfill for berm of pond.
5	ST	Medium brown fine silty sand with some clay	Very moist
10		Tan fine silty sand with some clay	Wet - auger sat for 2 days before finishing.
	US		
15		Medium brown silty sand with clay	Damp

026262

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

000089

PROJECT 38-26-0104 DATE 24 Jan 80

LOCATION Longhorn AAP DRILLERS 1LT Corbitt
Mr. Kestner

DRILL RIG Acker II BORE HOLE 1

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Med brown silty sand with clay	WT
20			
25			
30			

USAEHA Form 95, 12 Aug 74

026263

000090

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 24 Jan 92

LOCATION Longhorn AAP DRILLERS [illegible]

DRILL RIG Acker II BORE HOLE [illegible]

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Medium brown silty sand with clay	
35			
40	MB		
45			

USAEHA Form 95, 12 Aug 74

026264

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG 090091

PROJECT 38-26-0104 DATE 24 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kesner

DRILL RIG Acker II BORE HOLE 1

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Medium brown silty sand with clay	
		Gray clay mixed with sand	
	MB		
50		Bottom of hole	

026265

T0000092

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 24 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Fessner

Top of berm

DRILL RIG Acker II BORE HOLE ?

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Medium brown fine silty sand.	Fairly dry.
5	BS		
		Brick red fine silty sand with some clay	Fairly dry
10	BS	Tan fine silty sand with some clay	Getting wet
15			

026266

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

000093

PROJECT 38-26-0104 DATE 24 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of berm

DRILL RIG Acker II BORE HOLE 2

Page 2 of 4

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Tan fine silty sand with some clay	Getting wet
20			
25			WT
		Light tan silty sand with very little clay	Wet
30			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

000094

DRILLING LOG

PROJECT 38-26-0104 DATE 24 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of berm

DRILL RIG Acker II BORE HOLE 2

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
35		Light tan silty sand with very little clay	
40			
45			

026268

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000095

DRILLING LOG

PROJECT 38-26-0104 DATE 24 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of berm

DRILL RIG Acker II BORE HOLE 2

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Light tan silty sand with very little clay	
50			Well 52' deep
55		Tan clay, medium plastic	
		Bottom of hole	

USAEHA Form 95, 12 Aug 74

026269

US ARMY ENVIRONMENTAL HYGIENE AGENCY

000096

DRILLING LOG

PROJECT 38-26-0104 DATE 25 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

North side of rocket. Wash rock.
Surface disturbed

DRILL RIG Acker II BORE HOLE 3

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Medium brown fine silty sand.	Damp
5	BS	Tan fine silty sand with some clay.	
10	BS		Wet
15			Water running out of hole.

USAEHA Form 95, 12 Aug 74

026270

US ARMY ENVIRONMENTAL HYGIENE AGENCY

000097

DRILLING LOG

PROJECT 38-26-0104 DATE 25 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

North side of rocket. Wash rock.

Surface disturbed.

DRILL RIG Acker II BORE HOLE 3

Page 2 of 4

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan fine silty sand with some clay	
20			
25			
30			

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

000098

DRILLING LOG

PROJECT 38-26-0104 DATE 25 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

North side of Rocket. Wash rack.

Surface disturbed

DRILL RIG Acker II BORE HOLE 3

Page 3 of -

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Tan fine silty sand with some clay	
35			
40			
45			

026272

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000099

DRILLING LOG

PROJECT 38-26-0104 DATE 25 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

North side of Rocket. Wash rack.

Surface disturbed

DRILL RIG Acker II BORE HOLE 3

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
45		Medium brown silty clay.	Hangs to auger
50			WT
		Bottom of hole	

026273

000100

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 26 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kratner

10 feet to east side of road

DRILL-RIG Acker II BORE HOLE 4

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Medium brown fine silty sand.	Damp
5	MB		
	MB		
10			
15	MB		Getting wetter

026274

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000101

DRILLING LOG

PROJECT 38-26-0104 DATE 26 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

10 feet to east side of road

DRILL RIG Acker II BORE HOLE 4

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan fine silty sand with some clay	Water WT
20			
25			
30			

USAEHA Form 95, 12 Aug 74

026275

000102

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 26 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

10 feet to east side of road

DRILL RIG Acker II BORE HOLE 4

Page 1 of 4

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan fine silty sand with some clay	
35	MB		
40			
45			

USAEHA Form 95, 12 Aug 74

026276

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000103

DRILLING LOG

PROJECT 38-26-0104 DATE 26 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

10 feet to east side of road

DRILL RIG Acker II BORE HOLE 4

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Tan fine silty sand with some clay	
		Medium brown silty clay.	Hangs to auger
50		Bottom of hole	
55			
60			

026277

000104

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 26 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

DRILL RIG Acker II BORE HOLE 5

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Gravel, reddish in color	
		Medium brown, silty sand	
5	MB	Tan silty sand with some clay	
	MB	Brown fine sand silt	
	MB	Brick red fine silty sand with some clay.	Fairly dry
10			
15	MB 14-16'	Tan silty fine sand with clay.	

026278

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000105

DRILLING LOG

PROJECT 38-26-0104 [illegible] DATE 26 Jan 80 [illegible]

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

DRILL RIG Acker II BORE HOLE 5 [illegible]

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan silty fine sand with clay	
20			
25			WT
30			Wet

USAEHA Form 95, 12 Aug 74

026279

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 26 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. [illegible]

DRILL RIG Acker II BORE HOLE 5

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan silty fine sand with clay	
35			
40			
45			

USAEHA Form 95, 12 Aug 74

026280

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000107

DRILLING LOG

PROJECT 38-26-0104 DATE 26 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

DRILL RIG Acker II BORE HOLE 5

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
45		Medium brown silty clay.	Hangs to auger.
50			
55			
60		Bottom of hole	Well depth 60 feet

USAEHA Form 95, 12 Aug 74

026281

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 26-Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of berm

DRILL RIG Acker II BORE HOLE 06

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Medium brown silty sand.	Moist
		Brown silty sand	
5	BS		
10	BS	Brick red silty clay with fine sand	
		Light tan silty fine sand with some clay.	Moist
	BS		
15			

026282

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000109

DRILLING LOG

PROJECT 38-26-0104 DATE 26 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of berm

DRILL RIG Acker II BORE HOLE 6

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Light tan silty fine sand with some clay.	
20			Water
25			
		Light tan sandy silt	
30	BS 29-31 ft		Water

026283

000110

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 28-26-0104 DATE 26 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of berm

DRILL RIG Acker II BORE HOLE 6

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
	BS	Light tan sandy silt	
35			
40		Medium brown silty clay	
45			

USAEHA Form 95, 12 Aug 74

026284

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000111

DRILLING LOG

PROJECT 38-26-0104 DATE 26 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

DRILL RIG Acker II BORE HOLE 6

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
50		Gray fine sandy clay	Well depth
60		BOTTOM OF HOLE	

USAEHA Form 95, 12 Aug 74

026285

000112

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 27 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Edge of Road

DRILL RIG Acker II BORE HOLE 7

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Medium brown silty sand	
			Moist
		Tan silty sand, fine	Moist
5	BS		
10	BS		Water
15			

USAEHA Form 95, 12 Aug 74

026286

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000113

DRILLING LOG

PROJECT 38-26-0104 DATE 27 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Edge of Road

DRILL RIG Acker II BORE HOLE 7

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
	BS	Tan silty sand, fine	Moist
20			
			Water
30			
35			

026287

000114

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 27 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Foster

Edge of Road

DRILL RIG Acker II BORE HOLE 7

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Tan silty sand, fine	Moist
40		Tan fine silty sand w clay	
45		Gray fine sandy clay	
50		BOTTOM OF HOLE	

USAEHA Form 95, 12 Aug 74

026288

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000115

DRILLING LOG

PROJECT 38-26-0104 DATE 27 Jan-80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Edge of Road

DRILL RIG Acker II BORE HOLE 7

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
55			
60			Well depth

USAEHA Form 95, 12 Aug 74

026289

000116

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 27 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of Berm

DRILL RIG Acker II BORE HOLE 8

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Medium Brown silty sand; some clay	Moist
5	MB		
		Brown fine silty sand	
10	MB		
		Tan fine silty sand w some clay	
15			

USAEHA Form 95, 12 Aug 74

026290

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000117

DRILLING LOG

PROJECT 38-26-0104 DATE 27 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of Berm

DRILL RIG Acker II BORE HOLE 8

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
	MB	Tan fine silty sand w some clay	
			Wet
20			
	MB		
25		Medium to fine sandy silt	Wet
			Water
30			

USAEHA Form 95, 12 Aug 74

026291

000118

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 27 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of Berm

DRILL RIG Acker II BORE HOLE 8

Page 3 of 4

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
40			
45		Tan silty clay	
	MB		
50			

026292

US ARMY ENVIRONMENTAL HYGIENE AGENCY

000119

DRILLING LOG

PROJECT 38-26-0104 DATE 27 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of Berm

DRILL RIG Acker II BORE HOLE 8

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan silty clay	
55		Gray sandy clay	
			Well depth.
60		BOTTOM OF HOLE	

USAEHA Form 95, 12 Aug 74

026293

000120

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of Berm

DRILL RIG Acker II BORE HOLE 9

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan fine silty sand	
	MB		
		Brown fine silty sand	
5			
	MB		
10			
		Tan fine silty sand w some clay	
	MB		
15			

026294

US ARMY ENVIRONMENTAL HYGIENE AGENCY

009121

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of Berm

DRILL RIG Acker II BORE HOLE 9

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Tan fine silty sand w some clay	
	MB		
20			Wet
25			
			Water level
30			

USAEHA Form 95, 12 Aug 74

026295

000122

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan-[illegible]

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. [illegible]

Top of Berm

DRILL RIG Acker II BORE HOLE 9

Page 3 of 4

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan fine silty sand w some clay	
35			
40			
45			

USAEHA Form 95, 12 Aug 74

026296

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000123

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of Berm

DRILL RIG Acker II BORE HOLE 9

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Tan fine silty sand w some clay	
		Brick red & gray silty clay	Wet
50			
			Well depth
55		Brown fine silty sand w clay	Dry
60		BOTTOM OF HOLE	

USAEHA Form 95, 12 Aug 74

026297

000124

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of Berm

DRILL RIG Acker II BORE HOLE 10

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Brown silty sand	Moist
5			
		Tan fine silty sand w some clay	Moist
10			
15			

USAEHA Form 95, 12 Aug 74

026298

US ARMY ENVIRONMENTAL HYGIENE AGENCY

000125

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Top of Berm

DRILL RIG Acker II BORE HOLE 10'

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan fine silty sand w some clay	Moist
20			Water
			Water level
25			
	MB		
30			

USAEHA Form 95, 12 Aug 74

026299

000126

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kreitner

Top of Berm

DRILL RIG Acker II BORE HOLE 16

Page 3 of 4

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
35			
40		Medium brown clay	
45			

USAEHA Form 95, 12 Aug 74

026300

US ARMY ENVIRONMENTAL HYGIENE AGENCY 070127

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner
Top of Berm

DRILL RIG Acker II BORE HOLE 10

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Medium brown clay	
	PB		
			Well depth
50			
55		BOTTOM OF HOLE	

USAEHA Form 95, 12 Aug 74

026301

US ARMY ENVIRONMENTAL HYGIENE AGENCY

000128

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

DRILL RIG Acker II BORE HOLE 11

Page 1 of 4

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Medium Brown silty sand	
5			
10		Brick red firm silty sand	
		Tan firm silty sand	
15			

USAEHA Form 95, 12 Aug 74

026302

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000129

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

DRILL RIG Acker II BORE HOLE 11

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan firm silty sand	
20			
25			Getting wet
30			

USAEHA Form 95, 12 Aug 74

026303

US ARMY ENVIRONMENTAL HYGIENE AGENCY

000130

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan 81

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. [illegible]

DRILL RIG Acker II BORE HOLE 11

Page 3 of 4

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan firm silty sand	
35			
40			
45			

USAEHA Form 95, 12 Aug 74

026304

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 28 Jan 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

DRILL RIG Acker II BORE HOLE 11

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan firm silty sand	
		Brick red silty clay	Dry
50		BOTTOM OF HOLE	

USAEHA Form 95, 12 Aug 74

026305

000168

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 2 Feb 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Old Road Bed to Burning Cage

DRILL RIG Acker II BORE HOLE 21

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Brick red gravel & silty sand w some clay	
		Brown silty sand w clay	
		Tan silty sand w clay	
5		Brick red silty sand w clay	
		Tan silty sand	
			Damp
10		Dark tan silty sand w some clay	
15			

USAEHA Form 95, 12 Aug 74

026306

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000169

DRILLING LOG

PROJECT 38-26-0104 DATE 2 Feb 90

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

Old Road Bed to Burning Cage

DRILL RIG Acker II BORE HOLE 21

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Dark tan silty sand w some clay	
20			Getting wet; Water level
25			
30			Wet

USAEHA Form 95, 12 Aug 74

026307

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 2 Feb 80

LOCATION Longhorn AAP DRILLERS LT Corbin, Mr. Fenton

Old Road Bed to Burning Cage

DRILL RIG Acker II BORE HOLE 21

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Dark tan silty sand w some clay	
35		Tan intermixed w gray silty clay	
40			
45			

026308

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000171

DRILLING LOG

PROJECT 38-26-0104 DATE 2 Feb 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Keatner

Old Road Bed to Burning Cage

DRILL RIG Acker II BORE HOLE 21

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan intermixed w gray silty clay	
50		BOTTOM OF HOLE	

USAEHA Form 95, 12 Aug 74

026309

000172

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 2 Feb 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kratner

DRILL RIG Acker II BORE HOLE 22

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Medium brown silty sand w some clay	
		Brown silty sand w some clay	
5			
		Tan silty sand	
10			
15			

USAEHA Form 95, 12 Aug 74

026310

US ARMY ENVIRONMENTAL HYGIENE AGENCY 009173

DRILLING LOG

PROJECT 38-26-0104 DATE 2 Feb 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

DRILL RIG Acker II BORE HOLE 22

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Tan silty sand	
20			
25			
30			Water

026311

000174

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0104 DATE 2 Feb 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

DRILL RIG Acker II BORE HOLE 22

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Tan silty sand	
35		Gray sandy clay	Hangs to auger
40			
45			

USAEHA Form 95, 12 Aug 74

026312

US ARMY ENVIRONMENTAL HYGIENE AGENCY 000175

DRILLING LOG

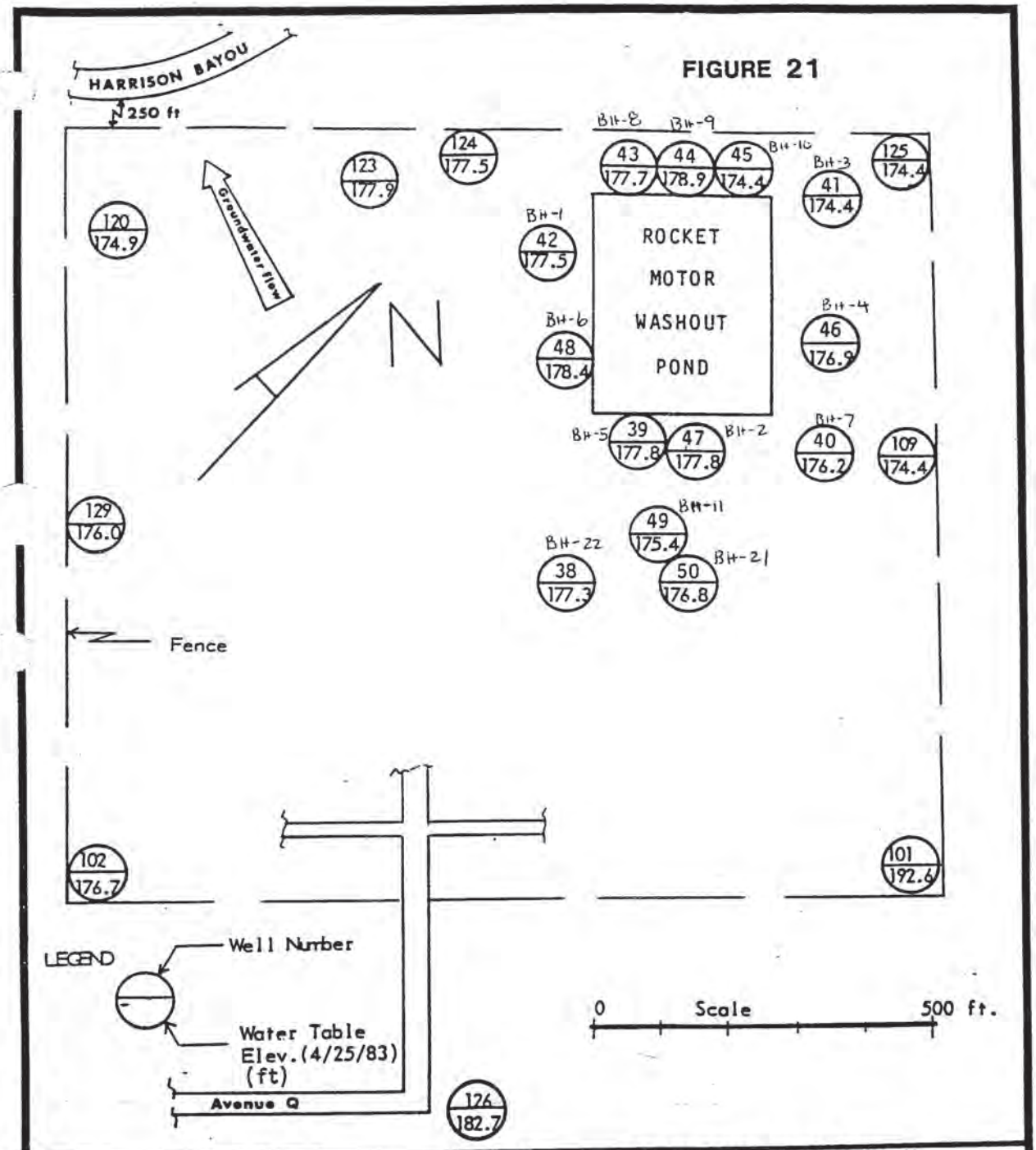
PROJECT 38-26-0104 DATE 2 Feb 80

LOCATION Longhorn AAP DRILLERS LT Corbitt, Mr. Kestner

DRILL RIG Acker II BORE HOLE 22

FEET DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Gray sandy clay	Hangs to auger
50		BOTTOM OF HOLE	

USAEHA Form 95, 12 Aug 74



ACTIVE BURNING GROUNDS

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

01227515

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 18~~2~~DPT1

8. NAME OF DRILLER: Kerri Powell

9. DIRECTION OF HOLE: ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 42'

13. SIZE AND TYPE OF BIT: 2 1/4" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): ~

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/14/2021; b. COMPLETED 03/14/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SILTY CLAY, DARK BROWN TO RED, LOW PLAST, MED. STIFF, ~~to~~ MOIST	2/4 %		
		2		%		
		3		%		
		4	CLAYEY SAND, LT. BROWN, COHESIVE, FINE, MOIST			
		5		2.5/4 %		
		6	SILTY CLAY, LT. BROWN, SOFT, LOW PLAST., MOIST			
		7		%		
		8		%		
		9		%		

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PROJECT

HOLE NUMBER

VERSION 1.0

01227516

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT1

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SILTY CLAY W/ SAND, LT. BROWN, SOFT, LOW PLAST., MOIST	3.5/4 = %		
	11			%		
	12					
	13		SAA	%		
	14			3.75/4 = %		
	15		CLAYEY SAND W/ SILT, LT. BROWN TO ORANGE, COHESIVE, FINE, MOIST	%		
	16					
	17		SILTY SAND, LT. BROWN TO ORANGE, LOOSE, FINE TO MED, MOIST TO WET	%		
	18			3.5/4 = %		
	19			%		
	20					
	21		SAA, LIGHT BROWN/ ORANGE TO GREY	%		
	22			2.5/4 = %		
	23			%		
	24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT1

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SAND, LT. BROWN TO GREY, MED. GRAIN, LOOSE, WET	%		
	26			3.5/4 %		
	27		CLAYEY SAND W/ SILT, LT. BROWN TO GREY, FINE, COHESIVE, WET	%		
	28		SAA	2/2 %		
	29		SILT, LT. BROWN TO GREY, LOW PLAST., SOFT, WET			
	30		SAA	%		
	31		SILTY SAND, LT. BROWN, FINE, COHESIVE, WET	2/2 %		
	32		SAA	2/2 %		
	33		SILTY CLAY, LT. BROWN, SOFT, ~~MED.~~ HIGH PLAST., WET			
	34		SILTY SAND W/ CLAY, LT. BROWN, COHESIVE, FINE GRAIN, WET	%		
	35			2/2 %		
	36		SAA, CLAY LENSE	%		
	37		@ 37'	2/2 %		
	38		SILTY CLAY W/ TRACE SAND, LIGHT BROWN, STIFF, MED. PLAST., MOIST TO WET			
	39			2/2 %		

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6. PROJECT

7. HOLE NUMBER

01227518

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT1

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40	CLAY, GREY, STIFF, HIGH PLAST., MOIST	2/2 %		SET WELL @ 42' BGS, SCREEN 32'-42'
		41				
		42		%		
		43		%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

01227519

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT2

8. NAME OF DRILLER: KERRI POWELL

9. DIRECTION OF HOLE
☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 38'

13. SIZE AND TYPE OF BIT: 2 1/4" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL):

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/14/2021 b. COMPLETED 03/14/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: JL Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SILTY CLAY, MOTTLED LT. BROWN, GREY & RED, STIFF, ~~HIGHLY~~ MED. PLAST., MOIST	2/4 %		
		2				
		3		%		
		4				
		5	SAA, LT. BROWN TO GREY	3.5/4 %		
		6				
		7	SANDY CLAY W/ SILT, LT. BROWN TO GREY, HIGH PLAST., SOFT, MOIST	%		
		8				
		9		%		

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PROJECT

HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT2

SHEET 2 OF ~~4~~ 3 SHEETS

3. PROJECT: LHAAP1824

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	~~SAA~~ fm SILTY CLAY, TRACE SAND, ~~AA~~ fm MOTTLED LT. BROWN, GREY & ORANGE, MED. STIFF, HIGH PLAST., MOIST	3.75/4		
		12				
		13	SAA	3.5/4		
		14				
		15	CLAYEY SAND, LT. BROWN TO REDDISH BROWN, LOOSE, FINE TO MED., MOIST			
		16				
		17	SAA			
		18		3/4		
		19				
		20				
		21	SILTY SAND W/ CLAY, LT. BROWN, SOFT, FINE, COHESIVE, WET	4/4		
		22				
		23				
		24				

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT2

SHEET 3 OF 4fm3 SHEETS

3. PROJECT: LHAAP1824

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SAA	%		
	26		CLAYEY SILT, MOTTLED LT. BROWN, GREY & ORANGE, SOFT, WET	4/4 %		
	27			%		
	28					
	29		SAA, LT. BROWN TO GREY, TRACE SAND	2/2 %		
	30					
	31		SAA	% 2/2		
	32		SILTY SAND, LT. BROWN TO GREY, FINE TO MED, COHESIVE, WET	%		
	33		SAA	2/2 %		
	34					
	35		SAA	% 2/2		
	36		SILTY CLAY, MOTTLED LT. BROWN, GREY & ORANGE, STIFF, HIGH PLAST., MOIST	%		
	37		CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., MOIST	2/2 %		SET WELL @ 38' BGS, SCREEN 28'-38'
	38					
	39			%		

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

01227522

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT3

8. NAME OF DRILLER: KERRI POWELL

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 42'

13. SIZE AND TYPE OF BIT: 2¼" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/14/2021; b. COMPLETED 03/14/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: JL Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		SANDY SILT W/ CLAY, DARK BROWN TO LIGHT BROWN, SOFT, WET	2/4 %		
	2			%		
	3			%		
	4		SILTY CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., MOIST	%		
	5			4/4 %		
	6					
	7			%		
	8					
	9			%		

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PROJECT

HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT3

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	10		SAA	%		
	11		SANDY CLAY, LT. BROWN TO ORANGE-BROWN, SOFT, MED. PLAST., MOIST	3.5/4 %		
	12		SAA	%		
	13			4/4		
	14		CLAYEY SAND, LT. BROWN TO GREY, FINE GRAIN, COHESIVE, MOIST	%		
	15			%		
	16		SILTY SAND, LT. BROWN, GREY & ORANGE, COHESIVE, FINE TO MED. GRAIN, MOIST	%		
	17			%		
	18			3.5/4 %		
	19			%		
	20		SAA, INCREASING CLAY CONTENT, WET	%		
	21			3.75/4 %		
	22			%		
	23			%		
	24			%		

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. *(Translucent)*

6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE: —

2. HOLE NUMBER: 1824DPT3

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SAA	3.75/4 %		
	26					
	27			%		
	28		SILTY CLAY W/ SAND, LT BROWN, GREY & ORANGE, SOFT, LOW PLAST., WET	2/2 %		
	29					
	30		SANDY SILT, LT. BROWN TO GREY, SOFT, WET	%		
	31			2/2		
	32		SILTY SAND, FINE TO MED., COHESIVE, WET, LT. BROWN TO ORANGE	2/2 %		
	33					
	34		SAA	2/2 %		
	35					
	36		CLAYEY SILT W/ SAND, SOFT, LOW PLAST, WET	%		
	37			2/2 %		
	38		SAA, INCREASING CLAY CONTENT	2/2 %		
	39					

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER (To be assigned): 1824DPT3

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	40			%		
			SAA	2/2		SET WELL @ 42' BGS, SCREEN 32'-42'
	41		CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., WET	%		
	42			%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227526

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT 4

8. NAME OF DRILLER: KERRI POWELL

9. DIRECTION OF HOLE: ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 43'

13. SIZE AND TYPE OF BIT: 2 1/4" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/14/2021; b. COMPLETED

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: John Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SILTY CLAY W/ SAND, DARK BROWN TO LT. BROWN, LOW PLAST., SOFT, WET	1.75/4 %		
		2		%		
		3		%		
		4	CLAY, REDDISH BROWN TO LT. BROWN, HIGH PLAST., MED. STIFF, MOIST	4/4 %		
		5		%		
		6		%		
		7		%		
		8		%		
		9		%		

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PROJECT | HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT4

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	SANDY CLAY, LT. BROWN, SOFT, MED. PLAST., MOIST	% 4/4 %		
		12	CLAYEY SAND, LT. BROWN TO GREY, COHESIVE, FINE GRAIN, MOIST	% 3.5/4 %		
		16	SAA, CLAY LENSE @ 18'	% 3/4 %		DISCOLORATION AROUND 17'-18' BGS
		20	SAA, FINE TO MED. GRAIN, WET	% 2.75/4 %		
		24		%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPTH

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SILTY SAND, REDDISH BROWN TO GREY, COHESIVE, FINE TO MED., WET	3.75/4 = %		
	26					
	27			%		
	28		SAA	2/2 = %		
	29		SANDY SILT, LT. BROWN, SOFT, WET			
	30		SILTY CLAY W/ SAND, LT. BROWN, SOFT, WET, LOW PLAST.	2/2 = %		
	31					
	32		SILTY SAND, LT. BROWN, COHESIVE, FINE, WET	2/2 = %		
	33		CLAYEY SILT W/ SAND, SOFT, WET			
	34		SAA	2/2 = %		
	35					
	36		SILTY SAND, LT. BROWN, FINE, WET	%		
	37		SAA, COARSENING	2/2 = %		
	38		SANDY SILT W/ CLAY, SOFT, WET	2/2 = %		
	39					

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT4

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	40		CLAYEY SAND W/ SILT, LT. BROWN, FINE TO MED, WET	%		
	41		SAA	2/2 %		
	42		CLAY, STIFF, GREY, HIGH PLAST, WET			SET WELL @ 43' BGS, SCREEN 33'-43'
	43		SAA	1/1 %		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

ENG FORM 1836A, JUN 1987 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION
LHAAP

SHEET 1 OF 4 SHEETS

PROJECT
LHAAP 18/24

LOCATION (Coordinates or Station)
LHAAP

DRILLING AGENCY
WHE

HOLE NUMBER (as shown on drawing title and title number)
1824DPT5

NAME OF DRILLER
Kerri Powell

DIRECTION OF HOLE
[X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

THICKNESS OF OVERBURDEN ~

DEPTH DRILLED INTO ROCK ~

TOTAL DEPTH OF HOLE 42'

13. SIZE AND TYPE OF BIT 2¼" Diameter

14. DATUM FOR ELEVATION SHOWN (TBM or MSL)
~

15. MANUFACTURERS DESIGNATION OF DRILL
Geoprobe 7822DT

16. TOTAL NO. OF OVER, BURDEN SAMPLES TAKEN: a. DISTURBED ~ b. UNDISTURBED ~

17. TOTAL NUMBER CORE BOXES ~

18. ELEVATION GROUND WATER ~

19. DATE HOLE (YYYYMMDD): a. STARTED 03/15/2021 b. COMPLETED 03/15/2021

20. ELEVATION TOP OF HOLE (feet) ~

21. TOTAL CORE RECOVERY FOR BORING % ~

22. SIGNATURE OF INSPECTOR
Dk Mann

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		SILTY CLAY, DARK BROWN TO RED, MED. PLAST, SOFT TO MED. STIFF, WET	2/4 %		
	2			%		
	3			%		
	4		SANDY CLAY W/ SILT, MOTLED LT. BROWN, RED & GREY, LOW PLAST., MED. STIFF, WET	%		
	5			4/4 %		
	6			%		
	7			%		
	8			%		
	9			%		

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PROJECT

HOLE NUMBER

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT5

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	SAA	4/4 %		
		11	CLAYEY SAND, LT. BROWN TO ORANGE, COHESIVE, FINE, WET	%		
		12	SANDY CLAY, LT. BROWN, HIGH PLAST., MED. STIFF, MOIST	%		
		13	CLAYEY SAND, LT. BROWN TO GREY, COHESIVE, FINE, MOIST	3.75/4 %		
		14				
		15		%		
		16	SILTY SAND W/ TRACE CLAY, ~~AAA-PM~~ COHESIVE, FINE TO MED., MOIST	%		
		17		3/4 %		
		18				
		19		%		
		20	SAA			
		21		4/4 %		
		22	SANDY SILT W/ CLAY, LT. BROWN TO GREY, SOFT, WET	%		
		23				
		24		%		

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT5

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SILTY CLAY W/ SAND, LT. BROWN TO GREY, SOFT TO MED. STIFF, MED. PLAST., WET	4/4 %		
		26				
		27		%		
		28				
		29	SILTY SAND, GREY, COHESIVE, FINE, WET	2/2 %		
		30	SAA	%		
		31	SILTY CLAY, LT. BROWN TO GREY, SOFT, MED. PLAST., WET	2/2 %		
		32	CLAYEY SILT, LT. BROWN, SOFT, WET	2/2 %		
		33				
		34	SAA	2/2 %		
		35				
		36	SILTY CLAY, LT. BROWN, MED. STIFF, ~~MED.~~ HIGH PLAST. WET	%		
		37	CLAYEY SAND, LT. BROWN, COHESIVE, FINE TO MED., WET	2/2 %		
		38	SAA	2/2 %		
		39				

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet) For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG	1. ELEVATION TOP OF HOLE	2. HOLE NUMBER 1824DPT5	SHEET 4 OF 4 SHEETS
3. PROJECT LHAAP 18/24		4. INSTALLATION LHAAP	

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SAA	%		
	40					
			CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., WET	2/2 %		SET WELL @ 42' BGS, SCREEN 32'-42'
	41					
	42					
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227534

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804, the proponent agency is CECW-EG

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT6

8. NAME OF DRILLER: Kerri Powell

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT. —

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 43'

13. SIZE AND TYPE OF BIT: 2 1/4" Diameter

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: Geoprobe 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/15/2021 b. COMPLETED 03/15/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: [signature]

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	0–4		SILTY CLAY, REDDISH BROWN, MED. PLAST., SOFT, MOIST	2/4 = 50%		
	4–5		SAA			
	5–8		SANDY CLAY, LT. BROWN TO GREY, MED. STIFF, LOW PLAST, MOIST	3/4 = 75%		

ENG FORM 1836, MAY 1971 PREVIOUS EDITIONS ARE OBSOLETE (Translucent) PROJECT HOLE NUMBER

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT6

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SAA	3.5/4 %		
	11			%		
	12			%		
	13		SAA	3/4 %		
	14					
	15		CLAYEY SAND, MOTTLED LT. BROWN, ORANGE & GREY, COHESIVE, FINE, MOIST	%		
	16		SANDY CLAY W/ SILT, LT. BROWN TO ORANGE, SOFT, LOW PLAST., MOIST TO WET	%		
	17			3/4 %		
	18		CLAYEY SAND, LT. BROWN TO DARK BROWN, COHESIVE, FINE TO MED., WET	%		
	19			%		
	20		SAA, MED. TO COARSE	~~3.75~~ Am %		
	21			3/4 %		
	22			%		
	23			%		
	24					

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. *(Translucent)*

6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT6

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SAA	%		
	26		SILTY CLAY, LT. GREY, SOFT, LOW PLAST., WET	3.75/4 %		
	27			%		
	28		CLAYEY SAND W/ SILT, LT. BROWN TO GREY, COHESIVE, FINE TO MED., WET	%		
	29		SILTY CLAY, LT. GREY, LOW PLAST., SOFT, WET	2/2 %		
	30		SILTY SAND, LT. BROWN, FINE TO MED, LOOSE, WET	%		
	31			2/2 %		
	32		SAA, INCREASED CLAY CONT.	%		
	33			2/2 %		
	34		SANDY SILT W/ CLAY, LT. BROWN, LOW PLAST., SOFT, WET	%		
	35			2/2 %		
	36		SAA	%		
	37			%		
	38			%		
	39					

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT6

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVE	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SAA	2/2 %		
	40		SILTY CLAY W/ SAND, LT. BROWN, SOFT, LOW TO MED. PLAST., WET	2/2 %		
	42		CLAY, STIFF LT. BROWN TO GREY, STIFF, HIGH PLAST., MOIST	1/1 %		SET WELL @ 43', SCREEN 33'-43'
	43			%		

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT7

8. NAME OF DRILLER: Kerri Powell

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 42'

13. SIZE AND TYPE OF BIT: 2¼" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN	a. DISTURBED	b. UNDISTURBED
	—	—

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD)	a. STARTED	b. COMPLETED
	03/15/2021	03/15/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: JL Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	~~SILTY CLAY~~ CLAYEY SILT, DARK BROWN TO REDDISH BROWN, SOFT, WET	2/4 %		
		2				
		3	CLAY, LT. BROWN TO REDDISH BROWN, STIFF, HIGH PLAST, MOIST	%		
		4				
		5	SAA	3.5/4 %		
		6				
		7		%		
		8				
		9		%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT7

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/27

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SAA	3.5/4 %		
	11		CLAYEY SAND W/ SILT, LT. BROWN, FINE, COHESIVE, MOIST	%		
	12		SAA, MED. TO COARSE	%		
	13					
	14			3.5/4 %		
	15			%		
	16		SAA	%		
	17			3.25/4 %		
	18					
	19			%		
	20		SAA, WET	%		
	21			4/4 %		
	22					
	23			%		
	24					

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT7

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SAA, INCREASING SILT CONTENT, WET	4/4 %		
	26					
	27			%		
	28		SILTY SAND, LT. BROWN TO GREY, COHESIVE, WET, FINE TO COARSE	2/2 %		
	29					
	30		SAA, MED. TO COARSE	%		
	31		SANDY SILT, LT. BROWN, SOFT, WET	2/2 %		
	32		CLAYEY SILT W/ SAND, LIGHT BROWN, SOFT, WET	2/2 %		
	33					
	34		SAA	%		
	35			2/2		
	36		SAA, SAND LENSE FROM 37'-37.5'	%		
	37			2/2 %		
	38					
	39		SAA, INCREASING SAND CONT.	2/2 %		

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6. PROJECT

7. HOLE NUMBER

01227541

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT7

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SILTY CLAY, LT. BROWN TO ORANGISH BROWN, MED. STIFF, HIGH PLAST., WET	%		
	40					
			CLAY, MED. STIFF TO STIFF, LT. BROWN TO DARK BROWN/GREY, HIGH PLAST., WET	2/2 %		SET WELL @ 42' BGS, SCREEN 32-42
	41					
	42					
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT8

8. NAME OF DRILLER: Kerri Powell

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE

13. SIZE AND TYPE OF BIT: 2¼" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/15/2021 b. COMPLETED 03/15/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: John Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		CLAYEY SILT, DARK BROWN, SOFT, WET	2/4 %		
	2–3		SILTY CLAY, REDDISH BROWN, STIFF, HIGH PLAST., MOIST	%		
	4–8		SILTY CLAY W/ SAND, BROWN TO REDDISH BROWN, STIFF, MED. PLAST., MOIST	3.75/4 %		
	9			%		

VERSION 1.1

01227543

DRILLING LOG (Continuation Sheet) For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	1. ELEVATION TOP OF HOLE	2. HOLE NUMBER 1824DPT8	SHEET 2 OF 4 SHEETS
3. PROJECT LHAAP 18/24		4. INSTALLATION LHAAP	

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10		% 4/4		
		11	CLAYEY SAND, LT. BROWN, COHESIVE, FINE, MOIST	%		
		12	SANDY CLAY W/ SILT, BROWN, SOFT, LOW PLAST., MOIST	%		
		13		3.5/4		
		14	CLAYEY SAND W/ SILT, REDDISH BROWN, DARK BROWN, LT. BROWN, FINE TO MED., COHESIVE, WET	%		
		15		%		
		16	SAA, MED. TO COARSE, WET, DARK REDDISH BROWN TO REDDISH BROWN	% 4/4		
		17				
		18		%		
		19		%		
		20	SAA, LT. BROWN TO ORANGE			
		21		% 3.5/4		
		22		%		
		23				
		24		%		

ENG FORM 1836A, JUN 1967	PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)	6. PROJECT	7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT8

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SAA	4/4 %		
	26					
	27			%		
	28					
	29		SAA	2/2 %		
	30					
	31		SANDY SILT, SOFT, LT. BROWN, FINE TO MED., WET	2/2 %		
	32		SAA, FINE GRAIN	2/2 %		
	33					
	34					
	35		SILTY SAND, LT. BROWN, COHESIVE, WET, FINE GRAIN	2/2 %		
	36			%		
	37		SAA	2/2 %		
	38		SANDY SILT, LT. BROWN, SOFT, WET			
	39		SILTY CLAY, MED STIFF, HIGH PLAST., LT. BROWN, WET	2/2 %		

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT8

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SANDY SILT, LT. BROWN TO ORANGE, FINE, SOFT, WET			
	40					
			CLAY, STIFF, LT. BROWN TO GREY, HIGH PLAST., MOIST TO WET	2/2 %		SET WELL @ 42' BGS, SCREEN 32'-42'
	42					
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): KARNACK, TX

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT9

8. NAME OF DRILLER: KERRI POWELL

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 43' BGS

13. SIZE AND TYPE OF BIT: 2 1/4" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 3/12/2021; b. COMPLETED 3/12/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: JL Mooney

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SILTY SAND, DARK BROWN TO REDDISH BROWN, FINE GRAIN, MOIST	3.75/4 = %		
		2	SANDY CLAY, LT. BROWN, MED PLAST., MED. STIFF, MOIST	%		
		3		%		
		4	SAA, MOTLED REDDISH BROWN, LT. BROWN & GREY	%		
		5		4/4 = %		
		6		%		
		7		%		
		8		%		
		9		%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT9

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	SAA, INCREASING SAND CONTENT,	3.75/4 = %		
		11		%		
		12				
		13	SAA, LT. BROWN TO GREY, MOIST	4/4 = %		
		14		%		
		15		%		
		16				
		17	CLAYEY SAND, MOTTLED LT. BROWN, GREY & ORANGE, FINE TO MED. GRAIN, COHESIVE, DRY TO MOIST	4/4 = %		
		18		%		
		19		%		
		20				
		21	SAA	%		
		22	SILTY SAND, LT. BROWN TO ORANGISH BROWN, FINE TO MED GRAIN, COHESIVE, WET	4/4 = %		
		23		%		
		24		%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPTQ

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SANDY SILT, LT. BROWN TO ORANGE, FINE GRAIN, WET, COHESIVE	4/4 %		
		26		%		
		27		%		
		28				
		29	SAA, LT. BROWN TO GREY	4/4 %		
		30		%		
		31		%		
		32				
		33	SAA, SOME CLAY, WET	4/4 %		
		34		%		
		35		%		
		36				
		37	SAA	1/1		
		38	SAA	1/1 %		
		39	SAA INCREASING CLAY CONT.	1/1 %		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT9

SHEET 4 OF 4 SHEETS

PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40		%		
		41		%		
		42	CLAY, LT. BROWN, STIFF, HIGH PLAST., WET	1/1 %		SET WELL @ 43' BGS, SCREEN 33'-43'
		43		%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

01227550

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION *(Coordinates or Station)*: LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER *(as shown on drawing title and title number)*: ~~KERRI POWELL~~ JM 1824DPT10

8. NAME OF DRILLER: KERRI POWELL

9. DIRECTION OF HOLE
☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE

13. SIZE AND TYPE OF BIT: 2 1/4" DIAMETER

14. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*: —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE *(YYYYMMDD)*: a. STARTED 03/12/2021; b. COMPLETED 03/12/2021

20. ELEVATION TOP OF HOLE *(feet)*: —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: John Moorman

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	1–4		SANDY/SILTY CLAY, DARK BROWN, LOW PLAST, MED. STIFF, MOIST	2.75/4 = %		
	5–8		SAA, STIFF, MED. PLAST., LT. BROWN TO GREY	3.5/4 = %		
	9		CLAY, LT. BROWN TO GREY, HIGH PLAST., STIFF, MOIST	%		

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PROJECT

HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE	2. HOLE NUMBER	SHEET 2 OF 4 SHEETS
	1824DPT10	

3. PROJECT	4. INSTALLATION
LHAAP 18/24	LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	10			4/4 %		
	11					
	12		SAA	%		
	13		SANDY CLAY, SOME SAND LENSES THROUGHOUT, MOTTLED LT. BROWN, DARK BROWN & GREY, LOW PLAST., MED. STIFF, MOIST TO WET	3/4 %		
	14					
	15			%		
	16		SAA	%		
	17			4/4 %		
	18		CLAYEY SAND W/ SILT, LT. BROWN TO GREY, FINE, COHESIVE, MOIST			
	19			%		
	20		SILTY CLAY W/ TRACE SAND, LT. BROWN TO GREY, LOW PLAST., SOFT, MOIST	%		
	21					
	22			4/4 %		
	23					
	24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT10

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SILTY CLAY, LT. BROWN TO ORANGE-BROWN, MED. STIFF, ~~MED. PLAST.~~, MOIST TO WET HIGH PLASTICITY	3/4 %		
	26					
	27			%		
	28		CLAYEY SAND W/ SILT, LT. BROWN, COHESIVE, FINE GRAIN, WET	4/4 %		
	29					
	30			%		
	31					
	32			%		1540 - LINER STUCK DOWN IN HOLE, ALL RODS
	33		CLAYEY SILT, LT. BROWN, LOW PLAST., SOFT, WET	3/4 %		1600 - SAMPLE RETRIEVED, CONT. DRILLING
	34					
	35			%		
	36			%		
	37		SILTY SAND, LT. BROWN, COHESIVE, FINE, WET	1/1 %		
	38		SAA	1/1 %		
	39		SAA	%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT10

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40	SAA, SAND COARSENING NEAR 40'	2/2 %		
		41		%		
		42	SAA, INCREASING CLAY NEAR 42'	2/2 %		
			CLAY, LT. BROWN TO GREY, HIGH PLAST. STIFF, MOIST			SET WELL @ 43' BGS, SCREEN 33'-43'
		43		%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT11

8. NAME OF DRILLER: KERRI POWELL

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE

13. SIZE AND TYPE OF BIT: 2 1/4" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): ~

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/13/2021; b. COMPLETED 03/13/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: JL Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SILTY CLAY, DARK BROWN, LOW TO MED PLAST., SOFT, WET	2/4 %		
		2				
		3		%		
		4				
		5	SANDY CLAY, MOTTLED LT. BROWN, GREY & RED, MED. PLAST., MED. STIFF, MOIST	4/4 %		
		6				
		7	SAND LENSE FROM 7'-9' BGS	%		
		8				
		9	SAA, LT. BROWN	%		

ENG FORM 1836, MAR 1971 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

PROJECT

HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT11

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10		4/4 %		
		11		%		
		12	CLAYEY SAND, LT. BROWN TO GREY, COHESIVE, FINE, MOIST	%		
		13		4/4 %		
		14		%		
		15		%		
		16	SANDY CLAY, LT. BROWN, LOW PLAST., MED. STIFF, MOIST	%		
		17		4/4 %		
		18		%		
		19		%		
		20	SILTY CLAY, MOTTLED LT. BROWN & GREY, MED. PLAST., SOFT, WET	%		
		21		4/4 %		
		22		%		
		23		%		
		24				

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. *(Translucent)*

6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT11

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SANDY SILT, GREY, COHESIVE, FINE GRAIN, WET	4/4 %		
		26		%		
		27		%		
		28	SAA	2/2 %		
		29	SILTY SAND, LT. BROWN, FINE TO MED., COHESIVE, WET			
		30	SILT, LT. BROWN, COHESIVE, WET, SOFT	2/2 %		
		31				
		32	~~SANDY SILT~~ SM LT. BROWN, COHESIVE, SOFT, WET, FINE SILTY SAND	2/2 %		
		33				
		34	SAA, FINE TO MED. GRAIN	2/2 %		
		35				
		36	SAA	2/2 %		
		37				
		38	SAA	2/2 %		
		39				

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT11

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	40		SANDY SILT, LT. BROWN, WET	%		SET WELL @ 42' BGS, SCREEN 32'-42'
	41		CLAY, LT. BROWN, HIGH PLAST, SOFT, MOIST	2/2 %		
	42			%		
	43			%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

01227558

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION

SHEET 1 OF 4 SHEETS

4. PROJECT
LHAAP 18/24

5. LOCATION *(Coordinates or Station)*
LHAAP

6. DRILLING AGENCY
WHE

7. HOLE NUMBER *(as shown on drawing title and title number)*
1824DPT12

8. NAME OF DRILLER
KERRI POWELL

9. DIRECTION OF HOLE
☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN —

11. DEPTH DRILLED INTO ROCK —

12. TOTAL DEPTH OF HOLE

13. SIZE AND TYPE OF BIT 2¼" DIAMETER

14. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* —

15. MANUFACTURERS DESIGNATION OF DRILL
GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN — a. DISTURBED — b. UNDISTURBED

17. TOTAL NUMBER CORE BOXES —

18. ELEVATION GROUND WATER —

19. DATE HOLE *(YYYYMMDD)* a. STARTED 03/13/2021 b. COMPLETED 03/13/2021

20. ELEVATION TOP OF HOLE *(feet)* —

21. TOTAL CORE RECOVERY FOR BORING % —

22. SIGNATURE OF INSPECTOR
Jeb Mann

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		1	CLAYEY SILT, TRACE SAND, LT. BROWN, LOW PLAST., SOFT, WET	2/4 %		
		2		%		
		3		%		
		4	SILTY CLAY, LT. BROWN TO GREY, HIGH PLAST., MED. STIFF, MOIST	%		
		5		3.5/4' %		
		6		%		
		7	CLAYEY SILT, LT. BROWN, SOFT, WET	%		
		8		%		
		9		%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE	2. HOLE NUMBER	SHEET 2 OF 4 SHEETS
	1824DPT12	

3. PROJECT	4. INSTALLATION
LHAAP 18/24	LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	10		SANDY CLAY, LT. BROWN TO GREY, MED. PLAST., MED. STIFF, MOIST	4/4		
	11		SAND LENSE @ 11' BGS			
	12		SAA			
	13					
	14		SAND, LT. BROWN TO ORANGE, COHESIVE, FINE GRAIN, MOIST	4/4		
	15					
	16					
	17		SAA	3/4		
	18					
	19		CLAYEY SAND W/ SILT, COHESIVE, LT. BROWN TO GREY, FINE, MOIST			
	20		SAA			
	21		SAND, LT. BROWN TO REDDISH BROWN, LOOSE, FINE TO MED. GRAIN, MOIST	2.75/4		
	22					
	23					
	24					

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT12

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SILTY CLAY W/ SAND, LT. BROWN TO GREY, LOW PLAST., SOFT, MOIST	4/4 %		
	26					
	27		SILTY SAND, GREY, LOOSE, FINE, MOIST	%		
	28		SANDY SILT, LT. BROWN, TRACE CLAY, LOW PLAST., SOFT, COHESIVE, WET, FINE GRAIN	%		
	29					
	30			4/4 %		
	31			%		
	32		SILT, LT. BROWN, SOFT, COHESIVE, FINE, WET	%		
	33					
	34			4/4 %		
	35			%		
	36		SAA	%		
	37		SANDY SILT, LT. BROWN, FINE GRAIN, SOFT, WET	2/2 %		
	38					
	34			%		

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT12

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SAA	2/2 %		
		40				
			SAA	2/2 %		
		41				
			CLAY, GREY, HIGH PLAST., MED. STIFF, WET			
		42				SET WELL @ 48' BGS, SCREEN 33'-43'
			SAA, STIFF, LT. BROWN TO GREY	1/1 %		
		43				
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227562

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION *(Coordinates or Station)*: LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER *(as shown on drawing title and title number)*: 1824DPT13

8. NAME OF DRILLER: KERRI POWELL

9. DIRECTION OF HOLE
☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 43' BGS

13. SIZE AND TYPE OF BIT: 2¼" DIAMETER

14. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*: —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE *(YYYYMMDD)*: a. STARTED 03/13/2021; b. COMPLETED 03/13/2021

20. ELEVATION TOP OF HOLE *(feet)*: —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: J. Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		1	SANDY SILT, DARK BROWN TO LIGHT BROWN, SOFT, FINE TO MED., WET	2/4 %		
		2		%		
		3		%		
		4	CLAY, MOTTLED LT. BROWN, RED & GREY, HIGH PLAST., MED. STIFF, MOIST	3/4 %		
		5		%		
		6		%		
		7		%		
		8		%		
		9		%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT13

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SANDY CLAY, LT. BROWN TO GREY, LOW PLAST., MED. STIFF; MOIST	4/4		
	11					
	12					
	13		SAA	2/4		
	14					
	15		SILTY SAND, MOTTLED LT. BROWN, GREY & ORANGE, FINE, COHESIVE, DRY TO MOIST			
	16		CLAYEY SAND, LT. BROWN TO ORANGE, COHESIVE, FINE GRAIN, MOIST			
	17					
	18			3/4		
	19					
	20					
	21		SAA, COARSENING NEAR BOTTOM			
	22			3/4		
	23					
	24					

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT13

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	5. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SAA	%		
	26		SILTY CLAY, LT. BROWN TO ORANGE, HIGH PLAST., ~~MOIST~~ SOFT, MOIST	3.5/4 %		
	27		SILTY SAND, LT. BROWN TO GREY, FINE TO MED., MOIST	%		
	28		SAA			
	29		SILT, LT. BROWN TO GREY, SOFT, MOIST TO WET	%		
	30			4/4 %		
	31			%		
	32		SAA, WET			
	33			%		
	34			4/4 %		
	35			%		
	36		SANDY SILT, LT. BROWN TO GREY, SOFT, COHESIVE, WET	%		
	37			2/2 %		
	38		SAA	2/2 %		
	39					

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT13

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	40		SILTY SAND, LT. BROWN, COHESIVE, FINE TO MED, WET	%		
	41		SAA, WET	2/2 %		
	42		CLAY, LT. BROWN TO ORANGE, WET			
	43		CLAY, LT. BROWN TO GREY, HIGH PLAST, MED. STIFF, WET	1/1 %		SET WELL @ 43' BGS, SCREEN 33'–43'
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227566

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT14

8. NAME OF DRILLER: Kerri Powell

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 44' BGS

13. SIZE AND TYPE OF BIT: 2¼" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/13/2021; b. COMPLETED 03/13/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: John Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SILTY CLAY, DARK BROWN TO RED, MED. PLAST., MED. STIFF, MOIST	2.5/4 %		
		2				
		3	SANDY SILT, LT. BROWN, SOFT, WET	%		
		4				
		5	CLAY, MOTTLED LT. BROWN, GREY, REDDISH BROWN, MED. STIFF, HIGH PLAST., MOIST	%		
		6		3/4 %		
		7				
		8		%		
		9		%		

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PROJECT

HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT14

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SILTY CLAY W/ SAND, LT. BROWN TO GREY. STIFF, LOW PLAST., MOIST	4/4 %		
	11			%		
	12			%		
	13		SAA	%		
	14			4/4 %		
	15		CLAYEY SAND, LT. BROWN TO GREY, FINE TO MED., COHESIVE, MOIST	%		
	16			%		
	17		SAA	%		
	18			3.75/4 %		
	19			%		
	20			%		
	21		SANDY CLAY, LT. BROWN TO GREY, LOW PLAST., MED. STIFF, MOIST	3.5/4 %		
	22		CLAYEY SAND, LT. BROWN TO GREY, COHESIVE, FINE GRAIN, MOIST	%		
	23			%		
	24			%		

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT14

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SAA	%		
	25		SANDY CLAY, MOTTLED LT. BROWN, REDDISH BROWN & GREY, MED. STIFF, HIGH PLAST., MOIST	3.5/4 %		
	26					
	27			%		
	28		SILTY SAND, LT. BROWN TO GREY, COHESIVE, FINE, WET	%		
	29		SILTY CLAY, LT. BROWN, MED. PLAST., SOFT, WET	4/4 %		
	30					
	31		CLAYEY SAND, LT. BROWN TO GREY, COHESIVE, FINE, WET.	%		1245 - SLEEVE STUCK DOWN IN HOLE
	32		SAA			1300 - SAMPLE RETRIEVED
	33		SILT, LT. BROWN TO GREY, SOFT, WET	% 2/4		
	34			%		
	35					1315 - SLEEVE STUCK DOWN IN HOLE
	36		SAA, LT. BROWN	%		1330 - SAMPLE RETRIEVED
	37			1/2 %		
	38		SANDY SILT, LT. BROWN, SOFT, WET, FINE	1/2 %		
	39					

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824 DPT 14

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	40			%		
	41		SILTY SAND, LT. BROWN, COHESIVE, FINE, WET	1.75/2 %		
	42					1410 - SLEEVE STUCK DOWN IN HOLE
	43		CLAY, LT. BROWN TO GREY, HIGH PLAST, STIFF, WET	2/2 %		1420 - SAMPLE RETRIEVED SET WELL @ 44' BGS, SCREEN 34'-44'
	44			%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT15

8. NAME OF DRILLER: Kerri Powell

9. DIRECTION OF HOLE
☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE

13. SIZE AND TYPE OF BIT: 2¼" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/13/2021; b. COMPLETED 03/13/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: JL Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SILTY CLAY, REDDISH BROWN, HIGH PLAST., MED. STIFF, MOIST	2/4 %		
		2	ASH / FILL	%		
		3	SANDY SILT, DARK BROWN TO GREY, SOFT, MOIST	%		
		4	SILTY CLAY, TRACE SAND, ~~STIFF~~ LT. BROWN TO GREY, HIGH PLAST., STIFF, MOIST	%		
		5		~~2.5~~ %		
		6		2/4 %		
		7		%		
		8		%		
		9		%		

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PROJECT

HOLE NUMBER

VERSION 1.0

01227571

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT15

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SAA	%		
	10		CLAYEY SAND, LT. BROWN, FINE TO MED., COHESIVE, WET	3.75/4		
	11		SILTY CLAY W/ SAND, MOTTLED LT. BROWN & GREY, MED. STIFF, MED. PLAST., MOIST	%		
	12		CLAYEY SAND W/ SILT, LT. BROWN TO GREY, FINE GRAIN, WET	%		
	13			3.5/4		
	14			%		
	15			%		
	16		SAA, CLAY LENSES THROUGHOUT	%		
	17			%		
	18			2/4		
	19		SAND, ORANGE, FINE TO MED, LOOSE, MOIST	%		
	20		SANDY SILT, MOTTLED LT. BROWN, GREY & ORANGE, SOFT, ~~HIGH~~ MED. PLAST., MOIST	%		
	21			3.5/4		
	22			%		
	23			%		
	24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT15

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SAA, SAND LENSE @ 24'	%		
	26		SILTY SAND W/ TRACE CLAY, MOTTLED LT. BROWN, ORANGE & GREY, FINE GRAIN, COHESIVE, MOIST	3.5/4 %		
	27			%		
	28		SAA, WET	2/2 %		
	29					
	30		CLAY, LT. BROWN TO GREY, HIGH PLAST., MED. STIFF, MOIST	%		
	31		SILTY SAND, LT. BROWN, COHESIVE, FINE TO MED. GRAIN, WET	2/2 %		
	32		SAA, LT. BROWN TO GREY	2/2 %		
	33					
	34		SANDY SILT, LT. BROWN, SOFT, WET	%		
	35		SILTY SAND, LT. BROWN TO GREY, COHESIVE, FINE TO MED., WET	2/2 %		
	36		SAA	2/2 %		
	37					
	38		SAA	2/2 %		
	39					

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6. PROJECT

7. HOLE NUMBER

01227573

DRILLING LOG (Continuation Sheet) For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	1. ELEVATION TOP OF HOLE	2. HOLE NUMBER 1824DPT15	SHEET 4 OF 4 SHEETS
3. PROJECT LHAAP 18/24		4. INSTALLATION LHAAP	

5 ELEVATION	a DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40		%		
		41	SAA, INCREASING SILT CONTENT	2/2 %		
		42	~~ST~~ CLAY, LT. BROWN, MED. STIFF, HIGH PLAST., WET	1/1 %		SET WELL @ ~~48' BGS~~ 43' BGS SCREEN ~~34'-44'~~ 33'-43'
		43		2/2 %		
		44		%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

ENG FORM 1836A, JUN 1967	PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)	6 PROJECT	7. HOLE NUMBER

01227574

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION *(Coordinates or Station)*: LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER *(as shown on drawing title and title number)*: 1824DPT16

8. NAME OF DRILLER: Kerri Powell

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT. —

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 43'

13. SIZE AND TYPE OF BIT: 2 ¼" DIAMETER

14. DATUM FOR ELEVATION SHOWN *(TBM or MSL)*: —

15. MANUFACTURERS DESIGNATION OF DRILL: Geoprobe 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE *(YYYYMMDD)*: a. STARTED 03/14/2021; b. COMPLETED 03/14/2021

20. ELEVATION TOP OF HOLE *(feet)*: —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: [signature]

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		1	SILTY CLAY, DARK BROWN, LOW PLAST., SOFT, MOIST	1.75/4 %		
		2				
		3		%		
		4	SANDY CLAY W/ SILT, MOTTLED LT. BROWN, DARK BROWN & GREY, STIFF, MED. PLAST., MOIST	3/4 %		
		5		%		
		6				
		7		%		
		8				
		9		%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DBT16

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SAA, MED. STIFF, LOW PLAST.	4/4 %		
	11			%		
	12		SAA, SOFT	%		
	13					
	14			3.75/4 %		
	15			%		
	16		CLAYEY SAND, LT. BROWN TO GREY, COHESIVE, FINE GRAIN, MOIST	%		
	17			~~4.0m/4.0~~ %		
	18			3.75/4 %		
	19					
	20			%		
	21		SAA, FINE TO MED., MOIST	%		
	22			%		
	23					
	24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet) For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	1. ELEVATION TOP OF HOLE	2. HOLE NUMBER LB24DPT16	SHEET 3 OF 4 SHEETS
3. PROJECT LHAAP18/24		4. INSTALLATION LHAAP	

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SAA	%		
	26		SILTY CLAY, LT. BROWN TO GREY, HIGH PLAST., STIFF, MOIST TO WET	4/4 %		
	27		CLAYEY SAND, LT. BROWN TO GREY, COHESIVE, FINE TO MED., WET	%		
	28		SAA	2/2 %		
	29		CLAYEY SILT W/ SAND, LT. BROWN TO GREY, LOW PLAST., WET, SOFT			
	30		SAA, INCREASING SAND CONTENT	% 2/2 %		
	31					
	32		SAA	2/2 %		
	33		SILTY CLAY W/ SAND, LT. BROWN TO GREY, SOFT, LOW PLAST., WET			
	34		SILTY SAND, LT. BROWN TO GREY, FINE TO MED., COHESIVE, WET	% 2/2 %		
	35					
	36		SAA	2/2 %		
	37					
	38			%		
	39					

ENG FORM 1836A, JUN 1967	PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)	6. PROJECT	7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT16

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SANDY SILT, LT. BROWN, COHESIVE, SOFT, WET	2/2 %		
	40		SANDY CLAY W/ SILT, LT. BROWN TO GREY,	2/2 %		
	41		SOFT, LOW PLAST, WET			
	42		CLAY, LT. BROWN TO GREY, HIGH PLAST., STIFF, MOIST TO WET	1/1 %		SEE WELL (2) 33'-43' BGS
	43			%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804, the proponent agency is CECW-EG	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 3 SHEETS

4. PROJECT LHAAP 18/24	13. SIZE AND TYPE OF BIT 2¼" DIAMETER
5. LOCATION (Coordinates or Station) LHAAP	14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —
6. DRILLING AGENCY WHE	15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT17	16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —
8. NAME OF DRILLER KERRI POWELL	17. TOTAL NUMBER CORE BOXES —
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.	18. ELEVATION GROUND WATER —
10. THICKNESS OF OVERBURDEN —	19. DATE HOLE (YYYYMMDD): a. STARTED 03/19/2021 b. COMPLETED 03/19/2021
11. DEPTH DRILLED INTO ROCK —	20. ELEVATION TOP OF HOLE (feet) —
12. TOTAL DEPTH OF HOLE 30' BGS	21. TOTAL CORE RECOVERY FOR BORING % —
	22. SIGNATURE OF INSPECTOR John Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		CLAYEY SILT W/ SAND, DARK BROWN TO LT. BROWN, SOFT, WET	4/4 %		
	2					
	3			%		
	4		~~CLAYEY SAND, LT. BROWN, FINE TO MED. DRY TO MOIST~~			
	5		SANDY CLAY, LT. BROWN TO REDDISH BROWN, STIFF, MED PLAST., DRY TO MOIST	4/4 %		
	6					
	7			%		
	8		CLAYEY SAND, LT. BROWN, COHESIVE, FINE TO MED., DRY TO MOIST	4/4 %		
	9					

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT17

SHEET 2 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	10			%		
	11			%		
	12					
	13		SAA	% 4/4		
	14			%		
	15			%		
	16					
	17		SILTY CLAY, TRACE SAND, LT. BROWN TO REDDISH BROWN, SOFT, MED. PLAST., MOIST	%		
	18			3.5/4 %		
	19					
	20		INCREASING SAND CONT.	%		
	21		SANDY CLAY, REDDISH BROWN TO ORANGE, SOFT, LOW PLAST., MOIST	%		
	22			3.5/4 %		
	23					
	24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 824DPT17

SHEET 3 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SAA			
	25		CLAYEY SAND, LT. BROWN TO GREY, COHESIVE, FINE TO COARSE, WET MED.	3.5/4 %		
	26					
	27					
	28		SAA			
	29		CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., WET	2/2 %		SET WELL @ 30' BGS, SCREEN 20'-30'
	30					SOIL SAMPLES COLLECTED @ 29' BGS
	31					
	32					
	33					
	34					
	35					
	36					
	37					
	38					
	39					

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6. PROJECT

7. HOLE NUMBER

01227581

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 3 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT18

8. NAME OF DRILLER: KERRI POWELL

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 30' BGS

13. SIZE AND TYPE OF BIT: 2 1/4" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/25/2021 b. COMPLETED 03/25/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: John Mooney

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	0–4		SILTY CLAY, ORANGISH BROWN, MED. STIFF, HIGH PLAST., WET	2/4 %		
	4–7		SAA	4/4 %		
	7–8		SANDY CLAY, LT. BROWN TO GREY, SOFT, MED. PLAST., WET	%		
	8–9			%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT18

SHEET 2 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	SAA, INCREASING SAND CONTENT	4/4 %		
		11		%		
		12	SAA	%		
		13		3.5/4 %		
		14		%		
		15	SILTY CLAY W/ TRACE SAND, MOTTLED LT. BROWN, GREY, ORANGE, STIFF, MED. PLAST., MOIST	%		
		16	SAA			
		17	SILTY SAND W/ CLAY, LT. BROWN, COHESIVE, FINE GRAIN, MOIST	%		
		18		4/4 %		
		19		%		
		20	SAA, DRY TO MOIST.	%		
		21		4/4 %		
		22		%		
		23		%		
		24		%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

01227583

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT18

SHEET 3 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SAA, MED TO COARSE, WET	%		
	26		SANDY SILT W/ CLAY, LT. BROWN TO GREY, SOFT, ~~LOW PLAST.~~ MED. PLAST., MOIST	4/4 %		
	27			%		
	28		SILTY SAND W/ CLAY, LT. BROWN TO GREY, COHESIVE, MED. TO COARSE, WET	%		WILCOX CLAY REACHED, SET WELL @ 30' BGS
	29		CLAY, LT. BROWN, STIFF, HIGH PLAST., WET	2/2 %		SAMPLE @ 29' @ 1000
	30			%		
	31			%		
	32			%		
	33			%		
	34			%		
	35			%		
	36			%		
	37			%		
	38			%		
	39			%		

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6. PROJECT

7. HOLE NUMBER

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804, the proponent agency is CECW-EG

2. DIVISION

3. INSTALLATION

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT19

8. NAME OF DRILLER: KERRI POWELL

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 44' BGS

13. SIZE AND TYPE OF BIT: 2¼" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/25/2021 b. COMPLETED 03/25/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: John Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		CLAYEY SILT W/SAND, DARK BROWN, SOFT, WET	2/4 %		
	2					
	3			%		
	4		CLAY W/ TRACE SAND, REDDISH BROWN, STIFF, MED. PLAST., MOIST	3/4 %		
	5					
	6			%		
	7		CLAYEY SAND, LT. BROWN, COHESIVE, FINES DRY TO MOIST	%		
	8					
	9			%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT19

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10–12		SAA	4/4 %		
	12–14		SAA, DRY	4/4 %		
	14–16		SANDY CLAY, LT. BROWN, STIFF, LOW PLAST., DRY	%		
	16–20		SAA, MOIST, MED PLAST.	4/4 %		
	20–22		SAA	3/4 %		
	22–24		SILTY SAND W/ CLAY, LT. BROWN TO GREY, ~~SOFT~~ FINE TO MED., MOIST TO WET, COHESIVE	4 %		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the preparing agency is OECMEG

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT19

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	6. DEPTH	7. LEGEND	8. CLASSIFICATION OF MATERIALS (Description)	9. % CORE RECOVERY	10. BOX OR SAMPLE NUMBER	11. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		CLAYEY SAND W/ SILT, LT. BROWN TO GREY, COHESIVE, MED. TO COARSE, WET	3/4 = %		
	26					
	27					
	28		SILTY SAND, ORANGISH BROWN TO GREY, MED TO COARSE, COHESIVE, WET FINE GRAIN @ BOTTOM	2/2 = %		
	29					
	30		SANDY SILT W/ CLAY, LT. BROWN TO GREY, SOFT, WET	2/2 = %		
	31					
	32		~~CLAEY~~ SAND W/SILT, LT. BROWN TO ORANGISH BROWN, MED. TO COARSE, COHESIVE, WET	2/2 = %		
	33					
	34		SAA, LT. BROWN TO GREY	2/2 = %		
	35					
	36		SAA, SOME CLAY	2/2 = %		
	37					
	38		SAA	%		
	39					

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6. PROJECT

7. HOLE NUMBER

01227587

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT19

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	40		SANDY/SILTY CLAY, MED. STIFF, MED. PLAST., WET, LT. BROWN	2/2 %		
	41		SAA, MOTTLED ORANGE, LT. BROWN, GREY	2/2 %		
	42		CLAY, STIFF, LT. BROWN TO GREY, HIGH PLAST., WET	2/2 %		WILCOX CLAY REACHED @ 42' BGS, SET WELL 34-44'. SAMPLE TAKEN 42' BGS @ 1340
	43			%		
	44			%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3 INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2¼" DIAMETER	
5. LOCATION (Coordinates or Station) LHAAP		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER (as shown on drawing title and title number) 18SHDPT20		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN a. DISTURBED — b. UNDISTURBED —	
8. NAME OF DRILLER KERRI POWELL		17. TOTAL NUMBER CORE BOXES —	
9. DIRECTION OF HOLE [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN —		19. DATE HOLE (YYYYMMDD) a. STARTED 03/25/2021 b. COMPLETED 03/25/2021	
11. DEPTH DRILLED INTO ROCK —		20. ELEVATION TOP OF HOLE (feet) —	
12. TOTAL DEPTH OF HOLE 42' BGS		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR JL Mooney	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		SILTY CLAY W/ TRACE SAND, BROWN TO ORANGE, LOOSE, WET, LOW PLAST.	1.75/4 %		
	2			%		
	3			%		
	4		CLAY, REDDISH BROWN; STIFF, HIGH PLAST., MOIST	%		
	5			4/4 %		
	6		CLAYEY SAND, LT. BROWN, BRITTLE, FINE TO MED., DRY TO MOIST.	%		
	7			%		
	8			%		
	9			%		

01227589

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE	2. HOLE NUMBER	SHEET 2 OF 4 SHEETS
	1824DPT20	

3. PROJECT	4. INSTALLATION
LHAAP 18/24	LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		10	~~SAFM~~ CLAYEY SAND, COHESIVE, MED. TO COARSE, DRY TO MOIST, COHESIVE	4/4 %		
		11	SANDY CLAY, LT. BROWN, STIFF, LOW TO MED. PLAST., DRY TO MOIST, SAND LENSES THROUGHOUT	%		
		12	CLAYEY SAND, LT. BROWN, MED. TO	%		
		13	COARSE, BRITTLE, DRY			
		14		4/4 %		
		15		%		
		16				
		17	SAA	%		
		18	SILTY CLAY, MOTTLED LT. BROWN & GREY, STIFF, MED. PLAST.,	4/4 %		
		19	MOIST	%		
		20				
		21	SANDY CLAY W/ SILT, LT. BROWN, SOFT, LOW PLAST., MOIST TO WET	%		
		22	CLAYEY SAND W/ SILT, LT. BROWN TO GREY, COHESIVE, FINE TO MED.,	3/4 %		
		23	MOIST			
		24		%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE	2. HOLE NUMBER	SHEET 3 OF 4 SHEETS
	1824DPT20	

3. PROJECT	4. INSTALLATION
LHAAP 18/24	LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	25		SAA, WET, INCREASING CLAY/SILT	3.25/4 %		
	26			%		
	27			%		
	28		SAA, MED TO COARSE	2/2 %		
	29					
	30		SILTY CLAY W/ SAND, LT. BROWN TO GREY, SOFT, MED. PLAST., WET	2/2 %		
	31					
	32		SILTY SAND W/ CLAY, LT. BROWN, MED TO COARSE, COHESIVE, WET	2/2 %		
	33					
	34		SAA, MOTTLED LT. BROWN & GREY	2/2 %		
	35					
	36		SAA, WET, FINE TO MED.	2/2 %		
	37					
	38		~~SILTY SAND~~ SAA	2/2 %		
	39					

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT20

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40	SAA	2/2		WILCOX CLAY REACHED @ 41' BGS, SET WELL 32'-42' BGS SAMPLE COLLECTED @ 41' BGS, MS/MSD COLLECTED
		41	CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., MOIST TO WET			
		42				

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

01227592

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 18ZMDPT21

8. NAME OF DRILLER: KERRI POWELL

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 40' BGS

13. SIZE AND TYPE OF BIT: 2 ¼" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 03/25/2021 b. COMPLETED 03/25/2021

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: J. Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	CLAYEY SILT, DARK BROWN, SOFT, WET	2/4 %		
		2	SILTY CLAY W/ TRACE SAND, REDDISH BROWN, STIFF, MOIST, MED. PLAST.	4 %		
		3		%		
		4	SAA			
		5	SANDY CLAY, LT. BROWN TO GREY, MED. STIFF, MED. PLAST., MOIST	4/4 %		
		6		%		
		7		%		
		8				
		9		%		

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PROJECT

HOLE NUMBER

VER 2021.1.9

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824PPT21

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	10		SAA	4/4 %		
	11		CLAYEY SAND, LT. BROWN TO ORANGE, COHESIVE, FINE TO MED., MOIST	%		
	12					
	13		SAA.	% 4/4 %		
	14					
	15		SANDY CLAY W/ SILT, MOTTLED BROWN & GREY, MED. STIFF, MED. PLAST., MOIST	%		
	16					
	17		SAA, HIGH PLAST.	%		
	18			4/4 %		
	19			%		
	20					
	21		CLAYEY SAND, LT. BROWN, COHESIVE, MED. TO COARSE, MOIST	% 4/4		
	22			%		
	23					
	24			%		

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT21

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SAA, INCREASING CLAY CONTENT	%		
		26		3.25/4 %		
		27		%		
		28				
		29	SILTY SAND, LT. BROWN, COHESIVE, FINE, WET	2/2 %		
		30				
		31	CLAYEY SILT W/ SAND, LT. BROWN, SOFT, WET	2/2 %		
		32				
		33	SILTY CLAY W/ SAND, GREY TO LT. BROWN, SOFT, ~~brown~~ PLAST., MED. WET	2/2 %		
		34				
		35	CLAYEY SILT W/ SAND, GREY TO LT. BROWN, SOFT, WET	2/2 %		
			SILTY SAND W/ CLAY, LT. BROWN, FINE TO MED. COHESIVE, WET			
		36	SANDY SILT, LT. BROWN TO GREY, SOFT, WET	%		
		37	SILTY SAND W/ CLAY, FINE, COHESIVE, WET, LT. BROWN TO ORANGE	2/2 %		
		38				
		39		%		

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6. PROJECT

7. HOLE NUMBER

01227595

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT21

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		40	CLAY, ORANGE, LT. BROWN & GREY, STIFF, HIGH PLAST., MOIST TO WET	2/2 %		WILCOX CLAY REACHED @ 38', SET WELL 30'-40', SAMPLE TAKEN 38'865 @ 1510
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227596

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2¼" DIAMETER	
5. LOCATION (Coordinates or Station) LHAAP		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
6. DRILLING AGENCY WHE		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN	a. DISTURBED — / b. UNDISTURBED —
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT22		17. TOTAL NUMBER CORE BOXES —	
		18. ELEVATION GROUND WATER —	
8. NAME OF DRILLER KERRI POWELL		19. DATE HOLE (YYYYMMDD)	a. STARTED 03/25/2021 / b. COMPLETED 03/25/2021
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		20. ELEVATION TOP OF HOLE (feet) —	
10. THICKNESS OF OVERBURDEN —		21. TOTAL CORE RECOVERY FOR BORING % —	
11. DEPTH DRILLED INTO ROCK —		22. SIGNATURE OF INSPECTOR J. Moore	
12. TOTAL DEPTH OF HOLE 40' BGS			

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SANDY SILT W/ CLAY, DARK BROWN TO LT. BROWN, SOFT, WET	1.5/4 = %		
		2				
		3	SILTY CLAY, REDDISH BROWN, MED. STIFF, MED. PLAST., WET	%		
		4	SAA	%		
		5				
		6		2/4 = %		
		7	CLAYEY SAND, LT. BROWN TO GREY, COHESIVE, FINE	%		
		8	DRY TO MOIST			
		9		3.75/4 = %		

DRILLING LOG (Continuation Sheet) For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	1. ELEVATION TOP OF HOLE	2. HOLE NUMBER 1824DPT22	SHEET 2 OF 4 SHEETS
3. PROJECT LHAAP 18/24		4. INSTALLATION LHAAP	

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	SAA, BRITTLE, DRY TO MOIST, COARSENING NEAR	%		
		11	BOTTOM	%		
		12	SAA, INCREASING CLAY CONTENT	%		
		13		4/4		
		14		%		
		15		%		
		16	SAA, LT. BROWN TO ORANGE, MED. TO COARSE, CLAY LENSES THROUGHOUT	%		
		17		4/4		
		18		%		
		19		%		
		20	SAA	%		
		21		4/4		
		22		%		
		23	SILTY, CLAY W/ SAND, LT. BROWN TO GREY, SOFT, LOW PLAST., WET	%		
		24	SAND, LITE BROWN, FINE TO			

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT22

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			MED. COHESIVE, WET			
		25	SILTY SAND W/ CLAY, LT. BROWN, FINE, COHESIVE, WET	4/4 %		
		26				
		27	SILTY CLAY, LT. BROWN, SOFT, LOW PLAST., WET, TRACE SAND	%		
		28	SILTY SAND W CLAY, LT. BROWN, MED. TO COARSE, COHESIVE, WET	2/2 %		
		29	SANDY CLAY, LT. BROWN TO GREY, SOFT, LOW PLAST., WET			
		30	SILTY SAND, LT. BROWN, FINE TO MED., COHESIVE, WET	2/2 %		
		31				
		32	SAA, MED. TO COARSE, SOME CLAY	2/2 %		
		33				
		34	SANDY CLAY, LT. BROWN, MED. STIFF, MED. PLAST., WET	2/2 %		
		35				
		36	CLAYEY SAND, LT. BROWN TO DARK BROWN, ~~COAL~~ COHESIVE, FINE, WET	2/2 %		
		37				
		38		%		
		39				

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet) For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	1. ELEVATION TOP OF HOLE	2. HOLE NUMBER 1824DPT22	SHEET 4 OF 4 SHEETS
3. PROJECT LHAAP 18/24		4. INSTALLATION LHAAP	

5 a. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40	CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., WET	2/2 %		WILCOX CLAY REACHED @ 38', SET WELL SCREEN 30'-40' BGS, SAMPLE TAKEN 38' BGS @ 1720
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227600

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804, the proponent agency is CECW-EG	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 3 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2 ¼" DIAMETER	
5. LOCATION (Coordinates or Station) LHAAP		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT23		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN	a. DISTURBED — b. UNDISTURBED —
8. NAME OF DRILLER KERRI POWELL		17. TOTAL NUMBER CORE BOXES —	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN —		19. DATE HOLE (YYYYMMDD)	a. STARTED 03/23/2021 b. COMPLETED 03/23/2021
11. DEPTH DRILLED INTO ROCK —		20. ELEVATION TOP OF HOLE (feet) —	
12. TOTAL DEPTH OF HOLE 39' BGS		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR Jh Moore	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SILTY CLAY W/ SAND, LT. BROWN, LOW PLAST., SOFT, WET	1.5 2 3 4 %		
			CLAY, REDDISH BROWN, MED. STIFF, MED. PLAST., MOIST	%		
			SAA, TRACE SAND	4/4 %		
				%		
				%		

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PROJECT

HOLE NUMBER

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT23

SHEET 2 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SAA, INCREASING SAND	%		
		10	CLAYEY SAND W/ SILT, LT. BROWN TO GREY, COHESIVE, DRY TO MOIST	4/4		
		11	SANDY CLAY OR SILT, LT. BROWN, SOFT, MED. PLAST., MOIST	%		
		12	~~CLAYEY SAND, MOTTLED~~ ~~LT. BROWN, GREY & ORANGE,~~ ~~COHESIVE, FINE GRAIN,~~ ~~MOIST~~ SAA, INCREASING SAND	%		
		13		3.5/4		
		14		%		
		15		%		
		16	SAA	%		
		17		3.5/4		
		18	CLAYEY SAND, LT. BROWN, COHESIVE, FINE GRAIN, MOIST	%		
		19		%		
		20	SAA, WET	%		
		21		4/4		
		22		%		
		23		%		
		24		%		

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT23

SHEET 3 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SAA, INCREASING GRAIN SIZE	3.5/4 %		
		26				
		27		%		
		28	SAA	2/2 %		
		29	CLAY, GREY, MED. STIFF, HIGH PLAST., WET			
		30	SANDY CLAY, LT. BROWN TO GREY, MED. STIFF, LOW PLAST., WET	1/1 %		
		31	CLAYEY SAND W SILT, LT. BROWN TO GREY, COHESIVE, ~~FINE~~, WET, FINE TO MED. GRAIN	2/2 %		
		32	SILTY CLAY, LT. BROWN TO GREY, MED. STIFF, HIGH PLAST., WET			
		33	SILTY SAND, LT. BROWN TO GREY, FINE, COHESIVE, WET	%		
		34		2/2 %		
		35	SILTY SAND W/ CLAY, LT. BROWN, COHESIVE, FINE	2/2 %		
		36				
		37	SAA, INCREASING CLAY	%		WILCOX CLAY REACHED @ 39', SET WELL, SCREEN 29'-39'
		38	CLAY, LT. BROWN & GREY, STIFF, HIGH PLAST., WET	2/2 %		
		39		%		

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6. PROJECT

7. HOLE NUMBER

01227603

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804, the proponent agency is CECW-EG	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 3 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2 1/4". DIAMETER	
5. LOCATION (Coordinates or Station) LHAAP		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) ~	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT24		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN a. DISTURBED ~ b. UNDISTURBED ~	
8. NAME OF DRILLER KERRI POWELL		17. TOTAL NUMBER CORE BOXES ~	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER ~	
10. THICKNESS OF OVERBURDEN ~		19. DATE HOLE (YYYYMMDD) a. STARTED 03/17/2021 b. COMPLETED 03/17/2021	
11. DEPTH DRILLED INTO ROCK ~		20. ELEVATION TOP OF HOLE (feet) ~	
12. TOTAL DEPTH OF HOLE 32', GROUT, NEW HOLE 29'		21. TOTAL CORE RECOVERY FOR BORING % ~	
		22. SIGNATURE OF INSPECTOR [signature]	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SILTY CLAY W/ SAND, DARK BROWN, LT. BROWN, GREY, SOFT, LOW PLAST., WET	2/4 %		
		2				
		3				
		4	CLAY, LT. BROWN TO GREY, MED. STIFF, HIGH PLAST, MOIST			
		5		3.75/4 %		
		6	SANDY CLAY, LT. BROWN, MED. STIFF, MED. PLAST., MOIST			
		7				
		8				
		9				

DRILLING LOG (Continuation Sheet) For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	1. ELEVATION TOP OF HOLE	2. HOLE NUMBER 1824DPT24	SHEET 2 OF 3 SHEETS
3. PROJECT LHAAP 18/24		4. INSTALLATION LHAAP	

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SAA	4/4 %		
	11		CLAYEY SAND, LT. BROWN TO ORANGE, COHESIVE, FINE GRAIN, MOIST			
	12			%		
	13		SAA, SANDY CLAY LENSES THROUGHOUT	4/4 %		
	14					
	15			%		
	16					
	17		SAA	2/2 %		
	18		SANDY CLAY, LT. BROWN, MED. STIFF, MED. PLAST., MOIST			
	19		SILTY CLAY W/ SAND, LT. BROWN, MED. STIFF, MED. PLAST., MOIST	2/2 %		
	20			%		
	21		SANDY CLAY, LT. BROWN, SOFT, LOW PLAST., MOIST TO WET	2/2 %		
	22		CLAYEY SAND, LT. BROWN, COHESIVE, FINE TO MED, MOIST TO WET			
	23		SILTY SAND, LT. BROWN TO GREY, ~~MOIST TO~~ WM COHESIVE, FINE TO MED., WET	2/2 %		
	24			%		

01227605

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT24

SHEET 3 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SAA, MED. TO COARSE	2/2 %		
	26		SAA, INCREASING SILT CONT.	2/2 %		
	27		CLAY, MED. STIFF, HIGH PLAST., LT. BROWN TO GREY, WET	%		
	28		SAA, STIFF, DARK GREY	2/2 %		
	29			%		
	30		SAA	2/2 %		WILCOX CLAY REACHED @ 27.5', DRILLED TOO FAR INTO CLAY, DRILL NEW HOLE & SET WELL @ 29' BGS, SCREEN 19'-29', SAMPLES TAKEN @ 27.5'
	31			%		
	32			%		
	33			%		
	34			%		
	35			%		
	36			%		
	37			%		
	39			%		

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6. PROJECT

7. HOLE NUMBER

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804, the proponent agency is CECW-EG	2. DIVISION	3 INSTALLATION LHAAP	SHEET 1 OF 3 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2¼" DIAMETER	
5. LOCATION (Coordinates or Station) LHAAP		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT25		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN a. DISTURBED — b. UNDISTURBED —	
8. NAME OF DRILLER Kerri Powell		17. TOTAL NUMBER CORE BOXES —	
9. DIRECTION OF HOLE [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN —		19. DATE HOLE (YYYYMMDD) a. STARTED 03/17/2021 b. COMPLETED 03/17/2021	
11. DEPTH DRILLED INTO ROCK —		20. ELEVATION TOP OF HOLE (feet) —	
12. TOTAL DEPTH OF HOLE 30' BGS		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR Jh Moore	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SILTY CLAY W/ SAND, DARK BROWN TO LT. BROWN, SOFT, LOW PLAST., WET	% 2/4		
		2		%		
		3		%		
		4	SANDY CLAY, LT. BROWN TO GREY, MED. STIFF, LOW PLAST., MOIST	% 4/4		
		5		%		
		6		%		
		7		%		
		8		%		
		9		%		

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PROJECT

HOLE NUMBER

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804, the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT25

SHEET 2 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	SAA	3/4 %		
		11	CLAYEY SAND, LT. BROWN TO GREY, MED TO COARSE, COHESIVE, MOIST TO WET	%		
		12				
		13	SAA	%		
		14		3/4 %		
		15	SANDY CLAY W/ SILT, LT. BROWN TO GREY, MED. STIFF, LOW PLAST., MOIST	%		
		16				
		17	SAA, INCREASING SILT CONT.	%		
		18	~~SANDY SILT,~~ SILTY CLAY W/ SAND, LT. BROWN TO GREY, SOFT, MED. PLAST., MOIST	3.75/4 %		
		19		%		
		20				
		21	SANDY SILT W/ CLAY, SOFT, WET	%		
		22		4/4 %		
		23				
		24	SILTY SAND, FINE TO MED, COHESIVE, LT. BROWN, WET	%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT25

SHEET 3 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SILTY CLAY W/ SAND, LT. BROWN TO ORANGE, SOFT, MED PLAST., WET	%		
	26			3.5/4 %		
	27		CLAYEY SAND W/ SILT, LT. BROWN TO ORANGE, FINE TO MED., WET			
	28		SILTY CLAY, MED. STIFF, HIGH PLAST., MOIST	%		SET WELL @ 30' BGS, SCREEN 20'-30'
	29		CLAY, STIFF, HIGH PLAST, LT. BROWN, TO GREY, MOIST	2/2 %		TAKE SOIL SAMPLE @ ~ 28' BGS
	30			%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227609

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS

4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2 ¼" DIAMETER	
5. LOCATION (Coordinates or Station) KARNACK, TX		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT26		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN	a. DISTURBED —
8. NAME OF DRILLER KERRI POWELL			b. UNDISTURBED —
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		17. TOTAL NUMBER CORE BOXES —	
10. THICKNESS OF OVERBURDEN —		18. ELEVATION GROUND WATER —	
11. DEPTH DRILLED INTO ROCK —		19. DATE HOLE (YYYYMMDD)	a. STARTED 06/11/2021
12. TOTAL DEPTH OF HOLE 40' BGS			b. COMPLETED 06/11/2021
		20. ELEVATION TOP OF HOLE (feet) —	
		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR J. Mowrer	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		SILTY CLAY W/ SAND, DARK BROWN, MED. STIFF, LOW PLAST., WET	2/4 %		
	2					
	3					
	4					
	5		SANDY CLAY, LT. BROWN TO GREY, ~~FAIR~~ STIFF, LOW PLAST., DRY TO MOIST	3.5/4 %		
	6					
	7					
	8					
	9					

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PROJECT

HOLE NUMBER

VERSION 1.3

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 18ZYDAT26

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	10		SAA	2.75/4 %		
	11		CLAYEY SAND, LT. BROWN TO GREY, FINE GRAIN, COHESIVE, MOIST	%		
	12			%		
	13		SAA, INCREASING GRAIN SIZE	3.75/4 %		
	14			%		
	15			%		
	16			%		
	17		SANDY CLAY, LT. BROWN TO ORANGE, MED. STIFF, LOW PLAST., MOIST	1.5/4 %		
	18			%		
	19			%		
	20			%		SWITCH TO 2' RUNS, SLEEVE GETTING STUCK IN BARREL
	21		SAA	1.75/2 %		
	22		CLAYEY SAND, LT. BROWN TO GREY, MED. TO COARSE, WET	%		
	23		SAA	1.75/2 %		
	24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT26

SHEET 3 OF 4 SHEETS

PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SANDY CLAY, LT. BROWN, MED. STIFF, LOW PLAST., WET	1.5/2 %		
	26			%		
	27		CLAY, LT. BROWN, STIFF, HIGH PLAST., MOIST	2/2 %		
	28					
	29		SAA, LT. BROWN TO GREY	2/2 %		
	30		~~SANDY~~ CLAY, LT. BROWN TO GREY,	%		
	31		MED. STIFF, MED TO HIGH PLAST., MOIST, TRACE SAND	2/2 %		
	32		CLAYEY SAND, LT. BROWN TO ORANGE,			
	33		MED. GRAIN, COHESIVE, WET	2/2 %		
	34		SAA, MED TO	%		
	35		COARSE, SILTY, GREY NEAR 35.5'	2/2		
	36		SILTY CLAY W/ TRACE SAND, GREY, SOFT, MED. PLAST., WET	%		
	37		SILT, GREY, SOFT, LOW PLAST, WET	2/2 %		
	38					
	39			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT26

SHEET 4 OF 4 SHEETS

PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
			CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., MOIST TO WET	2/2 %		SET WELL 30'-40' BGS
	40			%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

01227613

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 3 SHEETS

4. PROJECT LHAAP 18/24	13. SIZE AND TYPE OF BIT 2¼" DIAMETER
5. LOCATION *(Coordinates or Station)* KARNACK, TX	14. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* —
6. DRILLING AGENCY WHE	15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822 DT
7. HOLE NUMBER *(as shown on drawing title and title number)* 1824DPT27	16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — ; b. UNDISTURBED —
8. NAME OF DRILLER KERRI POWELL	17. TOTAL NUMBER CORE BOXES —
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.	18. ELEVATION GROUND WATER —
10. THICKNESS OF OVERBURDEN —	19. DATE HOLE *(YYYYMMDD)*: a. STARTED 06/11/21 ; b. COMPLETED
11. DEPTH DRILLED INTO ROCK —	20. ELEVATION TOP OF HOLE *(feet)* —
12. TOTAL DEPTH OF HOLE 38' BGS	21. TOTAL CORE RECOVERY FOR BORING % —
	22. SIGNATURE OF INSPECTOR

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		1	CLAYEY SILT, DARK BROWN TO LT. BROWN, SOFT, LOW PLAST, WET	2/4 %		
		2				
		3		%		
		4	SILTY CLAY, LT. BROWN TO REDDISH BROWN, SOFT, MED. PLAST., WET			
		5		%		
		6	SANDY CLAY, LT. BROWN, STIFF, MED. PLAST., MOIST	2.5/4 %		
		7				
		8		%		
		9		%		

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PROJECT | HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT27

SHEET 2 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	SAA	4/4 %		
		11	CLAYEY SAND, LT. BROWN TO GREY, MED GRAIN, COHESIVE	%		
		12	SAND, ORANGISH BRWN. TO GREY, LOOSE, FINE TO MED, DRY TO MOIST	%		
		13	SANDY CLAY, DARK BRWN. TO ORANGISH BRWN., STIFF, LOW PLAST., DRY TO MOIST	4/4 %		
		14		%		
		15	CLAYEY SAND, ORANGISH BRWN., FINE TO MED., COHESIVE, MOIST	%		
		16	SAA, MOTTLED LT. BRWN., GREY, ORANGISH BRWN.,	%		
		17		4/4 %		
		18		%		
		19		%		
		20	CLAYEY SAND, DARK BROWN TO ORANGISH BROWN, MED TO COARSE, WET, SILTY @ BOTOM	3.5 %		
		21		4/4 %		
		22		%		
		23		%		
		24				

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT27

SHEET 3 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		25	SILTY CLAY W/ SAND, GRAYISH BROWN, SOFT, LOW TO MED. PLAST., WET	%		
		26	SILTY SAND, MED TO COARSE, LT. BROWN, COHESIVE, WET	4/4 %		
		27	~~SILTY CLAY, SOFT, LT.~~ & SM	%		
		28	SAA, FINE, SOME CLAY	2/2 %		
		29				
		30	SAA, MED. TO COARSE	%		
		31		2/2 %		
		32	SAA	%		
		33		2/2 %		
		34	SAA	%		
		35	SANDY CLAY W/ SILT, LT. BROWN, SOFT, LOW PLAST., WET	2/2 %		
		36	CLAY, GREY, MED. STIFF, HIGH PLAST., MOIST TO WET	%		SET WELL 28'-30' BGS
		37		%		
		38				
		39		%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

01227616

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804, the proponent agency is CECW-EG	2. DIVISION —	3 INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS

4. PROJECT LHAAP 18/24	13. SIZE AND TYPE OF BIT 2 1/4" DIAMETER
5. LOCATION (Coordinates or Station) LHAAP	14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —
6. DRILLING AGENCY WHE	15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT28	16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — ; b. UNDISTURBED ~
8. NAME OF DRILLER KERRI POWELL	17. TOTAL NUMBER CORE BOXES ~
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.	18. ELEVATION GROUND WATER —
10. THICKNESS OF OVERBURDEN ~	19. DATE HOLE (YYYYMMDD): a. STARTED 06/11/21 ; b. COMPLETED 06/11/2021
11. DEPTH DRILLED INTO ROCK —	20. ELEVATION TOP OF HOLE (feet) ~
12. TOTAL DEPTH OF HOLE 42' BGS	21. TOTAL CORE RECOVERY FOR BORING % ~
	22. SIGNATURE OF INSPECTOR

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		SILTY CLAY, DARK BRWN. TO REDDISH BRWN., SOFT, LOW PLAST., WET	2/4 %		
	2					
	3			%		
	4		CLAY W/ TRACE SAND, MED. STIFF, HIGH PLAST., MOIST, LT. BRWN TO GREY	4/4 %		
	5			%		
	6			%		
	7					
	8			%		
	9			%		

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VER 2.00 [1]

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE —

2. HOLE NUMBER 1824DPT28

SHEET 2 OF 4 SHEETS

3. PROJECT LHAAP 18/24

4. INSTALLATION LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	SAA, STIFF	4/4 %		
		11		%		
		12				
		13	SAA, SAND LENSES THROUGHOUT	% 4/4		
		14		%		
		15		%		
		16				
		17	SAA, MOTTLED REDDISH BRWN., LT. BRWN. & GREY, INCREASING SAND	% 4/4		
		18		%		
		19		%		
		20				
		21	SAA	% 3.5/4		
		22		%		
		23	CLAYEY SAND, LT. BROWN TO GREY, MED. GRAIN, COHESIVE, MOIST	%		
		24				

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT28

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SILTY SAND, LT. BROWN TO GREY, MED. TO COARSE, COHESIVE, WET	4/4 %		
	26					
	27					
	28			%		
	29		CLAY, STIFF, LT. BROWN TO GREY, HIGH PLAST., MOIST	2/2 %		
	30			%		
	31		SAA	2/2 %		
	32					
	33		SAA, GREY	2/2 %		
	34					
	35		SAA LT. BROWN TO GREY	2/2 %		
	36			%		
	37		SAA, LT. BROWN, REDDISH BROWN & GREY	2/2 %		
	38					
	39			%		

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT28

SHEET 4 OF 4 SHEETS

PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40	SAA, DARK BRWN. TO GREY	2/2 %		
		41	CLAYEY SILT W/ SAND, LT. BROWN, SOFT, LOW PLAST., MOIST TO WET	2/2 %		SET WELL 32'-42' BGS
		42	CLAY, DARK BROWN TO GREY, STIFF, HIGH PLAST, MOIST			
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227620

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2 1/4" DIAMETER	
5. LOCATION (Coordinates or Station) KARNACK, TX		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT29		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN — a. DISTURBED — b. UNDISTURBED —	
8. NAME OF DRILLER KERRI POWELL		17. TOTAL NUMBER CORE BOXES —	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN —		19. DATE HOLE (YYYYMMDD) a. STARTED 06/10/21 b. COMPLETED 06/10/21	
11. DEPTH DRILLED INTO ROCK —		20. ELEVATION TOP OF HOLE (feet) —	
12. TOTAL DEPTH OF HOLE		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SANDY CLAY, REDDISH BRWN. TO DARK BROWN, MED. STIFF, MED. PLAST., DRY TO MOIST	2.75 %		
		2		4 %		
		3		%		
		4	SILTY CLAY W/ SAND, MOTTLED LT. BROWN, RED, GREY, SOFT, MED. PLAST., MOIST	2.75 %		
		5		4 %		
		6				
		7		%		
		8				
		9		%		

ENG FORM 1836, MAR 1971 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent) PROJECT HOLE NUMBER

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT29

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	10		SANDY CLAY, MED. STIFF, LOW PLAST., LT. BROWN TO GREY, MOIST	4/4 %		
	11		CLAYEY SAND, LT BROWN TO GREY, MED., COHESIVE, MOIST	%		
	12					
	13		SAA	3.75/4 %		
	14			%		
	15			%		
	16					
	17		SAA	2.75/4 %		
	18		SANDY CLAY W/ SILT, LT. BROWN, MED. STIFF, ~~LOW PLAST~~ MED. PLAST., WET	%		
	19			%		
	20					
	21		SAA	2.5/4 %		
	22		CLAYEY SAND, MOTTLED ORANGE & GREY, MED TO COARSE, COHESIVE, MOIST	%		
	23			%		
	24					

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE
2. HOLE NUMBER: 1824DPT29
SHEET 3 OF 4 SHEETS
3. PROJECT: LHAAP 18/24
4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SAA	4/4 %		
		26				
		27		%		
		28	CLAY, MOTLED ORANGE & GREY, MED STIFF, HIGH PLAST., MOIST			
		29	SILTY SAND, LT. BROWN TO GREY, MED. TO COARSE, WET, COHESIVE	2/2 %		SET 1824DPT29A SCREEN 20'-30' BGS
		30	SILTY CLAY, LT. BROWN, SOFT, MED. PLAST., MOIST			
		31	CLAYEY SILT, LT. BROWN, SOFT, LOW PLAST., WET	2/2 %		
		32		%		
		33	SILTY CLAY, LT. BROWN TO ORANGE, SOFT, MED. PLAST, MOIST	2/2 %		
		34				
		35	SAA, SOME SAND, WET	2/2 %		
		36	CLAYEY SAND, LT. BROWN & GREY, FINE TO MED. COHESIVE, MOIST	%		
		37	SILTY SAND W/ CLAY, LT. BROWN TO GREY, FINE, COHESIVE, WET	2/2 %		
		38				
		39	SAA	2/2 %		

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6. PROJECT
7. HOLE NUMBER
VERSION 1.0

01227623

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT29

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40		%		
		41	CLAY W/ TRACE SAND, LT. BROWN TO ORANGE, STIFF, HIGH PLAST., WET	2/2		
		42	CLAYEY SAND, MED. TO COARSE, LT. BROWN, WET	%		
		43	CLAY, LT. BROWN TO ORANGE, STIFF, HIGH PLAST., MOIST	2/2		SET 1824DPT29 SCREEN 34'-44' BGS
		44		%		

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6. PROJECT

7. HOLE NUMBER

01227624

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804, the proponent agency is CECW-EG	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2¼" DIAMETER	
5. LOCATION (Coordinates or Station) KARNACK, TX		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT30		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN a. DISTURBED — b. UNDISTURBED —	
8. NAME OF DRILLER KERRI POWELL		17. TOTAL NUMBER CORE BOXES —	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN —		19. DATE HOLE (YYYYMMDD) a. STARTED 06/10/21 b. COMPLETED 06/10/21	
11. DEPTH DRILLED INTO ROCK —		20. ELEVATION TOP OF HOLE (feet) —	
12. TOTAL DEPTH OF HOLE		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR John Mann	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		CLAYEY SILT, DARK BRWN. TO LT. BRWN., SOFT, LOW PLAST., WET	1.5/4 %		
	2					
	3					
	4		SANDY CLAY W/ SILT, RED TO LT. BRWN., STIFF, MED. PLAST., WET			
	5					
	6			3/4 %		
	7					
	8					
	9					

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT30

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SAA, LT. BROWN. SAND LENSE @ ~ 10' BGS	4/4 %		
	12			%		
	13		SAA, SAND LENSE ~15' BGS	4/4 %		
	15			%		
	16		CLAYEY SAND, LT. BROWN TO ORANGE, FINE TO MED. ~~COHES~~ BRITTLE, DRY	4/4 %		
	18		SANDY CLAY, LT. BROWN TO ORANGE, SOFT, LOW PLAST., MOIST	%		
	20		CLAYEY SAND, LT. BROWN TO ORANGE, MED. TO COARSE, COHESIVE, WET	4/4 %		
	22			%		
	24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT30

SHEET 3 OF 4 SHEETS

PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SAA	4/4 %		
		26	SANDY CLAY W/ SILT, LT. BRWN. TO LT. GREY, MED STIFF, MED PLAST., WET			
		27		%		
		28	CLAYEY SAND, FINE TO MED., LT. BROWN, COHESIVE, WET	2/2 %		
		29				
			~~SANDY CLAY, LT. BROWN, MED. STIFF, MED. PLAST., WET~~			
		30	SILTY CLAY, LT. BROWN, SOFT, HIGH PLAST., MOIST TO WET	2/2 %		
		31		%		
		32	CLAYEY SILT, LT. BROWN, SOFT, LOW PLAST., WET	2/2 %		
		33				
		34	SAA, LT. BROWN TO GREY, WITH SAND	2/2 %		
		35				
		36	~~SAA~~	%		
		37	~~SILTY CLAY, MOTTLED GREY, ORANGE & BROWN, SOFT, MED PLAST., MOIST~~	2/2 %		CLAY, MOTTLED GREY, LT. BROWN, ORANGE, MED. STIFF, HIGH PLAST., MOIST
		38		%		
		39				

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT30

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40	~~SILTY~~ SAA CLAYEY SAND, LT. BROWN, MED. TO COARSE, WET	2/2 %		
		41	SAA	2/2 %		
		42				
		43	SAA	2/2 %		
		44		%		
		45	SAA	2/2 %		DRILLED TOO FAR, PULL OUT OF HOLE & MOVE 3' TO SET WELL 28'-38' BGS
		46		%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227628

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2¼" DIAMETER	
5. LOCATION (Coordinates or Station) KARNACK, TX		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT31		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN a. DISTURBED — b. UNDISTURBED —	
8. NAME OF DRILLER KERRI POWELL		17. TOTAL NUMBER CORE BOXES —	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN —		19. DATE HOLE (YYYYMMDD) a. STARTED 06/10/21 b. COMPLETED 06/10/21	
11. DEPTH DRILLED INTO ROCK —		20. ELEVATION TOP OF HOLE (feet) —	
12. TOTAL DEPTH OF HOLE 40'		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR [signature]	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		SILTY CLAY, DARK BROWN TO GREY, STIFF, MED TO HIGH PLAST, MOIST TO WET	1.5/4 %		
	2			%		
	3			%		
	4		SILTY SAND W/ CLAY, BRITTLE, DARK BROWN TO GREY, FINE TO MED., DRY	2.75/4 %		
	5			%		
	6			%		
	7			%		
	8		SAA	%		
	9			%		

DRILLING LOG (Continuation Sheet) For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	1. ELEVATION TOP OF HOLE	2. HOLE NUMBER 1824DPT31	SHEET 2 OF 4 SHEETS
3. PROJECT LHAAP 18/24		4. INSTALLATION LHAAP	

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		CLAYEY SILT W/ SAND, BROWN TO LT. GREY, LOOSE, LOW PLAST., DRY	3.25/4 %		
	11			%		
	12		CLAYEY SAND, LT. BROWN, FINE, COHESIVE, MOIST			
	13		SILTY SAND, MOTLED BRWN. & ORANGE, FINE, COHESIVE, MOIST	%		
	14		CLAYEY SAND, LT. BROWN TO GREY, FINE, COHESIVE, MOIST	3/4 %		
	15			%		
	16					
	17		CLAYEY SAND W/ SILT, MOTLED ORANGE, GREY, LT. BROWN, FINE TO MED, COHESIVE, MOIST	% 3.25/4 %		
	18					
	19		SANDY SILT W/ CLAY, LT. BROWN TO GREY, LOW PLAST., MOIST	%		
	20		CLAYEY SAND, LT. BROWN, MED TO COARSE, COHESIVE, WET			
	21			3.25/4 %		
	22			%		
	23		SILT, LT. BROWN TO ORANGE, SOFT, LOW PLAST, WET			
	24			%		

ENG FORM 1836A, JUN 1967	PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)	6. PROJECT	7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT31

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAA

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SAA			
	25		CLAYEY SAND W/ SILT, LT. BROWN, MED., COHESIVE, WET	%		
	26			3/4		
			SANDY CLAY, W/ SILT, MED. STIFF, MED. PLAST., ORANGE TO LT. BROWN, MOIST TO WET	%		
	27					
	28			%		
			SILTY CLAY, LT. BROWN TO GREY, SOFT, MED TO HIGH PLAST.	2/2 %		
	29					
	30					
			CLAYEY SILT W/ SAND, LT. BROWN, SOFT, MED. PLAST., WET	%		
	31			2/2		
			SANDY CLAY, LT BROWN TO GREY, FINE, LOW PLAST, MOIST TO WET	%		
	32					
			CLAYEY SAND, LT. BROWN TO ORANGE, MED TO COARSE, COHESIVE, WET	2/2 %		
	33					
	34					
			SANDY SILT, LT. BROWN, SOFT, WET, LOW PLAST.	%		
	35			2/2		
	36			%		
			SAA			
	37			2/2 %		
			SILTY CLAY, LT. BROWN, SOFT, WET, ~~HIGH~~ MED PLAST			
	38					
	39			%		

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6. PROJECT

7. HOLE NUMBER

01227631

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT31

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40	CLAY, LT. BROWN TO GREY, MED. STIFF, HIGH PLAST., WET	%		SET WELL 30'-40' BGS
		41		%		
		42		%		
		43		%		
		44		%		
		45		%		BORING LOCATION @ LOW ELEVATION, SURFACE WATER MAY ENTER BORING
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

01227632

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2 1/4" DIAMETER	
5. LOCATION *(Coordinates or Station)* LHAAP		14. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER *(as shown on drawing title and title number)* 1824DPT32		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN a. DISTURBED — b. UNDISTURBED —	
8. NAME OF DRILLER KERRI POWELL		17. TOTAL NUMBER CORE BOXES —	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN —		19. DATE HOLE *(YYYYMMDD)* a. STARTED 06/08/21 b. COMPLETED 06/08/21	
11. DEPTH DRILLED INTO ROCK —		20. ELEVATION TOP OF HOLE *(feet)* —	
12. TOTAL DEPTH OF HOLE 42' BGS		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	1		CLAYEY SILT, DARK BROWN, LOW PLAST., WET	%		
	2		SILTY CLAY, LT. BROWN, SOFT, LOW TO MED. PLAST., WET.	2/4 %		
	3			%		
	4		SILTY CLAY W/ TRACE SAND, REDDISH BROWN TO LT. BROWN, STIFF, MED. TO HIGH PLAST., MOIST	%		
	5			3/4 %		
	6			%		
	7			%		
	8		SAA, MED. STIFF	4/4 %		
	9			%		

ENG FORM 1836, MAR 1971 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent) PROJECT HOLE NUMBER

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1604; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT32

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	10			%		
	11			%		
	12					
	13		SAA, INCREASING SAND, LT. BROWN TO GREY	%		
	14			4/4 %		
	15					
	16					
	17		SAA	%		
	18			4 %		
	19		SILTY SAND W/ CLAY, LT. BROWN TO ORANGE, FINE TO MED, COHESIVE, MOIST			
	20					
	21		SAA, MED. TO COARSE, MOTTLED LT. BROWN, ORANGE & GREY	%		
	22			4/4 %		
	23					
	24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT32

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SAA, MOIST TO WET, LT. BROWN TO ORANGE	3,5/4 %		
		26				
		27		%		
		28				SWITCH TO 2' RUNS
		29	SAA, INCREASING CLAY	2/2 %		
		30				
		31	SANDY CLAY W/ SILT, SOFT, MED. PLAST., WET, LT. BROWN TO GREY	2/2 %		
		32				
		33	SANDY SILT W/ CLAY, LT. BROWN, LOW PLAST., SOFT, WET	2/2 %		
		34				
		35	SILTY SAND, LT. BROWN, ~~MED. GRAIN,~~ COHESIVE, WET MED. TO COARSE	2/2 %		
		36				
		37	SILTY CLAY W/ SAND, MED. PLAST., LT. BROWN TO ORANGE, WET, SOFT	2/2 %		
		38				
		39	CLAYEY SAND W/ SILT, LT. BROWN, MED. TO FINE, COHESIVE, WET	2/2 %		

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT32

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40	SAA	2/2		CLAY REACHED @ 41' BGS, SET WELL SCREEN 32'-42' BGS
		41	CLAY, LT. BROWN TO ORANGE, HIGH PLAST., STIFF, MOIST			
		42				
		43				
		44				
		45				

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

01227636

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS

4. PROJECT LHAAP 18/24	13. SIZE AND TYPE OF BIT 2 1/4" DIAMETER
5. LOCATION (Coordinates or Station) KARNACK, TX	14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —
6. DRILLING AGENCY WHE	15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT33	16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —
8. NAME OF DRILLER KERRI POWELL	17. TOTAL NUMBER CORE BOXES —
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.	18. ELEVATION GROUND WATER —
10. THICKNESS OF OVERBURDEN —	19. DATE HOLE (YYYYMMDD): a. STARTED 06/09/21 b. COMPLETED 06/09/21
11. DEPTH DRILLED INTO ROCK —	20. ELEVATION TOP OF HOLE (feet) —
12. TOTAL DEPTH OF HOLE 42' BGS	21. TOTAL CORE RECOVERY FOR BORING % —
	22. SIGNATURE OF INSPECTOR

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		SANDY SILT W/ CLAY, DARK BROWN, SOFT, WET, LOW PLAST.	1.75/4 %		
	2					
	3		CLAY, RED, STIFF, HIGH PLAST., MOIST	%		
	4		SANDY CLAY, MOTTLED LT. BROWN, RED, GREY, STIFF, MED. PLAST., DRY TO MOIST	%		
	5			3/4 %		
	6		SILTY CLAY W/ SAND, LT. BROWN TO GREY, SOFT, MED. PLAST., ~~W~~ M MOIST	%		
	7					
	8			%		
	9			%		

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT33

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SANDY CLAY, MOTTLED REDDISH BRWN. & GREY, MED STIFF, MED. PLAST., MOIST	3.75/4 %		
	11		SILTY SAND W/ CLAY, ORANGISH BRWN. TO GREY, COHESIVE, FINE, MOIST	%		
	12					
	13		SANDY CLAY, MOTTLED LT. BRWN., ORANGE, GREY, MED STIFF, MED. PLAST., MOIST	%		
	14			4/4 %		
	15			%		
	16					
	17		SAA, SAND LENSES THROUGHOUT	% 4/4		
	18			%		
	19			%		
	20					
	21		SAA	4/4 %		
	22		CLAYEY SAND, MOTTLED LT. BRWN., ORANGE & GREY, MED. TO COARSE, COHESIVE, WET	%		
	23			%		
	24					

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT33

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SANDY SILT, LT. BROWN, SOFT, LOW PLAST., WET	4/4 %		
	26					
	27		SILTY SAND W/ CLAY, LT. BROWN TO GREY, MED. TO COARSE, COHESIVE, WET	%		
	28		SILTY CLAY W/ SAND			
	29		SANDY SILT W/ CLAY, LT. BROWN TO GREY, SOFT, LOW PLAST., WET	2/2 %		
	30					
	31		SAA, SAND LENSE @ ~ 31'	2/2 %		
	32					
	33		SILTY SAND, LT. BROWN, MED TO COARSE, COHESIVE, WET	2/2 %		
	34					
	35		SANDY SILT, LT. BROWN TO GREY, SOFT, WET, LOW PLAST.	2/2 %		
	36		SILTY SAND, LT. BROWN TO GREY, MED. TO COARSE, COHESIVE, WET	%		
	37		SAA, INCREASING SILT	2/2 %		
	38					
	39			%		

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT33

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
			SAA	2/2 %		
	40		CLAYEY SILT, DARK BROWN, SOFT, WET, LOW PLAST.,			
	41		CLAY, BROWN, STIFF, HIGH PLAST., MOIST	2/2 %		SET WELL 32'-42' BGS
	42			%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

ENG FORM 1836A, JUN 1987 PREVIOUS EDITIONS ARE OBSOLETE. *(Translucent)*

6. PROJECT

7. HOLE NUMBER

01227640

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): KARNACK, TX

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT34

8. NAME OF DRILLER: KERRI POWELL

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 42' BGS

13. SIZE AND TYPE OF BIT: 2 1/4" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL): —

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 06/08/21; b. COMPLETED 06/08/21

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: John Mowinn

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		SILTY CLAY W/SAND, DARK BROWN, MED. PLAST, MED. STIFF, WET	2/4 %		
	2		CLAYEY SILT W/ SAND, LT. BROWN, SOFT, LOW PLAST., WET	%		
	3			%		
	4		SAA	%		
	5		CLAY, MOTLED REDDISH BROWN & GREY, STIFF, HIGH PLAST., MOIST	2/4 %		
	6			%		
	7			%		
	8			%		
	9			%		

ENG FORM 1836, MAR 1971 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent) PROJECT HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT34

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SAA, TRACE SAND	3/4 %		
	11			%		
	12		SAND LENSE, FINE TO MED, GREY, DRY	%		
	13		CLAY W/ TRACE SAND, MOTTLED ORANGE, BROWN, DARK GREY, MED. STIFF, HIGH PLAST., MOIST	4/4 %		
	14			%		
	15			%		
	16		SANDY CLAY, MOTTLED ORANGE, BROWN, GREY, STIFF, MED. PLAST., MOIST	%		
	17			4/4 %		
	18			%		
	19			%		
	20		SAA, INCREASING SAND	%		
	21			%		
	22		CLAYEY SAND, LT. BROWN TO ORANGE, FINE, COHESIVE, MOIST	3/4 %		
	23			%		
	24			%		

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DT34

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SAA	4/4 %		
		26	SILT W/ TRACE SAND, LT. BROWN, LOW PLAST., SOFT, WET	%		
		27		%		
		28				
		29	SILTY SAND, LT. BROWN TO ORANGE, MED. TO COARSE GRAIN, WET	2/2 %		
		30				
		31	SANDY CLAY, MOTTLED LT. BROWN & GREY, MED. STIFF, MED. PLAST., MOIST TO WET	2/2 %		
		32				
		33	CLAYEY SILT W/ TRACE SAND, SOFT, MED TO HIGH PLAST, LT. BROWN, MOIST	2/2 %		
		34				
		35	SILTY SAND, LT. BROWN TO GREY, MED. GRAIN, COHESIVE, WET	2/2 %		
		36				
		37	SILTY CLAY W/ SAND, LT. BROWN TO GREY, MED. STIFF, MED. PLAST., WET	2/2 %		
		38				
		39		%		

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT34

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	6. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40	SILTY SAND, LT. BROWN, MED. TO COARSE, COHESIVE, WET	2/2 %		
			SAA			
		41		2/2 %		SET WELL 32'-42' BGS
		42	CLAY, LT. BROWN, STIFF, HIGH PLAST., WET			
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227644

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2 1/4" DIAMETER	
5. LOCATION (Coordinates or Station) LHAAP		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT35		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN a. DISTURBED — b. UNDISTURBED —	
8. NAME OF DRILLER KERRI POWELL		17. TOTAL NUMBER CORE BOXES —	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN ~		19. DATE HOLE (YYYYMMDD) a. STARTED 06/08/21 b. COMPLETED 06/08/21	
11. DEPTH DRILLED INTO ROCK —		20. ELEVATION TOP OF HOLE (feet) —	
12. TOTAL DEPTH OF HOLE 42' BGS		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR John Moore	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SANDY SILT, DARK BROWN, SOFT, WET	2/4 %		
		2	SANDY CLAY, DARK BROWN TO DARK GREY, STIFF, HIGH PLAST., MOIST	%		
		3		%		
		4	SAA			
		5	CLAYEY SAND, LT. BROWN, COHESIVE, FINE, DRY TO MOIST	%		
		6		3/4 %		
		7		%		
		8				
		9		%		

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT35

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10–11		SANDY CLAY, MOTTLED, LT. BROWN, GREY, ORANGE, STIFF, LOW PLAST., MOIST	3.75/4 %		
	12–13		SAA	2.75/4 %		
	14–15		CLAY W/ TRACE SAND, LT. BROWN TO ORANGE, MED. STIFF, HIGH PLAST., MOIST	%		
	16–18		CLAYEY SAND, LT. BROWN, COHESIVE, FINE TO MED., MOIST	2.5/4 %		
	19			%		
	20–22		SILTY SAND W/ CLAY, LT. BROWN TO GREY, COHESIVE, SOFT, WET	4/4 %		
	23–24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Corps of Engineers Specification) — 1. ELEVATION TOP OF HOLE — 2. HOLE NUMBER: 1824DPT35 — SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24 — 4. INSTALLATION: LHAAP

5. ELEVATION	6. DEPTH	7. LEGEND	8. CLASSIFICATION OF MATERIALS (Description)	9. % CORE RECOVERY	10. BOX OR SAMPLE NUMBER	11. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	CLAYEY SILT W/ SAND, ORANGE TO GREY, SOFT, LOW PLAST, MOIST TO WET	4/4 %		
		26				
		27		%		
		28	SILT CLAY, LT. BROWN TO ORANGE, MED. STIFF, HIGH PLAST, MOIST	2/2 %		
		29				
		30	SAA	2/2 %		
		31				
		32	SAA	2/2 %		
		33				
		34	SAA	2/2 %		
		35				
		36	~~STIFF CLAY~~ INCREASING SILT CLAYEY SILT W/ TRACE SAND, LT. BROWN TO GREY, SOFT, MOIST, MED PLAST.	2/2 %		
		37				
		38		%		
		39				

ENG FORM 1836A, JUN 1967 — PREVIOUS EDITIONS ARE OBSOLETE. (Translucent) — 6. PROJECT — 7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT35

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40	SAA	2/2 %		
		41	CLAY, LT. BROWN TO GREY, MED. STIFF, HIGH PLAST., MOIST	2/2 %		
		42		%		
		43		%		
		44		%		
		45		%		
		46		%		
		47		%		
		48		%		
		49		%		
		50		%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227648

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 3 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): LHAAP

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): 1824DPT36

8. NAME OF DRILLER: KERRY POWELL

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 36' BGS

13. SIZE AND TYPE OF BIT: 2 ¼" DIAMETER

14. DATUM FOR ELEVATION SHOWN (TBM or MSL):

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 7822DT

16. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 06/08/21 b. COMPLETED 06/08/21

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: John Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		CLAYEY SILT W/ SAND, DARK BROWN, LOOSE, WET	2.5/4 %		
	2		SANDY CLAY, MOTTLED RED, LT. BROWN, ORANGE, MED. STIFF, HIGH PLAST., MOIST	%		
	3					
	4			%		
	5		SAA	4/4 %		
	6					
	7			%		
			SLAYEY SAND, LT. BROWN TO ORANGE SOFT, LOW PLAST., MOIST			
	8			%		
	9			%		

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1604; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER ~~LHAAP~~ 1824DPT36

SHEET 2 OF 3 SHEETS

3. PROJECT LHAAP 18/24

4. INSTALLATION LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SILTY CLAY W/ SAND, MED. STIFF, MOTTLED LT. BROWN, GREY, ORANGE, MED. STIFF TO SOFT, LOW PLAST., MOIST	4/4 %		
	12		SILTY SAND W/ CLAY, MOTTLED LT. BROWN, GREY, ORANGE, MED. STIFF, ~~LOW~~ ~~PLAST.~~, COHESIVE, FINE TO MED. MOIST	~~4~~ % 3.75/4 %		
	16		CLAYEY SAND, LT. BROWN TO ORANGISH BROWN, MED. TO COARSE, COHESIVE, MOIST TO WET	4/4 %		
	20		SANDY SILT, LT. BROWN TO GREY, SOFT, LOW PLAST., MOIST TO WET	3.75/4 %		
	24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT36

SHEET 3 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SAA, TRACE CLAY	4/4 %		
		26				
		27				
		28	SANDY SILT W/ CLAY, LT. BROWN TO GREY, SOFT, LOW PLAST., FINE GRAIN, WET	2/2 %		
		29				
		30	SAA, INCREASING CLAY	2/2 %		
		31				
		32	SAA	2/2 %		
		33				
		34	CLAY, LT. BROWN TO GREY, MED. STIFF, HIGH PLAST, MOIST	2/2 %		SET WELL SCREEN 26'-36' BGS
		35				
		36		%		

ENG FORM 1836A, JUN 1987 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

01227651

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP		13. SIZE AND TYPE OF BIT 2 ¼" DIAMETER	
5. LOCATION (Coordinates or Station) KARNACK, TX		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT37		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN a. DISTURBED — b. UNDISTURBED —	
8. NAME OF DRILLER KERRI POWELL		17. TOTAL NUMBER CORE BOXES —	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN —		19. DATE HOLE (YYYYMMDD) a. STARTED 06/10/21 b. COMPLETED 6/10/21	
11. DEPTH DRILLED INTO ROCK —		20. ELEVATION TOP OF HOLE (feet) —	
12. TOTAL DEPTH OF HOLE 44' BGS		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR [signature]	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	0					
	1		SILTY CLAY, REDDISH BRWN. TO DARK BRWN, SOFT, LOW PLAST., WET	2/4		
	2					
	3					
	4		CLAY, REDDISH BRWN., STIFF, HIGH PLAST., MOIST.	2.25/4		
	5					
	6					
	7					
	8					
	9					

ENG FORM 1836, MAR 1974 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent) PROJECT HOLE NUMBER

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE	2. HOLE NUMBER	SHEET 2 OF 4 SHEETS
	1824DPT37	

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		SAA W/ SAND	4/4 %		
	11			%		
	12					
	13		SAA	%		
	14			4/4 %		
	15		CLAYEY SAND, BROWN TO ORANGE MED TO COARSE, COHESIVE, MOIST	%		
	16					
	17		SAA	3.5/4 %		
	18			%		
	19			%		
	20					
	21		SAA	%		
	22		SANDY CLAY, MOTTLED LT. BROWN, ORANGE, GREY, MED. STIFF, LOW PLAST., DRY TO MOIST	4/4 %		
	23			%		
	24					

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. *(Translucent)*

6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT37

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SILTY SAND, ORANGE, FINE, COHESIVE, WET	4/4 %		
		26				
		37	CLAYEY SAND, MED. TO COARSE, LT. BROWN, WET	%		
		28	CLAYEY SILT, LT. BROWN TO GREY, SOFT, LOW PLAST., WET	2/2 %		
		29		~~2.75~~ 4 %		
		30	SAA	%		
		31		2/2 %		
		32	SAA	%		
		33		2/2 %		
		34	SILTY SAND, LT. BROWN TO GREY, MED GRAIN, COHESIVE, WET	%		
		35		1.25/2 %		
		36	SAA	%		
		37	CLAYEY SAND, LT. BROWN, MED, COHESIVE, WET	4.75/2 %		
		38	SAA	1.5/2 %		
		39				

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT37

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	40			%		
	41		SILTY CLAY, LT. BROWN, GREY, ORANGE, SOFT, MED PLAST, MOIST	2/2 %		
	42		CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST, MOIST TO WET	2/2 %		SET WELL 34'-44' BGS
	43					
	44			%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. *(Translucent)*

6. PROJECT

7. HOLE NUMBER

01227655

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 3 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2 1/4" DIAMETER	
5. LOCATION (Coordinates or Station) LHAAP		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT38		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN a. DISTURBED ~ b. UNDISTURBED ~	
8. NAME OF DRILLER KERRI POWELL		17. TOTAL NUMBER CORE BOXES ←	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN ←		19. DATE HOLE (YYYYMMDD) a. STARTED 06/08/21 b. COMPLETED 06/08/21	
11. DEPTH DRILLED INTO ROCK ←		20. ELEVATION TOP OF HOLE (feet) —	
12. TOTAL DEPTH OF HOLE 38' BGS		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR JL Moore	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SILTY CLAY W/ SAND, DARK BROWN, SOFT, LOW PLAST., WET	2/4 %		
		2				
		3		%		
		4				
		5	SANDY CLAY, DARK BROWN TO LT. BROWN, MED. STIFF, LOW PLAST., MOIST	2/4 %		
		6				
		7		%		
		8				
		9		%		

ENG FORM 1836, MAR 1971 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent) PROJECT HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER LHAAP/1 1824DP138

SHEET 2 OF 3 4/m SHEETS

3. PROJECT LHAAP 18/24

4. INSTALLATION LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	CLAYEY SAND, LT. BROWN, FINE GRAIN, COHESIVE, MOIST	2.75/4 %		
		11				
		12				
		13	SAA/m SANDY CLAY, MOTTLED LT. BROWN & GREY, LOW PLAST., MOIST	3/4 %		
		14				
		15		%		
		16				
		17	SAA	%		
		18	CLAYEY SAND, LT. BROWN TO ORANGE, FINE GRAIN, COHESIVE, WET	4/4 %		
		19		%		
		20				
		21	SAA	%		
		22	SANDY CLAY, LT. BROWN TO GREY, STIFF, LOW PLAST., MOIST	4/4 %		
		23				
		24		%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT38

SHEET 3 OF 4 3 SHEETS

PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	SAA	4/4 %		
		26		%		
		27		%		
		28	SILTY SAND W/ CLAY, LT. BROWN TO ORANGE, MED. TO COARSE, COHESIVE, WET	2/2 %		
		29				
		30	SAA	%		
		31		2/2 %		
		32				
		33	SAA, INCREASING CLAY @ BOTTOM	2/2 %		
		34				
		35	SANDY CLAY, LT. BROWN TO GREY, SOFT, HIGH PLAST., WET	2/2 %		
		36		%		
		37	CLAY, ORANGE TO DARK GREY, STIFF, HIGH PLAST., MOIST	2/2 %		SET WELL 28'-38' BGS
		38				
				%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

01227658

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS

4. PROJECT LHAAP 18/24	13. SIZE AND TYPE OF BIT 2 ¼" Diameter
5. LOCATION *(Coordinates or Station)* LHAAP	14. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* —
6. DRILLING AGENCY WHE	15. MANUFACTURERS DESIGNATION OF DRILL Geoprobe 7822DT
7. HOLE NUMBER *(as shown on drawing title and title number)* 1824DPT39	16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —; b. UNDISTURBED —
8. NAME OF DRILLER Kerri Powell	17. TOTAL NUMBER CORE BOXES —
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.	18. ELEVATION GROUND WATER —
10. THICKNESS OF OVERBURDEN —	19. DATE HOLE *(YYYYMMDD)*: a. STARTED 06/09/21; b. COMPLETED 06/09/21
11. DEPTH DRILLED INTO ROCK —	20. ELEVATION TOP OF HOLE *(feet)* —
12. TOTAL DEPTH OF HOLE 40' BGS	21. TOTAL CORE RECOVERY FOR BORING % —
	22. SIGNATURE OF INSPECTOR J. Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	1		~~SILTY~~ CLAYEY SILT, DARK BRWN., SOFT, LOW PLAST., WET	1.75/4 %		
	2		SILTY CLAY W/ TRACE SAND, RED, MED. STIFF, MED. PLAST., MOIST	%		
	3					
	4		SAA, REDDISH BRWN. TO LT. BRWN.,	%		
	5			4/4 %		
	6					
	7		CLAYEY SAND, LT. BRWN, COHESIVE, FINE GRAIN, MOIST	%		
	8					
	9			%		

01227659

DRILLING LOG (Construction Style) For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DFT39

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	SILTY SAND W/ CLAY, LT. BROWN, FINE, COHESIVE, MOIST TO WET	3.5/4 = %		
		11	SANDY SILT W/ CLAY, LT. BROWN, MED. PLAST, SOFT, WET	%		
		12				
		13	SANDY CLAY, GREY TO REDDISH BRWN., MED. STIFF, LOW PLAST., MOIST	4/4 = %		
		14				
		15				
		16	CLAYEY SAND, REDDISH BROWN, FINE, COHESIVE, MOIST	%		
		17	SAA, MOTTLED REDDISH BRWN. & LT. GREY.	4/4 = %		
		18				
		19		%		
		20				
		21	SILTY SAND W/ CLAY, LT. BROWN TO GREY, MED. GRAIN, COHESIVE, MOIST TO WET	3.75/4 = %		
		22				
		23		%		
		24				

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG

3 ELEVATION TOP OF HOLE

4 HOLE NO. FOR

1824DPT39

SHEET 3 4

5 PROJECT

LHAAP 18/24

8 INSTALLATION

LHAAP

9 ELEVATION	10 DEPTH	11 LEGEND	12 CLASSIFICATION OF MATERIALS (Description)	13 % CORE RECOVERY	14 BOX OR SAMPLE NUMBER	15 REMARKS (Drilling Time, Water Loss, Depth of Weathering, Etc.)
		25	SANDY SILT, MOTLED LT. BROWN & GREY, SOFT, LOW PLAST., MOIST TO WET	3.5/4		
		26	CLAYEY SAND, LT. BROWN TO GREY, FINE TO MED., COHESIVE, WET			
		27				
		28				
		29	SAA, INCREASING GRAIN SIZE	2/2		
		30				
		31	SANDY SILT W/ CLAY, LT. BROWN TO GREY, MED. STIFF, MED PLAST., WET	2/2		
		32				
		33	SAA	2/2		
		34				
		35	SAA, INCREASING CLAY	2/2		
		36				
		37	SANDY CLAY, GREY TO ORANGISH BROWN, MED. STIFF, MED. PLAST., MOIST	2/2		
		38				
		39				

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6 PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT39

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., MOIST	2/2 %		SET WELL 30'-40' BGS
	40			%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

ENG FORM 1836A, JUN 1967 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent)

6. PROJECT

7. HOLE NUMBER

01227662

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2¼" DIAMETER	
5. LOCATION (Coordinates or Station) LHAAP		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
6. DRILLING AGENCY WHE		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED —	b. UNDISTURBED —
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT40		17. TOTAL NUMBER CORE BOXES —	
		18. ELEVATION GROUND WATER ✓	
8. NAME OF DRILLER KERRI POWELL		19. DATE HOLE (YYYYMMDD): a. STARTED 06/09/21	b. COMPLETED 06/09/21
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		20. ELEVATION TOP OF HOLE (feet) —	
10. THICKNESS OF OVERBURDEN —		21. TOTAL CORE RECOVERY FOR BORING % —	
11. DEPTH DRILLED INTO ROCK —		22. SIGNATURE OF INSPECTOR [signature]	
12. TOTAL DEPTH OF HOLE ~~38 BGS~~/m 41' BGS			

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	CLAYEY SILT, DARK BRWN., SOFT, MED. PLAST., WET	% 1.25		
		2	CLAY W/ TRACE SAND, MOTTLED LT. BROWN & RED, STIFF, HIGH PLAST., MOIST	% 4		
		3		%		
		4				
		5	SAA, MOTTLED LT. BROWN & GREY, INCREASED SAND @ BOTTOM	% 4		
		6		% 4		
		7				
		8		%		
		9		%		

ENG FORM 1836, MAR 1971 PREVIOUS EDITIONS ARE OBSOLETE. (Translucent) PROJECT HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT40

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	SAA	4/4 %		
		11	CLAYEY SAND, MOTTLED LT. BROWN & GREY, FINE GRAIN, COHESIVE, MOIST	%		
		12	SAA	%		
		13	SANDY CLAY, MOTLED REDDISH BRWN. & GREY, STIFF, HIGH TO MED PLAST., MOIST TO WET	4/4 %		
		14		%		
		15		%		
		16	SAA	%		
		17		4/4 %		
		18	CLAYEY SAND, ORANGISH BROWN, FINE TO MED, COHESIVE, MOIST	%		
		19	SANDY CLAY, LT. BROWN, MED. STIFF. LOW PLAST., MOIST	%		
		20	CLAYEY SAND, LT. BRWN. TO ORANGISH BRWN., MED TO COARSE, COHESIVE, WET	2.75/4 %		
		21		%		
		22		%		
		23		%		
		24		%		

1. DRILLING LOG			5. HOLE DESIGNATION		8. SHEET 3
			1824DPT40		4
2. PIT OR PROJECT			3. DRILLING AGENCY		
LHAAP 18/24			LHAAP		

A. ELEVATION	B. DEPTH	C. LEGEND	D. CLASSIFICATION OF MATERIALS (Description)	E. % CORE RECOVERY	F. BOX OR SAMPLE NUMBER	G. REMARKS (Drilling Time per foot, Water Loss, Depth Cavities, Etc.)
	25		SAA, INCREASING CLAY/SILT	4/4		
	26					
	27					
	28		CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., MOIST	2/2		
	29		SANDY SILT, MOTTLED ORANGE & GREY, SOFT, LOW PLAST., WET			
	30		SAA	2/2		
	31		SILTY SAND W/ CLAY, LT. BROWN, FINE TO MED., COHESIVE, WET			
	32		SAA	2/2		
	33					
	34		SAA, INCREASING CLAY	2/2		
	35					
	36		SANDY CLAY W/ SILT, SOFT, LT. BROWN TO GREY, LOW PLAST., WET	2/2		
	37					
	38					
	39					

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT40

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SAA, DECREASING SAND	2/2 %		
	40					SEE WELL SCREEN
			CLAY, DARK BROWN TO GREY, STIFF, HIGH PLAST, MOIST	1/1 %		31'-41' BGS
	41					
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227666

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 3 SHEETS

4. PROJECT LHAAP 18/24	13. SIZE AND TYPE OF BIT 2 ¼" DIAMETER
5. LOCATION (Coordinates or Station) KARNACK, TX	14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —
6. DRILLING AGENCY WHE	15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT41	16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —
8. NAME OF DRILLER KERRI POWELL	17. TOTAL NUMBER CORE BOXES —
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.	18. ELEVATION GROUND WATER —
10. THICKNESS OF OVERBURDEN —	19. DATE HOLE (YYYYMMDD): a. STARTED 06/09/21 b. COMPLETED 06/09/21
11. DEPTH DRILLED INTO ROCK —	20. ELEVATION TOP OF HOLE (feet) —
12. TOTAL DEPTH OF HOLE 38' BGS	21. TOTAL CORE RECOVERY FOR BORING % —
	22. SIGNATURE OF INSPECTOR

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		SILTY CLAY, DARK BROWN TO REDDISH BROWN, STIFF, LOW PLAST., DRY TO MOIST	2/4 %		
	2			%		
	3			%		
	4					
	5		SAA, LT. BROWN, MOIST	2.75 %		
	6		SANDY SILT W/ CLAY, LT. BROWN TO GREY, SOFT, LOW PLAST., WET	4 %		
	7					
	8			%		
	9		CLAY, MOTTLED LT. BROWN & GREY, MED. STIFF, HIGH PLAST. MOIST	3/4 %		

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PROJECT

HOLE NUMBER

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT41

SHEET 2 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	10		SANDY CLAY w/ SILT, LT. BROWN TO GREY, MED. STIFF, LOW PLAST., MOIST	%		
	11			%		
	12		SAA	%		
	13		CLAYEY SAND, LT. BROWN TO ORANGISH BROWN, COHESIVE, MOIST, MED GRAIN	1.5/4		
	14			%		
	15			%		
	16		SAA, INCREASING GRAIN SIZE, WET	%		
	17			3/4		
	18			%		
	19			%		
	20		SAA	%		
	21		SANDY SILT w/ CLAY, LT BROWN TO GREY, SOFT, LOW PLAST., WET	4/4		
	22			%		
	23		SILTY SAND, FINE TO MED, LT. BROWN, WET	%		
	24					

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT41

SHEET 3 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25	CLAYEY SILT W/ SAND, LT. BROWN, SOFT, LOW PLAST., WET	4/4 %		
		26		%		
		27		%		
		28	SAA, INCREASING SAND	2/2 %		
		29		%		
		30	SAA	2/2 %		
		31	SILTY SAND W/ CLAY, LT. BROWN, SOFT, WET, LOW PLAST, FINE	%		
		32	SILTY CLAY, LT. BROWN, SOFT, MED TO HIGH PLAST., WET	2/2 %		
		33	SILTY SAND, LT BROWN, FINE TO MED., WET, COHESIVE	%		
		34	SILTY CLAY, LT. BROWN, MED. STIFF, MED. PLAST., WET	2/2 %		
		35		%		
		36	CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., MOIST	2/2 %		SET WELL 28'-38' BGS
		37		%		
		38		%		

6. PROJECT

7. HOLE NUMBER

01227669

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 3 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 2 ¼" DIAMETER	
5. LOCATION (Coordinates or Station) KARNACK, TX		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 7822DT	
6. DRILLING AGENCY WHE		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN a. DISTURBED — b. UNDISTURBED —	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT42		17. TOTAL NUMBER CORE BOXES —	
8. NAME OF DRILLER KERRI POWELL		18. ELEVATION GROUND WATER —	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		19. DATE HOLE (YYYYMMDD) a. STARTED 06/09/21 b. COMPLETED 06/09/21	
10. THICKNESS OF OVERBURDEN —		20. ELEVATION TOP OF HOLE (feet) —	
11. DEPTH DRILLED INTO ROCK —		21. TOTAL CORE RECOVERY FOR BORING % —	
12. TOTAL DEPTH OF HOLE 34' BGS		22. SIGNATURE OF INSPECTOR JK Mowen	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	1		SILTY CLAY W/ SAND, RED, MED. STIFF, MED. PLAST., MOIST	1.75/4 %		
	2					
	3			%		
	4					
	5		SAA	2/4 %		
	6		SANDY SILT, DARK BROWN, SOFT, LOW PLAST., WET			
	7			%		
	8					
	9			%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT42

SHEET 2 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
			SAA	%		
	10		SANDY CLAY, DARK BROWN, SOFT, WET,	2.75/4		
	11		LOW PLAST.	%		
			PLAYEY SAND, DARK BROWN, FINE TO MED., WET, COHESIVE			
	12		SILTY SAND, LT. BROWN TO GREY, LOOSE,	%		VERY WET, SULFUR-LIKE SMELL COMING FROM CORE
	13		WET, MED. TO COARSE	3/4		
	14			%		
	15			%		
	16					
			SAA	%		
	17					
	18			3/4		
				%		
	19			%		
	20					
			SAA, INCREASING CLAY / SILT	%		
	21			4/4		
	22					
			SILTY CLAY W/ SAND, LT. BROWN TO GREY, WET, SOFT,	%		
	23		LOW PLAST.			
				%		
	24					

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG

LHAAP 12/24

1234DT42.

LHAAP

3

3

ELEVATION	DEPTH	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BLOWS PER FOOT	REMARKS
	25	SAA	4/4		
	26				
	27				
	28	SAA	2/2		
	29				
	30	CLAY, DARK BROWN TO GREY, STIFF, HIGH PLAST., MOIST	2/2		
	31				
	32	SAA	2/2		DRILLED TOO FAR INTO CLAY, PULL OUT OF HOLE & MOVE 3' NE & SET WELL 21'-31' BGS
	33				
	34				
	35				
	36				
	37				
	38				
	39				

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6 PROJECT

7. HOLE NUMBER

01227672

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 3 SHEETS

4. PROJECT LHAAP 18/24	13. SIZE AND TYPE OF BIT 6"
5. LOCATION (Coordinates or Station) KARNACK, TX	14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —
6. DRILLING AGENCY WHE	15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 8150 LS
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPTMW1	16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —
8. NAME OF DRILLER COLBY POUNDS	17. TOTAL NUMBER CORE BOXES —
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.	18. ELEVATION GROUND WATER —
10. THICKNESS OF OVERBURDEN —	19. DATE HOLE (YYYYMMDD): a. STARTED 06/18/2021 b. COMPLETED 06/21/2021
11. DEPTH DRILLED INTO ROCK —	20. ELEVATION TOP OF HOLE (feet) —
12. TOTAL DEPTH OF HOLE 35' BGS	21. TOTAL CORE RECOVERY FOR BORING % —
	22. SIGNATURE OF INSPECTOR JL Moore

23. a. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SILTY CLAY, REDDISH BROWN, MED. STIFF, MED. PLAST., WET	%		
		2		%		
		3		2.5/10		
		4		%		
		5		%		
		6		%		
		7		%		
		8		%		
		9		%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPTMW1

SHEET 2 OF 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		10	SAA, SOME SAND	%		
		11		%		
		12		%		
		13	CLAYEY SAND, ORANGE; FINE TO MED., MOIST, COHESIVE			
		14	SILTY SAND, LT. BROWN TO GREY, MED TO COARSE, COHESIVE, WET	10 / 10		
		15		%		
		16		%		
		17		%		
		18		%		
		19		%		
		20	SANDY, SILT; LT. BROWN, SOFT, WET, LOW PLAST.			
		21		%		
		22		10 / 10 %		
		23		%		
		24		%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 824DPTMW1

SHEET 3 OF ~~4~~ 3 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		25		%		
		26		%		
		27		%		
		28				
		29	SILTY CLAY, SOFT TO MED., ORANGISH BROWN, MED. PLAST., WET	%		
		30				
			SAA	%		
		31	CLAY, LT. BROWN TO GREY, MED. STIFF, HIGH PLAST., MOIST			HIT CLAY @ 30.5' BGS, SET WELL SCREEN 22'-32' BGS
		32		%		
				5/5		
		33		%		
		34				
				%		
		35				
		36		%		
		37		%		
		38				
		39		%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 6"	
5. LOCATION (Coordinates or Station) 1824DPT MW2 Karnack TX		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 8150 LS	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPTMW2		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN —	a. DISTURBED — / b. UNDISTURBED —
8. NAME OF DRILLER Colby Pounds		17. TOTAL NUMBER CORE BOXES —	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN —		19. DATE HOLE (YYYYMMDD) a. STARTED 06/16/2021 / b. COMPLETED 06/16/2021	
11. DEPTH DRILLED INTO ROCK —		20. ELEVATION TOP OF HOLE (feet) —	
12. TOTAL DEPTH OF HOLE 40' BGS		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR John Moore	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	CLAYEY SILT W/SAND, BROWN, SOFT, WET, LOW PLAST.	%		
		2		%		
		3		3.5 / 10		
		4	CLAY, MOTTLED RED, GREY, LT. BROWN, STIFF, HIGH PLAST., MOIST	%		
		5		%		
		6		%		
		7		%		
		8		%		
		9		%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPTMW2

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		10	SILTY CLAY, MOTLED RED & BROWN, SOFT, LOW PLAST, WET, TRACE SAND	%		
		11	SAA	%		
		12		%		
		13	SANDY CLAY, MOTLED LT. BROWN, DARK BROWN & GREY, MED. STIFF, LOW PLAST, DRY TO MOIST, SAND LENSES THROUGHOUT	5/10 %		
		14		%		
		15		%		
		16		%		
		17		%		
		18		%		
		19		%		
		20		%		
		21		%		
		22		%		
		23		%		
		24		%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPTMW2

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
			SAA	%		
		25				
		26	CLAYEY SAND, LT. BROWN TO ORANGISH BROWN, FINE TO MED, DRY	5/10 %		
		27		%		
		28				
		29	CLAYEY SAND W/ SILT, FINE TO MED., LT. BROWN TO GREY, COHESIVE, WET	%		
		30				
		31	CLAYEY SILT W/ SAND, LT. BROWN, SOFT, WET, LOW PLAST.	%		
		32				
		33		%		
		34		10/10 %		
		35				
		36		%		
		37				
		38		%		
		39	CLAY, ~~TRACE~~ LT. BROWN TO ORANGISH BROWN, STIFF, HIGH PLAST., MOIST	%		

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet) For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	1. ELEVATION TOP OF HOLE	2. HOLE NUMBER 1824DPTMW2	SHEET 4 OF 4 SHEETS
3. PROJECT LHAAP 18/24		4. INSTALLATION LHAAP	

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40		%		CLAY REACHED @ 38.5' BGS, SCR WELL SCREEN 30'. 40' BGS
		41		%		
		42		%		
		43		%		
		44		%		
		45		%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

01227679

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 6"	
5. LOCATION (Coordinates or Station) KARNACK, TX		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
6. DRILLING AGENCY WSHE		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 8150 LS	
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPTMW3		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN —	a. DISTURBED — / b. UNDISTURBED —
8. NAME OF DRILLER KERRI POWELL		17. TOTAL NUMBER CORE BOXES —	
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		18. ELEVATION GROUND WATER —	
10. THICKNESS OF OVERBURDEN —		19. DATE HOLE (YYYYMMDD) a. STARTED 06/16/2021	b. COMPLETED 06/17/2021
11. DEPTH DRILLED INTO ROCK —		20. ELEVATION TOP OF HOLE (feet) —	
12. TOTAL DEPTH OF HOLE 40' BGS		21. TOTAL CORE RECOVERY FOR BORING % —	
		22. SIGNATURE OF INSPECTOR J. Moore	

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	CLAYEY SILT, DARK BROWN, SOFT, WET, LOW PLAST., SOME SAND	%		
		2	SANDY CLAY, LT. BROWN, MED. STIFF, MED. PLAST., WET, SAND LENSES THROUGHOUT	%		
		3		%		
		4				
		5		10 / 10		
		6		%		
		7				
		8		%		
		9		%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPTMW3

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
	10		SAA	%		
	11		SILTY CLAY, LT. BROWN, MED. STIFF, MED. PLAST, MOIST, SAND LENSES THROUGHOUT	%		
	12			%		
	13					
	14			6/10 %		
	15			%		
	16					
	17		CLAYEY SAND, LT. BROWN TO GREY, FINE TO MED. COHESIVE, MOIST	%		
	18			%		
	19			%		
	20		SAA			
	21			%		
	22			%		
	23			%		
	24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPTMW3

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SILTY CLAY, LT. BROWN TO GREY, MED. STIFF, HIGH PLAST., WET	10/10		
	30		SILT, LT. BROWN TO GREY, SOFT, WET, LOW PLAST.			
	35			10/10		
	39		CLAY, LT. BROWN TO ORANGISH BROWN, STIFF, HIGH PLAST., MOIST			

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPTMW3

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		40		%		HIT CLAY @ 38.5' BGS, SET WELL SCREEN 30'-40' BGS
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

01227683

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 6"	
		14. DATUM FOR ELEVATION SHOWN (TBM or MSL) —	
5. LOCATION (Coordinates or Station) KARNACK, TX		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 8150LS	
6. DRILLING AGENCY WHE		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN	a. DISTURBED ~ / b. UNDISTURBED —
7. HOLE NUMBER (as shown on drawing title and title number) 1824DPT MW4		17. TOTAL NUMBER CORE BOXES ~	
		18. ELEVATION GROUND WATER —	
8. NAME OF DRILLER Colby Pounds		19. DATE HOLE (YYYYMMDD)	a. STARTED 06/17/2021 / b. COMPLETED
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		20. ELEVATION TOP OF HOLE (feet) —	
10. THICKNESS OF OVERBURDEN —		21. TOTAL CORE RECOVERY FOR BORING % —	
11. DEPTH DRILLED INTO ROCK —		22. SIGNATURE OF INSPECTOR JL Moore	
12. TOTAL DEPTH OF HOLE 40'BGS			

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SANDY/SILTY CLAY, LT. BROWN, SOFT, WET, LOW PLAST.	%		
		2		%		
		3	SANDY CLAY, MOTLED LT. BROWN, RED & GREY, STIFF, MED. PLAST., MOIST	5/10 %		
		4				
		5		%		
		6		%		
		7				
		8		%		
		9		%		

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPT MW14

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10	CLAYEY SILT W/ SAND, LT. BROWN, SOFT, WET, LOW PLAST.	%		
		11		%		
		12				
		13	SANDY CLAY, LT. BROWN TO GREY, STIFF, LOW PLAST., DRY TO MOIST	%		
		14		7/10 %		
		15		%		
		16		%		
		17		%		
		18		%		
		19		%		
		20	SANDY SILT/ SILTY SAND, LT. BROWN, SOFT, WET, LOW PLAST., FINE GRAIN	%		
		21		%		
		22		%		
		23		8/10 %		
		24				

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPTMW4

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25		%		
		26		%		
		27		%		
		28		%		
		29		%		
		30		%		
		31		%		
		32	SAA			
		33		10/10 %		
		34		%		
		35		%		
		36		%		
		37		%		
		38		%		
		39	CLAY, LT. BROWN TO ORANGE, STIFF, HIGH PLAST.	%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: 1824DPTMW4

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		40	WET	%		CLAY REACHED @ 38.5' BGS. SET WELL SCREEN 30'-40' BGS
		41		%		
		42		%		
		43		%		
		44		%		
		45		%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

01227687

1. HOLE NUMBER

DRILLING LOG For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.	2. DIVISION	3. INSTALLATION LHAAP	SHEET 1 OF 4 SHEETS
4. PROJECT LHAAP 18/24		13. SIZE AND TYPE OF BIT 6"	
		14. DATUM FOR ELEVATION SHOWN *(TBM or MSL)* —	
5. LOCATION *(Coordinates or Station)* KARNACK, TX		15. MANUFACTURERS DESIGNATION OF DRILL GEOPROBE 8150 LS	
6. DRILLING AGENCY WHE		16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN a. DISTURBED —	b. UNDISTURBED —
7. HOLE NUMBER *(as shown on drawing title and title number)* MW-05		17. TOTAL NUMBER CORE BOXES —	
		18. ELEVATION GROUND WATER —	
8. NAME OF DRILLER Colby Pounds		19. DATE HOLE *(YYYYMMDD)* a. STARTED 06/15/2021	b. COMPLETED
9. DIRECTION OF HOLE ☒ a. VERTICAL ☐ b. INCLINED c. DEG. FROM VERT.		20. ELEVATION TOP OF HOLE *(feet)* —	
10. THICKNESS OF OVERBURDEN —		21. TOTAL CORE RECOVERY FOR BORING % —	
11. DEPTH DRILLED INTO ROCK —		22. SIGNATURE OF INSPECTOR John F. Mooney	
12. TOTAL DEPTH OF HOLE 40' BGS			

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS *(Description)*	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS *(Drilling Time, water loss, depth of weathering, etc., if significant)*
		1	CLAY, RED TO LT. BROWN, MED. STIFF, HIGH PLAST., MOIST	%		
		2		%		
		3		10%		
		4		10%		
		5		%		
		6		%		
		7		%		
		8		%		
		9		%		

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: MW-05

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	10		~~SAND~~ SM	%		
	11		SAA	%		
	12			%		
	13		SANDY CLAY, LT. BROWN TO GREY, SOFT, MED. PLAST., MOIST	%		
	14			10/10		
	15			%		
	16			%		
	17		CLAYEY SAND W/ SILT, LT. BROWN, COHESIVE, FINE TO MED., MOIST	%		
	18			%		
	19			%		
	20		SILTY SAND; LT. BROWN, FINE TO MED, COHESIVE, WET	%		
	21			%		
	22			10/10		
	23			%		
	24			%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: MW-05

SHEET 3 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
	25		SANDY CLAY, LT. BROWN, MED. STIFF, ~~LOW PLAST.~~, WET	%		
	26		MED. PLAST.	%		
	27					
	28		CLAYEY SILT W/ SAND, LT. BROWN, SOFT, WET, LOW PLAST.	%		
	29			%		
	30		CLAYEY SAND W/ SILT, LT. BROWN, FINE TO MED., COHESIVE, WET	%		
	31			%		
	32			5/5		
	33			%		
	34		SANDY SILT, LT. BROWN, SOFT, WET, LOW PLAST.	%		
	35		SAA, V. WET	%		
	36			%		
	37		CLAYEY SAND, LT. BROWN, COHESIVE, FINE TO MED., WET	5/5 %		
	38					
	39		CLAY, LT. BROWN TO GREY, STIFF, HIGH PLAST., WET	%		

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG (Continuation Sheet)
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: MW-05

SHEET 4 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40		%		SET WELL SCREEN 30'-40' BGS
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		
				%		

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6. PROJECT

7. HOLE NUMBER

01227691

1. HOLE NUMBER

DRILLING LOG
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

2. DIVISION

3. INSTALLATION: LHAAP

SHEET 1 OF 4 SHEETS

4. PROJECT: LHAAP 18/24

5. LOCATION (Coordinates or Station): KARNACK, TX

6. DRILLING AGENCY: WHE

7. HOLE NUMBER (as shown on drawing title and title number): MW-06

8. NAME OF DRILLER: Colby Pounds

9. DIRECTION OF HOLE: [X] a. VERTICAL [ ] b. INCLINED c. DEG. FROM VERT.

10. THICKNESS OF OVERBURDEN: —

11. DEPTH DRILLED INTO ROCK: —

12. TOTAL DEPTH OF HOLE: 52' BGS

13. SIZE AND TYPE OF BIT: 6"

14. DATUM FOR ELEVATION SHOWN (TBM or MSL):

15. MANUFACTURERS DESIGNATION OF DRILL: GEOPROBE 8150 LS

16. TOTAL NO. OF OVER BURDEN SAMPLES TAKEN: a. DISTURBED — b. UNDISTURBED —

17. TOTAL NUMBER CORE BOXES: —

18. ELEVATION GROUND WATER: —

19. DATE HOLE (YYYYMMDD): a. STARTED 06/15/2021 b. COMPLETED

20. ELEVATION TOP OF HOLE (feet): —

21. TOTAL CORE RECOVERY FOR BORING %: —

22. SIGNATURE OF INSPECTOR: JL Moore

23. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		1	SANDY SILT W/ CLAY, LT. BROWN, SOFT, MED. PLAST., WET	%		
		2		%		
		3		9M		
		4	SILTY CLAY W/ SAND, LT. BROWN TO ORANGE-BROWN, MED. STIFF, MED. PLAST., WET	%		
		5		10/10		
		6		%		
		7		%		
		8	SILTY SAND, LT. BRWN. TO GREY, MED. GRAIN, COHESIVE, WET	%		
		9		%		

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PROJECT

HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: MW-06

SHEET 2 OF 4 SHEETS

3. PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		10		%		
		11	SAA	%		
		12		%		
		13		%		
		14		10/10 %		
		15		%		
		16		%		
		17		%		
		18		%		
		19		%		
		20		%		
		21	SAA	%		
		22		10/10 %		
		23		%		
		24		%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: MW-06

SHEET 3 OF 4 SHEETS

PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		25		%		
		26		%		
		27		%		
		28		%		
		29		%		
		30	SILTY SAND, SOME CLAY, FINE TO MED, WET, COHESIVE, DARK BROWN TO DARK GREY	%		
		31		%		
		32		5/5 %		
		33		%		
		34		%		
		35	SAA, INCREASING CLAY	%		
		36		%		
		37		10/10 %		
		38	SILTY CLAY, GREY, MED. STIFF, HIGH PLAST., WET	%		
		39		%		

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6. PROJECT

7. HOLE NUMBER

DRILLING LOG *(Continuation Sheet)*
For use of this form, see EM 1110-1-1804; the proponent agency is CECW-EG.

1. ELEVATION TOP OF HOLE

2. HOLE NUMBER: MW-06

SHEET 4 OF 4 SHEETS

PROJECT: LHAAP 18/24

4. INSTALLATION: LHAAP

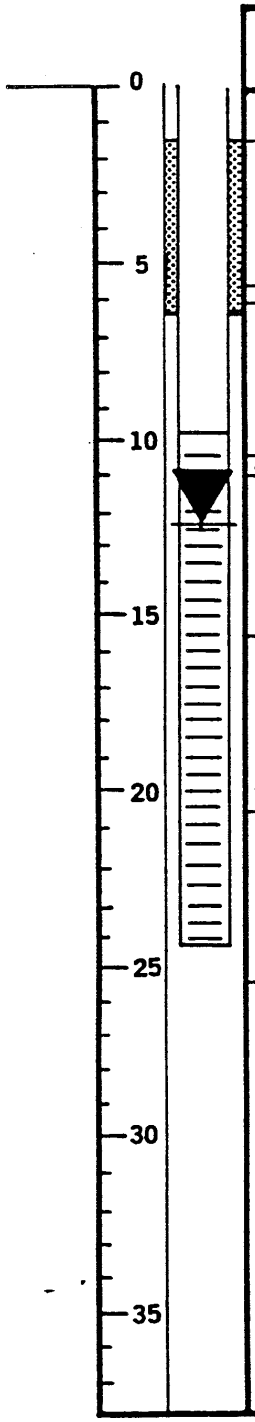
5. ELEVATION	a. DEPTH	b. LEGEND	c. CLASSIFICATION OF MATERIALS (Description)	d. % CORE RECOVERY	e. BOX OR SAMPLE NUMBER	f. REMARKS (Drilling Time, water loss, depth of weathering, etc., if significant)
		40	SAND, DARK BROWN TO GREY, MED TO COARSE, WET	%		SET OUTER CASING FROM SURFACE TO 40' BGS, 10" DIAMETER
		41		%		
		42		%		
		43		%		
		44		%		
		45	SAA	%		
		46		%		
		47		%		
		48		%		
		49		%		
		50	CLAY/GRAVEL, DARK BROWN, WET,	%		BACK FILL 1' W/ BENTONITE. SET WELL, 41'-51' BGS SCREEN
		51		%		
		52		%		
		53		%		
		54		%		

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6. PROJECT

7. HOLE NUMBER

VERSION 1.0



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SP	3/4	Slightly silty dry sand Yellowish brown & strong brown	5 –	
SC	3/3	Slightly clayey sand Yellowish brown		
SC	3/19	Seam of clayey sand	35	
SM	15/15	Silty sand Yellowish brown & strong brown	15	
SM/SC	6/11	Silty fine sand seam w/2 thin *	60.3	
SM to SM + SC	12/13	Slightly silty sand Yellowish brown mixed w/strong brown to silty sand w/thin silty clayey**	22.0 55.7	2.4 x10^{-3} ft/min
SC to ML-CL	4/7 8/13	Clayey silty sand 30% silt 15% clay Light grey slightly mottled w/light olive brown to clayey sandy silt	45.9 86.0	
CL + SM	9/18 22/9 15/20	Clay & silty sand 70% clay thin bedding 30% silty sand mixture Silty sand 70% fine sand	93.9 30	

* thin clayey sand seams
** sand seam

*BLOWS PER 6 INCH USING 1⅜, 24 or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 103 DATE DRILLED 7/8/82

STUDY AREA Active Landfill

EVATION TOP OF STEEL CASING = 196.10 ft

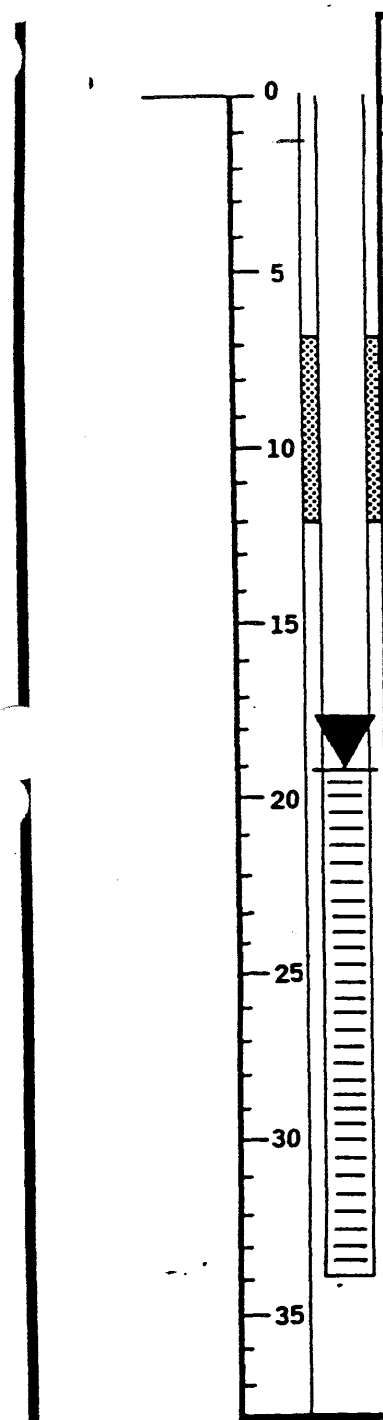
ELEVATION TOP OF PVC RISER = 194.80 ft

ELEVATION OF GROUND SURFACE = 192.66 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM-SP		Pale brown silty sand	10	
SC	5/4 4/6	Clayey sand Light brownish grey mottled w/red		
SM	10/12 21/17	Silty fine sand Light grey mottled w/yellowish red	30	
	8/11			
CL	15/20	Clay seam		
SM		Silty sand Light brownish grey	30	
SM-SP	7/9	Slightly silty sand	10	
SM-SP	11/11	Clayey sand Light grey	30	
SC-SM	7/7 9/11	Slightly clayey sand 10% clay 15% silt Light grey mottled w/yellowish brown	25	
CL	6/11	Thin sandy clay seam		
SM	17/20	Silty sand	15	
CL		Thin sandy clay seam		
SM-CL	18/20 20/2"	Silty sand w/thin clay seams Yellowish brown & pale brown 70% silty sand 30% clay		

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 121 DATE DRILLED 7/2/82

STUDY AREA Active Landfill

ELEVATION TOP OF STEEL CASING = 203.22 ft

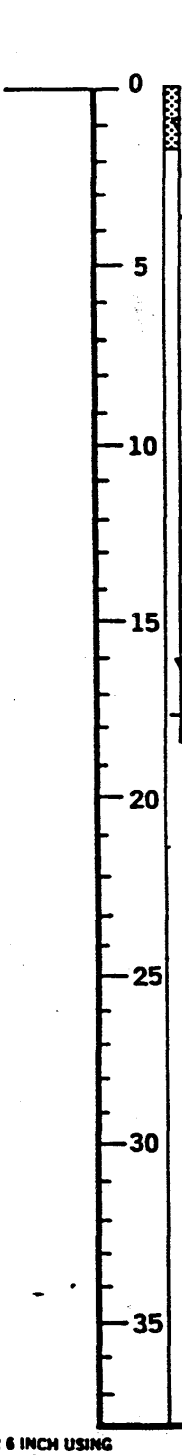
ELEVATION TOP OF PVC RISER = 203.12 ft

ELEVATION OF GROUND SURFACE = 199.92 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM		Silty sand		
SM	1/1 2/1 2/3	Silty sand Light brownish grey mottled w/yellowish brown	15	
CL	10/18/20	Very sandy clay 45% sand Light olive grey mottled w/light olive brown		
SC		Clayey sand *		
CL		Sandy clay **	35	
SC	3/5/7	Clayey sand Light olive grey mottled w/light**		
CL		Sandy clay 25% fine sand Light grey mottled w/olive		
ML	4/4/7	Sandy silt seam	74	
CL		Sandy clay 25% fine sand Light olive grey mottled w/light**		

*Light olive grey mottled w/light olive brown
**olive brown

*BLOWS PER 6 INCH USING 18, 24 or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

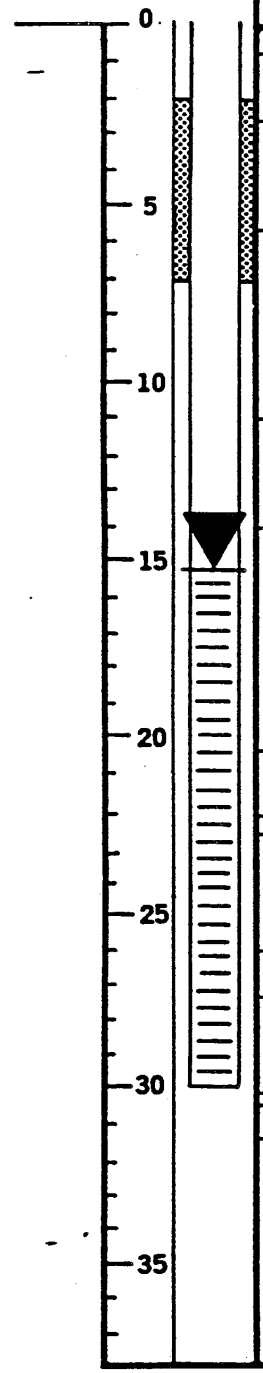
WELL 101 DATE DRILLED 6/24/82
STUDY AREA Active Burning Grounds

ELEVATION TOP OF STEEL CASING = 197.28 ft
ELEVATION TOP OF PVC RISER = 197.09 ft
ELEVATION OF GROUND SURFACE = 193.84 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM		Silty sand		
SM	1/2 2/2	Silty sand Yellowish red	12	
SM-SC	2/5	Slightly clayey silty sand 15% clay 15% silt Olive brown	30	
CL	3/6 9/10 12/12	Sandy clay 25% fine sand Light brownish grey mottled w/yellowish brown		
SC		Clayey sand Light brownish grey mottled w/ yellowish brown	20	
SM + CL	3/3 3/7 5/4	Silty sand w/seams of clay 80% silty sand mixture 20% sandy clay Light yellowish brown Sandy clay 40% fine sand	71.2 50.6 32.7	9.9 x 10^{-5} ft/min
CL	2/2 3/6	Sandy clay 40% fine sand Light brownish grey mottled with*		
SM	8/9	Silty sand seam	25	
CL	5/6	Sandy clay Light brownish grey mottled w/yellowish brown		
CL	7/15 /20	Clay w/seam of iron rock		
CL+ SM		Sandy clay w/seams of silty sand Light grey 70% clay Olive yellow 30% silty sand	63.6	
**				
CL	9/7 /8	Sandy clay		

* with yellowish brown
** Silt sand mixture (ML-SM)

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

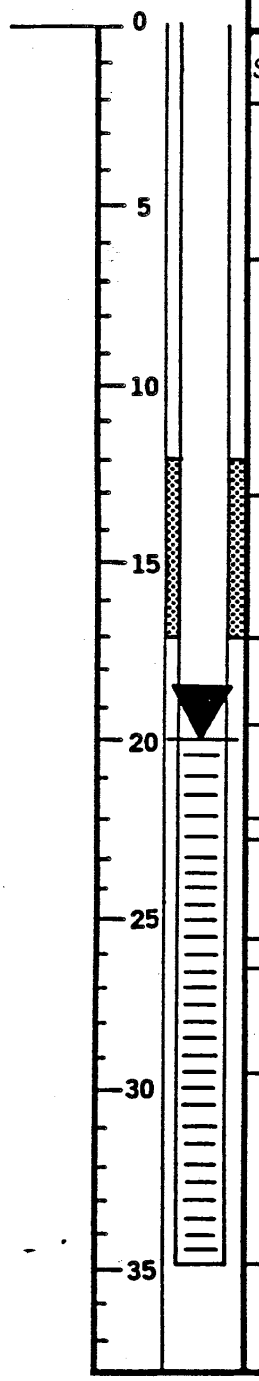
WELL 102 DATE DRILLED 6/25/82
STUDY AREA Active Burning Grounds

EVATION TOP OF STEEL CASING = 194.33 ft
ELEVATION TOP OF PVC RISER = 193.63 ft
ELEVATION OF GROUND SURFACE = 191.34 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM-SP	4/5 4/5	Silty sand Yellowish brown	10	
CL	7/8 5/8	Slightly sandy clay 20% fine sand Pale brown mottled w/yellowish brown		
CL	7/11 11/11 3/4 8/8 11/13	Slightly sandy clay 10% fine sand Pale brown mottled w/yellowish brown		
SM	5/6 7/9 8/8	Silty sand Pale brown mottled with yellowish brown	15	
ML		Sandy clay & silt 20% fine sand mixture Pale brown w/yellowish brown		
SM	8/8 8/8	Silty sand Yellowish brown	23.0	8.0×10^{-4} ft/min
CL	12/20	Clay w/silty sand seams	53.2	
ML-SM		Sandy silt mixture Pale brown mottled w/yellowish brown		
CL	3/4	Clay		
SM	10/20	Silty sand Pale brown mottled w/yellowish brown	26.3	
CL	3/5 5/5 5/5	Clay Pale brown & yellowish red		

*BLOWS PER 6 INCH USING 18, 24 or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 109 DATE DRILLED 6/10/82

STUDY AREA Active Burning Grounds

ELEVATION TOP OF STEEL CASING = 196.90 ft

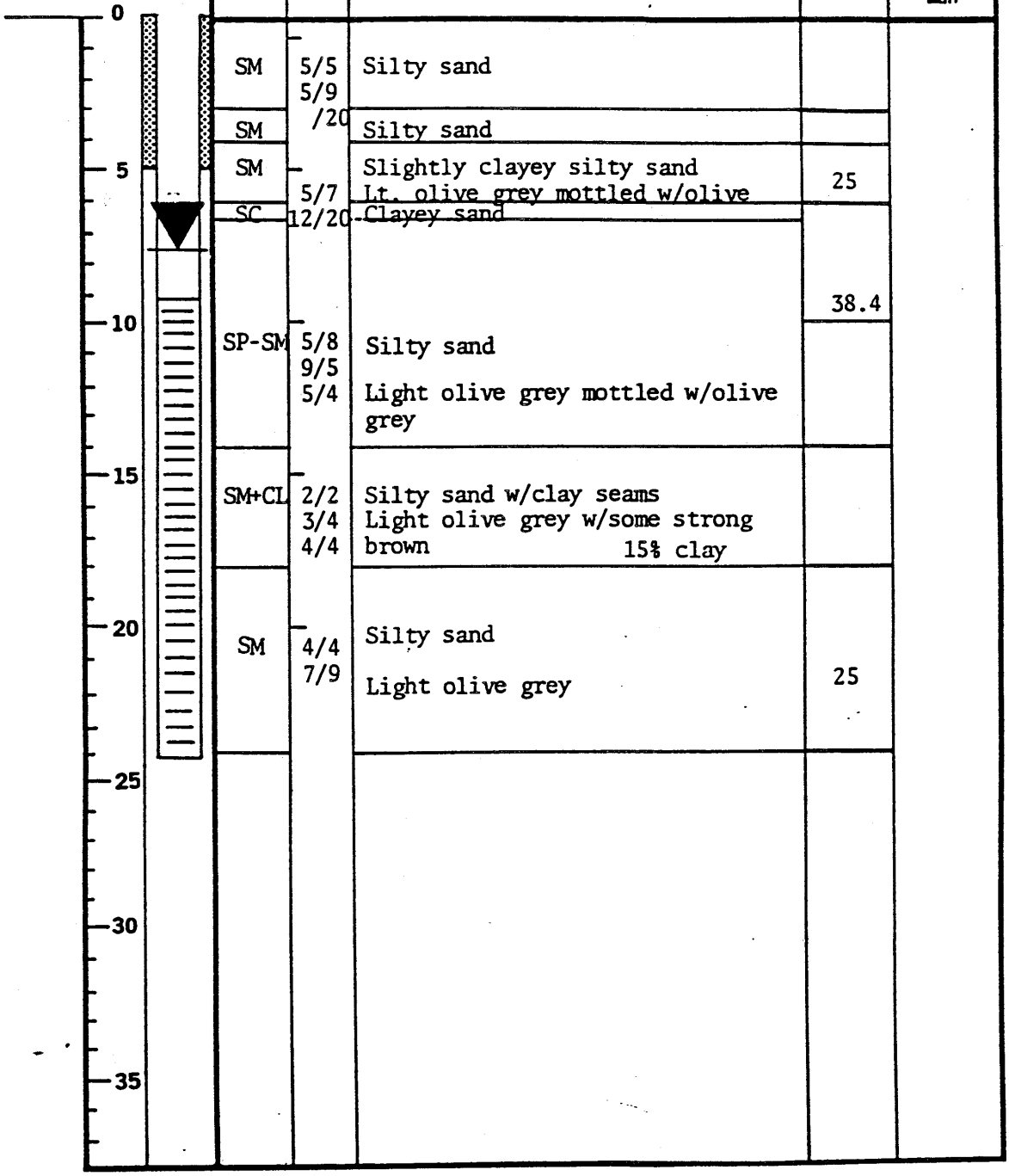
ELEVATION TOP OF PVC RISER = 196.72 ft

ELEVATION OF GROUND SURFACE = 193.94 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	5/5 5/9	Silty sand		
SM	/20	Silty sand		
SM	5/7	Slightly clayey silty sand Lt. olive grey mottled w/olive	25	
SC	12/20	Clayey sand	38.4	
SP-SM	5/8 9/5 5/4	Silty sand Light olive grey mottled w/olive grey		
SM+CL	2/2 3/4 4/4	Silty sand w/clay seams Light olive grey w/some strong brown 15% clay		
SM	4/4 7/9	Silty sand Light olive grey	25	

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 120 DATE DRILLED 6/26/82

STUDY AREA Active Burning Grounds

ELEVATION TOP OF STEEL CASING = 183.08 ft

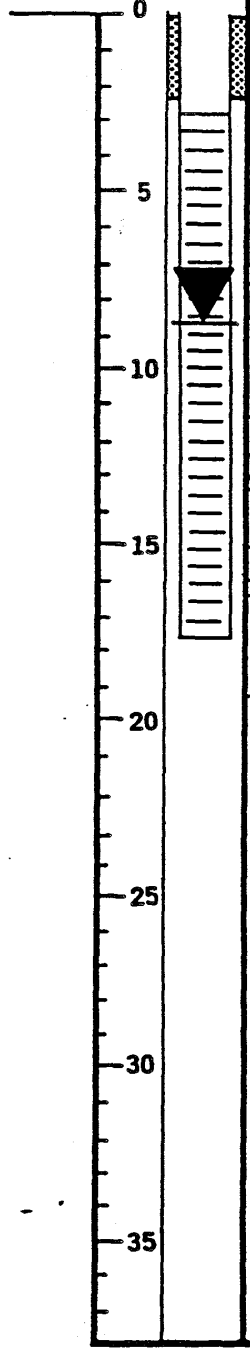
ELEVATION TOP OF PVC RISER = 182.83 ft

ELEVATION OF GROUND SURFACE = 180.15 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	2/1	Silty sand *	15	
SC	2/4 4/6	Clayey sand Light yellowish brown mottled w/yellowish brown	20	
SM		Slightly silty sand	10	
CL	2/3	Seam of sandy clay	32.2	
SC	7/8	Clayey sand **		
CL	9/9	Seam of sandy clay[1] 70% fine sand		
SC		Clayey sand		
SM	5/5	Silty sand Olive	25.4	1.2×10^{-3} ft/min
SM	5/9 10/6	Slightly clayey silty sand	40	
ML-SM		Very sandy silt ***	58.6	
SM+ CL		Silty sand w/clay seams		
CL	3/7	Clay Lt. olive grey w/olive		
SM	7/9	Silty sand seam		
CL	9/10 10/12 /18	Sandy clay 20% fine sand Light olive grey mottled w/olive		

*Light yellowish brown
**Light yellowish brown mottled w/yellowish brown
***Yellowish brown
[1]Pinkish grey

*BLOWS PER 6 INCH USING 18, 24 or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

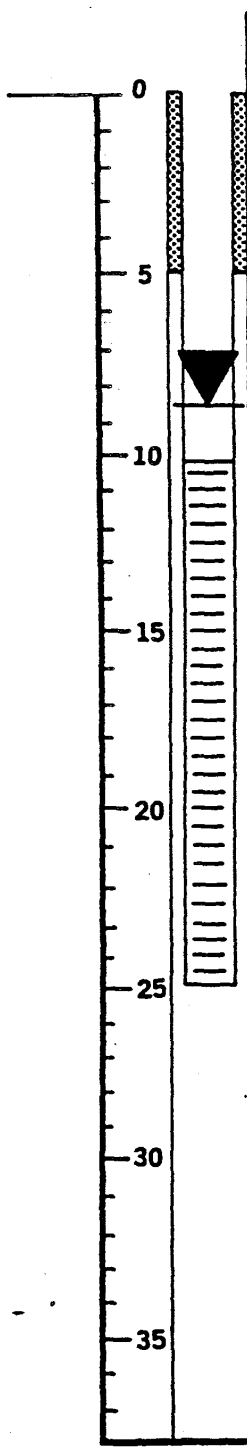
WELL 123 DATE DRILLED 6/26/82
STUDY AREA Active Burning Grounds

ELEVATION TOP OF STEEL CASING = 186.13 ft
ELEVATION TOP OF PVC RISER = 185.03 ft
ELEVATION OF GROUND SURFACE = 183.55 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM		Silty sand		
SC	5/8	Dark yellowish brown clayey sand		
SM	4/3	Silty sand Dark yellowish brown	15	
SC		Slightly clayey sand	12	
ML	3/12 25/20	Very sandy silt Very pale brown w/brownish yellow	66.4 60.7	
SC		Clayey sand seam *		
SM	9/8 7/6	Slightly silty sand Dark yellowish brown	14.2	6.9 x 10^{-3} ft/min
CL	3/5 7/9	Sandy clay 20% fine sand Light grey mottled with brownish yellow		
SM	1/2 3/3	Silty sand	33.4	
	3/5 /5	Light grey mottled with brownish yellow	41.3	
		*Light grey and brownish yellow		

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 124 DATE DRILLED 7/10/82

STUDY AREA Active Burning Grounds

ELEVATION TOP OF STEEL CASING = 186.16 ft

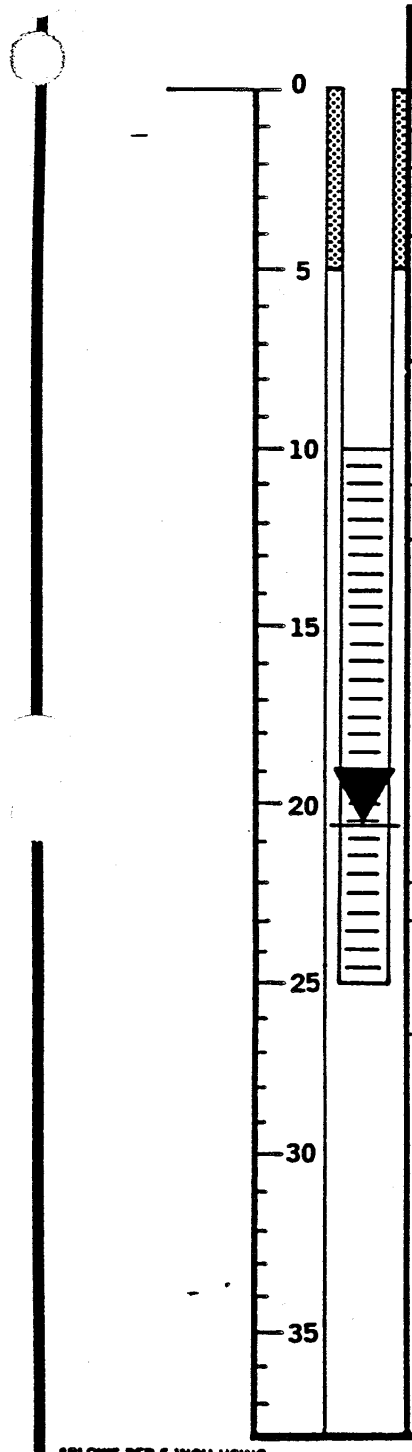
ELEVATION TOP OF PVC RISER = 185.24 ft

ELEVATION OF GROUND SURFACE = 183.05 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SP		Slightly silty sand *		
SM	5/4	Silty sand**	30	
SC	3/5 6/8	Clayey sand Lt. yellowish brown w/yellowish red	30	
SC	5/6 8/11 12/15	Slightly clayey sand Light brownish grey mottled w/yellowish red	15	
SM-		Silty sand Light brownish grey	20	
		Transition to	46.7	
SM	5/9 8/7 9/8	Very silty sand Light brownish grey	45	
		Clayey silt w/seams of sandy clay 40% fine sand	89.9	
ML + CL	3/6 6/8 9/10	Light yellowish brown mottled w/yellowish red	98.1	
			80.3	
	3/4 8/8			
SM	11/10	Silty sand	38.0	9.1×10^{-3} ft/min
CL	4/5 /7	Sandy clay 5-15% fine sand Light yellowish brown mottled w/yellowish red	93.8	
		* Dark yellowish brown		

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 125 DATE DRILLED 6/10/82

STUDY AREA Active Burning Grounds

ELEVATION TOP OF STEEL CASING = 196.04 ft

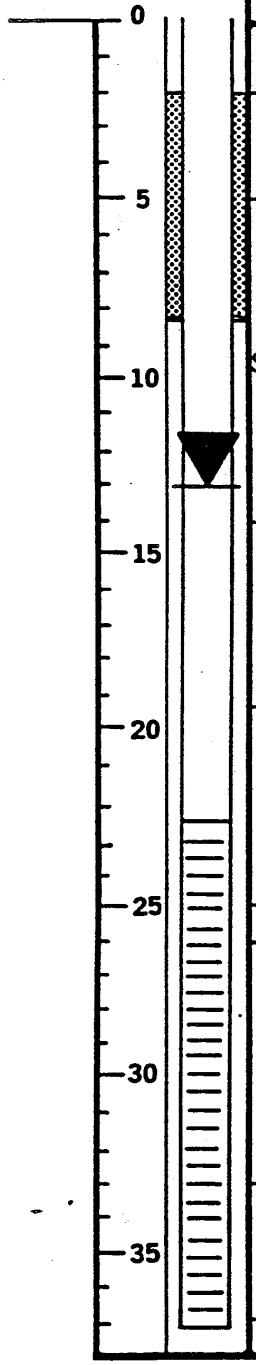
ELEVATION TOP OF PVC RISER = 194.99 ft

ELEVATION OF GROUND SURFACE = 193.01 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM	2/2 2/4	Clayey silty sand Lt. yellowish brown w/strong brown	20	
CL		Slightly sandy clay 15% fine sand		
SM-SC	12/20 /20 12/12 15/15	Slightly cemented & highly compacted clayey silty sand 15% silt 7% clay Pinkish grey mottled w/strong brown	22.0	
SM	7/9 9/11	Silty sand Pinkish grey mottled w/strong brown	20	
CL	15/18 19/20	Slightly sandy clay w/seams of silty sand Pinkish grey mottled w/strong brown		
SM		Slightly clayey silty sand		
CL	10/10 12/12 5/10 11/12	Slightly sandy clay 7% fine sand Pinkish grey mottled w/strong brown		
SM	 1/0 0/0	Silty sand Pinkish grey	15	

*BLOWS PER 6 INCH USING 18, 24, or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 126 DATE DRILLED 6/28/82

TUDY AREA Active Burning Grounds

ELEVATION TOP OF STEEL CASING = 199.10 ft

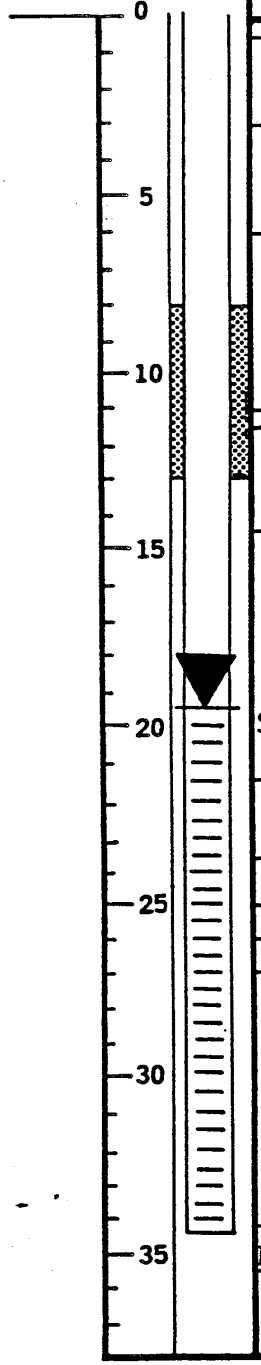
ELEVATION TOP OF PVC RISER = 198.68 ft

ELEVATION OF GROUND SURFACE = 196.21 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND



VISUAL U/S	BLOW COUNT*	MATERIAL CLASSIFICATION	% FINES	AQUIFER PERMEABILITY
SM		Silty sand		
SM	4/5 /4	Very silty sand Strong brown	30	
CL	4/5	Very sandy clay 40% fine sand Pale brown & red		
SC	11/12	Clayey sand Light grey mottled with yellowish brown	20	
SM	4/7	Silty sand		
SC	9/10	Clayey sand Light grey mottled with yellowish brown	20	
SM to SM-SP	7/7 9/9	Silty sand Very pale brown mottled with strong brown	15 12.4	9.7 x 10^{-3} ft/min
SC	3/3 3/3	Clayey sand Very pale brown mottled with strong brown		
CL		Sandy clay seam		
SM		Silty sand-lt. yellowish brown	31.2	
CL	10/14 7/7	Slightly sandy clay 15% fine sand		
ML	2/3 2/4	Clayey sandy silt 35% fine sand Light grey mottled with yellowish brown	74.4 61.9	
SM & ML-CL	7/10 /15	Clayey silt seams	65.7	

*BLOWS PER 6 INCH USING 18, 24 or 36 SPLITSPOON

VERTICAL SCALE 1" = 5.0'

WELL 129 DATE DRILLED 7/10/82

STUDY AREA Active Burning Grounds

ELEVATION TOP OF STEEL CASING = 196.93 ft

ELEVATION TOP OF PVC RISER = 196.38 ft

ELEVATION OF GROUND SURFACE = 194.06 ft

SOURCE: ENVIRONMENTAL PROTECTION SYSTEMS, INC. - 1983

CONTAMINATION SURVEY
LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS

U. S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

APPENDIX F

EISB Substrate Calculation Sheets

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Phase I: Summary of EISB Loading/Injection - Pilot Tests
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Injection Area ID	Number of Points	KB-1 Plus Volume per Point (liter/point)	Total KB-1 Plus Volume (liters)	KB-1 Primer (gallons/point)	Total KB-1 Primer (gallons)
Pilot Test Area 1	24	1.5	36	125	3000
Pilot Test Area 2	5	2	10	125	625
Pilot Test Area 3	9	2	18	125	1125
TOTAL			***64***		***4750***

Quantities Required:

KB-1 Plus			
Total Volume of Diluted KB-1 Plus Required for Pilot Tests:	64	liter	
KB-1 Plus Dilution Ratio:	10	to	1
Total Volume of Concentrated KB-1 Plus Required for Pilot Tests:	*6.4*	*liter*	
KB-1 Primer			
Total KB-1 Primer Required for Pilot Tests:	4750	gallons	
KB-1 Primer Grams per Gallon of Water Ratio:	3.2	grams/gallon	
Total Mass of KB-1 Primer Required for Pilot Tests:	15,200	grams	
Total Mass of KB-1 Primer Required for Pilot Tests:	*34*	*pounds*	

Injection Area ID	Number of Points	Approximate Target Area (square feet)	Target Total Treatment Thickness (feet)	Bulk Volume (BV) (cubic feet)	Effective Porosity (n_e) (%)	Total Pore Volume (PV) in Target Area (cubic feet)	Total Pore Volume (PV) in Target Area (gallons)	Total Pore Volume (PV) in Target Area (liters)
Pilot Test Area 1	24	7,500	12	90,000	25%	22,500	168,312	637,129
Pilot Test Area 2	5	2,450	12	29,400	25%	7,350	54,982	208,129
Pilot Test Area 3	9	2,800	20	56,000	25%	14,000	104,727	396,436
Total	***-***	***12,750***	***-***	***175,400***	***-***	***43,850***	***328,021***	***1,241,693***

Injection Area ID	Dose as Vegetable Oil (grams/liter in PV)	EDS-ER™ (pounds)*1*	TersOx™ Nutrients-QR dose (grams/liter in PV)	TersOx™ Nutrients-QR (pounds)	Sodium bicarbonate (grams/liter in PV)	Sodium bicarbonate (pounds)
Pilot Test Area 1	8	12,083	0.2	281	1.0	1,405
Pilot Test Area 2	8	3,947	0.2	92	1.0	459
Pilot Test Area 3	10	9,398	0.2	175	1.0	874
Subtotal	***-***	***25,428***	***-***	***547***	***-***	***2,737***
Available Quantity/Units		420		25		50
Units		pounds/drum		pounds/pail		pounds/bag
Required Quantities		61		22		55
Units		Drums		Pails		Bags
Shipped Quantities		***25,620***		***550***		***2,750***
Units		***pounds***		***pounds***		***pounds***

1 - assumes EDS-ER @ 93%

Phase I: Summary of EISB Loading/Injection - Pilot Tests
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Radius of Influence (ROI) Confirmation

Injection Area ID	Approximate Target Area (square feet)	Number of Points	Treatment Area per Point (square feet)	Estimated Radius of Influence (ROI, feet)
Pilot Test Area 1	7,500	24	313	10.0
Pilot Test Area 2	2,450	5	490	12.5
Pilot Test Area 3	2,800	9	312	10.0

Suggested Water Requirements

Injection Area ID	Approximate Target Area (square feet)	Number of Points	Pore Volume Replacement (%)	*Total Water Required (gallons)*
Pilot Test Area 1	7,500	24	35%	*58,910*
Pilot Test Area 2	2,450	5	35%	*19,244*
Pilot Test Area 3	2,800	9	35%	*36,655*

Suggested Material Allocation per Point

Injection Area ID	EDS-ER™ (pounds)	EDS-ER % by Weight	*EDS-ER™ (~ gallons/point)**	TersOx™ Nutrients-QR % by Weight	*TersOx™ Nutrients-QR (~pounds/point)***	Sodium bicarbonate by Weight	*Sodium bicarbonate (~pounds/point)***
Pilot Test Area 1	12,083	47.5%	*65*	51.3%	*11.8*	51.3%	*58.8*
Pilot Test Area 2	3,947	15.5%	*103*	16.8%	*18.4*	16.8%	*92.2*
Pilot Test Area 3	9,398	37.0%	*136*	31.9%	*19.5*	31.9%	*97.6*

*EDS-ER™, approximate gallons per point for each area = ((Shipped Quantities. x EDS-ER % by weight for Area) / Number of Points) / Density of EDS-ER)
**TersOx™ Nutrients-QR and Sodium Bicarbonate (~ pounds/point) = ((Shipped lbs. x % by weight for Area) / Number of Points)

Phase I: Summary of EISB Loading/Injection - EISB Grid Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Injection Area ID	Number of Points	KB-1 Plus Volume per Point (liter/point)	Total KB-1 Plus Volume (liters)	KB-1 Primer (gallons/point)	Total KB-1 Primer (gallons)
EISB Grid 1A	825	1.5	1237.5	125	103,125
EISB Grid 1B	437	1.5	655.5	125	54,625
EISB Grid 1C	16	1.5	24	125	2,000
EISB Grid 1D	16	1.5	24	125	2,000
EISB Grid 2	912	1	912	125	114,000
EISB Grid 3	68	1	68	125	8,500
EISB Grid 4 - Wilcox Formation	16	1	16	125	2,000
ESIB Grid 4 - Shallow Zone	25	1	25	125	3,125
TOTAL			***2,962***		***289,375***

Quantities Required:

KB-1 Plus			
Total Volume of Diluted KB-1 Plus Required for Pilot Tests:		2,962	liter
KB-1 Plus Dilution Ratio:	10 to	1	
Total Volume of Concentrated KB-1 Plus Required for Pilot Tests:		*296.2*	*liter*
KB-1 Primer			
Total KB-1 Primer Required for Pilot Tests:		289,375	gallons
KB-1 Primer Grams per Gallon of Water Ratio:		3.2	grams/gallon
Total Mass of KB-1 Primer Required for Pilot Tests:		926,000	grams
Total Mass of KB-1 Primer Required for Pilot Tests:		*2038*	*pounds*

Injection Area ID	Number of Points	Approximate Target Area (square feet)	Target Total Treatment Thickness (feet)	Bulk Volume (BV) (cubic feet)	Effective Porosity (n_e) (%)	Total Pore Volume (PV) in Target Area (cubic feet)	Total Pore Volume (PV) in Target Area (gallons)	Total Pore Volume (PV) in Target Area (liters)
EISB Grid 1A	825	329,900	20	6,598,000	25%	1,649,500	12,339,118	46,708,620
EISB Grid 1B	437	174,900	23	4,022,700	25%	1,005,675	7,522,972	28,477,533
EISB Grid 1C	16	6,400	23	147,200	25%	36,800	275,283	1,042,060
EISB Grid 1D	16	6,400	23	147,200	25%	36,800	275,283	1,042,060
EISB Grid 2	912	364,800	12	4,377,600	25%	1,094,400	8,186,681	30,989,944
EISB Grid 3	68	27,200	8	217,600	25%	54,400	406,940	1,540,436
EISB Grid 4 - Wilcox Formation	16	6,400	20	128,000	25%	32,000	239,377	906,139
ESIB Grid 4 - Shallow Zone	25	10,000	12	120,000	25%	30,000	224,416	849,505
Total	***-***	***926,000***	***-***	***15,758,300***	***-***	***3,939,575***	***29,470,070***	***111,556,296***

Phase I: Summary of EISB Loading/Injection - EISB Grid Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Injection Area ID	Dose as Vegetable Oil (grams/liter in PV)	Soybean Oil (pounds)	TASK™ MicroEVO™ Self-Emulsifier (pounds)[1]	TersOx™ Nutrients-QR dose (grams/liter in PV)	TersOx™ Nutrients-QR (pounds)	Sodium bicarbonate (grams/liter in PV)	Sodium bicarbonate (pounds)
EISB Grid 1A	8	823,800	62,006	0.2	20,595	1.0	102,975
EISB Grid 1B	8	502,258	37,804	0.2	12,556	1.0	62,782
EISB Grid 1C	8	18,379	1,383	0.2	459	1.0	2,297
EISB Grid 1D	8	18,379	1,383	0.2	459	1.0	2,297
EISB Grid 2	8	546,570	41,140	0.2	13,664	1.0	68,321
EISB Grid 3	8	27,169	2,045	0.2	679	1.0	3,396
EISB Grid 4 - Wilcox Formation	8	15,982	1,203	0.2	400	1.0	1,998
ESIB Grid 4 - Shallow Zone	8	14,983	1,128	0.2	375	1.0	1,873
Subtotal	**-**	***1,967,518***	***148,093***	**-**	***49,188***	**-**	***245,940***
Available Quantity/Units		48,000	430		25		50
Units		pounds/bulk tanker	pounds/drums		pounds/pail		pounds/bag
Required Quantities		*41*	*345*		*1,968*		*4,919*
Units		bulk tanker	drums		Pails		Bags
Shipped Quantities		***1,968,000***	***148,350***		***49,200***		***245,950***
Units		***pounds***	***pounds***		***pounds***		***pounds***

1- Based on 7 parts TASK™ MicroEVO™ Self-Emulsifier to 93 parts soybean Oil ratio

Radius of Influence (ROI) Confirmation

Injection Area ID	Approximate Target Area (square feet)	Number of Points	Treatment Area per Point (square feet)	Estimated Radius of Influence (ROI, feet)
EISB Grid 1A	329,900	825	400	11.3
EISB Grid 1B	174,900	437	401	11.3
EISB Grid 1C	6,400	16	400	11.3
EISB Grid 1D	6,400	16	400	11.3
EISB Grid 2	364,800	912	400	11.3
EISB Grid 3	27,200	68	400	11.3
EISB Grid 4 - Wilcox Formation	6,400	16	400	11.3
ESIB Grid 4 - Shallow Zone	10,000	25	400	11.3

Phase I: Summary of EISB Loading/Injection - EISB Grid Areas
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Suggested Water Requirements

Injection Area ID	Approximate Target Area (square feet)	Number of Points	Pore Volume Replacement (%)	*Total Water Required (gallons)*
EISB Grid 1A	329,900	825	35%	*4,318,692*
EISB Grid 1B	174,900	437	35%	*2,633,041*
EISB Grid 1C	6,400	16	35%	*96,350*
EISB Grid 1D	6,400	16	35%	*96,350*
EISB Grid 2	364,800	912	35%	*2,865,339*
EISB Grid 3	27,200	68	35%	*142,430*
EISB Grid 4 - Wilcox Formation	6,400	16	35%	*83,782*
ESIB Grid 4 - Shallow Zone	10,000	25	35%	*78,546*

Suggested Material Allocation per Point

Injection Area ID	Number of Points	Total Soybean Oil + Emulsifier (pounds)	*Soybean Oil + Emulsifier (~ gallons/point)**	Total TersOx™ Nutrients-QR (pounds)	*TersOx™ Nutrients-QR (~pounds/point)***	Total Sodium bicarbonate (pounds)	*Sodium bicarbonate (~pounds/point)***
EISB Grid 1A	825	885,806	*141*	20,595	*25.0*	102,975	*124.8*
EISB Grid 1B	437	540,062	*163*	12,556	*28.7*	62,782	*143.7*
EISB Grid 1C	16	19,762	*163*	459	*28.7*	2,297	*143.6*
EISB Grid 1D	16	19,762	*163*	459	*28.7*	2,297	*143.6*
EISB Grid 2	912	587,709	*85*	13,664	*15.0*	68,321	*74.9*
EISB Grid 3	68	29,214	*57*	679	*10.0*	3,396	*49.9*
EISB Grid 4 - Wilcox Formation	16	17,184	*141*	400	*25.0*	1,998	*124.9*
ESIB Grid 4 - Shallow Zone	25	16,110	*85*	375	*15.0*	1,873	*74.9*

*Soybean Oil + Emulsifier, approximate gallons per point for each area = (Soybean Oil + Emulsifier in pounds) / Number of Points / Density of Soybean Oil + Emulsifier)
**TersOx™ Nutrients-QR and Sodium Bicarbonate (~ pounds/point) = (pounds for Area) / Number of Points)

Phase I: Summary of EISB Loading/Injection - EISB Biobarriers
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Injection Area ID	Number of Points	KB-1 Plus Volume per Point (liter/point)	Total KB-1 Plus Volume (liters)	KB-1 Primer (gallons/point)	Total KB-1 Primer (gallons)
Shallow Zone EISB Biobarrier 1	37	1	37	125	4,625
Shallow Zone EISB Biobarrier 2 - IW	92	1	92	125	11,500
Shallow Zone EISB Biobarrier 2 - DPT	34	1	34	125	4,250
Wilcox Formation EISB Biobarrier 1	31	2	62	125	3,875
Wilcox Formation EISB Biobarrier 2	26	2	52	125	3,250
Wilcox Formation EISB Biobarrier 3	25	2	50	125	3,125
TOTAL			***327***		***30,625***

Quantities Required:

KB-1 Plus			
Total Volume of Diluted KB-1 Plus Required for Pilot Tests:	327	liter	
KB-1 Plus Dilution Ratio:	10	to	1
Total Volume of Concentrated KB-1 Plus Required for Pilot Tests	*32.7*	*liter*	
KB-1 Primer			
Total KB-1 Primer Required for Pilot Tests:	30625	gallons	
KB-1 Primer Grams per Gallon of Water Ratio:	3.2	grams/gallon	
Total Mass of KB-1 Primer Required for Pilot Tests:	98,000	grams	
Total Mass of KB-1 Primer Required for Pilot Tests:	*216*	*pounds*	

Injection Area ID	Number of Points	Length (feet)	Approximate Target Area (square feet)*	Target Total Treatment Thickness (feet)	Bulk Volume (BV) (cubic feet)	Effective Porosity (n_e) (%)	Total Pore Volume (PV) in Target Area (cubic feet)	Total Pore Volume (PV) in Target Area (gallons)	Total Pore Volume (PV) in Target Area (liters)
Shallow Zone EISB Biobarrier 1	37	925	11,563	12	138,750	25%	34,688	259,481	982,240
Shallow Zone EISB Biobarrier 2 - IW	92	2,300	28,750	11	316,250	25%	79,063	591,429	2,238,800
Shallow Zone EISB Biobarrier 2 - DPT	34	680	8,500	11	93,500	25%	23,375	174,857	661,906
Wilcox Formation EISB Biobarrier 1	31	620	7,750	20	155,000	25%	38,750	289,870	1,097,277
Wilcox Formation EISB Biobarrier 2	26	520	6,500	20	130,000	25%	32,500	243,117	920,297
Wilcox Formation EISB Biobarrier 3	25	500	6,250	20	125,000	25%	31,250	233,766	884,901
Total	***-***		***69,313***	***-***	***958,500***	***-***	***239,625***	***1,792,520***	***6,785,422***

* Estimated by multiplying 12.5 feet of treatment width of wall perpendicular to groundwater flow.

Summary of EISB Loading/Injection - EISB Biobarriers Former
Longhorn Army Ammunition Plant (LHAAP) 18/24 Burning
Ground No. 3 and Unlined Evaporation Pond Karnack, Texas

Injection Area ID	Dose as Vegetable Oil (grams/liter in PV)	Soybean Oil (pounds)	TASK™ MicroEVO™ Self-Emulsifier (pounds)[1]	TersOx™ Nutrients-QR dose (grams/liter in PV)	TersOx™ Nutrients-QR (pounds)	Sodium bicarbonate (grams/liter in PV)	Sodium bicarbonate (pounds)
Shallow Zone EISB Biobarrier 1	9.5	20,572	1,548	0.2	433	1.0	2,165
Shallow Zone EISB Biobarrier 2 - IW	9.5	46,889	3,529	0.2	987	1.0	4,936
Shallow Zone EISB Biobarrier 2 - DPT	9.5	13,863	1,043	0.2	292	1.0	1,459
Wilcox Formation EISB Biobarrier 1	9.5	22,981	1,730	0.2	484	1.0	2,419
Wilcox Formation EISB Biobarrier 2	9.5	19,275	1,451	0.2	406	1.0	2,029
Wilcox Formation EISB Biobarrier 3	9.5	18,533	1,395	0.2	390	1.0	1,951
Subtotal	***-***	***142,113***	***10,697***	***-***	***2,992***	***-***	***14,959***
Available Quantity/Units		48,000	430		25		50
Units		pounds/bulk tanker	pounds/drums		pounds/pail		pounds/bag
Required Quantities		*3*	*25*		*120*		*300*
Units		bulk tanker	drums		Pails		Bags
Shipped Quantities		***144,000***	***10,750***		***3,000***		***15,000***
Units		***pounds***	***pounds***		***pounds***		***pounds***

1- Based on 7 parts TASK™ MicroEVO™ Self-Emulsifier to 93 parts soybean Oil ratio

Radius of Influence (ROI) Confirmation

Injection Area ID	Approximate Target Area (square feet)	Number of Points	Treatment Area per Point (square feet)	Estimated Radius of Influence (ROI, feet)
Shallow Zone EISB Biobarrier 1	11,563	37	313	10.0
Shallow Zone EISB Biobarrier 2 - IW	28,750	92	313	10.0
Shallow Zone EISB Biobarrier 2 - DPT	8,500	34	250	8.9
Wilcox Formation EISB Biobarrier 1	7,750	31	250	8.9
Wilcox Formation EISB Biobarrier 2	6,500	26	250	8.9
Wilcox Formation EISB Biobarrier 3	6,250	25	250	8.9

Phase I: Summary of EISB Loading/Injection - EISB Biobarriers
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Suggested Water Requirements

Injection Area ID	Approximate Target Area (square feet)	Number of Points	Pore Volume Replacement (%)	*Total Water Required (gallons)*
Shallow Zone EISB Biobarrier 1	11,563	37	35%	*90,819*
Shallow Zone EISB Biobarrier 2 - IW	28,750	92	35%	*207,001*
Shallow Zone EISB Biobarrier 2 - DPT	8,500	34	35%	*61,201*
Wilcox Formation EISB Biobarrier 1	7,750	31	35%	*101,455*
Wilcox Formation EISB Biobarrier 2	6,500	26	35%	*85,091*
Wilcox Formation EISB Biobarrier 3	6,250	25	35%	*81,819*

Suggested Material Allocation per Point

Injection Area ID	Number of Points	Total Soybean Oil + Emulsifier (pounds)	*Soybean Oil + Emulsifier (~ gallons/point)**	Total TersOx™ Nutrients-QR (pounds)	*TersOx™ Nutrients-QR (~pounds/point)***	Total Sodium bicarbonate (pounds)	*Sodium bicarbonate (~pounds/point)***
Shallow Zone EISB Biobarrier 1	37	22,120	*79*	433	*11.7*	2,165	*58.5*
Shallow Zone EISB Biobarrier 2 - IW	92	50,419	*72*	987	*10.7*	4,936	*53.6*
Shallow Zone EISB Biobarrier 2 - DPT	34	14,906	*58*	292	*8.6*	1,459	*42.9*
Wilcox Formation EISB Biobarrier 1	31	24,711	*105*	484	*15.6*	2,419	*78.0*
Wilcox Formation EISB Biobarrier 2	26	20,725	*105*	406	*15.6*	2,029	*78.0*
Wilcox Formation EISB Biobarrier 3	25	19,928	*105*	390	*15.6*	1,951	*78.0*

*Soybean Oil + Emulsifier, approximate gallons per point for each area = (Soybean Oil + Emulsifier in pounds) / Number of Points / Density of Soybean Oil + Emulsifier)
**TersOx™ Nutrients-QR and Sodium Bicarbonate (~ pounds/point) = (pounds for Area) / Number of Points)

Injection Duration Calculation Worksheet
Former Longhorn Army Ammunition Plant (LHAAP) 18/24
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Injection Parameters	Units	Pilot tests			EISB Grid Injection								EISB Biobarrier Injection					
		Pilot Test Area 1	Pilot Test Area 2	Pilot Test Area 3	EISB Grid 1A	EISB Grid 1B	EISB Grid 1C	EISB Grid 1D	EISB Grid 2	EISB Grid 3	EISB Grid 4 - Wilcox Formation	ESIB Grid 4 - Shallow Zone	Shallow Zone EISB Biobarrier 1	Shallow Zone EISB Biobarrier 2 - IW	Shallow Zone EISB Biobarrier 2 - DPT	Wilcox Formation EISB Biobarrier 1	Wilcox Formation EISB Biobarrier 2	Wilcox Formation EISB Biobarrier 3
		DPT	IW	DPT	DPT	DPT	DPT	DPT	DPT	DPT	DPT	DPT	IW	IW	DPT	DPT	DPT	DPT
Injection Spacing	feet	20	25	20	20	20	20	20	20	20	20	20	25	25	20	20	20	20
Target Depth (feet below ground surface)	feet below ground surface	40	38	50	43	41	41	41	37	33	50	25	38	27	27	65	50	60
Thickness	feet	12	12	20	20	23	23	23	12	8	20	12	12	11	11	20	20	20
Number of Points	#	24	5	9	825	437	16	16	912	68	16	25	37	92	34	31	26	25
Substrate Loading/Injection																		
Total Weight of Concentrated Substrate	pounds	12,083	3,947	9,398	885,806	540,062	19,762	19,762	587,709	29,214	17,184	16,110	22,120	50,419	14,906	24,711	20,725	19,928
Total Volume of Concentrated Substrate	gallons	1,560	510	1,213	116,554	71,061	2,601	2,601	77,331	3,844	2,262	2,120	2,911	6,635	1,962	3,252	2,728	2,623
Dilution Ratio of Substrate with Water	By Volume	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1	10:1
Volume of Diluted Substrate (with water)	gallons	15,600	5,100	12,130	1,165,540	710,610	26,010	26,010	773,310	38,440	22,620	21,200	29,110	66,350	19,620	32,520	27,280	26,230
Culture/Aerobic Water																		
Volume of KB-1 Plus	liters	36	10	18	1238	656	24	24	912	68	16	25	37	92	34	62	52	50
Volume of KB-1 Primer	gallons	3,000	625	1,125	103,125	54,625	2,000	2,000	114,000	8,500	2,000	3,125	4,625	11,500	4,250	3,875	3,250	3,125
Total Volume of Substrate + Culture/Anerobic Water	***gallons***	***18,737***	***5,763***	***13,324***	***1,273,350***	***767,717***	***28,101***	***28,101***	***890,763***	***47,198***	***24,681***	***24,420***	***33,876***	***78,199***	***23,999***	***36,630***	***30,727***	***29,545***
Total Volume per Point	gallons	781	1,153	1,480	1,543	1,757	1,756	1,756	977	694	1,543	977	916	850	706	1,182	1,182	1,182
Volume per foot	gallons	65	96	74	77	76	76	76	81	87	77	81	76	77	64	59	59	59
Injection Rate	gallons per minute (gpm)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Injection Pressure (not to exceed)	pounds per square inch (psi)	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
Time per Point	hours	4.4	6.5	8.3	8.6	9.8	9.8	9.8	5.5	3.9	8.6	5.5	5.1	4.8	4.0	6.6	6.6	6.6
Simultaneous Points	points	4	4	4	8	8	4	4	8	4	4	4	4	4	4	4	4	4
Hours of Injection per day	hours	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Gallons per day	gallons	5,760	5,760	5,760	11,520	11,520	5,760	5,760	11,520	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760	5,760
Days of Injection (rounded up to nearest full day)	days	4	2	3	111	67	5	5	78	9	5	5	6	14	5	7	6	6
TOTAL	**Days**	**9**			**285**								**44**					

EISB Backup Information and Material Safety Data Sheets

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond Karnack, Texas

Tersus Opportunity No. Q22-3867

Amendment Quantity Estimate
Longhorn Army Ammunition Plant
Karnack, TX
EISB Pilot Test Areas

Treat Location and Description	PT-1 Area	PT-2 Area	PT-3 Area	Total	
	24 DPT Points	5 Injection Wells	9 DPT Points		
Treatment Area (A, ft^2)	3,375	2,800	2,800	8,975	ft^2
Target Total Treatment Thickness (z, ft)	12	12	20	n/a	ft
Bulk Volume (V_B, ft^3)	40,500	33,600	56,000	130,100	ft^3
Effective Porosity (n_e, %)	25%	25%	25%	n/a	%
Total Pore Volume in Target Area (PV, ft^3)	10,125	8,400	14,000	32,525	ft^3
Total Pore Volume in Target Area (PV, gallons)	75,740	62,836	104,727	243,304	gallons
Total Pore Volume in Target Area (PV, liters)	286,708	237,861	396,435	921,004	liters

Description	PT-1 Area	PT-2 Area	PT-3 Area	Subtotal	Units	Qty	Units	Shipped lbs.
Dose as Vegetable Oil (g/L in PV)	*8.0*	*8.0*	*10.0*	*n/a*	*g/L*			
EDS-ER™ (lbs.)	5,437	4,511	9,398	19,346	lbs.	47	Drums	19,740
TersOx™ Nutrients-QR dose (g/L in PV)	*0.2*	*0.2*	*0.2*	*n/a*	*g/L*			
TersOx™ Nutrients-QR (lbs.)	126	105	175	406	lbs.	17	25 lb. Pails	425
Sodium bicarbonate (g/L)	*1.0*	*1.0*	*1.0*	*n/a*	*g/L*			
Sodium bicarbonate (lbs.)	632	524	874	2,030	lbs.	41	50-lb bags	2,050
Number of Points	**24**	**5**	**9**					
Treatment Area per Point (ft^2)	141	560	311					
Radius of Influence (ROI, ft)	6.7	13.4	10.0					
Suggested Water Requirements								
Pour Volume Replacement (%)	*35%*	*35%*	*35%*					
Water Required (gallons)	26,509	21,993	36,655					
Suggested Material Allocation per Point								
EDS-ER™, approximate gallons per point	30	119	137					
TersOx™ Nutrients-QR, approximate lbs. per point	5.5	22.0	20.3					
Sodium bicarbonate, lbs. approximate per point	26.6	105.9	98.0					

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Tersus Opportunity No. Q22-3867

Amendment Quantity Estimate
Longhorn Army Ammunition Plant
Karnack, TX
EISB Treatment Grids

Treat Location and Description	EISB Area 1	EISB Area 2	EISB Area 3	EISB Area 4 - Wilcox	EISB Area 4 - Shallow	Total	
	1,251 Injection Points	875 Injection Points	63 Injection Points	15 Injection Points	25 Injection Points		
Treatment Area (A, ft^2)	500,500	350,000	2,500	2,800	2,800	858,600	ft^2
Target Total Treatment Thickness (z, ft)	15	12	8	20	20	n/a	ft
Bulk Volume (V_B, ft^3)	7,507,500	4,200,000	20,000	56,000	56,000	11,839,500	ft^3
Effective Porosity (n_e, %)	25%	25%	25%	25%	25%	n/a	%
Total Pore Volume in Target Area (PV, ft^3)	1,876,875	1,050,000	5,000	14,000	14,000	2,959,875	ft^3
Total Pore Volume in Target Area (PV, gallons)	14,040,001	7,854,546	37,403	104,727	104,727	22,141,404	gallons
Total Pore Volume in Target Area (PV, liters)	53,147,094	29,732,640	141,584	396,435	396,435	83,814,188	liters

Description	EISB Area 1	EISB Area 2	EISB Area 3	EISB Area 4 - Wilcox	EISB Area 4 - Shallow	Subtotal	Units	Qty	Units	Shipped lbs.
Dose as Vegetable Oil (g/L in PV)	*8.0*	*8.0*	*8.0*	*8.0*	*8.0*	*n/a*	*g/L*			
Soybean Oil (lbs.)	937,353	524,393	2,497	6,992	6,992	1,478,227	lbs.	31	Bulk Tankers, 48,000 lbs. ea.	1,488,000
TASK™ MicroEVO™ Self-Emulsifier (lbs.)	70,553	39,470	188	526	526	111,264	lbs.	260	Drums	111,540
TersOx™ Nutrients-QR dose (g/L in PV)	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*n/a*	*g/L*			
TersOx™ Nutrients-QR (lbs.)	23,434	13,110	62	175	175	36,956	lbs.	1479	25 lb. Pails	36,975
Sodium bicarbonate (g/L)	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*n/a*	*g/L*			
Sodium bicarbonate (lbs.)	117,169	65,549	312	874	874	184,778	lbs.	3696	50-lb bags	184,800
Number of Points	**1251**	**875**	**63**	**15**	**25**					
Treatment Area per Point (ft^2)	400	400	40	187	112					
Radius of Influence (ROI, ft)	11.3	11.3	3.6	7.7	6.0					
Suggested Water Requirements										
Pour Volume Replacement (%)	*35%*	*35%*	*35%*	*35%*	*35%*					
Water Required (gallons)	4,914,000	2,749,091	13,091	36,655	36,655					
Suggested Material Allocation per Point										
EDS-ER™, approximate gallons per point	105	84	6	65	39					
TersOx™ Nutrients-QR, approximate lbs. per point	18.7	15.0	1.0	11.7	7.0					
Sodium bicarbonate, lbs. approximate per point	93.7	74.9	5.0	58.3	35.0					

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Tersus Opportunity No. Q22-3867

Amendment Quantity Estimate
Longhorn Army Ammunition Plant
Karnack, TX
EISB Biobarriers

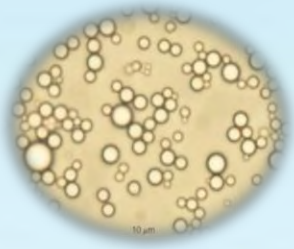
Treat Location and Description	EISB Shallow Wall 1 - IW	EISB Shallow Wall 2 - IW	EISB Shallow Wall 2 - DPT	EISB Wilcox Wall 1	EISB Wilcox Wall 2	EISB Wilcox Wall 3	Total	
	32 Injection Points	91 Injection Points	31 Injection Points	26 Injection Points	21 Injection Points	20 Injection Points		
Length (ft)	900	2240	760	625	500	475	n/a	ft
Width of wall perpendicular to groundwater flow (ft)	*12.5*	*12.5*	*12.5*	*12.5*	*12.5*	*12.5*	n/a	ft
Treatment Area (A, ft^2)	11,250	28,000	9,500	7,813	6,250	5,938	68,750	ft^2
Target Total Treatment Thickness (z, ft)	12	11	11	20	20	20	n/a	ft
Bulk Volume (V_B, ft^3)	135,000	308,000	104,500	156,250	125,000	118,750	947,500	ft^3
Effective Porosity (n_e, %)	25%	25%	25%	25%	25%	25%	n/a	%
Total Pore Volume in Target Area (PV, ft^3)	33,750	77,000	26,125	39,063	31,250	29,688	236,875	ft^3
Total Pore Volume in Target Area (PV, gallons)	252,468	576,000	195,429	292,208	233,766	222,078	1,771,948	gallons
Total Pore Volume in Target Area (PV, liters)	955,692	2,180,394	739,776	1,106,125	884,900	840,655	6,707,542	liters

Description	EISB Shallow Wall 1 - IW	EISB Shallow Wall 2 - IW	EISB Shallow Wall 2 - DPT	EISB Wilcox Wall 1	EISB Wilcox Wall 2	EISB Wilcox Wall 3	Subtotal	Units	Qty	Units	Shipped lbs.
Dose as Vegetable Oil (g/L in PV)	*9.5*	*9.5*	*9.5*	*9.5*	*9.5*	*9.5*	*n/a*	*g/L*			
Soybean Oil (lbs.)	20,016	45,666	15,494	23,167	18,533	17,607	140,482	lbs.	3	Bulk Tankers, 48,000 lbs. ea.	144,000
TASK™ MicroEVO™ Self-Emulsifier (lbs.)	1,507	3,437	1,166	1,744	1,395	1,325	10,574	lbs.	25	Drums	10,725
TersOx™ Nutrients-QR dose (g/L in PV)	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*n/a*	*g/L*			
TersOx™ Nutrients-QR (lbs.)	421	961	326	488	390	371	2,958	lbs.	119	25 lb. Pails	2,975
Sodium bicarbonate (g/L)	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*	*n/a*	*g/L*			
Sodium bicarbonate (lbs.)	2,107	4,807	1,631	2,439	1,951	1,853	14,788	lbs.	296	50-lb bags	14,800
Number of Points	**32**	**91**	**31**	**26**	**21**	**20**					
Treatment Area per Point (ft^2)	352	308	306	300	298	297					
Radius of Influence (ROI, ft)	10.6	9.9	9.9	9.8	9.7	9.7					
Suggested Water Requirements											
Pour Volume Replacement (%)	*35%*	*35%*	*35%*	*35%*	*35%*	*35%*					
Water Required (gallons)	88,364	201,600	68,400	102,273	81,818	77,727					
Suggested Material Allocation per Point											
EDS-ER™, approximate gallons per point	89	71	71	127	125	125					
TersOx™ Nutrients-QR, approximate lbs. per point	13.2	10.6	10.6	18.9	18.7	18.6					
Sodium bicarbonate, lbs. approximate per point	65.9	52.9	52.7	93.9	93.0	92.7					

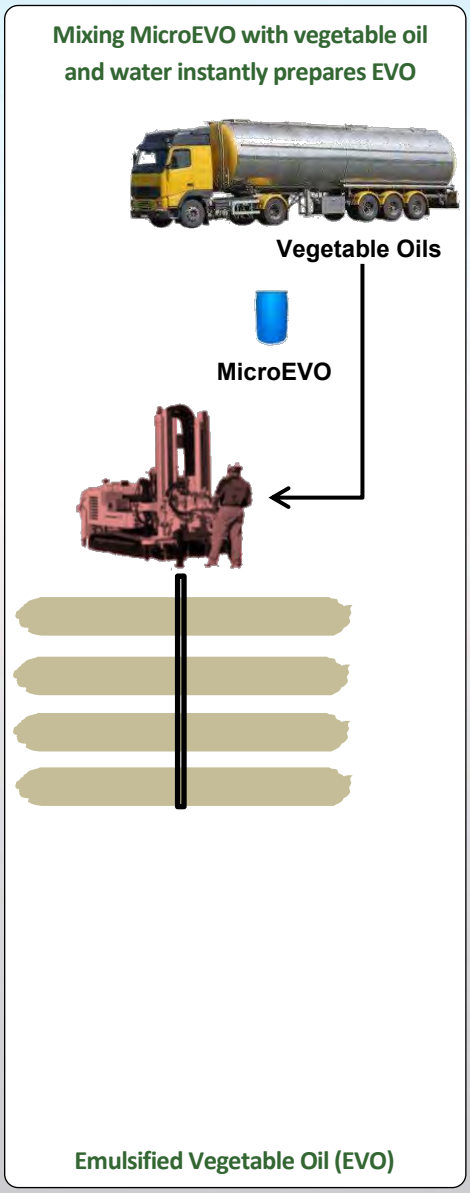
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Tersus Environmental, LLC
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MicroEvo™ Self-Emulsifier



- Emulsify locally procured vegetable oil
- Prepare a high-quality, stable, and small droplet size EVO
- Instant emulsification, standard mixing equipment suffices
- Easy to distribute in the subsurface, long-lasting electron donor
- Sustainable Approach



Principle

MicroEVO™ allows you to reduce costs for emulsified vegetable oil injection. Tersus will supply the emulsifying package, allowing our clients to source the soybean oil locally. Tersus can help you identify suitable soybean oil suppliers. You simply add the products together on site with equipment your injection contractors already own. The cost savings should be significant, as you will not be paying for shipping costs of the oil from a remote location.

Field-prepared EVO using *MicroEVO™* has a median droplet size of approximately one micron. At room temperature, 68 ºF (20 ºC), *MicroEVO™ Self-Emulsifier* is a yellow-amber liquid material with a viscosity of approximately 1,000 centipoise (cP). By comparison, at room temperature soybean oil has a viscosity of 80 cP and pancake syrup has a viscosity of 2,500 cP.

Tersus will ship the self-emulsifying agents to your site and assist you in identifying local suppliers of soybean oil. By purchasing the oil directly, you will dramatically reduce shipping costs and third party mark-up, you will easily comply with local regulations and offer a sustainable EVO alternative, Add emulsifier to the oil in the field (8 parts emulsifier to 92 parts oil), followed with water at a suitable ratio, using a centrifugal pump. The mixture will spontaneously form a Microscale emulsion, ready for injection. Your field crew can inject the micro-emulsion suspension directly or further dilute it according to a predetermined ratio.

Advantages

- Reduced shipping and third-party costs
- Buy Local!
- Simplify regulatory approval process

Field Application Design

Uniform distribution of an electron donor is the key to successfully enhancing anaerobic bioremediation. The correct placement of the product minimizes hot spots around injection points. Unfortunately, excessive amounts of an amendment can create adverse conditions for bacterial growth or for groundwater flow. Effective distribution also ensures that there is sufficient electron donor at the periphery of the radius of influence around injection points, in order to enhance effective bioremediation.

The diluted emulsion has a viscosity essentially equal to that of water. Therefore, Tersus suggests injecting a relatively dilute emulsion in a single step, as the oil droplets move with the injected water. The dilution allows the oil in *MicroEVO™* to

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Rev: 11/14/2018

be distributed over a much larger area around an injection well than would be the case with an injection of undiluted product. The oil droplets may remain suspended in the injection water between a few days and a few weeks after injection. They will then adsorb onto soil surfaces to act as a long-term source of electron donor. Injection points may be temporary or permanent wells or direct-push points.

Product Content

Chemical Name	CAS Number	Composition (% wt)
Food-contact/Food grade Emulsifiers	Proprietary	100

Product Characteristics

Parameter	Specification
Specific Gravity	1.01
Solubility in water	Dispersible
Flash Point	280 °C
Appearance	Liquid amber, mild odor.

Packaging Options

- 55-gallon poly drums
- 275-gallon IBC containers

Safety

No protective equipment is necessary under normal use conditions. All ingredients consist of food or food grade additives.

SAFETY DATA SHEET
TersOx™ Nutrients-QR

Revision date: 2019-06-14
Version 1.0

1. PRODUCT AND COMPANY IDENTIFICATION

Product Identifier

Product Name: TersOx™ Nutrients-QR

Synonyms: Water soluble nitrogen and phosphorus nutrient salt supplement for microbial process

Product Form: Mixture

Recommended use of the chemical and restrictions on use

Recommended Use: For use in stimulating biological activity in soils and sludges
Remediation of contaminated groundwater and soils

Restrictions on Use: Use as recommended by the label

Details of the supplier and of the safety data sheet

Supplier
Tersus Environmental, LLC
1116 Colonial Club Rd
Wake Forest, NC 27587
Phone: +1-919-453-5577
Email: info@tersusenv.com

Contact Person
David F. Alden
Phone: +1-919-453-5577 x2002
Email: david.alden@tersusenv.com

Emergency telephone number

For leak, fire, spill or accident emergencies, call:

+1-919-453-5577 (Tersus Office Hours, 8:00 AM to 5:00 PM Eastern)
+1-800-424-9300 (Chemtrec 24 Hour Service – Emergency Only)
+1-703-527-3887 (Chemtrec Outside United States 24 Hour Service – Emergency Only)
+1-919-638-7892 Gary M. Birk (Outside office hours)

2. HAZARD IDENTIFICATION

Relevant identified uses of the substance or mixture

Hazard Classification	Category	H-statement
Skin irritant	2	H315
Eye irritant	2A	H319
Acute toxicity – Inhalation	4	H332
Specific Target Organ Toxicity – Repeated	2	H371
Mutagenicity	2	H341

Label elements
Hazard Pictograms



Hazard Statements

Causes skin irritation (H315)
Causes serious eye irritation (H319)
Harmful if inhaled (H332)
May cause damage to lungs through prolonged or repeated exposure to inhalation of Urea: Known to cause emphysema (H371)
Urea – suspected of causing genetic defects (H341)

Precautionary statements

P201 – Obtain special instructions before use.
P202 – Do not handle until all safety precautions have been read and understood.
P260 – Do not breathe dust.
P264 – Wash thoroughly after handling.
P270 – Do not eat, drink or smoke when using this product.
P271 – Use only outdoors or in a well-ventilated area.
P280 – Wear protective gloves, clothing, eye, and face protection.
P302 + P352 – IF ON SKIN: Wash with soap and plenty of water.
P304 + P340 – IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P305 + P351 + P338 – IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308 + P311 + P313 – IF exposed or concerned: Call a POISON CENTER or doctor and get medical advice/attention.
P312 – Call a POISON CENTER or doctor if you feel unwell.
P332 + P313 – If skin irritation occurs: Get medical advice/attention.
P337 + P313 – If eye irritation persists: Get medical advice/attention.
P362 + P364 – Take off contaminated clothing and wash it before reuse.
P405 – Store locked up.
P501 – Dispose of contents/container in accordance with local, regional, and federal regulations.

Further information

Persons who have a compromised immune system or a history of severe allergic response should avoid contact and/or breathing dust or mist from product handling or manufacturing processes.

Other hazards

None known.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Formula Mixture

Hazardous components

Chemical Name	Concentration (%)	CAS Number
Urea	<75	57-13-6
Diammonium Phosphate	<25	7783-28-0
Tricalcium Phosphate	<1	1306-06-5

Synonyms are provided in Section 1.
Occupational exposure limits, if available, are listed in Section 8.

4. FIRST AID MEASURES

General Information	Check the vital functions. If unconscious place in recovery position and seek medical advice. In case of respiratory arrest, administer artificial respiration. Cardiac arrest: perform resuscitation. Victim conscious with labored breathing: half-seated. Victim in shock: on his back with legs slightly raised. Vomiting: prevent asphyxia/aspiration pneumonia. Prevent cooling by covering the victim (no warming up). Keep watching the victim. Give psychological aid. Keep the victim calm, avoid physical strain. Take victim to a doctor if irritation persists. Remove affected person from source of contamination.
Eye Contact	Product is a severe eye irritant. Direct contact with eyes must be avoided. In case of contact with eyes, flush eyes with low pressure water for at least 15 minutes. If irritation persists, seek medical attention.
Skin Contact	Product may cause slight irritation. Prolonged or repeated direct contact with skin may cause reddening, itching and inflammation. In case of contact with skin, wash skin with soap and water. Remove contaminated clothing and wash. If irritation persists, consult a physician.
Inhalation	May cause sensitization by inhalation in hypersensitive individuals, irritation of respiratory tract, or physical interference with breathing. Avoid inappropriate handling which may result in dust generation. If inhaled, remove from contaminated area to fresh air. Initiate CPR if victim has stopped breathing. Administer oxygen if victim has difficulty breathing. Report situation. Seek medical attention if allergic response or difficulty breathing is exhibited. No incidences of health effects from dust inhalation have been reported.
Ingestion	Ingestion of material may cause gastric disturbance including irritation, nausea, vomiting, and diarrhea. If swallowed, rinse mouth and throat with tap water. Consult a physician if symptoms exist.
Most important symptoms and effects, both acute and delayed	Most important symptoms/effects, acute and delayed: A single dose of 100 g has been reported to cause mild central nervous system depression, e.g. drowsiness and slow reflexes. Sensitization (shortness of breath, wheezing, and labored coughing) take individual to emergency room.
Indication of any immediate medical attention and special treatment needed	If exposed or concerned, get medical advice and attention.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media	Dry chemical, carbon dioxide, chemical foam or water (all common agents as appropriate to surrounding fire – this material burns with difficulty).

Specific Hazards Arising from the chemical or mixture	Avoid mixtures with strong acids (nitric or perchloric) which may create explosive mixture.
Special Fire Fighting Procedures	Irritating toxic substances may be emitted on thermal decomposition. Exposed firefighters should wear self-contained breathing apparatus and protective clothing. Cool containers exposed to flames with water until well after the fire is out. Use water spray to reduce vapors. If risk of water pollution occurs, notify appropriate authorities. Avoid water in straight hose stream; will scatter and spread fire. Keep upwind. Do not inhale explosion and combustion gases. Collect contaminated fire extinguishing water separately. This must not be discharged into drains. Cool containers exposed to flames with water until well after the fire is out. Use water spray to reduce vapors. If risk of water pollution occurs, notify appropriate authorities. Avoid water in straight hose stream; will scatter and spread fire. Wear positive-pressure, self-contained breathing apparatus (SCBA) and chemical protective clothing.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions	Provide enough ventilation. Advice for emergency responders: protective equipment see Section 8. Wear protective clothing as described in Section 8 of this safety data sheet. Do not smoke or use open fire or other sources of ignition. Contact with walking surface may result in formation of slippery film/falling hazard.
First Aid:	In case of contact with skin, wash with soap and water. If symptoms occur, seek medical attention. In case of contact with eyes, rinse with plenty of water for at least 15 minutes and see an eye specialist if irritation persists. In case of inhalation, remove to fresh air. In case of ingestion, drink water. If symptoms occur, seek medical assistance.
Environmental Precautions	Do not discharge into drains, sewers or watercourses or onto the ground. Inform the relevant authorities if this occurs. Spilled product should be removed immediately to avoid formation of dust. Contain spill, sweep up avoiding airborne dust. Provide enough ventilation. Recover product for reuse if possible. Avoid contamination of waterways and (if large quantity) vegetation.
Methods for Containment and Clean Up	Spilled product should be removed immediately to avoid formation of dust. Contain spill, sweep up avoiding airborne dust. Provide enough ventilation. Recover product for reuse if possible. Avoid contamination of waterways and (if large quantity) vegetation. Absorb in non-combustible material, vermiculite, dry sand or earth and place into containers.

7. HANDLING AND STORAGE

Precautions for safe handling	Avoid creating dust. Adequately ventilate when handling this product. Provide eyewash capability. Contain with applicable regulations. Avoid contact with eyes. Avoid inhalation of vapors and spray/mist. Remove contaminated clothing immediately. Clean contaminated objects and areas thoroughly observing environmental regulations. Keep away from sources of ignition – No smoking. Handle in accordance with good industrial hygiene and safety procedures. Discharge into the environment must be avoided. Keep container

	tightly closed. Either local exhaust or general room ventilation is usually required.
Hygiene measures	Handle in accordance with good industrial hygiene and safety procedures. Use good personal hygiene practices.
Conditions for safe storage, including any incompatibilities	Avoid mixtures with strong acids (nitric or perchloric) which may create explosive mixture.

8. EXPOSRE CONTROL / PERSONAL PROTECTION

Control parameters

Exposure guidelines, ingredients with workplace control parameters.

Name	CAS-No	TLV (ACGIH)	PEL (OSHA)
Urea	57-13-6	10mg/m3 {3}*	15mg/m3 {5}*
Diammonium phosphate	7783-28-0	10mg/m3 {3}*	15mg/m3 {5}*
Tricalcium phosphate	1306-06-5	10mg/m3 {3}*	15mg/m3 {5}*

* Specific limits not set for these chemicals. Limits are shown for Particles Not Otherwise Regulated (PNOR) or Particles Not Otherwise Classified (PNOC). First number is for total dust second number { } is for respirable dust.

Exposure Control

Protective equipment



Appropriate engineering controls	Provide adequate general and local exhaust ventilation. Observe any occupational exposure limits for the product or ingredients. Do not allow uncontrolled discharge of product into the environment.
Eye/face protection	The following protection should be worn: Safety glasses with shields, chemical splash goggles or face shield.
Respiratory protection	Dust mask or respirator for particle removal (NIOSH)
Hand protection	Neoprene. Vinyl, Rubber (natural, latex), Butyl rubber. Wear protective gloves made of the following material: Chemical-resistant, impervious gloves complying with an approved standard should be worn if a risk assessment indicates skin contact is possible. Polyvinyl chloride (PVC). Manufactured/tested in accordance with EN 374, Avoid the following conditions: Polyvinyl alcohol (PVA).
Other skin and body protection	Wear appropriate clothing to prevent any possibility of skin contact.
Hygiene measures	Wash promptly if skin becomes contaminated. Wash hands at the end of each work shift and before eating, smoking and using the toilet. When using do not eat, drink or smoke.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	White granular solid
Odor	Mild ammonia odor
Odor threshold	Information Not Available
pH	7 – 10 (10% sol)
Melting point /Freezing Point	130 °C
Initial Boiling point and boiling point range	Does Not Apply
Flash Point	Does Not Apply
Evaporation rate	Does Not Apply
Flammability (solid; gas)	Information Not Available
Upper/lower flammability or explosive limits	Does Not Apply
Vapor pressure	Low
Vapor density	Does Not Apply
Relative density	Information Not Available
Solubility (ies)	100g / 100mL in water
Partition coefficient: n-octanol/water	Does Not Apply
Initial Boiling point and boiling point range	Does Not Apply
Auto-ignition temperature	Information Not Available
Decomposition temperature	Information Not Available
Viscosity	Does Not Apply
Other Physical/Chemical Properties	Specific Gravity at 25°C – 1.3

10. STABILITY AND REACTIVITY

Reactivity	Stable under normal conditions and use.
Chemical stability	Information not available
Possibility of hazardous reactions	Information not available
Conditions to avoid	Avoid mixtures with strong acids (nitric or perchloric) which may create explosive mixture, extreme heat.
Incompatible materials	Strong alkalis, active metals (aluminum, magnesium), ammonia, inorganic materials. Strong oxidizers, chlorine compounds.
Hazardous decomposition products	Information not available
Hazardous Polymerization	Information not available

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Acute toxicity	(low) LD50 > 1000 mg/kg body weight
Skin Corrosion/Irritation	Dust may cause slight skin irritation, prolonged or repeated direct skin contact may cause reddening, itching and inflammation.
Serious Eye Damage/Irritation	Dust may cause severe irritation.
Respiratory or Skin Sensitization	Dust may cause irritation or allergy in susceptible individuals.

	May cause respiratory allergy in susceptible individuals: sensitization (shortness of breath, wheezing, and labored coughing) take individual to emergency room.
Ingestion	May cause severe gastric disturbances, sore throat.
Germ Cell Mutagenicity	Information Not Available
Carcinogenicity	Information Not Available
Reproductive Toxicity	Information Not Available
Specific Target Organ Toxicity – Single Exposure	Information Not Available
Specific Organ Toxicity – Repeated Exposure	Information Not Available
Aspiration Hazard	Information Not Available
General Remarks	Information Not Available

12. ECOLOGICAL INFORMATION

Chemical Fate Information
Product is readily biodegradable in wastewater treatment systems.

Biodegradability
Readily degradable.

Excess product in waterways may encourage eutrophication.

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods	Dispose according to federal, state and local laws. Dispose of waste to licensed waste disposal site in accordance with the requirements of the local Waste Authority. Waste is suitable for incineration.

14. TRANSPORTATION INFORMATION

UN Number	Mixture not classified as Hazardous according to Regulation (EC) 1272/2008.
UN Proper Shipping Name	n/a
Transport Hazard Class	n/a
Packing Group (if applicable)	n/a
Environmental Hazards	n/a
Special Precautions for User	n/a
Transport in Bulk According to Annex II of MARPOL 73/78 and the IBC Code	n/a
DOT Proper Shipping Name	Chemicals not otherwise indexed (NOI) non-hazardous.

15. REGULATORY INFORMATION

All ingredients used are listed on the USEPA TSCA Inventory list.

Ingredients are not listed in: Reportable Quantity (49CFR 172.101), SARA Title III Section 302/313 (Extremely Hazardous Substance List/ Toxic Chemicals), RCRA Hazardous Waste, California Proposition 65, State Right to Know Laws (Connecticut, Florida, Illinois, Louisiana, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island)

16. OTHER INFORMATION

Mixture classified as not dangerous according to Regulation (EC) 1272/2008.

Observe employment restrictions for people.
Product is not listed with IARC, NTP, ACGIH or OSHA as a carcinogen.

Components not precisely identified are proprietary or non-hazardous. All chemical ingredients appear on the EPA TSCA inventory.

The information contained in this Safety Data Sheet, as of the issue date, is believed to be true and correct. However, the accuracy or completeness of this information and any recommendations or suggestions are made without warranty or guarantee. Since the conditions of use are beyond the control of our company, it is the responsibility of the user to determine the conditions of safe use of this product. The information in this sheet does not represent analytical specifications; for this information contact Tersus Environmental.

Disclaimer: This information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. All recommendations for the use of our products, weather given by us, orally or to be implied from data or lab tests results by us, are based on the current state of our knowledge at the time those recommendations are made. When additional information is obtained, these recommendations may be updated. They may also be influenced by circumstances outside our control. Notwithstanding, such recommendation the user is responsible that the product as supplied by us is suitable to the process or purpose he intends to use it. The user of the product is solely responsible for compliance with all laws and regulations applying to the use of this product. Since we cannot control the application, use or processing of the product, we do not accept responsibility. Therefore, the user should assure that the intended use of the product will not infringe in any party's intellectual property right.

tersus environmental

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End of Safety Data Sheet



KB-1® plus

KB-1® Plus for Remediation of Low pH Sites

SiREM has developed a KB-1® Plus culture acclimated to dechlorinate chlorinated ethenes at lower pH

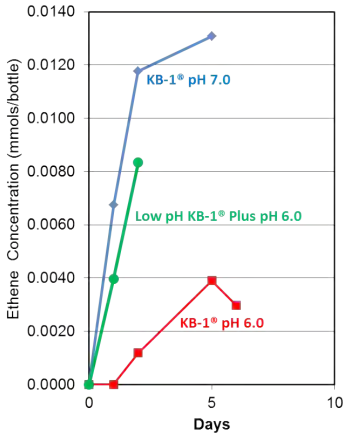


Contact SiREM for a quotation or more information on our line of leading bioaugmentation cultures.

toll free: 1-866-251-1747
phone: (519) 822-2265

Bioremediation of chlorinated ethenes (PCE, TCE, cDCE, VC) at low pH presents unique challenges due to the inhibitory effect of acidic conditions in groundwater aquifers. Many sites have an intrinsic pH below the optimum range for dechlorination (pH 6.8-7.8). At pH's below 6.0, slow and incomplete dechlorination is often observed, leading to accumulation of cDCE and VC. Moreover, dechlorination and the fermentation of electron donors (both acid producing processes) can further reduce pH to inhibitory conditions.

In order to mitigate the effects of lower pH, SiREM has developed a KB-1® Plus culture acclimated to these conditions which demonstrates complete dechlorination at a pH as low as 5.8. This culture exhibits dechlorination rates at pH 6.0 that compare favorably with KB-1® grown at pH 7.0 and may be part of an overall remediation solution, including aquifer buffering, for low pH sites.



Performance (ethene production rate) of low pH acclimated KB-1® Plus grown on TCE at pH 6.0 (green) compared to KB-1® at pH 7.0 (blue) and 6.0 (red). The ethene production rate of low pH acclimated KB-1® Plus (green) is 5 times higher than standard KB-1® at pH 6.0

Consider–Low pH Acclimated KB-1® Plus

- Where aquifer pH is 5.8-6.3
- In combination with aquifer neutralization to maximize dechlorination performance and/or reduce buffering needs
- To maximize performance in poorly buffered aquifers where pH declines are likely due to dechlorination and fermentation of electron donors (both acid producing processes)

All KB-1 ® Plus Purchases Include:

- KB-1® Plus Guarantee*
- Technical support to ensure a successful application at your site
- Complimentary Gene-Trac® Tests to verify the successful delivery growth and persistence of KB-1® Plus microbes in site groundwater

Contact SiREM for a quotation or more information on our line of leading bioaugmentation products.

*some conditions apply

siremlab.com

SAFETY DATA SHEET

KB-1® Primer

Prepared according to U.S. OSHA, CMA, ANSI, Canadian WHMIS, Australian WorkSafe, Japanese Industrial Standard JIS Z 7250:2000, and European Union REACH Regulations

SECTION 1 - PRODUCT AND COMPANY IDENTIFICATION

1.1 PRODUCT NAME:	**KB-1® Primer**
PRODUCT CODE:	N/A
CHEMICAL FAMILY NAME:	Mixture
U.N. NUMBER:	None
U.N. DANGEROUS GOODS CLASS:	Not Regulated
1.2 PRODUCT USE:	For preparation of anaerobic water for use in groundwater remediation. KB-1® products are intended for laboratory research and field applications for groundwater remediation, and are not intended to be used as human or animal therapeutics, cosmetics, agricultural or pesticidal products, food additives, or as household chemicals.
1.3 SUPPLIER/MANUFACTURER'S NAME:	**SiREM**
ADDRESS:	130 Stone Road, West, Guelph, Ontario Canada N1G 3Z2
1.4 EMERGENCY PHONE:	519-515-0840
BUSINESS PHONE:	519-515-0840 (Product Information)
WEB SITE:	www.siremlab.com
1.5 DATE OF PREPARATION:	December 05, 2018
DATE OF LAST REVISION:	New

SECTION 2 - HAZARDS IDENTIFICATION

2.1 Classification of the mixture:

This product does meet the definition of a hazardous substance or preparation as defined by 29 CFR 1910. 1200 AND the European Union Council Directives 67/548/EEC, 1999/45/EC, 1272/2008/EC, 2015/830/EU and subsequent Directives.

Component(s) Contributing to Classification(s)

L-Cysteine

2.2 GHS Label elements, including precautionary statements:

Pictogram(s):

None applicable.

Signal Word:

Warning!

GHS Hazard Classification(s):

Acute Toxicity Category 5 (Oral)

Hazard Statement(s):

H303: May be harmful if swallowed

Prevention Statement(s):

None Applicable

Response Statement(s):

P312: Call a POISON CENTER/doctor if you feel unwell.

Storage Statement(s):

None Applicable

Disposal Statement(s):

None Applicable.

2.3 Other Hazards:

This mixture does not meet the criteria for PBT or vPvB in accordance with Annex VII.

SiREM

SAFETY DATA SHEET

KB-1® Primer

SECTION 3 - COMPOSITION and INFORMATION ON INGREDIENTS

3.1 Substances: Not applicable

3.2 Mixtures:

HAZARDOUS INGREDIENTS:	CAS #	EINECS #	Index #	WT %	GHS CLASSIFICATION
L-Cysteine	52-90-4	200-158-2	Not Listed	1-10%	ACUTE TOX. CAT 4 (ORAL)
Balance of other ingredients are non-hazardous or hazardous below the applicable cut-off level.					

Additional Information: See SECTION 16 for full classification phrases.

SECTION 4 - FIRST-AID MEASURES

4.1 Description of first aid measures:

Contaminated individuals of chemical exposure must be taken for medical attention if any adverse effect occurs. Rescuers should be taken for medical attention, if necessary. Take copy of label and SDS to health professional with contaminated individual.

EYE CONTACT: If product enters the eyes, open eyes while under gentle running water for at least 15 minutes. Seek medical attention if irritation persists.

SKIN CONTACT: Wash skin thoroughly after handling. Seek medical attention if irritation develops and persists. Remove contaminated clothing. Launder before re-use.

INHALATION: If breathing becomes difficult, remove victim to fresh air. If necessary, use artificial respiration to support vital functions. Seek medical attention.

INGESTION: If product is swallowed, call physician or poison control center for most current information. If professional advice is not available, do not induce vomiting. Never induce vomiting or give diluents (milk or water) to someone who is unconscious, having convulsions, or who cannot swallow. Seek medical advice. Take a copy of the label and/or SDS with the victim to the health professional.

4.2 Most important symptoms and effects, both acute and delayed:

May be harmful if swallowed. See section 11 for additional information.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing skin problems may be aggravated by prolonged or repeated contact.

4.3 Indication of immediate medical attention and special treatment needed:

Treat symptoms and reduce over-exposure.

SECTION 5 - FIRE-FIGHTING MEASURES

5.1 Extinguishing media:

Use media suitable for surrounding area. Carbon dioxide, foam, dry chemical, halon, water spray.

5.2 Specific hazards arising from the chemical:

No data available for this product.

Explosion Sensitivity to Mechanical Impact:	Not Sensitive.
Explosion Sensitivity to Static Discharge:	Not Sensitive
Minimum Ignition Energy (M.I.E.)	No Data at this time

5.3 Special firefighting Procedure:

Incipient fire responders should wear eye protection. Structural firefighters must wear Self-Contained Breathing Apparatus and full protective equipment. Isolate materials not yet involved in the fire and protect personnel. Move containers from fire area if this can be done without risk; otherwise, cool with carefully applied water spray. If possible, prevent runoff water from entering storm drains, bodies of water, or other environmentally sensitive areas.

SiREM

SAFETY DATA SHEET

KB-1® Primer

SECTION 6 - ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures:
No action shall be taken involving any personal risk or without suitable training. Do not touch or walk through spilled material. Avoid breathing dust. Provide adequate ventilation. Use appropriate respirator when ventilation is inadequate and use personal protective clothing as described in Section 8 of this safety data sheet. See section 11 for additional information on health hazards.

6.2 Environmental precautions:
No specific data available for this product.

6.3 Methods and material for containment and cleaning up:
Wear suitable protective clothing. Avoid dust formation. Avoid breathing dust. Carefully sweep up and remove. Place material in a dry container and cover. Remove from the area. Flush spill area with water. Do not let products enter drains. Dispose of in accordance with applicable Federal, State, and local procedures (see Section 13, Disposal Considerations).

SECTION 7 - HANDLING and STORAGE

7.1 Precautions for safe handling:
As with all chemicals, avoid getting this product ON YOU or IN YOU. Wash thoroughly after handling this product. Do not eat, drink, smoke, or apply cosmetics while handling this product. Use in a well-ventilated location. Remove contaminated clothing immediately

7.2 Conditions for safe storage, including any incompatibilities:
Store in a tightly sealed container in a cool, dry and well-ventilated place. Store away from direct light. Avoid generation of dust. Do not breathe dust. Wash thoroughly after handling. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear suitable protective clothing. Segregate from strong oxidizing agents, acids, bases.

7.3 Specific end uses:
See section 1.2.

SECTION 8 - EXPOSURE CONTROLS - PERSONAL PROTECTION

8.1. Control parameters:

EXPOSURE LIMITS/GUIDELINES: None established for this product.

8.2 Exposure Controls:
Currently, International exposure limits are not established for the components of this product. Please check with competent authority in each country for the most recent limits in place.

VENTILATION AND ENGINEERING CONTROLS: Generally not required under normal conditions of use. If method of use will result in significant dust generation, use in lab hood or under conditions of adequate ventilation.
The following information on appropriate Personal Protective Equipment is provided to assist employers in complying with OSHA regulations found in 29 CFR Subpart I (beginning at 1910.132) or equivalent standard of Canada, or standards of EU member states (including EN 149 for respiratory PPE, and EN 166 for face/eye protection), and those of Japan. Please reference applicable regulations and standards for relevant details.

RESPIRATORY PROTECTION: Maintain airborne contaminant concentrations below guidelines listed above, if applicable. If necessary, use only respiratory protection authorized in the U.S. Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), equivalent U.S. State standards, Canadian CSA Standard Z94.4-93, the European Standard EN149, or EU member states.

EYE PROTECTION: Safety glasses or chemical goggles as appropriate to prevent eye contact. If necessary, refer to U.S. OSHA 29 CFR 1910.133 or appropriate Canadian Standards.

HAND PROTECTION: Use chemical resistant gloves to prevent skin contact. If necessary, refer to U.S. OSHA 29 CFR 1910.138 or appropriate Standards of Canada.

BODY PROTECTION: Use body protection appropriate to prevent contact (e.g. lab coat, overalls). If necessary, refer to appropriate Standards of Canada, or appropriate Standards of the EU, Australian Standards, or relevant Japanese Standards.

SiREM

SAFETY DATA SHEET

KB-1® Primer

SECTION 9 - PHYSICAL and CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties:

PHYSICAL STATE:	Solid (Granules)
APPEARANCE:	White to off-white powder or granules
ODOR:	Odorless
ODOR THRESHOLD (PPM):	Not Available
pH:	6-8 (aqueous solution)
MELTING / FREEZING POINT (C°):	Not Available
BOILING POINT (C°):	Not Available
FLASH POINT:	Not Available
EVAPORATION RATE (nBuAc = 1):	Not Available
FLAMMABILITY (solid, gas):	Not Available
FLAMMABLE LIMITS (in air by volume, %):	Not Available
VAPOR PRESSURE (mmHg):	Not Available
VAPOR DENSITY (AIR=1):	Not Available
RELATIVE DENSITY	2.4 to 2.6 g/cm3, depending on formulation
SOLUBILITY IN WATER (%)	Soluble
PARTITION COEFFICIENT: N-OCTANOL/WATER:	Not Available
AUTOIGNITION TEMPERATURE:	Not Available
DECOMPOSITION TEMPERATURE:	Not Available
VISCOSITY:	Not Available
EXPLOSIVE PROPERTIES:	Not Available
OXIDISING PROPERTIES:	Not Available

9.2 Other Information:

PACKING DENSITY:	Not Available
VOC:	Not Available

SECTION 10 - STABILITY and REACTIVITY

10.1 Reactivity: See section 10.5.
10.2 Chemical Stability: Product is stable.
10.3 Possibility of Hazardous Reactions: Under normal conditions of storage and use, hazardous reactions will not occur.
10.4 Conditions to avoid: Contact with incompatibles, exposure to light, and moist air.
10.5 Incompatible materials: Strong oxidizing agents, bases.
10.6 Hazardous Decomposition Products: Carbon monoxide, carbon dioxide, nitrogen oxides, sulfur oxides, potassium oxides.

SECTION 11 - TOXICOLOGICAL INFORMATION

11.1 Information on Toxicological Effects:

TOXICITY DATA:

L-Cysteine CAS# 52-90-4
Oral LD50 1890 mg/kg Rat
Oral LD50 660 mg/kg Mouse

11.1.2 Mixtures:

Acute toxicity	Acute Toxicity Category 5 (Oral)
Skin corrosion / irritation	Based on available data, the classification criteria are not met
Serious eye damage / irritation	Based on available data, the classification criteria are not met
Respiratory or skin sensitization	Based on available data, the classification criteria are not met
Germ cell mutagenicity	Based on available data, the classification criteria are not met
Carcinogenicity	Based on available data, the classification criteria are not met
Reproductive toxicity	Based on available data, the classification criteria are not met
STOT-single exposure	Based on available data, the classification criteria are not met
STOT-repeated exposure	Based on available data, the classification criteria are not met
Aspiration hazard	Based on available data, the classification criteria are not met

Other Information

POTENTIAL HEALTH HAZARDS OR RISKS FROM EXPOSURE:

ACUTE:

EYE CONTACT: Eye exposure may produce irritation.

SKIN CONTACT: Prolonged or repeated skin exposure may cause irritation.

INHALATION HAZARDS: Inhalation of dusts may cause irritation.

INGESTION HAZARDS: May be harmful if swallowed. May cause gastrointestinal tract irritation.

CHRONIC: None Known

TARGET ORGANS: ACUTE: Organs CHRONIC: None Known

CARCINOGENICITY: None of the ingredients are found on the following lists: FEDERAL OSHA Z LIST, NTP, CAL/OSHA, IARC and therefore are not considered to be, nor suspected to be a cancer-causing agent by these agencies.

IRRITANCY OF PRODUCT: Contact with this product can be irritating to skin and eyes.

SENSITIZATION OF PRODUCT: This product is not considered a skin sensitizer.

REPRODUCTIVE TOXICITY INFORMATION: No information concerning the effects of this product and its components on the human reproductive system.

MUTAGENICITY INFORMATION: This product does not contain a component that is suspected to be a mutagenicity hazard.

SPECIFIC TARGET ORGAN TOXICITY – SINGLE EXPOSURE: Data not sufficient for classification.

SPECIFIC TARGET ORGAN TOXICITY – REPEATED EXPOSURE: Data not sufficient for classification.

ASPIRATION HAZARD: Not applicable

SECTION 12 - ECOLOGICAL INFORMATION

ALL WORK PRACTICES MUST BE AIMED AT ELIMINATING ENVIRONMENTAL CONTAMINATION.

12.1 Toxicity:

No specific data available on this product.

12.2 Persistence and Degradability:

No specific data available on this product.

12.3 Bioaccumulative Potential:

No specific data available on this product.

12.4 Mobility in Soil:

No specific data available on this product.

12.5 Results of PBT and vPvB Assessment:

No specific data available on this product.

12.6 Other Adverse Effects:

No specific data available on this product.

12.7 Water Endangerment Class:

Not believed to be water endangering in accordance with EU Guideline 91/155-EWG. At present there are no ecotoxicological assessments for this product.

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SAFETY DATA SHEET

KB-1® Primer

SECTION 13 - DISPOSAL CONSIDERATIONS

13.1 Waste Treatment Methods:
Waste disposal must be in accordance with appropriate Federal, State, and local regulations, those of Canada, Australia, EU Member States and Japan.

SECTION 14 - TRANSPORTATION INFORMATION

14.1 Transport Information:

US DOT; IATA; IMO; ADR:

THIS PRODUCT IS NOT CLASSIFIED AS DANGEROUS GOODS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

PROPER SHIPPING NAME: None
HAZARD CLASS NUMBER and DESCRIPTION: Not Regulated
UN IDENTIFICATION NUMBER: None
PACKING GROUP: None
DOT LABEL(S) REQUIRED: None
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (2016): None
MARINE POLLUTANT: This product does not contain ingredients that are classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B)

TRANSPORT CANADA, TRANSPORTATION OF DANGEROUS GOODS REGULATIONS:
This product is not classified as Dangerous Goods, per regulations of Transport Canada

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA):
This product is not classified as Dangerous Goods, by rules of IATA:

INTERNATIONAL MARITIME ORGANIZATION SHIPPING and MARITIME DANGEROUS GOODS CODE SHIPPING INFORMATION (IMO / IMDG):
This product is not classified as Dangerous Goods.

EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR):
This product is not classified by the United Nations Economic Commission for Europe to be dangerous goods.

SECTION 15 - REGULATORY INFORMATION

15.1 Safety, Health and Environmental Regulations/Legislation Specific for the Substance or Mixture:

UNITED STATES REGULATIONS

SARA REPORTING REQUIREMENTS: This product is not subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act., as follows: None

TSCA: All components in this product are listed on the US Toxic Substances Control Act (TSCA) inventory of chemicals.

SARA 311/312:

Acute Health: No Chronic Health: No Fire: No Reactivity: No

U.S. SARA THRESHOLD PLANNING QUANTITY: There are no specific Threshold Planning Quantities for this product. The default Federal SDS submission and inventory requirement filing threshold of 10,000 lb (4,540 kg) may apply, per 40 CFR 370.20.

U.S. CERCLA REPORTABLE QUANTITY (RQ): None

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65): None of the ingredients are on the California Proposition 65 lists.

CANADIAN REGULATIONS:

CANADIAN DSL/NDSL INVENTORY STATUS: All of the components of this product are on the DSL Inventory

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) PRIORITIES SUBSTANCES LISTS: No component of this product is on the CEPA First Priorities Substance Lists.

CANADIAN WHMIS CLASSIFICATION and SYMBOLS: This product is categorized as per WHMIS 2015 Hazardous Product Regulations.

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SAFETY DATA SHEET

KB-1® Primer

EUROPEAN ECONOMIC COMMUNITY INFORMATION:

EU LABELING AND CLASSIFICATION:

Classification of the mixture according to Regulation (EC) No1272/2008. See section 2 for details.

AUSTRALIAN INFORMATION FOR PRODUCT:

AUSTRALIAN INVENTORY OF CHEMICAL SUBSTANCES (AICS) STATUS: Components of this product are listed on the AICS.

STANDARD FOR THE UNIFORM SCHEDULING OF DRUGS AND POISONS: Not applicable.

JAPANESE INFORMATION FOR PRODUCT:

JAPAN INDUSTRIAL SAFETY AND HEALTH LAW: This product has been classified per the Japan Industrial Safety and Health Law. See Section 2 for the GHS Classification.

KOREA ACT ON REGISTRATION AND EVALUATION OF CHEMICAL SUBSTANCES (K-REACH): This product has been classified per K-REACH. See Section 2 for the GHS Classification.

INTERNATIONAL CHEMICAL INVENTORIES:

Listing of the components on individual country Chemical Inventories is as follows:

Asia-Pac:	Listed
Australian Inventory of Chemical Substances (AICS):	Listed
Korean Existing Chemicals List (ECL):	Listed
Japanese Existing National Inventory of Chemical Substances (ENCS):	Listed
Philippines Inventory if Chemicals and Chemical Substances (PICCS):	Listed
Swiss Giftliste List of Toxic Substances:	Listed
U.S. TSCA:	Listed

15.2 Chemical Safety Assessment:

A chemical safety assessment has not been performed on this product.

SECTION 16 - OTHER INFORMATION

HMIS Rating (Scale 0-4)	**NFPA Rating (Scale 0-4)**
Health hazard: 1	Health hazard: 1
Flammability: 0	Flammability: 0
Physical Hazard: 0	Physical Hazard: 0

Caution: HMIS and NFPA ratings are based on a 0-4 rating scale

0= Minimal Hazard
1= Slight
2= Moderate
3= High
4= Extreme

Abbreviations and acronyms

ACGIH	*American Conference of Governmental Industrial Hygienists*
CFR	*Code of Federal Regulations*
DOT	*Federal Department of Transportation*
GHS	*The Globally Harmonized System of Classification and Labelling of Chemicals*
HMIS	*Hazardous Material Identification System*
HCS	*Hazard Communication Standard*
IARC	*International Agency for Research on Cancer*
IATA	*The International Air Transport Association*
ICAO	The *International Civil Aviation Organization*
IMDG	*International Maritime Dangerous Goods*
IMO	*International Maritime Organization*
LD50/LC50	*Lethal Concentration/Dose, 50 percent*
NFPA	*National Fire Protection Association*
NIOSH	*National Institute for Occupational Safety and Health*

SiREM

SAFETY DATA SHEET

KB-1® Primer

NTP	*National Toxicology Program*
OSHA	*Occupational Safety and Health*
PEL	*OSHA Permissible Exposure Limit*
SARA	*Superfund Amendments and Reauthorization Act*
TLV	*ACGIH Threshold Limit Value*
TWA	*Time-Weighted Average*
Acute Tox	*Acute Toxicity*
Skin Corr	*Skin Corrosion*

PREPARED BY: Chris Eigbrett MSDS to GHS Compliance

History Log:
December 05, 2018 - Document creation

End of SDS Sheet

SAFETY DATA SHEET

1. CHEMICAL IDENTIFICATION AND COMPANY INFORMATION

Product Name: **KB-1® PLUS**

Company Info:
SiREM
130 Stone Rd. W. Guelph, ON, N1G3Z2
Phone: 519-822-2265
Toll Free, North America: 1-866-251-1747
www.siremlab.com

Emergency Phone Number: 519-822-2265 (for 24/7 assistance, contact poison center hotline in your jurisdiction).

Description: Microbial inoculum (non-pathogenic, non-hazardous) in growth media consisting of a dilute aqueous solution of mineral salts and nutrients.

Recommended Use: Bioremediation of contaminated groundwater.

Restrictions on Use: KB-1® PLUS product intended for laboratory research and field applications for cleanup of contaminated groundwater. Products are not intended to be used as human or animal therapeutics, cosmetics, agricultural or pesticide products, food additives, or as household chemicals.

2. HAZARDS IDENTIFICATION

GHS Classification: Not classified as “hazardous” per OSHA 29 CFR 1910.1200, “Hazard Communication”.

GHS Label elements, including hazard and precautionary statements: Not Applicable.

HMIS Rating:	Health	Flammability	Physical Hazard	Personal Protection
	1	0	0	B*
NFPA Rating:	**Health**	**Flammability**	**Reactivity**	**Special Hazard**
	1	0	0	N/A

* B = Safety Glasses, Gloves.

A review of available data indicates minimal potential for health effects related to normal use of this product. Microbial components are non-pathogenic. The product is not expected to be a health hazard as a result of inhalation of mists, ingestion or skin contact. Eye contact may result in mild irritation/redness. Normal hygiene precautions should be observed, including eye protection, skin protection, and hand washing. The potential exists for individuals with hypersensitivity to biological materials to exhibit allergic sensitivity to biological components of this product (see Section 4, “First Aid Measures”).

3. COMPOSITION/INFORMATION ON INGREDIENTS

KB-1® PLUS is a microbial culture grown in an aqueous dilute solution of mineral salts and nutrients classified as non-hazardous in accordance with provisions of OSHA 29 CFR 1910.1200, “Hazard Communication.”

The microbial composition of KB-1® PLUS, as determined by phylogenetic analysis, includes:

Dehalococcoides sp.
Geobacter sp.
Methanomethylovorans sp.
Dehalobacter sp.
Dehalogenimonas sp.

Identification of organisms was obtained by matching 16S rRNA gene sequence of organisms in KB-1® PLUS to other known organisms. The characteristics of related organisms can be used to identify potential or likely characteristics of organisms in KB-1® PLUS.

4. FIRST AID MEASURES

Avoid direct contact with skin and eyes. In any case of any exposure which elicits a response, a physician should be consulted immediately.

Route of Entry	Symptoms	First Aid Procedures
Ingestion	Upset stomach, irritation of digestive tract	Do not induce vomiting. Drink several cups of water. Seek medical attention.
Skin contact	Skin irritation – reddening, itching or inflammation.	Remove contaminated clothes. Wash skin with plenty of water and soap. Seek medical attention if irritation develops or open wounds are present.
Eye contact	Eye irritation – redness, tearing, blurred vision.	Rinse immediately with plenty of water for 15 – 20 minutes, lifting lower and upper eyelids occasionally (remove contact lenses if easily possible). Seek medical attention if undue irritation or redness occurs.
Inhalation of mist	Respiratory irritation, coughing, breathing difficulty.	Remove victim to fresh air. Administer first aid as appropriate for symptoms. Seek medical attention if serious symptoms occur.

5. FIRE FIGHTING MEASURES

General:	This material is non-flammable, consisting primarily of water, and poses no special hazards if involved in a fire situation.
Suitable extinguishing media:	If material is involved in fire situation, use extinguishing media suitable for surrounding fire.
Special protective equipment and precautions for firefighters:	No special equipment necessary; use equipment appropriate for surrounding fire.
Hazardous combustion products:	Not applicable.
Toxic gases produced:	Not applicable.
Shock/impact sensitivity:	Not shock sensitive.

6. ACCIDENTAL RELEASE MEASURES

Method of containment and cleanup: Spilled KB-1® PLUS should be soaked up with sorbent and saturated with a 10% bleach solution (prepared by making a one in ten dilution of diluted standard bleach [normally sold at a strength of 5.25% sodium hypochlorite] to disinfect affected surfaces. Sorbent should be double

bagged and disposed of as indicated in Section 13. After removal of sorbent, area should be washed with 10% bleach solution to disinfect. If liquid from the culture vessel is present on the fittings, non-designated tubing or exterior of the stainless steel pressure vessel liquid should be wiped off and the area washed with 10% bleach solution.

Ventilation: No special ventilation is required in the event of the spill, as the material consists of water and non-volatile constituents. If the potential for generation of mist exists, open windows and provide adequate ventilation. If high levels of mist are encountered, use personal protective equipment indicated below.

Eye/skin protection: Have eye-washing facilities readily available where eye contact can occur. Wash skin with soap and water. Use appropriate protective gloves when handling. Showering and changing into street clothes after work is recommended.

Protective equipment for airborne mist: A NIOSH/MSHA approved dust mask or air purifying respirator with dust/mist filter is recommended where elevated concentrations of airborne mist are expected.

7. HANDLING AND STORAGE

Handling and storage precautions: Use personal protective equipment (eye & skin protection) and hygiene measures (hand washing) to minimize contact with the material.

KB-1® PLUS is shipped in stainless steel pressure vessels and connected to injection lines and inert gas is used to pressurize the vessel to displace the contents. KB-1® PLUS should be handled with care to avoid any spillage. Vessels are shipped with 1 to 5 pound per square inch (psi) pressure; valves should not be opened until connections to appropriate lines for subsurface injection are in place.

During storage, avoid exposing stainless steel pressure vessels to undue temperature extremes (i.e., temperatures less than 0°C or greater than 30°C may result in harm to the microbial cultures and damage to the vessels). All valves should be in the closed position when the vessel is not pressurized to prevent the escape of gases and to maintain anaerobic conditions in the vessel.

Incompatibilities: Avoid exposure of the culture to air as the presence of oxygen will kill the microbes.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OSHA Permissible Exposure Limits (PELs):

ACHIH Threshold Limit Values (TLVs): No occupational exposure limits are established for microbial constituents. Mixture is not classified as “hazardous” in accordance with 29 CFR 1910.1200 “Hazard Communication,” exceedance of exposure limits is not anticipated either under normal conditions of use, or as the result of an accidental release.

Engineering controls: Generally not required under normal conditions of use. If method of use will result in significant mist generation, use under conditions of adequate ventilation.

Work practices: Use good hygiene practices, avoid mist generation, and minimize contact with the material as a general precautionary measure.

Personal protective equipment:	Under normal conditions of use, wear safety glasses, protective gloves (latex, vinyl or nitrile) and steel toed footwear as general precautionary measures, particularly when opening pressure vessel valves or when pressurizing vessels to inject contents into the subsurface environment. For laboratory use, also wear lab coat. For higher risk of eye contact, wear safety goggles or face shield, as appropriate. Respiratory protection is not required under normal conditions of use (see Section 6, "Accidental Release Measures."

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance, physical state:	Aqueous liquid, dark grey, slightly turbid under anaerobic conditions, pink if exposed to air (oxygen).
Odor:	Pungent ("skunky") odor.
Solubility:	Soluble in water.
pH:	6.5 – 7.5
Melting range	Not determined, approximately equivalent to water.
Vapor density:	Not determined, approximately equivalent to water.
Vapor pressure:	Not determined, approximately equivalent to water.
Relative density:	Not determined, approximately equivalent to water.
Evaporation rate:	Not determined, approximately equivalent to water.
Initial Boiling point, boiling range	Not determined, approximately equivalent to water.
Flammability	Not flammable.
Partition coefficient	Not Applicable.
Auto-ignition temperature	Not Applicable.
Decomposition temperature:	No data, bacterial contents will decompose by heating.
Flash point	Not Applicable.
Flammable limits	Not Applicable.

10. STABILITY AND REACTIVITY

Chemical stability and reactivity:	Stable and non-reactive.
Possibility of hazardous reactions:	Stable. Spontaneous hazardous chemical reactions / decomposition will not occur.
Conditions to avoid:	Maintain under anaerobic conditions to preserve product integrity (exposure to air/oxygen will kill microbes).
Incompatible materials:	Strong oxidizers, acids, water reactive materials.
Hazardous decomposition products:	Not applicable.
Shock sensitivity:	Not shock sensitive; will not decompose and form shock sensitive compounds.

11. TOXICOLOGICAL INFORMATION

Potential for pathogenicity: KB-1® PLUS has tested **negative** (i.e., the organisms are not present) for a variety of pathogenic organisms indicated below:

Pathogenic Organisms	Disease(s) Caused	Test Results
Salmonella sp.	Typhoid fever, gastroenteritis	Not Detected
Listeria monocytogenes	Listerioses	"
Vibrio sp.,	Cholera, gastroenteritis	"
Campylobacter sp.,	Bacterial diarrhea	"
Clostridia sp.,	Food poisoning, botulism, tetanus, gas gangrene	"
Bacillus anthracis	Anthrax	"
Pseudomonas aeruginosa	Wound infection	"
Yersinia sp.,	Bubonic plague, intestinal infection	"
Yeast and Mold	Candidiasis, yeast infection, etc.	"
Fecal coliforms	Indicator organisms for many human pathogens diarrhea, urinary tract infections	"
Enterococci	Various opportunistic infections	"

While there is no evidence that virulent pathogenic organisms are present in KB-1® PLUS, there is potential that certain organisms in KB-1® PLUS may have the potential to act as opportunistic (mild) pathogens, particularly in individuals with open wounds and/or compromised immune systems. For this reason standard hygienic procedures such as hand washing after use should be observed.

12. ECOLOGICAL INFORMATION

This product is not rated as "hazardous" as either an acute or chronic ecological hazard, in accordance with the OSHA Hazard Communication standard, 29 CFR 1910.1200.

13. DISPOSAL CONSIDERATION

Material must be disinfected or sterilized prior to disposal. Consult local regulations prior to disposal.

14. TRANSPORT INFORMATION

U.S. (D.O.T.):	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not Applicable
	UN/NA:	Not Applicable
	Labels:	Not Applicable
Canada (T.D.G.)	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not Applicable
	UN/NA:	Not Applicable
	Labels:	Not Applicable

International:		
IMDG:	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not Applicable
	UN/NA:	Not Applicable
	Labels:	Not Applicable
IATA:	Proper Shipping Name:	Culture of Micro-organisms
	Hazard Class:	Not Applicable
	UN/NA:	Not Applicable
	Labels:	Not Applicable

15. REGULATORY INFORMATION

TSCA:	No

SARA TITLE III

Section 302 (EHS) Ingredients:	No
Section 313 Ingredients:	No
Section 304 (EHS/CERCLA) Ingredients:	No

SARA TITLE III NOTIFICATION INFORMATION

Acute Health Hazard:	No
Chronic Health Hazard:	No
Fire Hazard:	No
Sudden Release of Pressure Hazard:	No

16. OTHER INFORMATION

SiREM provides the information contained herein for hazard communication and safety planning purposes, based on existing information on each of the product components available in the literature; no independent testing was conducted on the final product. The above information is intended to be used only as a guide to the appropriate precautionary handling of this material by a properly trained person.

APPENDIX G

Annual LUC Compliance Documentation Form

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Annual Land Use Control Compliance Inspection Form

In accordance with the Remedial Design dated _____ for LHAAP-18/24 an inspection of the site was conducted by _____ [indicate transferee] on _____.

The land use control mechanisms are:

- Groundwater restrictions - prohibit access to the contaminated groundwater except for environmental monitoring and testing only until cleanup goals are met;
- Landfill integrity - preserve the integrity of the landfill cap and restrict intrusive activities (e.g., digging) that would degrade or alter the cap;
- Land use restrictions - restrict land use to nonresidential;
- Integrity of remedial and monitoring systems - maintain the integrity of any current or future remedial or monitoring systems until cleanup goals are met.

No unauthorized activities or uses have occurred. Compliance with land use controls and restrictions is as follows:

- No use of groundwater (other than environmental testing and monitoring), installation of new groundwater wells, or tampering with existing monitoring wells;
- No landfill intrusive activities (e.g., digging) that would degrade or alter the landfill cap; maintenance of vegetative cover and repair of soil subsidence or erosion areas on the cap;
- No land use other than nonresidential; and
- No activities that would compromise the integrity of the remedial or monitoring systems.

I, the undersigned, do document that the inspection was conducted as indicated above, and that the above information is true and correct to the best of my knowledge, information, and belief.

Date: _____

Name/Title: _____

Signature: _____

Annual compliance certification forms shall be completed no later than March 1 of each year for the previous calendar year, retained in the file and provided to Army, EPA and TCEQ upon request.

APPENDIX H

Specifications

LHAAP - 18/24
Former Longhorn Army Ammunition Plant (LHAAP)
Burning Ground No. 3 and Unlined Evaporation Pond
Karnack, Texas

Table of Contents

Division 1

Section No.	Title
01 35 45	Chemical Data Quality Control

Division 2

Section No.	Title
02 53 17	Enhanced In-Situ Bioremediation Injection Procedures and Monitoring

Division 3

Section No.	Title
31 23 00	Backfill, Compaction, and Grading
31 23 10	Excavation and Handling of Contaminated Materials
31 23 20	Transportation and Disposal of Contaminated Material
31 25 00	Erosion Control and Stormwater Management
31 38 50	Site Restoration

SECTION 01 35 45
CHEMICAL DATA QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers requirements for the Contractor's Chemical Data Quality Control (CDQC) for Remedial Action (RA) work at the site. This section is to be used to update an existing Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) prepared as part of the Installation-Wide Work Plan (IWWP) for the Longhorn Army Ammunition Site (Bhate, 2018), securing laboratory(ies), monitoring of subcontract laboratory performance, data validation, data reporting, and preparation of a chemical data final report. The updated UFP-QAPP shall contain the necessary technical detail and directions for all sampling and field measurements and specifies all quality assurance (QA) and quality control (QC) procedures required for planning, implementation, and assessment of the RA.

B. Field measurements and samples shall be collected by the Contractor and will include but not limited to:
   1. Cleared vegetation sampling
   2. Samples related to excavation
      a. Waste characterization sampling (soil)
      b. Post-excavation confirmatory sampling (soil)
      c. Backfill materials sampling
      d. Topsoil sampling
      e. Sampling beneath stockpile areas to check for stockpiles cross-contaminating underlying material (soil)
   3. Performance monitoring sampling (groundwater) during in-situ thermal desorption (ISTD) implementation
   4. Performance monitoring sampling during EISB pilot testing and full-scale EISB implementation (groundwater and surface water)

1.2 REFERENCES

A. References
   1. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only. Where reference is made to one of the standards below, the revision in effect at the time of contract award shall apply.
      a. American Society for Testing and Materials (ASTM)
         1) ASTM D5268-13 Standard Specification for Topsoil Used for Landscaping Purposes.
      b. United States Army Corps of Engineers (USACE), Tulsa District
         1) Final Installation Wide Work Plan for Longhorn Army Ammunition Plant (LHAAP IWWP), Karnack, Texas, revised by Bhate Environmental Associates, Inc. (May 2018; IWWP).
         2) Final Basewide Uniform Federal Policy Quality Assurance Project Plan – Longhorn Army Ammunition Plan (May 2018; Basewide UFP-QAPP)
      c. Environmental Protection Agency (EPA)
         1) EPA 450/4-89/015 Data Quality Objectives for Ambient Air Monitoring Around Superfund Sites (Stages I and II).

2) EPA 450/4-89/005 Data Quality Objectives for Ambient Air Monitoring Around Superfund Sites (Stage III).
3) EPA 402/B-04/001A Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual, Volume I.
4) EPA/240/B-06/001 Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4. February 2006.
5) EPA/240/R-02/009 Guidance for Quality Assurance Project Plans, EPA QA/G-5. December 2002.
6) EPA/240/B-01/003 EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5. March 2001. Reissued May 2006.
7) EPA 540/P-87/001B Compendium of Superfund Field Operation Methods.
8) EPA 540/R-014/013 Sampler's Guide: Contract Laboratory Program Guidance for Field Samplers. October 2014.
9) EPA 542-R-20-006 EPA Contract Laboratory Program (CLP) National Functional Guidelines for Inorganic Superfund Data Review. November 2020.
10) EPA 540-R-20-005 EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. November 2020.
11) EPA 540-R-20-005 Contract Laboratory Program Guidance for Field Samplers. November 2020.
12) EPA 600/R-96/055 Guidance for the Data Quality Objective Process, August 2000 EPA SW-846 (Rev 0; updates I, II, IIA, IIB, III, IIIA, IIIB, IVA, and IVB) Test Methods for Evaluating Solid Waste (Vol. IA, IB, IC, and II)
13) EPA 600/R-04/003 National Environmental Laboratory Accreditation Conference (NELAC) Standard, Chapter 5 – Quality Systems, June 2003 (or the 2009 NELAC Institute standards if already implemented by the applicable state accrediting body).
14) EPA 600/4-79/020 Methods for Chemical Analysis of Water and Wastes. March 1983.
15) Directive 9240.0-05A EPA Specifications and Guidance for Contaminant-Free Sample Containers, EPA/540/R-93/051, Office of Solid Waste and Emergency Response.
16) Directive 9200.1-103 Inclusion of Scribe into the Role of Tracking Superfund Sampling Data.
17) EPA Contract Laboratory Program, Statement of Work for Superfund Analytical Methods, Multi-Media, Multi-Concentration (SFAM01.1). November 2020.

d. Intergovernmental Data Quality Task Force (IDQTF)
1) EPA 505/B-04/900A Intergovernmental Data Quality Task Force (IDQTF), Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) Part 1 - Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs. March 2005.
2) EPA 505/B-04/900B Intergovernmental Data Quality Task Force (IDQTF), Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) Part 2B – Quality Assurance/Quality Control Compendium: Minimum QA/QC Activities. March 2005.
3) EPA 505/B-04/900C Intergovernmental Data Quality Task Force (IDQTF), Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) Part 2A – Workbook for UFP for QAPP (March 2005). Optimized UFP-QAPP Worksheets. March 2012.

e. Code of Federal Regulations (CFR)
1) 40 CFR 261 Identification and Listing of Hazardous Waste.

B. Definitions
1. The definition of acronyms used by the Contractor that pertain to CDQC shall be clearly defined for all contract-related products and communications.

1.3 SUBMITTALS

A. Approval from the Contracting Officer's Representative, in consultation with the regulators is required for submittals with an “RA” designation; submittals having an “FIO” designation are for information only. The Contractor shall submit the following to the Contracting Officer's Representative:
1. Contractor Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP); Pre-Construction Submittals; RA
a. The Contractor UFP-QAPP (modified from the Basewide UFP-QAPP, provided in Appendix C of the IWWP) shall be submitted to the Contracting Officer's Representative for approval at least 30 calendar days prior to the Pre-Work Conference in accordance with Paragraph 3.3.
2. Trip Report; Test Reports; FIO
a. The Contractor shall submit Trip Reports in accordance with Paragraph 1.5.H.1.a.
3. Topsoil and Backfill Material Testing Results; Test Reports; RA
a. The Contractor shall submit topsoil and backfill sample results to the Contracting Officer's Representative for approval prior to use of such sources in accordance with Paragraph 3.5.A.2.
4. Analytical Data; Test Reports; FIO
a. An electronic copy of all the analytical data collected at the site shall be submitted to the Contracting Officer's Representative in accordance with Paragraph 3.8.B.
5. Field Screening Data; Test Reports; FIO
a. Electronic copy of all field screening data collected at the site to verify the effectiveness of the decontamination method.
6. Non-Conformance Reports; Test Reports; FIO
a. Reports shall be submitted within 48-hours of the occurrence of any significant problem with sampling, analytical procedures, instrument calibration and maintenance, and project quality control. Significant problems shall include, without limitation, the items specified herein as requiring corrective actions by the Contractor.
7. Chemical Data Final Report (CDFR); Test Reports; RA
a. The CDFR as described in Paragraph 3.10 shall be submitted to the Contracting Officer's Representative within 30 calendar days of completing work at the site and before final payment. Each report shall be labeled with the contract number, project name, and location.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination Meeting
1. The Contractor shall meet with the Contracting Officer's Representative at the construction site prior to construction and discuss the Contractor Data Quality Control (CDQC) Plan and the UFP-QAPP.
2. The coordination meeting shall be simultaneous to any required CQC coordination meeting unless otherwise indicated or directed.

3. A list of definable features of work that involve chemical measurements shall be agreed upon. At a minimum, each matrix (soil, groundwater, surface water, etc.) shall be a definable feature of work.
4. Management of the chemical data quality system including project DQOs, project submittals, chemical data documentation, chemical data assessment, required sampling and analysis protocols, and minimum data reporting requirements shall be agreed upon.
5. The meeting will serve to establish an interrelationship between the Contractor's chemical data quality management and USACE chemical quality assurance requirements.
6. Minutes of the meeting shall be documented by the Contractor and shall be signed by both the Contractor and the Contracting Officer's Representative. The minutes shall include any or all unresolved chemical issues along with the conditions for resolution and shall become a part of the contract file.
7. There may be occasions when subsequent conferences will be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by the Contractor.

1.5 QUALITY ASSURANCE

A. The Contractor shall be responsible for the following QA/QC elements necessary to monitor and ensure the quality of chemical data produced.

B. Analytical Testing Laboratories
   1. General
      a. The Contractor shall comply with the Superfund Field and Analytical Services Teaming Advisory Committee (FASTAC) policy as detailed in SOP HW-32 in selecting and implementing analytical services for this project. This policy requires use of the tiered decision tree for procuring Superfund analytical services for all non-time critical data collection projects. The decision tree tiers are as follows:
         1) Tier 1: EPA Region VI Laboratory Services and Applied Science Division (LSASD)
         2) Tier 2: National Analytical Services Contract Laboratories Program (CLP)
         3) Tier 3: Region Specific Analytical Services (SAS) Contract laboratories
         4) Tier 4: Contractor, Interagency Agreement (IAG) and Field Contractor Subcontract laboratories
      b. The Contractor shall use the pre-contracted and pre-approved laboratory indicated in the Basewide UFP-QAPP (i.e., Tier 4 of the decision tree).

C. The Contractor shall propose analytical subcontract laboratories in the UFP-QAPP for analytical services that cannot be accommodated through the pre-contracted and pre-approved laboratory listed in the Basewide UFP-QAPP, LSASD, or CLP. The use of subcontract laboratories shall be approved by the Contracting Officer’s Representative. The Contractor shall provide justification for use of a subcontract laboratory to the Contracting Officer’s Representative indicating the required analyses, turnaround times, special requests, etc. The subcontract laboratory shall meet the certification requirements listed in Paragraph 1.5.E.

D. Subcontracted Laboratory Analytical Requirements
   1. The Contractor shall provide chemical analyses for all parameters by methods specified in the Contract Documents to achieve the project DQOs.

E. Subcontract Laboratory Certification
   1. Environmental laboratory services are to be provided only by laboratories compliant with the most recently published version of the DOD Quality Systems

Manual (QSM), including the National Environmental Laboratory Accreditation Conference (NELAC) Standard Chapter 5 and Appendix requirements (EPA/600/R-04/003), holding a current National Environmental Laboratory Accreditation Program (NELAP) accreditation for all appropriate fields-of-testing, and certified by the State of Texas. Before testing services can be performed by the laboratory, the Contractor shall verify the candidate laboratory's acceptability by reviewing their certifications. NELAP accreditation information is to be provided annually. The laboratory shall notify the Contracting Officer's Representative immediately of any change in the status of laboratory operations that may affect ongoing compliance with these requirements. The Contracting Officer's Representative may, at any time, conduct audits (including requests for pertinent data or information) that support an environmental laboratory's self-declaration of compliance with this policy. If the Contracting Officer's Representative finds the laboratory is in non-compliance, the Contractor shall utilize alternate, compliant laboratory services until such time as compliance is again demonstrated. Before performing environmental testing, the laboratory shall have access to the approved UFP-QAPP.

F. Subcontracted Laboratory Performance
   1. The Contractor shall provide oversight to ensure continued acceptable analytical performance and shall establish a procedure to address data deficiencies noted by review and/or quality control sample results. The Contractor shall provide and implement a mechanism for providing analytical laboratories with the UFP-QAPP, for monitoring the laboratory's performance and for performing corrective action procedures. The Contractor shall acquire analytical services with NELAP-accredited and State of Texas -certified laboratories.

G. Contractor QC Sample Collection and Analysis
   1. QC samples shall be collected and analyzed by the Contractor in accordance with the Contract Laboratory Program Guidance for Field Samplers (EPA 540/R-014/013), the Basewide UFP-QAPP, and other guidance documents and the Contractor's approved UFP-QAPP. QC samples shall be collected as described in the Contractor's approved UFP-QAPP. The following summarizes the minimum QC sampling requirements:
      a. Field duplicates shall be collected at the rates specified in the Basewide UFP-QAPP.
      b. The Contractor shall include one trip blank with each cooler that contains aqueous samples collected for VOC analysis to verify the presence or absence of cross contamination in VOC samples during handling and shipment from the field to the laboratory (as specified in the Basewide UFP-QAPP).
      c. Equipment/rinsate blanks shall be collected at a frequency of one per decontamination event, not to exceed one per day, for each equipment type and for each sample matrix to assess the effectiveness of equipment decontamination (as specified in the Basewide UFP-QAPP).
      d. The Contractor shall include one cooler temperature indicator or "temperature blank" in each cooler containing samples (solid and aqueous) for analysis to verify that samples have been maintained at 0-6° C (as specified in the Basewide UFP-QAPP).
      e. The Contractor will collect one matrix spike/matrix spike duplicate (MS/MSD) at the rate specified in the Basewide UFP-QAPP to demonstrate the accuracy of laboratory analysis. MS/MSDs are not required for VOC and SVOC analysis in EPA Region 6.

H. Documentation of Sample Collection and Analysis

1. CLP Laboratory
    a. If a CLP laboratory is used for analysis, the Contractor shall submit a trip report to the EPA RSCC within seven days of collection of the final sample in a CLP case for samples analyzed by a CLP laboratory. The trip report shall include sample locations, dates of collection and shipment, identification of QC samples, and names of laboratories to which samples were submitted. The trip report shall be submitted via email or hardcopy mail to the RSCC coordinator, Ms. Myra Perez, at the EPA Region 6 office, 281-983-2130 [USEPA Region VI, Houston Laboratory, 10625 Fallstone Road (MS 6MD-HO), Houston, TX 77099-4303].
2. Subcontract Laboratory
    a. The Contractor shall meet the timing, pathways, documentation, etc. requirements specified in the Basewide UFP-QAPP.

I. Review of Primary Laboratory Data
    a. The Contractor shall be responsible for the independent review of the entire data set.

J. Data Validation
1. The Contractor shall validate analytical data for samples analyzed by the Contractor's subcontract laboratory. The data shall be evaluated in accordance with new validation SOPs for CLP Method SFAM01.1 as appropriate or accordance with EPA Contract Laboratory Program National Functional Guidelines referenced in Paragraph 1.2. The Contractor shall contact Jennifer Feranda at Feranda.jennifer@epa.gov for new validation SOPs for CLP Method SFAM01.1. The Contractor shall provide validation SOPs for any methods not covered by these documents. Radionuclide data shall be evaluated in accordance with MARLAP Chapter 8, Section 5 (EPA/402/B-04/001A). Items listed below shall be assessed as part of the data validation. The data validation criteria shall be consistent with project DQOs and discussed in the approved UFP-QAPP. The Contractor shall prepare a data validation report, which shall include a summary of the independent data reviewer's findings. The summary shall consist of a table listing each QC result outside of established criteria, the established criteria, and the validation actions. Comments shall be included on how these data affect the validity of analytical results of the samples including data qualifiers used. The data validation report shall include, but not be limited to, the following parameters:
    a. Data completeness
    b. Method blank and field blank results
    c. Holding time including sample integrity
    d. Surrogate recovery results
    e. Instrument calibration
    f. Matrix spike results
    g. Continuing calibration verification
    h. Laboratory and field duplicate results
    i. Laboratory control samples
    j. Verification of sample results
2. The Contractor shall have the laboratory data validated by an organization independent of the organization generating the data. The data validation reports shall be submitted as an appendix to the Chemical Data Final Report discussed in Paragraph 3.10.
3. Data validation shall be conducted as specified in the Basewide UFP-QAPP.

PART 2 - PRODUCTS (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. The Contractor shall be responsible for chemical sample acquisition, sample analysis, instrumental measurements of chemical parameters and for CDQC. An effective CDQC system that meets the requirements for the chemical measurement DQO applicable to the project shall be established. The chemical data QC system shall consist of a chemical Quality Management staff responsible for the UFP-QAPP, analytical procedures, minimum data reporting requirements and the organization necessary to produce the required chemical data. The system shall cover chemical measurements pertaining to and required for Contractor- and subcontractor-produced chemical data. The Contractor shall control field screening, sampling, and testing in conjunction with remedial activities to meet all DQOs, minimize the amount of excavated material requiring temporary storage, prevent dilution of contaminated soils with clean soils, and ensure completion of work within the required time.

3.2 CONTRACTOR QUALITY CONTROL PLAN

A. General
   1. The CQC Plan shall incorporate the qualifications, authority and responsibilities of all chemical quality management and support personnel.

B. Chemistry Elements of the CQC Plan
   1. To cover contract related chemical measurements by the Contractor and all subcontractors, the CQC Plan shall include the following at a minimum:
      a. Qualifications
         1) Names, education, experience qualifications, authorities, and decision-making responsibilities of all chemical quality management and support personnel (as exemplified in the Basewide UFP-QAPP). The CQC Plan shall contain a copy of a letter from the project QC manager designating and authorizing a Chemical Quality Control Officer and chemical quality control organization staff.
      b. Authority and Responsibility
         1) A diagram, flow chart, or figure clearly depicting the chemical data quality management and support staff and the authority and responsibility of each of the staff for chemical sampling and analysis, procedures for corrective actions, deliverables and submittals, deviations and changes, chemical quality documentation, data validation, minimum data reporting requirements, and DQO for chemical parameter measurement by the Contractor and subcontractors (as exemplified in the Basewide UFP-QAPP). The contents of this section of the CQC Plan shall be included in the applicable "Project Organization" elements of the QAPP.

3.3 UNIFORM FEDERAL POLICY QUALITY ASSURANCE PROJECT PLAN (UFP-QAPP)

A. General
   1. The UFP-QAPP shall describe all chemical parameter measurements for all phases of the remedial action. The Contractor must provide sufficient detail for the project team to obtain data that meet the DQOs of the project. The Contractor’s QAPP shall be in accordance with the UFP-QAPP Manuals referenced in Paragraph 1.2.

B. Level of Detail

1. The UFP-QAPP shall contain necessary technical details and directions (as exemplified in the Basewide UFP-QAPP), such that field and laboratory personnel understand all sampling and field measurement requirements. It shall document all aspects of the project, planning, implementation, assessment, corrective actions, and reconciliation of completed tasks with documented planned objectives. It shall contain sufficient direction and detail that on-site personnel can perform all on-site activities required to attain project DQOs, including collection of samples for off-site chemical analysis, shipment of samples for off-site analyses, performance of on-site instrument measurements, and documentation and reporting requirements. The level of detail in the UFP-QAPP shall be such that any technically competent personnel unfamiliar with the Site can follow the plan and perform all required work. It shall contain sufficient direction and detail that analytical laboratory personnel understand the analytical methods required and project-required reporting limits, project DQIs measurement performance criteria, and project data validation and reporting requirements.

C. Appendices
   1. The Appendices section of the UFP-QAPP shall contain all Contractor standard forms, project figures and tables, and SOPs, and all references pertaining to the project requirements included in the UFP-QAPP relating to project DQOs, standard and non-standard measurement methods, equivalency data, U.S. Government and regional agency guidance and regulatory documents, existing Site-related documents, and other contract-related chemical analysis documents (as exemplified in the Basewide UFP-QAPP). Reference to all applicable SOPs from EPA/540/P-87/001B, Compendium of Superfund Field Operations Methods, or Contractor SOPs, where applicable, shall be included.

D. Content
   1. The UFP-QAPP shall meet the requirements of the UFP-QAPP Manual and shall cover, at a minimum, the following topics:
      a. Distribution List
      b. Title and Approval Page
      c. Project Description
      d. Introduction, including Summary of Scope and Objectives, Site History and Contaminants
      e. Existing Site Data Summary – Evaluation of Secondary Data and Use Limitations
      f. Project Description/Problem Definition/Site-Specific Analysis Problems
      g. Project Objectives/Systematic Planning Documentation/Data Quality Objectives
      h. Sampling Design and Rationale
      i. Scope and Objectives
      j. Project Schedule and Timelines
      k. Project Organization and Responsibility
      l. Personnel Responsibilities, Qualifications and Special Training Requirements
      m. Field Activities and Standard Operation Procedures (SOPs)
      n. Field and Laboratory QC Samples
      o. Sampling Procedures and Container/Preservation Requirements
      p. Sample Custody, Chain-of-Custody/Sample Documentation
      q. Sample Handling/Identification
      r. Field Logbooks and Contents; Documentation Procedures
      s. Sample Packaging and Shipping
      t. Equipment Decontamination

u. Contractor Quality Control
v. Daily Quality Control Reports
w. Field Quality Control and Corrective Actions
x. Sampling Apparatus and Field Instrumentation
y. Data Quality Objectives and Measurement Performance Criteria
z. Sample Custody and Holding Times
aa. Analytical Procedures
bb. Reference Limits and Evaluation of Quantitation Limit Goals
cc. Laboratory Calibration Procedures and Frequency
dd. Internal QC Checks
ee. Calculation of Data Quality Indicators
ff. Laboratory Corrective Actions
gg. Data Reduction, Review, Validation and Reporting
hh. Laboratory Reporting Requirements
ii. Preventive Maintenance (Field and Laboratory)
jj. Performance and System Audits
kk. QC Reports to Management
ll. Appendices

E. The UFP-QAPP shall include a table of contents; crosswalk showing that all UFP-QAPP elements have been addressed; definitions, acronyms, and references pertaining to the project; and other related chemical analysis documents such as the data validation SOPs.

F. The "Sampler's Guide: Contract Laboratory Program Guidance for Field Samplers" (EPA 540/R-014/013), October 2014 procedures shall be followed for sample packing and shipment.

G. All Department of Transportation (DOT) regulations under 40 CFR 261 shall be followed regarding shipment of the samples.

3.4 CHEMISTRY REQUIREMENTS

A. Chemical data shall be acquired, documented, verified, and reported in a manner that assures that the precision, accuracy, and completeness requirements are achieved, as specified in the Contractor's approved UFP-QAPP. The Contractor must demonstrate the analytical chemistry methods' ability to meet the project data quality objectives (DQOs). Where national standard methods are not available for the medium, methods published by reputable technical organizations (e.g., ASTM) shall be utilized. Sampling, analysis, and measurement requirements listed in the following subsections shall be included in the UFP-QAPP.

B. Data Quality Objectives
   1. Project Objective - the overall project objective is to remove the contaminated material (source materials including associated wastes and contaminated soil/sediment) from the site, backfill the excavation with certified clean fill material, and remediate impacted groundwater, in accordance with the Contract Documents.
   2. Sampling Objectives
      a. Samples shall be acquired, and chemical parameter measurements shall be performed in such a manner that the resulting data meets and supports data use requirements. Both definitive and field screening data are anticipated for this project, as defined by the EPA Guidance for Systematic Planning (EPA 240/B-06/001) and as indicated in the Basewide UFP-QAPP.
      b. Field screening quality data shall be generated for health and safety purposes, as well as to identify media or samples that may be subject to further analysis.

The Contractor shall also include a field screening method, if any proposed for the site.

c. Definitive level quality data shall be used to delineate soil and groundwater contamination, characterize cleared vegetation, characterize excavated material, demonstrate backfill materials and topsoil quality, and verify that the remediation cleanup levels have been met, and determine if contamination occurred below decontamination areas as a result of remedial activities. Definitive quality data shall be acquired, documented, verified, and reported to ensure that the specified data quality indicators (DQIs) (precision, accuracy, representativeness, comparability, completeness, and sensitivity) measurement performance criteria are achieved. Sampling objectives are discussed in detail to ensure that the data obtained will be of sufficient quality and quantity to meet the DQOs.
    1) Waste characterization samples from impacted soil shall be analyzed in accordance with disposal facility sampling requirements. Impacted water shall be transferred to the existing on-site groundwater treatment plant for further treatment. The analytical results obtained by the Contractor shall be sufficient to address any and all requirements of the selected disposal facility. The sampling requirements to be contained in the Contractor's UFP-QAPP shall include specific disposal facility requirements for sampling, analysis, and reporting.
    2) Samples of topsoil and backfill materials from each off-site source shall be collected and analyzed for the parameters listed in Paragraph 3.5.A.2. Sample data shall be sufficient to demonstrate that topsoil and backfill materials do not contain contaminant levels that are hazardous to human health or the environment. The Contractor shall compare chemical sample data to the TCEQ Risk Reduction Standard No. 2 Soil MSCs for industrial use. Radiological sample data shall be compared to the criteria specified in Paragraph 3.5.A.2.c. Sample results exceeding the TCEQ Risk Reduction Standard No. 2 Soil MSCs for industrial use and radiological criteria specified herein, where those numbers are not below method detection levels, shall be unacceptable as topsoil or backfill. The gamma spectroscopy sample summary shall include all detectable radionuclides. No backfill or topsoil shall be brought to the site without written approval from the Contracting Officer's Representative.
    3) Post-excavation soil/sediment samples shall be analyzed for contaminants of concern to confirm the final limits of excavation. The analytical results obtained by the Contractor shall be sufficient to confirm the final limits of excavation. The sampling requirements to be contained in the Contractor's UFP-QAPP shall include specific chemical concentrations as stated in the remedial action levels defined in Table 01 35 45-1A.
    4) Samples from beneath contaminated soil stockpile areas and decontamination pads shall be collected after removal of the stockpiles/decontamination pads to verify that no cross-contamination has occurred in the area due to leakage. The samples shall be analyzed and compared to the remedial cleanup levels. Areas where sample results exceed the criteria in Table 01 35 45-1 shall be scraped to remove the contamination in accordance with SECTION 31 23 10 – EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS and be re-sampled.

5) Baseline and performance monitoring groundwater and surface water samples collected during the Enhanced In-situ Bioremediation implementation and In-situ Thermal Desorption treatment shall be analyzed in accordance with the Contract Documents.

3. Chemical DQO
   a. Chemical data shall be acquired, documented, verified, and reported in a manner that ensures that the precision, accuracy, and completeness requirements provided in Table 4 of the Basewide UFP-QAPP are achieved. The UFP-QAPP shall comply with the DQO process requirements as specified in EPA 600/R-96/055.

3.5 SAMPLING, ANALYSIS, AND MEASUREMENT REQUIREMENTS

A. Sampling, analysis, and measurement requirements listed in the following subsections shall be included in the UFP-QAPP.
   1. Waste Characterization Sampling Requirements
      a. Samples from excavated contaminated soil shall be collected and analyzed in accordance with the Contractor's approved disposal facility requirements.
      b. Samples shall be analyzed for waste characteristics to determine handling, transportation, and disposal requirements. The number and volume of samples will be determined by the disposal facility.
      c. Standard analytical requirements for waste characterization samples are listed below:
         1) Paint Filter Liquid Test
         2) Corrosivity
         3) Ignitability
         4) Reactivity – Hydrogen Cyanide
         5) Reactivity – Hydrogen Sulfide
         6) Toxicity Characteristic Leaching Procedure (TCLP) – Metals
         7) TCLP – Volatile Organic Compounds (VOCs)
         8) TCLP – Semi-volatile Organic Compounds (SVOCs)
         9) TCLP – Pesticides
         10) TCLP – Herbicides
         11) Polychlorinated Biphenyls (PCBs)
         12) Moisture Content
      d. Analytical methods for the above parameters are included in Table 8 of the Basewide UFP-QAPP.
      e. The Contractor shall ensure that all the disposal facility requirements are met prior to shipment of the waste. EPA approval is required to utilize a disposal facility for hazardous waste generated from the Site.
   2. Backfill and Topsoil Sampling Requirements
      a. Clean backfill and topsoil material samples shall be collected as stated in SECTION 31 23 00 – BACKFILL, COMPACTION AND GRADING to ensure that they are free of chemical contamination.
      b. Analytical parameters to verify that backfill and topsoil are free of chemical contamination include:
         1) EPA TAL metals, mercury, and cyanide
         2) EPA Target Compound List (TCL) compounds + Acrolein, Acrylonitrile, Benzidine, 1,2-Diphenylhydrazine, N-Nitrosodimethylamine and Tertiary Butyl Alcohol
         3) Extractable Petroleum Hydrocarbon (EPH)
         4) Radium-226 (Gamma Spectroscopy)

5) Gamma Radiation Exposure Rate (Field Screening)
6) Soil pH (using method SW-846 9045D)

c. Analytical methods for the above parameters are included in Table 8 of the Basewide UFP-QAPP.
1) The criteria for backfill to be free of radiological contamination are listed below:
a) Radium-226 < 3 picoCuries per gram (pCi/g) (assuming background level of 1 pCi/g)
b) Gamma Radiation Exposure Rate < 30 micro-Roentgen per hour (μR/hr)

d. Analytical parameters for topsoil shall include, at a minimum, total organic carbon, pH, and nutrients (nitrogen, phosphate, and potassium). Sample data shall be sufficient to demonstrate that topsoil materials meet ASTM D5268 requirements in accordance with SECTION 31 38 50 – SITE RESTORATION.

3. Post-excavation samples shall be collected as per SECTION 31 23 10 – EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL and as shown in the Design Drawings. The samples shall be sent to the off-site laboratory for analyses to confirm or revise excavation requirements in accordance with the criteria listed in Table 01 35 45-1.
4. Decontamination Area and/or Stockpiles Area Sampling Requirements
a. The Contractor shall collect samples from the decontamination areas to verify that no cross-contamination has occurred in these areas due to leakage. The samples shall be collected as per SECTION 31 23 10 – EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL. The samples shall be sent to the off-site laboratory for analysis to verify the results are below the criteria listed in Table 01 35 45-1.
5. Baseline and performance monitoring groundwater and surface water Sampling Requirements
a. Baseline and performance monitoring for groundwater and surface water shall be conducted in accordance with the Contract Documents.

3.6 CONTROL OF CHEMICAL DATA QUALITY

A. General
1. Contractor CDQC shall ensure that a quality control program is in place that assures sampling and analytical activities and the resulting chemical parameter measurement data comply with the DQO and the requirements of the QAPP. The Contractor shall utilize the three phased control system that includes a preparatory, initial and follow up phase for each definable feature of work. The Contractor's three phase chemical data control process shall ensure that data reporting requirements are achieved and shall be implemented in accordance with the Contract Documents.

B. Three Phase Process
1. The preparatory phase shall include a review of the Specifications, UFP-QAPP, and all relevant SOPs for the chemical parameter measurement and/or chemical sample acquisition and shipment. It shall include a physical examination of all required forms, materials, and equipment to ensure conformance with the UFP-QAPP and that all materials are on Site. It shall include a demonstration of sampling procedures by the Contractor's field sampling personnel.
2. The initial phase shall be performed at the initiation of each definable feature of work by the CQC Representative to confirm compliance with the UFP-QAPP, including instrument calibration, operation and performance checks, sample

acquisition, labeling, and shipment in accordance with required SOPs, sampling equipment decontamination, and completion of all required documentation.

3. The follow up phase shall require daily inspections to ensure compliance with the UFP-QAPP.

3.7 SUBCONTRACT ANALYTICAL TESTING LABORATORIES

A. General

1. The Contractor shall propose the analytical laboratories to be used for the sample analyses in case the pre-contracted and pre-approved laboratory, LSASD, and CLP cannot accept the samples. Laboratory certification requirements shall be in accordance with Paragraph 1.5.E. The Contractor may utilize its own laboratory or utilize subcontract laboratories to achieve the required sample analyses.

B. Laboratory Analytical Requirements

1. The Contractor shall provide the chemical analyses specified in these Specifications through the subcontracted laboratory or LSASD/CLP laboratory. The Contractor shall provide chemical analyses for all parameters by methods specified in the project Specifications to achieve the project DQOs.

C. Laboratory Performance

1. The Contractor shall monitor and ensure continued acceptable analytical performance and shall establish a procedure to address data deficiencies noted by review and/or quality assurance sample results. The Contractor shall provide and implement a mechanism for providing analytical laboratories with the QAPP, for monitoring the laboratories' performance and for performing corrective action procedures. The Contractor shall acquire analytical services with NELAP-accredited and State of Texas-certified laboratories in case of LSASD or CLP cannot accept the samples.

3.8 ANALYTICAL DATA

A. Electronic Copy

1. The chemistry data packages shall be reproduced and provided to the Contracting Officer's Representative no later than 4 weeks after receipt of the analytical data package from the laboratory. The chemistry data package shall contain information to demonstrate that the project's DQO have been fulfilled.

B. Electronic Data Deliverables (EDD)

1. The Contractor shall prepare and submit to USACE a final EDD for all samples collected by the Contractor in accordance with the procedures and requirements set forth in the Comprehensive Specification Manual (current edition).
2. The EDD shall include sample information including sample locations (horizontal coordinates and surface elevation) and sample results. The EDD shall also include an updated geo- referenced electronic base map in AutoCAD drawing exchange (DXF) format showing Site features, monitoring well locations, and updated Site grades following the soil remediation program.
3. The Contractor shall provide the Contracting Officer's Representative with a copy of the transmittal letter for all EDD submissions, identifying what data were provided in the EDD. The Contractor shall also provide the Contracting Officer's Representative with a copy of the notice from EPA that the EDD submittal was successfully uploaded.

3.9 QUALIFICATIONS

A. Chemical Quality Control Officer

1. As a minimum, the Contractor's Chemical Quality Control Officer shall have a bachelor's degree (B.A. or B.S.) in Chemistry and three years of experience with Hazardous Toxic and Radioactive Waste (HTRW) Quality Control including hazardous waste manifesting. The Chemical Quality Control Officer shall ensure that all chemistry-related requirements including responsibilities for DQO definitions, sampling and analysis, project requirements for data documentation and validation, and final project reports are attained. The Chemical Quality Control officer need not be present on Site during routine sampling but shall be available for consultation with the Contracting Officer's Representative and Contractor personnel.

B. Environmental Sampler
   1. As a minimum, the Contractor's Environmental Sampler shall have a B.A. or B.S. degree in Chemistry or closely related scientific/technical field, 1 year of experience in and knowledge of EPA methods for collecting environmental and hazardous waste samples and 1 year of experience in calibration and operation of field screening equipment. The Environmental Sampler shall collect all on-site samples as well as perform all field-screening tests. The Environmental Sampler shall review the sampling results and provide recommendations for the Contractor's sampling program. The Environmental Sampler shall be on-site during excavation and stockpiling operations involving soil to be checked for contamination.

C. Project Chemist
   1. At a minimum, the Contractor's Project Chemist shall have: a B.A. or B.S. degree in chemistry; 3 years of experience related to investigations, studies, design, and remedial actions at Hazardous, Toxic, and Radioactive Waste (HTRW) sites; 2 field seasons of experience in calibrating and operating various field monitoring devices; and 2 years of sample analysis experience in HTRW program and activities. The Project Chemist shall ensure that all chemistry-related goals of the program are attained.

3.10 CHEMICAL DATA FINAL REPORT (CDFR)

A. The CDFR shall be produced after project completion; it shall include a summary of quality control practices employed and all chemical parameter measurement activities. This includes, but is not limited to, all data analyzed by the Contractor's subcontract laboratories, if any, and shall include all definitive data. At a minimum, the CDFR shall contain the following:
   1. Summary of project scope and description
   2. Summary of any deviations from the design chemical parameter measurement Specifications
   3. Summary of chemical parameter measurements performed as contingent measurements
   4. Summary discussion of resulting data including achieving data reporting requirements
   5. Summary of DQO parameters including achieving sampling project specific DQO
   6. Presentation and evaluation of the data to include an overall assessment on the quality of the data for each method and matrix
   7. Internal QC data generated during the project, including tabular summaries correlating sample identifiers with all blank, matrix spikes, surrogates, duplicates, laboratory control samples, and batch identifiers
   8. A list of the affected sample results for each analyte (indexed by method and matrix) including the appropriate data qualifier flag (J, U, UJ, and R), where sample results are potentially impacted by quality control outliers

9. Summary of field and laboratory oversight activities, providing a discussion of the reliability of the data, QC problems encountered, and a summary of the evaluation of data quality for each analysis and matrix as indicated by the laboratory QC data and any other relevant findings
10. Conclusions and recommendations
11. Appendices containing chemistry data packages for all subcontract laboratory data (hardcopy and electronic copy on disk) and data validation reports.

3.11 NOTIFICATION OF NON-COMPLIANCE

A. The Contracting Officer's Representative will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice.

END OF SECTION

TABLE 01 35 45-1A
Record of Decision Remediation Cleanup Levels for Soil/Sediment

Chemical of Concerns (COCs)	GWP-Ind MSC* (mg/kg)
Methylene Chloride	0.5
Trichloroethylene	0.5
Perchlorate	7.2
Tetrachloroethene	0.5

Notes:

*GWP-Ind MSC - Texas Commission on Environmental Quality soil medium-specific concentration (MSC) for industrial use based on groundwater protection

mg/kg – milligrams per kilogram

Source: LHAAP-18/24 Site Record of Decision (U. S. Army, 2020)

TABLE 01 35 45-1B
Record of Decision Remediation Cleanup Levels for Groundwater

Medium	Chemical of Concern	Cleanup Level
Shallow Zone Groundwater		**MCL (µg/L)**
	Methylene chloride	5
	Trichloroethylene	5
	cis-1,2-Dichloroethene*	70
	Tetrachloroethene	5
	Benzene	5
	1,1,2-Trichloroethane	5
	Vinyl chloride*	2
	Arsenic	10
	Barium	2,000
	Chromium	100
		$TRRP^{GW}$ GW_{Ing} PCL (µg/L)
	Bromodichloromethane	15
	1,3,5-trinitrobenzene	730
	1,4-Dioxane	9.1
	Cobalt	240
	Nickel	490
	Perchlorate	17
Wilcox Formation Groundwater		**MCL (µg/L)**
	Methylene chloride	5
	Trichloroethylene	5
	cis-1,2-Dichloroethene*	70
	Tetrachloroethene	5
	Benzene	5
	Vinyl chloride*	2
	Arsenic	10
	Barium	2,000
		$TRRP^{GW}$ GW_{Ing} PCL (µg/L)
	Bromodichloromethane	15
	1,3,5-trinitrobenzene	730
	1,4-Dioxane	9.1
	Perchlorate	17

Notes:
1. The PCL for Bromodichloromethane was increased in the 2021 TRRP tables, and this change should be addressed in the Fiver-Year Review.
* Trichloroethene daughter products
**TRRP $^{GW}GW_{Ing}$ PCL from April 2018, https://www.tceq.texas.gov/remediation/trrp/trrppcls.html
µg/L – micrograms per literMCL – Safe Drinking Water Act (SDWA) maximum contaminant level
PCL – Texas Risk Reduction Program (TRRP) Tier 1 Groundwater Residential Protective Concentration

SECTION 02 53 17
ENHANCED IN-SITU BIOREMEDIATION
INJECTION PROCEDURES AND MONITORING

PART 1 - GENERAL

1.1 SUMMARY

A. This section describes the requirements for completing an enhanced in-situ bioremediation (EISB) injection program to treat contaminated groundwater at the site. The section includes substrates and amendments to be injected, sequencing for injections, secondary containment and spill prevention, and monitoring.

1.2 REFERENCES

A. References
   1. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.
      a. American Society Mechanical Engineers International (ASME)
         1) ASME B40.100 (2013) Pressure Gauges and Gauge Attachments
         2) ASME PTC 19.5 (2004) Flow Measurement
      b. Code of Federal Regulations (CFR)
         1) 29 CFR 1910 Occupational Safety and Health Standards
         2) 40 CFR 144-148 Underground Injection Control Regulations
      c. United States Army Corps of Engineers (USACE), Tulsa District
         1) Final Installation Wide Work Plan for Longhorn Army Ammunition Plant (LHAAP IWWP), Karnack, Texas, revised by Bhate Environmental Associates, Inc. (May 2018; IWWP).
      d. Texas Administrative Code
         1) 16 TAC 76.1000 - Well Construction Standards – Monitoring or Injection Wells
         2) 30 TAC 331, Subchapters A, C, and H – Installation, operation, and closure of injection wells fall in the category of Class V Injection Wells

1.3 SUBMITTALS

A. Approval from the Contracting Officer's Representative, in consultation with the regulators is required for submittals with an "RA" designation; submittals having an "FIO" designation are for information only. The Contractor shall submit the following to the Contracting Officer's Representative:
   1. Injections Work Plan; Pre-Construction Submittals; RA
   2. Injection System Layout; Shop Drawings; RA
   3. Sequencing and Scheduling for injections; Product Data; RA
   4. Equipment and Materials; Product Data; RA
   5. Instrumentation and Controls; Product Data; RA
   6. Secondary Containment Systems; Product Data; RA
   7. Daily Injection Logs; Test Reports
   8. Groundwater Sample Results; Test Reports
   9. EISB Completion Report (One EISB completion report should be submitted for each injection event); RA
   10. Closeout Submittals; RA

1.4 ADMINISTRATIVE REQUIREMENTS

A. Not used.

1.5 QUALITY ASSURANCE

A. Contractor Qualifications
   1. The Contractor shall be required to have experience on at least three EISB projects of comparable size and scope within the past three (3) years.
   2. Such experience shall be current and explicitly display knowledge and hands-on expertise in current technologies and current regulations specifically applicable to this work.
   3. Key personnel shall have experience of EISB projects of comparable size and scope. Experience shall be current and explicitly display knowledge and hands-on expertise in current technologies and current regulations specifically applicable to this work.
   4. All Contractor personnel must be 40-hr OSHA trained as required in 29 CFR 1910.120 for hazardous waste operations.

1.6 SUBSURFACE CHARACTERISTICS

A. Geology
   1. Site stratigraphy consists of approximately 10 to 45 feet cover of unconsolidated shallow alluvium atop semi-consolidated sandstones (sands) and shales (clays and silts) of the Wilcox Formation.
      a. Shallow alluvium is characterized by laterally heterogeneous deposits of clays, silts, and sands with isolated sandy zones of higher permeability surrounded by silts and clays. Sand, silty sands, silts, and clays are generally orange, light brown/grey, yellow and light brown, respectively.
      b. A Wilcox clay unit separating the shallow alluvium from the Wilcox sands occurs at the top of the Wilcox Formation throughout most of the site within the containment area. However, this clay either thins out or is missing in the northwestern corner of the containment area and to the west and to the north of the containment area towards Harrison Bayou.
      c. Wilcox Formation consists of semi-consolidated sands and clays with sands broadly lenticular in morphology and more massive and has homogeneous geological features than the overlying alluvium sands.

B. Hydrogeology
   1. Contamination from historical activities at LHAAP-18/24 have impacted two groundwater zones: the Shallow Zone extending from the surface to a depth of approximately 45 ft below ground surface (bgs), and the Wilcox Formation below the Shallow Zone to a depth of approximately 65 ft bgs. These two units are separated by a mostly contiguous clay layer, which is believed to be present across most of the containment area but thins out or is missing in the northwestern corner of the containment area and to the west and to the north of the containment area towards Harrison Bayou.

1.7 TREATMENT AREA

A. As per the Contract Documents, injections will be conducted during Phase I of the remedial action in the three pilot test areas. Groundwater within the three pilot test areas is primarily contaminated with trichlorethylene (TCE), perchlorate, and methylene chloride, with maximum concentrations of 9,000 ug/L, 198,000 ug/L, and 20 ug/L, respectively.

B. During remedial action Phase II, injections will be conducted in two distinct configurations to treat groundwater and soil in an area of approximately 926,000 square feet with a thickness of between 8 to 20 vertical feet to a maximum depth of 65 ft bgs as per the Contract Documents. Groundwater is primarily contaminated with TCE, perchlorate, and methylene chloride, with maximum concentrations of 38,400 ug/L, 576,000 ug/L, and 6,980, respectively.
   1. Injections in EISB grids will be implemented to address elevated perchlorate (greater than approximately 1,000 ug/L) and/or TCE (greater than approximately 500 ug/L) concentrations to treat the dissolved plume within the containment area and outside of the containment area in the northeast.
   2. Injections in EISB biobarriers will be implemented to provide Shallow Zone groundwater treatment as it passes through the biobarriers located northeast area toward Caddo Lake, and radially outward from the containment area in a complex pattern from the site. Additional injections in EISB biobarriers will treat groundwater in Wilcox Formation near the northeastern, western, and southern corners of the containment area.

PART 2 - PRODUCTS

2.1 EQUIPMENT, MATERIALS AND STORAGE

A. Equipment and storage facilities shall be provided for storage and handling of substrates and amendments necessary for EISB. All equipment and materials must be compatible with the substrates and amendments used and stored at the site. The Contractor shall follow the substrate and amendment manufacturer instructions and precautions for storage and handling of all substrates and amendments.
   1. Capacity
      a. All tanks used to store substrates and amendments must be adequately sized and constructed of a material compatible with the contents being stored.
      b. Instrumentation and Sampling Instrumentation and equipment, including sensors, local indicators, connecting devices, recorders, analyzers, and components necessary to monitor and control the safe and efficient operation of the mixing and injection systems shall be provided.
      c. Pressure Gauges shall conform to ASME B40.100 and be of pressure detecting class, single Bourdon tube style, and suitable for detecting air pressure.
      d. Flow meters shall conform to ASME PTC 19.5, with type and flow range suitable for the use encountered.
   2. Substrate/Amendment and Mixing Storage Tanks
      a. Substrate/Amendment storage tanks shall be approved by the Contracting Officer's Representative prior to mobilization.
   3. Secondary Containment
      a. Secondary containment shall be constructed of materials compatible with the chemicals being stored and must have sufficient strength and thickness to prevent failure as a result of physical contact with chemicals stored, climatic conditions, or the stress of daily operations.

2.2 SUBSTRATES AND AMENDMENTS

A. All substrates used shall be environmentally safe and manufactured for the purpose of injecting into the subsurface for treatment of contaminated groundwater.
   1. Emulsified vegetable oil (EVO)

a. EVO shall have the following characteristics.
(1) Non-toxic, food-grade materials that are sufficiently biodegradable to support complete reductive dechlorination of the target contaminants.
(2) Slowly biodegradable such that residual organic amendment can remain effective in the aquifer for an extended period of time (e.g., 3 to 5 years).
(3) A low unit cost.
2) EVO shall be provided as water-mixable oil that contains no water as shipped.
3) EVO can be prepared in field by mixing and blending edible oils (locally sourced soybean oil) with emulsifying agents or surfactants (TASK™ MicroEVO™ Self-Emulsifier or comparable), yielding a smooth blend of small oil droplets suspended in a water matrix (i.e., an oil-in-water emulsion); however, the types of oil, the percent of oil in the mix, the types of emulsifying agents and other additives shall be approved by the Contracting Officer's Representative prior to initiating the injection.

2. Extended Release (EDS-ER™)
a. If EDS-ER™ or a comparable pre-mix electron donor solution is used, then it shall be a water-mixable oil formulated with at least 92 percent natural seed oils.

B. Nutrient Addition
1. Nutrients, such as nitrogen and phosphorus, or other trace nutrients necessary for cell growth will be required so that concentrations of nutrients in the subsurface do not become a limiting factor for the EISB application for the site.
2. The types of nutrients, percentage in the substrate mix, and other additives shall be approved by the Contracting Officer's Representative prior to initiating injections.
3. Nutrients are typically added as an amount of selected nutrients per volume of water and are shipped in buckets.
4. Fast-acting soluble nutrient blend, such as TersOx™ Nutrients-QR (available from Tersus Environmental) or comparable, shall be used as the nutrients for the site.

C. Buffering Agent
1. A typical pH buffering agent, such as sodium bicarbonate, will be needed for the site.
2. The types of buffering agent and percentage in the substrate mix shall be approved by the Contracting Officer's Representative prior to initiating injections.
3. Sodium bicarbonate is typically added as a mass per volume of water and is shipped in bags.

D. Bioaugmentation Culture
1. Contains a natural consortium of dechlorinating bacteria.
2. KB-1® Plus by SiREM shall be used as the bioaugmentation culture for the EISB injection program for the site.
3. KB-1® is shipped in stainless steel vessels by express courier and is applied under anaerobic conditions to prevent the exposure of oxygen-sensitive microbes to air.
4. KB-1® Plus shall be handled with care to avoid any spillage. Vessels shall be shipped with 1 pound per square inch (psi) pressure; valves should not be opened until connections to appropriate lines for subsurface injection are in place.

5. The Contractor shall avoid exposing stainless steel pressure vessels to undue temperature extremes (i.e., temperatures less than 0°C or greater than 30°C may result in harm to the microbial cultures and damage to the vessels). All valves shall be in a closed position when the vessel is not pressurized or not in use to prevent the escape of gases and to maintain anaerobic conditions in the vessel.
6. The Contractor shall avoid exposure of the culture to air as the presence of oxygen will kill dechlorinating microorganisms.

E. Anaerobic Water
1. KB-1® Primer shall be used to prepare anaerobic water to disperse electron donors and protect anaerobic bioaugmentation cultures during injections.
2. KB-1® Primer will be prepared in field with 800-gram pouch of KB-1® Primer to 250 gallons (for pilot testing) or for 1,000-gallon batch sizes using the 3.2 kg pouch of KB-1® Primer.
3. Anaerobic injection water prepared with KB-1® Primer meets the following criteria:
    a. Dissolved Oxygen less than 0.5 milligrams per liter.
    b. Oxidation-Reduction Potential (ORP) less than -75 millivolts (mV).
    c. pH between 6 and 8.

PART 3 - EXECUTION

3.1 INJECTIONS WORK PLAN

A. The Contractor shall submit the Injections Work Plan describing all work that will be performed. The plan shall include the following minimum information:
1. Diagram of the work site with layout showing location(s) of substrate and amendment storage areas, injection locations, equipment staging, decontamination facilities, site access points.
2. List of all equipment that will be used, including size, material type, and planned use. Equipment includes but is not limited to storage tanks, mixing tanks, secondary containment, generators, pumps, valves, gauges, etc.
3. List of key personnel along with resumes demonstrating knowledge and experience in the injection of EISB.
4. Level of personal protective equipment (PPE).
5. Total volume of each substrate and amendment delivered to the site and description of means and methods used to prepare solution for injection.
6. Safety Data Sheets (SDS) for all substrates and amendments to be used on site.
7. Procedures, means, and methods for monitoring injections.
8. Identification of permits/approvals.
9. Procedures for handling and storing all substrates and amendments.
10. Procedures for handling, storage, and disposal of waste materials generated during injections.
11. Schedule for work.
12. Emergency actions that will be taken by the Contractor in the event of a spill.

3.2 PERMIT EQUIVALIENCES/APPROVALS

A. The Contractor will be responsible for obtaining all permit equivalences/approvals related to injections before beginning any injections. Copies of permits shall be submitted to the Contracting Officer’s Representative at least two weeks before performing injections.

B. The Contractor shall notify Texas Commission on Environmental Quality and United States Environmental Protection Agency (in accordance with 40 CFR 144-148) two weeks in advance of commencement of fieldwork for injection activities.

3.3 UTILITY CLEARANCE

A. The Contractor shall conduct utility location and clearance for intrusive activities in accordance with Section 3.1 of the IWWP prior to drilling as follows:

B. The Contractor shall prepare a map indicating the area(s) where intrusive activity is planned to occur.

C. The Contractor shall perform the necessary document reviews.

D. The Contractor shall contact the Texas Excavation Safety System, Inc. utility notification service by calling 811 or 800-892-0123. This notification must be made a minimum of two working days prior to the initiation of intrusive activity (excluding Saturdays, Sundays, and holidays), but not greater than 14 days.

E. The Contractor shall verify that all underground installations have been located, physically marked, and then noted on the map. If needed, a third-party location service will be used.

F. The Contractor shall mark all overhead utilities with their kilovolts rating on the map.

G. The Contractor shall notify the appropriate agencies, the Contracting Officer's Representative, and subcontractor responsible for operating the existing Groundwater Treatment Plant.

H. The Contractor shall confirm utility clearance is complete and documented.

I. The Contractor shall hold a safety meeting, and a job safety analysis shall be completed by all personnel who are involved in the intrusive activities prior to initiating work.

3.4 LAYOUT

A. Contractor shall maintain all equipment and materials in the designated areas shown on the Contract Documents. If additional area is needed, the Contractor shall discuss obtaining additional area with the Contracting Officer's Representative before beginning injections. The Contractor shall phase the injection sequence to maintain access and designate access points during injections with cones or other measures to keep unauthorized persons from being in proximity to wells being actively injected.

B. Security
   1. The substrate and amendment storage areas shall be surrounded by temporary chain link fence at all times. During non-working hours, the gate shall be locked to prevent any unauthorized access.

3.5 GENERAL INJECTION STRATEGIES

A. Injections will be accomplished through permanent injection wells (IWs) and temporary direct push technology (DPT) injection locations, as per the Contract Documents. The Contractor shall install the injection wells as per Section 3.6.

B. For areas requiring injection wells, the Contractor shall complete IWs to the required depth intervals specified in the remedial action work plan (RAWP) prior to mobilization for injection of amendments. The following subsections outline the minimum requirements for EISB implementation.

3.6 INSTALLATION OF INJECTION WELLS

A. The Contractor shall install injection wells prior to mobilization for injections in accordance with the procedures described in Section 3.2 Task 2 - Monitoring Well/Compliance Well Installation, and SOP A7-Monitoring Well Installation, of Appendix A of the Final Installation Wide Work Plan for Longhorn Army Ammunition Plant, Karnack, Texas, with the following exceptions: the well screen slot size, sand, and completion with a threaded connection to connect the injection hoses for injections. Injection wells shall meet the requirements of 16 TAC 76.1000 and 30 TAC 331, Subchapters A, C, and H.

B. The details of the injection wells are provided in the Contract Documents and shall be included in the approved RAWP for the site.

C. The Contractor shall log the lithology at new well locations as per the procedure outlined in SOP A2 – Lithologic Description of Subsurface Samples and Completion of Drill Logs 2-1 in Appendix A of the IWWP.

D. Each newly installed well shall be developed no sooner than 24 hours following well completion. Well development shall be conducted in accordance with Section 3.2.2 Well Development of the IWWP. Procedures for well development are detailed in SOP A8 - Monitoring Well Development in Appendix A of IWWP.

E. The Contractor shall thoroughly develop all injection wells prior to beginning injections to obtain maximum injection rates and minimize the injection time.

F. The Contractor shall provide additional care when installing a cement/bentonite well seal directly above the target injection interval to reduce surface breakout when the substrates/amendments are injected under pressure.

G. Injection wells shall be able to withstand injection pressures at a minimum of 10 pounds per square gauge.

H. Injection wells shall be installed with at least 6 to 24 inches of PVC casing projecting above grade with a glue-on threaded PVC coupling, so that the injection hose can then be connected directly to the injection well.

3.7 INSTALLATION OF MONITORING WELLS

A. The Contractor shall install any new monitoring wells required for performance monitoring as per the Contract Documents and procedures described in Task 2, Monitoring Well/Compliance Well Installation, and SOP A7-Monitoring Well Installation, of Appendix A of the Final Installation Wide Work Plan for Longhorn Army Ammunition Plant, Karnack, Texas, as well as 16 TAC 76.1000.

B. All monitoring wells required for performance monitoring shall be developed prior to groundwater sampling.

C. Monitoring wells shall be installed as stickups with the top of protective outer casing two to three feet above grade.

3.8 SUBSTRATE AND AMENDMENT STORAGE AND HANDLING

A. All substrates and amendments shall be stored and handled in accordance with their Safety Data Sheet (SDS), the manufacturer’s recommendations and all governing regulations.

B. Containers shall be kept tightly closed in a cool, well-ventilated area and kept from freezing conditions.

C. Special Storage and Handling of Bioaugmentation Culture
   1. KB-1® Plus is shipped in stainless steel pressure vessels and connected to injection lines and inert gas is used to pressurize the vessel to displace the contents. KB-1® Plus shall be handled with care to avoid any spillage.
   2. Vessels will be shipped with 1 pound per square inch (psi) pressure; valves shall not be opened until connections to appropriate lines for subsurface injection are in place.
   3. The Contractor shall avoid exposing stainless steel pressure vessels to undue temperature extremes. Temperatures less than 0°C or greater than 30°C may result in harm to the microbial cultures and damage to the vessels.
   4. All valves shall be in a closed position when the vessel is not pressurized or not in use to prevent the escape of gases and to maintain anaerobic conditions in the vessel.
   5. The Contractor shall avoid exposing the culture to air, as the presence of oxygen will kill dechlorinating microorganisms.

3.9 HAZARDOUS MATERIALS

A. If any process residuals are found to contain hazardous materials, they shall be transported and disposed of in accordance with all applicable Federal, State, and local regulations.

3.10 SPILL PREVENTION, CONTAINMENT, AND EMERGENCY RESPONSE

A. Spill Response
   1. The Contractor shall have a plan included in the approved Injections Work Plan to quickly respond to spills or surfacing that may occur during EISB operations.
   2. The Contractor's spill response measures shall be in accordance with each substrate's Safety Data Sheet (SDS), the manufacturer's recommendations and all governing regulations.
   3. The Contractor's spill response measures shall include at a minimum the following:
      a. Procedures for immediately shutting down injections to affected wells and providing containment for any substrate or amendment releases; and
      b. Measures to cleanup affected areas. All substrate or amendment cleanups shall be conducted in accordance with the manufacturer's recommendations.

3.11 PRE-INJECTION ACTIVITIES

A. The Contractor shall install new injection and monitoring wells as per the Contract Documents.

B. The Contractor shall collect baseline (pre-remedy) readings and groundwater samples from existing and new monitoring wells as per the Contract Documents.

C. The Contractor shall also collect baseline field readings and surface water samples from the bayou at locations near the biobarrier as per the Contractor Documents.

D. The Contractor shall survey the newly installed monitoring and injection wells as per Section 3.3 Task 3 – Surveying of the IWWP. Detailed procedures for conducting survey of the monitoring and injection wells are provided in SOP A15-Surveying in Appendix A of the IWWP.

E. The Contractor shall dispose of wastes generated during the well installation and injection activities.

F. The Contractor shall review well completion logs for existing wells, which are included in the Contract Documents.

G. The Contractor shall review data from new wells and adjust any amendment quantities if needed if contamination is higher than expected.

3.12 INJECTION ACTIVITIES

A. Injection activities shall be conducted in accordance with Section 3.10 Task 10 – In-situ Bioremediation of the IWWP.

B. Injections shall be conducted during weekdays (and not on weekends) in order to facilitate visits by the U.S. Army and regulatory personnel for observation.

C. The Contractor shall mobilize materials, equipment, mixing tanks, and labor for injections.

D. The Contractor shall lay out injection arrays and clear DPT injection points as per the sequence provided in the Contract Documents.

E. The Contractor shall core concrete/asphalt at injection points, if needed, and adjust any points if obstructions are found.

F. The Contractor shall begin preparing substrate solution mix a day before its planned injection. Preparation of substrate solution mix shall be a continual activity. KB-1® Primer shall not be mixed until just before its injection; all anaerobic water mixed on a given day shall be injected that same day.

G. The Contractor shall start injecting EISB amendments following the sequencing as outlined in the Contract Documents (DAR text section 5.3.3.1 for the pilot tests and 5.3.3.2 for the full-scale EISB grid areas and biobarriers) and herein using the DPT locations and injection wells.

H. The Contractor shall continuously monitor for surfacing near the injection locations during injections.

I. Once injections are complete, the Contractor shall decontaminate and demobilize equipment, materials, and mixing tanks.

J. The Contractor shall restore the site to pre-injection conditions and demobilize personnel.

3.13 SITE PREPARATION

A. Prior to the EISB injections, the Contractor shall clear the site for aboveground hazards.

B. The Contractor shall use a GPS device to locate each injection point and lay out the injection grids.

C. After all underground utilities have been marked out, the Contractor shall verify that there are no injection points that will impact any utility. If there are points that are affected, the Contractor shall alter the plan and relocate those points to avoid the utility, while still meeting the injection objectives and submitting the revised plan to the Contracting Office’s Representative.

D. The final DPT injection locations shall be recorded with a GPS.

E. Prior to drilling with the DPT at each point, the Contractor shall hand-dig to 5 feet at each injection point within the containment area to check for underground obstructions/utilities.

3.14 SUBSTRATE PREPARATION

A. Contractor shall place water tanks (rigid or flexible pillow tanks) near the treatment area and fill each with treated effluent water from the existing GWTP located near the site.

B. The Contractor shall prepare substrate and all other required amendments in a properly sized mixing tank as per the manufacturer's instruction provided in the approved Injections Work Plan.
   1. The mixing tanks shall be located near the treatment areas; however, if field conditions do not allow for placement of the tanks near the treatment areas at the site, the tanks can be staged at the GWTP located near the site.
   2. The water required for mixing shall be obtained from the GWTP or from an off-base fire hydrant and transported to the water tanks or directly to the mixing tanks in a water truck.
   3. If the mixing tanks are staged at the GWTP, the amendment mixture shall be prepared at the GWTP and transported to the site either in water trucks or pumped through aboveground piping.

C. EDS-ER™ proposed for all three pilot tests shall be provided by the vendor as water-mixable oil that contains no water as shipped; therefore, it shall be mixed with water in the field.
   1. EDS-ER™ mixes easily with water and does not require high energy mixers. It formulates a completely miscible product when mixed with water (it does not create emulsions or particles in water), thus preventing clogging effects when injected in groundwater.
   2. The Contractor shall provide a mixing tank adjacent to the location of the pilot test areas to mix the product with water.
   3. The product shall be added to the tank in the volume desired, followed by pumping treated water from the GWTP into the tank to produce the mixture with the design concentration for injection.
   4. No mixers will be required due to the nature of the EDS-ER™ oil.

D. Emulsions prepared in the field
   1. Emulsions prepared in the field using the soybean oil with the TASK™ MicroEVO™ Self-Emulsifier or comparable shall follow through a four-step process outlined below:
      a. Dissolve all water-soluble reagents in water.
      b. Dissolve all oil soluble reagents in oil.
      c. Blend oil and water together using an appropriate mixer.
      d. Inject emulsion into the subsurface.
   2. Acceptable approaches to be used to mix the emulsifier with oil and water in the field include either a single pass through a 3-phase, 3-Hp high shear mixer (e.g., Silverson General Duty LS-Series In-Line Mixer, East Longmeadow, MA) or multiple passes through a high shear mixer.
   3. The Contractor shall mix the emulsifier with oil and water in the field with the high shear mixer for generating an emulsion with smaller and uniformly sized oil droplets for easy distribution with less permeability loss and to prevent pressure build up.

3.15 INJECTIONS

A. Injections shall be performed at low pressures (less than 10 psi) and shall in no case exceed 30 psi unless prior approval is received from the Contracting Officer's Representative.

B. DPT Injections
   1. The Contractor shall use a DPT rig to push down to the required depth and inject amendment through probe rods.
   2. A DPT rig shall be used to inject the amendment mixture at 2-foot intervals to cover the entire target interval using a top down or bottom-up approach depending on the lithology and field conditions.
   3. An injection tool string shall be advanced to the top of the injection interval and the amendment will be pumped through the probe rods.
   4. The injection cycle shall be repeated to provide coverage across the entire target depth interval.
   5. The Contractor shall use a simple injection system manifold (as shown in the Design Drawings), with each injection line consisting of a dedicated pressure gage, air blow-off valve, flow totalizer, and flow control valve to facilitate injections at several locations at one time.
   6. A minimum of four DPT locations shall be injected at one time.
   7. No soil cuttings shall be generated using DPT.
   8. Once injection is complete at a DPT injection point, the Contractor shall abandon the point as per the procedures outlined in SOP A16 – Soil Boring/Monitoring Well Abandonment in Appendix A of the IWWP.
   9. The Contractor shall record DPT injection point locations with global positioning system (GPS).

C. Injection via Wells
   1. Injection via wells shall be conducted using newly installed injection wells per the Contract Documents.
   2. The injection well screen, installed over the target interval shall be able to facilitate injections in the target interval; however, the injection well screen interval may be modified during well installation based on field observations including depth to groundwater.
   3. The Contractor shall install a permanent injection system manifold with each injection line consisting of a dedicated pressure gage, air blow-off valve, flow totalizer and flow control valve to facilitate injections at several injection wells at one time.
   4. A minimum of four injection well locations shall be injected at one time.

3.16 MONITORING DURING INJECTIONS

A. During active injections, the injection system must be continuously monitored by designated personnel.

B. The Contractor shall monitor pressure, volume, and flow rates into each injection point (DPT or well) by observing the gauges and totalizers on the injection system. Injection pressures will also be monitored since sudden reductions may be an indication of amendment loss into subsurface, possibly from fracturing induced by the injection or from a high-permeability zone.

C. The Contractor shall record the injection interval during injections and injection information on the injection log provided in Attachment A.

D. During active injections at the Shallow Zone Biobarrier 2, the Contractor shall have a dedicated person monitor the area between the biobarrier and Harrison Bayou.

E. During pilot testing, the Contractor shall use bromide as an indicator of distribution of the substrate. The bromide concentrations will be monitored, and an increase in bromide concentrations above the baseline results will indicate amendment distribution. Samples shall be collected and analyzed for bromide to determine if there is an increase in bromide over baseline to evaluate distribution of amendment.

3.17 FIELD READINGS

A. The Contractor shall collect the field readings using a handheld field instrument and record readings on field forms provided in Attachment A during the injections to ensure consistency.

B. The Contractor shall use a water quality meter probe placed in the bayou for a direct reading from the Harrison Bayou. If the carbon source reaches the bayou, the natural organisms will utilize the carbon and will create anaerobic conditions in the water which may impact aquatic life. If any sudden decrease in dissolved oxygen (DO) is observed to below baseline readings or a visual change is observed in the water (murkiness) along the bayou bank, the Contractor shall suspend injection activities in the vicinity of Harrison Bayou.

C. The Contractor shall conduct additional monitoring and visual observations to determine if the decrease in DO is from injection materials or changes in the environmental conditions. If injections are suspended, corrective actions (placement of aerators and/or hay bales) shall be implemented if needed. Once DO has stabilized and no visual confirmation of injection materials into the bayou is confirmed, the Contractor can resume injection activities.

D. During and after injections in the vicinity of Harrison Bayou, the Contractor shall monitor surface water of the Harrison Bayou for DO at a minimum of four locations. The following monitoring frequency will be conducted along the Bayou:
   1. Hourly visual and DO inspection along the Bayou during injections within 50 feet of any subsurface drainage feature.
   2. Daily visual and DO inspection during weekdays for one week after injections.
   3. Daily visual and DO inspections during the weekend if more than 1 inch of rain is recorded within a week after the injections.
   4. Visual and DO inspections every other day after the first significant rain (3 inches or more within a seven-day period) for two weeks.

3.18 INJECTATE SURFACING

A. In the event that daylighting (injectate surfacing) occurs, the Contractor shall immediately lower injection rates in the area of surfacing, notify the Contracting Officer's Representative, and fulfill the spill response requirements in the approved Injections Work Plan.

B. If daylighting continues, the Contractor and Contracting Officer's Representative will evaluate site conditions causing the daylighting and will consider how to modify injections in order to complete the injection event.

C. Steps that may be considered include but are not limited to:
   1. Further lowering the injection flow rate.
   2. Reducing the amount of substrate and amendment injected per event.
   3. Over-injecting in high-producing adjacent injection locations.

4. Abandoning the problem DPT injection locations, offsetting, and installing new DPT injection locations near the originally planned locations.
5. Decommissioning problem injection wells and installing replacement injection wells.

D. If daylighting in the Harrison Bayou is detected, injection rates will be reduced, or injections will be ceased.
   1. If a spill is observed along the Bayou, the Contractor shall isolate and control further migration of the amendments using sandbags and hay bales. The Contractor shall collect and dispose of the affected materials.
   2. The Contractor shall have a solar powered aerator available for use, if needed, to aerate and reoxygenate impacted surface water.

3.19 INJECTION SCHEDULE

A. A minimum of two injection events will be conducted. The first two injection events will be provided by the Contractor with an option for two additional injection events.

B. The first two injection events will be conducted a minimum of 3 years a part. Following each injection event performance groundwater samples will be collected to evaluate EISB performance. If additional events are needed these will be completed a minimum of 3 years apart or as otherwise determined by the Contracting Officer's Representative.

C. The schedule for injection events shall be developed by the Contractor and included in the Injections Work Plan.

D. An Injection Sequence shall be developed by the Contractor and included in the Injections Work Plan.

3.20 CONTINGENCY INJECTION EVENTS

A. Additional injection events may be necessary following evaluation of the results of groundwater samples collected after the second injection event. If additional injection events are required, the Contractor shall submit a new Work Plan with the below information for review and acceptance by the Contracting Officer's Representative. This Work Plan will only be prepared and submitted after receiving approval from the Contracting Officer's Representative to perform additional injections beyond the two base injection events.
   a. Injection wells proposed for injections.
   b. Type and volumes of substrates/amendments per additional injection event.
   c. Collection of groundwater samples to evaluate performance of each injection event with time frames of when samples will be collected.
   d. Injection sequence.

B. The Contractor shall allow for a minimum review period by the Contracting Officer's Representative of 30 days.

3.21 BASELINE SAMPLING

A. The Contractor shall collect baseline groundwater samples prior to the implementation of injections to characterize the site contaminant concentrations and geochemical conditions in the Shallow Zone and Wilcox Formation.

B. The Contractor shall collect baseline field readings and groundwater samples from existing and new monitoring wells as per the Contractor Documents. Procedures for purging and sampling the wells are detailed in SOP A10-Low Stress Groundwater Sampling in Appendix A of the IWWP. Groundwater samples shall be analyzed as per

the Contract Documents and Section 01 35 45 – CHEMICAL DATA QUALITY CONTROL.

C. The Contractor shall also collect baseline field readings and surface water samples from the bayou at locations near the biobarrier as per the Contractor Documents. Detailed procedures for collecting surface water are provided in SOP A11-Surface Water Sampling in Appendix A of the IWWP. Surface water samples shall be analyzed as per the Contract Documents and Section 01 35 45 – CHEMICAL DATA QUALITY CONTROL.

3.22 PERFORMANCE MONITORING SAMPLING

A. The Contractor shall collect groundwater data as per the Contract Document at these frequencies to evaluate effectiveness of injections.
   1. First Two Months of Each Injection Event
      a. Collect field reading for DO, ORP, and pH each month at locations specified in the Contact Documents.
      b. Collect groundwater samples each month at locations specified in the Contract Document for analytical parameters, including Bromide and Total Organic Carbon (TOC). Procedures for purging and sampling the wells are detailed in SOP A10-Low Stress Groundwater Sampling in Appendix A of the IWWP. Groundwater samples shall be analyzed as per the Contract Documents and Section 01 35 45 – CHEMICAL DATA QUALITY CONTROL.
   2. Year 0-1 of Each Injection Event
      a. Collect field readings for DO, ORP, and pH for four quarters at locations specified in the Contact Documents.
      b. Collect groundwater samples quarterly at locations specified in the Contract Document for analytical parameters including perchlorate, VOCs, alkalinity, anions, ethene, ethane, methane, DHC, Bromide, and TOC. Procedures for purging and sampling the wells are detailed in SOP A10-Low Stress Groundwater Sampling in Appendix A of the IWWP. Groundwater samples shall be analyzed as per the Contract Documents and Section 01 35 45 – CHEMICAL DATA QUALITY CONTROL.
   3. Year 1-2 of Each Injection Event
      a. Collect field readings for DO, ORP, and pH quarterly at locations specified in the Contact Documents.
      b. Collect groundwater samples quarterly at locations specified in the Contract Document for analytical parameters including perchlorate, VOCs, alkalinity, anions, ethane, methane, Bromide and TOC. Procedures for purging and sampling the wells are detailed in SOP A10-Low Stress Groundwater Sampling in Appendix A of the IWWP. Groundwater samples shall be analyzed as per the Contract Documents and Section 01 35 45 – CHEMICAL DATA QUALITY CONTROL.

3.23 DAILY INJECTION LOGS

A. Data indicating the injection rates, pressures, and total gallons injected at each location and each vertical interval shall be recorded daily in the logs provided in Attachment A during injections.

B. The field logbook should also describe calibration procedures conducted by the Contractor on monitoring equipment.

C. Logs shall be maintained throughout the duration of injections and shall be made available for inspection upon request by the Contracting Officer's Representative.

3.24 DEMOBILIZATION

A. The Contractor shall complete demobilization in accordance with the approved work plan.

B. The Contractor shall begin demobilization after all equipment has been decontaminated as per the approved work plan.

C. Demobilization includes disconnection of utilities, decontamination, disassembly, and removal of EISB injection equipment, and materials handling equipment.

D. Demobilization is complete when all EISB equipment and related equipment have left the site and work areas have been restored.

3.25 RESIDUALS WASTE MANAGEMENT

A. All residual waste substrate or amendment materials shall be collected and disposed of off-site as per the requirements of the manufacturer's recommendations, the substrate/amendment SDS, and in accordance with all local, state, and federal regulations.

B. The following wastes generated during the well installation and injection activities shall be disposed of soil cuttings, wastewater, soil piles, personal protective equipment (PPE), sampling equipment, well materials, and miscellaneous trash. This waste shall be managed as per Section 3.7 Task 7 – Investigation-Derived Waste Management of the IWWP. Detailed procedures for managing the Investigation-Derived Waste are provided in SOP 22 – Investigation Derived Materials in Appendix A of the IWWP.

3.26 INJECTION COMPLETION REPORT

A. The Contractor shall prepare and submit an Injection Completion Report that will summarize all activities performed during each injection event. The report shall include the following minimum information:
   1. Volume of substrates, amendments, and water injected during each injection event, along with total volumes injected into each location.
   2. Estimated average injection rates for each location.
   3. Pressure and flow rate measurements collected during injections.
   4. Summary of all work performed including but not limited to:
      a. Deliveries of substrates and amendments to the site.
      b. Storage and handling of substrates and amendments.
      c. Preparation of injection solutions.
      d. Description of methods and equipment used to inject solution into subsurface.
      e. Problems occurring during injections and resolutions taken.

END OF SECTION

LHAAP-18/24 - EISB Injections Log Sheet

EISB Area: _____ **Drilling Company:** _____ **Injections Oversight:** _____

EISB Area Log Sheet No.: _____ **Oversight Company:** _____ **Injections Operator:** _____

Date: _____

Injection Location ID	Injection Depth Interval (ft bgs)	Pump ID	Injectate Type	Time Start	Time End	Pressure (psi)	Flow Rate (gpm)	Vol. (gal)	Previous Vol.[1] (gal)	Cumulative Vol.[2] (gal)	Comments

LHAAP-18/24 - Surface Water Monitoring Log

Log No.: _____ **Weather Conditions:** _____ **Company:** _____

Date: _____ **Meter(s) Used:** _____ **Crew:** _____

Equipment Calibration

Cal. Standard	Lot#	Expiration	Standard Value	Units	Pre-Cal. Reading	Post-Cal. Reading	Acceptable Range	Comments
pH								
pH								
pH								
Conductivity								
DO								

Surface Water Quality Readings

Surface Water Monitoring Location ID	Temp. (C°)	Cond. (mS/cm)	ORP (mV)	D.O. (mg/L)	pH	TDS	Sal. (ppt)	Turb. (NTU)	Observations/Comments

Notes:

SECTION 31 23 00
BACKFILL, COMPACTION, AND GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. The purpose of this section is to provide the Contractor with the minimum requirements and constraints for backfill and compaction of earthen material in the excavated areas and grading as defined in this section.

B. The Contractor shall furnish all labor, materials, equipment, and incidentals necessary to perform all backfilling, compaction, and grading cover presented on the Design Drawings and specified herein.

C. All earthen materials used for backfilling and final grading shall be suitable for use as backfill, as specified in this section.

D. The Contractor may use on-site uncontaminated shallow soil excavated during the remedial action (RA) (soil excavated from 0 to 4 feet below ground surface and managed separately from contaminated soil) as backfill in accordance with the requirements specified herein.

1.2 REFERENCES

A. References
1. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only. Where reference is made to one of these standards, the revision in effect at the time of contract award shall apply.
   a. American Society for Testing and Materials (ASTM)
      1) ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 [600 kN-m/m^3])
      2) ASTM D1556M-15e1 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
      3) ASTM D2487-17 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
      4) ASTM D2974 Standard Test Methods for Determining the Water (Moisture) Content, Ash Content, and Organic Material of Peat and Other Organic Soils
      5) ASTM D3740 Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
      6) ASTM D421-85 Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
      7) ASTM D422-63 Standard Test Method for Particle-Size Analysis of Soils
      8) ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
      9) ASTM D4972-19 Standard Test Method for pH of Soils
      10) ASTM D5268-13 Standard Specification for Topsoil Used for Landscaping Purposes

11) ASTM D6938-17a Standard Test Method for In Place Density and Water Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
12) ASTM D7013M-15 Standard Guide for Calibration Facility Setup for Nuclear Surface Gauges
13) ASTM D7759M-14 Standard Guide for Nuclear Surface Moisture and Density Gauge Calibration

b. Texas Administrative Code
1) 30 TAC 111.111(a)(8)(A) - Control of Air Pollution from Visible Emissions and Particulate Matter

B. Definitions
1. Satisfactory materials
a. Satisfactory materials for common fill shall comprise any uncontaminated off-site materials classified by ASTM D 2487-17 as GW, SW, GC, GM, SC, or SM and any on-site uncontaminated shallow soil excavated during the RA (excavated from 0 to 4 feet below ground surface and managed separately from contaminated soil) that meets the requirements specified herein.
b. Satisfactory materials shall be free of:
1) Trees, stumps, branches, roots, noxious weeds, or other wood or lumber.
2) Rocks larger than 2 inches.
3) Wire, steel, cast iron, cans, drums, or other foreign material.
c. Common fill obtained from an off-site borrow source shall be tested and approved prior to initiating the removal action.
d. The testing requirements for common fill shall be in accordance with the standards outlined in Paragraph 3.4, SOIL TESTING.
e. All imported backfill material, including common fill, and topsoil shall meet the criteria outlined in Paragraph 1.5.A, CERTIFICATION OF MATERIALS, and shall meet the requirements of PART 2 – PRODUCTS of this Specification.
2. Unsatisfactory Materials
a. Unsatisfactory materials shall comprise any materials not meeting the standards of Paragraph 1.2.B.1 SATISFACTORY MATERIALS. This shall include any contaminated materials/soils, trash/refuse, materials containing excessive organic matter, or materials classified by ASTM D 2487-17 as PT, OH and OL.

1.3 SUBMITTALS

A. Approval from the Contracting Officer's Representative, in consultation with the regulators is required for submittals with an "RA" designation; submittals having an "FIO" designation are for information only. The Contractor shall submit the following to the Contracting Officer's Representative:
1. Samples of Proposed Fill and Topsoil; Samples; RA
a. The Contractor shall submit samples of each earthen material weighing approximately 50 pounds. The Contractor shall not use these materials as part of the contract work until receiving written authorization from the Contracting Officer's Representative.
2. Laboratory and Field Test Results; Test Reports; RA
a. The Contractor shall submit the results of all laboratory and field testing, as specified in Paragraph 3.4, SOIL TESTING, within 24 hours of receipt. These shall include the results of all chemical testing, sieve analyses performed, in-place density testing, moisture-density testing, shear strength and bearing

capacity testing, and all other testing performed of backfill materials and compaction requirements.

3. Backfill Materials Sources and Certification; Certificates; RA
   a. The Contractor shall submit the proposed source for all backfill materials including common fill, and topsoil. The Contractor shall include certificates of compliance attesting those materials meet the specified requirements for particle size, pH, organic matter content, textural class, soluble salts, chemical, and mechanical analyses as per SECTION 01 35 45 - CHEMICAL DATA QUALITY CONTROL.
4. Laboratory Certification Credentials; Certificates; RA
   a. The Contractor shall submit licenses or certifications of qualifications of the commercial testing laboratory and/or associated personnel for the Contractor's testing facilities, for the performance of field and laboratory testing in compliance with ASTM D3740.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Not used.

1.5 QUALITY ASSURANCE

A. Certification of Materials
   1. All materials used as fill, including on-site excavated material, off-site common fill and standard topsoil shall be tested to ensure they are free from chemical and radiological contamination, as specified in SECTION 01 35 45 - CHEMICAL DATA QUALITY CONTROL.
   2. Results shall be certified in writing. The Contracting Officer's Representative will accompany the Contractor to visit all backfill sources during sample collection and inspect all backfill materials. A minimum of one chemical test shall be performed per 1,000 cubic yards (CY) of material and no less than one test per borrowed area. Additional tests shall be performed at a frequency of one sample per 1,000 CY of material or as requested by the Contracting Officer's Representative.
   3. Analytical parameters to verify that fill materials are free of chemical contamination are included in SECTION 01 35 45 - CHEMICAL DATA QUALITY CONTROL.

1.6 DELIVERY, STORAGE AND HANDLING

A. If filled materials are delivered to the site prior to placement approval, materials shall be stockpiled on site within the Support Zone as directed by the Contracting Officer's Representative. Provisions shall be implemented to minimize surface water impact on the stockpile. Removal and placement of fill material shall be done in a manner to minimize intrusion of soils adjacent to and beneath the stockpile.

PART 2 - PRODUCTS

2.1 COMMON FILL

A. Uncontaminated shallow soil (0-4 ft bgs) removed from the remedial excavation areas will be managed separately from impacted material and stockpiled for possible use as backfill. The on-site material shall:
   1. Be free of trees, stumps, branches, roots, noxious weeds or other wood or lumber.
   2. Be free of rocks larger than 2 inches.
   3. Be free of wire, steel, cast iron, cans, drums, or other waste material.

4. Be sampled prior to use as backfill to ensure it meets the TCEQ Risk Reduction Standard No. 2 Soil MSCs for industrial use criteria for VOCs, explosives, metals, and perchlorate.

B. Off-site common fill shall meet the requirements of Paragraph 1.2.B.1 – SATISFACTORY MATERIALS, and shall meet the following requirements:
   1. Well graded.
   2. Free of rocks larger than 2 inches, loam, organic matter, very soft clays, swelling clays, or fine uniform sands that may be difficult to compact.
   3. A liquid limit of not more than 35 and plasticity index of not more than 12 in accordance with ASTM D4318.
   4. ASTM D2487 Group Symbol: Any except those described as poorly graded and except PT, OH and OL.

2.2 TOPSOIL

A. Topsoil shall be:
   1. Friable loam, neither of heavy clay nor of very light sandy nature.
   2. Reasonably free of roots, fragments larger than 3 inches in size, rocks or lumps larger than 1 inch in diameter, debris, weeds, plants or their roots, vegetation, seeds of noxious weeds, stolons, seeds; salts; soil sterilant; chemical contaminants; invasive species; or other materials detrimental to plant growth.
   3. Acidity Range (pH): 5.5 to 7.5, determined in accordance with ASTM D4972-19.
   4. Containing minimum 2 percent and maximum 10 percent organic matter. determined in accordance with ASTM D2974.
   5. Containing salt less than 2.0 ms/cm (millisiemens/cm) total salts.
   6. Capable of supporting growth of grass.
   7. Shall meet the requirements of ASTM D5268-13.

PART 3 - EXECUTION

3.1 GENERAL

A. All backfill material brought on site shall be clean, in accordance with Paragraph 1.5.A – CERTIFICATION OF MATERIALS. Written certification attesting to this shall be submitted to the Contracting Officer's Representative.

B. The Contractor shall coordinate the delivery of backfill materials with the performance of backfilling work to minimize the quantities of materials requiring on-site stockpiling.

C. In cases where stockpiling of backfill material on site is unavoidable, the Contractor shall place all such materials upon a 10-mil thick sheet of plastic, which will be stretched across the ground surface in a location approved by the Contracting Officer's Representative.

D. Fill materials shall be stored in a manner that prevents the common fill from becoming saturated, airborne, or mixed with contaminated soil in accordance with the Contractor's approved work plan.

E. The Contractor shall be responsible for scheduling the delivery of all backfill materials with the overall project schedule such that no delays in construction occur.

F. The Contractor shall remove any water accumulating in open excavations and transfer it to the site GWTP for treatment.

3.2 BACKFILL PLACEMENT AND COMPACTION

A. Common fill material shall be backfilled to the specified lines, grades, sections, and elevations shown on the Design Drawings to restore all excavations performed by the Contractor, making allowance for settlement of the material.

B. The backfill shall be certified to meet the soil cleanup levels as per the Contract Documents. The Contractor may use uncontaminated shallow soil (from 0 to 4 ft bgs), excavated during the remedial action, and managed separately from impacted soil, as backfill after meeting the testing requirements and approved by the Contracting Officer's Representative.

C. Backfill shall not be placed on snow, ice, standing water, or frozen ground surfaces.

D. Backfill shall not be placed over contaminated material. Backfill shall not be placed when the material is too wet either from rain or from excess application of water. At such times, work shall be suspended until the previously placed and new materials have thawed and/or dried to permit proper compaction.

E. Each lift of common fill shall be placed in horizontal layers not exceeding 12 inches (+ or – 0.5 inches) in loose thickness.

F. Upon completion of the backfill operations, the surface of the fill shall be sloped to facilitate surface drainage. This grade shall be maintained throughout backfilling operations, except were controlled by other specified grade and elevations. The final finished grade shall be as specified in Paragraph 3.6 – GRADING and as shown in the Design Drawings.

G. Settlement or washing that occurs in graded, topsoiled, or backfilled areas prior to acceptance of the work shall be repaired and grades reestablished to the required elevations and slopes. The Contractor shall notify the Contracting Officer's Representative of unexpected subsurface conditions and discontinue work in the affected area until notified to resume work.

H. Dust control and mitigation and air monitoring shall be performed in accordance with the Contractor's approved Site Safety and Health Plan, as specified under the Final Health and Safety Plan for Longhorn Army Ammunition Plant Karnack, Texas. Requirements for air monitoring are provided in the IWWP Appendix A SOP A21.2.1 – Air Monitoring. Visible emissions shall not exceed the limit specified in 30 TAC 111.111(a)(8)(A).

3.3 COMPACTION

A. The Contractor shall compact each lift of backfill as specified herein. Compaction in soil areas shall be accomplished by sheepsfoot rollers, pneumatic tired rollers, steel wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

B. The Contractor shall be responsible for providing appropriate compaction effort to achieve the required Percent of Laboratory Maximum Density (Modified Proctor) as outlined in this Specification. Backfill shall be compacted to a minimum density of 80% of ASTM D698 (Standard Proctor). Following placement density testing will be conducted in accordance with ASTM D1556/D1556M/D6938. Tests will be conducted at each lift at randomly selected locations for every 2,500 square feet or for each excavation area if the areal extent is less than 2,500 square feet.

C. If the Contracting Officer's Representative determines that added moisture is required, water shall be applied by sprinkler tanks or other sprinkler systems, which shall ensure uniform distribution of the water over the area to be treated and give complete and accurate control of the amount of water to be used. If too much water is added, the area shall be permitted to dry before compaction is continued.

D. The Contractor shall supply all hose, piping, valves, sprinklers, pumps, sprinkler tanks, hauling equipment, and all other materials and equipment necessary to place the water in the fill in the manner specified. Water shall be provided and obtained at the Contractor's expense.

E. Approved compacted subgrades that are disturbed by the Contractor's operations or adverse weather shall be scarified and recompacted to the required density, prior to further construction.

3.4 SOIL TESTING

A. Initial conformance testing shall be performed to show that the backfill materials meet the Specification requirements and to identify the compaction properties of the soils.

B. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor, subject to approval by the Contracting Officer's Representative.

C. The Contractor shall submit to the Contracting Officer's Representative for approval licenses or certifications of qualification for the performance of field and laboratory testing. At a minimum, the tests listed below shall be conducted for each material and submitted as initial conformance test results.

D. In addition, periodic conformance testing shall be conducted by the Contractor's Quality Control Laboratory on common fill soils prior to their use on the project.

E. The Contracting Officer's Representative reserves the right to reject material based on the results of these conformance tests and/or independent quality assurance testing conducted by the Contracting Officer's Representative. Rejected materials shall be removed from the site at no additional cost.

1. Chemical Testing
    a. Prior to the use of any backfill on site, the Contractor shall be responsible for performing chemical testing by an off-site laboratory of the proposed borrow material (both off-site material and on-site uncontaminated shallow soil [0 to 4 feet below ground surface] excavated during the remedial action), in accordance with SECTION 01 35 45 – CHEMICAL DATA QUALITY CONTROL.
2. Sieve Analysis
    a. Sieve analysis shall be performed in accordance with ASTM D421-85(2007) and ASTM D422-63(2007) e2. A retest for classification shall be performed at a minimum of every 1,000 cubic yards.
3. Density Testing
    a. Field in-place density tests shall be performed in accordance with ASTM D6938-17a. A minimum of one test shall be performed per 500 cubic yards of material placed, with no less than one test per lift. Calibration curves shall be checked and adjusted, if necessary, by the procedure described in ASTM D7013M-15 and D7759M-14. Calibration checks of both the density and moisture gauges shall be made at the beginning of each working day and for each different type of material encountered. Calibration for in-place density

testing shall consist of determining in-place density in accordance with D1556M-15e1.

4. Moisture-Density Test
   a. A moisture-density relationship for the soil shall be determined in accordance with ASTM D698. A minimum of one test per 1,000 cubic yards shall be performed, but no less than one test per borrow area. The Contracting Officer's Representative may direct additional tests should soil materials change during the course of work.
5. Imported Material Acceptance
   a. If tests indicate that the material does not meet Specification requirements, material placement shall be terminated until corrective actions are taken. Material that does not conform to the Specification requirements and is placed in the work shall be removed and replaced at the Contractor's sole expense. The presence of any compound above the requirements of Section 1.5.A herein shall be reason to reject the source, regardless of other test results.

3.5 SPREADING TOPSOIL

A. Areas where fill material has been placed and will be seeded shall be covered with a minimum topsoil thickness of 6 inches, as shown in the Design Drawings.

B. The surface shall be free of materials that would hinder planting or maintenance operations. The subgrade shall be pulverized to a depth of 2 inches by disking or plowing for the bonding of topsoil with the subsoil.

C. Topsoil shall then be uniformly spread, graded, and compacted to the thickness, elevations, and slopes shown, and left free of surface irregularities.

D. Topsoil shall be compacted by one pass of a cultipacker, roller, or equivalent.

E. Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to seeding or proper grading.

3.6 GRADING

A. The Contractor shall uniformly smooth, and grade all filled areas to provide a finished surface that is reasonably smooth, compacted to the specified project requirements, free from irregular surface changes, and sloped to drain properly. Grading shall not create swales or areas where ponding of water will occur. The finished surface shall be as indicated on the Design Drawings, as confirmed by surveying operations. Grading tolerances shall be plus or minus 0.1 feet for all exposed surfaces of backfill unless otherwise indicated on the Design Drawings.

B. During the process of grading, the area to be graded shall be maintained in such a condition that it shall be well drained at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water that may affect the execution or condition of the work.

C. If at the time of grading it is not possible to place any material in its final location, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.

D. The right is reserved to make minor adjustments or revisions in lines or grades if found necessary as the work progresses, in order to obtain satisfactory construction.

E. After grading is completed and accepted by the Contracting Officer's Representative, no further filling or grading shall be permitted except with the approval of and inspection by the Contracting Officer's Representative.

3.7 QUALITY CONTROL PROGRAM

A. An independent soil testing laboratory shall be retained by the Contractor and approved by the Contracting Officer's Representative to provide fill materials conformance and compaction testing as indicated herein.

3.8 SOIL EROSION AND SEDIMENT CONTROLS

A. Newly-graded areas shall be protected from erosion by installing soil erosion and sediment controls, in accordance with SECTION 31 25 00 – EROSION CONTROL AND STORMWATER MANAGEMENT and the Contractor's approved Soil Erosion and Sediment Control (SESC) Plan.

3.9 SOIL TREATMENT

A. No treatment of the backfill material with insecticides or herbicides is necessary as part of this Remedial action.

END OF SECTION

SECTION 31 23 10
EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS

PART 1 - GENERAL

1.1 SUMMARY

A. The purpose of this section is to provide the Contractor with the minimum requirements and constraints for excavation and handling of contaminated soil and collection and analysis of post-excavation confirmatory samples, as indicated on the Design Drawings, specified herein, and in accordance with the approved Remedial Action Work Plan.

B. The work shall include, without limitation, excavation, and disposal of contaminated soil; segregation of excavated material identified herein and in the Design Drawings; and collection and off-site analysis of post-excavation confirmatory soil samples.

C. Excavation shall extend to the widths and depths shown in the Design Drawings or as specified herein and shall include side slopes (maximum slope of 2H:1V).

D. The work consists of the following:
   1. Removal of 930 cubic yards of contaminated soil in Excavation Area 1, which requires excavation of potentially non-impacted shallow soil (from 0 to 4 feet below ground surface) from this area and its side slopes.
   2. Removal of 1,040 cubic yards of contaminated soil in Excavation Area 2, which requires excavation of potentially non-impacted shallow soil (from 0 to 4 feet below ground surface) from this area and its side slopes.
   3. Removal of 2,070 cubic yards of contaminated soil in Excavation Area 3, which requires excavation of potentially non-impacted shallow soil (from 0 to 4 feet below ground surface) from this area and their side slopes.

E. Materials excavated deeper than 4 feet below ground surface in the sidewall areas shall be managed as contaminated soil.

F. Approximate areas of contaminated soil are shown in the Design Drawings. The Contractor shall submit a Remedial Action Work Plan, specified herein.

G. There is a possibility of encountering unexploded ordnance (UXO) or munitions and explosives of concern (MEC) during excavation. The Contractor must stop all work and notify the Contracting Officer's Representative immediately if any munitions and explosives of concern are discovered during the removal of contaminated soil.

H. The Contractor shall notify the Contracting Officer's Representative within 24 hours and before advancing excavations if contaminated material is discovered that has not been previously identified or if other discrepancies between data provided and actual field conditions are discovered. Aside from clean material excavated in the course of the remedial action, additional backfill material is not available on-site.

I. All required sampling and chemical analysis shall be conducted in accordance with the requirements of SECTION 01 35 45 - CHEMICAL DATA QUALITY CONTROL.

J. No site personnel shall be allowed to enter the excavated area unless the excavation is performed in accordance with Occupational Safety and Health Administration (OSHA) regulations as specified in 29 CFR 1926, Subpart P.

K. The Contractor shall obtain the services of a Texas-licensed Surveyor to document the limits of excavation for the purposes of measurement and payment, and for preparation of As-Built drawings.

1.2 REFERENCES

A. References
1. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only. Where reference is made to one of these standards, the revision in effect at the time of contract award shall apply.
   a. Code of Federal Regulations (CFR)
      1) 29 CFR 1926, Subpart P Safety and Health Regulations for Construction - Subpart P: Excavations
      2) 40 CFR 268 Land Disposal Restrictions
      3) 40 CFR 261 Identification and Listing of Hazardous Waste
      4) 40 CFR 264 Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities Treatment, Storage, and Disposal Facilities
      5) 40 CFR 302 Designation, Reportable Quantities, and Notification
   b. United States Army Corps of Engineers (USACE), Tulsa District
      1) Final Health and Safety Plan for Longhorn Army Ammunition Plant (LHAAP HASP), Karnack, Texas (2018).
      2) Final Installation Wide Work Plan for Longhorn Army Ammunition Plant (LHAAP IWWP), Karnack, Texas, revised by Bhate Environmental Associates, Inc. (May 2018; IWWP).
   c. Texas Administrative Code
      1) 30 TAC 335 – Industrial Solid Waste and Municipal Hazardous Waste, Waste Analysis
      2) 30 TAC 111 – Control of Air Pollution from Visible Emissions and Particulate Matter, Requirements for Specified Sources
      3) 30 TAC 101.4 – General Air Quality Rules
   d. United States Code, 2010 Edition, Title 10
      1) 10 U.S.C. 101(e)(5)
      2) 10 U.S.C. 2710(e)(2)
      3) 10 U.S.C. 2710(e)(3)

B. Definitions
1. Munitions and Explosives of Concern (MEC)
   a. MEC distinguishes specific categories of military munitions that may pose unique explosives safety risks, such as Unexploded Ordnance (UXO), as defined in 10 U.S.C. 101(e)(5); discarded military munitions, as defined in 10 U.S.C. 2710(e)(2); or munitions constituents (e.g., TNT, RDX), as defined in 10 U.S.C. 2710(e)(3), present in high enough concentrations to pose an explosive hazard.
2. Debris
   a. Demolition debris in the form of concrete, scrap metals, remnants from previous investigation activities, etc.
3. Hazardous Waste
   a. A waste that meets criteria established in Resource Conservation and Recovery Act (RCRA) or specified by the EPA in 40 CFR 261 or which has been designated as hazardous by an RCRA authorized state program.

4. Non-hazardous Waste
   a. Any waste that does not meet the criteria of hazardous waste.
5. Post-Excavation Confirmatory Sample
   a. Soil sample collected subsequent to primary and secondary excavations to confirm that the soil cleanup levels have been met.

1.3 SUBMITTALS

A. Approval from the Contracting Officer's Representative, in consultation with the regulators, is required for submittals with an "RA" designation; submittals with an "FIO" designation are for information only. The Contractor shall submit the following to the Contracting Officer's Representative:
   1. Excavation and Handling Plan; Pre-Construction Submittals; RA
      a. The Contractor shall include an Excavation and Handling Plan as part of their work plan and submit it at least 30 calendar days prior to the Pre-Construction Conference. The Contractor should note that adverse conditions (heavy rain) may be encountered during excavation operations and provisions should be made for such an event. No work at the site, with the exception of site inspections and pre-construction surveys, shall be performed until the plan is approved. The Contractor shall allow 30 calendar days in the schedule for review by the Contracting Officer's Representative. No adjustment for time or money will be made if resubmittals of the plan are required due to deficiencies in the plan.
      b. At a minimum, the Excavation and Handling Plan shall include all elements listed below.
         1) Schedule of Activities – Provide a schedule for all activities. This schedule should include a phasing plan and sequence of events for all construction activities required to complete the work.
         2) Personnel requirements.
         3) Removal and excavation approach and sequence.
         4) Equipment and methods of excavation and backfill.
         5) Storage methods and locations for contaminated fluids and solids.
         6) Methods for prevention of cross-contamination at the stockpile area to be built within the containment area.
         7) Waste Characterization Sampling – The Contractor shall provide a plan for sampling required for waste characterization of the soil to be disposed of off-site.
         8) Handling of contaminated soil and potentially non-impacted shallow soil.
         9) Coordinating waste segregation and stockpiling logistics (i.e., separate handling of contaminated and non-impacted soil). The Contractor shall provide a plan showing the location of proposed stockpile areas within the containment area and how stockpiles will be protected to prevent the runoff of contaminated soil. The Contractor shall provide the locations for disposing of the excavated soil designated as hazardous and non-hazardous waste and shall provide a truck route plan.
         10) Shoring, bracing, and/or sloping as per the applicable OSHA requirements.
         11) Coordinating with the Site Safety and Health Plan for spill and discharge control and procedures for procedures in the event UXO/MEC are encountered.
         12) Post-excavation confirmatory sampling and analysis procedures.
         13) The Contractor shall coordinate haul routes.

14) Surveying of excavated areas and determination of excavation quantities.

2. Post-Excavation Confirmatory Sampling Results; Test Reports; FIO
   a. The Contractor shall provide the post-excavation confirmatory sampling results in a format consistent with the requirements. The analysis and reporting shall meet the requirements of SECTION 01 35 45 - CHEMICAL DATA QUALITY CONTROL.
3. Surveys; Shop Drawings; RA
4. Work Plan; Product Data; RA
5. Closure Report; Product Data; RA
6. Excavation field logs; Closeout Submittals; RA
7. Field screen readings; Closeout Submittals; RA
8. Quantity of materials removed from each area of contamination; Closeout Submittals; RA
9. Quantity of water removed during stormwater dewatering; Closeout Submittals; RA
10. Sampling locations; Closeout Submittals; RA
11. Scaled drawings; Closeout Submittals; RA
    a. Scaled drawings (a scale of no more than 50 ft/in) showing limits of excavation, limits of contamination, known underground utilities within 50 feet of excavation, sample locations, sample identification numbers. On-site stockpiles and loading areas shall also be shown.
12. Progress photographs; Closeout Submittals; FIO
    a. Digital, color photographs with correct exposure and focus, high resolution and sharpness, maximum depth of field, and minimum distortion, shall be used to document work progress. Photos of the site showing a minimum of four views of each contaminated area targeted for excavation, four views of the entrance/exit access road, and any other notable site conditions shall be taken before work begins. After work has started, activities at each work location shall be photographed daily. Photographs shall include:
       1) Soil removal.
          a) Any required protection of existing operational groundwater treatment system components and dismantling of non-operational system components.
          b) Any stormwater dewatering operations.
          c) Post-excavation confirmatory sampling.
          d) Fill placement and grading.
       2) Site restoration.
       3) Miscellaneous activities:
          a) Unanticipated events such as spills and the discovery of additional source materials.
          b) Contaminated material/water storage, handling, characterization sampling, treatment, and discharge/disposal.
          c) Post construction photographs shall be taken after completion of the work.
    b. Electronic copies of the progress photographs shall be uploaded to a cloud-based file sharing service, compatible with USACE systems, at minimum once a week for review by stakeholders off-site.
13. Other Submittal Requirements; Closeout Submittal; RA
    a. Submit separate cross-sections of each excavation area before and after excavation and after backfilling, test results, and the Closure Report within 14 calendar days of work completion at the site.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Not used.

1.5 REGULATORY REQUIREMENTS

A. Permits and Licenses
   1. These requirements governing transportation, administrative requirements and methods of treatment and disposal of hazardous wastes, and all other applicable Federal, State, or local laws, codes, and ordinances, which govern or regulate hazardous wastes, shall apply to the work of this section. The Contractor shall be responsible for obtaining permits necessary for excavation, stormwater dewatering, stockpiling and any other features of work associated with the excavation of contaminated soil.
   2. Excavations for sites under this remedial action are expected to be less than 1 acre in size and are thus not subject to the storm water pollution prevention requirements of Chapter 26 of the Texas Water Code and TCEQ General Permit TXR15000.

B. Air Emissions
   1. The Contractor shall monitor and control air emissions in accordance with the Final Health and Safety Plan for Longhorn Army Ammunition Plant Karnack, Texas.

1.6 QUALITY ASSURANCE

A. Shoring Plan
   1. The Contractor shall submit drawings describing the methods for any shoring of excavations. Drawings shall include material sizes and types, arrangement of members, and the sequence and method of installation and removal. Calculations shall include data and references used.

1.7 DESIGN AND PERFORMANCE RESPONSIBILITY

A. The Contractor is responsible for the design and execution of the means and methods to achieve the target excavation depths and minimize disturbance.

B. The Contractor is responsible for any damage to existing groundwater treatment plant (GWTP) utilities and work that may result from excavation and associated operations.

C. The Contractor is responsible for monitoring water quality and controlling the impact to the surface water bodies (Harrison Bayou) affected by the work specified herein.

D. Any design review and field monitoring activities performed by the Contracting Officer's Representative shall not relieve the Contractor of responsibility for the work.

1.8 SITE SOIL CLEANUP LEVEL

A. The remediation soil cleanup levels for this project are:
   1. Methylene Chloride – 0.5 milligrams per kilograms (mg/kg)
   2. Trichloroethylene – 0.5 mg/kg
   3. Perchlorate – 7.2 mg/kg
   4. Tetrachloroethene – 0.5 mg/kg

1.9 POST-EXCAVATION CONFIRMATORY SAMPLING CRITERIA

A. All excavations require verification in accordance with the requirements herein and the IWWP Section 3.8.3.

B. The Contractor shall collect a post-excavation confirmatory soil sample every 1,000 square feet of the excavation floor area and every 1,000 square feet of each vertical

sidewall of excavation. Points for each confirmatory sample shall be selected to represent the full area of the bottom/sidewall (i.e., the full width of the excavation bottom and the full height of sidewalls). In addition to the post-excavation confirmatory sampling, QA/QC sampling shall also be performed in accordance with SECTION 01 35 45 – CHEMICAL DATA QUALITY CONTROL.

C. Bottom Samples shall be collected from 0 to 3 inches at the bottom of the excavation.

D. The Contractor shall bias the post-excavation confirmatory sample locations within each 1,000-square-foot area to the locations with highest concentrations, based on field screening and data from previous investigation sample locations, type and characteristics of contaminant, and visual and other indicators of potential contamination.

E. If contaminants are detected above their soil cleanup levels during the confirmatory sampling, the area shall be excavated at least two to five feet laterally and one additional foot vertically. Excavations shall continue until confirmatory samples demonstrate the contaminants remaining in the soil are below their cleanup level or until groundwater is encountered.

1.10 WASTE TYPES

A. The following types of wastes are expected from the excavation operation:

TABLE 31 23 10 - 1

Waste Type	Waste Definition
Hazardous – RCRA	• Soils and wastewater that meet the criteria established in Resource Conservation and Recovery Act (RCRA) or specified by the EPA in 40 CFR 261 or which has been designated as hazardous by an RCRA authorized state program.
Non-Hazardous – Subtitle D	• Soils and wastewater with contaminant concentrations do not meet the above definition for Hazardous Waste. • Miscellaneous Construction Debris.
Recyclable – Non-hazardous	• Vegetation from clearing operations

B. In addition to the waste types listed above, shallow soil (0-4 ft bgs) removed from the remedial excavation areas and shallow soil (0-4 ft bgs) removed from the excavation area side slopes will be managed separately from impacted soil and stockpiled for possible use as backfill, depending on analytical results.

PART 2 - PRODUCTS (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 SURVEYS

A. Surveys shall be performed in accordance with the IWWP Appendix A SOP A15 - Surveying.

B. Surveys shall be performed immediately prior to commencing excavations and immediately after the Contracting Officer's Representative confirms that all target contaminated material has been removed to determine the total volume of contaminated material removed from each excavation area.

C. Surveys shall also be performed after backfilling and grading showing final grade. Locations of post-excavation confirmatory samples shall also be surveyed and shown in the drawings.

3.2 EXISTING STRUCTURES AND UTILITIES

A. The Contractor will be responsible for contacting the appropriate utility service providers and independently performing a geophysical investigation at the site prior to commencement of subsurface activities.

B. The Contractor shall discuss the approach to managing utilities with the Contracting Officer's Representative and any utility owners prior to commencement of subsurface activities.

C. The Contractor shall field-verify and mark the locations of all utilities within the work area prior to mobilizing heavy construction equipment, supplies, and facilities and to protect all existing utilities and structures for the duration of construction in accordance with this Section and Design Drawings.

D. The Contractor shall contact the Texas Excavation Safety System, Inc. utility notification service by calling 811 or 800-892-0123. This notification must be made a minimum of two working days prior to the initiation of intrusive activity (excluding Saturdays, Sundays, and holidays), but not greater than 14 days.

E. Site utilities will include but may not be limited to electric and the groundwater extraction system (including interceptor-collection trenches [ICTs] and associated conveyance piping).
   1. The Contractor shall take the necessary precautions to ensure no damage occurs to existing structures (such as the groundwater extraction system, including interceptor-collection trenches [ICTs] and associated piping) and utilities outside the excavation limits that are not part of the scope of work.
   2. Damage to existing structures and utilities outside the scope of work shall be repaired at no additional cost to the Government.

F. The Contractor shall use soft digging methods when excavating within 20 feet of the existing groundwater extraction system. The Contractor shall remove portions of inactive groundwater conveyance piping exposed during excavations and reinstall them during backfilling as indicated in the Design Drawings and in consultation with the Contracting Officer's Representative.

G. Unexpected active utilities encountered during excavation shall not be disturbed without written approval from the Contracting Officer's Representative.

3.3 CLEARING

A. Clearing shall be performed as required and as shown on the Design Drawings.

3.4 SITE PREPARTION

A. Site preparation shall be completed prior to excavation, as shown in the Design Drawings.

3.5 EXCAVATION SEQUENCING

A. Excavation shall be conducted as shown in the Design Drawings and as follows:
   1. Perform initial survey and mark all three areas of excavation.
   2. Perform excavations starting in Area 2, 1, and lastly Area 3.
   3. The Contractor shall perform post-excavation confirmatory sampling for each area based on the Post-Excavation Confirmatory Sampling Criteria listed in Paragraph 1.9, concurrently with the excavation activity.
      a. In case post-excavation confirmatory sample analytical results show contaminant concentrations greater than the soil cleanup levels, then the Contractor shall pause the excavation and contact Contracting Officer's Representative for further direction.
      b. The Contractor shall perform secondary excavation of contaminated material based on the results of post-excavation confirmatory sample analysis and/or field observations with approval from the Contracting Officer's Representative.
      c. The Contractor shall perform post-excavation confirmatory sampling to confirm that the site soil cleanup level has been achieved.
   4. During the excavation, the Contractor shall perform a civil survey to confirm the horizontal and vertical extent of excavation meets the Design Drawings.
   5. The Contractor shall conduct waste disposal sampling and soil load out activities concurrently with the excavation activity.

3.6 EXCAVATION

A. General
   1. An electronic copy of the Design Drawings will be provided to the Contractor to establish sampling locations and the corners of all primary excavation areas, as shown on the Design Drawings. The Contractor shall use North American Datum 1983 (NAD83) Texas State Plane North Central FIPS 4202 coordinates to lay out sample locations and the limits of excavation, using the services of a Texas State Licensed Surveyor.
   2. The Contractor shall perform all excavations to the lines, grades, and elevations shown on the Design Drawings. Vertical excavation shall stop if groundwater is encountered. The survey work to measure quantities shall be performed by the Contractor prior to backfilling the excavation, and shall be accurate to the nearest 0.1 ft.
   3. There is a possibility of encountering UXO/MEC during excavation. The Contractor must stop all work and notify the Contracting Officer's Representative immediately if any munitions and explosives of concern are discovered during the removal of contaminated soil. The Contractor shall follow the requirements regarding UXO/MEC in Attachment 1 of the LHAAP IWWP HASP (USACE, 2018).
   4. Excavation shall be performed in a manner that will limit spills and the potential for contaminated material to be mixed with uncontaminated material. An excavation log describing visible signs of contamination encountered shall be maintained for each area of excavation.
   5. The Contractor shall remove and dispose of any material that becomes contaminated as a result of the Contractor's operation at no additional cost to the Government.
   6. The Contractor shall stage operations to minimize the time the contaminated soil is exposed to the weather.

7. The Contractor shall be responsible for benching or sloping the excavation, as necessary, or for providing other temporary supports to prevent soil slippage along the side slopes and any other slope stability issues in accordance with the Contractor's approved Excavation and Handling Plan. All Contractor-designed sloping shall comply with the requirements of OSHA 1926, Subpart P. The soil type shall be considered Type C unless additional soil analysis is completed.
8. All slopes shall be inspected daily by a qualified staff member for cracks in the soil at the head or along the face of the slopes and other changed conditions such as bulges or sloughs on the slopes. Inspection results shall be documented in a Daily Inspection Log and any unusual or changed conditions shall be brought to the attention of the Contracting Officer's Representative.
9. The Design Drawings show a maximum slope of 2H:1V for excavation areas exceeding 4 feet in depth. However, if the excavation is to remain open for an extended period of time, or if water is present, the Contractor shall stabilize the slope to 3H:1V or flatter.
10. The Contractor shall maintain an excavation of sufficient size to allow workers ample room to complete the work.
11. Stockpiles shall be covered prior to any storm events to prevent re-saturation of dried material. Contaminated stockpiles shall meet the regulations defined in 40 CFR 264.250.
12. Blasting shall not be permitted.
13. Loading and transporting contaminated material shall be in accordance with SECTION 31 23 20 – TRANSPORTATION AND DISPOSAL OF CONTAMINATED MATERIAL. Following the receipt of waste characterization sample results collected in accordance with SECTION 31 23 20 – TRANSPORTATION AND DISPOSAL OF CONTAMINATED MATERIAL, the Contractor may perform direct loading of all excavation materials for off-site transport and disposal, unless moisture conditions require stockpiling and drying.
14. The stockpile areas shall be built in accordance with the Design Drawings. The Contractor shall stage contaminated soil on site in stockpile areas in either lined roll-off containers or stockpiled. The roll-off containers and/or the stockpiled soil shall be covered in the event of rainfall.
15. Non-hazardous decontamination water shall be stored in 55-gallon drums or larger until disposal at the LHAAP groundwater treatment plant (GWTP). The miscellaneous waste shall be placed in plastic bags until disposal.
16. Dust control and mitigation and air monitoring shall be performed in accordance with 30 TAC 111, 30 TAC 101.4, and the Contractor's approved Site Safety and Health Plan, as specified under Final Health and Safety Plan for Longhorn Army Ammunition Plant Karnack, Texas. Requirements for air monitoring are provided in the IWWP Appendix A SOP A21.2.1 – Air Monitoring.
17. Areas being excavated shall be maintained in a clean condition, free from leaves, brush, sticks, trash, and other debris. Organic materials including stumps, roots, and debris encountered during excavation shall be considered grubbed material and shall be disposed as a contaminated material in accordance with SECTION 31 23 20 – TRANSPORTATION AND DISPOSAL OF CONTAMINATED MATERIAL.
18. Surface water shall be directed away from open excavation and construction areas to prevent soil erosion, surface water runoff from coming in contact with contaminated material, and the accumulation of surface water in excavation areas. Diversion ditches, dikes, and grading shall be provided as necessary and soil erosion controls shall be implemented in accordance with SECTION 31 25 00 –

EROSION CONTROL AND STORMWATER MANAGEMENT and the Design Drawings. The Contractor shall stop work and reduce the exposed surface when heavy rain is predicted. After the rainfall event, any stormwater accumulated in the excavation will be pumped to a frac tank, allowed to settle, and then conveyed to the GWTP.

19. During the completion of both the excavation and backfilling stages of construction, all trapped sediment in the containment area shall be collected and removed as contaminated material.
20. All vehicles and equipment used for excavation shall be decontaminated between each excavation area and prior to demobilization in accordance with the Contractor's approved Site Safety and Health Plan, prior to entering clean areas.
21. If wildlife is identified within work areas, the Contractor shall immediately notify the Contracting Officer's Representative of their presence. The Contractor shall cease site operations if directed by the Contracting Officer's Representative.

B. Primary Excavation
   1. In total, three primary excavation areas have been designed to remove contamination as shown on the Design Drawings.
   2. The Contractor shall conduct excavations based on the approved Excavation and Handling Plan to the limits and depths shown on the Design Drawings. Excavation areas shall be excavated to not more than 0.2 feet beyond the final elevation or depths and extent indicated in the Design Drawings, unless directed otherwise by the Contracting Officer's Representative.

3.7 POST-EXCAVATION CONFIRMATORY SAMPLING AND SECONDARY EXCAVATION

A. The Contractor shall collect post-excavation confirmatory bottom and sidewall samples and send them to an off-site laboratory for Volatile Organic Compounds (VOCs) and perchlorate analyses with a turn-around-time (TAT) of 48 hours. All post-excavation sample results shall be compared to the site soil cleanup levels.

B. Secondary Excavation beyond the primary excavation limits shown on the Design Drawings shall be performed based solely on analytical results of post-excavation samples and/or visual observations of soil contamination, including DNAPL. Secondary Excavation shall be performed only with the approval of the Contracting Officer's Representative.

C. If analytical results of a bottom post-excavation sample exceed the soil cleanup levels, the Contractor shall perform secondary excavation of the corresponding 1,000-square-foot bottom sampling grid in 1-foot vertical increments, and then collect a new bottom sample. This process shall be repeated until the soil cleanup levels are met, or groundwater is encountered or as otherwise directed by the Contracting Officer's Representative. Additional sidewall post-excavation samples shall be collected for every 2 vertical feet of new sidewall exposed during secondary excavation.

D. If analytical results of a sidewall sample exceed the soil cleanup levels, the Contractor shall perform secondary excavation of the corresponding 1,000-square-foot sidewall sampling grid in 2- to 5-foot horizontal increments, and then collect new post excavation sidewall samples. This process shall be repeated until the soil cleanup levels are met, or as otherwise directed by the Contracting Officer's Representative. If the excavation expands horizontally, the Contractor shall monitor the overall excavation area to determine whether additional bottom samples are required to ensure that the post-excavation confirmatory sampling criteria listed herein are met.

E. All required sampling and chemical analysis shall be conducted in accordance with IWWP Appendix A SOP A13 – Sample Control and Documentation and the Contractor's approved UFP-QAPP and the requirements of SECTION 01 35 45 – CHEMICAL DATA QUALITY CONTROL.

3.8 WASTE HANDLING

A. The Contractor shall segregate the excavated material into distinct stockpiles corresponding to their respective categories listed in Table 31 23 10 – 1 in accordance with IWWP Appendix A SOP A22 – Investigation Derived Materials. All excavated contaminated material shall be transported off-site and routed to the appropriate disposal facilities for treatment and/or disposal in accordance with 31 23 20 – TRANSPORTATION AND DISPOSAL OF CONTAMINATED MATERIALS.

B. In addition to the waste types described above, shallow soil (0-4 ft bgs) removed from the remedial excavation areas and shallow soil (0-4 ft bgs) removed from the excavation area side slopes will be managed separately from impacted soil and stockpiled for possible use as backfill.

3.9 UNDERGROUND STORAGE TANKS (USTS)

A. No known USTs are present within the site. If an UST is encountered during the course of excavations, excavations in the vicinity of the UST shall be ceased and the Contracting Officer's Representative shall be immediately notified.

3.10 CONTAMINATED MATERIAL STORAGE

A. Material shall be placed in temporary stockpiles within the containment area immediately after excavation.

B. Stockpiles
   1. Stockpiles shall be constructed near the excavations within the containment area.
   2. Each stockpile shall be covered with a polyethylene cover free of holes or other damage to prevent precipitation from entering the stockpile. The cover material shall be extended over the berms and weighted with sandbags to prevent it from being removed or damaged by wind.
   3. Non-contaminated shallow soil removed from 0-4 feet below ground surface shall be managed in separate stockpiles from impacted soil.

3.11 SAMPLING BENEATH THE SOIL STOCKPILE AREAS

A. Samples from beneath the soil stockpile/loadout areas (including the shallow soil stockpiles if analytical results preclude their use as backfill) shall be collected after removal of the soil stockpiles to verify that no cross-contamination has occurred in the area. Five-point composite samples shall be collected at a frequency of one composite sample per 1,000 square feet of disturbed area (stockpile area), from a depth interval of 0 to 0.5 feet. Samples shall be collected from biased areas based on visual indications of potential leaks. Samples shall be analyzed for contaminants of concern only in accordance with the requirements of SECTION 01 35 45 – CHEMICAL DATA QUALITY CONTROL.

B. Areas showing contaminant sample results above the soil cleanup level shall be scraped to remove the contamination and re-sampled.

3.12 SPILLS

A. In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), pollutant, contaminant, or oil, the Contractor shall notify the Contracting Officer's Representative immediately.

B. If the spill exceeds the reporting threshold, the Contractor shall follow the pre-established procedures as described in the 2018 IWWP, Health and Safety Plan for immediate reporting and containment. The Contractor shall take immediate containment actions to minimize the effect of any spill or leak.

C. Cleanup shall be in accordance with applicable federal, state, and local regulations. As directed by the Contracting Officer's Representative, additional sampling and testing shall be performed to verify spills have been cleaned up. Spill cleanup and testing shall be done at no additional cost to the Government.

3.13 BACKFILLING

A. Confirmatory Test Results
   1. Excavations shall be backfilled immediately after all contaminated materials have been removed and confirmatory test results have been approved by the Contracting Officer's Representative. Backfilling shall be conducted as shown in the Design Drawings and in accordance with SECTION 31 23 00 – BACKFILL, COMPACTION, AND GRADING.

B. Compaction
   1. Compaction shall be in accordance with SECTION 31 23 00 – BACKFILL, COMPACTION, AND GRADING.

3.14 DISPOSAL REQUIREMENTS

A. Off-site disposal of contaminated material shall be in accordance with SECTION 31 23 20 – TRANSPORTATION AND DISPOSAL OF CONTAMINATED MATERIAL.

END OF SECTION

SECTION 31 23 20
TRANSPORTATION AND DISPOSAL OF CONTAMINATED MATERIAL

PART 1 - GENERAL

1.1 SUMMARY

A. The purpose of this section is to provide the Contractor with the minimum requirements for the transportation and disposal of contaminated materials.

B. The Contractor shall be responsible for obtaining all permits required for off-site transportation of waste in accordance with applicable Federal, State, and local regulations.

C. At a minimum, the Contractor shall be required to furnish all labor, material, equipment, and incidentals necessary for on-site preparation and off-site transportation, treatment, and disposal of materials from the remediation and associated activities. Waste generated shall be treated and disposed at approved Resource Conservation and Recovery Act (RCRA) Treatment, Storage, and Disposal Facilities (TSDFs), RCRA Subtitle C landfill(s), Subtitle D landfill(s), or a Construction and Demolition (C&D) landfill, depending on waste characteristics.

D. The Contractor shall prepare and maintain waste shipment records and manifests required by RCRA (as applicable), U.S. Federal Department of Transportation (DOT), and Texas State transportation department.

E. The Contractor shall be required to perform all sampling required for waste characterization and landfill acceptance of excavated soil, debris, and cleared vegetation. The Contractor shall also be required to provide all waste profile information to the landfill, per their requirements.

F. The Contractor shall ensure that all operations for loading and hauling of wastes comply with Federal and State DOT regulations, and all other applicable Federal, State, and local requirements.

1.2 REFERENCES

A. References
   1. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. Where reference is made to one of the standards below, the revision in effect at the time of contract award shall apply.
      a. American Society for Testing and Materials (ASTM)
         1) ASTM D1117 Standard Guide for Evaluating Non-Woven Fabrics
      b. Code of Federal Regulations (CFR)
         1) 29 CFR 1910 Occupational Safety and Health Standards
         2) 40 CFR 261 Identification and Listing of Hazardous Waste
         3) 40 CFR 264 Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
         4) 40 CFR 265 Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
         5) 40 CFR 268 Land Disposal Restrictions
         6) 40 CFR 270 EPA Administered Permit Programs: The Hazardous Waste Permit Program

7) 40 CFR 300 National Oil and Hazardous Substances Pollution Contingency Plan
8) 40 CFR 302 Designation, Reportable Quantities, and Notification
9) 49 CFR 107 Hazardous Materials Program Procedures
10) 49 CFR 172 Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans
11) 49 CFR 173 Shippers – General Requirements for Shipments and Packaging

c. United States Code (U.S.C.)
1) 10 U.S.C. 101(e)(5)
2) 10 U.S.C. 2701(e)(2)
3) 10 U.S.C. 2701(e)(3)
4) 33 U.S.C. 2701 et seq. Oil Pollution Act (OPA)
5) 42 U.S.C. 6901 et seq. Resource Conservation and Recovery Act
6) 42 U.S.C. 9601 et seq. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

d. United States Army Corps of Engineers (USACE), Tulsa District
1) Final Health and Safety Plan for Longhorn Army Ammunition Plant (LHAAP HASP), Karnack, Texas (2018).
2) Final Installation Wide Work Plan for Longhorn Army Ammunition Plant (LHAAP IWWP), Karnack, Texas, revised by Bhate Environmental Associates, Inc. (May 2018; IWWP).

B. Definitions
1. MEC – Munitions and Explosives of Concern
a. MEC distinguishes specific categories of military munitions that may pose unique explosives safety risks, such as unexploded ordnance (UXO), as defined in 10 U.S.C. 101(e)(5); discarded military munitions, as defined in 10 U.S.C. 2710(e)(2); or munitions constituents (e.g., TNT, RDX), as defined in 10 U.S.C. 2710(e)(3), present in high enough concentrations to pose an explosive hazard.
2. Debris
a. Demolition debris in the form of concrete, scrap metals, remnants from previous investigation activities, etc.
1. Hazardous Waste
a. A waste that meets criteria established in RCRA or specified by the EPA in 40 CFR 261, or that has been designated as hazardous by a RCRA-authorized state program.
2. Non-Hazardous Waste
a. Any waste that does not meet the criteria of hazardous waste. It is anticipated that contaminated soil will be classified as non-hazardous.

1.3 SUBMITTALS

A. Approval from the Contracting Officer's Representative, in consultation with the regulators, is required for submittals with an "RA" designation; submittals with an "FIO" designation are for information only. The Contractor shall submit the following to the Contracting Officer's Representative:
1. Waste Management and Transportation Plan; Pre-Construction Submittals; RA
a. The Contractor shall prepare the Waste Management and Transportation Plan as part of their work plan and submit it to the Contracting Officer's

Representative for approval at least 30 days prior to the Pre-Work Conference. Deficiencies in the Waste Management and Transportation Plan will be discussed at the Pre-Work Conference. The Contractor shall make all necessary amendments required by the Contracting Officer's Representative and resubmit it for approval. This procedure shall continue until the Contracting Officer's Representative gives final written approval. The Contractor shall make the necessary effort so that only one resubmittal is required. The plan shall include, at a minimum, the following:

1) Procedures for contaminated material management on-site and the management practices to be utilized.
2) Waste minimization methods.
3) Soil stockpile area where contaminated material is to be handled.
4) Proposed landfill facilities for waste disposal, including alternate facilities in the event that the primary facility cannot accept the waste.
5) Names, certificates, permits, licenses, EPA identification (ID) numbers, locations, and telephone numbers for the proposed disposal facility/facilities and waste haulers.
6) RCRA waste classification and volume estimates for the waste types, if existing sample results are sufficient for landfill acceptance. Otherwise, the Contractor shall conduct waste characterization sampling to meet landfill acceptance requirements.
7) Letters of commitment from the proposed waste haulers and disposal facilities, certifying acceptance of the LHAAP-18/24 waste.
8) Methods and equipment to be used to ensure accurate weight measurements of waste material.
9) Waste manifesting procedures.
10) Locations and procedures for the on-site waste handling areas.
11) Types of transport vehicles to be used for each type of material.
12) Packaging and transporting requirements for each type of waste, including any special requirements of the disposal facility.
13) Proposed truck routes from the worksite to the disposal facility/facilities. The route(s) to and from the disposal facility shall be in accordance with the disposal facility/facilities requirements and all Federal, State, and local regulations, laws, ordinances, and weight restrictions. The established truck routes from the site to the closest major freeway, minimizing transport on residential streets as much as feasible. Use of these routes shall be strictly enforced.
14) Methods to contain and clean up spills.
15) Procedures for incident response, including details of manpower and equipment available and the coordination necessary to mobilize forces in an emergency.
16) The Emergency Response Name and Telephone number that will be available on a 24/7 basis during the shipment period, and this information will be included in the Shipments Manifests as per the USDOT Regulations.

2. Notices of Non-Compliance and Notices of Violation; Product Data; RA
   a. Notices of non-compliance or notices of violation issued by a Federal, State, or local regulatory agency issued to the Contractor in relation to any work performed under this contract. The Contractor shall immediately provide copies of such notices to the Contracting Officer's Representative. The Contractor shall also furnish all relevant documents regarding the incident and any

information requested by the Contracting Officer's Representative and shall coordinate its response to the notice with the Contracting Officer's Representative prior to submission to the notifying authority. The Contractor shall also furnish a copy to the Contracting Officer's Representative of all documents submitted to the regulatory authority, including the final reply to the notice, and all other materials, until the matter is resolved.

3. Contaminated Material Stockpile Reports; Product Data; RA
   a. When contaminated materials are in interim storage, submit on a weekly basis, an inventory of the types, quantity, and locations of all contaminated materials in interim storage, and a record of the date, quantity, source, and disposition of all contaminated materials placed into or taken out of interim storage. Report all test results from sampling of stored material.
4. Annual and Biennial Reports; Test Reports; RA
   a. Information necessary to file State annual or USACE biennial reports for waste transported, treated, stored, or disposed of under this contract shall be submitted to the Contracting Officer's Representative at the specified time and shall not be forwarded directly to the regulatory agency. The submittal shall contain all the information necessary for filing of the formal reports in the form and format required by the governing Federal, State, and local regulatory agency. A cover letter shall accompany the data including the contract number, Contractor's name and project locations.
5. Spill Response; Test Reports; RA
   a. In the event of a spill or release of a pollutant, contaminant, hazardous substance (as designated in 40 CFR 302), or oil (as governed by 33 U.S.C. 2701 et seq.), the Contractor shall notify the Contracting Officer's Representative immediately and contact the National Response Center as per the Final Health and Safety Plan for Longhorn Army Ammunition Plant Karnack, Texas. If the spill exceeds a reporting threshold, the Contractor shall follow the pre-established procedures for immediate reporting to the Contracting Officer's Representative.
6. Manifest Exception Reports; Test Reports; RA
   a. In the event that a manifest copy documenting receipt of waste at the disposal facility is not received within 35 days of shipment initiation, the Contractor shall prepare and submit an exception report to the Contracting Officer's Representative within 37 days of shipment initiation.
7. Certification; Certificates; RA
   a. Copies of the current certificates of registration required by 49 CFR 107, Subpart G issued to the Contractor and/or Subcontractors or written statements certifying exemption from these requirements.
8. Transportation and Disposal Coordinator; Certificates; RA
   a. Transportation and Disposal Coordinator qualifications including proof of at least one year of specialized experience in management and transportation of hazardous wastes; proof of current Department of Transportation Hazardous Materials Training Certification.
9. Training; Certificates; RA
   a. Documentation that employees preparing or transporting hazardous materials have been trained, tested, and certified per 49 CFR 172, Subpart H, including general security awareness requirements and, where applicable, site-specific security plan requirements.
10. EPA Off-Site Policy; Certificates; RA

a. A letter certifying that EPA considers the facilities to be used for all off-site disposal to be acceptable in accordance with the Off-Site Policy in 40 CFR 300.440. This certification shall be provided for wastes from sites governed by 42 U.S.C. 6901 et seq. or 42 U.S.C. 9601 et seq. A sample Off-Site Policy certification memo is provided in Attachment A.

11. Transport Certification; Certificates; FIO
    a. The Contractor shall submit certification that all operators and vehicles used to transport contaminated material meet all existing Federal, State, and local regulations for vehicle operations.
12. Certificates of Disposal; Certificates; RA
    a. The Contractor shall provide certificates documenting the ultimate disposal of CERCLA remediation wastes within 180 days of initial shipment. Receipt of these certificates will be required for final payment.
13. Shipping Documents; Certificates; RA
    a. The Contractor shall submit all transportation-related shipping documents to the Contracting Officer's Representative for review including draft waste manifests, draft bills of lading, lists of corresponding proposed labels, packages, marks, and placards to be used for shipment, waste profiles, supporting waste analysis documents, for review a minimum of 14 calendar days prior to the anticipated shipping date. Packaging assurances shall be furnished prior to transporting the material, "generator copies" of hazardous waste manifests, bill of landings, and supporting waste analysis documents shall be furnished when shipments are originated. "Receipt copies" of waste manifests at the designated disposal facility shall be furnished no later than 35 days after acceptance of the shipment.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Qualifications
1. Transportation and Disposal Coordinator
    a. The Contractor shall designate, by position and title, one person to act as the Transportation and Disposal Coordinator (TDC) for this contract. The TDC shall serve as the single point of contact for all environmental regulatory matters and shall have overall responsibility for total environmental compliance at the site including, but not limited to, accurate identification and classification of hazardous waste and hazardous materials; determination of proper shipping names; identification of marking, labeling, packaging and placarding requirements; completion of waste profiles, hazardous waste manifests, bill of ladings, exception and discrepancy reports; and all other environmental documentation. The TDC shall have, at a minimum, one year of specialized experience in the management and transportation of hazardous waste and have been DOT-certified under 49 CFR 172, Subpart H.
2. Training
    a. The Contractor's hazardous materials employees shall be trained, tested, and certified to carry out their assigned duties safely and effectively in accordance with the Final Health and Safety Plan for Longhorn Army Ammunition Plant Karnack, Texas. The Contractor's employees transporting hazardous materials or preparing hazardous materials for transportation, including samples, shall be trained, tested, and certified in accordance with 49 CFR 172, Subpart H, including security awareness and any applicable security plans. Contractor employees making determinations that shipments do not constitute DOT

regulated hazardous materials shall also be trained, tested, and certified in accordance with 49 CFR 172, Subpart H.

1.5 LAWS AND REGULATORY REQUIREMENTS

A. Work shall meet or exceed the minimum applicable requirements established by Federal, State, and local laws and regulations. These requirements are amended frequently, and the Contractor shall be responsible for complying with amendments as they become effective. In the event that compliance exceeds the scope of work or conflicts with specific requirements of the contract, the Contractor shall notify the Contracting Officer's Representative immediately. At a minimum the requirements stipulated in the regulations referenced in Paragraph 1.2 – REFERENCES shall be met.

B. The Contractor shall comply with the Land Disposal Restrictions (LDR) 40 CFR 268 when treating and disposing of hazardous wastes.

C. The Contractor shall comply with 40 CFR 268.49, Alternative LDR Treatment Standards for Contaminated Soil, when treating and disposing of contaminated soil.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The Contractor shall provide all the materials required for the packaging, labeling, marking, placarding and transportation of hazardous materials, hazardous waste, and non-hazardous wastes in conformance with DOT standards. Details in this Specification shall not be construed as establishing the limits of the Contractor's responsibility.

B. Spill Response Materials
   1. The Contractor shall provide spill response materials including, but not limited to, containers, absorbent, shovels, and personal protective equipment. Spill response materials shall be available at all times during which waste is being handled or transported. Spill response materials shall be compatible with the type of material being handled.

2.2 CONTAINERS

A. Shipping Containers
   1. Impermeable containers shall be suitable to receive and retain contaminated materials until they are disposed of at an approved facility. The containers shall meet the standards of a "Strong, Tight Container" and conform to DOT Standard 49 CFR 173.24. Containers in a shipment must be loaded and braced securely to prevent shifting and damage during transport. Cover systems shall meet the criteria for a closed transport vehicle as specified in 49 CFR 173.403.

2.3 EQUIPMENT AND TOOLS

A. The Contractor shall provide miscellaneous equipment and tools necessary to handle waste in a safe and environmentally sound manner. The Contractor shall provide equipment that is appropriate to accomplish this type of work and shall maintain and use of it in strict compliance with Occupational Safety and Health Administration (OSHA) requirements (29 CFR 1910). The Contractor shall take all necessary precautions for safe operation of the equipment and the protection of the public from injury and damage from such equipment.

2.4 FACILITIES

A. The Contractor shall provide, install, and maintain any temporary loading facilities as required for the material handling operations as shown in the Design Drawings.

2.5 LABELING

A. The Contractor shall provide primary and subsidiary labels for materials/wastes consistent with the Federal, State, and local requirements. Labels shall be durable and weather resistant and capable of withstanding, without deterioration or substantial color change, a 180-day exposure to conditions reasonably expected to be encountered during container storage and transportation.

2.6 PLACARDS

A. For each off-site shipment of materials/wastes, the Contractor shall provide primary and subsidiary placards as required by Federal, State, and local regulations. Placards shall be provided for each side and each end of bulk packaging, freight containers, and transport vehicles requiring such placarding. Placards may be plastic, metal, or other material capable of withstanding, without deterioration, a 30-day exposure to open weather conditions.

2.7 TARPAULINS

A. Waterproof tarpaulins (tarps) shall be nylon vinyl-coated on both sides with a tearing strength of 70 lbs conforming to ASTM D1117, or equal. All edges shall be hemmed, with reinforced grommets on maximum 4 feet on centers.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall manage all contaminated material in accordance with IWWP Appendix A SOP A22 – Investigation Derived Materials, except were modified herein.

B. The Contractor shall ensure that all transport vehicles containing waste are covered with tarps before leaving the site. In addition to tarping all loads, the tailgate and bumper shall be swept to remove any spillage from the loading operation. All transport vehicles shall be decontaminated when leaving the loading area.

C. The Contractor shall coordinate the schedule for vehicle arrival and material deliveries at the construction site to meet the approved project schedule. The schedule shall be compatible with the availability of equipment and personnel for material handling operations. No claims shall be made by the Contractor for additional compensation due to a delay in the schedule related to vehicle arrival or material availability.

D. The Contractor shall organize and maintain the material shipment records required by the Federal and the State of Texas regulations.

E. The Contractor is responsible for obtaining and filling out waste profile sheets required by the disposal facility. The quantity of sheets per contained waste shall be in accordance with Federal, State, or local regulations. The Contractor shall submit each profile sheet to the Contracting Officer’s Representative.

F. The Contractor shall notify the Contracting Officer’s Representative immediately upon learning that a job-related accident has occurred. Notification of the accident shall include location of the accident, resultant damage or injury, person(s) involved,

probable cause, amount of waste spilled, and any other pertinent information concerning the accident.

G. Accident cleanup operations shall be performed as directed by the Contracting Officer's Representative at the expense of the Contractor. Cleanup shall be performed immediately.

H. The Contractor shall provide transportation of the waste directly to the disposal facility/facilities.

I. The Contractor shall provide all sampling and analytical services necessary for disposal in accordance with disposal facility requirements, and all applicable Federal, State, and local regulations, and as specified in SECTION 01 35 45 – CHEMICAL DATA QUALITY CONTROL.

3.2 CHARACTERIZATION AND SEGREGATION OF WASTE MATERIALS

A. The Contractor shall excavate contaminated material, stockpile material, and collect waste disposal samples per disposal facility requirements and in accordance with IWWP Appendix A SOP A13 – Sample Control and Documentation and SECTION 01 35 45 – CHEMICAL DATA QUALITY CONTROL.

B. The Contractor shall utilize the existing data found in the Contract Documents to the maximum extent possible for landfill acceptance. The Contractor shall perform additional waste characterization sampling and testing required by the landfill for acceptance.

C. The Contractor shall be responsible for segregating all waste generated as a result of construction and remedial activities. Excavated soil shall be segregated as described in SECTION 31 23 10 – EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS.

D. Temporary stockpiles of potentially non-impacted soil (shallow soil from 0 to 4 feet below ground surface), non-hazardous impacted soil and hazardous materials shall be covered with plastic sheeting or equivalent material to protect waste from adverse weather conditions and to prevent dust emissions. Erosion and sedimentation controls shall be installed around all stockpiles.

3.3 NON-HAZARDOUS WASTE MANAGEMENT

A. Non-hazardous waste from the site shall be disposed of off-site in an approved landfill in accordance with the approved Waste Management and Transportation Plan

B. Contaminated soil with concentrations below 75% of TCLP values shall be considered non-hazardous and disposed of at an approved Subtitle D landfill. The following non-hazardous wastes are expected from the site: Excavated soil with contaminant of concern concentrations more than the soil cleanup levels but less than the TCLP values.

C. Non-hazardous wastes above Remediation Cleanup Levels shall not be used as backfill, topsoil or sub-grade material.

3.4 HAZARDOUS WASTE MANAGEMENT

A. The Contractor shall be responsible for ensuring compliance with all Federal, State, and local hazardous waste laws and regulations and shall verify those requirements when preparing reports, waste shipment records, hazardous waste manifests, or other documents.

B. Hazardous Waste Characterization

1. The Contractor shall be required to perform any and all sampling required for landfill acceptance of excavated soil and debris. The Contractor shall also be required to provide all waste profile information to the landfill, per their requirements. Sampling and field screening methods shall be in accordance with disposal facility requirements and applicable Federal, State, and local regulations. The Contractor shall complete the waste profile information and submit it to the Contracting Officer's Representative for approval prior to sending it to the disposal facility.
2. The Contractor, in consultation with the Contracting Officer's Representative, shall identify all hazardous waste codes applicable to each hazardous waste stream based on requirements set forth in this section, 40 CFR 261, and applicable state and local laws or regulations. The Contractor shall also identify all applicable treatment standards in 40 CFR 268 and state LDRs and shall determine whether or not the waste meets or exceeds the standards. Waste profiles, analyses, classification, and treatment standards information shall be submitted to the Contracting Officer's Representative for review and approval.
3. Solid waste material other than soil, including vegetation from clearing and other debris encountered in excavations areas, shall be stockpiled, covered, and disposed of with non-hazardous soil.
4. The USACE is the owner and generator of the hazardous wastes for the LHAAP-18/24. Based on the available historical information and investigation results, an estimated 25 percent of the total excavated impacted material quantity (10,070 in-place cubic yards) of hazardous wastes are expected from the remedial activities from LHAAP – 18/24:

C. Stockpiles
1. The Contractor shall attempt to load hazardous soil as specified in SECTION 31 23 10 – EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS.
2. The excavated material shall not be mixed, and waste shall be segregated from soil into a separate stockpile to minimize the amount of RCRA waste requiring treatment. Solid waste material shall be stockpiled and covered or loaded into roll-off containers using a loading system approved by the Contracting Officer's Representative.
3. Stockpiles shall be constructed within the containment area in the areas to be remediated to isolate stored contaminated material from the environment. If multiple stockpiles are required, each unit shall be clearly labeled with an identification number.
4. The combined volume of all stockpiles shall be a size that is manageable and not create excess odors.
5. Stockpiles shall not be more than 10 feet in height. The maximum size of each stockpile shall be 500 cubic yards. Stockpiles of excessive size with height more than 10 feet and 500 cubic yards shall be subject to approval of the Contracting Officer's Representative.
6. The stockpiles shall be constructed in accordance with SECTION 31 23 10 – EXCAVATION AND HANDLING OF CONTAMINATED MATERIALS and shall meet the regulation defined in 40 CFR 264.250.
7. Creation and maintenance of stockpiles shall not interfere with the excavation, dewatering, and other on-site activities.

D. Contact Water Storage
1. Contact water may be generated during wet weather and shall be collected from excavations and stockpiles with saturated soil. The contact water shall be

temporarily stored in frac tanks, sampled, and treated at the on-site GWTP, if required.

E. Sampling of Stored Material
   1. Samples of contaminated material shall be collected at a frequency consistent with the requirements of the off-site disposal facility. The Contractor shall analyze the stored material for disposal purposes. Analytical levels for material to be shipped to the off-site disposal facility shall conform to Federal, State, and local criteria as well as to the requirements of the off-site disposal facility. Documentation of all analyses performed shall be furnished to the Contracting Officer's Representative.

F. Waste Management and Transportation Plan
   1. The Contractor shall prepare a plan detailing the manner in which hazardous wastes will be managed and describing the types and volumes of hazardous wastes anticipated to be managed as well as the management practices to be utilized. The plan shall identify the method to be used to ensure accurate piece counts and/or weights of shipments; shall identify waste minimization methods; shall propose facilities to be utilized for treatment, storage, and/or disposal; shall identify areas on-site where hazardous wastes are to be handled; shall identify whether transfer facilities are to be utilized; and if so, how the wastes will be tracked to ultimate disposal.

G. Disposal Facility and Transporter
   1. The Contractor shall provide the Contracting Officer's Representative with EPA ID numbers, names, locations, and telephone numbers of disposal facilities and transporters. This information shall be contained in the Waste Management and Transportation Plan and shall be approved by the Contracting Officer's Representative prior to waste disposal.

H. Status of the Facility
   1. Facilities receiving hazardous waste must be permitted in accordance with 40 CFR 270 or operating under interim status in accordance with 40 CFR 265 requirements or must be permitted by a state authorized by the Environmental Protection Agency to administer the RCRA permit program. Additionally, prior to using a TSDF, the Contractor shall contact the EPA Regional Office specified in 40 CFR 300.440 to determine the facility's status and document all information necessary to satisfy the requirements of the EPA Off-Site policy and furnish this information to the Contracting Officer's Representative.

I. Shipping Documents and Packaging Certification
   1. The Contractor shall be responsible for obtaining all permits and shipping documents to ship contaminated soil off-site.
   2. Prior to shipment of any hazardous material off-site, the Contractor's TDC shall provide written certification to the Contracting Officer's Representative that hazardous materials have been properly packaged, labeled, and marked in accordance with Department of Transportation and USACE requirements. The Contractor's TDC shall also provide written certification regarding waste minimization efforts documenting the efforts that have been taken to reduce the volume and toxicity of waste to the degree economically practicable and that the method of treatment, storage, or disposal selected minimizes threats to human health and the environment.

J. Vehicle Inspection
   1. Vehicles may be inspected by the Contracting Officer's Representative at the site prior to loading to ensure that the vehicles have no fluids leaks, no unusually noisy mufflers or tailpipes, tires that are in good condition, and operational brakes, horn, steering, operating controls, and safety devices. Vehicles shall be free of excess dirt, debris, oil, grease, and excessive rust. Vehicle beds used for hauling shall be free from drain holes, cracks, or other conditions that might permit waste material or contaminated water to leak from the vehicle beds. If the vehicle used for hauling has tailgates for dumping, the Contractor shall demonstrate to the Contracting Officer's Representative that the tailgates can be sealed watertight during operation. Any vehicle bed not providing an adequate leakproof seal shall be repaired or replaced as required. Tarpaulin covers shall be placed over all vehicle beds during waste transport to the disposal facility. Covers shall be placed over trucks, trailers or other conveyances used for bulk shipment to avoid spillage of the waste material and entrance of rain or snow during transport. The covers shall completely enclose the bulk shipment with no open areas along the sides or openings on the top. Cover systems shall meet the criteria for a closed transport vehicle as specified in 49 CFR 173.403. Failure of the shipping container, liner, seals, hatches, doors, or tarpaulin system to meet the above requirements which causes material to be rejected by disposal facility shall be addressed at the Contractor's expense.
   2. The Contractor shall coordinate recording quantities of waste leaving the site with the Contracting Officer's Representative.
   3. Vehicles/containers, either empty or loaded, shall not remain at the site, unless specific arrangements are made otherwise. Immediately after loading, they shall be sealed, weighed, and transported directly to the disposal facility.
   4. The Contractor shall provide clean containers/hauling vehicles for loading during normal work hours.
   5. Each vehicle/container shall be monitored for external contamination by the Contractor prior to leaving the worksite. The Contractor shall perform and document decontamination procedures prior to leaving the worksite and again before leaving the disposal site.

K. Transportation
   1. The Contractor shall meet all existing Federal, State, and local regulations for vehicle operations in transporting the waste on public roads and highways. All construction vehicles shall be decontaminated prior to leaving the site using the temporary decontamination facility. All haul and access roads shall be maintained in a clean condition so that no dirt or contamination is tracked onto clean areas or public roads and highways.
   2. Manifests requiring shipper's certification number shall be signed by the Contracting Officer's Representative. Copies of all manifests and waste profiles shall be submitted to the Contracting Officer's Representative within five days following shipment, and within five days after notification of receipt at the permitted disposal facility. Any manifest discrepancies shall be reported immediately to the Contracting Officer's Representative and resolved by the Contractor. A detailed report documenting the final disposal of all materials removed from the site shall be submitted to the Contracting Officer's Representative.
   3. The Contractor shall prepare land disposal restriction notifications as required by 40 CFR 268 or any applicable state or local law or regulation for each shipment of

hazardous waste. Notifications shall be submitted with the manifest to the Contracting Officer's Representative for review and approval.

4. The Contractor shall prepare a manifest for each shipment of hazardous waste which fulfills the shipping paper requirements. The bill of landing shall satisfy the requirements of 49 CFR 172, Subpart C, and any applicable state or local law or regulation, and shall be submitted to the Contracting Officer's Representative for review and approval. Bill of ladings requiring shipper's certifications shall be signed by the Contractor.
5. The Contractor shall be responsible for any and all actions necessary to remedy situations involving material spilled or leaked in transit on- or off- site, or mud and dust tracked off-site. This cleanup shall be accomplished at the Contractor's expense.
6. Transportation routes to and from project areas shall be in accordance with the approved Waste Management and Transportation Plan. No deviation from transportation routes shall be allowed without prior written approval from the Contracting Officer's Representative.
7. The Contractor shall be responsible for all repair costs for damage to structures, roads, bridges, and any other features affected by the Contractor's off-site transportation and disposal operations.

L. Treatment and Disposal of Hazardous Wastes

1. The Contractor shall ship hazardous waste only to facilities that are properly permitted to accept the hazardous waste or operating under interim status. The Contractor shall propose the TSDFs via submission of the Waste Management and Transportation Plan, subject to the approval of the Contracting Officer's Representative.
2. RCRA Subtitle C permitted facilities shall meet the requirements of 40 CFR 264 or facilities operating under interim status which meet the requirements of 40 CFR 265. All TSDFs must be accepted by the EPA. Off-site treatment, storage, and/or disposal facilities with significant RCRA violations or compliance problems (such as facilities known to be releasing hazardous constituents into groundwater, surface water, soil, or air) shall not be used.
3. Wastewater generated from equipment decontamination, well development, sampling, and purging activities will be transported to the groundwater treatment plant at LHAAP-18/24 for disposal by addition to the influent stream of the plant.
4. The Contractor shall not deliver waste to any facility other than those listed on the shipping manifest.
5. In the event that an identified and approved facility ceases to accept the stated materials or ceases operations, it is the Contractor's responsibility to locate an alternate facility and make the necessary arrangements to utilize the alternate facility. The alternate facility must be approved in writing by EPA in the same manner and with the same requirements as the original facility.
6. The Contractor shall ensure waste is treated to meet land disposal requirement standards in 40 CFR 268 prior to land disposal. Selected treatment facilities for treatment of contaminated soil shall be responsible for the ultimate disposal of the treated wastes or soil. Under no condition shall the treated waste or soil be returned to the site to be used as filling material.

M. Hazardous Materials Management

1. The Contractor, in consultation with the Contracting Officer's Representative, shall evaluate, prior to shipment of any material off-site, whether the material is regulated as a hazardous waste in addition to being regulated as a hazardous

material; this shall be done for the purpose of determining proper shipping descriptions, marking requirements, etc., as described below.

2. Identification of Proper Shipping Names
   a. The Contractor shall use 49 CFR 172, Section 101 to identify proper shipping names for each hazardous material (including hazardous wastes) to be shipped off-site. Proper shipping names shall be submitted to the Contracting Officer's Representative in the form of draft shipping documents for review and approval.
3. Packaging, Labeling, and Marking
   a. The Contractor shall package, label, and mark hazardous materials/wastes using the specified materials and in accordance with the referenced authorizations. The Contractor shall mark each container of hazardous waste of 110 gallons or less with the following:

"HAZARDOUS WASTE - Federal Law Prohibits Improper Disposal. If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.
Generator's name: The United States Army Corps of Engineers
Manifest Document Number: _____."

3.5 SHIPPING DOCUMENTS

A. The Contractor shall ensure that each shipment of waste sent off-site is accompanied by properly completed shipping documents as specified in Paragraph 1.3.A.13. This includes shipments of samples that may potentially meet the definition of a Department of Transportation regulated hazardous material. Documents shall be submitted to the Contracting Officer's Representative for review and approval.

B. The Contractor will be responsible for reporting waste shipments to the Texas Commission on Environmental Quality (TCEQ) One-Time Waste Shipment Program.

3.6 U.S. ARMY ID NUMBERS

A. U.S. Army will provide waste generator identification number for use on the manifest.

3.7 RECORDKEEPING

A. The Contractor shall organize and maintain the material shipment records/manifests required by 42 U.S.C. 6901 et seq., the State of Texas, and the state in which the disposal facility is located.

3.8 SPILL RESPONSE

A. The Contractor shall respond to any spills of hazardous material or hazardous waste which are in the custody or care of the Contractor, pursuant to this contract. Any direction from the Contracting Officer's Representative concerning a spill or release shall not be considered a change under the contract. The Contractor shall comply with all applicable requirements of Federal, State, or local laws or regulations regarding any spill incident.

3.9 EMERGENCY CONTACTS

A. The Contractor shall be responsible for complying with the emergency contact provisions in 49 CFR 172.604. Whenever the Contractor ships hazardous materials, the Contractor shall provide a 24-hour, 7-day a week monitoring telephone service emergency response contact. The person must be knowledgeable about the hazardous materials being shipped and who has comprehensive emergency response and incident

mitigation information for that material or has immediate access to a person who possesses such knowledge and information.

B. The phone must be monitored on a 24-hour basis at all times when the hazardous materials are in transportation, including during storage incidental to transportation.

C. The Contractor shall ensure that information regarding this emergency contact and phone number are placed on all hazardous material shipping documents. The Contractor shall designate an emergency coordinator and post the following information at areas in which hazardous wastes are managed:
   1. Emergency coordinator's name
   2. Emergency coordinator's phone number
   3. Local fire department phone number
   4. Fire extinguishers and spill control materials location

END OF SECTION

ATTACHMENT A

SAMPLE OFF-SITE POLICY CERTIFICATION MEMO

Project/Contract #:_____

Waste Stream: _____

Primary TSDF, EPA ID # and Location:

Alter. TSDF, EPA ID # and Location:_____

EPA Region Contact

I	(617) 918-1769
II	(732) 906-6874
III	(215) 814-3240
IV	(404) 562-8993
V	(312) 353-8207
VI	(214) 665-2282
VII	(913) 551-7149
VIII	(303) 312-6503
IX	(415) 972-3994
X	(206) 553-3859

Contracting Officer's Representative contacted:
Contracting Officer's Representative phone number:_____
Date contacted:_____
Comment:_____

The above Contracting Officer's Representative was contacted on _____. As of that date, the above site was considered acceptable in accordance with the Off-Site Policy in 40 CFR 300.440.

Signature: _____Date: _____

Phone number: _____

SECTION 31 25 00
EROSION CONTROL AND STORMWATER MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish all labor, materials, equipment, and incidentals necessary to perform erosion control for the duration of the project. Work shall be performed as shown on the Design Drawings, specified herein and identified in the Contract Documents.

1.2 REFERENCES

A. References
   1. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only. Where reference is made to one of these standards, the revision in effect at the time of contract award shall apply.
      a. Texas Commission on Environmental Quality (TCEQ)
         1) Texas Water Code Chapter 26
         2) General Permit TXR15000
         3) TCEQ RG-348, Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices
      b. American Society for Testing and Materials (ASTM)
         1) ASTM D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity
         2) ASTM D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
         3) ASTM D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
         4) ASTM D4833 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
         5) ASTM D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
         6) ASTM D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles

1.3 SUBMITTALS

A. Approval from the Contracting Officer's Representative, in consultation with the regulators, is required for submittals with an "RA" designation; submittals with an "FIO" designation are for information only. The Contractor shall submit the following to the Contracting Officer's Representative:
   1. Soil Erosion and Sedimentation Control (SESC) Plan to be submitted as part of the work plan.
   2. Samples; RA
      a. Samples of all materials shall be submitted for inspection and approval upon request from the Contracting Officer's Representative.
   3. Non-Woven Geotextile Filter Fabric Certificates of Compliance; Certificates; RA
      a. The Contractor shall submit certificates of compliance, furnished by the geotextile fabric manufacturer or supplier, stating the physical properties of the

geotextile fabric to be used on site meet the Specification requirements as described herein.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Not used.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Temporary Seeding and Mulching
   1. Temporary seeding, mulching, fertilizing, and/or erosion control matting shall be used as needed to reduce erosion as specified in the Design Drawings.

B. Baled Hay or Straw checks
   1. Baled hay or straw erosion checks are temporary measures to control erosion and prevent siltation. Bales shall be either hay or straw containing five cubic feet or more of material. The bales shall be free from noxious weeds.

C. Temporary Diversion Dikes
   1. Temporary Diversion Dikes, or straw bale dikes, are temporary measures placed downhill from a disturbed area to redirect/trap flows of debris (i.e., sediment). The dikes consist of bound bales bedded and staked in place. Diversion dikes shall be used as specified in the Design Drawings.

D. Temporary Silt Fences
   1. The siltation fence fabric shall be a geotextile material suitable for siltation control use with a minimum tensile strength of 100 pounds, meeting ASTM D4632. The equivalent opening size shall be between no. 50 and no. 70 sieve size. A 12-gauge metal fence with 4-inch by 4-inch openings shall be provided as support for the fence fabric.

E. Polyethylene sheeting
   1. The polyethylene sheeting shall be as specified in the Design Drawings.

F. Non-woven geotextile fabric
   1. The geotextile fabric shall be a non-woven fabric consisting only of continuous chain polymer filaments or yarns of polyester, formed into a stable network by needle punching. The fabric shall be mildew and rot resistant. The fabric shall contain the properties listed in Table 31 25 00-1.

Table 31 25 00-1 Non-Woven Geotextile Fabric Properties

Fabric Property	Test Method	Minimal Physical Properties
Fabric Weight	ASTM D5261	8.0 oz/yd3
Fabric Thickness	ASTM D5199	105 mils
Grab Strength	ASTM D4632	230 lbs
Puncture Resistance	ASTM D4833	100 lbs
Water Flow Rate	ASTM D4491	90 gpm/ft2
Permeability, K	ASTM D4491	0.34 cm/sec
Apparent Opening Size	ASTM D4751	Sieve Size 70

PART 3 - EXECUTION

3.1 SEDIMENT AND EROSION CONTROL

A. Excavations for the site are expected to be less than 1 acre in size and thus are not subject to the storm water pollution prevention requirements of Chapter 26 of the Texas Water Code and TCEQ General Permit TXR15000.

B. Sediment and erosion control practices shall be consistent with procedures outlined in TCEQ RG-348, Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices, July 2005. https://www.tceq.texas.gov/assets/public/comm_exec/pubs/rg/rg348/rg-348.pdf

C. If the Contractor desires to stockpile construction materials, such as stone, earth, etc., the location of these materials and the protection measures required shall be in accordance with the best management practices outlined in TCEQ RG-348, Complying with the Edwards Aquifer Rules: Technical Guidance on Best Management Practices, July 2005.

D. The Contractor shall not be permitted to divert stormwater onto adjacent properties. Stormwater shall be diverted around open excavation areas using diversion fencing.

E. All stormwater that comes in contact with contaminated soils shall be collected, stored, and conveyed to the GWTP. All other site run-off water shall be diverted to the on-site streams via the control measures (e.g., baled hay or straw check/silt fence filtration) as approved by the Contracting Officer's Representative.

3.2 CONSTRUCTION REQUIREMENTS

A. The Contracting Officer's Representative has the authority to limit the surface area of erodible earth material exposed by excavation and fill operations, and to direct the Contractor to provide immediate, permanent, and/or temporary pollution control measures to prevent contamination of areas adjacent to the containment area. Such work may involve the use of temporary mulches, mats, seeding, or other control devices or methods as necessary to control erosion.

B. The Contractor shall be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in its accepted schedule. Temporary pollution control measures shall be used to correct conditions that develop during construction, prior to installation of permanent pollution control features, or temporarily to control erosion that develops during normal construction practices.

C. The Contracting Officer's Representative has the authority to limit the area of excavation and fill operations in progress commensurate with the Contractor's capability and progress in keeping the finished grading, mulching, seeding and other such temporary or permanent pollution control measures current, in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.

D. In the event of conflict between these requirements and pollution control laws, rules, or regulations, or other Federal, State, or local agencies, the more restrictive laws, rules, or regulations shall apply.

3.3 CONSTRUCTION OF CONTROL MEASURES

A. Baled Hay or Straw Erosion Checks

1. Baled hay or straw checks shall be used where the existing ground slopes toward or away from an embankment, along the toe of slopes, in ditches, or other areas where the Contractor deems necessary to prevent siltation, erosion or water runoff problems.
2. Hay or straw erosion checks shall be embedded in the ground six inches to prevent water from flowing under them. The bales shall also be anchored securely to the ground, as shown in the Design Drawings. Bales and anchoring shall be removed after they have served their purpose, as determined by the Contracting Officer's Representative. The Contractor shall keep the checks in good condition by replacing broken or damaged bales immediately after damage occurs. Normal debris cleanout shall be considered routine maintenance.

B. Temporary Diversion Dikes and Silt Fences
1. Temporary silt fences shall be placed on the natural ground, at the bottom of fill slopes, in ditches, or in other areas where siltation is a problem. Silt fences are constructed of material designed for that application or another approved material on the up-grade side of the fence and anchored into the soil.
2. Temporary diversion dikes shall be constructed as per the details provided in the Design Drawings. Diversion dikes shall be placed upstream of excavations to divert water away from excavations and into the existing stormwater drainage pathway.
3. The Contractor shall be required to maintain diversion dikes and silt fencing in a satisfactory condition for the duration of the project or until removal is approved by the Contracting Officer's Representative. The silt accumulation at the fences shall be removed and properly disposed of as directed by the Contracting Officer's Representative. The diversion dikes and silt fencing become the property of the Contractor whenever the fence is removed.
4. The fence shall be fastened to the fence posts with metal clips 12 inches on center or an approved equal compatible with the fence material. The filter material shall be fastened to the fence at the top, center, and bottom with metal fasteners (nails or staples) and a high-strength reinforcement material (nylon webbing, grommets, washers, etc.) placed between the fastener and the geotextile fabric.

C. Construction Entrance
1. The access road from the site shall be maintained in a condition that will prevent tracking or flowing of sediment outside the LHAAP-18/24 containment area. This may require stabilizing the construction entrance and periodic top dressing with additional stone as required in order to maintain previously established stabilized construction access conditions. All construction vehicles shall be decontaminated, and wheels washed out prior to leaving the containment area at the temporary decontamination facility. No soil or sediment shall be spilled, dropped, washed, or tracked outside the containment area.
2. The Contractor shall routinely, as required, sweep surrounding roads to control dust and runoff from the site.

D. Maintenance
1. The temporary erosion control features installed by the Contractor shall be acceptably maintained by the Contractor until no longer needed or until permanent erosion control methods are installed. The erosion and stormwater control features shall be inspected daily. Required repairs shall be performed in a timely manner. Any related materials removed shall become the property of the Contractor.

END OF SECTION

SECTION 31 38 50
SITE RESTORATION

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall furnish all labor, equipment, material, and incidentals necessary to restore the site as specified herein and/or as directed by the Contracting Officer's Representative.

1.2 REFERENCES

A. United States Army Corps of Engineers (USACE)
   1. Final Health and Safety Plan for Longhorn Army Ammunition Plant (LHAAP HASP), Karnack, Texas (2018).
   2. Final Installation Wide Work Plan for Longhorn Army Ammunition Plant (LHAAP IWWP), Karnack, Texas, revised by Bhate Environmental Associates, Inc. (May 2018; IWWP).

1.3 SUBMITTALS

A. Not used

1.4 ADMINISTRATIVE REQUIREMENTS

A. Not used.

PART 2 - PRODUCTS (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall remove all equipment and materials used during project operation including, but not limited to, trailers, silt fence, construction fence, stormwater diversion structures, electrical wiring, staging area, and decontamination pads, prior to demobilization from the site.

B. The restoration of the site is to be completed within one month of the completion of each of these remedial activities listed below in accordance with the Contractor's approved remedial action Schedule.
   1. Phase I Remedial Action
      a. Excavation of unsaturated soil
      b. Implementation of In-Situ Thermal Desorption (ISTD) treatment to remove DNAPL.
      c. Implementation of three enhanced in-situ bioremediation (EISB) pilot tests
   2. Phase II Remedial Action
      a. First EISB injection event in biobarriers and grids
      b. Second EISB injection event in biobarriers and grids

C. Prior to demobilization, all equipment shall be decontaminated in accordance with the Final Health and Safety Plan for Longhorn Army Ammunition Plant Karnack, Texas and IWWP Appendix A SOP A1 – Decontamination Procedures.

D. All materials removed during site restoration activities shall be disposed of at an approved off-site disposal facility by the Contractor.

E. The Contractor shall replace the existing gravel access roads in kind and in accordance with Design Drawings.

F. The Contractor shall restore any existing groundwater extraction system components impacted by the remedial construction to conditions equivalent to or better than their original condition. Any components that are rendered unusable by the remedial construction shall be replaced in kind.

G. The Contractor shall inspect the vegetated areas within the containment area and disturbed areas shall be replanted with local species to prevent soil erosion and serve as sediment control, as shown in the Design Drawings.

H. At the completion of the work, the Contractor shall restore all areas affected by the construction activities to conditions equivalent to or better than the original conditions and as indicated in the Design Drawings.

I. The site will be restored when all punch list items have been completed to the satisfaction of the Contracting Officer's Representative.

END OF SECTION

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
US ARMY ENVIRONMENTAL COMMAND
2455 REYNOLDS ROAD
JOINT BASE SAN ANTONIO FORT SAM HOUSTON, TX 78234-7588

March 5, 2024

SUBJECT: Draft Final Year 1 Annual Remedial Action Operation Report (August 2022 - July 2023), LHAAP-17 Burning Ground No.2/Flashing Area Group 2, Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas, March 2024

Mr. Brian Follin
U.S. Environmental Protection Agency
1201 Elm Street, Suite 500
Dallas, TX 75270-2002

Dear Mr. Follin,

An electronic copy of the above referenced document has been added to the project portal's "Documents" folder at the following address for your review: (https://docs.cbifederalservices.com/sites/501032/regulators/Shared%20Documents/Forms/AllItems.aspx). An electronic copy of this letter and download instructions for the electronic file have been sent via email. The document includes revisions based upon the Environmental Protection Agency's (EPA) comments on the draft version received on January 18, 2024, and the Texas Commission on Environmental Quality's (TCEQ) comments received on January 16, 2024. Tables of responses to the EPA and TCEQ comments on the draft version are included with this draft final document. In accordance with the Federal Facility Agreement, this draft final will be considered final after 30 days without further comment.

The document was prepared by the Military Munitions Group/TLI Solutions, Inc (MMG-TLI) Joint Venture on behalf of the Army as part of MMG-TLI's contract. We respectfully request Jonathan Tatman, MMG-TLI's Project Manager, be copied on any communications related to the project.

The point of contact for this action is the undersigned. I may be contacted at (726) 999-0505, or by email at lena.j.sierocinski.civ@army.mil.

Sincerely,

Lena Sierocinski

Lena Sierocinski
LHAAP Environmental Support Manager
U.S. Army Environmental Command

Electronic copies furnished:
A. Palmie, TCEQ, Austin, TX
E. Duerkop, USFWS, Caddo Lake NWR, TX (1 hard copy and 1 CD)
C. Montoya USACE, Tulsa District, OK
A. Williams, USACE, Tulsa District, OK
K. Russell, BRAC, Huntsville, AL
J. Tatman, MMG-TLI JV, Knoxville, TN
P. Srivastav, APTIM, Houston, TX

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
US ARMY ENVIRONMENTAL COMMAND
2455 REYNOLDS ROAD
JOINT BASE SAN ANTONIO FORT SAM HOUSTON, TX 78234-7588

March 5, 2024

SUBJECT: Draft Final Year 1 Annual Remedial Action Operation Report (August 2022 - July 2023), LHAAP-17 Burning Ground No.2/Flashing Area Group 2, Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas, March 2024

Ms. April Palmie
Texas Commission on Environmental Quality
Superfund Section, MC-136
12100 Park 35 Circle, Bldg D
Austin, TX 78753

Dear Ms. Palmie,

An electronic copy of the above referenced document has been added to the project portal's "Documents" folder at the following address for your review: (https://docs.cbifederalservices.com/sites/501032/regulators/Shared%20Documents/Forms/AllItems.aspx). An electronic copy of this letter and download instructions for the electronic file have been sent via email. The document includes revisions based upon the Environmental Protection Agency's (EPA) comments on the draft version received on January 18, 2024, and the Texas Commission on Environmental Quality's (TCEQ) comments received on January 16, 2024. Tables of responses to the EPA and TCEQ comments on the draft version are included with this draft final document. In accordance with the Federal Facility Agreement, this draft final will be considered final after 30 days without further comment.

The document was prepared by the Military Munitions Group/TLI Solutions, Inc (MMG-TLI) Joint Venture on behalf of the Army as part of MMG-TLI's contract. We respectfully request Jonathan Tatman, MMG-TLI's Project Manager, be copied on any communications related to the project.

The point of contact for this action is the undersigned. I may be contacted at (726) 999-0505, or by email at lena.j.sierocinski.civ@army.mil.

Sincerely,

Lena Sierocinski

Lena Sierocinski
LHAAP Environmental Support Manager
U.S. Army Environmental Command

Electronic copies furnished:
B. Follin, USEPA Region 6, Dallas, TX
E. Duerkop, USFWS, Caddo Lake NWR, TX (1 hard copy and 1 CD)
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A. Williams, USACE, Tulsa District, OK
K. Russell, BRAC, Huntsville, AL
J. Tatman, MMG-TLI JV, Knoxville, TN
P. Srivastav, APTIM, Houston, TX

Response to Comments on
Draft Technical Memorandum
Draft Year 1 Annual Remedial Action Operation Report (August 2022 - July 2023), LHAAP-17 Burning Ground No.2/Flashing Area Group 2, Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas, December 2023
Document Date: 20 December 2023
Comment Date: 18 January 2024

Reviewers: Brian Follin - USEPA
Respondent: Lena Sierocinski - Army

1. Respondent Concurs (C), Does Not Concur (D), Takes Exception (E), or Delete (X)
2. Commenter Agrees (A) with response, or Does Not Agree (D) with response

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
1	Acronyms and Abbreviations section	The abbreviation "DCA" (used in table 1) is missing from the "Abbreviations and Acronyms" section in front matter of report.	C	Concur. Dichloroethane (DCA) will be added to the Acronyms list.	
2	Section 1.1, p. 1-1, 1st paragraph, 1st and 2nd sentences	Sentences reference several cities/towns and roads that are not shown in the cited figure (fig. 1-1).	C	Concur. Figure 1-1 will be revised to label the roads and towns mentioned in the Section 1.1. For example, an inset road map with Shreveport, will be added to Figure 1-1.	
3	Section 1.1, p. 1-1, 3rd paragraph, 1st sentence	The word "a" before "NPL" should be "an", and the comma after "site" is extraneous (i.e., "LHAAP-17, an NPL site known as the Burning Ground No. 2/Flashing Area, is a…").	C	Concur. The text in Section 1.1 will be revised as requested.	
4	Section 1.2, p. 1-2, Indented paragraph under 2nd bullet	TCE abbreviation defined on previous page (p. 1-1), so abbreviation does not need reintroduced here (i.e., should be "…so the conditions become amenable for TCE to attenuate naturally.")..	E	Clarification. The first use of TCE is within Section 1.2 on page 1-2; not page 1-1. No text changed is recommended at this time.	

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
5	Section 1.2, p. 1-3, 1st black bullet on page, 2nd sentence	There appears to be a missing word or wording between "place" and "until the groundwater…").	E	The first bullet on Page 1-3 is written as presented in the Final ROD (Shaw, August 2016). No text change is recommended at this time.	
6	Section 1.4.2, p. 1-4, 1st paragraph	Need to introduce concept of 3 groundwater zones before providing depth intervals for each zone.	C	Concur. The following text will be added at the beginning of Section 1.4.2: "*There are three groundwater zones (shallow, intermediate, and deep) identified at LHAAP-17. The intermediate and deep zones comprise the Wilcox Formation, which is separated by a Wilcox clay layer. With the exception of two monitoring wells, 17WW05 and 17WW16, which were completed in the deep zone (lower Wilcox), the remainder of the monitoring wells at the site have been completed in the shallow zone and intermediate zone (upper Wilcox)*."	
7	Section 1.4.2, p. 1-4, 4th paragraph, 4th sentence	Harrison Bayou is not identified on any report figure. However, surface-water bodies are shown in fig. 1-1 without identification. The bayou could be identified/labeled on fig. 1-1, and then the figure could be cited at the end of this sentence.	C	Concur. Harrison Bayou will be labeled on Figure 1-1, and a Figure 1-1 reference will be added to Section 1.4.2.	
8	Section 1.4.3, p. 1-5, 1st paragraph, 3rd and 4th sentences	Recommend revising both sentences to identify all VOCs and cite table 1-1: "Shallow groundwater zone COCs include perchlorate and five VOCs (1,1-dichloroethane [DCE], 1,2-dichloroethane [DCA], cis-1,2-DCE, TCE, and vinyl chloride) (Table 1-1). Intermediate groundwater zone COCs include perchlorate and one	C	Concur. The text in Section 1.4.3 and Table 1-1 will be revised as suggested.	

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
		VOC (TCE) (Table 1-1)." Also note that the word "groundwater" should be located between "shallow" and "zone" and between "intermediate" and "zone" —this comment applies to this sentence and table 1-1.			
9	Section 2.1.1, p. 2-1, 1st paragraph, 1st sentence	Would be helpful to specify these 2 locations are extraction wells by adding "extraction wells" before "17WW02 and 1;617WW06."	C	Concur. The text in Section 2.1.1 will be revised as follows: "*Groundwater extraction began on August 5, 2022, at LHAAP-17 at two locations where the highest perchlorate concentrations were identified, extraction wells 17WW02 and 17WW06*."	
10	Section 2.3.1, p. 2-2, 2nd paragraph, 1st sentence	Suggest revising sentence to improve clarity/readability, especially the part of the sentence consisting of the phrase "to establish initial analytical results." Perhaps revise sentence to something such as the following: "The baseline monitoring conducted on April 8, 2022, consisted of groundwater sampling at 5 wells to determine perchlorate concentrations prior to groundwater extraction (Figure 2-2)."). Alternatively, this and the next sentence could be combined: "The baseline monitoring conducted on April 8, 2022, consisted of groundwater sampling at 5 locations (extraction wells 17WW02 and 17WW06, and monitoring wells 17WW01, 17WW03, and 130) to determine perchlorate concentrations prior to groundwater extraction (Figure 2-2).")	C	Concur. The text is Section 2.3.1 will be revised as follows: "*The baseline monitoring conducted on April 8, 2022, involved sampling groundwater at five locations at LHAAP-17 to verify perchlorate concentrations prior to groundwater extraction (**Figure 2-2**)*."	

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
11	Section 2.3.1, p. 2-2, 2nd paragraph, 3rd sentence	1) Sentence is somewhat unclear as currently constructed—recommend revising sentence to more clearly indicate these values are the depths to the bottom of the well screen intervals. 2) Should cite source of well screen interval information.	C	Concur. The text will be revised as follows and will include a reference to Appendix B (Sample Collection Logs): "*The sampling depths were recorded on the sample collection logs presented in **Appendix B**.*"	
12	Section 2.3.2, p. 2- 2, 1st paragraph, 2nd sentence	The word "and" should be inserted before "selected events." However, believe it would be preferable to revise sentence to identify the "select events" associated with these 2 figures. For example, "The analytical results for all 7 sampling events are listed in Table 2-3, and analytical results for 4 sampling events are shown on maps in Figures 2-2 (April and November 2022) and 2-3 (March and June 2023)."	C	Concur. The text is Section 2.3.2 will be revised as follows: "*The analytical results for all seven events are presented in **Table 2-3** and analytical results for four sampling events are presented on **Figure 2-2** (April and November 2022) and **Figure 2-3** (March and June 2023)*."	
13	Table 2-2	1) Would be helpful to revise table 2-2 name to indicate it consists of pre-design monitoring analytical results (e.g., "Pre-design groundwater monitoring analytical results" or "Analytical results for pre-design groundwater monitoring (June 2021)"). Note: could remove "groundwater" from table title to reflect section 2.3.1 heading ("Pre-design and Baseline Monitoring (June 2021)", or alternatively, add "Groundwater" between "Baseline" and "Monitoring" to section heading to reflect table title. 2) Would be helpful to add a footnote for well 17WW10 indicating the well is a deep zone well and is not part of the performance monitoring	C	Concur. It is recommended to revise the title of Table 2-2 to "*Pre-Design Groundwater Monitoring Analytical Results (June 2021)*". The following footnote will be added to Table 2-2, noting that 17WW10 is a deep groundwater zone well not part of performance monitoring.	

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
14	Table 2-3	Would be helpful to revise table 2-3 name to indicate it consists of baseline monitoring analytical results (e.g., "Baseline groundwater monitoring analytical results (April 2022–June 2023)" or "Analytical results for baseline groundwater monitoring (April 2022–June 2023)"). Note: could remove "groundwater" from table title to reflect section 2.3.2 heading (Performance Monitoring (June 2021)"), or alternatively, add "Groundwater" between "Performance" and "Monitoring" to section heading to reflect table.	C	Concur. It is recommended to revise the title of Table 2-3 to: "*Baseline and Performance Groundwater Monitoring Analytical Results (April 2022 – June 2023)*".	
15	Section 2.3.4	1) Excluding the 2 potentiometric-surface maps, the report does not include any discussion/analysis of groundwater-level data collected during the year 1 RAO monitoring period. Groundwater-level fluctuations observed at specific locations (individual wells) and spatially across the site (multiple wells) provide insight into how the shallow zone (or parts of the shallow zone) is responding to the early stage of groundwater extraction. 2) As part of groundwater-level discussion, would be helpful to note that groundwater levels in all 11 shallow zone wells measured during the 2nd synoptic measurement event (February 10, 2003) were higher than groundwater levels measured during the 1st event (November 10, 2022). Specifically, groundwater-level elevation increases for the 3-month period	C	1. Concur. Groundwater level fluctuations during the reporting period will be discussed further in Section 2.3.4. Please refer to the specific text below under item number 2. 2. Concur. The following text will be added to Section 2.3.4: "*The groundwater level increased at each of the nine shallow zone monitoring wells between November 2022 and February 2023. Specifically, groundwater-level elevation increases for the 3-month period between November 2022 and February 2023, ranged from 0.21 (17WW10) to 2.17 feet (17WW20) (**Table 2-4**). In addition, hydrographs from monitoring wells 17WW01, 17WW03, and 130 are plotted on **Figure 2-1**. Groundwater level elevation increases were observed in the shallow zone at each of the three*	

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
		ranged from 0.21 to 2.17 feet (wells 17WW10 and17WW20, respectively). 3) Would be helpful to create hydrographs for the 5 performance monitoring wells by combining the water levels measured during the 1st and 2nd synoptic events (tables 2-4 and 2-5) and during the 7 performance monitoring water-quality sampling events. Could then use hydrographs to evaluate groundwater-level fluctuations at site (see #1-2 immediately above), including in relation to groundwater extraction volumes (by examining hydrographs in relation to extraction volumes with time shown in fig. 2-1).		*monitoring wells during the reporting period*." 3. Concur. Hydrographs will be created for monitoring wells 17WW01, 17WW03, and 130 and plotted on Figure 2-1 with the extraction volumes. Please note that depth to water level measurements cannot be collected on extraction wells 17WW02 and 17WW06.	
16	Section 2.3.4, p. 2-3, 1st paragraph, 3rd sentence	Description of groundwater-flow direction is not entirely accurate. Both potentiometric-surface maps clearly indicate that groundwater flow in much of the northwestern portion of the site was to the southwest.	C	Concur. The following sentence will be added to Section 2.3.4: "*Northwest of the site near monitoring well 17WW12, groundwater flows to the southwest*."	
17	Section 2.3.4, p. 2-3, 1st paragraph, 3rd sentence	The November 2022 groundwater elevations for well 17WW19 differ substantially between table 2-4 and fig. 2-4. Fig. 2-4 and this sentence indicate the measured elevation was 164.18 ft amsl, whereas table 2-4 indicates the elevation was 167.63 amsl. Need to determine which elevation measurement is correct, and revise report sections accordingly. If the elevation reported in table 2-4 is correct, the potentiometric-surface map will look	C	Concur. Figure 2-4 will be revised to match the correct groundwater elevation presented in Table 2-4.	

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
		considerably different than the current version.			
18	Section 2.3.4, 2nd paragraph, 3rd sentence	1) The February 2023 groundwater elevation for well 17WW01 used in this sentence (173.80 ft amsl) does not match the elevation listed in table 2-5 and shown in fig. 2-5 (both 169.72 ft amsl). 2) The February 2023 groundwater elevation for well 17WW19 differs substantially between table 2-5 and fig. 2-5. Fig. 2-5 and this sentence indicate the elevation measured in February 2023 was 164.18 ft amsl, whereas table 2-4 indicates the elevation was 167.63 amsl. Need to determine which elevation is correct, and revise report sections accordingly. If the elevation reported in table 2-5 is correct, the potentiometric-surface map will look considerably different than the current version.	C	1. Concur. The text in Section 2.3.4 will be revised to align with Table 2-5 and Figure 2-5. 2. Concur. Figure 2-5 will be revised to match the correct groundwater elevation presented in Table 2-5.	
19	Section 2.4.3, 1st paragraph, 1st sentence	Per table 2-3, the 24.5 µg/L value for 17WW01 is a duplicate sample, so a "(duplicate result)" parenthetical should be added after the concentration value.	C	Concur. The text in Section 2.4.3 will be revised as requested.	
20	Section 2.4.4, 1st paragraph, 2nd sentence	Per table 2-3, the 0.0271J µg/L value for 17WW03 is a duplicate sample, so a "(duplicate result)" parenthetical should be added after the concentration value.	C	Concur. The text in Section 2.4.4 will be revised as requested.	
21	Section 2.4.7, 1st paragraph, 2nd sentence	A less than symbol (<) is missing before the 0.0500 U µg/L value for 17WW03.	C	Concur. The text in Section 2.4.7 will be revised as requested.	

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
22	Tables 2-4 and 2-5, TOC column heading	The "(ft btoc)" parenthetical under "TOC Height" is incorrect is. Should be "(ft amsl)".	C	Concur. The TOC height is the measured stickup in feet above ground surface. It is recommended to revise the heading column to "*TOC Height (feet above ground surface)*". Table 2-4. In addition, please note that Table 2-4 and Table 2-5 will be combined into one table (Table 2-4 [Groundwater Elevations]), per TCEQ comment number 6.	
23	Figs. 2-3 and 2-4	Would be helpful to add additional groundwater-flow direction arrows.	C	Concur. Groundwater flow direction arrows will be added to Figures 2-3 and 2-4.	
24	Figs. 2-4 and 2-5	Color of blue potentiometric-surface contour lines and blue system piping line are indistinguishable on hardcopies.	C	Concur. The color of the extraction system piping lines will be adjusted, such that there is a clear distinction between the potentio-metric surface contour lines.	
25	Section 3, p. 3-1, 1st paragraph, 1st sentence	1) Should cite table 2-3 in addition to fig. 3-1 because the figure includes results for only 2 of the 5 performance wells (both extraction wells [17WW02 and 17WW06]). 2) Could revise sentence to indicate decreasing trends were observed in 4 of 5 performance wells (all but well 130, which had a slight increase with time).	C	1. Concur. A reference to Table 2-3 will be added as suggested to Section 3. 2. Concur. The text in Section 3 will be revised as follow: "*Results of the performance monitoring showed an overall decreasing trend in the perchlorate concentrations at four of the five performance monitoring locations over time, suggesting that the system is effective in reducing the contaminant levels (**Table 2-3** and **Figure 3-1**). Perchlorate slightly increased during the reporting period at monitoring well 130.*"	
26	Fig. 3-1	Would be helpful to indicate beginning of groundwater extraction and periods of treatment pauses.	C	Concur. Figure 3-1 will be revised to indicate when the extraction system initiated, when the extraction system was paused, and when the extraction system was restarted.	

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
27	Section 4.1, p. 4-1, 1st paragraph, 1st sentence	Could revise sentence to be more specific and indicate perchlorate was reduced to concentrations less than the PCL in 3 of 5 performance wells.	C	Concur. The text in Section 4.1 will be revised as suggested.	
28	Section 4.1, p. 4-1, 1st paragraph, 2nd sentence at	1) The words "significant" or "significantly" typically should be used only for discussions of statistical tests/results. The words "substantial" or "substantially" would be acceptable replacements. 2) Also recommend some additional sentence modifications: "However, perchlorate concentrations at both groundwater extraction wells (17WW02 and 17WW06) continued to remain substantially above the PCL."	C	1. Concur. It is recommended to remove the word significant from the text in Section 4.1. 2. Concur. The text in Section 4.1 will be revised.	
29	Section 4.1, p. 4-1, 1st paragraph, 3rd sentence	1) As currently constructed, the sentence indicates the "concentration trend" remains above the PCL instead of stating the perchlorate concentrations remained above the PCL. 2) See statistical comment in previous comment (#28).	C	1. Concur. The text in Section 4.1 will be revised as follows: "*The perchlorate concentration at extraction location 17WW06, while overall decreasing, remains above the trigger level of 20,000 µg/L*." 2. Concur. It is recommended to remove the word significant from the text in Section 4.1.	
30	Section 4.2, p. 4-1, Third Bullet	We agree that the extraction system operational period should be extended, but the rationale should be based on the work stoppage and the TCRA. It might be advised to continue extraction until the RA is completed. This will require a memo to file, since we are counter to the ROD but it is not a significant change.	C	Concur. The third bullet of Section 4.2 will be revised as follows: "*Due to the ongoing Time Critical Removal Action (TCRA), the 18-month operational period of the extraction system should be extended until the TCRA is completed. A memorandum to file will be required for this extension*."	

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
31	Section 4.2, p. 4-1, Last bullet	Suggest revising sentence to specify which wells are extraction wells and which are monitoring wells: “Paint and re-label extraction wells 17WW02 and 17WW06, and monitoring wells 17WW01, 17WW03, and 130.”	C	Concur. The fourth bullet of Section 4.2 will be revised as suggested.	

Response to Comments on
Draft Year 1 Annual Remedial Action Operation Report (August 2022 - July 2023), LHAAP-17 Burning Ground No.2/Flashing Area Group 2, Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas, December 2023
Document Date: 20 December 2023
Comment Date: 16 January 2024

Reviewers: April Palmie - TCEQ
Respondent: Lena Sierocinski - Army

1. Respondent Concurs (C), Does Not Concur (D), Takes Exception (E), or Delete (X)
2. Commenter Agrees (A) with response, or Does Not Agree (D) with response

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
1	2.4.1	Add to this section why 17WW01 was resampled.	C	Concur. The follow text will be added to Section 2.4.1: "*Monitoring well 17WW01 was resampled on April 21, 2022, due to improper pump placement on April 8, 2022. On April 8, 2022, the pump inlet was placed mid screen at 20.80 feet below top of casing. However, based on historical perchlorate data the sample should have been collected from a depth of 28 feet below top of casing to correspond with historical high detections. Therefore, the pump inlet depth was lowered during the resample event as displayed on the sample collection logs (**Appendix B**). Perchlorate was detected at 17WW01 on April 21, 2022, at 46.8 µg/L.*"	
2	2.4.4	Add "(duplicate result)" after 0.0271 J µg/L	C	Concur. The text in Section 2.4.4 will be revised as requested.	
3	4.2	Here or elsewhere, please note that additional wells and VOC sampling will be included in the sampling network when the site transitions to MNA.	C	Concur. It is recommended to add the following text to Section 2.1.1: "*Following completion of the groundwater extraction period, MNA sample collection will be conducted to evaluate change in geochemical*	

Comment #	Section/ Page/ Paragraph	Comment	C, D, E, or X[1]	Response	A or D[2]
				conditions and COC concentrations and to verify that the plume extent is stable or shrinking. For the first two years post-extraction, the wells will be sampled quarterly for perchlorate, VOCs, and MNA parameters."	
4	Figures 2-2 and 2-3	Baseline sampling is the only data set with downgradient and cross gradient results. The other figures should have dashed lines for most of the isoconcentration contours. Only the area between 130 and 17WW01 has sample results to support solid lines.	C	Concur. The isoconcentration contours on Figure 2-2 and Figure 2-3 will be revised as suggested using dashed lines where inferred.	
5	Table 2-1	This table needs a different display of the data, so it is legible at reasonable zoom or paper size. Suggest displaying this data with date and volume extracted fields as column headings with each date a row in the table.	C	Concur. Table 2-1 will be reformatted as suggested.	
6	Tables 2-4 and 2-5	Please combine results into one table. The format in LHAAP-58 RAO reports Table 1 is useful for seeing trends in each well (see Year 8 report, extracted table attached to email).	C	Concur. Table 2-4 and Table 2-5 will be combined into one table (Table 2-4).	

DRAFT FINAL
YEAR 1 ANNUAL REMEDIAL ACTION OPERATION REPORT (AUGUST 2022 – JULY 2023)
LHAAP-17 BURNING GROUND NO.2/FLASHING AREA GROUP 2
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

March 2024

Prepared For:





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TABLE OF CONTENTS

Acronyms and Abbreviations iii

1 Introduction 1-1

1.1 Site Description 1-1
1.2 Selected Remedy 1-2
1.3 Remedial Action Objectives 1-3
1.4 Conceptual Site Model 1-4
1.4.1 Site Geology 1-4
1.4.2 Hydrogeology and Surface Water Hydrology 1-4
1.4.3 Nature and Distribution of Contamination 1-5
1.4.4 Pathways 1-5
1.4.5 Receptors 1-5

2 Site Activities 2-1

2.1 Groundwater Extraction 2-1
2.1.1 System Startup 2-1
2.1.2 Extraction Volumes 2-1
2.2 Well Inspections, Maintenance, and Repairs 2-1
2.3 Groundwater Monitoring for RA(O) 2-2
2.3.1 Pre-Design and Baseline Monitoring (June 2021 and April 2022) 2-2
2.3.2 Performance Monitoring (August 2022 to June 2023) 2-2
2.3.3 Sampling Procedures and Analysis 2-3
2.3.4 Groundwater Elevation and Flow Direction 2-3
2.4 Groundwater Analytical Results 2-3
2.4.1 April 2022 Baseline Monitoring 2-3
2.4.2 August 2022 Monthly Performance Monitoring 2-4
2.4.3 October 2022 Monthly Performance Monitoring 2-4
2.4.4 November 2022 Monthly Performance Monitoring 2-4
2.4.5 January 2023 Monthly Performance Monitoring 2-4
2.4.6 February 2023 Monthly Performance Monitoring 2-4
2.4.7 March 2023 Monthly Performance Monitoring 2-4
2.4.8 June 2023 Quarterly Performance Monitoring 2-5

3 Evaluation of Extraction Effectiveness 3-1

4 Conclusions and Recommendations 4-1

4.1 Conclusions 4-1
4.2 Recommendations 4-1

5 References 5-1

Figures

Figure 1-1 Site Location Map
Figure 1-2 LHAAP-17 Site Map
Figure 2-1 Groundwater Extraction Volumes (August 2022 – July 2023)
Figure 2-2 April 2022 & November 2022 Groundwater Results
Figure 2-3 March 2023 & June 2023 Groundwater Results
Figure 2-4 Potentiometric Surface Map (November 2022)
Figure 2-5 Potentiometric Surface Map (February 2023)
Figure 3-1 LHAAP-17 Perchlorate Trend Chart

Tables

Table 1-1 Groundwater COCs for LHAAP-17
Table 2-1 Groundwater Extraction Volumes (August 2022 – July 2023)
Table 2-2 Pre-Design Groundwater Monitoring Analytical Results (June 2021)
Table 2-3 Baseline and Performance Groundwater Monitoring Analytical Results (April 2022 – June 2023)
Table 2-4 Groundwater Elevations

Appendices

Appendix A Well Inspection Forms
Appendix B Groundwater Sample Collection Forms
Appendix C Quality Control Summary Reports
Appendix D Laboratory Data Packages

ACRONYMS AND ABBREVIATIONS

<	less than
amsl	Above mean sea level
APTIM	APTIM Federal Services, LLC
bgs	Below ground surface
Bhate	Bhate Environmental Associates, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC(s)	Chemical(s) of concern
CSM	Conceptual site model
DCA	Dichloroethane
DCE	Dichloroethene
FFA	Federal Facilities Agreement
ft	Feet (or foot)
GWTP	Groundwater Treatment Plant
J	Data qualifier denoting an estimated concentration
Jacobs	Jacobs Engineering Group, Inc.
LHAAP	Longhorn Army Ammunition Plant
LTM	Long-term monitoring
LUC(s)	Land Use Control(s)
µg/L	Micrograms per liter
MEC	Munitions and Explosives of Concern
MMG-TLI JV	Munitions Management Group -TLI Solutions Joint Venture
MNA	Monitored Natural Attenuation
NCP	National Contingency Plan
No.	Number
NPL	National Priorities List
PCL	Protective cleanup level
Plexus	Plexus Scientific Corporation
QA/QC	Quality Assurance / Quality Control

RA	Remedial Action
RA(O)(s)	Remedial Action Operation(s)
RAO(s)	Remedial Action Objective(s)
RAWP	Remedial Action Work Plan
ROD	Record of Decision
Shaw	Shaw Environmental, Inc.
TCEQ	Texas Commission on Environmental Quality
TCE	Trichloroethene
TCRA	Time Critical Removal Action
TNT	Trinitrotoluene
U	Data qualifier denoting an undetected result
UFP-QAPP	Uniform Federal Policy – Quality Assurance Project Plan
U.S.	United States
U.S. Army	U.S. Department of the Army
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VC	Vinyl chloride
VOC(s)	Volatile Organic Compound(s)

1 INTRODUCTION

The United States (U.S.) Army Corps of Engineers (USACE), Tulsa District, contracted Munitions Management Group-TLI Solutions Joint Venture (MMG-TLI JV), to perform the remedial action (RA) at the former Longhorn Army Ammunition Plant (LHAAP) Burning Ground Number (No. 2)/Flashing Area Group 2, Comprehensive Environmental Response, Compensation, and Liability Information System, U.S. Environmental Protection Agency (USEPA) Identification Number TX6213820529 (hereinafter LHAAP-17), Karnack, Texas (**Figure 1-1**). This Remedial Action Operation (RA[O]) report was prepared by Bhate Environmental Associates (Bhate) as a subcontractor to MMG-TLI JV. Remedial activities are required under the Record of Decision (ROD) issued for LHAAP-17 in 2016 (Shaw Environmental, Inc. [Shaw], August 2016). The Remedial Action Work Plan (RAWP) for LHAAP-17 was prepared in March 2019 in accordance with the ROD (Bhate/APTIM Federal Services LLC [APTIM], March 2019).

1.1 Site Description

LHAAP is approximately 14 miles northeast of Marshall, Texas and approximately 40 miles west of Shreveport, Louisiana (**Figure 1-1**). The installation occupies approximately 1,300 of its former 8,416 acres between State Highway 43 at Karnack, Texas, and the western shore of Caddo Lake. The facility can be accessed via State Highways 43 and 134.

LHAAP was placed on the Superfund National Priorities List (NPL) on August 9, 1990. Activities to remediate contamination began in 1990. After its listing on the NPL, the U.S. Department of the Army (U.S. Army), the USEPA, and the Texas Water Commission (now the Texas Commission on Environmental Quality [TCEQ]) entered a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §120 Federal Facility Agreement (FFA) for remedial activities at LHAAP. The FFA became effective December 30, 1991. LHAAP operated until 1997 when it was placed on inactive status and classified by the U.S. Army Armament, Munitions, and Chemical Command as excess property. LHAAP has been under the administrative control of the Base Realignment and Closure Division of the Army since 2003 and is Defense Environmental Restoration Account funded. The majority of LHAAP has been transferred by the U.S. Army to the U.S. Fish and Wildlife Service (USFWS) for management as the Caddo Lake National Wildlife Refuge (Shaw, August 2016). Administrative control of LHAAP is under the United States Army Environmental Command.

LHAAP-17, an NPL site known as the Burning Ground No. 2/Flashing Area, is a 3.9-acre site located within a heavily wooded section in the southeastern portion of LHAAP (**Figure 1-2**). The site has two 185 feet by 305 feet cleared areas, separated by a gravel access road. The site is covered with grass and scattered brush, has been graded above the surrounding terrain, and is relatively flat. LHAAP-17 was used as a burning ground from 1959 through 1980 (Plexus Scientific Corporation [Plexus], February 2005). Bulk trinitrotoluene (TNT), photo flash powder, and reject material from Universal Match Corporation operations were burned at LHAAP-17. In 1959, the materials removed from the former TNT Production Area (LHAAP-29) and the former TNT Waste Disposal Plant (LHAAP-32) during demolition were burned and/or flashed at LHAAP-17. The site

was used as a flashing area to decontaminate recoverable metal byproducts until 1980, when it became inactive. Burning trenches were located around the inside perimeter of the previously fenced area and within the open area on the western boundary of the site. As each trench was filled with ash, it was covered, and a new trench was dug. The waste residues were reportedly removed from the trenches in 1984, and the site was allowed to revegetate (Jacobs Engineering Group, Inc. [Jacobs], April 2001).

The ROD identified groundwater chemicals of concern (COCs) for human health, as shown in **Table 1-1**. The remedy selected in the ROD included excavation and off-site disposal of soil, groundwater extraction, monitored natural attenuation (MNA), and land use controls (LUCs) to maintain the remedy and prohibit groundwater use until COC concentrations are reduced to levels supportive of unlimited use and unrestricted exposure. The soil excavation portion of the remedy is covered under a time critical removal action and is not within the scope of this document.

The principal contaminant at LHAAP-17 is perchlorate which is found at the site at concentrations several orders of magnitude greater than the other COCs, which are various volatile organic compounds (VOCs). Therefore, the perchlorate concentrations are the main factor driving the current RA(s) at the site. The protective cleanup level (PCL) for perchlorate is 17 micrograms per liter (µg/L).

1.2 Selected Remedy

Section 1.4 of the Final ROD (Shaw, August 2016) summarized the selected remedy as follows:

- Contaminated soil removal with off-site disposal to protect the hypothetical future maintenance worker and ecological receptors and to eliminate the soil-to-groundwater pathway.
- Extraction and treatment of groundwater until the trigger level of 20,000 µg/L of perchlorate is reached. The trigger level in this ROD is an interim cleanup level. Upon reaching the trigger level, the RA will transition from the initial measure of groundwater extraction to the primary remedy of MNA. Reduction of the perchlorate concentration to the trigger level is anticipated to expedite MNA.
    - If the 20,000 µg/L of perchlorate level is not reached after approximately 1.5 years, a contingency remedy of in situ bioremediation will be implemented to reduce the perchlorate levels more quickly so the conditions become amenable for trichloroethene (TCE) to attenuate naturally.
- MNA to confirm protection of human health and the environment by documenting that the contaminated groundwater remains localized with minimal migration and that contaminant concentrations are being reduced to cleanup levels.
    - Performance objectives will be evaluated after two years of MNA. During those two years, monitoring will be quarterly. If MNA is found to be ineffective, a contingency remedy to enhance MNA will be implemented. If MNA is found to be effective, it will be continued, and long-term monitoring (LTM) will be semiannual for three years. In

subsequent years, LTM will be annual until the next Five-Year Review, and annually thereafter until recommended otherwise by the Five-Year Review. The monitoring and reporting associated with this remedy will be used to track the effectiveness of MNA and will continue until recommended otherwise at the Five-Year Review.

- The LUC objectives include maintaining the integrity of any current or future remedial or monitoring systems and preventing the use of groundwater contaminated above cleanup levels as a potable water source. The groundwater treatment and MNA remedial components include a groundwater monitoring system that will be used to characterize the condition of the groundwater during the period the groundwater remedy is in place until the groundwater remediation goals are achieved, and to demonstrate achievement of the groundwater remediation goals when the groundwater remedy is complete. As a part of this groundwater remedy, the Army will maintain the remedial and monitoring systems associated with the groundwater remedies until these components of the remedy are no longer needed to achieve cleanup levels, and cleanup levels have been achieved. During the period of operation of the groundwater remedy, if any of the elements of the remedial and groundwater monitoring systems are damaged, destroyed, or become ineffective, they will be repaired or replaced with suitable components to assure that the remedial and groundwater monitoring systems are able to provide data of the quality necessary to determine the progress of and eventual completion of this component of the remedy. The actions to be taken to implement these LUC objectives and requirements will be provided through modifying the "Comprehensive Land Use Control (LUC) Management Plan, Former Longhorn Army Ammunition Plant, Karnack, Texas" and detailed in the LUC Remedial Design.
- The LUC for prohibition of groundwater use (except for monitoring and testing) shall be implemented and shall remain in place at the site until the COCs in soil and groundwater remaining at the site are reduced below levels that would support unlimited use and unrestricted exposure. The recordation notification for the site, to be filed with Harrison County, will include a description of the LUCs.
- The LUC restricting land use to nonresidential shall be implemented until it is demonstrated that surface and subsurface soil and groundwater COCs are at levels that allow for unlimited use and unrestricted exposure.
  - The LUC to maintain the integrity of any current or future remedial or monitoring systems will remain in place until the levels of COCs in groundwater are met.
- CERCLA Five Year Reviews until the levels of COCs in soil and groundwater allow for unlimited use and unrestricted exposure.

1.3 Remedial Action Objectives

The remedial action objectives (RAOs) developed for LHAAP-17 and outlined in the Final ROD (Shaw, August 2016) are:

- Protection of human health by preventing human exposure to the contaminated groundwater and contaminated soil;
- Protection of human health by preventing further potential degradation of groundwater from contaminated soil;
- Protection of ecological receptors by preventing exposure to the contaminated soil;
- Protection of human health and the environment by preventing contaminated groundwater from migrating into nearby surface water; and
- Return of groundwater to its potential beneficial uses as drinking water, wherever practicable.

The above RAOs recognize USEPA's policy to return all groundwater to beneficial uses, based on the non-binding programmatic expectation in the National Contingency Plan (NCP), and is consistent with the NCP regulations requiring the lead agency, the U.S. Army in this case, to establish RAOs specifying contaminants and media of concern, potential exposure pathways, and remediation goals.

1.4 Conceptual Site Model

The current full conceptual site model (CSM) for LHAAP-17 can be found in the Uniform Federal Policy – Quality Assurance Project Plan (UFP-QAPP) (Bhate/APTIM, August 2021). Key points from the CSM are briefly described below.

1.4.1 Site Geology

The local geology consists of silty, clayey, and sandy units of the Wilcox Group. The uppermost unit consists predominantly of silty clay to clay extending to depths ranging from 5 to 30 feet (ft) below ground surface (bgs). Underlying this layer is a gray to light brown, fine grained silty sandy unit interbedded with silty clay to clay lenses. The clay layers act as an aquitard separating the shallow zone from the intermediate zone. A fine to medium grained sand layer uninterrupted by silty clay lenses has been described from 50 to 150 ft bgs, and it is underlain by a dense, dark gray clayey shale.

1.4.2 Hydrogeology and Surface Water Hydrology

There are three groundwater zones (shallow, intermediate, and deep) identified at LHAAP-17. The intermediate and deep zones comprise the Wilcox Formation, which is separated from the shallow zone by a Wilcox clay layer. With the exception of two monitoring wells, 17WW05 and 17WW16, which were completed in the deep zone (lower Wilcox), the remainder of the monitoring wells at the site have been completed in the shallow zone and intermediate zone (upper Wilcox).

The depth of the shallow groundwater zone generally ranges from approximately 6 to 35 ft bgs. The intermediate zone is less defined, but its depth has been measured to approximately 55 ft

bgs. The deep groundwater zone extends to a depth of approximately 150 ft bgs. The predominant groundwater flow in the shallow and intermediate zones is generally to the northwest towards Harrison Bayou. Based on historical groundwater flows, the direction can vary more to the west or more to the north. Drainage ditches run along the eastern, western, and northern boundaries of the site that discharge to Harrison Bayou located approximately 1,500 ft to the northwest. Harrison Bayou discharges to Caddo Lake (**Figure 1-1**).

1.4.3 Nature and Distribution of Contamination

The primary source of contamination at LHAAP-17 is the release of perchlorate from historical activities. Groundwater contamination is found in both the shallow and intermediate groundwater zones. Shallow groundwater zone COCs include perchlorate and five VOCs (1,2-dichloroethane [DCA], 1,2-dichloroethene [DCE], cis-1,2-DCE, TCE, and vinyl chloride [VC]) (**Table 1-1**). Intermediate groundwater zone COCs are TCE and its daughter products (cis-1,2-DCE and VC) (**Table 1-1**).

1.4.4 Pathways

The primary pathway for contamination migration is through groundwater exiting the site and entering Harrison Bayou and Caddo Lake. This could lead to COC exposure by humans or ecological receptors via contact with contaminated groundwater or surface water, or through food chain pathways.

1.4.5 Receptors

Current security measures preclude unlimited public access to the site. Future land use for the site involves being added to the Caddo Lake National Wildlife Refuge. Potential human receptors include off-path Caddo Lake National Wildlife Refuge visitors and trespassers and environmental construction workers. Ecological receptors considered included: Deer Mouse, Short-Tailed Shrew, Red Fox, Townsend's Big-Eared Bat, Bank Swallow, Belted Kingfisher, American Woodcock, Red-Tailed Hawk, and Aquatic Life (benthic invertebrates). Both direct and indirect (food chain pathways) were considered for the ecological receptors.

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2 SITE ACTIVITIES

2.1 Groundwater Extraction

2.1.1 System Startup

Groundwater extraction began on August 5, 2022, at LHAAP-17 at two locations where the highest perchlorate concentrations were identified, extraction wells 17WW02 and 17WW06. The extraction system operates continuously and removes groundwater from the shallow alluvial aquifer, which is then treated to remove the perchlorate before being discharged to the bayou. The details on the startup and operation of the system can be found in the Interim Remedial Action Completion Report (MMG-TLI JV, October 2023). The RAWP for LHAAP-17 calls for the continuous operation of the extraction system for 18 months to achieve the performance objective of reducing the groundwater perchlorate concentrations to below 20,000 µg/L (Bhate/APTIM, March 2019).

Following completion of the groundwater extraction period, MNA sample collection will be conducted to evaluate change in geochemical conditions and COC concentrations and to verify that the plume extent is stable or shrinking. For the first two years post-extraction, the wells will be sampled quarterly for perchlorate, VOCs, and MNA parameters.

2.1.2 Extraction Volumes

Following system start up, groundwater extraction volumes were recorded during regular maintenance and monitoring events. Extraction volumes are measured via a totalizer located on the extraction system shed effluent pipeline. Between August 5, 2022, and July 31, 2023, a total of 626,848 gallons of contaminated groundwater was extracted from 17WW02 and 17WW06 and conveyed to the groundwater treatment plant (GWTP). The extraction volumes are presented in **Table 2-1** and **Figure 2-1**.

In late December 2022 the GWTP sustained damages due to unusual freezing weather conditions. The repairs began in late December 2022 and continued through January 2023 and February 2023, and the GWTP did not return to full capacity until late February 2023.

The GWTP was shut down on March 31, 2023, during contract transition and remained off until May 2, 2023, when the new contract was awarded. During the contract transition, no groundwater was extracted from LHAAP-17.

2.2 Well Inspections, Maintenance, and Repairs

During each sampling event, well inspections were conducted to assess the physical condition of the well screens, casings, and surface seals. Well inspection forms were completed for each well and a photographic log is included as **Appendix A**. During the Year 1 RA(O) inspections, there were no significant maintenance items observed impacting the integrity of the wells. However,

each LHAAP-17 well has been identified as needing fresh paint and labels. The necessary maintenance items will be addressed during the Year 2 RA(O) activities.

2.3 Groundwater Monitoring for RA(O)

Groundwater Monitoring for RA(O) at LHAAP-17 was conducted to establish the initial perchlorate concentration and areal distribution, assess the effectiveness of the selected remedy, and determine the groundwater elevation and flow direction. This involved pre-design sampling in June 2021, baseline monitoring in April 2022, and performance monitoring in August 2022, October 2022, November 2022, January 2023, February 2023, March 2023, and June 2023. Sitewide groundwater level measurement was conducted in November 2022 and February 2023 in conjunction with monthly groundwater monitoring events. The groundwater sample collection forms for each event are provided in **Appendix B**. The analytical results also included quality assurance/quality control (QA/QC) samples. The results of the QA/QC samples indicated that the analytical data were of acceptable quality and that the laboratory performed within the required QC limits. The full QC Summary Report is provided in **Appendix C**. The laboratory analytical data packages are presented in **Appendix D**.

2.3.1 Pre-Design and Baseline Monitoring (June 2021 and April 2022)

To inform the design of the groundwater extraction system, a pre-design sampling event was conducted on June 30, 2021, involving six monitoring locations: 17WW06, 17WW10, 17WW11, 17WW12, 17WW19, and 17WW20. The results are presented in **Table 2-2**.

The baseline monitoring conducted on April 8, 2022, involved sampling groundwater at five locations at LHAAP-17 to verify perchlorate concentrations prior to groundwater extraction (**Figure 2-2**). The monitoring network included well locations: 17WW01, 17WW02, 17WW03, 17WW06, and 130. The sampling depths were recorded on the sample collection logs presented in **Appendix B**.

2.3.2 Performance Monitoring (August 2022 to June 2023)

The performance monitoring conducted in August 2022, October 2022, November 2022, January 2023, February 2023, March 2023, and June 2023 involved sampling groundwater at 17WW01, 17WW02, 17WW03, 17WW06, and 130 to assess the effectiveness of the groundwater extraction for reducing perchlorate concentrations. The analytical results for all seven sampling events are presented in **Table 2-3**, and analytical results for four sampling events are presented on **Figure 2-2** (April and November 2022) and **Figure 2-3** (March and June 2023).

Performance monitoring was not conducted during September 2022. The sampling event that occurred on August 31, 2022, serves as the first monthly performance monitoring event, while the October 7, 2022, event serves as the second performance monitoring event. The December 2022 monthly performance monitoring was delayed until January 2023 due to the groundwater treatment plant requiring significant down time for repairs and severe weather encountered in late December 2022. The transition to quarterly sampling was made following the March 2023 sampling event. June 2023 was the first quarterly performance monitoring event.

2.3.3 Sampling Procedures and Analysis

Sampling was carried out in accordance with the UFP-QAPP and the RAWP. Each location was sampled using a bladder pump and disposable tubing. Prior to sampling, each well was gauged and purged. During purging of the wells, groundwater sample forms were used to record groundwater parameters including temperature, potential of Hydrogen, specific conductivity, dissolved oxygen, turbidity, and oxidation reduction potential.

2.3.4 Groundwater Elevation and Flow Direction

A sitewide groundwater elevation measurement event was conducted on November 10, 2022, in conjunction with the monthly groundwater sampling. The groundwater elevation data for the November 2022 event (**Table 2-4**) was used to construct a shallow zone potentiometric surface map (**Figure 2-4**). Results showed that groundwater at the site flows toward the northwest, with the groundwater elevation highest in the southeastern portion of the site at 17WW08 (169.51 ft above mean sea level [amsl]), and lowest in the northwestern portion of the site at 17WW10 (167.37 ft amsl). Northwest of the site near monitoring well 17WW12, groundwater flows to the southwest.

A second sitewide groundwater elevation measurement event was conducted on February 10, 2023, in conjunction with the monthly groundwater sampling. The groundwater elevation data for the February 2023 measurement event (**Table 2-4**) was used to construct a shallow zone potentiometric surface map (**Figure 2-5**). Results were consistent with the November 2022 measurements: the groundwater elevation was highest in the southeastern portion of the site at 17WW01 (169.72 ft amsl), and lowest in the northwestern portion of the site at 17WW10 (167.58 ft amsl).

The groundwater level increased at each of the nine shallow zone monitoring wells between November 2022 and February 2023. Specifically, groundwater level elevation increases for the 3-month period between November 2022 and February 2023, ranged from 0.21 feet (17WW10) to 2.17 feet (17WW20) (**Table 2-4**). In addition, hydrographs from monitoring wells 17WW01, 17WW03, and 130 are plotted on **Figure 2-1**. Groundwater level elevation increases were observed in the shallow zone at each of the three monitoring wells during the reporting period.

2.4 Groundwater Analytical Results

The analytical results for the baseline monitoring event and the performance monitoring events are presented in **Table 2-2** and **Table 2-3**, respectively.

2.4.1 April 2022 Baseline Monitoring

The analytical results of the April 8, 2022, baseline monitoring event reported four locations with perchlorate concentrations that exceeded the PCL: 17WW01 at 239 µg/L, 17WW02 at 5,250 µg/L, 17WW03 at 44.7 µg/L, and 17WW06 at 120,000 µg/L. The perchlorate concentration reported at monitoring well 130 was below the PCL at 15 µg/L. Monitoring well 17WW01 was resampled on April 21, 2022, due to improper pump placement on April 8, 2022. On April 8, 2022, the pump inlet was placed mid screen at 20.80 feet below top of casing. However, based on historical

perchlorate data, the sample should have been collected from a depth of 28 feet below top of casing to correspond with historical high detections. Therefore, the pump inlet depth was lowered during the resample event as displayed on the sample collection logs (**Appendix B**). Perchlorate was detected at 17WW01 on April 21, 2022, at 46.8 µg/L.

2.4.2 August 2022 Monthly Performance Monitoring

The analytical results of the August 31, 2022, performance monitoring event reported three locations with perchlorate concentrations that exceeded the PCL: 17WW01 at 1,740 µg/L, 17WW02 at 16,400 µg/L (duplicate result), and 17WW06 at 101,000 µg/L. The perchlorate concentrations reported at 17WW03 and 130 were below the PCL at 0.0694 estimated (J) µg/L and 0.0640 J µg/L, respectively.

2.4.3 October 2022 Monthly Performance Monitoring

The analytical results of the October 7, 2022, performance monitoring event reported three locations with perchlorate concentrations that exceeded the PCL: 17WW01 at 24.5 µg/L (duplicate result), 17WW02 at 19,000 µg/L, and 17WW06 at 104,000 µg/L. The perchlorate concentrations reported at 17WW03 and 130 were below the PCL at 0.0559 J µg/L and 0.0750 J µg/L, respectively.

2.4.4 November 2022 Monthly Performance Monitoring

The analytical results of the November 10, 2022, performance monitoring event reported two locations with perchlorate concentrations that exceeded the PCL: 17WW02 at 17,200 µg/L, and 17WW06 at 89,900 µg/L. The perchlorate concentrations reported at 17WW01, 17WW03, and 130 were below the PCL at 0.549 µg/L, 0.0271 J µg/L (duplicate result), and 0.463 µg/L, respectively.

2.4.5 January 2023 Monthly Performance Monitoring

The analytical results of the January 17, 2023, performance monitoring event reported two locations with perchlorate concentrations that exceeded the PCL: 17WW02 at 13,600 µg/L, and 17WW06 at 87,000 µg/L. The perchlorate concentrations reported at 17WW01, 17WW03, and 130 were below the PCL at 0.0500 not-detected (U) µg/L, 0.0417 J µg/L (duplicate result), and 0.633 µg/L, respectively.

2.4.6 February 2023 Monthly Performance Monitoring

The analytical results of the February 10, 2023, performance monitoring event reported two locations with perchlorate concentrations that exceeded the PCL: 17WW02 at 15,400 µg/L, and 17WW06 at 108,000 µg/L. The perchlorate concentrations reported at 17WW01, 17WW03, and 130 were below the PCL at 0.0491 J µg/L, 0.0674 J µg/L, and 1.79 µg/L, respectively.

2.4.7 March 2023 Monthly Performance Monitoring

The analytical results of the March 9, 2023, performance monitoring event reported two locations with perchlorate concentrations that exceeded the PCL: 17WW02 at 11,100 µg/L, and 17WW06 at 65,900 µg/L. The perchlorate concentrations reported at 17WW01, 17WW03, and

130 were below the PCL at 0.0332 J µg/L, less than (<) 0.0500 U µg/L, and 1.36 µg/L (duplicate result), respectively.

2.4.8 June 2023 Quarterly Performance Monitoring

The analytical results of the June 1, 2023, quarterly monitoring event reported two locations with perchlorate concentrations that exceeded the PCL: 17WW02 at 10,500 µg/L, and 17WW06 at 88,700 µg/L. The concentrations at 17WW01, 17WW03, and 130 were reported below the PCL at 0.114 J µg/L (duplicate result), 0.0414 J µg/L, and 2.41 µg/L, respectively.

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3 EVALUATION OF EXTRACTION EFFECTIVENESS

Results of the performance monitoring showed an overall decreasing trend in the perchlorate concentrations at four of the five performance monitoring locations over time, suggesting that the system is effective in reducing the contaminant levels (**Table 2-3** and **Figure 3-1**). Perchlorate slightly increased during the reporting period at monitoring well 130.

The perchlorate concentration at 17WW06 decreased following system startup on August 5, 2022, and an overall decreasing trend has been observed. Increases in the perchlorate concentrations in February 2023 and June 2023 were observed to follow periods when the extraction was paused due to GWTP downtime in January 2023 and April 2023.

The perchlorate concentration at 17WW02 initially increased following startup of the extraction system, from 5,250 µg/L on April 8, 2022, to a high of 19,000 µg/L on October 7, 2022. The concentration then began to decrease in concert with 17WW06 following that sampling event. This was likely due to a combination of two factors, the initial migration of groundwater with higher perchlorate concentrations from the vicinity of 17WW06 resulting from the changes to the localized groundwater flow, and the desorption of perchlorate from soils in the central portion of the plume. Like 17WW06, the increase in the perchlorate concentration at 17WW02 in February 2023 and the slowed rate of decline in June 2023 are attributed to the extraction and treatment pauses of January 2023 and April 2023, respectively. Increases in the concentrations during these periods indicate the soil source continues to contribute to the dissolved phase. Additional soil remediation at the site is ongoing but is beyond the scope of this groundwater report. The most recent relevant document is the Draft Final Interim Remedial Action Completion Report (MMG-TLI, October 2023).

Perchlorate concentrations at 17WW01, 17WW03, and 130 have decreased to below the PCL of 17 µg/L, indicating that the extraction system has already been effective in reducing the areal distribution of groundwater exceeding the PCL. As of June 2023, perchlorate concentrations remain above the trigger level (20,000 µg/L) at one of the five performance monitoring locations (17WW06). The system's effectiveness will continue to be evaluated through ongoing quarterly monitoring of the perchlorate groundwater concentrations.

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4 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The groundwater monitoring data collected at LHAAP-17 during the Year 1 RA(O) indicates that the extraction and treatment of perchlorate-contaminated groundwater has been effective in reducing groundwater perchlorate concentrations to below the PCL at three of five monitoring locations. However, perchlorate concentrations at both groundwater extraction locations (17WW02 and 17WW06), continue to remain above the PCL. The perchlorate concentration at extraction location 17WW06, while overall decreasing, remains above the trigger level of 20,000 µg/L. The overall decreasing concentration trends at both extraction locations indicates that the system continues to be effective at reducing groundwater perchlorate concentrations.

4.2 Recommendations

Based on the Year 1 RA(O) analytical results, the following activities should be completed during the Year 2 RA(O):

- Groundwater extraction and treatment should continue at both extraction wells (17WW02 and 17WW06).
- Performance monitoring should continue quarterly for a minimum of three more quarters (December 2023, March 2024, and May 2024).
- Due to the ongoing Time Critical Removal Action (TRCA), the 18-month operational period of the extraction system should be extended until the TCRA is completed. A memorandum to file will be required for this extension.
- Paint and re-label extraction wells 17WW02 and 17WW06, and monitoring wells 17WW01, 17WW03, and 130.

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5 REFERENCES

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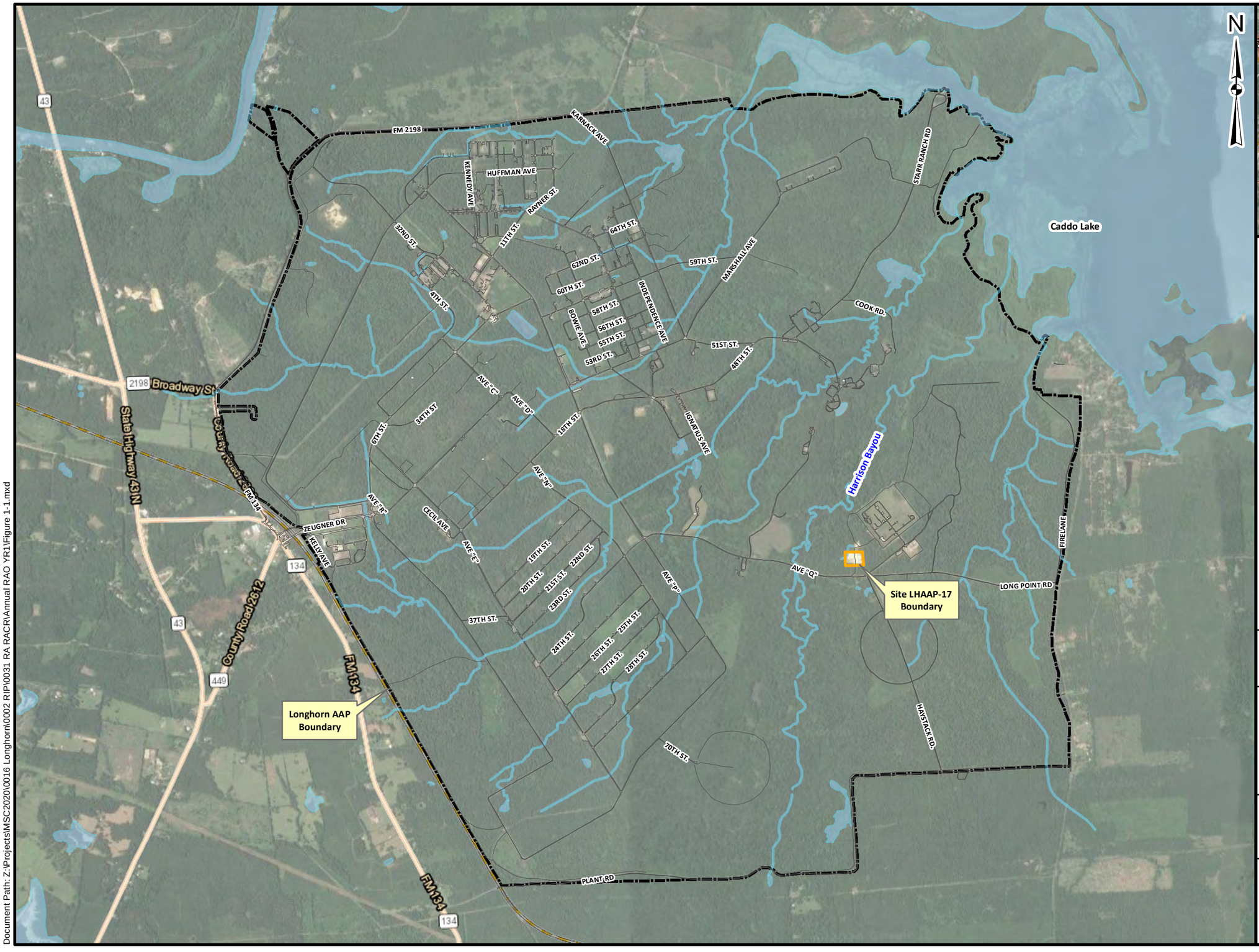
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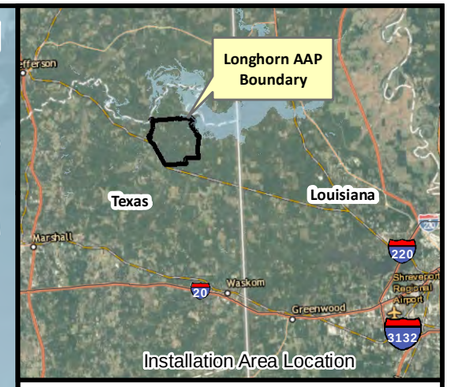
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FIGURES

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Legend

- Installation Boundary
- LHAAP-17 Boundary
- Road
- Stream

Longhorn Army Ammunition Plant
Karnack, Texas

Figure 1-1
Site Location Map

0 1,250 2,500 5,000 Feet

1 inch = 2,500 feet

Prepared By: MMG, TLI JOINT VENTURE

Map Date: 12/11/2023

Service Layer Credits: Google satellite imagery

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17WW15
17WW20
17WW12
17WW11
17WW18
MW-19
17WW09
17WW10
17WW16
130
17WW02
17WW19
17WW06
SCUDDAY AVE
17WW13
17WW05
17WW17
17WW03
17WW01
17WW14
LHAAP-17
17WW04
Approximate Groundwater Flow Direction
17WW07
17WW08
18WW14
18WW15
Approximate Pump House Location
AVE "Q"
LONG POINT RD
C-07
Approximate Location of Overhead Electrical Lines
HAYSTACK RD.

N

Longhorn Army Ammunition Plant
Karnack
LHAAP-17
Installation Area Location

Legend

- 17WW02 Performance Monitoring Locations Highlighted
- Extraction Well
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- LHAAP-17 Boundary
- System Piping
- Effluent Line Piping
- Road
- Stream

Longhorn Army Ammunition Plant
Karnack, Texas

Figure 1-2
LHAAP-17 Site Map

0 50 100 200 Feet
1 inch = 100 feet

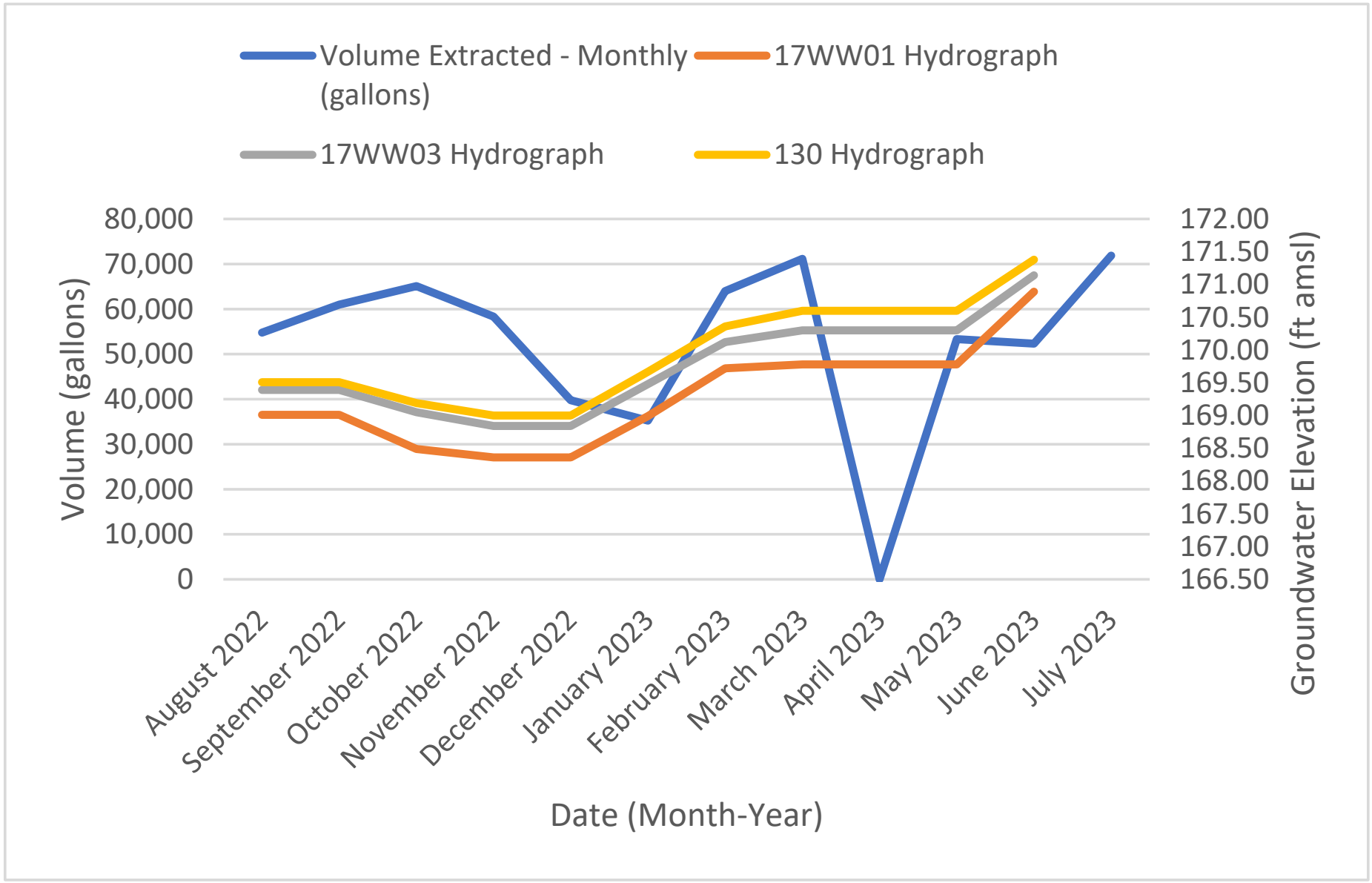
Prepared By: MMG, TLI JOINT VENTURE

Map Date: 12/11/2023

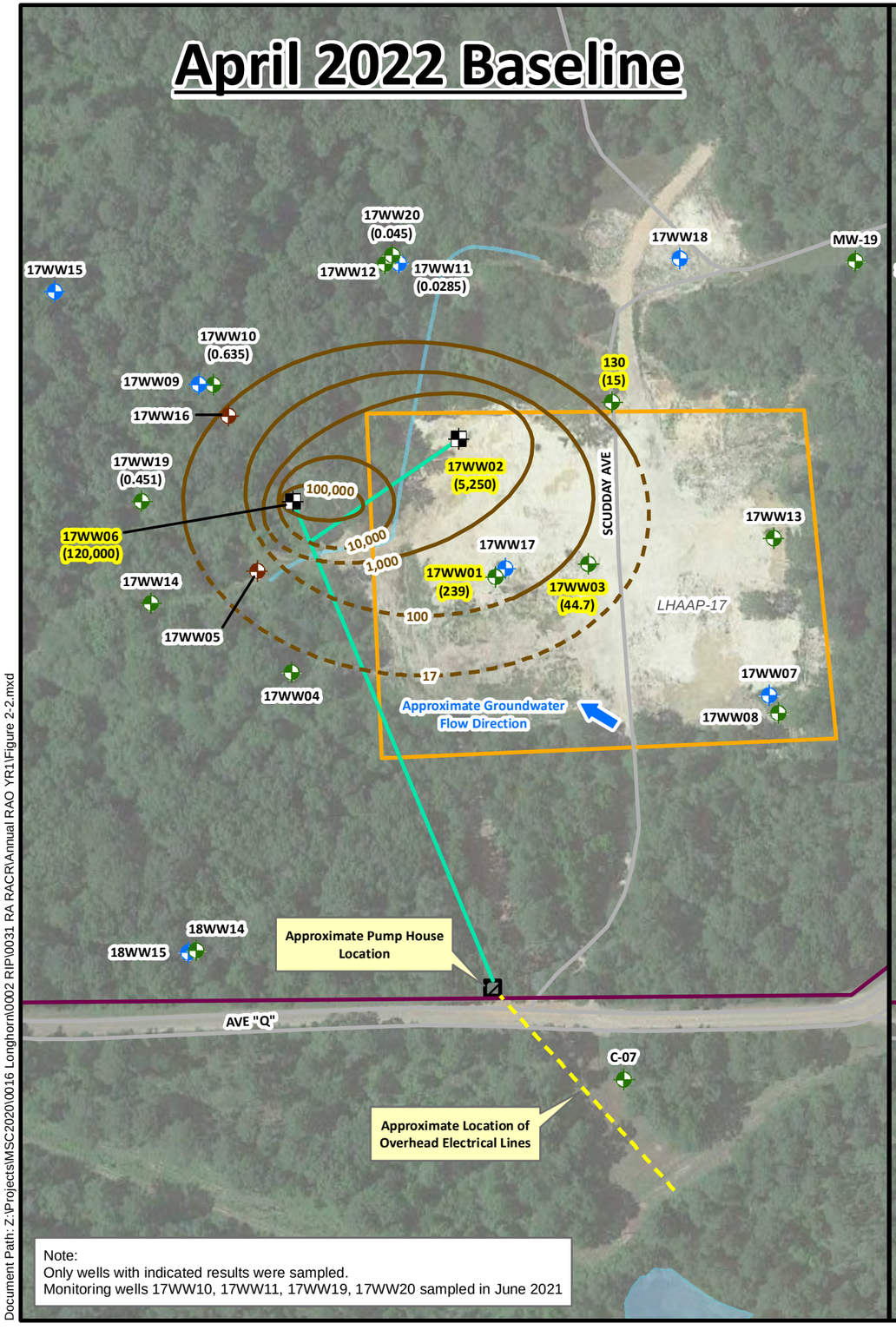
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Figure 2-1
Groundwater Extraction Volumes
(August 2022 - July 2023)

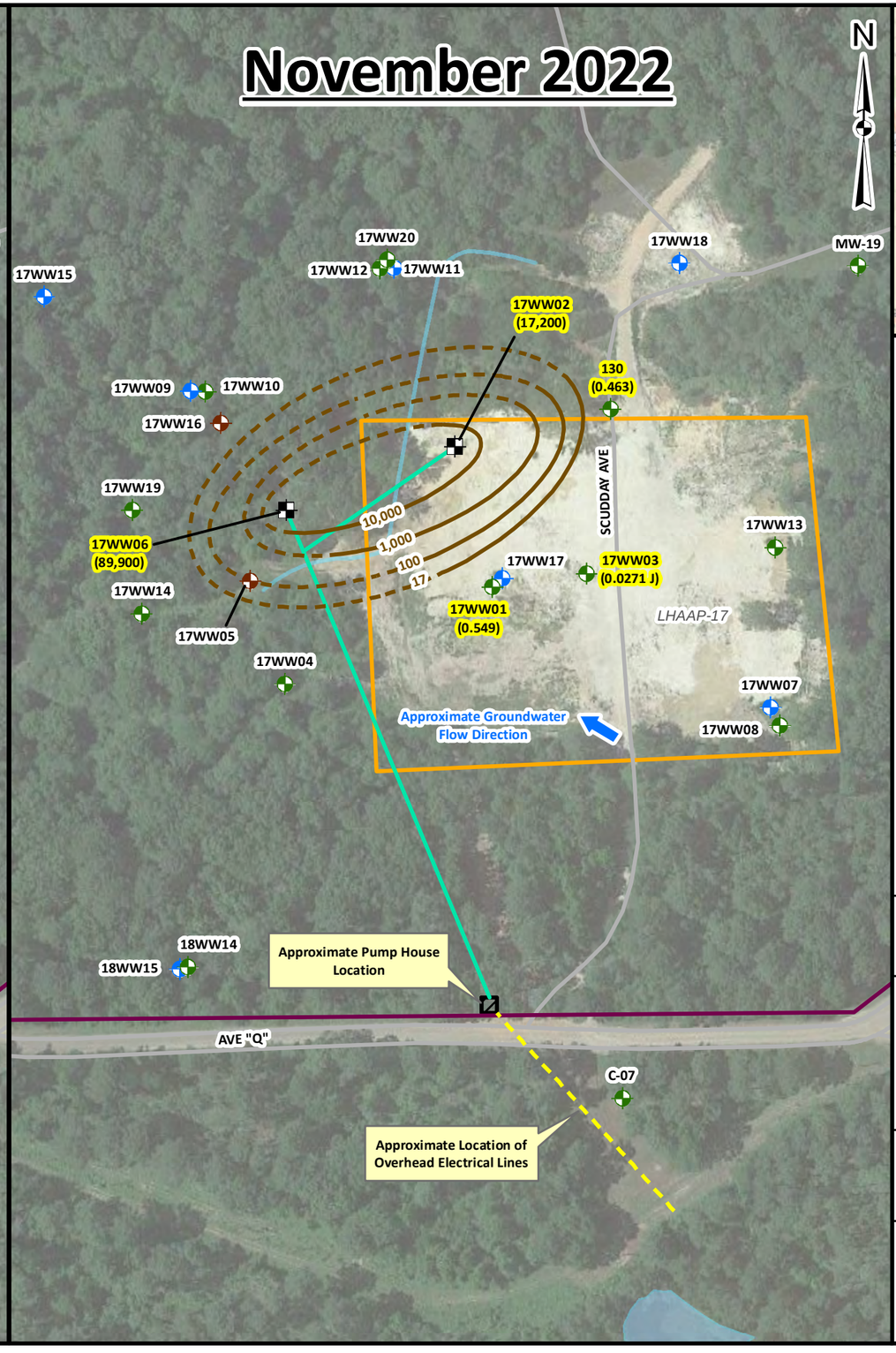


April 2022 Baseline



Note:
Only wells with indicated results were sampled.
Monitoring wells 17WW10, 17WW11, 17WW19, 17WW20 sampled in June 2021

November 2022





Legend

- 17WW02 — Performance Monitoring Locations Highlighted
- Extraction Well
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- (0.463) — Perchlorate Concentration Reported in Micrograms per Liter (µg/L)
- 17 — Perchlorate Isoconcentration Contour (µg/L) (Dashed where Inferred)
- (J) — Estimated Concentration
- LHAAP-17 Boundary
- System Piping
- Effluent Line Piping
- Road
- Stream

Longhorn Army Ammunition Plant
Karnack, Texas

Figure 2-2
April 2022 & November 2022
Groundwater Results

0 70 140 280 Feet
1 inch = 140 feet

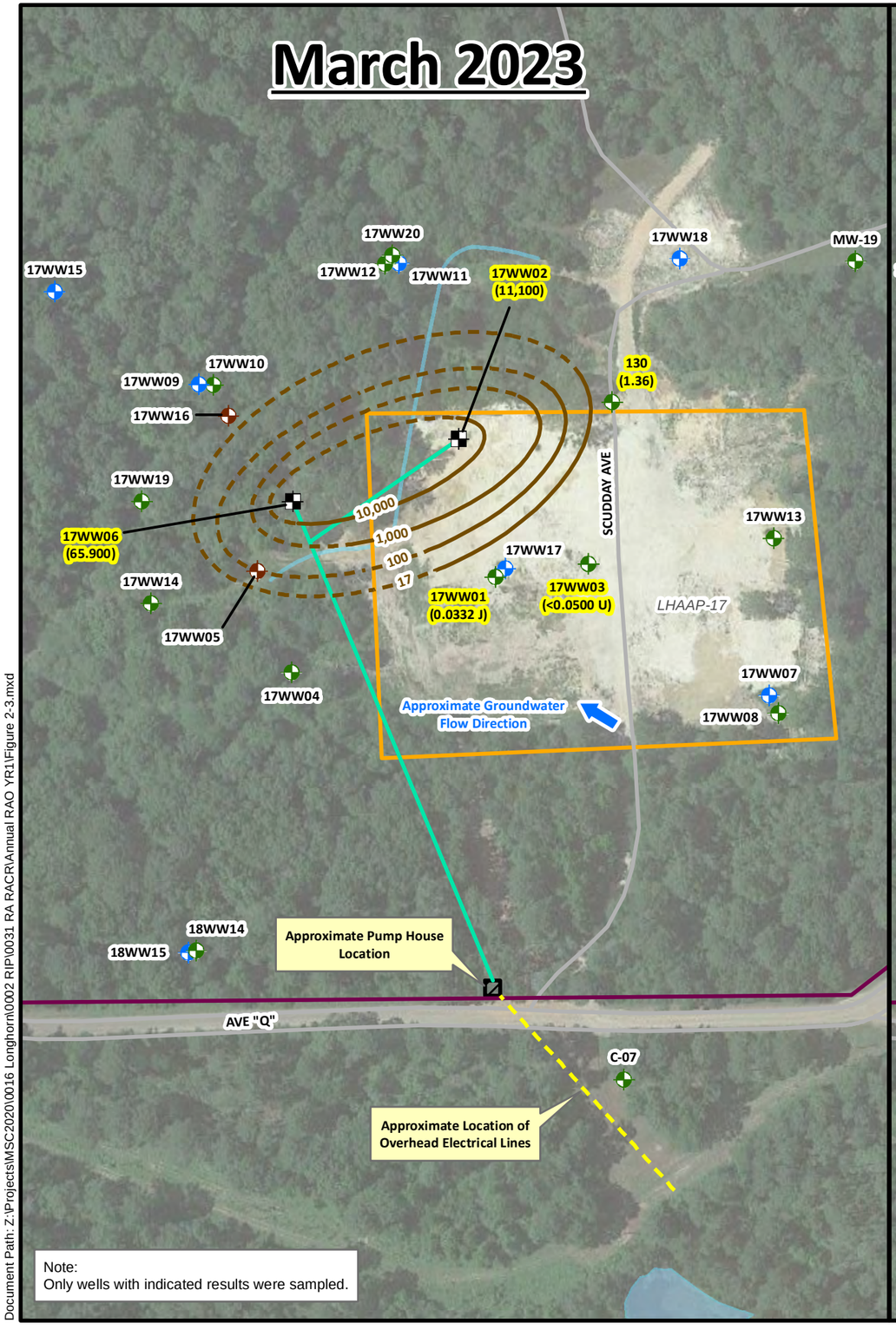
Prepared By: MMG, TLI JOINT VENTURE

Map Date: 12/11/2023

Service Layer Credits: Google satellite imagery

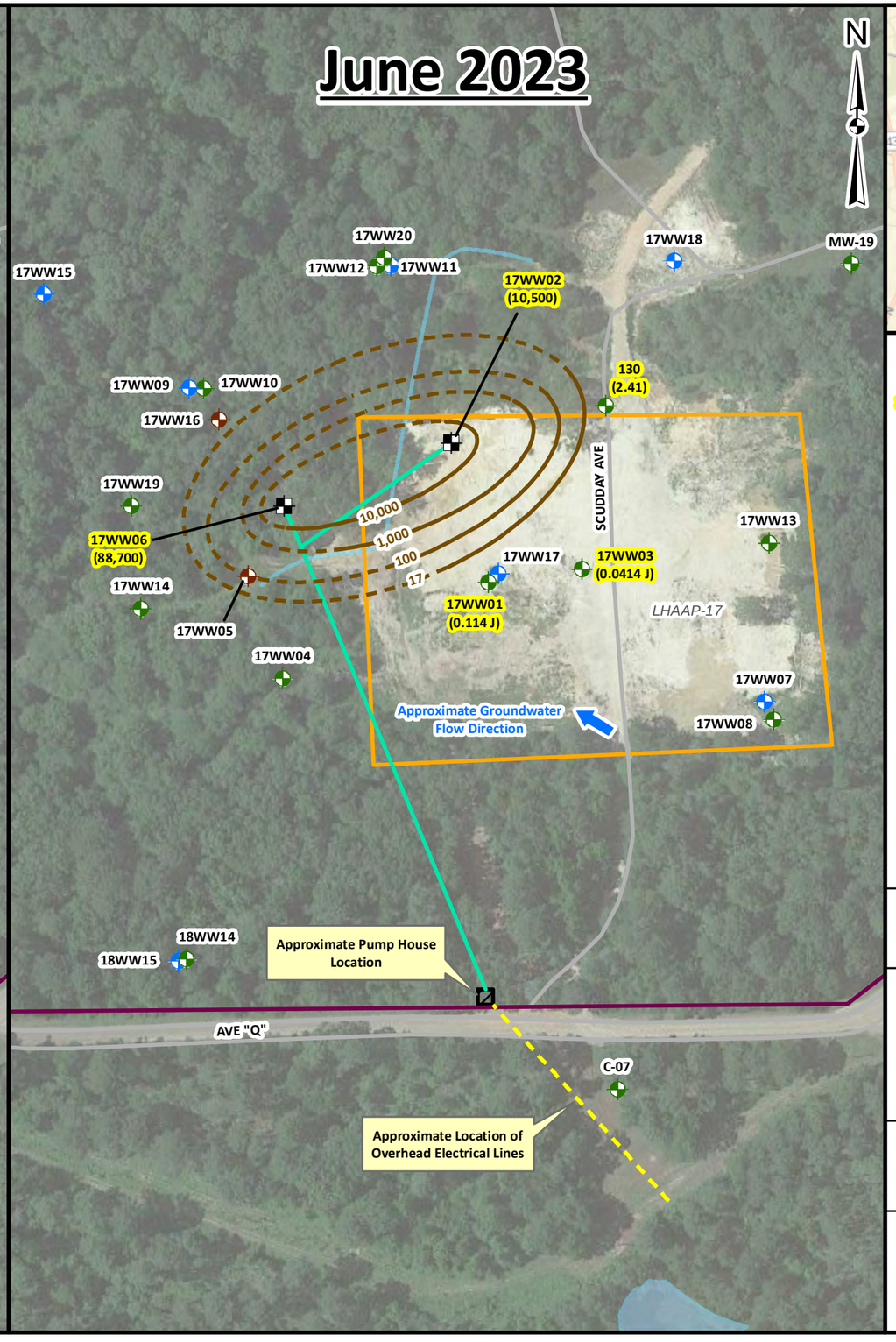
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March 2023



Note:
Only wells with indicated results were sampled.

June 2023





Legend

- 17WW02 — Performance Monitoring Locations Highlighted
- Extraction Well
- Shallow Monitoring Well
- Intermediate Monitoring Well
- Deep Monitoring Well
- (88,700) — Perchlorate Concentration Reported in Micrograms per Liter (µg/L)
- 17 — Perchlorate Isoconcentration Contour (µg/L) (Dashed where Inferred)
- (J) — Estimated Concentration
- (U) — Not Detected
- LHAAP-17 Boundary
- System Piping
- Effluent Line Piping
- Road
- Stream

Longhorn Army Ammunition Plant
Karnack, Texas

Figure 2-3
March 2023 & June 2023
Groundwater Results

0 70 140 280 Feet

1 inch = 140 feet

Prepared By: MMG, TLI JOINT VENTURE

Map Date: 12/11/2023

Service Layer Credits: Google satellite imagery

Document Path: Z:\Projects\MSC2020\0016 Longhorn\0002 RIP\0031 RA RACR\Annual RAO YR1\Figure 2-3.mxd

17WW20 (168.02)
17WW12 (168.84)
168.50
17WW10 (167.37)
167.50
17WW19 (167.63)
17WW06 (NM)
17WW02 (NM)
130 (169.00)
SCUDDAY AVE
17WW13 (169.09)
17WW03 (168.84)
17WW01 (168.36)
168.00
17WW14 (168.22)
LHAAP-17
168.50
17WW04 (168.53)
169.00
169.50
17WW08 (169.51)
Approximate Pump House Location
AVE "Q"
LONG POINT RD
Approximate Location of Overhead Electrical Lines
HAYSTACK RD.
N

Longhorn Army Ammunition Plant
Karnack
LHAAP-17
Installation Area Location

Legend

- Extraction Well
- Shallow Monitoring Well
- (169.09) Potentiometric Surface Elevation in Feet Above Mean Sea Level
- (NM) Not Measured
- Potentiometric Surface Contour
- Direction of Groundwater Flow
- LHAAP-17 Boundary
- System Piping
- Effluent Line Piping
- Road
- Stream

Longhorn Army Ammunition Plant
Karnack, Texas

Figure 2-4
Potentiometric Surface Map
(November 2022)

0 50 100 200 Feet
1 inch = 100 feet

Prepared By: MMG, TLI JOINT VENTURE

Map Date: 12/11/2023

Service Layer Credits: Google satellite imagery

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17WW12 (170.99)
17WW20 (170.19)
170.50
17WW10 (167.58)
168.00
17WW19 (168.38)
168.50
17WW06 (NM)
17WW14 (168.78)
169.00
169.50
17WW04 (169.61)
17WW02 (NM)
130 (170.36)
SCUDDAY AVE
17WW01 (169.72)
17WW03 (170.12)
17WW13 (170.09)
LHAAP-17
17WW08 (170.45)
170.00
Approximate Pump House Location
Approximate Location of Overhead Electrical Lines
AVE "Q"
LONG POINT RD
HAYSTACK RD.
N



Installation Area Location

Legend

- Extraction Well
- Shallow Monitoring Well
- (170.45) Potentiometric Surface Elevation in Feet Above Mean Sea Level
- (NM) Not Measured
- Potentiometric Surface Contour
- Direction of Groundwater Flow
- LHAAP-17 Boundary
- System Piping
- Effluent Line Piping
- Road
- Stream

Longhorn Army Ammunition Plant
Karnack, Texas

Figure 2-5
Potentiometric Surface Map
(February 2023)

0 50 100 200 Feet
1 inch = 100 feet

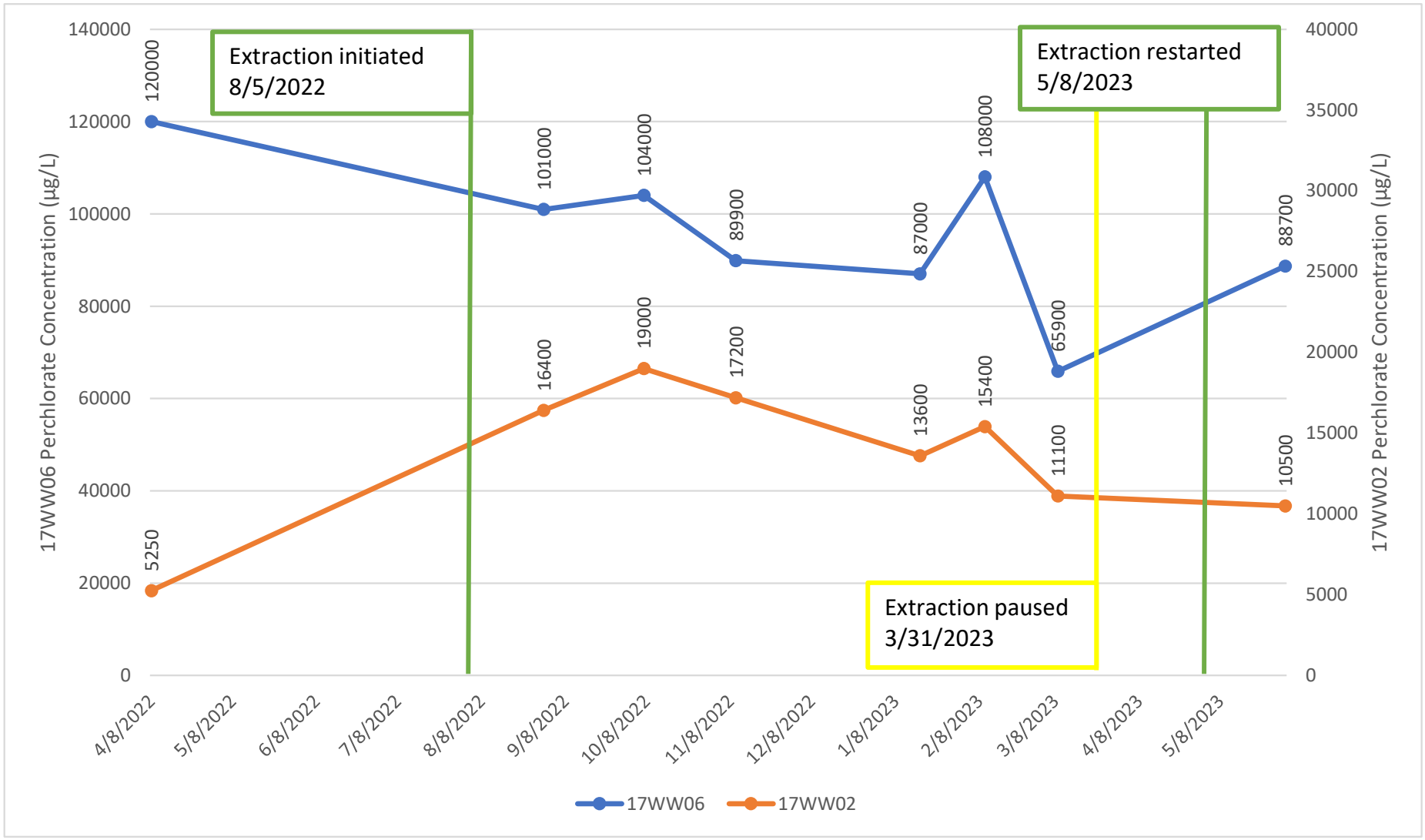
Prepared By: MMG, TLI JOINT VENTURE

Map Date: 12/11/2023

Service Layer Credits: Google satellite imagery

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Figure 3-1
LHAAP-17 Perchlorate Trend Chart



TABLES

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Table 1-1
Groundwater COCs for LHAAP-17

Media	Chemicals of Concern (COCs)
Shallow Groundwater Zone	1,1-dichloroethene (DCE) 1,2-dichloroethane (DCA) cis-1,2-DCE trichloroethene (TCE) vinyl chloride (VC) perchlorate
Intermediate Groundwater Zone	cis-1,2-DCE TCE VC

Table 2-1
Groundwater Extraction Volumes (August 2022 – July 2023)

Date	Volume Extracted - Cumulative (gallons)	Volume Extracted - Weekly (gallons)	Volume Extracted - Monthly (gallons)
8/5/2022	0	0	0
8/12/2022	17,482	17,482	54,782
8/17/2022	27,938	10,456	
8/26/2022	41,005	13,067	
9/1/2022	54,782	13,777	
9/7/2022	69,582	14,800	60,995
9/21/2022	88,968	19,386	
9/25/2022	101,785	12,817	
9/28/2022	115,777	13,992	
10/5/2022	131,102	15,325	65,107
10/12/2022	142,317	11,215	
10/19/2022	156,816	14,499	
10/26/2022	171,341	14,525	
10/31/2022	180,884	9,543	
11/30/2022	239,203	58,319	58,319
12/31/2022	278,966	39,763	39,763
1/31/2023	314,197	35,231	35,231
2/28/2023	378,204	64,007	64,007
3/30/2023	449,341	71,137	71,137
4/31/2023	449,341	0	0
5/31/2023	502,674	53,333	53,333
6/30/2023	554,995	52,321	52,321
7/31/2023	626,848	71,853	71,853
8/31/2023	691,990	65,142	65,142

Notes:
Extraction volumes measured on totalizer located on the effluent piping from the system shed.
5 August 2022 was the first day of extraction.
Cumulative extraction volume from 5 August 2022 through 31 July 2023.

Table 2-2
Pre-Design Groundwater Monitoring Analytical Results (June 2021)

Sample Location: Sample ID: Sample Date:	Units	PCL	17WW06 17WW06_063021 6/30/21	17WW10[1] 17WW10_063021 6/30/21	17WW11 17WW11_063021 6/30/21	17WW11 17WW11_063021_a 6/30/21	17WW12 17WW12_063021 6/30/21	17WW19 17WW19_063021 6/30/21	17WW20 17WW20_063021 6/30/21
Perchlorate	µg/L	17	**143,000**	**0.635**	< 0.0500 U	**0.0285 J**	< 0.0500 U	**0.451**	**0.0450 J**

Notes:

PCL - Texas Risk Reduction Program (TRRP) Tier 1 Groundwater Residential Protective Concentration Level

Highlighted results exceed the perchlorate PCL

µg/L - micrograms per liter

U - Undetected. The analyte was analyzed for, but not detected and reported to the limit of detection.

J - Estimated Value. Concentration found below the limit of quantitation.

[1] Monitoring well 17WW10 is in the deep groundwater zone and not part of the extraction system performance monitoring.

Table 2-3
Baseline and Performance Groundwater Monitoring Analytical Results (April 2022 – June 2023)

Location ID:	Units	PCL	17WW01	17WW01	17WW01	17WW01	17WW01	17WW01	17WW01	17WW01
Sample Date:			4/8/2022	4/21/2022	8/31/2022	10/7/2022	11/10/2022	1/17/2023	2/10/2023	3/9/2023
Perchlorate	µg/L	17	239	46.8	1,740	24.5 *	0.549	< 0.0500 U	0.0491 J	0.0332 J

Location ID:	Units	PCL	17WW02	17WW02	17WW02	17WW02	17WW02	17WW02	17WW02	17WW02
Sample Date:			4/8/2022	8/31/2022	10/7/2022	11/10/2022	1/17/2023	2/10/2023	3/9/2023	6/1/2023
Perchlorate	µg/L	17	5,250	16,400 *	19,000	17,200	13,600	15,400	11,100	10,500

Location ID:	Units	PCL	17WW03	17WW03	17WW03	17WW03	17WW03	17WW03	17WW03	17WW03
Sample Date:			4/8/2022	8/31/2022	10/7/2022	11/10/2022	1/17/2023	2/10/2023	3/9/2023	6/1/2023
Perchlorate	µg/L	17	44.7	0.0694 J	0.0559 J	0.0271 J *	0.0417 J *	0.0674 J	< 0.0500 U	0.0414 J

Location ID:	Units	PCL	17WW06	17WW06	17WW06	17WW06	17WW06	17WW06	17WW06	17WW06
Sample Date:			4/8/2022	8/31/2022	10/7/2022	11/10/2022	1/17/2023	2/10/2023	3/9/2023	6/1/2023
Perchlorate	µg/L	17	120,000	101,000	104,000	89,900	87,000	108,000	65,900	88,700

Location ID:	Units	PCL	130	130	130	130	130	130	130	130
Sample Date:			4/8/2022	8/31/2022	10/7/2022	11/10/2022	1/17/2023	2/10/2023	3/9/2023	6/1/2023
Perchlorate	µg/L	17	15	0.0640 J	0.0750 J	0.463	0.633	1.79	1.36 *	2.41

Notes:

PCL - Texas Risk Reduction Program (TRRP) Tier 1 Groundwater Residential Protective Concentration Level

Highlighted results exceed the perchlorate PCL

µg/L - micrograms per liter

J - Estimated Value. Concentration found below the limit of quantitation.

U - Not Detected above detection limit.

* - The higher value of the duplicate sample is reported.

Table 2-4
Groundwater Elevations

Well Identification	Sample Date	Ground Elevation (feet amsl)	TOC Elevation (feet amsl)	TOC Height (feet above ground surface)	Depth to Water (feet btoc)	Depth to Water (feet bgs)	Groundwater Elevation (feet amsl)
17WW01	8/31/2022	176.62	179.01	2.39	10.00	7.61	169.01
	10/7/2022	176.62	179.01	2.39	10.52	8.13	168.49
	11/10/2022	176.62	179.01	2.39	10.65	8.26	168.36
	1/17/2023	176.62	179.01	2.39	10.02	7.63	168.99
	2/10/2023	176.62	179.01	2.39	9.29	6.90	169.72
	3/9/2023	176.62	179.01	2.39	9.23	6.84	169.78
	6/1/2023	176.62	179.01	2.39	8.12	5.73	170.89
17WW02	11/10/2022	174.34	177.21	2.87	NM	NM	NM
	2/10/2023	174.34	177.21	2.87	NM	NM	NM
17WW03	8/31/2022	176.39	179.20	2.81	9.81	7.00	169.39
	10/7/2022	176.39	179.20	2.81	10.15	7.34	169.05
	11/10/2022	176.39	179.20	2.81	10.36	7.55	168.84
	1/17/2023	176.39	179.20	2.81	9.72	6.91	169.48
	2/10/2023	176.39	179.20	2.81	9.08	6.27	170.12
	3/9/2023	176.39	179.20	2.81	8.90	6.09	170.30
	6/1/2023	176.39	179.20	2.81	8.06	5.25	171.14
17WW04	11/10/2022	177.29	180.21	2.92	11.68	8.76	168.53
	2/10/2023	177.29	180.21	2.92	10.60	7.68	169.61
17WW05	11/10/2022	178.80	182.73	3.93	13.79	9.86	168.94
	2/10/2023	178.80	182.73	3.93	11.85	7.92	170.88
17WW06	11/10/2022	176.82	179.36	2.54	NM	NM	NM
	2/10/2023	176.82	179.36	2.54	NM	NM	NM
17WW07	11/10/2022	176.78	179.68	2.90	10.56	7.66	169.12
	2/10/2023	176.78	179.68	2.90	9.21	6.31	170.47
17WW08	11/10/2022	176.76	179.94	3.18	10.43	7.25	169.51
	2/10/2023	176.76	179.94	3.18	9.49	6.31	170.45
17WW09	11/10/2022	178.40	181.43	3.03	12.78	9.75	168.65
	2/10/2023	178.40	181.43	3.03	10.20	7.17	171.23
17WW10	11/10/2022	178.38	181.55	3.17	14.18	11.01	167.37
	2/10/2023	178.38	181.55	3.17	13.97	10.80	167.58
17WW11	11/10/2022	177.51	180.95	3.44	12.86	9.42	168.09
	2/10/2023	177.51	180.95	3.44	7.15	3.71	173.80
17WW12	11/10/2022	177.04	180.32	3.28	11.48	8.20	168.84
	2/10/2023	177.04	180.32	3.28	9.33	6.05	170.99
17WW13	11/10/2022	175.90	179.14	3.24	10.05	6.81	169.09
	2/10/2023	175.90	179.14	3.24	9.05	5.81	170.09
17WW14	11/10/2022	178.83	181.90	3.07	13.68	10.61	168.22
	2/10/2023	178.83	181.90	3.07	13.12	10.05	168.78
17WW15	11/10/2022	180.33	182.61	2.28	14.40	12.12	168.21
	2/10/2023	180.33	182.61	2.28	11.22	8.94	171.39
17WW16	11/10/2022	178.99	181.13	2.14	12.50	10.36	168.63
	2/10/2023	178.99	181.13	2.14	10.27	8.13	170.86
17WW17	11/10/2022	176.23	178.81	2.58	10.32	7.74	168.49
	2/10/2023	176.23	178.81	2.58	8.47	5.89	170.34
17WW18	11/10/2022	176.03	178.68	2.65	10.08	7.43	168.60
	2/10/2023	176.03	178.68	2.65	8.50	5.85	170.18
17WW19	11/10/2022	176.63	180.08	3.45	12.45	9.00	167.63
	2/10/2023	176.63	180.08	3.45	11.70	8.25	168.38
17WW20	11/10/2022	177.13	180.02	2.89	12.00	9.11	168.02
	2/10/2023	177.13	180.02	2.89	9.83	6.94	170.19
130	8/31/2022	174.94	177.73	2.79	8.22	5.43	169.51
	10/7/2022	174.94	177.73	2.79	8.54	5.75	169.19
	11/10/2022	174.94	177.73	2.79	8.73	5.94	169.00
	1/17/2023	174.94	177.73	2.79	8.06	5.27	169.67
	2/10/2023	174.94	177.73	2.79	7.37	4.58	170.36
	3/9/2023	174.94	177.73	2.79	7.13	4.34	170.60
	6/1/2023	174.94	177.73	2.79	6.35	3.56	171.38

Notes:
amsl - above mean sea level
btoc - below top of casing
NM - Not Measured
TOC - top of casing

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APPENDIX A
WELL INSPECTION FORMS

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01227884

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: Army
Site Name: 17
Well ID: 130
Inspection Date: 8/31/22
Well Completion Depth/ Measured Depth: 25.53
Inspector: Scott Baggenger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 2"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227885

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: ARmy
Site Name: 17
Well ID: 17WW01
Inspection Date: 8/31/22
Well Completion Depth/ Measured Depth: 33.58
Inspector: Scott Baesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☒ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED NA

Well cover present? ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☐ Yes ☒ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227886

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: Army
Site Name: 17
Well ID: 17MW03
Inspection Date: 8/31/22
Well Completion Depth/ Measured Depth: 32.03
Inspector: Scott Bassinger

ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☐ Yes ☒ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No SB
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227887

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC 2020.0016.0002.0022
Client: Army
Site Name: 17
Well ID: 130
Inspection Date: 10/7/22
Well Completion Depth/ Measured Depth: 25.50
Inspector: Scott Beesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 2"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227888

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: Army
Site Name: 17

Well ID: 17WW01
Inspection Date: 10/7/22
Well Completion Depth/ Measured Depth: 33.62
Inspector: Scott Beesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☐ Yes ☒ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227889

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: Army
Site Name: 17
Well ID: 17WW03
Inspection Date: 10/7/22
Well Completion Depth/ Measured Depth: 31.96
Inspector: Scott Beesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☒ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED NA

Well cover present? ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☐ Yes ☒ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227890

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC 2020-0016.0002.0022
Client: Army
Site Name: 17
Well ID: 130
Inspection Date: 11/10/22
Well Completion Depth/ Measured Depth: 25.50
Inspector: Scott Beesinger

ABOVE GROUND
Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED
Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:
Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:
Inner Diameter (inches): 2"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:
Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227891

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: ARmy
Site Name: 17
Well ID: 17WW01
Inspection Date: 11/10/22
Well Completion Depth/ Measured Depth: 33.60
Inspector: Scott Baggenbur

ABOVE GROUND
Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED
Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:
Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:
Inner Diameter (inches) 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:
Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227892

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.9816.0002.0022
Client: Army
Site Name: 17
Well ID: 17WW03
Inspection Date: 1/10/22
Well Completion Depth/ Measured Depth: 32.01
Inspector: Scott Baesinger

ABOVE GROUND
Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED
Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:
Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:
Inner Diameter (inches) 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☐ Yes ☒ No

WELL INTEGRITY:
Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC 2020.0016.0002.0022
Client: Army
Site Name: 17
Well ID: 130
Inspection Date: 1/17/23
Well Completion Depth/ Measured Depth: 25.52
Inspector: Scott Beesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☒ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches) 2"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: Army
Site Name: 17
Well ID: 17WW01
Inspection Date: 1/17/23
Well Completion Depth/ Measured Depth: 33.63
Inspector: Scott Beesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches) 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC 2020.0016.0002.0022
Client: Army
Site Name: 17
Well ID: 17MW03
Inspection Date: 1/17/23
Well Completion Depth/ Measured Depth: 32.03
Inspector: Scott Beesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED NA

Well cover present? ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☐ Yes ☒ No

WELL INTEGRITY:

Bailer present? ☒ Yes ☐ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227896

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: Army
Site Name: 17
Well ID: 130
Inspection Date: 2/10/23
Well Completion Depth/ Measured Depth: 25.52
Inspector: Scott Baesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 2"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227897

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: Army
Site Name: 17
Well ID: 17WW01
Inspection Date: 2/10/23
Well Completion Depth/ Measured Depth: 33.67
Inspector: Scott Beasinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227898

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002,0022
Client: Army
Site Name: 17
Well ID: 17WW03
Inspection Date: 2/10/23
Well Completion Depth/ Measured Depth: 32.03
Inspector: Scott Baesinger

ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? ~~☐~~ NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227899

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: ARMY
Site Name: 17
Well ID: 130
Inspection Date: 3/9/23
Well Completion Depth/ Measured Depth: 25.51
Inspector: Scott Beesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED NA

Well cover present? ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 2"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227900

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016,0002,0022
Client: ARmy
Site Name: 17
Well ID: 17WW01
Inspection Date: 3/9/23
Well Completion Depth/ Measured Depth: 33.71
Inspector: Scott Beesinger

ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Need Paint
Lid Condition: ☒ Good ☐ Broken ☒ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED NA

Well cover present? ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227901

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: Army
Site Name: 17

Well ID: 17WW03
Inspection Date: 3/9/23
Well Completion Depth/ Measured Depth: 32.02
Inspector: Scott Beesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☒ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227902

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC.2020.0016.0002.0022
Client: Army
Site Name: 17
Well ID: 17WW01
Inspection Date: 6/1/23
Well Completion Depth/ Measured Depth: 33.63
Inspector: Scott Beasinger

ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227903

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC2020.0016.0002.0022
Client: Army
Site Name: 17
Well ID: 17MW03
Inspection Date: 6/1/23
Well Completion Depth/ Measured Depth: 32.02
Inspector: Scott Beesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☒ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 4"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

01227904

WELL INSPECTION FORM

Job Name: LHAAP
Job No.: MSC 2020.0016.0002.0022
Client: ARMY
Site Name: 17
Well ID: 130
Inspection Date: 6/1/23
Well Completion Depth/ Measured Depth: 25.52
Inspector: Scott Beesinger

☒ ABOVE GROUND

Well Accessible? ☒ Yes ☐ No
Protective casing? ☒ Yes ☐ No
Material: METAL
Condition: ☐ Good ☐ Broken ☐ Cracked ☒ Need Paint
Lid Condition: ☒ Good ☐ Broken ☐ Cracked
Hinge Condition: ☒ Good ☐ Less than 50% rusted ☐ More than 50% rusted

☐ FLUSH MOUNTED

Well cover present? NA ☐ Yes ☐ No
Condition: ☐ Good ☐ Broken ☐ Cracked
Condition of Sump: ☐ Clean ☐ Dry ☐ Standing Water

CONCRETE PAD:

Sloped away from casing? ☒ Yes ☐ No
Pad Area Cleared of Vegetation? ☒ Yes ☐ No
Check any of the following features that apply:
☐ Many Cracks ☐ Gap Around Casing ☐ Few Cracks ☐ Ponded Water ☐ No Pad Present

WELL CONDITION:

Inner Diameter (inches): 2"
Condition: ☒ Good ☐ Broken ☐ Cracked ☐ Other (describe)
Cap present? ☒ Yes ☐ No
Well lock present? ☒ Yes ☐ No
Lock functioning properly? ☒ Yes ☐ No
Are bollards present and stable? ☒ Yes ☐ No
Well ID visible? ☒ Yes ☐ No

WELL INTEGRITY:

Bailer present? ☐ Yes ☒ No
Visual obstruction? ☐ Yes ☒ No
Is well open to completed depth? (complete when gauging) ☒ Yes ☐ No
Is silt present in well? (complete when gauging) ☒ Yes ☐ No
Is silt greater than 10% of well screen length? (complete when gauging) ☐ Yes ☒ No

COMMENTS:

Longhorn Army Ammunition Plant Site LHAAP-17 Photograph Log June 2023



Photo 1: Monitoring well 17WW01 in need of fresh paint and a new label.



Photo 2: Extraction well 17WW02 in need of fresh paint and a new label.

Longhorn Army Ammunition Plant Site LHAAP-17 Photograph Log June 2023



Photo 3: Monitoring well 17WW03 in need of fresh paint and a new label.



Photo 4: Extraction well 17WW06 in need of fresh paint and a new label.

Longhorn Army Ammunition Plant Site LHAAP-17 Photograph Log June 2023



Photo 5: Monitoring well 130 in need of fresh paint and a new label.

APPENDIX B
GROUNDWATER SAMPLE COLLECTION FORMS

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GROUNDWATER SAMPLE COLLECTION FORM

Page _____ of _____

LOCATION	Site: LHAAP - 17	Location ID: 17WW130	Date: 4-8-2022
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: ~~Scott Beesinger~~ Derrick Berry
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): PVC	Unit Casing Volume (gal/lin ft) (A): 0.16	Initial Depth to Water (ft) (B): 6.12
	Total Well Depth (ft) (C): 25.52	Water Column Thickness (ft) (C-B): 19.4	2nd Depth to Water(pre-purge): 6.12
	Screened Interval: 8.0-23.0	Weather: 60s	Well Volume (gal) (A*(C-B)): 3.1
	Pump placement: 21.50	Well Condition: Fair	Ferrous Iron:

CASING INFO										
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
4-8-22	1120	6.34	Initial	400	19.27	6.96	2.17	3.0	156	127	Cloudy, no odor
	1125	6.58	0.5		19.04	6.42	2.22	1.8	78	150	Cloudy, no odor
	1130	7.01	1.0		19.05	6.23	2.22	1.3	67	163	Cloudy, no odor
	1135	7.23	1.5		18.98	6.02	2.21	0.6	44	171	Cloudy, no odor
	1140	7.25	2.0		18.96	6.01	2.21	0.6	41	177	Cloudy, no odor
	1145	7.28	2.5		18.97	6.00	2.21	0.5	36	179	Clearing, no odor

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units	1	250mL Plastic		N	Y		Perchlorate

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW130-220408 Sample Time: 1146

17WW130-220408-MS
17WW130-220408-MSD

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW01	Date: 4-8-2022
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: ~~Scott Beesinger~~ Derrick Berry
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.65	Initial Depth to Water (ft) (B): 7.84
	Total Well Depth (ft) (C): 33.71	Water Column Thickness (ft) (C-B): 25.87	2nd Depth to Water(pre-purge): 7.84
	Screened Interval: 10.80 - 30.80	Weather: Cool ~50>	Well Volume (gal) (A*(C-B)): 16.8
	Pump placement: 20.80	Well Condition: Fair	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
4-8	0930	7.88	Initial	400	17.58	6.30	7.41	0.4	43	14	Cloudy, no odor
	0935	7.91	0.5		17.64	6.26	7.42	0.3	41	18	Cloudy, no odor
	0940	7.94	1.0		17.63	6.25	7.43	0.3	34	20	Clearing, no odor
	0945	7.98	1.5		17.61	6.23	7.44	0.2	32	22	Clearing, no odor
	0950	8.01	2.0		17.60	6.22	7.44	0.2	28	23	Clearing, no odor

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	250ml Plastic	NA	Y		PERCHLORATE

Conversions	Stabilization Criteria										
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%							
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%							
	Cond	+/- 10%	ORP	+/- 10	Sample ID: 17WW01-220408				Sample Time: 0951		

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW01	Date: 4/21/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): PVC 4"	Unit Casing Volume (gal/lin ft) (A): ~~2~~ 0.65	Initial Depth to Water (ft) (B): 7.63
	Total Well Depth (ft) (C): 33.65	Water Column Thickness (ft) (C-B): 26.02	2nd Depth to Water(pre-purge): 7.63
	Screened Interval: 10.80 - 30.80	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 16.97
	Pump placement: 28.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO	Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
	Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
4/21/22	0815	7.70	.13	100	19.68	7.41	7.58	0.93	40.5	6	
	0820	7.75	.26	100	19.35	6.98	7.55	0.41	38.9	0	
	0825	7.78	.39	100	19.28	6.88	7.52	0.27	36.7	-2	
	0830	7.80	.52	100	19.24	6.87	7.51	0.26	36.2	-3	
	0835	7.82	.65	100	19.20	6.86	7.50	0.26	35.6	-3	
	0840	7.83	.78	100	19.17	6.86	7.50	0.25	35.2	-3	

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	125 mL Plastic	NA	Y		Perchlorate

Conversions	Stabilization Criteria										
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%							
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%							
	Cond	+/- 10%	ORP	+/- 10	Sample ID: 17WW01_042122				Sample Time: 0840		

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW01	Date: 4/21/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): PVC 4"	Unit Casing Volume (gal/lin ft) (A): ~~2.652~~ 0.65	Initial Depth to Water (ft) (B): 7.63
	Total Well Depth (ft) (C): 33.65	Water Column Thickness (ft) (C-B): 26.02	2nd Depth to Water(pre-purge): 7.63
	Screened Interval: 10.80 - 30.80	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 16.97
	Pump placement: 28.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
4/21/22	0815	7.70	.13	100	19.68	7.41	7.58	0.93	40.5	6	
	0820	7.75	.26	100	19.35	6.98	7.55	0.41	38.9	0	
	0825	7.78	.39	100	19.28	6.88	7.52	0.27	36.7	-2	
	0830	7.80	.52	100	19.24	6.87	7.51	0.26	36.2	-3	
	0835	7.82	.65	100	19.20	6.86	7.50	0.26	35.6	-3	
	0840	7.83	.78	100	19.17	6.86	7.50	0.25	35.2	-3	

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	125 mL Plastic	NA	Y		Perchlorate

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW01_042122 Sample Time: 0840

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GROUNDWATER SAMPLE COLLECTION FORM

Page 1 of 1

LOCATION	Site: LHAAP - 17	Location ID: 17WW02	Date: 4-8-2022
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: ~~Scott Beesinger~~ Derick Berry
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.65	Initial Depth to Water (ft) (B): 5.98
	Total Well Depth (ft) (C): 24.97	Water Column Thickness (ft) (C-B): 18.99	2nd Depth to Water(pre-purge): 5.98
	Screened Interval: 12.00 - 22.00	Weather: 50's	Well Volume (gal) (A*(C-B)): 12.34
	Pump placement: 17.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
4-8	1035	6.11	Initial	400	19.07	6.64	1.85	3.6	197	157	Turbid, no odor
	1040	6.18	0.5		18.44	6.60	1.85	1.1	112	155	Turbid, no odor
	1045	6.23	1.0		18.45	6.01	1.84	1.0	88	154	Cloudy, no odor
	1050	6.26	1.5		18.61	5.92	1.82	0.5	74	154	Cloudy, no odor
	1055	6.28	2.0		18.63	5.91	1.82	0.5	71	154	Cloudy, no odor
	1100	6.31	2.5		18.64	5.90	1.80	0.4	68	154	Cloudy, no odor

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	250 ml Plastic	NA	Y		PERCHLORATE

Sample ID: 17WW02-220408 Sample Time: 1101

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GROUNDWATER SAMPLE COLLECTION FORM

Page _____ of _____

LOCATION	Site: LHAAP - 17	Location ID: 17WW03	Date: 4-8-2022
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: ~~Scott Beesinger~~ Derrick Berry
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): PVC	Unit Casing Volume (gal/lin ft) (A): 0.65	Initial Depth to Water (ft) (B): 7.92
	Total Well Depth (ft) (C): 32.01	Water Column Thickness (ft) (C-B): 24.09	2nd Depth to Water(pre-purge): 7.92
	Screened Interval: 19.0-29.0	Weather: 50s	Well Volume (gal) (A*(C-B)): 15.66
	Pump placement: 25.50	Well Condition: Poor	Ferrous Iron:

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
4-8-22	1005	8.10	In Aq	400	17.42	6.85	4.34	1.4	129	100	Turbid, no odor
	1010	8.12	0.5		17.97	6.51	4.31	0.6	89	122	Cloudy, no odor
	1015	8.21	1.0		18.55	6.27	4.28	0.5	84	146	Cloudy, no odor
	1020	8.24	1.5		18.56	6.25	4.28	0.4	80	150	Cloudy, no odor
	1025	8.28	2.0		18.58	6.23	4.26	0.4	79	151	Cloudy, no odor

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	250mL Plastic	N/A	Y		Perchlorate

Sample ID: 17WW03-220405 Sample Time: 1026

Field dup 17WW03-220408-A

01227916

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GROUNDWATER SAMPLE COLLECTION FORM

Page _____ of _____

LOCATION	Site: LHAAP - 17	Location ID: 17WW06	Date: 4-8-22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: ~~Scott Beesinger~~ Derick Berry
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): PVC	Unit Casing Volume (gal/lin ft) (A): 0.65	Initial Depth to Water (ft) (B): 8.48
	Total Well Depth (ft) (C): 22.97	Water Column Thickness (ft) (C-B): 14.49	2nd Depth to Water(pre-purge): 8.48
	Screened Interval: 11.0-21.0	Weather: 50s	Well Volume (gal) (A*(C-B)): 9.4
	Pump placement: 18.50	Well Condition: Poor	Ferrous Iron:

CASING INFO										
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
4-8-22	0845	8.55	Initial	400	17.46	6.83	4.21	0.5	35	155	Clear, no odor
	0850	8.58	0.5		17.54	6.79	4.22	0.3	21	154	Clear, no odor
	0855	8.60	1.0		17.56	6.76	4.22	0.3	18	155	Clear, no odor
	0900	8.61	1.5		17.59	6.74	4.21	0.2	16	156	Clear, no odor
	0905	8.61	2.0		17.58	6.72	4.21	0.2	10	154	Clear, no odor
	0910	8.62	2.5		17.59	6.69	4.21	0.2	8	156	Clear, no odor

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
1	250	Plastic				Perchlorate
Sample ID: 17WW06-220408				Sample Time: 0911		

Trip Blank / 0911

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW01	Date: 8/31/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): 10.00
	Total Well Depth (ft) (C): 33.58	Water Column Thickness (ft) (C-B): 23.58	2nd Depth to Water(pre-purge): 10.00
	Screened Interval: 13.80 - 33.80	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 15.37
	Pump placement: 28.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
8/31/22	0830	10.07	.13	100	24.15	6.56	7.02	0.65	39.7	-23	
	0835	10.13	.26	100	24.31	6.34	7.25	0.27	36.6	-20	
	0840	10.17	.39	100	24.47	6.25	7.35	0.07	35.8	-21	
	0845	10.20	.52	100	24.53	6.24	7.36	0.07	35.2	-21	
	0850	10.22	.65	100	24.67	6.24	7.37	0.06	34.6	-22	
	0855	10.24	.78	100	24.60	6.24	7.37	0.06	34.0	-22	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	200ml Plastic	NA	Y		PERCHLORATE

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW01_083122 Sample Time: 0855

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 130	Date: 8/31/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): PVC 2"	Unit Casing Volume (gal/lin ft) (A): 0.160	Initial Depth to Water (ft) (B): 8.22
	Total Well Depth (ft) (C): 25.53	Water Column Thickness (ft) (C-B): 17.31	2nd Depth to Water(pre-purge): 8.22
	Screened Interval: 10.57 - 25.57	Weather: Clear	Well Volume (gal) (A*(C-B)): 2.77
	Pump placement: 18.07	Well Condition: Needs Paint	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
									44.5		
8/31/22	0700	8.30	.13	100	24.45	7.36	2.60	0.72	[illegible]	-125	
	0705	8.36	.26	100	22.95	6.88	2.66	0.24	38.6	-115	
	0710	8.40	.39	100	22.83	6.73	2.62	0.06	36.8	-114	
	0715	8.42	.52	100	22.77	6.72	2.61	0.05	36.2	-113	
	0720	8.44	.65	100	22.74	6.71	2.60	0.05	35.7	-112	
	0725	8.45	.78	100	22.70	6.71	2.60	0.05	35.3	-112	

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	200ml Plastic	NA	Y		Perchlorate

Conversions	Stabilization Criteria										
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%							
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%							
	Cond	+/- 10%	ORP	+/- 10	Sample ID: 130_083122				Sample Time: 0725		

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW02	Date: 8/31/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water(pre-purge): NA
	Screened Interval: 15.00 -25.00	Weather: CLEAR	Well Volume (gal) (A*(C-B)): NA
	Pump placement: 20.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO										
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
	NO PARAMETERS COLLECTED										
	WELL PUMPS CONTINUOUS										

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	2	200 ml Plastic	NA	Y		PERCHLORATE

Sample ID: 17WW02_083122 Sample Time: 0905

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17		Location ID: ~~18~~ 17WW03		Date: 8/31/22
	Project Name: LHAAP		Project No./Phase: MSC2020.0016.0002.0022		Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro		Water Quality Meter/ID#: U-52 Horiba		PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101		Other Equipment/ID#: NA		Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"		Other Equipment/ID#: NA		PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"		Unit Casing Volume (gal/lin ft) (A): 0.652		Initial Depth to Water (ft) (B): 9.81
	Total Well Depth (ft) (C): 32.03		Water Column Thickness (ft) (C-B): 22.22		2nd Depth to Water(pre-purge): 9.81
	Screened Interval: 22.00 - 32.00		Weather: CLEAR		Well Volume (gal) (A*(C-B)): 14.49
	Pump placement: 27.00		Well Condition: NEEDS PAINT		Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
8/31/22	0750	9.88	.13	100	23.50	7.20	4.17	0.60	96.7	-65	
	0755	9.94	.26	100	23.29	6.73	4.32	0.20	88.5	-62	
	0800	9.98	.39	100	23.24	6.49	4.45	0.03	84.2	-62	
	0805	10.00	.52	100	23.20	6.48	4.46	0.03	83.5	-63	
	0810	10.02	.65	100	23.17	6.48	4.47	0.02	82.9	-62	
↓	0815	10.04	.78	100	23.14	6.47	4.48	0.02	82.2	-62	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	200 ml Plastic	NA	Y		Perchlorate
Sample ID: 17WW03_083122				Sample Time: 0815		

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW06	Date: 8/31/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water(pre-purge): NA
	Screened Interval: 13.54 - 23.54	Weather: CLEAR	Well Volume (gal) (A*(C-B)): NA
	Pump placement: 19.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
			NO	PARAMETERS	COLLECTED						
			WELL	PUMPS	CONTINUOUS						

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		3	200ml Plastic	NA	Y		PERCHLORATE

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW06_083122 Sample Time: 0915

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 130	Date: 10/7/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): PVC 2"	Unit Casing Volume (gal/lin ft) (A): 0.160	Initial Depth to Water (ft) (B): 8.54
	Total Well Depth (ft) (C): 25.50	Water Column Thickness (ft) (C-B): 16.96	2nd Depth to Water(pre-purge): 8.54
	Screened Interval: 10.57 - 25.57	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 2.71
	Pump placement: 18.07	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO										
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
10/7/22	0740	8.61	0.13	100	20.21	7.19	2.74	0.87	18.6	-76	
	0745	8.67	0.26	100	20.42	7.02	2.66	0.43	7.4	-85	
	0750	8.71	0.39	100	20.48	7.01	2.55	0.27	6.7	-90	
	0755	8.73	0.52	100	20.53	7.00	2.54	0.26	6.2	-91	
	0800	8.75	0.65	100	20.57	7.00	2.53	0.26	5.5	-92	
	0805	8.76	0.78	100	20.61	7.00	2.53	0.25	4.8	-92	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	200 ml Plastic	N	Y		PERCHLORATE

Sample ID: 130_100722

Sample Time: 0805

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW01	Date: 10/7/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): 10.52
	Total Well Depth (ft) (C): 33.62	Water Column Thickness (ft) (C-B): 23.10	2nd Depth to Water(pre-purge): 10.52
	Screened Interval: 13.80 - 33.80	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 15.06
	Pump placement: 28.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
10/7/22	0905	10.60	0.13	100	21.45	6.78	7.59	1.03	12.2	-5	
	0910	10.66	0.26	100	21.61	6.62	7.64	0.68	8.7	-10	
	0915	10.70	0.39	100	21.79	6.59	7.65	0.41	8.3	-10	
	0920	10.72	0.52	100	21.84	6.58	7.66	0.40	7.9	-11	
	0925	10.74	0.65	100	21.88	6.58	7.66	0.40	7.2	-12	
↓	0930	10.75	0.78	100	21.91	6.58	7.66	0.39	6.8	-12	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	2	200 ml Plastic	NA	Y		PERCHLORATE

Sample ID: 17WW01-100722 Sample Time: 0930

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW02	Date: 10/7/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water(pre-purge): NA
	Screened Interval: 15.00 - 25.00	Weather: CLEAR	Well Volume (gal) (A*(C-B)): NA
	Pump placement: 20.00	Well Condition: ~~Good~~ NEEDS PAINT	Ferrous Iron: NA

CASING INFO										
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
		NO PARAMETERS Collected									
		WELL Pumps CONTINUOUSLY									

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	200 ml Plastic	NA	Y		PERCHLORATE

Sample ID: 17WW02_100722 Sample Time: 0940

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW03	Date: 10/7/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): 10.15
	Total Well Depth (ft) (C): 31.96	Water Column Thickness (ft) (C-B): 21.81	2nd Depth to Water(pre-purge): 10.15
	Screened Interval: 22.00-32.00	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 14.22
	Pump placement: 27.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
10/7/22	0820	10.22	0.13	100	19.57	7.28	4.23	0.93	4.1	-50	
	0825	10.28	0.26	100	19.60	6.93	4.30	0.61	2.0	-48	
	0830	10.32	0.39	100	19.62	6.84	4.36	0.33	0.8	-48	
	0835	10.35	0.52	100	19.64	6.83	4.37	0.32	0.3	-49	
	0840	10.37	0.65	100	19.66	6.82	4.37	0.31	0.0	-49	
↓	0845	10.39	0.78	100	19.68	6.81	4.38	0.31	0.0	-50	

Colorimeter Results				
Time	Analyte	Dilution	Result	Units

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	3	200 ml Plastic	NA	Y		PERCHLORATE

Sample ID: 17WW03-100722

Sample Time: 0845

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW06	Date: 10/7/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water(pre-purge): NA
	Screened Interval: 13.54-23.54	Weather: CLEAR	Well Volume (gal) (A*(C-B)): NA
	Pump placement: 19.00	Well Condition: NEEDS PAINT	Ferrous Iron: NT

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
			NO PARAMETERS Collected								
			WELL Pumps Continously								

Colorimeter Results				
Time	Analyte	Dilution	Result	Units

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	200ml Plastic	NA	Y		PERCHLORATE
Sample ID: 17WW06.100722				Sample Time: 0950		

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 130	Date: 11/10/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): PVC 2"	Unit Casing Volume (gal/lin ft) (A): 0.160	Initial Depth to Water (ft) (B): 8.73
	Total Well Depth (ft) (C): 25.50	Water Column Thickness (ft) (C-B): 16.77	2nd Depth to Water(pre-purge): 8.73
	Screened Interval: 10.57-25.57	Weather: CLOUDY	Well Volume (gal) (A*(C-B)): 2.68
	Pump placement: 18.07	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
11/10/22	0655	8.80	0.13	100	20.10	7.14	2.63	0.75	29.3	-73	
	0700	8.86	0.26	100	20.30	6.70	2.58	0.22	24.7	-91	
	0705	8.90	0.39	100	20.35	6.59	2.47	0.04	22.6	-100	
	0710	8.92	0.52	100	20.39	6.59	2.46	0.04	22.1	-101	
	0715	8.94	0.65	100	20.44	6.58	2.45	0.03	21.5	-101	
↓	0720	8.95	0.78	100	20.48	6.57	2.45	0.03	21.0	-102	

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		3	200ml Plastic	NA	Y		PERCHLORATE

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 130-111022 Sample Time: 0720

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GROUNDWATER SAMPLE COLLECTION FORM

Page 1 of 1

LOCATION	Site: LHAAP - 17	Location ID: 17WW01	Date: 11/10/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): 10.65
	Total Well Depth (ft) (C): 33.60	Water Column Thickness (ft) (C-B): 22.95	2nd Depth to Water(pre-purge): 10.65
	Screened Interval: 13.80-33.80	Weather: Cloudy	Well Volume (gal) (A*(C-B)): 14.93
	Pump placement: 28.00	Well Condition: Needs Paint	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
11/10/22	0820	10.72	0.13	100	19.20	6.46	7.43	0.63	35.8	-8	
	0825	10.78	0.26	100	20.05	6.11	7.56	0.19	31.5	-9	
	0830	10.82	0.39	100	20.42	6.00	7.63	0.07	28.7	-12	
	0835	10.84	0.52	100	20.44	5.99	7.63	0.07	28.2	-12	
	0840	10.86	0.65	100	20.46	5.98	7.64	0.06	27.7	-13	
	0845	10.87	0.78	100	20.48	5.97	7.64	0.06	27.1	-13	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	200 ml Plastic	NA	Y		Perchlorate

Sample ID: 17WW01-111022

Sample Time: 0845

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

Page 1 of 1

LOCATION	Site: LHAAP - 17	Location ID: [redacted] 17WW02	Date: 11/10/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water(pre-purge): NA
	Screened Interval: 15.00 - 25.00	Weather: CLOUDY	Well Volume (gal) (A*(C-B)): NA
	Pump placement: NA	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
11/10/22											
		WELL	PUMPS		CONTINUOSLY						
		NO	PURGING		NEEDED						

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	200ml PLASTIC	NA	Y		PERCHLORATE

Sample ID: 17WW02-111022

Sample Time: 0905

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW03	Date: 11/10/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): 10.36
	Total Well Depth (ft) (C): 32.01	Water Column Thickness (ft) (C-B): 21.65	2nd Depth to Water(pre-purge): 10.36
	Screened Interval: 22.00-32.00	Weather: Cloudy	Well Volume (gal) (A*(C-B)): 14.12
	Pump placement: 27.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
11/10/22	0740	10.43	0.13	100	19.48	7.33	4.07	0.67	39.3	-59	
	0745	10.48	0.26	100	19.63	6.44	4.18	0.17	35.0	-53	
	0750	10.51	0.39	100	19.81	6.25	4.26	0.03	32.1	-53	
	0755	10.53	0.52	100	19.86	6.24	4.27	0.03	31.4	-52	
	0800	10.55	0.65	100	19.91	6.24	4.28	0.03	30.6	-52	
	0805	10.57	0.78	100	19.95	6.23	4.28	0.02	30.0	-52	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	2	200 ml Plastic	NA	Y		PERCHLORATE

Sample ID: 17WW03-111022 Sample Time: 0805

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GROUNDWATER SAMPLE COLLECTION FORM

Page 1 of 1

LOCATION	Site: LHAAP - 17	Location ID: 17WW06	Date: 11/10/22
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water(pre-purge): NA
	Screened Interval: 14.00-24.00	Weather: Cloudy	Well Volume (gal) (A*(C-B)): NA
	Pump placement: NA	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
11/10/22											
			Well Pumps Continuously								
			No Purging Needed								

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	200ml Plastic	NA	Y		Perchlorate

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW06_11102022 Sample Time: 0910

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GROUNDWATER SAMPLE COLLECTION FORM

Page 1 of 1

LOCATION	Site: LHAAP - 17		Location ID: 130		Date: 1/17/23
	Project Name: LHAAP		Project No./Phase: MSC2020.0016.0002.0022		Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro		Water Quality Meter/ID#: U-52 Horiba		PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101		Other Equipment/ID#: NA		Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"		Other Equipment/ID#: NA		PPE: Level D
WELL INFO	Casing Type / ID (in): PVC 2"		Unit Casing Volume (gal/lin ft) (A): 0.160		Initial Depth to Water (ft) (B): 8.06
	Total Well Depth (ft) (C): 25.52		Water Column Thickness (ft) (C-B): 17.46		2nd Depth to Water(pre-purge): 8.06
	Screened Interval: 10.57 - 25.57		Weather: CLEAR		Well Volume (gal) (A*(C-B)): 2.79
	Pump placement: 18.07		Well Condition: MINOR PAINT		Ferrous Iron: NA

CASING INFO										
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
1/17/23	0750	8.13	0.13	100	16.80	7.52	2.94	2.93	37.7	120	
	0755	8.19	0.26	100	17.59	6.92	2.77	2.79	31.5	104	
	0800	8.23	0.39	100	17.79	6.72	2.59	2.72	28.8	76	
	0805	8.25	0.52	100	17.86	6.71	2.58	2.70	28.4	75	
	0810	8.27	0.65	100	17.91	6.70	257	2.68	27.6	74	
↓	0815	8.28	0.78	100	17.96	6.69	257	2.67	27.2	73	

Colorimeter Results					**No. Containers/Volume/Type**			**Preserv.**	**Filter (Y/N)**	**Method**	**Parameter(s)**
Time	**Analyte**	**Dilution**	**Result**	**Units**		1	250ml Plastic	NA	Y		PERCHLORATE

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 130_011723 Sample Time: 0815

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW01	Date: 1/17/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): 10.02
	Total Well Depth (ft) (C): 33.63	Water Column Thickness (ft) (C-B): 23.61	2nd Depth to Water(pre-purge): 10.02
	Screened Interval: 13.80-33.80	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 15.39
	Pump placement: 28.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
1/17/23	0910	10.09	0.13	100	17.45	6.78	7.19	0.75	124	-43	
	0915	10.15	0.26	100	18.91	6.21	7.22	0.42	110	-38	
	0920	10.18	0.39	100	19.18	6.14	7.26	0.19	105	-38	
	0925	10.20	0.52	100	19.26	6.13	7.27	0.18	103	-37	
	0930	10.22	0.65	100	19.32	6.13	7.27	0.17	101	-37	
↓	0935	10.23	0.78	100	19.37	6.13	7.27	0.17	100	-37	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	3	250ml Plastic	NA	Y		PERCHLORATE

Sample ID: 17WW01-011723 Sample Time: 0935

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW02	Date: 1/17/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water(pre-purge): NA
	Screened Interval: 15.00-25.00	Weather: CLEAR	Well Volume (gal) (A*(C-B)): NA
	Pump placement: 20.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
		WELL		PUMPS		CONTINOUSLY					
			NO	PURGING		REQUIRED					

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	250ml Plastic	NA	Y		PERCHLORATE

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW02_011723 Sample Time: 0945

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GROUNDWATER SAMPLE COLLECTION FORM

Page 1 of 1

LOCATION	Site: LHAAP - 17	Location ID: 17WW03	Date: 1/17/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): 9.72
	Total Well Depth (ft) (C): 32.03	Water Column Thickness (ft) (C-B): 22.31	2nd Depth to Water(pre-purge): 9.72
	Screened Interval: 22.00 - 32.00	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 14.55
	Pump placement: 27.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
1/17/23	0830	9.79	0.13	100	17.34	6.81	4.18	0.89	208	-61	
	0835	9.84	0.26	100	17.88	6.39	4.21	0.50	188	-56	
	0840	9.87	0.39	100	17.96	6.28	4.27	0.30	176	-56	
	0845	9.89	0.52	100	18.02	6.28	4.27	0.29	174	-56	
	0850	9.90	0.65	100	18.08	6.27	4.28	0.29	172	-57	
	0855	9.91	0.78	100	18.13	6.26	4.28	0.28	171	-57	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	2	250ml Plastic	NA	Y		PERCHLORATE

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW03_011723 Sample Time: 0855

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17		Location ID: 17WW06		Date: 1/17/23
	Project Name: LHAAP		Project No./Phase: MSC2020.0016.0002.0022		Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro		Water Quality Meter/ID#: U-52 Horiba		PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101		Other Equipment/ID#: NA		Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"		Other Equipment/ID#: NA		PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"		Unit Casing Volume (gal/lin ft) (A): 0.652		Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA		Water Column Thickness (ft) (C-B): NA		2nd Depth to Water(pre-purge): NA
	Screened Interval: 14.00-24.00		Weather: CLEAR		Well Volume (gal) (A*(C-B)): NA
	Pump placement: 19.00		Well Condition: NEEDS PAINT		Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
		WELL PUMPS CONTINOUSLY									
		NO PURGING REQUIRED									

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	250ml Plastic	NA	Y		PERCHLORATE
Sample ID: 17WW06-011723				Sample Time: 0950		

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GROUNDWATER SAMPLE COLLECTION FORM

Page 1 of 1

LOCATION	Site: LHAAP - 17	Location ID: 130	Date: 2/10/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): PVC 2"	Unit Casing Volume (gal/lin ft) (A): 0.160	Initial Depth to Water (ft) (B): 7.37
	Total Well Depth (ft) (C): 25.52	Water Column Thickness (ft) (C-B): 18.15	2nd Depth to Water (pre-purge): 7.37
	Screened Interval: 10.57 - 25.57	Weather: CLEAR / COLD	Well Volume (gal) (A*(C-B)): 2.90
	Pump placement: 18.07	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO										
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
2/10/23	0725	7.45	0.13	100	13.20	7.07	2.19	0.73	68.7	153	
	0730	7.50	0.26	100	14.75	6.95	2.22	0.25	61.1	151	
	0735	7.53	0.39	100	15.15	6.84	2.21	0.09	57.1	143	
	0740	7.56	0.52	100	15.21	6.83	2.20	0.09	56.5	142	
	0745	7.58	0.65	100	15.25	6.82	2.20	0.08	55.8	141	
↓	0750	7.60	0.78	100	15.30	6.82	2.20	0.08	55.2	140	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	125 ml Plastic	NA	Y		PERCHLORATE

Sample ID: 130-021023 Sample Time: 0750

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW01	Date: 2/10/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): 9.29
	Total Well Depth (ft) (C): 33.67	Water Column Thickness (ft) (C-B): 24.38	2nd Depth to Water(pre-purge): 9.29
	Screened Interval: 13.80 - 33.80	Weather: CLEAR/COLD	Well Volume (gal) (A*(C-B)): 15.90
	Pump placement: 28.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
2/10/23	0850	9.36	0.13	100	14.10	6.07	1.33	0.70	33.7	131	
	0855	9.40	0.26	100	14.88	5.61	1.55	0.21	25.6	140	
	0900	9.43	0.39	100	15.61	5.20	1.68	0.05	21.8	145	
	0905	9.46	0.52	100	15.66	5.19	1.68	0.05	21.2	146	
	0910	9.48	0.65	100	15.70	5.18	1.69	0.05	20.6	146	
	0915	9.50	0.78	100	15.75	5.17	1.69	0.04	20.1	147	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	125ml PLASTIC	NA	Y		PERCHLORATE

Sample ID: 17WW01-021023 Sample Time: 0915

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17		Location ID: 17WW02		Date: 2/10/23
	Project Name: LHAAP		Project No./Phase: MSC2020.0016.0002.0022		Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro		Water Quality Meter/ID#: U-52 Horiba		PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101		Other Equipment/ID#: NA		Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"		Other Equipment/ID#: NA		PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"		Unit Casing Volume (gal/lin ft) (A): 0.652		Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA		Water Column Thickness (ft) (C-B): NA		2nd Depth to Water(pre-purge): NA
	Screened Interval: 15.00 - 25.00		Weather: CLEAR/COLD		Well Volume (gal) (A*(C-B)): NA
	Pump placement: 20.00		Well Condition: NEEDS PAINT		Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
		WELL PURGES CONTINOUSLY									
		NO PURGING REQUIRD									

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		3	125ml Plastic	NA	Y		Perchlorate

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW02-021023 Sample Time: 0925

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17		Location ID: 17WW03		Date: 2/10/23
	Project Name: LHAAP		Project No./Phase: MSC2020.0016.0002.0022		Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro		Water Quality Meter/ID#: U-52 Horiba		PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101		Other Equipment/ID#: NA		Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"		Other Equipment/ID#: NA		PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"		Unit Casing Volume (gal/lin ft) (A): 0.652		Initial Depth to Water (ft) (B): 9.08
	Total Well Depth (ft) (C): 32.03		Water Column Thickness (ft) (C-B): 22.95		2nd Depth to Water (pre-purge): 9.08
	Screened Interval: 22.00 - 32.00		Weather: CLEAR / COLD		Well Volume (gal) (A*(C-B)): 14.96
	Pump placement: 27.00		Well Condition: NEEDS PAINT		Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
2/10/23	0810	9.15	0.13	100	13.91	6.81	1.77	0.66	88.3	137	
	0815	9.20	0.26	100	14.87	6.53	1.89	0.21	82.5	159	
	0820	9.23	0.39	100	15.41	6.30	1.97	0.06	78.7	170	
	0825	9.25	0.52	100	15.45	6.30	1.98	0.06	78.2	171	
	0830	9.27	0.65	100	15.50	6.29	1.98	0.05	77.6	172	
	0835	9.28	0.78	100	15.54	6.28	1.99	0.05	77.0	172	

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	125ml PLASTIC	NA	Y		PERCHLORATE

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW03_021023 Sample Time: 0835

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW06	Date: 2/10/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water (pre-purge): NA
	Screened Interval: 14.00 - 24.00	Weather: CLEAR/COLD	Well Volume (gal) (A*(C-B)): NA
	Pump placement: 19.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
		WELL OPERATES CONTINUOUSLY									
		NO PURGING REQUIRED									

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type	Preserv.	Filter (Y/N)	Method	Parameter(s)
2 125ml Plastic	NA	Y		PERCHLORATE

Sample ID: 17WW06_021023 Sample Time: 0935

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 130	Date: 3/9/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): PVC 2"	Unit Casing Volume (gal/lin ft) (A): 0.160	Initial Depth to Water (ft) (B): 7.13
	Total Well Depth (ft) (C): 25.51	Water Column Thickness (ft) (C-B): 18.38	2nd Depth to Water(pre-purge): 7.13
	Screened Interval: 10.57 - 25.57	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 2.94
	Pump placement: 18.07	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO										
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
3/9/23	0705	7.20	0.13	100	17.49	7.45	2.50	1.67	54.5	136	
	0710	7.26	0.26	100	17.50	6.95	2.53	1.38	50.1	375	
	0715	7.30	0.39	100	17.52	7.15	2.49	1.26	47.7	39	
	0720	7.32	0.52	100	17.55	7.17	2.48	1.24	47.3	38	
	0725	7.33	0.65	100	17.57	7.19	2.47	1.22	46.6	37	
↓	0730	7.34	0.78	100	17.59	7.20	2.47	1.20	46.2	36	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	2	250ml Plastic	NA	Y		Perchlorate

Sample ID: 130_030923 Sample Time: 0730

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17MW01	Date: 3/9/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): 9.23
	Total Well Depth (ft) (C): 33.71	Water Column Thickness (ft) (C-B): 24.48	2nd Depth to Water(pre-purge): 9.23
	Screened Interval: 13.80-33.80	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 15.96
	Pump placement: 28.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO										
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
3/9/23	0840	9.30	0.13	100	18.13	7.29	6.46	0.20	161	-40	
	0845	9.35	0.26	100	18.41	6.61	6.48	0.22	152	-30	
	0850	9.38	0.39	100	18.45	6.45	6.48	0.07	148	-30	
	0855	9.40	0.52	100	18.49	6.44	6.48	0.07	146	-29	
	0900	9.42	0.65	100	18.52	6.43	6.48	0.07	145	-29	
↓	0905	9.43	0.78	100	18.56	6.42	6.48	0.06	144	-30	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	3	250ml Plastic	NA	Y		PERCHLORATE

Sample ID: 17MW01_030923 Sample Time: 0905

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GROUNDWATER SAMPLE COLLECTION FORM

Page 1 of 1

LOCATION	Site: LHAAP - 17	Location ID: 17WW02	Date: 3/9/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water(pre-purge): NA
	Screened Interval: 15.00 - 25.00	Weather: CLEAR	Well Volume (gal) (A*(C-B)): NA
	Pump placement: 20.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
			WELL		Pumps		CONTINUOUSLY				
			NO	PURGING		REQUIRED					

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	250 ml Plastic	NA	Y		PERCHLORATE

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW02-030923 Sample Time: 0915

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GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW03	Date: 3/9/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): 8.90
	Total Well Depth (ft) (C): 32.02	Water Column Thickness (ft) (C-B): 23.12	2nd Depth to Water(pre-purge): 8.90
	Screened Interval: 22.00-32.00	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 15.07
	Pump placement: 27.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
3/9/23	0755	8.97	0.13	100	17.40	7.55	4.00	0.67	195	-90	
	0800	9.03	0.26	100	17.70	6.79	4.06	0.21	182	-55	
	0805	9.07	0.39	100	17.88	6.68	4.08	0.06	162	-55	
	0810	9.09	0.52	100	17.93	6.68	4.09	0.06	161	-56	
	0815	9.11	0.65	100	17.97	6.68	4.09	0.05	159	-57	
	0820	9.12	0.78	100	18.02	6.67	4.09	0.05	157	-57	

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	250ml Plastic	NA	Y		Perchlorate

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW03_030923 Sample Time: 0820

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GROUNDWATER SAMPLE COLLECTION FORM

Page 1 of 1

LOCATION	Site: LHAAP - 17	Location ID: 17WW06	Date: 3/9/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): ' NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water(pre-purge): NA
	Screened Interval: 14.00 - 24.00	Weather: CLEAR	Well Volume (gal) (A*(C-B)): NA
	Pump placement: 19.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
		WELL PUMPS CONTINUOUSLY									
		NO PURGING REQUIRED									

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	250ml PLASTIC	NA	Y		PERCHLORATE

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW06-030923 Sample Time: 0920

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 130	Date: 6/1/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): PVC 2"	Unit Casing Volume (gal/lin ft) (A): 0.160	Initial Depth to Water (ft) (B): 6.35
	Total Well Depth (ft) (C): 25.52	Water Column Thickness (ft) (C-B): 19.17	2nd Depth to Water(pre-purge): 6.35
	Screened Interval: 10.57 - 25.57	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 3.07
	Pump placement: 18.07	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO										
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
6/1/23	0645	6.42	0.13	100	21.54	7.41	3.15	0.66	5.4	[redacted]41	
	0650	6.48	0.26	100	19.98	6.95	3.16	0.21	2.8	28	
	0655	6.52	0.39	100	19.88	6.84	3.10	0.05	1.3	4	
	0700	6.54	0.52	100	19.83	6.83	3.09	0.05	0.7	3	
	0705	6.55	0.65	100	19.77	6.82	3.09	0.04	0.0	3	
	0710	6.56	0.78	100	19.74	6.82	3.08	0.04	0.0	3	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	1	125ml Plastic	NA	Y		PERCHLORATE

Sample ID: 130-060123 Sample Time: 0710

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW01	Date: 6/1/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): 8.12
	Total Well Depth (ft) (C): 33.63	Water Column Thickness (ft) (C-B): 25.51	2nd Depth to Water(pre-purge): 8.12
	Screened Interval: 13.80-33.80	Weather: CLEAR	Well Volume (gal) (A*(C-B)): 16.32
	Pump placement: 28.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
6/1/23	0805	8.20	0.13	100	22.32	6.81	6.27	0.60	15.6	-48	
	0810	8.26	0.26	100	21.96	6.45	6.63	0.19	9.3	-25	
	0815	8.29	0.39	100	22.09	6.35	6.85	0.04	8.6	-29	
	0820	8.31	0.52	100	22.17	6.34	6.87	0.04	7.5	-30	
	0825	8.33	0.65	100	22.23	6.33	6.88	0.03	7.0	-30	
↓	0830	8.34	0.78	100	22.28	6.32	6.89	0.03	6.8	-30	

Colorimeter Results

Time	Analyte	Dilution	Result	Units

Conversions	**Stabilization Criteria**			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
	2	125ml PLASTIC	NA	Y		PERCHLORATE

Sample ID: 17WW01-060123 Sample Time: 0830

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17	Location ID: 17WW02	Date: 6/1/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water(pre-purge): NA
	Screened Interval: 15.00-2500	Weather: CLEAR	Well Volume (gal) (A*(C-B)): NA
	Pump placement: 20.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
		WELL PUMPS CONTINUOUSLY									
		NO PURGING REQUIRED									

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	125ml Plastic	NA	Y		PERCHLORATE

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW02-060123 Sample Time: 0838

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

LOCATION	Site: LHAAP - 17		Location ID: 17WW03		Date: 6/1/23
	Project Name: LHAAP		Project No./Phase: MSC2020.0016.0002.0022		Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro		Water Quality Meter/ID#: U-52 Horiba		PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101		Other Equipment/ID#: NA		Decon Method: Liqui inox & DI water
	Tubing Type/Diameter (in): 1/4"		Other Equipment/ID#: NA		PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"		Unit Casing Volume (gal/lin ft) (A): 0.652		Initial Depth to Water (ft) (B): 8.06
	Total Well Depth (ft) (C): 32.02		Water Column Thickness (ft) (C-B): 23.96		2nd Depth to Water(pre-purge): 8.06
	Screened Interval: 22.00-32.00		Weather: CLEAR		Well Volume (gal) (A*(C-B)): 15.62
	Pump placement: 27.00		Well Condition: NEEDS PAINT		Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
6/1/23	0725	8.13	0.13	100	20.22	6.85	4.50	0.70	88.7	-44	
	0730	8.18	0.26	100	20.50	6.48	4.60	0.23	79.6	-48	
	0735	8.21	0.39	100	20.62	6.42	4.68	0.07	76.2	-51	
	0740	8.24	0.52	100	20.67	6.42	4.69	0.07	75.5	-52	
	0745	8.26	0.65	100	20.72	6.41	4.70	0.07	74.8	-52	
↓	0750	8.28	0.78	100	20.76	6.41	4.70	0.06	74.1	-52	

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		3	125ml Plastic	NA	Y		PERCHLORATE

Conversions	Stabilization Criteria									
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%						
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%						
	Cond	+/- 10%	ORP	+/- 10	Sample ID: 17WW03_060123				Sample Time: 0750	

bhate ENVIRONMENT INFRASTRUCTURE

GROUNDWATER SAMPLE COLLECTION FORM

Page 1 of 1

LOCATION	Site: LHAAP - 17	Location ID: 17WW06	Date: 6/1/23
	Project Name: LHAAP	Project No./Phase: MSC2020.0016.0002.0022	Recorded By: Scott Beesinger
EQUIPMENT	Pump Type/ID#: Bladder Pump / SamplePro	Water Quality Meter/ID#: U-52 Horiba	PID Type/ID#: NA
	Water Level Indicator Type/ID#: Solinist 101	Other Equipment/ID#: NA	Decon Method: Liquinox & DI water
	Tubing Type/Diameter (in): 1/4"	Other Equipment/ID#: NA	PPE: Level D
WELL INFO	Casing Type / ID (in): SS 4"	Unit Casing Volume (gal/lin ft) (A): 0.652	Initial Depth to Water (ft) (B): NA
	Total Well Depth (ft) (C): NA	Water Column Thickness (ft) (C-B): NA	2nd Depth to Water(pre-purge): NA
	Screened Interval: 14.00-24.00	Weather: CLEAR	Well Volume (gal) (A*(C-B)): NA
	Pump placement: 19.00	Well Condition: NEEDS PAINT	Ferrous Iron: NA

CASING INFO											
Casing ID (in)	0.5	0.75	1.0	1.5	2.0	3.0	4.0	5.0	6.0	8.0
Unit Casing Volume (gal/lin ft)	0.016	0.020	0.043	0.103	0.160	0.378	0.652	1.03	1.48	2.57

DATE	TIME (24 Hr)	Water Level (BTOC)	Volume Removed (Gals)	Pumping Rate (ml/min)	Temp (C)	pH	Cond (mS/cm)	DO (mg/l)	Turb (NTU)	ORP (mV)	Remarks (odor, clarity, etc.)
		Well Pumps Continously									
		NO PURGING REQUIRED									

Colorimeter Results					No. Containers/Volume/Type			Preserv.	Filter (Y/N)	Method	Parameter(s)
Time	Analyte	Dilution	Result	Units		1	125ml Plastic	NA	Y		Perchlorate

Conversions	Stabilization Criteria			
1 L = 0.26 gals	Temp	+/- 10%	DO	+/- 10%
1 gal = 3.79 L	pH	+/- 0.1	Turb	+/- 10%
	Cond	+/- 10%	ORP	+/- 10

Sample ID: 17WW06-060123 Sample Time: 0843

APPENDIX C
QUALITY CONTROL SUMMARY REPORTS

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QUALITY CONTROL SUMMARY REPORT
LHAAP 17
LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

Prepared For:





U.S. Army Corps of Engineers

Prepared By:

bhate

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Birmingham, Alabama 35205
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April 2022

Table of Contents

1 INTRODUCTION 3
1.1 Intended Use of Data 3
1.2 Preservation and Holding Times 3
1.3 Blanks 3
1.4 Laboratory Control Sample (LCS)/Laboratory Control Sample Duplicate (LCSD) 3
1.5 Field Precision 3
2 DATA USABILITY SUMMARY 3

List of Tables

Table 1: Field Sample Identification and Laboratory Identification
Table 2: Qualified Analytical Data
Table 3: Completeness by Method

1 INTRODUCTION

Bhate reviewed 11 data packages from ALS Environmental, Houston, Texas. Perchlorate samples were collected January 2021 to April 2022 at site LHAAP 17 at the Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas. Data were reviewed for conformance to the requirements of the following guidance documents: *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review* (USEPA, November 2020) and the *Final Basewide Uniform Federal Policy* [UFP] – *Quality Assurance Project Plan* [QAPP] *Longhorn Army Ammunition Plant* which is in Appendix C of the *Final Installation-Wide Work Plan for Longhorn Army Ammunition Plant Karnack, Texas* (Bhate, May 2018).

1.1 Intended Use of Data

Analyses requested included:

- SW6850 – Perchlorate

Table 1 lists the sample identification (ID) numbers and their associated laboratory ID numbers.

Table 2 lists qualified results with the associated quality control parameter that was exceeded.

1.2 Preservation and Holding Times

Sample ID data were evaluated for agreement with the chain-of-custody (COC). All samples were received in appropriate containers, within the proper temperature range, in good condition, and with the required signatures.

1.3 Blanks

If the sample result for an associated sample was non-detect or less than 5X the analyte concentration in the blank, the corresponding sample result for the analyte was qualified UB. Where the sample result for the affected analyte was greater than 5X the amount in the blank, no qualifier was applied.

Perchlorate was not detected in the method blanks.

1.4 Laboratory Control Sample (LCS)/Laboratory Control Sample Duplicate (LCSD)

LCS/LCSD recoveries were evaluated using limits defined for each method in Worksheet 15 of the project-specific QAPP.

All LCS/LCSD recoveries were within the control limits.

1.5 Field Precision

Precision is the measure of variability of individual sample measurements. Evaluation of field duplicates for precision was done using the Relative Percent Difference (RPD). The RPD is defined as the difference between two duplicate samples divided by the mean and expressed as a percent. Field duplicate RPD limits were set at <30% for groundwater matrices.

The RPD was within control limits when a field duplicate was collected.

2 DATA USABILITY SUMMARY

The data are usable for the intended purposes of the project (see Table 3). The data quality objectives have been met for the project.

Table 1: Field Sample Identification and Laboratory Identification

Client Sample Identification	Laboratory Package	Perchlorate
LHAAP17_012521_H1	HS21011069	X
LHAAP17_012521_H2		X
17WW20_063021	HS21070060	X
17WW12_063021		X
17WW11_063021		X
17WW11_063021_a		X
17WW06_063021		X
17WW10_063021		X
17WW19_063021		X
LHAAP17_AreaH_092021	E2101018	X
LHAAP17_AreaH_100721	E2101075	X
LHAAP17_AreaH_101321	E2101100	X
LHAAP-17_AreaH_101921	E2101113	X
LHAAP-17_AREA H_110421	E2101176	X
LHAAP17_Area H_011022	HS22010352	X
LHAAP17_AreaH_021022	HS22020587	X
17WW01_220408	HS22040532	X
17WW02_220408		X
17WW03_220408		X
17WW03_220408-A		X
17WW06_220408		X
17WW130_220408		X
17WW01_042122	E2200359	X

Notes:

SW-846 - Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, X – Sample analyzed for indicated parameter

Table 2: Qualified Analytical Data

Client Sample Identification	Laboratory Sample Identification	Analyte Name	Data Validation Qualifier	Reason for Qualification
N/A	N/A	N/A	N/A	N/A

N/A – Not applicable

Table 3: Completeness by Method

Analysis	No. of Rejected Results	% Completeness
Perchlorate	0	100

QUALITY CONTROL SUMMARY REPORT

LHAAP 17

LONGHORN ARMY AMMUNITION PLANT

KARNACK, TEXAS

Prepared For:





U.S. Army Corps of Engineers

Prepared By:

bhate

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September 2023

Table of Contents

1 INTRODUCTION 1
1.1 Intended Use of Data 1
1.2 Preservation and Holding Times 1
1.3 Calibrations 1
1.3.1 Continuing Calibration Verifications (CCV) 1
1.4 Blanks 1
1.5 Laboratory Control Sample(LCS)/Laboratory Control Sample Duplicate(LCSD) 2
1.6 Matrix Spike (MS)/Matrix Spike Duplicate Sample (MSD) 2
1.7 Internal Standards 2
1.8 Field Precision 2
2 DATA USABILITY SUMMARY 2

List of Tables

Table 1: Field Sample Identification and Laboratory Identification
Table 2: Qualified Analytical Data
Table 3: Completeness by Method

1 INTRODUCTION

Bhate reviewed four data packages from ALS Environmental, Houston, Texas. Water samples were collected January 17th, February 10th, March 9th, and June 1st 2023, from site LHAAP 17 for monthly perchlorate monitoring at the Longhorn Army Ammunition Plant (LHAAP), Karnack, Texas. Data were reviewed for conformance to the requirements of the following guidance documents: *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review* (USEPA, November 2020) and the *Final Basewide Uniform Federal Policy (UFP) – Quality Assurance Project Plan (QAPP) Longhorn Army Ammunition Plant* (Bhate, May 2018).

1.1 Intended Use of Data

Analysis included:

- SW6850 – Perchlorate by LC/MS/MS

Table 1 lists the sample identification numbers (IDs) and their associated laboratory package.

Table 2 lists qualified results with the associated quality control parameter that was exceeded.

The following narrative is a brief synopsis of the quality control data.

1.2 Preservation and Holding Times

Sample identification data were evaluated for agreement with the chain-of-custody (COC). All samples were received in appropriate containers, within the proper temperature range, in good condition, and with the required signatures.

1.3 Calibrations

All analytes reported must be present in the initial and continuing calibration. The calibrations must meet the acceptance criteria specified in Worksheet 24 (Analytical Instrument Calibration) of the QAPP. All results reported must be within the calibration range. Samples were diluted, if necessary, to bring analyte responses within the calibration range.

All calibrations met the method criteria.

1.3.1 Continuing Calibration Verifications (CCV)

The continuing calibration verification (CCV) acceptance criteria are specified in Worksheet 24 of the project-specific QAPP. For perchlorate, the methods criteria are if the CCV is outside ±15% difference (%D) the lab will reanalyze all samples since last acceptable CCV; 20% for VOCs and explosives. If reanalysis cannot be performed, all results in all samples since last acceptable CCV are qualified J or UJ.

All CCVs were within the acceptance criteria.

1.4 Blanks

If the sample result for an associated sample was non-detect or less than 5X (10X for common laboratory contaminants) the analyte concentration in the blank, the corresponding sample result for the analyte was qualified UB. Where the sample result for the affected analyte was greater

than 5X (10X) the amount in the blank, no qualifier was applied.

No compounds were detected in the blanks.

1.5 Laboratory Control Sample (LCS)/Laboratory Control Sample Duplicate(LCSD)

LCS/LCSD recoveries were evaluated using limits defined for each method in Worksheet 15 of the project-specific QAPP.

All LCS/LCSD recoveries were within the control limits.

1.6 Matrix Spike (MS)/Matrix Spike Duplicate Sample (MSD)

MS/MSD recoveries were evaluated using limits defined in Worksheet 15 of the project-specific QAPP. When sample results were greater than 4x the spike amount, control limits were not applicable and require no qualification. Furthermore, if a MS/MSD analyses was performed on a batched (unrelated) sample no qualification was made to the sample data.

The MS recovery for 17WW01_030923 was below control limits. The reported result was considered estimated and flagged “J”.

1.7 Internal Standards.

When the percent recovery for an internal standard in a sample is outside the laboratory limits, the associated sample is qualified for the analytes associated with the internal standard(s) outside of the acceptance criteria.

Internal standard recoveries were within the acceptance criteria.

1.8 Field Precision

Precision is the measure of variability of individual sample measurements. Evaluation of field duplicates for precision was done using the Relative Percent Difference (RPD). The RPD is defined as the difference between two duplicate samples divided by the mean and expressed as a percent. Field duplicate RPD limits were set at <30% for groundwater matrices.

The RPD exceeded project control limits between samples 17WW03_011723, 17WW01_060123 and their duplicates. The results were considered estimated and flagged “J” in both sets of samples.

2 DATA USABILITY SUMMARY

The data are usable for the intended purposes of the project (see Table 3). The data quality objectives have been met for the project.

Table 1: Field Sample Identification and Laboratory Identification

Client Sample ID	Laboratory Package	SW6850
130_011723	E2300067-001	X
17WW01_011723	E2300067-004	X
17WW02_011723	E2300067-005	X
17WW03_011723	E2300067-002	X
17WW03_011723_a	E2300067-003	X
17WW06_011723	E2300067-006	X
130_021023	E2300137-001	X
17WW01_021023	E2300137-003	X
17WW02_021023	E2300137-004	X
17WW03_021023	E2300137-002	X
17WW06_021023	E2300137-005	X
17WW06_021023_a	E2300137-006	X
130_030923	E2300238-001	X
130_030923_a	E2300238-002	X
17WW01_030923	E2300238-004	X
17WW02_030923	E2300238-005	X
17WW03_030923	E2300238-003	X
17WW06_030923	E2300238-006	X
130_060123	E2300528-001	X
17WW01_060123	E2300528-003	X
17WW01_060123_a	E2300528-004	X
17WW02_060123	E2300528-005	X
17WW03_060123	E2300528-002	X
17WW06_060123	E2300528-006	X

Table 2: Qualified Analytical Data

Client Sample ID	Laboratory Package	Analyte Name	Data Validation Qualifier (µg/L)	Reason for Qualification
17WW03_011723	E2300067	Perchlorate	0.0417 J	FD RPD
17WW03_011723_a	E2300067	Perchlorate	0.0304 J	FD RPD
17WW01_030923	E2300238	Perchlorate	0.0332 J	MS <
17WW01_060123	E2300528	Perchlorate	0.0606 J	FD RPD
17WW01_060123_a	E2300528	Perchlorate	0.114 J	FD RPD

FD RPD – field duplicate relative percent difference outside control limits, MS < - matrix spike below control limits, µg/L – micrograms per liter

Table 3: Completeness by Method

Method	No. of Rejected Results	% Completeness
SW6850	0	100
SW-846 - Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.		

APPENDIX D
LABORATORY DATA PACKAGES

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10450 Stancliff Rd. Suite 210
Houston, TX 77099
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July 16, 2021

Marcia Olive
Bhate Environmental Associates, Inc.
445 Union Blvd Ste 129
Lakewood, CO 80228

Work Order: **HS21070060**

Laboratory Results for: **LHAAP 17**

Dear Marcia Olive,

ALS Environmental received 7 sample(s) on Jul 01, 2021 for the analysis presented in the following report.

The analytical data provided relates directly to the samples received by ALS Environmental and for only the analyses requested. Results are expressed as "as received" unless otherwise noted.

QC sample results for this data met EPA or laboratory specifications except as noted in the Case Narrative or as noted with qualifiers in the QC batch information. Should this laboratory report need to be reproduced, it should be reproduced in full unless written approval has been obtained by ALS Environmental. Samples will be disposed in 30 days unless storage arrangements are made.

If you have any questions regarding this report, please feel free to call me.

Sincerely,



Generated By: JUMOKE.LAWAL
Ragen Giga
Project Manager

ALS Houston, US Date: 16-Jul-21

Client: Bhate Environmental Associates, Inc.
Project: LHAAP 17
Work Order: HS21070060

SAMPLE SUMMARY

Lab Samp ID	Client Sample ID	Matrix	TagNo	Collection Date	Date Received	Hold
HS21070060-01	17WW20_063021	Groundwater		30-Jun-2021 07:10	01-Jul-2021 09:55	☐
HS21070060-02	17WW12_063021	Groundwater		30-Jun-2021 07:50	01-Jul-2021 09:55	☐
HS21070060-03	17WW11_063021	Groundwater		30-Jun-2021 08:40	01-Jul-2021 09:55	☐
HS21070060-04	17WW11_063021_a	Groundwater		30-Jun-2021 08:40	01-Jul-2021 09:55	☐
HS21070060-05	17WW06_063021	Groundwater		30-Jun-2021 09:25	01-Jul-2021 09:55	☐
HS21070060-06	17WW10_063021	Groundwater		30-Jun-2021 10:10	01-Jul-2021 09:55	☐
HS21070060-07	17WW19_063021	Groundwater		30-Jun-2021 11:00	01-Jul-2021 09:55	☐

ALS Houston, US Date: 16-Jul-21

Client: Bhate Environmental Associates, Inc.
Project: LHAAP 17
Work Order: HS21070060

CASE NARRATIVE

Work Order Comments

- The analysis for Perchlorate was subcontracted to ALS High Res Lab Houston, TX. Final report attached.

ALS Houston, US Date: 16-Jul-21

Client: Bhate Environmental Associates, Inc.
Project: LHAAP 17
Sample ID: 17WW20_063021
Collection Date: 30-Jun-2021 07:10

ANALYTICAL REPORT
WorkOrder:HS21070060
Lab ID:HS21070060-01
Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	16-Jul-2021 18:47

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 16-Jul-21

Client: Bhate Environmental Associates, Inc.
Project: LHAAP 17
Sample ID: 17WW12_063021
Collection Date: 30-Jun-2021 07:50

ANALYTICAL REPORT
WorkOrder:HS21070060
Lab ID:HS21070060-02
Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	16-Jul-2021 18:47

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 16-Jul-21

Client: Bhate Environmental Associates, Inc.
Project: LHAAP 17
Sample ID: 17WW11_063021
Collection Date: 30-Jun-2021 08:40

ANALYTICAL REPORT
WorkOrder:HS21070060
Lab ID:HS21070060-03
Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	16-Jul-2021 18:47

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 16-Jul-21

Client: Bhate Environmental Associates, Inc.
Project: LHAAP 17
Sample ID: 17WW11_063021_a
Collection Date: 30-Jun-2021 08:40

ANALYTICAL REPORT
WorkOrder:HS21070060
Lab ID:HS21070060-04
Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	16-Jul-2021 18:47

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 16-Jul-21

Client: Bhate Environmental Associates, Inc.
Project: LHAAP 17
Sample ID: 17WW06_063021
Collection Date: 30-Jun-2021 09:25

ANALYTICAL REPORT
WorkOrder:HS21070060
Lab ID:HS21070060-05
Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	16-Jul-2021 18:47

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 16-Jul-21

Client: Bhate Environmental Associates, Inc.
Project: LHAAP 17
Sample ID: 17WW10_063021
Collection Date: 30-Jun-2021 10:10

ANALYTICAL REPORT
WorkOrder:HS21070060
Lab ID:HS21070060-06
Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	16-Jul-2021 18:47

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 16-Jul-21

Client: Bhate Environmental Associates, Inc.
Project: LHAAP 17
Sample ID: 17WW19_063021
Collection Date: 30-Jun-2021 11:00

ANALYTICAL REPORT
WorkOrder:HS21070060
Lab ID:HS21070060-07
Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	16-Jul-2021 18:47

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 16-Jul-21

Client: Bhate Environmental Associates, Inc.
Project: LHAAP 17
WorkOrder: HS21070060

DATES REPORT

Sample ID	Client Samp ID	Collection Date	Leachate Date	Prep Date	Analysis Date	DF
Batch ID: R387637 (0)	**Test Name :** SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)				**Matrix:** Groundwater	
HS21070060-01	17WW20_063021	30 Jun 2021 07:10			16 Jul 2021 18:47	1
HS21070060-02	17WW12_063021	30 Jun 2021 07:50			16 Jul 2021 18:47	1
HS21070060-03	17WW11_063021	30 Jun 2021 08:40			16 Jul 2021 18:47	1
HS21070060-04	17WW11_063021_a	30 Jun 2021 08:40			16 Jul 2021 18:47	1
HS21070060-05	17WW06_063021	30 Jun 2021 09:25			16 Jul 2021 18:47	1
HS21070060-06	17WW10_063021	30 Jun 2021 10:10			16 Jul 2021 18:47	1
HS21070060-07	17WW19_063021	30 Jun 2021 11:00			16 Jul 2021 18:47	1

ALS Houston, US Date: 16-Jul-21

Client: Bhate Environmental Associates, Inc.
Project: LHAAP 17
WorkOrder: **HS21070060**

QUALIFIERS, ACRONYMS, UNITS

Qualifier	Description
*	Value exceeds Regulatory Limit
a	Not accredited
B	Analyte detected in the associated Method Blank above the Reporting Limit
E	Value above quantitation range
H	Analyzed outside of Holding Time
J	Analyte detected below quantitation limit
M	Manually integrated, see raw data for justification
n	Not offered for accreditation
ND	Not Detected at the Reporting Limit
O	Sample amount is > 4 times amount spiked
P	Dual Column results percent difference > 40%
R	RPD above laboratory control limit
S	Spike Recovery outside laboratory control limits
U	Analyzed but not detected above the MDL/SDL

Acronym	Description
DCS	Detectability Check Study
DUP	Method Duplicate
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MBLK	Method Blank
MDL	Method Detection Limit
MQL	Method Quantitation Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PDS	Post Digestion Spike
PQL	Practical Quantitaion Limit
SD	Serial Dilution
SDL	Sample Detection Limit
TRRP	Texas Risk Reduction Program

CERTIFICATIONS,ACCREDITATIONS & LICENSES

Agency	Number	Expire Date
Arkansas	21-022-0	26-Mar-2022
Dept of Defense	PJLA L20-507-R2	22-Dec-2021
Florida	E87611-33	30-Jun-2022
Illinois	2000322021-7	09-May-2022
Kansas	E-10352 2020-2021	31-Jul-2021
Kentucky	123043, 2021-2022	30-Apr-2022
Louisiana	03087, 2021-2022	30-Jun-2022
North Carolina	624-2021	31-Dec-2021
Oklahoma	2020-165	31-Aug-2021
Texas	T104704231-21-27	30-Apr-2022
Utah	TX026932021-10	31-Jul-2021

ALS Houston, US Date: 16-Jul-21

Sample Receipt Checklist

Work Order ID: HS21070060 **Date/Time Received:** **01-Jul-2021 09:55**

Client Name: Bhate Environmental **Received by:** **Pablo Marinez**

Completed By: */S/ Jared R. Makan* 01-Jul-2021 17:54 **Reviewed by:** */S/ Corey Grandits* 02-Jul-2021 13:49

eSignature Date/Time eSignature Date/Time

Matrices: **Water** Carrier name: **FedEx Priority Overnight**

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
VOA/TX1005/TX1006 Solids in hermetically sealed vials?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	1 Page(s)
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Samplers name present on COC?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	

Temperature(s)/Thermometer(s):	0.7°C UC/C	IR31
Cooler(s)/Kit(s):	Blue	
Date/Time sample(s) sent to storage:	07/01/2021 17:55	

Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	N/A ☑
pH adjusted?	Yes ☐	No ☐	N/A ☑

pH adjusted by:

Login Notes:

Client Contacted: Date Contacted: Person Contacted:

Contacted By: Regarding:

Comments:

Corrective Action:

bhate

1608 13th Avenue South, Suite 300
Birmingham Alabama 35205
Tel: 205-918-4000
Fax: 205-918-4050

Chain of Custody and Analytical Request

Page: _____ of _____

Project/Phase No: NWO1312.0150

COC Number(1): _____

LIMS Number: _____

Facility/Base I.D.: LHAAP

Project/Site Name: LHAAP / Site 17

Client Name:

Collected by: Scott Beesinger

Field Sample ID (30 Characters Max)	Date Collected (dd-mmm-yyyy)	Time Collected (Military) (hhmm)	Sample Depth (beginning - ending)	SA Code (2)	Sample Number (3)	Sample Matrix (4)	Sample Analysis Requested (5): Number of containers	PERCHLORATE	Quality Assurance Samples (6): Ambient Blank Lot Control Number	Equipment Blank Lot Control Number	Trip Blank Lot Control Number	Cooler ID
17WW20_063021	30 JUN 2021	0710	-		N	WG	1	X				
17WW12_063021	30 JUN 2021	0750	-		N	WG	1	X				
17WW11_063021	30 JUN 2021	0840	-		N	WG	1	X				
17WW11_063021_CA	30 JUN 2021	0840			FD	WG	1	X				
17WW06_063021	30 JUN 2021	0925	-		N	WG	1	X				
17WW06_063021_MS	30 JUN 2021	0925	-		MS	WG	1	X				
17WW06_063021_MSD	30 JUN 2021	0925	-		SD	WG	1	X				
17WW10_063021	30 JUN 2021	1010	-		N	WG	1	X				
17WW19_063021	30 JUN 2021	1100	-		N	WG	1	X				
			-									
			-									

HS21070060

Bhate Environmental Associates, Inc.
LHAAP 17

COMMENTS: STANDARD TAT

Custody Transfers Prior to Receipt by Laboratory

Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time
1. [illegible]	6/30/21	1430	1. [illegible]	7-1-21	0955
2.			2.		
3.			3.		

Blue Ice TC IR3, CFO

Sample Delivery Details / Laboratory Receipt

Delivered Directly to Lab: _____ Shipped No.:

_____ Method of Shipment: _____

_____ Fed Ex _____ Airbill Number:

_____ Analytical Lab: ALS 10450 Stancliff Rd. Suite 210 Houston, TX 77099 (281) 530-5656

ATTN: SONIA WEST Lab Recipient: Delivery Date/Time:

1.) Chain of Custody Number = date collected + custody number (e.g. 09-02-1999-01)

2.) Sample Type (SA) Codes: N = Normal Sample, TB = Trip Blank (-c) Sample, FD = Field Duplicate (-a) Samples, FR = Field Replicate (-b) Samples, EB = Equipment Blank (-d) Samples, MS = Matrix Spike, SD = Matrix Spike Duplicate, AB = Ambient Blank (-e)

3.) Sample Number: Unique sample number collected from a particular location per day. (e.g. Groundwater sample collected from MW-1 on 10/10/99 = 01, if sampled again on 10/10/99 = 02, etc.)

4.) Matrix Codes: GS = Soil Gas, WG = Groundwater, WS = Surface Water, SO = Soil, SE = Sediment, SL = Sludge, SS = Surface Soil Samples, WQ = Aqueous Blank Samples (trip, equipment, ambient, etc), SQ = Soil Blanks

5.) Sample Analysis Requested: Analytical method requested and number of containers provided for each.

6.) Quality assurance samples are assigned by date (ddmmyy) and the sample number associated with the sample (01, 02, etc) (e.g. Equipment blank collected in association with MW-1 on 10/10/99 will be designated 10109901 in the Equipment Blank Lot Control

ALS
10450 Stancliff Rd. Suite 210
Houston, Texas 77099
Tel. +1 281 530 5656
Fax. +1 281 530 5887

BMW

CUSTODY SEAL

Date: 6/30/21 Time: 1430
Name: Scott Beesinger
Company: BHATE

Seal Broken By: SM
Date: 07/01/21

BMW JUL 01 2021

BMW

ORIGIN ID:SGRA (903) 930-8193
SCOTT BEESINER
BHATE ENVIRONMENTAL ASSOCIATES
1203-B EAST GRAND AVE. PMB202

MARSHALL, TX 75670
UNITED STATES US

SHIP DATE: 14MAY21
ACTWGT: 1.00 LB MAN
CAD: 0221247/CAFE3409
DIMS: 26x14x14 IN

TO SHIPPING DEPT
ALS LABORATORY GROUP
10450 STANCLIFF RD
SUITE 210
HOUSTON TX 77099
(281) 530-5656
REF: LHAAP - 18/24 - BO 78339 - RG

RMA:

FedEx Express

FedEx TRK# 0221 9473 0843 5898

THU - 01 JUL AA
PRIORITY OVERNIGHT

77099
TX-US
IAH

AB SGRA

FID: 5121960 30Jun0421 GCGA 56062/0265/1023

July 16, 2021 Service Request No:E2100756

Ragen Giga
ALS Environmental - US
10450 Stancliff Rd Suite 210
Houston, TX 77099

Laboratory Results for: HS21070060

Dear Ragen,

Enclosed are the results of the sample(s) submitted to our laboratory July 02, 2021
For your reference, these analyses have been assigned our service request number **E2100756.**

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. The test results meet requirements of the current TNI standards, where applicable, and except as noted in the laboratory case narrative provided. All results are intended to be considered in their entirety and ALS Environmental is not responsible for use of less than the complete final report. Results apply only to the items submitted to the laboratory, as received for analysis. In accordance with the current TNI Standard, a statement on the estimated uncertainty of measurement of any quantitative analysis will be supplied upon request.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental

Corey Grandits
Project Manager

ADDRESS 10450 Stancliff Rd., Suite 210, Houston, TX 77099
PHONE +1 281 530 5656 | FAX +1 281 530 5887
ALS Group USA, Corp.
dba ALS Environmental

Certificate of Analysis

ALS Environmental - Houston HRMS
10450 Stancliff Rd, Suite 210, Houston TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

ALS Environmental

Client:	ALS Houston	**Service Request No.:**	E2100756
Project:	HS21070060	**Date Received:**	07/02/21
Sample Matrix:	W		

CASE NARRATIVE

All analyses were performed in adherence to the quality assurance program of ALS Environmental. This report contains analytical results for samples designated for Tier II. When appropriate to the method, method blank results have been reported with each analytical test.

Sample Receipt

Seven samples were received for analysis at ALS Environmental in Houston on 07/02/21.

The samples were received in good condition and are consistent with the accompanying chain of custody form. The samples were stored in a refrigerator at 4°C upon receipt at the laboratory.

Data Validation Notes and Discussion

Precision and Accuracy:

EQ2100416: Laboratory Control Spike/Duplicate Laboratory Control Spike (LCS/DLCS) samples were analyzed and reported in addition to a MS/MSD for these extraction batches. The LCS and DLCS recoveries are within QC limits. MS/MSD recoveries not applicable, parent sample 143,000 ug/L.

DoD certification is held for the method/matrix/analytes provided in this report.

The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and ALS Environmental (ALS) is not responsible for utilization of less than the complete report.

Use of ALS group USA Corp dba ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to ALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.

Client: ALS Environmental - US **Service Request:**E2100756
Project: HS21070060

SAMPLE CROSS-REFERENCE

SAMPLE #	CLIENT SAMPLE ID	DATE	TIME
E2100756-001	17WW20_063021	6/30/2021	0710
E2100756-002	17WW12_063021	6/30/2021	0750
E2100756-003	17WW11_063021	6/30/2021	0840
E2100756-004	17WW11_063021_a	6/30/2021	0840
E2100756-005	17WW06_063021	6/30/2021	0925
E2100756-006	17WW10_063021	6/30/2021	1010
E2100756-007	17WW19_063021	6/30/2021	1100

Service Request Summary

Folder #: **E2100756**
Client Name: ALS Environmental - US
Project Name: HS21070060
Project Number:

Report To: Ragen Giga
ALS Environmental - US
10450 Stancliff Rd Suite 210
Houston, TX 77099
USA
Phone Number:
Cell Number:
Fax Number:
E-mail: ragenp.giga@alsglobal.com

Project Chemist: Corey Grandits
Originating Lab: HOUSTON
Logged By: CGRANDITS
Date Received: 07/02/21
Internal Due Date: 7/16/2021
QAP: LAB QAP
Qualifier Set: Lab Standard
Formset: Lab Standard
Merged?: Y
Report to MDL?: Y
P.O. Number: HS21070060
EDD: No EDD Specified

9 125 mL-Plastic Bottle Plastic
Location: EHRMS-AirArch 1
Pressure Gas:

Lab Samp No.	Client Samp No	Matrix	Collected	HOUSTON ClO4 DOD/6850
E2100756-001	17WW20_063021	Ground Water	06/30/21 0710	**IV**
E2100756-002	17WW12_063021	Ground Water	06/30/21 0750	**IV**
E2100756-003	17WW11_063021	Ground Water	06/30/21 0840	**IV**
E2100756-004	17WW11_063021_a	Ground Water	06/30/21 0840	**IV**
E2100756-005	17WW06_063021	Ground Water	06/30/21 0925	**IV**
E2100756-006	17WW10_063021	Ground Water	06/30/21 1010	**IV**
E2100756-007	17WW19_063021	Ground Water	06/30/21 1100	**IV**

Service Request Summary

Folder #: **E2100756**
Client Name: ALS Environmental - US
Project Name: HS21070060
Project Number:

Report To: Ragen Giga
ALS Environmental - US
10450 Stancliff Rd Suite 210
Houston, TX 77099
USA
Phone Number:
Cell Number:
Fax Number:
E-mail: ragenp.giga@alsglobal.com

Project Chemist: Corey Grandits
Originating Lab: HOUSTON
Logged By: CGRANDITS
Date Received: 07/02/21
Internal Due Date: 7/16/2021
QAP: LAB QAP
Qualifier Set: Lab Standard
Formset: Lab Standard
Merged?: Y
Report to MDL?: Y
P.O. Number: HS21070060
EDD: No EDD Specified

9 125 mL-Plastic Bottle Plastic
Location: EHRMS-AirArch 1
Pressure Gas:

Test Comments:

Group	Test/Method	Samples	Comments
Semivoa GCMS	ClO4 DOD/6850	6	Level II due 7/16,IV due 7/23
Semivoa GCMS	ClO4 DOD/6850	1	MS/MSD

Data Qualifiers

Lab Standard

+	Possible Tedlar bag artifact.
A	TIC is a suspected aldol-condensation product
B	Analyte found in the associated method blank as well as in the sample.
BC	Reported results are not blank corrected.
BH	The back section of the tube yielded higher results than the front.
BT	Results indicated possible breakthrough; back section >=10% front section.
C	Result identification confirmed.
D	Compound identified in an analysis at a secondary dilution factor
D	Spike was diluted out
DE	Reported results are corrected for desorption efficiency.
E	Estimated value. Concentration above calibration range
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
F	The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
H	The chromatographic fingerprint of the sample resembles a petroleum product but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
H1	Sample analysis performed past holding time. See case narrative.
H2	Initial analysis within holding time. Reanalysis for the required dilution was past holding time.
H3	Sample was received and analyzed past holding time.
H4	Sample was extracted past required extraction holding time, but analyzed within analysis holding time. See case narrative.
I	Internal standard not within the specified limits. See case narrative.
J	Estimated Value. Concentration found below MRL.
K	A deflection in the QC ion may indicate interference with the quantitation of this ion. The concentration of this analyte should be considered as an estimate.
K	Analyte was detected above the method reporting limit prior to normalization.
K	The reference ion ratio was outside acceptance criteria, which may indicate a potential bias to this result.
L	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
L1	Laboratory control sample recovery outside the specified limits; results may be biased high.
L2	Laboratory control sample recovery outside the specified limits; results may be biased low.
L3	Laboratory control sample recovery outside the specified limits.
M	Matrix interference; results may be biased high.
M	The duplicate injection precision not met.
M1	Matrix interference due to coelution with a non-target compound; results may be biased high.
N	Presumptive evidence of a compound for TICs that have been identified based on a mass spectral library search.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.

Data Qualifiers

Lab Standard

O	The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
P	Indicates chlorodiphenyl ether interference present at the retention time of the target compound.
P	Pesticide/Aroclor target analyte > 40% difference for detected concentrations between GC columns
Q	Indicates as estimated value because the P and P + 2 theoretical abundance ratio does not meet method criteria.
R	Duplicate Precision not met.
R1	Duplicate precision not within the specified limits; however, the results are below the MRL and considered estimated.
S	Surrogate recovery not within specified limits.
S	The reported value was determined by the Method of Standard Additions (MSA).
T	Analyte is a tentatively identified compound, result is estimated.
U	Compound was analyzed for, but was not detected (ND).
V1	The continuing calibration verification standard was outside (biased high) the specified limits for this compound.
V2	The continuing calibration verification standard was outside (biased low) the specified limits for this compound.
W	Result quantified, but the corresponding peak was detected outside the generated retention time window.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
X	See case narrative.
Y	Recovery outside limits
Y	The chromatogram resembles a petroleum product but does not match the calibration standard.
Z	The chromatogram does not resemble a petroleum product.
i	The MRL/MDL has been elevated due to a matrix interference.

ALS Laboratory Group

Acronyms

Cal	Calibration
Conc	CONCentration
Dioxin(s)	Polychlorinated dibenzo-p-dioxin(s)
EDL	Estimated Detection Limit
EMPC	Estimated Maximum Possible Concentration
Flags	Data qualifiers
Furan(s)	Polychlorinated dibenzofuran(s)
g	Grams
ICAL	Initial CALibration
ID	IDentifier
Ions	Masses monitored for the analyte during data acquisition
L	Liter (s)
LCS	Laboratory Control Sample
DLCS	Duplicate Laboratory Control Sample
MB	Method Blank
MCL	Method Calibration Limit
MDL	Method Detection Limit
mL	Milliliters
MS	Matrix Spiked sample
DMS	Duplicate Matrix Spiked sample
NO	Number of peaks meeting all identification criteria
PCDD(s)	Polychlorinated dibenzo-p-dioxin(s)
PCDF(s)	Polychlorinated dibenzofuran(s)
ppb	Parts per billion
ppm	Parts per million
ppq	Parts per quadrillion
ppt	Parts per trillion
QA	Quality Assurance
QC	Quality Control
Ratio	Ratio of areas from monitored ions for an analyte
% Rec.	Percent recovery
RPD	Relative Percent Difference
RRF	Relative Response Factor
RT	Retention Time
SDG	Sample Delivery Group
S/N	Signal-to-noise ratio
TEF	Toxicity Equivalence Factor
TEQ	Toxicity Equivalence Quotient

10450 Stancliff Rd, Houston, TX 77099 | 281-530-5656 | www.alsglobal.com

ALS Environmental

State Certifications, Accreditations, and Licenses

Agency	Number	Expire Date
American Association for Laboratory Accreditation	2897.01 2020	11/30/2021
Arkansas Department of Environmental Quality	21-022-0	3/26/2022
Arkansas Department of Environmental Quality	19-028-0	6/30/2022
Department of Defense	A2LA 2897.01	11/30/2021
Florida Department of Health	E87611-33	6/30/2022
Hawaii Department of Health	2021-2022	4/30/2022
Kansas Department of Health and Environment	E-10352-2020	7/31/2021
Louisiana Department of Environmental Quality	03087-2021	6/30/2022
Louisiana Department of Health and Hospitals	LA028-2021	12/31/2021
Maine Department of Health and Human Services	2020016	6/5/2022
Minnesota Department of Health	2021671	12/31/2021
Nevada Department of Concervation and Natural Resources	TX026932021-4	7/31/2021
New Hampshire Environmental Laboratory Accreditation Program	209421	4/24/2022
Oklahoma Department of Environmental Quality	2020-123	8/31/2021
Pennsylvania Department of Environmental Protection	68-03441-015	6/30/2022
Tennessee Department of Environment and Concervation	04016-2021	4/30/2022
Texas Commision on Environmental Quality	T104704231-21-27	4/30/2022
United States Department of Agriculture	P330-19-00299	10/10/2022
Utah Department of Health Environmental Laboratory Certification	TX026932021-10	7/31/2021

Chain of Custody

ALS Environmental - Houston HRMS
10450 Stancliff Rd, Suite 210, Houston TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

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Subcontract Chain of Custody

SAMPLING STATE: **Dept of Defense** **COC ID: 16419**

SUBCONTRACT TO:

ALS Environmental
10450 Stancliff RoadSuite 210
Houston, TX 77084

Phone: +1 281 530 5656

CUSTOMER INFORMATION:

Company:	ALS Houston
Contact:	Ragen Giga
Address:	10450 Stancliff Rd, Ste 210
Phone:	+1 281 530 5656
Email:	RagenP.Giga@ALSGlobal.com
Alternate Contact:	Jumoke M. Lawal
Email:	jumoke.lawal@alsglobal.com

INVOICE INFORMATION:

Company:	ALS Houston
Contact:	Accounts Payable
Address:	10450 Stancliff Rd, Ste 210
Phone:	+1 281 530 5656
Reference:	HS21070060
TSR:	Sonia West

	LAB SAMPLE ID	CLIENT SAMPLE ID	MATRIX	COLLECT DATE
	ANALYSIS REQUESTED			DUE DATE
1.	**HS21070060-01**	**17WW20_063021**	**Groundwater**	**30 Jun 2021 07:10**
	6850-Perch. DOD Level II & Level IV in separate pdf			16 Jul 2021
2.	**HS21070060-02**	**17WW12_063021**	**Groundwater**	**30 Jun 2021 07:50**
	6850-Perch. DOD Level II & Level IV in separate pdf			16 Jul 2021
3.	**HS21070060-03**	**17WW11_063021**	**Groundwater**	**30 Jun 2021 08:40**
	6850-Perch. DOD Level II & Level IV in separate pdf			16 Jul 2021
4.	**HS21070060-04**	**17WW11_063021_a**	**Groundwater**	**30 Jun 2021 08:40**
	6850-Perch. DOD Level II & Level IV in separate pdf			16 Jul 2021
5.	**HS21070060-05**	**17WW06_063021**	**Groundwater**	**30 Jun 2021 09:25**
	6850-Perch. DOD Level II & Level IV in separate pdf			16 Jul 2021
6.	**HS21070060-06**	**17WW10_063021**	**Groundwater**	**30 Jun 2021 10:10**
	6850-Perch. DOD Level II & Level IV in separate pdf			16 Jul 2021
7.	**HS21070060-07**	**17WW19_063021**	**Groundwater**	**30 Jun 2021 11:00**
	6850-Perch. DOD Level II & Level IV in separate pdf			16 Jul 2021

Comments:

Subcontract Chain of Custody

SAMPLING STATE: **Dept of Defense** **COC ID:** **16419**

Please analyze for the analysis listed above.
Send report to the emails shown above.

HS21070060-05 MS/MSD

QC Level: DOD IV (DoD Data Package)

Relinquished By:	J. MARCOTTE	Date/Time:	07/02/21
Received By:	[illegible]	Date/Time:	7/2/21 0942
Cooler ID(s):		Temperature(s):	

ALS Environmental

Cooler Receipt Form

Project Chemist CH

Client/Project ALS-H

Thermometer ID IR31

Date/Time Received: 7/2/21 Initials: CH Date/Time Logged in: 7/2/21 Initials CH

1. Method of delivery: ○ US Mail ○ Fed Ex ○ UPS ○ DHL ✓ ALS Courier ○ Client

2. Samples received in: ✓ Cooler ○ Box ○ Envelope ○ Other

3. Were custody seals on coolers? ○ Yes ✓ No
   Were they intact? ○ Yes ○ No ✓ N/A
   Were they signed and dated? ○ Yes ○ No ✓ N/A
   If yes, how many and where?

4. Packing Material: ○ Inserts ✓ Baggies ○ Bubble Wrap ○ Gel Packs ✓ Wet Ice ○ Sleeves ○ Other

5. Foreign or Regulated Soil? ○ Yes ○ No Location of Sampling:

Cooler Tracking Number	COC ID	Date Opened	Time Opened	Opened By	Temp. °C	Temp Blank?
NA		7/2/21	0942	CH	2.5	☑
						☐
						☐
						☐

6. Were custody papers properly filled out (ink, signed, dated, etc)? ✓ Yes ○ No
7. Did all bottles arrive in good condition (not broken, no signs of leakage)? ✓ Yes ○ No
8. Were all sample labels complete (i.e., sample ID, analysis, preservation, etc)? ✓ Yes ○ No
9. Were appropriate bottles/containers and volumes received for the requested tests? ✓ Yes ○ No
10. Did sample labels and tags agree with custody documents? ✓ Yes ○ No

Notes, Discrepancies, & Resolutions:

Service request Label:

HS-HRMSCoolerReceipt R1.0

ALS Environmental - Houston HRMS

10450 Stancliff Rd., Suite 210
Houston, TX 77099
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F: +1 713 266 1599
www.alsglobal.com

SAMPLE ACCEPTANCE POLICY

This policy outlines the criteria samples must meet to be accepted by ALS Environmental – Houston HRMS.

Cooler Custody Seals (desirable, mandatory if specified in SAP):

- ✓ Intact on outside of cooler, signed and dated

Chain-of-Custody (COC) documentation (mandatory):

The following is required on each COC:

- ✓ Sample ID, the location, date and time of collection, collector's name, preservation type, sample type, and any other special remarks concerning the sampleThe COC must be completed in ink.
- ✓ Signature and date of relinquishing party.

In the absence of a COC at sample receipt, the COC will be requested from the client.

Sample Integrity (mandatory):

Samples are inspected upon arrival to ensure that sample integrity was not compromised during transfer to the laboratory.

- ✓ Sample containers must arrive in good condition (not broken or leaking).
- ✓ Samples must be labeled appropriately, including Sample IDs, and requested test using durable labels and indelible ink.
- ✓ The correct type of sample bottle must be used for the method requested.
- ✓ An appropriate sample volume, or weight, must be received.
- ✓ Sample IDs and number of containers must reconcile with the COC.
- ✓ Samples must be received within the method defined holding time.

Temperature Requirement (varies by sample matrix):

- ✓ Aqueous and Non-aqueous samples must be shipped and stored cold, at 0 to 6ºC.
- ✓ Tissue samples must be shipped and stored frozen, at -20 to -10ºC.
- ✓ Air samples are shipped and stored cold, at 0 to 6ºC
- ✓ The sample temperature must be recorded on the COC

All cooler inspections are documented on the Cooler Receipt Form (CRF). A separate CRF is completed for each service request. Any samples not meeting the above criteria are noted on the CRF and the Project Manager notified. The Project Manager must resolve any sample integrity issues with the client prior to proceeding with the analysis. Such resolutions are documented in writing and filed with the project folder. Data associated with samples received outside of this acceptance policy will be qualified on the case narrative of the final report

Preparation Information Benchsheets

ALS Environmental - Houston HRMS
10450 Stancliff Rd., Suite 210, Houston, TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

Preparation Information Benchsheet

Prep Run#: 382800 **Prep WorkFlow:** GenExt28Day **Status:** Prepped
Team: Semivoa GCMS/GRIVERA **Prep Method:** Method **Prep Date/Time:** 7/13/21 12:30

#	Lab Code	Client ID	B#	Method /Test	pH	Cl	Matrix	Amt. Ext.	Sample Description
1	E2100741-001	18WW19_062821	.01	6850/ClO4 DOD			Ground Water	10mL	
2	E2100741-002	18WW19_062821_a	.01	6850/ClO4 DOD			Ground Water	10mL	
3	E2100741-003	18WW20_062821	.01	6850/ClO4 DOD			Ground Water	10mL	
4	E2100741-004	18CPTMW06_062821	.01	6850/ClO4 DOD			Ground Water	10mL	
5	E2100741-005	18CPTMW06_062821_a	.01	6850/ClO4 DOD			Ground Water	10mL	
6	E2100741-006	MW22_062821	.01	6850/ClO4 DOD			Ground Water	10mL	
7	E2100741-007	C06_062821	.01	6850/ClO4 DOD			Ground Water	10mL	
8	E2100741-008	18CPTMW16_062821	.01	6850/ClO4 DOD			Ground Water	10mL	
9	E2100756-001	17WW20_063021	.01	6850/ClO4 DOD			Ground Water	10mL	
10	E2100756-002	17WW12_063021	.01	6850/ClO4 DOD			Ground Water	10mL	
11	E2100756-003	17WW11_063021	.01	6850/ClO4 DOD			Ground Water	10mL	
12	E2100756-004	17WW11_063021_a	.01	6850/ClO4 DOD			Ground Water	10mL	
13	E2100756-005	17WW06_063021	.01	6850/ClO4 DOD			Ground Water	10mL	
14	E2100756-006	17WW10_063021	.01	6850/ClO4 DOD			Ground Water	10mL	
15	E2100756-007	17WW19_063021	.01	6850/ClO4 DOD			Ground Water	10mL	
16	EQ2100416-01	MB		6850/ClO4 DOD			Liquid	10mL	
17	EQ2100416-02	LCS		6850/ClO4 DOD			Liquid	10mL	
18	EQ2100416-03	DLCS		6850/ClO4 DOD			Liquid	10mL	
19	EQ2100416-04	17WW06_063021 MS	.02	6850/ClO4 DOD			Liquid	10mL	
20	EQ2100416-05	17WW06_063021 DMS	.03	6850/ClO4 DOD			Liquid	10mL	

Spiking Solutions

Name: Sodium Perchlorate 1 ug/mL (IS) (18-O) as CLO4 Inventory ID 214765 Logbook Ref: Sodium Perchlorate Expires On: 12/11/2022

E2100741-001	100.00µL	E2100741-002	100.00µL	E2100741-003	100.00µL	E2100741-004	100.00µL	E2100741-005	100.00µL	E2100741-006	100.00µL
E2100741-007	100.00µL	E2100741-008	100.00µL	E2100756-001	100.00µL	E2100756-002	100.00µL	E2100756-003	100.00µL	E2100756-004	100.00µL
E2100756-006	100.00µL	E2100756-007	100.00µL	EQ2100416-01	100.00µL	EQ2100416-02	100.00µL	EQ2100416-03	100.00µL	EQ2100416-04	100.00µL
EQ2100416-05	100.00µL										

Name: Perchlorate Intermediate Stock1 Inventory ID 217422 Logbook Ref: Perchlorate Expires On: 11/26/2021

EQ2100416-02	1.00µL	EQ2100416-03	1.00µL	EQ2100416-04	1.00µL	EQ2100416-05	1.00µL

Preparation Information Benchsheet

Prep Run#: 382800
Team: Semivoa GCMS/GRIVERA
Prep WorkFlow: GenExt28Day
Prep Method: Method
Status: Prepped
Prep Date/Time: 7/13/21 12:30

Preparation Steps

Step: Preparation
Started: 7/13/21 12:30
Finished: 7/13/21 13:00
By: GRIVERA
Comments

Comments: _____

Reviewed By: GR Date: 7/13/21

Chain of Custody

Relinquished By:		Date:		Extracts Examined
Received By:		Date:		Yes No

Analytical Results

ALS Environmental - Houston HRMS
10450 Stancliff Rd., Suite 210, Houston, TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	6/30/21 0710
Sample Matrix:	Ground Water	**Date Received:**	7/ 2/21
Sample Name:	17WW20_063021	**Units:**	µg/L
Lab Code:	E2100756-001	**Basis:**	As Received

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.0450**	J	0.100	0.0500	0.0250	1	7/13/21	7/15/21 12:45	382800	731254	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	6/30/21 0750
Sample Matrix:	Ground Water	**Date Received:**	7/ 2/21
Sample Name:	17WW12_063021	**Units:**	µg/L
Lab Code:	E2100756-002	**Basis:**	As Received

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	ND	U	0.100	0.0500	0.0250	1	7/13/21	7/15/21 12:53	382800	731254	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	6/30/21 0840
Sample Matrix:	Ground Water	**Date Received:**	7/ 2/21
Sample Name:	17WW11_063021	**Units:**	µg/L
Lab Code:	E2100756-003	**Basis:**	As Received

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	ND	U	0.100	0.0500	0.0250	1	7/13/21	7/15/21 13:02	382800	731254	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	6/30/21 0840
Sample Matrix:	Ground Water	**Date Received:**	7/ 2/21
Sample Name:	17WW11_063021_a	**Units:**	µg/L
Lab Code:	E2100756-004	**Basis:**	As Received

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.0285**	J	0.100	0.0500	0.0250	1	7/13/21	7/15/21 13:19	382800	731254	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	6/30/21 0925
Sample Matrix:	Ground Water	**Date Received:**	7/ 2/21
Sample Name:	17WW06_063021	**Units:**	µg/L
Lab Code:	E2100756-005	**Basis:**	As Received

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**143000**		500	250	125	5000	7/13/21	7/15/21 16:02	382800	731254	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	6/30/21 1010
Sample Matrix:	Ground Water	**Date Received:**	7/ 2/21
Sample Name:	17WW10_063021	**Units:**	µg/L
Lab Code:	E2100756-006	**Basis:**	As Received

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.635**		0.100	0.0500	0.0250	1	7/13/21	7/15/21 13:28	382800	731254	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	6/30/21 1100
Sample Matrix:	Ground Water	**Date Received:**	7/ 2/21
Sample Name:	17WW19_063021	**Units:**	µg/L
Lab Code:	E2100756-007	**Basis:**	As Received

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.451**		0.100	0.0500	0.0250	1	7/13/21	7/15/21 13:36	382800	731254	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	NA
Sample Matrix:	Ground Water	**Date Received:**	NA
Sample Name:	Method Blank	**Units:**	µg/L
Lab Code:	EQ2100416-01	**Basis:**	As Received

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	ND	U	0.100	0.0500	0.0250	1	7/13/21	7/14/21 18:38	382800	731262	

Accuracy & Precision

ALS Environmental - Houston HRMS
10450 Stancliff Rd., Suite 210, Houston TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client: ALS Environmental - US
Project: HS21070060
Sample Matrix: Ground Water

Service Request: E2100756
Date Analyzed: 7/14/21

Lab Control Sample Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Units: µg/L
Basis: As Received

Extraction Lot: 382800

	Lab Control Sample EQ2100416-02			Duplicate Lab Control Sample EQ2100416-03					
Analyte Name	**Result**	**Spike Amount**	**% Rec**	**Result**	**Spike Amount**	**% Rec**	**% Rec Limits**	**RPD**	**RPD Limit**
Perchlorate	0.0873	0.100	87	0.0849	0.100	85	84 - 119	3	15

Results flagged with an asterisk (*) indicate values outside control criteria.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	NA
Sample Matrix:	Ground Water	**Date Received:**	NA
Sample Name:	Lab Control Sample	**Units:**	µg/L
Lab Code:	EQ2100416-02	**Basis:**	As Received

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.0873**	J	0.100	0.0500	0.0250	1	7/13/21	7/14/21 18:47	382800	731262	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	NA
Sample Matrix:	Ground Water	**Date Received:**	NA
Sample Name:	Duplicate Lab Control Sample	**Units:**	µg/L
Lab Code:	EQ2100416-03	**Basis:**	As Received

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.0849**	J	0.100	0.0500	0.0250	1	7/13/21	7/14/21 18:55	382800	731262	

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	6/30/21
Sample Matrix:	Ground Water	**Date Received:**	7/2/21
		Date Analyzed:	7/14/21

Matrix Spike Summary

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Sample Name:	17WW06_063021	**Units:**	µg/L
Lab Code:	E2100756-005	**Basis:**	As Received

Analytical Method: 6850
Prep Method: Method

		17WW06_063021MS				17WW06_063021DMS					
		Matrix Spike				**Duplicate Matrix Spike**					
		EQ2100416-04				EQ2100416-05					
Analyte Name	**Sample Result**	**Result**	**Spike Amount**	**% Rec**		**Result**	**Spike Amount**	**% Rec**		**% Rec Limits**	**RPD**	**RPD Limit**
Perchlorate	143000	71100	0.100	-71956504#		70800	0.100	-7224467#		84 - 119	<1	15

Results flagged with an asterisk (*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	6/30/21 0925
Sample Matrix:	Ground Water	**Date Received:**	7/ 2/21
Sample Name:	17WW06_063021	**Units:**	µg/L
Lab Code:	EQ2100416-04	**Basis:**	As Received
Run Type:	Matrix Spike		

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**71100**	E	0.100	0.0500	0.0250	1	7/13/21	7/14/21 19:04	382800	731262	*

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	ALS Environmental - US	**Service Request:**	E2100756
Project:	HS21070060	**Date Collected:**	6/30/21 0925
Sample Matrix:	Ground Water	**Date Received:**	7/ 2/21
Sample Name:	17WW06_063021	**Units:**	µg/L
Lab Code:	EQ2100416-05	**Basis:**	As Received
Run Type:	Duplicate Matrix Spike		

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**70800**	E	0.100	0.0500	0.0250	1	7/13/21	7/14/21 19:12	382800	731262	*

10450 Stancliff Rd. Suite 210
Houston, TX 77099
T: +1 281 530 5656
F: +1 281 530 5887

April 13, 2022

Marcia Olive
Bhate Environmental Associates, Inc.
445 Union Blvd Ste 129
Lakewood, CO 80228

Work Order: **HS22040532**

Laboratory Results for: **LHAAP / 17**

Dear Marcia Olive,

ALS Environmental received 7 sample(s) on Apr 09, 2022 for the analysis presented in the following report.

The analytical data provided relates directly to the samples received by ALS Environmental and for only the analyses requested. Results are expressed as "as received" unless otherwise noted.

QC sample results for this data met EPA or laboratory specifications except as noted in the Case Narrative or as noted with qualifiers in the QC batch information. Should this laboratory report need to be reproduced, it should be reproduced in full unless written approval has been obtained by ALS Environmental. Samples will be disposed in 30 days unless storage arrangements are made.

If you have any questions regarding this report, please feel free to call me.

Sincerely,

Generated By: JUMOKE.LAWAL
Ragen Giga
Project Manager

ALS Houston, US Date: 13-Apr-22

Client: Bhate Environmental Associates, Inc.
Project: LHAAP / 17
Work Order: HS22040532

SAMPLE SUMMARY

Lab Samp ID	Client Sample ID	Matrix	TagNo	Collection Date	Date Received	Hold
HS22040532-01	Trip Blank	Water		08-Apr-2022 09:11	09-Apr-2022 08:50	☑
HS22040532-02	17WW01_220408	Groundwater		08-Apr-2022 09:51	09-Apr-2022 08:50	☐
HS22040532-03	17WW02_220408	Groundwater		08-Apr-2022 11:01	09-Apr-2022 08:50	☐
HS22040532-04	17WW03_220408	Groundwater		08-Apr-2022 10:26	09-Apr-2022 08:50	☐
HS22040532-05	17WW03_220408-A	Groundwater		08-Apr-2022 10:26	09-Apr-2022 08:50	☐
HS22040532-06	17WW06_220408	Groundwater		08-Apr-2022 09:11	09-Apr-2022 08:50	☐
HS22040532-07	17WW130_220408	Groundwater		08-Apr-2022 11:46	09-Apr-2022 08:50	☐

ALS Houston, US Date: 13-Apr-22

Client: Bhate Environmental Associates, Inc. **CASE NARRATIVE**
Project: LHAAP / 17
Work Order: HS22040532

Work Order Comments

- The analysis for Perchlorate was subcontracted to ALS specialty lab. Final report attached.

ALS Houston, US

Date: 13-Apr-22

Client: Bhate Environmental Associates, Inc.

ANALYTICAL REPORT

Project: LHAAP / 17

WorkOrder:HS22040532

Sample ID: 17WW01_220408

Lab ID:HS22040532-02

Collection Date: 08-Apr-2022 09:51

Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	13-Apr-2022 16:12

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US

Date: 13-Apr-22

Client: Bhate Environmental Associates, Inc.

ANALYTICAL REPORT

Project: LHAAP / 17

WorkOrder:HS22040532

Sample ID: 17WW02_220408

Lab ID:HS22040532-03

Collection Date: 08-Apr-2022 11:01

Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	13-Apr-2022 16:12

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US

Date: 13-Apr-22

Client: Bhate Environmental Associates, Inc.

ANALYTICAL REPORT

Project: LHAAP / 17

WorkOrder:HS22040532

Sample ID: 17WW03_220408

Lab ID:HS22040532-04

Collection Date: 08-Apr-2022 10:26

Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	13-Apr-2022 16:12

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US

Date: 13-Apr-22

Client: Bhate Environmental Associates, Inc.

ANALYTICAL REPORT

Project: LHAAP / 17

WorkOrder:HS22040532

Sample ID: 17WW03_220408-A

Lab ID:HS22040532-05

Collection Date: 08-Apr-2022 10:26

Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	13-Apr-2022 16:12

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 13-Apr-22

Client: Bhate Environmental Associates, Inc.
Project: LHAAP / 17
Sample ID: 17WW06_220408
Collection Date: 08-Apr-2022 09:11

ANALYTICAL REPORT
WorkOrder:HS22040532
Lab ID:HS22040532-06
Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	13-Apr-2022 16:12

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US

Date: 13-Apr-22

Client: Bhate Environmental Associates, Inc.

ANALYTICAL REPORT

Project: LHAAP / 17

WorkOrder:HS22040532

Sample ID: 17WW130_220408

Lab ID:HS22040532-07

Collection Date: 08-Apr-2022 11:46

Matrix:Groundwater

ANALYSES	RESULT	QUAL	DL	LOD	LOQ	UNITS	DILUTION FACTOR	DATE ANALYZED
SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)		**Method:NA**						Analyst: GR
Subcontract Analysis	See Attached		0	0		NA	1	13-Apr-2022 16:12

Note: See Qualifiers Page for a list of qualifiers and their explanation.

ALS Houston, US Date: 13-Apr-22

Client: Bhate Environmental Associates, Inc.
Project: LHAAP / 17
WorkOrder: HS22040532

DATES REPORT

Sample ID	Client Samp ID	Collection Date	Leachate Date	Prep Date	Analysis Date	DF
Batch ID: R406415 (0)	**Test Name :** SUBCONTRACT ANALYSIS - PERCHLORATE (EPA 6850)				**Matrix:** Groundwater	
HS22040532-02	17WW01_220408	08 Apr 2022 09:51			13 Apr 2022 16:12	1
HS22040532-03	17WW02_220408	08 Apr 2022 11:01			13 Apr 2022 16:12	1
HS22040532-04	17WW03_220408	08 Apr 2022 10:26			13 Apr 2022 16:12	1
HS22040532-05	17WW03_220408-A	08 Apr 2022 10:26			13 Apr 2022 16:12	1
HS22040532-06	17WW06_220408	08 Apr 2022 09:11			13 Apr 2022 16:12	1
HS22040532-07	17WW130_220408	08 Apr 2022 11:46			13 Apr 2022 16:12	1

ALS Houston, US Date: 13-Apr-22

Client: Bhate Environmental Associates, Inc.
Project: LHAAP / 17
WorkOrder: **HS22040532**

QUALIFIERS, ACRONYMS, UNITS

Qualifier	Description
*	Value exceeds Regulatory Limit
a	Not accredited
B	Analyte detected in the associated Method Blank above the Reporting Limit
E	Value above quantitation range
H	Analyzed outside of Holding Time
J	Analyte detected below quantitation limit
M	Manually integrated, see raw data for justification
n	Not offered for accreditation
ND	Not Detected at the Reporting Limit
O	Sample amount is > 4 times amount spiked
P	Dual Column results percent difference > 40%
R	RPD above laboratory control limit
S	Spike Recovery outside laboratory control limits
U	Analyzed but not detected above the MDL/SDL

Acronym	Description
DCS	Detectability Check Study
DUP	Method Duplicate
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
MBLK	Method Blank
MDL	Method Detection Limit
MQL	Method Quantitation Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PDS	Post Digestion Spike
PQL	Practical Quantitaion Limit
SD	Serial Dilution
SDL	Sample Detection Limit
TRRP	Texas Risk Reduction Program

CERTIFICATIONS,ACCREDITATIONS & LICENSES

Agency	Number	Expire Date
Florida	E87611-34	30-Jun-2022
Illinois	2000322021-7	09-May-2022
Kansas	E-10352 2021-2022	31-Jul-2022
Kentucky	123043, 2021-2022	30-Apr-2022
Louisiana	03087, 2021-2022	30-Jun-2022
Texas	T104704231-21-28	30-Apr-2022

ALS Houston, US Date: 13-Apr-22

Sample Receipt Checklist

Work Order ID: HS22040532 **Date/Time Received:** **09-Apr-2022 08:50**

Client Name: Bhate Environmental **Received by:** **Paresh M. Giga**

Completed By:	/S/ Nilesh D. Ranchod	11-Apr-2022 14:34	**Reviewed by:**	/S/ Corey Grandits	12-Apr-2022 13:19
	eSignature	Date/Time		eSignature	Date/Time

Matrices: **Water** Carrier name: **FedEx Priority Overnight**

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
VOA/TX1005/TX1006 Solids in hermetically sealed vials?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	1 Page(s)
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	COC IDs:04-08-2022
Samplers name present on COC?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	
Temperature(s)/Thermometer(s):	0.4C/0.9C UC/C		IR #31
Cooler(s)/Kit(s):	47489		
Date/Time sample(s) sent to storage:	04/11/2022 15:00		
Water - VOA vials have zero headspace?	Yes ☑	No ☐	No VOA vials submitted ☐
Water - pH acceptable upon receipt?	Yes ☐	No ☐	N/A ☑
pH adjusted?	Yes ☐	No ☐	N/A ☑
pH adjusted by:			

Login Notes:

Client Contacted: Date Contacted: Person Contacted:

Contacted By: Regarding:

Comments:

Corrective Action:

01228029

bhate

HS22040532

Bhate Environmental Associates, Inc.

LHAAP / 17

1608 13th Avenue South, Suite 300
Birmingham Alabama 35205
Tel: 205-918-4000
Fax: 205-918-4050

Chain

Page: 1 of 1

Project/Phase No: NWQ1312.0150

COC Number(1): 04-08-2022

LIMS Number:

Facility/Base I.D.: LHAAP

Project/Site Name: LHAAP / Site 17

Client Name: Army

Collected by: ~~Scott Beesinger~~ Derrick Berry

Field Sample ID (30 Character Max)	Date Collected (dd-mmm-yyyy)	Time Collected (Military) (hhmm)	Sample Depth (beginning - ending)	SA Code (3)	Sample Number (3)	Sample Matrix (4)	Number of containers	Sample Analysis Requested (5): PERCHLORATE	Sample Analysis Requested (5): VOCs 8260	Ambient Blank Lot Control Number	Equipment Blank Lot Control Number	Trip Blank Lot Control Number	Cooler ID
Trip Blank	08-APR2022	0911	-	WQ	01	TB	1		X				
17WW01-220408		0951	-	WG	01	N	1	X					
17WW02-220408		1101	-	WG	01	N	1	X					
17WW03-220408		1026		WG	01	N	1	X					
17WW03-220408-A		1026		WG	01	FD	1	X					
17WW06-220408		0911	-	WG	01	N	1	X					
17WW130-220408		1146	-	WG	01	N	1	X				VIC.	
17WW130-220408-MS		1146	-	WG	01	MS	1	X			47489	0.40	
17WW130-220408-MSD		1146	-	WG	01	MSD	1	X				#71	
			-									0.1-0.5	
			-										

Quality Assurance Samples (6)

COMMENTS:

Custody Transfers Prior to Receipt by Laboratory

Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time
1. [signature]	4-8-22	1400	1. [signature]	4/9/2022	08:30
2.			2.		
3.			3.		

Sample Delivery Details / Laboratory Receipt

Delivered Directly to Lab: _____ Shipped No.:

_____ Method of Shipment: _____

_____ Fed Ex _____ Airbill Number:

_____ Analytical Lab: ALS 10450 Stancliff Rd. Suite 210 Houston, TX 77099 (281) 530-5656

ATTN: SONIA WEST Lab Recipient: Delivery Date/Time:

1.) Chain of Custody Number = date collected + custody number (e.g. 09-02-1999-01)

2.) Sample Type (SA) Codes: N = Normal Sample, TB = Trip Blank (-c) Sample, FD = Field Duplicate (-a) Samples, FR = Field Replicate (-b) Samples, EB = Equipment Blank (-d) Samples, MS = Matrix Spike, SD = Matrix Spike Duplicate, AB = Ambient Blank (-e)

3.) Sample Number: Unique sample number collected from a particular location per day. (e.g. Groundwater sample collected from MW-1 on 10/10/99 = 01, if sampled again on 10/10/99 = 02, etc.)

4.) Matrix Codes: GS = Soil Gas, WG = Groundwater, WS = Surface Water, SO = Soil, SE = Sediment, SL = Sludge, SS = Surface Soil Samples, WQ = Aqueous Blank Samples (trip, equipment, ambient, etc), SQ = Soil Blanks

5.) Sample Analysis Requested: Analytical method requested and number of containers provided for each.

6.) Quality assurance samples are assigned by date (ddmmyy) and the sample number associated with the sample (01, 02, etc) (e.g. Equipment blank collected in association with MW-1 on 10/10/99 will be designated 10109901 in the Equipment Blank Lot Control)

ALS
10450 Stancliff Rd., Suite 210
Houston, Texas 77099
Tel. +1 281 530 5656
Fax. +1 281 530 5887

47489

CUSTODY SEAL

Date: 4-8-22 Time: 1405
Name: Brandt Beeson
Company: BHE

Seal Broken By: SM
Date: 04109122

47489 APR 0 9 2022

47489

ORIGIN ID:SGRA (903) 930-6193
SCOTT BEESINGER
APTIM ENVIROMENTAL & INFASTRUCTURE
1203-B EAST GRAND AVE
PMB 202
MARSHALL, TX 75670
UNITED STATES US

SHIP DATE: 23MAR22
ACTWGT: 1.00 LB MAN
CAD: 0221247/CAFE3512
DIMS: 19x16x13 IN

TO SHIPPING DEPT
ALS LABORATORY GROUP
10450 STANCLIFF RD
SUITE 210
HOUSTON TX 77099
(281) 530-5656
REF: LHAAP-BO 84324-RG
RMA:

FedEx Express

FedEx
TRK# 5300 5229 3371

SATURDAY 12:00P
PRIORITY OVERNIGHT

XO SGRA

77099
TX-US IAH

April 13, 2022 Service Request No:E2200313

Ragen Giga
ALS Environmental - US
10450 Stancliff Rd Suite 210
Houston, TX 77099

Laboratory Results for: HS22040532

Dear Ragen,

Enclosed are the results of the sample(s) submitted to our laboratory April 12, 2022
For your reference, these analyses have been assigned our service request number **E2200313.**

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. The test results meet requirements of the current TNI standards, where applicable, and except as noted in the laboratory case narrative provided. All results are intended to be considered in their entirety and ALS Environmental is not responsible for use of less than the complete final report. Results apply only to the items submitted to the laboratory, as received for analysis. In accordance with the current TNI Standard, a statement on the estimated uncertainty of measurement of any quantitative analysis will be supplied upon request.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental

Corey Grandits
Project Manager

Certificate of Analysis

ALS Environmental - Houston HRMS
10450 Stancliff Rd, Suite 210, Houston TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

ALS Environmental

Client:	ALS-Houston	**Service Request No.:**	E2200313
Project:	HS22040532	**Date Received:**	04/12/22
Sample Matrix:	W		

CASE NARRATIVE

All analyses were performed in adherence to the quality assurance program of ALS Environmental. This report contains analytical results for samples designated for Tier II. When appropriate to the method, method blank results have been reported with each analytical test.

Sample Receipt

Six samples were received for analysis at ALS Environmental in Houston on 04/12/22.

The samples were received in good condition and are consistent with the accompanying chain of custody form. The samples were stored in a refrigerator at 4°C upon receipt at the laboratory.

Data Validation Notes and Discussion

Precision and Accuracy:

EQ2200142: Laboratory Control Spike/Duplicate Laboratory Control Spike (LCS/DLCS) samples were analyzed and reported in addition to a MS/MSD for this extraction batch. The LCS-DLCS recoveries met acceptance criteria.

DoD Certification is held for the method/matrix/analytes provided in this report.

The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and ALS Environmental (ALS) is not responsible for utilization of less than the complete report.

Use of ALS group USA Corp dba ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to ALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.

Client: ALS Environmental - US **Service Request:**E2200313

Project: HS22040532

SAMPLE CROSS-REFERENCE

SAMPLE #	CLIENT SAMPLE ID	DATE	TIME
E2200313-001	17WW01_220408	4/8/2022	0951
E2200313-002	17WW02_220408	4/8/2022	1101
E2200313-003	17WW03_220408	4/8/2022	1026
E2200313-004	17WW03_220408-A	4/8/2022	1026
E2200313-005	17WW06_220408	4/8/2022	0911
E2200313-006	17WW130_220408	4/8/2022	1146

Service Request Summary

Folder #: **E2200313**
Client Name: ALS Environmental - US
Project Name: HS22040532
Project Number:

Report To: Ragen Giga
ALS Environmental - US
10450 Stancliff Rd Suite 210
Houston, TX 77099
USA
Phone Number:
Cell Number:
Fax Number:
E-mail: ragenp.giga@alsglobal.com

Project Chemist: Corey Grandits
Originating Lab: HOUSTON
Logged By: CGRANDITS
Date Received: 04/12/22
Internal Due Date: 4/15/2022
QAP: LAB QAP
Qualifier Set: Lab Standard
Formset: Lab Standard
Merged?: Y
Report to MDL?: Y
P.O. Number: HS22040532
EDD: No EDD Specified

8 120 mL-Plastic Bottle Natural WM Unpreserved
Location: EHRMS-AirArch 1
Pressure Gas:
Rush

Lab Samp No.	Client Samp No	Matrix	Collected	HOUSTON ClO4 DOD/6850
E2200313-001	17WW01_220408	Water	04/08/22 0951	**IV**
E2200313-002	17WW02_220408	Water	04/08/22 1101	**IV**
E2200313-003	17WW03_220408	Water	04/08/22 1026	**IV**
E2200313-004	17WW03_220408-A	Water	04/08/22 1026	**IV**
E2200313-005	17WW06_220408	Water	04/08/22 0911	**IV**
E2200313-006	17WW130_220408	Water	04/08/22 1146	**IV**

Service Request Summary

01228036

Folder #: **E2200313**
Client Name: ALS Environmental - US
Project Name: HS22040532
Project Number:

Report To: Ragen Giga
ALS Environmental - US
10450 Stancliff Rd Suite 210
Houston, TX 77099
USA
Phone Number:
Cell Number:
Fax Number:
E-mail: ragenp.giga@alsglobal.com

Project Chemist: Corey Grandits
Originating Lab: HOUSTON
Logged By: CGRANDITS
Date Received: 04/12/22
Internal Due Date: 4/15/2022
QAP: LAB QAP
Qualifier Set: Lab Standard
Formset: Lab Standard
Merged?: Y
Report to MDL?: Y
P.O. Number: HS22040532
EDD: No EDD Specified

8 120 mL-Plastic Bottle Natural WM Unpreserved
Location: EHRMS-AirArch 1
Pressure Gas:
Rush

Test Comments:

Group	Test/Method	Samples	Comments
Semivoa GCMS	ClO4 DOD/6850	6	IV due 5/2

Data Qualifiers

Lab Standard

+	Possible Tedlar bag artifact.
A	TIC is a suspected aldol-condensation product
B	Analyte found in the associated method blank as well as in the sample.
BC	Reported results are not blank corrected.
BH	The back section of the tube yielded higher results than the front.
BT	Results indicated possible breakthrough; back section >=10% front section.
C	Result identification confirmed.
D	Compound identified in an analysis at a secondary dilution factor
D	Spike was diluted out
DE	Reported results are corrected for desorption efficiency.
E	Estimated value. Concentration above calibration range
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
F	The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
H	The chromatographic fingerprint of the sample resembles a petroleum product but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
H1	Sample analysis performed past holding time. See case narrative.
H2	Initial analysis within holding time. Reanalysis for the required dilution was past holding time.
H3	Sample was received and analyzed past holding time.
H4	Sample was extracted past required extraction holding time, but analyzed within analysis holding time. See case narrative.
I	Internal standard not within the specified limits. See case narrative.
J	Estimated Value. Concentration found below MRL.
K	(Auto) The reference ion ratio was outside acceptance criteria, which may indicate a potential bias to this result.
K	A deflection in the QC ion may indicate interference with the quantitation of this ion. The concentration of this analyte should be considered as an estimate.
K	Analyte was detected above the method reporting limit prior to normalization.
K	The reference ion ratio was outside acceptance criteria, which may indicate a potential bias to this result.
L	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
L1	Laboratory control sample recovery outside the specified limits; results may be biased high.
L2	Laboratory control sample recovery outside the specified limits; results may be biased low.
L3	Laboratory control sample recovery outside the specified limits.
M	Matrix interference; results may be biased high.
M	The duplicate injection precision not met.
M1	Matrix interference due to coelution with a non-target compound; results may be biased high.

Data Qualifiers

Lab Standard

N	Presumptive evidence of a compound for TICs that have been identified based on a mass spectral library search.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
O	The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
P	Indicates chlorodiphenyl ether interference present at the retention time of the target compound.
P	Pesticide/Aroclor target analyte > 40% difference for detected concentrations between GC columns
Q	Indicates as estimated value because the P and P + 2 theoretical abundance ratio does not meet method criteria.
R	Duplicate Precision not met.
R1	Duplicate precision not within the specified limits; however, the results are below the MRL and considered estimated.
S	Surrogate recovery not within specified limits.
S	The reported value was determined by the Method of Standard Additions (MSA).
T	Analyte is a tentatively identified compound, result is estimated.
U	Compound was analyzed for, but was not detected (ND).
V1	The continuing calibration verification standard was outside (biased high) the specified limits for this compound.
V2	The continuing calibration verification standard was outside (biased low) the specified limits for this compound.
W	Result quantified, but the corresponding peak was detected outside the generated retention time window.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
X	See case narrative.
Y	Recovery outside limits
Y	The chromatogram resembles a petroleum product but does not match the calibration standard.
Z	The chromatogram does not resemble a petroleum product.
i	The MRL/MDL has been elevated due to a matrix interference.

ALS Laboratory Group

Acronyms

Cal	Calibration
Conc	CONCentration
Dioxin(s)	Polychlorinated dibenzo-p-dioxin(s)
EDL	Estimated Detection Limit
EMPC	Estimated Maximum Possible Concentration
Flags	Data qualifiers
Furan(s)	Polychlorinated dibenzofuran(s)
g	Grams
ICAL	Initial CALibration
ID	IDentifier
Ions	Masses monitored for the analyte during data acquisition
L	Liter (s)
LCS	Laboratory Control Sample
DLCS	Duplicate Laboratory Control Sample
MB	Method Blank
MCL	Method Calibration Limit
MDL	Method Detection Limit
mL	Milliliters
MS	Matrix Spiked sample
DMS	Duplicate Matrix Spiked sample
NO	Number of peaks meeting all identification criteria
PCDD(s)	Polychlorinated dibenzo-p-dioxin(s)
PCDF(s)	Polychlorinated dibenzofuran(s)
ppb	Parts per billion
ppm	Parts per million
ppq	Parts per quadrillion
ppt	Parts per trillion
QA	Quality Assurance
QC	Quality Control
Ratio	Ratio of areas from monitored ions for an analyte
% Rec.	Percent recovery
RPD	Relative Percent Difference
RRF	Relative Response Factor
RT	Retention Time
SDG	Sample Delivery Group
S/N	Signal-to-noise ratio
TEF	Toxicity Equivalence Factor
TEQ	Toxicity Equivalence Quotient

10450 Stancliff Rd, Houston, TX 77099 | 281-530-5656 | www.alsglobal.com

ALS Environmental

State Certifications, Accreditations, and Licenses

Agency	Number	Expire Date
Arizona Department of Health Services	AZ0793-2022	5/27/2022
California Department of Health Services	2919	4/30/2022
California Department of Health Services	2919-2022	4/30/2022
Florida Department of Health	E87611-34	6/30/2022
Hawaii Department of Health	2021-2022	4/30/2022
Illinois Environmental Protection Agency	2000322021-7	5/9/2022
Kansas Department of Health and Environment	E-10352 2022	7/31/2022
Louisiana Department of Environmental Quality	03087-2021	6/30/2022
Louisiana Department of Environmental Quality	03087-2020	6/30/2022
Louisiana Department of Health and Hospitals	LA028	12/31/2022
Maine Department of Health and Human Services	2020016	6/5/2022
Maryland Department of the Environment	343	6/30/2022
Michigan Depratment of Environmental Quality	9971	4/30/2022
Minnesota Department of Health	2228443	12/31/2022
Nebraska Department of Health and Human Services	NE-OS-25-13	4/30/2022
Nevada Department of Concervation and Natural Resources	TX026932022-1	7/31/2022
New Hampshire Environmental Laboratory Accreditation Program	209421	4/24/2022
New Hampshire Environmental Laboratory Accreditation Program	209419	4/24/2022
New Jersey Department of Environmental Protection	TX008	6/30/2022
New York Department of Health	11707	3/31/2023
Oklahoma Department of Environmental Quality	2021-080	8/31/2022
Pennsylvania Department of Environmental Protection	68-03441-015	6/30/2022
Tennessee Department of Environment and Concervation	04016	4/30/2022
Tennessee Department of Environment and Concervation	04016-2021	4/30/2022
Texas Commision on Environmental Quality	T104704231-21-28	4/30/2022
Texas Commision on Environmental Quality	T104704231-21-27	4/30/2022
United States Department of Agriculture	P330-19-00299	10/10/2022
Utah Department of Health Environmental Laboratory Certification	TX026932021-12	7/31/2022
Washington Department of Health	C819-2022	11/14/2022

Chain of Custody

ALS Environmental - Houston HRMS
10450 Stancliff Rd, Suite 210, Houston TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

10450 Stancliff Rd, Ste 210
Houston, TX 77099
T: +1 281 530 5656
F: +1 281 530 5887
www.alsglobal.com

Subcontract Chain of Custody

SAMPLING STATE: **Texas** **COC ID:** **18552**

SUBCONTRACT TO:

ALS Environmental
10450 Stancliff RoadSuite 210
Houston, TX 77084

Phone: +1 281 530 5656

CUSTOMER INFORMATION:

Company:	ALS Houston
Contact:	Ragen Giga
Address:	10450 Stancliff Rd, Ste 210
Phone:	+1 281 530 5656
Email:	RagenP.Giga@ALSGlobal.com
Alternate Contact:	Jumoke M. Lawal
Email:	jumoke.lawal@alsglobal.com

INVOICE INFORMATION:

Company:	ALS Houston
Contact:	Accounts Payable
Address:	10450 Stancliff Rd, Ste 210
Phone:	+1 281 530 5656
Reference:	HS22040532
TSR:	Houston House Acct

	LAB SAMPLE ID	CLIENT SAMPLE ID	MATRIX	COLLECT DATE
	ANALYSIS REQUESTED			DUE DATE
1.	**HS22040532-02**	**17WW01_220408**	**Groundwater**	**08 Apr 2022 09:51**
	Provide Level II and Level IV reports in separate pdf Perchlorate (EPA 6850)			18 Apr 2022
2.	**HS22040532-03**	**17WW02_220408**	**Groundwater**	**08 Apr 2022 11:01**
	Provide Level II and Level IV reports in separate pdf Perchlorate (EPA 6850)			18 Apr 2022
3.	**HS22040532-04**	**17WW03_220408**	**Groundwater**	**08 Apr 2022 10:26**
	Provide Level II and Level IV reports in separate pdf Perchlorate (EPA 6850)			18 Apr 2022
4.	**HS22040532-05**	**17WW03_220408-A**	**Groundwater**	**08 Apr 2022 10:26**
	Provide Level II and Level IV reports in separate pdf Perchlorate (EPA 6850)			18 Apr 2022
5.	**HS22040532-06**	**17WW06_220408**	**Groundwater**	**08 Apr 2022 09:11**
	Provide Level II and Level IV reports in separate pdf Perchlorate (EPA 6850)			18 Apr 2022
6.	**HS22040532-07**	**17WW130_220408**	**Groundwater**	**08 Apr 2022 11:46**
	Provide Level II and Level IV reports in separate pdf			18 Apr 2022

Comments: Please analyze for the analysis listed above.
Send report to the emails shown above.
HS22040532-07 MS/MSD

RIGHT SOLUTIONS RIGHT PEOPLE

Subcontract Chain of Custody

SAMPLING STATE: **Texas** **COC ID:** **18552**

QC Level: DOD IV (DoD Data Package)

Relinquished By: _____ Date/Time: _____

Received By: _____ Date/Time: 4/14/22 0822

Cooler ID(s): _____ Temperature(s): _____

ALS Environmental

Cooler Receipt Form

Project Chemist CG

Client/Project ALS-H

Thermometer ID IR#1

Date/Time Received: 4-12-22 Initials: CG

Date/Time Logged in: 4-12-22 Initials CG

1. Method of delivery: ○ US Mail ○ Fed Ex ○ UPS ○ DHL ☒ ALS Courier ○ Client

2. Samples received in: ☒ Cooler ○ Box ○ Envelope ○ Other

3. Were custody seals on coolers? ○ Yes ☒ No

Were they intact? ○ Yes ○ No ☒ N/A

Were they signed and dated? ○ Yes ○ No ☒ N/A

If yes, how many and where?

4. Packing Material: ○ Inserts ☒ Baggies ○ Bubble Wrap ○ Gel Packs ☒ Wet Ice ○ Sleeves ○ Other

5. Foreign or Regulated Soil? ○ Yes ○ No Location of Sampling:

Cooler Tracking Number	COC ID	Date Opened	Time Opened	Opened By	Temp. °C	Temp Blank?
NA		4-12-22	0822	CG	2.2	☒
						☐
						☐
						☐

6. Were custody papers properly filled out (ink, signed, dated, etc)? ☒ Yes ○ No

7. Did all bottles arrive in good condition (not broken, no signs of leakage)? ☒ Yes ○ No

8. Were all sample labels complete (i.e., sample ID, analysis, preservation, etc)? ☒ Yes ○ No

9. Were appropriate bottles/containers and volumes received for the requested tests? ☒ Yes ○ No

10. Did sample labels and tags agree with custody documents? ☒ Yes ○ No

Notes, Discrepancies, & Resolutions:

Service request Label:

10450 Stancliff Rd., Suite 210
Houston, TX 77099
T: +1 713 266 1599
F: +1 713 266 1599
www.alsglobal.com

SAMPLE ACCEPTANCE POLICY

This policy outlines the criteria samples must meet to be accepted by ALS Environmental – Houston HRMS.

Cooler Custody Seals (desirable, mandatory if specified in SAP):

- ✓ Intact on outside of cooler, signed and dated

Chain-of-Custody (COC) documentation (mandatory):

The following is required on each COC:

- ✓ Sample ID, the location, date and time of collection, collector's name, preservation type, sample type, and any other special remarks concerning the sampleThe COC must be completed in ink.
- ✓ Signature and date of relinquishing party.

In the absence of a COC at sample receipt, the COC will be requested from the client.

Sample Integrity (mandatory):

Samples are inspected upon arrival to ensure that sample integrity was not compromised during transfer to the laboratory.

- ✓ Sample containers must arrive in good condition (not broken or leaking).
- ✓ Samples must be labeled appropriately, including Sample IDs, and requested test using durable labels and indelible ink.
- ✓ The correct type of sample bottle must be used for the method requested.
- ✓ An appropriate sample volume, or weight, must be received.
- ✓ Sample IDs and number of containers must reconcile with the COC.
- ✓ Samples must be received within the method defined holding time.

Temperature Requirement (varies by sample matrix):

- ✓ Aqueous and Non-aqueous samples must be shipped and stored cold, at 0 to 6ºC.
- ✓ Tissue samples must be shipped and stored frozen, at -20 to -10ºC.
- ✓ Air samples are shipped and stored cold, at 0 to 6ºC
- ✓ The sample temperature must be recorded on the COC

All cooler inspections are documented on the Cooler Receipt Form (CRF). A separate CRF is completed for each service request. Any samples not meeting the above criteria are noted on the CRF and the Project Manager notified. The Project Manager must resolve any sample integrity issues with the client prior to proceeding with the analysis. Such resolutions are documented in writing and filed with the project folder. Data associated with samples received outside of this acceptance policy will be qualified on the case narrative of the final report

Preparation Information Benchsheets

ALS Environmental - Houston HRMS
10450 Stancliff Rd., Suite 210, Houston, TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

Preparation Information Benchsheet

Prep Run#: 397884 **Prep WorkFlow:** GenExt28Day **Status:** Prepped
Team: Semivoa GCMS/GRIVERA **Prep Method:** Method **Prep Date/Time:** 4/12/22 09:51

#	Lab Code	Client ID	B#	Method /Test	pH	Cl	Matrix	Amt. Ext.	Sample Description
1	E2200304-001	50WW05_220405	.01	6850/ClO4 DOD			Water	10mL	
2	E2200304-002	50WW29_220405	.01	6850/ClO4 DOD			Water	10mL	
3	E2200313-001	17WW01_220408	.01	6850/ClO4 DOD			Water	10mL	
4	E2200313-002	17WW02_220408	.01	6850/ClO4 DOD			Water	10mL	
5	E2200313-003	17WW03_220408	.01	6850/ClO4 DOD			Water	10mL	
6	E2200313-004	17WW03_220408-A	.01	6850/ClO4 DOD			Water	10mL	
7	E2200313-005	17WW06_220408	.01	6850/ClO4 DOD			Water	10mL	
8	E2200313-006	17WW130_220408	.01	6850/ClO4 DOD			Water	10mL	
9	EQ2200142-01	MB		6850/ClO4 DOD			Liquid	10mL	
10	EQ2200142-02	LCS		6850/ClO4 DOD			Liquid	10mL	
11	EQ2200142-03	DLCS		6850/ClO4 DOD			Liquid	10mL	
12	EQ2200142-04	17WW130_220408 MS	.01	6850/ClO4 DOD			Liquid	10mL	
13	EQ2200142-05	17WW130_220408 DMS	.01	6850/ClO4 DOD			Liquid	10mL	

Spiking Solutions

Name: Perchlorate Internal Standard 1ug/mL Inventory ID 221408 Logbook Ref: Perchlorate Internal Standard Expires On: 04/30/2022

E2200304-001	100.00µL	E2200304-002	100.00µL	E2200313-001	100.00µL	E2200313-002	100.00µL	E2200313-003	100.00µL	E2200313-004	100.00µL
E2200313-005	100.00µL	E2200313-006	100.00µL	EQ2200142-01	100.00µL	EQ2200142-02	100.00µL	EQ2200142-03	100.00µL	EQ2200142-04	100.00µL
EQ2200142-05	100.00µL										

Name: Perchlorate Intermediate Stock1 Inventory ID 221456 Logbook Ref: Perchlorate Expires On: 04/30/2022

EQ2200142-02	1.00µL	EQ2200142-03	1.00µL	EQ2200142-04	1.00µL	EQ2200142-05	1.00µL

Preparation Materials

Water HPLC Grade	08/03/2021 Water (218532)	6850 Amber Glass screw vial	2mL Screw Top Vial (221894)	537M Glass Culture Tubes	537M Glass Tubes (218064)
6850 0.45um syringe filters	6850 Syringe Filters (219639)	6850 Luer-Lok Syringes	Luer-Lok Syringes (221305)	6850 Pipette Tips 50-1000 uL	6850 Pipette Tips (221929)

Preparation Steps

Step: Preparation
Started: 4/12/22 09:51
Finished: 4/12/22 10:46
By: GRIVERA
Comments

Preparation Information Benchsheet

Prep Run#: 397884 **Prep WorkFlow:** GenExt28Day **Status:** Prepped
Team: Semivoa GCMS/GRIVERA **Prep Method:** Method **Prep Date/Time:** 4/12/22 09:51

Comments:

Reviewed By: GR Date: 4/12/22

Chain of Custody

Relinquished By:		Date:		Extracts Examined
Received By:		Date:		Yes No

Analytical Results

ALS Environmental - Houston HRMS
10450 Stancliff Rd., Suite 210, Houston, TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	4/ 8/22 0951
Sample Matrix:	Water	**Date Received:**	4/12/22
Sample Name:	17WW01_220408	**Units:**	µg/L
Lab Code:	E2200313-001	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**239**		1.00	0.500	0.250	10	4/12/22	4/13/22 12:42	397884	760391	

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	4/ 8/22 1101
Sample Matrix:	Water	**Date Received:**	4/12/22
Sample Name:	17WW02_220408	**Units:**	µg/L
Lab Code:	E2200313-002	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**5250**		20.0	10.0	5.00	200	4/12/22	4/13/22 12:50	397884	760391	

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	4/ 8/22 1026
Sample Matrix:	Water	**Date Received:**	4/12/22
Sample Name:	17WW03_220408	**Units:**	µg/L
Lab Code:	E2200313-003	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**44.7**		0.100	0.0500	0.0250	1	4/12/22	4/12/22 18:08	397884	760388	

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	4/ 8/22 1026
Sample Matrix:	Water	**Date Received:**	4/12/22
Sample Name:	17WW03_220408-A	**Units:**	µg/L
Lab Code:	E2200313-004	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**7.78**		0.100	0.0500	0.0250	1	4/12/22	4/12/22 18:16	397884	760388	

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	4/ 8/22 0911
Sample Matrix:	Water	**Date Received:**	4/12/22
Sample Name:	17WW06_220408	**Units:**	µg/L
Lab Code:	E2200313-005	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**120000**		500	250	125	5000	4/12/22	4/13/22 13:16	397884	760391	

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	4/ 8/22 1146
Sample Matrix:	Water	**Date Received:**	4/12/22
Sample Name:	17WW130_220408	**Units:**	µg/L
Lab Code:	E2200313-006	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**15.0**		0.100	0.0500	0.0250	1	4/12/22	4/13/22 12:34	397884	760391	

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
Sample Name:	Method Blank	**Units:**	µg/L
Lab Code:	EQ2200142-01	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	ND	U	0.100	0.0500	0.0250	1	4/12/22	4/12/22 14:58	397884	760388	

Accuracy & Precision

ALS Environmental - Houston HRMS
10450 Stancliff Rd., Suite 210, Houston TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

Client: ALS Environmental - US
Project: HS22040532
Sample Matrix: Water

Service Request: E2200313
Date Analyzed: 4/12/22

Lab Control Sample Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Units: µg/L
Basis: NA

Extraction Lot: 397884

	Lab Control Sample EQ2200142-02			Duplicate Lab Control Sample EQ2200142-03					
Analyte Name	**Result**	**Spike Amount**	**% Rec**	**Result**	**Spike Amount**	**% Rec**	**% Rec Limits**	**RPD**	**RPD Limit**
Perchlorate	0.113	0.100	113	0.118	0.100	118	84 - 119	4	15

Results flagged with an asterisk (*) indicate values outside control criteria.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
Sample Name:	Lab Control Sample	**Units:**	µg/L
Lab Code:	EQ2200142-02	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.113**		0.100	0.0500	0.0250	1	4/12/22	4/12/22 16:09	397884	760388	

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
Sample Name:	Duplicate Lab Control Sample	**Units:**	µg/L
Lab Code:	EQ2200142-03	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.118**		0.100	0.0500	0.0250	1	4/12/22	4/12/22 16:41	397884	760388	

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	4/8/22
Sample Matrix:	Water	**Date Received:**	4/12/22
		Date Analyzed:	4/12/22

Matrix Spike Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Sample Name:	17WW130_220408	**Units:**	µg/L
Lab Code:	E2200313-006	**Basis:**	NA

Analytical Method: 6850
Prep Method: Method

		17WW130_220408MS				17WW130_220408DMS					
		Matrix Spike				**Duplicate Matrix Spike**					
		EQ2200142-04				EQ2200142-05					
Analyte Name	**Sample Result**	**Result**	**Spike Amount**	**% Rec**		**Result**	**Spike Amount**	**% Rec**		**% Rec Limits**	**RPD**	**RPD Limit**
Perchlorate	15.0	16.9	0.100	1940	#	15.6	0.100	584	#	84 - 119	8	15

Results flagged with an asterisk (*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	4/ 8/22 1146
Sample Matrix:	Water	**Date Received:**	4/12/22
Sample Name:	17WW130_220408	**Units:**	µg/L
Lab Code:	EQ2200142-04	**Basis:**	NA
Run Type:	Matrix Spike		

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**16.9**		0.100	0.0500	0.0250	1	4/12/22	4/12/22 17:05	397884	760388	

Client:	ALS Environmental - US	**Service Request:**	E2200313
Project:	HS22040532	**Date Collected:**	4/ 8/22 1146
Sample Matrix:	Water	**Date Received:**	4/12/22
Sample Name:	17WW130_220408	**Units:**	µg/L
Lab Code:	EQ2200142-05	**Basis:**	NA
Run Type:	Duplicate Matrix Spike		

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**15.6**		0.100	0.0500	0.0250	1	4/12/22	4/12/22 17:13	397884	760388	

April 27, 2022 Service Request No:E2200359

Marcia Olive
Bhate Environmental Associates, Inc.
445 Union Blvd
Suite 129
Lakewood, CO 80228

Laboratory Results for: LHAAP17

Dear Marcia,

Enclosed are the results of the sample(s) submitted to our laboratory April 22, 2022
For your reference, these analyses have been assigned our service request number **E2200359.**

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. The test results meet requirements of the current TNI standards, where applicable, and except as noted in the laboratory case narrative provided. All results are intended to be considered in their entirety and ALS Environmental is not responsible for use of less than the complete final report. Results apply only to the items submitted to the laboratory, as received for analysis. In accordance with the current TNI Standard, a statement on the estimated uncertainty of measurement of any quantitative analysis will be supplied upon request.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental



Corey Grandits
Project Manager

ADDRESS 10450 Stancliff Rd., Suite 210, Houston, TX 77099
PHONE +1 281 530 5656 | FAX +1 281 530 5887
ALS Group USA, Corp.
dba ALS Environmental

Certificate of Analysis

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www.alsglobal.com

ALS Environmental

Client:	Bhate	**Service Request No.:**	E2200359
Project:	LHAAP17	**Date Received:**	04/22/22
Sample Matrix:	W		

CASE NARRATIVE

All analyses were performed in adherence to the quality assurance program of ALS Environmental. This report contains analytical results for samples designated for Tier II. When appropriate to the method, method blank results have been reported with each analytical test.

Sample Receipt

One sample was received for analysis at ALS Environmental in Houston on 04/22/22.

The sample was received in good condition and is consistent with the accompanying chain of custody form. The sample was stored in a refrigerator at 4°C upon receipt at the laboratory.

Data Validation Notes and Discussion

Precision and Accuracy:

EQ2200164: Laboratory Control Spike/Duplicate Laboratory Control Spike (LCS/DLCS) samples were analyzed and reported in lieu of a MS/MSD for this extraction batch. The LCS-DLCS recoveries met acceptance criteria.

DoD Certification is held for the method/matrix/analytes provided in this report.

The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and ALS Environmental (ALS) is not responsible for utilization of less than the complete report.

Use of ALS group USA Corp dba ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to ALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.

Client: Bhate Environmental Associates, Inc. **Service Request:**E2200359
Project: LHAAP17

SAMPLE CROSS-REFERENCE

SAMPLE #	CLIENT SAMPLE ID	DATE	TIME
E2200359-001	17WW01_042122	4/21/2022	0840

Service Request Summary

Folder #: **E2200359**
Client Name: Bhate Environmental Associates, Inc.
Project Name: LHAAP17
Project Number:

Report To: Marcia Olive
Bhate Environmental Associates, Inc.
445 Union Blvd
Lakewood, CO 80228
USA
Phone Number: 303-597-2450
Cell Number:
Fax Number:
E-mail: molive@bhate.com

Project Chemist: Corey Grandits
Originating Lab: HOUSTON
Logged By: CGRANDITS
Date Received: 04/22/22
Internal Due Date: 4/25/2022
QAP: LAB QAP
Qualifier Set: Lab Standard
Formset: Lab Standard
Merged?: Y
Report to MDL?: Y
P.O. Number: 2878
EDD: No EDD Specified

1 120 mL-Plastic Bottle Natural WM Unpreserved
Location: EHRMS-AirArch 1
Pressure Gas:
Rush

Lab Samp No.	Client Samp No	Matrix	Collected	HOUSTON ClO4 DOD/6850
E2200359-001	17WW01_042122	Water	04/21/22 0840	**IV**

Service Request Summary

Folder #: **E2200359**
Client Name: Bhate Environmental Associates, Inc.
Project Name: LHAAP17
Project Number:

Report To: Marcia Olive
Bhate Environmental Associates, Inc.
445 Union Blvd
Lakewood, CO 80228
USA
Phone Number: 303-597-2450
Cell Number:
Fax Number:
E-mail: molive@bhate.com

Project Chemist: Corey Grandits
Originating Lab: HOUSTON
Logged By: CGRANDITS
Date Received: 04/22/22
Internal Due Date: 4/25/2022
QAP: LAB QAP
Qualifier Set: Lab Standard
Formset: Lab Standard
Merged?: Y
Report to MDL?: Y
P.O. Number: 2878
EDD: No EDD Specified

1 120 mL-Plastic Bottle Natural WM Unpreserved
Location: EHRMS-AirArch 1
Pressure Gas:
Rush

Test Comments:

Group	Test/Method	Samples	Comments
Semivoa GCMS	ClO4 DOD/6850	1	IV DUE 5/13

Data Qualifiers

Lab Standard

+	Possible Tedlar bag artifact.
A	TIC is a suspected aldol-condensation product
B	Analyte found in the associated method blank as well as in the sample.
BC	Reported results are not blank corrected.
BH	The back section of the tube yielded higher results than the front.
BT	Results indicated possible breakthrough; back section >=10% front section.
C	Result identification confirmed.
D	Compound identified in an analysis at a secondary dilution factor
D	Spike was diluted out
DE	Reported results are corrected for desorption efficiency.
E	Estimated value. Concentration above calibration range
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
F	The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
H	The chromatographic fingerprint of the sample resembles a petroleum product but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
H1	Sample analysis performed past holding time. See case narrative.
H2	Initial analysis within holding time. Reanalysis for the required dilution was past holding time.
H3	Sample was received and analyzed past holding time.
H4	Sample was extracted past required extraction holding time, but analyzed within analysis holding time. See case narrative.
I	Internal standard not within the specified limits. See case narrative.
J	Estimated Value. Concentration found below MRL.
K	(Auto) The reference ion ratio was outside acceptance criteria, which may indicate a potential bias to this result.
K	A deflection in the QC ion may indicate interference with the quantitation of this ion. The concentration of this analyte should be considered as an estimate.
K	Analyte was detected above the method reporting limit prior to normalization.
K	The reference ion ratio was outside acceptance criteria, which may indicate a potential bias to this result.
L	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
L1	Laboratory control sample recovery outside the specified limits; results may be biased high.
L2	Laboratory control sample recovery outside the specified limits; results may be biased low.
L3	Laboratory control sample recovery outside the specified limits.
M	Matrix interference; results may be biased high.
M	The duplicate injection precision not met.
M1	Matrix interference due to coelution with a non-target compound; results may be biased high.

Data Qualifiers

Lab Standard

N	Presumptive evidence of a compound for TICs that have been identified based on a mass spectral library search.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
O	The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
P	Indicates chlorodiphenyl ether interference present at the retention time of the target compound.
P	Pesticide/Aroclor target analyte > 40% difference for detected concentrations between GC columns
Q	Indicates as estimated value because the P and P + 2 theoretical abundance ratio does not meet method criteria.
R	Duplicate Precision not met.
R1	Duplicate precision not within the specified limits; however, the results are below the MRL and considered estimated.
S	Surrogate recovery not within specified limits.
S	The reported value was determined by the Method of Standard Additions (MSA).
T	Analyte is a tentatively identified compound, result is estimated.
U	Compound was analyzed for, but was not detected (ND).
V1	The continuing calibration verification standard was outside (biased high) the specified limits for this compound.
V2	The continuing calibration verification standard was outside (biased low) the specified limits for this compound.
W	Result quantified, but the corresponding peak was detected outside the generated retention time window.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
X	See case narrative.
Y	Recovery outside limits
Y	The chromatogram resembles a petroleum product but does not match the calibration standard.
Z	The chromatogram does not resemble a petroleum product.
i	The MRL/MDL has been elevated due to a matrix interference.

ALS Laboratory Group

Acronyms

Cal	Calibration
Conc	CONCentration
Dioxin(s)	Polychlorinated dibenzo-p-dioxin(s)
EDL	Estimated Detection Limit
EMPC	Estimated Maximum Possible Concentration
Flags	Data qualifiers
Furan(s)	Polychlorinated dibenzofuran(s)
g	Grams
ICAL	Initial CALibration
ID	IDentifier
Ions	Masses monitored for the analyte during data acquisition
L	Liter (s)
LCS	Laboratory Control Sample
DLCS	Duplicate Laboratory Control Sample
MB	Method Blank
MCL	Method Calibration Limit
MDL	Method Detection Limit
mL	Milliliters
MS	Matrix Spiked sample
DMS	Duplicate Matrix Spiked sample
NO	Number of peaks meeting all identification criteria
PCDD(s)	Polychlorinated dibenzo-p-dioxin(s)
PCDF(s)	Polychlorinated dibenzofuran(s)
ppb	Parts per billion
ppm	Parts per million
ppq	Parts per quadrillion
ppt	Parts per trillion
QA	Quality Assurance
QC	Quality Control
Ratio	Ratio of areas from monitored ions for an analyte
% Rec.	Percent recovery
RPD	Relative Percent Difference
RRF	Relative Response Factor
RT	Retention Time
SDG	Sample Delivery Group
S/N	Signal-to-noise ratio
TEF	Toxicity Equivalence Factor
TEQ	Toxicity Equivalence Quotient

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ALS Environmental

State Certifications, Accreditations, and Licenses

Agency	Number	Expire Date
Arizona Department of Health Services	AZ0793-2022	5/27/2022
California Department of Health Services	2919	4/30/2022
California Department of Health Services	2919-2022	4/30/2022
Florida Department of Health	E87611-34	6/30/2022
Hawaii Department of Health	2021-2022	4/30/2022
Illinois Environmental Protection Agency	2000322021-7	5/9/2022
Kansas Department of Health and Environment	E-10352 2022	7/31/2022
Louisiana Department of Environmental Quality	03087-2021	6/30/2022
Louisiana Department of Environmental Quality	03087-2020	6/30/2022
Louisiana Department of Health and Hospitals	LA028	12/31/2022
Maine Department of Health and Human Services	2020016	6/5/2022
Maryland Department of the Environment	343	6/30/2022
Michigan Depratment of Environmental Quality	9971	4/30/2022
Minnesota Department of Health	2228443	12/31/2022
Nebraska Department of Health and Human Services	NE-OS-25-13	4/30/2022
Nevada Department of Concervation and Natural Resources	TX026932022-1	7/31/2022
New Jersey Department of Environmental Protection	TX008	6/30/2022
New York Department of Health	11707	3/31/2023
Oklahoma Department of Environmental Quality	2021-080	8/31/2022
Pennsylvania Department of Environmental Protection	68-03441-015	6/30/2022
Tennessee Department of Environment and Concervation	04016-2021	4/30/2022
Tennessee Department of Environment and Concervation	04016	4/30/2022
Texas Commision on Environmental Quality	T104704231-21-27	4/30/2022
Texas Commision on Environmental Quality	T104704231-21-28	4/30/2022
United States Department of Agriculture	P330-19-00299	10/10/2022
Utah Department of Health Environmental Laboratory Certification	TX026932021-12	7/31/2022
Washington Department of Health	C819-2022	11/14/2022

Chain of Custody

ALS Environmental - Houston HRMS
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Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

bhate ENVIRONMENTAL CONSTRUCTION ENGINEERS

1608 13th Avenue South, Suite 300
Birmingham Alabama 35205
Tel: 205-918-4000
Fax: 205-918-4050

Page: _____ of _____

Project/Phase No: NWO1312.0150

COC Number(1): _____

LIMS Number: _____

Chain of Custody and Analytical Request

Facility/Base I.D.: LHAAP

Project/Site Name: LHAAP / 17

Client Name:

Collected by: Scott Beesinger

Field Sample ID (30 Characters Max)	Date Collected (dd-mmm-yyyy)	Time Collected (Military) (hhmm)	Sample Depth (beginning - ending)	SA Code (2)	Sample Number (3)	Sample Matrix (4)	Sample Analysis Requested (5): Number of containers	Perchlorate	Ambient Blank Lot Control Number	Equipment Blank Lot Control Number	Trip Blank Lot Control Number	Cooler ID
17WW01_042122	21 APR 2022	0840	-	N		WG	1	X				
			-									
			-									
			-									
			-									
			-									
			-									
			-									
			-									

Quality Assurance Samples (6): Ambient Blank Lot Control Number: K-D; Equipment Blank Lot Control Number: w/c 2-C 0 +31 +[illegible]

COMMENTS: 24 HR. TAT

Custody Transfers Prior to Receipt by Laboratory

Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time
1. Scott Beesinger	4/21/22	1400	1.	4/22/2022	14:25
2.			2.		
3.			3.		

Sample Delivery Details / Laboratory Receipt

Delivered Directly to Lab: _____ Shipped

Method of Shipment: _____

Fed Ex _____ Airbill No.: _____ Number:

Analytical Lab: ALS 10450 Stanciff Rd. Suite 210 Houston, TX 77099 (281) 530-5656

ATTN: SONIA WEST Lab Recipient: Delivery Date/Time:

1.) Chain of Custody Number = date collected + custody number (e.g. 09-02-1999-01)

2.) Sample Type (SA) Codes: N = Normal Sample, TB = Trip Blank (-c) Sample, FD = Field Duplicate (-a) Samples, FR = Field Replicate (-b) Samples, EB = Equipment Blank (-d) Samples, MS = Matrix Spike, SD = Matrix Spike Duplicate, AB = Ambient Blank (-e)

3.) Sample Number: Unique sample number collected from a particular location per day. (e.g. Groundwater sample collected from MW-1 on 10/10/99 = 01, if sampled again on 10/10/99 = 02, etc.)

4.) Matrix Codes: GS = Soil Gas, WG = Groundwater, WS = Surface Water, SO = Soil, SE = Sediment, SL = Sludge, SS = Surface Soil Samples, WQ = Aqueous Blank Samples (trip, equipment, ambient, etc), SQ = Soil Blanks

5.) Sample Analysis Requested: Analytical method requested and number of containers provided for each.

6.) Quality assurance samples are assigned by date (ddmmyy) and the sample number associated with the sample (01, 02, etc) (e.g. Equipment blank collected in association with MW-1 on 10/10/99 will be designated 10109901 in the Equipment Blank Lot Control

ALS Environmental

Cooler Receipt Form

Project Chemist CG

Client/Project RHATE

Thermometer ID IR31

Date/Time Received: 4.22.22 Initials: PG

Date/Time Logged in: 4.22.22 Initials CG

1. Method of delivery: ○ US Mail ⊗ Fed Ex ○ UPS ○ DHL ○ Courier ○ Client

2. Samples received in: ⊗ Cooler ○ Box ○ Envelope ○ Other

3. Were custody seals on coolers? ⊗ Yes ○ No
   Were they intact? ⊗ Yes ○ No ○ N/A
   Were they signed and dated? ⊗ Yes ○ No ○ N/A
   If yes, how many and where? 1-F

4. Packing Material: ○ Inserts ⊗ Baggies ○ Bubble Wrap ○ Gel Packs ⊗ Wet Ice ○ Sleeves ○ Other

5. Foreign or Regulated Soil? ○ Yes ○ No Location of Sampling:

Cooler Tracking Number	COC ID	Date Opened	Time Opened	Opened By	Temp. °C	Temp Blank?
9477 0338 9531		4.22.22	1424	PG	3.0	☑
						☐
						☐
						☐

6. Were custody papers properly filled out (ink, signed, dated, etc)? ⊗ Yes ○ No
7. Did all bottles arrive in good condition (not broken, no signs of leakage)? ⊗ Yes ○ No
8. Were all sample labels complete (i.e., sample ID, analysis, preservation, etc)? ⊗ Yes ○ No
9. Were appropriate bottles/containers and volumes received for the requested tests? ⊗ Yes ○ No
10. Did sample labels and tags agree with custody documents? ⊗ Yes ○ No

Notes, Discrepancies, & Resolutions:

Service request Label:

10450 Stancliff Rd., Suite 210
Houston, TX 77099
T: +1 713 266 1599
F: +1 713 266 1599
www.alsglobal.com

SAMPLE ACCEPTANCE POLICY

This policy outlines the criteria samples must meet to be accepted by ALS Environmental – Houston HRMS.

Cooler Custody Seals (desirable, mandatory if specified in SAP):

- ✓ Intact on outside of cooler, signed and dated

Chain-of-Custody (COC) documentation (mandatory):

The following is required on each COC:

- ✓ Sample ID, the location, date and time of collection, collector's name, preservation type, sample type, and any other special remarks concerning the sampleThe COC must be completed in ink.
- ✓ Signature and date of relinquishing party.

In the absence of a COC at sample receipt, the COC will be requested from the client.

Sample Integrity (mandatory):

Samples are inspected upon arrival to ensure that sample integrity was not compromised during transfer to the laboratory.

- ✓ Sample containers must arrive in good condition (not broken or leaking).
- ✓ Samples must be labeled appropriately, including Sample IDs, and requested test using durable labels and indelible ink.
- ✓ The correct type of sample bottle must be used for the method requested.
- ✓ An appropriate sample volume, or weight, must be received.
- ✓ Sample IDs and number of containers must reconcile with the COC.
- ✓ Samples must be received within the method defined holding time.

Temperature Requirement (varies by sample matrix):

- ✓ Aqueous and Non-aqueous samples must be shipped and stored cold, at 0 to 6ºC.
- ✓ Tissue samples must be shipped and stored frozen, at -20 to -10ºC.
- ✓ Air samples are shipped and stored cold, at 0 to 6ºC
- ✓ The sample temperature must be recorded on the COC

All cooler inspections are documented on the Cooler Receipt Form (CRF). A separate CRF is completed for each service request. Any samples not meeting the above criteria are noted on the CRF and the Project Manager notified. The Project Manager must resolve any sample integrity issues with the client prior to proceeding with the analysis. Such resolutions are documented in writing and filed with the project folder. Data associated with samples received outside of this acceptance policy will be qualified on the case narrative of the final report

Preparation Information Benchsheets

ALS Environmental - Houston HRMS
10450 Stancliff Rd., Suite 210, Houston, TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

Preparation Information Benchsheet

Prep Run#: 398659 **Prep WorkFlow:** GenExt28Day **Status:** Prepped
Team: Semivoa GCMS/GRIVERA **Prep Method:** **Prep Date/Time:** 4/25/22 09:15

#	Lab Code	Client ID	B#	Method /Test	pH	Cl	Matrix	Amt. Ext.	Sample Description
1	E2200358-001	095-RS2137-210422	.01	6850/ClO4 DOD			Water	10mL	
2	E2200358-002	095-RS2139-210422	.01	6850/ClO4 DOD			Water	10mL	
3	E2200358-003	095-RS2663-210422	.01	6850/ClO4 DOD			Water	10mL	
4	E2200358-004	095-RS2135-210422	.01	6850/ClO4 DOD			Water	10mL	
5	E2200358-005	RSA-EB-01-210422	.01	6850/ClO4 DOD			Water	10mL	
6	E2200358-006	RSA-EB-02-210422	.01	6850/ClO4 DOD			Water	10mL	
7	E2200358-007	RSA-FB-01-210422	.01	6850/ClO4 DOD			Water	10mL	
8	E2200358-008	095-RS2133-210422	.01	6850/ClO4 DOD			Water	10mL	
9	E2200358-009	146-RS1722-210422	.01	6850/ClO4 DOD			Water	10mL	
10	E2200358-010	K95-RS1476-210422	.01	6850/ClO4 DOD			Water	10mL	
11	E2200358-011	K-RS684-210422	.01	6850/ClO4 DOD			Water	10mL	
12	E2200358-012	195-RS1641-210422	.01	6850/ClO4 DOD			Water	10mL	
13	E2200358-014	095-RS2829-210422	.01	6850/ClO4 DOD			Water	10mL	
14	E2200358-015	RSA-FD-02-210422	.01	6850/ClO4 DOD			Water	10mL	
15	E2200358-016	K-RS577-210422	.01	6850/ClO4 DOD			Water	10mL	
16	E2200358-017	195-RS1640-210422	.01	6850/ClO4 DOD			Water	10mL	
17	E2200358-018	095-RS2531-210422	.01	6850/ClO4 DOD			Water	10mL	
18	E2200358-019	RSA-03-210422	.01	6850/ClO4 DOD			Water	10mL	
19	E2200358-020	RSA-EB-04-210422	.01	6850/ClO4 DOD			Water	10mL	
20	E2200359-001	17WW01_042122	.01	6850/ClO4 DOD			Water	10mL	
21	EQ2200164-01	MB		6850/ClO4 DOD			Liquid	10mL	
22	EQ2200164-02	LCS		6850/ClO4 DOD			Liquid	10mL	
23	EQ2200164-03	DLCS		6850/ClO4 DOD			Liquid	10mL	

Spiking Solutions

Name: Perchlorate Internal Standard 1ug/mL Inventory ID 221408 Logbook Ref: Perchlorate Internal Standard Expires On: 04/30/2022

E2200358-001	100.00µL	E2200358-002	100.00µL	E2200358-003	100.00µL	E2200358-004	100.00µL	E2200358-005	100.00µL	E2200358-006	100.00µL
E2200358-007	100.00µL	E2200358-008	100.00µL	E2200358-009	100.00µL	E2200358-010	100.00µL	E2200358-011	100.00µL	E2200358-012	100.00µL
E2200358-014	100.00µL	E2200358-015	100.00µL	E2200358-016	100.00µL	E2200358-017	100.00µL	E2200358-018	100.00µL	E2200358-019	100.00µL
E2200358-020	100.00µL	E2200359-001	100.00µL	EQ2200164-01	100.00µL	EQ2200164-02	100.00µL	EQ2200164-03	100.00µL		

Name: Perchlorate Intermediate Stock1 Inventory ID 221456 Logbook Ref: Perchlorate Expires On: 04/30/2022

EQ2200164-02	1.00µL	EQ2200164-03	1.00µL

Preparation Information Benchsheet

Prep Run#: 398659 **Prep WorkFlow:** GenExt28Day **Status:** Prepped
Team: Semivoa GCMS/GRIVERA **Prep Method:** **Prep Date/Time:** 4/25/22 09:15

Preparation Materials

Water HPLC Grade	08/03/2021 Water (218532)	6850 Amber Glass screw vial	2mL Screw Top Vial (221894)	537M Glass Culture Tubes	537M Glass Tubes (218064)
6850 0.45um syringe filters	6850 Syringe Filters (222410)	6850 Luer-Lok Syringes	Luer-Lok Syringes (221305)	6850 Pipette Tips 50-1000 uL	6850 Pipette Tips (221929)

Preparation Steps

Step: Preparation
Started: 4/25/22 09:15
Finished: 4/25/22 10:30
By: GRIVERA
Comments

Comments: _____

Reviewed By: GR Date: 4/25/22

Chain of Custody

Relinquished By: _____ Date: _____

Received By: _____ Date: _____

Extracts Examined
Yes No

Analytical Results

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10450 Stancliff Rd., Suite 210, Houston, TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Collected:**	4/21/22 0840
Sample Matrix:	Water	**Date Received:**	4/22/22
Sample Name:	17WW01_042122	**Units:**	µg/L
Lab Code:	E2200359-001	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**46.8**		1.00	0.500	0.250	10	4/25/22	4/25/22 13:10	398659	761764	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
Sample Name:	Method Blank	**Units:**	µg/L
Lab Code:	EQ2200164-01	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	ND	U	0.100	0.0500	0.0250	1	4/25/22	4/25/22 11:23	398659	761764	

Accuracy & Precision

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10450 Stancliff Rd., Suite 210, Houston TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client: Bhate Environmental Associates, Inc. **Service Request:** E2200359
Project: LHAAP17 **Date Analyzed:** 4/25/22
Sample Matrix: Water

Lab Control Sample Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850 **Units:** µg/L
Prep Method: **Basis:** NA

Extraction Lot: 398659

	Lab Control Sample EQ2200164-02			Duplicate Lab Control Sample EQ2200164-03					
Analyte Name	**Result**	**Spike Amount**	**% Rec**	**Result**	**Spike Amount**	**% Rec**	**% Rec Limits**	**RPD**	**RPD Limit**
Perchlorate	0.103	0.100	103	0.102	0.100	102	84 - 119	1	15

Results flagged with an asterisk (*) indicate values outside control criteria.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
Sample Name:	Lab Control Sample	**Units:**	µg/L
Lab Code:	EQ2200164-02	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.103**		0.100	0.0500	0.0250	1	4/25/22	4/25/22 11:47	398659	761764	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
Sample Name:	Duplicate Lab Control Sample	**Units:**	µg/L
Lab Code:	EQ2200164-03	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.102**		0.100	0.0500	0.0250	1	4/25/22	4/25/22 11:55	398659	761764	

Initial Calibration

ALS Environmental - Houston HRMS
10450 Stancliff Rd., Suite 210, Houston, TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

20220225

1st Review: Grivera
2nd Review: Kneir

Injection Log
LCMS01 -Shimadzu 8050

ICAL Date: 2/25/2022
Cal. Std. xp: 7/25/2022
ICAL ID: **EC2200006**

Mobile Phases **A:** 0.75% Formic Acid/Water 3100819-05 **B:** MeOH 217304

			File Name	Acquisition Method	Dilution	R	Comments	Date/Time
1	PERCHLORATE2		20220225_013	Perchlorate6850c.lcm	1x	☒	3100818-02	2/25/2022 11:24
2	PERCHLORATE3		20220225_014	Perchlorate6850c.lcm	1x	☒	3100818-03	2/25/2022 11:32
3	PERCHLORATE4		20220225_015	Perchlorate6850c.lcm	1x	☒	3100818-04	2/25/2022 11:40
4	PERCHLORATE5		20220225_016	Perchlorate6850c.lcm	1x	☒	3100818-05	2/25/2022 11:48
5	PERCHLORATE6		20220225_017	Perchlorate6850c.lcm	1x	☒	3100818-06	2/25/2022 11:56
6	PERCHLORATE7		20220225_018	Perchlorate6850c.lcm	1x	☒	3100818-07	2/25/2022 12:04
7	PERCHLORATE8		20220225_019	Perchlorate6850c.lcm	1x	☒	3100818-08	2/25/2022 12:12
8	PERCHLORATE9		20220225_020	Perchlorate6850c.lcm	1x	☒	3100818-09	2/25/2022 12:19
10	PERCHLORATE10		20220225_021	Perchlorate6850c.lcm	1x	☒	3100819-01	2/25/2022 12:27
11	PERCHLORATE1		20220225_023	Perchlorate6850c.lcm	1x	☒	3100818-01	2/25/2022 13:31
12	PERCHLORATEICV		20220225_024	Perchlorate6850c.lcm	1x	☒	3100819-02	2/25/2022 13:47

Initial Calibration - Detailed Report

Calibration ID: EC2200006 **Instrument ID:** E-LCMS-01
Column Name: 1

#	Lab Code	Sample Name	File Location	Aquisition Date
01	EC2200006-01	PERCHLORATE2	20220225_013	02/25/2022 11:24
02	EC2200006-02	PERCHLORATE3	20220225_014	02/25/2022 11:32
03	EC2200006-03	PERCHLORATE4	20220225_015	02/25/2022 11:40
04	EC2200006-04	PERCHLORATE5	20220225_016	02/25/2022 11:48
05	EC2200006-05	PERCHLORATE6	20220225_017	02/25/2022 11:56
06	EC2200006-06	PERCHLORATE7	20220225_018	02/25/2022 12:04
07	EC2200006-07	PERCHLORATE8	20220225_019	02/25/2022 12:12
08	EC2200006-08	PERCHLORATE9	20220225_020	02/25/2022 12:19
09	EC2200006-09	PERCHLORATE10	20220225_021	02/25/2022 12:27
10	EC2200006-10	PERCHLORATE1	20220225_023	02/25/2022 13:31

Analyte **Curve Fit** **Weighting**

Perchlorate **Average RF** **RSD = 5.814** **Average RF = 0.1266**

#	Amount	RF	#	Amount	RF	#	Amount	RF	#	Amount	RF
01	0.5000	0.1139	02	0.7000	0.1266	03	1.0000	0.1322	04	2.0000	0.124
05	5.0000	0.1239	06	10.0000	0.1266	07	20.0000	0.1257	08	30.0000	0.1227
09	50.0000	0.1275	10	0.1000	0.1429						

Analyte

Perchlorate

#	Amount	Calculated Conc	%D	#	Amount	Calculated Conc	%D	#	Amount	Calculated Conc	%D
01	0.5000	0.450	-10.0	02	0.7000	0.700	-0.0	03	1.0000	1.04	4.4
04	2.0000	1.96	-2.0	05	5.0000	4.89	-2.1	06	10.0000	10.0	-0.0
07	20.0000	19.9	-0.7	08	30.0000	29.1	-3.1	09	50.0000	50.4	0.7
10	0.1000	0.113	12.9								

Initial Calibration Verification Summary Report

Calibration ID:	EC2200006	**Instrument ID:**	E-LCMS-01
Datafile ID:	20220225_024	**Column Name:**	1

Analyte	Lab Code	Type	Curve Fit	True Value	Calc Conc	Units	Result	Criteria
Perchlorate	EC2200006-11	T	Average RF	10	10.175	ng/mL	1.7	<= 15

Insight Report

Printed at 2/28/2022 9:41:00 AM

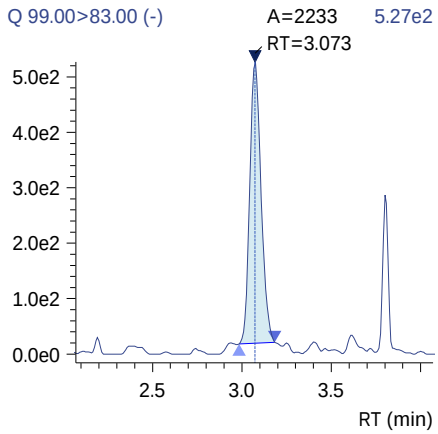
Method File: I:\LCMS01\DATA\20220225\20220225.lcm
Project File: I:\LCMS01\DATA\20220225\20220225.damlp

PERCHLORATE2

Sample ID: PERCHLORATE2
Date Acquired: 2/25/2022 11:24:44 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_013.lcd
Vial: 21 | Inj. Volume: 25.0000uL | Tray: 1

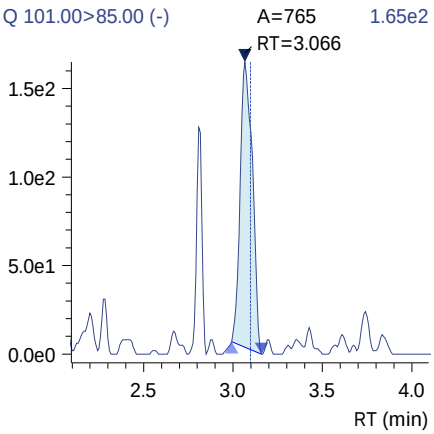
Perchlorate

Conc 0.4493



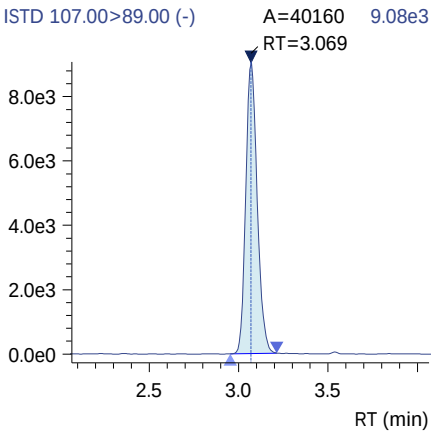
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 2/28/2022 9:59:18 AM

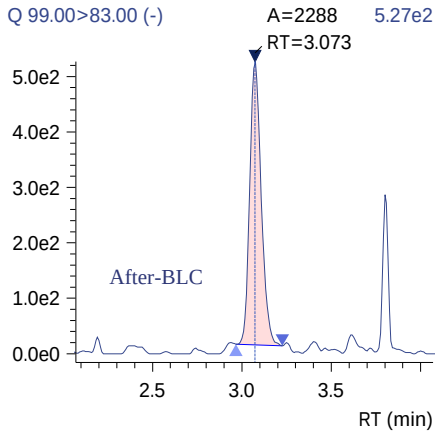
Method File: I:\LCMS01\DATA\20220225\20220225.lcm
Project File: I:\LCMS01\DATA\20220225\20220225-ICAL.damlp

PERCHLORATE2

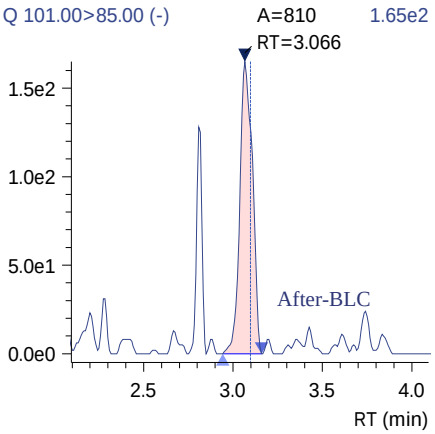
Sample ID: PERCHLORATE2
Date Acquired: 2/25/2022 11:24:44 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_013.lcd
Vial: 21 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	M	3.073	2288	40160	0.4500	ng/mL	35.38	21.36-39.66
Perchlorate 2	M	3.066	810	40160	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.069	40160	40160	1.0000	ng/mL	----	

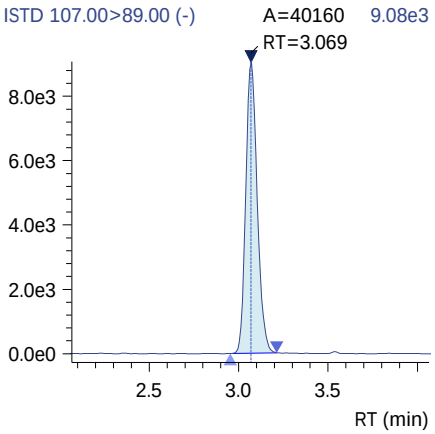
Perchlorate
Conc 0.4500



Perchlorate 2
Conc 0.0000



Sodium Perchlorate-18O4_IS
Conc 1.0000



Insight Report

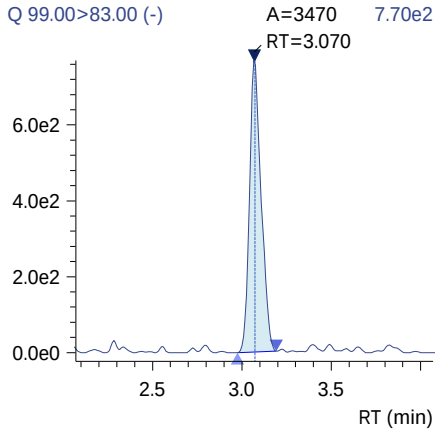
Printed at 2/28/2022 9:41:00 AM

PERCHLORATE3

Sample ID: PERCHLORATE3
Date Acquired: 2/25/2022 11:32:39 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_014.lcd
Vial: 22 | Inj. Volume: 25.0000uL | Tray: 1

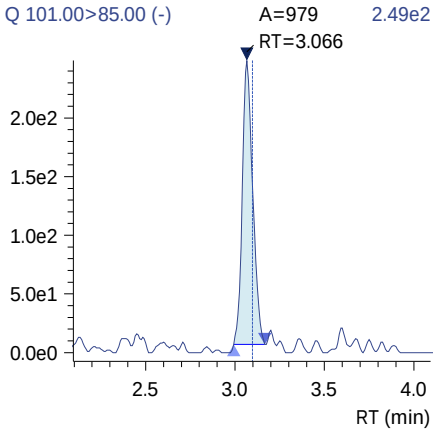
Perchlorate

Conc 0.7158



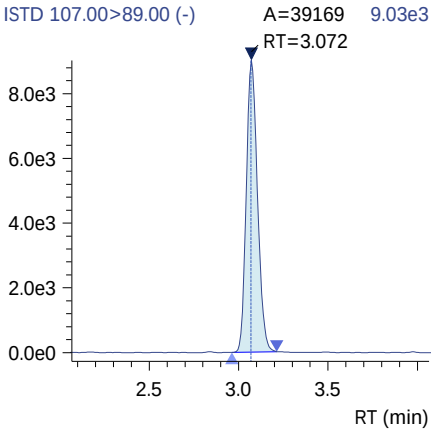
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 2/28/2022 9:59:18 AM

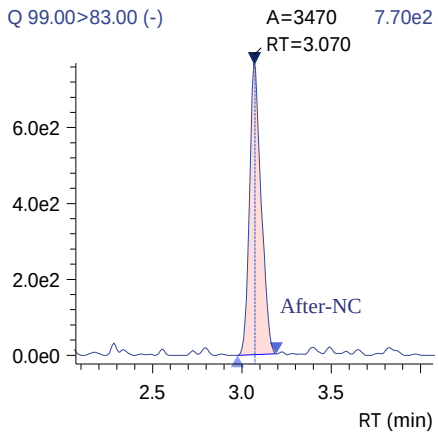
PERCHLORATE3

Sample ID: PERCHLORATE3
Date Acquired: 2/25/2022 11:32:39 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_014.lcd
Vial: 22 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	MI	3.070	3470	39169	0.6997	ng/mL	30.40	21.36-39.66
Perchlorate 2	M	3.066	1055	39169	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.072	39169	39169	1.0000	ng/mL	----	

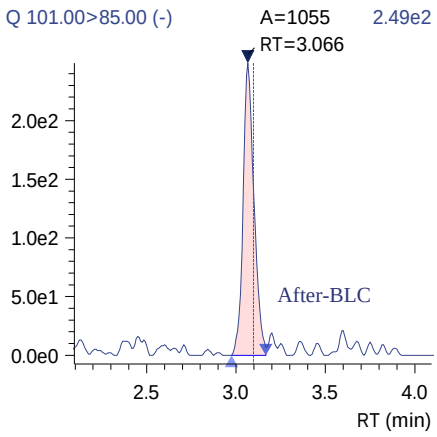
Perchlorate

Conc 0.6997



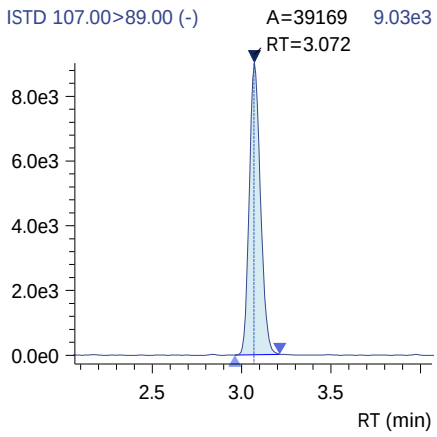
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

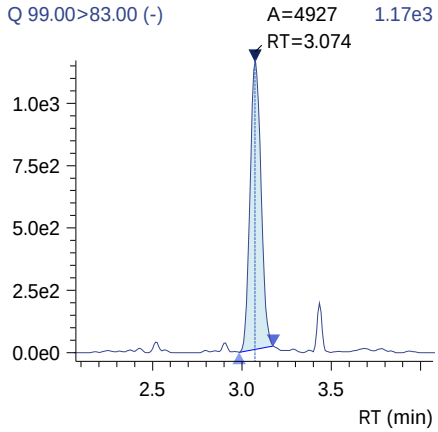
Printed at 2/28/2022 9:41:00 AM

PERCHLORATE4

Sample ID: PERCHLORATE4
Date Acquired: 2/25/2022 11:40:30 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_015.lcd
Vial: 23 | Inj. Volume: 25.0000uL | Tray: 1

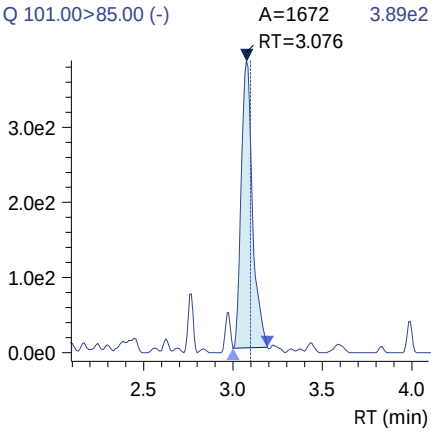
Perchlorate

Conc 1.0387



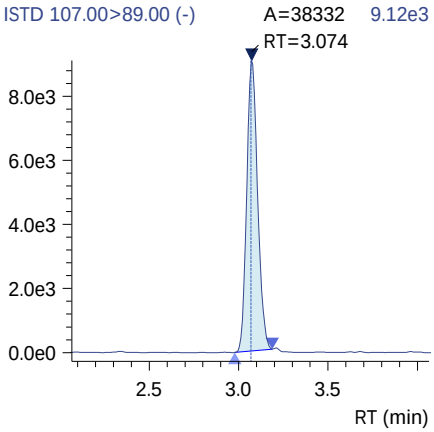
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 2/28/2022 9:59:18 AM

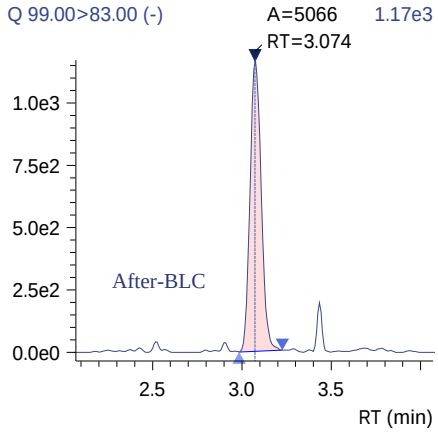
PERCHLORATE4

Sample ID: PERCHLORATE4
Date Acquired: 2/25/2022 11:40:30 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_015.lcd
Vial: 23 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	M	3.074	5066	38332	1.0438	ng/mL	33.24	21.36-39.66
Perchlorate 2	M	3.076	1684	38332	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.074	38332	38332	1.0000	ng/mL	----	

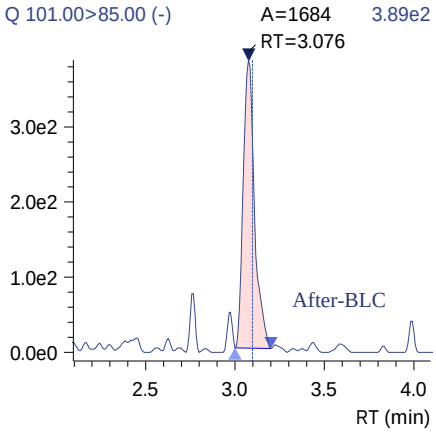
Perchlorate

Conc 1.0438



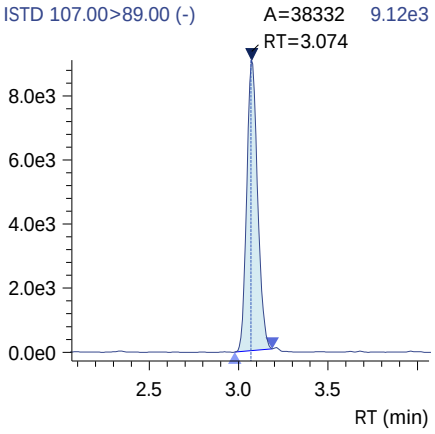
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

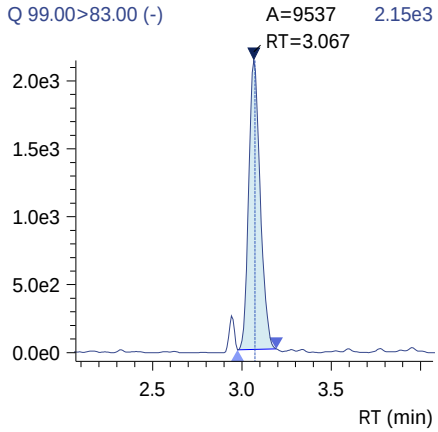
Printed at 2/28/2022 9:41:00 AM

PERCHLORATE5

Sample ID: PERCHLORATE5
Date Acquired: 2/25/2022 11:48:26 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_016.lcd
Vial: 24 | Inj. Volume: 25.0000uL | Tray: 1

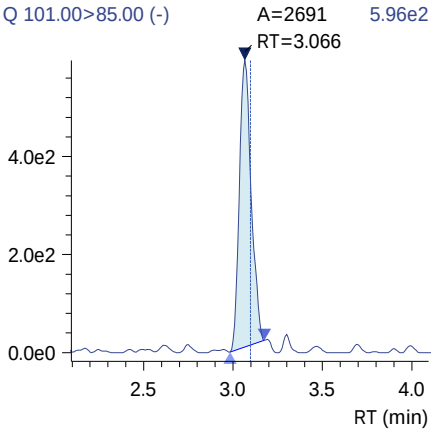
Perchlorate

Conc 2.0046



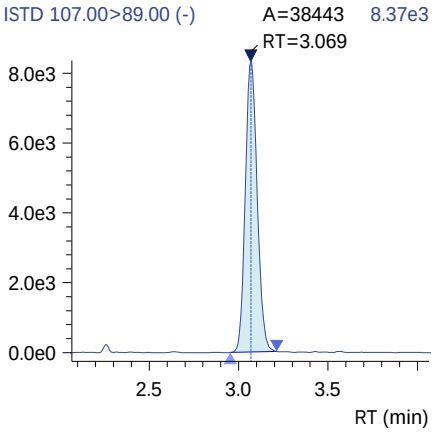
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 2/28/2022 9:59:18 AM

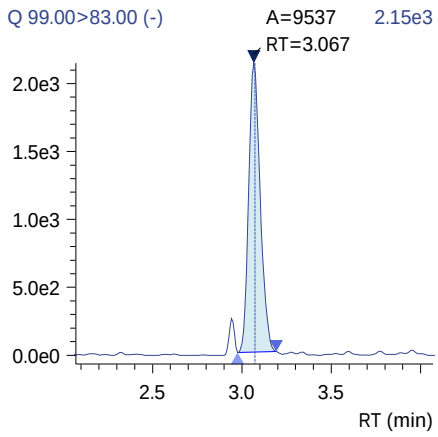
PERCHLORATE5

Sample ID: PERCHLORATE5
Date Acquired: 2/25/2022 11:48:26 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_016.lcd
Vial: 24 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.067	9537	38443	1.9595	ng/mL	28.22	21.36-39.66
Perchlorate 2	Auto	3.066	2691	38443	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.069	38443	38443	1.0000	ng/mL	----	

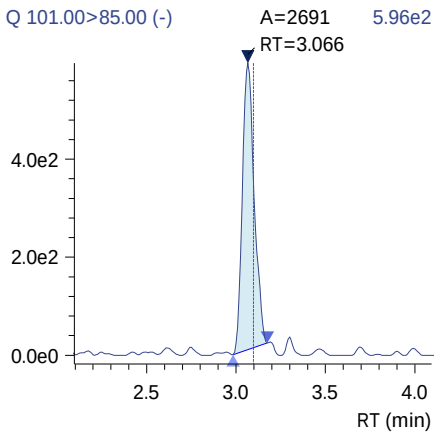
Perchlorate

Conc 1.9595



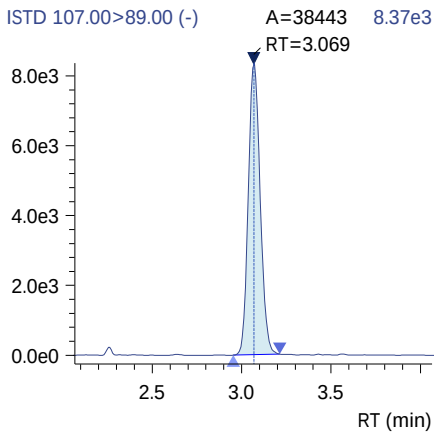
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

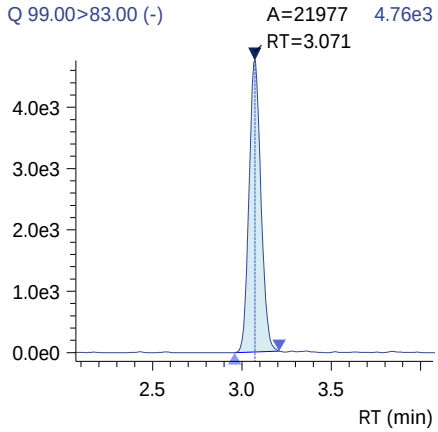
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PERCHLORATE6

Sample ID: PERCHLORATE6
Date Acquired: 2/25/2022 11:56:19 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_017.lcd
Vial: 25 | Inj. Volume: 25.0000uL | Tray: 1

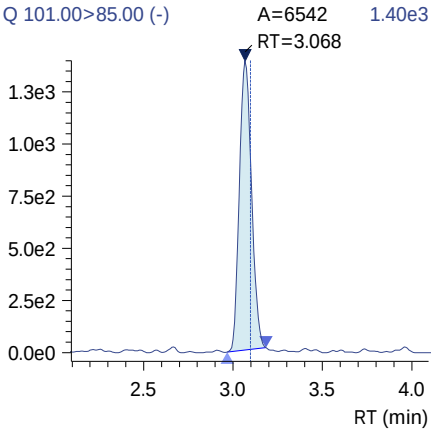
Perchlorate

Conc 5.0067



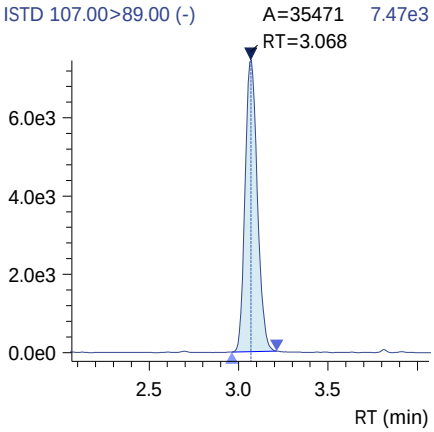
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 2/28/2022 9:59:18 AM

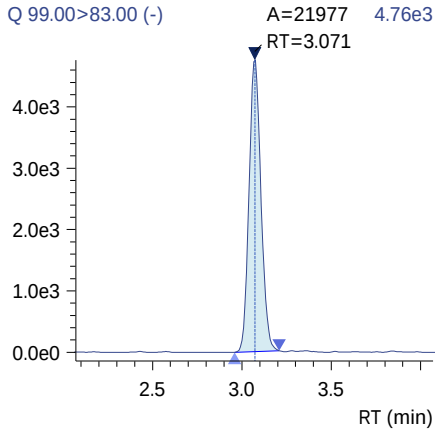
PERCHLORATE6

Sample ID: PERCHLORATE6
Date Acquired: 2/25/2022 11:56:19 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_017.lcd
Vial: 25 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	MI R1	3.071	21977	35471	4.8941	ng/mL	30.29	21.36-39.66
Perchlorate 2	M	3.068	6656	35471	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.068	35471	35471	1.0000	ng/mL	----	

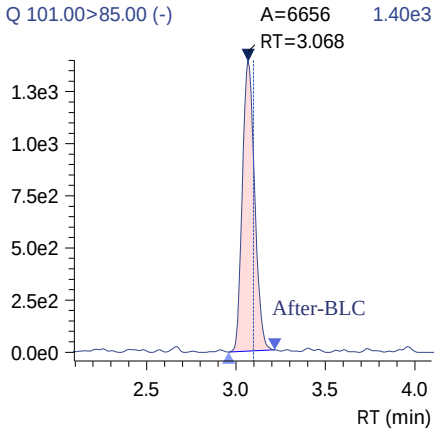
Perchlorate

Conc 4.8941



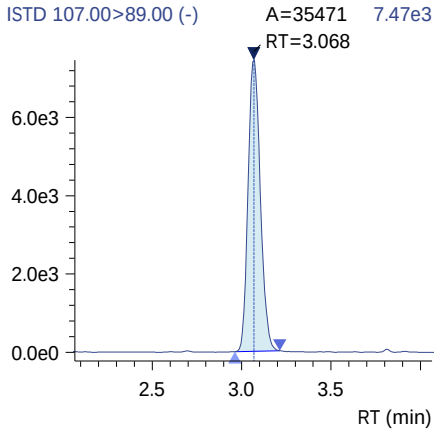
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

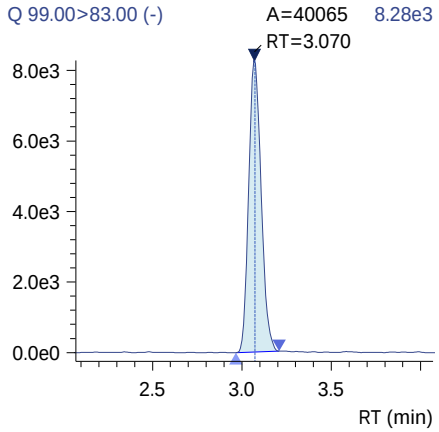
Printed at 2/28/2022 9:41:00 AM

PERCHLORATE7

Sample ID: PERCHLORATE7
Date Acquired: 2/25/2022 12:04:10 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_018.lcd
Vial: 26 | Inj. Volume: 25.0000uL | Tray: 1

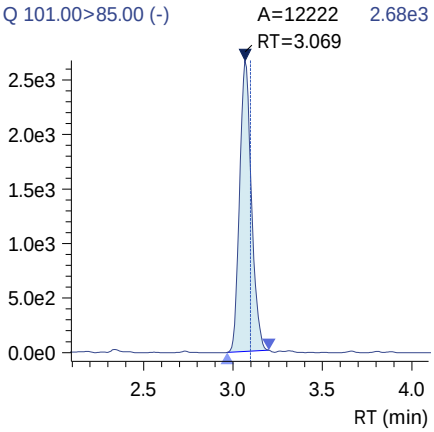
Perchlorate

Conc 10.2272



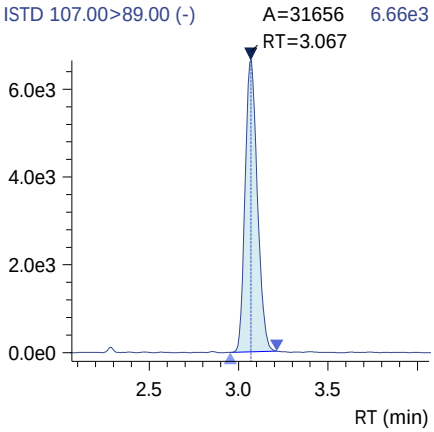
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 2/28/2022 9:59:18 AM

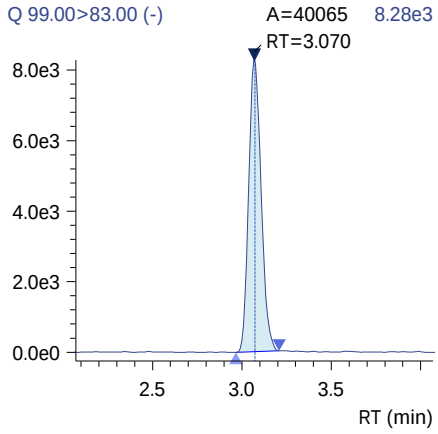
PERCHLORATE7

Sample ID: PERCHLORATE7
Date Acquired: 2/25/2022 12:04:10 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_018.lcd
Vial: 26 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.070	40065	31656	9.9971	ng/mL	30.51	21.36-39.66
Perchlorate 2	Auto	3.069	12222	31656	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.067	31656	31656	1.0000	ng/mL	----	

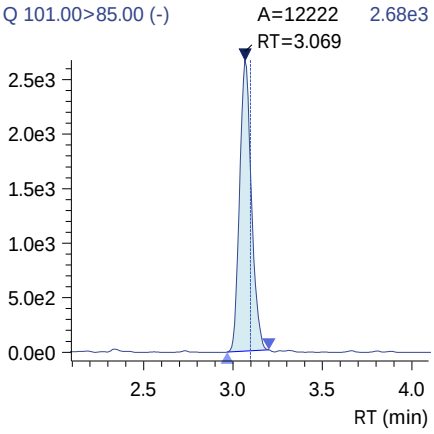
Perchlorate

Conc 9.9971



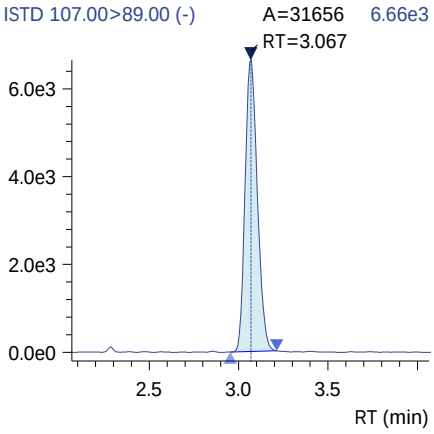
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

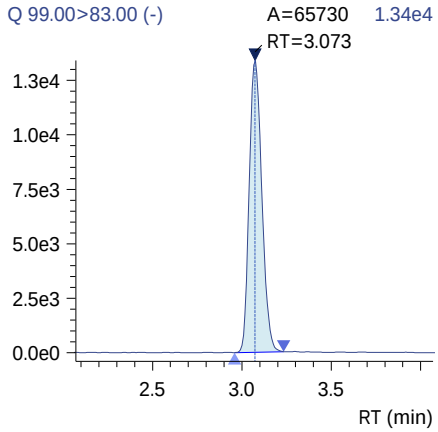
Printed at 2/28/2022 9:41:00 AM

PERCHLORATE8

Sample ID: PERCHLORATE8
Date Acquired: 2/25/2022 12:12:04 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_019.lcd
Vial: 27 | Inj. Volume: 25.0000uL | Tray: 1

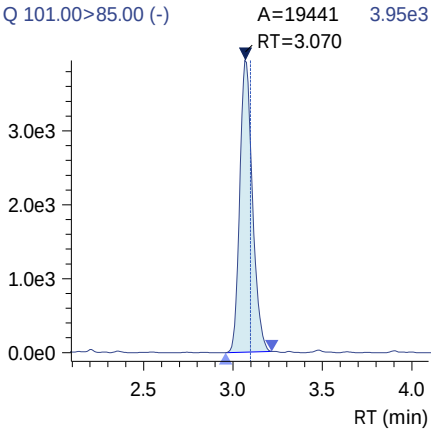
Perchlorate

Conc 20.3151



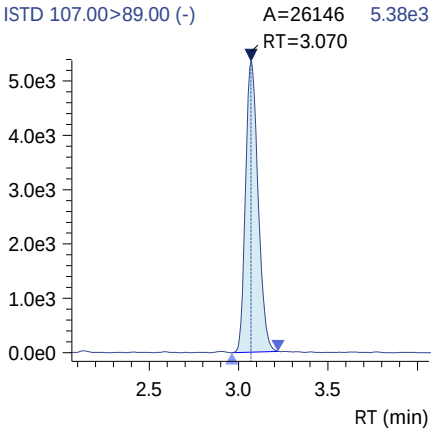
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 2/28/2022 9:59:18 AM

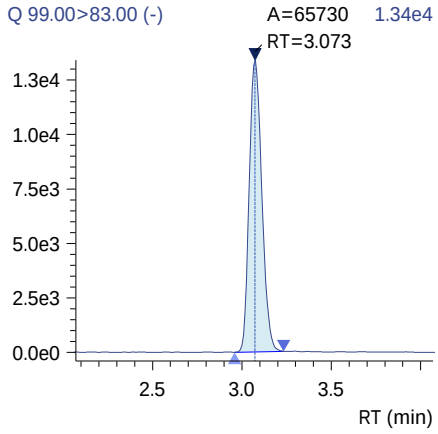
PERCHLORATE8

Sample ID: PERCHLORATE8
Date Acquired: 2/25/2022 12:12:04 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_019.lcd
Vial: 27 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.073	65730	26146	19.8581	ng/mL	29.58	21.36-39.66
Perchlorate 2	Auto	3.070	19441	26146	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.070	26146	26146	1.0000	ng/mL	----	

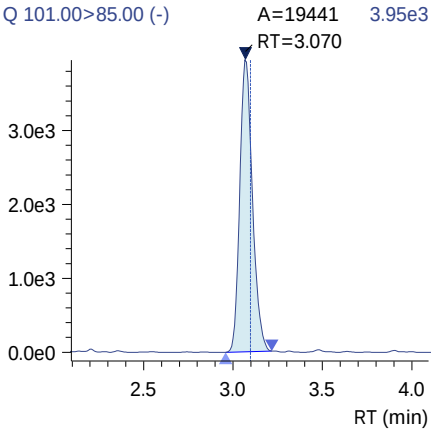
Perchlorate

Conc 19.8581



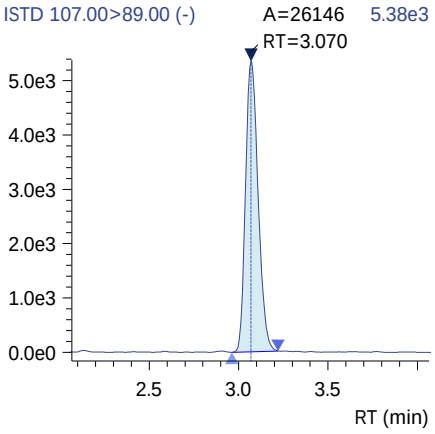
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

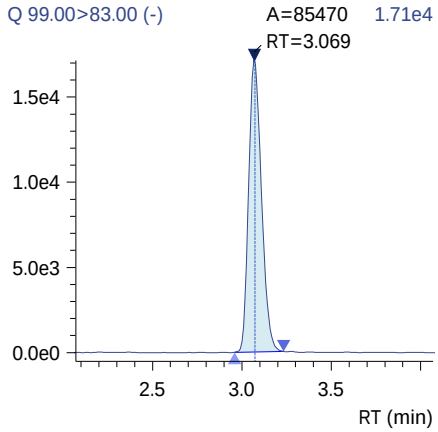
Printed at 2/28/2022 9:41:00 AM

PERCHLORATE9

Sample ID: PERCHLORATE9
Date Acquired: 2/25/2022 12:19:58 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_020.lcd
Vial: 28 | Inj. Volume: 25.0000uL | Tray: 1

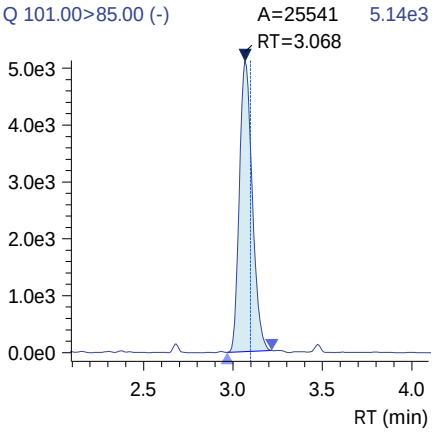
Perchlorate

Conc 29.7483



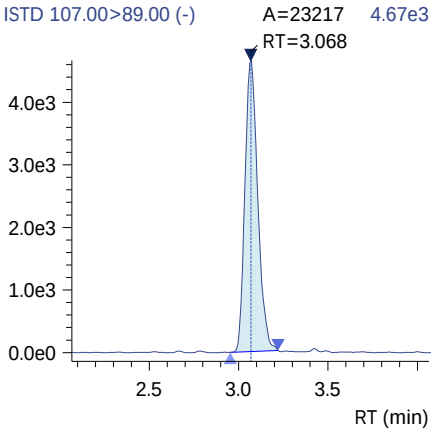
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 2/28/2022 9:59:18 AM

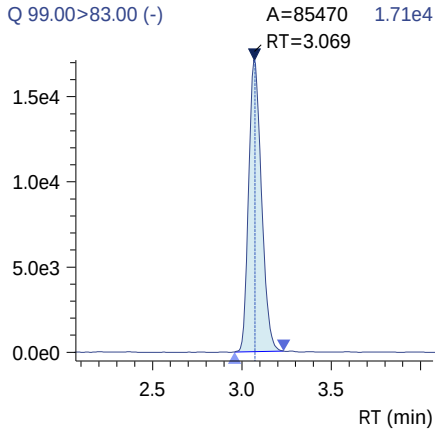
PERCHLORATE9

Sample ID: PERCHLORATE9
Date Acquired: 2/25/2022 12:19:58 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_020.lcd
Vial: 28 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.069	85470	23217	29.0791	ng/mL	29.88	21.36-39.66
Perchlorate 2	Auto	3.068	25541	23217	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.068	23217	23217	1.0000	ng/mL	----	

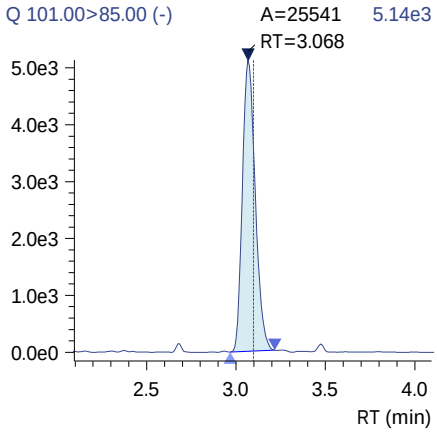
Perchlorate

Conc 29.0791



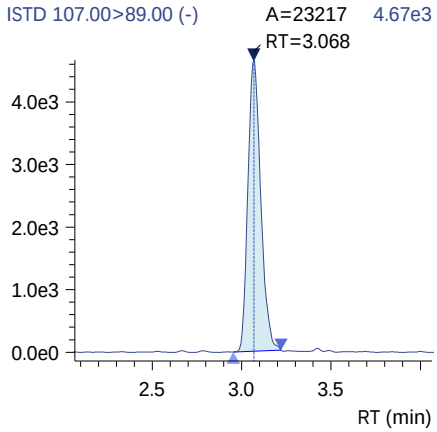
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

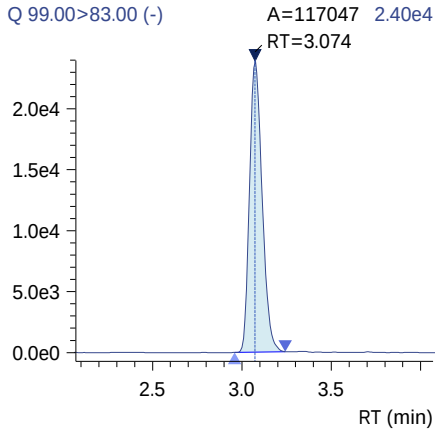
Printed at 2/28/2022 9:41:00 AM

PERCHLORATE10

Sample ID: PERCHLORATE10
Date Acquired: 2/25/2022 12:27:52 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_021.lcd
Vial: 29 | Inj. Volume: 25.0000uL | Tray: 1

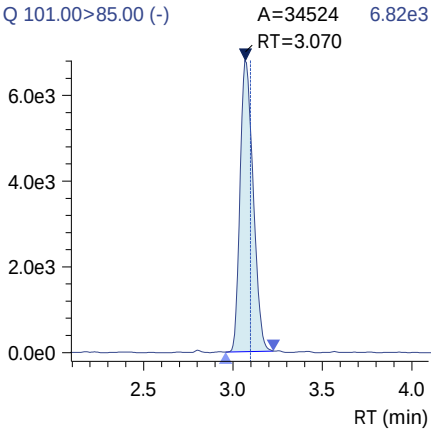
Perchlorate

Conc 51.5186



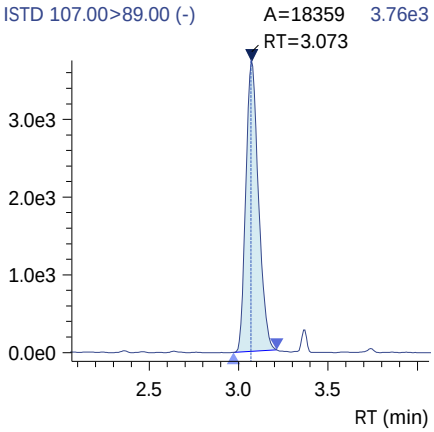
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 2/28/2022 9:59:18 AM

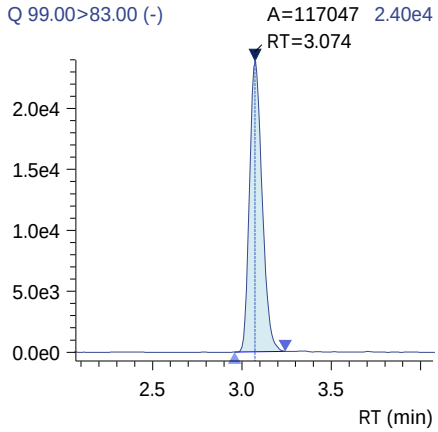
PERCHLORATE10

Sample ID: PERCHLORATE10
Date Acquired: 2/25/2022 12:27:52 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_021.lcd
Vial: 29 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.074	117047	18359	50.3597	ng/mL	29.50	21.36-39.66
Perchlorate 2	Auto	3.070	34524	18359	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.073	18359	18359	1.0000	ng/mL	----	

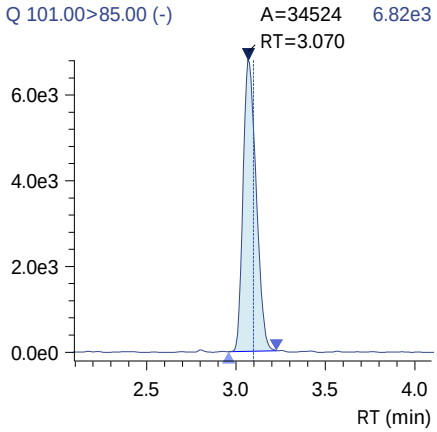
Perchlorate

Conc 50.3597



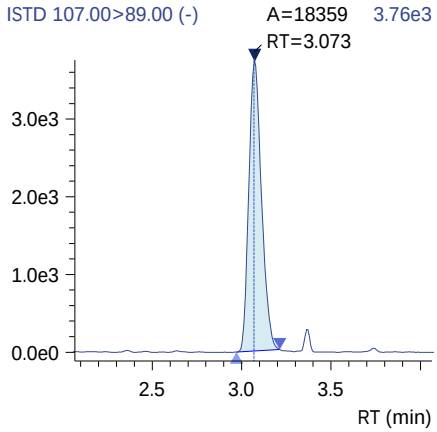
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

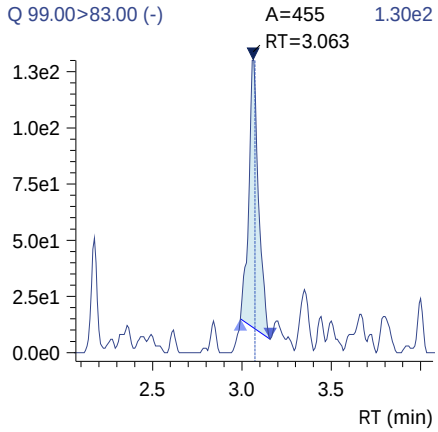
Printed at 2/28/2022 9:41:00 AM

PERCHLORATE1

Sample ID: PERCHLORATE1
Date Acquired: 2/25/2022 1:31:59 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_023.lcd
Vial: 20 | Inj. Volume: 25.0000uL | Tray: 1

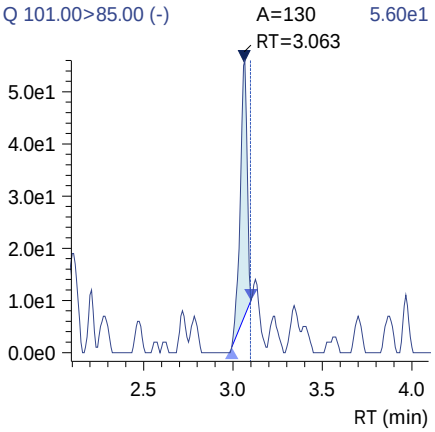
Perchlorate

Conc 0.0976



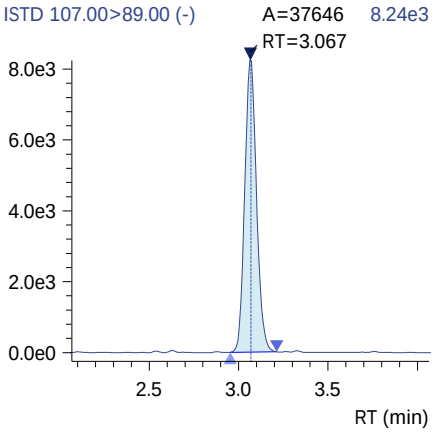
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 2/28/2022 9:59:18 AM

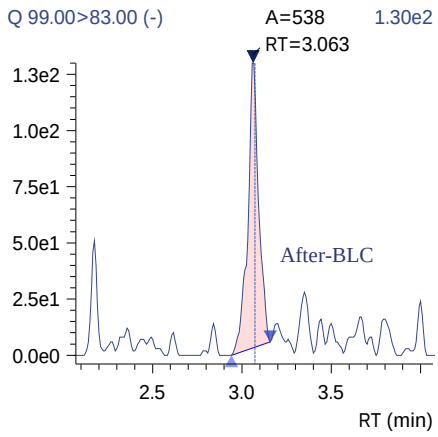
PERCHLORATE1

Sample ID: PERCHLORATE1
Date Acquired: 2/25/2022 1:31:59 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_023.lcd
Vial: 20 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	M	3.063	538	37646	0.1129	ng/mL	30.76	21.36-39.66
Perchlorate 2	M	3.063	166	37646	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.067	37646	37646	1.0000	ng/mL	----	

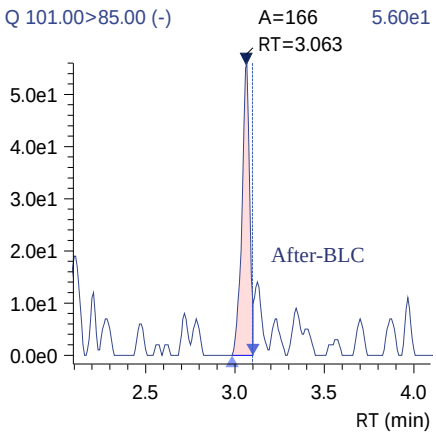
Perchlorate

Conc 0.1129



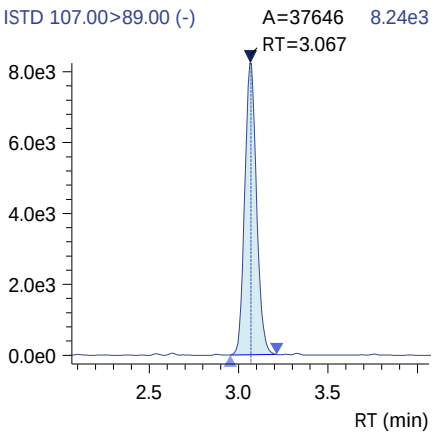
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

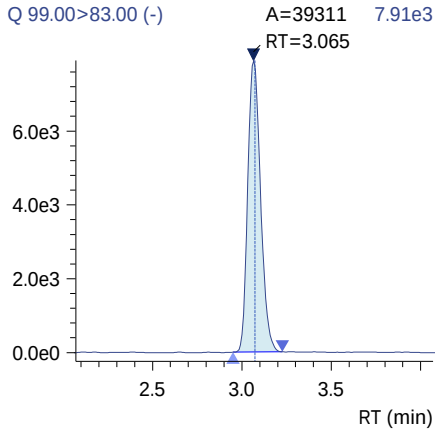
Printed at 2/28/2022 9:41:00 AM

PERCHLORATEICV

Sample ID: PERCHLORATEICV
Date Acquired: 2/25/2022 1:47:53 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_024.lcd
Vial: 30 | Inj. Volume: 25.0000uL | Tray: 1

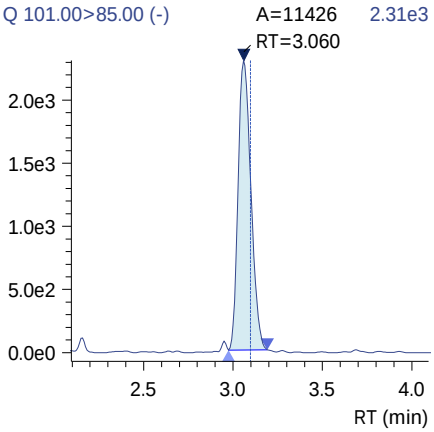
Perchlorate

Conc 10.4096



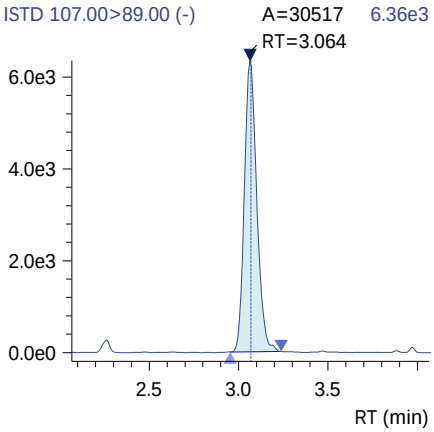
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 2/28/2022 9:59:18 AM

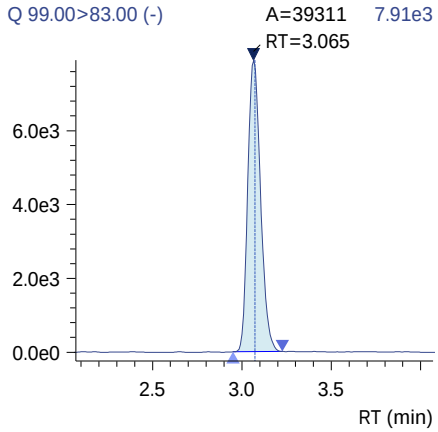
PERCHLORATEICV

Sample ID: PERCHLORATEICV
Date Acquired: 2/25/2022 1:47:53 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220225\20220225_024.lcd
Vial: 30 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.065	39311	30517	10.1754	ng/mL	29.07	21.36-39.66
Perchlorate 2	Auto	3.060	11426	30517	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.064	30517	30517	1.0000	ng/mL	----	

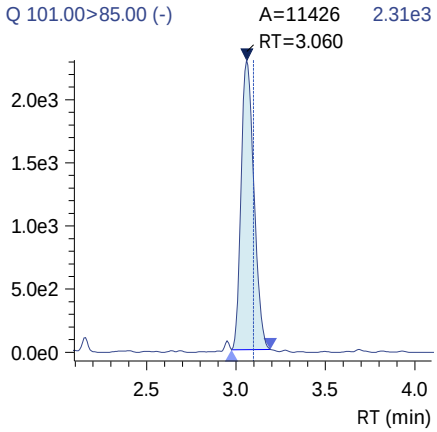
Perchlorate

Conc 10.1754



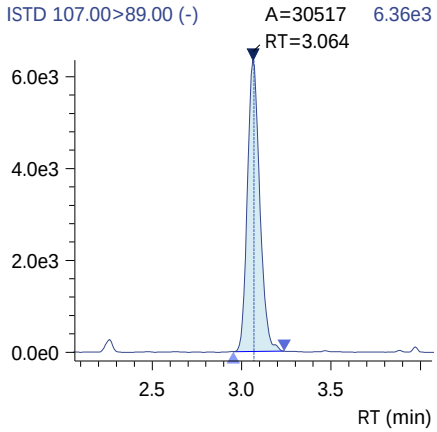
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Chromatograms and Selected Ion Monitoring

ALS Environmental - Houston HRMS
10450 Stancliff Rd., Suite 320, Houston TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

20220425

1st Review: GRivera
2nd Review: Kneir

ALS Environmental

Injection Log
LCMS01 -Shimadzu 8050

ICAL Date: 2/25/2022
Cal. Std. xp: 7/25/2022
ICAL ID: **EC2200006**

Mobile Phases **A:** 0.75% Formic Acid/Water 3100819-06 **B:** MeOH 217304

			File Name	Acquisition Method	Dilution	R	Comments	Date/Time
1	null		20220425_001	Perchlorate6850c.lcm	1x	☒		4/25/2022 9:53
2	null		20220425_002	Perchlorate6850c.lcm	1x	☒		4/25/2022 9:58
3	IB		20220425_003	Perchlorate6850c.lcm	1x	☒		4/25/2022 10:03
4	IB		20220425_004	Perchlorate6850c.lcm	1x	☒		4/25/2022 10:11
5	IB		20220425_005	Perchlorate6850c.lcm	1x	☒		4/25/2022 10:19
6	IB		20220425_006	Perchlorate6850c.lcm	1x	☒		4/25/2022 10:27
7	IB		20220425_007	Perchlorate6850c.lcm	1x	☒		4/25/2022 10:36
8	ICS		20220425_008	Perchlorate6850c.lcm	1x	☒		4/25/2022 10:43
10	PERCHLORATE7		20220425_009	Perchlorate6850c.lcm	1x	☒	3100818-07	4/25/2022 10:59
11	LODV		20220425_010	Perchlorate6850c.lcm	1x	☒	3100819-04	4/25/2022 11:07
12	EQ2200164-01		20220425_011	Perchlorate6850c.lcm	1x	☒		4/25/2022 11:23
13	EQ2200164-02		20220425_012	Perchlorate6850c.lcm	1x	☒		4/25/2022 11:47
14	EQ2200164-03		20220425_013	Perchlorate6850c.lcm	1x	☒		4/25/2022 11:55
15	E2200359-001DNU-IS		20220425_014	Perchlorate6850c.lcm	1x	☒	DNU-IS out of range	4/25/2022 12:02
16	IB		20220425_015	Perchlorate6850c.lcm	1x	☒		4/25/2022 12:23
17	E2200359-001X2DNU-IS		20220425_016	Perchlorate6850c.lcm	2x	☒	DNU-IS out of range	4/25/2022 12:31
18	PERCHLORATE7		20220425_017	Perchlorate6850c.lcm	1x	☒	3100818-07	4/25/2022 12:38
19	E2200358-001		20220425_018	Perchlorate6850c.lcm	1x	☒		4/25/2022 12:46
20	E2200358-002		20220425_019	Perchlorate6850c.lcm	1x	☒		4/25/2022 12:54
21	E2200358-003		20220425_020	Perchlorate6850c.lcm	1x	☒		4/25/2022 13:02
22	E2200359-001X10		20220425_021	Perchlorate6850c.lcm	10x	☒	Report	4/25/2022 13:10
23	E2200358-004		20220425_022	Perchlorate6850c.lcm	1x	☒		4/25/2022 13:18
24	E2200358-005		20220425_023	Perchlorate6850c.lcm	1x	☒		4/25/2022 13:26
25	PERCHLORATE7		20220425_024	Perchlorate6850c.lcm	1x	☒	3100818-07	4/25/2022 13:34
26	E2200358-006		20220425_025	Perchlorate6850c.lcm	1x	☒		4/25/2022 13:49
27	E2200358-007		20220425_026	Perchlorate6850c.lcm	1x	☒		4/25/2022 13:57
28	E2200358-008		20220425_027	Perchlorate6850c.lcm	1x	☒		4/25/2022 14:21
29	E2200358-009		20220425_028	Perchlorate6850c.lcm	1x	☒		4/25/2022 14:29
30	E2200358-010		20220425_029	Perchlorate6850c.lcm	1x	☒		4/25/2022 14:53
31	E2200358-011		20220425_030	Perchlorate6850c.lcm	1x	☒		4/25/2022 15:00
32	E2200358-012		20220425_031	Perchlorate6850c.lcm	1x	☒		4/25/2022 15:08
33	PERCHLORATE7		20220425_032	Perchlorate6850c.lcm	1x	☒	3100818-07	4/25/2022 15:16
34	E2200358-014		20220425_033	Perchlorate6850c.lcm	1x	☒		4/25/2022 15:24
35	E2200358-015		20220425_034	Perchlorate6850c.lcm	1x	☒		4/25/2022 15:32
36	E2200358-016		20220425_035	Perchlorate6850c.lcm	1x	☒		4/25/2022 15:40
38	E2200358-017		20220425_036	Perchlorate6850c.lcm	1x	☒		4/25/2022 15:48
39	E2200358-018		20220425_037	Perchlorate6850c.lcm	1x	☒		4/25/2022 15:56
40	E2200358-019		20220425_038	Perchlorate6850c.lcm	1x	☒		4/25/2022 16:03
41	E2200358-020		20220425_039	Perchlorate6850c.lcm	1x	☒		4/25/2022 16:11
42	PERCHLORATE7		20220425_040	Perchlorate6850c.lcm	1x	☒	3100818-07	4/25/2022 16:19

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Analyzed:**	4/25/22

Continuing Calibration Verification Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method:	6850	**Calibration Date:**	2/25/22
File ID:	I:\LCMS01\DATA\20220425\20220425_009	**Calibration ID:**	EC2200006
		Analysis Lot:	761764
		Units:	ng/mL

Analyte Name	Expected	Result	Average RF	CCV RF	%D	%Drift	Criteria	Curve Fit
Perchlorate	10.0	11.0	0.1266	0.1389	9.7	NA	± 15 %	Average RF

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Analyzed:**	4/25/22

Continuing Calibration Verification Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method:	6850	**Calibration Date:**	2/25/22
File ID:	I:\LCMS01\DATA\20220425\20220425_017	**Calibration ID:**	EC2200006
		Analysis Lot:	761764
		Units:	ng/mL

Analyte Name	Expected	Result	Average RF	CCV RF	%D	%Drift	Criteria	Curve Fit
Perchlorate	10.0	10.6	0.1266	0.1342	6.0	NA	± 15 %	Average RF

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Analyzed:**	4/25/22

Continuing Calibration Verification Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method:	6850	**Calibration Date:**	2/25/22
File ID:	I:\LCMS01\DATA\20220425\20220425_024	**Calibration ID:**	EC2200006
		Analysis Lot:	761764
		Units:	ng/mL

Analyte Name	Expected	Result	Average RF	CCV RF	%D	%Drift	Criteria	Curve Fit
Perchlorate	10.0	10.5	0.1266	0.1325	4.6	NA	± 15 %	Average RF

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Analyzed:**	4/25/22

Continuing Calibration Verification Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method:	6850	**Calibration Date:**	2/25/22
File ID:	I:\LCMS01\DATA\20220425\20220425_032	**Calibration ID:**	EC2200006
		Analysis Lot:	761764
		Units:	ng/mL

Analyte Name	Expected	Result	Average RF	CCV RF	%D	%Drift	Criteria	Curve Fit
Perchlorate	10.0	10.3	0.1266	0.1303	2.9	NA	± 15 %	Average RF

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Analyzed:**	4/25/22

Continuing Calibration Verification Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method:	6850	**Calibration Date:**	2/25/22
File ID:	I:\LCMS01\DATA\20220425\20220425_040	**Calibration ID:**	EC2200006
		Analysis Lot:	761764
		Units:	ng/mL

Analyte Name	Expected	Result	Average RF	CCV RF	%D	%Drift	Criteria	Curve Fit
Perchlorate	10.0	10.6	0.1266	0.1341	5.9	NA	± 15 %	Average RF

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Analyzed:**	4/25/22 10:59

Internal Standard Area and RT Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

File ID:	I:\LCMS01\DATA\20220425\20220425_009	**Lab Code:**	EQ2200165-01
Instrument ID:	E-LCMS-01	**Analysis Lot:**	761764
Analytical Method:	6850	**Signal ID:**	1

		Sodium Perchlorate-18O4	
		Area	**RT**
	ICAL Average ==>	32,860	3.07
	Upper Limit ==>	49,290	5.07
	Lower Limit ==>	16,430	1.07
Associated Analyses			
Continuing Calibration Verification	EQ2200165-01	29,818	2.98
Method Blank	EQ2200164-01	38,898	2.98
Lab Control Sample	EQ2200164-02	38,076	2.98
Duplicate Lab Control Sample	EQ2200164-03	39,202	2.98

Results flagged with an asterisk (*) indicate values outside control criteria.

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Analyzed:**	4/25/22 12:38

Internal Standard Area and RT Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

File ID:	I:\LCMS01\DATA\20220425\20220425_017	**Lab Code:**	EQ2200165-02
Instrument ID:	E-LCMS-01	**Analysis Lot:**	761764
Analytical Method:	6850	**Signal ID:**	1

		Sodium Perchlorate-18O4	
		Area	**RT**
	ICAL Average ==>	32,860	3.07
	Upper Limit ==>	49,290	5.07
	Lower Limit ==>	16,430	1.07
Associated Analyses			
Continuing Calibration Verification	EQ2200165-02	25,336	2.98
17WW01_042122	E2200359-001	17,925	2.96

Results flagged with an asterisk (*) indicate values outside control criteria.

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Analyzed:**	4/25/22 13:34

Internal Standard Area and RT Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

File ID:	I:\LCMS01\DATA\20220425\20220425_024	**Lab Code:**	EQ2200165-03
Instrument ID:	E-LCMS-01	**Analysis Lot:**	761764
Analytical Method:	6850	**Signal ID:**	1

		Sodium Perchlorate-18O4	
		Area	**RT**
	ICAL Average ==>	32,860	3.07
	Upper Limit ==>	49,290	5.07
	Lower Limit ==>	16,430	1.07
Associated Analyses			
Continuing Calibration Verification	EQ2200165-03	27,635	2.98

Results flagged with an asterisk (*) indicate values outside control criteria.

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Analyzed:**	4/25/22 15:16

Internal Standard Area and RT Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

File ID:	I:\LCMS01\DATA\20220425\20220425_032	**Lab Code:**	EQ2200165-04
Instrument ID:	E-LCMS-01	**Analysis Lot:**	761764
Analytical Method:	6850	**Signal ID:**	1

		Sodium Perchlorate-18O4	
		Area	**RT**
	ICAL Average ==>	32,860	3.07
	Upper Limit ==>	49,290	5.07
	Lower Limit ==>	16,430	1.07
Associated Analyses			
Continuing Calibration Verification	EQ2200165-04	28,426	2.98

Results flagged with an asterisk (*) indicate values outside control criteria.

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200359
Project:	LHAAP17	**Date Analyzed:**	4/25/22 16:19

Internal Standard Area and RT Summary
Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

File ID:	I:\LCMS01\DATA\20220425\20220425_040	**Lab Code:**	EQ2200165-05
Instrument ID:	E-LCMS-01	**Analysis Lot:**	761764
Analytical Method:	6850	**Signal ID:**	1

		Sodium Perchlorate-18O4	
		Area	**RT**
	ICAL Average ==>	32,860	3.07
	Upper Limit ==>	49,290	5.07
	Lower Limit ==>	16,430	1.07
Associated Analyses			
Continuing Calibration Verification	EQ2200165-05	29,289	2.98

Results flagged with an asterisk (*) indicate values outside control criteria.

Insight Report

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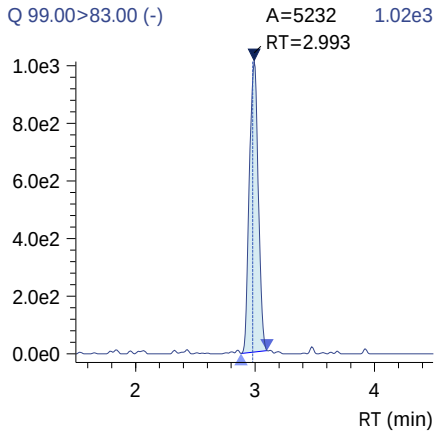
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ICS

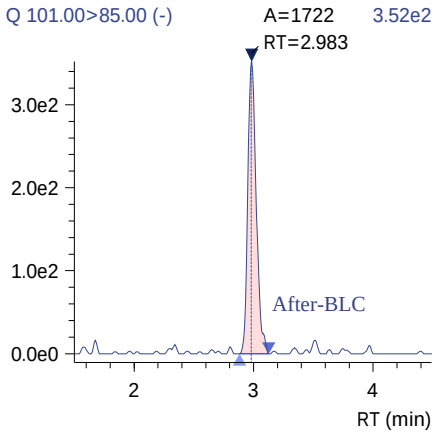
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Date Acquired: 4/25/2022 10:43:56 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_008.lcd
Vial: 32 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	MI R1	2.993	5232	36696	1.1261	ng/mL	32.91	21.11-39.20
Perchlorate 2	M	2.983	1722	36696	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	2.984	36696	36696	1.0000	ng/mL	----	

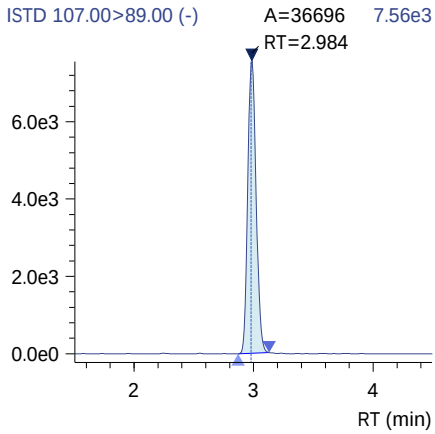
Perchlorate
Conc 1.1261



Perchlorate 2
Conc 0.0000



Sodium Perchlorate-18O4_IS
Conc 1.0000



Insight Report

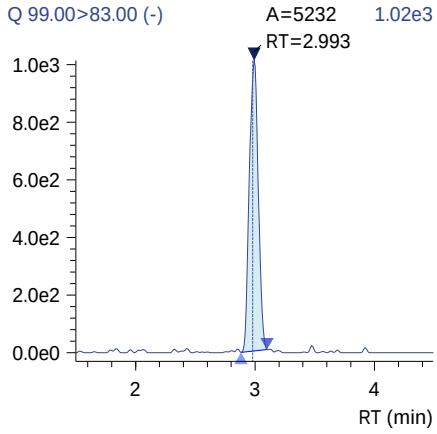
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ICS

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Vial: 32 | Inj. Volume: 25.0000uL | Tray: 1

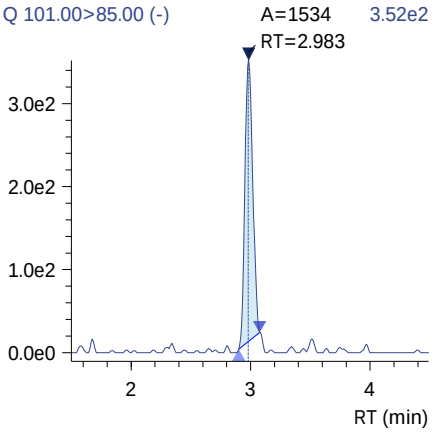
Perchlorate

Conc 1.1520



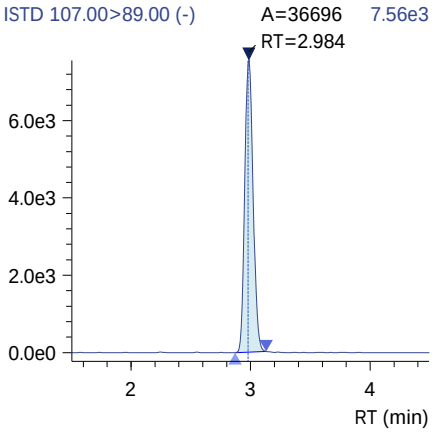
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

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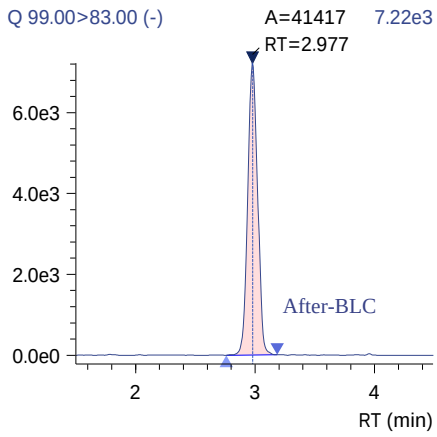
PERCHLORATE7

Sample ID: PERCHLORATE7
Date Acquired: 4/25/2022 10:59:45 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_009.lcd
Vial: 26 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	M	2.977	41417	29818	10.9718	ng/mL	29.50	21.11-39.20
Perchlorate 2	M	2.978	12218	29818	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	2.976	29818	29818	1.0000	ng/mL	----	

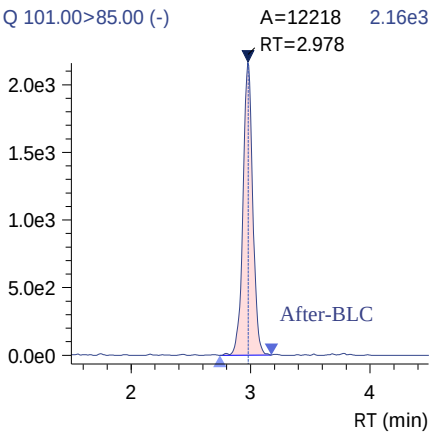
Perchlorate

Conc 10.9718



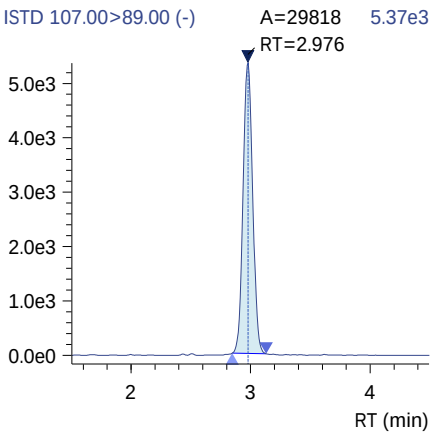
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

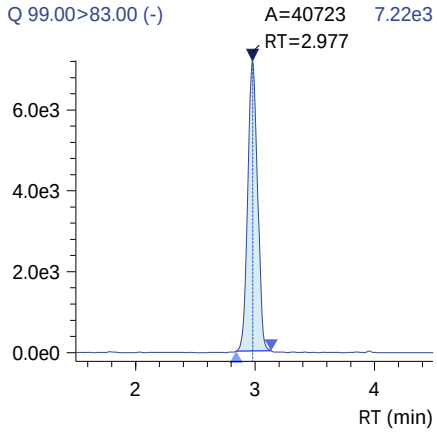
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PERCHLORATE7

Sample ID: PERCHLORATE7
Date Acquired: 4/25/2022 10:59:45 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_009.lcd
Vial: 26 | Inj. Volume: 25.0000uL | Tray: 1

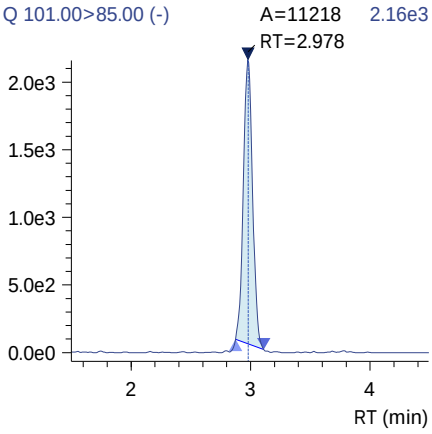
Perchlorate

Conc 11.0361



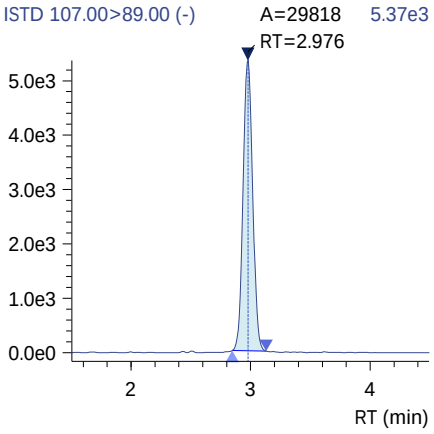
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

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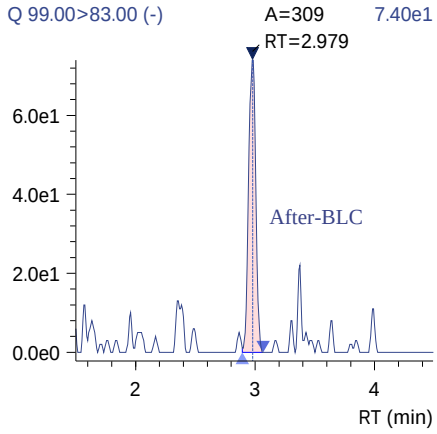
LODV

Sample ID: LODV
Date Acquired: 4/25/2022 11:07:41 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_010.lcd
Vial: 33 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	M	2.979	309	38294	0.0638	ng/mL	26.76	21.11-39.20
Perchlorate 2	M	2.988	83	38294	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	2.975	38294	38294	1.0000	ng/mL	----	

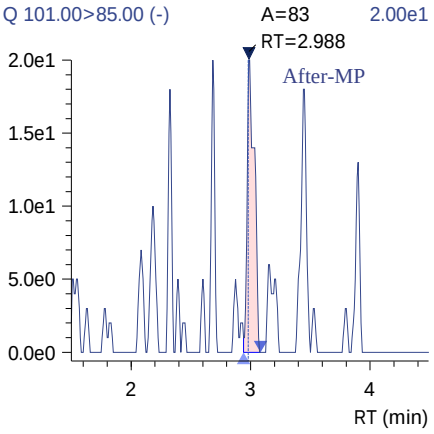
Perchlorate

Conc 0.0638



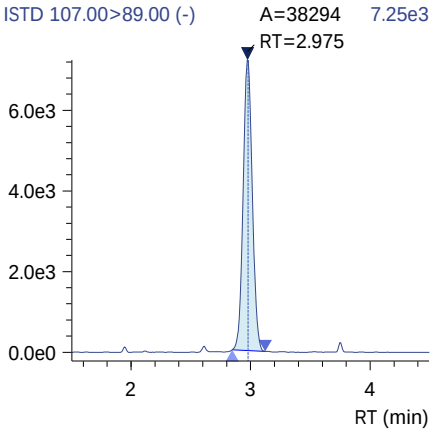
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

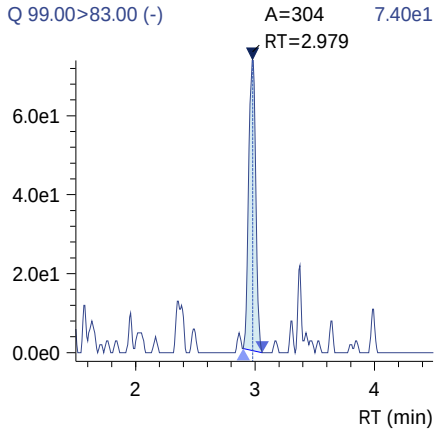
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LODV

Sample ID: LODV
Date Acquired: 4/25/2022 11:07:41 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_010.lcd
Vial: 33 | Inj. Volume: 25.0000uL | Tray: 1

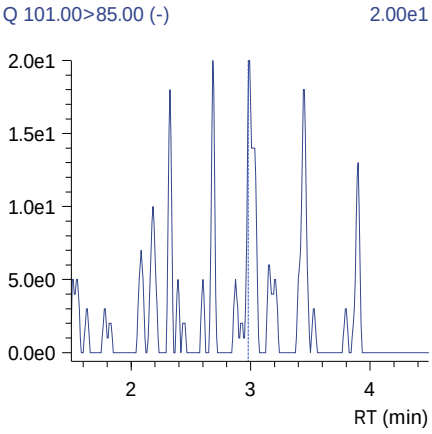
Perchlorate

Conc 0.0641



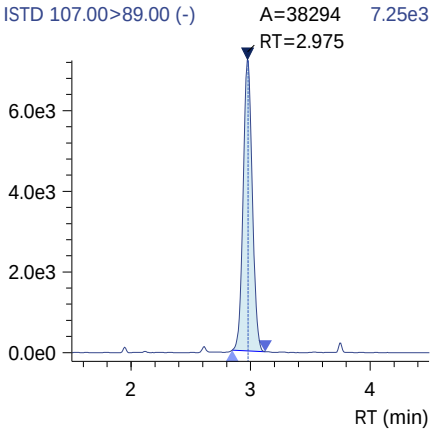
Perchlorate 2

Conc ----



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

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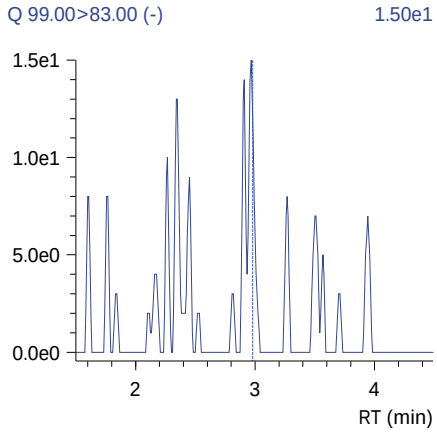
EQ2200164-01

Sample ID: EQ2200164-01
Date Acquired: 4/25/2022 11:23:28 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_011.lcd
Vial: 1 | Inj. Volume: 25.0000uL | Tray: 6

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	ND(W/B)	----	----	38898	----	ng/mL	0.00	21.11-39.20
Perchlorate 2	ND(W/B)	----	----	38898	----	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	2.983	38898	38898	1.0000	ng/mL	----	

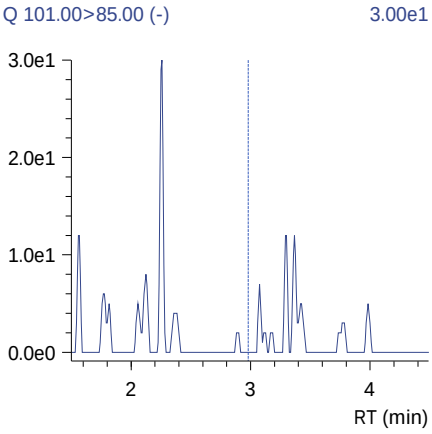
Perchlorate

Conc ----



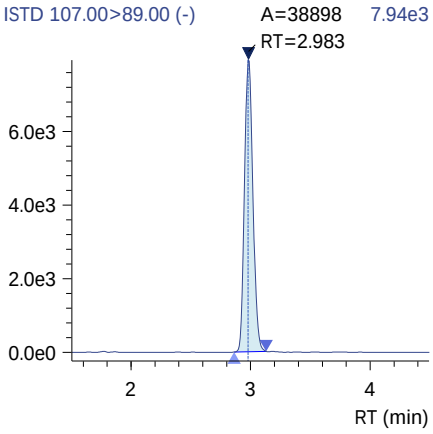
Perchlorate 2

Conc ----



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

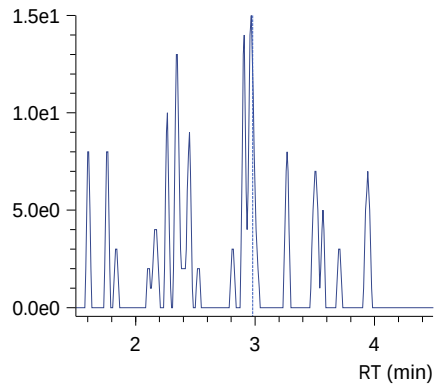
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EQ2200164-01

Sample ID: EQ2200164-01
Date Acquired: 4/25/2022 11:23:28 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_011.lcd
Vial: 1 | Inj. Volume: 25.0000uL | Tray: 6

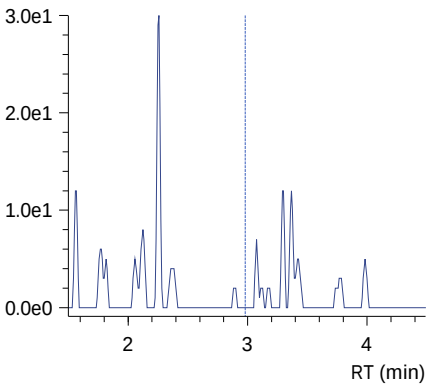
Perchlorate

Conc ----



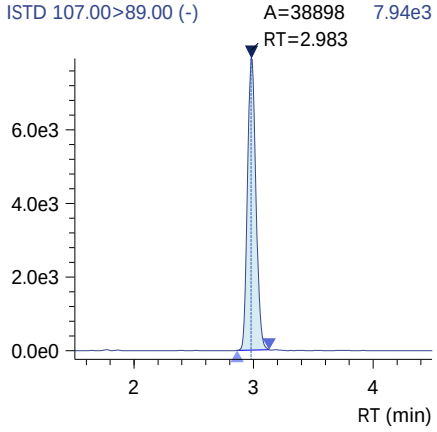
Perchlorate 2

Conc ----



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

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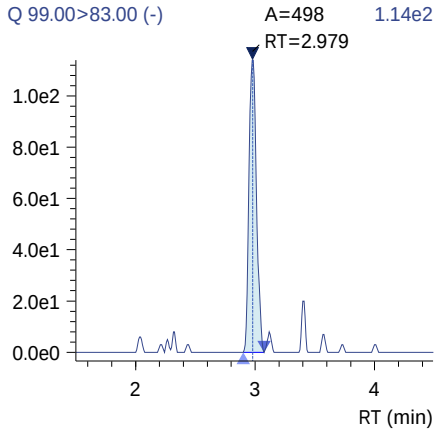
EQ2200164-02

Sample ID: EQ2200164-02
Date Acquired: 4/25/2022 11:47:12 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_012.lcd
Vial: 2 | Inj. Volume: 25.0000uL | Tray: 6

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	MI R1	2.979	498	38076	0.1032	ng/mL	25.63	21.11-39.20
Perchlorate 2	M	2.982	128	38076	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	2.980	38076	38076	1.0000	ng/mL	----	

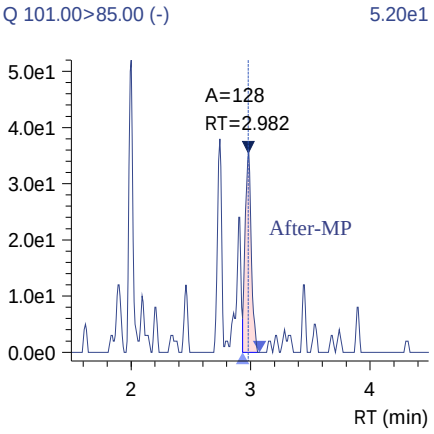
Perchlorate

Conc 0.1032



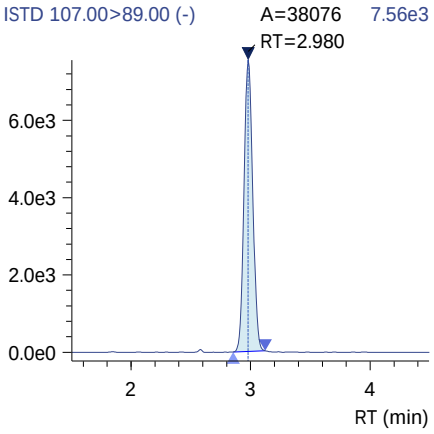
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

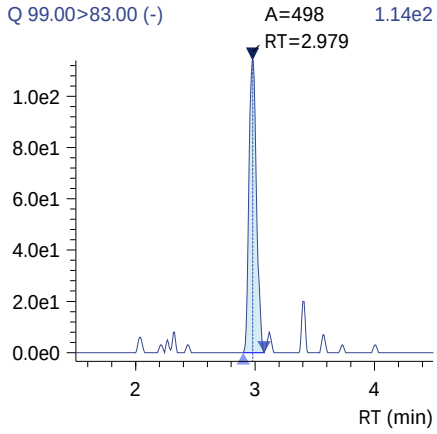
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EQ2200164-02

Sample ID: EQ2200164-02
Date Acquired: 4/25/2022 11:47:12 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_012.lcd
Vial: 2 | Inj. Volume: 25.0000uL | Tray: 6

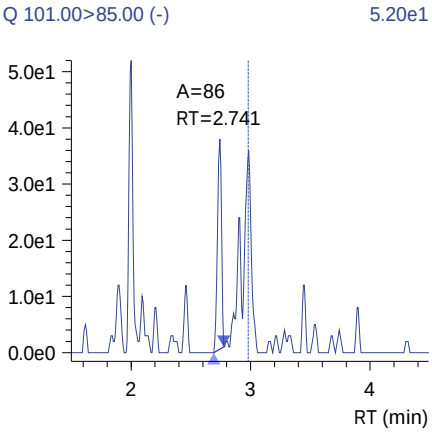
Perchlorate

Conc 0.1056



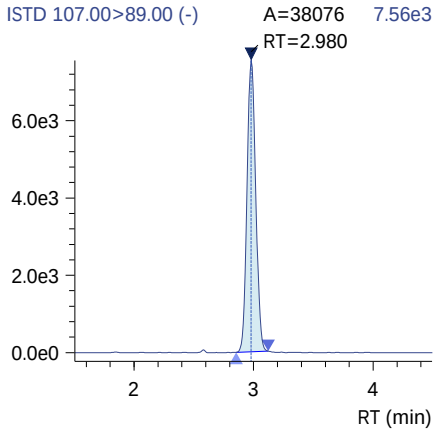
Perchlorate 2

Conc ----



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

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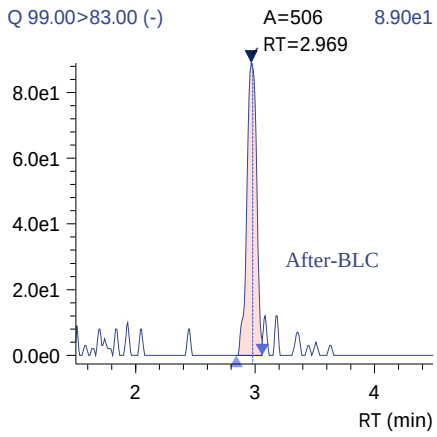
EQ2200164-03

Sample ID: EQ2200164-03
Date Acquired: 4/25/2022 11:55:03 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_013.lcd
Vial: 3 | Inj. Volume: 25.0000uL | Tray: 6

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	M	2.969	506	39202	0.1019	ng/mL	28.47	21.11-39.20
Perchlorate 2	M	2.988	144	39202	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	2.976	39202	39202	1.0000	ng/mL	----	

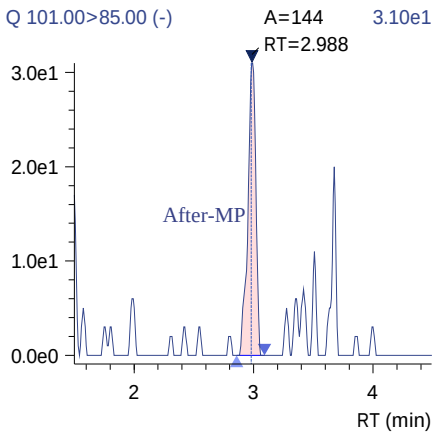
Perchlorate

Conc 0.1019



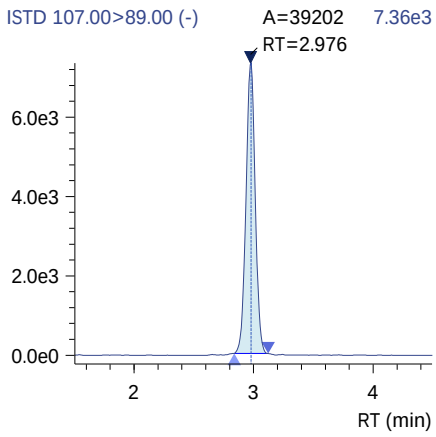
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

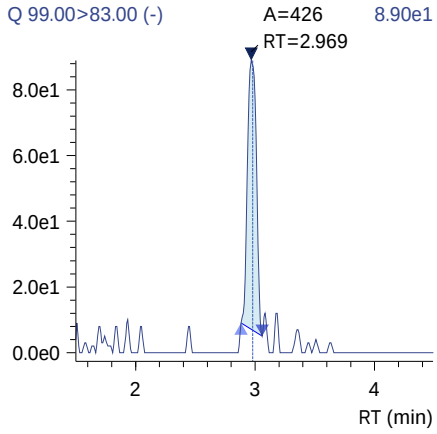
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EQ2200164-03

Sample ID: EQ2200164-03
Date Acquired: 4/25/2022 11:55:03 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_013.lcd
Vial: 3 | Inj. Volume: 25.0000uL | Tray: 6

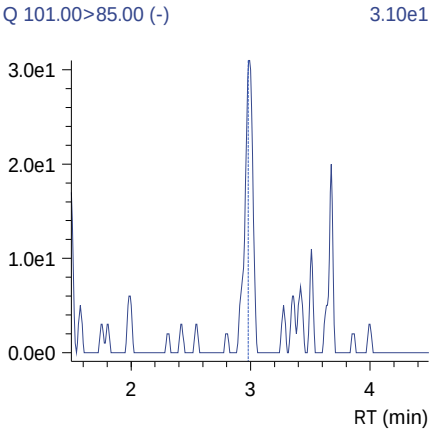
Perchlorate

Conc 0.0878



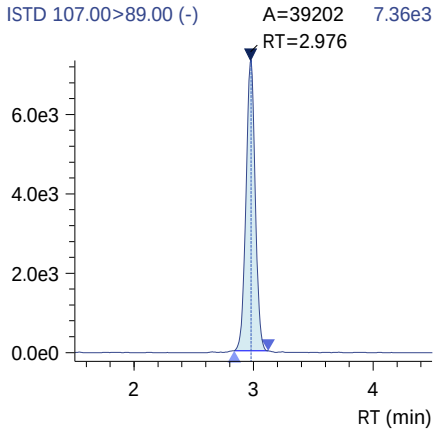
Perchlorate 2

Conc ----



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 4/26/2022 9:48:12 AM

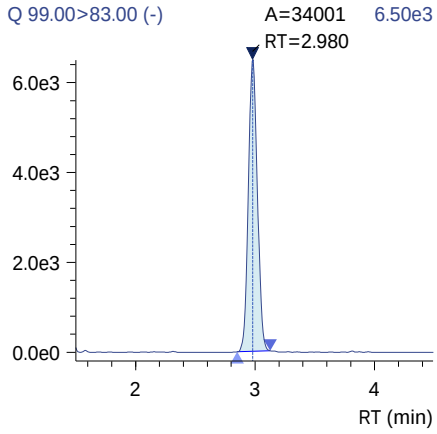
PERCHLORATE7

Sample ID: PERCHLORATE7
Date Acquired: 4/25/2022 12:38:59 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_017.lcd
Vial: 26 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	MI R1	2.980	34001	25336	10.6004	ng/mL	30.07	21.11-39.20
Perchlorate 2	M	2.980	10223	25336	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	2.978	25336	25336	1.0000	ng/mL	----	

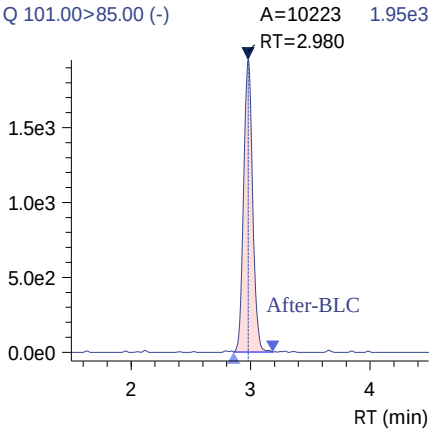
Perchlorate

Conc 10.6004



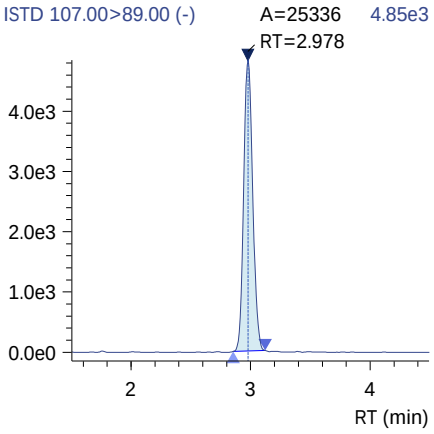
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

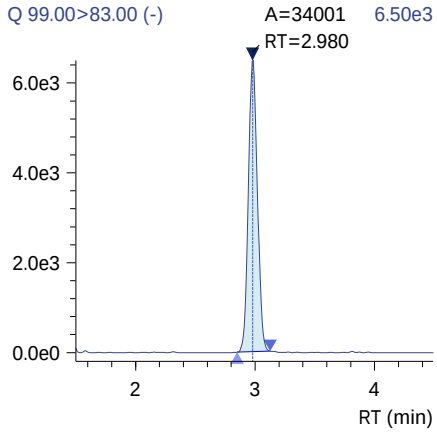
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PERCHLORATE7

Sample ID: PERCHLORATE7
Date Acquired: 4/25/2022 12:38:59 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_017.lcd
Vial: 26 | Inj. Volume: 25.0000uL | Tray: 1

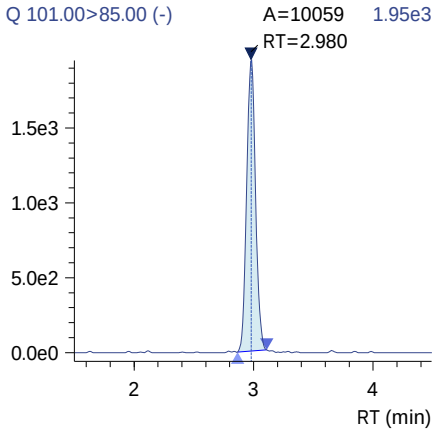
Perchlorate

Conc 10.8444



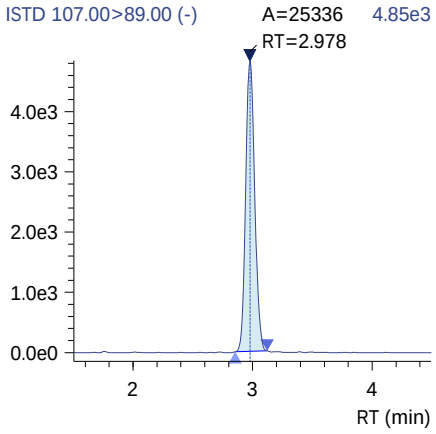
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 4/26/2022 9:48:12 AM

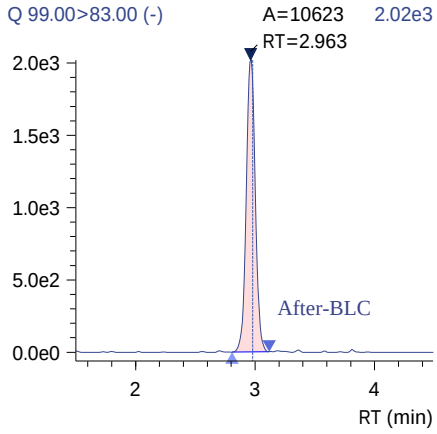
E2200359-001X10

Sample ID: E2200359-001X10
Date Acquired: 4/25/2022 1:10:34 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_021.lcd
Vial: 4 | Inj. Volume: 25.0000uL | Tray: 6

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	M	2.963	10623	17925	4.6811	ng/mL	34.46	21.11-39.20
Perchlorate 2	M	2.952	3660	17925	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	M	2.963	17925	17925	1.0000	ng/mL	----	

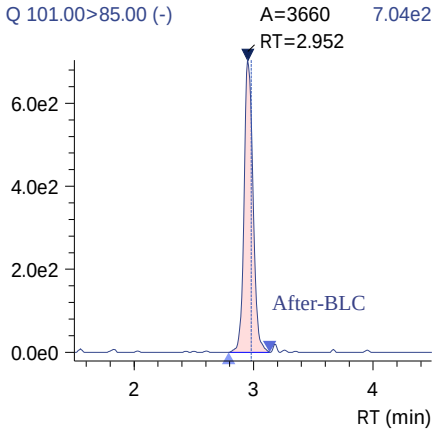
Perchlorate

Conc 4.6811



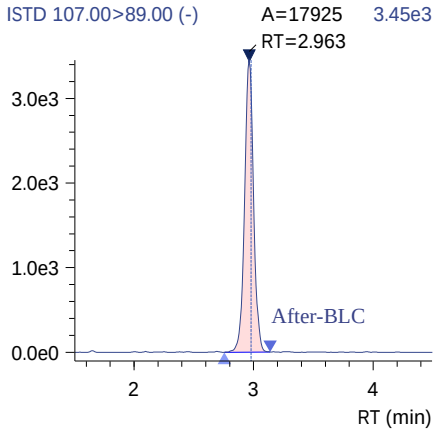
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

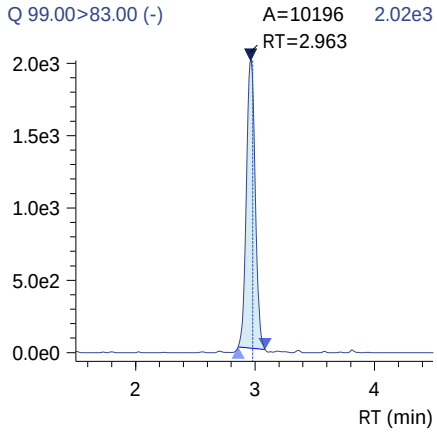
Printed at 4/26/2022 10:02:41 AM

E2200359-001X10

Sample ID: E2200359-001X10
Date Acquired: 4/25/2022 1:10:34 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_021.lcd
Vial: 4 | Inj. Volume: 25.0000uL | Tray: 6

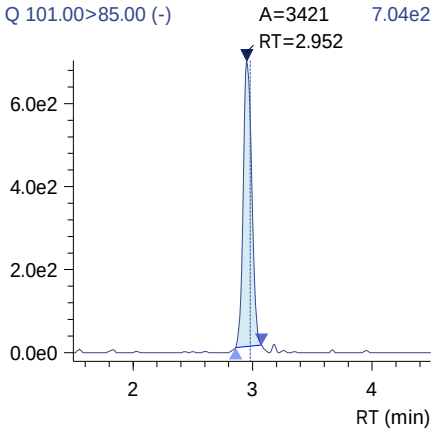
Perchlorate

Conc 4.7484



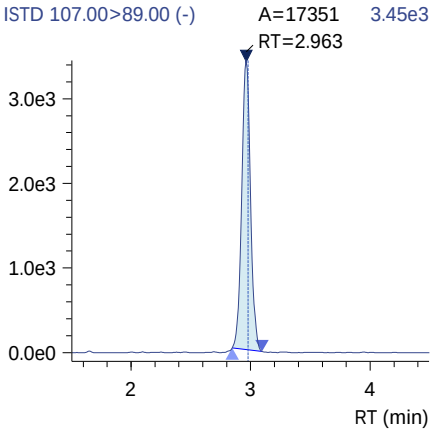
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 4/26/2022 9:48:12 AM

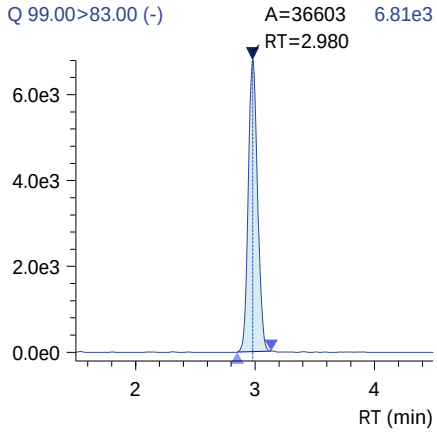
PERCHLORATE7

Sample ID: PERCHLORATE7
Date Acquired: 4/25/2022 1:34:12 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_024.lcd
Vial: 26 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	MI R1	2.980	36603	27635	10.4626	ng/mL	29.78	21.11-39.20
Perchlorate 2	M	2.978	10902	27635	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	2.980	27635	27635	1.0000	ng/mL	----	

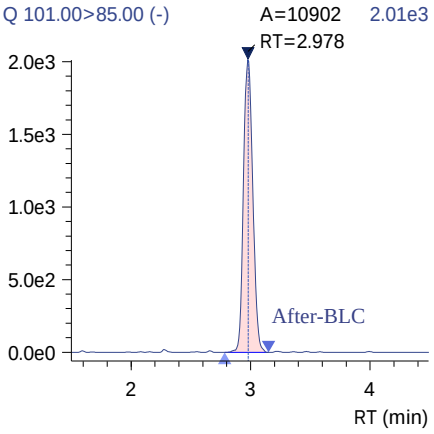
Perchlorate

Conc 10.4626



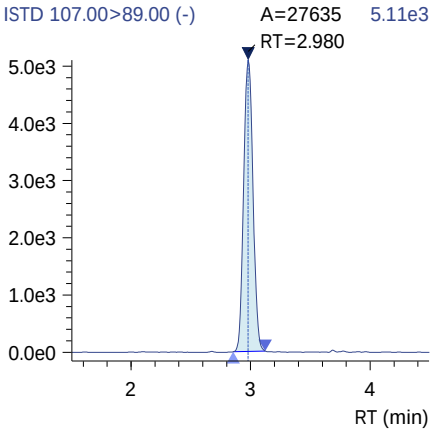
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

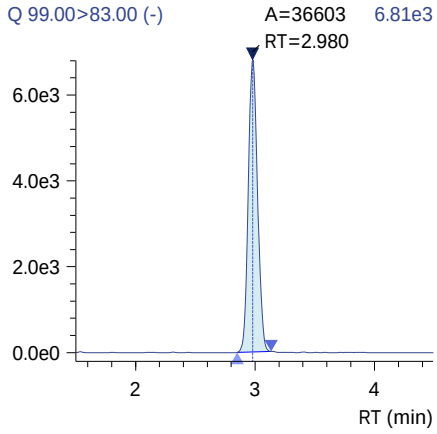
Printed at 4/26/2022 10:02:41 AM

PERCHLORATE7

Sample ID: PERCHLORATE7
Date Acquired: 4/25/2022 1:34:12 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220425\20220425_024.lcd
Vial: 26 | Inj. Volume: 25.0000uL | Tray: 1

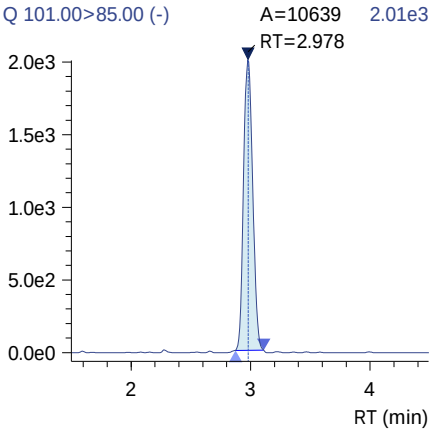
Perchlorate

Conc 10.7034



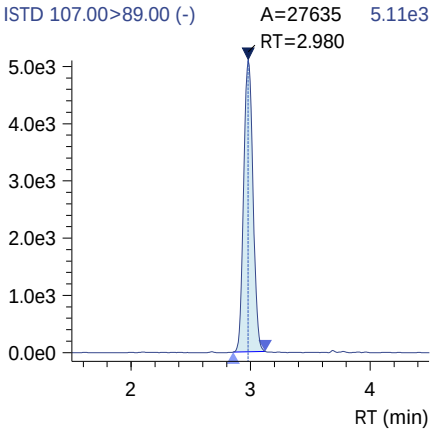
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



September 16, 2022 Service Request No:E2200864

Marcia Olive
Bhate Environmental Associates, Inc.
445 Union Blvd
Suite 129
Lakewood, CO 80228

Laboratory Results for: LHAAP17

Dear Marcia,

Enclosed are the results of the sample(s) submitted to our laboratory September 01, 2022
For your reference, these analyses have been assigned our service request number **E2200864.**

Analyses were performed according to our laboratory's NELAP-approved quality assurance program. The test results meet requirements of the current TNI standards, where applicable, and except as noted in the laboratory case narrative provided. All results are intended to be considered in their entirety and ALS Environmental is not responsible for use of less than the complete final report. Results apply only to the items submitted to the laboratory, as received for analysis. In accordance with the current TNI Standard, a statement on the estimated uncertainty of measurement of any quantitative analysis will be supplied upon request.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental

Corey Grandits
Project Manager

ADDRESS 10450 Stancliff Rd., Suite 210, Houston, TX 77099
PHONE +1 281 530 5656 | FAX +1 281 530 5887
ALS Group USA, Corp.
dba ALS Environmental

Certificate of Analysis

ALS Environmental - Houston HRMS
10450 Stancliff Rd, Suite 210, Houston TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

ALS Environmental

Client:	Bhate Environmental Associates, Inc.	**Service Request No.:**	E2200864
Project:	LHAAP17	**Date Received:**	09/01/22
Sample Matrix:	Water		

CASE NARRATIVE

All analyses were performed in adherence to the quality assurance program of ALS Environmental. This report contains analytical results for samples designated for Tier IV. When appropriate to the method, method blank results have been reported with each analytical test.

Sample Receipt

Six samples were received for analysis at ALS Environmental in Houston on 09/01/22.

The samples were received in good condition and are consistent with the accompanying chain of custody form. The samples were stored in a refrigerator at 4°C upon receipt at the laboratory.

Data Validation Notes and Discussion

Precision and Accuracy:

EQ2200387-02/03: Laboratory Control Spike/Duplicate Laboratory Control Spike (LCS/DLCS) samples were analyzed and reported in addition to a MS/MSD for this extraction batch. The MS/MSD was determined on sample 17WW06_083122; the results are included.

The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and ALS Environmental (ALS) is not responsible for utilization of less than the complete report.

Use of ALS group USA Corp dba ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to ALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.

Client: Bhate Environmental Associates, Inc. **Service Request:**E2200864
Project: LHAAP17

SAMPLE CROSS-REFERENCE

SAMPLE #	CLIENT SAMPLE ID	DATE	TIME
E2200864-001	130_083122	8/31/2022	0725
E2200864-002	17WW03_083122	8/31/2022	0815
E2200864-003	17WW01_083122	8/31/2022	0855
E2200864-004	17WW02_083122	8/31/2022	0905
E2200864-005	17WW02_083122_a	8/31/2022	0905
E2200864-006	17WW06_083122	8/31/2022	0915

Service Request Summary

Folder #: **E2200864**
Client Name: Bhate Environmental Associates, Inc.
Project Name: LHAAP17
Project Number:

Report To: Marcia Olive
Bhate Environmental Associates, Inc.
445 Union Blvd
Lakewood, CO 80228
USA
Phone Number: 303-597-2450
Cell Number:
Fax Number:
E-mail: molive@bhate.com

Project Chemist: Corey Grandits
Originating Lab: HOUSTON
Logged By: CGRANDITS
Date Received: 09/01/22
Internal Due Date: 9/16/2022
QAP: LAB QAP
Qualifier Set: Lab Standard
Formset: Lab Standard
Merged?: Y
Report to MDL?: Y
P.O. Number: 2878
EDD: BASIC_WQC_CASNo_LOD

8 120 mL-Plastic Bottle Natural WM Unpreserved
Location: EHRMS-AirArch 1
Pressure Gas:

Lab Samp No.	Client Samp No	Matrix	Collected	HOUSTON ClO4 DOD/6850
E2200864-001	130_083122	Water	08/31/22 0725	**IV**
E2200864-002	17WW03_083122	Water	08/31/22 0815	**IV**
E2200864-003	17WW01_083122	Water	08/31/22 0855	**IV**
E2200864-004	17WW02_083122	Water	08/31/22 0905	**IV**
E2200864-005	17WW02_083122_a	Water	08/31/22 0905	**IV**
E2200864-006	17WW06_083122	Water	08/31/22 0915	**IV**

Service Request Summary

Folder #: **E2200864**
Client Name: Bhate Environmental Associates, Inc.
Project Name: LHAAP17
Project Number:

Report To: Marcia Olive
Bhate Environmental Associates, Inc.
445 Union Blvd
Lakewood, CO 80228
USA
Phone Number: 303-597-2450
Cell Number:
Fax Number:
E-mail: molive@bhate.com

Project Chemist: Corey Grandits
Originating Lab: HOUSTON
Logged By: CGRANDITS
Date Received: 09/01/22
Internal Due Date: 9/16/2022
QAP: LAB QAP
Qualifier Set: Lab Standard
Formset: Lab Standard
Merged?: Y
Report to MDL?: Y
P.O. Number: 2878
EDD: BASIC_WQC_CASNo_LOD

8 120 mL-Plastic Bottle Natural WM Unpreserved
Location: EHRMS-AirArch 1
Pressure Gas:

Test Comments:

Group	Test/Method	Samples	Comments
Semivoa GCMS	ClO4 DOD/6850	1	MS/MSD
Semivoa GCMS	ClO4 DOD/6850	5	IV DUE 9/16

Data Qualifiers

Lab Standard

+	Possible Tedlar bag artifact.
A	TIC is a suspected aldol-condensation product
B	Analyte found in the associated method blank as well as in the sample.
BC	Reported results are not blank corrected.
BH	The back section of the tube yielded higher results than the front.
BT	Results indicated possible breakthrough; back section >=10% front section.
C	Result identification confirmed.
D	Compound identified in an analysis at a secondary dilution factor
D	Spike was diluted out
DE	Reported results are corrected for desorption efficiency.
E	Estimated value. Concentration above calibration range
E	The percent difference for the serial dilution was greater than 10%, indicating a possible matrix interference in the sample.
F	The chromatographic fingerprint of the sample matches the elution pattern of the calibration standard.
H	The chromatographic fingerprint of the sample resembles a petroleum product but the elution pattern indicates the presence of a greater amount of heavier molecular weight constituents than the calibration standard.
H1	Sample analysis performed past holding time. See case narrative.
H2	Initial analysis within holding time. Reanalysis for the required dilution was past holding time.
H3	Sample was received and analyzed past holding time.
H4	Sample was extracted past required extraction holding time, but analyzed within analysis holding time. See case narrative.
I	(Auto) The reference ion ratio was outside acceptance criteria, which may indicate a potential bias to this result.
I	Internal standard not within the specified limits. See case narrative.
I	The reference ion ratio was outside acceptance criteria, which may indicate a potential bias to this result.
J	Estimated Value. Concentration found below MRL.
K	A deflection in the QC ion may indicate interference with the quantitation of this ion. The concentration of this analyte should be considered as an estimate.
K	Analyte was detected above the method reporting limit prior to normalization.
K	The reference ion ratio was outside acceptance criteria, which may indicate a potential bias to this result.
L	The chromatographic fingerprint of the sample resembles a petroleum product, but the elution pattern indicates the presence of a greater amount of lighter molecular weight constituents than the calibration standard.
L1	Laboratory control sample recovery outside the specified limits; results may be biased high.
L2	Laboratory control sample recovery outside the specified limits; results may be biased low.
L3	Laboratory control sample recovery outside the specified limits.
M	Matrix interference; results may be biased high.
M	The duplicate injection precision not met.

Data Qualifiers

Lab Standard

M1	Matrix interference due to coelution with a non-target compound; results may be biased high.
N	Presumptive evidence of a compound for TICs that have been identified based on a mass spectral library search.
N	The Matrix Spike sample recovery is not within control limits. See case narrative.
O	The chromatographic fingerprint of the sample resembles an oil, but does not match the calibration standard.
P	Indicates chlorodiphenyl ether interference present at the retention time of the target compound.
P	Pesticide/Aroclor target analyte > 40% difference for detected concentrations between GC columns
Q	Indicates as estimated value because the P and P + 2 theoretical abundance ratio does not meet method criteria.
R	Duplicate Precision not met.
R1	Duplicate precision not within the specified limits; however, the results are below the MRL and considered estimated.
S	Surrogate recovery not within specified limits.
S	The reported value was determined by the Method of Standard Additions (MSA).
T	Analyte is a tentatively identified compound, result is estimated.
U	Compound was analyzed for, but was not detected (ND).
V1	The continuing calibration verification standard was outside (biased high) the specified limits for this compound.
V2	The continuing calibration verification standard was outside (biased low) the specified limits for this compound.
W	Result quantified, but the corresponding peak was detected outside the generated retention time window.
W	The post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is less than 50% of spike absorbance.
X	See case narrative.
Y	Recovery outside limits
Y	The chromatogram resembles a petroleum product but does not match the calibration standard.
Z	The chromatogram does not resemble a petroleum product.
i	The MRL/MDL has been elevated due to a matrix interference.

ALS Laboratory Group

Acronyms

Cal	Calibration
Conc	CONCentration
Dioxin(s)	Polychlorinated dibenzo-p-dioxin(s)
EDL	Estimated Detection Limit
EMPC	Estimated Maximum Possible Concentration
Flags	Data qualifiers
Furan(s)	Polychlorinated dibenzofuran(s)
g	Grams
ICAL	Initial CALibration
ID	IDentifier
Ions	Masses monitored for the analyte during data acquisition
L	Liter (s)
LCS	Laboratory Control Sample
DLCS	Duplicate Laboratory Control Sample
MB	Method Blank
MCL	Method Calibration Limit
MDL	Method Detection Limit
mL	Milliliters
MS	Matrix Spiked sample
DMS	Duplicate Matrix Spiked sample
NO	Number of peaks meeting all identification criteria
PCDD(s)	Polychlorinated dibenzo-p-dioxin(s)
PCDF(s)	Polychlorinated dibenzofuran(s)
ppb	Parts per billion
ppm	Parts per million
ppq	Parts per quadrillion
ppt	Parts per trillion
QA	Quality Assurance
QC	Quality Control
Ratio	Ratio of areas from monitored ions for an analyte
% Rec.	Percent recovery
RPD	Relative Percent Difference
RRF	Relative Response Factor
RT	Retention Time
SDG	Sample Delivery Group
S/N	Signal-to-noise ratio
TEF	Toxicity Equivalence Factor
TEQ	Toxicity Equivalence Quotient

10450 Stancliff Rd, Houston, TX 77099 | 281-530-5656 | www.alsglobal.com

ALS Environmental

State Certifications, Accreditations, and Licenses

Agency	Number	Expire Date
Arizona Department of Health Services	AZ0793	5/27/2023
Arkansas Department of Environmental Quality	22-041-0	3/27/2023
California Department of Health Services	2919-2023	4/30/2023
Department of Defense	L22-90	3/31/2024
Florida Department of Health	E87611-36	6/30/2023
Florida Department of Health	E87611-36	6/30/2023
Florida Department of Health	E87611-36	6/30/2023
Florida Department of Health	E87611-36	6/30/2023
Hawaii Department of Health	2022	4/30/2023
Illinois Environmental Protection Agency	2000322022-9	5/9/2023
Kansas Department of Health and Environment	E-10352 2022-2023	7/31/2023
Louisiana Department of Environmental Quality	03087-2022	6/30/2023
Louisiana Department of Health and Hospitals	LA028	12/31/2022
Maine Department of Health and Human Services	2022017	6/5/2024
Maryland Department of the Environment	343	6/30/2023
Michigan Depratment of Environmental Quality	9971-2022	4/30/2023
Minnesota Department of Health	2228443	12/31/2022
Nebraska Department of Health and Human Services	NE-OS-25-13	4/30/2023
Nevada Department of Conservation and Natural Resources	TX026932023-1	7/31/2023
New Hampshire Environmental Laboratory Accreditation Program	209422	4/24/2023
New Jersey Department of Environmental Protection	TX008-2023	6/30/2023
New York Department of Health	11707	3/31/2023
Oklahoma Department of Environmental Quality	2022-141	8/31/2023
Oregon Environmental Laboratory Accreditation Program	TX200002	5/15/2023
Pennsylvania Department of Environmental Protection	68-03441-016	6/30/2023
Perry Johnson Laboratory Accreditation	L22-91	3/31/2024
Tennessee Department of Environment and Concervation	04016-2022	4/30/2023
Texas Commision on Environmental Quality	T104704231-22-29	4/30/2023
United States Department of Agriculture	P330-19-00299	10/10/2022
Utah Department of Health Environmental Laboratory Certification	TX026932022-13	7/31/2023
Washington Department of Health	C819-2022	11/14/2022

Chain of Custody

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Phone (713)266-1599 Fax (713)266-0130
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bhate ENVIRONMENTAL CONSTRUCTION ENERGY

1608 13th Avenue South, Suite 300
Birmingham Alabama 35205
Tel: 205-918-4000
Fax: 205-918-4050

Chain of Custody and Analytical Request

Page: _____ of _____

Project/Phase No: MSC2020.0016.0002.0022

COC Number(1): _____

LIMS Number: _____

Facility/Base I.D.: LHAAP

Project/Site Name: LHAAP / Site 17

Client Name:

Collected by: Scott Beesinger

Field Sample ID (30 Characters Max)	Date Collected (dd-mmm-yyyy)	Time Collected (Military) (hhmm)	Sample Depth (beginning - ending)	SA Code (2)	Sample Number (3)	Sample Matrix (4)	Number of containers	PERCHLORATE										Ambient Blank Lot Control Number	Equipment Blank Lot Control Number	Trip Blank Lot Control Number	Cooler ID
							Sample Analysis Requested (5)											Quality Assurance Samples (6)			
130_083122	31 AUG 2022	0725	-	N		WG	1	X													
17WW03_083122	31 AUG 2022	0815	-	N		WG	1	X													
17WW01_083122	31 AUG 2022	0855	-	N		WG	1	X													
17WW02_083122	31 AUG 2022	0905		N		WG	1	X													
17WW02_083122_a	31 AUG 2022	0905		FD		WG	1	X													
17WW06_083122	31 AUG 2022	0915	-	N		WG	1	X													
17WW06_083122_MS	31 AUG 2022	0915	-	MS		WG	1	X													
17WW06_083122_MSD	31 AUG 2022	0915	-	SD		WG	1	X													
			-																		
			-																		
			-																		

COMMENTS: Standard TAT

Custody Transfers Prior to Receipt by Laboratory

	Relinquished By (Signed)	Date	Time	Received by (signed)	Date	Time
1.	~~Scott Beesinger~~	8/31/22	1300	CORETH	9/1/22	0845
2.						
3.						

1,402
1021
CF2-02

Sample Delivery Details / Laboratory Receipt

Delivered Directly to Lab: _____ Shipped _____ No.:

Method of Shipment: _____

Fed _____ Ex _____ Airbill _____ Number:

Analytical Lab: ALS 10450 Stancliff Rd, Suite 210 Houston, TX 77099 (281) 530-5656

ATTN: Dane Wacasey Lab Recipient: Delivery Date/Time:

1.) Chain of Custody Number = date collected + custody number (e.g. 09-02-1999-01)

2.) Sample Type (SA) Codes: N = Normal Sample, TB = Trip Blank (-c) Sample, FD = Field Duplicate (-a) Samples, FR = Field Replicate (-b) Samples, EB = Equipment Blank (-d) Samples, MS = Matrix Spike, SD = Matrix Spike Duplicate, AB = Ambient Blank (-e)

3.) Sample Number: Unique sample number collected from a particular location per day. (e.g. Groundwater sample collected from MW-1 on 10/10/99 = 01, if sampled again on 10/10/99 = 02, etc.)

4.) Matrix Codes: GS = Soil Gas, WG = Groundwater, WS = Surface Water, SO = Soil, SE = Sediment, SL = Sludge, SS = Surface Soil Samples, WQ = Aqueous Blank Samples (trip, equipment, ambient, etc), SQ = Soil Blanks

5.) Sample Analysis Requested: Analytical method requested and number of containers provided for each.

6.) Quality assurance samples are assigned by date (ddmmyy) and the sample number associated with the sample (01, 02, etc) (e.g. Equipment blank collected in association with MW-1 on 10/10/99 will be designated 10109901 in the Equipment Blank Lot Control

ALS Environmental

Cooler Receipt Form

Project Chemist CH

Client/Project RHATE

Thermometer ID IR4

Date/Time Received: 9/11/22 Initials: CH

Date/Time Logged in: 9/11/22 Initials CH

1. Method of delivery: ○ US Mail ⊗ Fed Ex ○ UPS ○ DHL ○ Courier ○ Client

2. Samples received in: ⊗ Cooler ○ Box ○ Envelope ○ Other

3. Were custody seals on coolers? ⊗ Yes ○ No

Were they intact? ⊗ Yes ○ No ○ N/A

Were they signed and dated? ⊗ Yes ○ No ○ N/A

If yes, how many and where? 1-F

4. Packing Material: ○ Inserts ⊗ Baggies ○ Bubble Wrap ○ Gel Packs ⊗ Wet Ice ○ Sleeves ○ Other

5. Foreign or Regulated Soil? ○ Yes ○ No Location of Sampling:

Cooler Tracking Number	COC ID	Date Opened	Time Opened	Opened By	Temp. °C	Temp Blank?
5700 9224 0107		9/11/22	0949	CH	1.2	☒
						☐
						☐
						☐

6. Were custody papers properly filled out (ink, signed, dated, etc)? ⊗ Yes ○ No

7. Did all bottles arrive in good condition (not broken, no signs of leakage)? ⊗ Yes ○ No

8. Were all sample labels complete (i.e., sample ID, analysis, preservation, etc)? ⊗ Yes ○ No

9. Were appropriate bottles/containers and volumes received for the requested tests? ⊗ Yes ○ No

10. Did sample labels and tags agree with custody documents? ⊗ Yes ○ No

Notes, Discrepancies, & Resolutions:

Service request Label:

10450 Stancliff Rd., Suite 210
Houston, TX 77099
T: +1 713 266 1599
F: +1 713 266 1599
www.alsglobal.com

SAMPLE ACCEPTANCE POLICY

This policy outlines the criteria samples must meet to be accepted by ALS Environmental – Houston HRMS.

Cooler Custody Seals (desirable, mandatory if specified in SAP):

- ✓ Intact on outside of cooler, signed and dated

Chain-of-Custody (COC) documentation (mandatory):

The following is required on each COC:

- ✓ Sample ID, the location, date and time of collection, collector's name, preservation type, sample type, and any other special remarks concerning the sampleThe COC must be completed in ink.
- ✓ Signature and date of relinquishing party.

In the absence of a COC at sample receipt, the COC will be requested from the client.

Sample Integrity (mandatory):

Samples are inspected upon arrival to ensure that sample integrity was not compromised during transfer to the laboratory.

- ✓ Sample containers must arrive in good condition (not broken or leaking).
- ✓ Samples must be labeled appropriately, including Sample IDs, and requested test using durable labels and indelible ink.
- ✓ The correct type of sample bottle must be used for the method requested.
- ✓ An appropriate sample volume, or weight, must be received.
- ✓ Sample IDs and number of containers must reconcile with the COC.
- ✓ Samples must be received within the method defined holding time.

Temperature Requirement (varies by sample matrix):

- ✓ Aqueous and Non-aqueous samples must be shipped and stored cold, at 0 to 6ºC.
- ✓ Tissue samples must be shipped and stored frozen, at -20 to -10ºC.
- ✓ Air samples are shipped and stored cold, at 0 to 6ºC
- ✓ The sample temperature must be recorded on the COC

All cooler inspections are documented on the Cooler Receipt Form (CRF). A separate CRF is completed for each service request. Any samples not meeting the above criteria are noted on the CRF and the Project Manager notified. The Project Manager must resolve any sample integrity issues with the client prior to proceeding with the analysis. Such resolutions are documented in writing and filed with the project folder. Data associated with samples received outside of this acceptance policy will be qualified on the case narrative of the final report

Preparation Information Benchsheets

ALS Environmental - Houston HRMS
10450 Stancliff Rd., Suite 210, Houston, TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

Preparation Information Benchsheet

Prep Run#: 405735 **Prep WorkFlow:** GenExt28Day **Status:** Prepped
Team: Semivoa GCMS/GRIVERA **Prep Method:** Method **Prep Date/Time:** 9/1/22 13:30

#	Lab Code	Client ID	B#	Method /Test	pH	Cl	Matrix	Amt. Ext.	Sample Description
1	E2200850-001	HBW7_082622	.01	6850/ClO4 DOD			Water	10mL	
2	E2200850-002	HBW10_082622	.01	6850/ClO4 DOD			Water	10mL	
3	E2200850-003	HBW1_082622	.01	6850/ClO4 DOD			Water	10mL	
4	E2200850-004	HBW1_082622_a	.01	6850/ClO4 DOD			Water	10mL	
5	E2200850-005	GPW1_082622	.01	6850/ClO4 DOD			Water	10mL	
6	E2200850-006	GPW3_082622	.01	6850/ClO4 DOD			Water	10mL	
7	E2200851-021	ICT14C_082522	.01	6850/ClO4 DOD			Water	10mL	
8	E2200851-022	ICT14D_082522	.01	6850/ClO4 DOD			Water	10mL	
9	E2200851-023	ICT14E_082522	.01	6850/ClO4 DOD			Water	10mL	
10	E2200861-001	LH18/24-SP650_083022_AIX	.01	6850/ClO4 DOD			Water	10mL	
11	E2200861-002	LH18/24-SP650_083022_BIX	.01	6850/ClO4 DOD			Water	10mL	
12	E2200864-001	130_083122	.01	6850/ClO4 DOD			Water	10mL	
13	E2200864-002	17WW03_083122	.01	6850/ClO4 DOD			Water	10mL	
14	E2200864-003	17WW01_083122	.01	6850/ClO4 DOD			Water	10mL	
15	E2200864-004	17WW02_083122	.01	6850/ClO4 DOD			Water	10mL	
16	E2200864-005	17WW02_083122_a	.01	6850/ClO4 DOD			Water	10mL	
17	E2200864-006	17WW06_083122	.01	6850/ClO4 DOD			Water	10mL	
18	EQ2200387-01	MB		6850/ClO4 DOD			Liquid	10mL	
19	EQ2200387-02	LCS		6850/ClO4 DOD			Liquid	10mL	
20	EQ2200387-03	DLCS		6850/ClO4 DOD			Liquid	10mL	
21	EQ2200387-04	ICT14D_082522 MS	.02	6850/ClO4 DOD			Liquid	10mL	
22	EQ2200387-05	ICT14D_082522 DMS	.02	6850/ClO4 DOD			Liquid	10mL	
23	EQ2200387-06	17WW06_083122 MS	.02	6850/ClO4 DOD			Liquid	10mL	
24	EQ2200387-07	17WW06_083122 DMS	.02	6850/ClO4 DOD			Liquid	10mL	
25	R2207855-003	2208170817Y WB-5-280	.01	6850/ClO4			Water	10mL	
26	R2207855-011	2208181449Y WB-14-520	.01	6850/ClO4			Water	10mL	

Spiking Solutions

Name: Perchlorate Intermediate Stock1 Inventory ID 222798 Logbook Ref: Perchlorate (1st Source) Expires On: 10/29/2022

EQ2200387-02 1.00µL EQ2200387-02 1.00µL EQ2200387-03 1.00µL EQ2200387-03 1.00µL EQ2200387-04 1.00µL EQ2200387-05 1.00µL
EQ2200387-06 1.00µL EQ2200387-07 1.00µL

Name: Perchlorate Internal Standard 1ug/mL Inventory ID 223118 Logbook Ref: Perchlorate Internal Standard Expires On: 10/31/2022

Preparation Information Benchsheet

Prep Run#: 405735 **Prep WorkFlow:** GenExt28Day **Status:** Prepped

Team: Semivoa GCMS/GRIVERA **Prep Method:** Method **Prep Date/Time:** 9/1/22 13:30

E2200850-001	100.00µL	E2200850-002	100.00µL	E2200850-003	100.00µL	E2200850-004	100.00µL	E2200850-005	100.00µL	E2200850-006	100.00µL
E2200851-021	100.00µL	E2200851-022	100.00µL	E2200851-023	100.00µL	E2200861-001	100.00µL	E2200861-002	100.00µL	E2200864-001	100.00µL
E2200864-002	100.00µL	E2200864-003	100.00µL	E2200864-004	100.00µL	E2200864-005	100.00µL	E2200864-006	100.00µL	EQ2200387-01	100.00µL
EQ2200387-01	100.00µL	EQ2200387-02	100.00µL	EQ2200387-02	100.00µL	EQ2200387-03	100.00µL	EQ2200387-03	100.00µL	EQ2200387-04	100.00µL
EQ2200387-05	100.00µL	EQ2200387-06	100.00µL	EQ2200387-07	100.00µL	R2207855-003	100.00µL	R2207855-011	100.00µL		

Preparation Materials

Water HPLC Grade	5/12/2022 Water (223056)	6850 Amber Glass screw vial	2mL Screw Top Vial (221894)	6850 0.45um syringe filters	6850 Syringe Filters (224414)
6850 Luer-Lok Syringes	Luer-Lok Syringes (221305)	6850 Pipette Tips 50-1000 uL	6850 Pipette Tips (221929)		

Preparation Steps

Step: Preparation
Started: 9/1/22 13:30
Finished: 9/1/22 14:25
By: GRIVERA
Comments

Comments: _____

Reviewed By: GR Date: 09/01/22

Chain of Custody

Relinquished By: _____ Date: _____

Received By: _____ Date: _____

Extracts Examined
Yes No

Analytical Results

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ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	8/31/22 0725
Sample Matrix:	Water	**Date Received:**	9/ 1/22
Sample Name:	130_083122	**Units:**	µg/L
Lab Code:	E2200864-001	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.0640**	J	0.100	0.0500	0.0250	1	9/ 1/22	9/13/22 12:45	405735	777303	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	8/31/22 0815
Sample Matrix:	Water	**Date Received:**	9/ 1/22
Sample Name:	17WW03_083122	**Units:**	µg/L
Lab Code:	E2200864-002	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.0694**	J	0.100	0.0500	0.0250	1	9/ 1/22	9/13/22 13:44	405735	777303	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	8/31/22 0855
Sample Matrix:	Water	**Date Received:**	9/ 1/22
Sample Name:	17WW01_083122	**Units:**	µg/L
Lab Code:	E2200864-003	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**1740**		10.0	5.00	2.50	100	9/ 1/22	9/13/22 13:02	405735	777303	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	8/31/22 0905
Sample Matrix:	Water	**Date Received:**	9/ 1/22
Sample Name:	17WW02_083122	**Units:**	µg/L
Lab Code:	E2200864-004	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**16400**		100	50.0	25.0	1000	9/ 1/22	9/13/22 13:11	405735	777303	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	8/31/22 0905
Sample Matrix:	Water	**Date Received:**	9/ 1/22
Sample Name:	17WW02_083122_a	**Units:**	µg/L
Lab Code:	E2200864-005	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**16200**		100	50.0	25.0	1000	9/ 1/22	9/13/22 13:19	405735	777303	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	8/31/22 0915
Sample Matrix:	Water	**Date Received:**	9/ 1/22
Sample Name:	17WW06_083122	**Units:**	µg/L
Lab Code:	E2200864-006	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**101000**		500	250	125	5000	9/ 1/22	9/13/22 13:27	405735	777303	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
Sample Name:	Method Blank	**Units:**	µg/L
Lab Code:	EQ2200387-01	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	ND	U	0.100	0.0500	0.0250	1	9/ 1/22	9/9/22 13:50	405735	776946	

Accuracy & Precision

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ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Analyzed:**	9/ 9/22
Sample Matrix:	Water		

Lab Control Sample Summary

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method:	6850	**Units:**	µg/L
Prep Method:	Method	**Basis:**	NA
		Extraction Lot:	405735

	Lab Control Sample EQ2200387-02			Duplicate Lab Control Sample EQ2200387-03					
Analyte Name	**Result**	**Spike Amount**	**% Rec**	**Result**	**Spike Amount**	**% Rec**	**% Rec Limits**	**RPD**	**RPD Limit**
Perchlorate	0.104	0.100	104	0.0941	0.100	94	84 - 119	10	15

Results flagged with an asterisk (*) indicate values outside control criteria.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
Sample Name:	Lab Control Sample	**Units:**	µg/L
Lab Code:	EQ2200387-02	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.104**		0.100	0.0500	0.0250	1	9/ 1/22	9/9/22 13:58	405735	776946	

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	NA
Sample Matrix:	Water	**Date Received:**	NA
Sample Name:	Duplicate Lab Control Sample	**Units:**	µg/L
Lab Code:	EQ2200387-03	**Basis:**	NA

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**0.0941**	J	0.100	0.0500	0.0250	1	9/ 1/22	9/9/22 14:07	405735	776946	

ALS Group USA, Corp. dba ALS Environmental

QA/QC Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	8/31/22
Sample Matrix:	Water	**Date Received:**	9/1/22
		Date Analyzed:	9/ 9/22

Matrix Spike Summary

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Sample Name:	17WW06_083122	**Units:**	µg/L
Lab Code:	E2200864-006	**Basis:**	NA

Analytical Method: 6850
Prep Method: Method

		17WW06_083122MS				17WW06_083122DMS					
		Matrix Spike				**Duplicate Matrix Spike**					
		EQ2200387-06				EQ2200387-07					
Analyte Name	**Sample Result**	**Result**	**Spike Amount**	**% Rec**		**Result**	**Spike Amount**	**% Rec**	**% Rec Limits**	**RPD**	**RPD Limit**
Perchlorate	101000	93900	0.100	-666477	#	95900	0.100	-459727	1# 84 - 119	2	15

Results flagged with an asterisk (*) indicate values outside control criteria.

Results flagged with a pound (#) indicate the control criteria is not applicable.

Percent recoveries and relative percent differences (RPD) are determined by the software using values in the calculation which have not been rounded.

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	8/31/22 0915
Sample Matrix:	Water	**Date Received:**	9/ 1/22
Sample Name:	17WW06_083122	**Units:**	µg/L
Lab Code:	EQ2200387-06	**Basis:**	NA
Run Type:	Matrix Spike		

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**93900**	E	0.100	0.0500	0.0250	1	9/ 1/22	9/9/22 20:19	405735	776946	*

ALS Group USA, Corp. dba ALS Environmental

Analytical Report

Client:	Bhate Environmental Associates, Inc.	**Service Request:**	E2200864
Project:	LHAAP17	**Date Collected:**	8/31/22 0915
Sample Matrix:	Water	**Date Received:**	9/ 1/22
Sample Name:	17WW06_083122	**Units:**	µg/L
Lab Code:	EQ2200387-07	**Basis:**	NA
Run Type:	Duplicate Matrix Spike		

Perchlorates in Water, Soils, Solid Wastes Using High Performance LC/Electrospray/Mass Spectrometry

Analytical Method: 6850
Prep Method: Method

Analyte Name	Result	Q	LOQ	LOD	MDL	Dilution Factor	Date Extracted	Date Analyzed	Extraction Lot	Analysis Lot	Note
Perchlorate	**95900**	E	0.100	0.0500	0.0250	1	9/ 1/22	9/9/22 20:27	405735	776946	*



Initial Calibration

ALS Environmental - Houston HRMS
10450 Stancliff Rd., Suite 210, Houston, TX 77099
Phone (713)266-1599 Fax (713)266-0130
www.alsglobal.com

20220909

1st Review: GRivera
2nd Review: Kneir

Injection Log
LCMS01 -Shimadzu 8050

ICAL Date: 9/9/2022
Cal. Std. xp: 10/29/2022
ICAL ID: **EC2200013**

Mobile Phases **A:** 0.10% Formic Acid/Water 3100820-05 **B:** MeOH 218535

			File Name	Acquisition Method	Dilution	R	Comments	Date/Time
1	PERCHLORATE1		20220909_013	Perchlorate6850c.lcm	1x	☒	224623	9/9/2022 11:35
2	PERCHLORATE2		20220909_014	Perchlorate6850c.lcm	1x	☒	224624	9/9/2022 11:52
3	PERCHLORATE3		20220909_015	Perchlorate6850c.lcm	1x	☒	224625	9/9/2022 12:01
4	PERCHLORATE4		20220909_016	Perchlorate6850c.lcm	1x	☒	224626	9/9/2022 12:09
5	PERCHLORATE5		20220909_017	Perchlorate6850c.lcm	1x	☒	224628	9/9/2022 12:17
6	PERCHLORATE6		20220909_018	Perchlorate6850c.lcm	1x	☒	224629	9/9/2022 12:26
7	PERCHLORATE7		20220909_019	Perchlorate6850c.lcm	1x	☒	224631	9/9/2022 12:34
8	PERCHLORATE8		20220909_020	Perchlorate6850c.lcm	1x	☒	224632	9/9/2022 12:43
9	PERCHLORATE9		20220909_021	Perchlorate6850c.lcm	1x	☒	224634	9/9/2022 12:51
10	PERCHLORATE10		20220909_022	Perchlorate6850c.lcm	1x	☒	224636	9/9/2022 12:59
11	PERCHLORATEICV		20220909_023	Perchlorate6850c.lcm	1x	☒	224637	9/9/2022 13:08
12	IB		20220909_024	Perchlorate6850c.lcm	1x	☒		9/9/2022 13:16
13	LODV		20220909_025	Perchlorate6850c.lcm	1x	☒	224622	9/9/2022 13:25
14	ICS		20220909_026	Perchlorate6850c.lcm	1x	☒		9/9/2022 13:33
15	PERCHLORATE7		20220909_027	Perchlorate6850c.lcm	1x	☒	224631	9/9/2022 13:41
16	EQ2200387-01		20220909_028	Perchlorate6850c.lcm	1x	☒		9/9/2022 13:50
17	EQ2200387-02		20220909_029	Perchlorate6850c.lcm	1x	☒		9/9/2022 13:58
18	EQ2200387-03		20220909_030	Perchlorate6850c.lcm	1x	☒		9/9/2022 14:07
19	E2200861-001		20220909_031	Perchlorate6850c.lcm	1x	☒		9/9/2022 14:48
20	E2200861-002		20220909_032	Perchlorate6850c.lcm	1x	☒		9/9/2022 14:57
21	PERCHLORATE7		20220909_033	Perchlorate6850c.lcm	1x	☒	224631	9/9/2022 15:05
22	EQ2200385-01		20220909_034	Perchlorate6850c.lcm	1x	☒		9/9/2022 15:14
23	EQ2200385-02		20220909_035	Perchlorate6850c.lcm	1x	☒		9/9/2022 15:22
24	EQ2200385-03		20220909_036	Perchlorate6850c.lcm	1x	☒		9/9/2022 16:23
25	E2200851-001		20220909_037	Perchlorate6850c.lcm	50x	☒		9/9/2022 16:32
26	E2200851-002		20220909_038	Perchlorate6850c.lcm	100x	☒		9/9/2022 16:41
27	E2200851-003		20220909_039	Perchlorate6850c.lcm	10x	☒		9/9/2022 16:49
28	E2200851-004		20220909_040	Perchlorate6850c.lcm	10x	☒		9/9/2022 16:58
29	E2200851-005		20220909_041	Perchlorate6850c.lcm	500x	☒		9/9/2022 17:06
30	E2200851-006		20220909_042	Perchlorate6850c.lcm	500x	☒		9/9/2022 17:14
31	E2200851-007		20220909_043	Perchlorate6850c.lcm	1000x	☒		9/9/2022 17:23
32	PERCHLORATE7		20220909_044	Perchlorate6850c.lcm	1x	☒	224631	9/9/2022 17:31
33	E2200851-008		20220909_045	Perchlorate6850c.lcm	2000x	☒		9/9/2022 17:40
34	E2200851-009		20220909_046	Perchlorate6850c.lcm	50x	☒		9/9/2022 17:48
35	E2200851-010		20220909_047	Perchlorate6850c.lcm	10x	☒		9/9/2022 17:56
36	E2200851-011		20220909_048	Perchlorate6850c.lcm	10x	☒		9/9/2022 18:05
37	E2200851-012		20220909_049	Perchlorate6850c.lcm	2000x	☒		9/9/2022 18:13
38	E2200851-013		20220909_050	Perchlorate6850c.lcm	500x	☒		9/9/2022 18:21
39	E2200851-014		20220909_051	Perchlorate6850c.lcm	10x	☒		9/9/2022 18:30
40	E2200851-015		20220909_052	Perchlorate6850c.lcm	200x	☒		9/9/2022 18:38
41	E2200851-016		20220909_053	Perchlorate6850c.lcm	1x	☒	DNU-IR	9/9/2022 18:47
42	E2200851-017		20220909_054	Perchlorate6850c.lcm	50x	☒		9/9/2022 18:55
43	PERCHLORATE7		20220909_055	Perchlorate6850c.lcm	1x	☒	224631	9/9/2022 19:03
44	E2200851-018		20220909_056	Perchlorate6850c.lcm	1x	☒		9/9/2022 19:12
45	E2200851-019		20220909_057	Perchlorate6850c.lcm	10x	☒		9/9/2022 19:20
46	E2200851-020		20220909_058	Perchlorate6850c.lcm	500x	☒		9/9/2022 19:29
47	PERCHLORATE7		20220909_059	Perchlorate6850c.lcm	1x	☒	224631	9/9/2022 19:37
48	R2207855-003		20220909_060	Perchlorate6850c.lcm	1x	☒		9/9/2022 19:45
49	R2207855-011DNU-IS		20220909_061	Perchlorate6850c.lcm	1x	☒	DNU-IS out of range	9/9/2022 19:54
50	EQ2200387-04		20220909_062	Perchlorate6850c.lcm	1x	☒		9/9/2022 20:02
51	EQ2200387-05		20220909_063	Perchlorate6850c.lcm	1x	☒		9/9/2022 20:11
52	EQ2200387-06		20220909_064	Perchlorate6850c.lcm	1x	☒	MS over ICAL range	9/9/2022 20:19
53	EQ2200387-07		20220909_065	Perchlorate6850c.lcm	1x	☒	DMS over ICAL range	9/9/2022 20:27
54	E2200850-001		20220909_066	Perchlorate6850c.lcm	1x	☒	Reanalyze: carryover	9/9/2022 20:36
55	E2200850-002		20220909_067	Perchlorate6850c.lcm	1x	☒	Reanalyze: carryover	9/9/2022 20:44
56	E2200850-003		20220909_068	Perchlorate6850c.lcm	1x	☒	Reanalyze: carryover	9/9/2022 20:53
57	E2200850-004		20220909_069	Perchlorate6850c.lcm	1x	☒	Reanalyze: carryover	9/9/2022 21:01
58	PERCHLORATE7		20220909_070	Perchlorate6850c.lcm	1x	☒	224631	9/9/2022 21:09
59	E2200850-005		20220909_071	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 21:18
60	E2200850-006		20220909_072	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 21:26
61	E2200864-001		20220909_073	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 21:34
62	E2200864-002		20220909_074	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 21:43
63	E2200864-003		20220909_075	Perchlorate6850c.lcm	1x	☒	DNU-over ICAL range	9/9/2022 21:51
64	E2200864-004		20220909_076	Perchlorate6850c.lcm	1x	☒	DNU-over ICAL range	9/9/2022 22:00
65	E2200864-005		20220909_077	Perchlorate6850c.lcm	1x	☒	DNU-over ICAL range	9/9/2022 22:08
66	E2200864-006		20220909_078	Perchlorate6850c.lcm	1x	☒	DNU-over ICAL range	9/9/2022 22:16

20220909

1st Review: GRivera
2nd Review: Kneir

Injection Log
LCMS01 -Shimadzu 8050

ICAL Date: 9/9/2022
Cal. Std. xp: 10/29/2022
ICAL ID: **EC2200013**

Mobile Phases **A:** 0.10% Formic Acid/Water 3100820-05 **B:** MeOH 218535

			File Name	Acquisition Method	Dilution	R	Comments	Date/Time
67	PERCHLORATE7		20220909_079	Perchlorate6850c.lcm	1x	☒	224631-CCV failed high	9/9/2022 22:25
68	E2200851-021		20220909_080	Perchlorate6850c.lcm	1x	☒	DNU-over ICAL range	9/9/2022 22:33
69	E2200851-022		20220909_081	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 22:41
70	E2200851-023		20220909_082	Perchlorate6850c.lcm	1x	☒	DNU-over ICAL range	9/9/2022 22:50
71	PERCHLORATE7		20220909_083	Perchlorate6850c.lcm	1x	☒	224631-CCV failed high	9/9/2022 22:58
72	E2200852-001		20220909_084	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 23:07
73	E2200852-002		20220909_085	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 23:15
74	E2200852-003		20220909_086	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 23:24
75	E2200852-004		20220909_087	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 23:32
76	E2200852-005		20220909_088	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 23:40
77	E2200852-006		20220909_089	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 23:49
78	E2200852-007		20220909_090	Perchlorate6850c.lcm	1x	☒	Reanalyze CCV failed	9/9/2022 23:57
79	PERCHLORATE7		20220909_091	Perchlorate6850c.lcm	1x	☒	224631	9/10/2022 0:06
80	E2200852-008		20220909_092	Perchlorate6850c.lcm	1000x	☒	DNU-over ICAL range	9/10/2022 0:14
81	E2200852-009		20220909_093	Perchlorate6850c.lcm	1000x	☒	DNU-over ICAL range	9/10/2022 0:22
82	E2200852-010		20220909_094	Perchlorate6850c.lcm	1000x	☒	Run a 500x	9/10/2022 0:31
83	E2200852-011		20220909_095	Perchlorate6850c.lcm	1000x	☒	DNU-over ICAL range	9/10/2022 0:39
84	E2200852-012		20220909_096	Perchlorate6850c.lcm	1000x	☒	DNU-over ICAL range	9/10/2022 0:47
85	E2200852-013		20220909_097	Perchlorate6850c.lcm	1000x	☒	DNU-over ICAL range	9/10/2022 0:56
86	E2200852-014		20220909_098	Perchlorate6850c.lcm	1000x	☒	DNU-over ICAL range	9/10/2022 1:04
87	E2200852-015		20220909_099	Perchlorate6850c.lcm	1x	☒	Reanalyze: carryover	9/10/2022 1:13
88	E2200852-016		20220909_100	Perchlorate6850c.lcm	1x	☒	DNU-over ICAL range	9/10/2022 1:21
89	PERCHLORATE7		20220909_101	Perchlorate6850c.lcm	1x	☒	224631	9/10/2022 1:29
90	E2200852-017		20220909_102	Perchlorate6850c.lcm	1x	☒	DNU-over ICAL range	9/10/2022 1:38
91	E2200852-019		20220909_103	Perchlorate6850c.lcm	1000x	☒	DNU-over ICAL range	9/10/2022 1:46
92	PERCHLORATE7		20220909_104	Perchlorate6850c.lcm	1x	☒	224631-CCV failed high	9/10/2022 1:55
93	IB		20220909_105	Perchlorate6850c.lcm	1x	☒		9/10/2022 2:03
94	IB		20220909_106	Perchlorate6850c.lcm	1x	☒		9/10/2022 2:12
95	null		20220909_107	Perchlorate6850c.lcm	1x	☒		9/10/2022 2:17
96	null		20220909_108	Perchlorate6850c.lcm	1x	☒		9/10/2022 2:22

Initial Calibration - Detailed Report

Calibration ID: EC2200013 **Instrument ID:** E-LCMS-01
Column Name: 1

#	Lab Code	Sample Name	File Location	Aquisition Date
01	EC2200013-01	PERCHLORATE1	20220909_013	09/09/2022 11:35
02	EC2200013-02	PERCHLORATE2	20220909_014	09/09/2022 11:52
03	EC2200013-03	PERCHLORATE3	20220909_015	09/09/2022 12:01
04	EC2200013-04	PERCHLORATE4	20220909_016	09/09/2022 12:09
05	EC2200013-05	PERCHLORATE5	20220909_017	09/09/2022 12:17
06	EC2200013-06	PERCHLORATE6	20220909_018	09/09/2022 12:26
07	EC2200013-07	PERCHLORATE7	20220909_019	09/09/2022 12:34
08	EC2200013-08	PERCHLORATE8	20220909_020	09/09/2022 12:43
09	EC2200013-09	PERCHLORATE9	20220909_021	09/09/2022 12:51
10	EC2200013-10	PERCHLORATE10	20220909_022	09/09/2022 12:59

Analyte **Curve Fit** **Weighting**

Perchlorate **Average RF** **RSD = 7.827** **Average RF = 0.1354**

#	Amount	RF	#	Amount	RF	#	Amount	RF	#	Amount	RF
01	0.1000	0.1628	02	0.5000	0.1427	03	0.7000	0.1329	04	1.0000	0.1318
05	2.0000	0.1326	06	5.0000	0.1273	07	10.0000	0.1353	08	20.0000	0.1312
09	30.0000	0.1303	10	50.0000	0.127						

Analyte

Perchlorate

#	Amount	Calculated Conc	%D	#	Amount	Calculated Conc	%D	#	Amount	Calculated Conc	%D
01	0.1000	0.120	20.3	02	0.5000	0.527	5.4	03	0.7000	0.687	-1.8
04	1.0000	0.973	-2.7	05	2.0000	1.96	-2.1	06	5.0000	4.70	-5.9
07	10.0000	9.99	-0.1	08	20.0000	19.4	-3.1	09	30.0000	28.9	-3.8
10	50.0000	46.9	-6.2								

Initial Calibration Verification Summary Report

Calibration ID:	EC2200013	**Instrument ID:**	E-LCMS-01
Datafile ID:	20220909_023	**Column Name:**	1

Analyte	Lab Code	Type	Curve Fit	True Value	Calc Conc	Units	Result	Criteria
Perchlorate	EC2200013-11	T	Average RF	10	10.678	ng/mL	6.8	<= 15

Insight Report

Printed at 9/9/2022 1:20:08 PM

Method File: I:\LCMS01\DATA\20220909\20220909.lcm
Project File: I:\LCMS01\DATA\20220909\20220909-ICAL.damlp

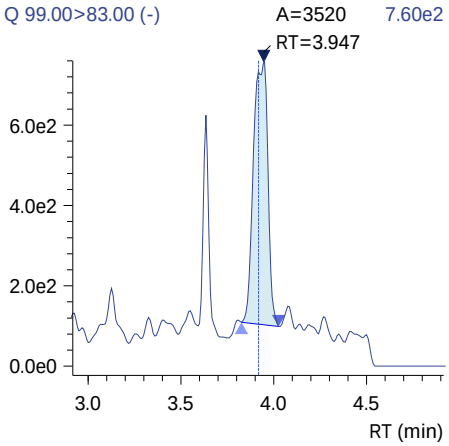
PERCHLORATE1

Sample ID: PERCHLORATE1
Date Acquired: 9/9/2022 11:35:32 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_013.lcd
Vial: 20 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	MI R1	3.947	3520	216224	0.1203	ng/mL	49.18	26.81-49.79
Perchlorate 2	M	3.921	1731	216224	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.915	216224	216224	1.0000	ng/mL	----	

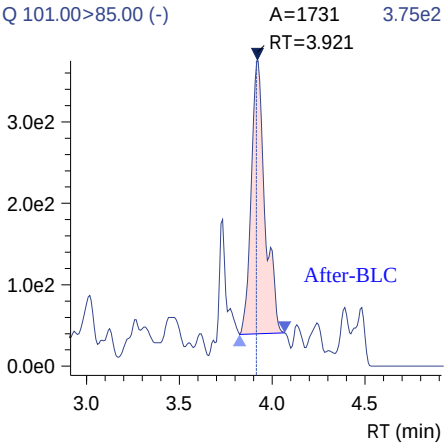
Perchlorate

Conc 0.1203



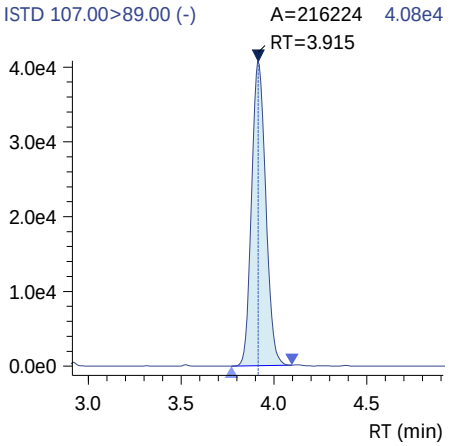
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 9/9/2022 1:21:18 PM

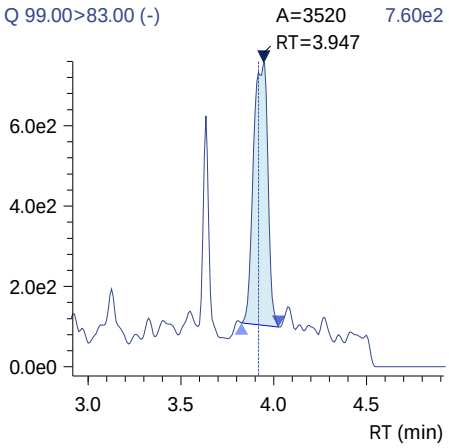
Method File: I:\LCMS01\DATA\20220909\20220909.lcm
Project File: I:\LCMS01\DATA\20220909\20220909-ICAL.damlp

PERCHLORATE1

Sample ID: PERCHLORATE1
Date Acquired: 9/9/2022 11:35:32 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_013.lcd
Vial: 20 | Inj. Volume: 25.0000uL | Tray: 1

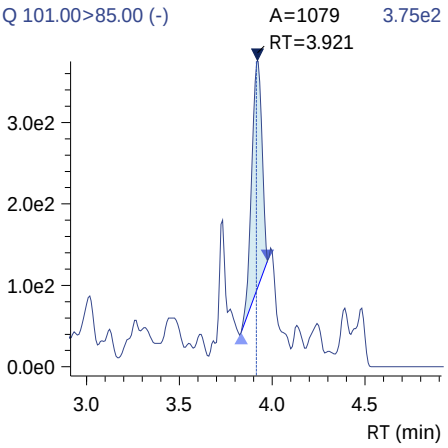
Perchlorate

Conc 0.1203



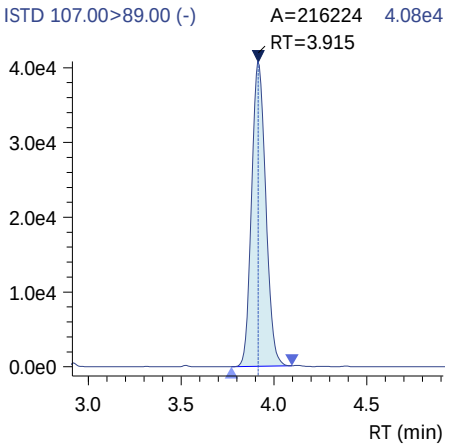
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 9/9/2022 1:20:08 PM

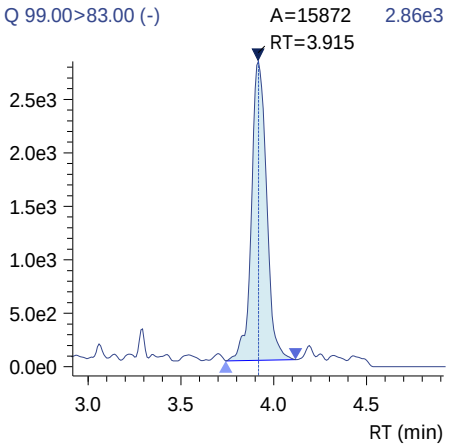
PERCHLORATE2

Sample ID: PERCHLORATE2
Date Acquired: 9/9/2022 11:52:35 AM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_014.lcd
Vial: 21 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.915	15872	222527	0.5269	ng/mL	30.66	26.81-49.79
Perchlorate 2	Auto	3.918	4866	222527	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.915	222527	222527	1.0000	ng/mL	----	

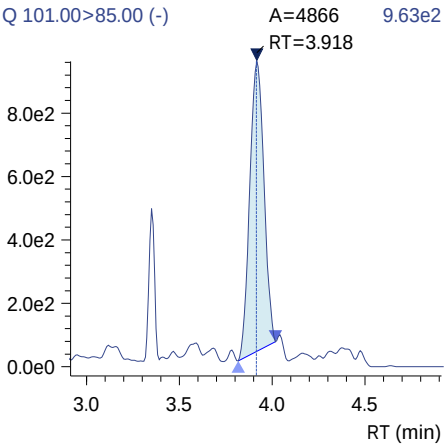
Perchlorate

Conc 0.5269



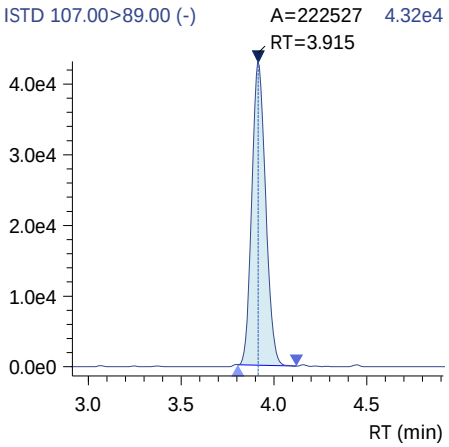
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 9/9/2022 1:20:08 PM

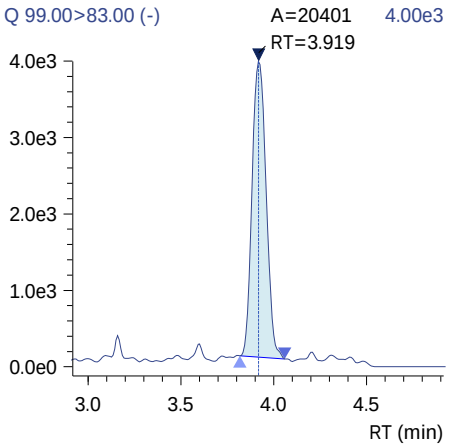
PERCHLORATE3

Sample ID: PERCHLORATE3
Date Acquired: 9/9/2022 12:01:01 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_015.lcd
Vial: 22 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.919	20401	219300	0.6872	ng/mL	38.76	26.81-49.79
Perchlorate 2	Auto	3.911	7907	219300	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.913	219300	219300	1.0000	ng/mL	----	

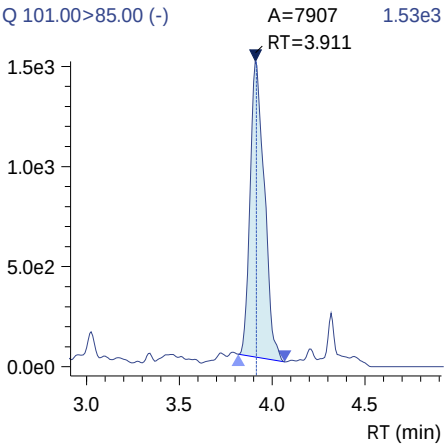
Perchlorate

Conc 0.6872



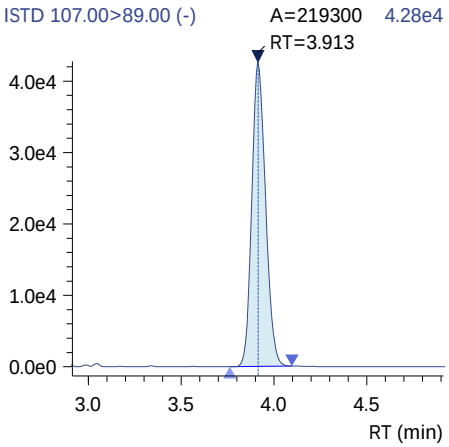
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

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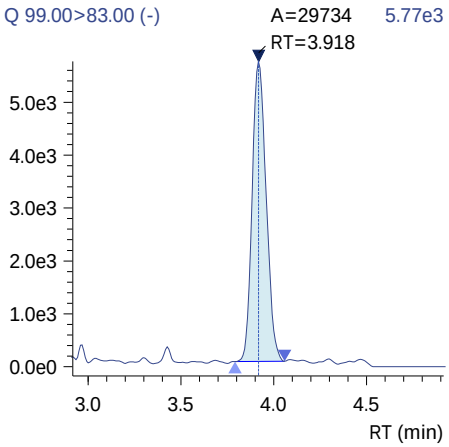
PERCHLORATE4

Sample ID: PERCHLORATE4
Date Acquired: 9/9/2022 12:09:26 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_016.lcd
Vial: 23 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.918	29734	225679	0.9732	ng/mL	35.80	26.81-49.79
Perchlorate 2	Auto	3.914	10645	225679	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.914	225679	225679	1.0000	ng/mL	----	

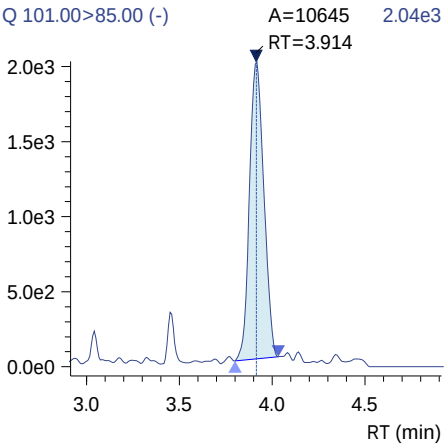
Perchlorate

Conc 0.9732



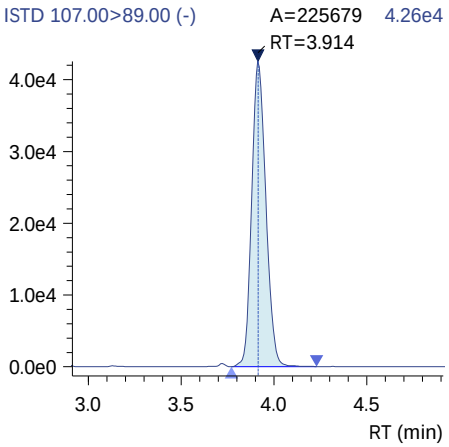
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 9/9/2022 1:20:08 PM

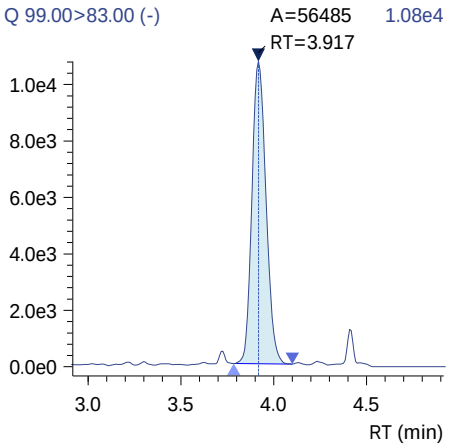
PERCHLORATE5

Sample ID: PERCHLORATE5
Date Acquired: 9/9/2022 12:17:50 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_017.lcd
Vial: 24 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.917	56485	213010	1.9588	ng/mL	39.28	26.81-49.79
Perchlorate 2	Auto	3.915	22186	213010	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.913	213010	213010	1.0000	ng/mL	----	

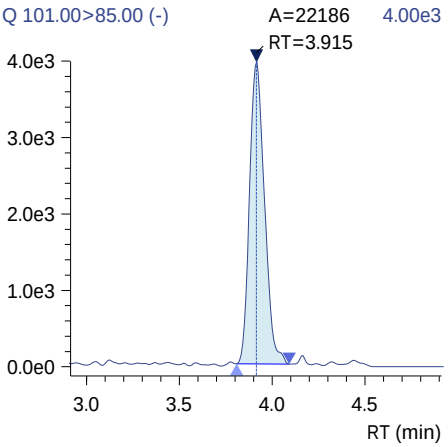
Perchlorate

Conc 1.9588



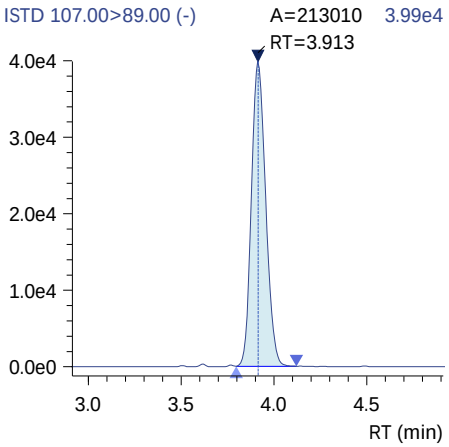
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 9/9/2022 1:20:08 PM

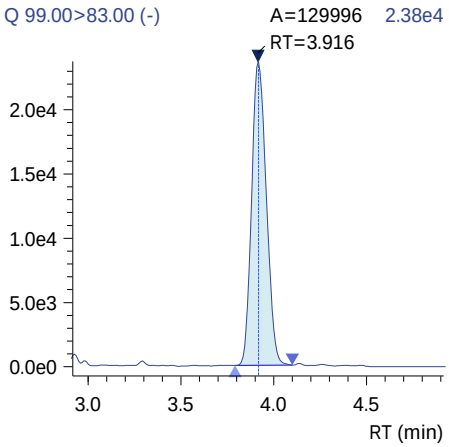
PERCHLORATE6

Sample ID: PERCHLORATE6
Date Acquired: 9/9/2022 12:26:13 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_018.lcd
Vial: 25 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	MI R1	3.916	129996	204200	4.7026	ng/mL	38.88	26.81-49.79
Perchlorate 2	M	3.911	50537	204200	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.914	204200	204200	1.0000	ng/mL	----	

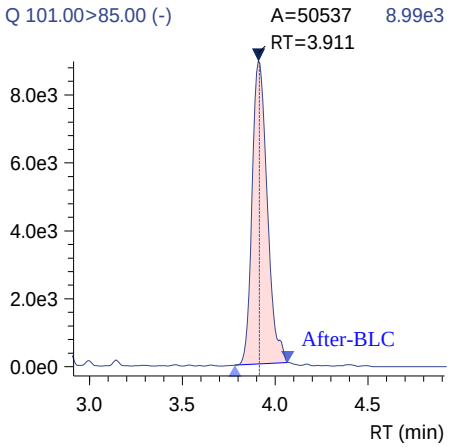
Perchlorate

Conc 4.7026



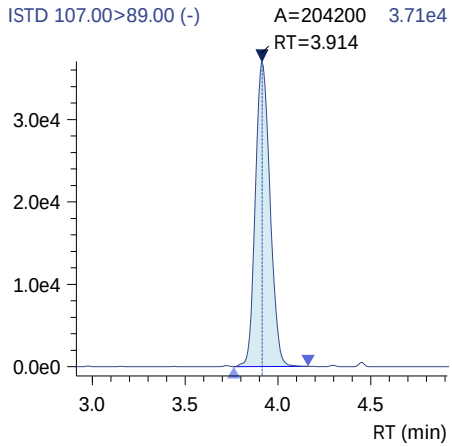
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

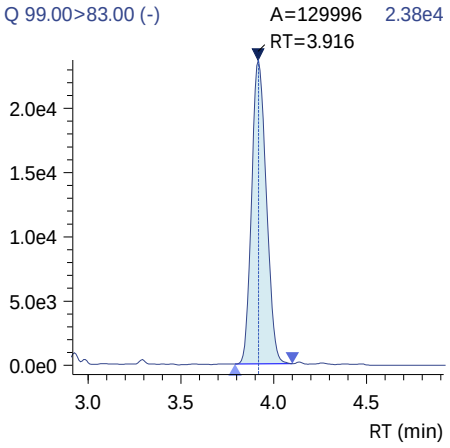
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PERCHLORATE6

Sample ID: PERCHLORATE6
Date Acquired: 9/9/2022 12:26:13 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_018.lcd
Vial: 25 | Inj. Volume: 25.0000uL | Tray: 1

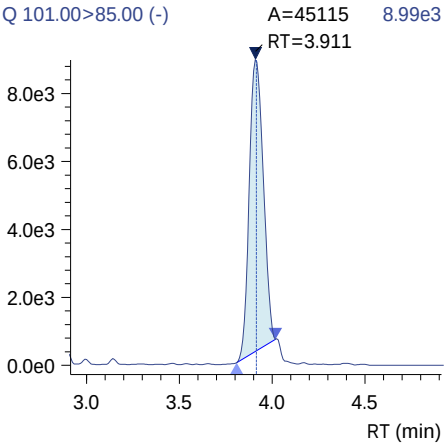
Perchlorate

Conc 4.7026



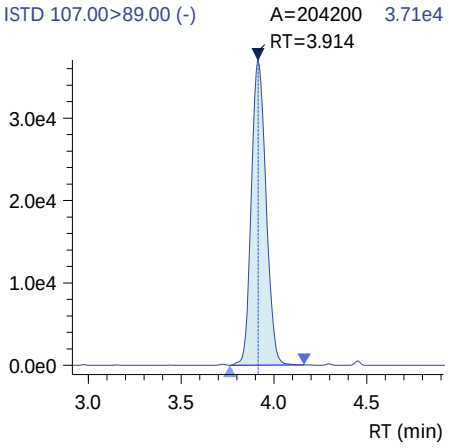
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 9/9/2022 1:20:08 PM

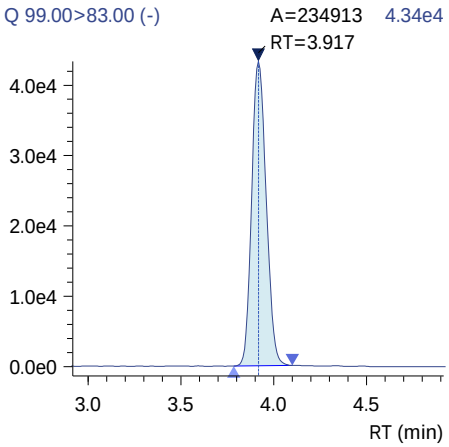
PERCHLORATE7

Sample ID: PERCHLORATE7
Date Acquired: 9/9/2022 12:34:38 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_019.lcd
Vial: 26 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.917	234913	173644	9.9933	ng/mL	38.30	26.81-49.79
Perchlorate 2	Auto	3.914	89967	173644	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.913	173644	173644	1.0000	ng/mL	----	

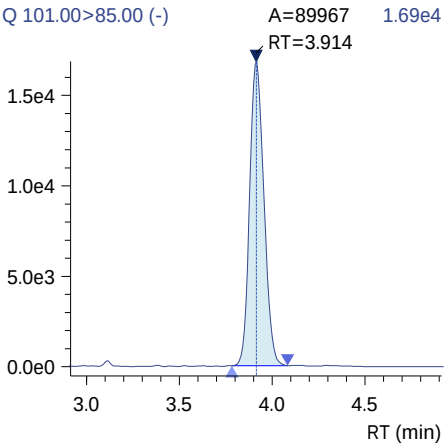
Perchlorate

Conc 9.9933



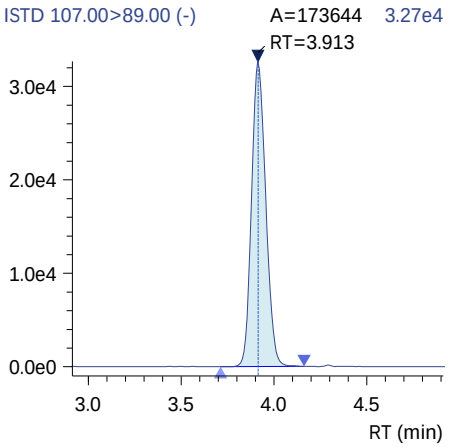
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 9/9/2022 1:20:08 PM

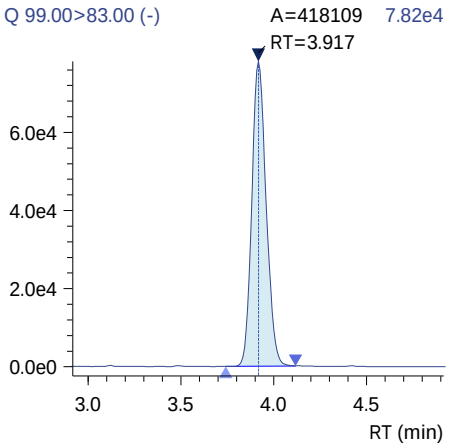
PERCHLORATE8

Sample ID: PERCHLORATE8
Date Acquired: 9/9/2022 12:43:02 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_020.lcd
Vial: 27 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.917	418109	159338	19.3835	ng/mL	37.90	26.81-49.79
Perchlorate 2	Auto	3.915	158442	159338	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.913	159338	159338	1.0000	ng/mL	----	

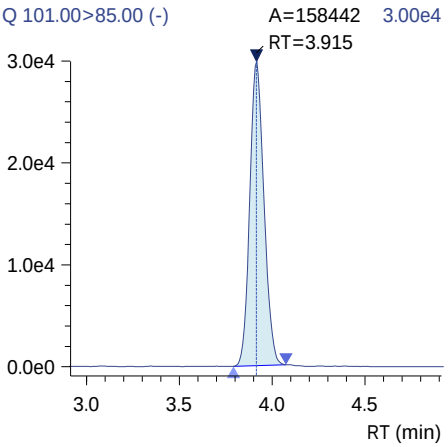
Perchlorate

Conc 19.3835



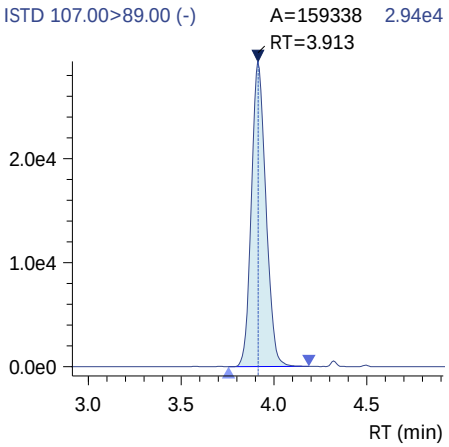
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

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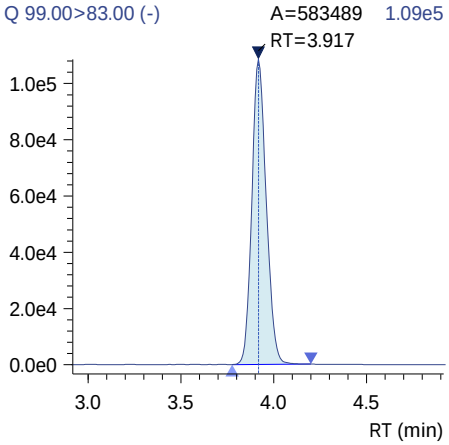
PERCHLORATE9

Sample ID: PERCHLORATE9
Date Acquired: 9/9/2022 12:51:25 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_021.lcd
Vial: 28 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.917	583489	149291	28.8709	ng/mL	38.38	26.81-49.79
Perchlorate 2	Auto	3.914	223954	149291	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.914	149291	149291	1.0000	ng/mL	----	

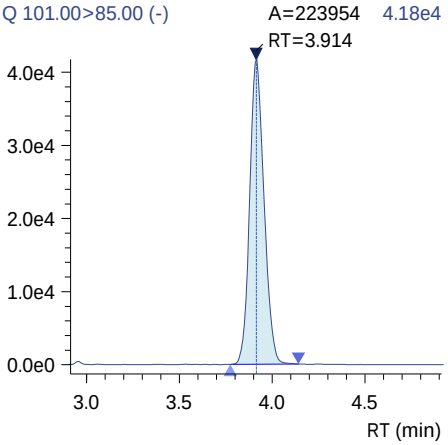
Perchlorate

Conc 28.8709



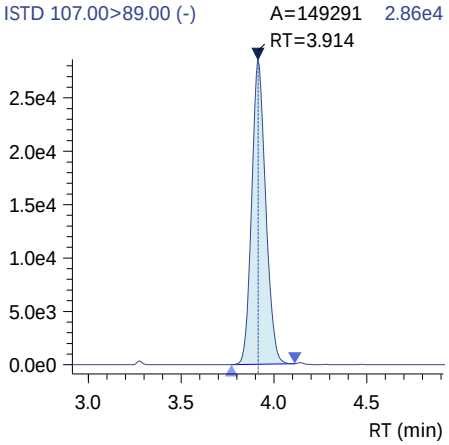
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

Printed at 9/9/2022 1:20:08 PM

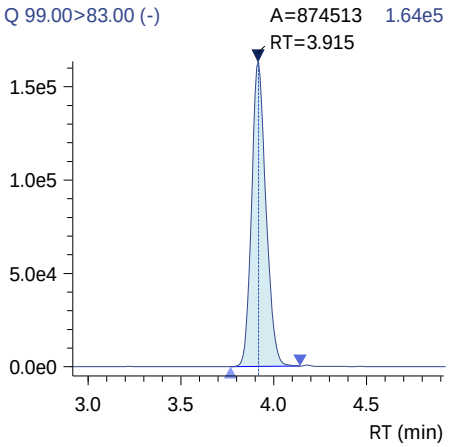
PERCHLORATE10

Sample ID: PERCHLORATE10
Date Acquired: 9/9/2022 12:59:50 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_022.lcd
Vial: 29 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.915	874513	137744	46.8981	ng/mL	38.21	26.81-49.79
Perchlorate 2	Auto	3.912	334169	137744	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.913	137744	137744	1.0000	ng/mL	----	

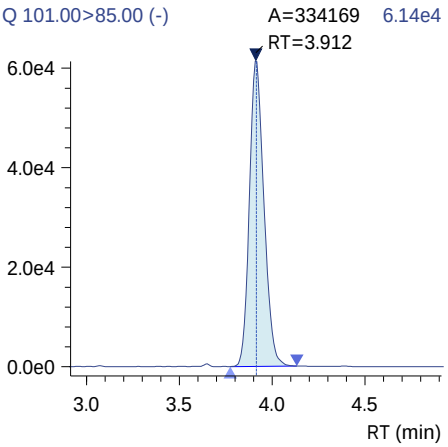
Perchlorate

Conc 46.8981



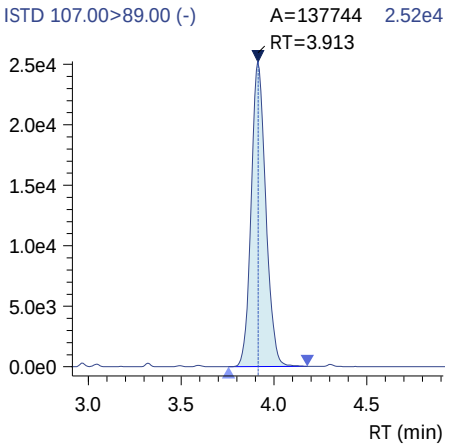
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Insight Report

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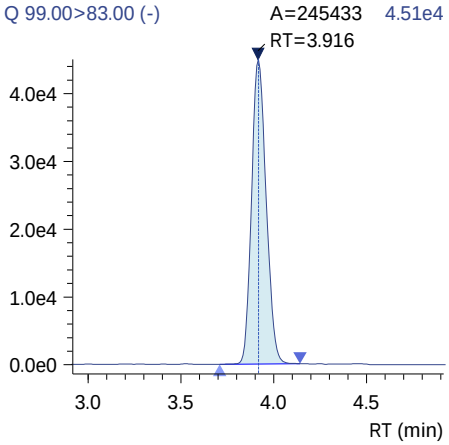
PERCHLORATEICV

Sample ID: PERCHLORATEICV
Date Acquired: 9/9/2022 1:08:14 PM
Acquired by: System Administrator
Data File: I:\LCMS01\DATA\20220909\20220909_023.lcd
Vial: 30 | Inj. Volume: 25.0000uL | Tray: 1

Name	Mode ID	Found RT	Area	ISTD Area	Conc.	Unit	Ref 1 Actual Ratio	Comment 1
Perchlorate	Auto	3.916	245433	169790	10.6778	ng/mL	38.49	26.81-49.79
Perchlorate 2	Auto	3.913	94465	169790	0.0000	ng/mL	----	
Sodium Perchlorate-18O4_IS	Auto	3.912	169790	169790	1.0000	ng/mL	----	

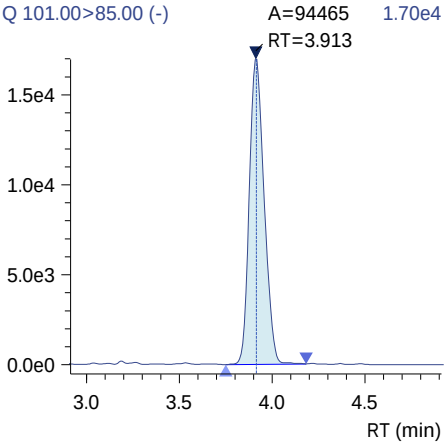
Perchlorate

Conc 10.6778



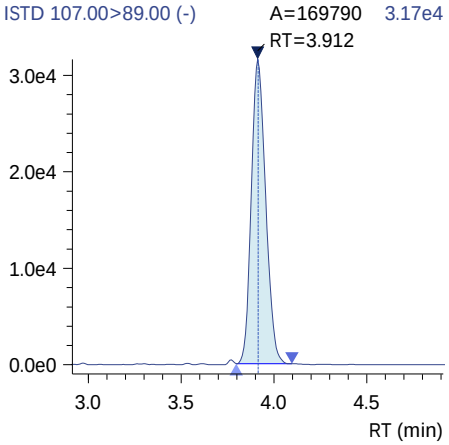
Perchlorate 2

Conc 0.0000



Sodium Perchlorate-18O4_IS

Conc 1.0000



Chromatograms and Selected Ion Monitoring

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