

LONGHORN ARMY AMMUNITION PLANT

KARNACK, TEXAS

ADMINISTRATIVE RECORD

VOLUME 1 of 13

1994

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Prepared for:

**Department of the Army
Longhorn Army Ammunition Plant
Marshall, Texas 75671-1059**

1995

**LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS
ADMINISTRATIVE RECORD - CHRONOLOGICAL INDEX**

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1994

- A. **Title:** **Final Workplan - Phase II Pilot Study For Interim Remedial Action (IRA) For Burning Ground 3 & The Unlined Evaporation Pond**
 Group(s): **Early Interim Action At Burning Ground No. 3**
 Site(s): **LHAAP-18 & LHAAP-24 Burning Ground / Washout Pond & Evaporation Pond**
 Location: **Longhorn Army Ammunition Plant, Marshall, Texas**
 Agency: **U.S. Army Corps Of Engineers, Tulsa District**
 Author(s): **U.S. Army Corps Of Engineers, Tulsa District**
 Recipient: **U.S. Army, Longhorn Army Ammunition Plant**
 Date: **January, 1994**
 Bate Stamp: **007335 - 007473**
- B. **Title:** **Letter - Subject: TWC's Comments On Draft Field Summary Report For Group No. 1**
 Group(s): **1**
 Site(s): **LHAAP-1 Inert Burning Grounds**
 LHAAP-11 Suspected TNT Burial Site At Avenues P & Q
 LHAAP-27 South Test Area
 LHAAP-XX Ground Signal Test Area
 Location: **Longhorn Army Ammunition Plant, Marshall, Texas**
 Agency: **Texas Water Commission**
 Author(s): **Michael A. Moore, Superfund Investigation Section**
 Recipient: **Lynn Muckelrath, Longhorn Army Ammunition Plant**
 Date: **January 11, 1994**
 Bate Stamp: **007474 - 007478**
- C. **Title:** **Letter - Subject: Draft Final Interim Risk Assessment For Unlined Evaporation Pond / Burning Ground No. 3**
 Group(s): **Early Interim Action At Burning Ground No. 3**
 Site(s): **LHAAP-18 & LHAAP-24 Burning Ground / Washout Pond & Unlined Evaporation Pond**
 Location: **Longhorn Army Ammunition Plant, Marshall, Texas**
 Agency: **Department Of The Army, Longhorn Army Ammunition Plant**
 Author(s): **Lawrence J. Sowa, Lieutenant Colonel, U.S. Army**
 Recipient: **Lisa Marie Price, Environmental Protection Agency**
 Date: **January 19, 1994**
 Bate Stamp: **007479**
- D. **Title:** **Letter - Subject: EPA's Comments On Draft Revised Schedule**
 Group(s): **1,2,&3**
 Site(s): **LHAAP-1 Inert Burning Grounds**
 LHAAP-11 Suspected TNT Burial Site At Avenues P & Q
 LHAAP-12 Active Landfill

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LHAAP-13 Suspected TNT Burial Site Between Old & Active Landfills
LHAAP-14 Area 54 Burial Ground
LHAAP-16 Old Landfill
LHAAP-17 Burning Ground No. 2 / Flashing Area
LHAAP-18 & LHAAP-24 Burning Ground / Washout Pond & Evaporation Pond
LHAAP-27 South Test Area
LHAAP-29 Former TNT Production Area
LHAAP-32 Former TNT Disposal Plant
LHAAP-54 or LHAAP-XX Ground Signal Test Area

Location: Longhorn Army Ammunition Plant, Marshall, Texas
Agency: Environmental Protection Agency
Author(s): Ms. Lisa M. Price, Environmental Protection Agency
Recipient: Lawrence J. Sowa, Lieutenant Colonel, U.S. Army
Date: January 19, 1994
Bate Stamp: 007480 - 007482

- E. Title:** Letter - Subject: Final Pilot Study Work Plan For Unlined Evaporation Pond At Burning Ground No. 3
Group(s): Early Interim Action At Burning Ground No. 3
Site(s): LHAAP-18 & LHAAP-24 Burning Ground / Washout Pond & Unlined Evaporation Pond
Location: Longhorn Army Ammunition Plant, Marshall, Texas
Agency: U.S. Army Corps Of Engineers, Tulsa District
Author(s): Lawrence J. Sowa, Lieutenant Colonel, U.S. Army
Recipient: Ms. Lisa Marie Price, Environmental Protection Agency
Date: January 25, 1994
Bate Stamp: 007483
- F. Title:** Letter - Subject: Submission Of Document Statistical Methods Used For Calculation Of Background Levels
Group(s): All
Site(s): General
Location: Longhorn Army Ammunition Plant, Marshall, Texas
Agency: Environmental Protection Agency
Author(s): Ms. Lisa M. Price, Environmental Protection Agency
Recipient: Lawrence J. Sowa, Lieutenant Colonel, U.S. Army
Date: January 27, 1994
Bate Stamp: 007484
- G. Title:** Letter - Subject: TWC 's Comments On Pilot Study Work Plan For Unlined Evaporation Pond At Burning Ground No. 3

July 12, 1995

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1994

Group(s): Early Interim Action At Burning Ground No. 3
Site(s): LHAAP-18 & LHAAP-24 Burning Ground / Washout Pond & Unlined Evaporation Pond
Location: Longhorn Army Ammunition Plant, Marshall, Texas
Agency: U.S. Army Corps Of Engineers, Tulsa District
Author(s): Michael A. Moore, Texas Water Commission
Recipient: Lynn Muckelrath, Longhorn Army Ammunition Plant
Date: February 2, 1994
Bate Stamp: 007485 - 007486

H. Title: **Final Report** - Phase I Interim Remedial Action Stabilization Treatment Study
Group(s): Early Interim Action At Burning Ground No. 3
Site(s): LHAAP-18 & LHAAP-24 Burning Ground / Washout Pond & Evaporation Pond
Location: Longhorn Army Ammunition Plant, Marshall, Texas
Company: Recra Environmental, Inc.
Author(s): Recra Environmental, Inc.
Recipient: AWD Laboratories, Inc.
Date: February 4, 1994
Bate Stamp: 007487 - 007563

I. Title: **Final Report** - Carbon Adsorption And Ion Exchange Treatability Study
Group(s): Early Interim Action At Burning Ground No. 3
Site(s): LHAAP-18 & LHAAP-24 Burning Ground / Washout Pond & Evaporation Pond
Location: Longhorn Army Ammunition Plant, Marshall, Texas
Company: AWD Technologies, Inc., Rockville, Md.
Author(s): AWD Technologies, Inc., Rockville, Md.
Recipient: U.S. Army Corps of Engineers, Tulsa District
Date: February 7, 1994
Bate Stamp: 007564 - 007842

July 12, 1995

007335

LONGHORN ARMY AMMUNITION PLANT
KARNACK, TEXAS

FINAL

PROJECT PLAN

PHASE II
PILOT STUDY FOR IRA

SITE LHAAP 18 & 24

BURNING GROUND 3 &
THE UNLINED EVAPORATION POND

January 1994

Prepared by

TULSA DISTRICT
U.S. ARMY CORPS OF ENGINEERS

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- B USACE Guide Specification Military Construction;
Section 03200 Concrete Reinforcement**
- C USACE Guide Specification Military Construction;
Section 02515 Concrete Pavement**
- D USACE Guide Specification Military Construction;
Section 03300 Concrete For Building Construction**
- E USACE Guide Specification Military Construction;
Section 03100 Structural Concrete Formwork**
- F USACE Guide Specification Military Construction;
Section 02241 Aggregate Base Course**
- G USACE Guide Specification Military Construction;
Section 02200 Earth Work**
- H USACE Guide Specification Military Construction;
Section 03250 Expansion Joints, Contraction Joints,
and Waterstops**

ACRONYMS

ACD	Air Curtain Destructor
CERCLA	Comprehensive Environmental, Response, Compensation and Liability Act
DNAPL	Dense Nonaqueous Phase Liquids
EPA	Environmental Protection Agency
HDPE	High Density Polyethylene
HEW	Horizontal Extraction Well
ICT	Interceptor Collection Trench
IRA	Interim Remedial Action
LDRs	Land Disposal Regulations
LHAAP	Longhorn Army Ammunition Plant
MEC	Methylene Chloride
RCRA	Resource Conservation and Recovery Act
TCE	Trichloroethylene
TNRCC	Texas Natural Resource Conservation Commission
UEP	Unlined Evaporation Pond
VELE	Vacuum Enhanced Liquid Extraction
VEW	Vertical Extraction Well

EXECUTIVE SUMMARY

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This report presents a plan of activities and facilities for the Phase II Pilot Study of the Interim Remedial Action (IRA) project for Burning Ground 3 and the Unlined Evaporation Pond (UEP) at Longhorn Army Ammunition Plant (LHAAP). The purpose of the preliminary construction and pilot testing is to gather site specific field information on excavation methods, saturation of the subsurface, slope stability, flow characteristics, construction methods, and soil and water quality.

This Project Plan for the Pilot Study incorporates the following components:

- * Construction of a full-scale soil dewatering/staging area with a sloping, reinforced concrete pad and gravel storage area for soil and water resulting from construction and pumping
- * Installation and pumping of an interceptor collection trench and a horizontal extraction well and pumping of a vertical extraction well, each to be tested under gravity flow and vacuum enhanced liquid extraction
- * Continuous monitoring of groundwater elevations during the flow test
- * Sampling of the pumped water for quality parameters

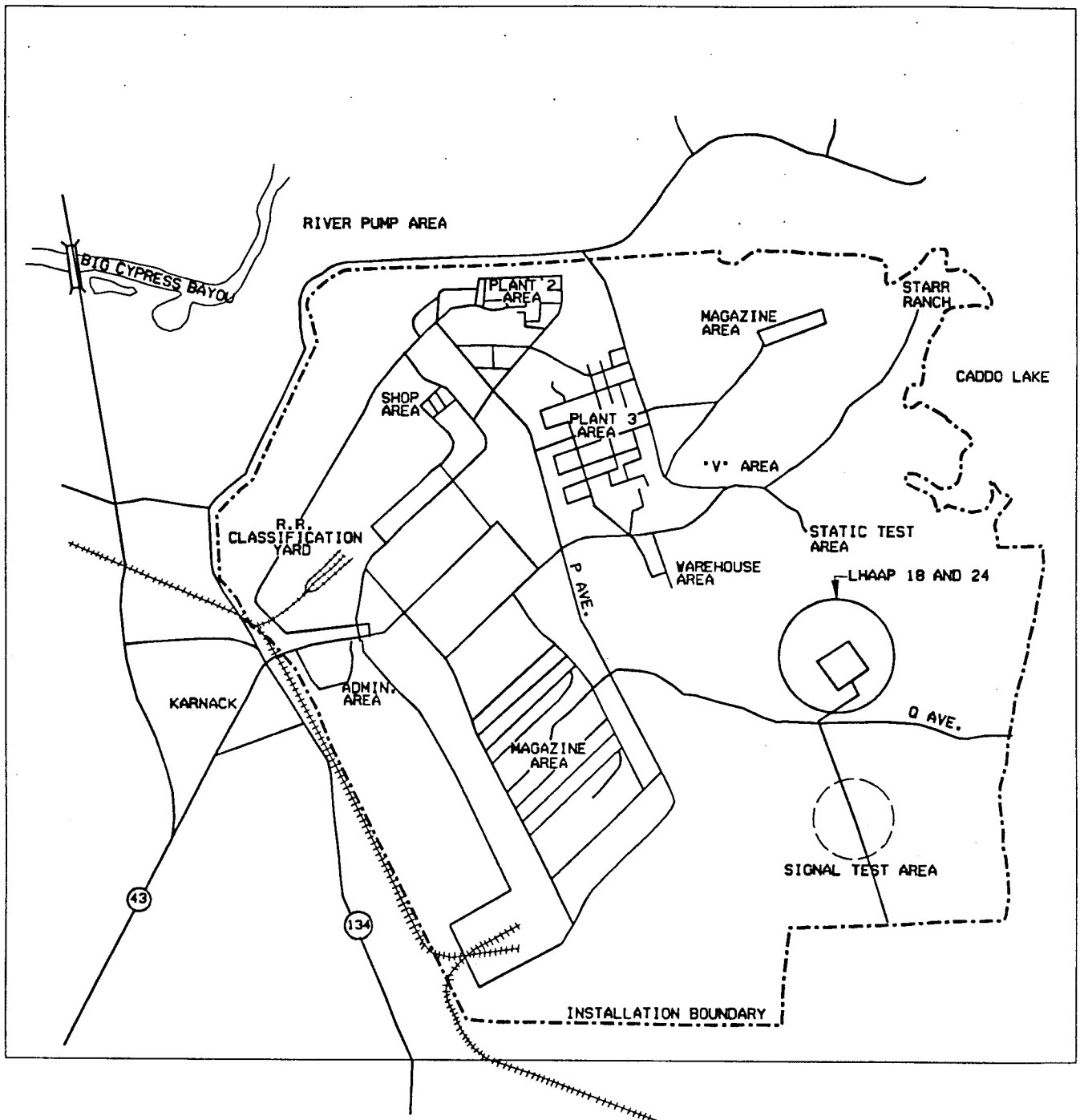
These tasks will be further delineated in the Field Work Plan to be written by the construction contractor.

PROJECT PLAN
PHASE II
PILOT STUDY FOR INTERIM REMEDIAL ACTION (IRA)

1.0 INTRODUCTION. This plan delineates the pilot study as described in the Record of Communication resulting from the Scoping Meeting of Longhorn Army Ammunition Plant (LHAAP); Environmental Protection Agency (EPA), Region VI; Texas Natural Resource Conservation Commission (TNRCC), formerly Texas Water Commission; and Tulsa District, Corps of Engineers representatives. The Record of Communication is provided in Appendix A. This report provides a plan of activities and facilities to be included in the pilot study. Detailed information on this plan will be provided in the Field Work Plan for the Pilot Study to be developed by the construction contractor.

1.1 SITE BACKGROUND. The LHAAP 18 & 24 qualifies as a site under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). The site consists of a fenced 34.5-acre secured area located in the southeast quadrant of LHAAP at the end of Avenue Q, as shown on Figure 1.1. This site has been used for the treatment, storage, and disposal of solid and liquid explosive, pyrotechnic, and combustible solvent wastes, using open burning pits, the Unlined Evaporation Pond (UEP), stockpiles of solvent soaked sawdust, and burial trenches. For a detailed site description and background, reference should be made to Section 3.6 of the June 1992 Longhorn Army Ammunition Plant RI/FS Work Plan, Volume 1, General and the May 1993 Data Summary Report, Burning Ground 3 and Unlined Evaporation Pond, Longhorn Army Ammunition Plant.

007342



0 2000 4000
APPROX. SCALE IN FEET

LOCATION MAP FOR LHAAP #18 & 24
FIGURE 1-1

1.2 PURPOSE AND OBJECTIVES OF THE PILOT STUDY. The purpose of the pilot study is to construct and test six different groundwater extraction methods. The groundwater extraction methods to be tested are gravity flow and vacuum enhanced liquid extraction through an interceptor collection trench (ICT), a vertical extraction well (VEW), and a horizontal extraction well (HEW). This pilot study is performed to demonstrate that a given technology can effectively extract groundwater.

The objectives of these tests are to provide data and information regarding construction methods (i.e., problems/solutions) of the extraction facilities, flow values, and groundwater quality parameters. The data will be used in the design of the IRA.

2.0 SUPPORT FACILITIES FOR THE PILOT STUDY. Support facilities are to be built to assist in construction of the extraction facilities and storage of water produced during the flow tests. A description of the support facilities is provided in the following paragraphs. All construction will be accomplished in accordance with U.S. Army Corps of Engineers guide specifications contained in Appendices B through H.

2.1 SOIL DEWATERING/STAGING AREA. A soil dewatering/staging area will be constructed to process potentially contaminated soil/debris excavated from the site. The soil dewatering/staging area will incorporate a concrete pad and graveled storage area and is currently planned to be located southeast of Burning Ground 3, near the bend in Avenue Q, as shown on Figure 2.1. This area is heavily timbered and relatively flat, and will require grubbing and grading.

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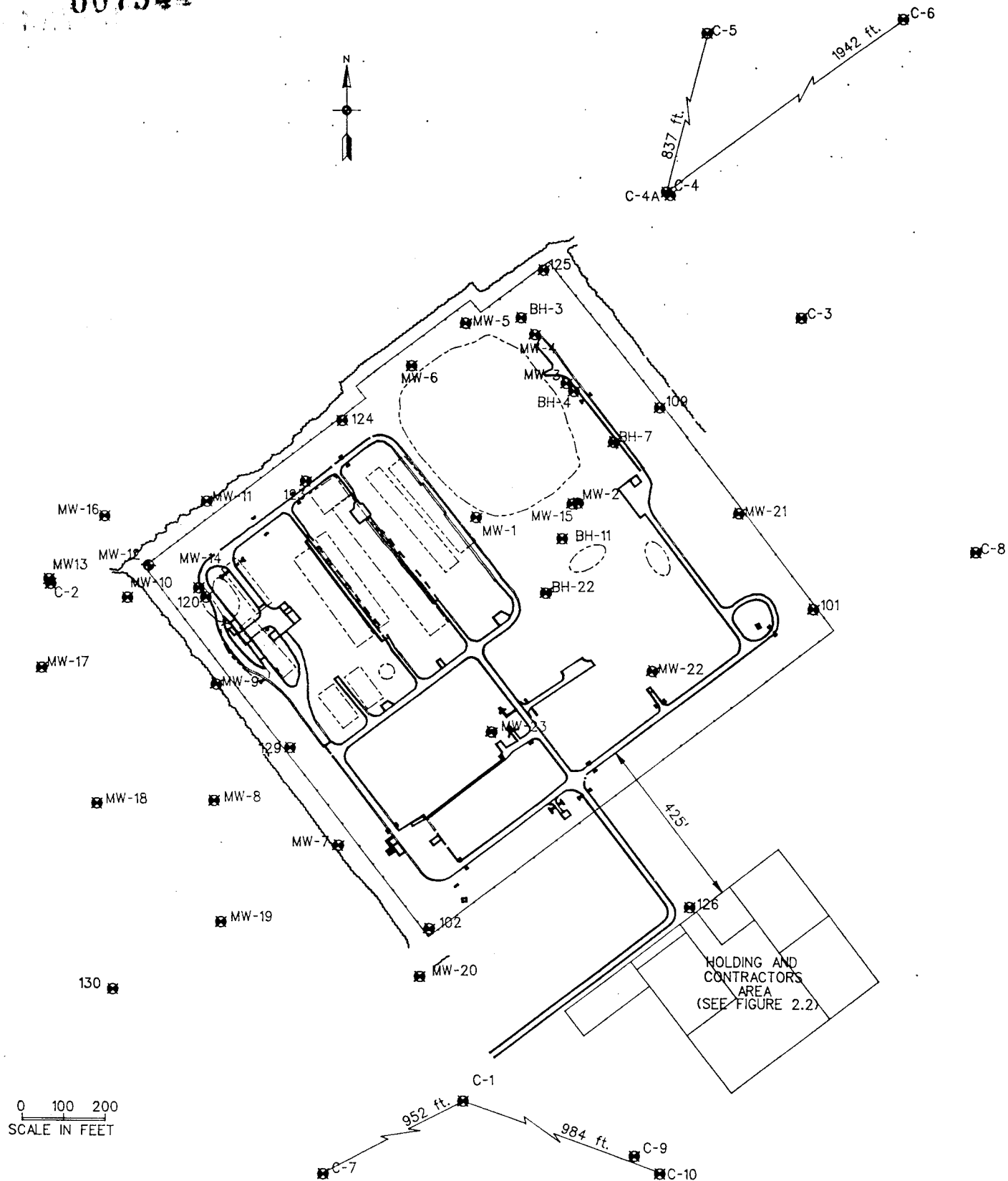


FIGURE 2.1
BURNING GROUND 3 & UEP SITE
WITH PROPOSED HOLDING AREA & MONITORING WELLS
LONGHORN ARMY AMMUNITION PLANT

2.1.1 CONCRETE PAD.

2.1.1.1 PURPOSE. The concrete pad will be used to unload, dewater, and repack soil removed during construction of the pilot study facilities at Burning Ground 3.

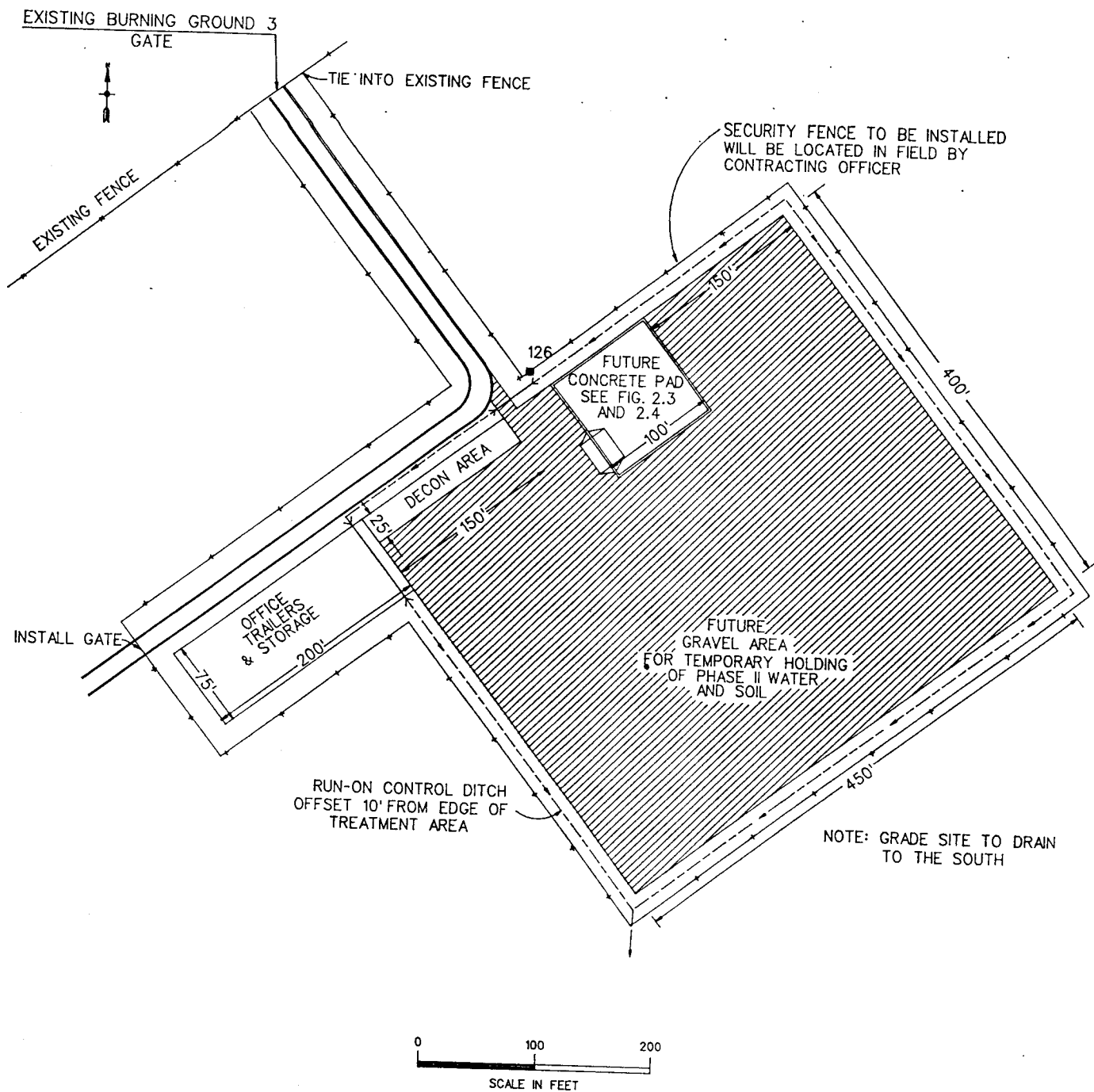
2.1.1.2 LOCATION. The concrete pad will be located as close as possible to the entrance of the temporary storage area (as shown on Figure 2.2) to minimize the distance contaminated soils will be hauled.

2.1.1.3 DESCRIPTION. The pad will be sized at approximately 100 feet by 100 feet and will be built to accommodate haul trucks loaded with excavated soil. It will be a reinforced portland cement concrete pad with a wing wall and truck ramp. The wing wall will be held at a constant elevation to control runoff and facilitate soil handling. A ditch offset 10 feet from the edge of the staging area will be constructed for run-on control. The effects of rainfall will be controlled by a pre-fabricated building. This building will be of sufficient height to allow mobility of trucks and front end loaders inside the area. Vapor releases from the pad will be addressed in the contractor's Health and Safety Plan. To facilitate soil dewatering, the concrete pad will slope 1.5% toward a sump. Water will then be pumped to the frac tanks. Details and cross sections of the pad are shown on Figures 2.3 and 2.4.

2.1.2 GRAVEL STORAGE AREA.

2.1.2.1 PURPOSE. The gravel storage area will be used to store roll-off bins containing dewatered soil from the ICT and HEW and storage tanks containing flow water from the VEW, HEW, and ICT.

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TEMPORARY HOLDING AREA
FOR INTERIM REMEDIAL ACTION (IRA)
BURNING GROUND 3 & UNLINED EVAPORATION POND
LONGHORN ARMY AMMUNITION PLANT

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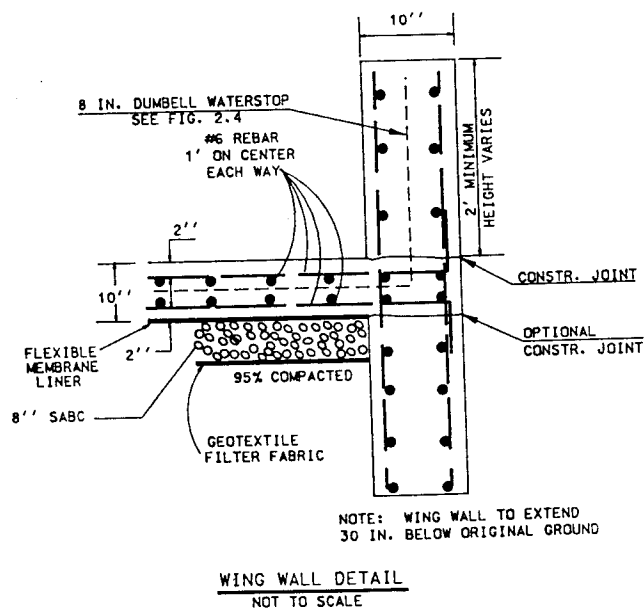
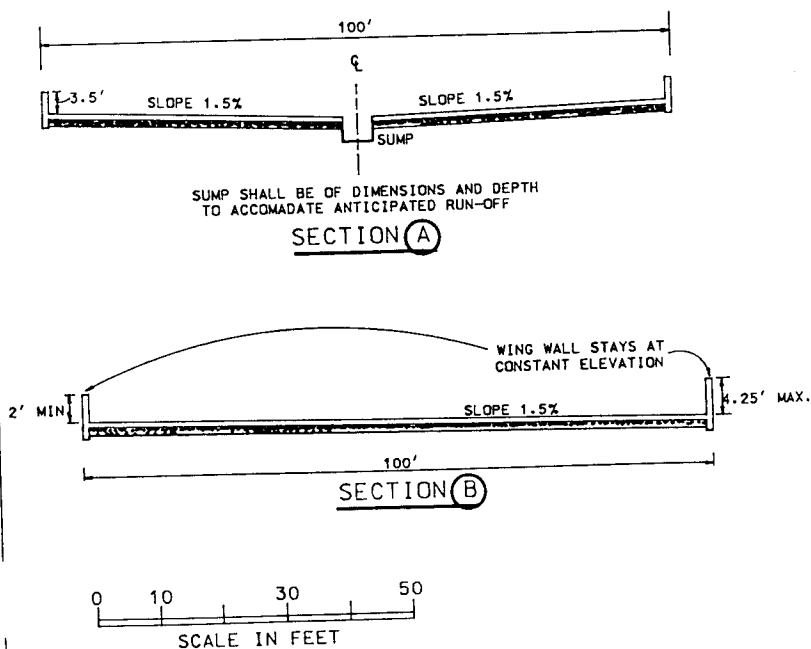
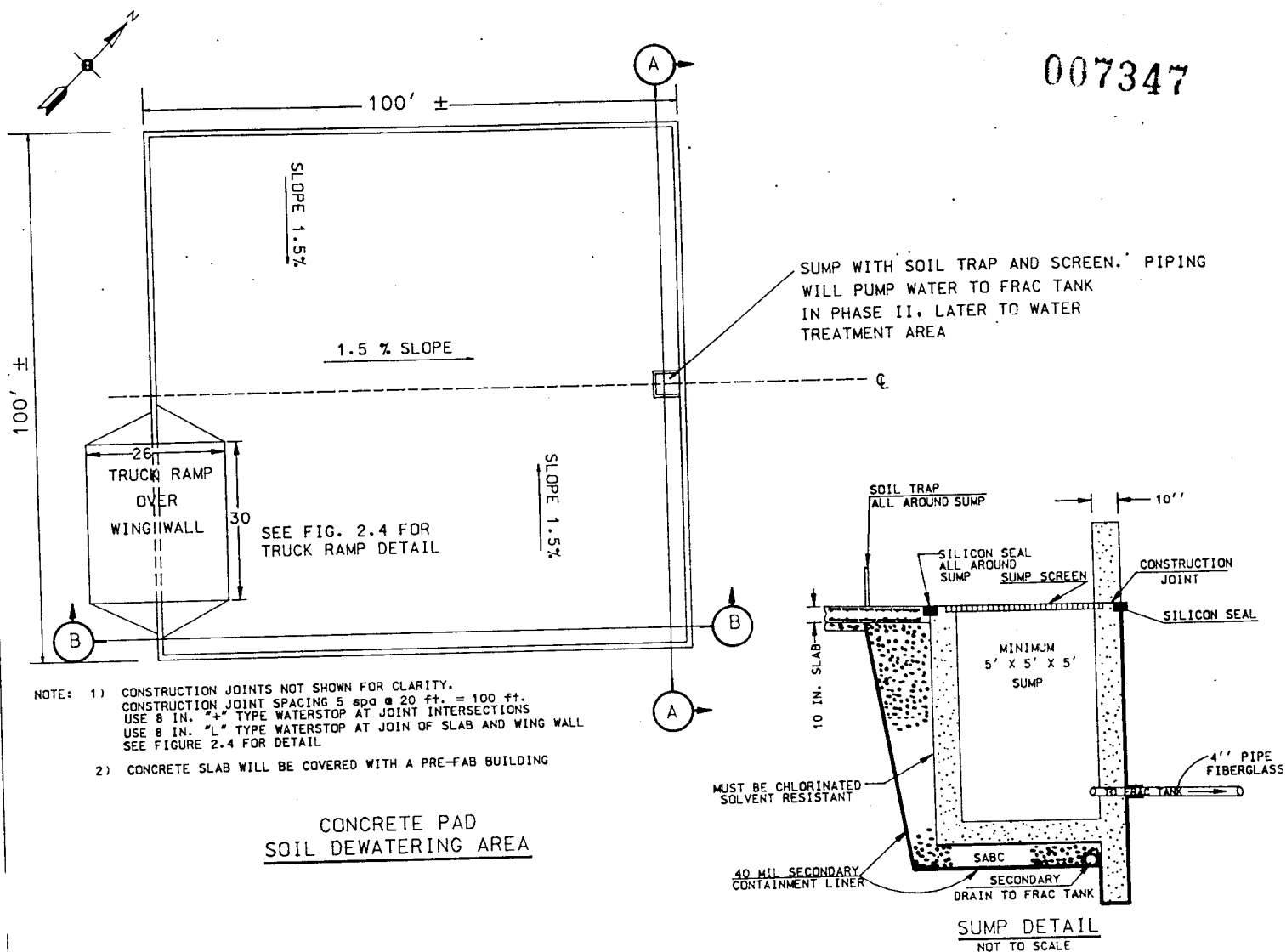


FIGURE 2.3
CONCRETE PAD
SOIL DEWATERING AREA
DETAILS

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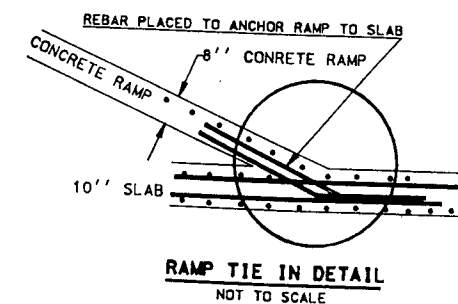
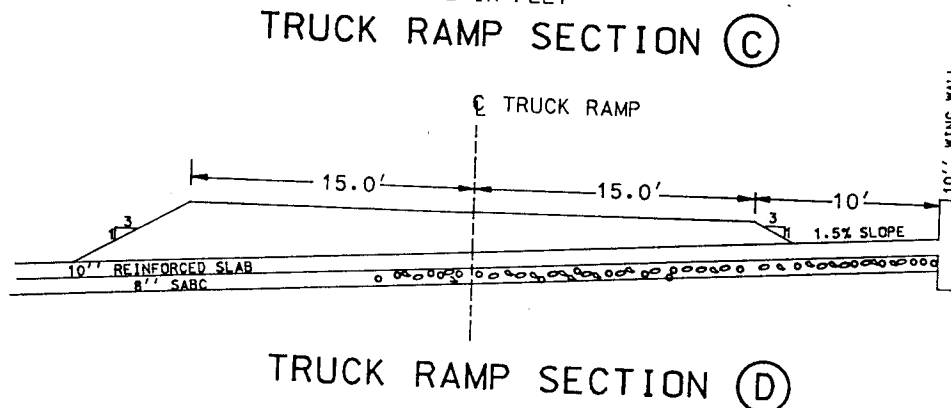
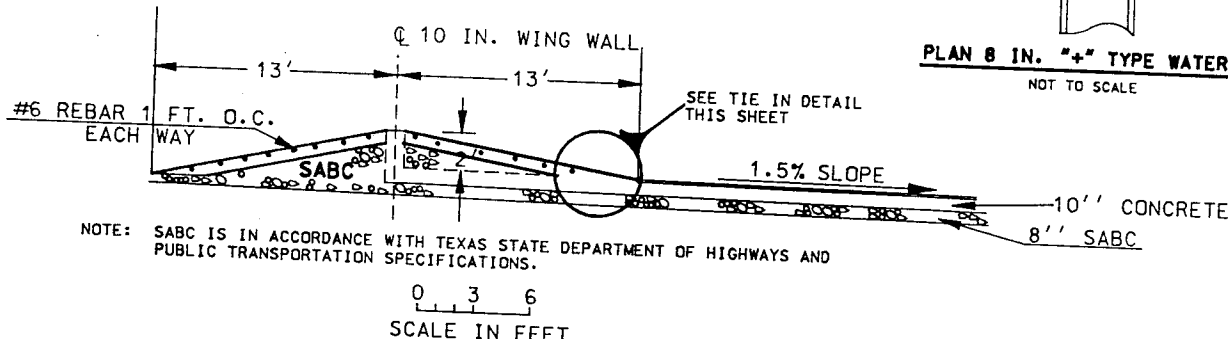
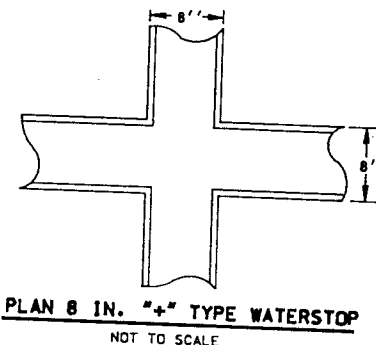
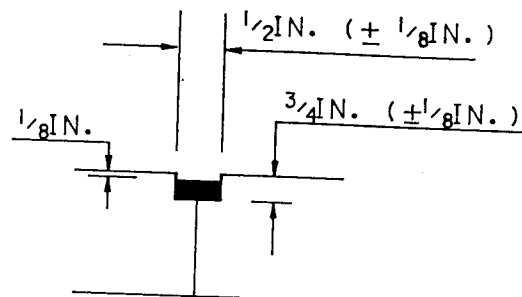
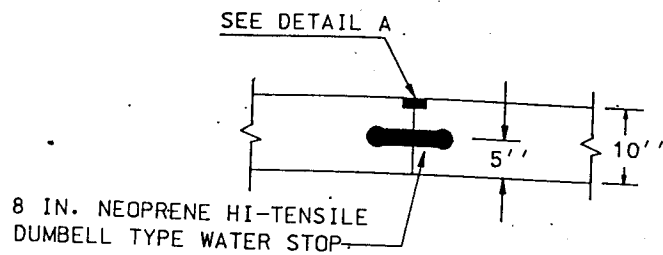
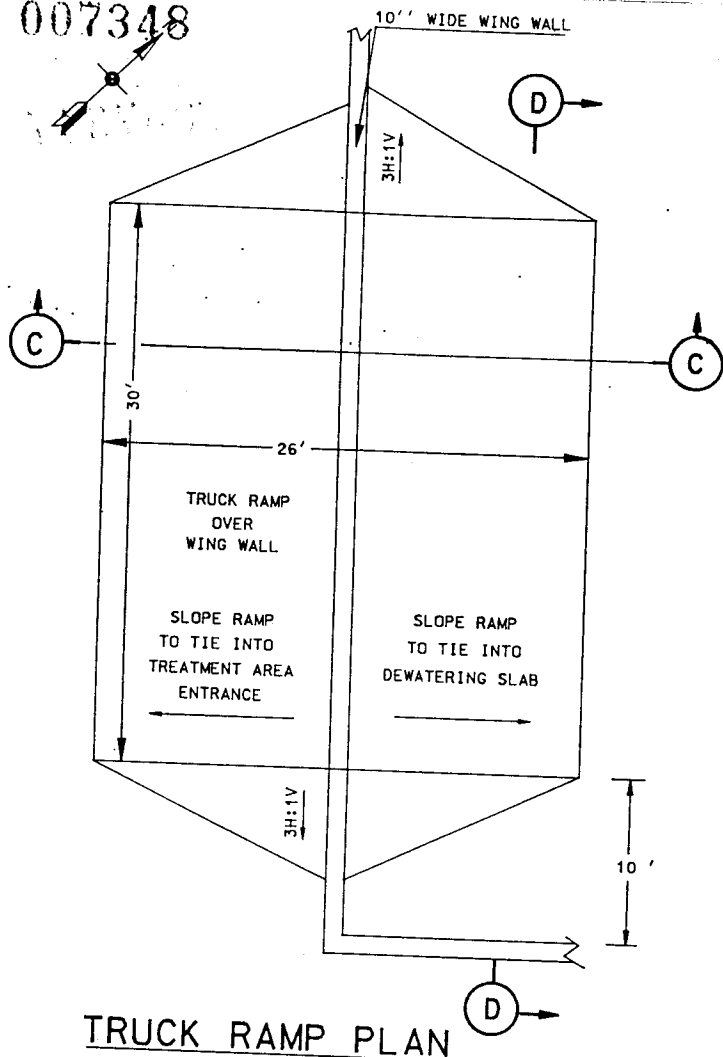


FIGURE 2.4
CONCRETE PAD
SOIL DEWATERING AREA
DETAILS

2.1.2.2 LOCATION. The storage yard will be adjacent to the concrete pad, as shown on Figure 2.2.

2.1.2.3 DESCRIPTION. The 80,000- to 90,000-square-foot storage area will be graded and covered with a geotextile material to prevent seepage of any liquids containing contaminants into the underlying soil. The material will be designed to withstand the load pressure of the overlying gravel layer. The gravel will be graded with varying gravel sizes to prevent puncture of the geotextile material, and will be approximately 9 to 12 inches thick to support the load pressure of roll-off bins and trucks. The gravel layer will assist in the maneuverability of equipment.

2.2 STORAGE CONTAINERS.

2.2.1 PURPOSE. Wastes from the LHAAP 18 & 24 IRA Phase II will be handled under CERCLA and held on site until remediation. Water storage containers will be used to store water generated as a result of pilot tests and roll-off bins will be used to store soil generated as a result of installation of the HEW and ICT.

2.2.2 LOCATION. Storage containers will be placed in the 80,000- to 90,000-square-foot storage area, located southeast of Burning Ground 3.

2.2.3 DESCRIPTION. Excavated soil from all construction activities will be containerized in roll-off bins and properly labeled and stored. The bins will be made of material that will not chemically react with contaminants or atmospheric conditions. Dewatered soil will be stored in lined or water-tight containers to prevent evaporation or leakage of contaminants. Approximately 1,500 cubic yards of soil will be stored until final remediation occurs.

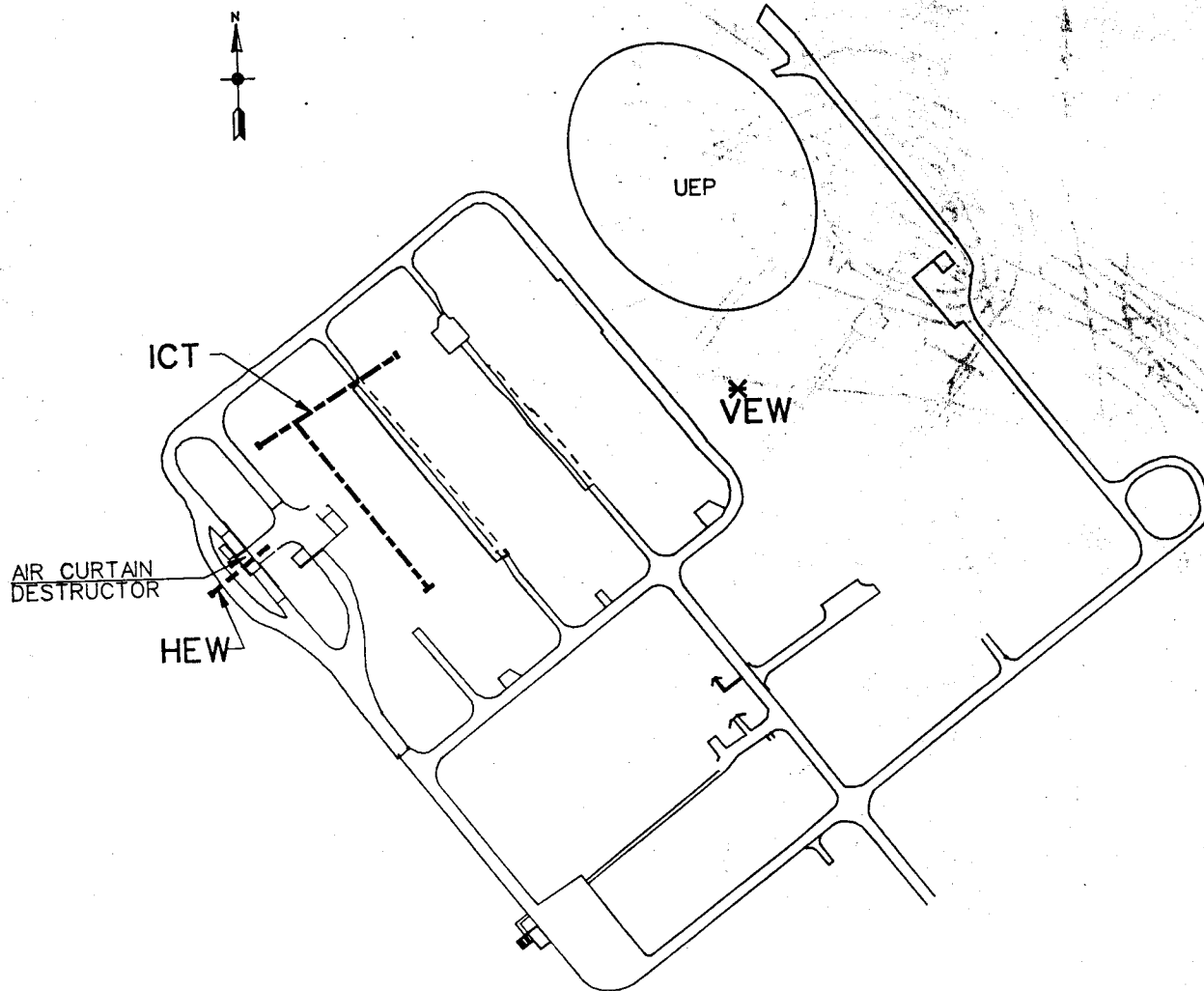
Water from pumping of the ICT, HEW, and VEW will be containerized and properly stored and labeled. The water storage containers will be frac tanks made of a material that is non-reactive with the waste constituents or atmospheric conditions present at the site. Approximately 100,000 gallons will be stored until remediation occurs. For more information on storage containers and handling of wastes, refer to the Longhorn Army Ammunition Plant Waste Management Plan.

3.0 EXTRACTION FACILITIES FOR THE PILOT STUDY. Extraction facilities will be constructed to test different groundwater extraction methods. A description of each extraction facility is provided in the following paragraphs. The location of each extraction facility is shown on Figure 3.1. The locations are related to groundwater contours and contaminant plumes as shown on Figure 3.2. Depths of the extraction facilities will vary based on depth to groundwater, saturation thickness, and stratigraphic layers.

3.1 INTERCEPTOR COLLECTION TRENCH.

3.1.1. PURPOSE. The purpose of the Interceptor Collection Trench (ICT) is to dewater soils of low hydraulic conductivity. The ICT will act as an infinite number of wells collecting water through the entire saturated thickness. With interbedded clay, silt, and sand layers present at the site, Dense Non-Aqueous Phase Liquids (DNAPL), such as methylene chloride (MEC) and trichloroethylene (TCE), could be pooling at a number of elevations above the lower semi-confining retardation layer. The ICT will cut through the layers and provide an avenue for the DNAPL and contaminated water to be collected and removed for temporary storage.

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LEGEND

- X VERTICAL EXTRACTION WELL (VEW)
- - - INTERCEPTOR COLLECTION TRENCH (ICT)
- - - HORIZONTAL EXTRACTION WELL (HEW)

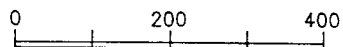
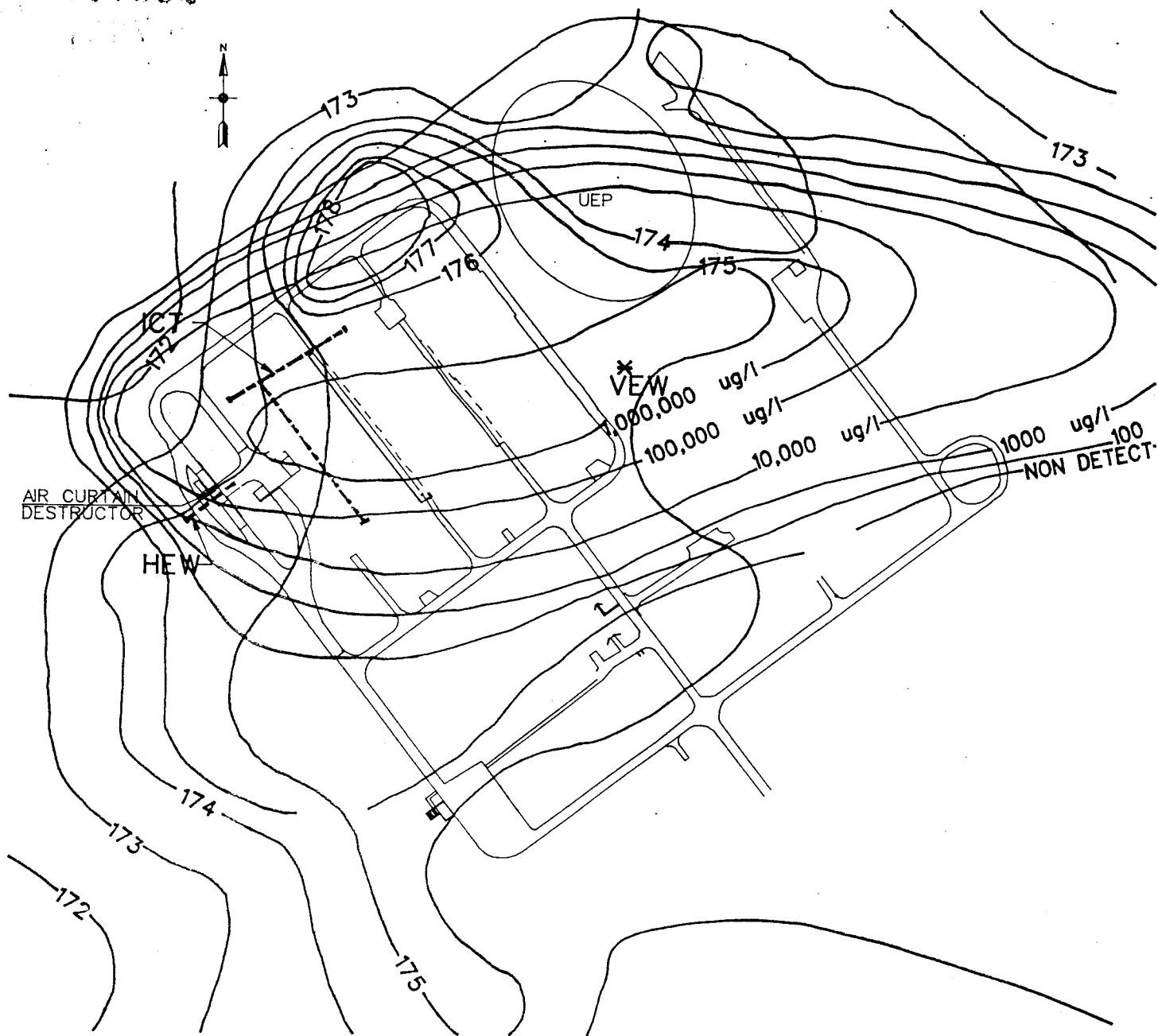
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LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS
LHAAP 18 & 24
IRA PHASE II
PILOT TEST LOCATIONS

FIGURE 3.1

007352



SCALE IN FEET

LEGEND

- VERTICAL EXTRACTION WELL (VEW)
- INTERCEPTOR COLLECTION TRENCH (ICT)
- HORIZONTAL EXTRACTION WELL (HEW)
- METHYLENE CHLORIDE ISOCONCENTRATION CONTOURS
- POTENTIOMETRIC GROUNDWATER CONTOURS

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
TULSA, OKLAHOMA



LONGHORN ARMY AMMUNITION PLANT
MARSHALL, TEXAS
LHAAP 18 & 24
IRA PHASE II
PILOT TEST LOCATIONS WITH
GROUNDWATER AND METHYLENE CHLORIDE
CONTOURS

FIGURE 3.2

3.1.2. LOCATION. The location for the ICT was selected utilizing geologic logs, groundwater elevations, groundwater contaminant concentrations, and knowledge of physical limitations of ongoing operations within the burning ground (Figure 3.2). The pilot study ICT will be located east and northeast of the Air Curtain Destructor (ACD) as shown on Figure 3.1.

3.1.3. DESCRIPTION. The ICT will be 450 feet long and approximately 25 feet deep and will rest on the lower semi-confining retardation layer. Soil borings will be collected prior to construction to determine the exact depth of the ICT (see Section 4.3). The ICT will have a vertical drainage system consisting of a high density polyethylene (HDPE) drainage synthetic geocomposite tied into a perforated pipe at the bottom of the ICT. The drainage geocomposite will have HDPE or similar chemical reactive resistant filter material on both sides. It will have a minimum discharge capacity of 15 gallons/minute/foot, be able to sustain the pressure developed by the soil, and will not collapse at the installed depth. The bottom pipe will be perforated fiberglass pipe with an HDPE filter fabric sleeve. The pipe will rest on a 6-inch sand bed with a minimum permeability of 1×10^{-3} cm/s. The pipe will slope into a sump with a pump sized to handle the expected flow. Four sumps will be used to drain the ICT. ICT water will be pumped to temporary storage and transferred to frac tanks for temporary holding. Soil excavated during construction of the ICT will be stored in containers as described in Section 2.2.

3.2 HORIZONTAL EXTRACTION WELL.

3.2.1 PURPOSE. The purpose of a Horizontal Extraction Well (HEW) is to extract groundwater from a large horizontal area where surface structures or other restrictions may prohibit construction of an ICT or vertical extraction well.

3.2.2 LOCATION. The HEW will enter the ground southwest of the roads near the back of the ACD (see Figure 3.1). It will run in a northeast direction under the ACD. The reasoning for this location is that very high groundwater contaminant concentrations have been detected near the ACD, and more traditional groundwater extraction facilities cannot be built in this location due to the ACD and ongoing operations (see Figure 3.2).

3.2.3 DESCRIPTION. The HEW will be installed at an approximate depth of 35 feet and will extend for 125 feet. The target location will be on the top of the lower semi-confining retardation layer beneath the upper saturated zone. Soil borings will be performed prior to construction to determine the exact depth of the HEW (see Section 4.3). The extraction pump will be sized to handle the expected flow. HEW water will be pumped to temporary storage and transferred to frac tanks for temporary holding. Soil excavated to construct the HEW will be stored in containers as described in Section 2.2.

3.3 VERTICAL EXTRACTION WELL

3.3.1 PURPOSE. The purpose of a Vertical Extraction Well (VEW) is to extract groundwater from several subsurface layers.

3.3.2 LOCATION. The VEW is located near the south end of the Unlined Evaporation Pond (UEP), near monitoring well (MW) 1 (see Figure 3.1). This is the most highly contaminated portion of the trichloroethylene and methylene chloride plume.

3.3.3 DESCRIPTION. The VEW was installed during Phase I activities to a total depth of 38.0 feet. It has a 12-inch-diameter boring and a 6-inch-diameter pipe and screen. The VEW was constructed with a 20-foot screen placed at 35.0 feet to pump from the entire saturated thickness. A 2-foot sump was

installed at the bottom of the well due to the high percentage of fine-grained material in the soil.

4.0 PILOT STUDY TESTING. Field testing is planned to begin after installation of the water storage and soil storage facilities. Field testing guidelines are summarized in Table 1.1, "IRA Pilot Study Field Test." Testing will be completed according to the approved RI/FS Work Plan.

TABLE 1.1 IRA PILOT STUDY FIELD TEST				
PARAMETERS	TEST COMPONENTS			
	DELAYED YIELD PUMPING	FLOW TEST	EQUALIZATION PERIOD	VACUUM ENHANCED LIQUID EXTRACTION
DURATION	10 DAYS	3 DAYS + CONTINUE IF FLOW RATE SUBSTANTIALLY INCREASING	7 DAYS MIN. OR AFTER 2 DAYS AQUIFER STABILIZATION	3 DAYS + CONTINUE IF FLOW RATE SUBSTANTIALLY INCREASING
WATER LEVEL	EXTRACTION SYSTEMS & SURROUNDING WELLS	EXTRACTION SYSTEMS & SURROUNDING WELLS	EXTRACTION SYSTEMS & SURROUNDING WELLS	EXTRACTION SYSTEMS & SURROUNDING WELLS
FLOW RATE & VOLUME	EXTRACTION SYSTEMS ONLY	EXTRACTION SYSTEMS ONLY	NONE	EXTRACTION SYSTEMS ONLY
SAMPLES FOR LABORATORY ANALYSIS	NONE	EXTRACTION SYSTEMS ONLY	NONE	EXTRACTION SYSTEMS ONLY

4.1 WATER FLOW TESTING. Two forms of flow tests, gravity and vacuum enhanced, will be performed on each of the extraction systems (ICT, HEW, and VEW). Gravity flow tests will take place without the addition of positive or negative pressure with the exception of the displacement from the sump pump. Vacuum tests will consist of the addition of negative pressure on the system. The addition of vacuum pressure on similar systems has been found to increase groundwater flow. The purpose of these tests is to determine the optimum condition for groundwater and contaminant recovery.

The extraction wells (vertical and horizontal) and the ICT will be pumped for a minimum of 10 days. The duration of the pumping is to take into account the effects of delayed yield.

4.1.1 GRAVITY FLOW TESTING. Given a hydraulic conductivity of approximately $1\text{E-}4$ (reference Appendix F, "Data Summary Report", USCOE 1993), a radius of approximately 400 feet from an extraction system was determined to be very conservative. The number of accessible wells within this radius was found to be 22. During the pumping and equalization periods, flow rate, volume of flow, and water level readings from the 22 surrounding wells will be monitored with an automatic water level recorder. During the pumping period, samples will be taken for laboratory analysis of metals, volatile organics, semi-volatile organics, explosives, and groundwater quality parameters. Field testing will also be performed for pH and conductivity. After this procedure is completed, the aquifer will be allowed to equalize for a minimum of 1 week.

4.1.2 VACUUM ENHANCED LIQUID EXTRACTION. After the gravity flow tests and equalization period are completed and aquifer levels have stabilized for at least 2 days, vacuum enhanced liquid extraction (VELE) flow tests will be performed. A vacuum will be placed on the piping at the bottom of the ICT, on the horizontal extraction well, and on the vertical extraction well to expedite flow. The

VELE will be conducted separately for a minimum of 3 days on each extraction system. The vacuum pump should be capable of pulling 12 inches of mercury on each of the extraction systems; however, the vacuum may be varied (4, 8, and 12 inches of mercury) to determine the most effective vacuum. Vapors from the extraction system will be sampled and analyzed to determine contaminants and contaminant concentrations, and the vapors will be directed through an activated carbon filter. The volumetric rate and quality of the vapors that are pumped will be recorded over the duration of the VELE test.

4.2 WATER QUALITY TESTING. Water sampling and analysis will be conducted to provide additional data for treatment.

4.2.1 FREQUENCY. Water samples should be taken every day during the 10-day pumping and equalization period. During the actual flow test, one sample should be taken each day from each extraction facility for laboratory analysis.

4.2.2 PARAMETERS. Flow rate, volume of flow, and water level readings from 22 surrounding wells will be monitored with an automatic water level recorder during the pumping and equalization periods. Laboratory analysis of daily samples from the VEW, HEW, and ICT, for metals, volatile organics, semi-volatile organics, and explosives will take place. Analysis for water quality parameters pH, alkalinity, hardness, total dissolved solids, total suspended solids, silica, sulfate, ammonia, nitrate, nitrite, oil and grease, total petroleum hydrocarbons and conductivity will also take place during the testing period.

4.3 SOIL TESTING. Soil sampling and analysis will be conducted to provide additional data for treatment.

4.3.1 FREQUENCY. Prior to ICT and HEW construction, soil samples from borings will be taken in the vadose zone, near the top of the water table and just above the lower semi-confining layer in the area of the ICT and HEW. A composite sample will be required from the three depths for each 50 feet of ICT. A sample will be taken from the HEW installation area for each 25 feet of length.

4.3.2 PARAMETERS. All soil samples will be tested for metals, explosives, volatile organics, and semi-volatile organics. Samples will be taken for physical testing for grain size analysis, Atterberg limits, and moisture content from the three depths, described above, for every 50 feet of ICT length.

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APPENDIX A

SCOPING MEETING RECORD OF COMMUNICATION

007360

RECORD OF COMMUNICATION	Phone call	Conference	DATE: 8/4/93
	Discussion x	Other	TIME: 9:30am
TO: Longhorn AAP Site File FROM: Longhorn AAP Project Coordinators			
SUBJECT: Scoping of Pilot Study for IRA at UEP/Burning Grd. No. 3			

Summary of Communication:

LHAAP, TWC, EPA, and COE representatives (sign-in sheet attached) on 8/4/93 to discuss the scoping for the pilot study to be conducted for the Interim Remedial Action at the UEP/Burning Ground No. 3 on the Longhorn AAP facility. The pilot study is to include the following items/issues:

- construction of the full-scale dewatering/staging area for contaminated soil/sludge,
- a temporary storage area for collected contaminated ground water,
- installation and pumping of an interceptor collection trench (ICT) into contaminated material,
- installation and pumping of an extraction well,
- a test trench into and removal of contaminated soil/sludge,
- and continuous monitoring of wells in the area to determine affect of ICT and extraction well pumping.

Any material removed during the installation of the ICT and the extraction well and during the test trenching will be staged and stored until full remediation of the area during the IRA. The contaminated water collected during the pumping of the ICT and extraction well will be temporarily stored on site until disposal can be arranged.

The placement of the ICT and extraction well is expected to be in the UEP area.

It was concurred on by all parties that during the investigative phase for the IRA, a test hole into contaminated material with a small bucket of a backhoe would be dug. Enough contaminated material to run the various treatability tests would be collected. The open hole would be monitored for 24 hours in order to determine rough ground water recharge rates and that a ground water sample would be collected from the open hole after the 24 hour period. The contaminated water collected would be used in the ground water treatability tests. The hole would subsequently be backfilled with the remaining material.

All parties also agreed that pump tests may be necessary but that any pump tests would be conducted in the context of the field work for the overall facility Remedial Investigation.

OPTIONAL FORM 90 (7-90)

FAX TRANSMITTAL		# of pages 2
From: <i>Denny Lanier</i>	To: <i>Lisa Price</i>	
Phone: <i>214 655 6744</i>	Fax: <i>918 669 7526</i>	

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Conclusions, action taken or required:

The TRC and September Project Coordinators meeting has been scheduled for 9/14/93 at the Longhorn AAP facility.

Information copies to:

Lynn Muckelrath, LHAAP Project Coordinator
Lisa Price, EPA Project Coordinator
Mike Moore, TWC Project Coordinator

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APPENDIX B

**USACE GUIDE SPECIFICATION MILITARY CONSTRUCTION
SECTION 03200 CONCRETE REINFORCEMENT**

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

CEGS-03200 (November 1988)

Superseding
CEGS-03200 (October 1987)

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GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION

Includes summary Special change (December 1992)
Includes changes through Notice 4 (October 1992)
Includes submittal Special change 1 (March 1991)
Includes Text Adjustment 1 (November 1991)

Latest Change indicated by \&\ tokens

SECTION 03200

<<Xfile xname="COEASC\03200.ASC" xtype="ref" xtitle="incl"> CONCRETE R
11/88

NOTE: This specification covers the requirements
for concrete reinforcement, including welded wire
fabric, for building construction. This guide
will be used in conjunction with Section 03300
CONCRETE FOR BUILDING CONSTRUCTION. This guide
specification is to be used in the preparation of
project specifications in accordance with ER
1110-345-720.

<<Topic topicid="P1">PART 1 GENERAL

NOTE: See Additional Note A.

1.1 REFERENCES

NOTE: Issue (date) of references included in
project specifications need not be more current than
provided by the latest change (Notice) to this guide
specification.

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.

AMERICAN CONCRETE INSTITUTE (ACI)

MI 318

(1989; 318R-89) Building Code
Requirements for Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

<<Page pageid="2">

ASTM A 53	\&(1990b)&\ Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 82	(1990a) Steel Wire, Plain, for Concrete Reinforcement
ASTM A 184	(1990) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	(1990a) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 497	\&(1990b)&\ Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
ASTM A 499	(1989) Steel Bars and Shapes, Carbon Rolled from "T" Rails
ASTM A 615	(1990) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 675	(1990a) Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM A 706	(1990) Low-Alloy Steel Deformed Bars for Concrete Reinforcement
ASTM C 1116	(1989) Fiber-Reinforced Concrete and Shotcrete

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4	(1979) Structural Welding Code - Reinforcing Steel
----------	--

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

\&CRSI MSP-1	(1990)&\ Manual of Standard Practice
--------------	--------------------------------------

1.2 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

SD-08: Delete welding requirements if welding is not permitted. Welding will not be specified in blast-resistant structures.

SD-13: Certified mill reports should be obtained

when welding is specified or permitted. On minor

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projects with no welding, submittal SD-13 may be deleted.

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300

SUBMITTAL DESCRIPTIONS:

SD-04 Drawings

Concrete Reinforcement System; [____].

Detail drawings showing reinforcing steel schedules, sizes, grades, and splicing and bending details. Drawings shall show support details including types, sizes and spacing.

SD-08 Statements

Qualifications; [____].

A list of names of qualified welders.

SD-13 Certificates

Reinforcing Steel; [____].

Certified copies of mill reports attesting that the reinforcing steel furnished meets the requirements specified, prior to the installation of reinforcing steel.

1.3 QUALIFICATIONS

Welders shall be qualified in accordance with AWS D1.4. Qualification test shall be performed at the worksite and the Contractor shall notify the Contracting Officer 24 hours prior to conducting tests. \&Special welding procedures and welders qualified by others may be accepted as permitted by AWS D1.4.&\

1.4 DELIVERY AND STORAGE

Reinforcement and accessories shall be stored off the ground on platforms, skids, or other supports.

<<Topic topicid="P2">PART 2 PRODUCTS

2.1 DOWELS

Dowels shall conform to ASTM A 675, Grade 80, or ASTM A 499. Steel pipe conforming to ASTM A 53, Schedule 80, may be used as dowels provided the ends are closed with metal or plastic inserts or with mortar.

2.2 FABRICATED BAR MATS

Fabricated bar mats shall conform to ASTM A 184.

2.3 REINFORCING STEEL

NOTE: Grades and sizes of reinforcing steel will be

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shown on the drawings. Low-alloy steel conforming to ASTM A 706 is specified for its special qualities such as bending ability and ease of welding.

Special coated bars (epoxy and zinc) may be specified for use in a highly corrosive atmosphere where concrete cover is not considered sufficient. In which case reference to ASTM A 767 and A 775 will be included.

Reinforcing steel shall be deformed bars conforming to ASTM A 615 or ASTM A 706, grades and sizes as indicated. Cold drawn wire used for spiral reinforcement shall conform to ASTM A 82.

2.4 WELDED WIRE FABRIC

Welded wire fabric shall conform to ASTM A 185 or ASTM A 497.

2.5 WIRE TIES

Wire ties shall be 16-gauge or heavier black annealed steel wire.

2.6 SUPPORTS

Bar supports for formed surfaces shall be designed and fabricated in accordance with \&CRSI MSP-1&\ and shall be steel or precast concrete blocks. \&Precast concrete blocks shall have wire ties and shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Where concrete formed surfaces will be exposed to weather or where surfaces are to be painted, steel supports within 1/2 inch of concrete surface shall be galvanized, plastic protected or of stainless steel&\. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks, plastic coated steel fabricated with bearing plates, or specifically designed wire-fabric supports fabricated of plastic.

2.7 SYNTHETIC FIBER REINFORCEMENT

\&Synthetic fiber shall be polypropylene with a denier less than 100 and a nominal fiber length of 2 inches&\.

<<Topic topicid="P3">PART 3 EXECUTION

3.1 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety. \&Wire tie ends shall face away from the forms&\.

3.1.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other

deleterious coating that could reduce bond with the concrete.

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Reinforcement shall be placed in accordance with ACI 318 at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints and shall be as indicated through construction or contraction joints. Concrete coverage shall be as indicated or as required by ACI 318. If bars are moved more than one bar diameter to avoid interference with other reinforcement, conduits or embedded items, the resulting arrangement of bars, including additional bars required to meet structural requirements, shall be approved before concrete is placed.

3.1.2 Splicing

 NOTE: Delete welding requirements if welding is not permitted. Welding will not be specified in blast resistant structures.

Splices of reinforcement shall conform to ACI 318 and shall be made only as required or indicated. Splicing shall be by lapping or by mechanical or welded butt connection; except that lap splices shall not be used for bars larger than No. 11 unless otherwise indicated. Welding shall conform to AWS D1.4. Welded butt splices shall be full penetration butt welds. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6-inches. Mechanical butt splices shall be in accordance with the recommendation of the manufacturer of the mechanical splicing device. Butt splices shall develop 125 percent of the specified minimum yield tensile strength of the spliced bars or of the smaller bar in transition splices. Bars shall be flame dried before butt splicing. Adequate jigs and clamps or other devices shall be provided to support, align, and hold the longitudinal centerline of the bars to be butt spliced in a straight line.

3.2 WELDED-WIRE FABRIC

Welded-wire fabric shall be placed in slabs as indicated. Fabric placed in slabs on grade shall be continuous between expansion, construction, and contraction joints. \&Fabric placement at joints shall be as indicated&\. Lap splices shall be made in such a way that the overlapped area equals the distance between the outermost crosswires plus 2 inches. Laps shall be staggered to avoid continuous laps in either direction. Fabric shall be wired or clipped together at laps at intervals not to exceed 4 feet. Fabric shall be positioned by the use of supports.

3.3 DOWELS

Dowels shall be installed in slabs on grade at locations indicated and at right angles to joint being doweled. Dowels shall be accurately \&positioned and&\ aligned parallel to the finished concrete surface \&before concrete placement. Dowels shall be&\ rigidly supported during concrete placement. One end of dowels shall be coated with a bond breaker.

3.4 SYNTHETIC FIBER REINFORCED CONCRETE

 NOTE: Synthetic fiber reinforcement may be used in concrete slabs as an aid in preventing plastic

shrinking cracking in placements susceptible to this

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condition. Fiber reinforcement will not be used as a substitute for wire mesh and where service temperature may exceed 150 degrees Centigrade. Concentrations above 0.1 percent by volume are not cost-effective.

Fiber reinforcement shall be added to the concrete mix in accordance with the applicable sections of ASTM C 1116 and the recommendations of the manufacturer and in an amount of [0.1] [_____] percent by volume.

ADDITIONAL NOTES

NOTE A: For additional information on the use of all CEGS, see CEGS-01000 CEGS GENERAL NOTES.

-- End of Section --

APPENDIX C

**USACE GUIDE SPECIFICATION MILITARY CONSTRUCTION:
SECTION 02515 CONCRETE PAVEMENT**

007374

02515.SEC
AUGUST 1992

SECTION 02515

CONCRETE PAVEMENT

NOTE: THIS SECTION HAS BEEN PREPARED TO COVER
CONCRETE PAVING FOR ROADS, STREETS, AND PARKING
AREAS LESS THAN 100 C.Y. WHERE THE QUANTITY OF
PAVING EXCEEDS APPROXIMATELY 100 C.Y., OR IF THE
PAVING IS FOR AIRFIELDS, GUIDE SPECIFICATION CEGS
02513 SHOULD BE USED.

THIS SECTION MUST BE USED WITH GUIDE SPECIFICATION
CEGS-03300, "CONCRETE FOR BUILDING CONSTRUCTION."

PART 1 GENERAL

1.1 APPLICABLE PUBLICATIONS

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.

ARMY CORPS OF ENGINEERS (COE)

\-COE CRD-C 572-\ (1974) Polyvinylchloride Water Stop

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 184-\ (1990) Fabricated Deformed Steel Bar Mats
for Concrete Reinforcement

\-ASTM A 185-\ (Rev A; 1990) Steel Welded Wire Fabric,
Plain; for Concrete Reinforcement

\-ASTM A497-\ (Rev B; 1990) Steel Welded Wire Fabric,
Deformed, for Concrete Reinforcement

\-ASTM A 499-\ (1989) Steel Bars and Shapes, Carbon
Rolled from 'T' Rails

\-ASTM A 675-\ (Rev A; 1990) Steel Bars, Carbon,
Hot-Rolled, Special Quality, Mechanical
Property

\-ASTM D 1751-\ (1983) Preformed Expansion Joint Filler
for Concrete Paving and Structural
Construction (Non-Extruding and Resilient
Bituminous Types)

\-ASTM D 1752-\ (1984) Preformed Sponge Rubber and Cork
Expansion Joint Fillers for Concrete Paving
and Structural Construction

1.2 GENERAL

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Materials and concrete work for concrete pavement shall conform to the requirements of Section \=03300=\ CONCRETE FOR BUILDING CONSTRUCTION, except as otherwise specified herein or shown on the drawings. All pavement concrete shall be [650 psi flexural strength] [____psi compressive strength].

1.3 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL DESCRIPTIONS:

SD-01 Data\

Equipment and Methods\; *[____]*\.

A list of make, type, capacity, and number of all equipment to be used on the job.

SD-09 Reports\

Material Acceptance Testing\; *[____]*\.

Manufacturer's certified test reports on epoxy-resin material, showing that specific lots or batches, from which the material for this project is obtained, conform to the requirements of these specifications. Certified copies of aggregate tests and concrete mixture proportioning made by the laboratory, prior to use in the work.

SD-14 Samples\

Material Acceptance Testing\; *[____]*\.

Samples of approved aggregates, taken under the supervision of the Contracting Officer in accordance with \-COE CRD-C 100-\, accompanied by test reports indicating conformance with grading requirements specified. Samples of materials other than aggregates shall be representative of those proposed for the project and shall be accompanied by the manufacturer's test reports indicating compliance with applicable specified requirements.

SD-18 Records\

Material Acceptance Testing\; *[____]*\.

Results of tests conducted at the project site, reported weekly

within 3 days after the end of each weekly reporting period.

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PART 2 PRODUCTS

Joint Filler

2.1.1 For Expansion Joints

Filler shall be preformed materials conforming to \-ASTM D 1751-\ or \-ASTM D 1752-\.

2.1.2 For Contraction Joints

Contraction joint inserts shall have sufficient stiffness to permit placement in plastic concrete without undue deviation from a straight line. PVC inserts shall conform to \- COE CRD-C 572-\.

2.2 REINFORCEMENT

All reinforcement shall be free from loose flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce the bond with concrete. Removal of thin powdery rust and tight rust is not required. However, reinforcing steel which is rusted to the extent that it does not conform to the required dimensions or mechanical properties shall not be used.

2.2.1 Bar Mats

\-ASTM A 184-\ . The bar members shall be billet, rail, or axle steel, grade 60.

.2 Welded Steel Wire Fabric

\-ASTM A 185-\.

2.2.3 Welded Deformed Steel Wire Fabric

\-ASTM A 497-\.

2.2.4 Dowels

Plain steel bars conforming to \-ASTM A 675-\, grade 80, or \-ASTM A 499-\.

PART 3 EXECUTION

3.1 JOINTS

Joints shall conform to the details indicated and shall be perpendicular to the finished grade of the pavement. Transverse expansion and contraction joints shall be straight and continuous from edge to edge of the pavement.

3.1.1 Construction Joints

a. Longitudinal construction joints: Longitudinal construction joints between paving lanes shall be located as indicated. Dowels, keys or keys and tie bars shall be installed in the longitudinal construction joints or the edges shall be thickened as required and as indicated. When the concrete is placed using stationary forms, metal forms securely fastened to the concrete form shall be used to form the keyway in the plastic concrete. The dimensions of the keyway forms shall not vary more than plus or minus 1/8 inch from the dimensions indicated and shall not deviate more than plus

or minus 1/4 inch from the mid-depth of the pavement. Longitudinal construction joints shall be edged and subsequently sawed to provide a groove at the top conforming to the details and dimensions indicated.

b. Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for 30 minutes or longer. Insofar as practicable, transverse construction joints shall be installed in the location of a planned joint. When concrete placement cannot be continued, the transverse construction joint may be installed within the slab unit but not less than 10 feet from a planned transverse joint. Transverse construction joints shall be doweled as shown. When the construction joint is located at planned transverse joints, one half of each dowel shall be painted and oiled to permit movement at the joint. These joints shall be edged and subsequently sawed to provide a groove at the top conforming to the details and dimensions indicated. When a construction joint is installed within a slab unit, the dowel bars shall not be painted or oiled, and no groove shall be provided at the joint. When concrete placing is resumed, the planned joint spacing shall be used beginning with the first regularly scheduled transverse joint.

3.1.2 Expansion Joints

Expansion joints shall be formed by means of preformed filler material. The filler shall be securely held in position by means of approved metal supports which shall remain in the pavement. A removable metal channel cap bar shall be used to hold the parts of the joint in proper position and protect the filler from damage during concreting operations. The cap bar shall be removable without damage to the pavement to provide a space for sealing of the joint. Adjacent sections of filler shall be fitted tightly together and the filler shall extend across the full width of the paving lane in order to prevent entrance of concrete into the expansion space. Expansion joints shall be formed about structures and features that project through, into, or against pavement, using joint filler of the type, thickness, width indicated, and installed in such manner as to form a complete, uniform separation between the structure and pavement.

3.1.3 Contraction joints

Transverse and longitudinal contraction joints shall be of the weakened-plane or dummy type, and shall be constructed as indicated. Longitudinal contraction joints shall be constructed by sawing a groove in the hardened concrete with a power-driven saw in conformance with paragraph "Sawed Joints" below, unless otherwise approved. Transverse contraction joints shall be constructed in conformance with paragraph "Sawed Joints" or "Filler Type Joints" below, unless otherwise approved.

a. Sawed Joints: Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8 inch blade to the full depth as indicated. After expiration of the curing period, the upper portion of the groove shall be widened by sawing to the width and depth indicated. The time of sawing shall be varied, depending on existing and anticipated weather conditions, and shall be such as to prevent uncontrolled cracking of the pavement. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit cutting the concrete without chipping, spalling or tearing. The sawed faces of joints will be inspected for undercutting or washing of the concrete due to the early sawing, and sawing shall be delayed if undercutting is sufficiently deep to cause structural weakness or excessive roughness in the joint. The sawing operation shall be carried on as required during both day and night regardless of weather conditions.

The joints shall be sawed at the required spacing consecutively in the sequence of the concrete placement. A chalk line or other suitable guide shall be used to mark the alignment of the joint. The saw cut shall not vary more than 1/2 inch from the true joint alignment. Before sawing a joint, the concrete shall be examined closely for cracks, and the joint shall not be sawed if a crack has occurred near the joint location. Sawing shall be discontinued when a crack develops ahead of the saw cut. Workmen and inspectors shall wear clean, rubber-soled footwear, and the number of persons walking on the pavement shall be limited to those actually performing the sawing operation. Immediately after joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly flushed with water until all waste from sawing is removed from the joint. Any membrane-cured surface damaged during the sawing operations shall be resprayed as soon as the surface becomes dry. The sawing equipment shall be adequate in number of units and power to complete the sawing at the required rate. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in the good working order shall be available at the jobsite at all times during the sawing operation.

b. Filler Type Joints: Insert type contraction joints shall be constructed by installation of a preformed insert in the plastic concrete to form a weakened plane to induce cracking. The insert materials shall conform to \-ASTM D 2828-\, or \-COE CRD-C 572-\, whichever is applicable. The inserts shall be constructed so insert material can be removed to form a groove in the concrete as required in paragraph "Grooving Operation" below.

All types of inserts shall be approved prior to installation. Inserts shall be furnished in heights for the various depth of joints shown and in lengths equal to the width of the paving lane.

(1) Equipment: Equipment for installing inserts shall be a machine equipped with a vibratory bar for cutting a groove in the plastic concrete for placement of the insert or for vibrating the insert into place at the prescribed joint location. Installation of the insert shall be to the required depth throughout the full width of the paving lane. The vibration units shall be so arranged that the vibration will be uniformly distributed throughout the bar. The intensity of vibration shall be adjustable as necessary to form a groove of proper size for the filler or forcing the insert into the plastic concrete and for consolidating the concrete around the in-place insert. The vibratory float shall be used following the placement of the insert material in lieu of hand floating or troweling the finish.

(2) Insert installation: The insert shall be installed in the plastic concrete immediately following the final machine finishing with a maximum of two joint spacings between finishing machine and inserter. Additional straightedge and texturing operations shall be accomplished without disturbing the installed insert. Adjacent sections of the joint inserts within each slab unit shall be securely joined together and the insert shall extend across the full width of the slab. The concrete shall be thoroughly consolidated against and for the full depth of the insert. The insert shall be perpendicular to the finished grade of the pavement and shall be straight in alignment at the prescribed joint locations shown, with the top of the insert flush or not more than 1/8 inch below the pavement surface. The insert equipment shall be available on the job in good condition prior to the placement of concrete to insure proper vibration and floating.

(3) Grooving operations: After the expiration of the curing period a groove for joint sealer shall be formed as specified below. The top portion of fiberboard fillers or sawable preformed inserts shall be removed by sawing with a power saw to form a groove of required dimensions. The sawing shall be so accomplished as to abrade the concrete surfaces in the joint groove and remove all traces of the filler or insert. Nonsawable insert material shall be removed as prescribed by the manufacturer. The dimensions and characteristics of the groove thus formed shall be as shown on the plans. The grooves shall have edges free of ravel and spalls. The grooves shall be straight from edge to edge of the pavement and shall not vary more than 1/2 inch from alignment.

3.1.4 Sealing Joints

Joints shall be sealed immediately following curing of the concrete or as shown thereafter as weather conditions permit, as directed. Sawing of filler-type joints shall be accomplished immediately before sealing of the joints. Joints shall be sealed as specified in Section \=02592=\ FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS.

3.1.5 Grooving and Sealing Cracks

Random cracks, except those specifically excluded by the Contracting Officer, that occur in the pavement during construction shall be grooved and sealed. The top of the crack shall be grooved to a depth of 3/4 inch and to a width not less than 3/8 inch nor more than 5/8 inch means of an approved mechanical grooving machine. The grooving tool shall be capable of following closely the path of the crack and of widening the top of the crack to the required section without spalling or otherwise damaging the concrete. Loose and fractured concrete shall be removed, and the groove shall be thoroughly cleaned and completely filled with approved joint sealing material of the type required for the area in which the crack occurs. No separate payment will be made for grooving, cleaning, and sealing of cracks.

3.2 FINISH FOR PAVEMENT

The pavement shall be struck off to grade and immediately straightedged with a 10-ft. straightedge in both directions. Floating shall be started after the surface has been straightedged and all the surface water has disappeared. The initial floating may be performed by use of power-driven equipment. The final surface texture of the pavement shall be provided by means of a burlap drag, or broom as approved.

SUBPART

3.2.1 Burlap-Drag Texture

Surface texture shall be applied by dragging the surface of the pavement, in the direction of the concrete placement, with an approved multiple-ply burlap drag at least three feet in width and equal in length to the width of a slab. The leading transverse edge of the drag shall be securely fastened to a lightweight pole or travelling bridge, and at least one foot of the burlap shall be in contact with the pavement during dragging operation. The drag shall be operated with the burlap moist and the burlap shall be cleaned and changed as required. The dragging shall be done so as to produce a uniform finished surface having a fine sandy texture without disfiguring marks.

3.2.2 Broom Texturing

Surface texture shall be applied using an approved hand or mechanical stiff bristle broom of a type that will produce uniform corrugations. For hand brooming the brooms shall have handles longer than half the width of slab to be finished. The hand brooms shall be drawn transversely across the surface from the centerline to each edge with slight overlapping strokes.

For mechanical operations the broom shall be operated with the length of the broom parallel to the pavement centerline. The broom shall be capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Successive passes of the broom shall be overlapped the minimum necessary to obtain a uniformly textured surface. Brooms shall be washed thoroughly and dried at frequent intervals during use. Worn or damaged brooms shall be removed from the job site. Brooming should be completed before the concrete has dried to the point where the surface will be unduly torn or roughened, but after drying has progressed enough so that the mortar will not flow and attenuate the sharpness of the corrugations. The corrugations should be uniform in appearance and approximately 1/16 in. in depth but not more than 1/8 in. in depth.

SUBPART

3.3 SURFACE TEST

After the concrete curing period, the surface of the paving shall be tested with a straightedge or device which shall be operated in such manner as to reveal any irregularities. Any portion of the pavement which shows a variation or departure greater than 1/8-inch from the testing edge of a 10-foot straightedge, shall be removed and replaced or corrected as directed by the Contracting Officer.

3.4 CURING AND PROTECTION

The Contractor shall protect the pavement against all damage prior to final acceptance of the work by the Government. Traffic shall be excluded from the pavement until the concrete is at least 14 days old, or for a longer period if so directed by the Contracting Officer. Curing of concrete shall be as specified in Section \=03300=\ CONCRETE FOR BUILDING CONSTRUCTION, of these specifications.

3.5 PAVEMENT THICKNESS

The pavement shall be constructed in accordance with the thickness shown on the drawings. No variation in thickness of over 1/4-inch will be permitted. If a variation in thickness occurs and, in the opinion of the Contracting Officer, is sufficient to seriously impair the service expected from the pavement, the deficient area shall be removed and replaced with a slab of quality and thickness satisfactory to the Contracting Officer. The Contracting Officer may allow the Contractor the choice of leaving the defective section in place and receiving no compensation or payment for same, or of removing and replacing the pavement as provided above.

 NOTE: WHEN CONCRETE CURBS ARE TO BE CONSTRUCTED
 MONOLITHICALLY WITH THE PAVING OF THE STREET OR
 PARKING AREA, THE PARAGRAPH "INTEGRAL OR MONOLITHIC
 CURBS" SHOULD BE RETAINED. WHEN THE CURBS AND
 GUTTERS ARE CONSTRUCTED WITH BITUMINOUS PAVING,
 GUIDE SPECIFICATION CEGS-02511 SHOULD BE USED AND
 THE PARAGRAPH ENTITLED "INTEGRAL OR MONOLITHIC
 CURBS" SHOULD BE DELETED.

3.6 INTEGRAL OR MONOLITHIC CURBS

3.6.1 General

Integral or monolithic curbs shall be constructed to the dimensions and at the locations indicated. Curbs shall be constructed of portland-cement concrete conforming with these specifications except as modified herein. The maximum nominal size of the coarse aggregate for curb construction shall be 1-1/2 inches.

3.6.2 Forms for Integral or Monolithic Curbs

Forms for the curbs shall be of similar material to that used for the pavements. The outside form shall be of a depth equal to the combined depth of the integral curb and pavement slab. The form may be a built-up section, the lower portion equal to the depth of the pavement slab and the upper portion equal to the depth of the integral curb. The built-up form shall be so designed as to assure rigid connection between the lower and upper portions. The inside curb-face form shall have a batter from the top of the curb to the finished pavement surface as indicated. The inside curb form shall be securely fastened to and supported by the outside form. The fastenings shall be so designed as not to obstruct satisfactory finishing and edging of the top of the curb and to permit early removal of the face form.

3.6.3 Placing

The concrete curb shall be placed as soon as practical after the slab is placed but in no case shall the time between the placing of the slab and the placing of the curb exceed 45 minutes. The concrete shall be thoroughly spaded or vibrated until well compacted and until a good bond is obtained between the curb and the slab.

If it is impractical to complete the integral curb simultaneously with the pavement slab, deformed tie bars, 5/8-inch in diameter and 7 inches in length, shall be embedded vertically in the slab at 1-foot intervals and so as to extend 2 inches into the curb. While the slab is still green, the surface shall be dapped approximately 1 inch below the screeded surface for the full width of the curb leaving a recess with a roughened surface to provide bond for the curb section.

Transverse joints shall be of the type and construction specified for transverse joints for the pavement slab on which the curb is placed. Pavement joints shall extend through the curb with the exception that horizontal dowels will not be required between joints in the curb.

3.6.4 Finishing

The top of the curb shall be floated in such manner as to thoroughly compact the concrete and produce a smooth even surface. The edges of the curb and joints shall be rounded by using appropriate edging tools. Vertical edges of joints shall be dressed when the curb form is removed. While the concrete is green, the top and face of the curb shall be finished by rubbing the surface with a wood or concrete rubbing block and water until all blemishes, form marks, and tool marks have been removed. Ample water shall be used during the rubbing to avoid a plastered condition. The rubbed surface shall then be brushed with a fine-textured brush to obtain a uniform surface texture. The face of the finished curb shall be true and straight. The top surface of the curb shall be of uniform width, free from humps, sags, and other irregularities. The top and face of the curb shall

Blank

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APPENDIX D

USACE GUIDE SPECIFICATION MILITARY CONSTRUCTION: SECTION 03300 CONCRETE FOR BUILDING CONSTRUCTION

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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

CEGS-03300 (December 1988)

Superseding
CEGS-03300 (October 1987)

GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION

Includes summary Special change (December 1992)
Includes changes through Notice 7 (October 1992)
Includes submittal Special change 1 (March 1991)

Latest Change indicated by \&\ tokens

SECTION 03300

<<Xfile xname="COEASC\03300.ASC" xtype="ref" xtitle="incl"> CONCRETE FOR BUI
11/88

NOTE: This guide specification covers the requirements for cast-in-place concrete materials, mixing, placement, and finishes. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-720.

<<Topic topicid="P1">PART 1 GENERAL

NOTE: See Additional Notes A and B.

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

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.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 117

\&(1990; Errata)&\ Standard Tolerances
for Concrete Construction and Materials

CI 211.1

\&(1989) Standard Practice for&\
Selecting Proportions for Normal,
Heavyweight, and Mass Concrete

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ACI 211.2

(1991) \&Standard Practice for&\

Selecting Proportions for Structural
Lightweight Concrete

- CI 301 (1989) Structural Concrete for
Buildings
- ACI 305R (1989) Hot Weather Concreting
- ACI 318 (1989; 318R-89) Building Code
Requirements for Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM C 31 (1990a) Making and Curing Concrete
Test Specimens in the Field
- ASTM C 33 (1990) Concrete Aggregates
- ASTM C 39 (1986) Compressive Strength of
Cylindrical Concrete Specimens
- ASTM C 42 (1990) Obtaining and Testing Drilled
Cores and Sawed Beams of Concrete
- ASTM C 78 (1984) Flexural Strength of Concrete
(Using Simple Beam With Third-Point Loading)
- ASTM C 94 (1990) Ready-Mixed Concrete
- ASTM C 109 (1990) Compressive Strength of
Hydraulic Cement Mortars (Using 2-in. or
50-mm Cube Specimens)
- ASTM C 143 (1990a) Slump of Hydraulic Cement
Concrete
- ASTM C 150 (1989) Portland Cement
- ASTM C 171 (1991) Sheet Materials for Curing
Concrete
- ASTM C 172 (1990) Sampling Freshly Mixed
Concrete
- ASTM C 173 (1978) Air Content of Freshly Mixed
Concrete by the Volumetric Method
- ASTM C 192 (1990a) Making and Curing Concrete
Test Specimens in the Laboratory
- ASTM C 231 (1991) Air Content of Freshly Mixed
Concrete by the Pressure Method
- ASTM C 260 (1986) Air-Entraining Admixtures for
Concrete
- ASTM C 309 (1989) Liquid Membrane-Forming Compounds
for Curing Concrete

ASTM C 330

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(1989) Lightweight Aggregates for

Structural Concrete

ASTM C 494	(1990) Chemical Admixtures for Concrete
ASTM C 552	(1991) Cellular Glass Thermal Insulation
ASTM C 567	(1991) Unit Weight of Structural Lightweight Concrete
ASTM C 578	(1987a) Preformed, Cellular Polystyrene Thermal Insulation
ASTM C 591	(1985) Unfaced Preformed Rigid Cellular Polyurethane Thermal Insulation
ASTM C 595	(1989) Blended Hydraulic Cements
ASTM C 597	(1983) Pulse Velocity Through Concrete
ASTM C 618	(1991) Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 803	(1990) Penetration Resistance of Hardened Concrete
ASTM C 805	(1985) Rebound Number of Hardened Concrete
ASTM C 989	(1989) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1017	(1990) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1107	(1991) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D 98	(1987) Calcium Chloride
ASTM E 96	\&(1992)&\ Water Vapor Transmission of Materials

FEDERAL SPECIFICATIONS (FS)

FS CCC-C-467	\&(Rev C)&\ Cloth, Burlap, Jute (or Kenaf)
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NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	\&(1990)&\ Concrete Plant Standards
NRMCA QC 3	\&(1984)&\ Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready-Mixed Concrete Production Facilities
NRMCA TMMB 1	\&(1989) Truck Mixer, Agitator

and Front Discharge Concrete Carrier

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1.2 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-08 Statements

Proportions of Mix; [____].

The results of trial mix along with a statement giving the maximum nominal coarse aggregate size and the proportions of all ingredients that will be used in the manufacture of each strength of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an independent commercial testing laboratory, attesting that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the work without additional tests to show that the quality of the concrete is satisfactory.

SD-09 Reports

Sampling and Testing; [____].

Certified copies of laboratory test reports, including all test data, for aggregate, admixtures, and curing compound. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials.

SD-13 Certificates

Cementitious Materials; [____].

Manufacturer's certification of compliance, accompanied by mill test reports attesting that the materials meet the requirements of the specification under which it is furnished, for cement, pozzolan, and ground iron blast-furnace slag. No cement, pozzolan, or slag shall be used until notice of acceptance has been given. Cement, pozzolan, and slag may be subjected to check testing by the Government from samples obtained at the mill, at transfer points, or at the project site.

\&Perimeter Insulation; [____].

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Certificate attesting that the polyurethane insulation furnished for the project contains recovered material, and showing an estimated percentage of such recovered material.&\

1.3 GENERAL REQUIREMENTS

Tolerances for concrete construction and materials shall be in accordance with ACI 117.

1.3.1 Strength Requirements

NOTE: The designer will list the strengths of concrete for the job and the uses for each. A 28-day compressive strength of 3000 pounds per square inch will be required for most building work. Concrete of 4000 pounds per square inch should be used in containers for liquids, and in other structures where loading, durability, or wear requirements dictate. A 28-day flexural strength of 600 pounds per square inch will normally be specified for slabs on grade subject to vehicular traffic; however, since cylinders are easier to cast and test than beams, 4000 pounds per square inch compressive strength concrete may be specified if appropriate. Concrete for hangar floors will be designed according to airfield pavement criteria and will be specified in Section 02515 CONCRETE PAVEMENT FOR ROADS AND AIRFIELDS.

Structural concrete for [all work] [_____] shall have a 28-day compressive strength of [3000] [_____] pounds per square inch. Concrete slabs on-grade [as indicated] [in the [_____] [_____] shall have a 28-day flexural strength of [600] [_____] pounds per square inch. Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type I or II portland cement.

1.3.2 Air Entrainment

NOTE: All concrete that will be exposed to freezing and thawing cycles will be air-entrained. In climates where freezing is not a factor, but where air-entrainment is used in local commercial practice to improve the workability and placeability of concrete, concrete having air content of 3 to 5 percent may be specified.

Concrete in [_____] structure shall contain from 5 to 7 percent total air. Other concrete may, at the option of the Contractor, be air entrained to produce concrete with 3 to 5 percent total air. [Concrete in [_____] structure shall not be air entrained.]

1.3.3 Special Properties

NOTE: If the use of a particular type of admixture

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is required for certain parts of the structure, this paragraph should be revised accordingly.

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Superplasticizing admixtures used to produce flowing concrete may be approved for use in concrete in any part of the structure. The dosage rate depends on the slump of the base concrete which should be kept constant and low (2-1/2 to 3 inches).

Superplasticized concrete can lose slump in 60 to 90 minutes, or sooner if temperature is above 70 degrees F, therefore the admixture should be added to the mix at the project site if there is a probable combination of long concrete haul and warm temperature during placing operation. Otherwise the admixture should be added in accordance with the manufacturer's instruction.

Concrete may contain other admixtures, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if approved.

1.3.4 Slump

Slump shall be within the following limits:

Structural Element	Slump in inches	
	Minimum	Maximum
Walls, columns and beams	2	4
Foundation walls, substructure walls, footings, pavement, and slabs	1	3
Any structural concrete approved for placement by pumping	None	6

*Where use of superplasticizers are approved to produce flowing concrete these slump requirements do not apply.

1.3.5 Technical Service for Specialized Concrete

The service of a technical representative shall be obtained to oversee proportioning, batching, mixing, placing, consolidating and finishing of specialized structural concrete, such as lightweight or flowing concrete until field controls indicate concrete of specified quality is furnished.

1.4 PROPORTIONS OF MIX

NOTE: This guide specification places the responsibility for mixture proportioning on the Contractor. Where Government mix design is required, the specification will be revised accordingly.

1.4.1 Mixture Proportioning, Normal Weight Concrete

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Trial batches shall contain materials proposed to be used in the project. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios. Trial mixes shall be proportioned to produce concrete strengths specified. In the case where ground iron blast-furnace slag is used, the weight of the slag will be substituted in the equations for the term P which is used to denote the weight of pozzolan. Trial mixtures shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results a curve shall be plotted showing the relationship between water-cement ratio and strength. For each strength of concrete the maximum allowable water-cement ratio shall be that shown by these curves to produce an average strength as specified in paragraph AVERAGE STRENGTH.

1.4.2 Mixture Proportioning, Lightweight Concrete

NOTE: The 28-day air-dry maximum average unit weights for corresponding 28-day compressive strengths in ASTM C 330 apply to concrete containing all lightweight structural concrete aggregates. Lightweight structural concrete aggregate producers will be consulted as to maximum unit weight of concrete for a given strength when ASTM C 33 fine aggregate is used in the mix. When the design requires use of only lightweight structural aggregate concrete floor fill, a maximum 28-day air-dry weight of 115 pcf and 28-day minimum compressive strength of 2500 psi will be indicated to assure finishing quality.

Trial batches shall contain materials proposed to be used in the project. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in ACI 211.2, using at least three different cement contents. Trial mixes shall be proportioned to produce concrete strengths specified. Trial mixtures shall be proportioned for maximum permitted slump and air content. Test specimens and testing shall be as specified for normal weight concrete except that the 28-day compressive strength shall be determined from test cylinders that have been air dried at 50 percent relative humidity for the last 21 days. A curve shall be plotted using these results showing the relationship between cement factor and strength. Normal weight fine aggregate may be substituted for part or all of the lightweight fine aggregate provided the concrete meets the strength and unit weight specified. Air dry unit weight of lightweight structural concrete shall be between [] and [] pounds per cubic foot as determined in accordance with ASTM C 567.

1.4.3 Average Strength

In meeting the strength requirements specified, the selected mixture proportion shall produce an average compressive strength exceeding the specified strength by the amount indicated below. Where a concrete production facility has test records, a standard deviation shall be

established. Test records from which a standard deviation is calculated

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shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths within 1000 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at other test age designated for determination of the specified strength.

1.4.3.1 Test Records Exceeding 29

Required average compressive strength used as the basis for selection of concrete proportions shall be the larger of the specified strength plus the standard deviation multiplied by 1.34 or the specified strength plus the standard deviation multiplied by 2.33 minus 500.

1.4.3.2 Test Records Less Than 29

Where a concrete production facility does not have test records meeting the above requirements but does have a record based on 15 to 29 consecutive tests, a standard deviation may be established as the product of the calculated standard deviation and a modification factor from the following table:

No. of tests (1)	Modification factor for standard deviation
less than 15	See Note
15	1.16
20	1.08
25	1.03
30 or more	1.00

(1) Interpolate for intermediate numbers of tests.

When a concrete production facility does not have field strength test records for calculation of standard deviation or the number of tests is less than 15, the required average strength shall be:

- a. The specified strength plus 1000 specified strength of less than 3000 psi.
- b. The specified strength plus 1200 for specified strengths of 3000 to 5000 psi.
- c. The specified strength plus 1400 for specified strengths greater than 5000 psi.

1.5 SAMPLE CONCRETE PANEL

 NOTE: Sample panels will not be specified for small structures or for structures in locations where appearance is not important. The number of panels may be increased if required by the size of the project.

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Prior to construction of structural formwork, a sample concrete panel shall

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be constructed on the project site where directed. Sample panel shall not be built in or be part of the structure. Panel shall be not less than 8 feet long and 4 feet high and constructed of concrete conforming to the approved mix design. Panel shall be of typical wall thickness for the construction represented. Forming, reinforcement, and construction method shall reflect the proposed method to be used for the wall or section represented. Panel forms shall be designed and constructed to provide a simulated defect on one wall of the panel. Simulated defect shall be irregular in shape, 1-1/2 to 2 inches deep, and covering approximately 60 square inches. After removal of forms, tie rod and form tie holes shall be patched and the simulated defective area repaired. Patching and repair work and final finish of the panel shall be indicative of that proposed for the project. The approved panel shall be used as a standard of workmanship required. If the panel is not approved, the Contractor shall construct additional panels until an acceptable panel is produced. Sample panel shall be protected from weather and construction operations and shall not be removed until concrete work for which it represents is complete.

1.6 STORAGE OF MATERIALS

Cement and pozzolan shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Reinforcing bars and accessories shall be stored above the ground on platforms, skids or other supports. Other materials shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless tested and proven to meet the specified requirements.

<<Topic topicid="P2">PART 2 PRODUCTS

2.1 ADMIXTURES

Admixtures shall conform to the following:

2.1.1 Accelerating Admixture

 NOTE: Where the designer believes corrosion of reinforcing steel will be a problem, calcium chloride should not be specified. For more information, see ACI 201.1R and ACI 222R for a detailed discussion on this subject.

ASTM C 494, Type C or E; or calcium chloride conforming to ASTM D 98.

2.1.2 Air-Entraining Admixture

ASTM C 260.

2.1.3 Flowing Concrete Admixture

ASTM C 1017, Type 1 or 2.

2.1.4 Water-Reducing or Retarding Admixture

2.2 CEMENTITIOUS MATERIALS

NOTE: Type IA, IIA, or IIIA portland cement are not generally recommended because they do not permit close control of the air content, but may be used on small projects. For projects with alkali-reactive aggregates, the alkali content of the cement should not exceed 0.6 percent, or a pozzolan of demonstrated effectiveness when tested in accordance with ASTM C 441 should be used. Where concrete is exposed to brackish or seawater, or to sewage, protection against sulfate attack must be provided. This protection is provided by using a dense, high-quality concrete with low water-cement ratio, and a cement having the needed sulfate resistance. The degree of protection required depends on the severity of the exposure, and is given in ACI 201.2R. Types of cementing materials that are not available in the project area may be deleted.

Cementitious materials shall each be of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall conform to one of the following:

2.2.1 Cement

ASTM C 150, Type I or II [or III] [, low alkali].

2.2.2 Portland Blast-Furnace-Slag Cement

ASTM C 595, Type IS [IS (MS)] [IS (MH)].

2.2.3 Portland-Pozzolan Cement

ASTM C 595, Type IP [IP (MS)] [IP (MH)].

2.2.4 Pozzolan

ASTM C 618, Class F[, C] [or] [N].

2.2.5 Ground Iron Blast-Furnace Slag

ASTM C 989, Grade 120.

2.3 AGGREGATES

NOTE: The nominal maximum size of aggregate shall be not larger than 1/5 the narrowest dimension between sides of forms, 3/4 the minimum clear spacing between bars, nor more than 1/4 the depth of slabs. Consideration should also be given to the local aggregate supply situation.

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Aggregates shall conform to the following:

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2.3.1 Lightweight Aggregate

ASTM C 330, Size Designation [____].

.2 Normal Weight Aggregate

ASTM C 33. Grading requirement for coarse aggregate shall conform to size number [____].

2.4 CURING MATERIALS

2.4.1 Burlap

FS CCC-C-467.

2.4.2 Impervious Sheets

ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.4.3 Membrane-Forming Compounds

ASTM C 309, Type 1-D, Class A or B.

2.5 EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application. Dovetail slots shall be galvanized steel. Hangers for suspended ceilings shall be as specified in Section 09510 ACOUSTICAL CEILINGS. Inserts for shelf angles and bolt hangers shall be of malleable iron or cast or wrought steel.

2.6 NONSHRINK GROUT

NOTE: See Additional Note C.

Nonshrink grout shall conform to ASTM C 1107 Grade [____] and shall be a formulation suitable for the application.

2.7 NONSLIP SURFACING MATERIAL

Nonslip surfacing material shall consist of fifty-five percent, minimum, aluminum oxide or silicon-dioxide abrasive ceramically bonded together to form a homogenous material sufficiently porous to provide a good bond with portland paste; or factory-graded emery material consisting of not less than 45 percent aluminum oxide and 25 percent ferric oxide. The material shall be well graded from particles retained on the No. 30 sieve to particles passing the No. 8 sieve.

2.8 FLOOR HARDENER

NOTE: Floor hardener should only be specified on indoor floors where dusting of concrete would present a problem.

Floor hardener shall be a colorless aqueous solution containing zinc silicofluoride, magnesium silicofluoride, or sodium silicofluoride. These silicofluoride can be used individually or in combination. Proprietary hardeners may be used if approved by the contracting officer.

PERIMETER INSULATION

NOTE: \&Show required R-value on the drawings&\.

\&Insulation shall contain the highest practicable percentage of recovered material which has been recovered or diverted from solid waste, but not involving material reused in a manufacturing process. Where two materials have the same price and performance, the one containing the higher recovered material content shall be provided. Perimeter insulation shall be polystyrene conforming to ASTM C 578, Type II; polyurethane conforming to ASTM C 591, Type II and having a minimum recovered material content of 9 percent by weight of core material in the polyurethane portion; or cellular glass conforming to ASTM C 552, Type I or IV.&\

2.10 VAPOR BARRIER

Vapor barrier shall be polyethylene sheeting with a minimum thickness of 6 mils or other equivalent material having a vapor permeance rating not exceeding 0.5 perms as determined in accordance with ASTM E 96.

2.11 WATER

Water shall be potable, except that nonpotable water may be used if it produces mortar cubes having 7- and 28-day strengths at least 90 percent of the strength of similar specimens made with water from a municipal supply. The strength comparison shall be made on mortars, identical except for mixing water, prepared and tested in accordance with ASTM C 109. Water for curing shall not contain any substance injurious to concrete, or which causes staining.

<<Topic topicid="P3">PART 3 EXECUTION

3.1 PREPARATION OF SURFACES

Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Conduit and other similar items shall be in place and clean of any deleterious substance.

3.1.1 Foundations

Earthwork shall be as specified in Section 02221 EXCAVATION, FILLING, AND BACKFILLING FOR BUILDINGS. Flowing water shall be diverted without washing over freshly deposited concrete. Rock foundations shall be cleaned by high velocity air-water jets, sandblasting, or other approved methods. Debris and loose, semi-detached or unsound fragments shall be removed. Rock surfaces shall be moist but without free water when concrete is placed. Semiporous subgrades for foundations and footings shall be damp when concrete is placed. Pervious subgrades shall be sealed by blending impervious material with the top 6 inches of the in-place pervious material or by covering with an impervious membrane.

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3.1.2 Perimeter Insulation

 NOTE: The drawings will indicate the location
 and extent of perimeter insulation.

Perimeter insulation shall be installed at locations indicated. Adhesive shall be used where insulation is applied to the interior surface of foundation walls.

3.1.3 Vapor Barrier

Unless otherwise indicated, subgrades for slabs in buildings shall be covered with a vapor barrier. Vapor barrier edges shall be lapped at least 4 inches and ends shall be lapped not less than 6 inches. Patches and lapped joints shall be sealed with pressure-sensitive adhesive or tape not less than 2 inches wide and compatible with the membrane.

3.1.4 Preparation of Previously Placed Concrete

 NOTE: If the project has a large number of critical joints, this paragraph should be modified to include such information as air-water cutting, sandblasting and high pressure water jet cutting.

Concrete surfaces to which other concrete is to be bonded shall be roughened in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be moist but without free water when concrete is placed.

3.2 INSTALLATION OF EMBEDDED ITEMS

Embedded items shall be free from oil, loose scale or rust, and paint. Embedded items shall be installed at the locations indicated and required to serve the intended purpose. Voids in sleeves, slots and inserts shall be filled with readily removable material to prevent the entry of concrete.

3.3 BATCHING, MIXING AND TRANSPORTING CONCRETE

 NOTE: Concrete made by volumetric batching and continuous mixing conforming to ASTM C 685 may be specified as an option to ready-mixed concrete on projects where the quantities of concrete are small and where a long haul would be involved if ready-mixed concrete were used and this type of equipment is available.

Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and nonagitating units shall comply with NRMCA TMMB 1. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA QC 3. Site-mixed concrete shall be mixed in accordance with ACI 301. On-site plant shall conform to the NRMCA CPMB 100.

3.3.1 Admixtures

NOTE: If the use of a particular type of admixture is required for certain parts of the structure, this paragraph should be revised accordingly.

Superplasticizing admixtures used to produce flowing concrete may be approved for use in concrete in any part of the structure. The dosage rate depends on the slump of the base concrete which should be kept constant and low (2-1/2 to 3 inches).

Superplasticized concrete can lose slump in 60 to 90 minutes, or sooner if temperature is above 70 degrees F, therefore the admixture should be added to the mix at the project site if there is a probable combination of long concrete haul and warm temperature during placing operation. Otherwise the admixture should be added in accordance with the manufacturer's instruction.

Admixtures shall be batched within an accuracy of 3 percent. Where two or more admixtures are used in the same batch, they shall be batched separately and must be compatible. Retarding admixture shall be added within one minute after addition of water is complete or in the first quarter of the required mixing time, whichever is first. Superplasticizing admixtures shall be added [at the project site, and the concrete with the admixture shall be mixed 4 to 5 minutes before placing] [as recommended by manufacturer]. Concrete that shows evidence of total collapse or segregation caused by the use of admixture shall be removed from the site.

.2 Control of Mixing Water

No water from the truck system or elsewhere shall be added after the initial introduction of mixing water for the batch except when on arrival at the jobsite, the slump of the concrete is less than that specified. Water added to bring the slump within the specified range shall not change the total water in the concrete to a point that the approved water-cement ratio is exceeded. The drum shall be turned an additional 30 revolutions, or more, if necessary, until the added water is uniformly mixed into the concrete. Water shall not be added to the batch at any later time.

3.3.3 Mixing of Lightweight Concrete

The mixing cycle shall be as recommended by the aggregate producer for the batching and mixing as required by the absorptivity of the aggregate. Typically, the mixer is charged with approximately 2/3 of the total mixing water and all of the aggregate. Ingredients are mixed for not less than 30 seconds in a stationary mixer nor less than 10 revolutions at mixing speed in a truck mixer. Cement, air entraining admixture, and the rest of the mixing water are added to obtain the required slump and mixing is continued for 30 revolutions at mixing speed.

3.4 SAMPLING AND TESTING

NOTE: Requirements for tests will be edited to reflect the minimum necessary for the project. For critical structures where a high degree of quality control is required, the number and frequency of tests may be increased.

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Sampling and Testing is the responsibility of the Contractor and shall be performed by an approved testing agency.

..4.1 Aggregates

Aggregates for normal weight concrete shall be sampled and tested in accordance with ASTM C 33. Lightweight aggregate shall be sampled and tested in accordance with ASTM C 330. Gradation tests shall be performed on the first day and every other day thereafter during concrete construction.

3.4.2 Sampling of Concrete

Samples of concrete for air, slump, unit weight, and strength tests shall be taken in accordance with ASTM C 172.

3.4.2.1 Air Content

Test for air content shall be performed in accordance with ASTM C 173 or ASTM C 231. A minimum of [1] [] test per day shall be conducted.

3.4.2.2 Slump

At least 2 slump tests shall be made on randomly selected batches of each mixture of concrete during each day's concrete placement. Tests shall be performed in accordance with ASTM C 143.

..2.3 Unit Weight

Test for unit weight of lightweight concrete shall be performed in accordance with ASTM C 567. Tests shall be conducted on each batch sampled for strength tests and on random samples taken for each 75 cubic yards of concrete placed. The unit weight of fresh concrete shall not vary more than 2 pounds per cubic foot from the corresponding unit weight of the approved proportions.

3.4.3 Evaluation and Acceptance of Concrete

3.4.3.1 Frequency of Testing

Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 150 cubic yards of concrete, nor less than once for each 5000 square feet of surface area for slabs or walls. If this sampling frequency results in less than 5 strength tests for a given class of concrete, tests shall be made from at least 5 randomly selected trucks or from each truck if fewer than 5 truck loads are used. Field cured specimens for determining form removal time or when a structure may be put in service shall be made in numbers directed to check the adequacy of curing and protection of concrete in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the portion of the structure the samples represent.

3.4.3.2 Testing Procedures

Cylinders and beams for acceptance tests shall be molded and cured in

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accordance with ASTM C 31. Cylinders shall be tested in accordance

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with ASTM C 39 and beams shall be tested in accordance with ASTM C 78. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at another specified test age.

3.4.3.3 Evaluation of Results

Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength and no individual strength test result falls below the required strength by more than 500 pounds per square inch. For flexural strength concrete, the strength level of the concrete will be considered satisfactory if the averages of all sets of five consecutive strength test results equal or exceed the required flexural strength, and not more than 20 percent of the strength test results fall below the required strength by more than [] pounds per square inch.

3.4.4 Investigation of Low-Strength Test Results

When any strength test of standard-cured test cylinder falls below the specified strength requirement by more than 500 pounds per square inch, or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C 597, ASTM C 803 or ASTM C 805 may be permitted by the Contracting Officer to determine the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection. When strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by the Contracting Officer to least impair the strength of the structure. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 degrees F, relative humidity less than 60 percent) for seven days before testing and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to or at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. If the core tests are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318. Concrete work evaluated by structural analysis or by results of a load test and found deficient shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed, and approved by the Contracting Officer, at the expense of the Contractor.

CONVEYING CONCRETE

Concrete shall be conveyed from mixer to forms as rapidly as possible and within the time interval specified in paragraph CONCRETE PLACEMENT by

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method which will prevent segregation or loss of ingredients.

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3.5.1 Chutes

When concrete can be placed directly from a truck mixer or other transporting equipment, chutes attached to this equipment may be used. Separate chutes will not be permitted except when specifically approved.

3.5.2 Buckets

Bucket design shall be such that concrete of the required slump can be readily discharged. Bucket gates shall be essentially grout tight when closed. The bucket shall provide means for positive regulations of the amount and rate of deposit of concrete in each dumping position.

3.5.3 Belt Conveyors

Belt conveyors may be used when approved. Belt conveyors shall be designed for conveying concrete and shall be operated to assure a uniform flow of concrete to the final place of deposit without segregation or loss of mortar. Conveyors shall be provided with positive means for preventing segregation of the concrete at transfer points and point of placement.

3.5.4 Pumps

Concrete may be conveyed by positive displacement pumps when approved. Pump shall be the piston or squeeze pressure type. Pipeline shall be steel pipe or heavy duty flexible hose. Inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. Distance to be pumped shall not exceed the limits recommended by the pump manufacturer. Concrete shall be supplied to the pump continuously. When pumping is completed, the concrete remaining in the pipeline shall be ejected without contaminating the concrete in place. After each use, the equipment shall be thoroughly cleaned. Flushing water shall be wasted outside the forms.

3.6 CONCRETE PLACEMENT

Mixed concrete which is transported in truck mixers or agitators or concrete which is truck mixed, shall be discharged within 1-1/2 hours or before the drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. These limitations may be waived by the Government if the concrete is of such slump after the 1-1/2 hour time or 300 revolution limit has been reached that it can be placed, without the addition of water to the batch. When the concrete temperature exceeds 85 degrees F, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the truck.

3.6.1 Placing Operation

Concrete shall be handled from mixer to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 8 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated

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that it will be effectively consolidated in horizontal layers not more than 12 inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level to avoid excessive shimming or grouting.

3.6.2 Consolidation

NOTE: For large jobs, this paragraph may be expanded. Consolidation equipment and procedures are described in detail in ACI 309.

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for slabs 4 inches or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 8000 vibrations per minute, and the head diameter and amplitude shall be appropriate for the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then withdrawn slowly. The use of form vibrators must be specifically approved. Vibrators shall not be used to transport concrete within the forms. Slabs 4 inches and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique. Excessive vibration of lightweight concrete resulting in segregation and flotation of coarse aggregate shall be avoided.

3.6.3 Cold Weather Requirements

NOTE: Where the designer believes corrosion of reinforcing steel will be a problem, calcium chloride should not be specified. For more information, see ACI 201.1R and ACI 222R for a detailed discussion on this subject.

Special protection measures, approved by the Contracting Officer, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 40 degrees F. The temperature of the concrete when placed shall be not less than 50 degrees F nor more than 75 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Upon written approval, calcium chloride or chemical admixture conforming to ASTM C 494 Type C or E may be used. The amount of calcium chloride shall not exceed 2 percent by weight of the cement, and it shall be batched in solution form. Calcium chloride shall not be used where concrete will be in contact with aluminum or zinc-coated items, or where sulfate resistant or prestressed concrete is

3.6.4 Warm Weather Requirements

NOTE: The placing of exposed slabs during the daylight hours of summer may be limited by specifying the maximum atmospheric temperature, humidity, and wind velocity under which such concrete may be placed. If desired, placement of floor slabs may be delayed until protected by a roof. Additional information concerning hot weather concreting may be obtained from ACI 305R.

The temperature of the concrete placed during warm weather shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. In no case shall the placing temperature exceed [95] [_____] degrees F.

3.7 CONSTRUCTION JOINTS

Construction joints shall be located as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled as shown. Concrete columns, walls, or piers shall be in place at least 2 hours, or until the concrete is no longer plastic, before placing concrete on beams, girders, or slabs thereon. In walls having door window openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details. Where horizontal construction joints are required, a strip of 1-inch square-edge lumber, bevelled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 1 inch above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be leveled off with a wood float, and all laitance shall be removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph PREPARATIONS OF SURFACES.

3.8 FINISHING CONCRETE

3.8.1 Formed Surfaces

NOTE: Classes of finish should be indicated on the contract drawings or this paragraph modified to clearly specify surfaces to receive different classes of finish. Class A finish is expensive and troublesome to apply and cure and will be used only where appearance is important. This finish will not be applied to industrial-type structures or structures in remote areas. Class B finish will normally be specified for surfaces that are permanently exposed to public view where a smooth surface obtained through the use of Grade B-B plywood is satisfactory. Class C finish will be

specified for surfaces not permanently exposed to public view or for concrete that is to receive other finish such as paint or ceramic tile. This finish may also be specified for industrial-type structures or structures in remote locations. Class D finish will be specified for most concealed surfaces or for structures where appearance is not of importance and the surface texture imparted by the forms is acceptable.

3.8.1.1 Repair of Surface Defects

Surface defects shall be repaired within 24 hours after the removal of forms. Honeycombed and other defective areas shall be cut back to solid concrete or to a depth of not less than 1 inch, whichever is greater. Edges shall be cut perpendicular to the surface of the concrete. The prepared areas shall be dampened and brush-coated with neat cement grout. The repair shall be made using mortar consisting of not more than 1 part cement to 2-1/2 parts sand. The mixed mortar shall be allowed to stand to stiffen (approximately 45 minutes), during which time the mortar shall be intermittently remixed without the addition of water. After the mortar has attained the stiffest consistency that will permit placing, the patching mix shall be thoroughly tamped into place by means approved by the Contracting Officer and finished slightly higher than the surrounding surface. For [Class A and] Class B finished surfaces the cement used in the patching mortar shall be a blend of job cement and white cement proportioned to produce a finished repair surface matching, after curing, the color of adjacent surfaces. Holes left after the removal of form ties shall be cleaned and filled with patching mortar. Holes left by the removal of tie rods shall be reamed and filled by dry-packing. Repaired surfaces shall be cured as required for adjacent surfaces. The temperature of concrete, mortar patching material, and ambient air shall be above 50 degrees F while making repairs and during the curing period. Concrete with defects which affect the strength of the member or with excessive honeycombs will be rejected, or the defects shall be corrected as directed.

3.8.1.2 Class A Finish

Where a Class A finish is indicated, fins shall be removed. A mortar mix consisting of one part portland cement and two parts well-graded sand passing a No. 30 sieve, with water added to give the consistency of thick paint, shall be prepared. White cement shall be used to replace part of the job cement. After the surface has been thoroughly wetted and allowed to approach surface dryness, the mortar shall be vigorously applied to the area by clean burlap pads or by cork or wood-floating, to completely fill all surface voids. Excess grout shall be scraped off with a trowel. As soon as it can be accomplished without pulling the mortar from the voids, the area shall be rubbed with burlap pads until all visible grout film is removed. The rubbing pads shall have on their surfaces the same sand-cement mix specified above but without any mixing water. The finish of any area shall be completed in the same day, and the limits of a finished area shall be made at natural breaks in the surface. The surface shall be continuously moist cured for 48 hours. The temperature of the air adjacent to the surface shall be not less than 50 degrees F for 24 hours prior to, and 48 hours after, the application. In hot, dry weather the smooth finish shall be applied in shaded areas.

3.8.1.3 Class B Finish

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Where a Class B finish is indicated, fins shall be removed. Concrete surface shall be smooth with a texture at least equal to that obtained through the use of Grade B-B plywood forms.

.1.4 Class C Finish

Where a Class C finish is indicated, fins shall be removed. Concrete surfaces shall be relatively smooth with a texture imparted by the forms used.

3.8.1.5 Class D Finish

Where a Class D finish is indicated, fins exceeding 1/4 inch in height shall be chipped or rubbed off. Concrete surfaces shall be left with the texture imparted by the forms used.

3.8.2 Unformed Surfaces

NOTE: Type of finish of unformed surfaces should be shown on the drawings.

For normal slab surfaces a deviation of no more than 5/16 inch will be specified. However where appearance of the finish surface is critical (such as a narrow corridor surfaced with vinyl composition tile) a flatter deviation should be specified. Where a variety of surfaces is in the design the last sentence should be expanded to cover design conditions. Classification of floor finish tolerances are as follows:

Classification	Tolerance
Conventional	
Bullfloated	1/2 inch
Straightedged	5/16 inch
Flat	3/16 inch
Very Flat	1/8 inch

In cold weather, the air temperature in areas where concrete is being finished shall not be less than 50 degrees F. In hot windy weather when the rate of evaporation of surface moisture, as determined by methodology presented in ACI 305R, may reasonably be expected to exceed 0.2 pounds per square foot per hour; coverings, windbreaks, or fog sprays shall be provided as necessary to prevent premature setting and drying of the surface. The dusting of surfaces with dry materials or the addition of water during finishing will not be permitted. Finished surfaces shall be plane, with no deviation greater than [_____] inch when tested with a 10-foot straightedge. Surfaces shall be pitched to drains.

9.2.1 Rough-Slab Finish

NOTE: Rough-slab finish is used when a bonded surface course for heavy use industrial floor is

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specified, or where roof fill or thick mortar

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setting bed is used.

Slabs to receive fill or mortar setting beds shall be screeded with straightedges immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible.

3.8.2.2 Float Finish

Slabs to receive a steel trowel finish and slabs [, where indicated,] [in the [____]] shall be given a float finish. Screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened to permit the operation and the water sheen has disappeared, it shall be wood floated. Lightweight concrete or concrete that portrays stickiness shall be finished with a magnesium float in lieu of a wood float, and left free of ridges and other projections.

Float finish is normally specified for surfaces that will receive other treatment such as built-up roofing, nonslip surfacing material or other types of dry-shake surface. It should not be specified as a wearing surface.

3.8.2.3 Trowel Finish

Slabs [, where indicated,] [in the [____]] shall be given a trowel finish immediately following floating. Surfaces shall be trowelled to produce smooth, dense slabs free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. A final hard steel troweling shall be done by hand.

Trowel finish will be specified for most wearing surfaces and where a smooth finish is required.

3.8.2.4 Two-Course Floor System

NOTE: Where the design calls for a two-course floor, this paragraph should also be used.

Otherwise it should be deleted.

A topping shall be bonded to a concrete slab left 1 inch below final grade. The floor topping mixture shall have a specified compressive strength of 6000 psi at 28 days, 1 inch maximum slump, 1/2-inch maximum size coarse aggregate and shall be proportioned to obtain required finish. The surface of the base slab shall be thoroughly cleaned by sandblasting. The base slab shall be kept continuously wet for the first 12 hours during the 24-hour period immediately prior to placing the finished floor. After all free water has evaporated or has been removed from the surface, a grout shall be scrubbed in. The grout shall be a 1.1 mixture of portland cement and sand passing the No. 30 sieve mixed to a cream-like consistency. The grout shall be applied to the floor segments. The topping course shall be immediately placed, spread, and struck off. The topping shall be thoroughly compacted by tamping or rolling, and then finished by a disc-type power float or equivalent. There shall be a minimum of two trowelings, the first of which may be applied by machine. The final, hard steel troweling shall be done by hand.

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3.8.2.5 Broom Finish

 NOTE: Broom finish will be given to exterior platforms, ramps, loading docks, stair treads, landings, and entrances. However, stair treads less than 10 inches wide with nonslip nosings need not have a broom finish.

After floating, slabs [, where indicated,] [_____] shall be lightly trowelled, and then broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.

3.8.2.6 Abrasive Finish

 NOTE: An abrasive finish will be given to main entrance and traffic aisles of warehouse type structure and to other interior surfaces where a nonslip surface is needed.

After wood floating, slabs [, where indicated,] [_____] shall be given a nonslip abrasive finish. Abrasive material shall be uniformly sprinkled over the surface at a rate of not less than 1/4 pound per square foot. The surface shall be steel-trowelled to a smooth, even finish of uniform texture. Immediately after curing, the abrasive material shall be exposed by steel brushing, rubbing with an abrasive stone, or sandblasting.

3.8.2.7 FLOOR HARDENER

 NOTE: Floor hardener should only be specified on floors where dusting of concrete would present a problem.

Floor hardener shall be applied after the concrete had been air dried for [14] [28] days. Three coats shall be applied, each the day after the preceding coat was applied. For the first application, one pound of the silicofluoride shall be dissolved in one gallon of water. For subsequent applications, the solution shall be two pounds of silicofluoride to each gallon of water. Floor should be mopped with clear water shortly after the preceding application has dried to remove encrusted salts. Proprietary hardeners shall be applied in accordance with the manufacturer's instructions. During application, area should be well ventilated. Precautions shall be taken when applying silicofluorides due to the toxicity of the salts. Any compound that contacts glass or aluminum should be immediately removed with clear water.

3.9 CURING AND PROTECTION

3.9.1 General

1 concrete shall be cured by an approved method for the period of time given below:

Concrete with Type III cement

3 days

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Concrete with Type I, II, IP or IS cement

7 days

Concrete with Type I or Type II cement
blended with pozzolan

7 days

Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Air and forms in contact with concrete shall be maintained at a temperature above 50 degrees F for the first 3 days and at a temperature above 32 degrees F for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. All materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat shall be permitted near or in direct contact with the concrete at any time. Curing shall be accomplished by any of the following methods, or combination thereof, as approved.

3.9.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period. If water or curing materials used stains or discolors concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 2-inch minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene-coated burlap or saturated burlap.

3.9.3 Membrane Curing

Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete; except a styrene acrylate or chlorinated rubber compound meeting ASTM C 309, Class B requirements may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. Surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. Compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage in accordance with the manufacturer's printed instructions. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. On surfaces permanently exposed to view, the surface shall be shaded from direct rays of the sun for the duration of the curing period. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.10 SETTING BASE PLATES AND BEARING PLATES

NOTE: Damp-pack bedding mortar will be specified for setting base and bearing plates, except that nonshrink grout will be specified where design requires precision setting of plates or requires that bedding material have high resistance to shear, impact, or vibration, and where good damp packing is difficult or impossible. When using nonshrink grout on important structures, such as large machinery bases, the grout should be required to meet ASTM C 1107.

After being properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be set to the proper line and elevation with damp-pack bedding mortar, except where nonshrink grout is indicated. The thickness of the mortar or grout shall be approximately 1/24 the width of the plate, but not less than 3/4 inch. Concrete and metal surfaces in contact with grout shall be clean and free of oil and grease, and concrete surfaces in contact with grout shall be damp and free of laitance when grout is placed.

3.10.1 Damp-Pack Bedding Mortar

Damp-pack bedding mortar shall consist of 1 part cement and 2-1/2 parts fine aggregate having water content such that a mass of mortar tightly squeezed in the hand will retain its shape but will crumble when disturbed. The space between the top of the concrete and bottom of the bearing plate or base shall be packed with the bedding mortar by tamping or ramming with a bar or rod until it is completely filled.

3.10.2 Nonshrink Grout

Nonshrink grout shall be mixed and placed in accordance with material manufacturer's written recommendations. Forms of wood or other suitable material shall be used to retain the grout. The grout shall be placed quickly and continuously, completely filling the space without segregation or bleeding of the mix.

3.10.3 Treatment of Exposed Surfaces

For metal-oxidizing nonshrink grout, exposed surfaces shall be cut back 1 inch and immediately covered with a parget coat of mortar consisting of 1 part portland cement and 2-1/2 parts fine aggregate by weight, with sufficient water to make a plastic mixture. The parge coat shall have a smooth finish. For other mortars or grouts, exposed surfaces shall be left untreated. Curing shall comply with paragraph CURING AND PROTECTION.

ADDITIONAL NOTES

NOTE A: For additional information on the use of all CEGS, see CEGS-01000 CEGS GENERAL NOTES.

NOTE B: This specification covers concrete work primarily for buildings, but may also be used for other applications such as wharves, docks, walks,

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curbs, gutters, drainage structures, warehouse type

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slabs, and driveways. The following guide specifications are relative to this section and will be included to the extent applicable in projects where this section is used:

Section 03100 STRUCTURAL CONCRETE FORMWORK
Section 03200 CONCRETE REINFORCEMENT
Section 03250 EXPANSION JOINTS, CONTRACTION
JOINTS, AND WATERSTOPS

Specifications on concrete for bridge construction should be in a separate section and should be essentially in agreement with concrete construction requirements in the American Association of State Highway and Transportation Officials, "Standard Specifications for Highway Bridges." Requirements for deck slabs, curbs, gutters, and sidewalks forming an integral part of the bridge should be included in the section concerning concrete for bridge construction.

NOTE C: Enter the proper grade based on the following guidance:

Grade A provides for 0.0 percent shrinkage in the plastic state since the volume control of the grout is caused by expansion before hardening occurs.

Grade B is the least restrictive of all grades; volume control of the grout is caused by expansion after grout hardens.

Grade C provides for a grout that shows 0.0 percent shrinkage in both the plastic and hardened states and is best suited for precision applications.

-- End of Section --

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APPENDIX E

**USACE GUIDE SPECIFICATION MILITARY CONSTRUCTION:
SECTION 03100 STRUCTURAL CONCRETE FORMWORK**

GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION

Includes summary Special change (December 1992)
Includes Changes through Notice 5 (February 1993)
Includes submittal Special change 1 (March 1991)
Includes Text Adjustment change 1 (February 1992)

Latest Change indicated by \&\ tokens

SECTION 03100

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NOTE: This guide specification covers the
requirements for formwork for cast-in-place
concrete and will be used with Section 03300
CONCRETE FOR BUILDING CONSTRUCTION. Formwork for
architectural cast-in-place concrete is specified in
Section 03330 CAST-IN-PLACE ARCHITECTURAL CONCRETE.
This guide specification is to be used in the
preparation of project specifications in accordance
with ER 1110-345-720.

<<Topic topicid="P1">PART 1 GENERAL

NOTE: See Additional Note A.

1.1 REFERENCES

NOTE: Issue (date) of references included in
project specifications need not be more current than
provided by the latest change (Notice) to this guide
specification.

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.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 347R

(1988) Guide to Formwork for Concrete

AMERICAN HARDBOARD ASSOCIATION (AHA)

<<Topic topicid="P2">

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1

(1983) Construction and Industrial
Plywood

1.2 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL DESCRIPTIONS:

SD-01 Data

\&Design&\; [____].

Design analysis and calculations for form design and methodology used in the design.

Concrete Formwork; [____].

Manufacturer's data including literature describing form materials, accessories, and form releasing agents.

SD-04 Drawings

Concrete Formwork; [____].

Drawings showing details of formwork including, dimensions of fiber voids, joints, supports, studding and shoring, and sequence of form and shoring removal.

SD-06 Instructions

Form Releasing Agents; [____].

Manufacturer's recommendation on method and rate of application of form releasing agents.

SD-13 Certificates

Fiber Voids; [____].

Certificates attesting that fiber voids conform to the specified

requirements.

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Fiber Voids; [____].

One sample unit of fiber voids prior to installation of the voids.

1.3 \&DESIGN&\

Formwork shall be designed in accordance with methodology of ACI 347R for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the class of finish specified in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

<<Topic topicid="P3">PART 2 PRODUCTS

2.1 FORM MATERIALS

NOTE: This paragraph should be edited to reflect project requirements. Description of classes of finish are contained in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION.

2.1.1 Forms For Class A and Class B Finish

Forms for Class A and Class B finished surfaces shall be plywood panels conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels. Forms for round columns shall be the prefabricated seamless type.

2.1.2 Forms For Class C Finish

Forms for Class C finished surfaces shall be shiplap lumber; plywood conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II; tempered concrete form hardboard conforming to AHA A135.4; other approved concrete form material; or steel, except that steel lining on wood sheathing shall not be used. Forms for round columns may have one vertical seam.

2.1.3 Forms For Class D Finish

Forms for Class D finished surfaces, except where concrete is placed against earth, shall be wood or steel or other approved concrete form material.

2.1.4 Retain-In-Place Metal Forms

Retain-in-place metal forms for concrete slabs and roofs shall be as specified in Section 05300 STEEL DECKING.

.1.5 Pan-Form Units

Pan-form units for one-way or two-way concrete joist and slab construction shall be factory-fabricated units of the approximate section indicated.

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Units shall consist of steel or molded fiberglass concrete form pans.
Closure units shall be furnished as required.

2.1.6 Form Ties

Form ties shall be factory-fabricated metal ties, shall be of the removable or internal disconnecting or snap-off type, and shall be of a design that will not permit form deflection and will not spall concrete upon removal. Solid backing shall be provided for each tie. Except where removable tie rods are used, ties shall not leave holes in the concrete surface less than 1/4 inch nor more than 1 inch deep and not more than 1 inch in diameter. Removable tie rods shall be not more than 1-1/2 inches in diameter.

2.1.7 Form Releasing Agents

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

2.1.8 \&Fiber Voids&\

Fiber voids shall be the product of a reputable manufacturer regularly engaged in the commercial production of fiber voids. The voids shall be double faced, corrugated fiberboard, constructed of waterproof paper and laminated with waterproof adhesive and shall be of the size shown on the drawings. The voids shall be designed to support not less than 1000 psf, and shall not lose more than 15% of their original strength after being completely submerged in water for 24 hours and then dried naturally. Fiber voids shall be assembled with steel banding at 4'-0" on center maximum, or by adequate stapling, provided liners and flutes are impregnated with a waterproofing as recommended by the manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Formwork

Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION and conforming to construction tolerance given in TABLE 1. Where concrete surfaces are to have a Class A \&or&\ Class B finish, joints in form panels shall be arranged as approved. Where forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms to be reused shall be cleaned of mortar from previous concreting and of all other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

3.1.2 Fiber Voids

Voids shall be placed on a smooth firm bed of suitable material so as not to be displaced vertically and \&shall&\ be set tight, with no buckled

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cartons, in order that horizontal displacement cannot take place. Each

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section of void shall have its ends sealed by dipping in waterproofing wax, with any additional cutting of voids at the job site to be field dipped in the same type of wax sealer, unless liners and flutes are completely impregnated with waterproofing. Prior to placing reinforcement, the entire formed area for slabs shall be covered with a 4 feet x 8 feet minimum x 0.100-inch thick waterproofed solid fiberboard cover. Joints shall be sealed with a waterproof tape having a minimum width of 3 inches. If voids are destroyed or damaged for any reason and are not capable of supporting the design load, they shall be replaced prior to placing of concrete.

3.2 CHAMFERING

Except as otherwise shown, external corners that will be exposed shall be chamfered, beveled, or rounded by moldings placed in the forms.

3.3 COATING

Forms for Class A and Class B finished surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for Class C and D finished surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures coating shall be mandatory. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.4 REMOVAL OF FORMS

Forms shall be removed in a manner that will prevent injury to the concrete and ensure the complete safety of the structure. Formwork for columns, walls, side of beams and other parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement. Supporting forms and shores shall not be removed from beams, floors and walls until the structural units are strong enough to carry their own weight and any other construction or natural loads. In no case will supporting forms or shores be removed before the concrete strength has reached 70 percent of design strengths as determined by field cured cylinders or other approved methods. This strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test strengths and the strength of forming and shoring system. The job-cured test specimens for form removal purposes shall be provided in numbers as directed and shall be in addition to those required for concrete quality control. The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent.

TABLE 1

TOLERANCES FOR FORMED SURFACES

- | | |
|---|---|
| 1. Variations from the plumb: | In any 10 feet of length ----- 1/4 inch |
| a. In the lines and surfaces of columns, piers, walls and in arises | Maximum for entire length ----- 1 inch |

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- b. For exposed corner columns, control-joint grooves, and other conspicuous lines In any 20 feet of length ----- 1/4 inch
Maximum for entire length ---- 1/2 inch
2. Variation from the level or from the grades indicated on the drawings: In any 10 feet of length ----- 1/4 inch
In any bay or in any 20 feet of length ----- 3/8 inch
- a. In slab soffits, ceilings, beam soffits, and in arises, measured before removal of supporting shores Maximum for entire length ---- 3/4 inch
- b. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines In any bay or in any 20 feet of length ----- 1/4 inch
Maximum for entire length ---- 1/2 inch
3. Variation of the linear building lines from established position in plan In any 20 feet ----- 1/2 inch
Maximum ----- 1 inch
4. Variation of distance between walls, columns, partitions 1/4 inch per 10 feet of distance, but not more than 1/2 inch in any one bay, and not more than 1 inch total variation
5. Variation in the sizes and locations of sleeves, floor openings, and wall opening Minus ----- 1/4 inch
Plus ----- 1/2 inch
6. Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls Minus ----- 1/4 inch
Plus ----- 1/2 inch
7. Footings:
- a. Variation of dimensions in plan Minus ----- 1/2 inch
Plus ----- 2 inches when formed or plus 3 inches when placed against unformed excavation
- b. Misplacement of eccentricity 2 percent of the footing width in the direction of misplacement but not more than ----- 2 inches
- c. Reduction in thickness Minus ----- 5 percent of specified thickness
8. Variation in steps: Riser ----- 1/8 inch
- a. In a flight of stairs Tread ----- 1/4 inch
- b. In consecutive steps Riser ----- 1/16 inch
Tread ----- 1/8 inch

ADDITIONAL NOTES

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NOTE A: For additional information on the use of

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all CEGS, see CEGS-01000 CEGS GENERAL NOTES.

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-- End of Section --

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ALL COPS, AND COPS-2100 COPS GENERAL NOTES.

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-- End of Section --

APPENDIX F

**USACE GUIDE SPECIFICATION MILITARY CONSTRUCTION:
SECTION 02241 AGGREGATE BASE COURSE**

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, TULSA DISTRICT

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TULSA DISTRICT GUIDE SPECIFICATION

SECTION 02241

AGGREGATE BASE COURSE
04/92

NOTE: This guide specification covers the requirements for \@base course for roads and streets and for airfield pavements designed for light loads, Type B and C traffic areas for medium loads, overruns, and Type D traffic area@\. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-720.

PART 1 GENERAL

NOTE: See Additional Note A.

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

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.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|----------------|--|
| \-ASTM C 29-\ | \&(1991a)&\ Unit Weight and Voids in Aggregate |
| \-ASTM C 127-\ | (1988) Specific Gravity and Absorption of Course Aggregate |
| \-ASTM C 128-\ | (1988) Specific Gravity and Absorption of |

Fine Aggregate

\-ASTM C 131-\

(1989) Resistance to Degradation of
Small-Size Coarse Aggregate by Abrasion and
Impact in the Los Angeles Machine

\-ASTM C 136-\

(1984a) Sieve Analysis of Fine and Coarse
Aggregates

\-ASTM D 75-\

(1987) Sampling Aggregates

\-ASTM D 422-\

(1963; R 1990) Particle-Size Analysis of
Soils

\-ASTM D 1556-\

(1990) Density \& Unit Weight\ of
Soil in Place by the Sand-Cone Method

\-ASTM D 1557-\

\&(1991) Laboratory Compaction
Characteristics of Soil Using Modified Effort
(56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))\&

\-ASTM D 2167-\

(1984; R 1990) Density and Unit Weight of
Soil in Place by the Rubber Balloon Method

\-ASTM D 2922-\

\&(1991)\& Density of Soil and
Soil-Aggregate in Place by Nuclear Methods
(Shallow Depth)

\-ASTM D 4253-\

(1991) Maximum Index Density and Unit
Weight of Soils Using a Vibratory Table

\-ASTM D 4318-\

(1984) Liquid Limit, Plastic Limit, and
Plasticity Index of Soils

\-ASTM D 4643-\

(1987) Determination of Water (Moisture)
Content of Soil by the Microwave Oven Method

\-ASTM E 11-\

(1987) Wire-Cloth Sieves for Testing
Purposes

1.2 UNIT PRICE

NOTE: Paragraphs Measurement for Payment and Basis
for Payment will be deleted when lump-sum payment is
desired.

1.2.1 Measurement for Payment

NOTE: Method of measurement not applicable to job
conditions will be deleted.

[The quantity of aggregate base course completed and accepted as determined

by the Contracting Officer will be measured in [square yards.] [cubic yards.] [2000-pound tons of aggregate used in the accepted work.]] [The volume of aggregate base course in-place and accepted will be determined by the average job thickness specified and the dimensions indicated.]

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1.2.2 Basis for Payment

Payment for aggregate base course on the tonnage basis will be allowed if more economical than the square yard or cubic yard basis.

Payment for aggregate base course, constructed and accepted, will be made at the respective contract unit price in the unit price schedule. No payment will be made for any material wasted, used for the convenience of the Contractor, unused or rejected, or for water used.

1.3 DEFINITIONS

1.3.1 Aggregate Base

Aggregate base as used herein is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.3.2 Degree of Compaction

Degree of compaction is a percentage of the maximum laboratory dry density obtained by the test procedure presented in \-ASTM D 1557-\ or \-ASTM D 4253-\. \-ASTM D 1557-\ shall be used for soils containing 15 percent or more passing the no. 200 sieve (fines). \-ASTM D 4253-\ shall be used for soils containing 5 percent or less fines. The maximum laboratory dry density for soils containing between 5 and 15 percent fines shall be determined by the above procedure yielding the highest laboratory dry density. The percentage of material passing the no. 200 sieve shall be determined in accordance with \-ASTM D 4253-\. Degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained by the appropriate procedure as defined above. Percentage of maximum laboratory dry density has been abbreviated hereinafter as percent laboratory maximum density.

1.4 GENERAL

The work specified herein consists of the construction of an aggregate base course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes and typical sections shown in the plans. Sources of all materials shall be selected well in advance of the time that materials will be required in the work.

1.5 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\

SUBMITTAL DESCRIPTIONS:

SD-01 Data\

Plant, Equipment, Machines, and Tools\; *[____]*\.

List of proposed equipment to be used in performance of construction work including descriptive data.

SD-09 Reports\

Sampling and Testing\; *[____]*\.

Field Density\; *[____]*\.

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within [24] [____] hours after the tests are performed. Certified copies of test results for approval not less than [30] [____] days before material is required for the work.

SD-18 Records\

Waybills and Delivery Tickets\; *[____]*\.

Coarse Aggregate\; *[____]*\.

Copies of waybills and delivery tickets during the progress of the work. Certified waybills and delivery tickets for all materials actually used. A notification stating which type of coarse aggregate is to be used.

1.6 *WAYBILLS AND DELIVERY TICKETS*\

NOTE: This paragraph will be deleted when lump-sum payment is desired.

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all aggregates actually used in the construction.

1.7 WEATHER LIMITATIONS

Base shall not be constructed when the atmospheric temperature is less than 35 degrees F. Base shall not be constructed on subgrades that are frozen or contain frost. If the temperature falls below 35 degrees F, completed areas shall be protected against any detrimental effects of freezing.

1.8 *PLANT, EQUIPMENT, MACHINES, AND TOOLS*\

1.8.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to

approval and shall be maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. The equipment shall be adequate and have the capability of producing the results specified.

1.8.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type weighing not less than 10 tons, with a minimum weight of 300 pounds per inch width of rear wheel. Wheels of the rollers shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.

1.8.3 Pneumatic-Tired Rollers

NOTE: Types of equipment specified but not required
in this type of base course will be deleted, and
other items of equipment not listed will be added as
appropriate.

Pneumatic-tired rollers shall have four or more tires, each loaded to a minimum of 30,000 pounds and inflated to a minimum pressure of 150 psi. The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Towing equipment shall also be pneumatic-tired.

8.4 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. The spreader shall contain a hopper, an adjustable screed, and outboard bumper rolls and be designed to have a uniform, steady flow of material from the hopper. The spreader shall be capable of laying material without segregation across the full width of the lane to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers shall conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

1.8.5 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

1.8.6 Tamers

Tamers shall be of an approved mechanical type, operated by either pneumatic pressure or internal combustion, and shall have sufficient weight and striking power to produce the compaction required.

1.8.7 Straightedge

The Contractor shall furnish and maintain at the site, in good condition,

one [10-] [12-] foot straightedge for each bituminous paver, for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

1.9 STOCKPILING MATERIALS

Materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at locations designated. Before stockpiling of material, storage sites shall be cleared, and sloped to drain. Materials obtained from different sources shall be stockpiled separately.

1.10 *SAMPLING AND TESTING*\

1.10.1 General Requirements

NOTE: Guidance for preparation of criteria to be used in evaluating laboratory facilities is contained in ASTM E 548.

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing shall be permitted until the facilities have been inspected and approved. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Tests shall be performed in sufficient numbers and at the locations and times directed to insure that materials and compaction meet specified requirements. Copies of test results shall be furnished to the Contracting Officer within 24 hours of completion of tests.

1.10.2 Test Results

Results shall verify that materials comply with this specification. When a material source is changed, the new material will be tested for compliance. When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or modified as directed by the Contracting Officer.

1.10.3 Sampling

Aggregate samples for laboratory tests shall be taken in accordance with \-ASTM D 75-\.

1.10.4 Sieve Analysis

Before starting work, at least one sample of material shall be tested in accordance with \-ASTM C 136-\ and \-ASTM D 422-\ on sieves conforming to \-ASTM E 11-\ . After the initial test, a minimum of one analysis shall be performed for each 1000 tons of material placed, with a minimum of three analyses for each day's run until the course is completed.

1.10.5 Liquid Limit and Plasticity Index

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One liquid limit and plasticity index shall be performed for each sieve analysis. Liquid limit and plasticity index shall be in accordance with \-ASTM D 4318-\ . A minimum of one liquid limit and plastic limit test shall be run each day.

1.10.6 Laboratory Density

Tests shall provide a moisture-density relationship for the aggregate. Tests shall be conducted in accordance with \-ASTM D 1557-\ , Method D.

1.10.7 Weight Per Cubic Foot of Slag

Weight per cubic foot of slag shall be determined in accordance with \-ASTM C 29-\ .

1.10.8 Wear Tests

Wear tests shall be performed in accordance with \-ASTM C 131-\ . One test shall be run per [] square yards of completed base course. A minimum of one test per aggregate source shall be run.

1.10.9 Optimum Moisture and Laboratory Maximum Dry Density

The laboratory maximum dry density shall be determined from materials obtained at a sand cone test location using the appropriate procedure specified in Part 1 above. When \-ASTM D 1557-\ is used, the optimum moisture content shall be determined. A minimum of one laboratory maximum dry density test shall be run each placement day or fraction thereof. Additional laboratory maximum dry density tests shall be run for each material change.

PART 2 PRODUCTS

2.1 MATERIALS

NOTE: See Additional Note B.

2.1.1 Aggregates

Aggregates shall consist of crushed stone or slag, crushed gravel, angular sand, or other approved material. Aggregates shall be durable and sound, free from lumps of clay, organic matter, objectionable coatings, and other foreign material. Material retained on a No. 4 sieve shall be known as coarse aggregate and that passing the No. 4 sieve shall be known as binder material.

2.1.1.1 *Coarse Aggregate*\

NOTE: Selection of the type of coarse aggregate will be the Contractor's option.

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Only one type of coarse aggregate shall be used on the project. Coarse aggregates, consisting of angular fragments of uniform density and quality, shall have a percentage of wear not to exceed 50 percent after 500 revolutions when tested in accordance with \-ASTM C 131-\. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3, and an elongated particle is one having a ratio of length to width greater than

3.

a. Crushed Gravel: Crushed gravel shall be manufactured from gravel particles 50 percent of which by weight are retained on the maximum size gradation sieve specified.

b. Crushed Stone: Crushed stone retained on each sieve specified shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are adjacent, the angle between the planes of the fractures must be at least 30 degrees to count as two fractured faces.

2.1.1.2 Slag

Slag shall be an air-cooled blast-furnace product having a dry unit weight of not less than 65 pcf.

2.1.2 Binder Material

NOTE: Aggregate should be nonplastic or as nearly so as possible. Values shown are the absolute maximum allowable values for liquid limit and plasticity index.

Binder material shall consist of screenings, angular sand, or other finely divided mineral matter processed or naturally combined with the coarse aggregate. Liquid-limit and plasticity-index requirements shall apply to any component that is blended to meet the required gradation and shall also apply to the completed course. The portion of any component or of the completed course passing the No. 40 sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

2.1.3 Gradation

NOTE: See Additional Note C.

Requirements for gradation specified shall apply to the completed base course. The aggregates shall have a [2] [1-1/2] [1] maximum size and shall be continuously graded within the following limits:

Sieve

Percentage by Weight Passing

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Designation	Square-mesh Sieve (a) (b)
2-inch	---
1-1/2-inch	100
1-inch	60-100
1/2-inch	30-65
No. 4	20-50
No. 10	15-40
No. 40	5-25
No. 200	0-8

(a) Particles having diameters less than 0.02 millimeter shall not be in excess of 3 percent by weight of the total sample tested.

(b) The values are based on aggregates of uniform specific gravity, and the percentages passing the various sieves are subject to appropriate correction in accordance with \-ASTM C 127-\ and \-ASTM C 128-\ when aggregates of varying specific gravities are used.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the base is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF AGGREGATE SOURCES

NOTE: Investigate the availability of
Government-owned aggregate source that meets the
specification requirement. If none is available,
delete material in the first set of brackets.

Aggregates shall be obtained from off-site sources.

3.3 PREPARATION OF UNDERLYING COURSE

NOTE: Reference to the applicable specification
section will be retained. Proper compaction of
cohesionless materials may be obtained by other
methods based on local experience.

3.3.1 General Requirements

Before constructing aggregate base course, the previously constructed underlying course shall be cleaned of foreign substances. Surface of underlying course shall meet the specified compaction and surface tolerances. Subgrade shall conform to [Section \=02240=\ LIME MODIFIED SUBGRADE]. [Granular subbase course shall conform to [Section \=02234=\ SUBBASE COURSE]]. Ruts or soft, yielding spots that may appear in the underlying course, areas having inadequate compaction, and deviations of the surface from requirements specified shall be corrected. For cohesionless underlying materials containing sands, sand gravels, or any other cohesionless material in harmful quantities, the surface shall be mechanically stabilized with aggregate prior to placement of the aggregate course. Stabilization may be accomplished by mixing base course material into the underlying course and compacting by approved methods. Properly compacted material will be considered as part of the underlying course and shall meet all requirements for the underlying course. Finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until base course is placed.

3.3.2 Grade Control

Underlying material shall be excavated to sufficient depth for the required base course thickness so that the finished base course with the subsequent surface course will meet the fixed grade. Finished and completed area shall conform to the lines, grades, cross section, and dimensions indicated.

3.4 INSTALLATION

3.4.1 Mixing and Placing

NOTE: More details of mixing methods will be included if applicable.

Materials shall be mixed by the stationary plant, traveling plant, or road mix method and placed in such a manner as to obtain uniformity of the aggregate base course material and at a uniform optimum water content for compaction. The Contractor shall make such adjustments in mixing or placing procedures or in equipment to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to ensure a satisfactory base course.

3.4.2 Edges of Base Course

Approved material shall be placed along edges of aggregate base course in such quantities as will compact to thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 1-foot width of the shoulder to be rolled and compacted simultaneously with rolling and compacting of each layer of base course.

3.4.3 Compaction

NOTE: Appropriate percentage will be inserted.

Each layer of aggregate base course [including shoulders] shall be compacted. Water content shall be maintained at optimum. Density of compacted mixture shall be at least [100] [_____] percent of laboratory maximum density. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. Areas inaccessible to the rollers shall be compacted with mechanical tampers, and shall be shaped and finished by hand methods.

3.4.4 Layer Thickness

Compacted thickness of the aggregate course shall be [as indicated] [(_____) inches]]. No layer shall be in excess of 8 inches nor less than 3 inches in compacted thickness.

3.4.5 Proof Rolling

NOTE: See Additional Note D.

Proof rolling of the areas indicated shall be in addition to the compaction specified and shall consist of the application of 30 coverages with a heavy pneumatic-tired roller having four or more tires, each loaded to a minimum of 30,000 pounds and inflated to a minimum of 150 psi. In areas designated, proof rolling shall be applied to the top lift or layer on which base course is laid and to each layer of base course. Water content of the top lift or layer on which base course is laid shall be maintained at optimum or at percentage directed from start of compaction to completion of proof rolling of that layer. Water content of each layer of the base course shall be maintained at the optimum percentage directed from start of compaction to completion of proof rolling. Materials in base course or underlying materials that produce unsatisfactory results by rolling shall be removed and replaced with satisfactory materials and recompacted.

3.4.6 Finishing

The surface of the top layer shall be finished to grade and cross section shown. Finished surface shall be of uniform texture. Light blading during compaction may be necessary for the finished surface to conform to the lines, grades, and cross sections. Should the surface for any reason become rough, corrugated, uneven in texture, or traffic marked prior to completion, such unsatisfactory portion shall be scarified, reworked, recompacted, or replaced as directed.

3.4.6.1 Smoothness

Surface of each layer shall show no deviations in excess of 3/8 inch when tested with the [10-] [12-] foot straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed.

3.4.6.2 Thickness Control

NOTE: See Additional Note E.

Compacted thickness of the base course shall be within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated.

3.5 FIELD QUALITY CONTROL

3.5.1 \+*Field Density*\+

A sufficient quantity of material shall be obtained from the sand cone test location to determine the maximum laboratory dry density, gradation, liquid limit, and plastic limit. A gradation test shall be run on the sample prior to determining the maximum laboratory dry density. A portion of the sampled material passing the no. 40 sieve shall be tested to determine the liquid limit and plasticity index. Additional tests shall be run for each material change.

3.5.1 Field Density and Moisture Content

Field in-place density shall be determined in accordance with \-ASTM D 1556- \ or \-ASTM D 2922-\ . If \-ASTM D 2922-\ is used, in-place densities shall be checked by ASTM D 1556 at least once per each 8 nuclear density tests and at least once per each lift placed. The sand cone test shall be performed adjacent to the location where a nuclear density test was taken to ensure a proper correlation is established between the two methods. Moisture contents shall be determined in accordance with \-ASTM D 4643-\ or -\ASTM D 2216-\ . If ASTM D 4643 is used, moisture contents shall be checked by ASTM D 2216 once per each ten microwave tests. The laboratory tests specified in paragraph 1.10 shall be run on materials obtained from a sand cone test sample location. At least one field density and one moisture content test shall be performed for each 1,000 square yards of each layer of stabilized aggregate base material placed.

3.5.2 \+Smoothness+\

Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a 10 foot straightedge. Measurements shall also be taken perpendicular to the road centerline at [50] [_____] foot intervals.

3.5.3 \+Thickness+\

Thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each [1,000] [_____] square yards of base course. Measurements shall be made in 3-inch diameter test holes penetrating the base course.

3.6 TRAFFIC

Completed portions of the area may be opened to traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

3.7 MAINTENANCE

The aggregate base course shall be maintained in a satisfactory condition until accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact.

3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for the base course material that is removed for the required correction of defective areas, and waste material and debris shall be disposed of [as directed] [in waste disposal areas indicated].

ADDITIONAL NOTES

NOTE A: For additional information on the use of all CEGS, see CEGS-01000 CEGS GENERAL NOTES.

NOTE B: Materials requirement from State or other local highway agency specifications may be incorporated in contract documents for constructing aggregate base course for roads, streets, or similar-use pavements if the following conditions are met:

a. Percentage of material by weight passing the No. 200 sieve shall not exceed 10.

b. Where local conditions dictate a non-frost-susceptible material, particles having a diameter of less than 0.02 millimeter shall not exceed 3 percent.

c. Portion of the material passing the No. 40 (425 micron) sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 5.

d. State or other local highway specifications selected for projects requiring not more than 750 cubic yards of material must be approved by the Division Engineer.

e. State or other local highway specifications selected for projects requiring more than 750 cubic yards must be approved by the Chief of Engineers prior to incorporation in the contract documents. A copy of the specifications or proper reference thereto and information regarding traffic conditions and facilities to be paved will be submitted to the HQDA (CEMP-ET), with the request for approval.

f. Rounded aggregates (such as river-run gravel) generally will not be allowed since they do not

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provide sufficient interlocking action to produce the desired compaction.

NOTE C: Desired gradation size and maximum aggregate size will be selected. On the basis of local conditions, the percentage passing the No. 200 sieve may be further restricted to help control the amount of particles having diameters less than 0.02 millimeter. The frost susceptibility requirement will be deleted in areas where the material is not subject to frost action.

NOTE D: Drawings should be checked to ensure that any supplementary information required by the paragraph has been shown and that there is no conflict between the drawings and the specifications.

When aggregate base course is used in medium-load airfield runway pavement construction, this paragraph will be retained; when used otherwise, references to proof rolling will be deleted unless it is specifically required by the design engineer.

NOTE E: When aggregate base courses are constructed less than 6 inches in total thickness, a deficiency of 1/2 inch in thickness of any area of such paving is considered excessive. Applicable to job conditions, the thickness-tolerance provisions may be modified as required, restricting all deficiencies to not over 1/4 inch.

-- End of Section --

APPENDIX G

**USACE GUIDE SPECIFICATION MILITARY CONSTRUCTION:
SECTION 02200 EARTH WORK**

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DEPARTMENT OF THE ARMY, TULSA DISTRICT
U.S. ARMY CORPS OF ENGINEERS

CEGS-02200 (Mar 93)JRP

TULSA DISTRICT GUIDE SPECIFICATION

SECTION 02200

EARTHWORK (MINOR REQUIREMENTS)

NOTE: This section covers earthwork for buildings, roadways and parking areas, utility trenches, and grading. It may be used for projects where all of the above is generally of a minor nature, for instance building projects with less than 5000 SF ground floor area with parking area and service line type utilities. This section will replace sections 02110, 02210, 02221, 02222, & 02225.

PART 1 GENERAL

1.1 REFERENCES

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.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- \-ASTM C 33-\ (1990) Concrete Aggregates
- \-ASTM C 136-\ (1984a) Sieve Analysis of Fine and Coarse Aggregates
- \-ASTM D 422-\ (1963, R-1990) Particle Size Analysis of Soils
- \-ASTM D 1556-\ (1990) Density of Soil in Place by the Sand-Cone Method
- \-ASTM D 1557-\ (1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft (2,700 kN-m/m))
- \-ASTM D 2216-\ (1992) Laboratory Determination of Water (Moisture) Content of Soil and Rock
- \-ASTM D 2487-\ (1992) Classification of Soils for Engineering Purposes
- \-ASTM D 2922-\ (1991) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- \-ASTM D 2937-\ (1983; R 1990) Density of Soil in Place by the Drive-Cylinder Method
- \-ASTM D 4253-\ (1991) Maximum Index Density and Unit

Weight of Soils Using a Vibratory Table

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ASTM D 4318-(1984) Liquid Limit, Plastic Limit,
and Plasticity Index of Soils

ASTM D 4643-

(1987) Determination of Water (Moisture)
Content of Soil by the Microwave Oven Method

1.2 DEGREE OF COMPACTION

Degree of compaction is a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D 1557- or ASTM D 4253-. ASTM D 1557- shall be used for soils containing 15 percent or more passing the no. 200 sieve (fines). ASTM D 4253- shall be used for soils containing 5 percent or less fines. The maximum laboratory dry density for soils containing between 5 and 15 percent fines shall be determined by the above procedure yielding the highest laboratory dry density. The percentage of material passing the no. 200 sieve shall be determined in accordance with ASTM D 4253-. Degree of compaction shall be expressed as a percentage of the maximum laboratory dry density obtained by the appropriate procedure as defined above. Percentage of maximum laboratory dry density has been abbreviated hereinafter as percent laboratory maximum density.

PART 2 PRODUCTS

2.1 MATERIALS:

2.1.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified in ASTM D 2487-, as GW, GP, GC, GM, SW, SP, SM, SC, CL, and CH.

2.1.2 Unsatisfactory Materials

Unsatisfactory materials shall comprise any materials classified in ASTM D 2487-, as PT, OH, OL, ML and MH.

2.1.3 Cohesionless and Cohesive Materials

Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Cohesionless materials include materials classified in ASTM D 2487-, as GW, GP, SW, and SP. Materials classified as GM and SM are identified as cohesionless only when the fines have a plasticity index of zero. Additional particle size analysis shall be made as necessary using ASTM C 136- or ASTM D 422- as applicable.

2.1.4 Nonexpansive Fill

Nonexpansive fill shall be satisfactory material having a plasticity index less than or equal to 12.

2.1.5 Unyielding Material

Unyielding material shall consist of rock and gravelly soils with stones greater than 3 inches in any dimension.

2.1.6 Unstable Material

Unstable material shall consist of materials too wet to properly support

the utility pipe, conduit, or appurtenance structure.

2.1.7 Granular Material

Granular materials shall be sand, crushed stone, crushed gravel, or pea gravel conforming to the requirements of \-ASTM C 33-\, gradation size 67 as follows:

Sieve Size	Percent Passing
1"	100
3/4"	90 to 100
3/8"	20 to 55
No. 4	0 to 10
No. 200	0 to 5

2.1.8 Select Backfill Material

Select backfill material for trench backfill shall consist of satisfactory material free from stones larger than 2 inches in any dimension except that where the pipe is coated or wrapped for protection against corrosion, the backfill material shall be free of stones larger than 1 inch in any dimension.

2.1.9 Capillary Water Barrier

Capillary water barrier under concrete floor slabs on grade shall consist of clean, crushed, nonporous rock, crushed gravel, or uncrushed gravel. The maximum particle size shall be 1-1/2 inches and no more than 2 percent by weight shall pass the No. 4 sieve size.

2.1.10 Plastic Marking Tape

Plastic marking tape shall be acid and alkali- resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified below and shall bear a continuous printed inscription describing the specific utility:

TAPE COLOR

Red	Electric
Yellow	Gas, Oil, Dangerous Materials
Orange	Telephone, Telegraph, Television, Police and Fire Communications
Blue	Water Systems
Green	Sewer Systems

2.2 CLASSIFICATION OF EXCAVATION

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

PART 3 EXECUTION

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3.1 CLEARING AND GRUBBING

[Clearing and grubbing shall conform to Section \=02110=\ CLEARING AND GRUBBING.] [The areas within lines 5 feet outside of each building and structure line shall be cleared and grubbed of trees, stumps, roots, brush, and other vegetation, debris, existing foundations, pavements, utility lines, structures, fences, and other items that would interfere with construction operations. Stumps, logs, roots, and other organic matter shall be completely removed and the resulting depressions shall be filled with satisfactory material placed and compacted in accordance with paragraph "Filling and Backfilling." Materials removed shall be disposed of [in the designated waste disposal areas] [outside the limits of Government controlled property at the Contractor's responsibility].]

3.2 STRIPPING AND CONSERVATION AND REPLACEMENT OF TOPSOIL

Topsoil shall be defined as natural, friable surface soil possessing the characteristics of representative soils in the vicinity that produce heavy growth of crops, grass, or other vegetation. Topsoil in cut or fill areas shall be stripped and spread on areas already graded and prepared for topsoil, or when so directed, topsoil shall be transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Topsoil shall be stripped to a minimum depth of 6 inches and, when stored, shall be kept separate from other excavated materials and stockpiled free of roots, stones, and other undesirable materials. Upon completion of excavation or fill, topsoil or stripping conserved shall be uniformly distributed over all disturbed areas.

3.3 BLASTING

Blasting [will] [will not] be permitted. [The Contractor shall submit a Blasting Plan and obtain written approval prior to performing any blasting. The plans shall contain provisions for storing, handling and transporting explosives as well as for the blasting operations. The Contractor shall be responsible for damage caused by blasting operations.]

3.4 EXCAVATION

After all stripping has been completed, excavation of every description, regardless of material encountered, shall be performed to the lines and grades indicated. Satisfactory excavation material shall be transported to and placed in fill areas within limits of the work. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be removed as directed and replaced with satisfactory material. Payment therefor will be made in conformance with the contract clause entitled "Changes". Satisfactory material removed below the depths indicated without specific direction of the Contracting Officer shall be replaced at no additional cost to the Government, to the indicated excavation grade with satisfactory materials, except that concrete footings shall be increased in thickness to the bottom of the overdepth excavations and overbreak in rock excavation. Provide proper drainage at all times.

3.4.1 Drainage

Excavation shall be performed so that the area of the site and the area immediately surrounding the site and affecting operations at the site will be continually and effectively drained. Water shall not be permitted to

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accumulate in excavations. The excavation shall be drained by pumping or other satisfactory methods to prevent softening of subgrades or foundations.

4.2 Ditches

Excavation of ditches shall be accomplished by cutting accurately to the cross sections, grades, and elevations shown. Care shall be taken not to excavate ditches below grades shown. Excessive open ditch excavation shall be backfilled with satisfactory, thoroughly compacted material to grades shown at no additional cost to the Government. The Contractor shall maintain all excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.4.3 Drainage Structures

Excavations shall be made accurately to the lines, grade, and elevations shown or as directed. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown.

3.4.4 Shoring

Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheeting shall be removed as excavations are backfilled, in a manner to prevent caving. In lieu of shoring, banks may be cut to backslopes in accordance with the Corps of Engineers Safety Manual.

4.5 Final Grade of Surfaces to Support Concrete

Excavation to final grade shall not be made until just before concrete is to be placed. Approximately level surfaces shall be roughened, and sloped surfaces shall be cut into rough steps or benches to provide a satisfactory bond. Subgraded surfaces for concrete boxes may be overexcavated provided the backfill consists of crushed rock, gravel, sand, or lean concrete fill leveled to provide a working surface for the structure slab. Shales shall be protected from slaking or other erosion resulting from ponding or flow of water.

3.4.6 Trench Excavation

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below and above the top of the pipe shall be sloped, or made vertical, as recommended in the manufacturer's installation manual. The trench width below the top of the pipe shall not exceed that recommended in the installation manual. Where no manufacturer's installation manuals are available, trench walls below the top of the pipe shall be vertical, and trench walls above the top of the pipe shall be sloped as required to properly complete the work. Trench width below the top of the pipe shall not exceed 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inches inside diameter, and shall not exceed 36 inches plus pipe O.D. for larger sizes.

4.6.1 Bottom Preparation

When pipe is laid directly on trench bottom, the bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Bell holes shall be excavated to the

necessary size of each joint or coupling to eliminate point bearing. Stones of 8 inches or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

3.4.6.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, such material shall be removed 4 inches below the required grade and replaced with suitable materials.

3.4.6.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with granular material specified hereinbefore. When removal of unstable material is required due to the fault or neglect of the Contractor in his performance of the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

3.4.6.4 Jacking, Boring, and Tunneling

Unless otherwise indicated, excavation shall be by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly tamped in such sections. Plans shall be submitted for approval indicating the proposed method and materials.

3.5 UTILIZATION OF EXCAVATED MATERIALS

All unsatisfactory materials removed from excavations shall be disposed of in designated waste disposal or spoil areas [or outside the limits of Government controlled land at the Contractors expense.] Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, subgrades, shoulders, and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be [disposed of in designated areas approved for surplus material storage or designated waste areas as directed], or [uniformly spread in the graded area] or [spread to uniformly widen embankment side slopes].

3.6 BORROW MATERIAL

Where satisfactory materials are not available in sufficient quantity from required excavations, borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas shown or from other approved sources, either private or within the limits of the project site. The Contractor shall obtain from the owners, the right to procure material, pay all royalties and other charges involved, and bear all expense of developing the sources, including rights-of-way for hauling. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation and shall be performed by the Contractor at no additional cost to the Government.

3.7 BACKFILL ADJACENT TO STRUCTURES

Backfill adjacent to structures shall be placed and compacted uniformly in such manner as to prevent wedging action or eccentric loading upon or against the structures. Slopes bounding or within areas to be backfilled shall be stepped or serrated to prevent sliding of the fill. During backfilling operations and in the formation of fills, equipment that will overload the structure in passing over and compacting these fills shall not be used. Backfill for storm drains and subdrains, including the bedding and backfill for structures other than culverts and drains, shall conform to the additional requirements in other applicable sections.

3.8 PREPARATION OF GROUND SURFACE FOR FILL

Vegetation, such as roots, brush, heavy sods, heavy growth of grass, and all decayed vegetable matter, rubbish and other unsatisfactory material within the area upon which fill is to be placed shall be stripped or otherwise removed before the fill is started. In no case shall unsatisfactory material remain in or under the fill area. Sloped ground surfaces steeper than 1 vertical to 4 horizontal on which fill is to be placed shall be plowed, stepped or benched, or broken, up, as directed, in such manner that the fill material will bond with the existing surface. Prepared surfaces on which compacted fill is to be placed shall be scarified wetted, or dried, as may be required to obtain the compaction specified.

3.9 CAPILLARY WATER BARRIER

The capillary water barrier shall be placed directly on the subgrade beneath the concrete floor slabs on grade and shall be compacted with minimum of two passes of a hand-operated plate-type vibratory compactor.

3.10 FILLING AND SUBGRADE PREPARATION

Satisfactory materials free from roots and debris shall be used in bringing fills to the lines and grades indicated and for replacing unsatisfactory materials. Nonexpansive soils shall be used in nonexpansive fill under building slabs. Where nonexpansive fill is indicated under floor slabs all fill under such slabs shall be nonexpansive fill. Where no fill is required or where the fill under the capillary water barrier is less than 18 inches in depth, the subgrade shall be excavated and replaced with nonexpansive fill to a minimum depth of 18 inches beneath the capillary water barrier. The subgrade below the nonexpansive fill shall be loosened to a depth of 6 inches, moistened, manipulated and recompactd as specified hereinafter. The moisture content of both the nonexpansive fill and subgrade material after compaction shall be equal to or greater than optimum moisture content. When the subgrade under buildings is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches and compacted as specified for the adjacent fill. Satisfactory material shall be placed in horizontal loose depth layers not exceeding 8 inches for fill under buildings and structures, 6 inches under road or parking areas, and 8 to 12 inches for all other areas and then compacted. Material shall not be placed on surfaces that are muddy, frozen, or contain frost.

3.11 PAVEMENT SUBGRADE PREPARATION

Pavement subgrade shall be shaped to line, grade, and cross section, and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain specified compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with

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satisfactory excavated material or other approved material as directed. Rock encountered in the cut section shall be excavated to a depth of 6 inches below finished grade for the subgrade. Low areas resulting from removal of unsatisfactory material or excavation of rock shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified. The elevation of the finished subgrade shall not vary more than 0.05 foot from the established grade and cross section.

3.12 TRENCH BACKFILL

Trenches shall be backfilled to the grade shown. The trench shall be backfilled to 2 feet above the top of pipe or to top of grade surface prior to performing the required pressure tests. The joints and couplings shall be left uncovered during the pressure test.

3.12.1 Bedding and Select Backfill:

3.12.1.1 General

Bedding material shall consist of granular material specified hereinbefore or material recommended by the pipe manufacturer. Select backfill shall be material specified hereinbefore or as recommended by the pipe manufacturer. Bedding and select backfill material shall be placed in layers of a maximum of 6 inches loose thickness and compacted with approved tampers. The backfill shall be brought up evenly on both sides of pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

3.12.1.2 Class B (First Class) bedding

All flexible pipe as defined below shall be placed in Class B bedding. Class B shall consist of a bedding material from the trench bottom to one foot over the top of the pipe and a minimum of 4 inches under the pipe.

3.12.1.3 Class C (Ordinary) bedding

All cast iron, ductile iron or vitrified clay pipe greater than 3 inches in diameter shall be placed in Class C bedding. Class C bedding shall consist of bedding material from the trench bottom up to a distance equal to 1/6 times the outside diameter of the pipe above the pipe bottom and a minimum of 4 inches under the pipe. Select backfill material shall then be placed to a minimum of one foot above the top of the pipe.

3.12.1.4 Select material backfill

All pipe not placed in bedding shall be placed with select backfill from the trench bottom to a minimum of one foot above the top of the pipe. Where trench bottom is rock, select backfill material shall also be placed to a minimum depth of 4 inches beneath pipe.

3.12.2 Final Backfill

The remainder of the trench above the bedding or select backfill except for special materials for paved areas shall be backfilled with satisfactory material. Backfill material shall be deposited as follows and compacted as specified in paragraph "Compaction".

3.12.2.1 Traffic Areas

Backfill shall be placed in accordance with paragraph: Filling and Subgrade Preparation. Water flooding or jetting methods of compaction will not be permitted.

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2.2.2 All Other Areas

Backfill shall be deposited in layers of a maximum of 12-inch loose thickness, and compacted. [Water flooding or jetting methods of compaction will be permitted for granular on-cohesive backfill material. Water jetting shall not be allowed to penetrate the initial backfill.] [Compaction by water flooding or jetting will not be permitted.] This requirement shall also apply to all other areas not specifically designated above.

3.12.3 Flexible Pipe

The following types of pipe shall be considered flexible pipe for purposes of backfill requirements.

Polypropylene
ABS
PVC
Polybutylene

Polyethylene
Reinforced Thermosetting Resin (RTRP)
Reinforced Plastic Mortar (RPMP)

3.13 SPECIAL TRENCHING REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utility trenching are as follows:

3.13.1 Gas Distribution

Trenches shall be excavated to a depth that will provide not less than 18 inches of cover in rock excavation and not less than 24 inches of cover in other excavation. Trenches shall be graded as specified for pipelaying requirements in Section \=02685=\ GAS-DISTRIBUTION SYSTEM.

3.13.2 Waterlines

Trenches shall be of a depth to provide a minimum cover of 2-1/2 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

3.13.3 Heat Distribution System

Initial backfill material shall be free of stones larger than 1/4 inch in any dimension.

3.13.4 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated. [Special trenching requirements for direct-burial electrical cables and conduits are specified in Section \=16375=\ ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND].

3.5 Plastic Marking Tape

Marking tapes shall be installed in the trench directly above the utility at a depth of [6] [12] [18] inches below finished grade.

3.14 COMPACTION

Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Unless otherwise specified, 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. Using the appropriate laboratory maximum dry density test procedure as defined in Part 1 above, each layer of fill and backfill shall be compacted to not less than the percentage of maximum density specified below:

	Percent Laboratory Maximum Density	
	ASTM D 4253	ASTM D 1557
Fill, embankment, and backfill		
Under proposed structures, building slabs, steps, and paved areas except nonexpansive fill	90	95
Under sidewalks and grassed areas	85	90
Nonexpansive fill	92	95
Subgrade		
Under building slabs, steps, and paved areas, top 12 inches	90	95
Under sidewalks, top 6 inches	85	90

3.15 FINISHING

The surface of all excavations, fills, and subgrades shall be finished to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. The degree of finish for all graded areas shall be within 0.1 foot of the grades and elevations indicated except as otherwise specified for roadway subgrades. Ditches shall be finished in a manner that will result in effective drainage. The surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials.

3.16 SUBGRADE AND FILL PROTECTION

During construction, fills, and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained in such a manner as to drain effectively at all times. The finished subgrade shall not be disturbed by traffic or other operations and shall be protected and maintained by the Contractor in a satisfactory condition until base course or pavement is placed. The storage or stockpiling of materials on the finished subgrades will not be permitted. No base course or pavement shall be laid until the subgrade has been checked and approved, and in no case shall base, surfacing, or pavement, be placed on a muddy, spongy, or frozen subgrade.

3.17 TESTING

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Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor subject to approval. If the Contractor elects to establish testing facilities, no work requiring testing will be permitted until the Contractor's facilities have been inspected and approved by the Contracting Officer. Moisture contents shall be determined in accordance with \-ASTM D 4643-\ and/or \-ASTM D 2216-\. If the \-ASTM D 4643-\ procedure is used, moisture contents shall be checked by the ASTM D 2216 procedure once per each 10 ASTM D 4643 tests. Field in-place density shall be determined in accordance with \-ASTM D 1556-\ or \-ASTM D 2922-\. If \-ASTM D 2922-\ is used, in-place densities shall be checked by the \-ASTM D 1556-\ procedure at a frequency on one sand cone test for each 8 nuclear density tests and not less than one sand cone density test per lift. The sand cone test shall be performed adjacent to the location where a nuclear density test was performed to insure a proper correlation is established between the two density test procedures. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, the material shall be removed, replaced and recompacted to meet specification requirements, at no additional expense to the Government. Tests on recompacted areas shall be performed to determine conformance with specification requirements. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

3.17.1 Moisture Content

Moisture contents shall be determined on materials obtained from each density sample location.

3.17.2 Field In-Place Density Tests:

3.17.2.1 Buildings

One test per 1000 (building 5000 sq. ft. or less), 2500 (buildings 5,000 to 20,000 sq. ft.) 5000 (buildings over 20,000 sq. ft.) square feet per lift of subgrades or fills beneath buildings but not less than one test per lift

3.17.2.2 Paved Areas

One test per 2000 square yards per lift of compacted material or fraction thereof.

3.17.2.3 Sidewalks

One test per 600 square feet of walkway surface or fraction thereof.

3.17.2.4 Turfed Areas

One test per 2500 cubic yards of compacted material, or fraction thereof.

3.17.2.5 Trenching

One test per 100 linear feet of trench per lift in paved areas and one test per 300 linear feet of trench per lift in all other areas.

3.17.3 Optimum Moisture and Laboratory Maximum Dry Density

The laboratory maximum dry density shall be determined from materials obtained at a sand cone test location using the appropriated procedure specified in Part 1 above. When \-ASTM D 1557-\ is used, the optimum moisture content shall be determined. A minimum of one laboratory maximum dry density test shall be run each placement day or fraction thereof. Additional laboratory maximum dry density tests shall be run for each material change.

3.18 DISPLACEMENT OF SEWERS

After other required tests have been performed and the trench backfill compacted to 2 feet above the top of the pipe or to the finished grade surface, the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Contracting Officer. Pipe sizes larger than 36 inches shall be entered and examined, while smaller diameter pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by use of television cameras passed through the pipe. If, in the judgment of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied.

--End of Section--

APPENDIX H

**USACE GUIDE SPECIFICATION MILITARY CONSTRUCTION:
SECTION 03250 EXPANSION JOINTS, CONTRACTION JOINTS,
AND WATERSTOPS**

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<!DOCTYPE CCBcrit SYSTEM "CCBCRIT.DTD"[]><<CCBcrit prn="y"><<Page pageid="1">
*****
DEPARTMENT OF THE ARMY                                CEGS-03250 (December 1988)
U.S. ARMY CORPS OF ENGINEERS                          -----
                                                    Superseding
                                                    CEGS-03250 (October 1987)
```

GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION

Includes summary Special change (December 1992)
Includes changes through Notice 2 (February 1993)
Includes submittal Special change 1 (March 1991)
Includes Text Adjustment 1 (November 1991)

Latest Change indicated by \&\ tokens

SECTION 03250

```
<<Xfile xname="COEASC\03250.ASC" xtype="ref" xtitle="incl"> EXPANSION JOINTS, CONTRAC
11/88
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NOTE: This guide specification covers the requirements for expansion joints, contraction joints and water stops used in concrete construction. This guide will be used in conjunction with Section 03300, CONCRETE FOR BUILDING CONSTRUCTION. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-720.

```
<<Topic topicid="P1">PART 1  GENERAL
```

NOTE: See Additional Note A.

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

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.

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4 (1982; R 1988) Basic Hardboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

007466

ASTM D 1751
(1991)

(1983; R 1991) Preformed Expansion Joint

Filler for Concrete Paving and Structural
Construction (Nonextruding and Resilient
Bituminous Types)

- ASTM D 1752 (1984; R 1992) Preformed Sponge Rubber
and Cork Expansion Joint Fillers for Concrete
Paving and Structural Construction
- ASTM D 2628 \&(1991)\& Preformed Polychloroprene
Elastomeric Joint Seals for Concrete
Pavements
- ASTM D 2835 (1989) Lubricant for Installation of
Preformed Compression Seals in Concrete
Pavements

CORPS OF ENGINEERS (COE)

- COE CRD-C 513 (1974) \&Corps of Engineers
Specifications for Rubber Waterstops&\
- COE CRD-C 572 (1974) \&Corps of Engineers
Specifications for Polyvinylchloride
Waterstops&\

FEDERAL SPECIFICATIONS (FS)

- FS SS-S-200 (Rev E; Am 1) Sealants, Joint,
Two-Component, Jet-Blast-Resistant,
Cold-Applied, for Portland Cement Concrete
Pavement
- FS SS-S-1401 (Rev C; Notice 1) Sealant, Joint,
Non-Jet-Fuel-Resistant, Hot-Applied, for
Portland Cement and Asphalt Concrete
Pavements
- FS SS-S-1614 (Rev A; Notice 1) Sealants, Joint,
Jet-Fuel-Resistant, Hot-Applied, for Portland
Cement and Tar Concrete Pavements

1.2 SUBMITTALS

NOTE: Submittals must be limited to those necessary
for adequate quality control. The importance of an
item in the project should be one of the primary
factors in determining if a submittal for the item
should be required.

Indicate submittal classification in the blank space
using "GA" when the submittal requires Government
approval or "FIO" when the submittal is for
information only.

Government approval is required for submittals with a "GA" designation;
submittals having an "FIO" designation are for information only. The
following shall be submitted in accordance with Section 01300 SUBMITTAL

DESCRIPTIONS:

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Materials; [____].

Manufacturer's catalog data and manufacturer's recommended instructions for splicing of waterstops.

SD-13 Certificates

Materials; [____].

Certificates of compliance stating that the joint filler and sealant materials and waterstops conform to the requirements specified.

1.3 DELIVERY AND STORAGE

Material delivered and placed in storage shall be stored off the ground and protected from moisture, dirt, and other contaminants. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

<<Topic topicid="P2">PART 2 PRODUCTS

2.1 CONTRACTION-JOINT STRIPS

Contraction-joint strips shall be 1/8-inch thick tempered hardboard conforming to AHA A135.4, Class 1. In lieu of hardboard strips, rigid polyvinylchloride (PVC) insert strips specifically designed to induce controlled cracking in slabs on grade may be used. Such insert strips shall have removable top section.

2.2 EXPANSION-JOINT FILLER

Expansion-joint filler shall be premolded material conforming to ASTM D 1751 or ASTM D 1752. Unless otherwise indicated, filler material shall be 3/8-inch thick and of a width applicable for the joint formed.

2.3 JOINT SEALANT

NOTE: Types of joint material should be shown.
Elastomeric joint seals (ASTM D 2628) will be used in compression type joints. For slabs receiving considerable fuel spillage, either the cold-or hot-applied jet-fuel resistant type will be used.

Joint sealant shall conform to the following:

2.3.1 Preformed Polychloroprene Elastomeric Joint Seals

ASTM D 2628.

2.3.2 Lubricant for Installation of Preformed Compression Seals

ASTM D 2835.

2.3.3 Hot-Poured Type

3.4 Cold-Applied Jet-Fuel Resistant Type

FS SS-S-200, Type M.

2.3.5 Hot-Applied Jet-Fuel Resistant Type

FS SS-S-1614.

2.4 WATERSTOPS

Waterstops shall conform to COE CRD-C 513 or COE CRD-C 572.

<<Topic topicid="P3">PART 3 EXECUTION

3.1 JOINTS

Joints shall be installed at locations indicated and as authorized.

3.1.1 Contraction Joints

NOTE: Since contraction joint strips are difficult to align and maintain in alignment, the option for use of joint strips should be deleted, where appearance is important or where concrete slabs will not be covered with subsequent toppings that will hide the joint.

Contraction joints may be constructed by inserting tempered hardboard strips or rigid PVC insert strips into the plastic concrete or by cutting the concrete with a saw after concrete has set. Joints shall be approximately 1/8-inch wide and shall extend into the slab approximately one-fourth the slab thickness but not less than 1 inch.

3.1.1.1 Joint Strips

Strips shall be of the required dimensions and as long as practicable. After the first floating, the concrete shall be grooved with a tool at the joint locations. The strips shall be inserted in the groove and depressed until the top edge of the vertical surface is flush with the surface of the slab. The slab shall be floated and finished as specified. Working of the concrete adjacent to the joint shall be the minimum necessary to fill voids and consolidate the concrete. Where indicated, the top portion of the strip shall be sawed out after the curing period to form a recess for sealer. The removable section of PVC strips shall be discarded and the insert left in place. Means shall be provided to insure true alignment of the strips is maintained during insertion.

3.1.1.2 Sawed Joints

Joint sawing shall be early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Concrete-sawing machines shall be adequate in number and power, and with sufficient replacement blades to complete the sawing at the required rate. Joints shall be cut to true alignment and shall be cut in sequence of concrete placement. Sludge and cutting debris shall be

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removed.

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3.1.2 Expansion Joints

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Premolded expansion joint filler shall be used in expansion and isolation joints in slabs around columns and between slabs on grade and vertical surfaces where indicated. The filler shall extend the full slab depth, unless otherwise indicated. The edges of the joint shall be neatly finished with an edging tool of 1/8-inch radius, except where a resilient floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed-and-oiled wood strip temporarily secured to the top thereof to form a recess 3/4-inch deep to be filled with sealant. The wood strip shall be removed after the concrete has set. In lieu of the wood strip a removable expansion filler cap designed and fabricated for this purpose may be used.

3.1.3 Joint Sealant

NOTE: Types of joint material should be shown.
Elastomeric joint seals (ASTM D 2628) will be used
in compression type joints. For slabs receiving
considerable fuel spillage, either the cold-or
hot-applied jet-fuel resistant type will be used.

Sawed contraction joints and expansion joints in slabs shall be filled with joint sealant, unless otherwise shown. Types and locations of sealants shall be as indicated. Joint surfaces shall be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Joint sealant shall be applied as recommended by the manufacturer of the sealant. Joints sealed with field molded sealant shall be completely filled with sealant.

3.2 WATERSTOPS

Waterstops shall be of the type indicated and shall be installed at the locations shown to form a continuous water-tight diaphragm. Adequate provision shall be made to support and completely protect the waterstops during the progress of the work. Any waterstop punctured or damaged shall be repaired or replaced. Splices shall be made in conformance with the recommendations of the waterstop manufacturer. Continuity of cross sectional features shall be maintained across the splice. Splices showing evidence of separation after bending shall be remade.

ADDITIONAL NOTES

NOTE A: For additional information on the use of
all CEGS, see CEGS-01000 CEGS GENERAL NOTES.

-- End of Section --

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Page 1 of 1
Expansion Joint

Removable expansion joint filler shall be used in expansion and contraction joints in slabs, beams, columns and between slabs on grade and vertical surfaces where indicated. The filler shall extend the full width and depth of the joint. The edges of the joint shall be neatly finished with an edging tool of 1/8-inch radius, except where a radius floor surface will be applied. Where the joint is to receive a sealant, the filler strips shall be installed at the proper level below the finished floor with a slightly tapered, dressed-and-oiled wood strip temporarily secured to the top flange to form a recess 3/4-inch deep to be filled with sealant. The wood strip shall be removed after the concrete has set. In lieu of the wood strip a removable expansion filler cap designed and fabricated for this purpose may be used.

3.1.1 Joint Sealant

NOTE: Types of joint material should be shown. Elastomeric joint seals (ASTM D 1525) will be used in compression type joints. For slabs receiving considerable fuel spillage, either the cold- or hot-applied fuel-resistant type will be used.

Sealed contraction joints and expansion joints in slabs shall be filled with joint sealant, unless otherwise shown. Types and locations of sealants shall be as indicated. Joint surfaces shall be clean, dry, and free of oil or other foreign material which would adversely affect the bond between sealant and concrete. Joint sealant shall be applied as recommended by the manufacturer of the sealant. Joints sealed with fluid applied sealant shall be completely filled with sealant.

3.2 WATERSTOP

Waterstop shall be of the type indicated and shall be installed at the locations shown to form a continuous water-tight diaphragm. Adequate provision shall be made to support and completely protect the waterstop during the progress of the work. Any waterstop punctured or damaged shall be repaired or replaced. Splices shall be made in conformance with the recommendations of the waterstop manufacturer. Continuity of cross sectional features shall be maintained across the splices. Splices showing evidence of separation after bending shall be repaired.

ADDITIONAL NOTES

NOTE A: For additional information on the use of all CDS, see CDS-01000 CDS GENERAL NOTES.

John Hall, *Chairman*
Pam Reed, *Commissioner*
Peggy Garner, *Commissioner*
Anthony Grigsby, *Executive Director*



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RECEIVED
EPA REGION VI

1994 JAN 20 AM 10:07
SUPERFUND BRANCH

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

January 11, 1994

CERTIFIED MAIL

RETURN RECEIPT REQUESTED

Lynn Muckelrath, Project Manager
Longhorn Army Ammunition Plant
Attn: SMCLO-EN
Marshall, Texas 75671-1059

Re: Longhorn Army Ammunition Plant
Field Investigation Summary Report -- Group I Sites

Dear Mr. Muckelrath:

The Texas Natural Resource Conservation Commission (TNRCC) staff have completed our review of the "Field Investigation Summary Report" for Group I sites, dated November 1993. Our comments, which include recommendations for scoping of Phase II activities, are enclosed. I've kept the comments fairly brief, since most of this information was discussed at the December project managers' meeting.

If you have any additional questions or comments, please contact me at (512) 239-2483.

Sincerely yours,

A handwritten signature in cursive script that reads "Michael A. Moore".

Michael A. Moore
RI/FS II Unit
Superfund Investigation Section
Pollution Cleanup Division

MM:

Enclosure

cc: Capt. Ross Nguyen, COE Tulsa District
Lisa Price (6H-ET), EPA Region VI
Bud Jones, LEGAL/FO - Region 5/Tyler
Mark Weegar, WASTE/IHW - Corrective Action

TNRCC Comments
on
Longhorn Army Ammunition Plant
Remedial Investigation
Field Investigation Summary Report
(Group I Sites)

Section	Page	Comment
2.1	7	We do not have a copy of Ebasco, February 1992 or Ebasco, October 1993. The Ebasco "Chemical Data Acquisition Plan" and "Sampling and Data Results Report" received by TNRCC are dated December 1992 and July 1993, respectively.
2.1	7	I could not find the individual sample data for pH and conductivity. Please identify where these data are reported, or furnish them if they have not yet been submitted for our review.
2.4	11	Were the soil samples composited, or homogenized?
2.5	12	Please provide drilling logs and well construction data for the five existing monitoring wells which were sampled as part of this investigation.
3.0	various	The data tables include useful statistical information which may eventually be used in the risk assessment, but do not include enough information for TNRCC staff to evaluate the spatial distribution of contaminants at the sites investigated. It is requested that additional tables of data be included in the RI report to list all of the analytical results for constituents which were detected in a particular medium at a particular site (i.e. exclude only the constituents for which no "hits" were detected at the site). An example of such a table is attached at the end of these comments.

Section	Page	Comment
3.1	14	We concur with EPA's comments regarding "background". As discussed during the project managers' meeting on 8 and 9 December, an acceptable method for determining background concentrations of metals and other inorganic parameters must still be developed before comparisons between site-specific sample data and background can be made.
3.1	14-18	Texas ground water and surface water standards, and risk reduction standards must be included as chemical-specific ARAR's.
3.2	21-27	It is noted that sample LHAAP11-GG-04 was the only sample from the six sites investigated in Group I to have a detectable concentration of 1,3,5-TNB. This sample also had greater than two times the nitrate/nitrite concentration of the other saturated zone samples from this site. These findings could indicate that TNT waste is indeed present in the vicinity of the intersection of avenues 'P' and 'Q', but that it may not be in the particular location that has received most of the investigative efforts to date (i.e. in the north-east quadrant of the intersection). It is recommended that the Phase II investigation of this site include investigation of ground water in the uppermost saturated zone so that in the event that a contaminated plume is encountered, it may be traced to the source. Additionally, the apparently elevated sulfate concentrations in the vicinity of SB-05 and SB-06 should be investigated during Phase II.
3.2	23	The box in Table 8 for the median concentration for nickel appears to contain a typographical error.

Section	Page	Comment
3.3	33	It is noted that the chloride concentrations in samples from the monitoring well at site LHAAP-13 are nearly two orders of magnitude greater than for samples from the well across the street at LHAAP-14. Sulfate and conductivity are also higher at LHAAP-13 than at LHAAP-14. It appears that additional investigation of the ground water in the LHAAP-13/14 area is warranted to determine the source of the elevated chloride and sulfate.
3.6	53	It is noted that acetone was detected in soil samples from SB-19. As discussed during the project managers' meeting on 8 and 9 December, additional investigation of this area should be conducted to verify the presence of volatile organics.
3.7	66	It is noted that nitrobenzene and RDX were detected in the saturated zone samples from SB-33, and that nitrate-nitrite appears to be elevated in SB-38. It is recommended that additional ground water investigation be focused in these areas during the Phase II RI.

Table __. LHAAP 11 Groundwater Grab Samples.
Summary of Positive Analytical Results -- All Parameters.

PARAMETER	SAMPLE					
	GG-01	GG-02	GG-03	GG-04	GG-05	GG-06
EXPLOSIVES (ug/l)						
1,3,5-TNB	<0.10	<0.10	<0.10	0.62	<0.10	<0.10
ANIONS (mg/l), pH, CONDUCTIVITY (umhos/cm)						
Chloride	34.5	<1.0	8.9	<1.0	<1.0	17.7
Nitrate-nitrite	0.11	0.02	0.5	1.23	0.6	0.6
Sulfate	96	72	<1	13	590	1400
pH						
Conductivity						
TOC (mg/l) and TOX (ug/l)						
TOC	2.4	2.2	1.5	<1.0	<1.0	28
TOX	40	34	44	<5	<5	87



REPLY TO
ATTENTION OF

Environmental Office

DEPARTMENT OF THE ARMY
LONGHORN/LOUISIANA ARMY AMMUNITION PLANTS
MARSHALL, TEXAS 75671-1059

007479



January 19, 1994

RECEIVED
EPA REGION VI
1994 JAN 25 AM 10:40

SUPERFUND BRANCH

Ms. Lisa Price
Superfund Enforcement
U.S. Environmental Protection Agency
1445 Ross Avenue
Dallas, Texas 75202

Dear Ms. Price:

This is the official transmittal letter for the four copies of the Draft Final Interim Risk Assessment for Burning Ground #3 and the Unlined Evaporation Pond (LHAAP 18 & 24) in Longhorn Army Ammunition Plant (LHAAP). Above transmittal was expedited by overnight mail on January 17, 1994.

Please review and send your comments back to us by 17 February 1994. If there are any questions, our point of contact is Mr. Lynn Muckelrath, (903)679-2980.

Sincerely,

Lawrence J. Sowa
Lieutenant Colonel, U.S. Army
Commanding Officer

Enclosures

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JAN 19 1994

CERTIFIED MAIL: RETURN RECEIPT REQUESTED

Lieutenant Colonel Lawrence J. Sowa
Commanding Officer, U.S. Army
Longhorn Army Ammunition Plant
Marshall, Texas 75671-1059

Lynn Muckelrath, Project Manager
Longhorn Army Ammunition Plant
Attn: SMCLO-EN
Marshall, Texas 75671-1059

Dear Colonel and Lynn:

Pursuant to the Federal Facilities Agreement (FFA) for the Longhorn Army Ammunition Plant, EPA has reviewed the draft revised schedule submitted on December 2, 1993, for Primary and Secondary documents for the Longhorn Army Ammunition Plant Superfund site. EPA's comments are as follows:

General Comments

EPA appreciates the difficult task in preparing a schedule such as this for many sites with many tasks that eventually may progress at different rates and on different remedial paths. EPA is fully aware as it becomes necessary to break the sites down into smaller or different groups, the schedule will again require revision. However, in submitting the following comments, EPA hopes to provide to you a certain understanding regarding tasks and deliverables that either do not require the time and effort this schedule affords them or should be undertaken concurrent with other tasks and deliverables in order to keep the site progressing on a realistic time schedule.

Group #1 Sites

EPA takes serious exception to the amount of time planned to complete the remedial investigation and feasibility study for the Group #1 sites, and EPA hopes that extensive revisions of this portion of the schedule are planned given the limited scope of work that was agreed to by EPA and the Texas Natural Resource Conservation Commission (TNRCC) in December 1993, for the phase 2 remedial investigation for the Group #1 sites.

For example, given that very little if any further site characterization work is planned for the Group #1 sites, preparation of the Site Characterization Summary (pursuant to the

WP: R35SCHEDU.LGH/1-19-94
6H-ET
H.H. 1/20/94

FFA, Section VIII., paragraph D.1.(b)) should begin immediately if contractually possible. Furthermore, because the Site Characterization Summary is a Secondary Document (pursuant to the FFA), no time should be planned in the schedule for final approval of this document. Additionally, as the Site Characterization Summary is a Secondary Document, therefore a portion of the associated Primary Report, the drafting the Remedial Investigation Report should begin concurrently with the drafting of the Site Characterization Summary. This also holds true for all Primary Reports with associated Secondary Documents. It is EPA's hope that to avoid duplication of effort that the same contractor tasked with the preparation of the Secondary Document is also tasked with the preparation of the associated Primary Report.

The schedule for the Group #1 sites should reflect the amount of field work time necessary to carry out the scope of work agreed to in December 1993, by EPA and TNRC. The schedule should also eliminate the task of the treatability study/pilot testing. As these sites appear to show little if no contamination posing threats to human health and the environment, treatment inevitably will not be conducted.

A 90-day period for the drafting of the Detailed Analysis of Alternatives is included in the schedule for the Group #1 sites. This Secondary Document (pursuant to the FFA), especially for the Group #1 sites, should not require a 90-day drafting period and does not require a final approval period.

As the schedule stands from final approval of the Remedial Investigation Report (02/21/96) until a draft Feasibility Study Report is made available to EPA and TNRC for review over one year (03/18/97) will pass. EPA feels that an inordinate amount of time is planned to address what appears to be sites that will require no further action pursuant to CERCLA and RCRA, and EPA considers this unacceptable.

Group #2 Sites and 145 Sumps

Because the Site Characterization Summary, the Detailed Analysis of Alternatives, and the Treatability Study report are Secondary Documents (pursuant to the FFA), no time should be planned in the schedule for final approval of these documents.

As the Site Characterization Summary is a Secondary Document to the Remedial Investigation Report, the schedule should reflect that preparation of the Remedial Investigation Report begins with the drafting of the Site Characterization Summary. This holds true as well with the Feasibility Study and its Secondary Documents (i.e., the Detailed Analysis of Alternatives, and the Treatability Study report). Again, it is EPA's hope that to avoid duplication of effort that the same contractor tasked with the preparation of the Secondary Document will also be tasked with the preparation of the associated Primary Report.

According to the schedule, the only activity planned during the treatability study and pilot study portion for the Group #2 sites and the 145 Sumps is the drafting and final approval of the document themselves, which according to the schedule will take almost one full year. The purpose of the requirement of the treatability study portion of the project, pursuant to the FFA, is to test potentially viable treatment technologies. If the laboratory-scale of the treatment technology appears to be effective, a pilot study may be a prudent next-step. Therefore, in addition to the time involved in developing the necessary work plans for the testing of potentially viable treatment technologies, the actual testing must be planned for in the schedule.

For the Group #2 sites, as the schedule stands from final approval of the Remedial Investigation Report (04/24/96) until a draft Feasibility Study Report is made available to EPA and TNRCC over one year (05/22/97) will pass. Furthermore, from the close of the public comment period on the proposed plan for these sites until a ROD is issued, the schedule allows 6 months to pass. Therefore, from final approval of the phase 1 Remedial Investigation/Feasibility Study Work Plan until a ROD is issued (08/24/98), six years will have passed. Again, EPA finds this excessive.

For the 145 Sumps, from final approval of the Remedial Investigation Report (05/30/96) until a draft Feasibility Study Report is made available to EPA and TNRCC approximately 8 months will have elapsed (03/15/97), with the remedy decision not being final until June of 1998. This schedule, therefore, allows 5 years from the initial investigation until the issuance of a ROD, and again EPA considers this unacceptable.

If you have any questions about EPA's comments or any other matter, please contact me at (214) 655-6744.

Sincerely,

Original signed by LMP
Lisa Marie Price
Remedial Project Manager
Superfund Texas Enforcement

cc: Tulsa District Corps of Engineers VIA FAX
P.O. Box 61
Attn: Mr. Ross Nyugen
CESWT-PP-E
Tulsa, OK 74121-0061

Mike Moore, Superfund
Texas Water Commission
P.O. Box 13087
Capital Station
1700 N. Congress Avenue
Austin, TX 78711-3087



REPLY TO
ATTENTION OF

Environmental Office

DEPARTMENT OF THE ARMY
LONGHORN/LOUISIANA ARMY AMMUNITION PLANTS
MARSHALL TEXAS 75671-1059

January 25, 1994

007483

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1994 JAN 27 PM 12:29
SUPERFUND BRANCH



Ms. Lisa Price
Superfund Enforcement
U.S. Environmental Protection Agency
1445 Ross Avenue
Dallas, Texas 75202

Dear Ms. Price:

Enclosed are two copies of the Final Project Plan Phase II
Pilot Study for IRA Site LHAAP 18 & 24 Burning Ground #3 and the
Unlined Evaporation Pond.

If there are any questions, our point of contact is Mr. Lynn
Muckelrath, (903)679-2980.

Sincerely,

Lawrence J. Sowa
Lieutenant Colonel, U.S. Army
Commanding Officer

Enclosures



DEPARTMENT OF THE ARMY
LONGHORN/LOUISIANA ARMY AMMUNITION PLANTS
MARSHALL, TEXAS 75671-1059

007484



January 27, 1994

REPLY TO
ATTENTION OF

Engineering Office

Ms. Lisa Price
Superfund Enforcement
U.S. Environmental Protection Agency
1445 Ross Avenue
Dallas, Texas 75202

Dear Ms. Price:

Enclosed are four copies of the documentation describing how background concentrations were determined for soils at Longhorn Army Ammunition Plant. As requested, this information is being provided to all participants of the January 1994 Monthly Project Coordinators Meeting held via conference call on January 13, 1994.

If there are any questions, please contact Mr. Lynn Muckelrath at (903)679-2980.

Sincerely,


Lawrence J. Sowa
Lieutenant Colonel, U.S. Army
Commanding Officer

Enclosures

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TEXAS NATURAL RESOURCE CONSERVATION COMMISSION

Protecting Texas by Reducing and Preventing Pollution

February 2, 1994

CERTIFIED MAIL

RETURN RECEIPT REQUESTED

Lynn Muckelrath, Project Manager
Longhorn Army Ammunition Plant
Attn: SMCLO-EN
Marshall, Texas 75671-1059

Re: Longhorn Army Ammunition Plant
Phase II Pilot Study for IRA

Dear Mr. Muckelrath:

The Texas Natural Resource Conservation Commission (TNRCC) staff have completed our review of the "Draft Final Project Plan, Phase II Pilot Study for IRA, Site LHAAP 18 & 24, Burning Ground 3 & The Unlined Evaporation Pond", dated December 1994. Our comments are enclosed.

If you have any additional questions or comments, please contact me at (512) 239-2483.

Sincerely yours,

A handwritten signature in cursive script, reading "Michael A. Moore".

Michael A. Moore
RI/FS II Unit
Superfund Investigation Section
Pollution Cleanup Division

A handwritten mark or signature, possibly initials, in cursive script.

MM:

cc: Capt. Ross Nguyen, COE Tulsa District
Lisa Price (6H-ET), EPA Region VI
Bud Jones, LEGAL/FO - Region 5/Tyler
Mark Weegar, WASTE/IHW - Corrective Action

TNRCC Comments
on
Longhorn Army Ammunition Plant
Phase II Pilot Study for IRA
Burning Ground 3 & The Unlined Evaporation Pond
Project Plan

Section	Page	Comment
2.1.1	3	It does not appear that the concrete pad, as designed, will meet the requirements of 40 CFR §264.251 (Waste Piles -- Design and Operating Requirements). Additionally, the land disposal restrictions in 40 CFR Part 268 appear to prohibit the use of a waste pile for treatment (dewatering) of soil and debris containing spent solvents. It is recommended that the soils be dewatered in tanks or containers.
2.1.1.3	3	(Figures 2.3 and 2.4) Seals, waterstops, and expansion joints in the concrete slab must be compatible with and impervious to the solvents and any other hazardous wastes which will be managed in the unit.
2.1.2	3	It does not appear that the proposed gravel storage area will satisfy the secondary containment requirements for tanks or containers as described in 40 CFR §§264.193 and 264.175, respectively.
4.1	12	It is recommended that various pumping rates as well as pumping/non-pumping cycles be used to evaluate pumping effects and effectiveness on the aquifer.



**RECRA
ENVIRONMENTAL
INC.**

007487

Chemical and Environmental Analysis Services

**PHASE I INTERIM REMEDIAL ACTION
LONGHORN ARMY AMMUNITION PLANT
STABILIZATION TREATABILITY STUDY
FINAL REPORT**

**Prepared for:
AWD Technologies, Inc.
15204 Omega Drive, Suite 200
Rockville, MD 20850**

**Prepared by:
Recra Environmental, Inc.
10 Hazelwood Drive
Amherst, NY 14228**

**Reference:
USACE Contract No. DACA-56-93-D-0016
Delivery Order No. 0002
REI Project No. 4C4836**

February 4, 1994

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APPENDICES

- A. Recra Environmental's Project Work Plan Dated December 9, 1994
- B. Recra Environmental's Laboratory Report and Chain of Custody Form
- C. GZA GeoEnvironmental Laboratory Report
- D. Recra Environmental's Stabilization Form Worksheets

1.0 INTRODUCTION

AWD Technologies, Inc. authorized Recra Environmental, Inc. to undertake a Stabilization Treatability Study in accordance with an agreed upon work plan supporting the Phase I Interim Remedial Action at the Longhorn Army Ammunition Plant.

The contents of this report summarize all pertinent experimental observations and results. Recra's assessment of the analytical results focused on the effects of cementitious reagent addition on metal immobilization.

Enclosed as appendicized references are copies of:

- . Recra Environmental's Project Work Plan Dated December 9, 1993
- . Recra Environmental's Laboratory Report and Chain of Custody Form
- . GZA GeoEnvironmental's Laboratory Report
- . Recra Environmental's Stabilization Form Worksheets

2.0 PROCESS DESCRIPTION

2.1 Site Background

Recra Environmental, Inc. was provided with a very limited amount of background information characterizing the conditions and degree of contamination at the Longhorn Army Ammunition Plant. Based on limited correspondence and discussions with AWD Technologies, Inc., Recra was advised that two composite soil samples would be collected to take into account potential variability in the concentrations of methylene chloride, trichloroethene and barium.

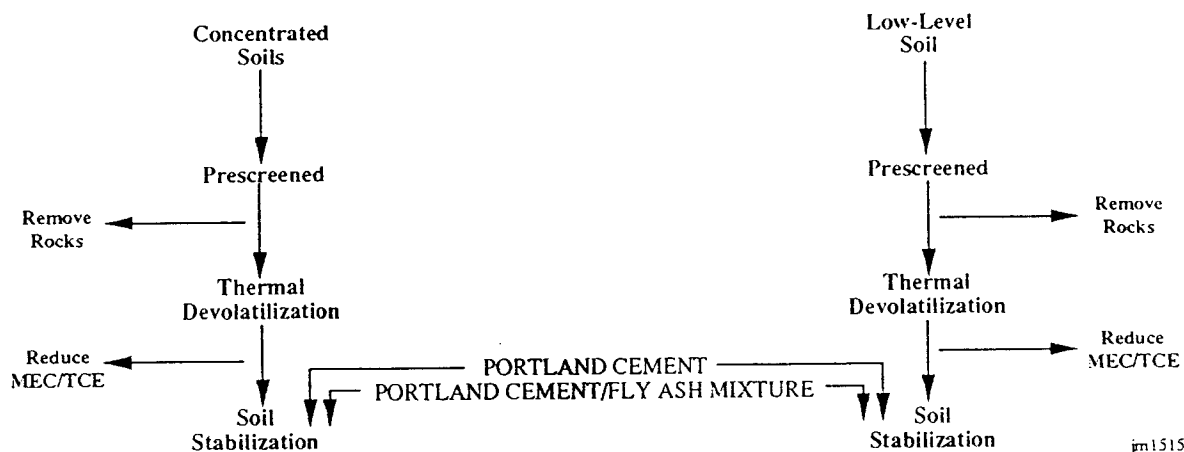
The project work plan (reference Appendix A) was prepared by Recra personnel with input from Mr. Amine Bou Onk of AWD Technologies, Inc. AWD Technologies, as noted in the enclosed work plan, was responsible for characterizing site conditions.

2.2 Remedial Technology Description

The enclosed treatability study was designed to experimentally simulate, on a bench scale, the effects of adding predefined dosages of portland cement and fly ash to known quantities of each soil sample. The reagents were selected for their cementitious and pozzolanic properties, which alone or in combination may prove advantageous in reducing the leachability of entrained metal-laden contaminants.

The experimental trials simulated the conceptual flow of remedial actions referenced on Figure 1.

FIGURE 1



In each case, the remedial action is designed to chemically stabilize the resulting soils, in a manner that would immobilize entrained metal pollutants.

2.3 Project Work Plan

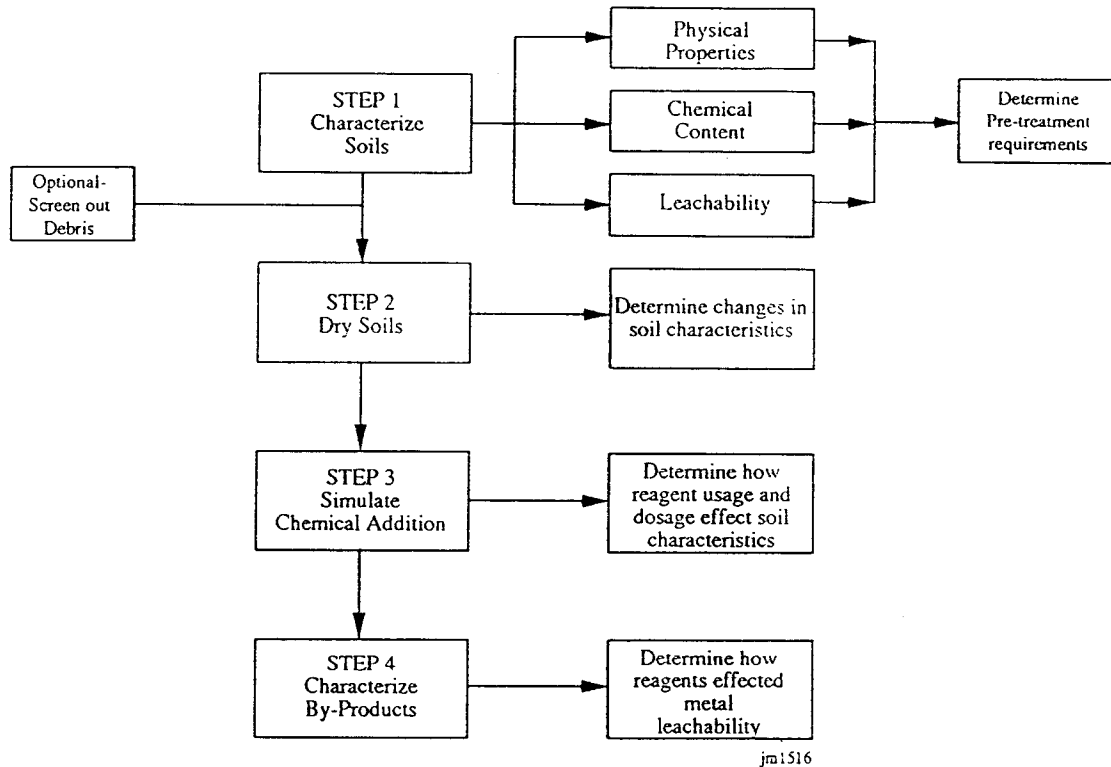
As noted, the project work plan (Appendix A) was prepared in accordance with EPA's Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final (EPA/540/G-89/004). The work plan contents address:

- a. Test objectives,
- b. Test plan matrix and parameters to measure,
- c. Equipment and materials,
- d. Analytical methods and data management,
- e. Health and safety considerations, and
- f. Residual management



The overall approach to characterizing the soils and experimentally simulating reagent additions is schematically summarized on Figure 2.

**FIGURE 2
SUMMARIZED APPROACH TO CONDUCTING
STABILIZATION TREATABILITY STUDY**



3.0 SAMPLE CHARACTERIZATIONS

3.1 Sample Receipt

Referencing the chain of custody (Appendix B), Mr. Keith Dodrill of AWD Technologies collected and shipped to Recra's facility in Tonawanda, New York, two samples labelled as:

1. Test Pit #1 - (BS-1) Hot Spot (#82)
2. Test Pit #2 and #3 - (BS-2) Composite (#91)

The two five-gallon containers of each material were received at Recra's Tonawanda, New York facility on December 4, 1993. Both samples were transferred to Recra's Amherst, New York facility on December 6, 1993. The samples were identified as:

- . H-Waste - Solid
NOS NA 3077

The sample labelled BS-1 did respond positively to initial HNU readings (50-2000ppm).

3.2 Physical Characteristics

Both samples were individually homogenized using dedicated and precleaned trays and trowels. Based on visual observations, the appearance of each sample was characterized as follows:

- BS-1 . Clayish appearance
 - . Light brown/grey in color
 - . High visual viscosity
 - . No visual signs of free liquid
 - . No apparent debris or large rock particles
- BS-2 . Clayish, somewhat mud-like in appearance
 - . Brown in color with some blackish soil
 - . High visual viscosity
 - . No visual signs of free liquid
 - . No apparent debris or large rock particles

Both materials were relatively high in total solid content:

- . BS-1 - 84.3% Total Solids
- . BS-2 - 82.1% Total Solids

Excess alkalinity associated with each sample was not significant.

Recra did subcontract GZA GeoEnvironmental of New York for particle size analysis. Appendix C summarizes the test data, protocol and data plots.

3.3 Chemical Content

In accordance with the work plan test matrix, both samples were individually characterized for parameters cited on Table 1.

**TABLE 1
SAMPLE CHARACTERIZATION TEST PARAMETERS
AND METHODOLOGIES**

	Method
Total solids	160.3
Alkalinity as CaCO ₃	310.1 (water)
Total metals	
Pb	7420/7421
Cr	7191/7190
Ba	7080
Fe	7380
Ca	7140
Mg	7450
Chloride	9250*
Sulfate	9035-38*
Fluoride	340.2 (water)*
Leachable phosphorous	365.1*
Volatile halogenated organics	
MEC/TCE	8010
Toxic Characteristic Leaching Procedure	1311
Particle analysis of soils	ASTM D422-63

* Chloride, sulfate, fluoride and phosphorous test results are reported as 'leachable' values.

Portions of both samples were also thermally dried in an oven maintained at a temperature of 103°C $\pm$ 5°C for an approximate period of twenty-four hours. The dried samples were characterized for a select number of parameters summarized on Table 1.

The analytical results are comparatively tabulated on Table 2.

TABLE 2
BS-1 (HOT SPOT/TEST PIT #1)
Analytical Results

Parameter	BS-1 As Is (ppm)	
	No Thermal Drying	Thermally Dried
Methylene Chloride	2.5	0.13
Trichloroethene	11.0	0.069
Total Metals		
Barium	237	243
Calcium	1070	----
Chromium	9.0	12.4
Iron	12,400	20,100
Lead	8.0	14.0
Magnesium	1670	----
Leachable Chloride	1.0	----
Leachable Fluoride	0.13	----
Leachable Phosphorous	224	----
Leachable Sulfate	1.0	----
Leachable Total Alkalinity	5.0	----
Total Solids	84.3	----

BS-2 (TEST PIT #2 and #3)
Analytical Results

Parameter	BS-2 As Is (ppm)	
	No Thermal Drying	Thermally Dried
Methylene Chloride	0.430	0.080
Trichloroethene	0.880	0.065
Total Metals		
Barium	1170	1920
Calcium	206	----
Chromium	11.7	22.5
Iron	6920	7,590
Lead	9.9	41.5
Magnesium	287	----
Leachable Chloride	21.7	----
Leachable Fluoride	0.10	----
Leachable Phosphorous	136	----
Leachable Sulfate	1.0	----
Leachable Total Alkalinity	5.0	----
Total Solids	82.1	----

FLY ASH
Thermally Dried - Analytical Results

Parameter	Fly Ash As In (ppm)
Total Metals	
Barium	698
Chromium	36.6
Lead	23.2
Iron	12,500



The analytical results are extrapolated from Recra's complete laboratory report findings. The laboratory report is enclosed as Appendix B.

Based on the analytical results, it would appear that both samples are contaminated with elevated levels of barium. Lead and chromium were detected in both samples at concentrations significantly below those detected for barium. Elevated concentrations of magnesium, calcium and iron were also noted, however, the metals may be inherent to the soil conditions at the site.

The elevated levels of magnesium, calcium and iron may enhance the immobilization reactions that occur with the addition of a portland cement slurry. The soil in itself may have pollutant attenuation properties warranting further study.

Both samples yielded elevated concentrations of leachable phosphorous with significantly lower levels of leachable chloride, sulfate and fluoride.

The volatile halogenated constituents, methylene chloride and trichloroethene, were detected in both samples. The concentrations of both constituents were slightly higher in the sample labelled BS-1, Hot Spot/Test Pit #1.

Both samples displayed lower concentrations of methylene chloride and trichloroethene after they were subjected to thermal drying. The reported values are not expected to adversely effect the efficiency of the experimental trials.

3.4 Leachability Characteristics

Both samples were subjected to the Toxic Characteristic Leach Procedure (TCLP). In addition, the thermally dried samples were also subjected to the TCLP for targeted metals. The results of these TCLP tests are comparatively summarized on Table 3.

TABLE 3
TOXIC CHARACTERISTIC LEACH PROCEDURE
BS-1 (HOT SPOT/TEST PIT #1)
Analytical Results

Parameter	BS-1 Leachate from TCLP	
	No Thermal Drying	Thermally Dried
Methylene Chloride	.018	----
Trichloroethene	.057	----
Total Metals		
Barium	0.49	0.75
Calcium	----	----
Chromium	0.010	0.010
Iron	0.65	----
Lead	0.19	0.090
Magnesium	----	----
Leachable Chloride	----	----
Leachable Fluoride	----	----
Leachable Phosphorous	----	----
Leachable Sulfate	----	----
Leachable Total Alkalinity	----	----
Total Solids	----	----

BS-2 (TEST PIT #2 and #3)
Analytical Results

Parameter	BS-2 Leachate from TCLP	
	No Thermal Drying	Thermally Dried
Methylene Chloride	.009	----
Trichloroethene	.048	----
Total Metals		
Barium	7.8	6.2
Calcium	----	----
Chromium	0.011	0.010
Iron	39.1	----
Lead	0.090	0.090
Magnesium	----	----
Leachable Chloride	----	----
Leachable Fluoride	----	----
Leachable Phosphorous	----	----
Leachable Sulfate	----	----
Leachable Total Alkalinity	----	----
Total Solids	----	----

FLY ASH
Thermally Dried - Analytical Results

Parameter	Fly Ash Leachate from TCLP
Total Metals	
Barium	0.38
Chromium	0.025
Lead	0.090



The TCLP results suggest that the leachable metal loadings were not significant with the exception of the values noted for barium and iron in the BS-2 leachate. The leachate values reported for the thermally dried samples were not significantly different from those values reported for the untreated soils.

Accounting for dilution, it would appear that the soils do provide some attenuation capacity. The pH values of leachates after twenty-four hour extraction ranged between pH 5.2 - 5.30.

3.5 Reagent Properties

A sample of (wet) fly ash was provided by the Niagara Mohawk, C.R. Huntley Generating Station on December 23, 1993. The generating station is located in Tonawanda, New York.

The fly ash was characterized as a very fine, black composite of solids. The material was dried at 103°C for approximately twenty-four hours before it was tested for the parameters summarized on Table 4.

**TABLE 4
FLY ASH
ANALYTICAL RESULTS**

Parameter	Thermally Dried Value (ppm)	Leachate from TCLP (ppm)
Total Metals		
Barium	698.0	0.38
Chromium	36.6	0.025
Lead	23.2	0.090
Iron	12,500.0	Not performed

A sample of commercially available portland cement was collected from a regional supplier. The material was classified as **portland cement type III**. The properties and content of this cement are referenced on Exhibit 1.

According to the supplier, portland cement type III has the following properties.



007499

EXHIBIT 1

6265 Sheridan Dr., Suite 218
Williamsville, NY 14221
(716) 634-8963

CEMENT MILL TEST REPORT

CONSIGNEE:

Date: January 1994

Plant: Woodstock

Cement Type: III

PHYSICAL DATA		CHEMICAL DATA	Percent
Specific Surface (Blaine) (sq.cm./gm.).....	5820	Silicon Dioxide (SiO ₂).....	21.2
Percent Passing 325 Mesh.....	98.5	Aluminum Oxide (Al ₂ O ₃).....	5.4
Compressive Strength (psi):		Ferric Oxide (Fe ₂ O ₃).....	2.0
Mortar Cubes		Calcium Oxide (CaO).....	63.0
1 day....	3290	Magnesium Oxide (MgO).....	3.3
3 day....	4920	Sulphur Trioxide (SO ₃).....	3.9
prev. month 28 day....	7090	Loss on Ignition (LOI).....	1.4
Vicat Setting Time		Insoluble Residue.....	0.33
Initial (min.).....	100	Free Lime.....	0.62
Final (min.).....	204	Tricalcium Silicate (C ₃ S) ..	45
Air Content (%).....	7.0	Tricalcium Aluminate (C ₃ A) ..	11
Autoclave Expansion (%).....	0.03	Total Alkali as Na ₂ O.....	0.50

CERTIFIED BY:

We hereby certify that this cement complies with current ASTM C 150 specifications

4.0 STABILIZATION RESULTS

4.1 Sample and Reagent Preparation

4.1.1 Reagent Preparation

Using the thermally dried sample of fly ash, Recra prepared a mixture of portland cement and fly ash at a 60:40 weight ratio. The reagents were both preweighed on a dry basis before they were mixed together. The mixture was prepared with manual agitation.

The sample of portland cement was used in its existing physical state.

4.1.2 Sample Preparation

Recra prepared equal weight portions (100g) of each thermally dried soil sample. The individual samples (twelve in total) were contained in clean plastic bottles.

None of the samples were modified in terms of particle size adjustment.

4.2 Experimental Trials

Each soil sample was mixed with a predefined dosage of portland cement and the 60:40 portland cement/fly ash mixture. The applicable dosages are summarized on Table 5.

**TABLE 5
REAGENT DOSAGES ADDED TO EACH SAMPLE**

Sample I.D.	Reagent	Quantity Reagent Added
100g BS-1PA	Portland cement	10g
100g BS-1PB	Portland cement	20g
100g BS-1PC	Portland cement	30g
100g BS-1FA	Portland cement/fly ash (60:40)	10g
100g BS-1FB	Portland cement/fly ash (60:40)	20g
100g BS-1FC	Portland cement/fly ash (60:40)	30g
100g BS-2PA	Portland cement	10g
100g BS-2PB	Portland cement	20g
100g BS-12C	Portland cement	30g
100g BS-2FA	Portland cement/fly ash (60:40)	10g
100g BS-2FB	Portland cement/fly ash (60:40)	20g
100g BS-2FC	Portland cement/fly ash (60:40)	30g

* (PC = Portland cement Type III)

The reagents were added and mixed with each soil sample on a dry weight basis.

To each mixture, Recra added a quantified amount of deionized water. Enough water was added to each sample to convert them into pastes. The experimental observations and worksheets are documented on individual stabilization worksheets. The individual worksheets are enclosed as Appendix D for review and reference.

Based on the individual observations and experimental measurements, the evaluations suggest the following:

- a. All of the mixtures begin to cure immediately after the addition of water. The paste-like consistency of each sample cures into a dry, solid material with visually apparent surface cracking.
- b. The addition of water did not result in any visual signs of fuming or gassing, however, the mixtures did result in a 2-7°C incremental temperature increase. The temperature increase was more noticeable with the samples of BS-1 treated with portland cement.

Note: The cement reportedly contains calcium oxide at 63% weight basis. With the addition of water, temperature is expected to increase slightly.

- c. The structural integrity of each sample increased after twenty-four hours of curing under ambient conditions in the laboratory fume hood. The unconfined compressive strength (UCS) values were determined with a pocket penetrometer. The reported values are summarized on Table 6.

TABLE 6
UNCONFINED COMPRESSIVE STRENGTH
POCKET PENETROMETER READINGS

Sample I.D.	Reagent	% Reagent Added by wt.	UCS (tons/ft ²)
BS-1PA	P	10	1.5
BS-1PB	P	20	1.5
BS-1PC	P	30	4.0
BS-1FA	F/P	10	4.5
BS-1FB	F/P	20	4.0
BS-1FC	F/P	30	4.0
BS-2PA	P	10	4.25
BS-2PB	P	20	4.75
BS-2PC	P	30	4.5
BS-2FA	F/P	10	1.5
BS-2FB	F/P	20	4.0
BS-2FC	F/P	30	4.25

P = Portland cement type III

F/P = Fly ash/Portland cement 40:60 mixture



(c.- Continued)

- c. The visual observations suggest that the structural integrity can be increased by adding either reagent. The optimum determination of dosage requires further evaluation, however, it would appear that any criteria dictating a monolithic by-product would require more than a 10% dosage by weight of this type of portland cement.
- d. The mixtures prepared with portland cement/fly ash did require more water at low dosages to generate a material displaying a pasty appearance. As the ratio of cement increases, it appears the water requirements level out.

4.3 Leachability Characteristics

All twelve samples were subjected to the Toxic Characteristic Leach Procedure (TCLP). The resulting leachate (extracts) were submitted for metal analyses summarized on Tables 7 through 10.

TABLE 7
BS-1 THERMALLY DRIED (HOT SPOT/TEST PIT #1)
Analytical Stabilization Results with
Portland Cement Type III

Parameter	As Is (ppm)	TCLP Leachate From 'As Is' (ppm)	Reagent Amount (g)	TCLP Leachate from Stabilization (ppm)
Lead	14	0.090	10	0.25
			20	0.10
			30	0.13
Chromium	12.4	0.010	10	0.016
			20	0.022
			30	0.23
Barium	243	0.75	10	0.72
			20	0.72
			30	0.67

TABLE 8
BS-1 THERMALLY DRIED (HOT SPOT/TEST PIT #1)
Analytical Stabilization Results with
Fly Ash Mixture

Parameter	As Is (ppm)		TCLP Leachate From 'As Is' (ppm)		Reagent Amount (g)	TCLP Leachate from Stabilization (ppm)
	BS-1	Fly Ash Mix	BS-1	Fly Ash Mix		
Lead	14	23.2	0.090	0.090	10	0.12
					20	0.09
					30	0.09
Chromium	12.4	36.6	0.010	0.025	10	0.063
					20	0.058
					30	0.019
Barium	243	698	0.75	0.38	10	0.69
					20	0.90
					30	0.99



TABLE 9
BS-2 THERMALLY DRIED (TEST PIT #2 AND #3)
 Analytical Stabilization Results with
 Portland Cement Type III

Parameter	As Is (ppm)	TCLP Leachate From 'As Is' (ppm)	Reagent Amount (g)	TCLP Leachate from Stabilization (ppm)
Lead	41.5	0.090	10	0.12
			20	0.090
			30	0.090
Chromium	22.5	0.010	10	0.12
			20	0.037
			30	0.085
Barium	1920	6.2	10	1.5
			20	1.6
			30	1.1

TABLE 10
BS-2 THERMALLY DRIED (TEST PIT #2 AND #3)
 Analytical Stabilization Results with
 Fly Ash Mixture

Parameter	As Is (ppm)		TCLP Leachate From 'As Is' (ppm)		Reagent Amount (g)	TCLP Leachate from Stabilization (ppm)
	BS-2	Fly Ash Mix	BS-2	Fly Ash Mix		
Lead	41.5	23.2	0.090	0.090	10	0.12
					20	0.13
					30	0.090
Chromium	22.5	36.6	0.010	0.025	10	0.110
					20	0.120
					30	0.32
Barium	1920	698	6.2	0.38	10	1.2
					20	1.2
					30	1.6



The leachability results suggest the following:

- a. The addition of portland cement to BS-1 samples did not appreciably reduce the resulting leachate concentrations for barium. As the dosage of cement increases, the resulting leachate concentrations for lead and chromium appear to increase slightly.
- b. The addition of cement/fly ash had no measurable impact on the resulting concentrations of lead, chromium and barium. The data indicates that barium concentrations increase slightly as reagent dosages are increased. Lead values are relatively unchanged and chromium appears to increase slightly.
- c. The addition of portland cement to samples of BS-2 did reduce the leachable concentrations of barium, however, there doesn't appear to be significant variability in the results as the dosages of cement are increased. The same effects were noted with the addition of cement/fly ash.
- d. Leachable chromium concentrations increase slightly in all BS-2 treated samples as the dosages of both reagents increase.
- e. The changes in leachable lead concentrations are relatively insignificant.

With the exception of two samples, BS-1PC and BS-2FC, the pH of the resulting leachates were slightly acidic, with readings ranging from 4.45 (BS-2FA) to 6.28 (BS-1PB).

The stated comparisons were based on a review of the resulting analyses without any correction for reagent addition.

5.0 SUMMARY

Bench-scale experimental evaluations were undertaken by Recra Environmental, Inc. to determine whether a stabilization technology employing portland cement would be effective in immobilizing elevated concentrations of barium, analytically detected in samples collected from the Longhorn Army Ammunition Plant.

The experimental results questions the need for a stabilization technology employing a variable dosage of cementitious reagent. The analytical results did confirm the presence of barium as well as lead, chromium, iron, magnesium and calcium. When subjected to the Toxic Characteristic Leach Procedure (TCLP), the data suggests that the entrained metals are not readily leachable. Additional evaluations should substantiate both the attenuation properties of the soils and the leachability properties of the entrained metals.

Experimental evaluations simulating the addition of portland cement and a mixture of portland cement and fly ash did increase the structural integrity of the resulting samples.

For the most part, the additions of cement and cement/fly ash to the soil samples did reduce the leachability of the targeted metals, however, the leachability results did not vary significantly from the values attained without treatment. Additional evaluations are warranted to substantiate treatment requirements under variable leachable conditions. Future studies should define variability in metals taking into account plant clean-up standards.

The results of this study suggest the need for additional evaluations to substantiate the ideal method of applying chemical reagents to the soils. There may not be a need or economic benefit associated with the addition of portland cement. The cost of portland cement type III (\$78/ton) can be based on a 25-ton truck. Using the three experimental dosages of cement, the reagent costs for stabilization would range from \$7.80/ton of soil (10% dosage) to \$23.40/ton of soil. This cost excludes equipment and labor.

For
RECRA ENVIRONMENTAL, INC.



Thomas F. Stanczyk
Senior Vice President



APPENDIX A

Recra Environmental's Project Work Plan Dated December 9, 1993





**RECRA
ENVIRONMENTAL
INC.**

007508

Chemical and Environmental Analysis Services

**PHASE I INTERIM REMEDIAL ACTION
LONGHORN ARMY AMMUNITION ACTION
STABILIZATION TREATABILITY STUDY
WORK PLAN**

**Prepared for:
AWD Technologies, Inc.
15204 Omega Drive, Suite 200
Rockville, MD 20850**

**Prepared by:
Thomas F. Stanczyk
Sr. Vice President
Recra Environmental, Inc.
10 Hazelwood Drive
Amherst, NY 14228**

**Reference:
USACE Contract No. DACA-56-93-D-0016
Delivery Order No. 0002
REI Project No. 4C4836**

**Revised
December 9, 1993**

awd.06

1.0 PROJECT DESCRIPTION

AWD Technologies, Inc. has contracted with Recra Environmental, Inc. to perform a bench-scale stabilization treatability study in accordance with the scope of services referenced in Recra's quote no. Q94-C002. The treatability study is being conducted in support of the Phase 1 Interim Remedial Action at the Longhorn Army Ammunition Plant.

The contents of this document serves as the work plan for the cited study. AWD Technologies will provide Recra Environmental with two (2) samples of contaminated soil to determine how the addition of chemical reagent will effect the leachability of entrained metal contaminants.

The two soil samples are representative of materials categorized as:

- a. A composite sample collected from the project site, and
- b. A composite sample collected from a project area assumed to have the highest concentration of heavy metals.

The laboratory data derived from this study will be tabulated and assessed in the context of the study objectives.

This work plan has been prepared in accordance with EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA", Interim Final (EPA/540/G-89/004).

1.1 SITE BACKGROUND

To be summarized by AWD Technologies, Inc.

The background data characterizing site conditions does influence the experimental design and operating conditions. It has been stated, that the two samples of soil are believed to have concentrations of solvents (primarily trichloroethylene (TCE) and methylene chloride (MEC)) as well as heavy metals (primarily barium).

Recra Environmental, Inc. is assuming that these soils do not display reactive or radioactive properties posing hazards to lab personnel. The presence of either property would alter the approach to this work plan. Recra also assumes that these soils do not contain PCBs. AWD Technologies, Inc. has the responsibility for characterizing site conditions and any pertinent hazards. Recra Environmental will be advised accordingly prior to the receipt of any samples at our laboratory.

2.0 REMEDIATION TECHNOLOGIES DESCRIPTION

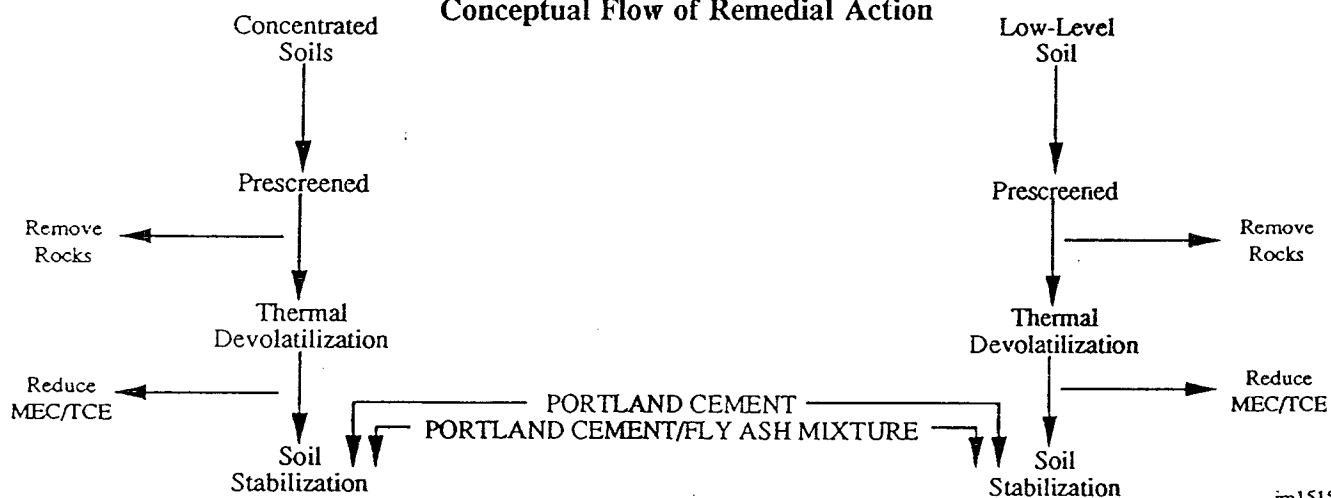
The treatability study will simulate a stabilization technology utilizing reagents that have the potential for chemically immobilizing metals entrained within the soils. The stabilization technology will rely on cementitious reagents providing excess alkalinity for pH adjustment and immobilization.

Prior to subjecting the soils to stabilization, each soil sample will be dried at a temperature ranging between 100° - 110°C for a period of 10-24 hours. These materials will be subjected to drying with intermittent (not continuous) agitation. This step of the process will simulate a thermal devolatilization process to reduce the loadings of volatile solvents prior to subjecting them to stabilization.

Prior to drying, Recra will separate out from the soils any large inert debris, i.e. wood chips, rocks or scrap metal. This step of the process would simulate the material handling and pretreatment of soils.

Figure 1 summarizes the conceptual flow of technologies and remedial action serving as a basis for the bench-scale treatability study.

FIGURE 1
Conceptual Flow of Remedial Action



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3.0 TEST OBJECTIVES

The prime objective of this study is to determine whether the heavy metals in the two soil composites can be immobilized with a stabilization technology utilizing cementitious reagents.

As secondary objectives, the study will determine how: 1) thermal drying effects the physical and chemical characteristics of soil requiring stabilization, and 2) Fly Ash alters the structural integrity and leachability of the stabilized samples.

4.0 SPECIALIZED EQUIPMENT AND MATERIALS

The two samples of soil will be visually inspected to determine the presence of any large rocks or other inert debris. These materials will be separated manually or by a course sieve.

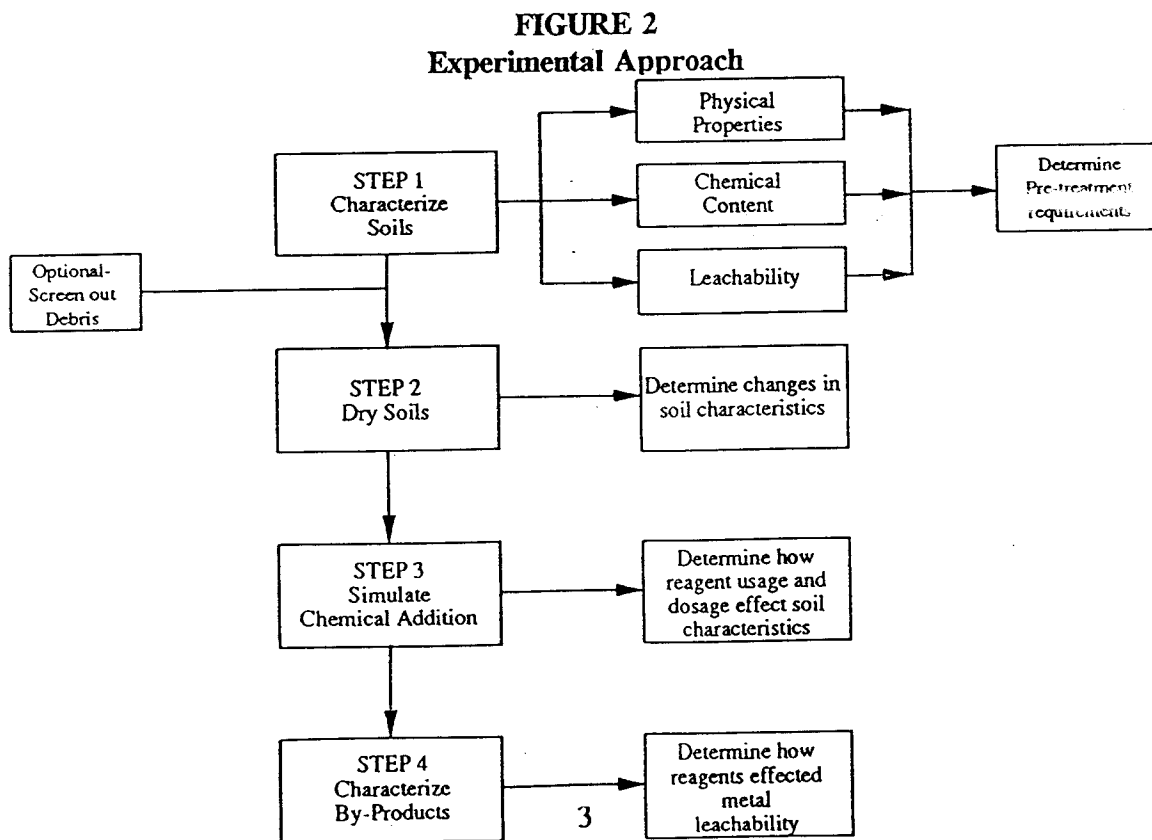
Soil aliquots will be separated from the original container using precleaned trowels. These aliquots will be placed in large glass beakers for drying in an oven that is monitored at a controlled temperature.

The dried soils will be further divided on an equal weight basis into plastic cups or disposable containers. Reagents will be added directly to the soils in these containers. The reagents selected for use include:

- Commercial grade Portland Cement.
- Fly Ash from Niagara Mohawk Huntley Generating Station

5.0 TREATABILITY TEST PLAN MATRIX AND PARAMETERS TO MEASURE

The overall approach to characterizing the soils and experimentally simulating the technology is summarized on Figure 2.



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The individual steps of this study are summarized as follows.

Step 1 Characterize Soil

Step 1.1

AWD Technologies, Inc. will ship to Recra Environmental, Inc. two (2) composite samples of soil under chain of custody.

AWD Technologies' personnel will be responsible for providing the proper containers and paperwork for sample transportation and shipment to Recra Environmental.

Recra is requesting that each soil sample be shipped to:

Recra Environmental, Inc.
111 Wales Avenue
Tonawanda, NY 14150
ATTN: PAT FILEY

Note: Recra does require advanced notice of shipment.

Step 1.2

Upon receipt, Recra personnel will complete and file chain of custody forms. The two samples will be pre-screened for:

- . Physical appearance
- . Visual signs of fumes
- . Odor
- . Reactivity with water

If Recra determines the soils to be mixed with notably large inert debris (rocks, etc.), efforts will be made to separate materials typically representing soil. Any residual rock will be treated as discarded residue.

Step 1.3

Both soil composites will be characterized for the following parameters:

- . Total solids
- . Alkalinity as CaCO_3
- . Total metals (Pb, Cr, Ba, Fe, Ca, Mg)
- . Chloride
- . Fluoride
- . Sulfate
- . Phosphates on leached sample
- . Volatile halogenated organic
MEC/TCE
- . Toxic characteristic leachate procedures
Metals (Pb, Cr, Ba, Fe)
Volatile halogenated organic (MEC/TCE)
- . Particle-size analysis of soils

Step 1.4

The analytical results will be reviewed to **profile** each soil relative to their chemical content and leachability characteristics.

Step 2 Dry Soils

Step 2.1

Based on the volatile halogenated organic content, Recra will determine whether each soil should be subjected to drying. AWD Technologies will provide guidance on the solvent removal requirements.

Step 2.2

Assuming both soils do contain ppm levels of MEC and TCE, Recra will separate out approximately 3000g of each soil sample (two total). Both of these samples will be placed in an oven for a period not exceeding 24 hours. Both samples will be intermittently mixed with a trowel. The duration and temperature at which the soils are subjected will be monitored.

Note: The drying will occur in an oven placed in a fume hood. The scope does not require the solvents to be captured for characterization.



Step 2.3

The two samples will be allowed to cool to ambient laboratory conditions. Approximately 150-200g of each soil sample will be separated and characterized for the following parameters:

- . Physical appearance
- . Alkalinity as CaCO_3
- . Total metal content (Pb, Cr, Ba)
- . Total volatile halogenated organic
MEC/TCE
- . Leachable - Pb, Cr, Ba (using TCLP)

Step 2.4

Recra will compile analytical findings and assess how the soil properties influence reagent selection and dosage.

Step 3 Simulate Chemical Addition

Step 3.1

Recra personnel will prepare six samples of each soil composite (twelve total). Each sample will weigh approximately 100g.

Step 3.2

Recra will secure representative samples of Portland Cement and a sample of Portland Cement/Fly Ash mixture.

The Portland Cement/Fly Ash mixture will be prepared by mixing Portland Cement with a dry sample of Fly Ash obtained from the Niagara Mohawk Huntley Generating Station. This mixture will represent 60% Portland Cement and 40% Fly Ash.

The fly ash will be characterized for:

- . Alkalinity as CaCO_3
- . Total metal content (Fe, Pb, Cr, Ba)
- . Leachable metals - Pb, Cr, Ba (using TCLP)

Step 3.3

Reagents will be added to each sample on a dry weight basis in accordance with the following dosage rates.

Concentrated Soil	Reagent		Low-Level Soil	Reagent	
Weight	PC Wt.	PC/FA Wt.	Weight	PC Wt.	PC/FA Wt.
100g	10g	10g	100g	10g	10g
100g	20g	20g	100g	20g	20g
100g	30g	30g	100g	30g	30g

PC = Portland Cement; FA = Fly Ash

The reagents will be manually mixed into the soils. Recra will add a known amount of tap water to each of the twelve samples to facilitate mixing and chemical interaction. Each sample will represent a wet solid after mixing.

All twelve samples will be weighed after reagent and water additions. Any observations relative to odor intensity, heat generation, or fuming will be visually noted.

Step 3.4

All twelve samples will be allowed to cure in a fume hood exposed to the atmosphere for approximately 24 hours. After curing for this period of time, Recra will note visual changes in appearance and structural integrity. A pocket penetrometer will be used to determine a range of unconfined compressive strength (UCS).

Recra will compare the resulting samples on the basis of physical appearance and visual structural integrity taking into account dosage rates and reagent usage.

Step 4 Characterize By-Products

Recra will subject the twelve (12) treated samples to TCLP for targeted metals only. Each resulting leachate will be tested for:

- . Visual appearance
- . pH
- . Total Pb, Cr, Ba

Prior to subjecting each sample to leachability, each treated sample will be broken down in particle size to allow for maximum contact with the leaching media.

6.0 ANALYTICAL METHODS

The treated and untreated soil samples will be characterized by Recra Environmental using the following analytical methodologies:

	Method
Total solids	160.3
Alkalinity as CaCO ₃	310.1 (water)
Total metals	
Pb	7420/7421
Cr	7191/7190
Ba	7080
Fe	7380
Ca	7140
Mg	7450
Chloride	9250
Sulfate	9035-38
Fluoride	340.2 (water)
Leachable phosphates	365.1
Volatile halogenated organics	
MEC/TCE	8010
Toxic Characteristic Leaching Procedure	1311
Particle analysis of soils	ASTM D422-63

Note: Recra will subcontract particle analysis of soils.

7.0 DATA MANAGEMENT

All experimental observations and procedures will be documented in a bound laboratory notebook. The project manager will sign-off each day.

All analytical results will be properly referenced in the project file.

All information associated with the required testing will be documented and managed by Recra consistent with the facility's Quality Assurance/Quality Control Plan (referenced as Appendix A).

8.0 DATA ANALYSIS AND INTERPRETATION

Recra will compile all experimental work, observations and findings in one report.

This report will include an analysis of the test results as well as an assessment of the findings in relation to the study objectives.

9.0 HEALTH AND SAFETY

All employees will adhere to Recra's written health and safety procedures while conducting any experimental trials as well as performing routine analytical tests.

10.0 RESIDUALS MANAGEMENT

Recra will retain all samples for a period not exceeding 45 days after which time provisions will be made to ship back to AWD Technologies the following:

- . All unused samples of each soil
- . All treated soil by-products

Recra will properly dispose of any waste resulting from the testing of soils for metal and organic content.

All samples handled and generated within Recra will be individually codified and tracked. A formal procedure will log sample duration and disposal.

11.0 PROJECT SCHEDULE

The following time frame estimates the schedule for project implementation and completion.

Sample Receipt	December 6, 1993
Initial Characterization	December 13, 1993
Soil Drying and Characterization	December 20, 1993
Simulate Chemical Adaption	December 27, 1993
Treated Soil Characterization	January 10, 1994
Report	January 17, 1994



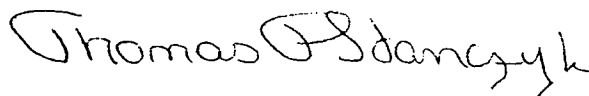
12.0 PROJECT STAFF

The following personnel will have the following responsibilities:

Thomas F. Stanczyk, Project Principal
Robert K. Wyeth
Patrick Filey
James E. Stadelmaier
Julianne Merlo

Work Plan/Scheduling and Report Oversight
Quality Assurance
Project Manager
Health and Safety
Administrative Assistant

Sincerely,
FOR RECRA ENVIRONMENTAL, INC.



Thomas F. Stanczyk
Senior Vice President

APPENDIX B

Recra Environmental's Laboratory Report and Chain of Custody Form

ANALYTICAL RESULTS

Prepared For

AWD Technologies, Inc.

Prepared By

Recra Environmental, Inc.
10 Hazelwood Drive, Suite 106
Amherst, New York 14228-2298

METHODOLOGIES

The specific methodologies employed in obtaining the enclosed analytical results are indicated on the specific data table. The method numbers presented refer to the following U.S. Environmental Protection Agency reference.

- * U.S. Environmental Protection Agency "Test Methods for Evaluating Solid Waste-Physical/Chemical Methods." Office of Solid Waste and Emergency Response. November 1986, SW-846, Third Edition.
- * The Toxicity Characteristic Leaching Procedure was performed in accordance with modified method 1311, 40 CFR, Appendix II to Part 261, June 1990.

COMMENTS

Comments pertain to data on one or all pages of this report.

The enclosed data has been reported utilizing data qualifiers (Q) as defined on the Inorganic Data Comment Page.

Quality control analysis were performed on a batch basis. All results were within acceptable limits.

INORGANIC DATA COMMENT PAGE

Laboratory Name RECRA ENVIRONMENTAL, INC.

USEPA Defined Inorganic Data Qualifiers:

- B - Indicates a value greater than or equal to the instrument detection limit but less than the contract required detection limit.
- U - Indicates element was analyzed for but not detected. Report with the detection limit value (e.g., 100).
- E - Indicates a value estimated or not reported due to the presence of interference.
- S - Indicates value determined by Method of Standard Addition.
- N - Indicates spike sample recovery is not within control limits.
- * - Indicates duplicate analysis is not within control limits.
- + - Indicates the correlation coefficient for method of standard addition is less than 0.995.
- M - Indicates duplicate injection results exceeded control limits.
- W - Post digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.



Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AS054272
Client Sample ID: BS-1PA

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	0.72	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.016	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.25	-	

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AWD TECHNOLOGIES, INC.

Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AS054273
Client Sample ID: BS-1PB

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	0.72	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.022	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.10	-	

AWD TECHNOLOGIES, INC.

Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AS054274
Client Sample ID: BS-1PC

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	0.67	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.23	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.13	-	

AWD TECHNOLOGIES, INC.

Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AS054275
Client Sample ID: BS-1FA

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	0.69	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.063	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.12	-	

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Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AS054276
Client Sample ID: BS-1FB

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	0.90	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.058	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.090	-	U

Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AS054277
Client Sample ID: BS-1FC

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	0.99	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.019	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.090	-	

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Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AS054278
Client Sample ID: BS-2PA

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	1.5	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.12	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.12	-	

AWD TECHNOLOGIES, INC.

Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AS054279
Client Sample ID: BS-2PB

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	1.6	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.037	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.090	-	U

Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AS054280
Client Sample ID: BS-2PC

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	1.1	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.085	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.090	-	

Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AS054281
Client Sample ID: BS-2FA

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	RQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	1.2	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.11	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.12	-	

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Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECONY
Lab Job No: A94-0081
Lab Sample ID: AS054282
Client Sample ID: BS-2FB

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	1.2	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.12	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.13	-	

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0013

Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - REQNY
Lab Job No: A94-0081
Lab Sample ID: AS054283
Client Sample ID: BS-2FC

Matrix: Solid:Leachate
Sample Date: 01/06/94
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	1.6	-	
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.32	-	
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.090	-	

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0014

Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AR013898
Client Sample ID: EXTRACTOR BLANK

Matrix: Solid:Leachate
Sample Date: -
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	0.030	-	U
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.010	-	U
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.090	-	U

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0015

AWD TECHNOLOGIES, INC.

Toxicity Characteristic Leaching Procedure
TOTAL METALS

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081
Lab Sample ID: AR013899
Client Sample ID: METHOD BLANK

Matrix: Solid:Leachate
Sample Date: -
Dilution Factor: 1

EPA HW Number	Parameter	Method	Digestion Date	Analysis Date	Regulatory Level (MG/L)	PQL	Uncorrected Result (MG/L)	Bias Corrected Result (MG/L)	Q
D005	Barium - Total	6010	01/13/94	01/14/94	100.0000	0.030	0.030	-	U
D007	Chromium - Total	6010	01/13/94	01/14/94	5.0000	0.010	0.010	-	U
D008	Lead - Total	7420	01/13/94	01/14/94	5.0000	0.090	0.090	-	U

AWD TECHNOLOGIES, INC.

METHOD 9045 - LEACHABLE pH

Laboratory: Recra Environmental, Inc. - RECNY
Lab Job No: A94-0081

Units: S.U.

Client Sample ID	Lab Sample ID	Matrix	Method	Sample Date	Analysis Date	Result	Q
BS-1FA	AS054275	Solid	9045	01/06/94	01/11/94	11.19	
BS-1FB	AS054276	Solid	9045	01/06/94	01/11/94	11.68	
BS-1FC	AS054277	Solid	9045	01/06/94	01/11/94	11.81	
BS-1PA	AS054272	Solid	9045	01/06/94	01/11/94	11.28	
BS-1PB	AS054273	Solid	9045	01/06/94	01/11/94	11.80	
BS-1PC	AS054274	Solid	9045	01/06/94	01/11/94	12.60	
BS-2FA	AS054281	Solid	9045	01/06/94	01/11/94	11.83	
BS-2FB	AS054282	Solid	9045	01/06/94	01/11/94	11.90	
BS-2FC	AS054283	Solid	9045	01/06/94	01/11/94	11.68	
BS-2PA	AS054278	Solid	9045	01/06/94	01/11/94	11.76	
BS-2PB	AS054279	Solid	9045	01/06/94	01/11/94	11.85	
BS-2PC	AS054280	Solid	9045	01/06/94	01/11/94	11.63	

RECRA ENVIRONMENTAL, INC.

CHAIN OF CUSTODY RECORD

PROJECT NO. 424836		SITE NAME AWD Technology		NO OF CON. TAINERS	REMARKS
SAMPLERS (SIGNATURE) <i>R. Blinton</i>		STATION LOCATION			
STATION NO	DATE/TIME	COMP	GRAB		
1	11/6	X	BS-1PA	1	Each sample is to be analyzed for: TCLP. Run the following parameters on the resulting leachate: - PH - Pb (Lead) - Cr (chromium) - BA (Barium)
2		X	BS-1PB	1	
3		X	BS-1PC	1	
4		X	BS-1FA	1	
5		X	BS-1FB	1	
6		X	BS-1FC	1	
7		X	BS-2PA	1	
8		X	BS-2PB	1	
9		X	BS-2PC	1	
10		X	BS-2FA	1	
11		X	BS-2FB	1	
12		X	BS-2FC	1	
TOTAL				(12)	
RELINQUISHED BY (SIGNATURE) <i>Randy B. Blinton</i>		DATE/TIME 1-7-94/1600	RECEIVED BY (SIGNATURE) <i>D. Blum</i>	RELINQUISHED BY (SIGNATURE)	DATE/TIME
RELINQUISHED BY (SIGNATURE)		DATE/TIME	RECEIVED BY (SIGNATURE)	RELINQUISHED BY (SIGNATURE)	DATE/TIME
RELINQUISHED BY (SIGNATURE)		DATE/TIME	RECEIVED FOR LABORATORY BY (SIGNATURE)	RELINQUISHED BY (SIGNATURE)	DATE/TIME

Distribution: Original accompanies shipment. copy to coordinator field files

5 Day Business Turnaround

007537

ANALYTICAL RESULTS

Prepared For

AWD Technologies, Inc.

Prepared By

Recra Environmental, Inc.
10 Hazelwood Drive, Suite 106
Amherst, New York 14228-2298

METHODOLOGY

The specific methodology employed in obtaining the enclosed analytical results are indicated on the specific data table. The method number presented refers to the following U.S. Environmental Protection Agency reference.

- * U.S. Environmental Protection Agency "Test Methods for Evaluating Solid Waste-Physical/Chemical Methods ". Office of Solid Waste and Emergency Response. November 1986, SW-846, Third Edition.

COMMENTS

Comments pertain to data on one or all pages of this report.

The enclosed data has been reported utilizing data qualifiers (Q) as defined on the Inorganic Data Comment Page.

No deviations from protocol were encountered during analyses.



RECRA
ENVIRONMENTAL
INC.

Laboratory Name RECRA ENVIRONMENTAL, INC.

USEPA Defined Inorganic Data Qualifiers:

- B - Indicates a value greater than or equal to the instrument detection limit but less than the contract required detection limit.
- U - Indicates element was analyzed for but not detected. Report with the detection limit value (e.g., 100).
- E - Indicates a value estimated or not reported due to the presence of interference.
- S - Indicates value determined by Method of Standard Addition.
- N - Indicates spike sample recovery is not within control limits.
- * - Indicates duplicate analysis is not within control limits.
- + - Indicates the correlation coefficient for method of standard addition is less than 0.995.
- M - Indicates duplicate injection results exceeded control limits.
- W - Post digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.



AWD TECHNOLOGIES, INC.

TOTAL IRON

Laboratory: Recra Environmental, Inc. - REQNY
Lab Job No: A94-0276

Units: MG/KG

Client Sample ID	Lab Sample ID	Method	Matrix	Sample Date	Digestion Date	Analysis Date	Result	Q
BS-1D	A4027601	7380	Soil	12/23/93	12/29/93	02/02/94	20100	
BS-2D	A4027602	7380	Soil	12/23/93	12/29/93	02/02/94	7590	
FLY ASH	A4027603	7380	Ash	12/23/93	12/29/93	02/02/94	12500	
METHOD BLANK	AR014350	7380	Soil	-	12/29/93	02/02/94	7.0	U

007540

0003

APPENDIX C

GZA GeoEnvironmental Laboratory Report



GZA
GeoEnvironmental
of New York

Engineers and
Scientists

007542

January 25, 1994
File: 6069.00



Mr. Jim Stellerecht
RECRA Environmental, Inc.
10 Hazelwood Drive
Amherst, New York

Re: Geotechnical Laboratory Testing Services
RECRA Job No. 4C4836

Dear Mr. Stellerecht:

364 Nagel Drive
Buffalo, New York
14225
716-685-2300
FAX 716-685-3629

GZA GeoEnvironmental of New York (GZA) in accordance with our proposal for services dated December 15, 1993, has laboratory tested two samples delivered to our Buffalo, N.Y. office.

Attached, please find one copy of the geotechnical laboratory testing data summary, data plots, legend for summary sheet and laboratory test procedures.

This completes testing assigned by RECRA Environmental, Inc. (RECRA). Please do not hesitate to contact us if you have any questions or require any additional information. GZA appreciates the opportunity to be of service to RECRA and looks forward to a continued association.

Very truly yours,

GZA GEOENVIRONMENTAL OF NEW YORK

Robert A. Redenbach

Robert A. Redenbach
Senior Engineering Technician

Irvine G. Reinig II
Irvine G. Reinig II, P.E.
Principal

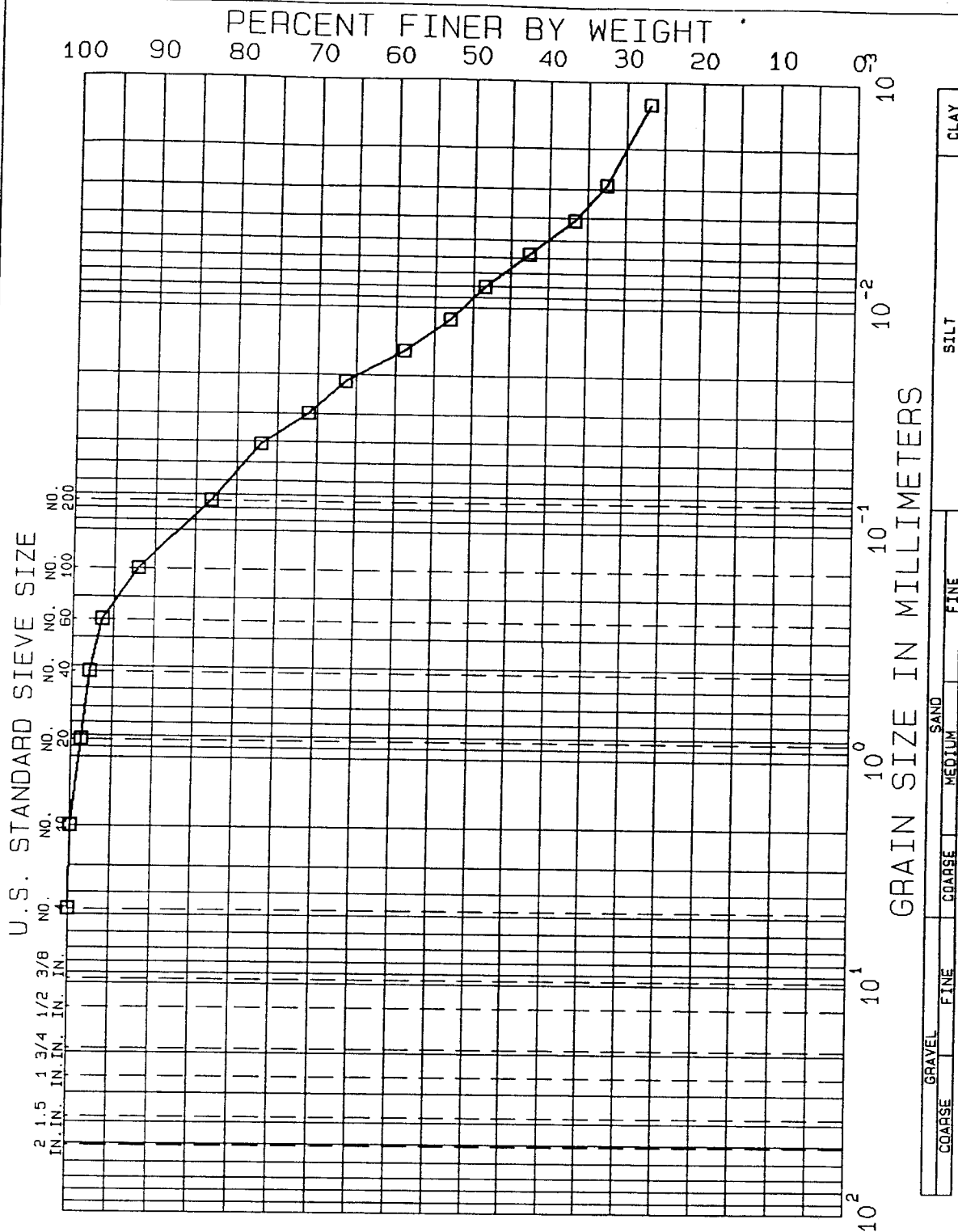
RAR
Attachments

PROJECT NAME: LONGHORN ARMY AMMUNITIONS PLANT STABILIZATION TREATMENT STATION
PROJECT NO. 6069.00
PROJECT ENGINEER: J. STELLERFUCHT

MATERIAL SOURCE: PROJECT SITE
DATE ASSIGNED: 1/21/94

WORK ORDER NO. 2282

[illegible]

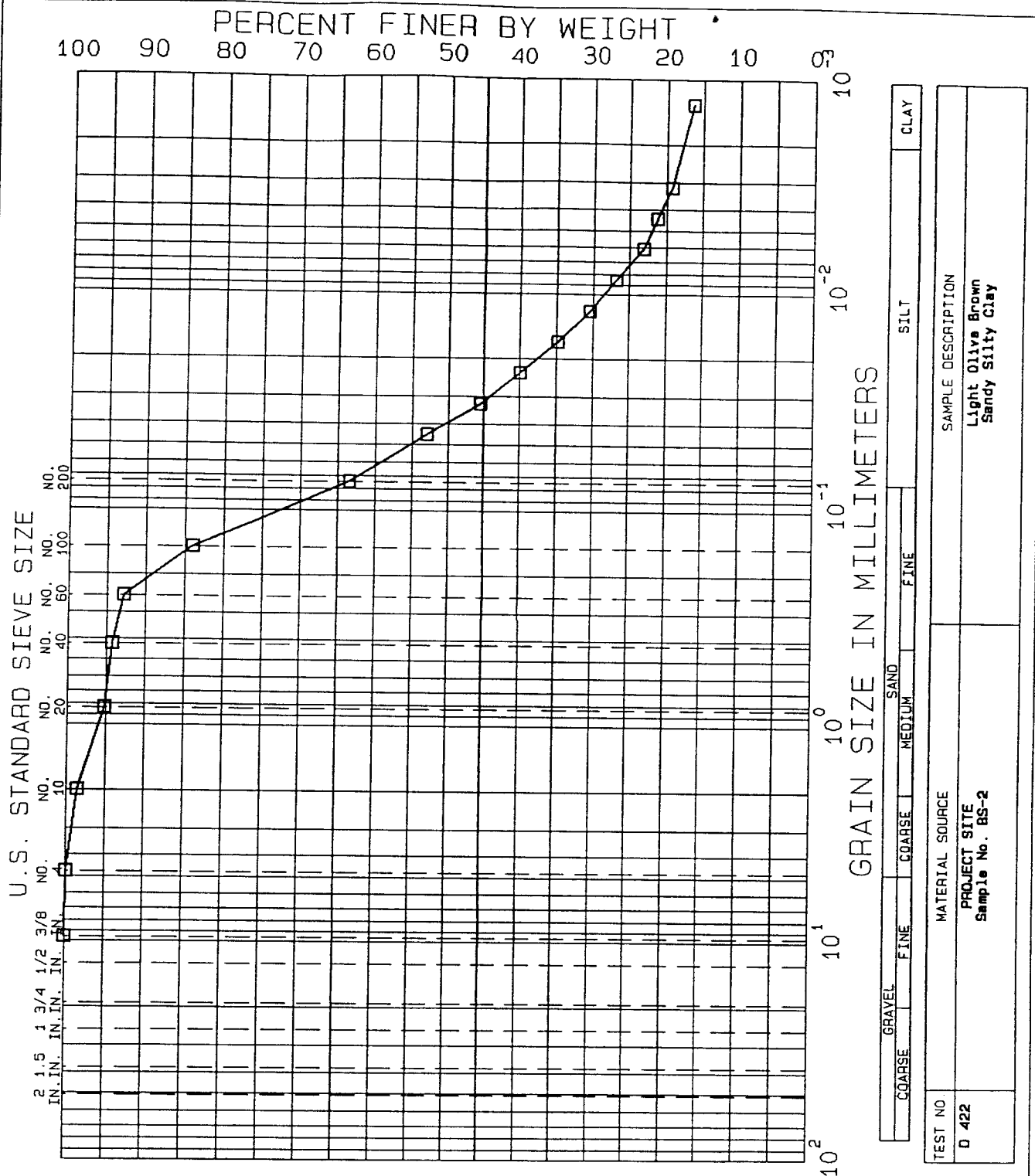


TEST NO.	PROJECT SITE	SAMPLE DESCRIPTION
0 422	Sample No. BS-1	Light Yellowish Brown Lean Clay with Sand

LONGHORN ARMY AMMUNITIONS PLANT
STABILIZATION TREATMENT STATION
GRADATION TESTS

EXPLOR. NO.
SAMPLE NO. BS-1
DEPTH
TECH. WGL
REVIEWER RAR

WORK ORDER
NO. 2282
DATE 1/24/94
FILE 6069.00



**LONGHORN ARMY AMMUNITIONS PLANT
STABILIZATION TREATMENT STATION
GRADATION TESTS**

EXPLOR. NO.
SAMPLE NO. **BS-2**
DEPTH
TECH. **WGL**
REVIEWER **RAR**

WORK ORDER
NO. **2282**
DATE **1/24/94**
FILE **6069.00**

**LEGEND FOR GEOTECHNICAL
LABORATORY DATA SUMMARY SHEET**

WATER CONTENT (ASTM D 2216)

% = WATER CONTENT IN PERCENT

ATTERBERG LIMITS (ASTM D 4318)

LL % = LIQUID LIMIT IN PERCENT

PL % = PLASTIC LIMIT IN PERCENT

PI = PLASTICITY INDEX

GRAIN SIZE ANALYSIS (ASTM D 422)

SIEVE -200 % = PERCENT FINES, MATERIAL FINER THAN NO. 200 SIEVE
(0.074 MM)

HYD. -2 μ % = PERCENT FINER THAN 2 MICRONS

MOISTURE-DENSITY RELATIONSHIP (Modified) (ASTM D 1557)

MAX. DRY DENSITY pcf = MAXIMUM DRY DENSITY IN POUNDS PER CUBIC FOOT

OPT. WATER CONTENT % = OPTIMUM WATER CONTENT IN PERCENT

PERMEABILITY TEST (ASTM D 5084)

PERMEABILITY cm/sec. = PERMEABILITY MEASURED IN CENTIMETERS PER SECOND

TYPE OF TEST K_r = RECONSTITUTED (REMOLDED) SAMPLE
 K = UNDISTURBED SAMPLE

$\bar{\sigma}_c$ psf = EFFECTIVE CONFINING PRESSURE DURING PERMEABILITY
TEST IN POUNDS PER SQUARE FOOT

DRY UNIT WT. pcf = DRY DENSITY OF TEST SAMPLE IN POUNDS PER CUBIC
FOOT

WATER CONTENT % = WATER CONTENT OF TEST SAMPLE IN PERCENT

GEOTECHNICAL LABORATORY TEST PROCEDURES

LONGHORN ARMY AMMUNITIONS PLANT
STABILIZATION TREATMENT STATION

File No. 6069.00

1. The following tests were performed with the noted ASTM test designation:

TESTASTM DESIGNATION

Grain Size Analysis

D 422-92 (See Item 2)

2. Test Procedure for Combined Sieve and Hydrometer Analysis

When both sieve and hydrometer analyses are required a combined mechanical analysis is performed. This procedure is, in part, similar to ASTM's D 2217-66 (wet preparation of soil sample for grain-size analysis and determination of soil constants-B).

A representative portion of the minus No. 4 material was mixed with a defloculant agent and distilled water mixture and then mechanically mixed into a slurry. The fines suspended in this slurry were then poured over a No. 200 sieve into an empty hydrometer jar. Coarser fractions remaining on the No. 200 sieve after the separation process were then oven dried and sieved through a nest of sieves (Nos. 10, 20, 40, 60, 100, and 200). Any material passing the No. 200 sieve was added to the hydrometer jar containing the finer fraction.

Hydrometer analysis of these fines was performed in the conventional manner.

CHAIN OF CUSTODY RECORD

007548

[illegible]

APPENDIX D

Recra Environmental's Stabilization Form Worksheets



RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-1PA

1. Reagent Used	Portland cement type III
2. Weight of Sample (g)	100
3. Reagent Weight (g)	10
4. Amount of H ₂ O Used (ml)	33
5. Total Weight of Dry Sample (g)	110
6. Total Weight of Mixture (g)	144
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	26.0°C
9. Change Temperature (°C)	+5.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial	1444 - 1/6/94
Final	1425 - 1/7/94
13. Pocket Penetrometer (UCS)	1.5 tons per sq. ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - Mixing in water, sample appears to be setting up and drying; color is clay brown.

1/7/94 - Color is tan; dry; non-uniform surface; little clumps of material; crumbles easily with fingers.



RECRA ENVIRONMENTAL, INC.
Stabilization Form

007551

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-1PB

1. Reagent Used	Portland cement type III
2. Weight of Sample (g)	100
3. Reagent Weight (g)	20
4. Amount of H ₂ O Used (ml)	31
5. Total Weight of Dry Sample (g)	120
6. Total Weight of Mixture (g)	151
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	25.0°C
9. Change Temperature (°C)	+4.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1434 - 1/6/94 1434 - 1/7/94
13. Pocket Penetrometer (UCS)	1.5 tons per sq. ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water, sample appears to be setting up and drying; color is clay brown.

1/7/94 - Color is tan; dry; hard non-uniform surface; hard to crumble with fingers.



RECRA
ENVIRONMENTAL
INC.

pjf.01

RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-2PC

1. Reagent Used	Portland cement type III
2. Weight of Sample (g)	100
3. Reagent Weight (g)	30
4. Amount of H ₂ O Used (ml)	45
5. Total Weight of Dry Sample (g)	130
6. Total Weight of Mixture (g)	178
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	24.0°C
9. Change Temperature (°C)	+3.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1520 - 1/6/94 1439 - 1/7/94
13. Pocket Penetrometer (UCS)	4.5 tons per sq. ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing with water, sample is setting up and drying out; color is clay brown.

1/7/94 - Color is tan; dry; hard non-uniform surface; crumbles easily with fingers.



007553

RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-1FA

1. Reagent Used	Fly ash mixture
2. Weight of Sample (g)	100
3. Reagent Weight (g)	10
4. Amount of H ₂ O Used (ml)	40
5. Total Weight of Dry Sample (g)	110
6. Total Weight of Mixture (g)	153
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	24.0°C
9. Change Temperature (°C)	+3.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1419 - 1/6/94 1450 - 1/7/94
13. Pocket Penetrometer (UCS)	4.5 tons per sq. ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water, sample appears to be setting up and drying out; color is brownish grey.

1/7/94 - Color is grey; non-uniform surface; very hard to crumble with fingers.



RECRA
ENVIRONMENTAL
INC.

pjf.01

RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-1FB

1. Reagent Used	Fly ash mixture
2. Weight of Sample (g)	100
3. Reagent Weight (g)	20
4. Amount of H ₂ O Used (ml)	47
5. Total Weight of Dry Sample (g)	120
6. Total Weight of Mixture (g)	166
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	23.0°C
9. Change Temperature (°C)	+2.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1423 - 1/6/94 1456 - 1/7/94
13. Pocket Penetrometer (UCS)	4.0 tons per sq. ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water sample appears to be setting up and drying out; color is brownish grey.

1/7/94 - Color is grey; dry; non-uniform surface; crumbles easily with fingers.



**RECRA
ENVIRONMENTAL
INC.**

RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-1FC

1. Reagent Used	Fly ash mixture
2. Weight of Sample (g)	100
3. Reagent Weight (g)	30
4. Amount of H ₂ O Used (ml)	40
5. Total Weight of Dry Sample (g)	130
6. Total Weight of Mixture (g)	174
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	26.0°C
9. Change Temperature (°C)	+5.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1426 - 1/6/94 1459 - 1/7/94
13. Pocket Penetrometer (UCS)	4.0 tons per sq. ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water sample appears to be setting up and drying out; color is brownish grey.

1/7/94 - Color is grey; dry; non-uniform surface; crumbles easily with fingers.



RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-2PA

1. Reagent Used	Portland cement type III
2. Weight of Sample (g)	100
3. Reagent Weight (g)	10
4. Amount of H ₂ O Used (ml)	36
5. Total Weight of Dry Sample (g)	110
6. Total Weight of Mixture (g)	149
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	23.0°C
9. Change Temperature (°C)	+2.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1511 - 1/6/94 1511 - 1/7/94
13. Pocket Penetrometer (UCS)	4.25 tons per sq. ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water, sample is setting up and drying up; color is grey brown.

1/7/94 - Color is brownish tan; dry; medium-uniformity surface; crumbles easily with fingers.



RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-2PB

1. Reagent Used	Portland cement type III
2. Weight of Sample (g)	100
3. Reagent Weight (g)	20
4. Amount of H ₂ O Used (ml)	40
5. Total Weight of Dry Sample (g)	120
6. Total Weight of Mixture (g)	162
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	23.0°C
9. Change Temperature (°C)	+2.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1514 - 1/6/94 1514 - 1/7/94
13. Pocket Penetrometer (UCS)	4.75 tons per sq.ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water, sample is setting up and drying out; color is clay brown.

1/7/94 - Color is tan; smooth surface with cracks in it; crumbles easily with fingers.



RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-IPC

1. Reagent Used	Portland cement type III
2. Weight of Sample (g)	100
3. Reagent Weight (g)	30
4. Amount of H ₂ O Used (ml)	39
5. Total Weight of Dry Sample (g)	130
6. Total Weight of Mixture (g)	170
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	28.0°C
9. Change Temperature (°C)	+7.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1438 - 1/6/94 1518 - 1/7/94
13. Pocket Penetrometer (UCS)	4.0 tons per sq. ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water, sample appears to be setting up and drying; color is clay brown.

1/7/94 - Color is tan; dry; non-uniform surface; hard to crumble with fingers.



RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-2FA

1. Reagent Used	Fly ash mixture
2. Weight of Sample (g)	100
3. Reagent Weight (g)	10
4. Amount of H ₂ O Used (ml)	41
5. Total Weight of Dry Sample (g)	110
6. Total Weight of Mixture (g)	152
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	21.0°C
9. Change Temperature (°C)	0.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1500 - 1/6/94 1523 - 1/7/94
13. Pocket Penetrometer (UCS)	1.5 tons per sq. ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water, sample is setting up and drying out; color is brownish grey.

1/7/94 - Color is brownish tan; smooth surface with some cracks in it; crumbles with ease.



RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-2FB

1. Reagent Used	Fly ash mixture
2. Weight of Sample (g)	100
3. Reagent Weight (g)	20
4. Amount of H ₂ O Used (ml)	44
5. Total Weight of Dry Sample (g)	120
6. Total Weight of Mixture (g)	170
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	24.0°C
9. Change Temperature (°C)	+3.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1504 - 1/6/94 1527 - 1/7/94
13. Pocket Penetrometer (UCS)	4.0 tons per sq. ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water, sample is setting up and drying out; color is brownish grey.

1/7/94 - Color is brownish tan; dry; uniform surface with some cracks around the edge; crumbles easily with fingers.



RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: BS-2FC

1. Reagent Used	Fly ash mixture
2. Weight of Sample (g)	100
3. Reagent Weight (g)	30
4. Amount of H ₂ O Used (ml)	37
5. Total Weight of Dry Sample (g)	130
6. Total Weight of Mixture (g)	170
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	24.0°C
9. Change Temperature (°C)	+3.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1508 - 1/6/94 1534 - 1/7/94
13. Pocket Penetrometer (UCS)	4.25 tons per sq. ft.

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water, sample is setting up and drying out; color is grey brown.

1/7/94 - Color is light tan; uniform surface with some cracks; hard to crumble with fingers.



RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: Blank of PC/FA (Portland cement type III/fly ash)

1. Reagent Used	None
2. Weight of Sample (g)	30
3. Reagent Weight (g)	0
4. Amount of H ₂ O Used (ml)	9
5. Total Weight of Dry Sample (g)	30
6. Total Weight of Mixture (g)	40
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	21.0°C
9. Change Temperature (°C)	0.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial	1526 - 1/6/94
Final	1545 - 1/7/94
13. Pocket Penetrometer (UCS)	-----

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water, sample is setting up and drying out; color is dark grey.

1/7/94 - Color is dark grey; uniform surface; crumbles hard with fingers.



RECRA ENVIRONMENTAL, INC.
Stabilization Form

Date: 1/6/94

Analyst: P. Filey, R. Blinston

Sample I.D.: Blank of PC (Portland cement type III)

1. Reagent Used	None
2. Weight of Sample (g)	30
3. Reagent Weight (g)	0
4. Amount of H ₂ O Used (ml)	12
5. Total Weight of Dry Sample (g)	30
6. Total Weight of Mixture (g)	41
7. Mixture Ambient Temperature (°C)	21.0°C
8. Mixture Stabilized Temperature (°C)	21.0°C
9. Change Temperature (°C)	0.0°C
10. Odor Present	No
11. Fuming Present	No
12. Stabilization Time / Initial Final	1523 - 1/6/94 1544 - 1/7/94
13. Pocket Penetrometer (UCS)	-----

Analytical: TCLP Metals (Pb, Cr, Ba)

Comments:

1/6/94 - After mixing in water, sample is setting up and drying out; color is light grey.

1/7/94 - Color is light tan; uniform surface with some cracks; crumbles with fingers



Final Report
Longhorn Army Ammunition Plant, Karnack TX
Carbon Adsorption and Ion Exchange
Technology Evaluation

AWD Project 2379
AWD Task 252

February 7, 1994

Presented To:

Amine Bou Onk
AWD Technologies
Rockville, MD

Presented By:

Roy DeGesero
Bill McIlhenny
Walter Precourt
Mohamed Zeitoun
AWD Technologies
Houston, TX

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Glossary

Definitions are from Appendix A of the US EPA's Process Design Manual for Activated Carbon, EPA 625/1-71-002a, October, 1973. Trademarks are from product suppliers.

ADSORBATE - The material, e.g., color bodies, taste and odor compounds, which is adsorbed on an activated carbon or other adsorbent.

ADSORBENT - A material, such as activated carbon, upon which adsorption takes place.

ADSORPTION - The adhesion of an extremely thin layer of molecules (of gas, liquid) to which the surface of solids (granular activated carbons, for instance) or liquids with which they are in contact.

ADSORPTION ISOTHERMS - A measurement of the adsorptive capacity of an adsorbent as a function of the concentration, or pressure of the adsorbing material **at a given temperature**. It is defined as **the constant temperature relationship** between amount adsorbed per unit weight of adsorbent and the equilibrium concentration, or partial pressure.

ADSORPTION ISOTONE - A measurement of the adsorptive capacity of an adsorbent as a function of the concentration, or pressure of the adsorbing material. It is defined as the relationship between amount adsorbed per unit weight of adsorbent and the equilibrium concentration, or partial pressure.

DESORPTION - The opposite of adsorption. A phenomenon where an adsorbed molecule leaves the surface of the adsorbent.

DOWEX™ HCR - A high capacity, gel-type, strong acid, cation exchange resin manufactured by Dow Chemical.

DOWEX™ MSC-1 - A high capacity, macroporous, strong acid, cation exchange resin manufactured by Dow Chemical.

NORIT HYDRODARCO™ GCW ACTIVATED CARBON - A microporous activated carbon manufactured by American Norit Company

REGENERATION - Restoration of sorptive capacity to a used adsorbent by chemical or thermal treatment.

WESTVACO NUCHAR™ WB-V - An activated carbon manufactured by Westvaco Corporation.

Equivalent Weight

The concentration of ions in solution is commonly expressed in terms of mili equivalent per liter (meq/l). To convert from mg/l to meq/l, divide the mg/l concentration by the equivalent weight. The equivalent weight of an element equals the molecular weight divided by the elemental charge. Equivalent weights are presented in Table H.0.

Example

Problem: Convert 2.07 mg/l to meq/l.

Solution: Molecular wt. Ba = 137.4
Charge of Ba = +2
Equivalent wt. Ba = $137.4 / 2 = 68.7$

$$(2.07) / (68.7) = 0.03 \text{ meq/l}$$

Table H.0
Equivalent Weights

Element	Equivalent Wt.
Aluminum	9.0
Barium	68.7
Calcium	20.0
Copper	31.8
Magnesium	12.2
Potassium	39.1
Sodium	23.0

1.0 Executive Summary

The groundwater beneath *Burning Ground 3* and the *Unlined Evaporation Pond* at the Longhorn Army Ammunition Plant in Karnack, TX (Longhorn) contains organic and inorganic compounds which may require treatment. The United States Army Corps of Engineers has contracted with AWD Technologies, Inc. (AWD) to screen a variety of technologies which could be applied to remediate groundwater at the Longhorn site. In support of AWD's technology screening, the Houston office of AWD evaluated the feasibility of granular activated carbon and ion exchange.

Analytical characterization and treatability verification samples were shipped from Longhorn to AWD in Houston. The shipment included groundwater from extraction well EW-1 and monitoring wells MW-1 and MW-2.

AWD's contract laboratory, Southwestern Laboratories (SWL), completed a comprehensive characterization of the groundwater. Data indicate high levels of methylene chloride are present in all three groundwaters. Trichloroethene was observed in the EW-1 sample. Based upon a review of the detection limits for this compound and data from PDP laboratories, it is suspected that trichloroethene was also present in MW-1 and MW-2.

From an inorganic perspective, elevated levels of barium were detected in MW-1 and MW-2. The iron and suspended solids concentrations were distinctly higher in EW-1 than in MW-1 and MW-2.

Upon completion of the groundwater characterization, granular activated carbon (GAC) treatment was evaluated. After data review and discussion with vendors, Westvaco Nuchar WB-V and Norit Hydrodarco GCW were evaluated in isotherm tests. Based upon performance findings, Norit Hydrodarco GCW was used in subsequent column testing. Conclusions of the GAC evaluation include:

- From a technical perspective, granular activated carbon can be used to remove methylene chloride from Longhorn groundwater.
- Freundlich isotherm data indicate that Westvaco Nuchar WB-V has an ultimate capacity of 305 mg methylene chloride/ g carbon. Norit Hydrodarco GCW has an ultimate capacity of 750 mg methylene chloride/ g carbon.
- Column studies indicate that less than 12.5 gallons of groundwater can be treated per pound of Norit Hydrodarco GCW. At 20 gpm, this translates to a minimum daily carbon usage rate of 2300 pounds.
- The feasibility of activated carbon would be enhanced if it were employed as a secondary means of methylene chloride removal, ie as a polishing step for some other process or technology.

Concurrent with the GAC evaluation, ion exchange resins were screened for barium removal. Upon completion of a comprehensive screening process, DOWEX HCR and DOWEX MSC-1 were evaluated in preliminary testing. While both resins appeared capable of barium removal, DOWEX

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MSC-1 exhibited better performance. This resin was therefore selected for use in follow up column evaluation. Conclusions of the ion exchange evaluation include:

- From a technical perspective, ion exchange can be used to remove barium from Longhorn groundwater.
- Freundlich isotone data indicates that DOWEX MSC-1 has an ultimate capacity of 0.0245 meq barium/ g resin. DOWEX HCR has an ultimate capacity of 0.0186 meq barium/ g resin.
- Solids, such as precipitated iron, should be removed prior to the use of ion exchange.
- An ion exchange system designed to reduce the barium concentration present in 20 gpm of groundwater from 4 mg/l to < 1.0 mg/l could be designed using an estimated 10 cubic ft. of DOWEX MSC-1 or less. Ten cubic feet of DOWEX MSC-1 costs approximately \$1100.

2.0 Sampling and Analytical

Groundwater from Longhorn monitoring wells MW-1 and MW-2, and extraction well EW-1 was sampled on December 15, 1993. Samples were shipped on ice by overnight courier to Southwestern Laboratories' Houston facility. Samples were received by the laboratory on December 16, 1993. Upon being logged into Southwestern Laboratories' sample management system, the samples were placed under refrigeration. Samples were maintained at $< 4^{\circ}\text{C}$ except as required for analysis or use in the treatability studies.

Table 2.0 contains a description of the containers used and analyses requested. Table 2.1 contains the results from metals analyses. Conventional and inorganic parameters are presented in Table 2.2. Finally, semivolatile and volatile organics data are presented in Table 2.3. The full lab report has been placed in appendix A.

Table 2.0
Analytical Requirements and Sample Containers

Sample	Container	Analysis Requested
MW-1	2 @ Qt glass	Semivolatile organics
	2 @ 40 ml VOA	Volatile organics
	2 @ Qt plastic	SO ₄ , NO ₃ , Cl, CN, Cr ⁺⁶ , Radioactivity* (Gross alpha & beta), pH, TOC, TOC**, COD, TDS, TSS, Oil & Grease, Acidity or Alkalinity, Al, Sb, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mo, K, Ag, Na, Ti, Tl, Sn, V, Zn
	1 @ 5 Gal plastic	For use in treatability evaluation (not shipped on ice)
MW-2	2 @ Qt glass	Semivolatile organics
	2 @ 40 ml VOA	Volatile organics
	1 @ 0.5 Gal plastic 1 @ Qt glass	SO ₄ , NO ₃ , Cl, CN, Cr ⁺⁶ , Radioactivity* (Gross alpha & beta), pH, TOC, TOC**, COD, TDS, TSS, Oil & Grease, Acidity or Alkalinity, Al, Sb, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mo, K, Ag, Na, Ti, Tl, Sn, V, Zn
	1 @ 5 Gal plastic	For use in treatability evaluation (not shipped on ice)
EW-1	2 @ Qt glass	Semivolatile organics
	2 @ 40 ml VOA	Volatile organics
	2 @ Qt plastic	SO ₄ , NO ₃ , Cl, CN, Cr ⁺⁶ , Radioactivity* (Gross alpha & beta), pH, TOC, TOC**, COD, TDS, TSS, Oil & Grease, Acidity or Alkalinity, Al, Sb, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mo, K, Ag, Na, Ti, Tl, Sn, V, Zn
	2 @ 5 Gal plastic	For use in treatability evaluation (not shipped on ice)

* MW-1, MW-2, and MW-3 to be composited (1:1:1) for radioactivity analysis

** TOC** was run without sparging and acidification

Table 2.1
Metals

Analyte	Method	Detection Limit	Units	MW-1	MW-2	EW-1
Aluminum	EPA 200.7	0.05	mg/l	0.27	0.05	7.29
Antimony	EPA 204.2	0.01	mg/l	<0.01	<0.01	<0.01
Barium	EPA 200.7	0.22	mg/l	3.81	2.39	0.57
Beryllium	EPA 200.7	0.02	mg/l	<0.02	<0.02	<0.02
Cadmium	EPA 200.7	0.02	mg/l	<0.02	<0.02	<0.02
Calcium	EPA 200.7	0.01	mg/l	108	93	16.0
Chromium	EPA 200.7	0.04	mg/l	<0.04	<0.04	<0.04
Cobalt	EPA 200.7	0.02	mg/l	0.03	0.02	<0.02
Copper	EPA 200.7	0.04	mg/l	0.04	0.02	0.04
Iron	EPA 200.7	0.10	mg/l	<0.10	0.21	27.2
Lead	EPA 239.1	0.10	mg/l	<0.10	<0.01	<0.10
Magnesium	EPA 242.1	0.05	mg/l	106	83.2	10.7
Molybdenum	EPA 200.7	0.02	mg/l	<0.02	<0.02	<0.02
Potassium	EPA 258.1	0.04	mg/l	4.2	2.0	2.3
Silver	EPA 272.1	0.05	mg/l	<0.05	<0.05	<0.05
Sodium	EPA 273.1	0.05	mg/l	385	295	130
Thallium	EPA 279.2	0.01	mg/l	<0.01	<0.01	<0.01
Tin	EPA 200.7	0.13	mg/l	0.13	0.05	0.27
Titanium	EPA 200.7	0.02	mg/l	<0.02	<0.02	0.15
Vanadium	EPA 200.7	0.02	mg/l	<0.02	<0.02	<0.02
Zinc	EPA 200.7	0.02	mg/l	<0.02	<0.02	<0.02

Table 2.2
Conventional and Inorganic Parameters

Analyte	Method	Detection Limit	Units	MW-1	MW-2	EW-1
Alkalinity	EPA 310.1	5.0				
Hydroxide	EPA 310.1		mg/l*	0	0	0
Carbonate	EPA 310.1		mg/l*	0	0	0
Bicarbonate	EPA 310.1		mg/l*	155	135	0
COD	EPA 410.4	15.0	mg/l	150	117	101
Chloride	EPA 325.3	0.25	mg/l	1110	774	130
Cyanide	EPA 335.3	0.01	mg/l	<0.01	<0.01	<0.01
Chromium ⁺⁶	SW-846	0.01	mg/l	<0.01	<0.01	<0.01
Nitrate as N	EPA 353.2	0.05	mg/l	14.1	13.9	56.5
Oil & Grease	EPA 413.1	1.0	mg/l	1.5	2.0	<1.0
Sulfate	EPA 375.2	3.0	mg/l	6.32	6.07	<3.0
TDS	EPA 160.1	5.0	mg/l	2400	2070	605
TOC	EPA 415.1	1.0	mg/l	96.0	1066	35.7
TOC**	EPA 415.1	1.0	mg/l	114	1119	37.1
TSS	EPA 160.2	1.0	mg/l	6.0	1.0	123
pH	EPA 150.1			6.10	6.25	4.5
Gross alpha		2	pci/l	3 +/- 2		
Gross beta		3	pci/l	6 +/- 4		

1 : 1 : 1 composite of the three groundwater samples was prepared for gross alpha and gross beta analysis.

* as CaCO₃

** TOC** was run without sparging and acidification

Table 2.3
Semivolatile and Volatile Organics

Analyte	Method	Units	MW-1	MW-2	EW-1
Semivolatile Organics					
Benzyl Alcohol	EPA 625	ug/l	BDL*	48.0	BDL
Di-n-Butylphthalate	EPA 625	ug/l	BDL*	22.6	12.1
bis(2-Ethylhexyl) Phthalate	EPA 625	ug/l	BDL*	145	BDL
Di-n-Octyl Phthalate	EPA 625	ug/l	BDL*	22.8	BDL
Benzoic Acid	EPA 625	ug/l	BDL*	BDL*	94.8
Volatile Organics					
Methylene Chloride	EPA 624	mg/l	423	6850	2540
Trichloroethene	EPA 624	mg/l	BDL*	BDL*	198

* Below Detection Limits (BDL). Detection limits varied with the dilution required for sample analysis.

3.0 Granular Activated Carbon

Granular activated carbon (GAC) is widely used to remove organic constituents from contaminated groundwater. The adsorption of organics from the liquid to the solid phase is generally assumed to occur in three stages (Adams et al, 1981):

- 1) movement of the contaminant, or sorbate, through a film surface surrounding the granular activated carbon
- 2) diffusion of the sorbate within the pores of the granular activated carbon
- 3) sorption of the material onto the surface of the granular activated carbon

Because such things as groundwater matrix, GAC characteristics, and operating conditions can influence the rate and extent of the adsorption process, laboratory studies are commonly conducted to evaluate the feasibility of employing carbon adsorption for a given application.

Preliminary screening commonly consists of groundwater characterization, literature review, vendor consultation, and isotherm construction. This information is then combined with the data collected during continuous column operation to allow for a detailed engineering assessment of granular activated carbon suitability.

Carbon Isotherm

The adsorption capacity of a granular activated carbon (GAC) is often characterized by an isotherm. The data required for isotherm generation are collected by placing varying quantities of adsorbent, or GAC, into aliquots of solution, or groundwater. After equilibrium has been reached, and the concentration of adsorbate remaining in each aliquot has been measured, an isotherm is constructed.

The Freundlich isotherm is frequently used to describe adsorption in aqueous systems. The equation of the Freundlich isotherm is:

$$X/M = KC^{(1/N)}$$

Where:

- X = amount of adsorbate adsorbed (mg or g)
- M = weight of adsorbent in the sample (mg or g)
- C = equilibrium concentration of adsorbate in solution after adsorption (mg/l)
- K = constant
- N = constant

The isotherm is constructed by plotting X/M (sorbate capacity) versus C (equilibrium concentration) on log - log paper. The value of K is defined by the y intercept, while 1/N is defined by the slope.

So as to initiate the Longhorn isotherm studies, groundwaters MW-1, MW-2, and EW-1 were characterized. As methylene chloride was found to be a predominant component in each of the three groundwaters, it was selected as the target compound for monitoring purposes.

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Calgon, Norit, and Westvaco were contacted to discuss GAC products which might be suitable for this particular application. Based upon technical considerations, Westvaco's Nuchar WB-V (Westvaco) and American Norit's Hydrodarco GCW (Norit) were selected for isotherm evaluation. The evaluation process was conducted as described below.

- 1) Using a mortar and pestle, grind the GAC samples into powdered form.
- 2) To minimize volatile organic contamination potential, place the powdered carbon in a 140°C drying oven overnight.
- 3) Using an analytical balance, weigh out various quantities of carbon.
- 4) Place the carbon samples in 40 ml VOA bottles.
- 5) Composite MW-1, MW-2, and EW-1 groundwater samples (approximately 1 : 1: 1). Fill each VOA bottle with composited groundwater.
- 6) Using a wrist action shaker, agitate the samples and a control for approximately 24 hours.
- 7) Analyze the samples for methylene chloride.

Testing was initiated on January 5, 1993. Based upon information contained in technical literature, carbon doses of 91 mg/l, 273 mg/l, 545 mg/l, 818 mg/l, and 1636 mg/l were selected. Analytical results have been placed in Table 3.0 below.

Table 3.0
Carbon Isotherm Data - Test 1

Carbon Dose (mg/l)	MeCl Remaining with Norit Carbon (mg/l)	MeCl Remaining with Westvaco Carbon (mg/l)
91	4980	6700
273	5500	5600
545	5000	5300
818	3140	8450
1636	4480	4960

control MeCl = 5775; control pH = 6.9

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When plotted as an isotherm, the data presented in Table 3.0 suggested that a higher carbon dose would be required to obtain data points which could be distinguished from background noise. Thus, on January 17th the test was repeated at GAC doses of 3409 mg/l, 6818 mg/l, and 13636 mg/l. Analytical results from this second test have been placed in Table 3.1 below.

Table 3.1
Carbon Isotherm Data - Test 2

Sample	COD Remaining (mg/l)	TOC Remaining (mg/l)	MeCl Remaining (mg/l)
Control	448	37	3880
Westvaco - 3409 mg/l	302	38	3040
Westvaco - 6818 mg/l	318	28	2670
Westvaco - 13,636 mg/l	297	26	1960
Norit - 3409 mg/l	242	28	2240
Norit - 6818 mg/l	197	24	1250
Norit - 13,636 mg/l	163	23	760

control pH = 6.9

In addition to methylene chloride data, COD and TOC data were also collected. The purpose of collecting this additional information was to determine if either parameter would be suitable as an indicator of methylene chloride breakthrough during column operation. Although sample volatilization is an issue with both analytical procedures, the COD test appeared to offer a potential means of sample screening when Norit carbon was used. The correlation between COD and methylene chloride was significantly poorer for groundwater treated with Westvaco carbon. Correlation curves are presented in Appendix C.

Methylene chloride data from Table 3.1 was fit to the Freundlich equation. The data was regressed to produce the Freundlich isotherm constants presented in Table 3.2. The data indicates that Norit Hydrodarco GCW outperformed Westvaco Nuchar WB-V in terms of methylene chloride removal for the groundwater matrix evaluated.

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Table 3.2
Freundlich Isotherm Parameters

Parameter	Westvaco WB-V	Norit Hydrodarco GCW
K (mg/g)	0.01789	2.705
1/N	1.179	0.6787
R ²	0.8942	0.9258
Ultimate Capacity (mg/g)	305	750

Ultimate capacity represents the amount of adsorbate adsorbed when the carbon is in equilibrium with the maximum solute concentration (ie 3880 mg/l).

To better understand what the isotherm data means in terms of methylene chloride removal, consider the information presented in Tables 3.3 and 3.4. These tables show how much carbon would be required to reduce the groundwater methylene chloride concentration to various levels. Note that this data is for the batch removal of methylene chloride present in 1.0 liter of composited groundwater.

Table 3.3
Batch Adsorption of MeCl from 1 Liter of Groundwater Mixture
using Norit Hydrodarco GCW carbon

MeCl concentration remaining in 1 liter of groundwater mg/l	Quantity of Norit Hydrodarco GCW required g
3880	0.00
3492	0.56
3104	1.22
2716	2.01
2328	2.98
1940	4.21
1552	5.88
1164	8.33
564	12.5

Table 3.4
Batch Adsorption of MeCl from 1 Liter of Groundwater Mixture
using Westvaco WB-V carbon

MeCl concentration remaining in 1 liter of groundwater mg/l	Quantity of Westvaco WB-V required g
3880	0.00
3492	1.44
3104	3.31
2716	5.82
2328	9.30
1940	14.4
1552	22.5
1164	36.9
564	68.0

As shown, 8.33 grams of Norit carbon would be required to reduce the MeCl concentration from an initial value of 3880 mg/l to 1164 mg/l. It would take 4.4 times that amount, or 36.9 grams, to achieve the same quality effluent if Westvaco WB-V were used.

From the above data it was apparent that substantial quantities of GAC would be required to treat the Longhorn groundwater to drinking water standards. It is known that when carbon adsorption is practiced at high doses, metals removal is a fairly common observation. So as to develop an initial level of insight concerning barium removal by activated carbon, 55 grams of each carbon was contacted with 300 ml samples of MW-1. MW-1 contained 4.4 mg/l barium. After equilibrium, the groundwater contacted with Westvaco contained 1.0 mg/l barium, while the groundwater contacted with Norit contained 1.1 mg/l.

Carbon Column Study

From the isotherm data described above, Norit GCW was selected for evaluation in a column study. Vendor supplied product information for this material can be found in Appendix D.

Column testing was initiated on January 24, 1994. The apparatus used in the column study is shown in picture 1.0, Appendix E. The equipment was set up and operated as described below.

- 1) Place three one inch diameter columns in series. Label the columns A, B, and C; with column A being the first in series and C being the last. Tube the columns so that the liquid flows upward through the column.

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- 2) Place glass wool in the bottom of each column.
- 3) Slurry the GAC in deionized water and bring the mixture to a boil. After a boil is reached, pour off the carbon fines.
- 4) Half fill each column with boiling water (use the water from step 3).
- 5) Place eleven inches of carbon into each column. Eleven inches of Norit carbon has a dry weight of approximately 46 grams.
- 6) Tap the columns to minimize void space formation.
- 7) Drain the column and allow the carbon to cool.
- 8) Place a small amount of glass wool on the top of the carbon, then stopper the column.
- 9) Place a mixture of MW-1, MW-2, and EW-1 into zero headspace sampling bags. Use 0.8 : 1.2 : 1.0 as the MW-1 : MW-2 : EW-1 ratio.
- 10) Connect the feed pump, and calibrate the flow rate to 10 ml/min. This rate translates to a surface loading rate of approximately 0.5 gpm/ft².
- 11) Begin column operation and sample as required.

Data collected during the steady state operation of the column is recorded in Table 3.5 below.

Table 3.5
MeCl in Column Effluent
(influent MeCl = 6000 mg/l)

Nominal Sample Collection Time (min)	Column A Effluent (mg/l)	Column B Effluent (mg/l)	Column C Effluent (mg/l)
78	0.009	0.009	0.016
126	0.016	1.3	0.093
377	844	0.830	0.008
541	6040	0.550	<0.005
1442	6200	5340	4180

Columns were sampled in reverse alphabetical order. Nominal time is defined as the time that column B was sampled.

4.0 Ion Exchange

Inorganic compounds dissolve in water and unless complexed, dissociate into positively charged ions (cations) and negatively charged ions (anions). Metals are typically found as cations, while such things as chlorides, sulfates, and chromates exist as anions. Both cations and anions can be removed from water by ion exchange. (See Appendix F for background on ion exchange fundamentals).

In the ion exchange process, undesirable ions are bound to a resin in exchange for acceptable ions which are released to the water. The exchange process is reversible, and there is no permanent change in the structure of the resin. The exchange process is somewhat similar to adsorption in that the ions being removed from solution diffuse into the molecular network of the resin where the exchange occurs. The exchange process continues until an equilibrium between the ions bound to the resin and the ions in solution has been reached.

There are four general classifications of ion exchange resins (see list below). Depending upon water treatment goals, a particular class of resins is selected for evaluation.

Ion Exchange Resin Classifications

- Strong acid cation exchangers
- Weak acid cation exchangers
- Strong base anion exchangers
- Weak base anion exchangers

Like activated carbon, the ion exchange process is influenced by such things as the liquid matrix, properties of the ion exchange resin, and operating conditions. Not surprisingly, the process of resin selection is nearly identical to that of carbon selection. Preliminary screening consists of groundwater characterization, literature review, vendor input, and isotone construction (an isotone is similar to an isotherm, except that the data presented in an isotone are not temperature dependent). Column studies typically follow the preliminary investigations.

Ion Exchange Isotone

The process of resin selection typically begins with an evaluation of the organics and inorganics present in the solid and dissolved phases. Organic evaluation is important, as elevated levels of organic material have a tendency to poison ion exchange resins. The presence of suspended solids must be considered because they could result in resin bed plugging. Finally, the inorganic ions must be evaluated to select the appropriate resins for screening.

Groundwaters MW-1, MW-2, and EW-1 were evaluated in light of the above criteria. Data presented in Section 2 (Sampling and Analytical) were reviewed, and supplemental water chemistry calculations were performed (see Appendix G). With the exception of EW-1, which contained iron solids, the groundwaters do not present a suspended solids problem. From an organics perspective, the concentration levels of methylene chloride present in Longhorn groundwater appears incompatible with the use of ion exchange resins.

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Based upon a comprehensive review of the above discussed factors, DOWEX HCR and DOWEX MSC-1 were selected for evaluation. Both resins are high capacity strong acid cation exchange resins (see Appendix D for vendor data).

Barium was selected as the target inorganic analyte because of its elevated concentration in groundwaters MW-1 and MW-2. MW-1 was selected for screening purposes because it had the highest concentration of the target analyte.

Testing took place on January 21, 1994 and followed the procedure outlined below.

- 1) Heat and aerate MW-1 to drive off volatile organics.
- 2) Exercise the resin samples. Wash with alternate cycles of NaCl water solution (20% on a w/w basis) and deionized water.
- 3) Thoroughly rinse the resin with deionized water and dry the resin to a constant weight.
- 4) Using an analytical balance, weigh out quantities of resin.
- 5) Place the resin samples in 500 ml plastic bottles.
- 6) Place 300 ml of MW-1 groundwater in each bottle.
- 7) Using a wrist action shaker, agitate the samples for approximately 24 hours.
- 8) Analyze the samples for barium, calcium, and magnesium ions.

Weight - Volume conversion factors for the resins are listed in Table 4.0 below.

Table 4.0
Weight - Volume Conversion Factors

Resin	Volume Occupied by 1 gram After Drying (ml)	Volume Occupied by 1 gram of Dried Resin When Water is Added (ml)
DOWEX MSC-1	1.66	2.23
DOWEX HCR	1.3	1.9

NOTE: This information is for comparison of data presented in this report. Use vendor data for design considerations.

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Results of the resin screening tests are contained in Tables 4.1 - 4.4 below. Data are presented in terms of both mg/l and meq/l (mili-equivalent per liter). For additional information on expressing material in terms of equivalents, see Appendix H.

Table 4.1
Evaluation of DOWEX HCR
Cation data Expressed as mg/l

g resin/ 300 ml groundwater	mg/l Al remaining	mg/l Ba remaining	mg/l Ca remaining	mg/l Cu remaining	mg/l Mg remaining
0.0	0.053	2.07	161	<0.01	107
0.2	0.060	1.38	134	<0.01	95.8
0.5	0.039	0.587	90.4	<0.01	74.9
1.0	0.037	0.146	26.4	<0.01	33.9
1.5	0.040	0.119	12.6	<0.01	14
2.0	0.044	0.735	6.73	<0.01	6.9

Table 4.2
Evaluation of DOWEX HCR
Cation data Expressed as meq/l

g resin/ 300 ml groundwater	meq/l Al remaining	meq/l Ba remaining	meq/l Ca remaining	meq/l Cu remaining	meq/l Mg remaining
0.0	0.005889	0.030131	8.05	0.000314	8.77
0.2	0.006667	0.020087	6.70	0.000314	7.85
0.5	0.004333	0.008544	4.52	0.000314	6.14
1.0	0.004111	0.002125	1.32	0.000314	2.78
1.5	0.004444	0.001732	0.63	0.000314	1.15
2.0	0.004889	0.010699	0.34	0.000314	0.57

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Table 4.3
Evaluation of DOWEX MSC-1
Cation Data Expressed as mg/l

g resin/ 300 ml groundwater	mg/l Al remaining	mg/l Ba remaining	mg/l Ca remaining	mg/l Cu remaining	mg/l Mg remaining
0.0	0.053	2.07	161	<0.01	107
0.2	0.075	1.12	119	<0.01	98.9
0.5	0.078	0.352	71.8	<0.01	79.7
1.0	0.041	0.051	23.2	<0.01	43.8
1.5	0.031	0.075	11.9	<0.01	23.4
2.0	0.042	0.083	9.94	<0.01	15.8

Table 4.4
Evaluation of DOWEX MSC-1
Cation Data Expressed as meq/l

g resin/ 300 ml groundwater	mg/l Al remaining	mg/l Ba remaining	mg/l Ca remaining	mg/l Cu remaining	mg/l Mg remaining
0.0	0.005889	0.030131	8.05	0.000314	8.77
0.2	0.008333	0.016303	5.95	0.000314	8.11
0.5	0.008667	0.005124	3.59	0.000314	6.53
1.0	0.004556	0.000742	1.16	0.000314	3.59
1.5	0.003444	0.001092	0.595	0.000314	1.92
2.0	0.004667	0.001208	0.4745	0.000314	1.30

4.5

Barium isotones were developed from the data presented in Tables 4.2 and 4.4. These isotones are presented as Figures 4.0 and 4.1. A regression analysis was conducted on the linear portion of each isotone (data points used in the regression have been starred in Tables 4.2 and 4.4) to produce the data contained in Table 4.4 below. Volume and weight conversion factors for the resins are listed in Table 4.5.

Table 4.5
Freundlich Isotone Parameters

Parameter	DOWEX MSC-1	DOWEX HCR
K (meq/g)	0.0647	0.0652
1/N	0.2768	0.3575
R ²	0.999	0.8922
Ultimate Capacity (meq/g)	0.0245	0.0186

Ultimate capacity represents the amount of barium adsorbed when the resin is in equilibrium with the maximum barium concentration (ie 0.030131 meq/l or 2.07 mg/l).

As shown in table 4.4, DOWEX MSC-1 exhibited better barium removal capability than DOWEX HCR. So as to confirm DOWEX MSC-1's selectivity for barium, Figure 4.3 was developed. This plot clearly shows that the resin is selective for barium removal. (Supporting calculations have been placed in Appendix I).

Figure 4.0

DOWEX MSC-1

Freundlich Isotone - Barium Removal

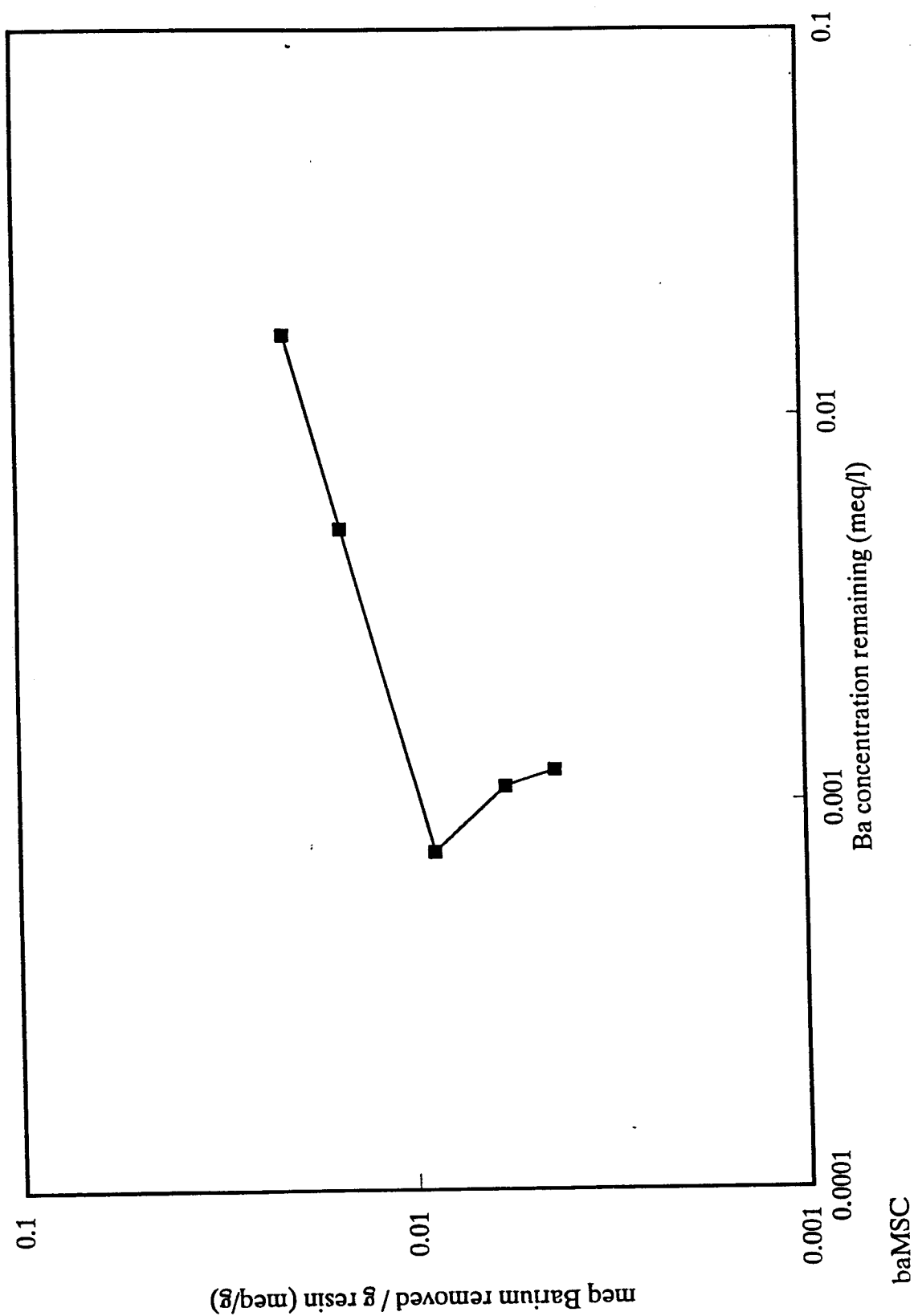


Figure 4.1
DOWEX HCR
Freundlich Isotone - Barium Removal

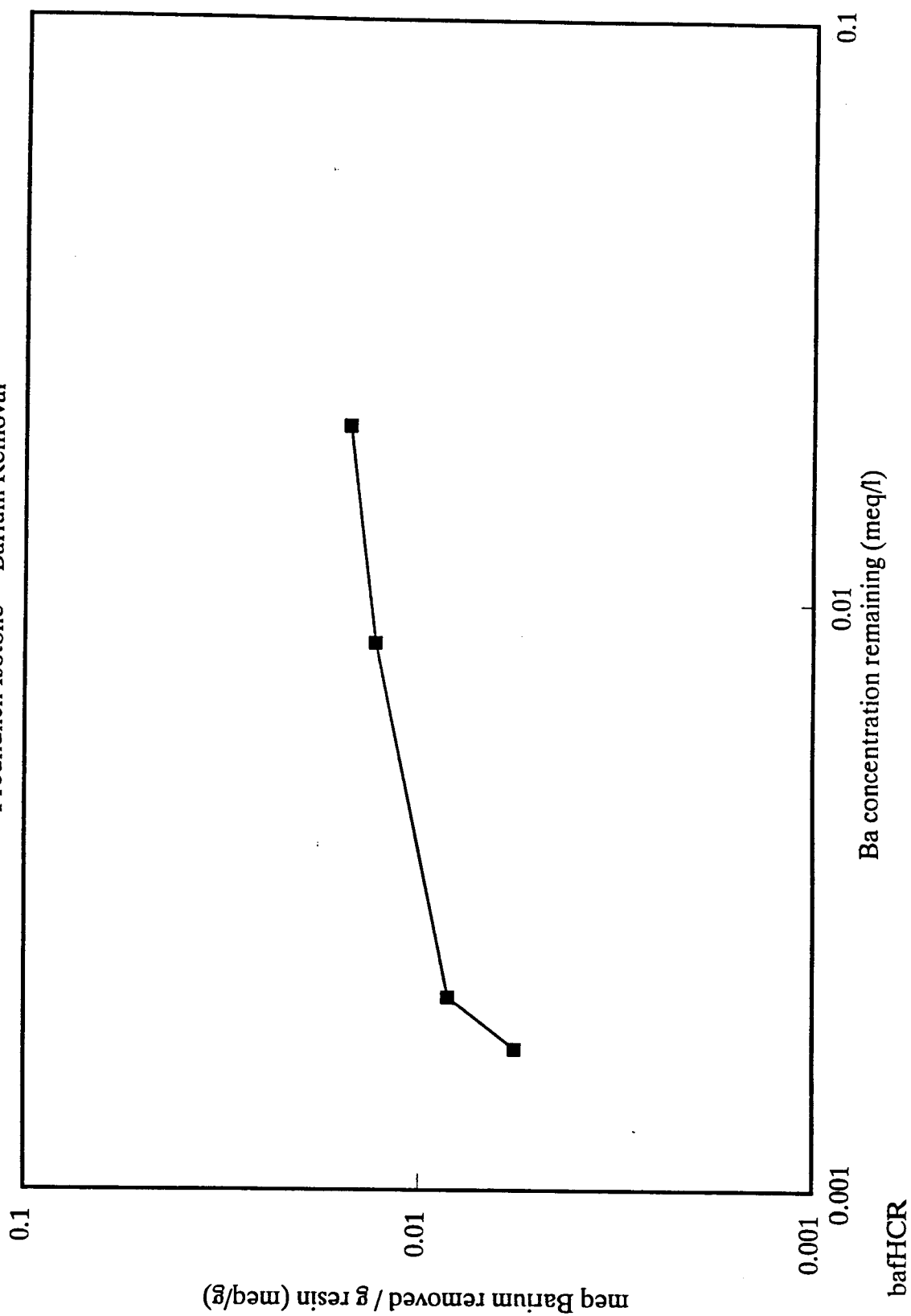
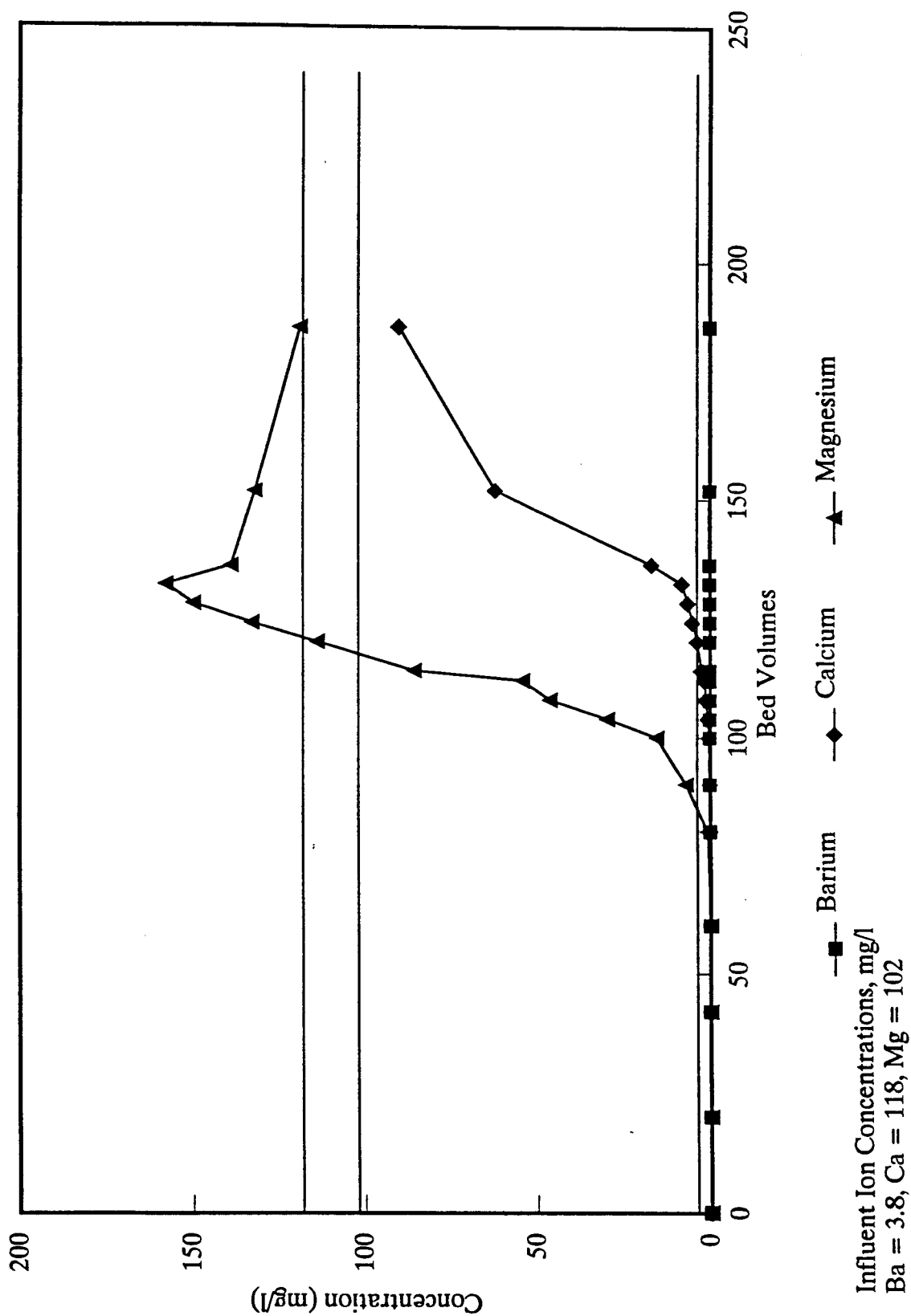


Figure 4.2
Ion Exchange Column
DOWEX MSC-1



4-9**Ion Exchange Column Study**

Although both ion exchange resins exhibited barium removal potential, DOWEX MSC-1 was selected for use in the column study.

The study was initiated on January 28, 1994. The apparatus used for this phase of the investigation is shown in picture 2.0, Appendix E. The equipment was set up and operated as described below.

- 1) Heat and aerate an MW-1 - MW-2 composite (1 : 1 ratio, v/v basis) to drive off volatile organics.
- 2) Exercise the resin sample. Wash with alternate cycles of NaCl water solution (20% on a w/w basis) and deionized water.
- 3) Thoroughly rinse the resin with deionized water and dry the resin to a constant weight.
- 4) Place glass beads and glass wool in the bottom of a 0.5 inch (nominal) diameter column.
- 5) Half fill the column with deionized water.
- 6) Pour resin in the column up to the 90 ml mark. This quantity of resin occupies approximately 2.8 linear feet.
- 7) Cap the column and connect all necessary tubing.
- 8) Flow deionized water up through the column to fluidize the resin bed. Taper back the flow and allow the resin beads to settle.
- 9) Calibrate the feed pump for 30 ml/min. Note that the feed will flow down through the column.
- 10) Operate the column until either the feed supply is exhausted or barium breakthrough occurs.
- 11) Backwash the column with a NaCl water solution (20% w/w basis). Backwash at 20 ml/min.

Data collected during the column operation has been placed in Table 4.6 below. The data appears plotted in figure 4.2.

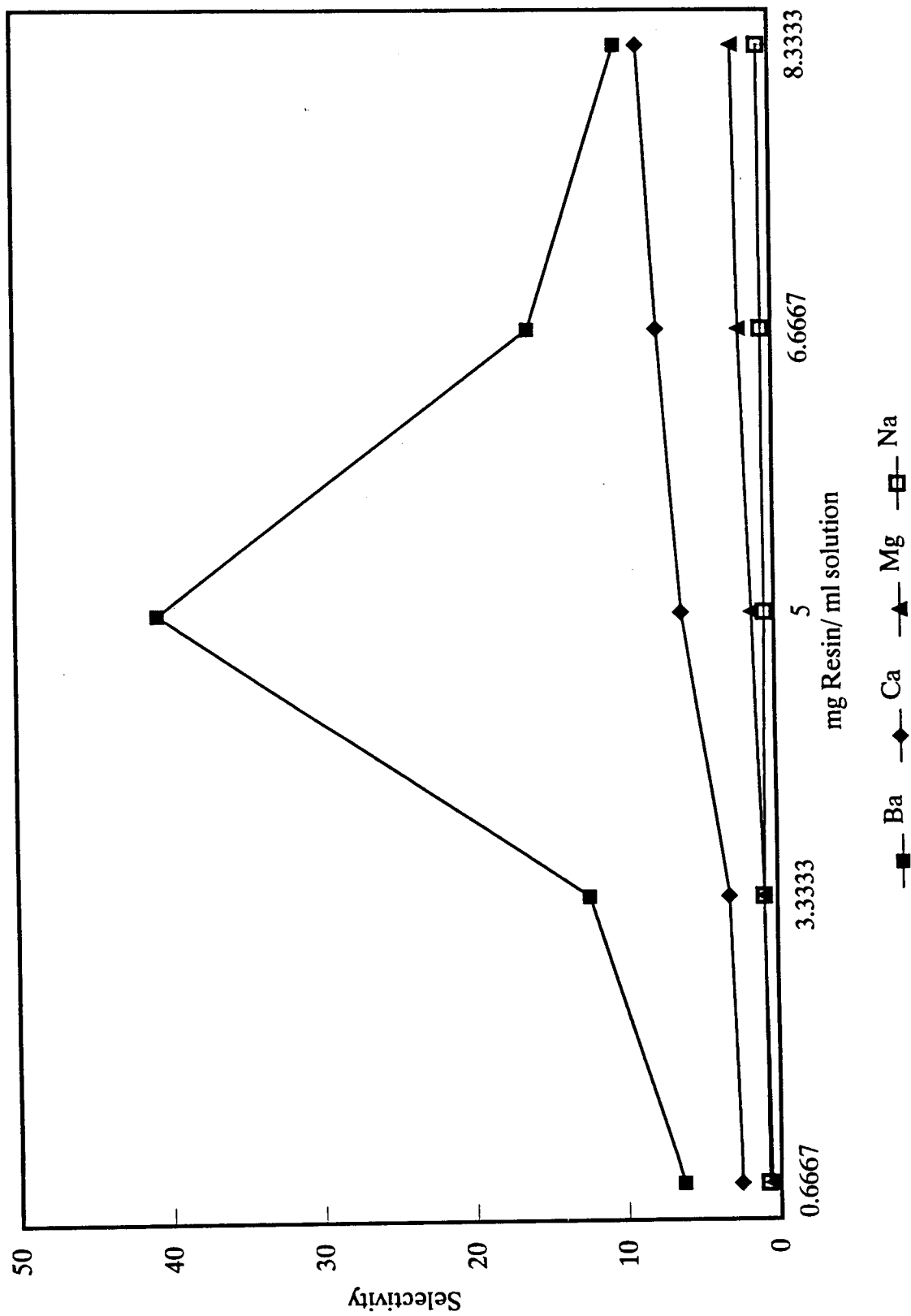
The data presented in figure 4.2 indicates that DOWEX MSC-1 has a selectivity for barium and can be utilized for barium removal.

Table 4.6
Ion Exchange Column Data

Sample	Barium (mg/l)	Calcium (mg/l)	Magnesium (mg/l)
Column Influent	3.80	118	102
Effluent @ 60 min	<0.22	0.016	<0.007
Effluent @ 126 min	<0.22	<0.01	<0.007
Effluent @ 180 min	<0.22	<0.01	<0.007
Effluent @ 240 min	<0.22	<0.01	<0.007
Effluent @ 270 min	<0.22	<0.01	0.869
Effluent @ 300 min	<0.22	0.169	7.12
Effluent @ 312 min	<0.22	0.403	15.5
Effluent @ 324 min	<0.22	0.799	29.0
Effluent @ 336 min	<0.22	1.34	46.4
Effluent @ 342 min	<0.22	1.63	54.4
Effluent @ 360 min	<0.22	2.62	85.9
Effluent @ 372 min	<0.22	3.86	114
Effluent @ 384 min	<0.22	5.08	133
Effluent @ 396 min	<0.2	6.45	150
Effluent @ 408 min	<0.22	8.2	158
Effluent @ 456 min	<0.22	16.9	139
Effluent @ 560 min	<0.22	62.2	132
Effluent @ 620 min	<0.22	90.2	119
1st 500 ml regen	12.6	256	73.5
Balance of regen*	72.5	2910	1080

* Balance of regeneration solution equals 1500 ml

Figure 4.3
DOWEX MSC-1
Ion Selectivity



5.0 Conclusions

Granular Activated Carbon

- Granular activated carbon technology can be utilized for the removal of methylene from Longhorn groundwater. However, considering the concentration of methylene chloride in the groundwater, and the adsorption capacity of granular activated carbon, this technology could prove cost prohibitive.

Consider the data presented in Table 3.5. 138 grams of GAC (3 columns @ 46 grams per column) were exhausted in less than 24 hours. During the 24 hour period, 14.4 liters of Longhorn groundwater were pumped through the column. Assuming that the column did not exhaust until the end of the 24 hour period, then the absolute maximum treatment capacity would be 104 liters per kilogram of carbon (14.4 L treated / 0.0138 kg carbon) or 12.5 gallons per pound. At a flow rate of 20 gallons per minute, the carbon demand would be 2300 pounds per day. 2300 pounds of virgin carbon costs approximately \$2500 plus transportation. Note that actual system design would be considerably more conservative than this example.

- Freundlich isotherm data indicated that Westvaco WB-V has an ultimate capacity of 305 mg methylene chloride/ g carbon. Norit Hydrodarco GCW has an ultimate capacity of 750 mg methylene chloride/ g carbon.
- The feasibility of activated carbon would be enhanced if it were employed as a secondary means of methylene chloride removal, ie as a polishing step for some other process or technology.

Ion Exchange Resin

- Two strong acid cation exchange resins proved capable of barium removal. Based upon the column study results, DOWEX MSC-1 should be considered as a viable means of removing barium from Longhorn groundwater.
- Freundlich isotone data indicates that DOWEX MSC-1 has an ultimate capacity of 0.0245 meq/ g resin. DOWEX HCR has an ultimate capacity of 0.0186 meq/ g resin.
- Solids, such as precipitated iron, should be removed prior the use of ion exchange.
- An ion exchange system designed to reduce the barium concentration present in 20 gpm of groundwater from 4 mg/l to < 1.0 mg/l could be designed using an estimated 10 cubic ft. of DOWEX MSC-1 or less. Ten cubic feet of DOWEX MSC-1 costs approximately \$1100.

Appendix A
Groundwater Characterization
Supporting Documentation

007596



SOUTHWESTERN LABORATORIES

222 CAVALCADE * P.O. BOX 8768, HOUSTON, TEXAS 77249 * 713 692-9151

Client AWD TECHNOLOGIES, INC.
400 W. SAM HOUSTON PKWY SOUTH
HOUSTON, TEXAS 77042

Client No. 2_0686_00
Report No. 93-12-259
Report Date 02/03/94 11:26

Attn: ROY A. DEGESERO

Project CHEMICAL ANALYSIS

Date Sampled 12/15/93

Sampled By CLIENT

Sample Type LIQUID SAMPLES

Transported by DELIVERY SERVICE

P.O. # _____

Date Received 12/16/93

REVISION #2

Lab No.

93-12-259-01

93-12-259-02

93-12-259-03

Sample Identification

MW-1

MW-2

EW-1

HR
Reviewed By

SOUTHWESTERN LABORATORIES

Chris Barry
CHRIS BARRY

Sample: 01A MW-1

Collected: 12/15/93

Test Name	Method	Result	Units	Detection Date		Analyst
				Limit	Started	
ALUMINUM	EPA 200.7	0.27	mg/L	0.05	12/21/93	CL
ANTIMONY	EPA 204.2	<0.01	mg/L	0.01	12/20/93	JP
B/N,ACID - WATER - GC/MS	EPA 625	ENCLOSURE	DATE		12/21/93	RKW
BARIUM	EPA 200.7	3.81	mg/L	0.22	12/21/93	CL
BASE/NEUTRAL,ACID EXTRACT	EPA 625/8270	12/20/93	DATE		12/20/93	CAM
BERYLLIUM	EPA 200.7	<0.02	mg/L	0.02	12/21/93	CL
CADMIUM	EPA 200.7	<0.02	mg/L	0.02	12/22/93	CL
CALCIUM	EPA 200.7	108	mg/L	0.01	12/22/93	CL
CHROMIUM	EPA 200.7	<0.04	mg/L	0.04	12/21/93	CL
COBALT	EPA 200.7	0.03	mg/L	0.02	12/21/93	CL
COPPER	EPA 200.7	0.04	mg/L	0.04	12/22/93	CL
IRON	EPA 200.7	<0.10	mg/L	0.10	12/22/93	CL
LEAD	EPA 239.1	<0.10	mg/L	0.10	12/20/93	JP
MAGNESIUM	EPA 242.1	106	mg/L	0.05	12/23/93	GLM
MOLYBDENUM	EPA 200.7	<0.02	mg/L	0.02	12/21/93	CL
POTASSIUM	EPA 258.1	4.20	mg/L	0.04	12/21/93	GMB
SILVER	EPA 272.1	<0.05	mg/L	0.05	12/21/93	JP
SODIUM	EPA 273.1	385	mg/L	0.05	12/21/93	GMB
THALLIUM	EPA 279.2	<0.01	mg/L	0.01	12/20/93	JP
TIN	EPA 200.7	0.13	mg/L	0.13	12/22/93	CL
TITANIUM	EPA 200.7	<0.02	mg/L	0.02	12/21/93	CL
VANADIUM	EPA 200.7	<0.02	mg/L	0.02	12/21/93	CL
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		12/21/93	RKW
ZINC	EPA 200.7	<0.02	mg/L	0.02	12/22/93	CL

Sample: 01B MW-1

Collected: 12/15/93

Test Name	Method	Result	Units	Detection Date		Analyst
				Limit	Started	
ALKALINITY (CACO3)	EPA 310.1			5.0		
HYDROXIDE	EPA 310.1	0	mg/l as		12/22/93	SLJ
CARBONATE	EPA 310.1	0	mg/l as		12/22/93	SLJ
BICARBONATE	EPA 310.1	155	mg/l as		12/22/93	SLJ
CHEMICAL OXYGEN DEMAND	EPA 410.4	150	mg/L	15.0	12/22/93	JD
CHLORIDE	EPA 325.3	1110	mg/L	0.25	12/17/93	JD
CYANIDE	EPA 335.3	<0.01	mg/L	0.01	12/18/93	JA
HEXAVALENT CHROMIUM	SW-846 7197	<0.01	mg/L	0.01	12/21/93	WJ
NITRATE AS N	EPA 353.2	14.1	mg/L	0.05	12/22/93	JA
OIL and GREASE	EPA 413.1	1.5	mg/L	1.0	12/21/93	JD
SULFATE-WATER\WASTEWATER	EPA 375.2	6.32	mg/L	3.00	12/21/93	JA
TOTAL DISSOLVED SOLIDS	EPA 160.1	2400	mg/L	5	12/17/93	JD
TOTAL ORGANIC CARBON	EPA 415.1	96.0	mg/L	1.0	12/21/93	MPG
TOTAL SUSPENDED SOLIDS	EPA 160.2	6.0	mg/L	1.0	12/17/93	JD
pH	EPA 150.1	6.10	pH UNITS		12/16/93	RF

Order # 93-12-259
02/03/94 11:26
Client: AWD TECHNOLOGIES, INC.

TEST RESULTS BY SAMPLE

Sample: 01C MW-1

Collected: 12/15/93

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
TOTAL ORGANIC CARBON	EPA 415.1	114	mg/L	1.0	12/21/93	MPG

Sample: 02A MW-2

Collected: 12/15/93

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
ALUMINUM	EPA 200.7	0.05	mg/L	0.05	12/21/93	CL
ANTIMONY	EPA 204.2	<0.01	mg/L	0.01	12/20/93	JP
B/N,ACID - WATER - GC/MS	EPA 625	ENCLOSURE	DATE		12/21/93	RKW
BARIUM	EPA 200.7	2.39	mg/L	0.22	12/21/93	CL
BASE/NEUTRAL,ACID EXTRACT	EPA 625/8270	12/20/93	DATE		12/20/93	CAM
BERYLLIUM	EPA 200.7	<0.02	mg/L	0.02	12/21/93	CL
CADMIUM	EPA 200.7	<0.02	mg/L	0.02	12/22/93	CL
CALCIUM	EPA 200.7	93	mg/L	0.01	12/22/93	CL
CHROMIUM	EPA 200.7	<0.04	mg/L	0.04	12/22/93	CL
COBALT	EPA 200.7	0.02	mg/L	0.02	12/21/93	CL
COPPER	EPA 200.7	0.02	mg/L	0.02	12/22/93	CL
IRON	EPA 200.7	0.21	mg/L	0.10	02/02/94	GLM
LEAD	EPA 239.1	<0.10	mg/L	0.10	12/20/93	JP
MAGNESIUM	EPA 242.1	83.2	mg/L	0.05	12/23/93	GLM
MOLYBDENUM	EPA 200.7	<0.02	mg/L	0.02	12/21/93	CL
POTASSIUM	EPA 258.1	2.0	mg/L	0.04	12/21/93	GMB
SILVER	EPA 272.1	<0.05	mg/L	0.05	12/21/93	JP
SODIUM	EPA 273.1	295	mg/L	0.05	12/21/93	GLM
THALLIUM	EPA 279.2	<0.01	mg/L	0.01	12/20/93	JP
TIN	EPA 200.7	0.05	mg/L	0.05	12/22/93	CL
TITANIUM	EPA 200.7	<0.02	mg/L	0.02	12/21/93	CL
VANADIUM	EPA 200.7	<0.02	mg/L	0.02	12/21/93	CL
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		12/21/93	RKW
ZINC	EPA 200.7	<0.02	mg/L	0.02	12/22/93	CL

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THALLIUM	EPA 279.2	<0.01 mg/L	0.01	12/20/93	JP
TIN	EPA 200.7	0.27 mg/L	0.13	12/22/93	CL
TITANIUM	EPA 200.7	0.15 mg/L	0.05	12/21/93	CL
VANADIUM	EPA 200.7	<0.02 mg/L	0.02	12/21/93	CL
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE DATE		12/21/93	RKW
ZINC	EPA 200.7	<0.02 mg/L	0.02	12/22/93	CL

Sample: 02B MW-2

Collected: 12/15/93

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
ALKALINITY (CACO3)	EPA 310.1			5.0		
HYDROXIDE	EPA 310.1	0	mg/l as		12/22/93	SLJ
CARBONATE	EPA 310.1	0	mg/l as		12/22/93	SLJ
BICARBONATE	EPA 310.1	135	mg/l as		12/22/93	SLJ
CHEMICAL OXYGEN DEMAND	EPA 410.4	117	mg/L	15.0	12/22/93	JD
CHLORIDE	EPA 325.3	774	mg/L	0.25	12/17/93	JD
CYANIDE	EPA 335.3	<0.01	mg/L	0.01	12/18/93	JA
HEXAVALENT CHROMIUM	SW-846 7197	<0.01	mg/L	0.01	12/21/93	WJ
NITRATE AS N	EPA 353.2	13.9	mg/L	0.05	12/22/93	JA
OIL and GREASE	EPA 413.1	2.0	mg/L	1.0	12/21/93	JA
SULFATE-WATER\WASTEWATER	EPA 375.2	6.07	mg/L	3.00	12/21/93	JA
TOTAL DISSOLVED SOLIDS	EPA 160.1	2070	mg/L	5	12/17/93	JD
TOTAL ORGANIC CARBON	EPA 415.1	1066	mg/L	1.0	12/21/93	MPG
TOTAL SUSPENDED SOLIDS	EPA 160.2	1.0	mg/L	1.0	12/17/93	JD
pH	EPA 150.1	6.25	pH UNITS		12/16/93	RF

Sample: 02C MW-2

Collected: 12/15/93

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
TOTAL ORGANIC CARBON	EPA 415.1	1119	mg/L	1.0	12/21/93	MPG

Sample: 03A EW-1

Collected: 12/15/93

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
ALUMINUM	EPA 200.7	7.29	mg/L	0.05	12/21/93	CL
ANTIMONY	EPA 204.2	<0.01	mg/L	0.01	12/20/93	JP
B/N,ACID - WATER - GC/MS	EPA 625	ENCLOSURE	DATE		12/21/93	RKW
BARIUM	EPA 200.7	0.57	mg/L	0.22	12/21/93	CL
BASE/NEUTRAL,ACID EXTRACT	EPA 625/8270	12/20/93	DATE		12/20/93	CAM
BERYLLIUM	EPA 200.7	<0.02	mg/L	0.02	12/21/93	CL
CADMIUM	EPA 200.7	<0.02	mg/L	0.02	12/22/93	CL
CALCIUM	EPA 200.7	16.0	mg/L	0.01	12/22/93	CL
CHROMIUM	EPA 200.7	<0.04	mg/L	0.04	12/22/93	CL
COBALT	EPA 200.7	<0.02	mg/L	0.02	12/21/93	CL
COPPER	EPA 200.7	0.04	mg/L	0.04	12/22/93	CL
IRON	EPA 200.7	27.2	mg/L	0.02	02/02/94	GLM
LEAD	EPA 239.1	<0.10	mg/L	0.10	12/20/93	JP
MAGNESIUM	EPA 242.1	10.7	mg/L	0.05	12/23/93	GLM
MOLYBDENUM	EPA 200.7	<0.02	mg/L	0.02	12/21/93	CL
POTASSIUM	EPA 258.1	2.30	mg/L	0.04	12/21/93	GMB
SILVER	EPA 272.1	<0.05	mg/L	0.05	12/21/93	JP
SODIUM	EPA 273.1	130	mg/L	0.05	12/21/93	GMB

SOUTHWESTERN LABORATORIES

Order # 93-12-259

Page 5

02/03/94 11:26

TEST RESULTS BY SAMPLE

Client: AWD TECHNOLOGIES, INC.

Sample: 03B EW-1

Collected: 12/15/93

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
ALKALINITY (CaCO ₃)	EPA 310.1			5.0		
HYDROXIDE	EPA 310.1	0	mg/l as		12/22/93	SLJ
CARBONATE	EPA 310.1	0	mg/l as		12/22/93	SLJ
BICARBONATE	EPA 310.1	0	mg/l as		12/22/93	SLJ
CHEMICAL OXYGEN DEMAND	EPA 410.4	101	mg/L	15.0	12/22/93	JD
CHLORIDE	EPA 325.3	130	mg/L	0.25	12/17/93	JD
CYANIDE	EPA 335.3	<0.01	mg/L	0.01	12/18/93	JA
HEXAVALENT CHROMIUM	SW-846 7197	<0.01	mg/L	0.01	12/21/93	WJ
NITRATE AS N	EPA 353.2	56.5	mg/L	0.05	12/22/93	JA
OIL and GREASE	EPA 413.1	<1.0	mg/L	1.0	12/21/93	JD
SULFATE-WATER\WASTEWATER	EPA 375.2	<3.00	mg/L	3.00	12/21/93	JA
TOTAL DISSOLVED SOLIDS	EPA 160.1	605	mg/L	5	12/17/93	JD
TOTAL ORGANIC CARBON	EPA 415.1	35.7	mg/L	1.0	12/21/93	MPG
TOTAL SUSPENDED SOLIDS	EPA 160.2	123	mg/L	1.0	12/17/93	JD
pH	EPA 150.1	4.50	pH UNITS		12/16/93	RF

Sample: 03C EW-1

Collected: 12/15/93

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
TOTAL ORGANIC CARBON	EPA 415.1	37.1	mg/L	1.0	12/21/93	MPG

007602

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 625 - WATER

EPA METHOD 8270 - SOIL/WASTE

CASE NO 312259LABORATORY SwL - HoustonCONTRACT CHEM ANALYS

SAS NO _____

REPORTED 12/21/93 10:47CUSTOMER AWDFILE NAME X1221005SAMPLE ID MW-1LEVEL LOWTYPE EPALAB SAMP ID 9312259-01AMATRIX WATERINST FINNANALYZED 12/21/93 15:04UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C310	62-75-9	N-Nitrosodimethylamine		10.0	U
C315	108-95-2	Phenol		10.0	U
C320	62-53-3	Aniline		10.0	U
C322	110-86-1	Pyridine		10.0	U
C325	111-44-4	bis(2-Chloroethyl)Ether		10.0	U
C330	95-57-8	2-Chlorophenol		10.0	U
C335	541-73-1	1,3-Dichlorobenzene		10.0	U
C340	106-46-7	1,4-Dichlorobenzene		10.0	U
C345	100-51-6	Benzyl Alcohol		10.0	U
C350	95-50-1	1,2-Dichlorobenzene		10.0	U
C355	95-48-7	2-Methylphenol		10.0	U
C360	39638-32-9	bis(2-Chloroisopropyl)Ether		10.0	U
C365	106-44-5	4-Methylphenol		10.0	U
C370	621-64-7	N-Nitroso-Di-n-Propylamine		10.0	U
C375	67-72-1	Hexachloroethane		10.0	U
C410	98-95-3	Nitrobenzene		10.0	U
C415	78-59-1	Isophorone		10.0	U
C420	88-75-5	2-Nitrophenol		10.0	U
C425	105-67-9	2,4-Dimethylphenol		10.0	U
C430	65-85-0	Benzoic Acid		50.0	U
C435	111-91-1	bis(2-Chloroethoxy)Methane		10.0	U
C440	120-83-2	2,4-Dichlorophenol		10.0	U
C445	120-82-1	1,2,4-Trichlorobenzene		10.0	U
C450	91-20-3	Naphthalene		10.0	U
C455	106-47-8	4-Chloroaniline		10.0	U
C460	87-68-3	Hexachlorobutadiene		10.0	U
C465	59-50-7	4-Chloro-3-Methylphenol		10.0	U
C470	91-57-6	2-Methylnaphthalene		10.0	U
C510	77-47-4	Hexachlorocyclopentadiene		10.0	U
C515	88-06-2	2,4,6-Trichlorophenol		10.0	U
C520	95-95-4	2,4,5-Trichlorophenol		10.0	U
C525	91-58-7	2-Chloronaphthalene		10.0	U
C530	88-74-4	2-Nitroaniline		50.0	U
C535	131-11-3	Dimethylphthalate		10.0	U
C540	208-96-8	Acenaphthylene		10.0	U
C545	606-20-2	2,6-Dinitrotoluene		10.0	U
C550	99-09-2	3-Nitroaniline		50.0	U
C555	83-32-9	Acenaphthene		10.0	U

007603

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 625 - WATER
EPA METHOD 8270 - SOIL/WASTE

CASE NO 312259
SAS NO

LABORATORY SwL - Houston
REPORTED 12/21/93 10:47

CONTRACT CHEM ANALYS
CUSTOMER AWD

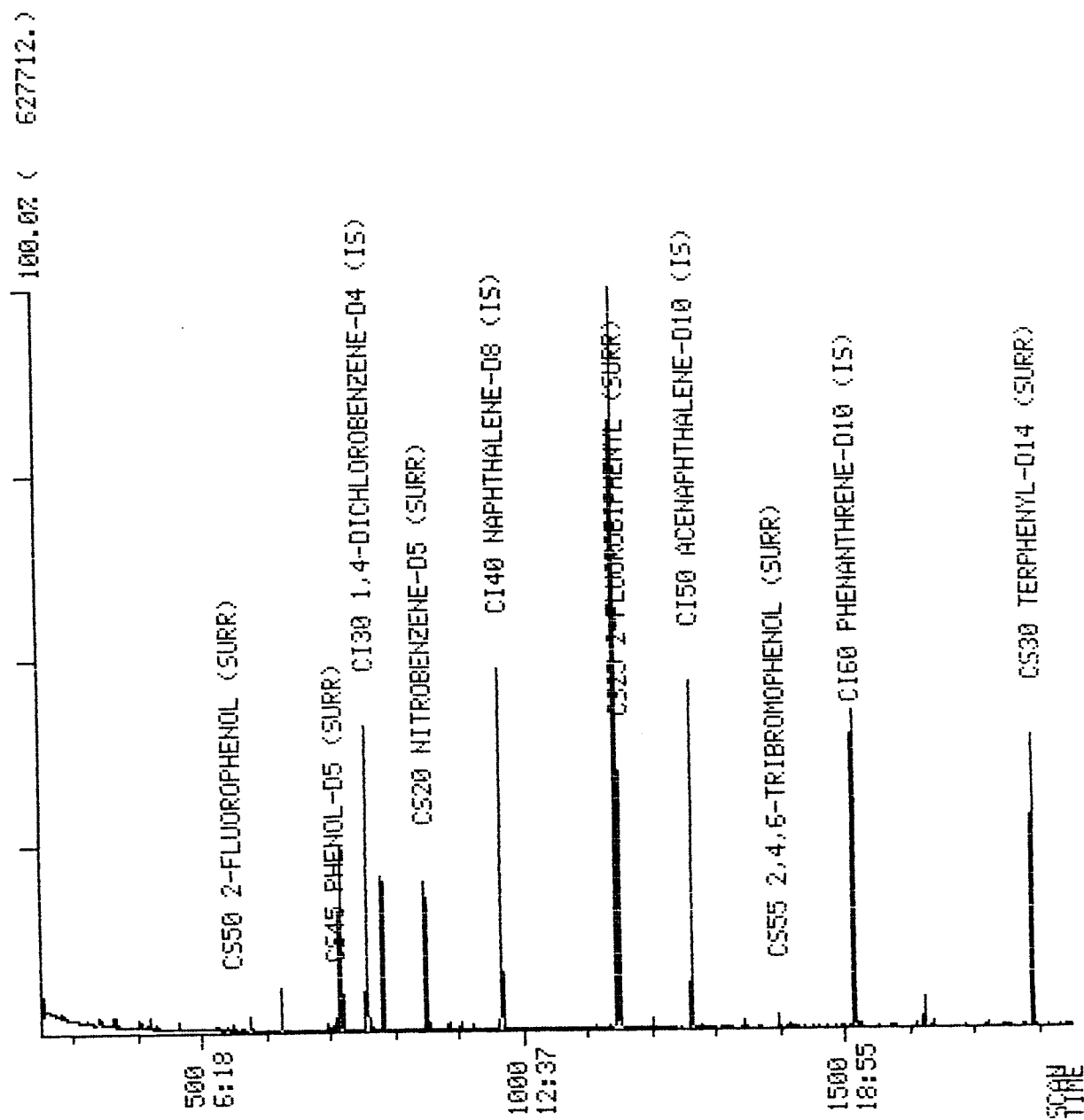
CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
555	51-28-5	2,4-Dinitrophenol		50.0	U
560	100-02-7	4-Nitrophenol		50.0	U
565	132-64-9	Dibenzofuran		10.0	U
570	121-14-2	2,4-Dinitrotoluene		10.0	U
576	103-33-3	Azobenzene		10.0	U
580	84-66-2	Diethylphthalate		10.0	U
585	7005-72-3	4-Chlorophenyl-phenylether		10.0	U
590	86-73-7	Fluorene		10.0	U
595	100-01-6	4-Nitroaniline		50.0	U
610	534-52-1	4,6-Dinitro-2-Methylphenol		20.0	U
615	86-30-6	N-Nitrosodiphenylamine (1)		10.0	U
625	101-55-3	4-Bromophenyl-phenylether		10.0	U
630	118-74-1	Hexachlorobenzene		10.0	U
635	87-86-5	Pentachlorophenol		25.0	U
640	85-01-8	Phenanthrene		10.0	U
645	120-12-7	Anthracene		10.0	U
650	84-74-2	Di-n-Butylphthalate		10.0	U
655	206-44-0	Fluoranthene		10.0	U
671	92-87-5	Benzidine		50.0	U
6715	129-00-0	Pyrene		10.0	U
6720	85-68-7	Butylbenzylphthalate		10.0	U
6725	91-94-1	3,3'-Dichlorobenzidine		20.0	U
6730	56-55-3	Benzo(a)Anthracene		10.0	U
6740	218-01-9	Chrysene		10.0	U
6745	117-81-7	bis(2-Ethylhexyl)Phthalate		10.0	U
6760	117-84-0	Di-n-Octyl Phthalate		10.0	U
6765	205-99-2	Benzo(b)Fluoranthene		10.0	U
6770	207-08-9	Benzo(k)Fluoranthene		10.0	U
6775	50-32-8	Benzo(a)Pyrene		10.0	U
6780	193-39-5	Indeno(1,2,3-cd)Pyrene		10.0	U
6785	53-70-3	Dibenz(a,h)Anthracene		10.0	U
6790	191-24-2	Benzo(g,h,i)Perylene		10.0	U

ates and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

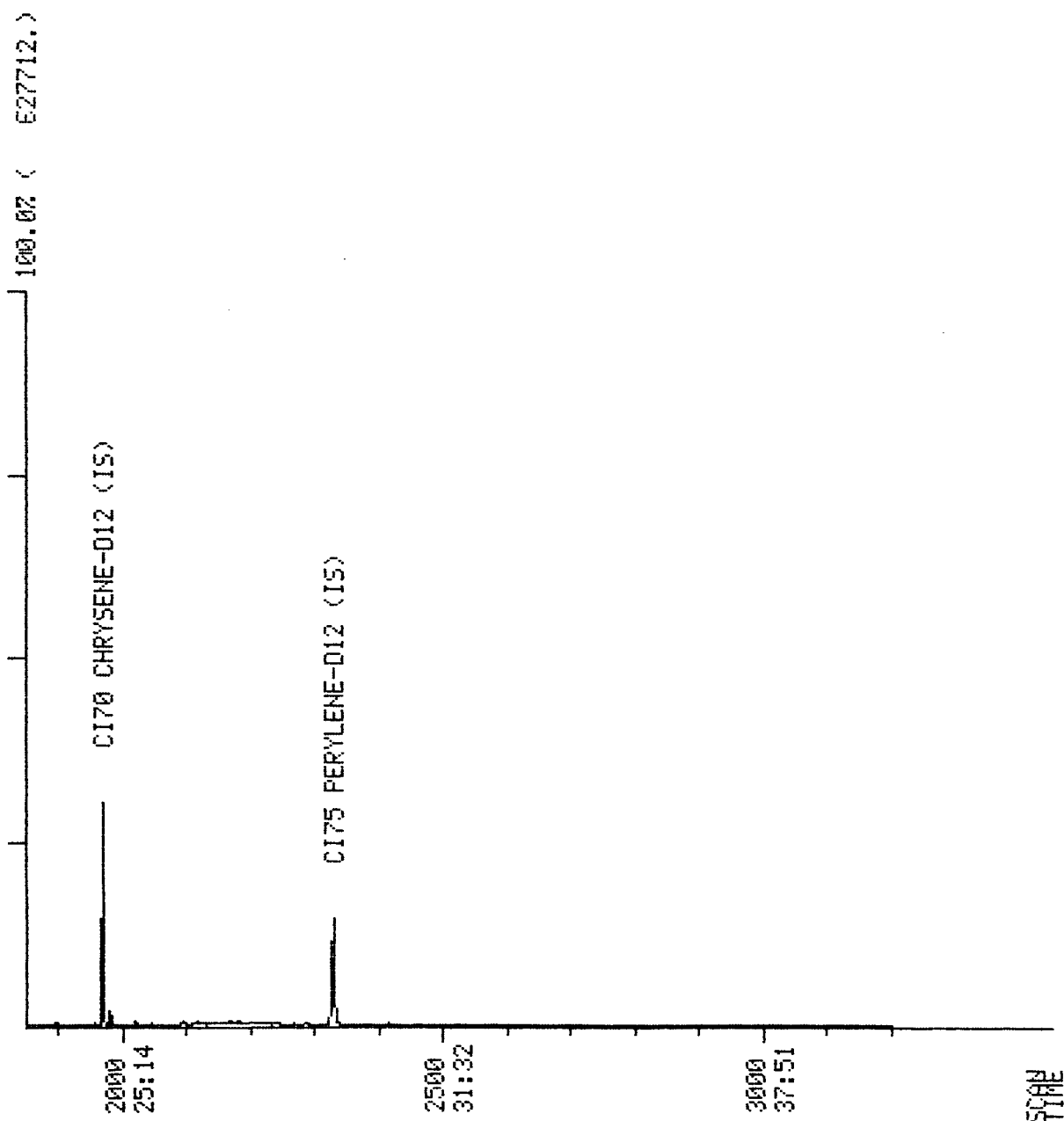
DATA FROM FILE: X1221005 SCANS 250 TO 1850 ACQUIRED: 12/21/93 15:04:00
CALI: X1221005 #3 OUT OF 250 TO 3200

SAMPLE: 9312259-01 AND MW-1
COND.: 40(4) TO 285 @ 12/MIN HOLD 17



SCANS 1850 TO 3200 ACQUIRED: 12/21/93 15:04:00
CALI: X1221005 #3 OUT OF 250 TO 3200

SAMPLE: 9312253-01 AND MW-1
CONDS.: 40(4) TO 285 @ 12/MIN HOLD 17



SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 625 - WATER
EPA METHOD 8270 - SOIL/WASTECASE NO 312259

SAS NO _____

LABORATORY SwL - Houston
REPORTED 12/21/93 10:44CONTRACT CHEM ANALYS
CUSTOMER AWDFILE NAME X1221002TYPE EPAINST FINNSAMPLE ID MW-2LAB SAMP ID 9312259-02AANALYZED 12/21/93 12:17LEVEL LOWMATRIX WATERUNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C310	62-75-9	N-Nitrosodimethylamine		10.0	U
C315	108-95-2	Phenol		10.0	U
C320	62-53-3	Aniline		10.0	U
C322	110-86-1	Pyridine		10.0	U
C325	111-44-4	bis(2-Chloroethyl)Ether		10.0	U
C330	95-57-8	2-Chlorophenol		10.0	U
C335	541-73-1	1,3-Dichlorobenzene		10.0	U
C340	106-46-7	1,4-Dichlorobenzene		10.0	U
C345	100-51-6	Benzyl Alcohol		48.0	U
C35	95-50-1	1,2-Dichlorobenzene		10.0	U
C35	95-48-7	2-Methylphenol		10.0	U
C360	39638-32-9	bis(2-Chloroisopropyl)Ether		10.0	U
C365	106-44-5	4-Methylphenol		10.0	U
C370	621-64-7	N-Nitroso-Di-n-Propylamine		10.0	U
C375	67-72-1	Hexachloroethane		10.0	U
C380	98-95-3	Nitrobenzene		10.0	U
C385	78-59-1	Isophorone		10.0	U
C420	88-75-5	2-Nitrophenol		10.0	U
C425	105-67-9	2,4-Dimethylphenol		10.0	U
C430	65-85-0	Benzoic Acid		50.0	U
C435	111-91-1	bis(2-Chloroethoxy)Methane		10.0	U
C440	120-83-2	2,4-Dichlorophenol		10.0	U
C445	120-82-1	1,2,4-Trichlorobenzene		10.0	U
C450	91-20-3	Naphthalene		10.0	U
C455	106-47-8	4-Chloroaniline		10.0	U
C460	87-68-3	Hexachlorobutadiene		10.0	U
C465	59-50-7	4-Chloro-3-Methylphenol		10.0	U
C470	91-57-6	2-Methylnaphthalene		10.0	U
C510	77-47-4	Hexachlorocyclopentadiene		10.0	U
C515	88-06-2	2,4,6-Trichlorophenol		10.0	U
C520	95-95-4	2,4,5-Trichlorophenol		10.0	U
C525	91-58-7	2-Chloronaphthalene		10.0	U
C530	88-74-4	2-Nitroaniline		50.0	U
C535	131-11-3	Dimethylphthalate		10.0	U
C540	208-96-8	Acenaphthylene		10.0	U
C54	606-20-2	2,6-Dinitrotoluene		10.0	U
C545	99-09-2	3-Nitroaniline		50.0	U
C550	83-32-9	Acenaphthene		10.0	U

007607
page 2

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 625 - WATER
EPA METHOD 8270 - SOIL/WASTE

CASE NO 312259

SAS NO _____

LABORATORY SWL - Houston
REPORTED 12/21/93 10:44

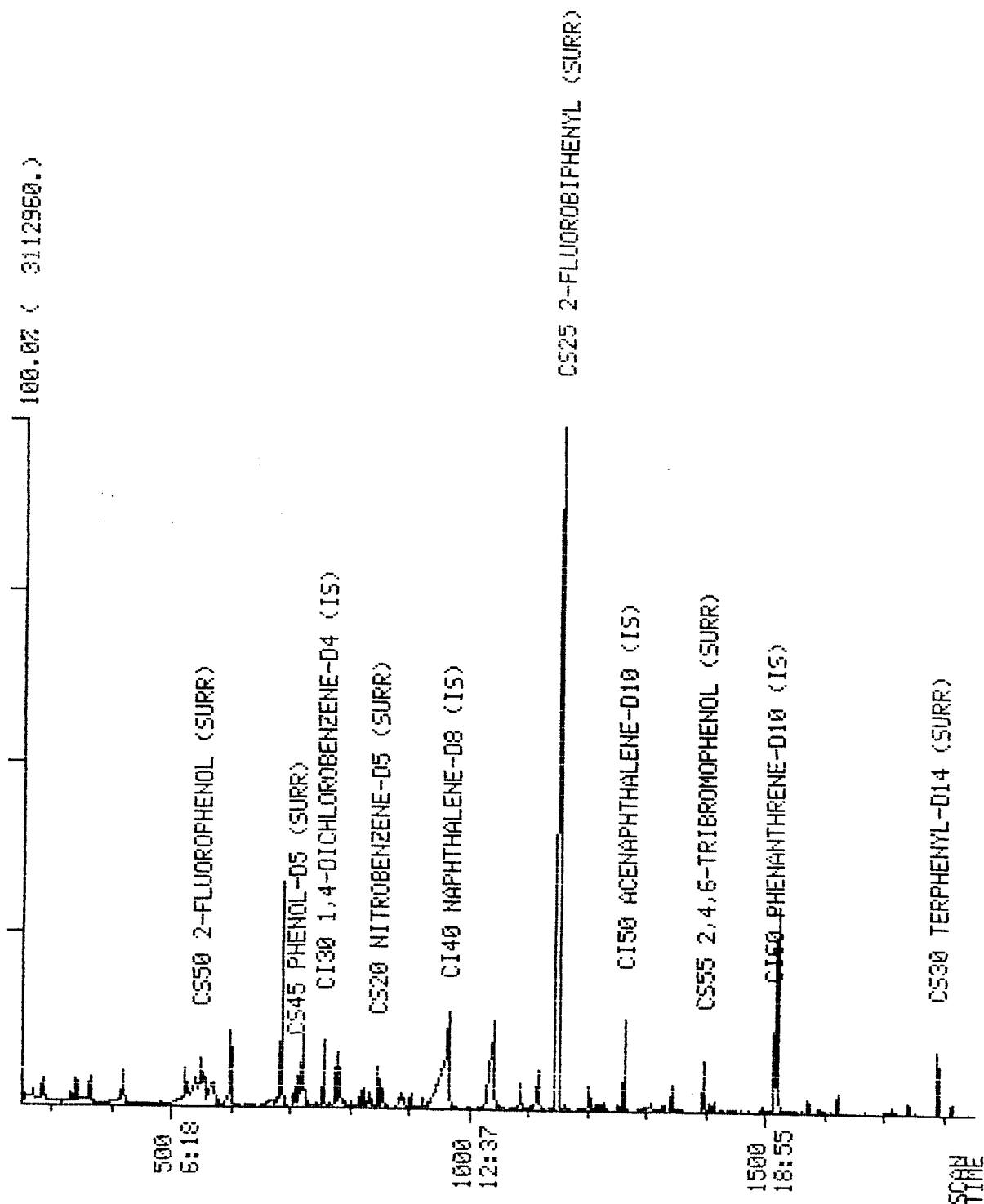
CONTRACT CHEM ANALYS
CUSTOMER AWD

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C555	51-28-5	2,4-Dinitrophenol		50.0	U
C560	100-02-7	4-Nitrophenol		50.0	U
C565	132-64-9	Dibenzofuran		10.0	U
C570	121-14-2	2,4-Dinitrotoluene		10.0	U
C576	103-33-3	Azobenzene		10.0	U
C580	84-66-2	Diethylphthalate		10.0	U
C585	7005-72-3	4-Chlorophenyl-phenylether		10.0	U
C590	86-73-7	Fluorene		10.0	U
C595	100-01-6	4-Nitroaniline		50.0	U
C610	534-52-1	4,6-Dinitro-2-Methylphenol		20.0	U
C615	86-30-6	N-Nitrosodiphenylamine (1)		10.0	U
C625	101-55-3	4-Bromophenyl-phenylether		10.0	U
C630	118-74-1	Hexachlorobenzene		10.0	U
C635	87-86-5	Pentachlorophenol		25.0	U
C640	85-01-8	Phenanthrene		10.0	U
C645	120-12-7	Anthracene		10.0	U
C650	84-74-2	Di-n-Butylphthalate		22.6	
C655	206-44-0	Fluoranthene		10.0	U
C670	92-87-5	Benzidine		50.0	U
C715	129-00-0	Pyrene		10.0	U
C720	85-68-7	Butylbenzylphthalate		10.0	U
C725	91-94-1	3,3'-Dichlorobenzidine		20.0	U
C730	56-55-3	Benzo(a)Anthracene		10.0	U
C740	218-01-9	Chrysene		10.0	U
C745	117-81-7	bis(2-Ethylhexyl)Phthalate		145	
C760	117-84-0	Di-n-Octyl Phthalate		22.8	
C765	205-99-2	Benzo(b)Fluoranthene		10.0	U
C770	207-08-9	Benzo(k)Fluoranthene		10.0	U
C775	50-32-8	Benzo(a)Pyrene		10.0	U
C780	193-39-5	Indeno(1,2,3-cd)Pyrene		10.0	U
C785	53-70-3	Dibenz(a,h)Anthracene		10.0	U
C790	191-24-2	Benzo(g,h,i)Perylene		10.0	U

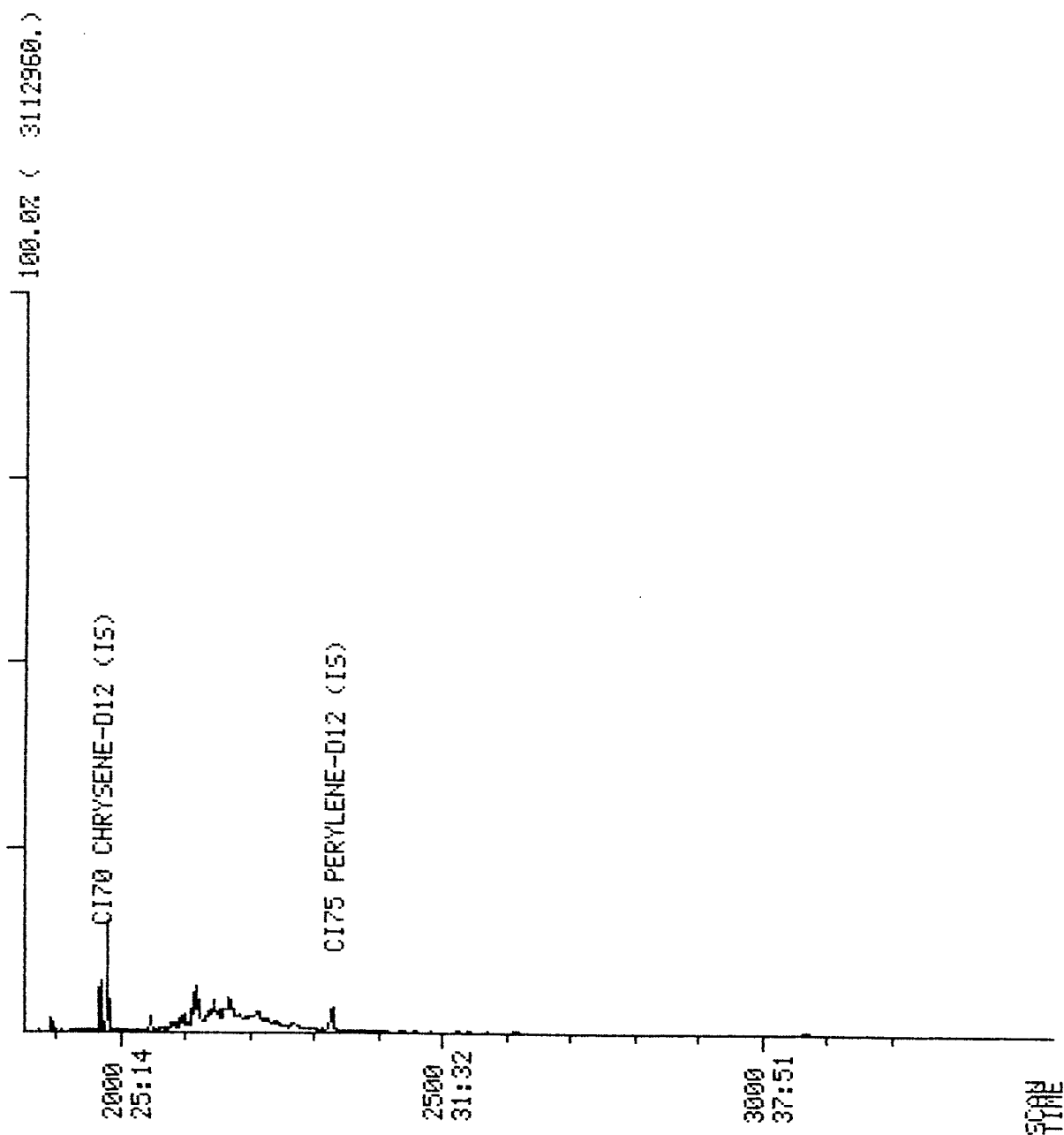
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: X1221002 SCANS 250 TO 1850 ACQUIRED: 12/21/93 12:17:00
SAMPLE: 9312259-02 AND MW-2 CALI: X1221002 #3 OUT OF 250 TO 3200
CONDS.: 40(4) TO 285 @ 12/MIN HOLD 17



DATA FROM FILE: X1221002 SCANS 1850 TO 3200 ACQUIRED: 12/21/93 12:17:00
SAMPLE: 9312259-02 AMD MM-2 CALL: X1221002 #3 OUT OF 250 TO 3200
CONDS.: 40(4) TO 285 @ 12/MIN HOLD 17



SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 625 - WATER
EPA METHOD 8270 - SOIL/WASTE

007610

CASE NO 312259
SAS NO _____

LABORATORY SwL - Houston
REPORTED 12/21/93 10:45

CONTRACT CHEM ANALYS
CUSTOMER AWD

FILE NAME X1221003
TYPE EPA
INST FINN

SAMPLE ID EW-1
LAB SAMP ID 9312259-03A
ANALYZED 12/21/93 13:13

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C310	62-75-9	N-Nitrosodimethylamine		10.0	U
C315	108-95-2	Phenol		10.0	U
C320	62-53-3	Aniline		10.0	U
C322	110-86-1	Pyridine		10.0	U
C325	111-44-4	bis(2-Chloroethyl)Ether		10.0	U
C330	95-57-8	2-Chlorophenol		10.0	U
C335	541-73-1	1,3-Dichlorobenzene		10.0	U
C340	106-46-7	1,4-Dichlorobenzene		10.0	U
C345	100-51-6	Benzyl Alcohol		10.0	U
C350	95-50-1	1,2-Dichlorobenzene		10.0	U
C355	95-48-7	2-Methylphenol		10.0	U
C360	39638-32-9	bis(2-Chloroisopropyl)Ether		10.0	U
C365	106-44-5	4-Methylphenol		10.0	U
C370	621-64-7	N-Nitroso-Di-n-Propylamine		10.0	U
C375	67-72-1	Hexachloroethane		10.0	U
C410	98-95-3	Nitrobenzene		10.0	U
C415	78-59-1	Isophorone		10.0	U
C420	88-75-5	2-Nitrophenol		10.0	U
C425	105-67-9	2,4-Dimethylphenol		10.0	U
C430	65-85-0	Benzoic Acid		94.8	
C435	111-91-1	bis(2-Chloroethoxy)Methane		10.0	U
C440	120-83-2	2,4-Dichlorophenol		10.0	U
C445	120-82-1	1,2,4-Trichlorobenzene		10.0	U
C450	91-20-3	Naphthalene		10.0	U
C455	106-47-8	4-Chloroaniline		10.0	U
C460	87-68-3	Hexachlorobutadiene		10.0	U
C465	59-50-7	4-Chloro-3-Methylphenol		10.0	U
C470	91-57-6	2-Methylnaphthalene		10.0	U
C510	77-47-4	Hexachlorocyclopentadiene		10.0	U
C515	88-06-2	2,4,6-Trichlorophenol		10.0	U
C520	95-95-4	2,4,5-Trichlorophenol		10.0	U
C525	91-58-7	2-Chloronaphthalene		10.0	U
C530	88-74-4	2-Nitroaniline		50.0	U
C535	131-11-3	Dimethylphthalate		10.0	U
C540	208-96-8	Acenaphthylene		10.0	U
C545	606-20-2	2,6-Dinitrotoluene		10.0	U
C546	99-09-2	3-Nitroaniline		50.0	U
C550	83-32-9	Acenaphthene		10.0	U

SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 625 - WATER

EPA METHOD 8270 - SOIL/WASTE

007611

CASE NO 312259LABORATORY SwL - HoustonCONTRACT CHEM ANALYS

SAS NO _____

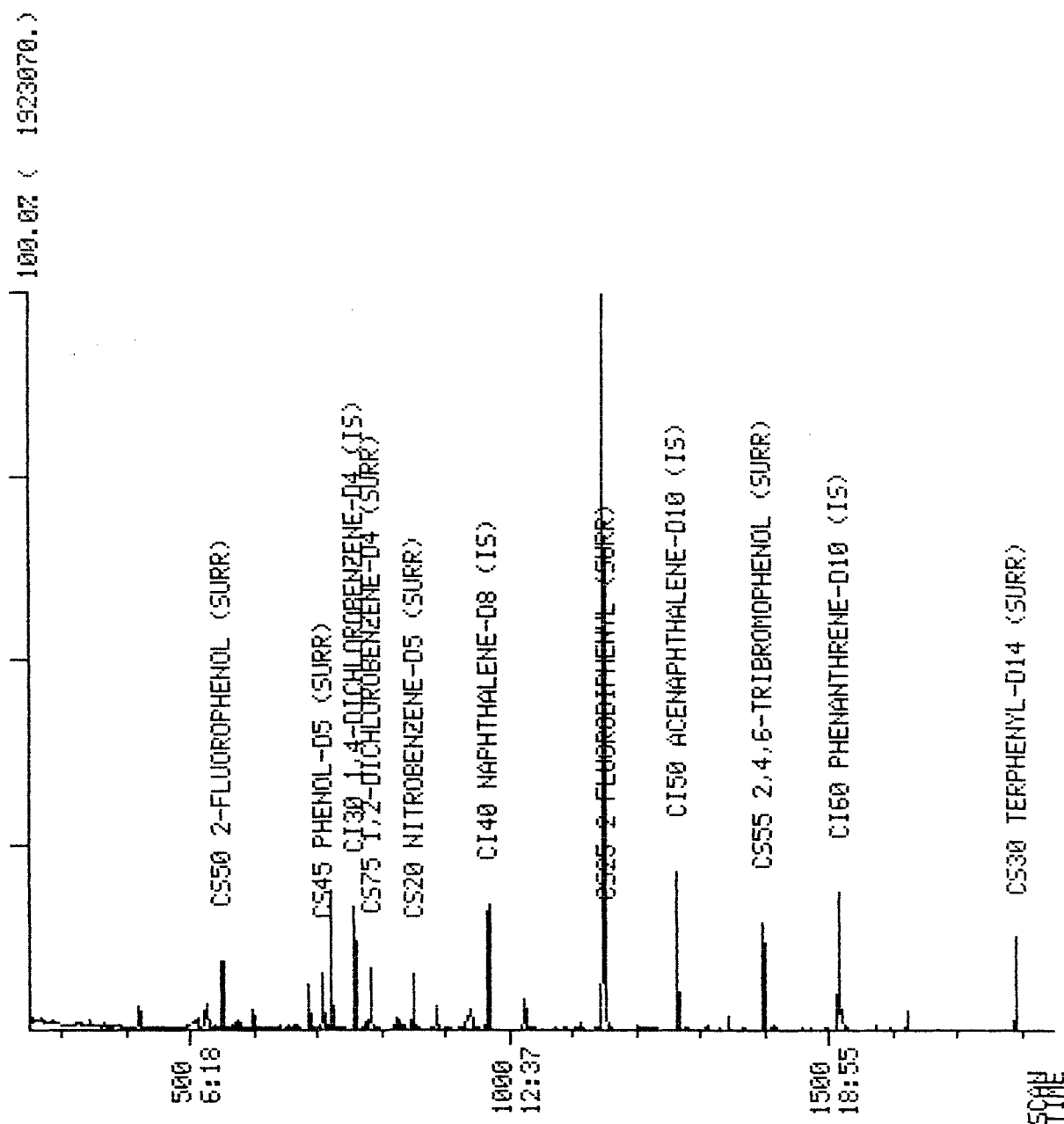
REPORTED 12/21/93 10:45CUSTOMER AWD

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C555	51-28-5	2,4-Dinitrophenol		50.0	U
C560	100-02-7	4-Nitrophenol		50.0	U
C565	132-64-9	Dibenzofuran		10.0	U
C570	121-14-2	2,4-Dinitrotoluene		10.0	U
C576	103-33-3	Azobenzene		10.0	U
C580	84-66-2	Diethylphthalate		10.0	U
C585	7005-72-3	4-Chlorophenyl-phenylether		10.0	U
C590	86-73-7	Fluorene		10.0	U
C595	100-01-6	4-Nitroaniline		50.0	U
C610	534-52-1	4,6-Dinitro-2-Methylphenol		20.0	U
C615	86-30-6	N-Nitrosodiphenylamine (1)		10.0	U
C625	101-55-3	4-Bromophenyl-phenylether		10.0	U
C630	118-74-1	Hexachlorobenzene		10.0	U
C635	87-86-5	Pentachlorophenol		25.0	U
C640	85-01-8	Phenanthrene		10.0	U
C645	120-12-7	Anthracene		10.0	U
C650	84-74-2	Di-n-Butylphthalate		12.1	
C655	206-44-0	Fluoranthene		10.0	U
C671	92-87-5	Benzidine		50.0	U
C715	129-00-0	Pyrene		10.0	U
C720	85-68-7	Butylbenzylphthalate		10.0	U
C725	91-94-1	3,3'-Dichlorobenzidine		20.0	U
C730	56-55-3	Benzo(a)Anthracene		10.0	U
C740	218-01-9	Chrysene		10.0	U
C745	117-81-7	bis(2-Ethylhexyl)Phthalate		10.0	U
C760	117-84-0	Di-n-Octyl Phthalate		10.0	U
C765	205-99-2	Benzo(b)Fluoranthene		10.0	U
C770	207-08-9	Benzo(k)Fluoranthene		10.0	U
C775	50-32-8	Benzo(a)Pyrene		10.0	U
C780	193-39-5	Indeno(1,2,3-cd)Pyrene		10.0	U
C785	53-70-3	Dibenz(a,h)Anthracene		10.0	U
C790	191-24-2	Benzo(g,h,i)Perylene		10.0	U

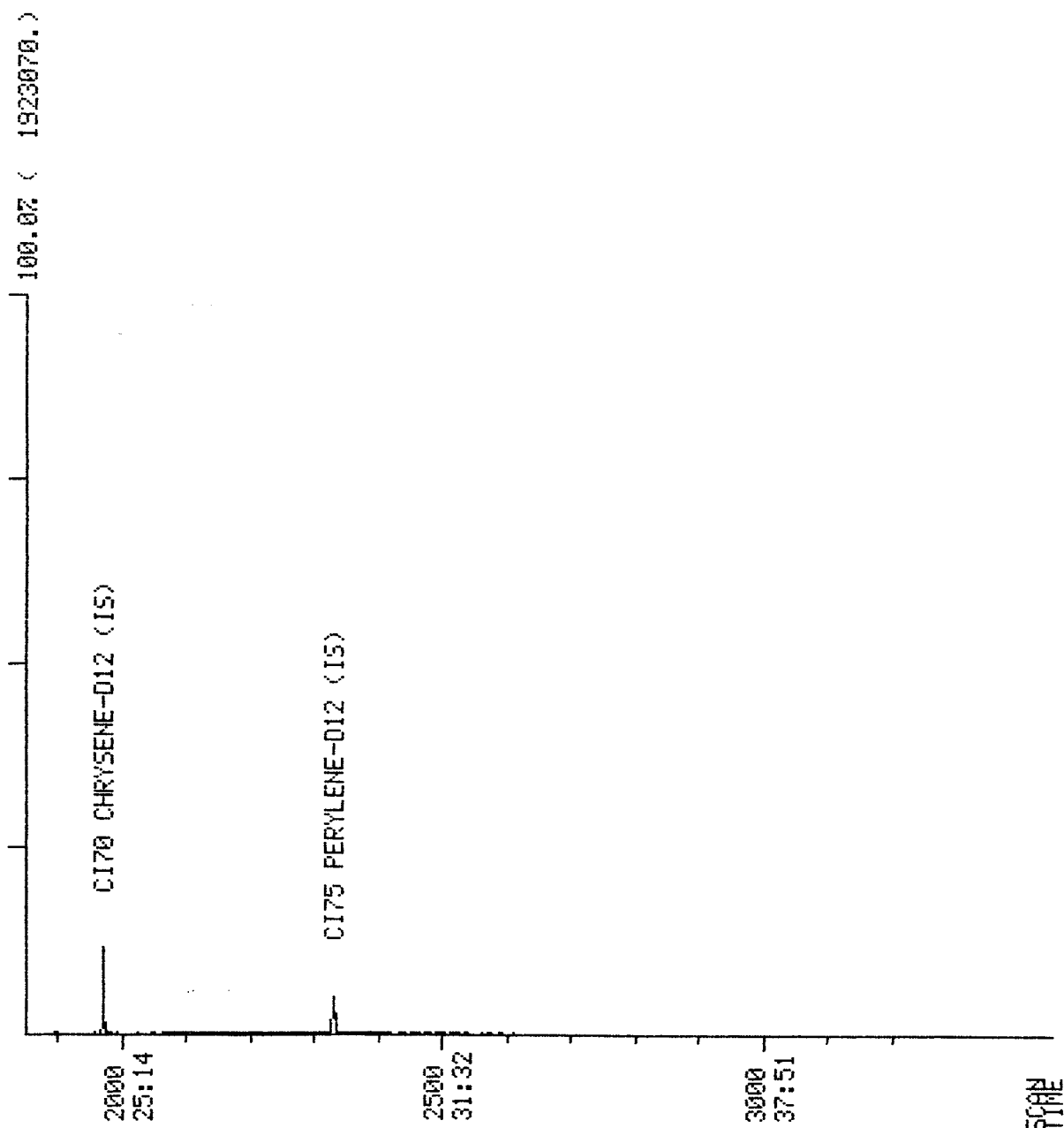
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: X1221003 SCANS 250 TO 1850 ACQUIRED: 12/21/93 13:13:00
CALI: X1221003 #3 OUT OF 250 TO 3200
SAMPLE: 9312259-03 AND EM-1
CONDS.: 40(4) TO 285 @ 12/MIN HOLD 17



DATA FROM FILE: X1221003 SCANS 1850 TO 3200 ACQUIRED: 12/21/93 13:13:00
CALI: X1221003 #3 OUT OF 250 TO 3200
SAMPLE: 9312259-03 AND EW-1
COND5.: 40(4) TO 285 @ 12/MIN HOLD 17



VOLATILE ORGANICS ANALYSIS DATA SHEET,
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 312259
SAS NO

LABORATORY SwL - Houston
REPORTED 02/01/94 10:29

CONTRACT CHEM ANALYS
CUSTOMER AWD

FILE NAME I122003
TYPE EPA
INST FINN

SAMPLE ID MW-1
LAB SAMP ID 9312259-01A
ANALYZED 12/19/93 18:32

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		50000	U
C015	74-83-9	Bromomethane		50000	U
C020	75-01-4	Vinyl Chloride		50000	U
C025	75-00-3	Chloroethane		50000	U
C030	75-09-2	Methylene Chloride		423000	
C035	67-64-1	Acetone		250000	U
C040	75-15-0	Carbon Disulfide		25000	U
C045	75-35-4	1,1-Dichloroethene		25000	U
C050	75-34-3	1,1-Dichloroethane		25000	U
C053	540-59-0	1,2-Dichloroethene (Total)		25000	U
C060	67-66-3	Chloroform		25000	U
C065	107-06-2	1,2-Dichloroethane		25000	U
C110	78-93-3	Methylethyl ketone (MEK)		50000	U
C115	71-55-6	1,1,1-Trichloroethane		25000	U
C120	56-23-5	Carbon Tetrachloride		25000	U
C125	108-05-4	Vinyl Acetate		50000	U
C130	75-27-4	Bromodichloromethane		25000	U
C140	78-87-5	1,2-Dichloropropane		25000	U
C143	10061-01-5	cis-1,3-Dichloropropene		25000	U
C150	79-01-6	Trichloroethene		25000	U
C155	124-48-1	Dibromochloromethane		25000	U
C160	79-00-5	1,1,2-Trichloroethane		25000	U
C165	71-43-2	Benzene		25000	U
C172	10061-02-6	trans-1,3-Dichloropropene		25000	U
C180	75-25-2	Bromoform		25000	U
C205	108-10-1	4-Methyl-2-Pentanone		50000	U
C210	591-78-6	2-Hexanone		50000	U
C220	127-18-4	Tetrachloroethene		25000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		25000	U
C230	108-88-3	Toluene		25000	U
C235	108-90-7	Chlorobenzene		25000	U
C240	100-41-4	Ethylbenzene		25000	U
C245	100-42-5	Styrene		25000	U
C250	1330-20-7	Xylene (total)		25000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

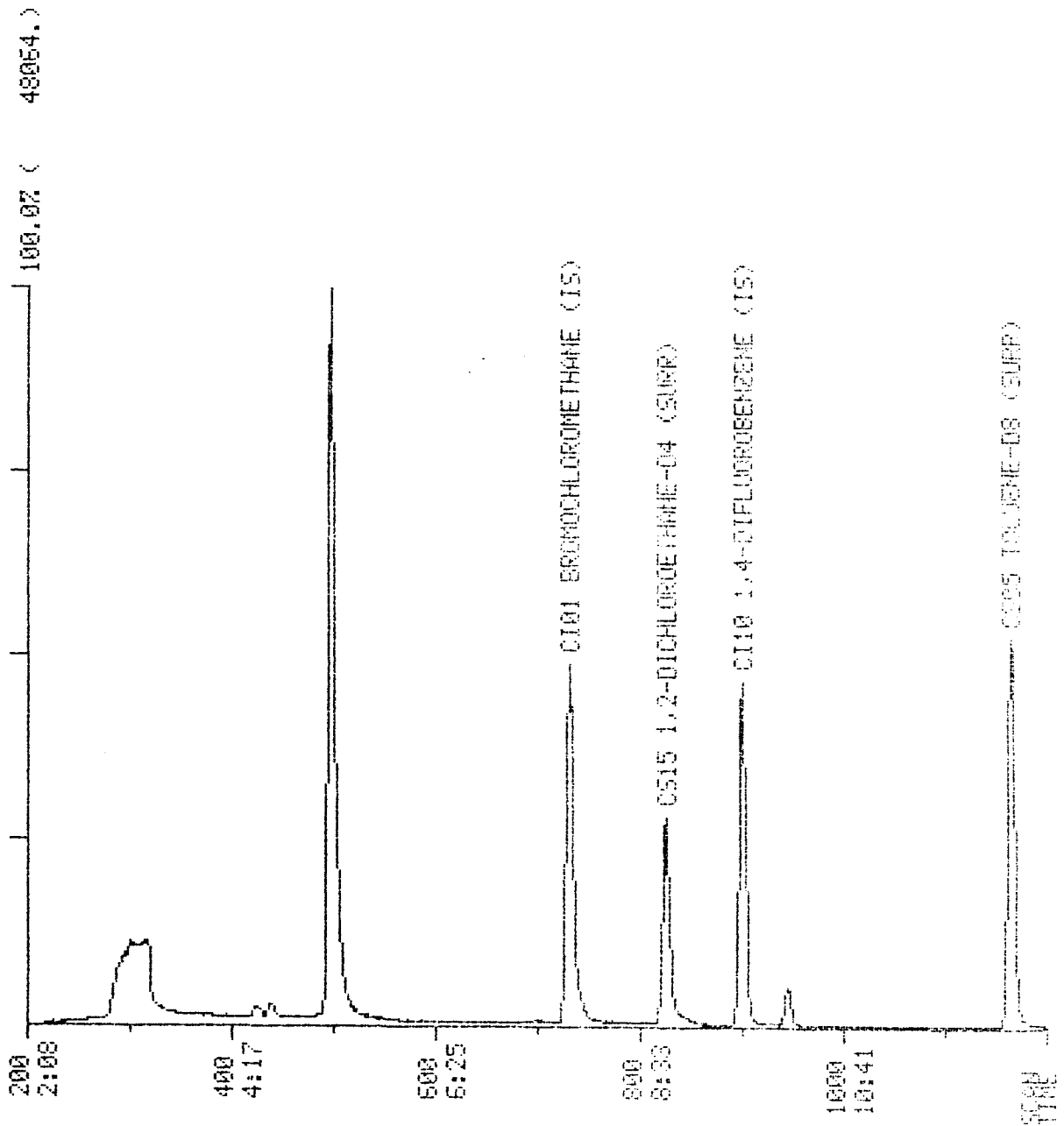
EPA METHOD 8240 - SOIL/WASTE

CASE NO 312259
SAS NO _____LABORATORY SwL - Houston
REPORTED 02/01/94 10:29CONTRACT CHEM ANALYS
CUSTOMER AWD

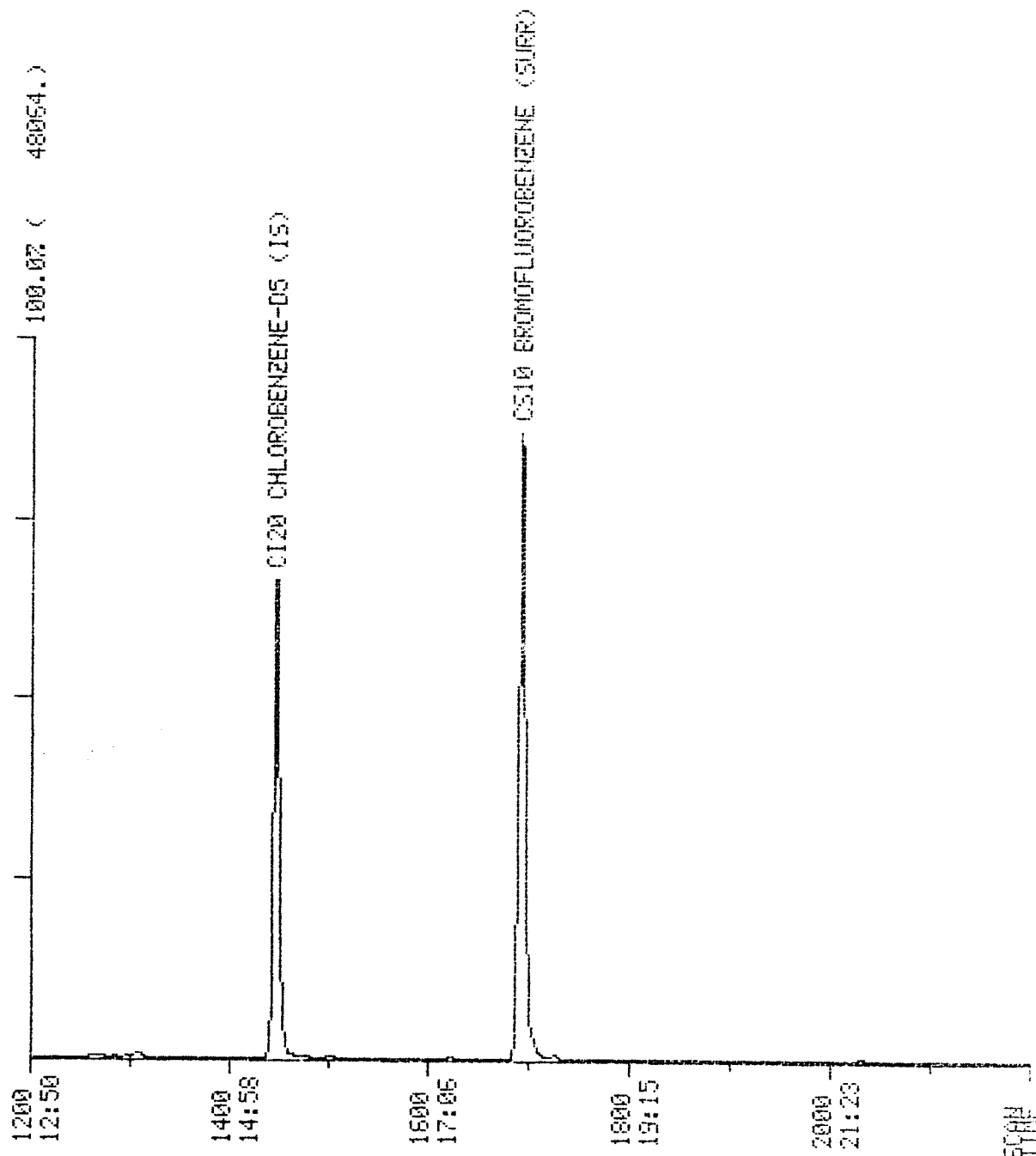
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I122003 SCANS 200 TO 1200 ACQUIRED: 12/19/93 18:32:00
CALI: I122003 #3 OUT OF 200 TO 2200
SAMPLE: 9312259-01A AND MW-1 20UL OF 50UL/1ML
CONDS.: 40(3)-18005/MIN CAPILLARY 75M



DATA FROM FILE: I122003 SCANS 1200 TO 2200 ACQUIRED: 12/19/93 18:32:00
SAMPLE: 9312259-01A AND MW-1 20UL OF 50UL/1ML CALI: I122003 #3 OUT OF 200 TO 2200
CONDS.: 40(3)-18005/MIN CAPILLARY 75M



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 312259
SAS NO

LABORATORY SwL - Houston
REPORTED 12/22/93 12:16

CONTRACT CHEM ANALYS
CUSTOMER AWD

FILE NAME I122101
TYPE EPA
INST FINN

SAMPLE ID MW-2
LAB SAMP ID 9312259-02A
ANALYZED 12/21/93 16:10

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		1000000	U
C015	74-83-9	Bromomethane		1000000	U
C020	75-01-4	Vinyl Chloride		1000000	U
C025	75-00-3	Chloroethane		1000000	U
C030	75-09-2	Methylene Chloride		6850000	
C035	67-64-1	Acetone		4900000	U
C040	75-15-0	Carbon Disulfide		500000	U
C045	75-35-4	1,1-Dichloroethene		500000	U
C050	75-34-3	1,1-Dichloroethane		500000	U
C 3	540-59-0	1,2-Dichloroethene (total)		500000	U
C060	67-66-3	Chloroform		500000	U
C065	107-06-2	1,2-Dichloroethane		500000	U
C110	78-93-3	Methylethyl ketone (MEK)		1000000	U
C115	71-55-6	1,1,1-Trichloroethane		500000	U
C120	56-23-5	Carbon Tetrachloride		500000	U
C125	108-05-4	Vinyl Acetate		1000000	U
C130	75-27-4	Bromodichloromethane		500000	U
C140	78-87-5	1,2-Dichloropropane		500000	U
C143	10061-01-5	cis-1,3-Dichloropropene		500000	U
C150	79-01-6	Trichloroethene		500000	U
C155	124-48-1	Dibromochloromethane		500000	U
C160	79-00-5	1,1,2-Trichloroethane		500000	U
C165	71-43-2	Benzene		500000	U
C172	10061-02-6	trans-1,3-Dichloropropene		500000	U
C180	75-25-2	Bromoform		500000	U
C205	108-10-1	4-Methyl-2-Pentanone		1000000	U
C210	591-78-6	2-Hexanone		1000000	U
C220	127-18-4	Tetrachloroethene		500000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		500000	U
C230	108-88-3	Toluene		500000	U
C235	108-90-7	Chlorobenzene		500000	U
C240	100-41-4	Ethylbenzene		500000	U
C245	100-42-5	Styrene		500000	U
C250	1330-20-7	Xylene (total)		500000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 312259

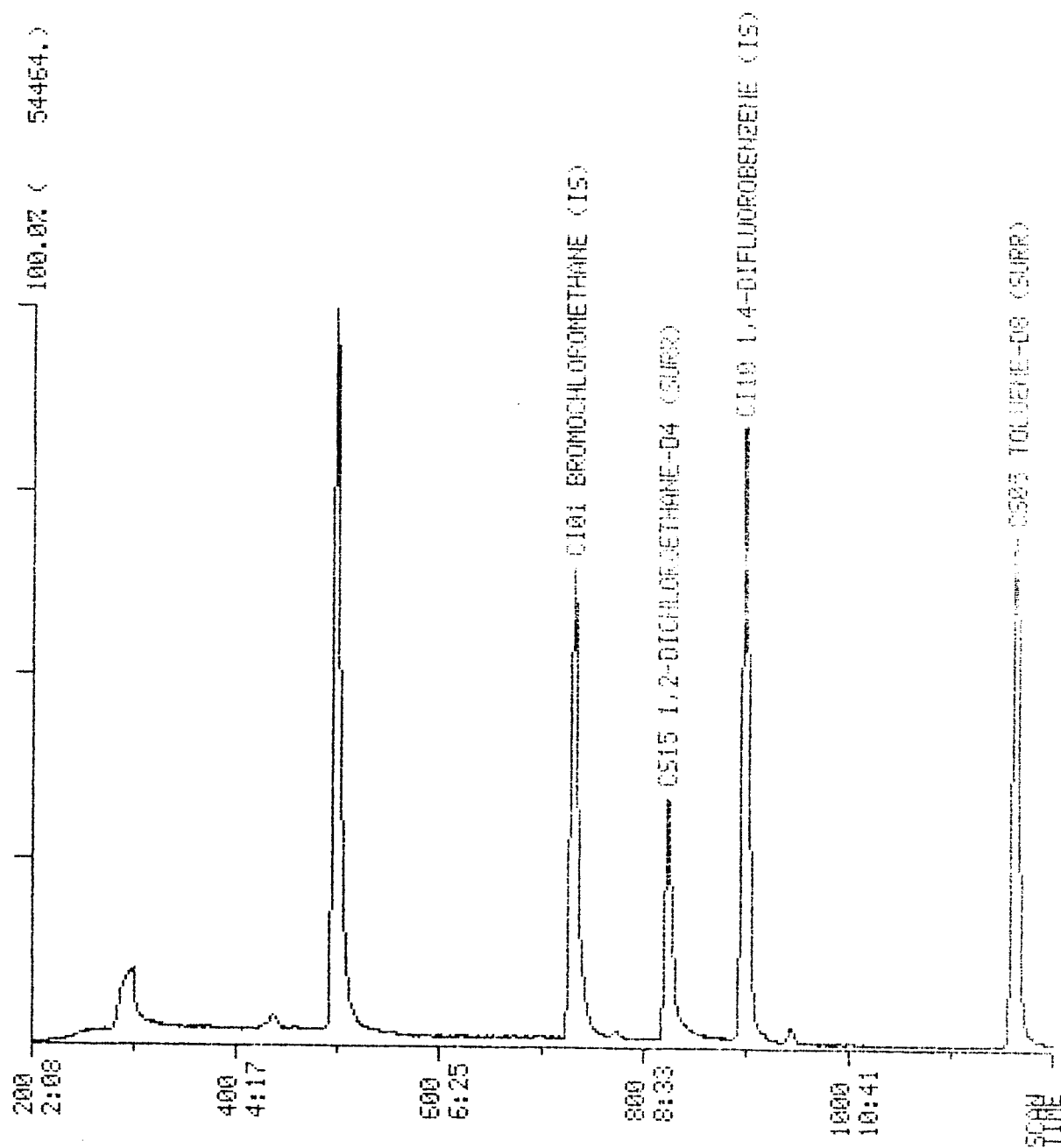
SAS NO _____

LABORATORY SwL - HoustonREPORTED 12/22/93 12:16CONTRACT CHEM ANALYSCUSTOMER AWD

Notes and summary data for this report.

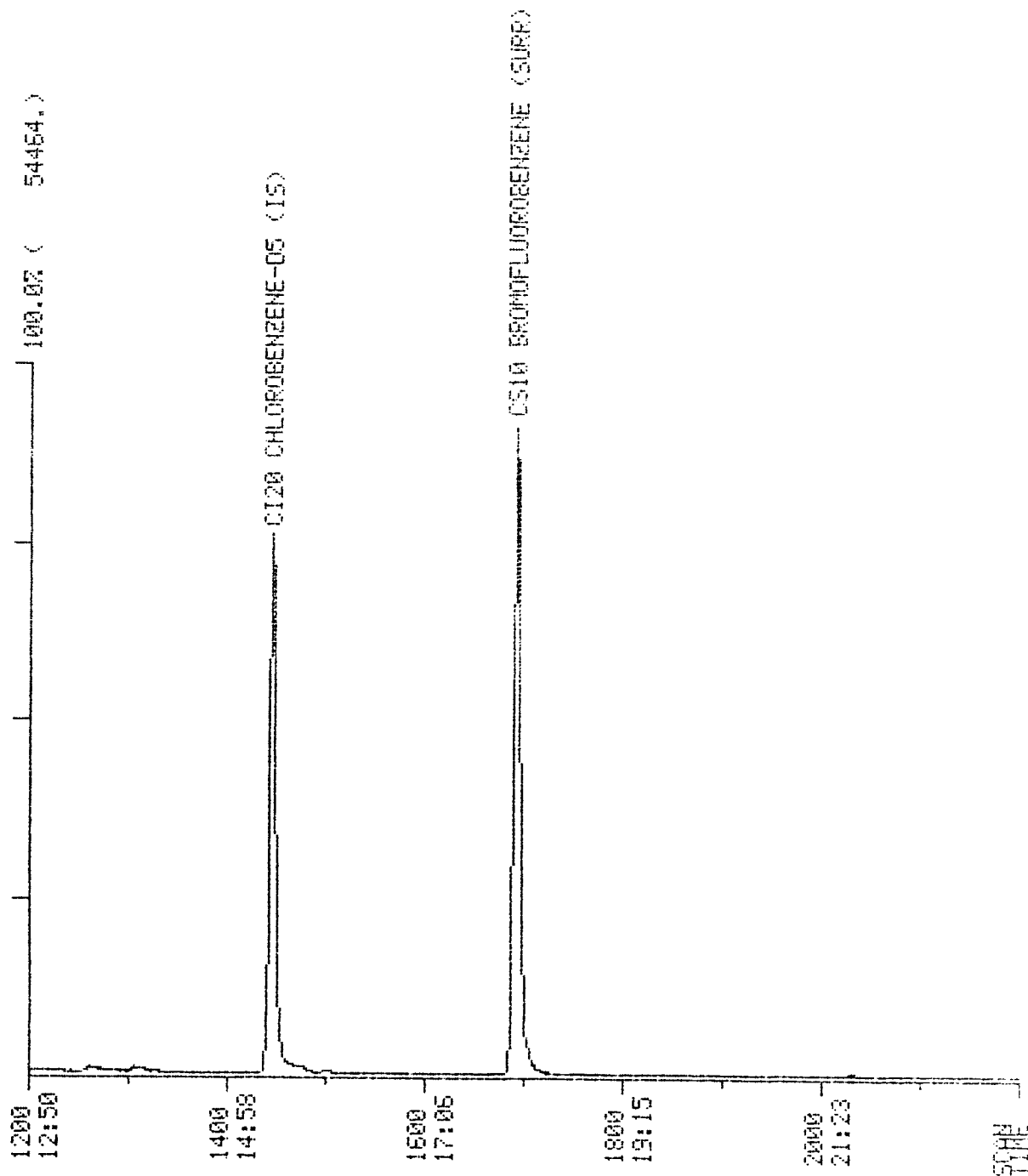
U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I122101 SCANS 200 TO 1200 ACQUIRED: 12/21/93 15:10:00
CALI: I122101 #3 OUT OF 200 TO 2200
SAMPLE: 9312259-02A AMD MK-2 1UL OF 50UL/1ML
COND5.: 40(3)-13006/MIN



007621

DATA FROM FILE: I122101 SCANS 1200 TO 2200 ACQUIRED: 12/21/93 16:10:00
CALI: I122101 #3 OUT OF 200 TO 2200
SAMPLE: 9312259-02A AND MM-2 1UL OF 50UL/1ML
CONDS.: 40(3)-18005/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 312259
SAS NO _____

LABORATORY SwL - Houston
REPORTED 12/22/93 12:17

CONTRACT CHEM ANALYS
CUSTOMER AWD

FILE NAME I122102
TYPE EPA
INST FINN

SAMPLE ID EW-1
LAB SAMP ID 9312259-03A
ANALYZED 12/21/93 16:51

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
C020	75-01-4	Vinyl Chloride		200000	U
C025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		2540000	
C035	67-64-1	Acetone		980000	U
C040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
C050	75-34-3	1,1-Dichloroethane		100000	U
C 3	540-59-0	1,2-Dichloroethene (total)		100000	U
C060	67-66-3	Chloroform		100000	U
C065	107-06-2	1,2-Dichloroethane		100000	U
C110	78-93-3	Methylethyl ketone (MEK)		200000	U
C115	71-55-6	1,1,1-Trichloroethane		100000	U
C120	56-23-5	Carbon Tetrachloride		100000	U
C125	108-05-4	Vinyl Acetate		200000	U
C130	75-27-4	Bromodichloromethane		100000	U
C140	78-87-5	1,2-Dichloropropane		100000	U
C143	10061-01-5	cis-1,3-Dichloropropene		100000	U
C150	79-01-6	Trichloroethene		198000	
C155	124-48-1	Dibromochloromethane		100000	U
C160	79-00-5	1,1,2-Trichloroethane		100000	U
C165	71-43-2	Benzene		100000	U
C172	10061-02-6	trans-1,3-Dichloropropene		100000	U
C180	75-25-2	Bromoform		100000	U
C205	108-10-1	4-Methyl-2-Pentanone		200000	U
C210	591-78-6	2-Hexanone		200000	U
C220	127-18-4	Tetrachloroethene		100000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
C230	108-88-3	Toluene		100000	U
C235	108-90-7	Chlorobenzene		100000	U
C240	100-41-4	Ethylbenzene		100000	U
C245	100-42-5	Styrene		100000	U
C250	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 312259

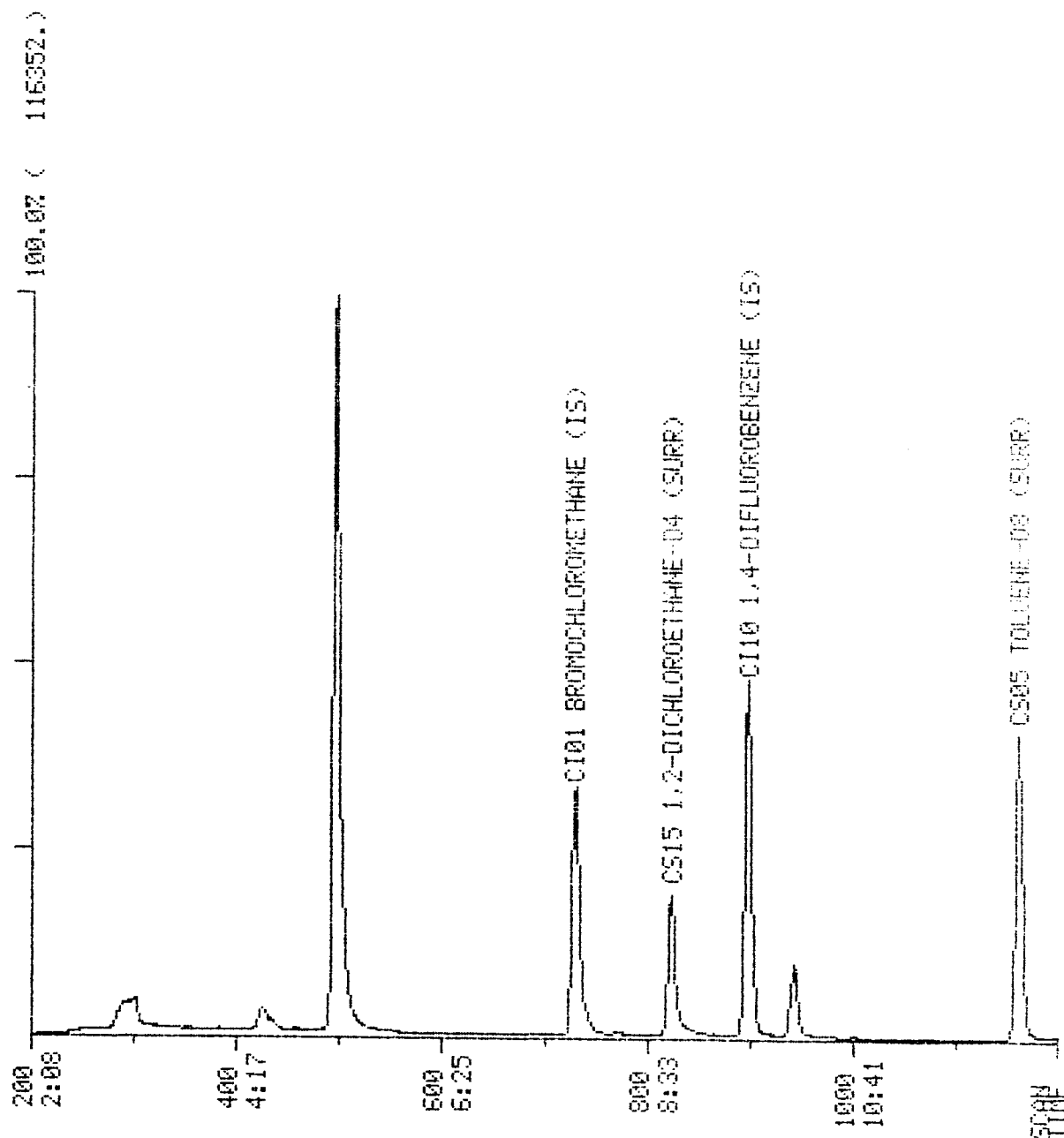
SAS NO _____

LABORATORY SwL - HoustonREPORTED 12/22/93 12:17CONTRACT CHEM ANALYSCUSTOMER AWD

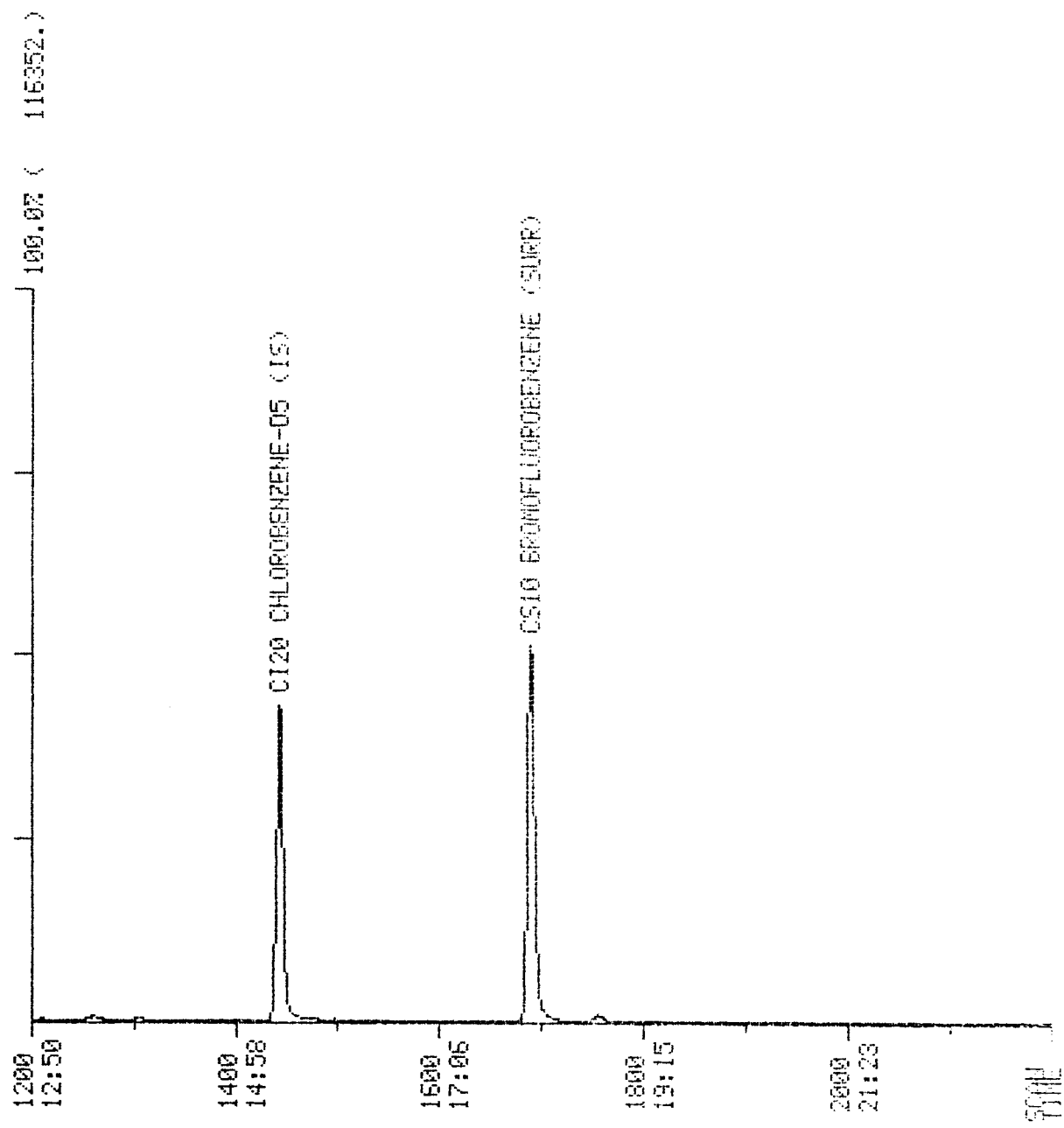
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I122102 SCANS 200 TO 1200 ACQUIRED: 12/21/93 16:51:00
SAMPLE: 9312259-03A AND EM-1 SUL OF 50UL/1ML CALI: I122102 #3 OUT OF 200 TO 2200
COND5.: 40(3)-18006/MIN



DATA FROM FILE: 1122102 SCANS 1200 TO 2200 ACQUIRED: 12/21/93 16:51:00
 SAMPLE: 9312259-03A AMD EW-1 5UL OF 50UL/INL CALI: 1122102 #3 OUT OF 200 TO 2200
 CONDS.: 40(3)-18005/MIN



Analysis Request and Chain of Custody Record

Page 1 of 3

SOUTHWESTERN LABORATORIES

- ☒ HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151
☐ DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700
☐ MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no.		Client/Project					Analysis Requested		Laboratory Remarks		
Lab ID No.	Field Sample No./ Identification	Date and Time	Q.C. #	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative					
	MW 1	12/15/93		2-qt-Hubs liquid		N/A	BNA				
				2-40ml			VOA				
				2-qt-pl			SO ₄ , NO ₃ , Cl, CN, Cr ¹⁶ , Radioactivity (Gross Alpha/Beta) pH				
							Al, Sb, Ba, Br, Cd, Ca, Cr, Co, Cu, Fe, Pb,				
							Mg, Mo, K, Ag, Na, 7 , Sn, Ti, V, Zn				
							TOC*, COD, TDS, TSS, Acidity or Alkalinity, etc				
Samplers: (Print)		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		COC Seal No.	
Affiliation		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		REC'D. ON ICE Yes No	
Results by <u>7 days</u>		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		Intact Yes No	
Rush Charges Authorized		REMARKS: * Run TOC normally and also run TOC on non-acidified sample that has been sparged				Data Results To:				Laboratory No.	
Yes No						1.				93-12-251	
						2.					



SOUTHWESTERN LABORATORIES

- ☒ HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151
☐ DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700
☐ MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Analysis Request and Chain of Custody Record

Page 2 of 3

Project no.		Client/Project					ANALYSIS REQUESTED		LABORATORY REMARKS				
Lab ID No.	Field Sample No./ Identification	Date and Time	g/g	Com	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative						
	MWZ	12/15/93			204 Amb	liquid	None	BVA					
					240ml			UVA					
					1-1/2 gal			SO ₄ , NO ₃ , Cl, F, Cr ⁶⁺ , Radioactivity (Gross Alpha/Beta), pH					
					1-qt			Al, Sb, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb,					
								Mg, Mo, K, Ag, Hg, Ti, Sn, Ti, V, Zn					
								TOC*, CO ₂ , TDS, TSS, Acid/Alk, O+G					
Samplers: (Print)		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		COC Seal No.			
Affiliation		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		REC'D. ON ICE Yes No			
		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		Intact: Yes No			
Results by		REMARKS: * See note on pg 1										Laboratory No.	
Rush Charges Authorized												93-12-259	
Yes No													

Analysis Request and Chain of Custody Record

Page 3 of 3

SOUTHWESTERN LABORATORIES

- ☒ HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151
☐ DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700
☐ MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no.		Client/Project					ANALYSIS REQUESTED		LABORATORY REMARKS	
Lab ID No.	Field Sample No./ Identification	Date and Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative			
	Ew1	12/15/13			2-Q-Hub	liquid	None	BNA		
					2-Q-Hub	liquid	None	WVA		
					2-Q-Hub	liquid	None	SC ₄ , NO ₃ , Cl, Cu, Cr ⁶ , Radioactivity (Gross Alpha/Beta), pH		
								Al, Se, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb,		
								Mg, Mo, K, As, Na, Ti, Sn, Tl, U, Zn		
								TOC*, COD, TDS, TSS, Acid/Alk, DTG		
Samplers: (Print)		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		COC Seal No.
Affiliation		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		REC'D. ON ICE Yes No
		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		Intact: Yes No
Results by _____		REMARKS: * see note on pg 1				Data Results to:		Laboratory No.		
Rush Charges Authorized										
Yes _____ No _____										

00769

93-12-258

007629



SOUTHWESTERN LABORATORIES

222 CAVALCADE * P.O. BOX 8768, HOUSTON, TEXAS 77249 * 713 692-9151

Client AWD TECHNOLOGIES, INC.
400 W. SAM HOUSTON PKWY SOUTH
HOUSTON, TEXAS 77042

Client No. 2_0686_00
Report No. 94-01-223
Report Date 01/20/94 12:08

Attn: WALT PRECOURT

Project IRON ANALYSIS

Date Sampled 01/19/94

Sampled By NOT INDICATED

Sample Type LIQUID SAMPLE

Transported by CLIENT

P.O. # _____

Date Received 01/19/94

REFERENCE REPORT NO. 93-12-125-01A

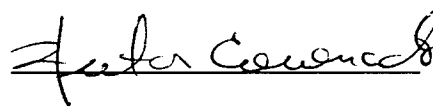
Lab No.
94-01-223-01

Sample Identification
LONGHORN/MW-1/RETEST

SOUTHWESTERN LABORATORIES



Reviewed By



HECTOR CORONADO

007630

SOUTHWESTERN LABORATORIES

Order # 94-01-223

01/20/94 12:08

Client: AWD TECHNOLOGIES, INC.

TEST RESULTS BY SAMPLE

Page 2

Sample: 01A LONGHORN/MW-1/RETEST

Collected: 01/19/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
IRON	EPA 200.7	0.15	mg/L	0.02	01/20/94	GLM



SOUTHWESTERN LABORATORIES

- ☒ **HOUSTON EAS** 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151
 - ☐ **DALLAS EAS** 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700
 - ☐ **MIDLAND EAS** 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no. Longhorn		Client/Project Arid - Longhorn						Wait Review						
Lab ID No.	Field Sample No./ Identification	Date and Time	Gra	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative	ANALYSIS REQUESTED	LABORATORY REMARKS					
	Longhorn	1-19-94	P		500ml Plastic	Liquid	none	Iron - total						
								RUSH						
Samplers: (Print)		Relinquished by: (Signature) Wally Brown		Date: 1-19-94 Time: 1:25P		Received by: (Signature)		Date: Time:		COC Seal No. <i>Dance</i>				
Affiliation		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		REC'D ON ICE Yes _____ No _____				
		Relinquished by: (Signature)		Date: Time:		Received by Laboratory: (Signature) Mike Fuller		Date: Time:		Intact: N/A				
Results by 1-20		REMARKS: Please fax results								Laboratory No.				
Rush Charges Authorized										1.				
Yes X No ____		Reference 93-12-259-01A-								2.				

007631

007632

Appendix B
Testing Data
Supporting Documentation



SOUTHWESTERN LABORATORIES

007633

222 CAVALCADE * P.O. BOX 8768, HOUSTON, TEXAS 77249 * 713 692-9151

Client AWD TECHNOLOGIES, INC.
400 W. SAM HOUSTON PKWY SOUTH
HOUSTON, TEXAS 77042

Client No. 2_0686_00
Report No. 94-01-059
Report Date 01/11/94 13:17

Attn: WALT PRECOURT

Project VOLATILE ANALYSIS

Date Sampled 01/05/94

Sampled By NOT INDICATED

Sample Type LIQUID SAMPLES

Transported by AWD-WP

P.O. # _____

Date Received 01/06/94

Lab No.

94-01-059-01
94-01-059-02
94-01-059-03
94-01-059-04
94-01-059-05
94-01-059-06
94-01-059-07
94-01-059-08
94-01-059-09
94-01-059-10
94-01-059-11
94-01-059-12
94-01-059-13

Sample Identification

W-100 LONGHORN
W-300 LONGHORN
W-600 LONGHORN
W-900 LONGHORN
W-1800 LONGHORN
N-100 LONGHORN
N-300 LONGHORN
N-600
N-900 LONGHORN
N-1800 LONGHORN
CONTROL-LONGHORN
COMPOSITE LONGHORN
COMPOSITE/PH



Reviewed By

SOUTHWESTERN LABORATORIES



CHRIS BARRY

Activated Carbon - Isotherm 1

Order # 94-01-059

01/11/94 13:17

Client: AWD TECHNOLOGIES, INC.

TEST RESULTS BY SAMPLE

Page 2 007634

Sample: 01A W-100 LONGHORN

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

Sample: 02A W-300 LONGHORN

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

Sample: 03A W-600 LONGHORN

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

Sample: 04A W-900 LONGHORN

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

Sample: 05A W-1800 LONGHORN

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

Sample: 06A N-100 LONGHORN

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

Order # 94-01-059

Page 3

01/11/94 13:17

TEST RESULTS BY SAMPLE

Client: AWD TECHNOLOGIES, INC.

Sample: 07A N-300 LONGHORN

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

Sample: 08A N-600

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

Sample: 09A N-900 LONGHORN

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

Sample: 10A N-1800 LONGHORN

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

Sample: 11A CONTROL-LONGHORN

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

Sample: 12A COMPOSITE LONGHORN

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/10/94	DBD

SOUTHWESTERN LABORATORIES

Order # 94-01-059

01/11/94 13:17

Client: AMD TECHNOLOGIES, INC.

Page 4

007636

TEST RESULTS BY SAMPLE

Sample: 13A COMPOSITE/PH

Collected: 01/05/94 09:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection</u>	<u>Date</u>	<u>Limit</u>	<u>Started</u>	<u>Analyst</u>
pH	EPA 150.1	6.93	pH UNITS				01/06/94	RF

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

LABORATORY SwL - Houston
REPORTED 01/11/94 10:17

CONTRACT VOLATILES
CUSTOMER AWD TECH

FILE NAME V011001
TYPE EPA
INST 5100

SAMPLE ID W-100 LONGHOR
LAB SAMP ID 9401059-01A
ANALYZED 01/10/94 16:36

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		6700000	
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
C055	540-59-0	1,2-Dichloroethene (Total)		250000	U
C060	67-66-3	Chloroform		250000	U
C065	107-06-2	1,2-Dichloroethane		250000	U
C110	78-93-3	Methylethyl ketone (MEK)		500000	U
C115	71-55-6	1,1,1-Trichloroethane		250000	U
C120	56-23-5	Carbon Tetrachloride		250000	U
C125	108-05-4	Vinyl Acetate		500000	U
C130	75-27-4	Bromodichloromethane		250000	U
C140	78-87-5	1,2-Dichloropropane		250000	U
C143	10061-01-5	cis-1,3-Dichloropropene		250000	U
C150	79-01-6	Trichloroethene		250000	U
C155	124-48-1	Dibromochloromethane		250000	U
C160	79-00-5	1,1,2-Trichloroethane		250000	U
C165	71-43-2	Benzene		250000	U
C172	10061-02-6	trans-1,3-Dichloropropene		250000	U
C180	75-25-2	Bromoform		250000	U
C205	108-10-1	4-Methyl-2-Pentanone		500000	U
C210	591-78-6	2-Hexanone		500000	U
C220	127-18-4	Tetrachloroethene		250000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C230	108-88-3	Toluene		250000	U
C235	108-90-7	Chlorobenzene		250000	U
C240	100-41-4	Ethylbenzene		250000	U
C245	100-42-5	Styrene		250000	U
C250	1330-20-7	Xylene (total)		250000	U

007638

page 2

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059SAS NO LONGHORNLABORATORY SwL - HoustonREPORTED 01/11/94 10:17CONTRACT VOLATILESCUSTOMER AWD TECH

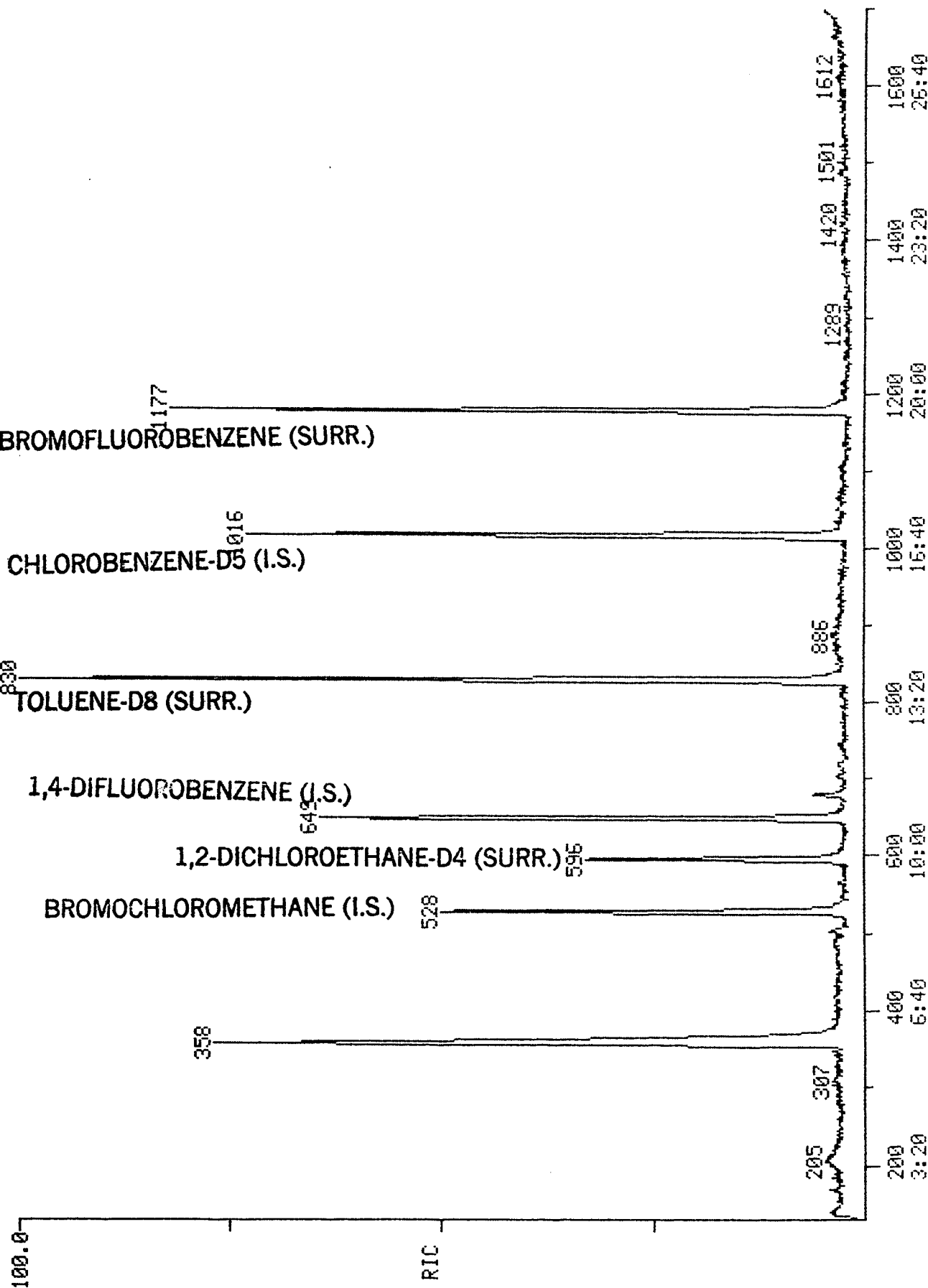
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

MIDRIC
 01/10/94 16:36:00
 DATA: U011001 #1
 CALI: U011001 #2
 SAMPLE: 9401059-01A AMD W-100 LONGHORN 50,000 X DILUTION
 COND5.: 35(3) 35-200 @ 5/MIN
 RANGE: G 1.3000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
 SCANS 130 TO 1700

196352.

007639



SCAN
TIME

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 401059
SAS NO LONGHORNLABORATORY SwL - Houston
REPORTED 01/11/94 10:17CONTRACT VOLATILES
CUSTOMER AWD TECHFILE NAME V011002
TYPE EPA
INST 5100SAMPLE ID W-300 LONGHOR
LAB SAMP ID 9401059-02A
ANALYZED 01/10/94 17:12LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		5600000	
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
X	540-59-0	1,2-Dichloroethene (Total)		250000	U
C060	67-66-3	Chloroform		250000	U
C065	107-06-2	1,2-Dichloroethane		250000	U
C110	78-93-3	Methylethyl ketone (MEK)		500000	U
C115	71-55-6	1,1,1-Trichloroethane		250000	U
C120	56-23-5	Carbon Tetrachloride		250000	U
C125	108-05-4	Vinyl Acetate		500000	U
C130	75-27-4	Bromodichloromethane		250000	U
C140	78-87-5	1,2-Dichloropropane		250000	U
C143	10061-01-5	cis-1,3-Dichloropropene		250000	U
C150	79-01-6	Trichloroethene		250000	U
C155	124-48-1	Dibromochloromethane		250000	U
C160	79-00-5	1,1,2-Trichloroethane		250000	U
C165	71-43-2	Benzene		250000	U
C172	10061-02-6	trans-1,3-Dichloropropene		250000	U
C180	75-25-2	Bromoform		250000	U
C205	108-10-1	4-Methyl-2-Pentanone		500000	U
C210	591-78-6	2-Hexanone		500000	U
C220	127-18-4	Tetrachloroethene		250000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C230	108-88-3	Toluene		250000	U
C235	108-90-7	Chlorobenzene		250000	U
C240	100-41-4	Ethylbenzene		250000	U
C245	100-42-5	Styrene		250000	U
C250	1330-20-7	Xylene (total)		250000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059SAS NO LONGHORNLABORATORY SwL - HoustonREPORTED 01/11/94 10:17CONTRACT VOLATILESCUSTOMER AWD TECH

Notes and summary data for this report.

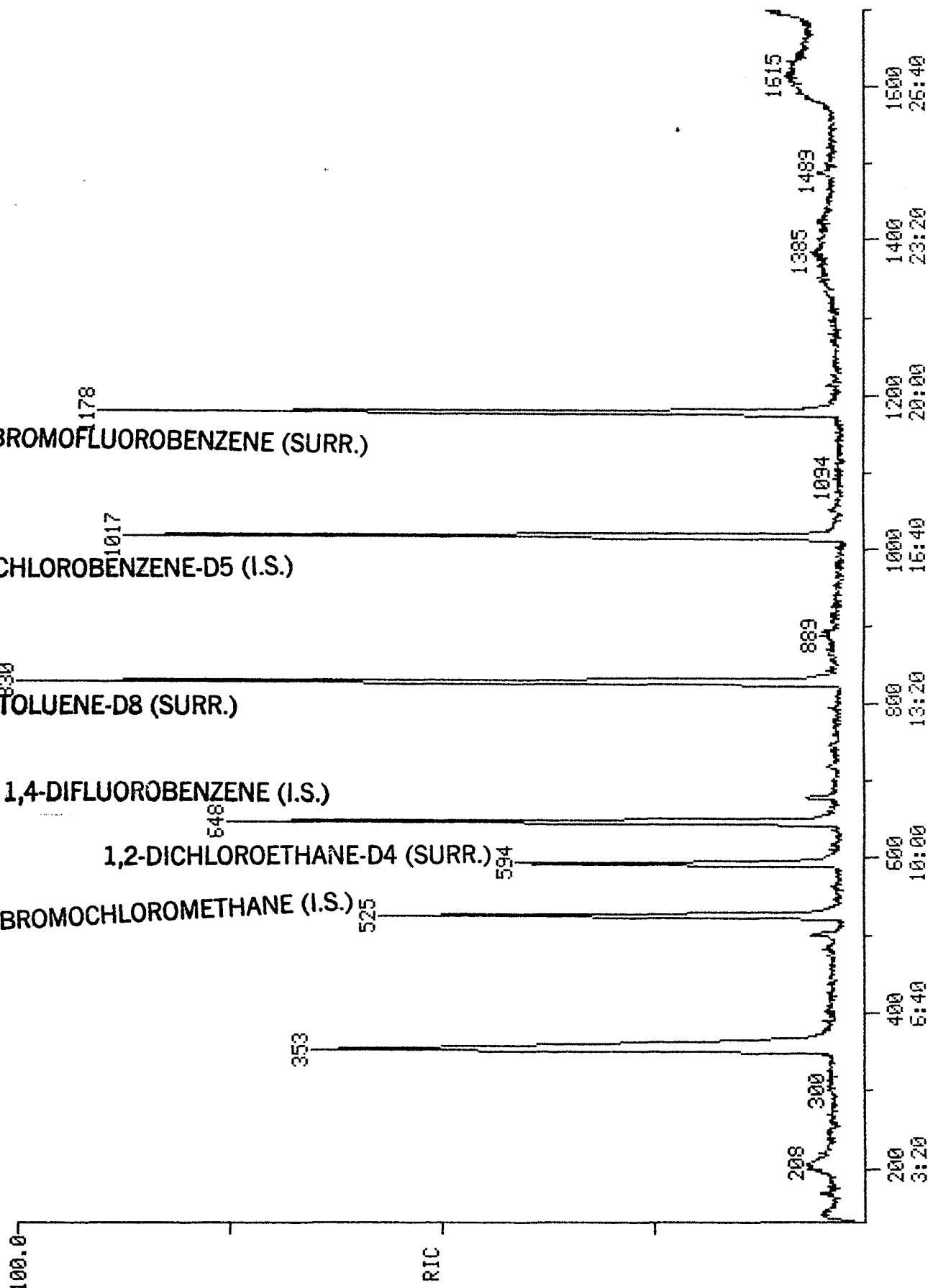
U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

MIDRIC
 01/10/94 17:12:00
 DATA: U011002 #1
 CALI: U011002 #2
 SAMPLE: 9401059-02A AND W-300 LONGHORN 50.000 X DILUTION
 CONDS.: 35(3) 35-200 @ 6/MIN
 RANGE: G 1.3000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
 SCANS 130 TO 1700

152832.

007642

SCAN
TIME



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

LABORATORY SwL - Houston
REPORTED 01/11/94 10:18

CONTRACT VOLATILES
CUSTOMER AWD TECH

FILE NAME V011003
TYPE EPA
INST 5100

SAMPLE ID W-600 LONGHOR
LAB SAMP ID 9401059-03A
ANALYZED 01/10/94 17:48

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		5300000	U
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
C050	540-59-0	1,2-Dichloroethene (Total)		250000	U
C060	67-66-3	Chloroform		250000	U
C065	107-06-2	1,2-Dichloroethane		250000	U
C110	78-93-3	Methylethyl ketone (MEK)		500000	U
C115	71-55-6	1,1,1-Trichloroethane		250000	U
C120	56-23-5	Carbon Tetrachloride		250000	U
C125	108-05-4	Vinyl Acetate		500000	U
C130	75-27-4	Bromodichloromethane		250000	U
C140	78-87-5	1,2-Dichloropropane		250000	U
C143	10061-01-5	cis-1,3-Dichloropropene		250000	U
C150	79-01-6	Trichloroethene		250000	U
C155	124-48-1	Dibromochloromethane		250000	U
C160	79-00-5	1,1,2-Trichloroethane		250000	U
C165	71-43-2	Benzene		250000	U
C172	10061-02-6	trans-1,3-Dichloropropene		250000	U
C180	75-25-2	Bromoform		250000	U
C205	108-10-1	4-Methyl-2-Pentanone		500000	U
C210	591-78-6	2-Hexanone		500000	U
C220	127-18-4	Tetrachloroethene		250000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C230	108-88-3	Toluene		250000	U
C235	108-90-7	Chlorobenzene		250000	U
C240	100-41-4	Ethylbenzene		250000	U
C245	100-42-5	Styrene		250000	U
C250	1330-20-7	Xylene (total)		250000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 401059
SAS NO LONGHORNLABORATORY SwL - Houston
REPORTED 01/11/94 10:18CONTRACT VOLATILES
CUSTOMER AWD TECH

Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

MIDRIC

01/10/94 17:48:00

DATA: U011003 #1

SCANS 130 TO 1700

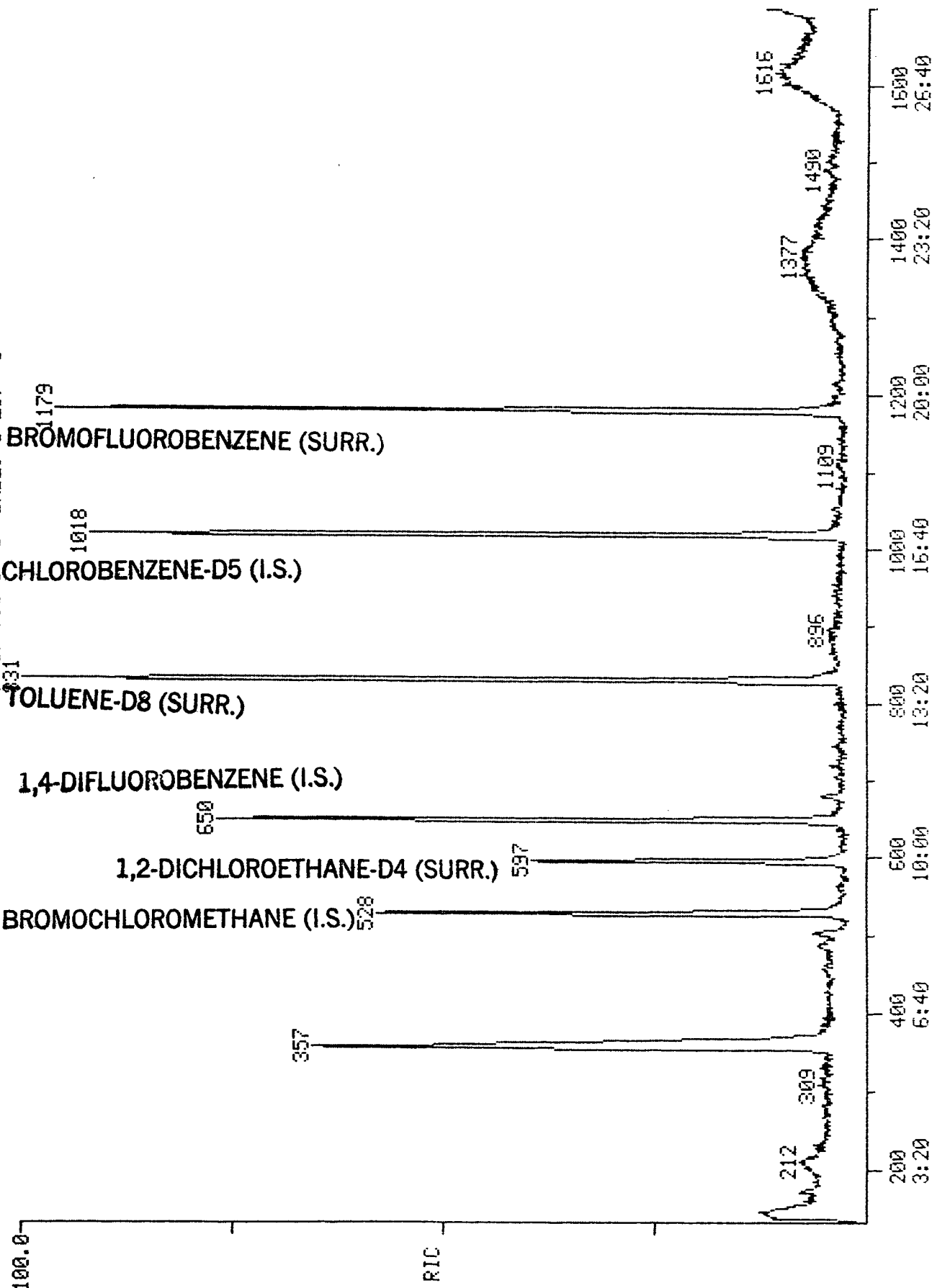
CALI: U011003 #2

SAMPLE: 9401059-03A AND W-600 LONGHORN 50,000 X DILUTION

CONDS.: 35(3) 35-200 @ 6/MIN

RANGE: G 1.3000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3

148480.



007645

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059SAS NO LONGHORNLABORATORY SWL - HoustonREPORTED 01/11/94 10:39CONTRACT VOLATILESCUSTOMER AWD TECHFILE NAME V011004TYPE EPAINST 5100SAMPLE ID W-900 LONGHORLAB SAMP ID 9401059-04AANALYZED 01/10/94 18:24LEVEL LOWMATRIX WATERUNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		8450000	
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
C055	540-59-0	1,2-Dichloroethene (Total)		250000	U
C060	67-66-3	Chloroform		250000	U
C065	107-06-2	1,2-Dichloroethane		250000	U
C110	78-93-3	Methylethyl ketone (MEK)		500000	U
C115	71-55-6	1,1,1-Trichloroethane		250000	U
C120	56-23-5	Carbon Tetrachloride		250000	U
C125	108-05-4	Vinyl Acetate		500000	U
C130	75-27-4	Bromodichloromethane		250000	U
C140	78-87-5	1,2-Dichloropropane		250000	U
C143	10061-01-5	cis-1,3-Dichloropropene		250000	U
C150	79-01-6	Trichloroethene		250000	U
C155	124-48-1	Dibromochloromethane		250000	U
C160	79-00-5	1,1,2-Trichloroethane		250000	U
C165	71-43-2	Benzene		250000	U
C172	10061-02-6	trans-1,3-Dichloropropene		250000	U
C180	75-25-2	Bromoform		250000	U
C205	108-10-1	4-Methyl-2-Pentanone		500000	U
C210	591-78-6	2-Hexanone		500000	U
C220	127-18-4	Tetrachloroethene		250000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C230	108-88-3	Toluene		250000	U
C235	108-90-7	Chlorobenzene		250000	U
C240	100-41-4	Ethylbenzene		250000	U
C245	100-42-5	Styrene		250000	U
C250	1330-20-7	Xylene (total)		250000	U

007647

page 2

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

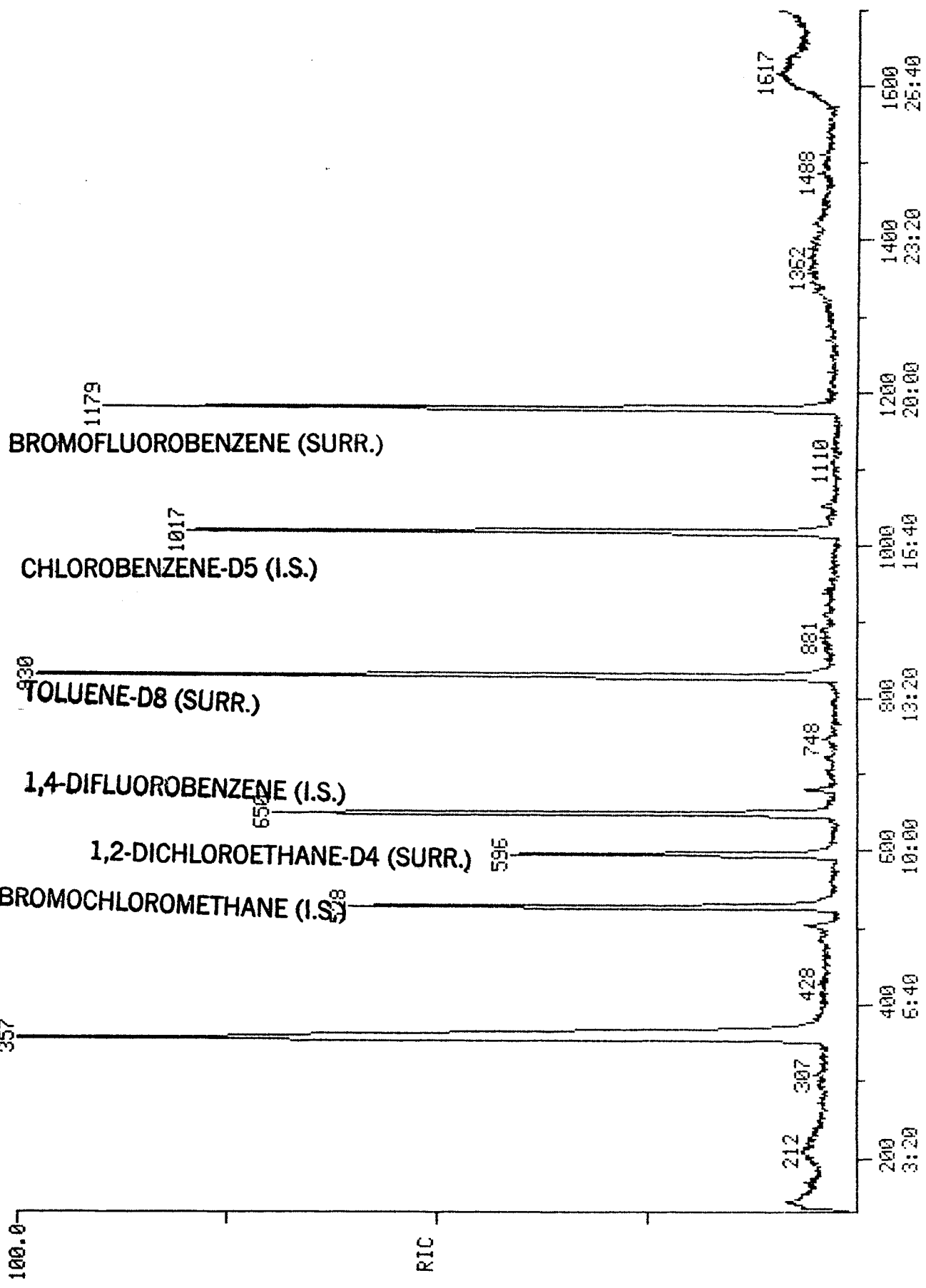
LABORATORY SwL - Houston
REPORTED 01/11/94 10:39

CONTRACT VOLATILES
CUSTOMER AWD TECH

Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

MIDRIC
01/10/94 18:24:00
DATA: 0011004 #1
CALI: 0011004 #2
SAMPLE: 9401059-04A AND W-900 LONGHORN 50,000 X DILUTION
COND5.: 35(3) 35-200 @ 6/MIN
RANGE: G 1,3000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



007648

157440.

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 401059
SAS NO LONGHORNLABORATORY SwL - Houston
REPORTED 01/11/94 10:40CONTRACT VOLATILES
CUSTOMER AWD TECHFILE NAME V011005
TYPE EPA
INST 5100SAMPLE ID W-1800 LONGHO
LAB SAMP ID 9401059-05A
ANALYZED 01/10/94 19:00LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		4960000	
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
C055	540-59-0	1,2-Dichloroethene (Total)		250000	U
C060	67-66-3	Chloroform		250000	U
C065	107-06-2	1,2-Dichloroethane		250000	U
C110	78-93-3	Methylethyl ketone (MEK)		500000	U
C115	71-55-6	1,1,1-Trichloroethane		250000	U
C120	56-23-5	Carbon Tetrachloride		250000	U
C125	108-05-4	Vinyl Acetate		500000	U
C130	75-27-4	Bromodichloromethane		250000	U
C140	78-87-5	1,2-Dichloropropane		250000	U
C143	10061-01-5	cis-1,3-Dichloropropene		250000	U
C150	79-01-6	Trichloroethene		250000	U
C155	124-48-1	Dibromochloromethane		250000	U
C160	79-00-5	1,1,2-Trichloroethane		250000	U
C165	71-43-2	Benzene		250000	U
C172	10061-02-6	trans-1,3-Dichloropropene		250000	U
C180	75-25-2	Bromoform		250000	U
C205	108-10-1	4-Methyl-2-Pentanone		500000	U
C210	591-78-6	2-Hexanone		500000	U
C220	127-18-4	Tetrachloroethene		250000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C230	108-88-3	Toluene		250000	U
C235	108-90-7	Chlorobenzene		250000	U
C240	100-41-4	Ethylbenzene		250000	U
C245	100-42-5	Styrene		250000	U
C250	1330-20-7	Xylene (total)		250000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

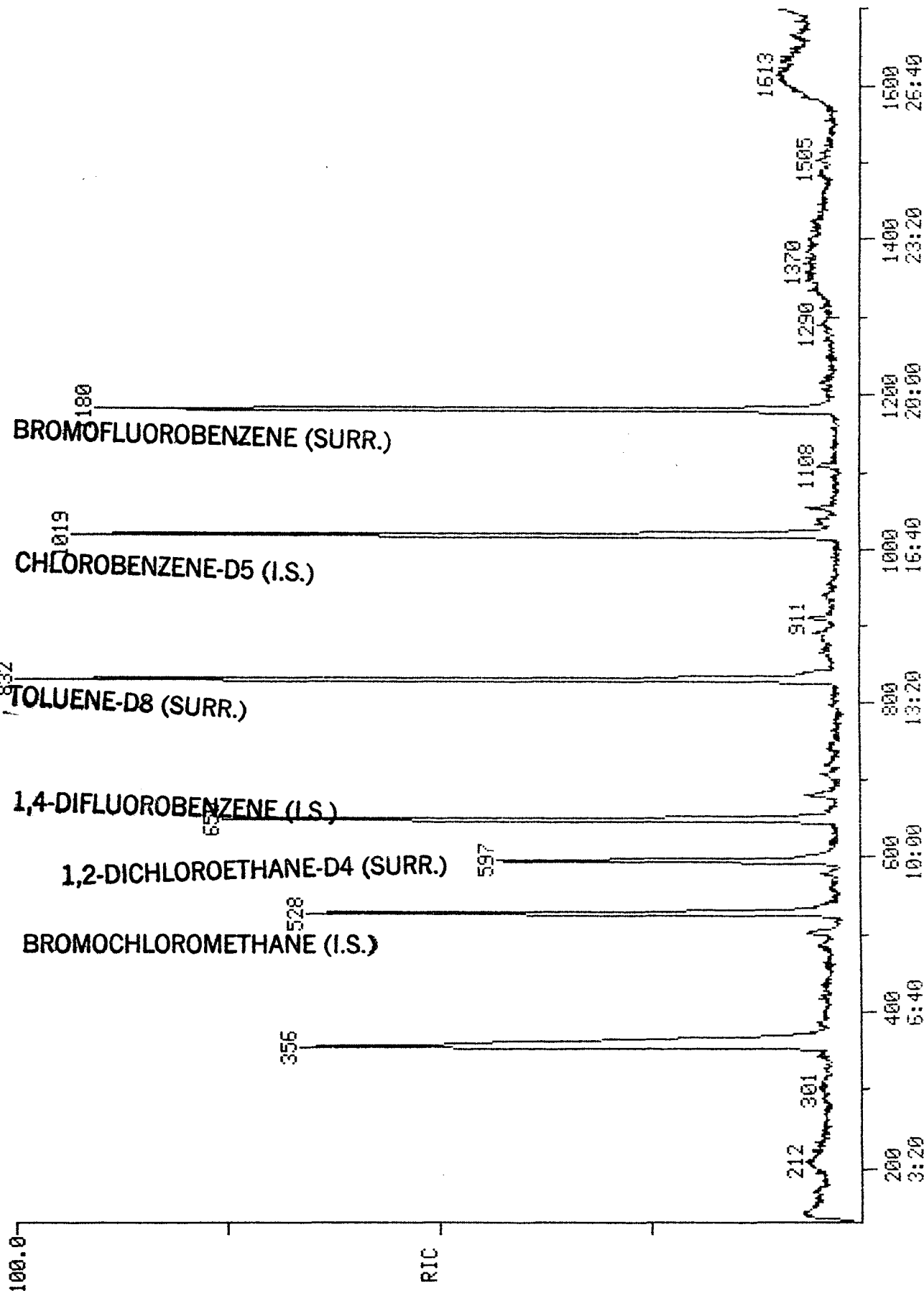
LABORATORY SwL - Houston
REPORTED 01/11/94 10:40

CONTRACT VOLATILES
CUSTOMER AWD TECH

Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

MIDRIC
01/10/94 19:00:00
SAMPLE: 9401059-05A AND W-1800 LONGHORN 50.000 X DILUTION
CONDS.: 35(3) 35-200 @ 6/MIN
RANGE: G 1.3000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
DATA: V011005 #1
CALI: V011005 #2
SCANS 130 TO 1700
152320.



007651

SCAN
TIME

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

LABORATORY SwL - Houston
REPORTED 01/11/94 10:21

CONTRACT VOLATILES
CUSTOMER AWD TECH

FILE NAME V011006
TYPE EPA
INST 5100

SAMPLE ID N-100 LONGHOR
LAB SAMP ID 9401059-06A
ANALYZED 01/10/94 19:35

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		4980000	
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
C	540-59-0	1,2-Dichloroethene (Total)		250000	U
C060	67-66-3	Chloroform		250000	U
C065	107-06-2	1,2-Dichloroethane		250000	U
C110	78-93-3	Methylethyl ketone (MEK)		500000	U
C115	71-55-6	1,1,1-Trichloroethane		250000	U
C120	56-23-5	Carbon Tetrachloride		250000	U
C125	108-05-4	Vinyl Acetate		500000	U
C130	75-27-4	Bromodichloromethane		250000	U
C140	78-87-5	1,2-Dichloropropane		250000	U
C143	10061-01-5	cis-1,3-Dichloropropene		250000	U
C150	79-01-6	Trichloroethene		250000	U
C155	124-48-1	Dibromochloromethane		250000	U
C160	79-00-5	1,1,2-Trichloroethane		250000	U
C165	71-43-2	Benzene		250000	U
C172	10061-02-6	trans-1,3-Dichloropropene		250000	U
C180	75-25-2	Bromoform		250000	U
C205	108-10-1	4-Methyl-2-Pentanone		500000	U
C210	591-78-6	2-Hexanone		500000	U
C220	127-18-4	Tetrachloroethene		250000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C230	108-88-3	Toluene		250000	U
C235	108-90-7	Chlorobenzene		250000	U
C240	100-41-4	Ethylbenzene		250000	U
C245	100-42-5	Styrene		250000	U
C250	1330-20-7	Xylene (total)		250000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

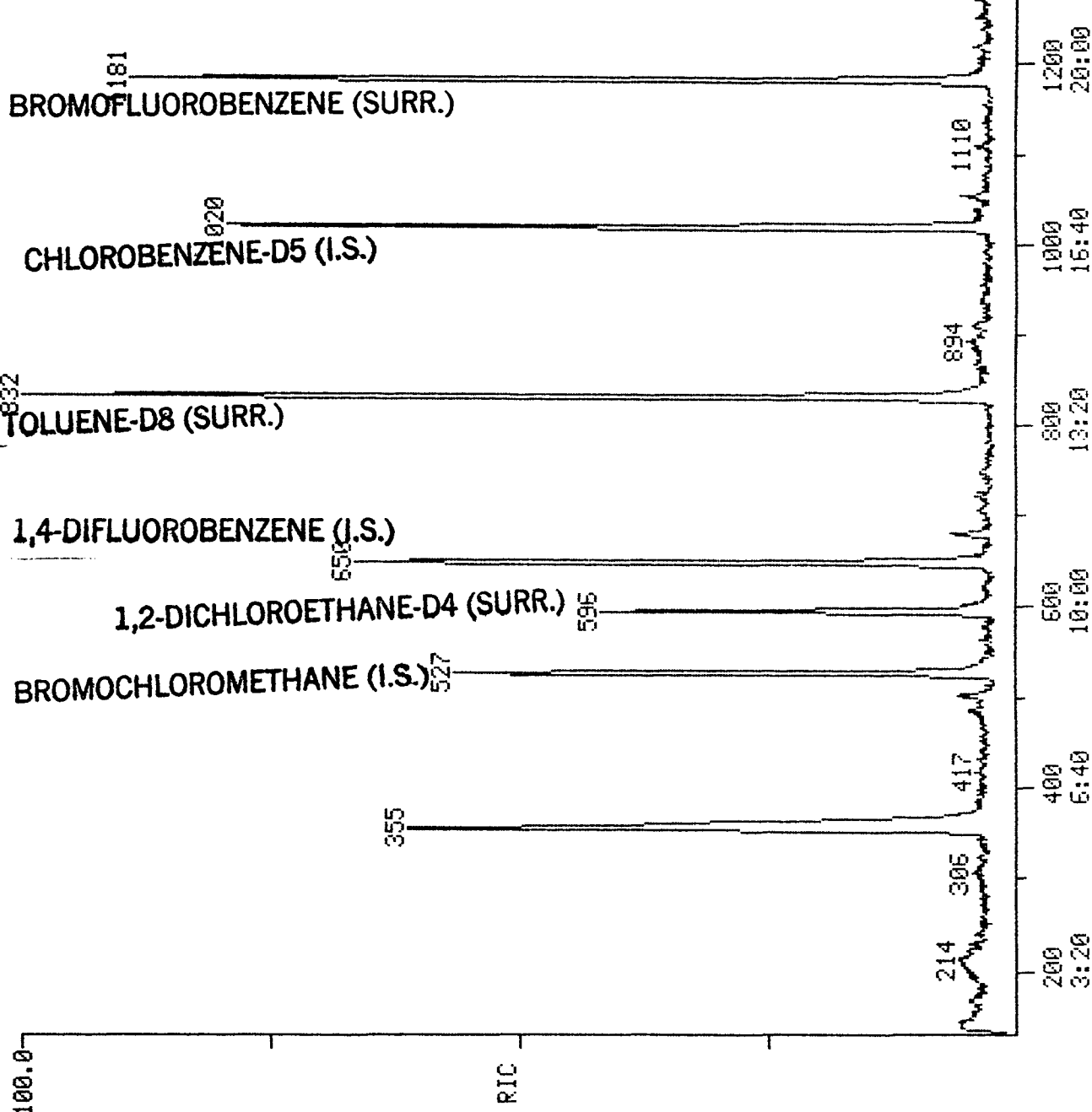
LABORATORY SwL - Houston
REPORTED 01/11/94 10:21

CONTRACT VOLATILES
CUSTOMER AWD TECH

Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

MIDRIC
01/10/94 19:35:00
DATA: V011005 #1
CALI: V011005 #2
SAMPLE: 9401053-05A AND N-100 LONGHORN 50,000 X DILUTION
COND5.: 35(3) 35-200 @ 6/MIN
RANGE: G 1.3000 LABEL: N 0, 4.0 QUAM: A 0, 1.0 J 0 BASE: U 20, 3



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 401059
SAS NO LONGHORNLABORATORY SWL - Houston
REPORTED 01/11/94 10:40CONTRACT VOLATILES
CUSTOMER AWD TECHFILE NAME V011007
TYPE EPA
INST 5100SAMPLE ID N-300 LONGHOR
LAB SAMP ID 9401059-07A
ANALYZED 01/10/94 20:11LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		5500000	
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
C060	540-59-0	1,2-Dichloroethene (Total)		250000	U
C065	67-66-3	Chloroform		250000	U
C110	107-06-2	1,2-Dichloroethane		250000	U
C115	78-93-3	Methylethyl ketone (MEK)		500000	U
C120	71-55-6	1,1,1-Trichloroethane		250000	U
C125	56-23-5	Carbon Tetrachloride		250000	U
C130	108-05-4	Vinyl Acetate		500000	U
C140	75-27-4	Bromodichloromethane		250000	U
C143	78-87-5	1,2-Dichloropropane		250000	U
C150	10061-01-5	cis-1,3-Dichloropropene		250000	U
C155	79-01-6	Trichloroethene		250000	U
C160	124-48-1	Dibromochloromethane		250000	U
C165	79-00-5	1,1,2-Trichloroethane		250000	U
C172	71-43-2	Benzene		250000	U
C180	10061-02-6	trans-1,3-Dichloropropene		250000	U
C205	75-25-2	Bromoform		250000	U
C210	108-10-1	4-Methyl-2-Pentanone		500000	U
C220	591-78-6	2-Hexanone		500000	U
C225	127-18-4	Tetrachloroethene		250000	U
C230	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C235	108-88-3	Toluene		250000	U
C240	108-90-7	Chlorobenzene		250000	U
C245	100-41-4	Ethylbenzene		250000	U
C250	100-42-5	Styrene		250000	U
	1330-20-7	Xylene (total)		250000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

007656 2

CASE NO 401059
SAS NO LONGHORN

LABORATORY SwL - Houston
REPORTED 01/11/94 10:40

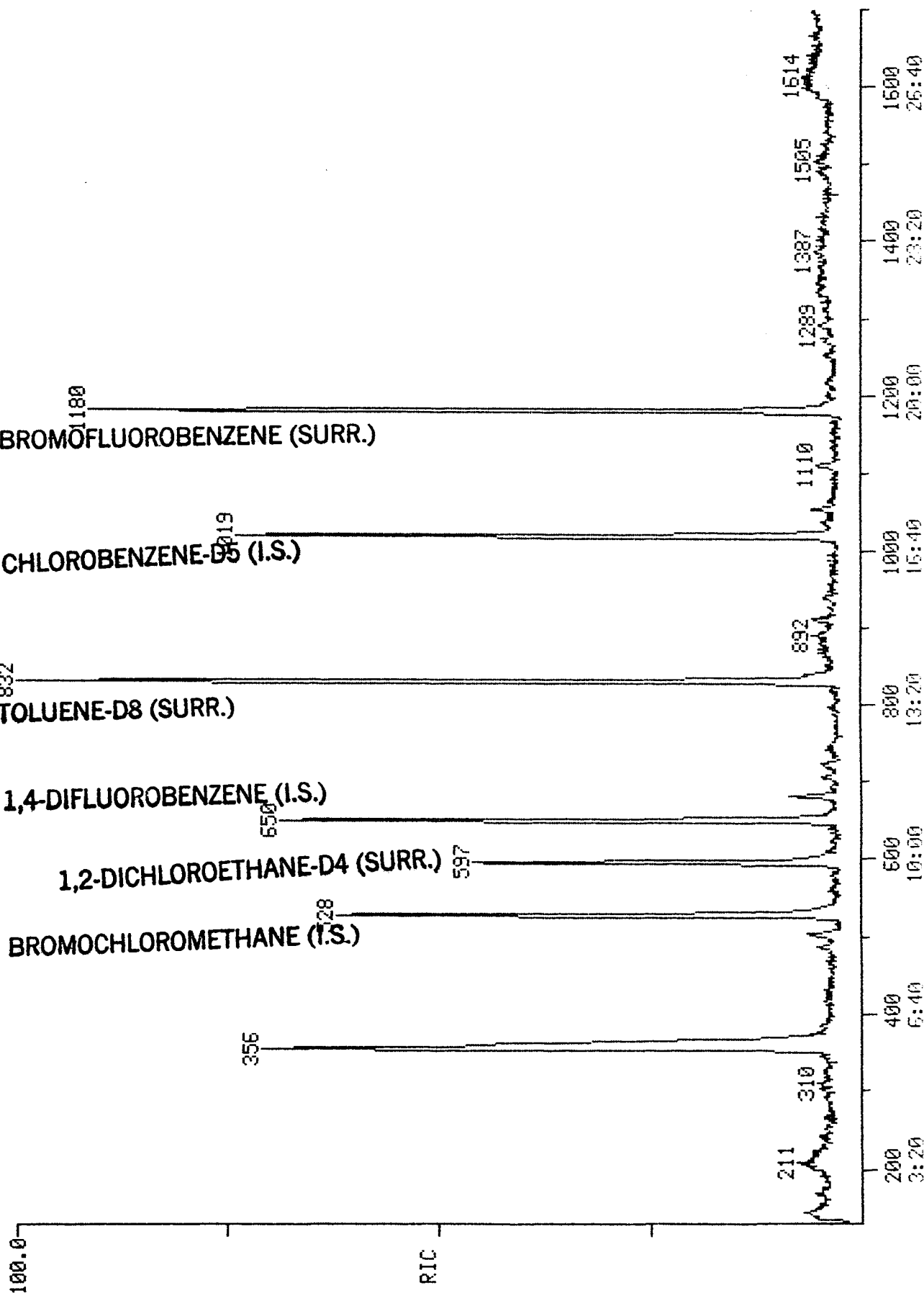
CONTRACT VOLATILES
CUSTOMER AWD TECH

Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

MIDRIC
01/10/94 20:11:00
DATA: V011007 #1
CALI: V011007 #2
SAMPLE: 9401059-07A AND N-300 LONGHORN 50.000 X DILUTION
COND.: 35(3) 35-200 @ 6/MIN
RANGE: G 1.3000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
143872.

SCANS 130 TO 1700



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

LABORATORY SwL - Houston
REPORTED 01/11/94 10:23

CONTRACT VOLATILES
CUSTOMER AWD TECH

FILE NAME V011008
TYPE EPA
INST 5100

SAMPLE ID N-600 LONGHOR
LAB SAMP ID 9401059-08A
ANALYZED 01/10/94 20:47

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		5000000	U
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
C050	540-59-0	1,2-Dichloroethene (Total)		250000	U
C060	67-66-3	Chloroform		250000	U
C065	107-06-2	1,2-Dichloroethane		250000	U
C110	78-93-3	Methylethyl ketone (MEK)		500000	U
C115	71-55-6	1,1,1-Trichloroethane		250000	U
C120	56-23-5	Carbon Tetrachloride		250000	U
C125	108-05-4	Vinyl Acetate		500000	U
C130	75-27-4	Bromodichloromethane		250000	U
C140	78-87-5	1,2-Dichloropropane		250000	U
C143	10061-01-5	cis-1,3-Dichloropropene		250000	U
C150	79-01-6	Trichloroethene		250000	U
C155	124-48-1	Dibromochloromethane		250000	U
C160	79-00-5	1,1,2-Trichloroethane		250000	U
C165	71-43-2	Benzene		250000	U
C172	10061-02-6	trans-1,3-Dichloropropene		250000	U
C180	75-25-2	Bromoform		250000	U
C205	108-10-1	4-Methyl-2-Pentanone		500000	U
C210	591-78-6	2-Hexanone		500000	U
C220	127-18-4	Tetrachloroethene		250000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C230	108-88-3	Toluene		250000	U
C235	108-90-7	Chlorobenzene		250000	U
C240	100-41-4	Ethylbenzene		250000	U
C245	100-42-5	Styrene		250000	U
C250	1330-20-7	Xylene (total)		250000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

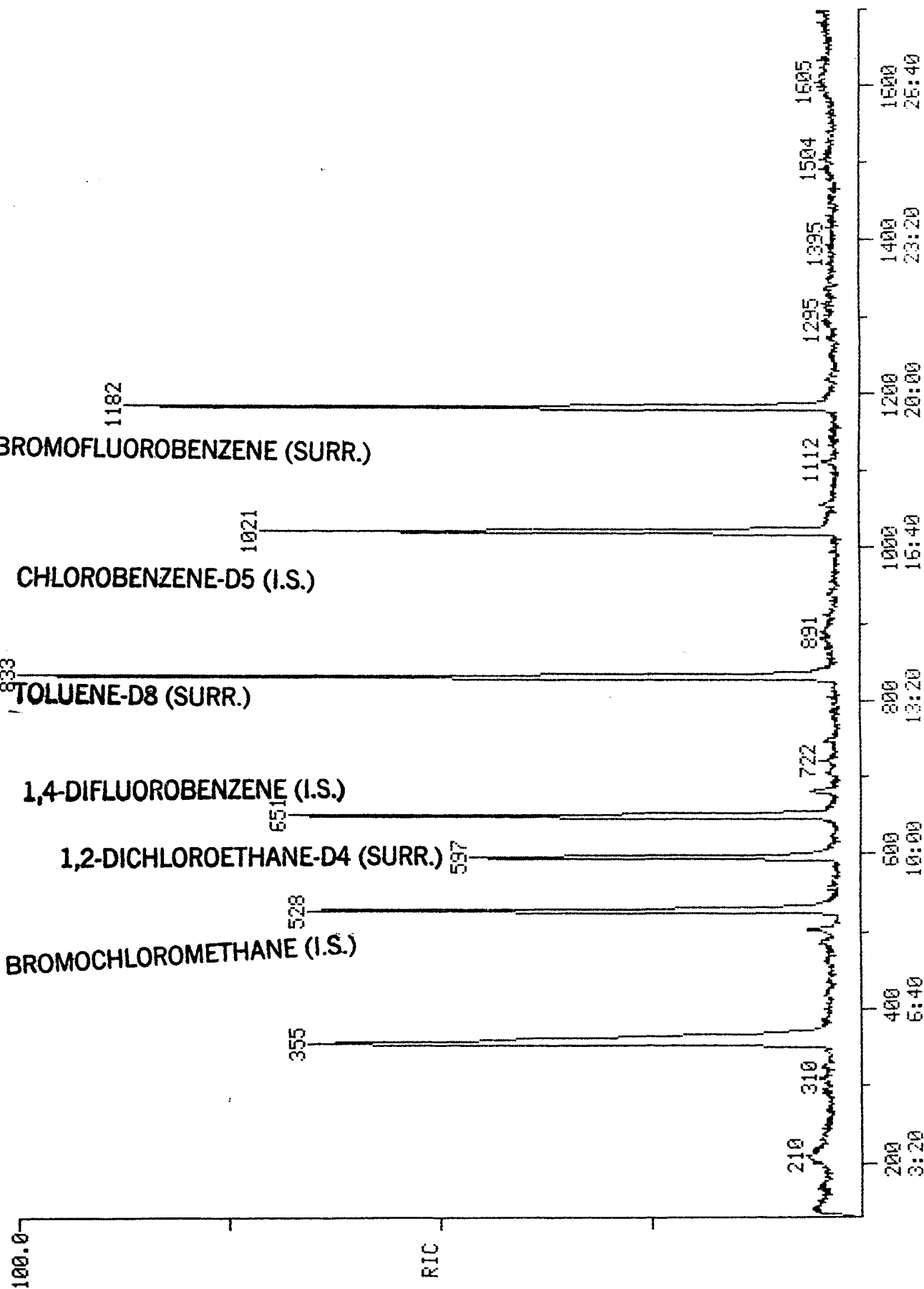
LABORATORY SwL - Houston
REPORTED 01/11/94 10:23

CONTRACT VOLATILES
CUSTOMER AWD TECH

Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

MIDRIC
01/10/94 20:47:00
DATA: U011008 #1
CALI: U011008 #2
SAMPLE: 9401059-08A AND N-500 LONGHORN 50,000 X DILUTION
COND.: 35(3) 35-200 @ 6/MIN
RANGE: G 1.3000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
SCANS 130 TO 1700



144896.

007660
SCAN
TIME

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

LABORATORY SwL - Houston
REPORTED 01/11/94 10:24

CONTRACT VOLATILES
CUSTOMER AWD TECH

FILE NAME V011009
TYPE EPA
INST 5100

SAMPLE ID N-900 LONGHOR
LAB SAMP ID 9401059-09A
ANALYZED 01/10/94 21:23

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		3140000	
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
C060	540-59-0	1,2-Dichloroethene (Total)		250000	U
C065	67-66-3	Chloroform		250000	U
C110	107-06-2	1,2-Dichloroethane		250000	U
C115	78-93-3	Methylethyl ketone (MEK)		500000	U
C120	71-55-6	1,1,1-Trichloroethane		250000	U
C125	56-23-5	Carbon Tetrachloride		250000	U
C130	108-05-4	Vinyl Acetate		500000	U
C140	75-27-4	Bromodichloromethane		250000	U
C143	78-87-5	1,2-Dichloropropane		250000	U
C150	10061-01-5	cis-1,3-Dichloropropene		250000	U
C155	79-01-6	Trichloroethene		250000	U
C160	124-48-1	Dibromochloromethane		250000	U
C165	79-00-5	1,1,2-Trichloroethane		250000	U
C172	71-43-2	Benzene		250000	U
C180	10061-02-6	trans-1,3-Dichloropropene		250000	U
C205	75-25-2	Bromoform		250000	U
C210	108-10-1	4-Methyl-2-Pentanone		500000	U
C220	591-78-6	2-Hexanone		500000	U
C225	127-18-4	Tetrachloroethene		250000	U
C230	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C235	108-88-3	Toluene		250000	U
C240	108-90-7	Chlorobenzene		250000	U
C245	100-41-4	Ethylbenzene		250000	U
C250	100-42-5	Styrene		250000	U
	1330-20-7	Xylene (total)		250000	U

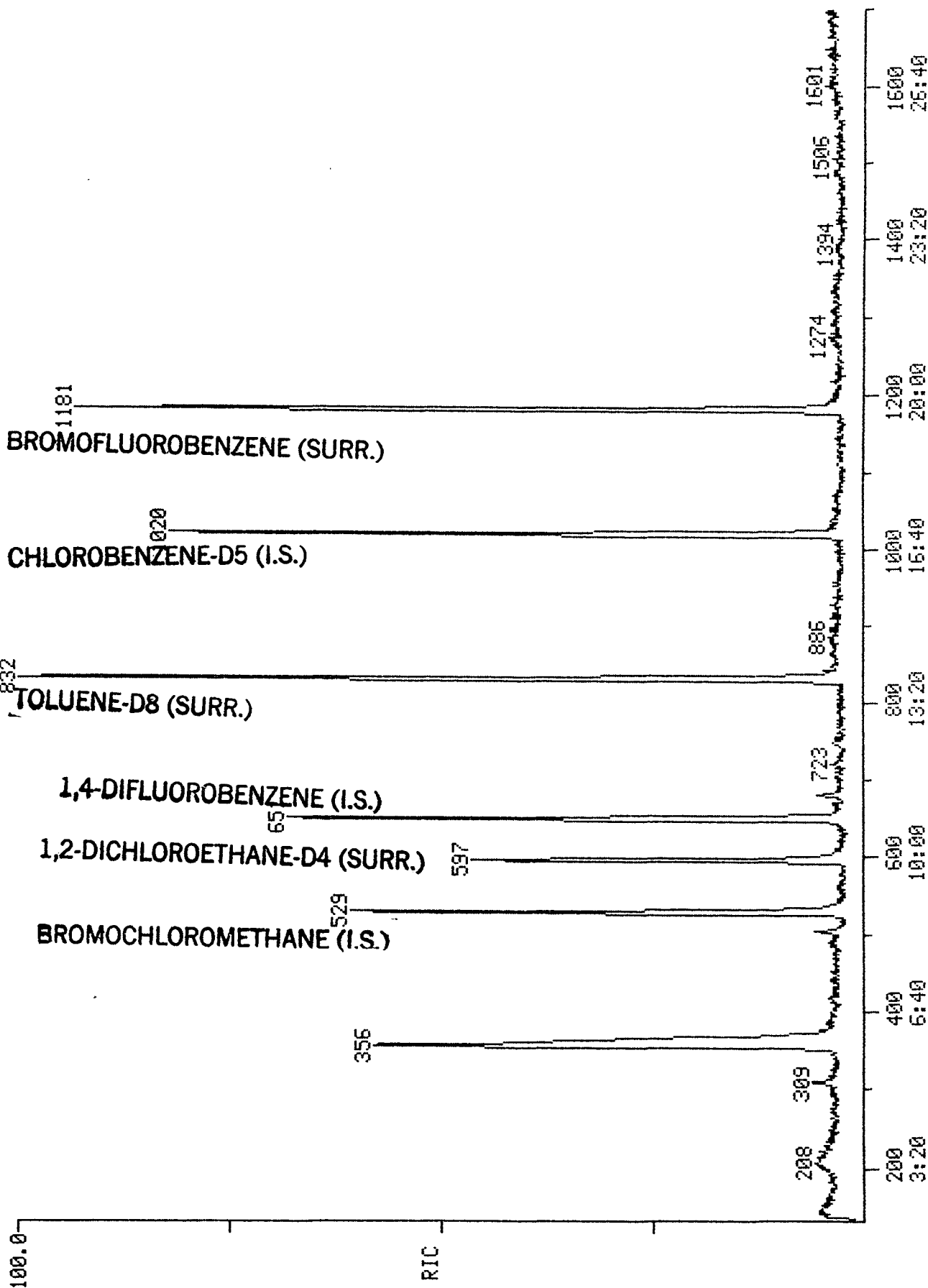
VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059SAS NO LONGHORNLABORATORY SwL - HoustonREPORTED 01/11/94 10:24CONTRACT VOLATILESCUSTOMER AWD TECH

Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA: U011009 #1
CALI: U011009 #2
SAMPLE: 9401059-09A AND N-900 LONGHORN 50,000 X DILUTION
COND.: 35(3) 35-200 @ 6/MIN
RANGE: G 1.3000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
SCANS 130 TO 1700



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

LABORATORY SwL - Houston
REPORTED 01/11/94 10:41

CONTRACT VOLATILES
CUSTOMER AWD TECH

FILE NAME VO11010
TYPE EPA
INST 5100

SAMPLE ID N-1800 LONGHO
LAB SAMP ID 9401059-10A
ANALYZED 01/10/94 21:59

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		4480000	
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
C055	540-59-0	1,2-Dichloroethene (Total)		250000	U
C060	67-66-3	Chloroform		250000	U
C065	107-06-2	1,2-Dichloroethane		250000	U
C110	78-93-3	Methylethyl ketone (MEK)		500000	U
C115	71-55-6	1,1,1-Trichloroethane		250000	U
C120	56-23-5	Carbon Tetrachloride		250000	U
C125	108-05-4	Vinyl Acetate		500000	U
C130	75-27-4	Bromodichloromethane		250000	U
C140	78-87-5	1,2-Dichloropropane		250000	U
C143	10061-01-5	cis-1,3-Dichloropropene		250000	U
C150	79-01-6	Trichloroethene		250000	U
C155	124-48-1	Dibromochloromethane		250000	U
C160	79-00-5	1,1,2-Trichloroethane		250000	U
C165	71-43-2	Benzene		250000	U
C172	10061-02-6	trans-1,3-Dichloropropene		250000	U
C180	75-25-2	Bromoform		250000	U
C205	108-10-1	4-Methyl-2-Pentanone		500000	U
C210	591-78-6	2-Hexanone		500000	U
C220	127-18-4	Tetrachloroethene		250000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C230	108-88-3	Toluene		250000	U
C235	108-90-7	Chlorobenzene		250000	U
C240	100-41-4	Ethylbenzene		250000	U
C245	100-42-5	Styrene		250000	U
C250	1330-20-7	Xylene (total)		250000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

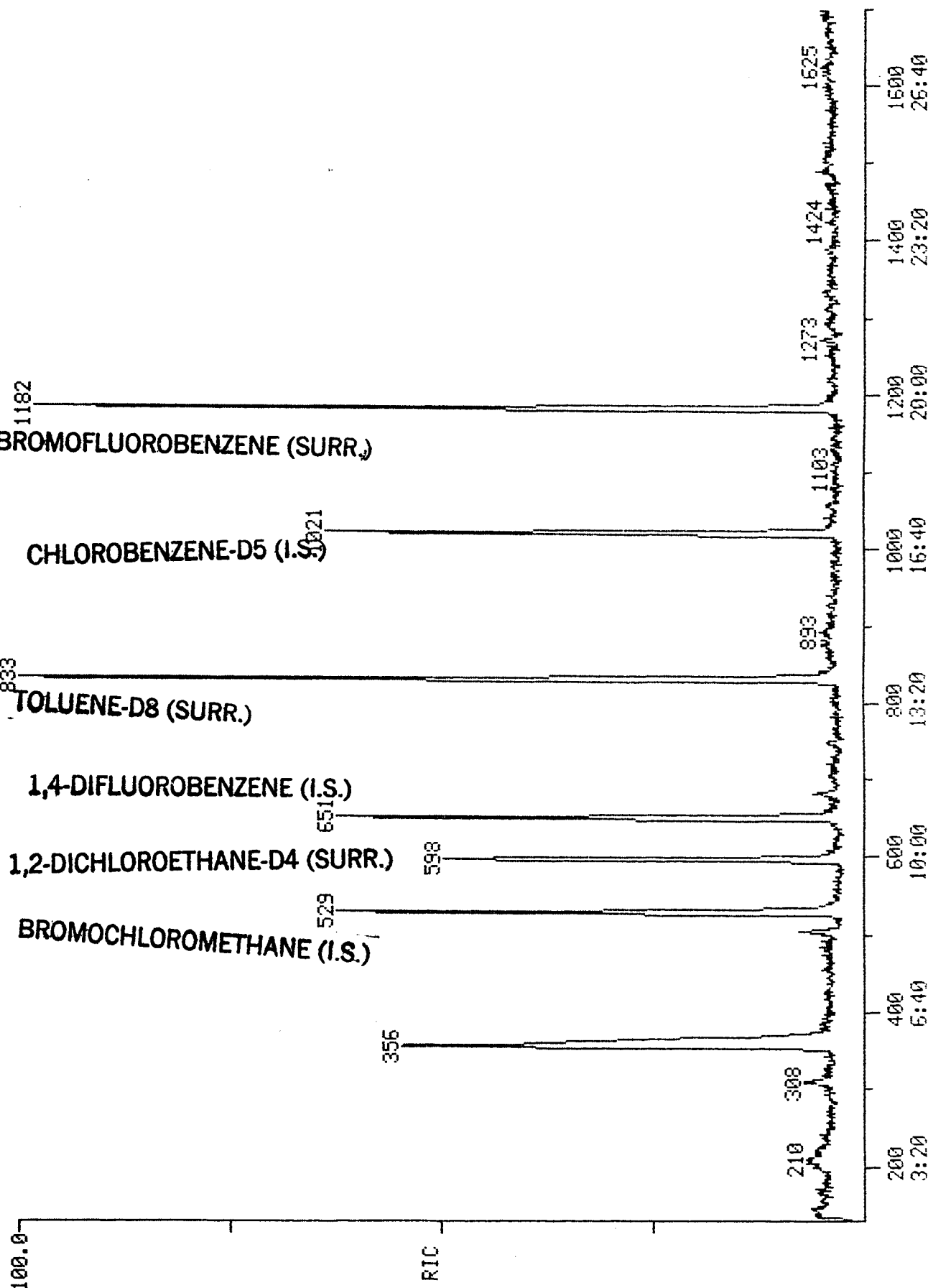
LABORATORY SwL - Houston
REPORTED 01/11/94 10:41

CONTRACT VOLATILES
CUSTOMER AWD TECH

Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

MIDRIC DATA: U011010 #1
01/10/94 21:59:00 CALI: U011010 #2
SAMPLE: 9401059-10A AMD N-1800 LONGHORN 50,000 X DILUTION
COND.: 35(3) 35-200 @ 6/MIN
RANGE: G 1.3000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

LABORATORY SwL - Houston
REPORTED 01/11/94 10:42

CONTRACT VOLATILES
CUSTOMER AWD TECH

FILE NAME VO11011
TYPE EPA
INST 5100

SAMPLE ID CONTROL LONGH
LAB SAMP ID 9401059-11A
ANALYZED 01/10/94 22:35

LEVEL LOW
MATRIX WATER
UNITS ug/L

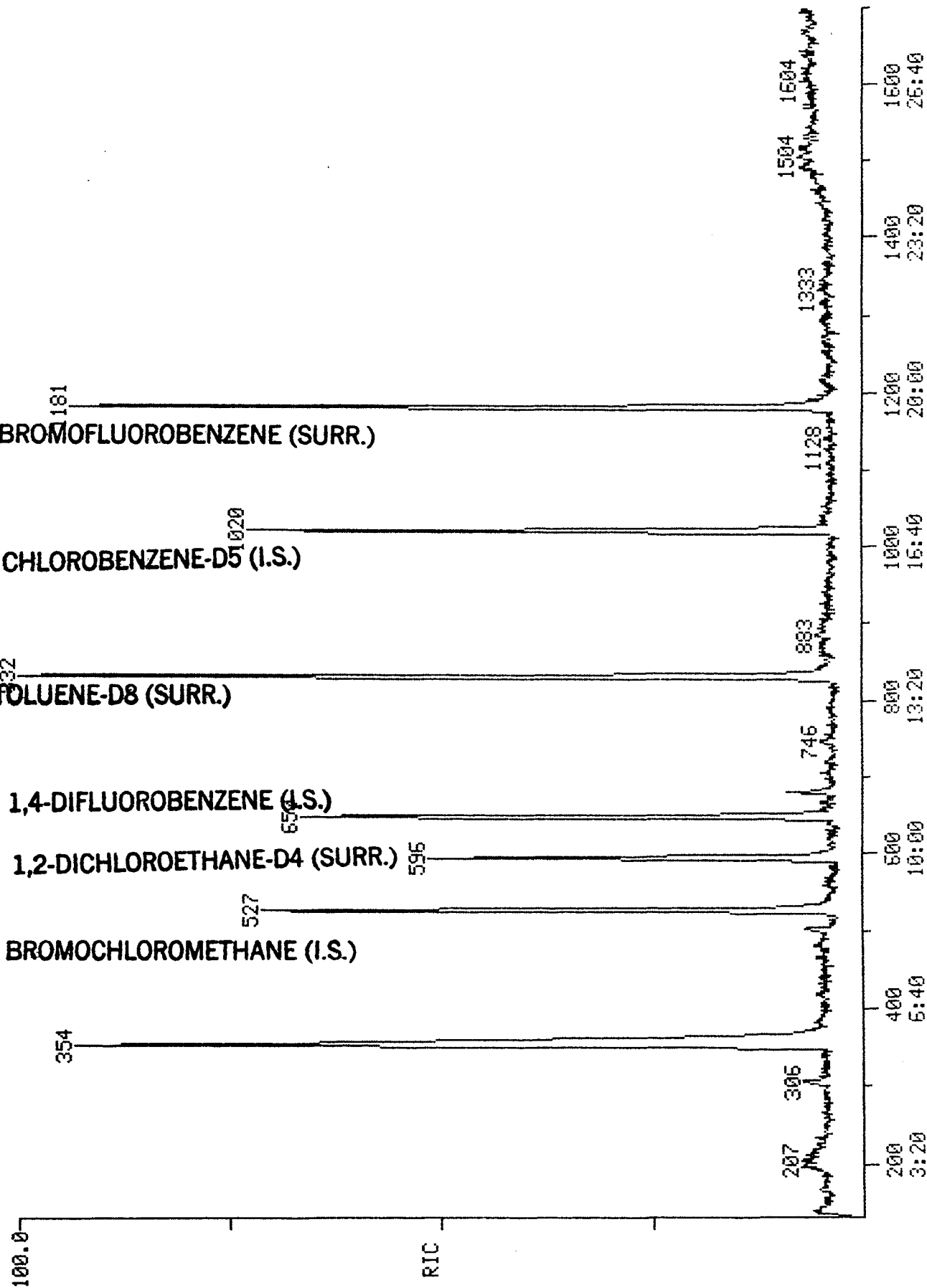
CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		6300000	U
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
C050	540-59-0	1,2-Dichloroethene (Total)		250000	U
C060	67-66-3	Chloroform		250000	U
C065	107-06-2	1,2-Dichloroethane		250000	U
C110	78-93-3	Methylethyl ketone (MEK)		500000	U
C115	71-55-6	1,1,1-Trichloroethane		250000	U
C120	56-23-5	Carbon Tetrachloride		250000	U
C125	108-05-4	Vinyl Acetate		500000	U
C130	75-27-4	Bromodichloromethane		250000	U
C140	78-87-5	1,2-Dichloropropane		250000	U
C143	10061-01-5	cis-1,3-Dichloropropene		250000	U
C150	79-01-6	Trichloroethene		250000	U
C155	124-48-1	Dibromochloromethane		250000	U
C160	79-00-5	1,1,2-Trichloroethane		250000	U
C165	71-43-2	Benzene		250000	U
C172	10061-02-6	trans-1,3-Dichloropropene		250000	U
C180	75-25-2	Bromoform		250000	U
C205	108-10-1	4-Methyl-2-Pentanone		500000	U
C210	591-78-6	2-Hexanone		500000	U
C220	127-18-4	Tetrachloroethene		250000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C230	108-88-3	Toluene		250000	U
C235	108-90-7	Chlorobenzene		250000	U
C240	100-41-4	Ethylbenzene		250000	U
C245	100-42-5	Styrene		250000	U
C250	1330-20-7	Xylene (total)		250000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 401059
SAS NO LONGHORNLABORATORY SwL - Houston
REPORTED 01/11/94 10:42CONTRACT VOLATILES
CUSTOMER AWD TECH

Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

MIDRIC
01/10/94 22:35:00
DATA: U011011 #1
CALI: U011011 #2
SAMPLE: 9401059-11A AND CONTROL- LONGHORN 50.000 X DILUTION
COND5.: 35(3) 35-200 @ 6/MIN
RANGE: G 1.3000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 J 0 BASE: U 20, 3
SCANS 130 TO 1700



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

LABORATORY SwL - Houston
REPORTED 01/11/94 10:43

CONTRACT VOLATILES
CUSTOMER AWD TECH

FILE NAME V011012
TYPE EPA
INST 5100

SAMPLE ID COMPOSITE LON
LAB SAMP ID 9401059-12A
ANALYZED 01/10/94 23:11

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		500000	U
C015	74-83-9	Bromomethane		500000	U
C020	75-01-4	Vinyl Chloride		500000	U
C025	75-00-3	Chloroethane		500000	U
C030	75-09-2	Methylene Chloride		5250000	
C035	67-64-1	Acetone		2500000	U
C040	75-15-0	Carbon Disulfide		250000	U
C045	75-35-4	1,1-Dichloroethene		250000	U
C050	75-34-3	1,1-Dichloroethane		250000	U
C055	540-59-0	1,2-Dichloroethene (Total)		250000	U
C060	67-66-3	Chloroform		250000	U
C065	107-06-2	1,2-Dichloroethane		250000	U
C110	78-93-3	Methylethyl ketone (MEK)		500000	U
C115	71-55-6	1,1,1-Trichloroethane		250000	U
C120	56-23-5	Carbon Tetrachloride		250000	U
C125	108-05-4	Vinyl Acetate		500000	U
C130	75-27-4	Bromodichloromethane		250000	U
C140	78-87-5	1,2-Dichloropropane		250000	U
C143	10061-01-5	cis-1,3-Dichloropropene		250000	U
C150	79-01-6	Trichloroethene		250000	U
C155	124-48-1	Dibromochloromethane		250000	U
C160	79-00-5	1,1,2-Trichloroethane		250000	U
C165	71-43-2	Benzene		250000	U
C172	10061-02-6	trans-1,3-Dichloropropene		250000	U
C180	75-25-2	Bromoform		250000	U
C205	108-10-1	4-Methyl-2-Pentanone		500000	U
C210	591-78-6	2-Hexanone		500000	U
C220	127-18-4	Tetrachloroethene		250000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		250000	U
C230	108-88-3	Toluene		250000	U
C235	108-90-7	Chlorobenzene		250000	U
C240	100-41-4	Ethylbenzene		250000	U
C245	100-42-5	Styrene		250000	U
C250	1330-20-7	Xylene (total)		250000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401059
SAS NO LONGHORN

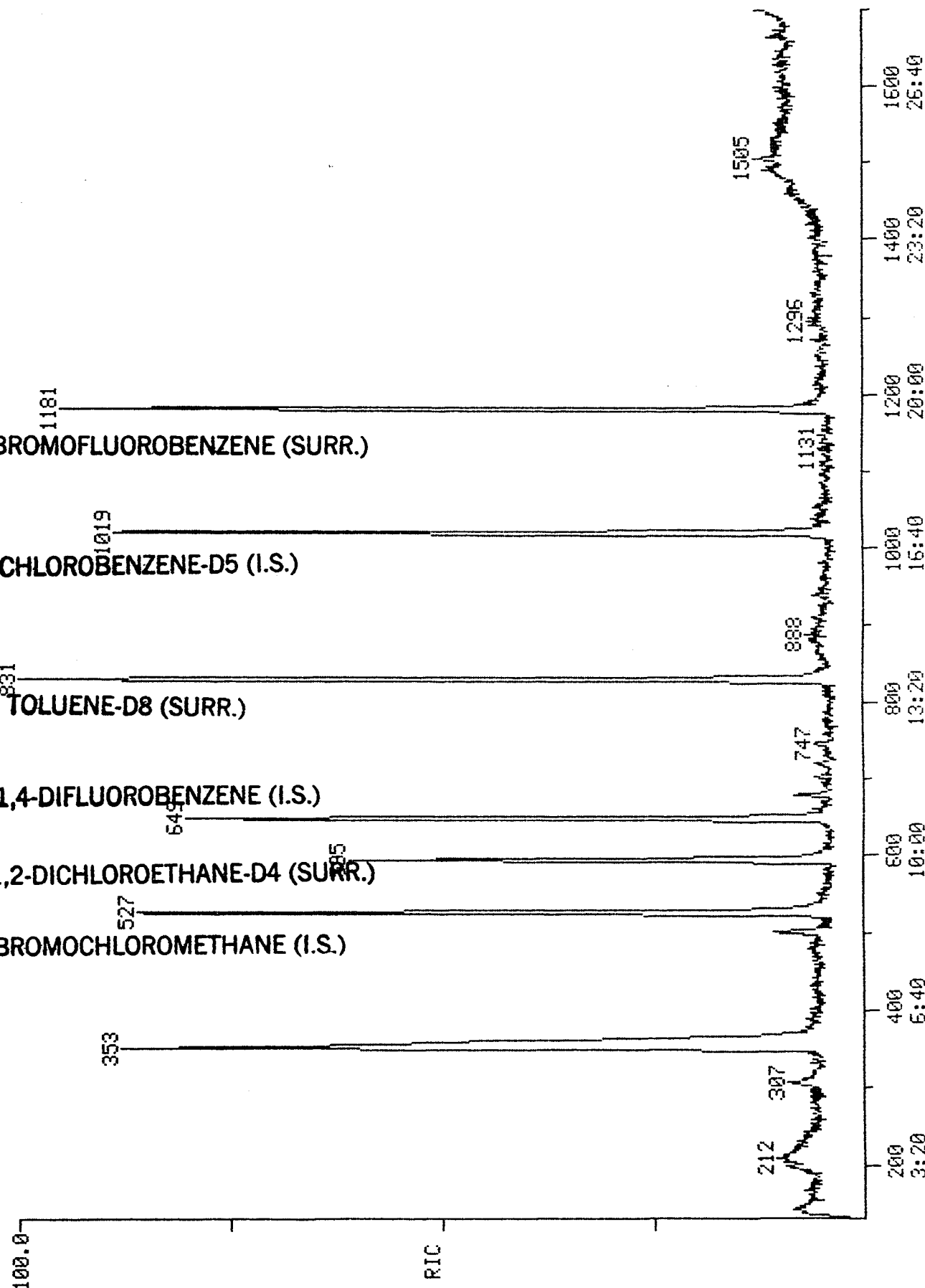
LABORATORY SwL - Houston
REPORTED 01/11/94 10:43

CONTRACT VOLATILES
CUSTOMER AWD TECH

Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

MIDRIC
01/10/94 23:11:00
SAMPLE: 9401059-12A AND COMPOSITE LONGHORN 50,000 X DILUTION
CONDS.: 35(3) 35-200 @ 5/MIN
RANGE: G 1.3000 LABEL: N 0.4.0 QUAN: A 0.1.0 J 0 BASE: 120.3
DATA: U011012 #1
CALI: U011012 #2
SCANS 130 TO 1700



Analysis Request and Chain of Custody Record

Page 1 of 2**SWL**

SOUTHWESTERN LABORATORIES

☐ HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151☐ DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700☐ MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no.		Client/Project				Project		ANALYSIS REQUESTED		LABORATORY REMARKS	
Project no.		Client/Project				Project		ANALYSIS REQUESTED		LABORATORY REMARKS	
Lab ID No.	Field Sample No./ Identification	Date and Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative	ANALYSIS REQUESTED		LABORATORY REMARKS	
1	W-100 Longhorn	11/5/94 9:30A		X	40ml vial	liquid	none	vbl. - filter carbon out			
2	W-300 Longhorn							of sample during injection any questions			
3	W-600 Longhorn							Please Call w/ Precont			
4	W-900 Longhorn							713-978-3005			
5	W-1800 Longhorn										
6	N-100 Longhorn										
7	N-300 Longhorn										
8	N-600 Longhorn										
9	N-900 Longhorn										
10	N-1800 Longhorn										
Samplers: (Print)		Relinquished by: (Signature)		W Precont		Date: 8:30 Time: 1-6-94		Received by: (Signature)		COC Seal No.	
Affiliation		Relinquished by: (Signature)				Date: Time:		Received by: (Signature)		RECD. ON ICE Yes No	
		Relinquished by: (Signature)				Date: Time:		Received by: (Signature)		Intact: Yes No	
Results by <u>3 day turn around</u>		REMARKS:		Please have sample at room temperature when shot.		Data Results To:		Received by: (Signature)		Laboratory No.	
Rush Charges Authorized								1. <u>Walt Precont</u>		<u>94-01-059</u>	
Yes <u>(No)</u>											

007673

Analysis Request and Chain of Custody Record

Page 2 of 2

SOUTHWESTERN LABORATORIES

☐ HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151☐ DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700☐ MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no.		Client/Project					ANALYSIS REQUESTED		LABORATORY REMARKS		
		AurD Technologies - Longhorn Project					713-978-3005				
Lab ID No.	Field Sample No./ Identification	Date and Time	gals	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative				
11	Control - Longhorn	1-5-94 9:30A		X	40ml VOL	liquid	none	Vol. RUSH			
12	Composite Longhorn			X				Vol.			
13	Composite/pH			X				(pH)			
								Filter the vol samples			
								the same way those			
								with carbon were			
								filtered			
Samplers: (Print)		Relinquished by: (Signature)		Date: 8/20 Time: 1-6-94		Received by: (Signature)		Date: _____ Time: _____		COC Seal No.	
Affiliation		Relinquished by: (Signature)		Date: _____ Time: _____		Received by: (Signature)		Date: _____ Time: _____		REC'D. ON ICE Yes _____ No ☒	
Results by <u>John S</u>		Relinquished by: (Signature)		Date: _____ Time: _____		Received by: (Signature)		Date: 1-6-94 Time: 0830		Intact: <u>Yes</u> Laboratory No. _____	
Rush Charges Authorized		REMARKS:									
Yes _____ No ☒		1. Walt Records									
		2.									

007675



SOUTHWESTERN LABORATORIES

222 CAVALCADE * P.O. BOX 8768, HOUSTON, TEXAS 77249 * 713 692-9151

Client AWD TECHNOLOGIES, INC.
400 W. SAM HOUSTON PKWY SOUTH
HOUSTON, TEXAS 77042

Client No. 2_0686_00
Report No. 94-01-209
Report Date 01/21/94 15:33

Attn: WALTER PRECOURT

Project LONGHORN-2379

Date Sampled 01/17/94

Sampled By AWD

Sample Type LIQUID SAMPLES

Transported by AWD

P.O. # _____

Date Received 01/18/94

Lab No.

94-01-209-01
94-01-209-02
94-01-209-03
94-01-209-04
94-01-209-05
94-01-209-06
94-01-209-07
94-01-209-08
94-01-209-09
94-01-209-10

Sample Identification

N-15 LONGHORN
N-30 LONGHORN
N-60 LONGHORN
W-15 LONGHORN
W-30 LONGHORN
W-60 LONGHORN
CONTROL LONGHORN
W-55 LONGHORN
N-55 LONGHORN
CONTROL LONGHORN

AE
Reviewed By

SOUTHWESTERN LABORATORIES

Chris Barry
CHRIS BARRY

Activated carbon- Column Test # 2

Order # 94-01-209

01/21/94 15:33

Page 2

Client: AWD TECHNOLOGIES, INC.

TEST RESULTS BY SAMPLE

Sample: 01A N-15 LONGHORN

Collected: 01/17/94 15:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	242	mg/L	15.0	01/21/94	JD
TOTAL ORGANIC CARBON	EPA 415.1	27.9	mg/L	1.0	01/21/94	MPG
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/19/94	RKW

Sample: 02A N-30 LONGHORN

Collected: 01/17/94 15:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	197	mg/L	15.0	01/21/94	JD
TOTAL ORGANIC CARBON	EPA 415.1	24.2	mg/L	1.0	01/21/94	MPG
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/19/94	RKW

Sample: 03A N-60 LONGHORN

Collected: 01/17/94 15:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	163	mg/L	15.0	01/21/94	JD
TOTAL ORGANIC CARBON	EPA 415.1	23.1	mg/L	1.0	01/21/94	MPG
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/20/94	RKW

Sample: 04A W-15 LONGHORN

Collected: 01/17/94 15:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	302	mg/L	15.0	01/21/94	JD
TOTAL ORGANIC CARBON	EPA 415.1	38.4	mg/L	1.0	01/21/94	MPG
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/20/94	RKW

Sample: 05A W-30 LONGHORN

Collected: 01/17/94 15:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	318	mg/L	15.0	01/21/94	JD
TOTAL ORGANIC CARBON	EPA 415.1	28.2	mg/L	1.0	01/21/94	MPG
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/19/94	RKW

SOUTHWESTERN LABORATORIES

Order # 94-01-209

01/21/94 15:33

Client: AWD TECHNOLOGIES, INC.

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TEST RESULTS BY SAMPLE

Sample: 06A W-60 LONGHORN

Collected: 01/17/94 15:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	297	mg/L	15.0	01/21/94	JD
TOTAL ORGANIC CARBON	EPA 415.1	25.6	mg/L	1.0	01/21/94	MPG
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/19/94	RKW

Sample: 07A CONTROL LONGHORN

Collected: 01/17/94 15:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	448	mg/L	15.0	01/21/94	JD
TOTAL ORGANIC CARBON	EPA 415.1	37.3	mg/L	1.0	01/21/94	MPG
VOLATILE ORGANICS - WATER	EPA 624	ENCLOSURE	DATE		01/20/94	RKW

Sample: 08A W-55 LONGHORN

Collected: 01/17/94 15:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	8.41	mg/L	0.05	01/21/94	GLM
DISSOLVED BARIUM	EPA 200.7	0.98	mg/L	0.22	01/21/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.06	mg/L	0.06	01/21/94	GLM
DISSOLVED IRON	EPA 200.7	9.86	mg/L	0.02	01/21/94	GLM
pH	EPA 150.1	5.4	pH UNITS		01/21/94	GLM

Sample: 09A N-55 LONGHORN

Collected: 01/17/94 15:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.53	mg/L	0.05	01/21/94	GLM
DISSOLVED BARIUM	EPA 200.7	1.13	mg/L	0.22	01/21/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.06	mg/L	0.06	01/21/94	GLM
DISSOLVED IRON	EPA 200.7	0.21	mg/L	0.02	01/21/94	GLM
pH	EPA 150.1	9.3	pH UNITS		01/21/94	GLM

SOUTHWESTERN LABORATORIES

Order # 94-01-209

01/21/94 15:33

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TEST RESULTS BY SAMPLE

Client: AWD TECHNOLOGIES, INC.

Sample: 10A CONTROL LONGHORN

Collected: 01/17/94 15:30

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Limit</u>	<u>Date</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.42	mg/L	0.05	01/21/94	GLM
DISSOLVED BARIUM	EPA 200.7	4.42	mg/L	0.22	01/21/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.06	mg/L	0.06	01/21/94	GLM
DISSOLVED IRON	EPA 200.7	0.12	mg/L	0.02	01/21/94	GLM
pH	EPA 150.1	6.9	pH UNITS		01/21/94	GLM

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 01-19-94
SAS NO _____LABORATORY SwL - Houston
REPORTED 01/20/94 12:24CONTRACT LONGHORN
CUSTOMER AWDFILE NAME I011901
TYPE EPA
INST FINNSAMPLE ID N-15 LONGHORN
LAB SAMP ID 9401209-01A
ANALYZED 01/19/94 16:40LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		100000	U
C015	74-83-9	Bromomethane		100000	U
020	75-01-4	Vinyl Chloride		100000	U
025	75-00-3	Chloroethane		100000	U
C030	75-09-2	Methylene Chloride		2240000	
035	67-64-1	Acetone		500000	U
040	75-15-0	Carbon Disulfide		50000	U
C045	75-35-4	1,1-Dichloroethene		50000	U
C050	75-34-3	1,1-Dichloroethane		50000	U
0	540-59-0	1,2-Dichloroethene (Total)		50000	U
C060	67-66-3	Chloroform		50000	U
C065	107-06-2	1,2-Dichloroethane		50000	U
110	78-93-3	Methylethyl ketone (MEK)		100000	U
115	71-55-6	1,1,1-Trichloroethane		50000	U
C120	56-23-5	Carbon Tetrachloride		50000	U
125	108-05-4	Vinyl Acetate		100000	U
130	75-27-4	Bromodichloromethane		50000	U
C140	78-87-5	1,2-Dichloropropane		50000	U
C143	10061-01-5	cis-1,3-Dichloropropene		50000	U
150	79-01-6	Trichloroethene		50000	U
C155	124-48-1	Dibromochloromethane		50000	U
C160	79-00-5	1,1,2-Trichloroethane		50000	U
165	71-43-2	Benzene		50000	U
172	10061-02-6	trans-1,3-Dichloropropene		50000	U
C180	75-25-2	Bromoform		50000	U
C205	108-10-1	4-Methyl-2-Pentanone		100000	U
210	591-78-6	2-Hexanone		100000	U
C220	127-18-4	Tetrachloroethene		50000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		50000	U
230	108-88-3	Toluene		50000	U
C235	108-90-7	Chlorobenzene		50000	U
C240	100-41-4	Ethylbenzene		50000	U
245	100-42-5	Styrene		50000	U
250	1330-20-7	Xylene (total)		50000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 01-19-94

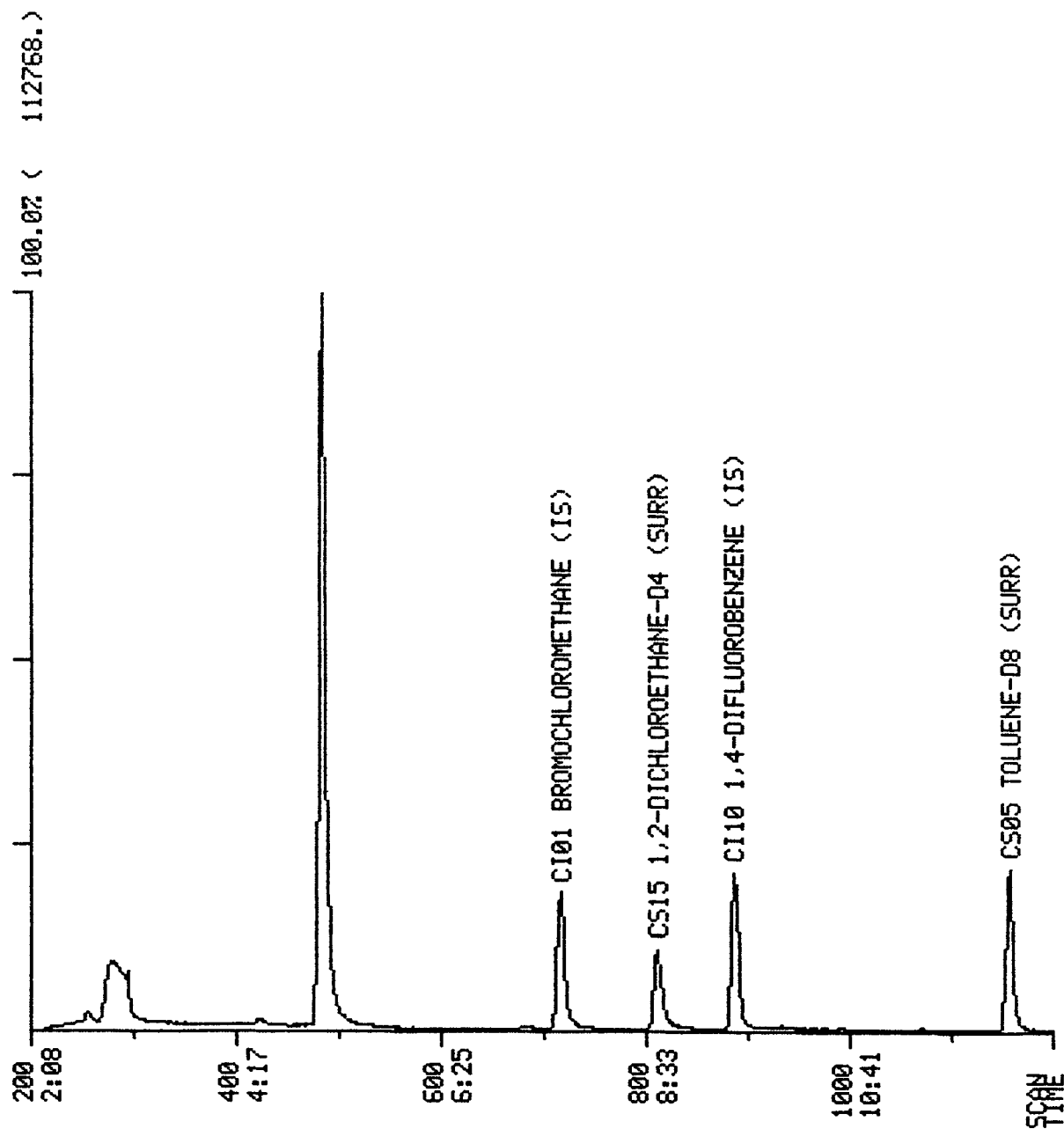
SAS NO _____

LABORATORY SwL - HoustonREPORTED 01/20/94 12:24CONTRACT LONGHORNCUSTOMER AWD

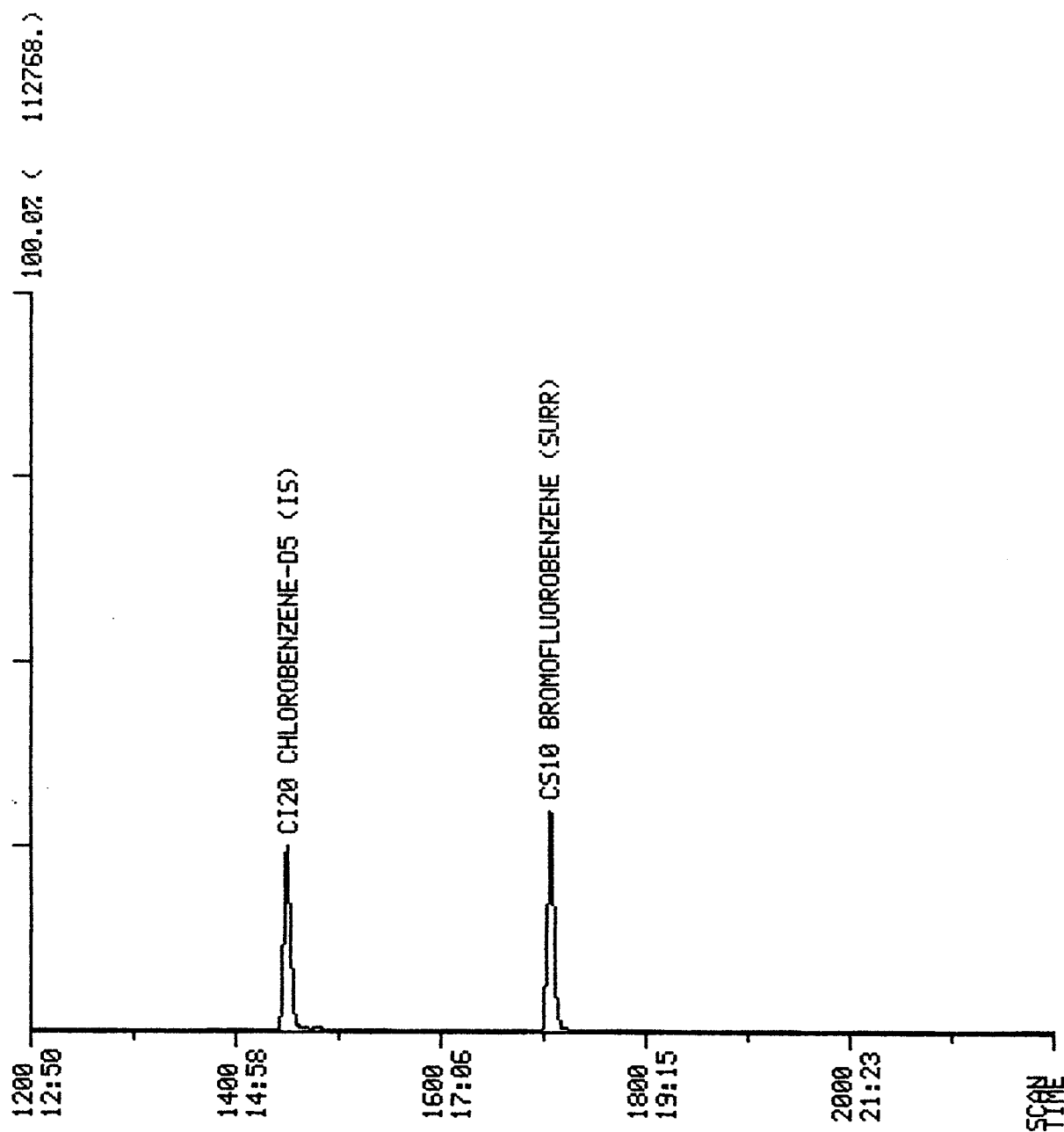
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I011901 SCANS 200 TO 1200 ACQUIRED: 01/19/94 16:40:00
CALI: I011901 #3
SAMPLE: 9401209-01A AND N-15 LONGHORN 10UL OF 50UL/1ML
CONDS.: 40(3)-18005/MIN CAPILLARY 75M



DATA FROM FILE: I011901 SCANS 1200 TO 2200 ACQUIRED: 01/19/94 16:40:00
CALI: I011901 #3 OUT OF 200 TO 2200
SAMPLE: 9401209-01A AND N-15 LONGHORN 10UL OF 50UL/1ML
COND5.: 40(3)-18005/MIN CAPILLARY 75M



007683

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 01-19-94

SAS NO _____

LABORATORY SwL - Houston

REPORTED 01/20/94 12:24

CONTRACT LONGHORN

CUSTOMER AWD

FILE NAME I011902

TYPE EPA

INST FINN

SAMPLE ID N-30 LONGHORN

LAB SAMP ID 9401209-02A

ANALYZED 01/19/94 17:23

LEVEL LOW

MATRIX WATER

UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		100000	U
C015	74-83-9	Bromomethane		100000	U
C020	75-01-4	Vinyl Chloride		100000	U
C025	75-00-3	Chloroethane		100000	U
C030	75-09-2	Methylene Chloride		1250000	
C035	67-64-1	Acetone		500000	U
C040	75-15-0	Carbon Disulfide		50000	U
C045	75-35-4	1,1-Dichloroethene		50000	U
C050	75-34-3	1,1-Dichloroethane		50000	U
C055	540-59-0	1,2-Dichloroethene (Total)		50000	U
C060	67-66-3	Chloroform		50000	U
C065	107-06-2	1,2-Dichloroethane		50000	U
C110	78-93-3	Methylethyl ketone (MEK)		100000	U
C115	71-55-6	1,1,1-Trichloroethane		50000	U
C120	56-23-5	Carbon Tetrachloride		50000	U
C125	108-05-4	Vinyl Acetate		100000	U
C130	75-27-4	Bromodichloromethane		50000	U
C140	78-87-5	1,2-Dichloropropane		50000	U
C143	10061-01-5	cis-1,3-Dichloropropene		50000	U
C150	79-01-6	Trichloroethene		50000	U
C155	124-48-1	Dibromochloromethane		50000	U
C160	79-00-5	1,1,2-Trichloroethane		50000	U
C165	71-43-2	Benzene		50000	U
C172	10061-02-6	trans-1,3-Dichloropropene		50000	U
C180	75-25-2	Bromoform		50000	U
C205	108-10-1	4-Methyl-2-Pentanone		100000	U
C210	591-78-6	2-Hexanone		100000	U
C220	127-18-4	Tetrachloroethene		50000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		50000	U
C230	108-88-3	Toluene		50000	U
C235	108-90-7	Chlorobenzene		50000	U
C240	100-41-4	Ethylbenzene		50000	U
C245	100-42-5	Styrene		50000	U
C250	1330-20-7	Xylene (total)		50000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 01-19-94
SAS NO _____

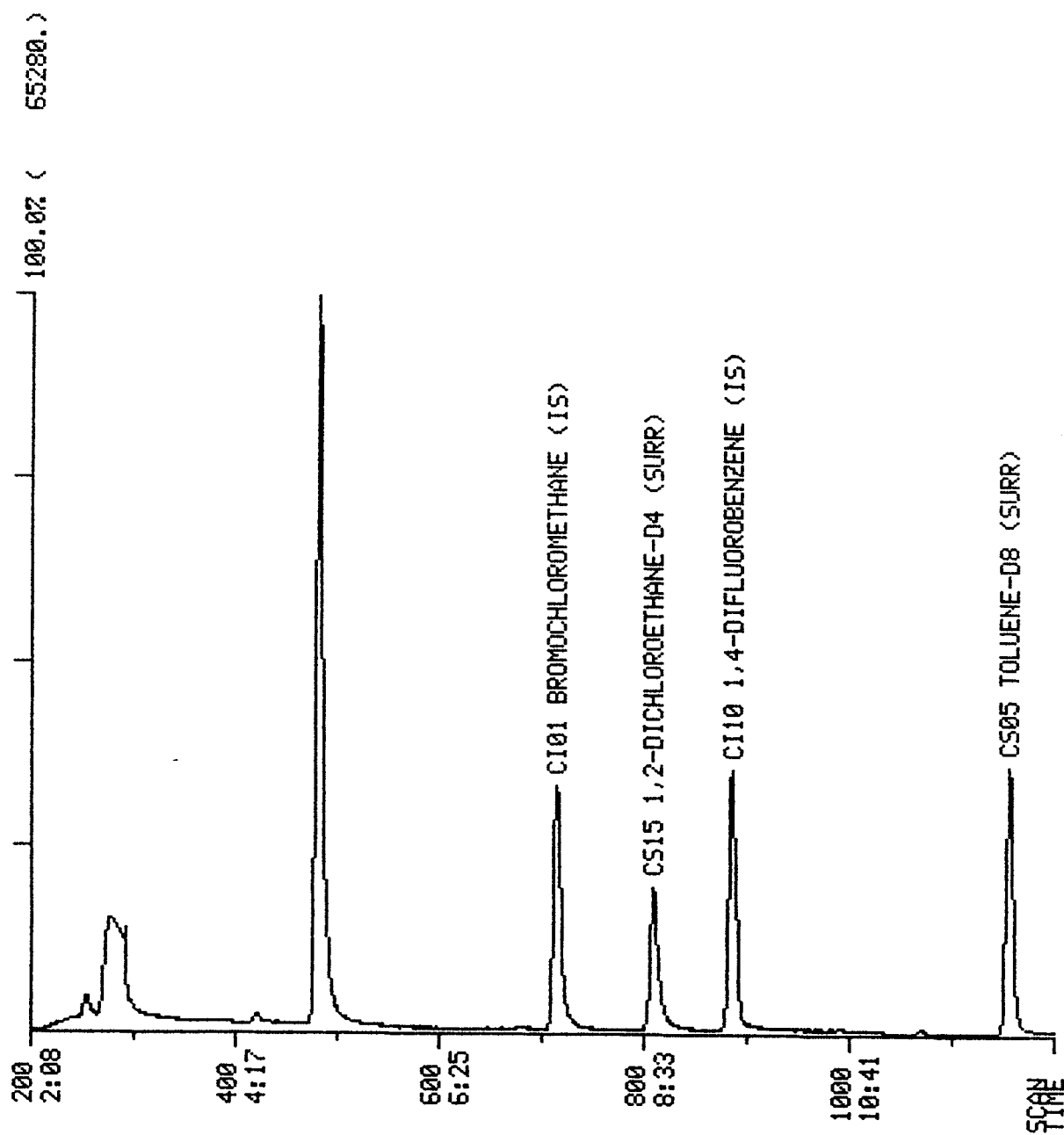
LABORATORY SwL - Houston
REPORTED 01/20/94 12:24

CONTRACT LONGHORN
CUSTOMER AWD

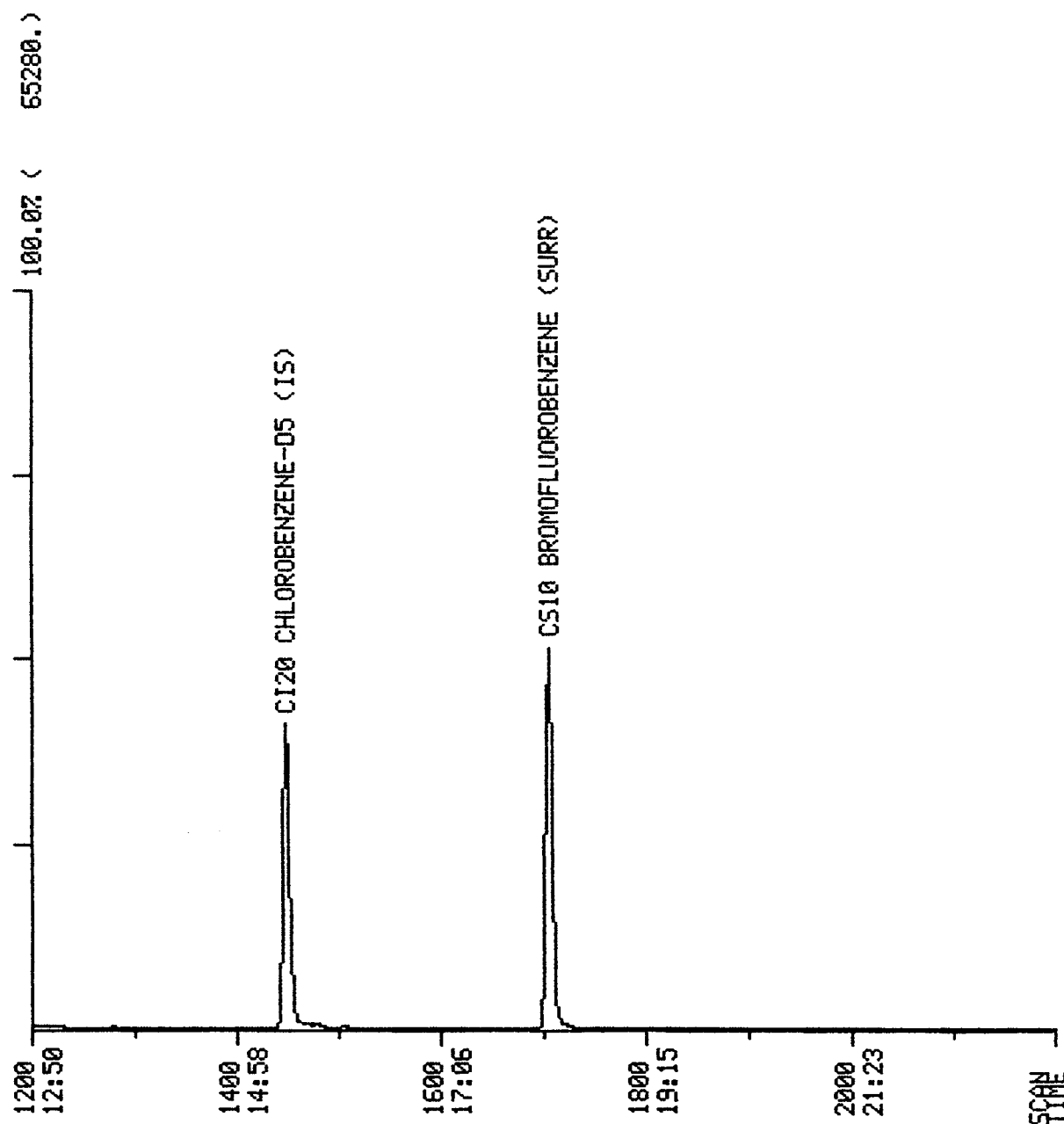
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I011902 SCANS 200 TO 1200 ACQUIRED: 01/19/94 17:23:00
CALI: I011902 #3 OUT OF 200 TO 2200
SAMPLE: 9401209-02A AND N-30 LONGHORN 10UL OF 50UL/1ML
CONDS.: 40(3)-18005/MIN CAPILLARY 75M



DATA FROM FILE: I011902 SCANS 1200 TO 2200 ACQUIRED: 01/19/94 17:23:00
CALI: I011902 #3 OUT OF 200 TO 2200
SAMPLE: 9401209-02A AND N-30 LONGHORN 10UL OF 50UL/1ML
CONDS.: 40(3)-18005/MIN CAPILLARY 75M



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 01-20-94
SAS NO _____LABORATORY SwL - Houston
REPORTED 01/21/94 10:16CONTRACT LONGHORN
CUSTOMER AWDFILE NAME I012004
TYPE EPA
INST FINNSAMPLE ID N-60 LONGHORN
LAB SAMP ID 9401209-03A
ANALYZED 01/20/94 18:37LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		50000	U
C015	74-83-9	Bromomethane		50000	U
C020	75-01-4	Vinyl Chloride		50000	U
C025	75-00-3	Chloroethane		50000	U
C030	75-09-2	Methylene Chloride		760000	
C035	67-64-1	Acetone		250000	U
C040	75-15-0	Carbon Disulfide		25000	U
C045	75-35-4	1,1-Dichloroethene		25000	U
C050	75-34-3	1,1-Dichloroethane		25000	U
C055	540-59-0	1,2-Dichloroethene (Total)		25000	U
C060	67-66-3	Chloroform		25000	U
C065	107-06-2	1,2-Dichloroethane		25000	U
C110	78-93-3	Methylethyl ketone (MEK)		50000	BU
C115	71-55-6	1,1,1-Trichloroethane		25000	U
C120	56-23-5	Carbon Tetrachloride		25000	U
C125	108-05-4	Vinyl Acetate		50000	U
C130	75-27-4	Bromodichloromethane		25000	U
C140	78-87-5	1,2-Dichloropropane		25000	U
C143	10061-01-5	cis-1,3-Dichloropropene		25000	U
C150	79-01-6	Trichloroethene		25000	U
C155	124-48-1	Dibromochloromethane		25000	U
C160	79-00-5	1,1,2-Trichloroethane		25000	U
C165	71-43-2	Benzene		25000	U
C172	10061-02-6	trans-1,3-Dichloropropene		25000	U
C180	75-25-2	Bromoform		25000	U
C205	108-10-1	4-Methyl-2-Pentanone		50000	U
C210	591-78-6	2-Hexanone		50000	U
C220	127-18-4	Tetrachloroethene		25000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		25000	U
C230	108-88-3	Toluene		25000	U
C235	108-90-7	Chlorobenzene		25000	U
C240	100-41-4	Ethylbenzene		25000	U
C245	100-42-5	Styrene		25000	U
C250	1330-20-7	Xylene (total)		25000	U

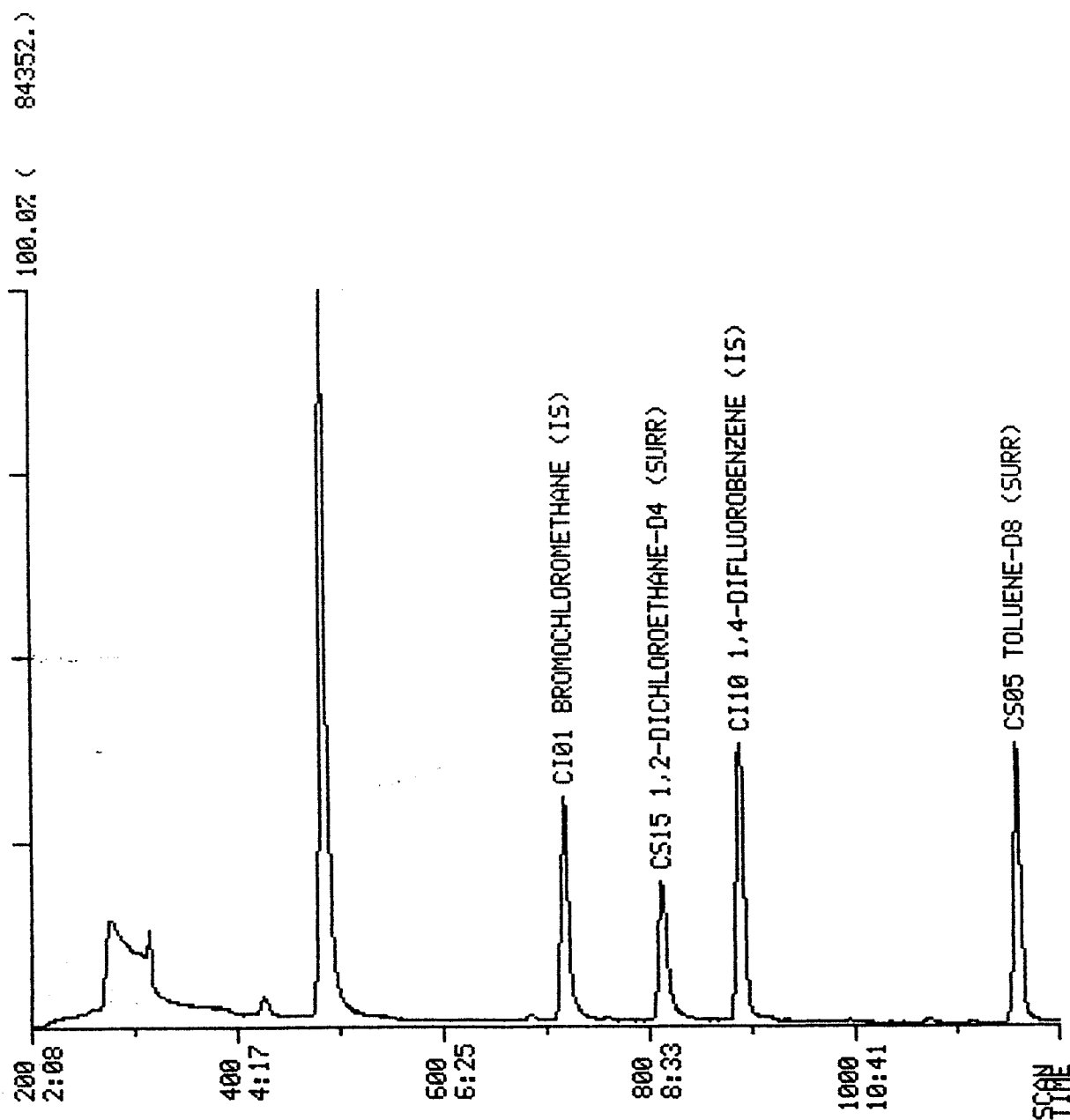
VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 01-20-94
SAS NO LABORATORY SwL - Houston
REPORTED 01/21/94 10:16CONTRACT LONGHORN
CUSTOMER AWD

notes and summary data for this report.

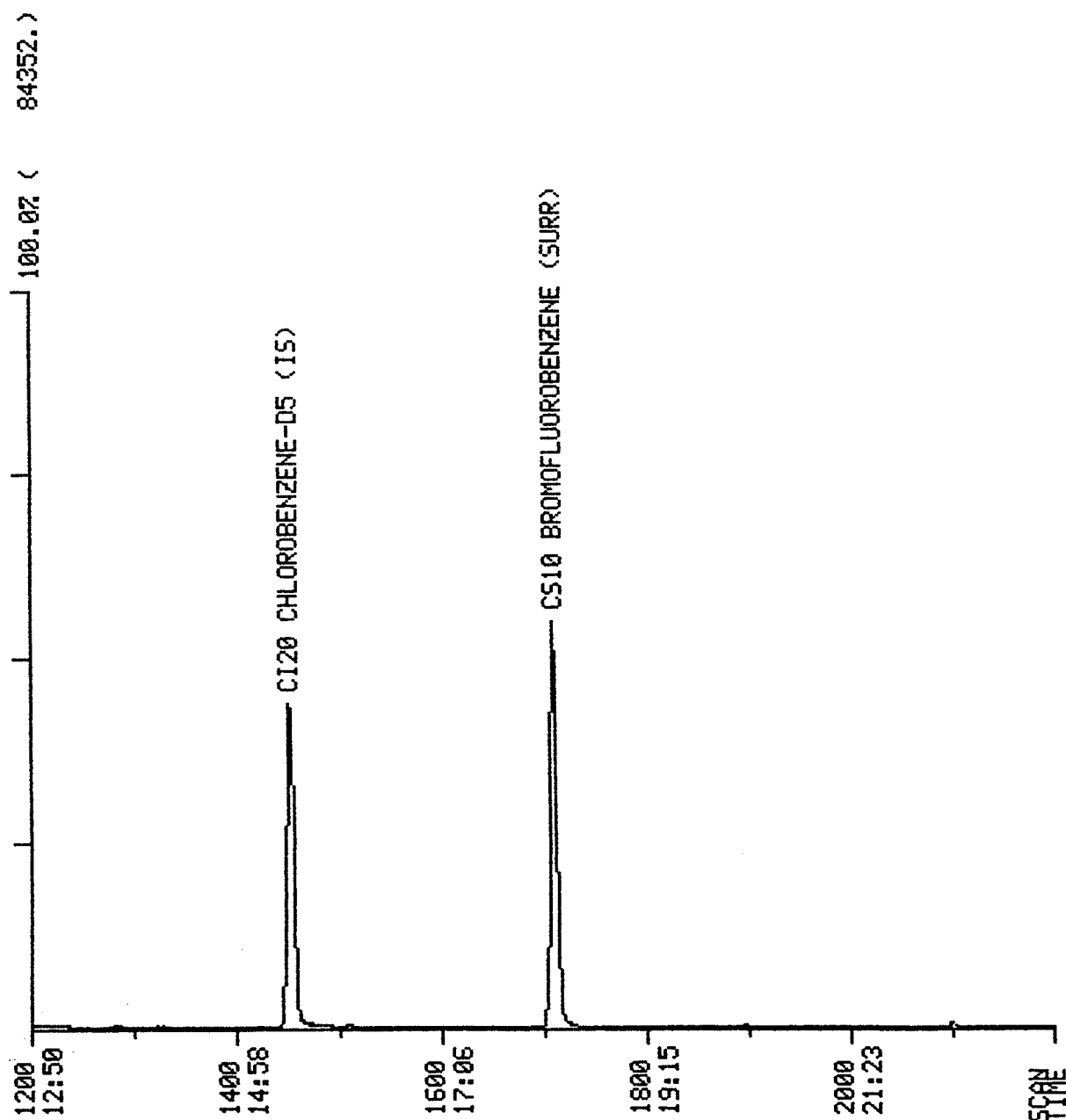
B - Compound was detected in the QC blank.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012004 SCANS 200 TO 1200 ACQUIRED: 01/20/94 18:37:00
CALI: I012004 #3 OUT OF 200 TO 2200
SAMPLE: 9401209-03A AWD N-60 LONGHORN 20UL/50UL/1ML
COND5.: 40(3) 40-180 @ 6/MIN



DATA FROM FILE: I012004 SCANS 1200 TO 2200 ACQUIRED: 01/20/94 18:37:00
CALI: I012004 #3 OUT OF 200 TO 2200
SAMPLE: 9401209-03A AWD N-60 LONGHORN 20UL/50UL/1ML
CONDS.: 40(3) 40-180 @ 6/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 01-20-94LABORATORY SwL - HoustonCONTRACT LONGHORN

SAS NO _____

REPORTED 01/21/94 10:15CUSTOMER AWDFILE NAME I012002SAMPLE ID W-15 LONGHORNLEVEL LOWTYPE EPALAB SAMP ID 9401209-04AMATRIX WATERINST FINNANALYZED 01/20/94 17:14UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
C020	75-01-4	Vinyl Chloride		200000	U
C025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		3040000	
C035	67-64-1	Acetone		1000000	U
C040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
C050	75-34-3	1,1-Dichloroethane		100000	U
C055	540-59-0	1,2-Dichloroethene (Total)		100000	U
C060	67-66-3	Chloroform		100000	U
C065	107-06-2	1,2-Dichloroethane		100000	U
C110	78-93-3	Methylethyl ketone (MEK)		200000	BU
C115	71-55-6	1,1,1-Trichloroethane		100000	U
C120	56-23-5	Carbon Tetrachloride		100000	U
C125	108-05-4	Vinyl Acetate		200000	U
C130	75-27-4	Bromodichloromethane		100000	U
C140	78-87-5	1,2-Dichloropropane		100000	U
C143	10061-01-5	cis-1,3-Dichloropropene		100000	U
C150	79-01-6	Trichloroethene		100000	U
C155	124-48-1	Dibromochloromethane		100000	U
C160	79-00-5	1,1,2-Trichloroethane		100000	U
C165	71-43-2	Benzene		100000	U
C172	10061-02-6	trans-1,3-Dichloropropene		100000	U
C180	75-25-2	Bromoform		100000	U
C205	108-10-1	4-Methyl-2-Pentanone		200000	U
C210	591-78-6	2-Hexanone		200000	U
C220	127-18-4	Tetrachloroethene		100000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
C230	108-88-3	Toluene		100000	U
C235	108-90-7	Chlorobenzene		100000	U
C240	100-41-4	Ethylbenzene		100000	U
C245	100-42-5	Styrene		100000	U
C250	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 01-20-94

SAS NO _____

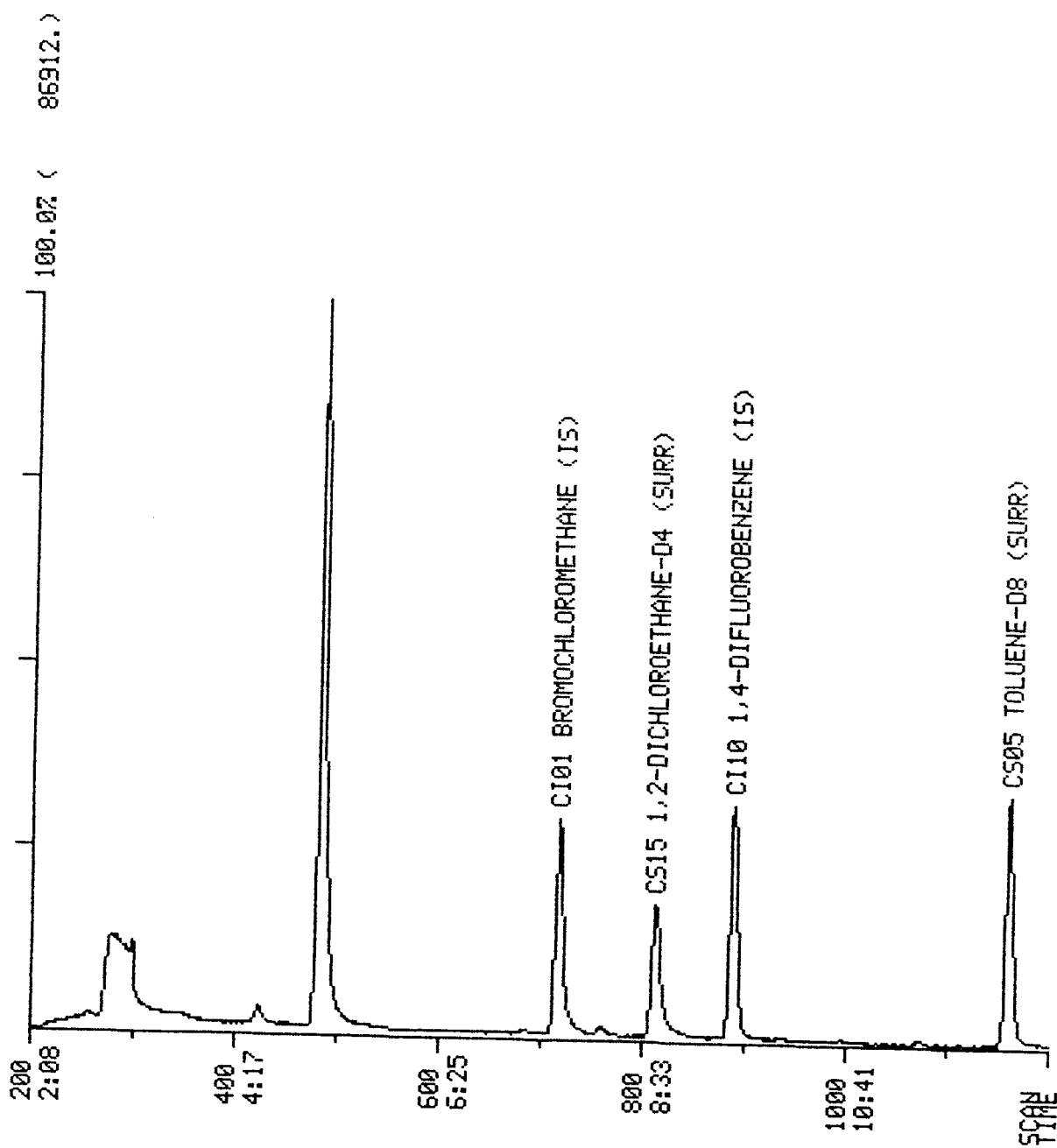
LABORATORY SwL - HoustonREPORTED 01/21/94 10:15CONTRACT LONGHORNCUSTOMER AWD

Notes and summary data for this report.

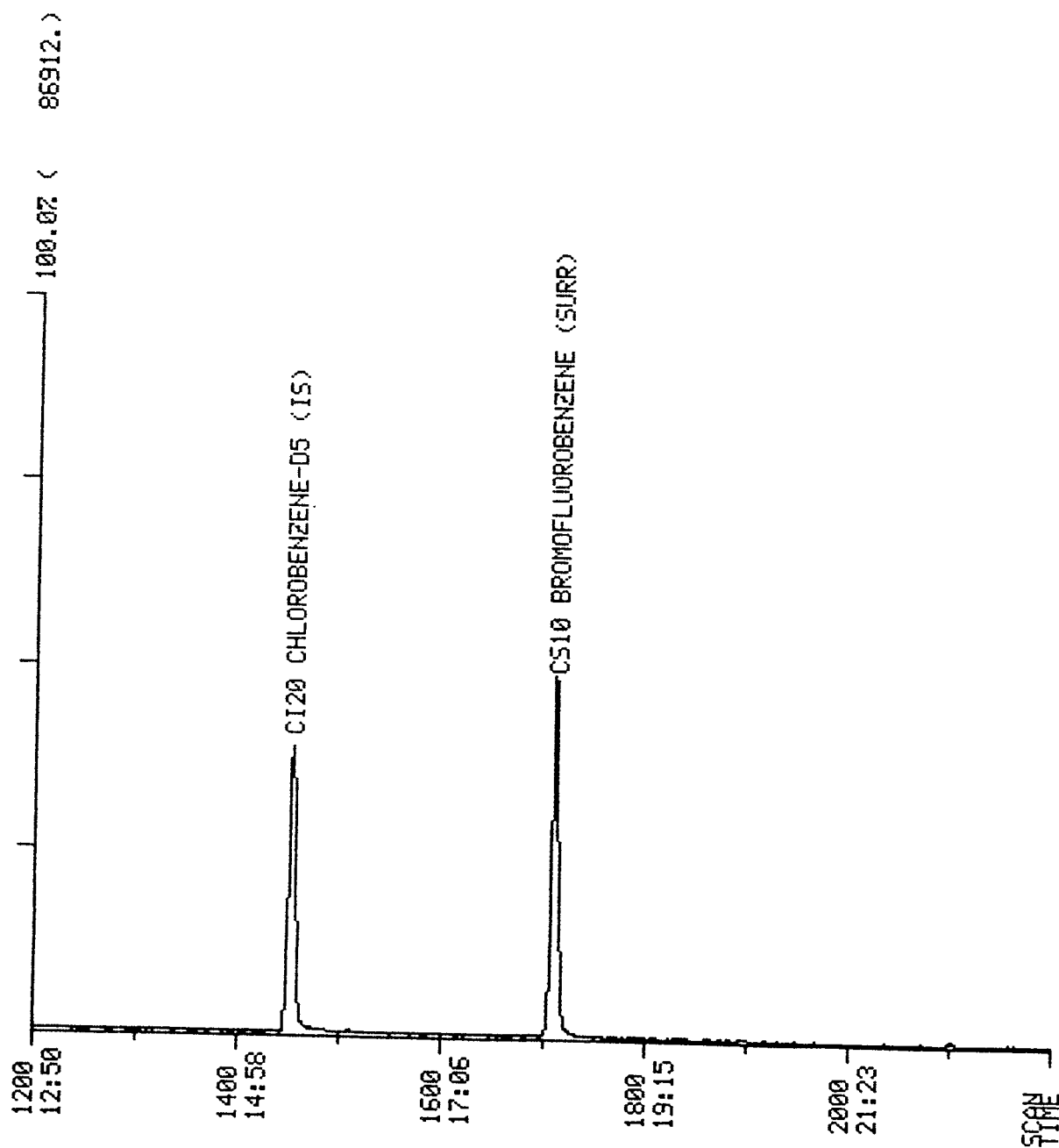
B - Compound was detected in the QC blank.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

JATA FROM FILE: I012002 SCANS 200 TO 1200 ACQUIRED: 01/20/94 17:14:00
SAMPLE: 9401209-04A AND W-15 LONGHORN SUL/50UL/1ML CALI: I012002 #3 OUT OF 200 TO 2200
CONDS.: 40(3) 40-180 @ 5/MIN



DATA FROM FILE: I012002 SCANS 1200 TO 2200 ACQUIRED: 01/20/94 17:14:00
SAMPLE: 9401209-04A AND W-15 LONGHORN SUL/50UL/1ML CALI: I012002 #3 OUT OF 200 TO 2200
CONDS.: 40(3) 40-180 @ 6/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 01-19-94

SAS NO _____

LABORATORY SwL - HoustonREPORTED 01/20/94 12:25CONTRACT LONGHORNCUSTOMER AWDFILE NAME I011905TYPE EPAINST FINNSAMPLE ID W-30 LONGHORNLAB SAMP ID 9401209-05AANALYZED 01/19/94 19:26LEVEL LOWMATRIX WATERUNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		100000	U
C015	74-83-9	Bromomethane		100000	U
C020	75-01-4	Vinyl Chloride		100000	U
C025	75-00-3	Chloroethane		100000	U
C030	75-09-2	Methylene Chloride		2670000	
C035	67-64-1	Acetone		500000	U
C040	75-15-0	Carbon Disulfide		50000	U
C045	75-35-4	1,1-Dichloroethene		50000	U
C050	75-34-3	1,1-Dichloroethane		50000	U
C050	540-59-0	1,2-Dichloroethene (Total)		50000	U
C060	67-66-3	Chloroform		50000	U
C065	107-06-2	1,2-Dichloroethane		50000	U
C110	78-93-3	Methylethyl ketone (MEK)		100000	U
C115	71-55-6	1,1,1-Trichloroethane		50000	U
C120	56-23-5	Carbon Tetrachloride		50000	U
C125	108-05-4	Vinyl Acetate		100000	U
C130	75-27-4	Bromodichloromethane		50000	U
C140	78-87-5	1,2-Dichloropropane		50000	U
C143	10061-01-5	cis-1,3-Dichloropropene		50000	U
C150	79-01-6	Trichloroethene		50000	U
C155	124-48-1	Dibromochloromethane		50000	U
C160	79-00-5	1,1,2-Trichloroethane		50000	U
C165	71-43-2	Benzene		50000	U
C172	10061-02-6	trans-1,3-Dichloropropene		50000	U
C180	75-25-2	Bromoform		50000	U
C205	108-10-1	4-Methyl-2-Pentanone		100000	U
C210	591-78-6	2-Hexanone		100000	U
C220	127-18-4	Tetrachloroethene		50000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		50000	U
C230	108-88-3	Toluene		50000	U
C235	108-90-7	Chlorobenzene		50000	U
C240	100-41-4	Ethylbenzene		50000	U
C245	100-42-5	Styrene		50000	U
C250	1330-20-7	Xylene (total)		50000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 01-19-94

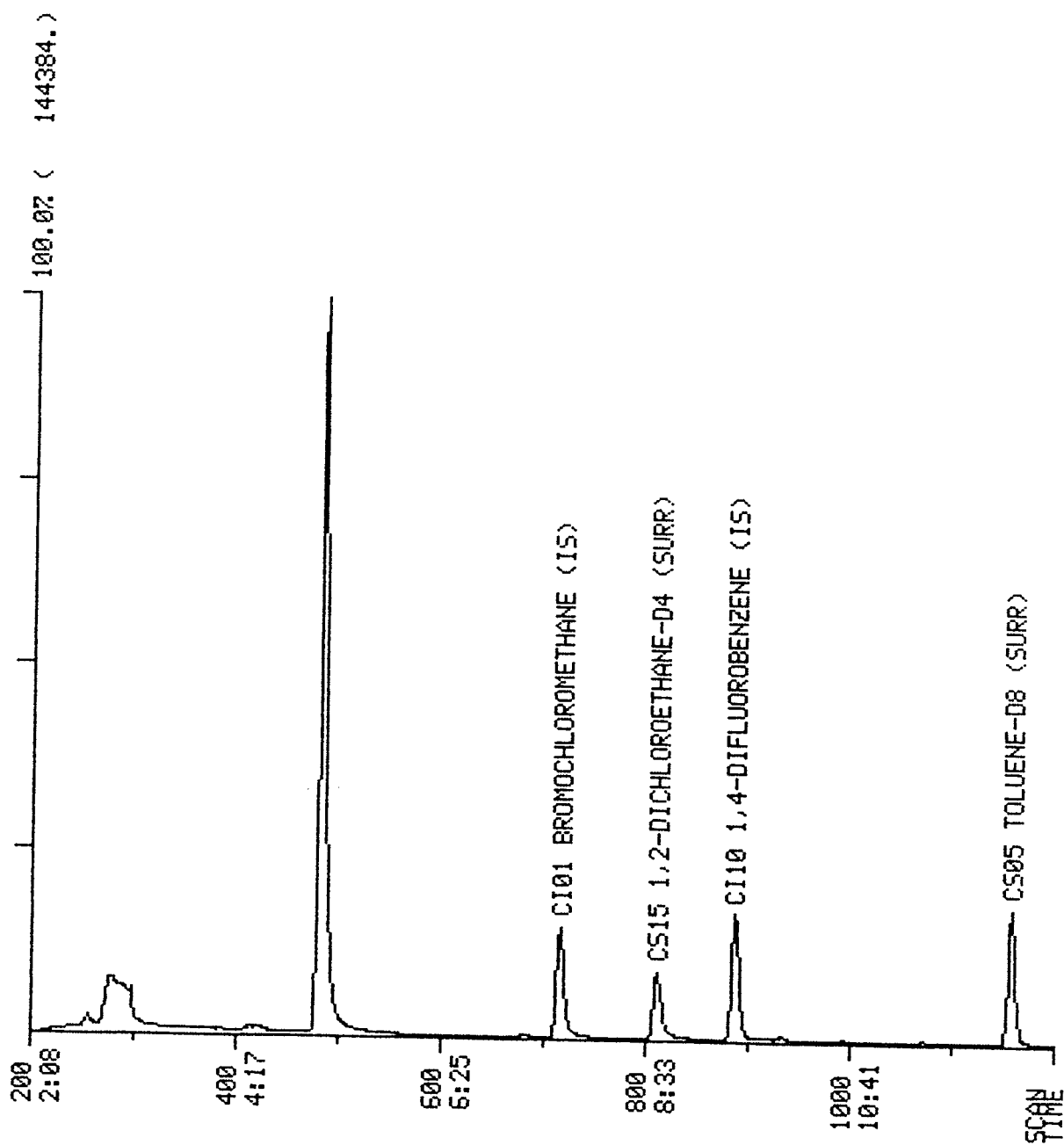
SAS NO _____

LABORATORY SwL - HoustonREPORTED 01/20/94 12:25CONTRACT LONGHORNCUSTOMER AWD

Notes and summary data for this report.

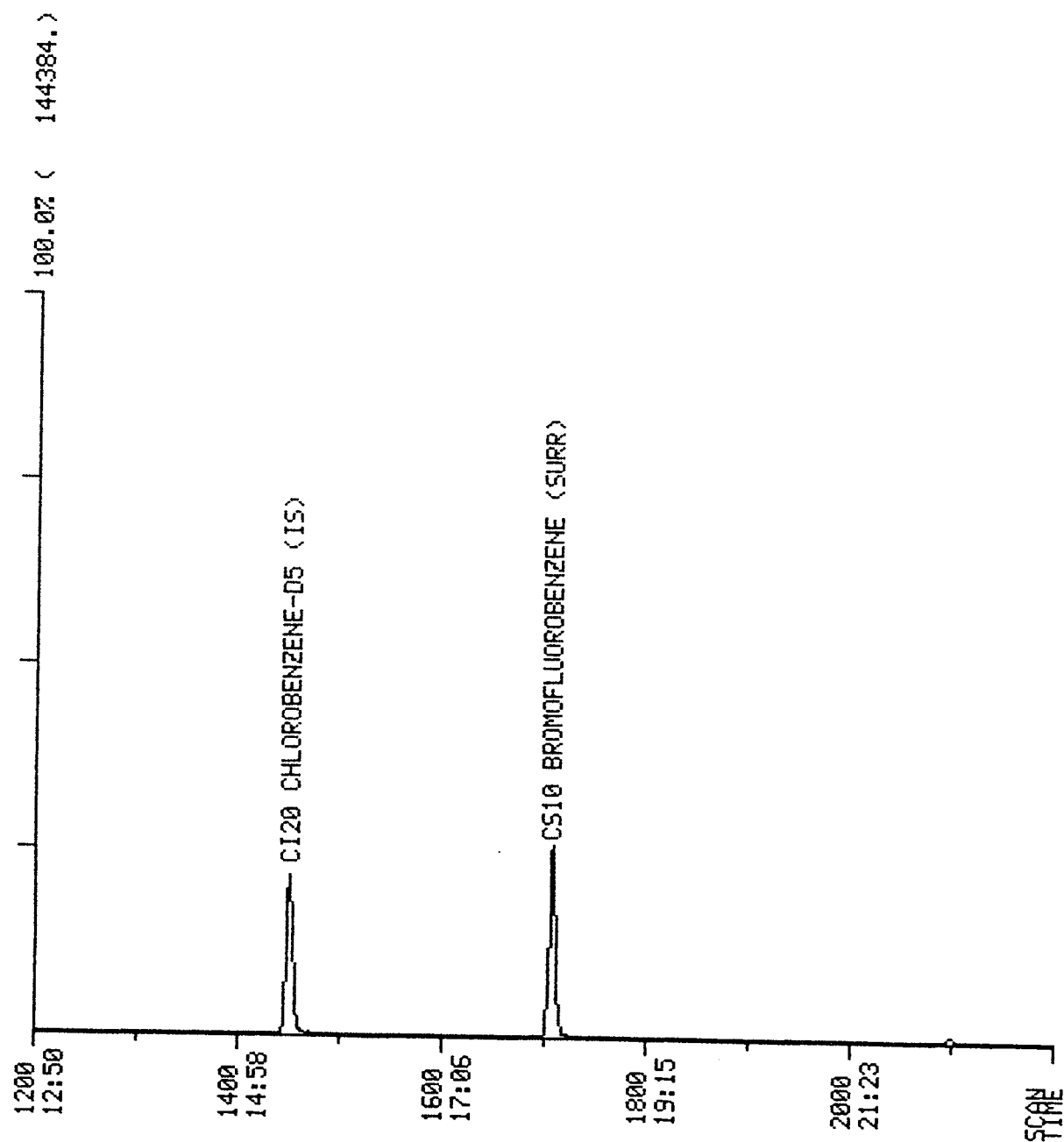
U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I011905 SCANS 200 TO 1200 ACQUIRED: 01/19/94 19:25:00
SAMPLE: 9401209-05A AND W-30 LONGHORN 10UL OF 50UL/1ML
COND.: 40(3)-18006/MIN CAPILLARY 75M
CALI: I011905 #3 OUT OF 200 TO 2200



007698

DATA FROM FILE: I011905 SCANS 1200 TO 2200 ACQUIRED: 01/19/94 19:26:00
CALI: I011905 #3 OUT OF 200 TO 2200
SAMPLE: 9401209-05A AND W-30 LONGHORN 10UL OF 50UL/1ML
CONDS.: 40(3)-18005/MIN CAPILLARY 75M



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 01-19-94

SAS NO _____

LABORATORY SwL - HoustonREPORTED 01/20/94 12:26CONTRACT LONGHORNCUSTOMER AWDFILE NAME I011906TYPE EPAINST FINNSAMPLE ID W-60 LONGHORNLAB SAMP ID 9401209-06AANALYZED 01/19/94 20:08LEVEL LOWMATRIX WATERUNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		100000	U
C015	74-83-9	Bromomethane		100000	U
C020	75-01-4	Vinyl Chloride		100000	U
C025	75-00-3	Chloroethane		100000	U
C030	75-09-2	Methylene Chloride		1960000	U
C035	67-64-1	Acetone		500000	U
C040	75-15-0	Carbon Disulfide		50000	U
C045	75-35-4	1,1-Dichloroethene		50000	U
C050	75-34-3	1,1-Dichloroethane		50000	U
C055	540-59-0	1,2-Dichloroethene (Total)		50000	U
C060	67-66-3	Chloroform		50000	U
C065	107-06-2	1,2-Dichloroethane		50000	U
C110	78-93-3	Methylethyl ketone (MEK)		100000	U
C115	71-55-6	1,1,1-Trichloroethane		50000	U
C120	56-23-5	Carbon Tetrachloride		50000	U
C125	108-05-4	Vinyl Acetate		100000	U
C130	75-27-4	Bromodichloromethane		50000	U
C140	78-87-5	1,2-Dichloropropane		50000	U
C143	10061-01-5	cis-1,3-Dichloropropene		50000	U
C150	79-01-6	Trichloroethene		50000	U
C155	124-48-1	Dibromochloromethane		50000	U
C160	79-00-5	1,1,2-Trichloroethane		50000	U
C165	71-43-2	Benzene		50000	U
C172	10061-02-6	trans-1,3-Dichloropropene		50000	U
C180	75-25-2	Bromoform		50000	U
C205	108-10-1	4-Methyl-2-Pentanone		100000	U
C210	591-78-6	2-Hexanone		100000	U
C220	127-18-4	Tetrachloroethene		50000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		50000	U
C230	108-88-3	Toluene		50000	U
C235	108-90-7	Chlorobenzene		50000	U
C240	100-41-4	Ethylbenzene		50000	U
C245	100-42-5	Styrene		50000	U
C250	1330-20-7	Xylene (total)		50000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 01-19-94
SAS NO

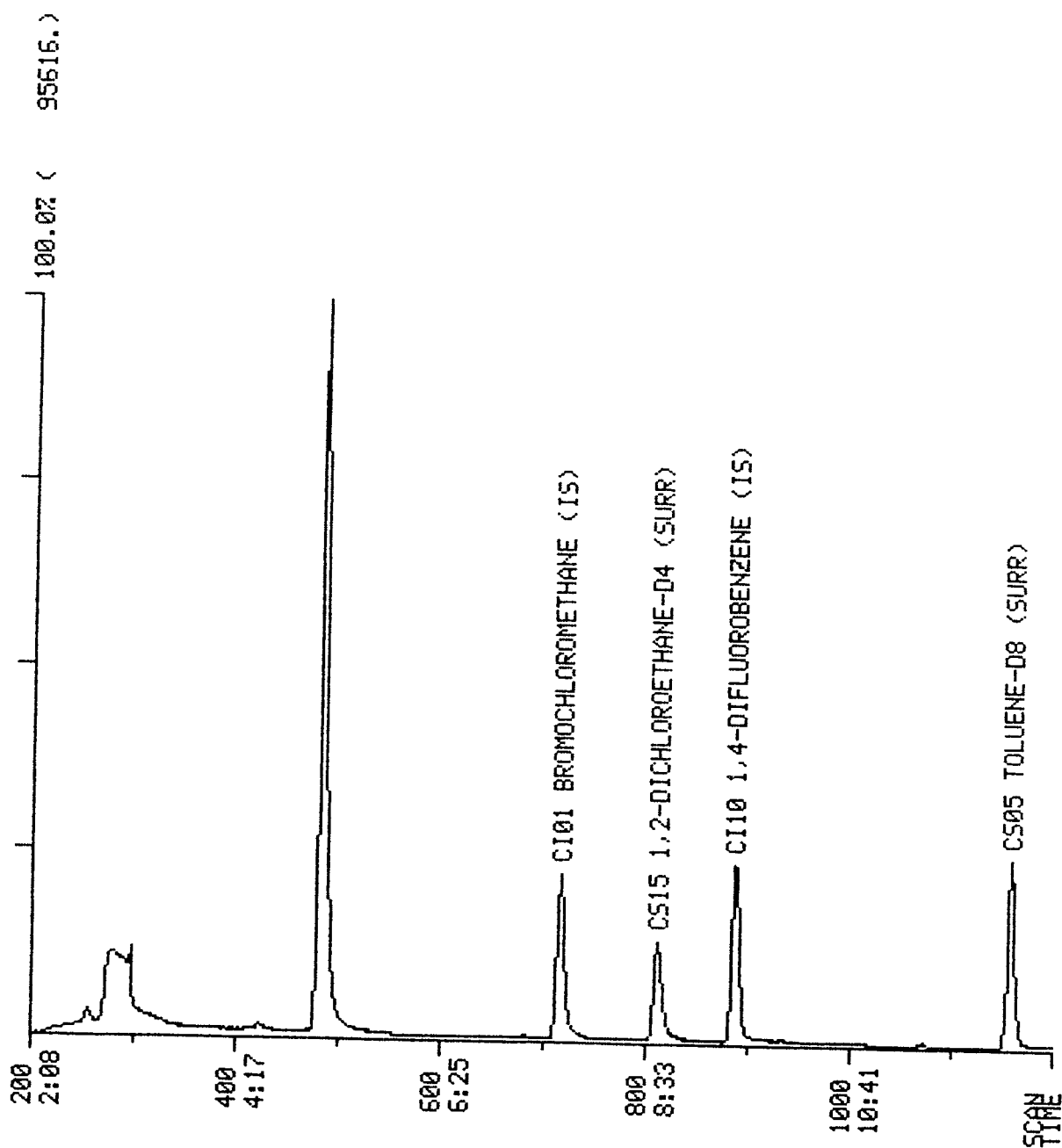
LABORATORY SwL - Houston
REPORTED 01/20/94 12:26

CONTRACT LONGHORN
CUSTOMER AWD

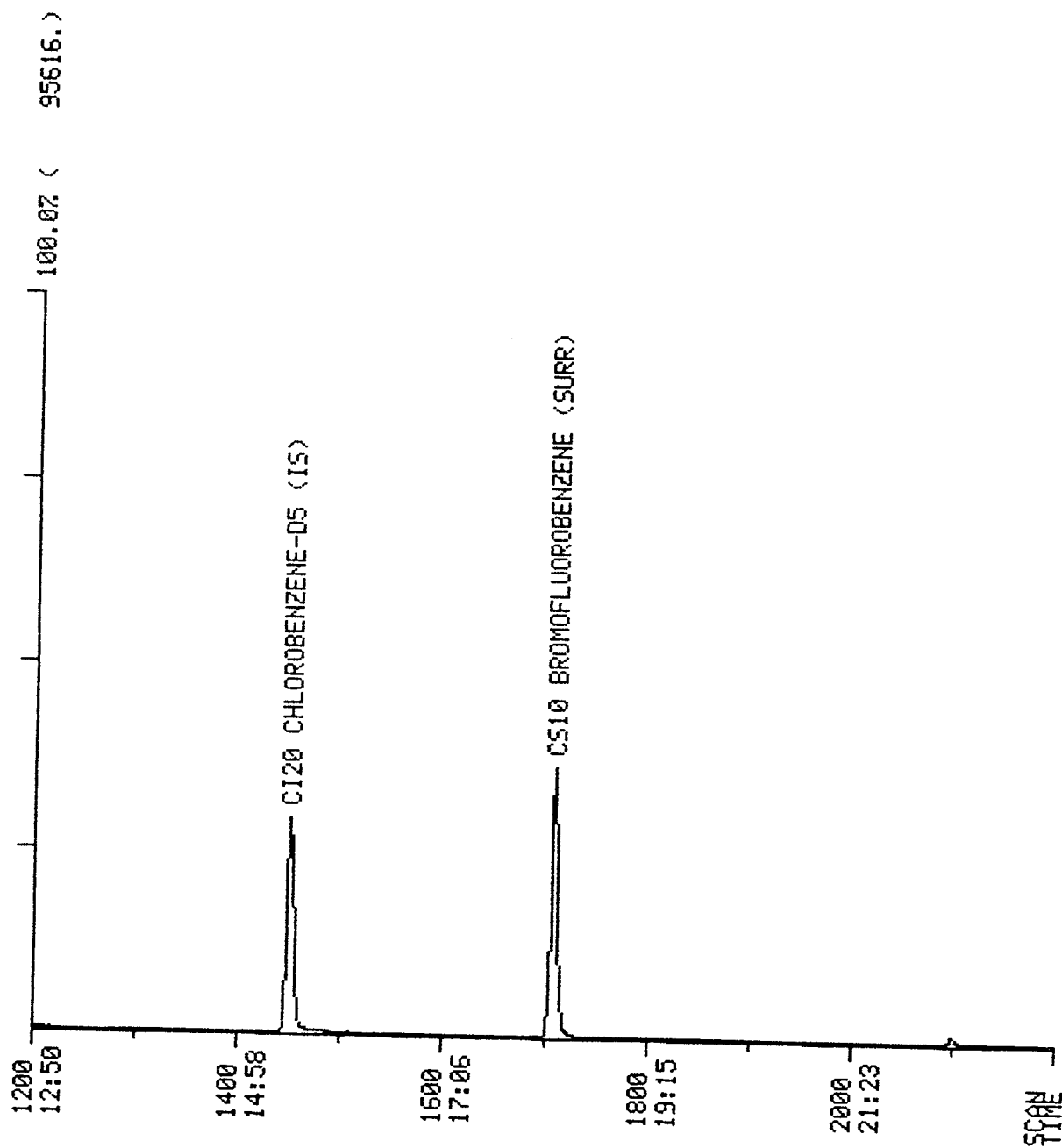
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I011906 SCANS 200 TO 1200 ACQUIRED: 01/19/94 20:08:00
CALI: I011906 #3
SAMPLE: 9401209-06A AND W-60 LONGHORN 10UL OF 50UL/1ML
CONDS.: 40(3)-18006/MIN CAPILLARY 75M



DATA FROM FILE: I011906 SCANS 1200 TO 2200 ACQUIRED: 01/19/94 20:08:00
CALI: I011906 #3 OUT OF 200 TO 2200
SAMPLE: 9401209-06A AND W-50 LONGHORN 10UL OF 50UL/1ML
COND5.: 40(3)-18005/MIN CAPILLARY 75M



VOLATILE ORGANICS ANALYSIS DATA SHEET

007703

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 01-20-94

SAS NO _____

LABORATORY SwL - HoustonREPORTED 01/21/94 10:16CONTRACT LONGHORNCUSTOMER AWDFILE NAME I012003TYPE EPAINST FINNSAMPLE ID CONTROL LHORNLAB SAMP ID 9401209-07AANALYZED 01/20/94 17:55LEVEL LOWMATRIX WATERUNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
C020	75-01-4	Vinyl Chloride		200000	U
C025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		3880000	
C035	67-64-1	Acetone		1000000	U
C040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
C050	75-34-3	1,1-Dichloroethane		100000	U
C055	540-59-0	1,2-Dichloroethene (Total)		100000	U
C060	67-66-3	Chloroform		100000	U
C065	107-06-2	1,2-Dichloroethane		100000	U
C110	78-93-3	Methylethyl ketone (MEK)		200000	BU
C115	71-55-6	1,1,1-Trichloroethane		100000	U
C120	56-23-5	Carbon Tetrachloride		100000	U
C125	108-05-4	Vinyl Acetate		200000	U
C130	75-27-4	Bromodichloromethane		100000	U
C140	78-87-5	1,2-Dichloropropane		100000	U
C143	10061-01-5	cis-1,3-Dichloropropene		100000	U
C150	79-01-6	Trichloroethene		100000	U
C155	124-48-1	Dibromochloromethane		100000	U
C160	79-00-5	1,1,2-Trichloroethane		100000	U
C165	71-43-2	Benzene		100000	U
C172	10061-02-6	trans-1,3-Dichloropropene		100000	U
C180	75-25-2	Bromoform		100000	U
C205	108-10-1	4-Methyl-2-Pentanone		200000	U
C210	591-78-6	2-Hexanone		200000	U
C220	127-18-4	Tetrachloroethene		100000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
C230	108-88-3	Toluene		100000	U
C235	108-90-7	Chlorobenzene		100000	U
C240	100-41-4	Ethylbenzene		100000	U
C245	100-42-5	Styrene		100000	U
C250	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 01-20-94

SAS NO _____

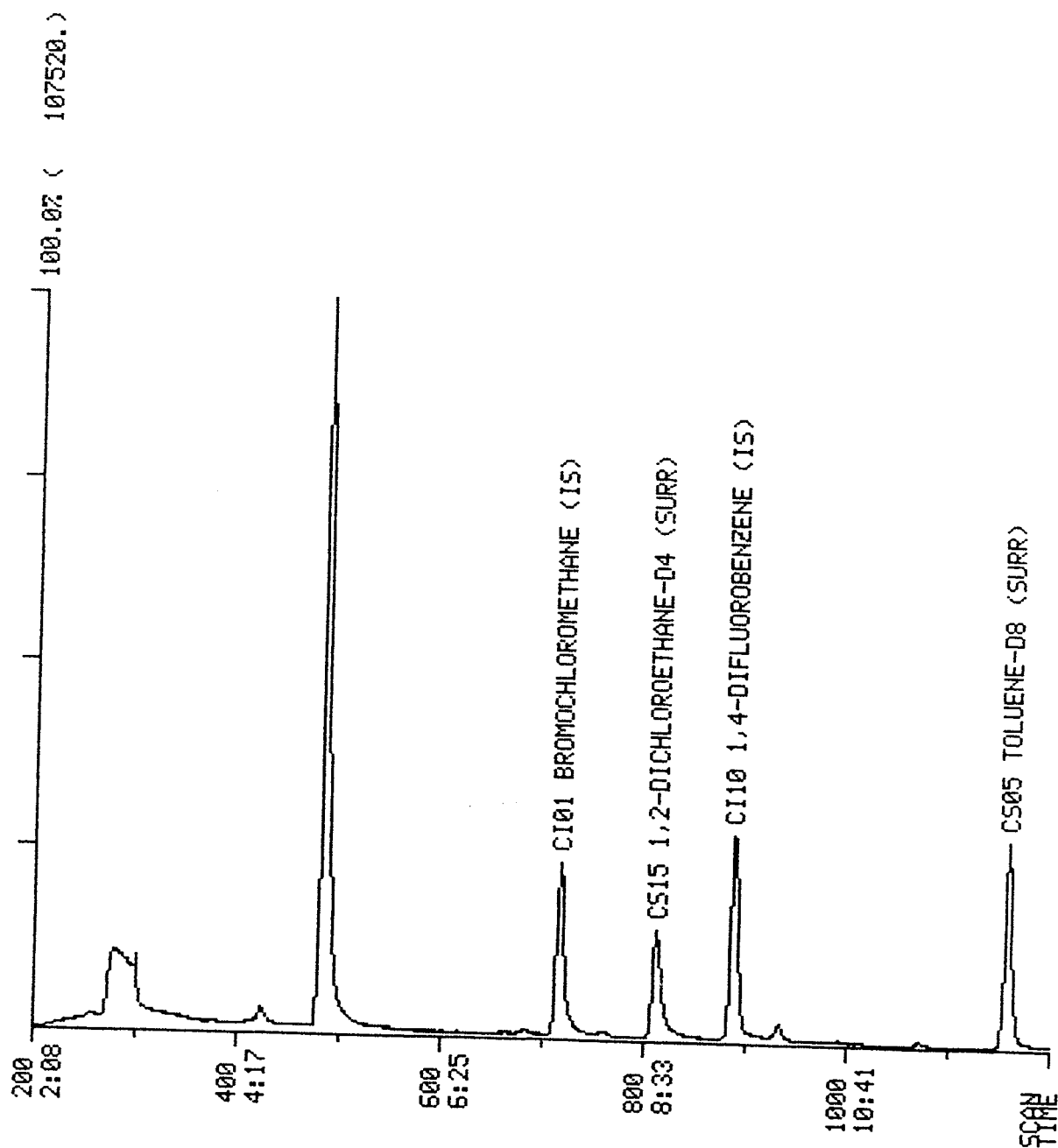
LABORATORY SwL - Houston
REPORTED 01/21/94 10:16CONTRACT LONGHORN
CUSTOMER AWD

Notes and summary data for this report.

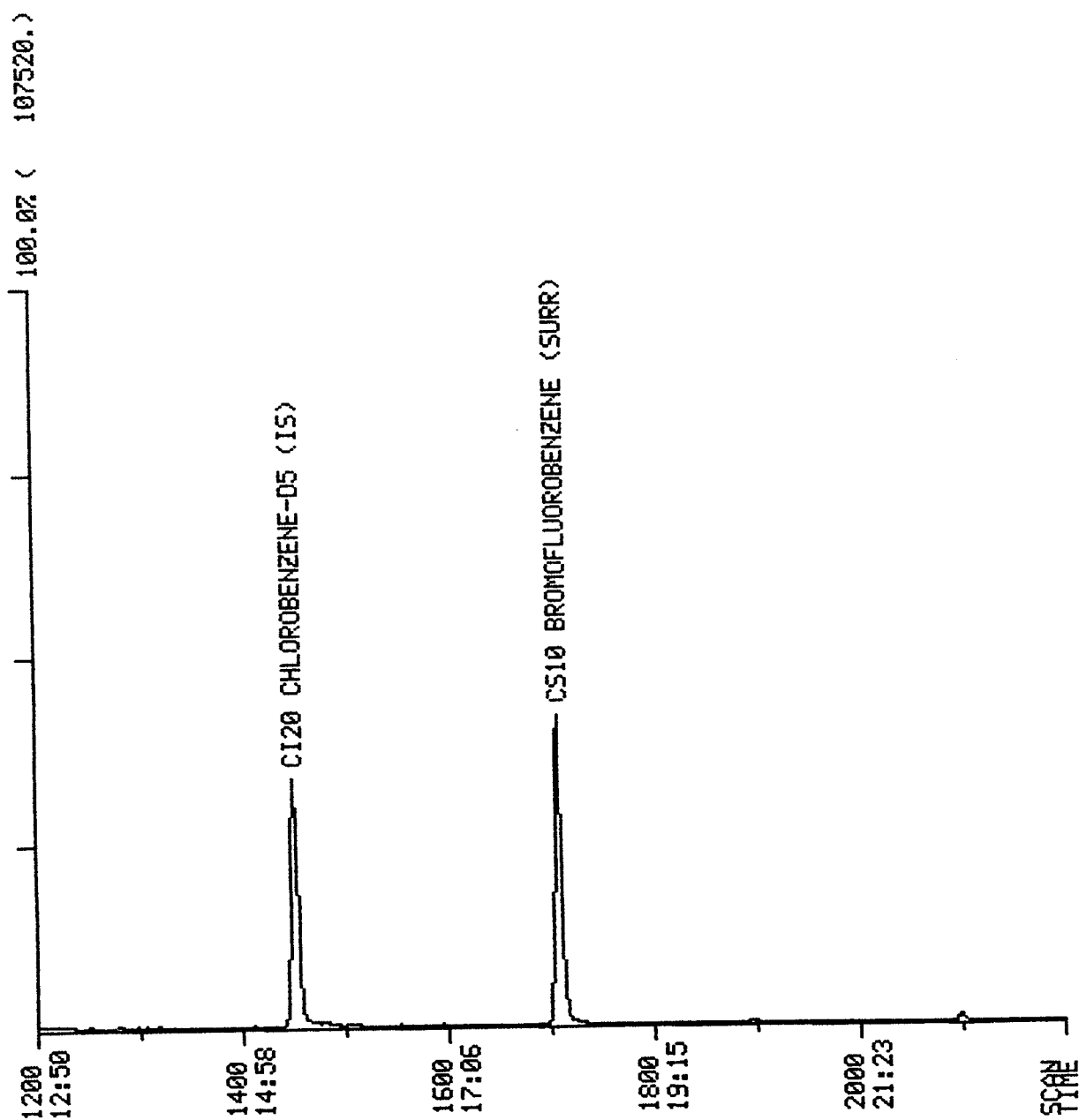
B - Compound was detected in the QC blank.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012003 SCANS 200 TO 1200 ACQUIRED: 01/20/94 17:55:00
CALI: I012003 #3
SAMPLE: 9401209-07A AND CONTROL LONGHORN SUL/50UL/1ML
COND.: 40(3) 40-180 @ 6/MIN



DATA FROM FILE: I012003 SCANS 1200 TO 2200 ACQUIRED: 01/20/94 17:55:00
CALI: I012003 #3 OUT OF 200 TO 2200
SAMPLE: 9401209-07A AND CONTROL LONGHORN 5UL/50UL/1ML
CONDS.: 40(3) 40-180 @ 6/MIN



Analysis Request and Chain of Custody Record



SOUTHWESTERN LABORATORIES

- ☒ HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151
- ☐ DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700
- ☐ MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no.		Client/Project		Analysis Requested				Laboratory Remarks	
Longhorn - 2379		AWD Technologies Longhorn Project						W. Record 713-978-3005	
Lab ID No.	Field Sample No./ Identification	Date and Time	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative			
	N-15 Longhorn	1-17-94 3:50p	✓	VOA bottle	Water with Activated carbon	none	VOA - Filtered, TOC > COD		
	N-30 Longhorn		✓				1. Head		
	N-60 Longhorn		✓				also for COD		
	W-15 Longhorn		✓				Run TOC sample		
	W-30 Longhorn		-				if any after		
	W-60 Longhorn		-				Numerous after		
	Control Longhorn		-				VOA		
Sampers: (Print) Walter Record / AWD				Relinquished by: (Signature) Walter Record	Date: 1-18-94 Time: 4:30p	Received by: (Signature)	Date: Time:	COC Seal No.	11091
Affiliation AWD				Relinquished by: (Signature)	Date: Time:	Received by: (Signature)	Date: Time:	REC'D: ON ICE	Yes No
Results by 3 day turn around → 1-21-94 Rush Charges Authorized				Relinquished by: (Signature)	Date: Time:	Received by: (Signature)	Date: Time:	Intact: N/A	Yes No
REMARKS: Filter all samples @ time. Samples @ room temp of VOA Analysis				Data Results To: 1. Walter Record AWD Technologies		Laboratory No. 94-01-209			

Page 2 of 2

TMS

SOUTHWESTERN LABORATORIES

☒ **HOUSTON EAS** 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151

☐ **DALLAS EAS** 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700

☐ **MIDLAND EAS** 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no. Longhorn-2379						Client/Project AWD Technologies - Longhorn Project							
Lab ID No.	Field Sample No./ Identification	Date and Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative	ANALYSIS REQUESTED			LABORATORY REMARKS		
	N-SS Longhorn	1-17-94 3:30P		✓	500 ml plastic	Water w/ Activated Carbon	None	Aluminum, Barium, Copper, Iron → Filtered + pH					
	M-SS Longhorn	1-17-94 3:30P	✓		500 ml plastic	Water w/ Active Carbon							
	Control Longhorn	1-17-94 3:30P	✓		500 ml plastic	Water		plus pH					
Samplers: (Print) <u>Walter Recourt / AWD</u>		Relinquished by: (Signature) <u>Walter Recourt</u>		Date: <u>4:30P</u> Time: <u>1-18-94</u>		Received by: (Signature)		Date:		COC Seal No. <u>1198</u>	REC'D ON ICE		
Affiliation <u>AWD</u>		Relinquished by: (Signature)		Date:		Received by: (Signature)		Time:		Yes ___ No ___	Intact		
		Relinquished by: (Signature)		Date:		Received by: (Signature)		Time:		Yes ___ No ___	Laboratory No.		
Results by <u>3 day turn around</u> <u>1-21-94</u> Rush Charges Authorized		REMARKS: All samples to be Filtered										Data Results To: 1. <u>Walter Recourt - AWD Technology</u>	
Yes ___ No <u>X</u>												04-01-209	

**SOUTHWESTERN LABORATORIES**

222 CAVALCADE * P.O. BOX 8768, HOUSTON, TEXAS 77249 * 713 692-9151

Client AWD TECHNOLOGIES, INC.
400 W. SAM HOUSTON PKWY SOUTH
HOUSTON, TEXAS 77042

Client No. 2_0686_00
Report No. 94-01-311
Report Date 01/26/94 14:56

Attn: WALT PRECOURT

Project LONGHORN/COD ANALYSIS

Date Sampled 01/25/94

Sampled By CLIENT

Sample Type LIQUID SAMPLE

Transported by CLIENT

P.O. # _____

Date Received 01/25/94

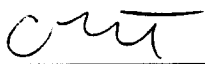
Lab No.

94-01-311-01
94-01-311-02
94-01-311-03
94-01-311-04
94-01-311-05

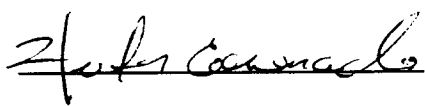
Sample Identification

INFLUENT/6:43 Z
COL A/6:28 Z
COL A/2:17 Z
COL B/6:17 Z
COL C/6:05 Z

SOUTHWESTERN LABORATORIES



Reviewed By



HECTOR CORONADO

COD Data - GAC

TEST RESULTS BY SAMPLE

Sample: 01A INFLUENT/6:43 Z

Collected: 01/25/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	686	mg/L	15.0	01/26/94	HC

Sample: 02A COL A/6:28 Z

Collected: 01/25/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	362	mg/L	15.0	01/26/94	HC

Sample: 03A COL A/2:17 Z

Collected: 01/25/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	100	mg/L	15.0	01/26/94	HC

Sample: 04A COL B/6:17 Z

Collected: 01/25/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	96.4	mg/L	15.0	01/26/94	HC

Sample: 05A COL C/6:05 Z

Collected: 01/25/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
CHEMICAL OXYGEN DEMAND	EPA 410.4	86.8	mg/L	15.0	01/26/94	HC

007712



SOUTHWESTERN LABORATORIES

222 CAVALCADE * P.O. BOX 8768, HOUSTON, TEXAS 77249 * 713 692-9151

Client AWD TECHNOLOGIES, INC.
400 W. SAM HOUSTON PKWY SOUTH
HOUSTON, TEXAS 77042

Client No. 2_0686_00
Report No. 94-01-337
Report Date 02/03/94 11:16

Attn: WALT PRECOURT

Project VOLATILE ANALYSIS

Date Sampled 01/25/94 01/26/94

Sampled By CLIENT

Sample Type LIQUID SAMPLES

Transported by CLIENT

P.O. # _____

Date Received 01/26/94

Lab No.

94-01-337-01
94-01-337-02
94-01-337-03
94-01-337-04
94-01-337-05
94-01-337-06
94-01-337-07
94-01-337-08
94-01-337-09
94-01-337-10
94-01-337-11
94-01-337-12
94-01-337-13
94-01-337-14
94-01-337-15
94-01-337-16
94-01-337-17
94-01-337-18
94-01-337-19
94-01-337-20

Sample Identification

COL A/1:14
COL A/2:11
COL A/6:28
COL A/9:07
COL A/24:10
INFLUENT/2:30
COL B/1:18
COL B/2:06
COL B/6:17
COL B/9:01
COL B/24:02
COL C/1:23
COL C/2:22
COL C/6:05
COL C/8:55
COL C/23:55
COL A/
COL B/
COL C/
INFLUENT/32:05

HL
Reviewed By

SOUTHWESTERN LABORATORIES

Chris Barry
CHRIS BARRY

GAC-Column Data

SOUTHWESTERN LABORATORIES

Order # 94-01-337

Page 2

02/03/94 11:16

REGULAR TEST RESULTS BY TEST

Client: AMD TECHNOLOGIES, INC.

VOLATILE ORGANICS - WATER
Method: EPA 624

Minimum:

Maximum:

<u>Sample</u>	<u>Sample Description</u>	<u>Result</u>	<u>Units</u>	<u>Limit</u>	<u>Extracted</u>	<u>Analyzed</u>	<u>By</u>
01A	COL A/1:14	ENCLOSURE	DATE			02/01/94	RKW
02A	COL A/2:11	ENCLOSURE	DATE			01/28/94	RKW
03A	COL A/6:28	ENCLOSURE	DATE			01/28/94	RKW
04A	COL A/9:07	ENCLOSURE	DATE			01/28/94	RKW
05A	COL A/24:10	ENCLOSURE	DATE			01/28/94	RKW
06A	INFLUENT/2:30	ENCLOSURE	DATE			01/28/94	RKW
07A	COL B/1:18	ENCLOSURE	DATE			02/01/94	RKW
08A	COL B/2:06	ENCLOSURE	DATE			01/26/94	RKW
09A	COL B/6:17	ENCLOSURE	DATE			01/26/94	RKW
10A	COL B/9:01	ENCLOSURE	DATE			01/26/94	RKW
11A	COL B/24:02	ENCLOSURE	DATE			01/28/94	RKW
12A	COL C/1:23	ENCLOSURE	DATE			02/01/94	RKW
13A	COL C/2:22	ENCLOSURE	DATE			01/28/94	RKW
14A	COL C/6:05	ENCLOSURE	DATE			02/02/94	RKW
15A	COL C/8:55	ENCLOSURE	DATE			02/02/94	RKW
16A	COL C/23:55	ENCLOSURE	DATE			01/28/94	RKW
17A	COL A/	ENCLOSURE	DATE			02/01/94	RKW
18A	COL B/	ENCLOSURE	DATE			01/28/94	RKW
19A	COL C/	ENCLOSURE	DATE			02/01/94	RKW

pH

Minimum:

Maximum:

Method: EPA 150.1

<u>Sample</u>	<u>Sample Description</u>	<u>Result</u>	<u>Units</u>	<u>Limit</u>	<u>Extracted</u>	<u>Analyzed</u>	<u>By</u>
20A	INFLUENT/32:05	6.47	pH UNITS			01/26/94	RF

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337

SAS NO _____

LABORATORY SwL - HoustonREPORTED 02/03/94 12:52CONTRACT VOA ANALYSISCUSTOMER AWDFILE NAME I020101TYPE EPAINST FINNSAMPLE ID COL A 1-14LAB SAMP ID 9401337-01AANALYZED 02/01/94 19:03LEVEL LOWMATRIX WATERUNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		10.0	U
C015	74-83-9	Bromomethane		10.0	U
C020	75-01-4	Vinyl Chloride		10.0	U
C025	75-00-3	Chloroethane		10.0	U
C030	75-09-2	Methylene Chloride		8.73	
C035	67-64-1	Acetone		50.0	U
C040	75-15-0	Carbon Disulfide		5.00	U
C045	75-35-4	1,1-Dichloroethene		5.00	U
C050	75-34-3	1,1-Dichloroethane		5.00	U
C060	540-59-0	1,2-Dichloroethene (Total)		5.00	U
C065	67-66-3	Chloroform		5.00	U
C110	107-06-2	1,2-Dichloroethane		5.00	U
C115	78-93-3	Methylethyl ketone (MEK)		10.0	U
C120	71-55-6	1,1,1-Trichloroethane		5.00	U
C125	56-23-5	Carbon Tetrachloride		5.00	U
C130	108-05-4	Vinyl Acetate		10.0	U
C135	75-27-4	Bromodichloromethane		5.00	U
C140	78-87-5	1,2-Dichloropropane		5.00	U
C143	10061-01-5	cis-1,3-Dichloropropene		5.00	U
C150	79-01-6	Trichloroethene		5.00	U
C155	124-48-1	Dibromochloromethane		5.00	U
C160	79-00-5	1,1,2-Trichloroethane		5.00	U
C165	71-43-2	Benzene		5.00	U
C172	10061-02-6	trans-1,3-Dichloropropene		5.00	U
C180	75-25-2	Bromoform		5.00	U
C205	108-10-1	4-Methyl-2-Pentanone		10.0	U
C210	591-78-6	2-Hexanone		10.0	U
C220	127-18-4	Tetrachloroethene		5.00	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		5.00	U
C230	108-88-3	Toluene		5.00	U
C235	108-90-7	Chlorobenzene		5.00	U
C240	100-41-4	Ethylbenzene		5.00	U
C245	100-42-5	Styrene		5.00	U
C250	1330-20-7	Xylene (total)		5.00	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337LABORATORY SwL - HoustonCONTRACT VOA ANALYSIS

SAS NO _____

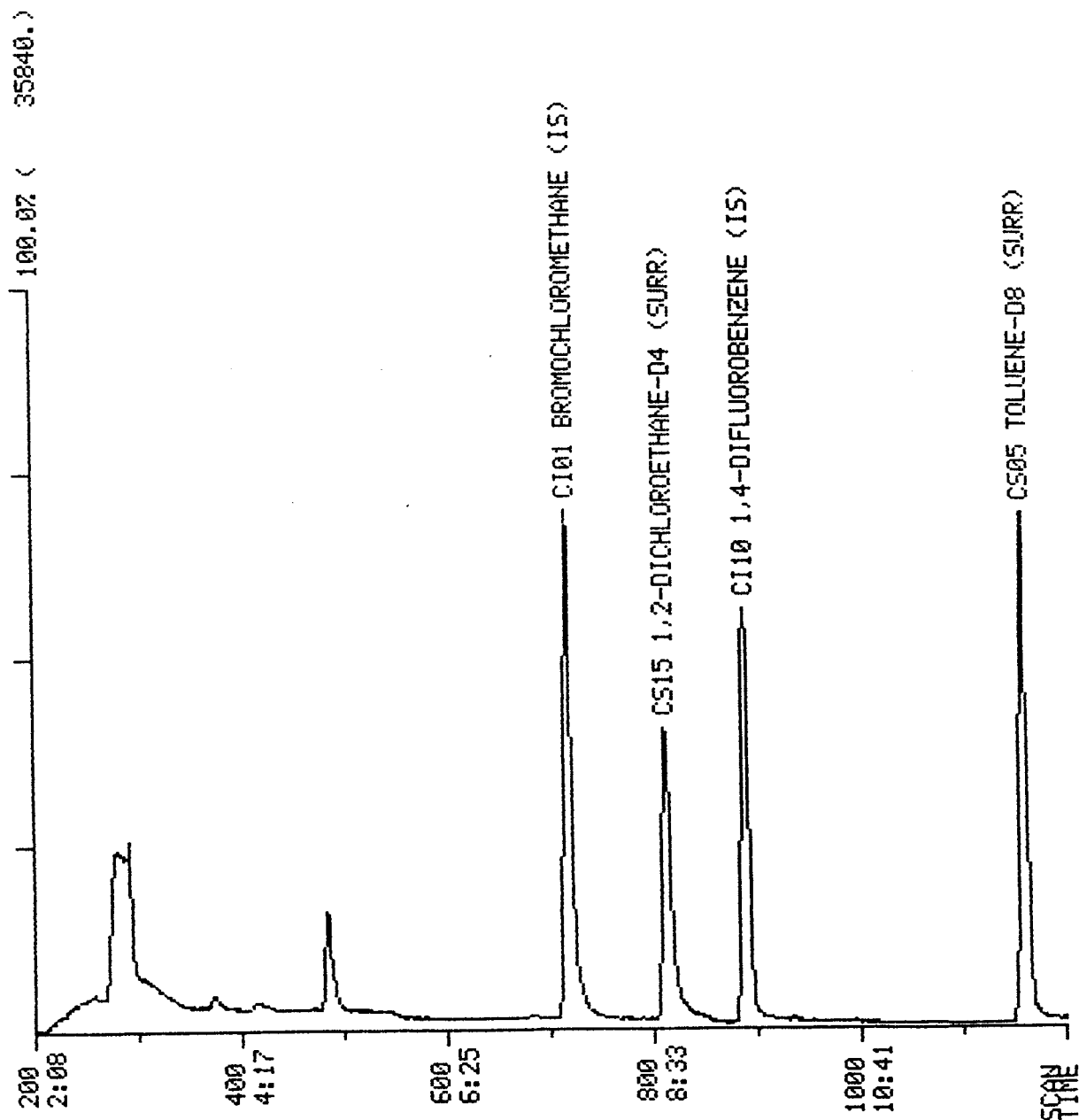
REPORTED 02/03/94 12:52CUSTOMER AWD

Notes and summary data for this report.

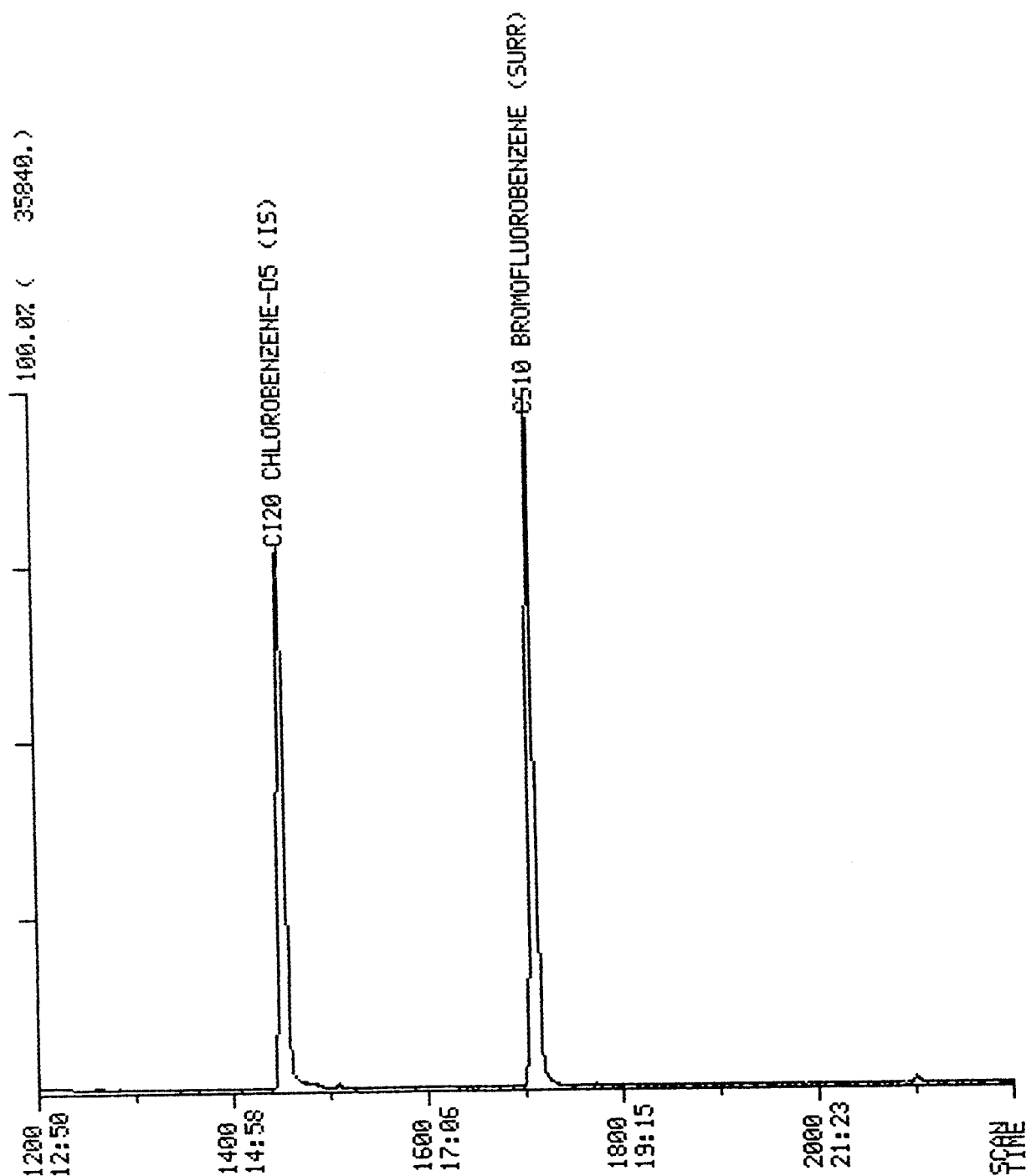
U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

007716

DATA FROM FILE: I020101 SCANS 200 TO 1200 ACQUIRED: 02/01/94 19:03:00
 CALI: I020101 #3 OUT OF 200 TO 2200
 SAMPLE: 9401337-01A AMD COL A/1:14 5ML
 CONDS.: 40(3)-18006/MIN CAPILLARY 75M



DATA FROM FILE: 1020101 SCANS 1200 TO 2200 ACQUIRED: 02/01/94 19:03:00
CALI: 1020101 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-01A AND COL A/1:14 5ML
CONDS.: 40(3)-18005/MIN CAPILLARY 75M



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

007718

CASE NO <u>401337</u>	LABORATORY <u>SwL - Houston</u>	CONTRACT <u>VOA ANALYSIS</u>
SAS NO <u> </u>	REPORTED <u>02/03/94 12:41</u>	CUSTOMER <u>AWD</u>

FILE NAME <u>I012802</u>	SAMPLE ID <u>COL A 2-11</u>	LEVEL <u>LOW</u>
TYPE <u>EPA</u>	LAB SAMP ID <u>9401337-02A</u>	MATRIX <u>WATER</u>
INST <u>FINN</u>	ANALYZED <u>01/28/94 18:14</u>	UNITS <u>ug/L</u>

ODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		10.0	U
C015	74-83-9	Bromomethane		10.0	U
020	75-01-4	Vinyl Chloride		10.0	U
C025	75-00-3	Chloroethane		10.0	U
C030	75-09-2	Methylene Chloride		15.6	
035	67-64-1	Acetone		50.0	U
C040	75-15-0	Carbon Disulfide		5.00	U
C045	75-35-4	1,1-Dichloroethene		5.00	U
050	75-34-3	1,1-Dichloroethane		5.00	U
0	540-59-0	1,2-Dichloroethene (Total)		5.00	U
C060	67-66-3	Chloroform		5.00	U
C065	107-06-2	1,2-Dichloroethane		5.00	U
110	78-93-3	Methylethyl ketone (MEK)		10.0	U
C115	71-55-6	1,1,1-Trichloroethane		5.00	U
C120	56-23-5	Carbon Tetrachloride		5.00	U
125	108-05-4	Vinyl Acetate		10.0	U
C130	75-27-4	Bromodichloromethane		5.00	U
C140	78-87-5	1,2-Dichloropropane		5.00	U
143	10061-01-5	cis-1,3-Dichloropropene		5.00	U
150	79-01-6	Trichloroethene		5.00	U
C155	124-48-1	Dibromochloromethane		5.00	U
C160	79-00-5	1,1,2-Trichloroethane		5.00	U
165	71-43-2	Benzene		5.00	U
C172	10061-02-6	trans-1,3-Dichloropropene		5.00	U
C180	75-25-2	Bromoform		5.00	U
205	108-10-1	4-Methyl-2-Pentanone		10.0	U
210	591-78-6	2-Hexanone		10.0	U
C220	127-18-4	Tetrachloroethene		5.00	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		5.00	U
230	108-88-3	Toluene		5.00	U
C235	108-90-7	Chlorobenzene		5.00	U
C240	100-41-4	Ethylbenzene		5.00	U
245	100-42-5	Styrene		5.00	U
C250	1330-20-7	Xylene (total)		5.00	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

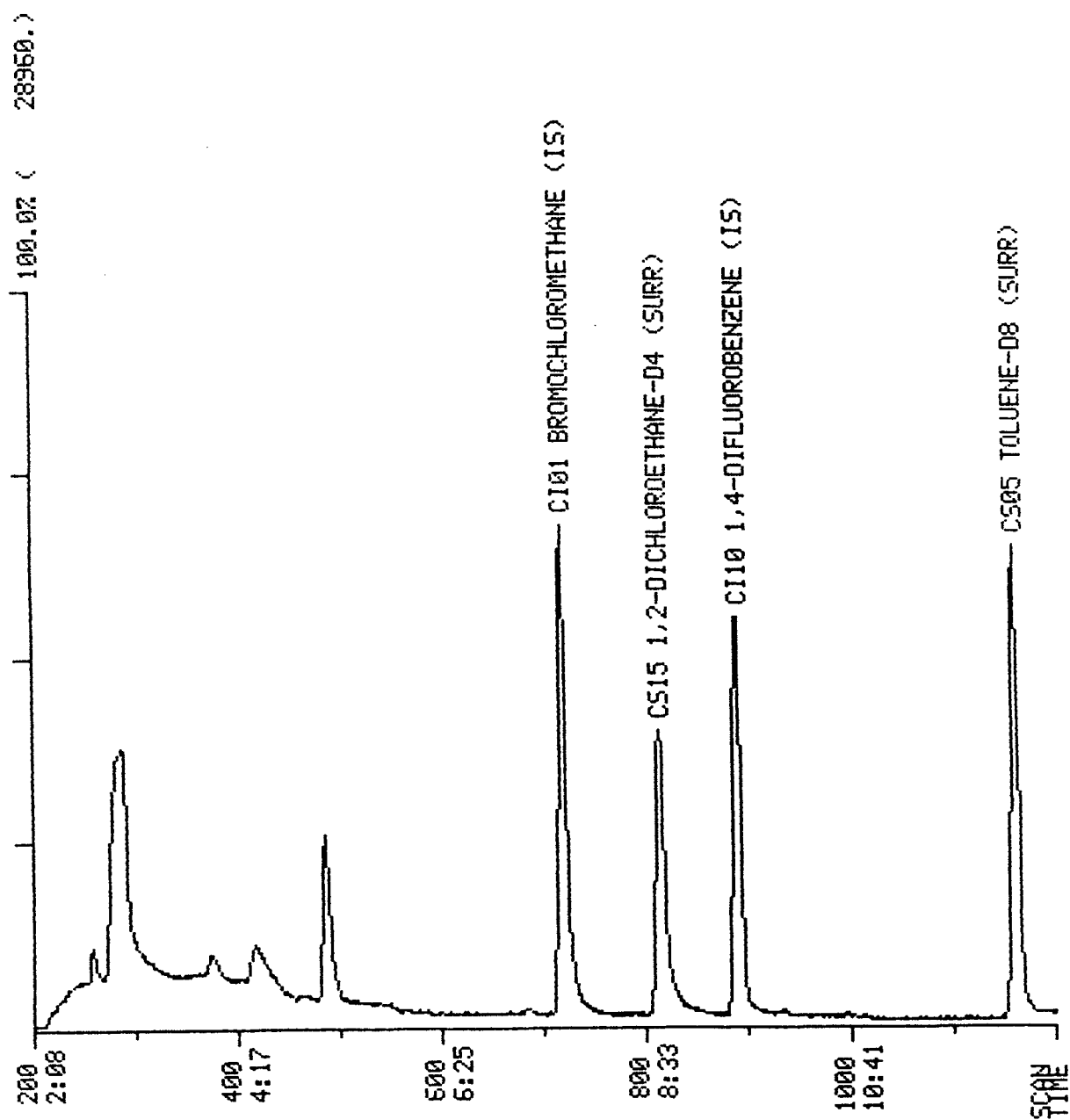
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO _____LABORATORY SwL - Houston
REPORTED 02/03/94 12:41CONTRACT VOA ANALYSIS
CUSTOMER AWD

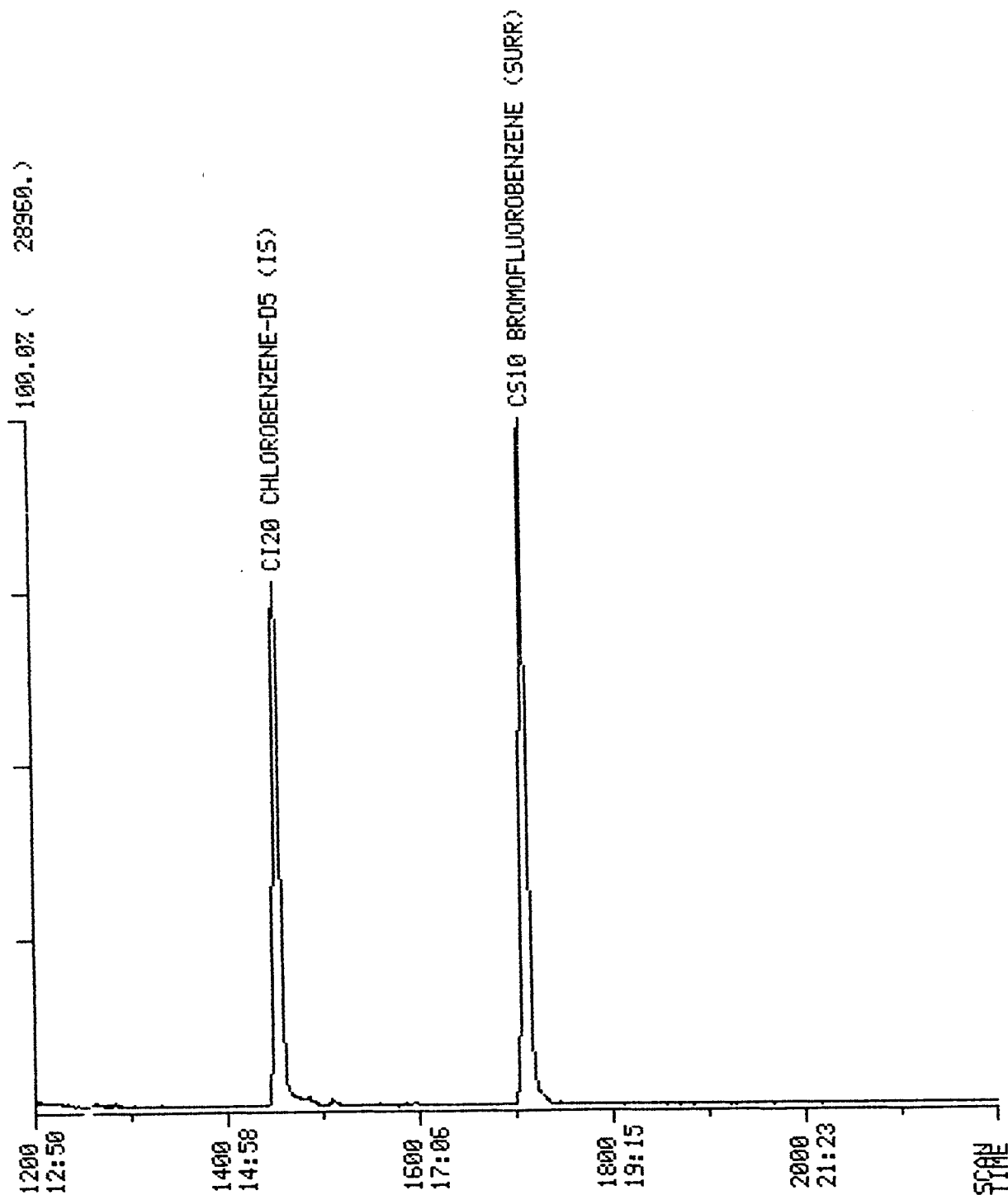
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012802 SCANS 200 TO 1200 ACQUIRED: 01/28/94 18:14:00
CALI: I012802 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-02A AND COL A/2:11 5ML
CONDS.: 40(3) 40-180 @ 6/MIN



DATA FROM FILE: I012802 SCANS 1200 TO 2200 ACQUIRED: 01/28/94 18:14:00
CALI: I012802 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-02A AND COL A/2:11 5ML
CONDS.: 40(3) 40-180 @ 6/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO LABORATORY SwL - Houston
REPORTED 02/03/94 12:42CONTRACT VOA ANALYSIS
CUSTOMER AWDFILE NAME I012803
TYPE EPA
INST FINNSAMPLE ID COL A 6-28
LAB SAMP ID 9401337-03A
ANALYZED 01/28/94 18:55LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
C020	75-01-4	Vinyl Chloride		200000	U
C025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		844000	
C035	67-64-1	Acetone		1000000	U
C040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
C050	75-34-3	1,1-Dichloroethane		100000	U
C060	540-59-0	1,2-Dichloroethene (Total)		100000	U
C060	67-66-3	Chloroform		100000	U
C065	107-06-2	1,2-Dichloroethane		100000	U
C110	78-93-3	Methylethyl ketone (MEK)		200000	U
C115	71-55-6	1,1,1-Trichloroethane		100000	U
C120	56-23-5	Carbon Tetrachloride		100000	U
C125	108-05-4	Vinyl Acetate		200000	U
C130	75-27-4	Bromodichloromethane		100000	U
C140	78-87-5	1,2-Dichloropropane		100000	U
C143	10061-01-5	cis-1,3-Dichloropropene		100000	U
C150	79-01-6	Trichloroethene		100000	U
C155	124-48-1	Dibromochloromethane		100000	U
C160	79-00-5	1,1,2-Trichloroethane		100000	U
C165	71-43-2	Benzene		100000	U
C172	10061-02-6	trans-1,3-Dichloropropene		100000	U
C180	75-25-2	Bromoform		100000	U
C205	108-10-1	4-Methyl-2-Pentanone		200000	U
C210	591-78-6	2-Hexanone		200000	U
C220	127-18-4	Tetrachloroethene		100000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
C230	108-88-3	Toluene		100000	U
C235	108-90-7	Chlorobenzene		100000	U
C240	100-41-4	Ethylbenzene		100000	U
C245	100-42-5	Styrene		100000	U
C250	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO _____

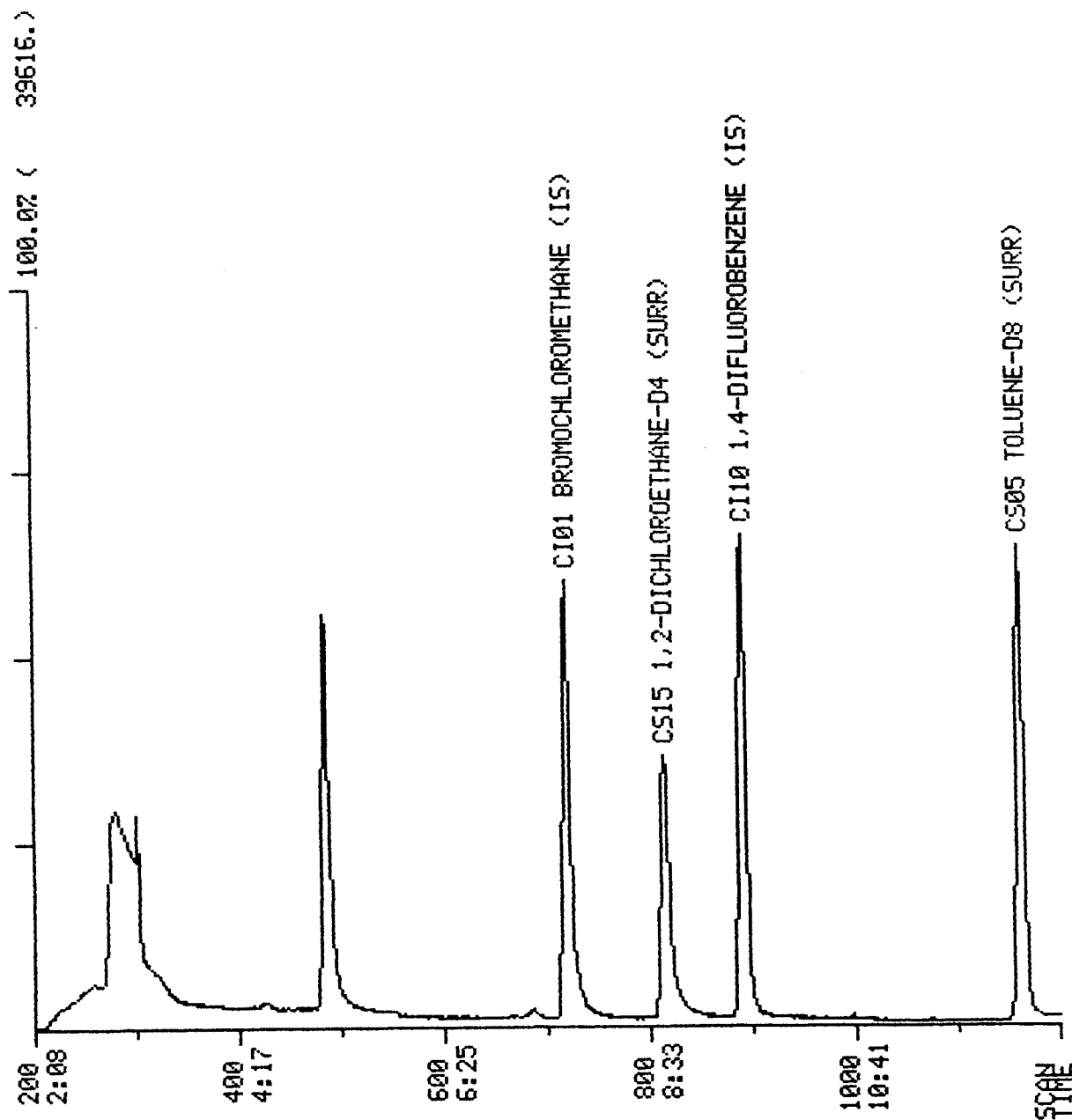
LABORATORY SwL - Houston
REPORTED 02/03/94 12:42

CONTRACT VOA ANALYSIS
CUSTOMER AWD

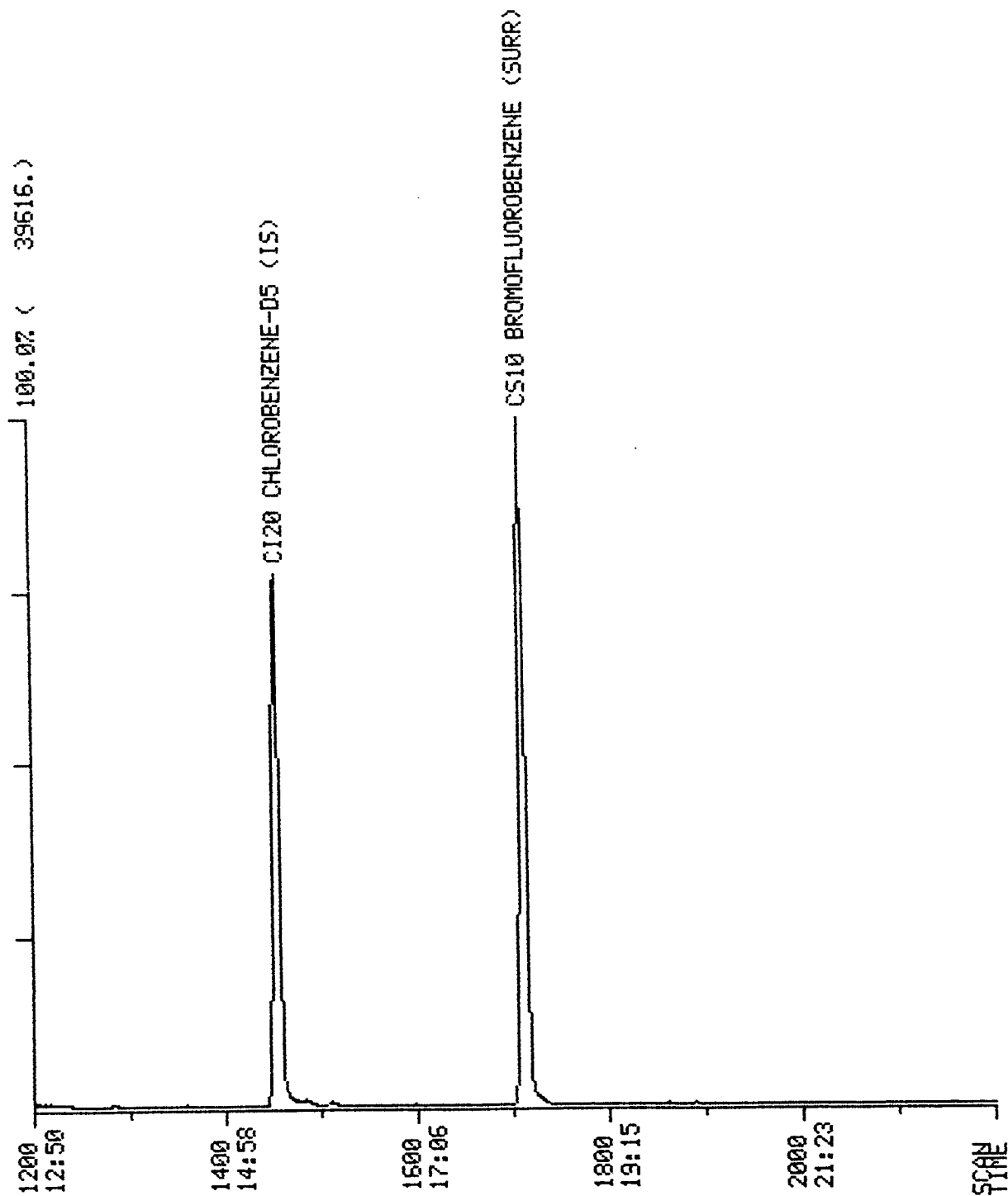
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012803 SCANS 200 TO 1200 ACQUIRED: 01/28/94 18:55:00
CALI: I012803 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-03A AND COL A/6:28 10UL/25UL/1ML
CONDS.: 40(3) 40-180 @ 5/MIN



DATA FROM FILE: I012803 SCANS 1200 TO 2200 ACQUIRED: 01/28/94 18:55:00
CALI: I012803 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-03A AND COL A/6:28 10UL/25UL/1ML
CONDS.: 40(3) 40-180 @ 6/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 401337
SAS NO _____LABORATORY SwL - Houston
REPORTED 02/03/94 12:43CONTRACT VOA ANALYSIS
CUSTOMER AWDFILE NAME I012804
TYPE EPA
INST FINNSAMPLE ID COL A 9-07
LAB SAMP ID 9401337-04A
ANALYZED 01/28/94 19:36LEVEL LOW
MATRIX WATER
UNITS ug/L

ODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
020	75-01-4	Vinyl Chloride		200000	U
C025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		6040000	
035	67-64-1	Acetone		1000000	U
040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
050	75-34-3	1,1-Dichloroethane		100000	U
0	540-59-0	1,2-Dichloroethene (Total)		100000	U
C060	67-66-3	Chloroform		100000	U
C065	107-06-2	1,2-Dichloroethane		100000	U
110	78-93-3	Methylethyl ketone (MEK)		200000	U
C115	71-55-6	1,1,1-Trichloroethane		100000	U
C120	56-23-5	Carbon Tetrachloride		100000	U
125	108-05-4	Vinyl Acetate		200000	U
130	75-27-4	Bromodichloromethane		100000	U
C140	78-87-5	1,2-Dichloropropane		100000	U
143	10061-01-5	cis-1,3-Dichloropropene		100000	U
150	79-01-6	Trichloroethene		100000	U
C155	124-48-1	Dibromochloromethane		100000	U
C160	79-00-5	1,1,2-Trichloroethane		100000	U
165	71-43-2	Benzene		100000	U
C172	10061-02-6	trans-1,3-Dichloropropene		100000	U
C180	75-25-2	Bromoform		100000	U
205	108-10-1	4-Methyl-2-Pentanone		200000	U
210	591-78-6	2-Hexanone		200000	U
C220	127-18-4	Tetrachloroethene		100000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
230	108-88-3	Toluene		100000	U
C235	108-90-7	Chlorobenzene		100000	U
C240	100-41-4	Ethylbenzene		100000	U
245	100-42-5	Styrene		100000	U
C250	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337LABORATORY SwL - HoustonCONTRACT VOA ANALYSIS

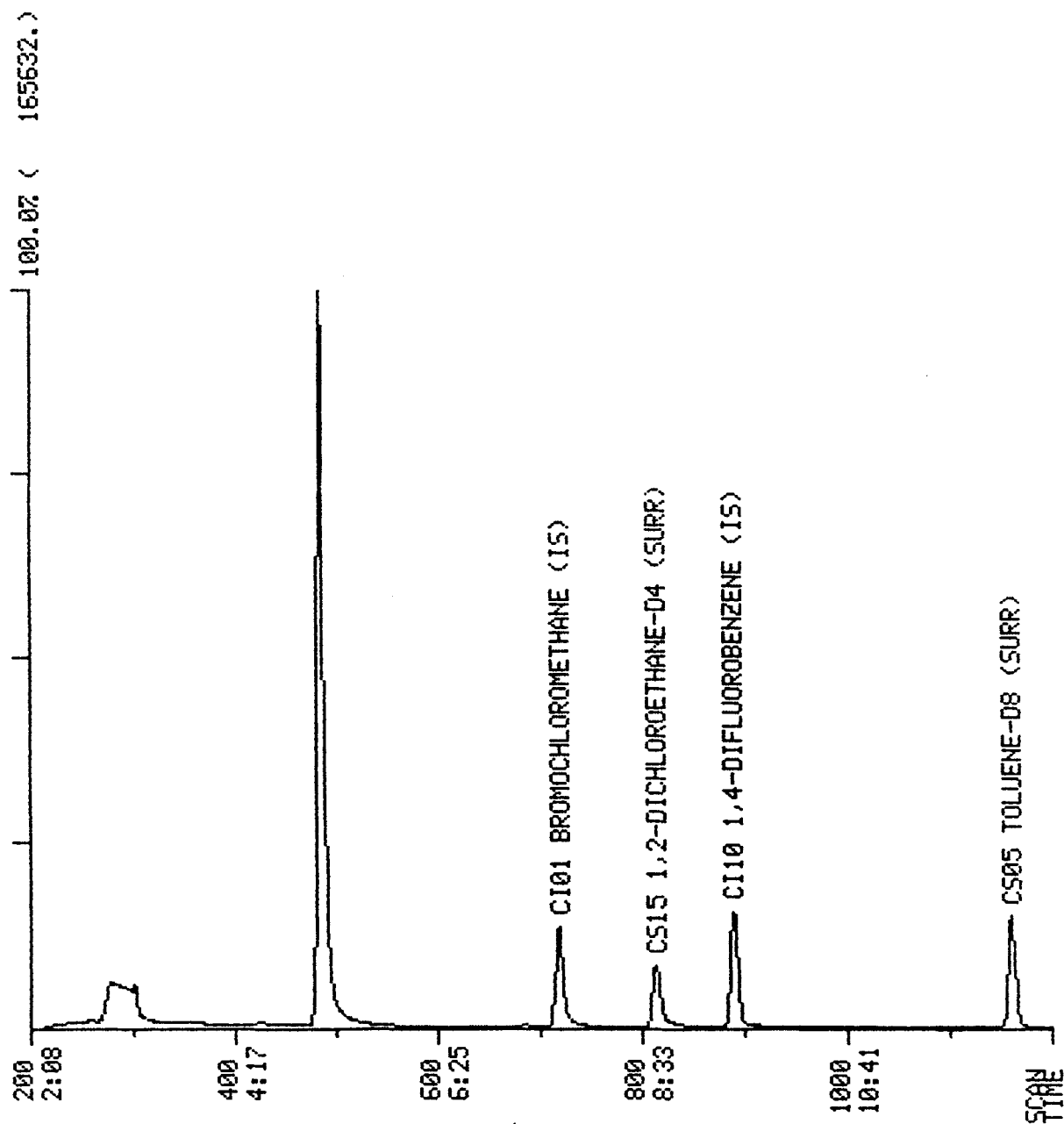
SAS NO _____

REPORTED 02/03/94 12:43CUSTOMER AWD

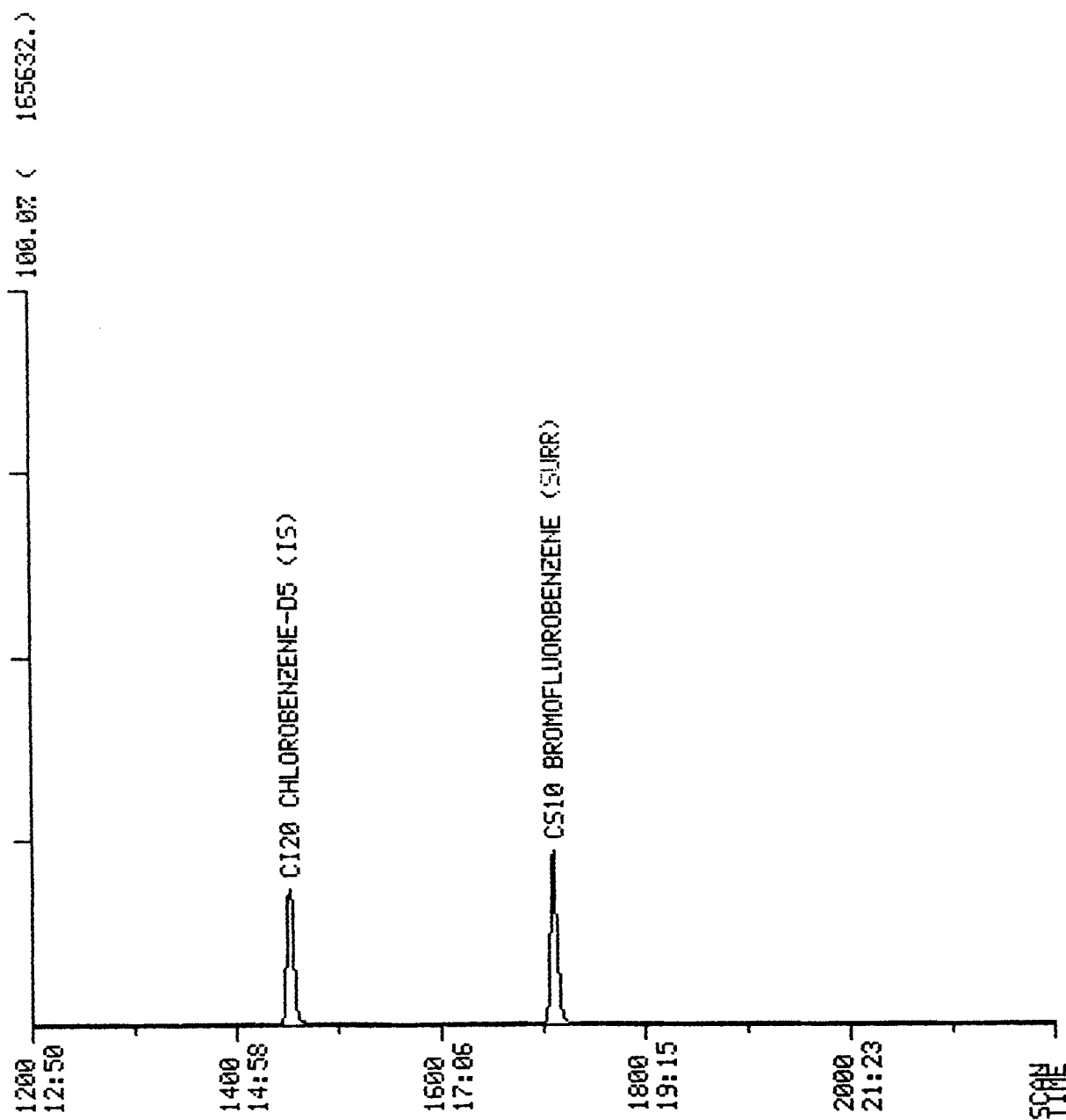
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012804 SCANS 200 TO 1200 ACQUIRED: 01/28/94 19:35:00
CALI: I012804 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-04A AND COL A/9:07 10UL/25UL/1ML
CONDS.: 40(3) 40-180 @ 5/MIN



DATA FROM FILE: I012804 SCANS 1200 TO 2200 ACQUIRED: 01/28/94 19:35:00
CALI: I012804 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-04A AND COL A/3:07 10UL/25UL/1ML
CONDS.: 40(3) 40-180 @ 5/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337

SAS NO

LABORATORY SwL - Houston

REPORTED 02/03/94 12:45

CONTRACT VOA ANALYSIS

CUSTOMER AWD

FILE NAME I012805

TYPE EPA

INST FINN

SAMPLE ID COL A 24-10

LAB SAMP ID 9401337-05A

ANALYZED 01/28/94 20:17

LEVEL LOW

MATRIX WATER

UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
C020	75-01-4	Vinyl Chloride		200000	U
C025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		6200000	
C035	67-64-1	Acetone		1000000	U
C040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
C050	75-34-3	1,1-Dichloroethane		100000	U
C060	540-59-0	1,2-Dichloroethene (Total)		100000	U
C060	67-66-3	Chloroform		100000	U
C065	107-06-2	1,2-Dichloroethane		100000	U
C110	78-93-3	Methylethyl ketone (MEK)		200000	U
C115	71-55-6	1,1,1-Trichloroethane		100000	U
C120	56-23-5	Carbon Tetrachloride		100000	U
C125	108-05-4	Vinyl Acetate		200000	U
C130	75-27-4	Bromodichloromethane		100000	U
C140	78-87-5	1,2-Dichloropropane		100000	U
C143	10061-01-5	cis-1,3-Dichloropropene		100000	U
C150	79-01-6	Trichloroethene		100000	U
C155	124-48-1	Dibromochloromethane		100000	U
C160	79-00-5	1,1,2-Trichloroethane		100000	U
C165	71-43-2	Benzene		100000	U
C172	10061-02-6	trans-1,3-Dichloropropene		100000	U
C180	75-25-2	Bromoform		100000	U
C205	108-10-1	4-Methyl-2-Pentanone		200000	U
C210	591-78-6	2-Hexanone		200000	U
C220	127-18-4	Tetrachloroethene		100000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
C230	108-88-3	Toluene		100000	U
C235	108-90-7	Chlorobenzene		100000	U
C240	100-41-4	Ethylbenzene		100000	U
C245	100-42-5	Styrene		100000	U
C250	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337LABORATORY SwL - HoustonCONTRACT VOA ANALYSIS

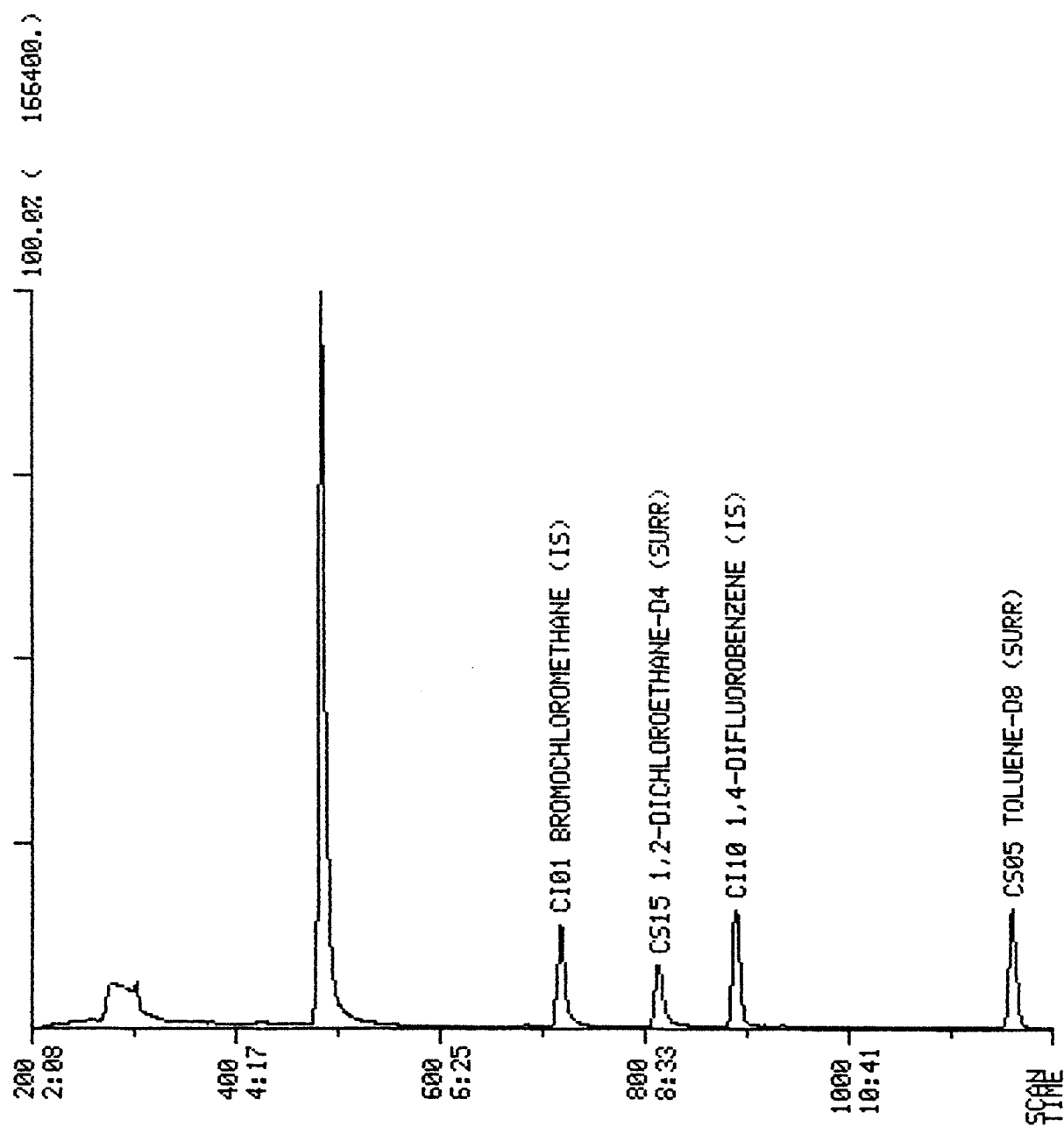
SAS NO _____

REPORTED 02/03/94 12:45CUSTOMER AWD

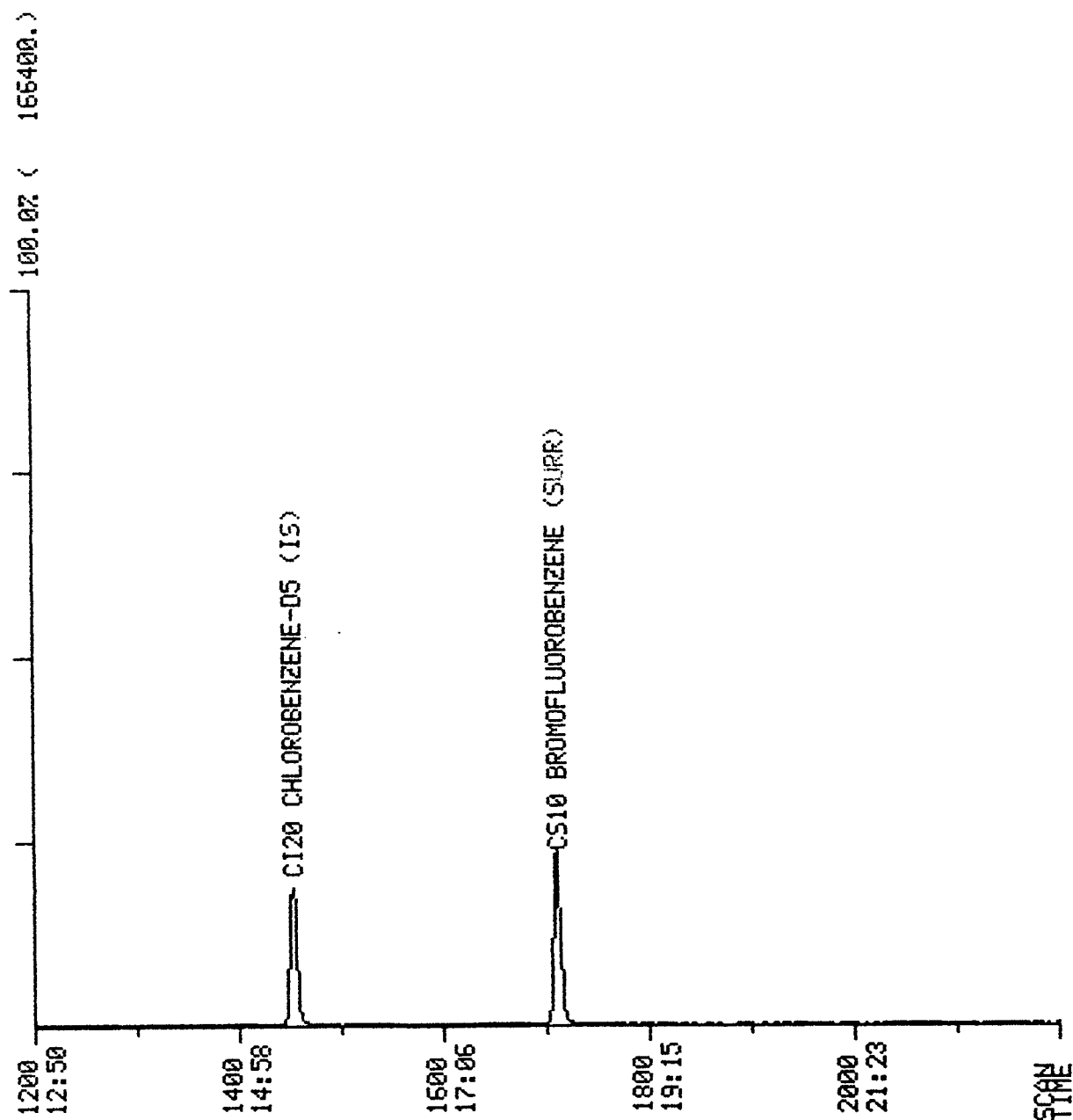
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

ATA FROM FILE: I012805 SCANS 200 TO 1200 ACQUIRED: 01/28/94 20:17:00
SAMPLE: 9401337-05A AND COL A/24:10 10UL/25UL/1ML
COND.: 40(3) 40-180 @ 6/MIN
CALI: I012805 #3 OUT OF 200 TO 2200



DATA FROM FILE: 1012805 SCANS 1200 TO 2200 ACQUIRED: 01/28/94 20:17:00
CALI: 1012805 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-05A AND COL A/24:10 10UL/25UL/1ML
COND5.: 40(3) 40-180 @ 6/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO _____LABORATORY SwL - Houston
REPORTED 02/03/94 12:46CONTRACT VOA ANALYSIS
CUSTOMER AWDFILE NAME 1012806
TYPE EPA
INST FINNSAMPLE ID INFLUENT 2-30
LAB SAMP ID 9401337-06A
ANALYZED 01/28/94 20:59LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
C020	75-01-4	Vinyl Chloride		200000	U
C025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		6000000	
C035	67-64-1	Acetone		1000000	U
C040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
C050	75-34-3	1,1-Dichloroethane		100000	U
C055	540-59-0	1,2-Dichloroethene (Total)		100000	U
C060	67-66-3	Chloroform		100000	U
C065	107-06-2	1,2-Dichloroethane		100000	U
C110	78-93-3	Methylethyl ketone (MEK)		200000	U
C115	71-55-6	1,1,1-Trichloroethane		100000	U
C120	56-23-5	Carbon Tetrachloride		100000	U
C125	108-05-4	Vinyl Acetate		200000	U
C130	75-27-4	Bromodichloromethane		100000	U
C140	78-87-5	1,2-Dichloropropane		100000	U
C143	10061-01-5	cis-1,3-Dichloropropene		100000	U
C150	79-01-6	Trichloroethene		100000	U
C155	124-48-1	Dibromochloromethane		100000	U
C160	79-00-5	1,1,2-Trichloroethane		100000	U
C165	71-43-2	Benzene		100000	U
C172	10061-02-6	trans-1,3-Dichloropropene		100000	U
C180	75-25-2	Bromoform		100000	U
C205	108-10-1	4-Methyl-2-Pentanone		200000	U
C210	591-78-6	2-Hexanone		200000	U
C220	127-18-4	Tetrachloroethene		100000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
C230	108-88-3	Toluene		100000	U
C235	108-90-7	Chlorobenzene		100000	U
C240	100-41-4	Ethylbenzene		100000	U
C245	100-42-5	Styrene		100000	U
C250	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337LABORATORY SwL - HoustonCONTRACT VOA ANALYSIS

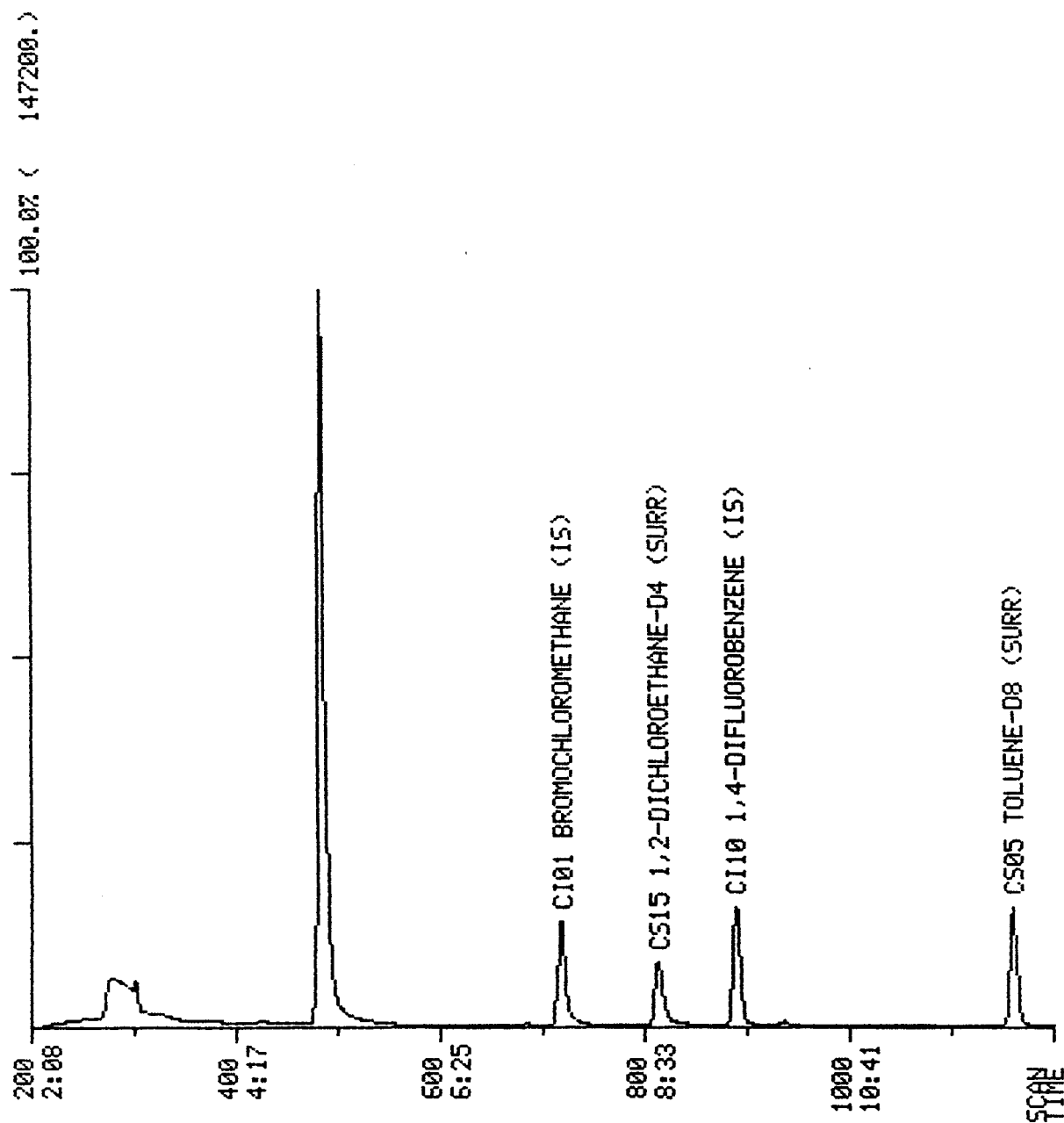
SAS NO _____

REPORTED 02/03/94 12:46CUSTOMER AWD

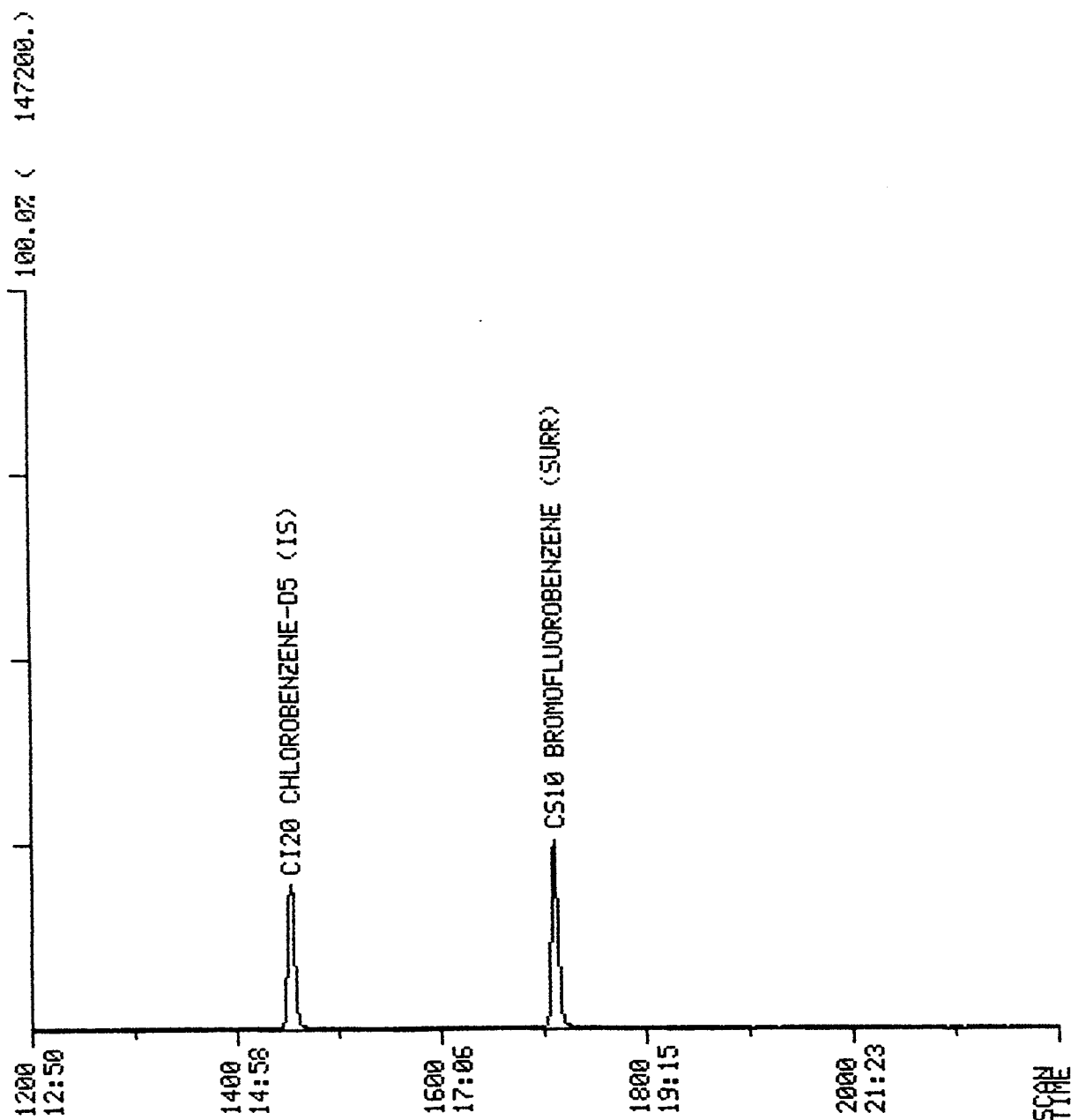
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012806 SCANS 200 TO 1200 ACQUIRED: 01/28/94 20:59:00
CALI: I012806 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-05A AND INFLUENT/2:30 10UL/25UL/1ML
CONDS.: 40(3) 40-180 @ 6/MIN



DATA FROM FILE: I012806 SCANS 1200 TO 2200 ACQUIRED: 01/28/94 20:59:00
CALI: I012806 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-06A AMD INFLUENT/2:30 10UL/25UL/1ML
CONDS.: 40(3) 40-180 @ 6/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 401337

SAS NO _____

LABORATORY SwL - HoustonREPORTED 02/03/94 12:53CONTRACT VDA ANALYSISCUSTOMER AWDFILE NAME I020102TYPE EPAINST FINNSAMPLE ID COL B 1-18LAB SAMP ID 9401337-07AANALYZED 02/01/94 19:44LEVEL LOWMATRIX WATERUNITS ug/L

ODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		10.0	U
C015	74-83-9	Bromomethane		10.0	U
C020	75-01-4	Vinyl Chloride		10.0	U
C025	75-00-3	Chloroethane		10.0	U
C030	75-09-2	Methylene Chloride		9.81	
C035	67-64-1	Acetone		50.0	U
C040	75-15-0	Carbon Disulfide		5.00	U
C045	75-35-4	1,1-Dichloroethene		5.00	U
C050	75-34-3	1,1-Dichloroethane		5.00	U
C060	540-59-0	1,2-Dichloroethene (Total)		5.00	U
C060	67-66-3	Chloroform		5.00	U
C065	107-06-2	1,2-Dichloroethane		5.00	U
C110	78-93-3	Methylethyl ketone (MEK)		10.0	U
C115	71-55-6	1,1,1-Trichloroethane		5.00	U
C120	56-23-5	Carbon Tetrachloride		5.00	U
C125	108-05-4	Vinyl Acetate		10.0	U
C130	75-27-4	Bromodichloromethane		5.00	U
C140	78-87-5	1,2-Dichloropropane		5.00	U
C143	10061-01-5	cis-1,3-Dichloropropene		5.00	U
C150	79-01-6	Trichloroethene		5.00	U
C155	124-48-1	Dibromochloromethane		5.00	U
C160	79-00-5	1,1,2-Trichloroethane		5.00	U
C165	71-43-2	Benzene		5.00	U
C172	10061-02-6	trans-1,3-Dichloropropene		5.00	U
C180	75-25-2	Bromoform		5.00	U
C205	108-10-1	4-Methyl-2-Pentanone		10.0	U
C210	591-78-6	2-Hexanone		10.0	U
C220	127-18-4	Tetrachloroethene		5.00	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		5.00	U
C230	108-88-3	Toluene		5.00	U
C235	108-90-7	Chlorobenzene		5.00	U
C240	100-41-4	Ethylbenzene		5.00	U
C245	100-42-5	Styrene		5.00	U
C250	1330-20-7	Xylene (total)		5.00	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

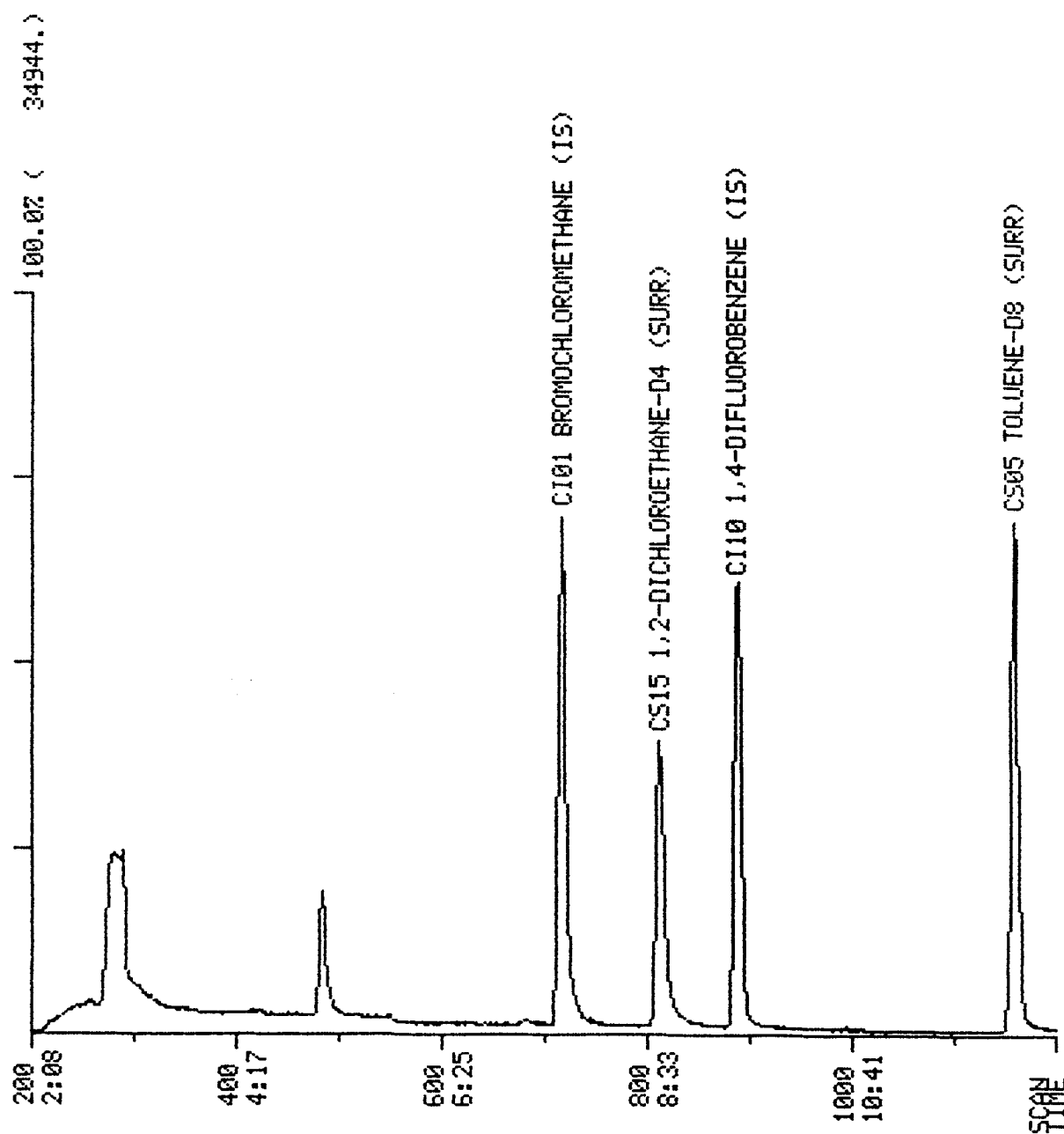
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337LABORATORY SwL - HoustonCONTRACT VOA ANALYSISSAS NO REPORTED 02/03/94 12:53CUSTOMER AWD

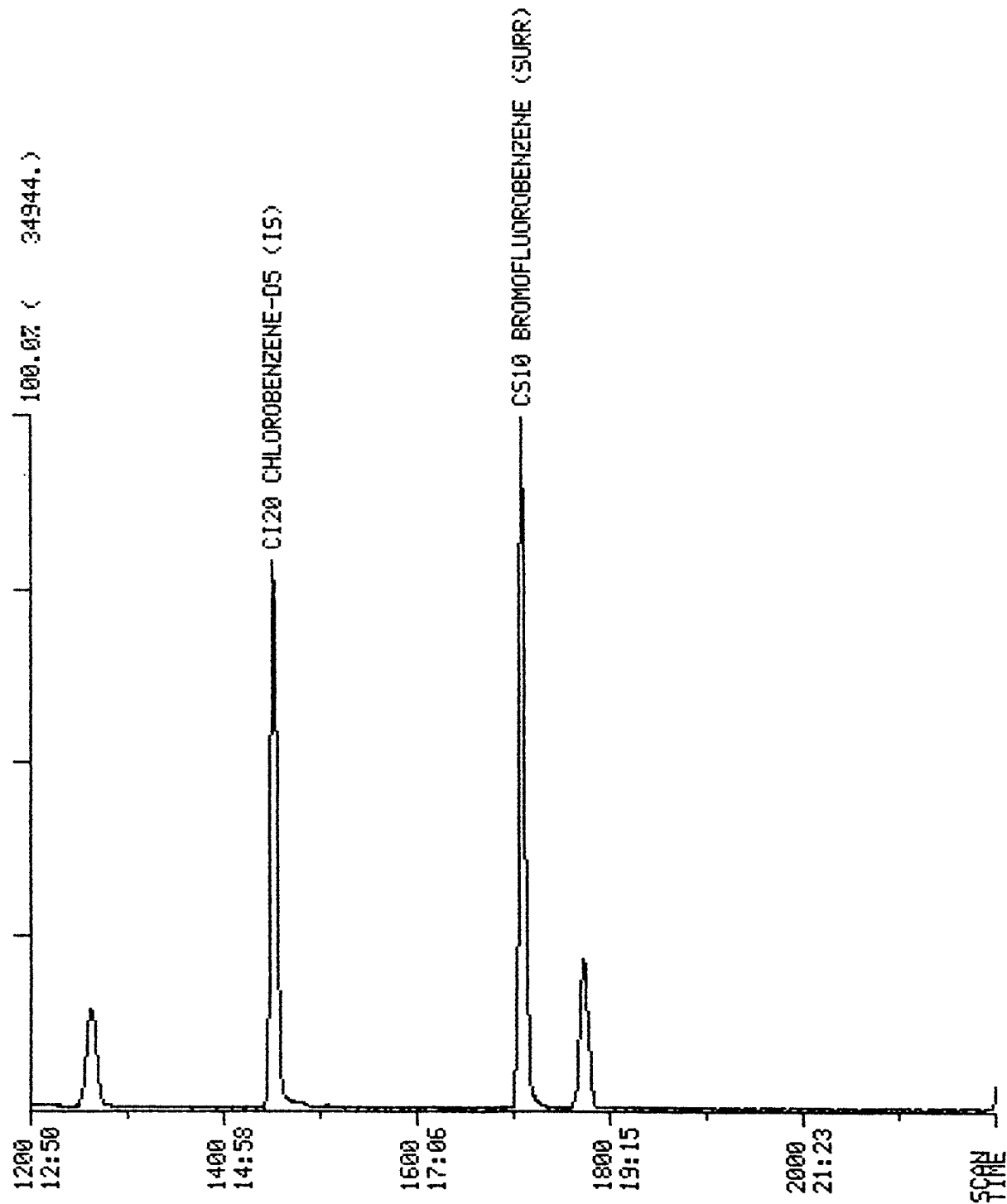
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I020102 SCANS 200 TO 1200 ACQUIRED: 02/01/94 19:44:00
CALI: I020102 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-07A AND COL B/1:18 5ML
COND5.: 40(3)-18005/MIN CAPILLARY 75M



DATA FROM FILE: 1020102 SCANS 1200 TO 2200 ACQUIRED: 02/01/94 19:44:00
CALI: 1020102 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-07A AMD COL B/1:18 SML
COND5.: 40(3)-18005/MIN CAPILLARY 75M



VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337

SAS NO

LABORATORY SWL - Houston

REPORTED 02/03/94 12:40

CONTRACT VOA ANALYSIS

CUSTOMER AWD

FILE NAME I012608

TYPE EPA

INST FINN

SAMPLE ID COL B 2-07

LAB SAMP ID 9401337-08A

ANALYZED 01/26/94 23:55

LEVEL LOW

MATRIX WATER

UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		50.0	U
C015	74-83-9	Bromomethane		50.0	U
C020	75-01-4	Vinyl Chloride		50.0	U
C025	75-00-3	Chloroethane		50.0	U
C030	75-09-2	Methylene Chloride		1320	
C035	67-64-1	Acetone		250	U
C040	75-15-0	Carbon Disulfide		25.0	U
C045	75-35-4	1,1-Dichloroethene		25.0	U
C050	75-34-3	1,1-Dichloroethane		25.0	U
C055	540-59-0	1,2-Dichloroethene (Total)		25.0	U
C060	67-66-3	Chloroform		25.0	U
C065	107-06-2	1,2-Dichloroethane		25.0	U
C110	78-93-3	Methylethyl ketone (MEK)		50.0	U
C115	71-55-6	1,1,1-Trichloroethane		25.0	U
C120	56-23-5	Carbon Tetrachloride		25.0	U
C125	108-05-4	Vinyl Acetate		50.0	U
C130	75-27-4	Bromodichloromethane		25.0	U
C140	78-87-5	1,2-Dichloropropane		25.0	U
C143	10061-01-5	cis-1,3-Dichloropropene		25.0	U
C150	79-01-6	Trichloroethene		132	
C155	124-48-1	Dibromochloromethane		25.0	U
C160	79-00-5	1,1,2-Trichloroethane		25.0	U
C165	71-43-2	Benzene		25.0	U
C172	10061-02-6	trans-1,3-Dichloropropene		25.0	U
C180	75-25-2	Bromoform		25.0	U
C205	108-10-1	4-Methyl-2-Pentanone		50.0	U
C210	591-78-6	2-Hexanone		50.0	U
C220	127-18-4	Tetrachloroethene		25.0	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		25.0	U
C230	108-88-3	Toluene		25.0	U
C235	108-90-7	Chlorobenzene		25.0	U
C240	100-41-4	Ethylbenzene		25.0	U
C245	100-42-5	Styrene		25.0	U
C250	1330-20-7	Xylene (total)		25.0	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337

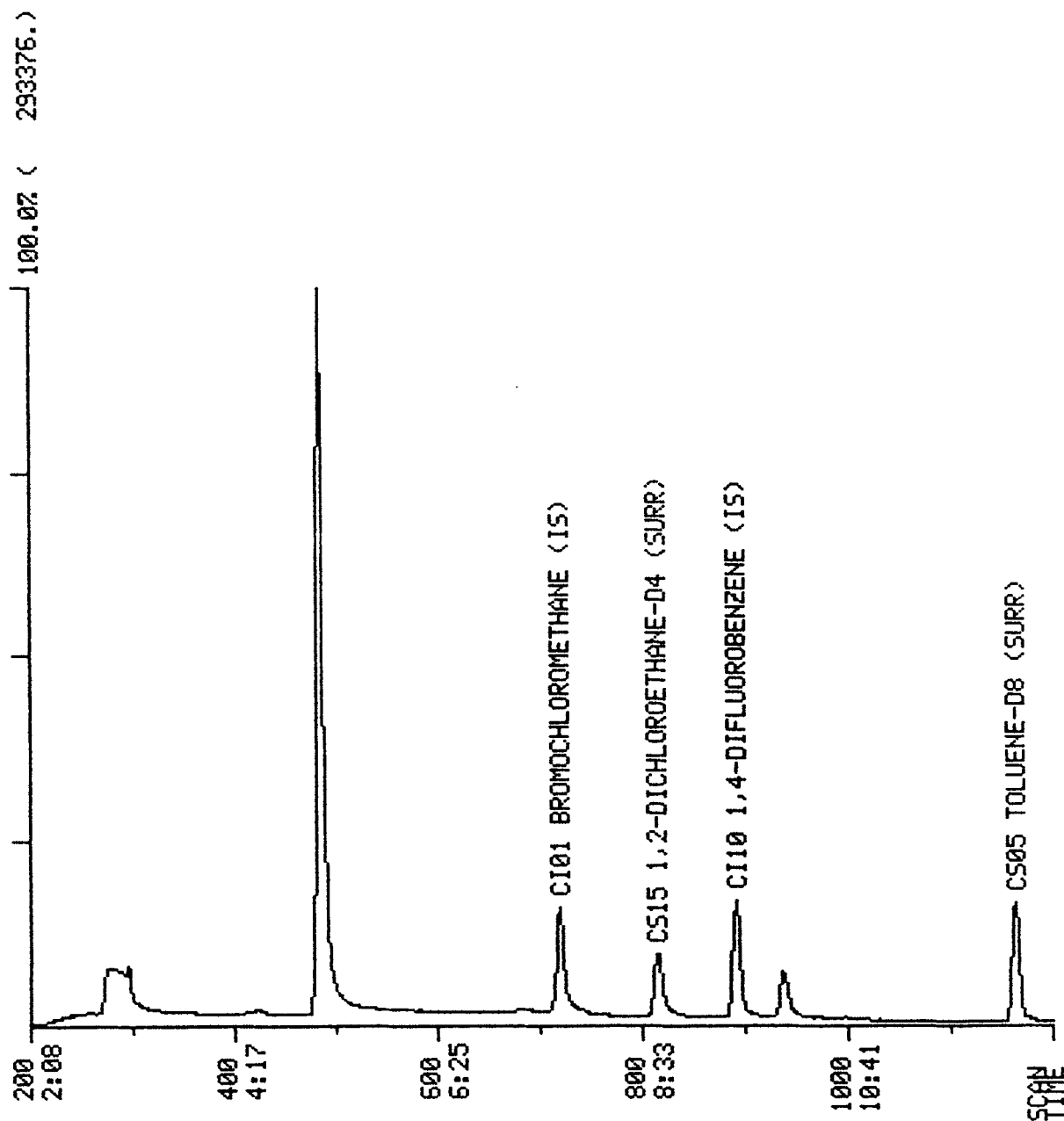
SAS NO _____

LABORATORY SwL - HoustonREPORTED 02/03/94 12:40CONTRACT VOA ANALYSISCUSTOMER AWD

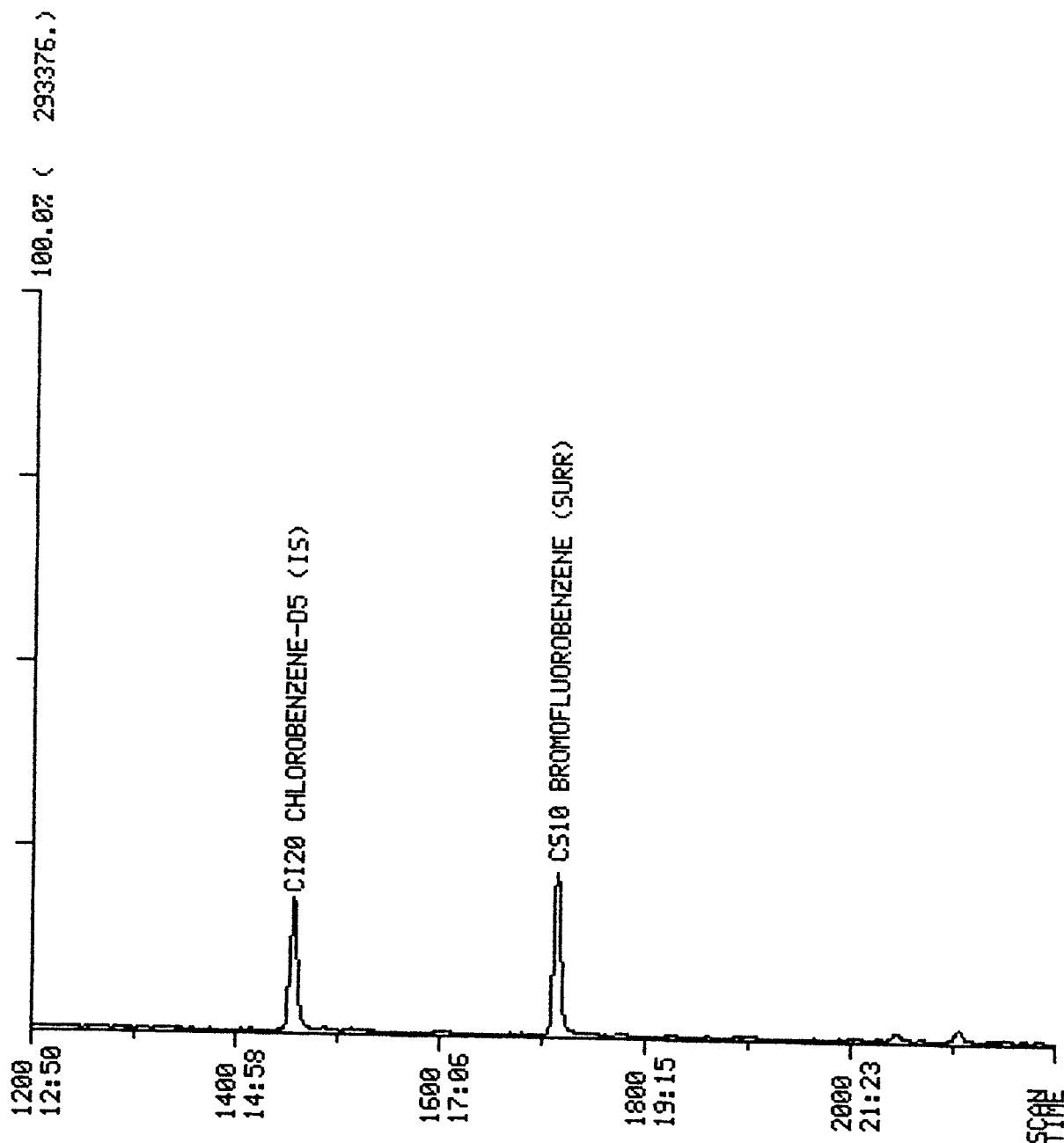
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012508 SCANS 200 TO 1200 ACQUIRED: 01/26/94 23:55:00
SAMPLE: 9401337-08A AWD COL B/2:05 1ML CALI: I012508 #3 OUT OF 200 TO 2200
CONDS.: 40(3) 40-180 @ 6/MIN



DATA FROM FILE: I012508 SCANS 1200 TO 2200 ACQUIRED: 01/26/94 23:55:00
SAMPLE: 9401337-08A AND COL B/2:06 1ML CALI: I012508 #3 OUT OF 200 TO 2200
CONDS.: 40(3) 40-180 @ 5/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337

SAS NO _____

LABORATORY SwL - Houston
REPORTED 02/03/94 12:40CONTRACT VOA ANALYSIS
CUSTOMER AWDFILE NAME I012609TYPE EPAINST FINNSAMPLE ID COL B 6-17LAB SAMP ID 9401337-09AANALYZED 01/27/94 00:37LEVEL LOWMATRIX WATERUNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane			
C015	74-83-9	Bromomethane		50.0	U
C020	75-01-4	Vinyl Chloride		50.0	U
C025	75-00-3	Chloroethane		50.0	U
C030	75-09-2	Methylene Chloride		50.0	U
C035	67-64-1	Acetone		830	
C040	75-15-0	Carbon Disulfide		250	U
C045	75-35-4	1,1-Dichloroethene		25.0	U
C050	75-34-3	1,1-Dichloroethane		25.0	U
C060	540-59-0	1,2-Dichloroethene (Total)		25.0	U
C065	67-66-3	Chloroform		25.0	U
C110	107-06-2	1,2-Dichloroethane		25.0	U
C115	78-93-3	Methylethyl ketone (MEK)		25.0	U
C120	71-55-6	1,1,1-Trichloroethane		50.0	U
C125	56-23-5	Carbon Tetrachloride		25.0	U
C130	108-05-4	Vinyl Acetate		25.0	U
C140	75-27-4	Bromodichloromethane		50.0	U
C143	78-87-5	1,2-Dichloropropane		25.0	U
C150	10061-01-5	cis-1,3-Dichloropropene		25.0	U
C155	79-01-6	Trichloroethene		25.0	U
C160	124-48-1	Dibromochloromethane		70.5	
C165	79-00-5	1,1,2-Trichloroethane		25.0	U
C172	71-43-2	Benzene		25.0	U
C180	10061-02-6	trans-1,3-Dichloropropene		25.0	U
C205	75-25-2	Bromoform		25.0	U
C210	108-10-1	4-Methyl-2-Pentanone		25.0	U
C220	591-78-6	2-Hexanone		50.0	U
C225	127-18-4	Tetrachloroethene		50.0	U
C230	79-34-5	1,1,2,2-Tetrachloroethane		25.0	U
C235	108-88-3	Toluene		25.0	U
C240	108-90-7	Chlorobenzene		25.0	U
C245	100-41-4	Ethylbenzene		25.0	U
C250	100-42-5	Styrene		25.0	U
	1330-20-7	Xylene (total)		25.0	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

007746 2

CASE NO 401337
SAS NO _____

LABORATORY SwL - Houston
REPORTED 02/03/94 12:40

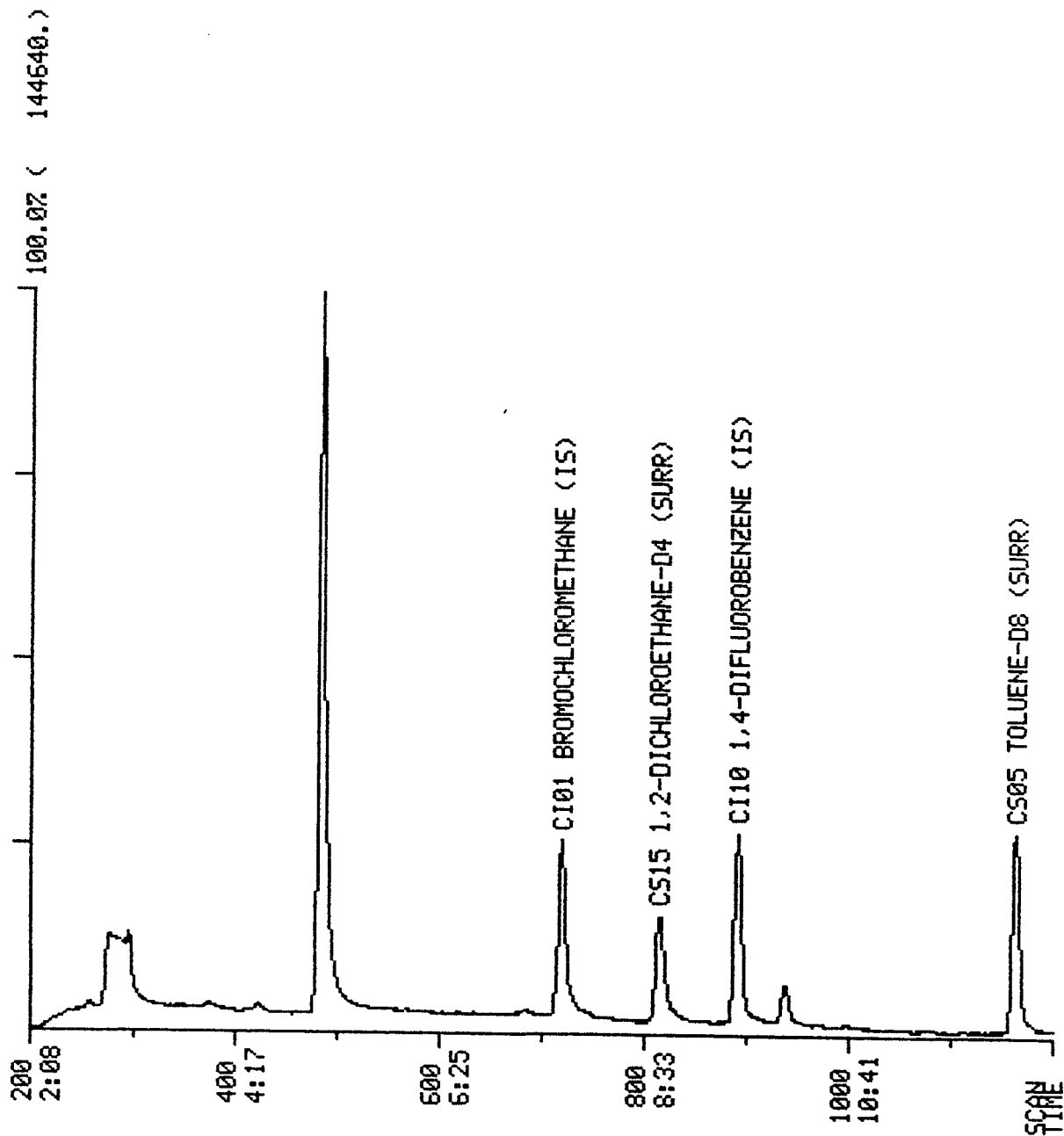
CONTRACT VOA ANALYSIS
CUSTOMER AWD

Notes and summary data for this report.

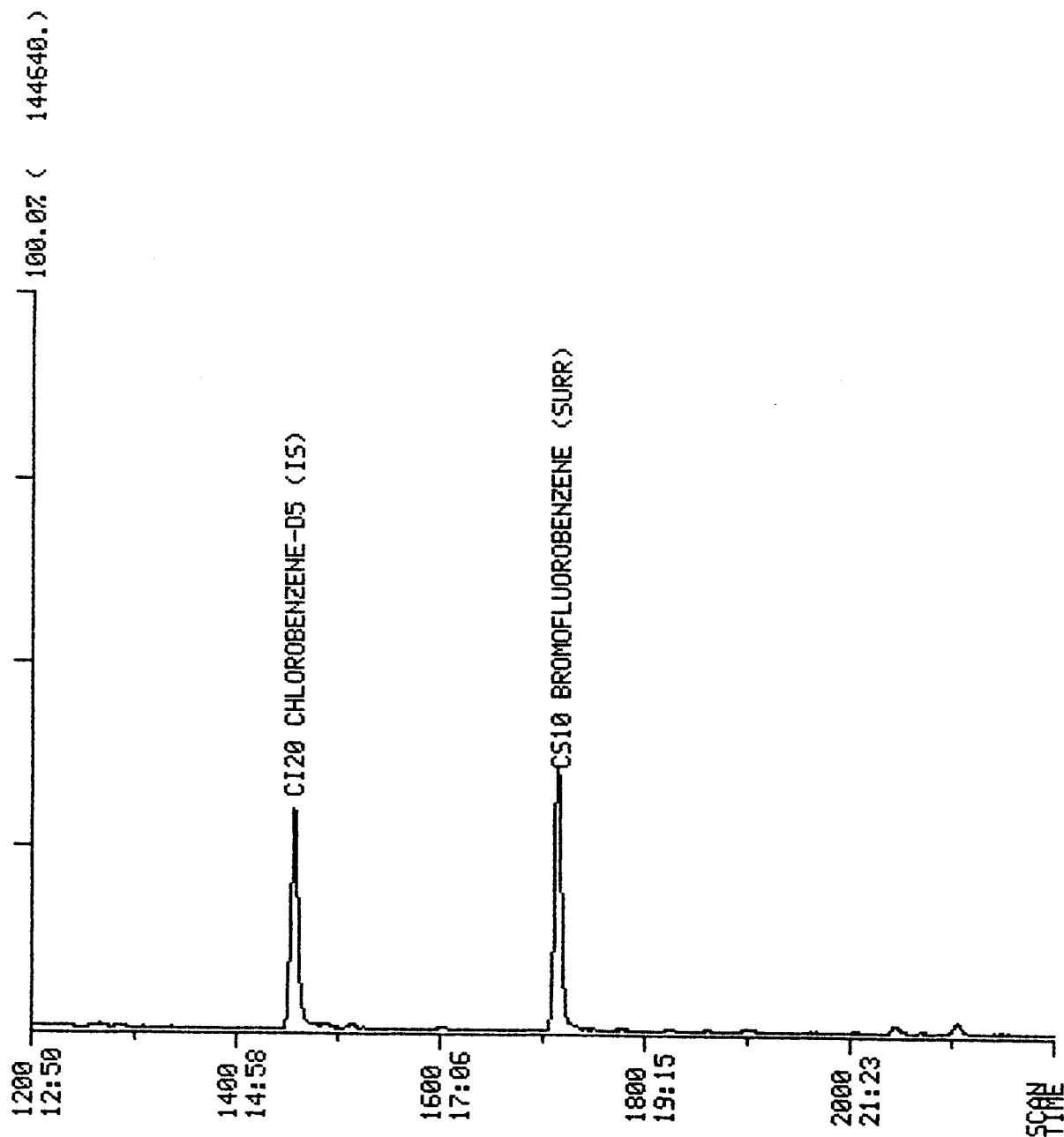
U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

007747

DATA FROM FILE: I012509 SCANS 200 TO 1200 ACQUIRED: 01/27/94 0:37:00
SAMPLE: 9401337-09A AMD COL B/6:17 1ML CALI: I012509 #3 OUT OF 200 TO 2200
CONDS.: 40(3) 40-180 @ 6/MIN



DATA FROM FILE: I012609 SCANS 1200 TO 2200 ACQUIRED: 01/27/94 0:37:00
CALI: I012609 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-09A AND COL B/6:17 1ML
COND.: 40(3) 40-180 @ 6/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO

LABORATORY SwL - Houston
REPORTED 02/03/94 12:41

CONTRACT VOA ANALYSIS
CUSTOMER AWD

FILE NAME I012610
TYPE EPA
INST FINN

SAMPLE ID COL B 9-01
LAB SAMP ID 9401337-10A
ANALYZED 01/27/94 01:19

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		50.0	U
C015	74-83-9	Bromomethane		50.0	U
020	75-01-4	Vinyl Chloride		50.0	U
025	75-00-3	Chloroethane		50.0	U
C030	75-09-2	Methylene Chloride		550	
035	67-64-1	Acetone		250	U
040	75-15-0	Carbon Disulfide		25.0	U
C045	75-35-4	1,1-Dichloroethene		25.0	U
C050	75-34-3	1,1-Dichloroethane		25.0	U
0	540-59-0	1,2-Dichloroethene (Total)		25.0	U
C060	67-66-3	Chloroform		25.0	U
C065	107-06-2	1,2-Dichloroethane		25.0	U
110	78-93-3	Methylethyl ketone (MEK)		50.0	U
115	71-55-6	1,1,1-Trichloroethane		25.0	U
C120	56-23-5	Carbon Tetrachloride		25.0	U
C125	108-05-4	Vinyl Acetate		50.0	U
130	75-27-4	Bromodichloromethane		25.0	U
C140	78-87-5	1,2-Dichloropropane		25.0	U
C143	10061-01-5	cis-1,3-Dichloropropene		25.0	U
150	79-01-6	Trichloroethene		46.1	
C155	124-48-1	Dibromochloromethane		25.0	U
C160	79-00-5	1,1,2-Trichloroethane		25.0	U
165	71-43-2	Benzene		25.0	U
172	10061-02-6	trans-1,3-Dichloropropene		25.0	U
C180	75-25-2	Bromoform		25.0	U
C205	108-10-1	4-Methyl-2-Pentanone		50.0	U
210	591-78-6	2-Hexanone		50.0	U
C220	127-18-4	Tetrachloroethene		25.0	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		25.0	U
230	108-88-3	Toluene		25.0	U
C235	108-90-7	Chlorobenzene		25.0	U
C240	100-41-4	Ethylbenzene		25.0	U
245	100-42-5	Styrene		25.0	U
250	1330-20-7	Xylene (total)		25.0	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337

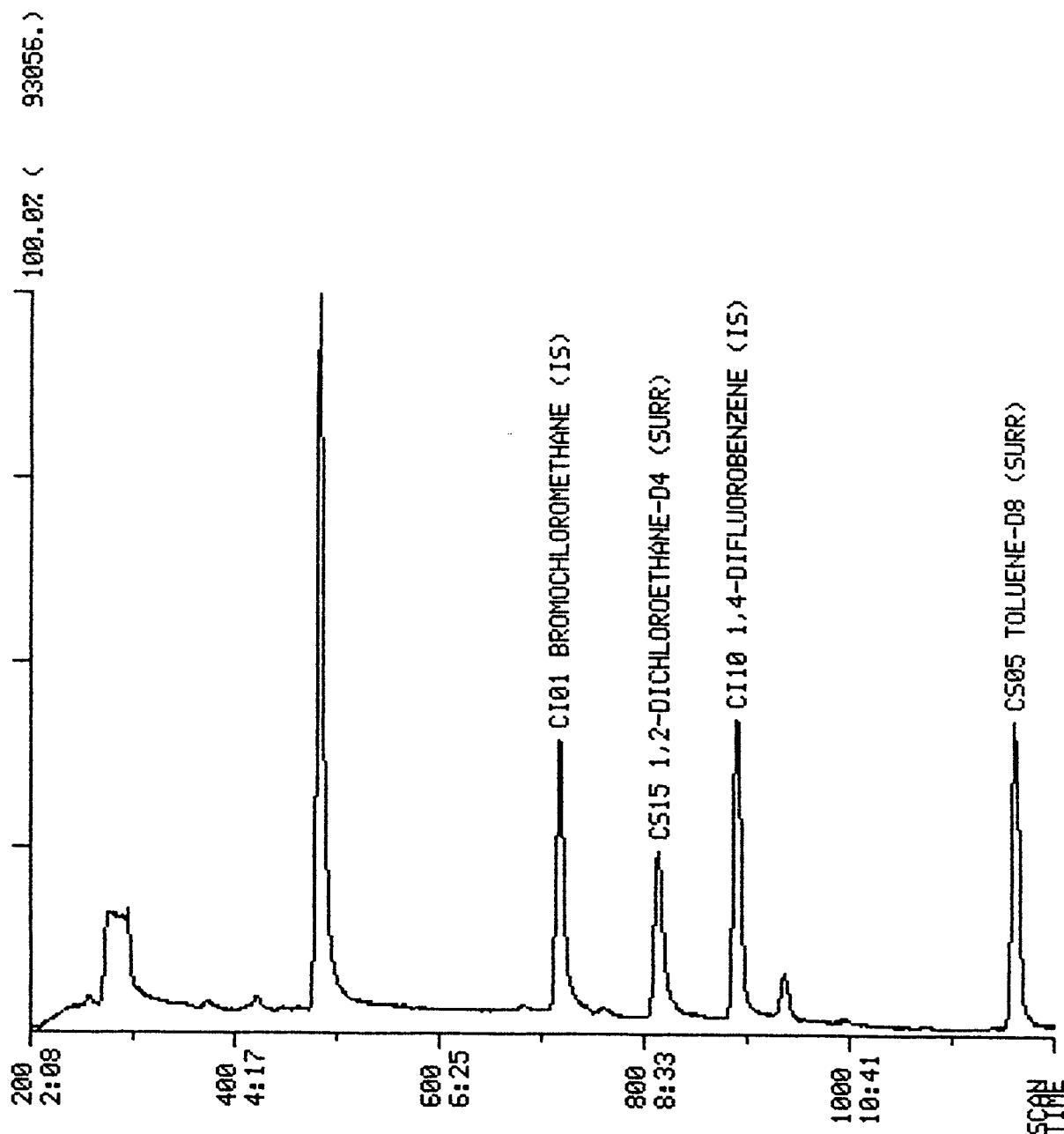
SAS NO _____

LABORATORY SwL - HoustonREPORTED 02/03/94 12:41CONTRACT VOA ANALYSISCUSTOMER AWD

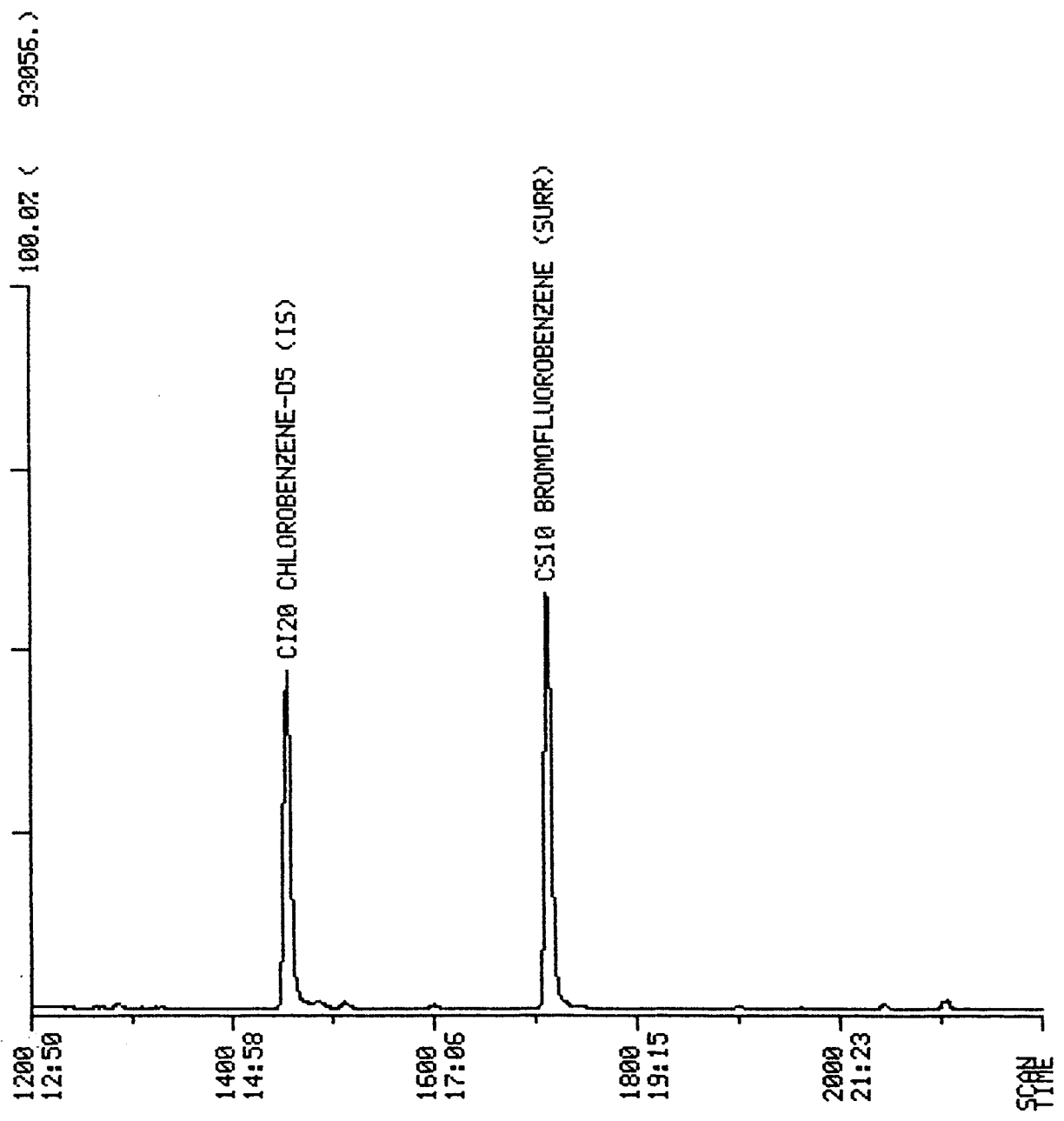
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012610 SCANS 200 TO 1200 ACQUIRED: 01/27/94 1:19:00
SAMPLE: 9401337-10A AND COL B/3:01 1ML CALI: I012610 #3 OUT OF 200 TO 2200
CONDS.: 40(3) 40-180 @ 6/MIN



DATA FROM FILE: I012610 SCANS 1200 TO 2200 ACQUIRED: 01/27/94 1:19:00
CALI: I012610 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-10A AND COL B/9:01 1ML
CONDS.: 40(3) 40-180 @ 6/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO

LABORATORY SwL - Houston
REPORTED 02/03/94 12:47

CONTRACT VOA ANALYSIS
CUSTOMER AWD

FILE NAME I012808
TYPE EPA
INST FINN

SAMPLE ID COL B 24-02
LAB SAMP ID 9401337-11A
ANALYZED 01/28/94 22:21

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
C020	75-01-4	Vinyl Chloride		200000	U
C025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		5340000	
C035	67-64-1	Acetone		1000000	U
C040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
C050	75-34-3	1,1-Dichloroethane		100000	U
C055	540-59-0	1,2-Dichloroethene (Total)		100000	U
C060	67-66-3	Chloroform		100000	U
C065	107-06-2	1,2-Dichloroethane		100000	U
C110	78-93-3	Methylethyl ketone (MEK)		200000	U
C115	71-55-6	1,1,1-Trichloroethane		100000	U
C120	56-23-5	Carbon Tetrachloride		100000	U
C125	108-05-4	Vinyl Acetate		200000	U
C130	75-27-4	Bromodichloromethane		100000	U
C140	78-87-5	1,2-Dichloropropane		100000	U
C143	10061-01-5	cis-1,3-Dichloropropene		100000	U
C150	79-01-6	Trichloroethene		100000	U
C155	124-48-1	Dibromochloromethane		100000	U
C160	79-00-5	1,1,2-Trichloroethane		100000	U
C165	71-43-2	Benzene		100000	U
C172	10061-02-6	trans-1,3-Dichloropropene		100000	U
C180	75-25-2	Bromoform		100000	U
C205	108-10-1	4-Methyl-2-Pentanone		200000	U
C210	591-78-6	2-Hexanone		200000	U
C220	127-18-4	Tetrachloroethene		100000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
C230	108-88-3	Toluene		100000	U
C235	108-90-7	Chlorobenzene		100000	U
C240	100-41-4	Ethylbenzene		100000	U
C245	100-42-5	Styrene		100000	U
C250	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337

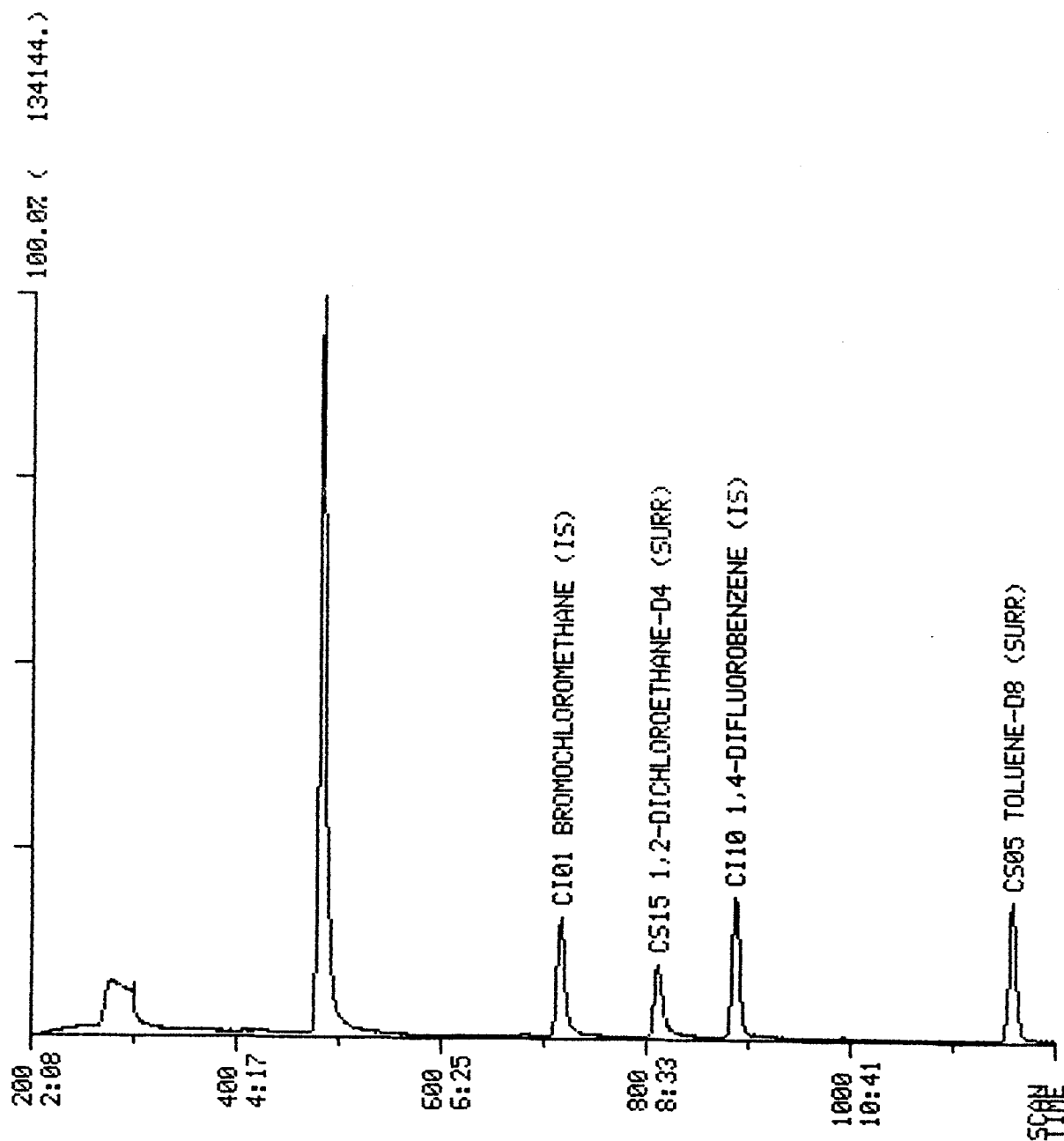
SAS NO _____

LABORATORY SwL - HoustonREPORTED 02/03/94 12:47CONTRACT VOA ANALYSISCUSTOMER AWD

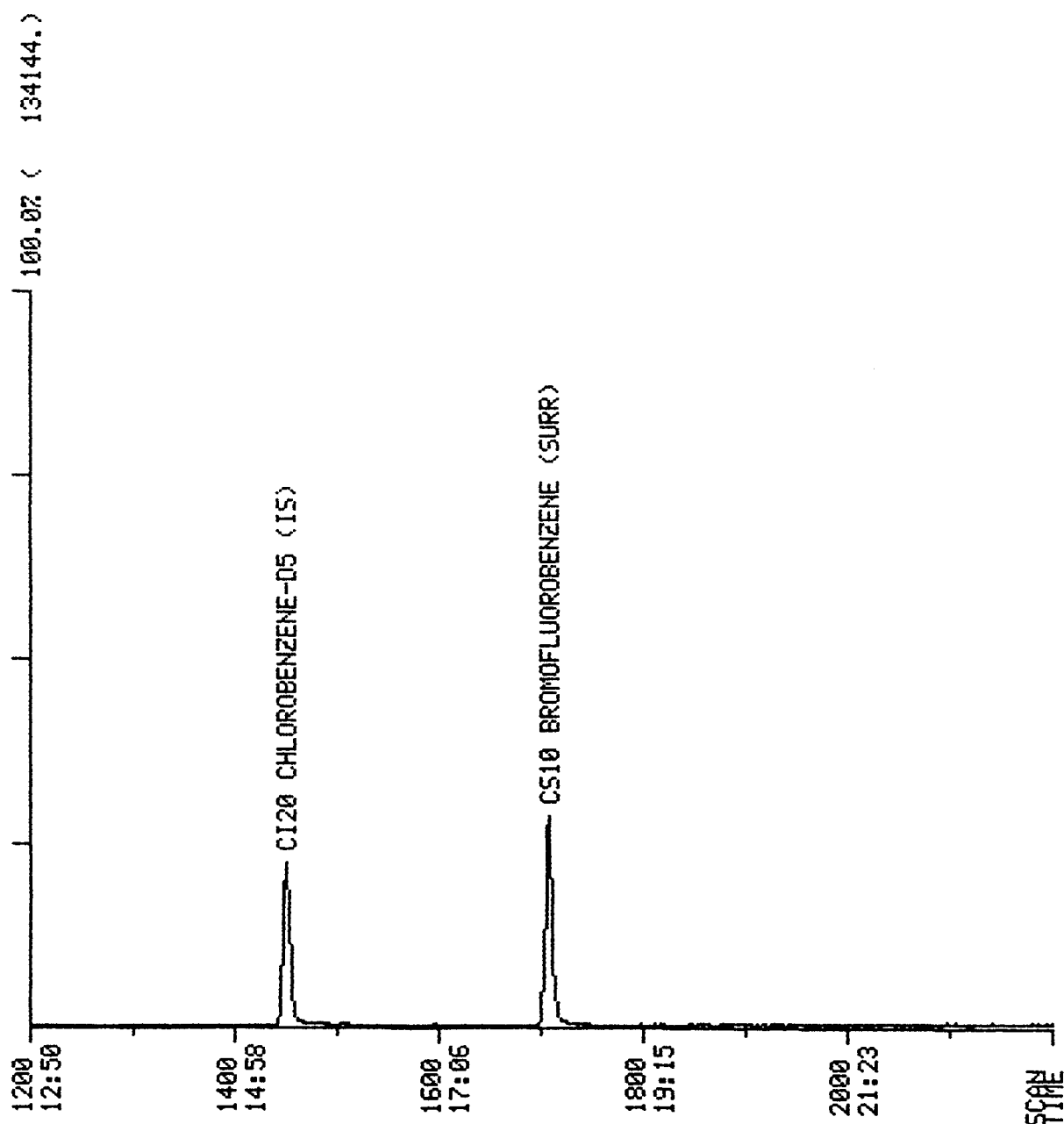
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012808 SCANS 200 TO 1200 ACQUIRED: 01/28/94 22:21:00
SAMPLE: 9401337-11A AND COL B/24:02 10UL/25UL/1ML
COND.: 40(3) 40-180 @ 5/MIN



DATA FROM FILE: I012808 SCANS 1200 TO 2200 ACQUIRED: 01/28/94 22:21:00
CALI: I012808 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-11A AMD COL B/24:02 10UL/25UL/1ML
CONDS.: 40(3) 40-180 @ 5/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO _____

LABORATORY SwL - Houston
REPORTED 02/03/94 12:54

CONTRACT VOA ANALYSIS
CUSTOMER AWD

FILE NAME I020103
TYPE EPA
INST FINN

SAMPLE ID COL C 1-23
LAB SAMP ID 9401337-12A
ANALYZED 02/01/94 20:25

LEVEL LOW
MATRIX WATER
UNITS ug/L

ODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		10.0	U
C015	74-83-9	Bromomethane		10.0	U
020	75-01-4	Vinyl Chloride		10.0	U
C025	75-00-3	Chloroethane		10.0	U
C030	75-09-2	Methylene Chloride		15.6	
035	67-64-1	Acetone		50.0	U
040	75-15-0	Carbon Disulfide		5.00	U
C045	75-35-4	1,1-Dichloroethene		5.00	U
050	75-34-3	1,1-Dichloroethane		5.00	U
0	540-59-0	1,2-Dichloroethene (Total)		5.00	U
C060	67-66-3	Chloroform		5.00	U
C065	107-06-2	1,2-Dichloroethane		5.00	U
110	78-93-3	Methylethyl ketone (MEK)		10.0	U
C115	71-55-6	1,1,1-Trichloroethane		5.00	U
C120	56-23-5	Carbon Tetrachloride		5.00	U
125	108-05-4	Vinyl Acetate		10.0	U
130	75-27-4	Bromodichloromethane		5.00	U
C140	78-87-5	1,2-Dichloropropane		5.00	U
C143	10061-01-5	cis-1,3-Dichloropropene		5.00	U
150	79-01-6	Trichloroethene		5.00	U
C155	124-48-1	Dibromochloromethane		5.00	U
C160	79-00-5	1,1,2-Trichloroethane		5.00	U
165	71-43-2	Benzene		5.00	U
C172	10061-02-6	trans-1,3-Dichloropropene		5.00	U
C180	75-25-2	Bromoform		5.00	U
205	108-10-1	4-Methyl-2-Pentanone		10.0	U
210	591-78-6	2-Hexanone		10.0	U
C220	127-18-4	Tetrachloroethene		5.00	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		5.00	U
230	108-88-3	Toluene		5.00	U
C235	108-90-7	Chlorobenzene		5.00	U
C240	100-41-4	Ethylbenzene		5.00	U
245	100-42-5	Styrene		5.00	U
C250	1330-20-7	Xylene (total)		5.00	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO

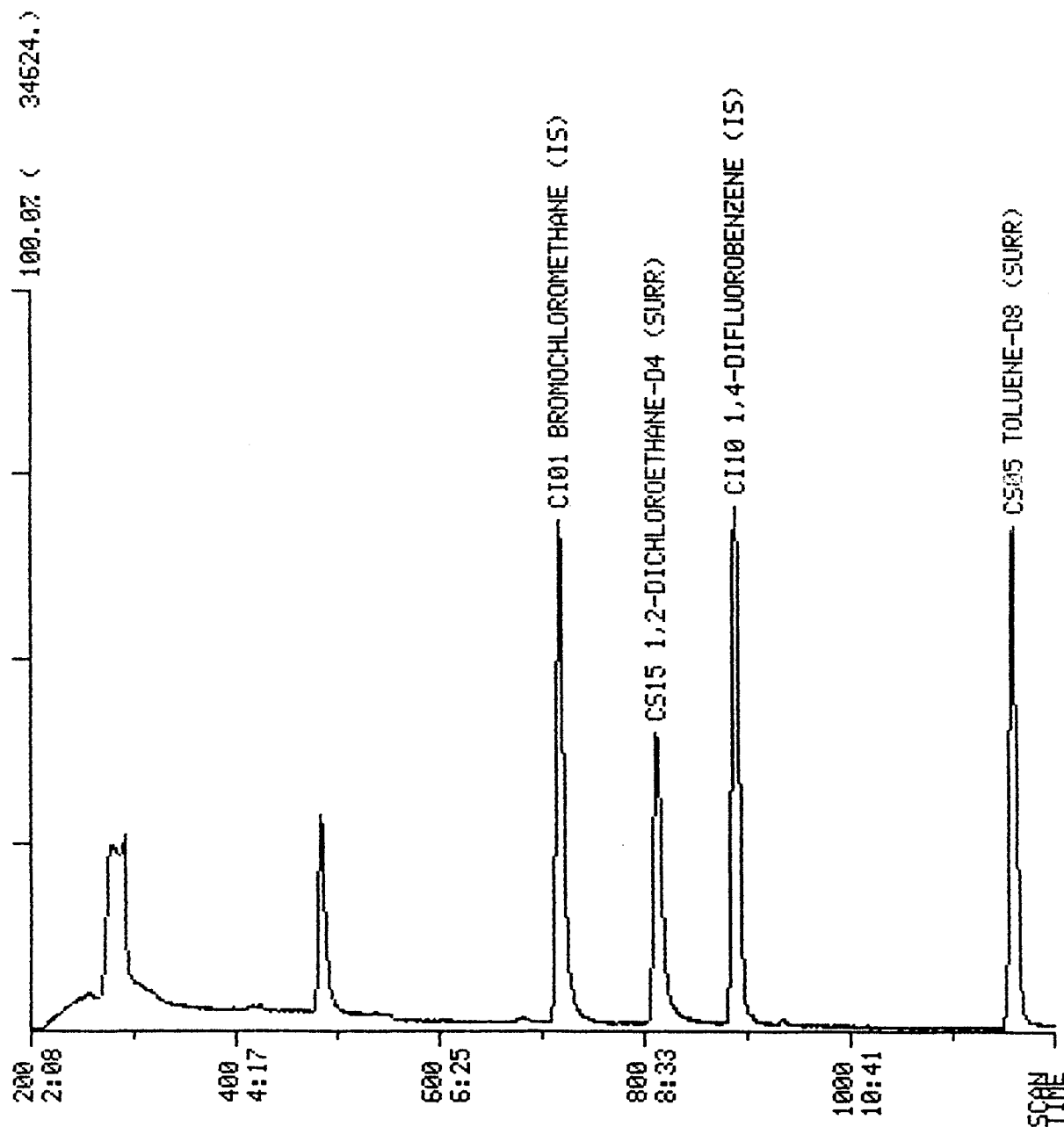
LABORATORY SwL - Houston
REPORTED 02/03/94 12:54

CONTRACT VOA ANALYSIS
CUSTOMER AWD

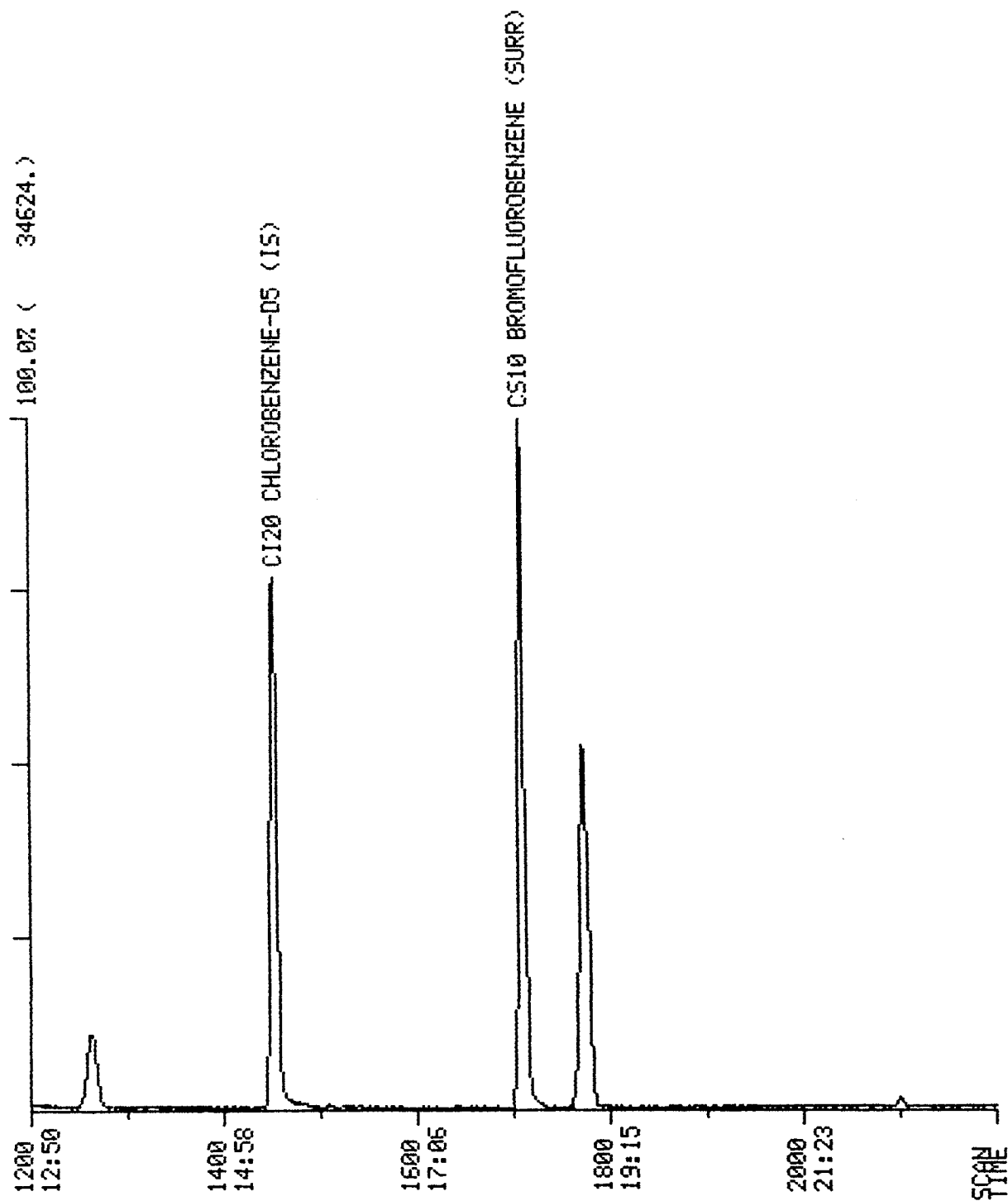
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I020103 SCANS 200 TO 1200 ACQUIRED: 02/01/94 20:25:00
CALI: I020103 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-12A AMD COL C/1:23 SML
CONDS.: 40(3)-18005/MIN CAPILLARY 75M



DATA FROM FILE: I020103 SCANS 1200 TO 2200 ACQUIRED: 02/01/94 20:25:00
CALI: I020103 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-12A AMD COL C/1:23 SML
CONDS.: 40(3)-18005/MIN CAPILLARY 75M



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO

LABORATORY SwL - Houston
REPORTED 02/03/94 12:48

CONTRACT VOA ANALYSIS
CUSTOMER AWD

FILE NAME I012810
TYPE EPA
INST FINN

SAMPLE ID COL C 2-22
LAB SAMP ID 9401337-13A
ANALYZED 01/28/94 23:43

LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		10.0	U
C015	74-83-9	Bromomethane		10.0	U
C020	75-01-4	Vinyl Chloride		10.0	U
C025	75-00-3	Chloroethane		10.0	U
C030	75-09-2	Methylene Chloride		92.8	
C035	67-64-1	Acetone		50.0	U
C040	75-15-0	Carbon Disulfide		5.00	U
C045	75-35-4	1,1-Dichloroethene		5.00	U
C050	75-34-3	1,1-Dichloroethane		5.00	U
C060	540-59-0	1,2-Dichloroethene (Total)		5.00	U
C065	67-66-3	Chloroform		5.00	U
C110	107-06-2	1,2-Dichloroethane		5.00	U
C115	78-93-3	Methylethyl ketone (MEK)		10.0	U
C120	71-55-6	1,1,1-Trichloroethane		5.00	U
C125	56-23-5	Carbon Tetrachloride		5.00	U
C130	108-05-4	Vinyl Acetate		10.0	U
C140	75-27-4	Bromodichloromethane		5.00	U
C143	78-87-5	1,2-Dichloropropane		5.00	U
C150	10061-01-5	cis-1,3-Dichloropropene		5.00	U
C155	79-01-6	Trichloroethene		5.00	U
C160	124-48-1	Dibromochloromethane		5.00	U
C165	79-00-5	1,1,2-Trichloroethane		5.00	U
C172	71-43-2	Benzene		5.00	U
C180	10061-02-6	trans-1,3-Dichloropropene		5.00	U
C205	75-25-2	Bromoform		5.00	U
C210	108-10-1	4-Methyl-2-Pentanone		10.0	U
C220	591-78-6	2-Hexanone		10.0	U
C225	127-18-4	Tetrachloroethene		5.00	U
C230	79-34-5	1,1,2,2-Tetrachloroethane		5.00	U
C235	108-88-3	Toluene		5.00	U
C240	108-90-7	Chlorobenzene		5.00	U
C245	100-41-4	Ethylbenzene		5.00	U
C250	100-42-5	Styrene		5.00	U
	1330-20-7	Xylene (total)		5.00	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO

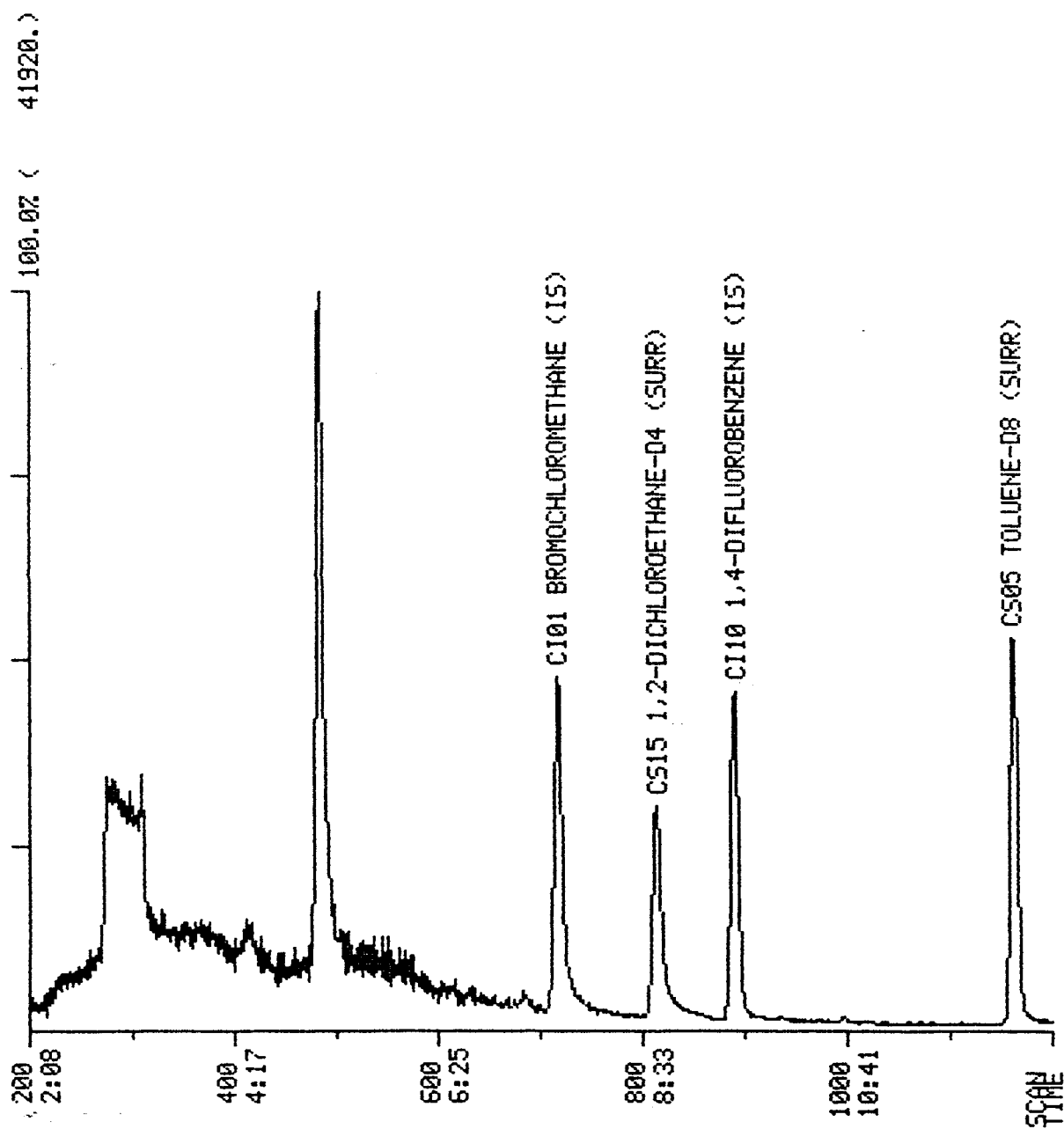
LABORATORY SwL - Houston
REPORTED 02/03/94 12:48

CONTRACT VOA ANALYSIS
CUSTOMER AWD

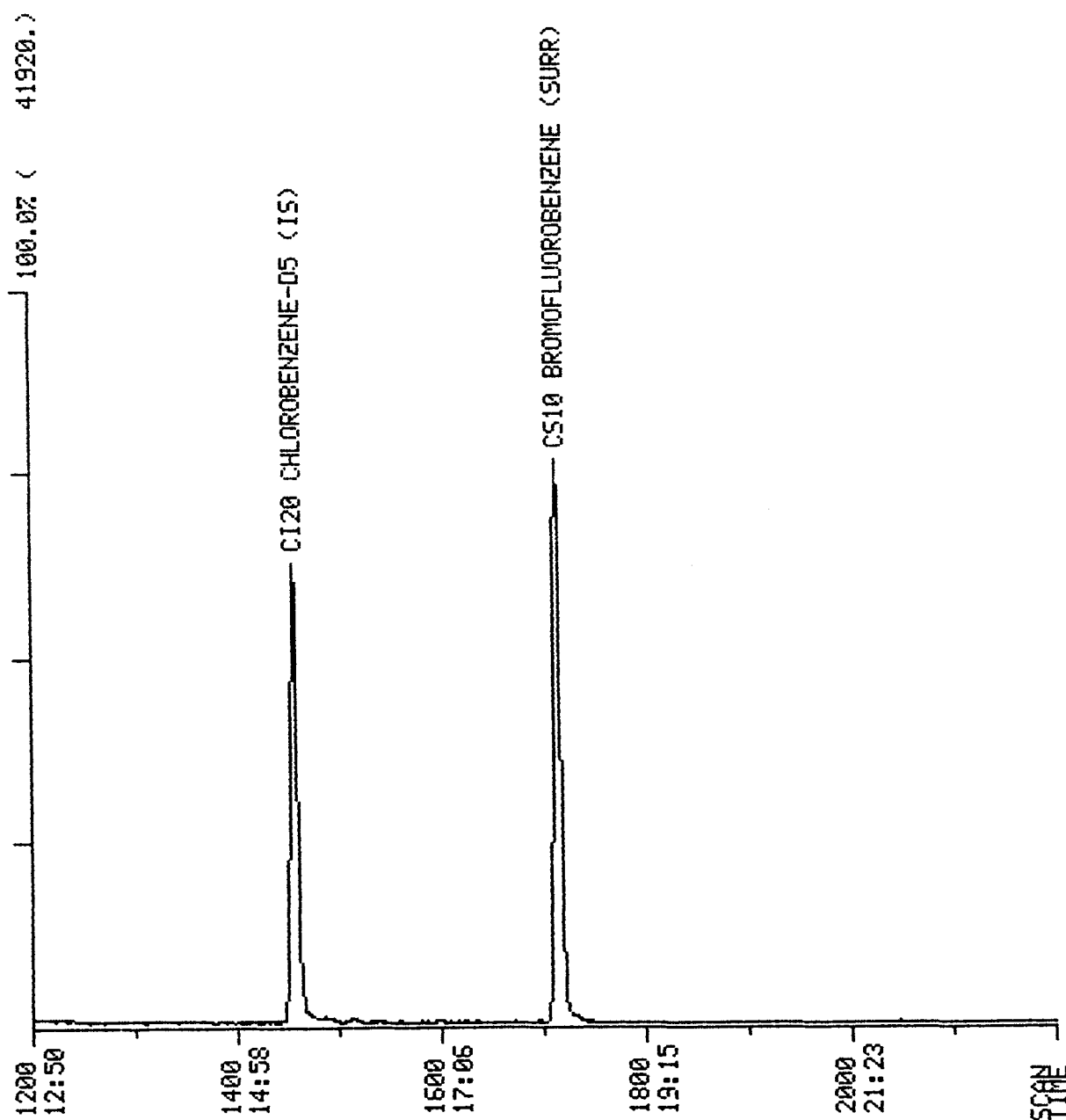
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012810 SCANS 200 TO 1200 ACQUIRED: 01/28/94 23:43:00
CALI: I012810 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-13A AND COL C/2:22 5ML
CONDS.: 40(3) 40-180 @ 5/MIN



DATA FROM FILE: I012810 SCANS 1200 TO 2200 ACQUIRED: 01/28/94 23:43:00
CALI: I012810 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-13A AND COL C/2:22 5ML
CONDS.: 40(3) 40-180 @ 5/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO LABORATORY SwL - Houston
REPORTED 02/03/94 12:58CONTRACT VOA ANALYSIS
CUSTOMER AWDFILE NAME I020201
TYPE EPA
INST FINNSAMPLE ID COL C 6-05
LAB SAMP ID 9401337-14A
ANALYZED 02/02/94 13:11LEVEL LOW
MATRIX WATER
UNITS ug/L

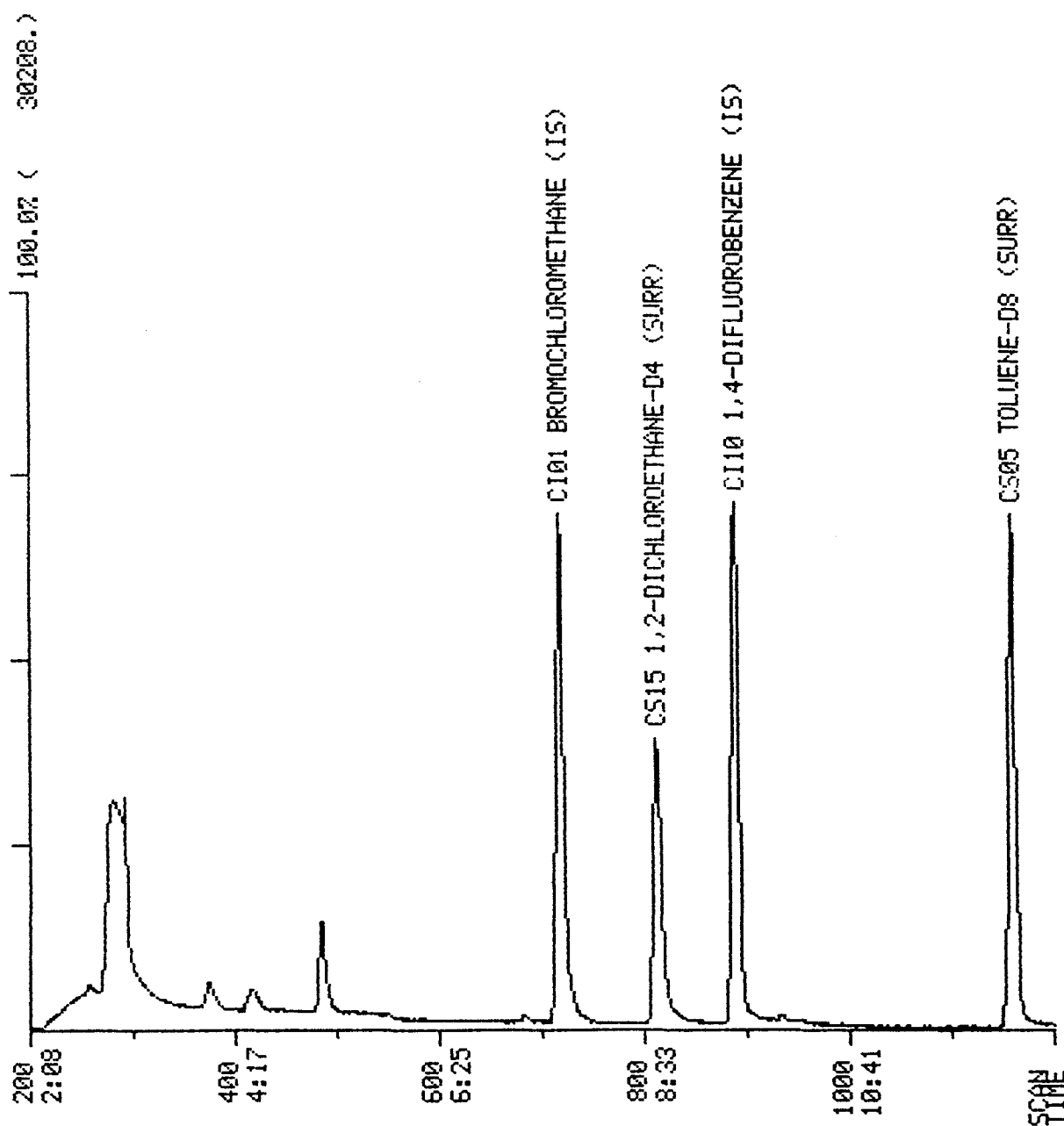
CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		10.0	U
C015	74-83-9	Bromomethane		10.0	U
020	75-01-4	Vinyl Chloride		10.0	U
025	75-00-3	Chloroethane		10.0	U
C030	75-09-2	Methylene Chloride		7.84	
035	67-64-1	Acetone		50.0	U
040	75-15-0	Carbon Disulfide		5.00	U
C045	75-35-4	1,1-Dichloroethene		5.00	U
C050	75-34-3	1,1-Dichloroethane		5.00	U
0	540-59-0	1,2-Dichloroethene (Total)		5.00	U
C060	67-66-3	Chloroform		5.00	U
C065	107-06-2	1,2-Dichloroethane		5.00	U
110	78-93-3	Methylethyl ketone (MEK)		10.0	U
115	71-55-6	1,1,1-Trichloroethane		5.00	U
C120	56-23-5	Carbon Tetrachloride		5.00	U
C125	108-05-4	Vinyl Acetate		10.0	U
130	75-27-4	Bromodichloromethane		5.00	U
C140	78-87-5	1,2-Dichloropropane		5.00	U
C143	10061-01-5	cis-1,3-Dichloropropene		5.00	U
150	79-01-6	Trichloroethene		5.00	U
C155	124-48-1	Dibromochloromethane		5.00	U
C160	79-00-5	1,1,2-Trichloroethane		5.00	U
165	71-43-2	Benzene		5.00	U
172	10061-02-6	trans-1,3-Dichloropropene		5.00	U
C180	75-25-2	Bromoform		5.00	U
C205	108-10-1	4-Methyl-2-Pentanone		10.0	U
210	591-78-6	2-Hexanone		10.0	U
C220	127-18-4	Tetrachloroethene		5.00	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		5.00	U
230	108-88-3	Toluene		5.00	U
C235	108-90-7	Chlorobenzene		5.00	U
C240	100-41-4	Ethylbenzene		5.00	U
245	100-42-5	Styrene		5.00	U
250	1330-20-7	Xylene (total)		5.00	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 401337
SAS NO _____LABORATORY SwL - Houston
REPORTED 02/03/94 12:58CONTRACT VOA ANALYSIS
CUSTOMER AWD

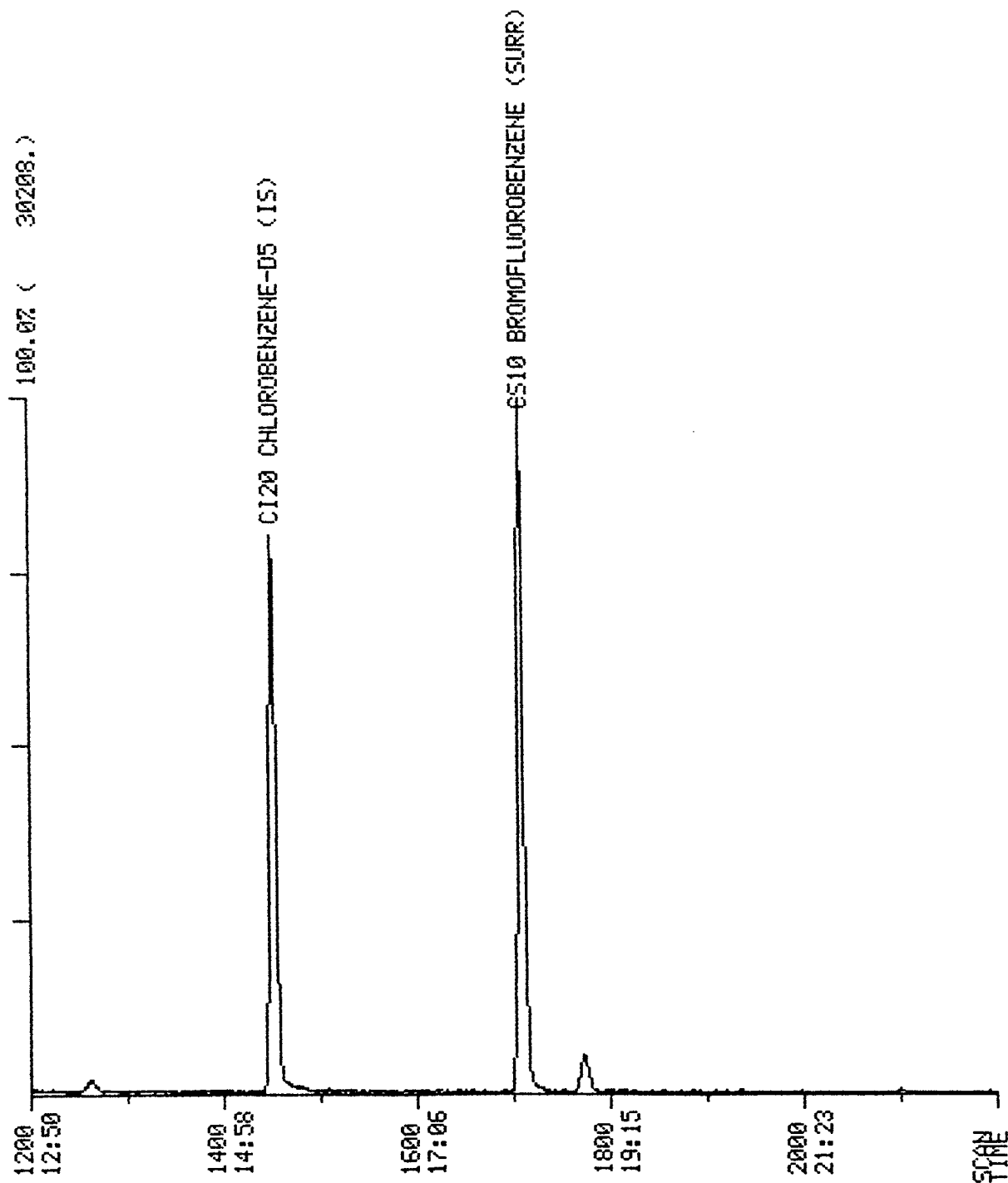
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I020201 SCANS 200 TO 1200 ACQUIRED: 02/02/94 13:11:00
CALI: I020201 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-14A AMD COL C/6:05 5ML
CONDS.: 40(3)-18006/MIN CAPILLARY 75M



DATA FROM FILE: I020201 SCANS 1200 TO 2200 ACQUIRED: 02/02/94 13:11:00
CALI: I020201 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-14A AND COL C/6:05 5ML
CONDS.: 40(3)-18005/MIN CAPILLARY 75M



VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337SAS NO LABORATORY SwL - HoustonREPORTED 02/03/94 12:59CONTRACT VOA ANALYSISCUSTOMER AWDFILE NAME I020202TYPE EPAINST FINNSAMPLE ID COL C 8-55LAB SAMP ID 9401337-15AANALYZED 02/02/94 13:53LEVEL LOWMATRIX WATERUNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		10.0	U
C015	74-83-9	Bromomethane		10.0	U
C020	75-01-4	Vinyl Chloride		10.0	U
C025	75-00-3	Chloroethane		10.0	U
C030	75-09-2	Methylene Chloride		5.00	U
C035	67-64-1	Acetone		50.0	U
C040	75-15-0	Carbon Disulfide		5.00	U
C045	75-35-4	1,1-Dichloroethene		5.00	U
C050	75-34-3	1,1-Dichloroethane		5.00	U
C055	540-59-0	1,2-Dichloroethene (Total)		5.00	U
C060	67-66-3	Chloroform		5.00	U
C065	107-06-2	1,2-Dichloroethane		5.00	U
C110	78-93-3	Methylethyl ketone (MEK)		10.0	U
C115	71-55-6	1,1,1-Trichloroethane		5.00	U
C120	56-23-5	Carbon Tetrachloride		5.00	U
C125	108-05-4	Vinyl Acetate		10.0	U
C130	75-27-4	Bromodichloromethane		5.00	U
C140	78-87-5	1,2-Dichloropropane		5.00	U
C143	10061-01-5	cis-1,3-Dichloropropene		5.00	U
C150	79-01-6	Trichloroethene		5.00	U
C155	124-48-1	Dibromochloromethane		5.00	U
C160	79-00-5	1,1,2-Trichloroethane		5.00	U
C165	71-43-2	Benzene		5.00	U
C172	10061-02-6	trans-1,3-Dichloropropene		5.00	U
C180	75-25-2	Bromoform		5.00	U
C205	108-10-1	4-Methyl-2-Pentanone		10.0	U
C210	591-78-6	2-Hexanone		10.0	U
C220	127-18-4	Tetrachloroethene		5.00	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		5.00	U
C230	108-88-3	Toluene		5.00	U
C235	108-90-7	Chlorobenzene		5.00	U
C240	100-41-4	Ethylbenzene		5.00	U
C245	100-42-5	Styrene		5.00	U
C250	1330-20-7	Xylene (total)		5.00	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

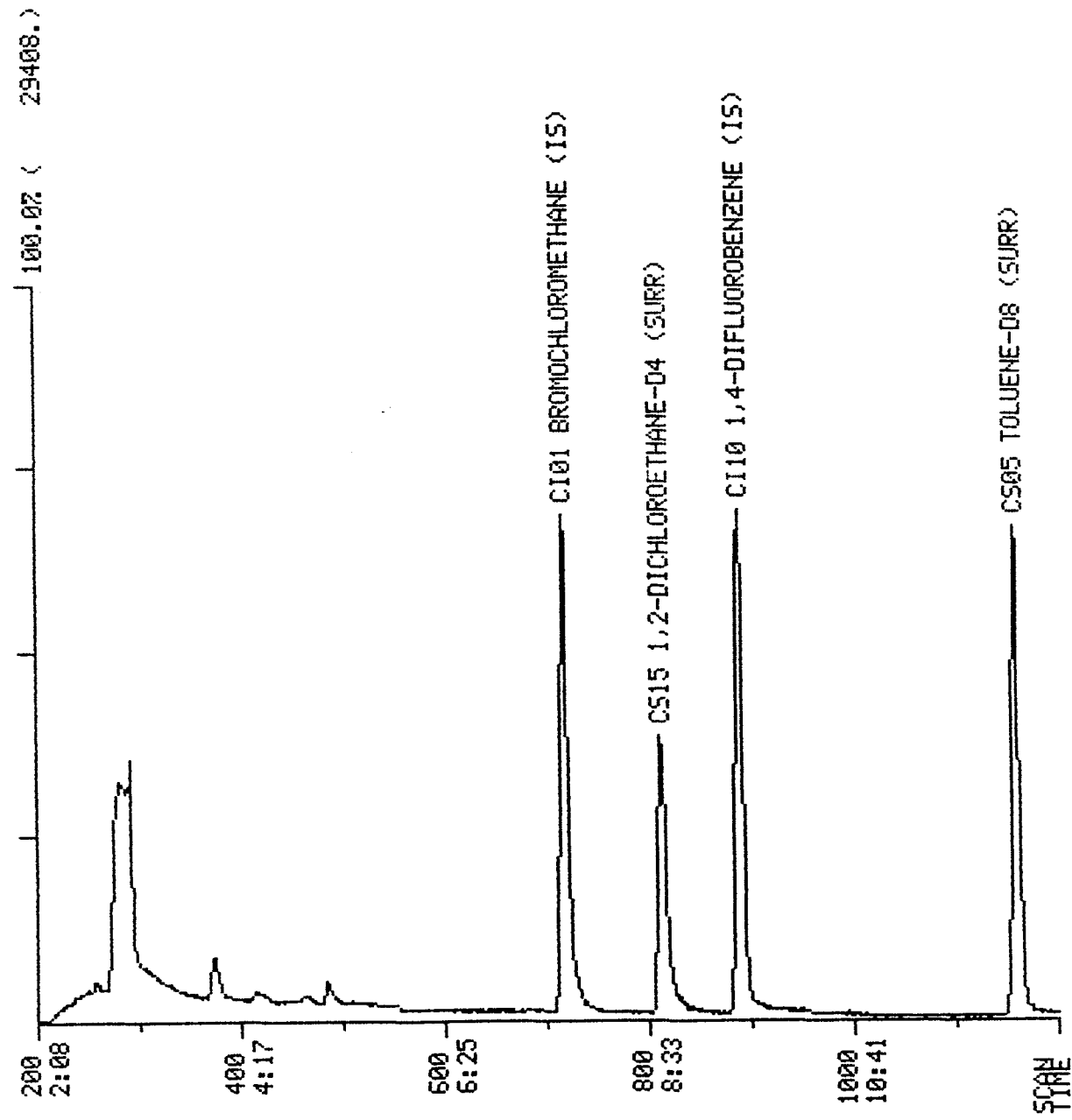
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CASE NO 401337
SAS NO LABORATORY SWL - Houston
REPORTED 02/03/94 12:59CONTRACT VOA ANALYSIS
CUSTOMER AWD

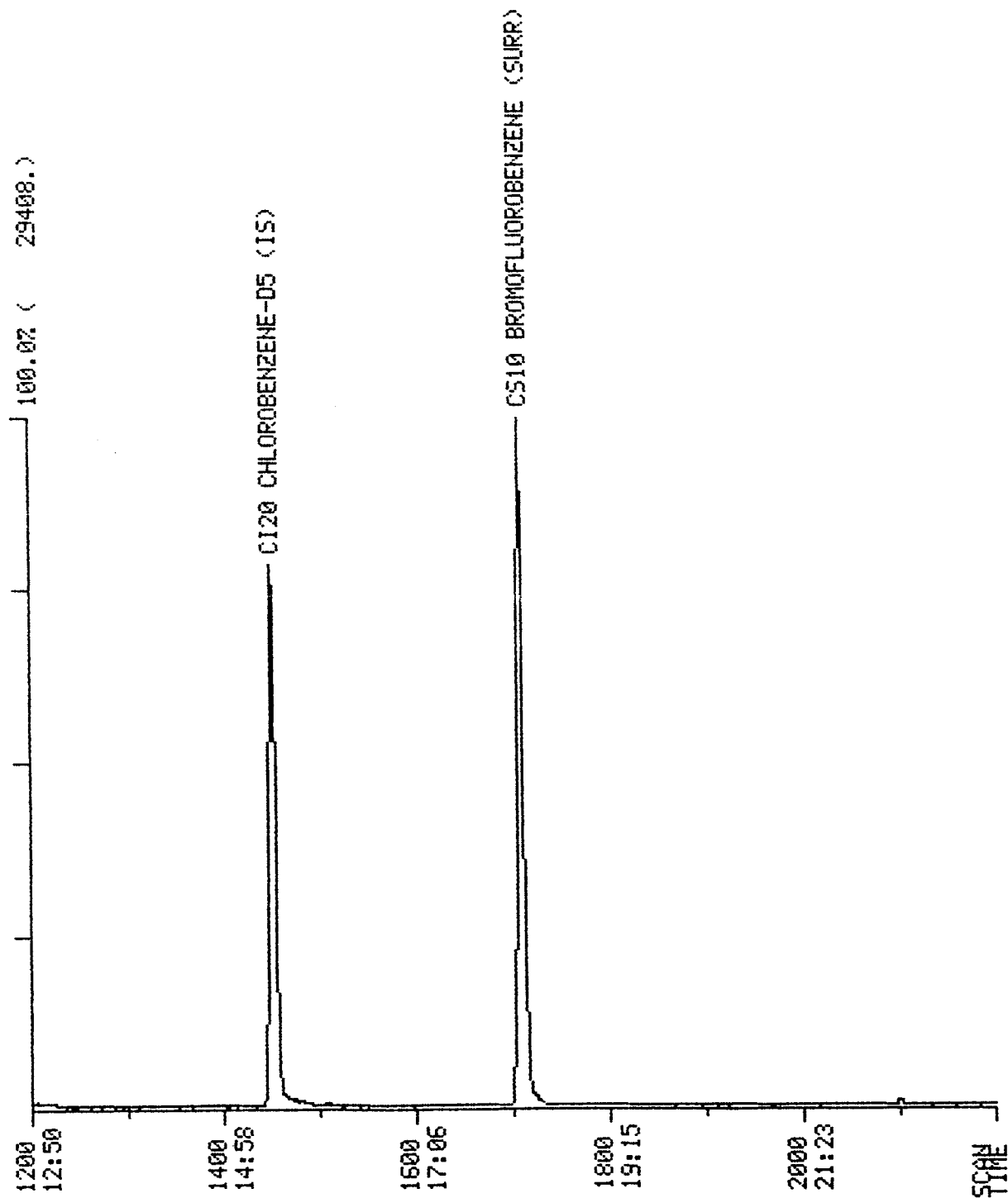
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I020202 SCANS 200 TO 1200 ACQUIRED: 02/02/94 13:53:00
CALI: I020202 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-15A AMD COL C/8:55 5ML
CONDS.: 40(3)-18006/MIN CAPILLARY 75M



DATA FROM FILE: I020202 SCANS 1200 TO 2200 ACQUIRED: 02/02/94 13:53:00
CALI: I020202 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-15A AND COL C/8:55 5ML
CONDS.: 40(3)-18006/MIN CAPILLARY 75M



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTECASE NO 401337
SAS NO _____LABORATORY SwL - Houston
REPORTED 02/03/94 12:49CONTRACT VOA ANALYSIS
CUSTOMER AWDFILE NAME I012813
TYPE EPA
INST FINNSAMPLE ID COL C 23-55
LAB SAMP ID 9401337-16A
ANALYZED 01/29/94 01:49LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
C020	75-01-4	Vinyl Chloride		200000	U
C025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		4180000	
C035	67-64-1	Acetone		1000000	U
C040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
C050	75-34-3	1,1-Dichloroethane		100000	U
C050	540-59-0	1,2-Dichloroethene (Total)		100000	U
C060	67-66-3	Chloroform		100000	U
C065	107-06-2	1,2-Dichloroethane		100000	U
C110	78-93-3	Methylethyl ketone (MEK)		200000	U
C115	71-55-6	1,1,1-Trichloroethane		100000	U
C120	56-23-5	Carbon Tetrachloride		100000	U
C125	108-05-4	Vinyl Acetate		200000	U
C130	75-27-4	Bromodichloromethane		100000	U
C140	78-87-5	1,2-Dichloropropane		100000	U
C143	10061-01-5	cis-1,3-Dichloropropene		100000	U
C150	79-01-6	Trichloroethene		100000	U
C155	124-48-1	Dibromochloromethane		100000	U
C160	79-00-5	1,1,2-Trichloroethane		100000	U
C165	71-43-2	Benzene		100000	U
C172	10061-02-6	trans-1,3-Dichloropropene		100000	U
C180	75-25-2	Bromoform		100000	U
C205	108-10-1	4-Methyl-2-Pentanone		200000	U
C210	591-78-6	2-Hexanone		200000	U
C220	127-18-4	Tetrachloroethene		100000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
C230	108-88-3	Toluene		100000	U
C235	108-90-7	Chlorobenzene		100000	U
C240	100-41-4	Ethylbenzene		100000	U
C245	100-42-5	Styrene		100000	U
C250	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

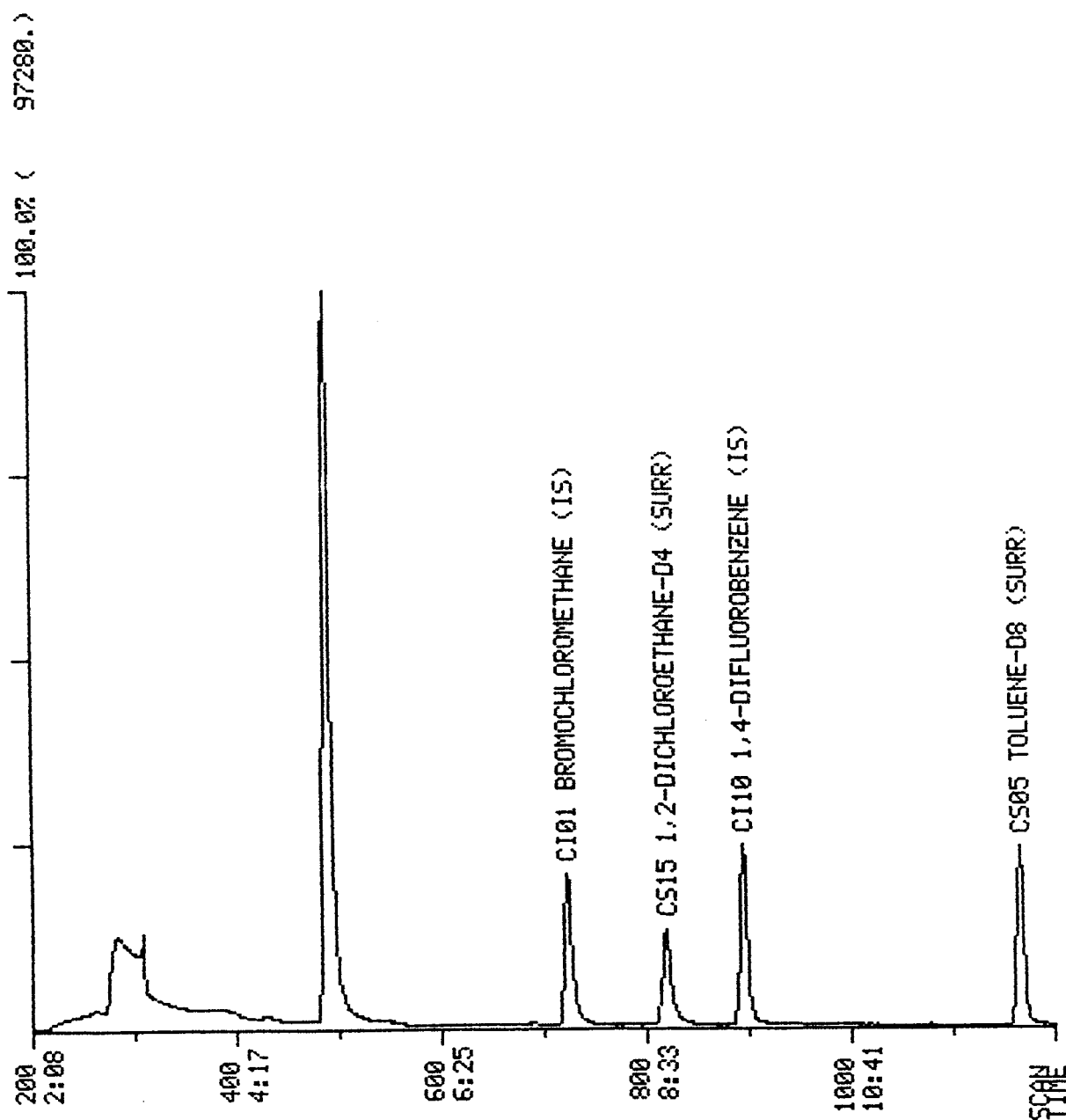
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO _____LABORATORY SwL - Houston
REPORTED 02/03/94 12:49CONTRACT VOA ANALYSIS
CUSTOMER AWD

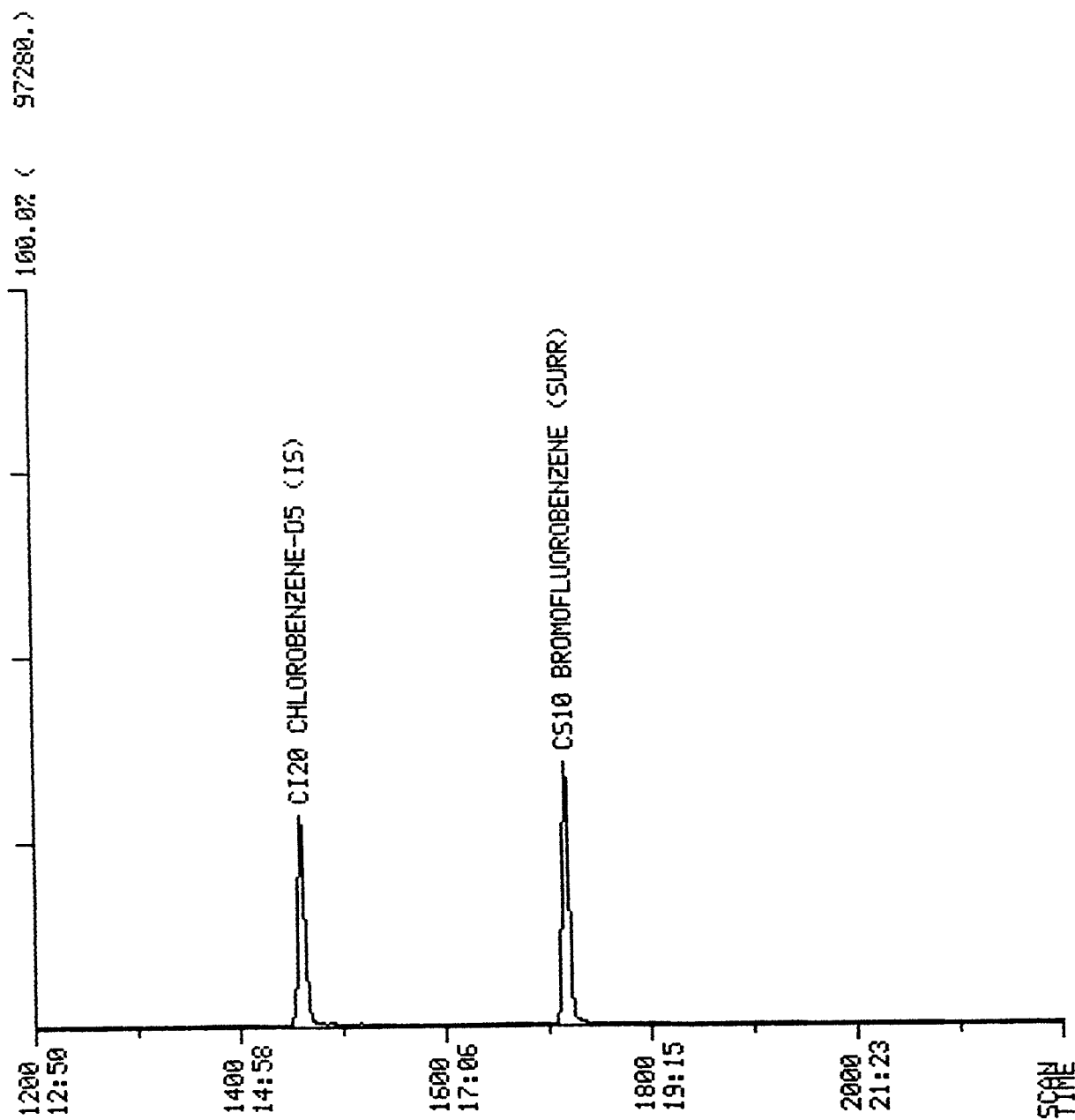
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012813 SCANS 200 TO 1200 ACQUIRED: 01/29/94 1:49:00
CALI: I012813 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-16A AND COL C/23:55 10UL/25UL/1ML
CONDS.: 40(3) 40-180 @ 6/MIN



DATA FROM FILE: I012813 SCANS 1200 TO 2200 ACQUIRED: 01/29/94 1:49:00
CALI: I012813 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-16A AND COL C/23:55 10UL/25UL/1ML
COND5.: 40(3) 40-180 @ 6/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO LABORATORY SwL - Houston
REPORTED 02/03/94 12:55CONTRACT VOA ANALYSIS
CUSTOMER AWDFILE NAME I020106
TYPE EPA
INST FINNSAMPLE ID COL A
LAB SAMP ID 9401337-17A
ANALYZED 02/01/94 22:29LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
020	75-01-4	Vinyl Chloride		200000	U
025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		4640000	
035	67-64-1	Acetone		1000000	U
040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
C050	75-34-3	1,1-Dichloroethane		100000	U
0	540-59-0	1,2-Dichloroethene (Total)		100000	U
C065	67-66-3	Chloroform		100000	U
110	107-06-2	1,2-Dichloroethane		100000	U
115	78-93-3	Methylethyl ketone (MEK)		200000	U
C120	71-55-6	1,1,1-Trichloroethane		100000	U
C125	56-23-5	Carbon Tetrachloride		100000	U
130	108-05-4	Vinyl Acetate		200000	U
C140	75-27-4	Bromodichloromethane		100000	U
C143	78-87-5	1,2-Dichloropropane		100000	U
150	10061-01-5	cis-1,3-Dichloropropene		100000	U
C155	79-01-6	Trichloroethene		100000	U
C160	124-48-1	Dibromochloromethane		100000	U
165	79-00-5	1,1,2-Trichloroethane		100000	U
172	71-43-2	Benzene		100000	U
C180	10061-02-6	trans-1,3-Dichloropropene		100000	U
C205	75-25-2	Bromoform		100000	U
210	108-10-1	4-Methyl-2-Pentanone		200000	U
C220	591-78-6	2-Hexanone		200000	U
C225	127-18-4	Tetrachloroethene		100000	U
230	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
235	108-88-3	Toluene		100000	U
C240	108-90-7	Chlorobenzene		100000	U
245	100-41-4	Ethylbenzene		100000	U
250	100-42-5	Styrene		100000	U
	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337
SAS NO

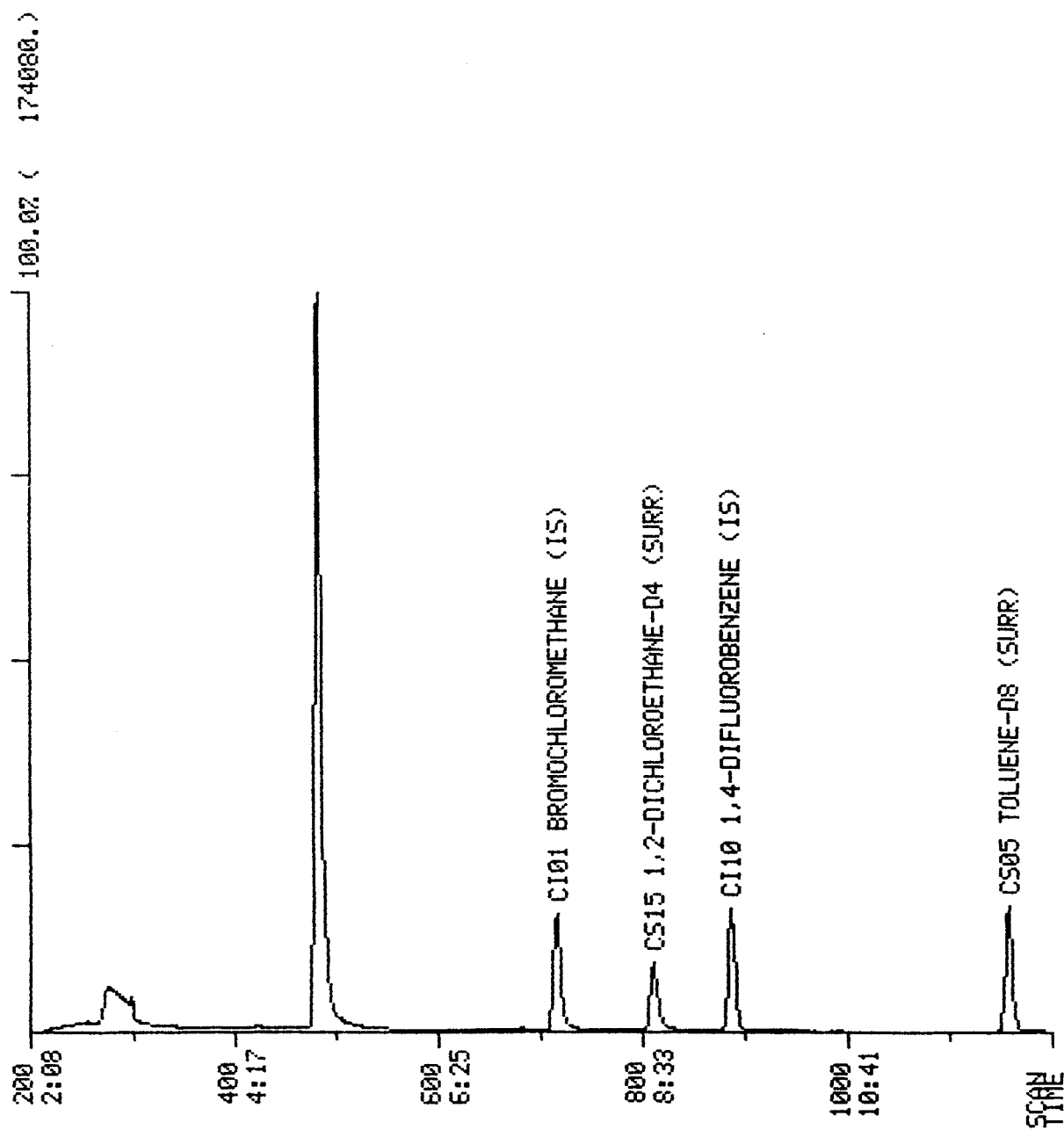
LABORATORY SwL - Houston
REPORTED 02/03/94 12:55

CONTRACT VDA ANALYSIS
CUSTOMER AWD

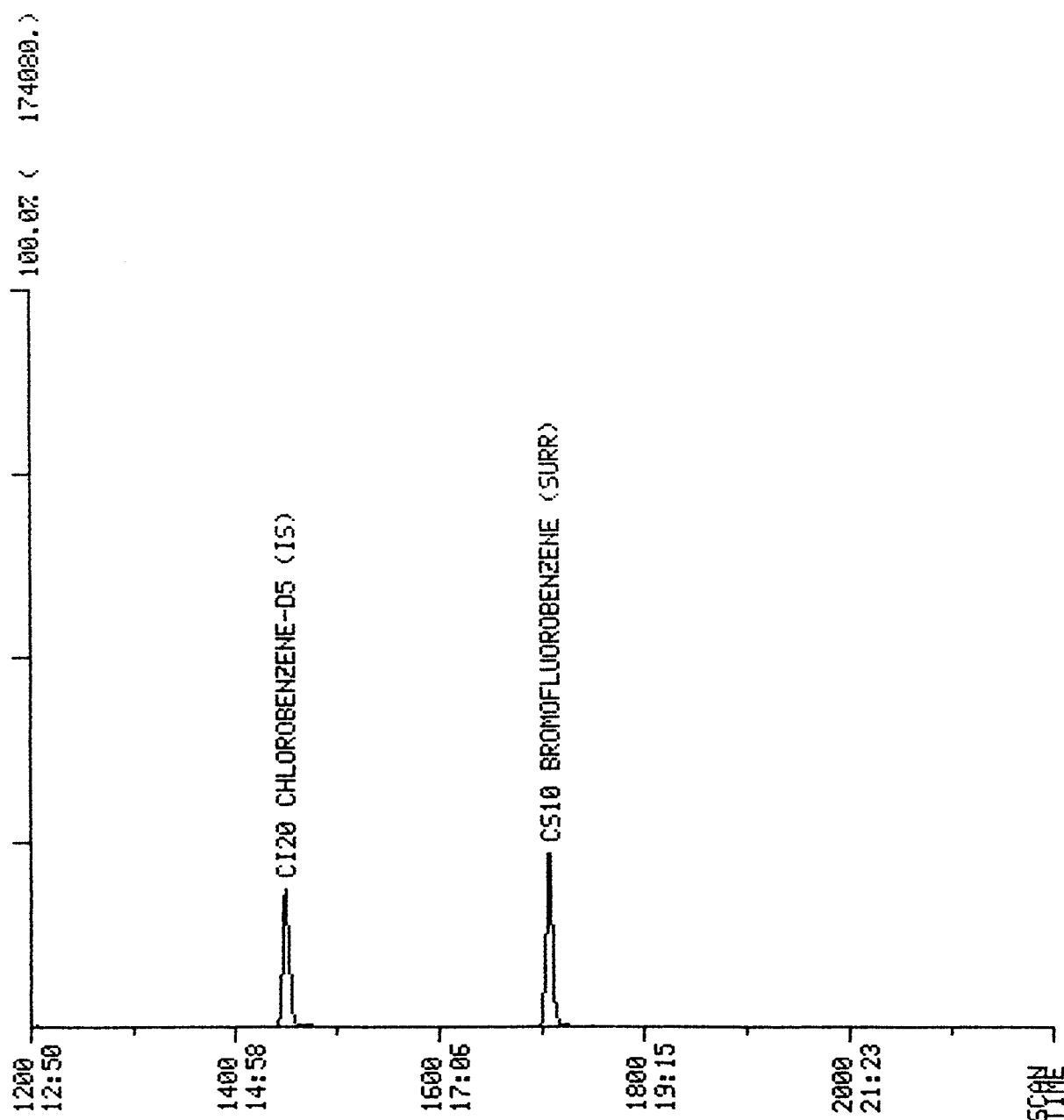
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I020106 SCANS 200 TO 1200 ACQUIRED: 02/01/94 22:29:00
CALI: I020106 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-17A AND COL A 10UL/25UL/1ML
COND5.: 40(3)-18006/MIN CAPILLARY 75M



ATA FROM FILE: I020106 SCANS 1200 TO 2200 ACQUIRED: 02/01/94 22:29:00
CALI: I020106 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-17A AND COL A 10UL/25UL/1ML
CONDS.: 40(3)-18006/MIN CAPILLARY 75M



VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337

LABORATORY SwL - Houston

CONTRACT VOA ANALYSIS

SAS NO

REPORTED 02/03/94 12:51

CUSTOMER AWD

FILE NAME I012815

SAMPLE ID COL B

LEVEL LOW

TYPE EPA

LAB SAMP ID 9401337-18A

MATRIX WATER

INST FINN

ANALYZED 01/29/94 04:00

UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
C020	75-01-4	Vinyl Chloride		200000	U
C025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		5160000	
C035	67-64-1	Acetone		1000000	U
C040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
C050	75-34-3	1,1-Dichloroethane		100000	U
C055	540-59-0	1,2-Dichloroethene (Total)		100000	U
C060	67-66-3	Chloroform		100000	U
C065	107-06-2	1,2-Dichloroethane		100000	U
C110	78-93-3	Methylethyl ketone (MEK)		322000	
C115	71-55-6	1,1,1-Trichloroethane		100000	U
C120	56-23-5	Carbon Tetrachloride		100000	U
C125	108-05-4	Vinyl Acetate		200000	U
C130	75-27-4	Bromodichloromethane		100000	U
C140	78-87-5	1,2-Dichloropropane		100000	U
C143	10061-01-5	cis-1,3-Dichloropropene		100000	U
C150	79-01-6	Trichloroethene		100000	U
C155	124-48-1	Dibromochloromethane		100000	U
C160	79-00-5	1,1,2-Trichloroethane		100000	U
C165	71-43-2	Benzene		100000	U
C172	10061-02-6	trans-1,3-Dichloropropene		100000	U
C180	75-25-2	Bromoform		100000	U
C205	108-10-1	4-Methyl-2-Pentanone		200000	U
C210	591-78-6	2-Hexanone		200000	U
C220	127-18-4	Tetrachloroethene		100000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
C230	108-88-3	Toluene		100000	U
C235	108-90-7	Chlorobenzene		100000	U
C240	100-41-4	Ethylbenzene		100000	U
C245	100-42-5	Styrene		100000	U
C250	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337LABORATORY SwL - HoustonCONTRACT VOA ANALYSIS

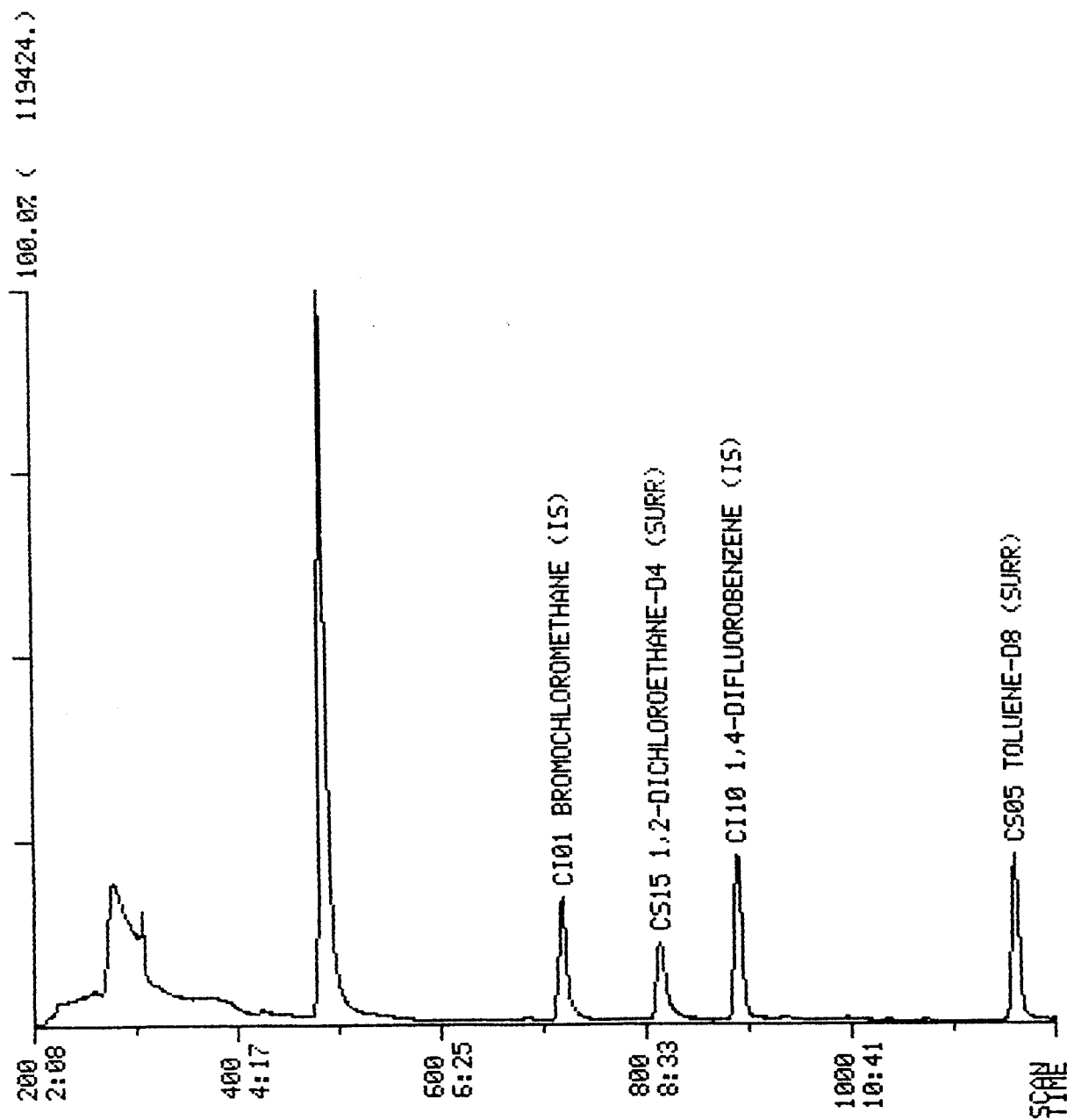
SAS NO _____

REPORTED 02/03/94 12:51CUSTOMER AWD

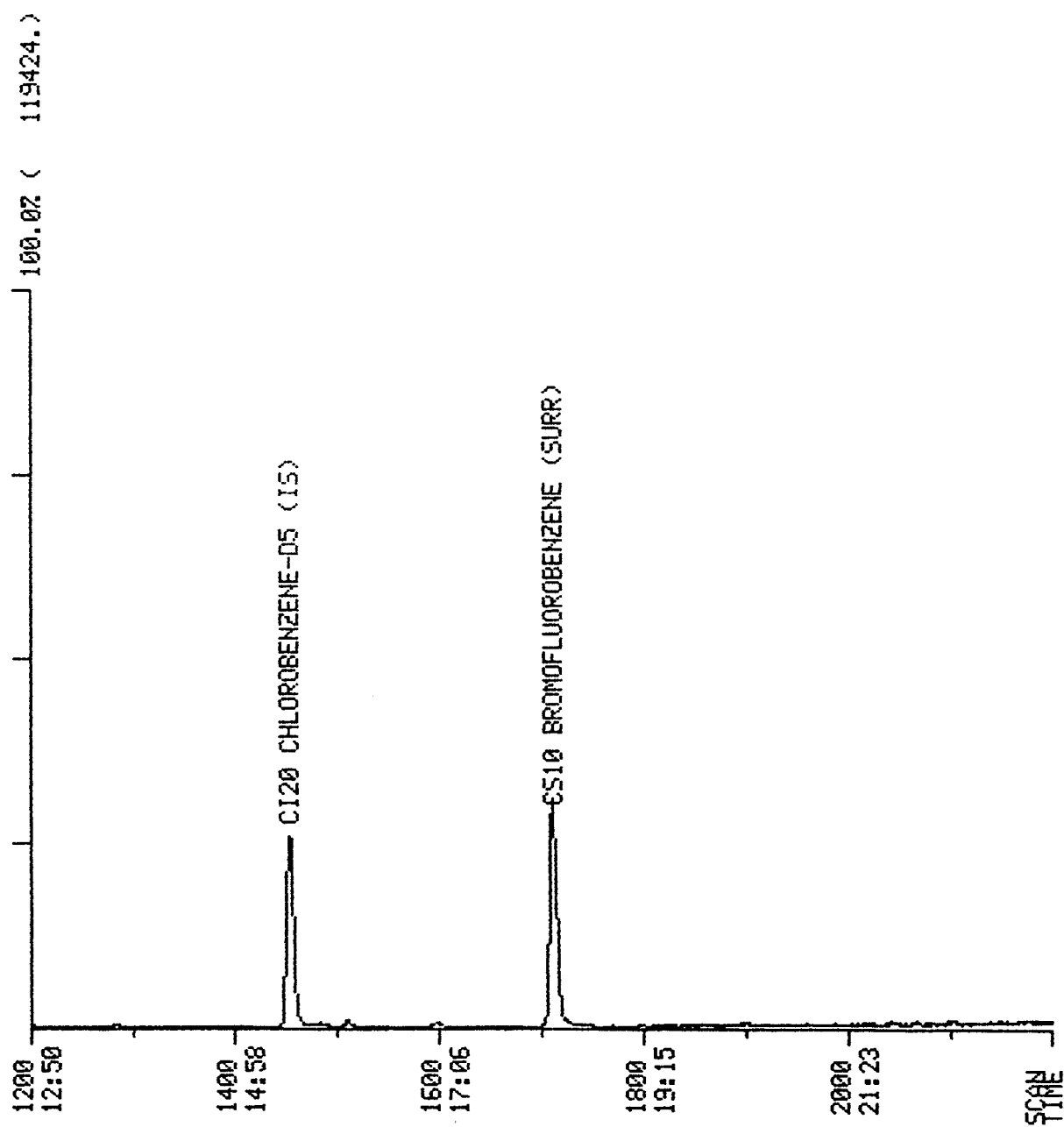
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012815 SCANS 200 TO 1200 ACQUIRED: 01/29/94 4:00:00
CALI: I012815 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-18A AMD COL B 10UL/25UL/1ML
COND.: 40(3) 40-180 @ 6/MIN



DATA FROM FILE: I012815 SCANS 1200 TO 2200 ACQUIRED: 01/29/94 4:00:00
CALI: I012815 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-18A AND COL B 10UL/25UL/1ML
CONDS.: 40(3) 40-180 @ 6/MIN



VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337

SAS NO

LABORATORY SwL - Houston

REPORTED 02/03/94 12:57

CONTRACT VOA ANALYSIS

CUSTOMER AWD

FILE NAME I020107

TYPE EPA

INST FINN

SAMPLE ID COL C

LAB SAMP ID 9401337-19A

ANALYZED 02/01/94 23:10

LEVEL LOW

MATRIX WATER

UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		200000	U
C015	74-83-9	Bromomethane		200000	U
C020	75-01-4	Vinyl Chloride		200000	U
C025	75-00-3	Chloroethane		200000	U
C030	75-09-2	Methylene Chloride		3900000	
C035	67-64-1	Acetone		1000000	U
C040	75-15-0	Carbon Disulfide		100000	U
C045	75-35-4	1,1-Dichloroethene		100000	U
C050	75-34-3	1,1-Dichloroethane		100000	U
C055	540-59-0	1,2-Dichloroethene (Total)		100000	U
C060	67-66-3	Chloroform		100000	U
C065	107-06-2	1,2-Dichloroethane		100000	U
C110	78-93-3	Methylethyl ketone (MEK)		200000	U
C115	71-55-6	1,1,1-Trichloroethane		100000	U
C120	56-23-5	Carbon Tetrachloride		100000	U
C125	108-05-4	Vinyl Acetate		200000	U
C130	75-27-4	Bromodichloromethane		100000	U
C140	78-87-5	1,2-Dichloropropane		100000	U
C143	10061-01-5	cis-1,3-Dichloropropene		100000	U
C150	79-01-6	Trichloroethene		100000	U
C155	124-48-1	Dibromochloromethane		100000	U
C160	79-00-5	1,1,2-Trichloroethane		100000	U
C165	71-43-2	Benzene		100000	U
C172	10061-02-6	trans-1,3-Dichloropropene		100000	U
C180	75-25-2	Bromoform		100000	U
C205	108-10-1	4-Methyl-2-Pentanone		200000	U
C210	591-78-6	2-Hexanone		200000	U
C220	127-18-4	Tetrachloroethene		100000	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		100000	U
C230	108-88-3	Toluene		100000	U
C235	108-90-7	Chlorobenzene		100000	U
C240	100-41-4	Ethylbenzene		100000	U
C245	100-42-5	Styrene		100000	U
C250	1330-20-7	Xylene (total)		100000	U

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401337LABORATORY SwL - HoustonCONTRACT VOA ANALYSIS

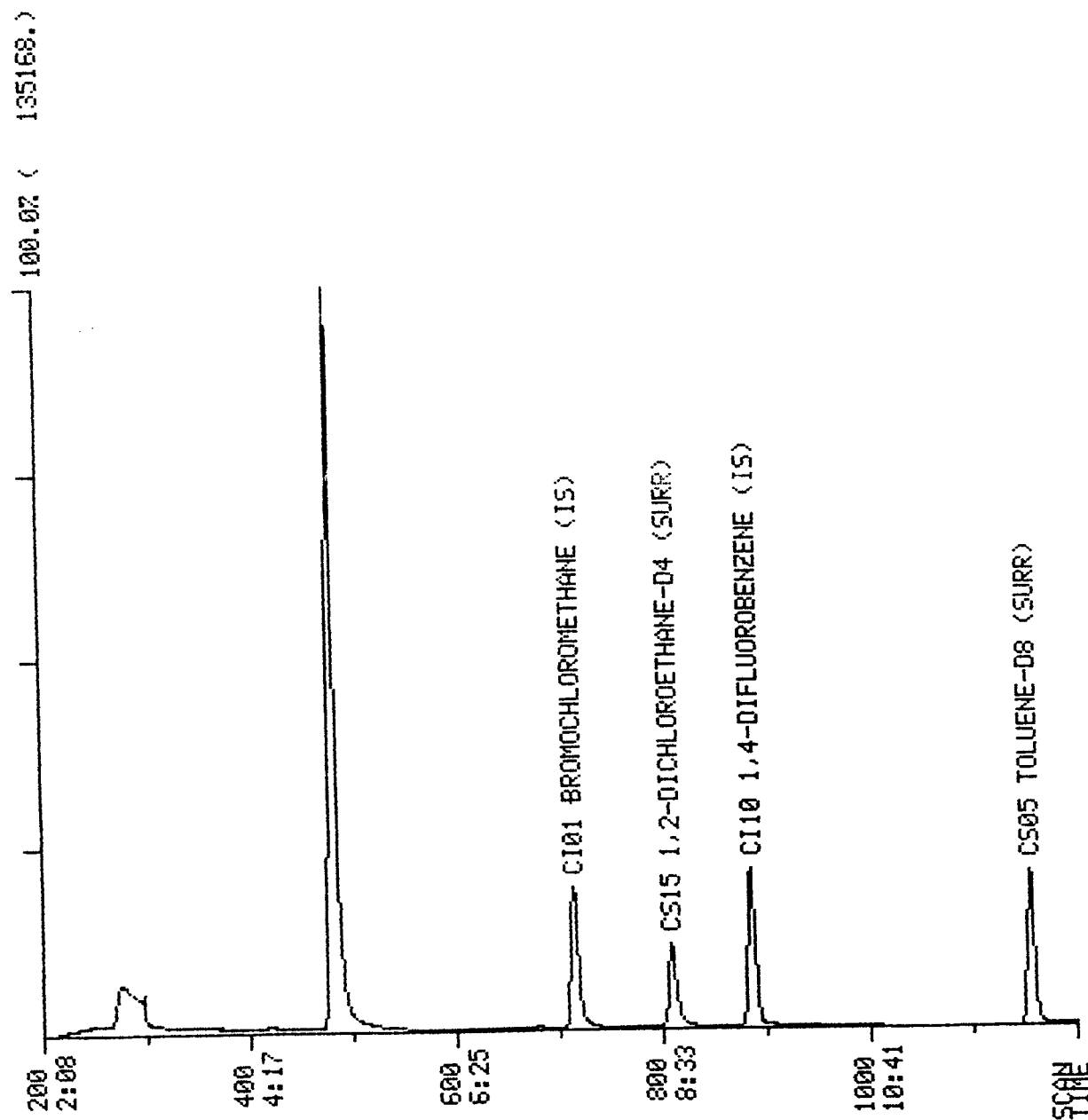
SAS NO _____

REPORTED 02/03/94 12:57CUSTOMER AWD

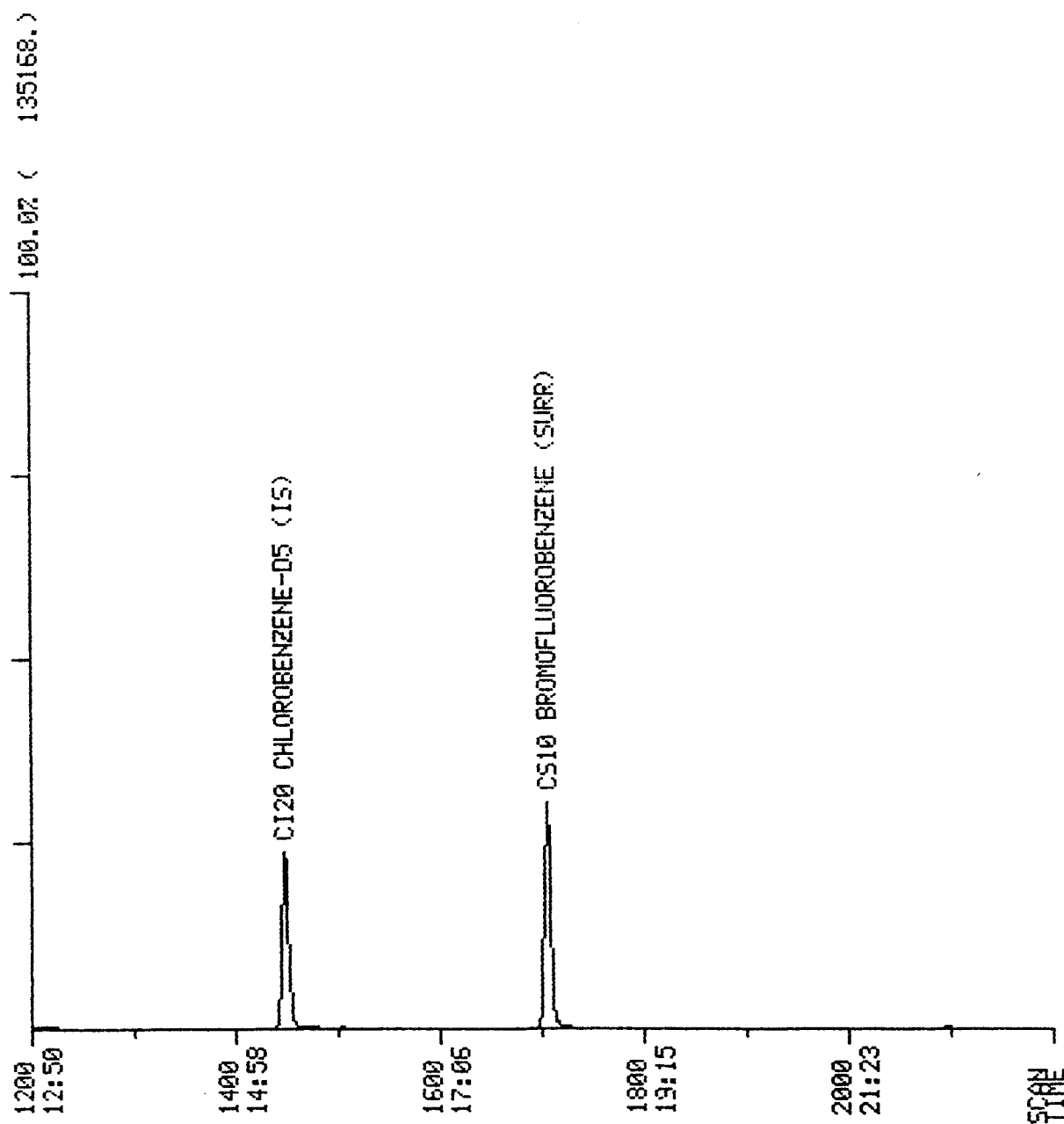
Notes and summary data for this report.

U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: 1020107 SCANS 200 TO 1200 ACQUIRED: 02/01/94 23:10:00
CALI: 1020107 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-19A AND COL C 10UL/25UL/1ML
CONDS.: 40(3)-1800E5/MIN CAPILLARY 75M



DATA FROM FILE: 1020107 SCANS 1200 TO 2200 ACQUIRED: 02/01/94 23:10:00
CALI: 1020107 #3 OUT OF 200 TO 2200
SAMPLE: 9401337-19A AND COL C 10UL/25UL/1ML
CONDS.: 40(3)-18006/MIN CAPILLARY 75M



Analysis Request and Chain of Custody Record



SOUTHWESTERN LABORATORIES

HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151
☐ DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700
☐ MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no.		Client/Project					ANALYSIS REQUESTED		LABORATORY REMARKS	
Lab ID No.	Field Sample No./ Identification	Date and Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative			
1	col A 1:14	1-25-94	✓		WDS	ground water	none	UGA		
2	col A 2:11		✓							
3	col A 6:28		✓							
4	col A 9:07		✓							
5	col A 24:10	1-26-94	✓							
6	Influent 2:30	1-25-94	✓							
7	col B 1:18		✓							
8	col B 2:06		✓							
9	col B 6:17		✓							
10	col B 9:01		✓							
Samplers: (Print)		Relinquished by: (Signature)		Date: 1-26-94		Time: 4:00		Received by: (Signature)		
Walter Forward		Walter Forward						Date: 1-26-94		
Affiliation		Relinquished by: (Signature)		Date: 1-26-94		Time: 4:00		Received by: (Signature)		
AWD		Relinquished by: (Signature)		Date: 1-26-94		Time: 4:00		Received by: (Signature)		
Results by 3 day test		REMARKS:		allow any carbon in the		bottles to settle to the		bottom		
Rush Charges Authorized		Yes		No		20		Data Results To:		
								1. Walter Forward		
								2.		
								Laboratory No. 94-01-337		

PUSH

Analysis Request and Chain of Custody Record

Project no.						Client/Project					
						W. Precourt					
Lab ID No.	Field Sample No./ Identification	Date and Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative	ANALYSIS REQUESTED	LABORATORY REMARKS		
11	COL B 24:02	1-26-94	V		JVA	ground water	none				
12	COL C 1:23	1-25-94									
13	COL C 2:22	1-25-94									
14	COL C 6:05	1-25-94									
15	COL C 8:55	1-25-94									
16	COL C 23:55	1-26-94									
17	COLA	1-26-94									
18	COLB										
19	COLC										
20	Inj 32:05										
Relinquished by: (Signature) W. Precourt						Date: 1-26-94 Time: 4:00					
Relinquished by: (Signature)						Date: Time:					
Relinquished by: (Signature)						Date: Time:					
REMARKS: allow any carbon in the bottles to settle to the bottom						Data Results for: 1. Wall Record 2.					

SWL SOUTHWESTERN LABORATORIES, HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151
DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700
MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no. _____ Client/Project _____

Field Sample No./ Identification _____ Date and Time _____ Grab _____ Comp _____ Sample Container (Size/Mat'l) _____ Sample Type (Liquid Sludge, Etc.) _____ Preservative _____ ANALYSIS REQUESTED _____ LABORATORY REMARKS _____

Relinquished by: (Signature) _____ Date: _____ Time: _____

Relinquished by: (Signature) _____ Date: _____ Time: _____

Relinquished by: (Signature) _____ Date: _____ Time: _____

REMARKS: _____

Results by: 3 day V at _____ Rush Charges Authorized Yes _____ No X



SOUTHWESTERN LABORATORIES

007791

222 CAVALCADE * P.O. BOX 8768, HOUSTON, TEXAS 77249 * 713 692-9151

Client AWD TECHNOLOGIES, INC.
400 W. SAM HOUSTON PKWY SOUTH
HOUSTON, TEXAS 77042

Client No. 2_0686_00
Report No. 94-01-283
Report Date 01/28/94 10:32

Attn: WALT PRECOURT

Project LONGHORN

Date Sampled 01/21/94

Sampled By CLIENT

Sample Type LIQUID SAMPLES

Transported by CLIENT

P.O. # _____

Date Received 01/24/94

Lab No.

94-01-283-01
94-01-283-02
94-01-283-03
94-01-283-04
94-01-283-05
94-01-283-06
94-01-283-07
94-01-283-08
94-01-283-09
94-01-283-10
94-01-283-11
94-01-283-12

Sample Identification

HCR-2.0
HCR-1.5
HCR-1.0
HCR-0.5
HCR-0.02
MSCI-2.0
MSCI-1.5
MSCI-1.0
MSCI-0.5
MSCI-0.02
IX CONTROL METALS
IX VOA CONTROL

CMT
Reviewed By

SOUTHWESTERN LABORATORIES

Chris Barry
CHRIS BARRY

Ion Exchange Isotane Data

TEST RESULTS BY SAMPLE

Sample: 01A HCR-2.0

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.044	mg/L	0.010	01/28/94	GLM
DISSOLVED BARIUM	EPA 200.7	0.735	mg/L	0.036	01/28/94	GLM
DISSOLVED CALCIUM	EPA 200.7	6.73	mg/L	0.010	01/28/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.010	mg/L	0.010	01/28/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	6.90	mg/L	0.002	01/28/94	GLM

Sample: 02A HCR-1.5

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.040	mg/L	0.010	01/28/94	GLM
DISSOLVED BARIUM	EPA 200.7	0.119	mg/L	0.036	01/28/94	GLM
DISSOLVED CALCIUM	EPA 200.7	12.6	mg/L	0.010	01/28/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.010	mg/L	0.010	01/28/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	14.0	mg/L	0.002	01/28/94	GLM

Sample: 03A HCR-1.0

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.037	mg/L	0.010	01/28/94	GLM
DISSOLVED BARIUM	EPA 200.7	0.146	mg/L	0.036	01/28/94	GLM
DISSOLVED CALCIUM	EPA 200.7	26.4	mg/L	0.010	01/28/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.010	mg/L	0.010	01/28/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	33.9	mg/L	0.002	01/28/94	GLM

Sample: 04A HCR-0.5

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.039	mg/L	0.010	01/28/94	GLM
DISSOLVED BARIUM	EPA 200.7	0.587	mg/L	0.036	01/28/94	GLM
DISSOLVED CALCIUM	EPA 200.7	90.4	mg/L	0.010	01/28/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.010	mg/L	0.010	01/28/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	74.9	mg/L	0.002	01/28/94	GLM

Order # 94-01-283

01/28/94 10:32

Client: AWD TECHNOLOGIES, INC.

Page 3

007793

TEST RESULTS BY SAMPLE

Sample: 05A HCR-0.02

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.060	mg/L	0.010	01/28/94	GLM
DISSOLVED BARIUM	EPA 200.7	1.38	mg/L	0.036	01/28/94	GLM
DISSOLVED CALCIUM	EPA 200.7	134	mg/L	0.010	01/28/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.010	mg/L	0.010	01/28/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	95.8	mg/L	0.002	01/28/94	GLM

Sample: 06A MSCI-2.0

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.042	mg/L	0.010	01/28/94	GLM
DISSOLVED BARIUM	EPA 200.7	0.083	mg/L	0.036	01/28/94	GLM
DISSOLVED CALCIUM	EPA 200.7	9.94	mg/L	0.010	01/28/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.010	mg/L	0.010	01/28/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	15.8	mg/L	0.002	01/28/94	GLM

Sample: 07A MSCI-1.5

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.031	mg/L	0.010	01/28/94	GLM
DISSOLVED BARIUM	EPA 200.7	0.075	mg/L	0.036	01/28/94	GLM
DISSOLVED CALCIUM	EPA 200.7	11.9	mg/L	0.010	01/28/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.010	mg/L	0.010	01/28/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	23.4	mg/L	0.002	01/28/94	GLM

Sample: 08A MSCI-1.0

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.041	mg/L	0.010	01/28/94	GLM
DISSOLVED BARIUM	EPA 200.7	0.051	mg/L	0.036	01/28/94	GLM
DISSOLVED CALCIUM	EPA 200.7	23.2	mg/L	0.010	01/28/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.010	mg/L	0.010	01/28/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	43.8	mg/L	0.002	01/28/94	GLM

Order # 94-01-283

01/28/94 10:32

Client: AWD TECHNOLOGIES, INC.

Page 007794

TEST RESULTS BY SAMPLE

Sample: 09A MSCI-0.5

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.078	mg/L	0.010	01/28/94	GLM
DISSOLVED BARIUM	EPA 200.7	0.352	mg/L	0.036	01/28/94	GLM
DISSOLVED CALCIUM	EPA 200.7	71.8	mg/L	0.010	01/28/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.010	mg/L	0.010	01/28/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	79.7	mg/L	0.002	01/28/94	GLM

Sample: 10A MSCI-0.02

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.075	mg/L	0.010	01/28/94	GLM
DISSOLVED BARIUM	EPA 200.7	1.12	mg/L	0.036	01/28/94	GLM
DISSOLVED CALCIUM	EPA 200.7	119	mg/L	0.010	01/28/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.010	mg/L	0.010	01/28/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	98.9	mg/L	0.002	01/28/94	GLM

Sample: 11A IX CONTROL METALS

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.053	mg/L	0.010	01/28/94	GLM
DISSOLVED BARIUM	EPA 200.7	2.07	mg/L	0.036	01/28/94	GLM
DISSOLVED CALCIUM	EPA 200.7	161	mg/L	0.010	01/28/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.010	mg/L	0.010	01/28/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	107	mg/L	0.002	01/28/94	GLM

Sample: 12A IX VOA CONTROL

Collected: 01/21/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
VOLATILES-DRINKING WATER	EPA 524.2	ENCLOSURE	DATE		01/25/94	RKW

VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA METHOD 624 - WATER

EPA METHOD 8240 - SOIL/WASTE

CASE NO 401283
SAS NO _____LABORATORY SwL - Houston
REPORTED 01/25/94 15:54CONTRACT LONGHORN
CUSTOMER AWDFILE NAME I012501
TYPE EPA
INST FINNSAMPLE ID IX VOA CONTRL
LAB SAMP ID 9401283-12A
ANALYZED 01/25/94 14:45LEVEL LOW
MATRIX WATER
UNITS ug/L

CODE	CAS NO	COMPOUND	TYPES	CONC	FLAGS
C010	74-87-3	Chloromethane		25.0	U
C015	74-83-9	Bromomethane		25.0	U
C020	75-01-4	Vinyl Chloride		25.0	U
C025	75-00-3	Chloroethane		25.0	U
C030	75-09-2	Methylene Chloride		270	
C035	67-64-1	Acetone		125	U
C040	75-15-0	Carbon Disulfide		12.5	U
C045	75-35-4	1,1-Dichloroethene		12.5	U
C050	75-34-3	1,1-Dichloroethane		12.5	U
C055	540-59-0	1,2-Dichloroethene (Total)		12.5	U
C060	67-66-3	Chloroform		12.5	U
C065	107-06-2	1,2-Dichloroethane		12.5	U
C110	78-93-3	Methylethyl ketone (MEK)		25.0	U
C115	71-55-6	1,1,1-Trichloroethane		12.5	U
C120	56-23-5	Carbon Tetrachloride		12.5	U
C125	108-05-4	Vinyl Acetate		25.0	U
C130	75-27-4	Bromodichloromethane		12.5	U
C140	78-87-5	1,2-Dichloropropane		12.5	U
C143	10061-01-5	cis-1,3-Dichloropropene		12.5	U
C150	79-01-6	Trichloroethene		22.3	
C155	124-48-1	Dibromochloromethane		12.5	U
C160	79-00-5	1,1,2-Trichloroethane		12.5	U
C165	71-43-2	Benzene		12.5	U
C172	10061-02-6	trans-1,3-Dichloropropene		12.5	U
C180	75-25-2	Bromoform		12.5	U
C205	108-10-1	4-Methyl-2-Pentanone		25.0	U
C210	591-78-6	2-Hexanone		25.0	U
C220	127-18-4	Tetrachloroethene		12.5	U
C225	79-34-5	1,1,2,2-Tetrachloroethane		12.5	U
C230	108-88-3	Toluene		12.5	U
C235	108-90-7	Chlorobenzene		12.5	U
C240	100-41-4	Ethylbenzene		12.5	U
C245	100-42-5	Styrene		12.5	U
C250	1330-20-7	Xylene (total)		12.5	U

VOLATILE ORGANICS ANALYSIS DATA SHEET
EPA METHOD 624 - WATER
EPA METHOD 8240 - SOIL/WASTE

CASE NO 401283
SAS NO _____

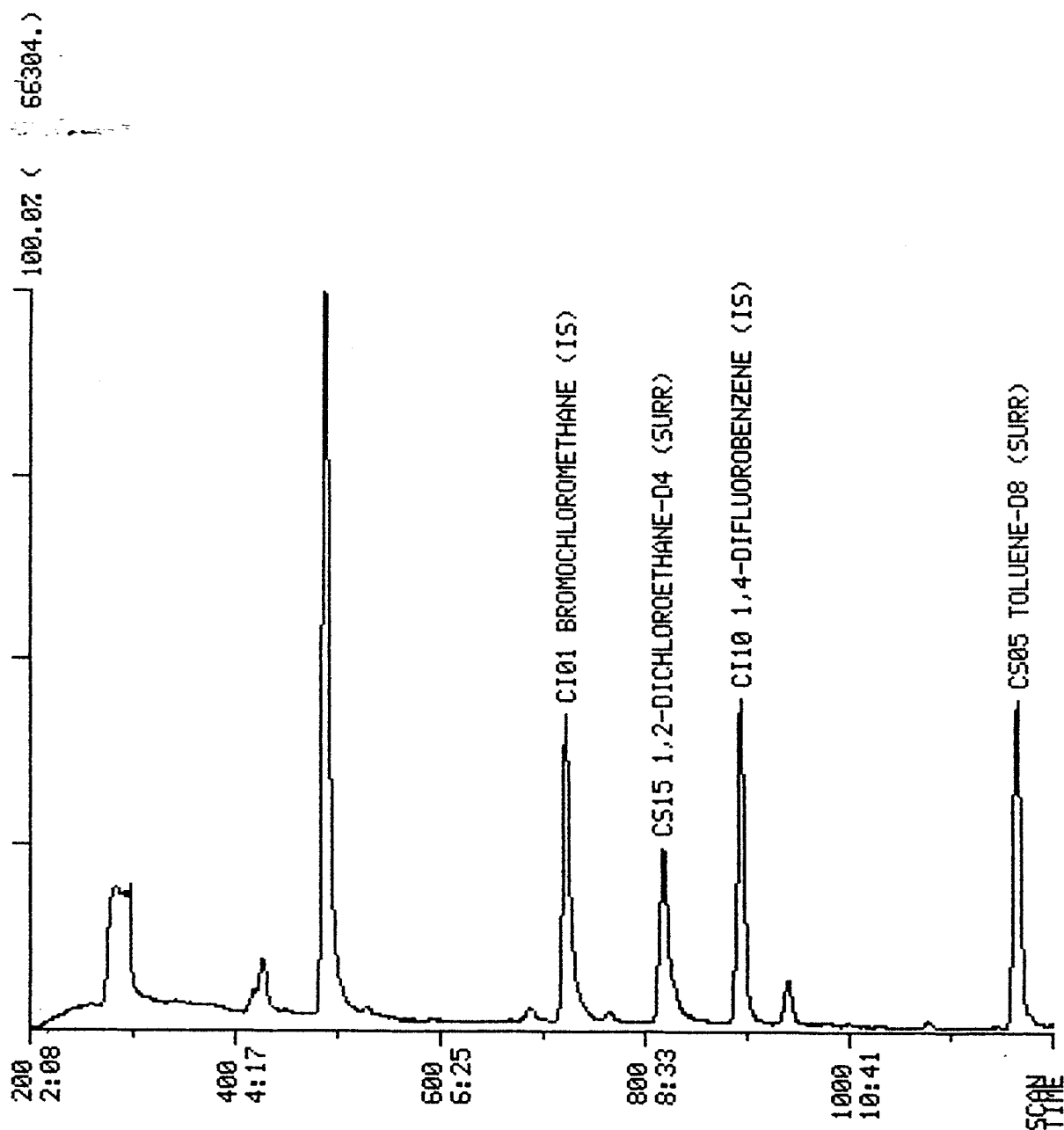
LABORATORY SwL - Houston
REPORTED 01/25/94 15:54

CONTRACT LONGHORN
CUSTOMER AWD

Notes and summary data for this report.

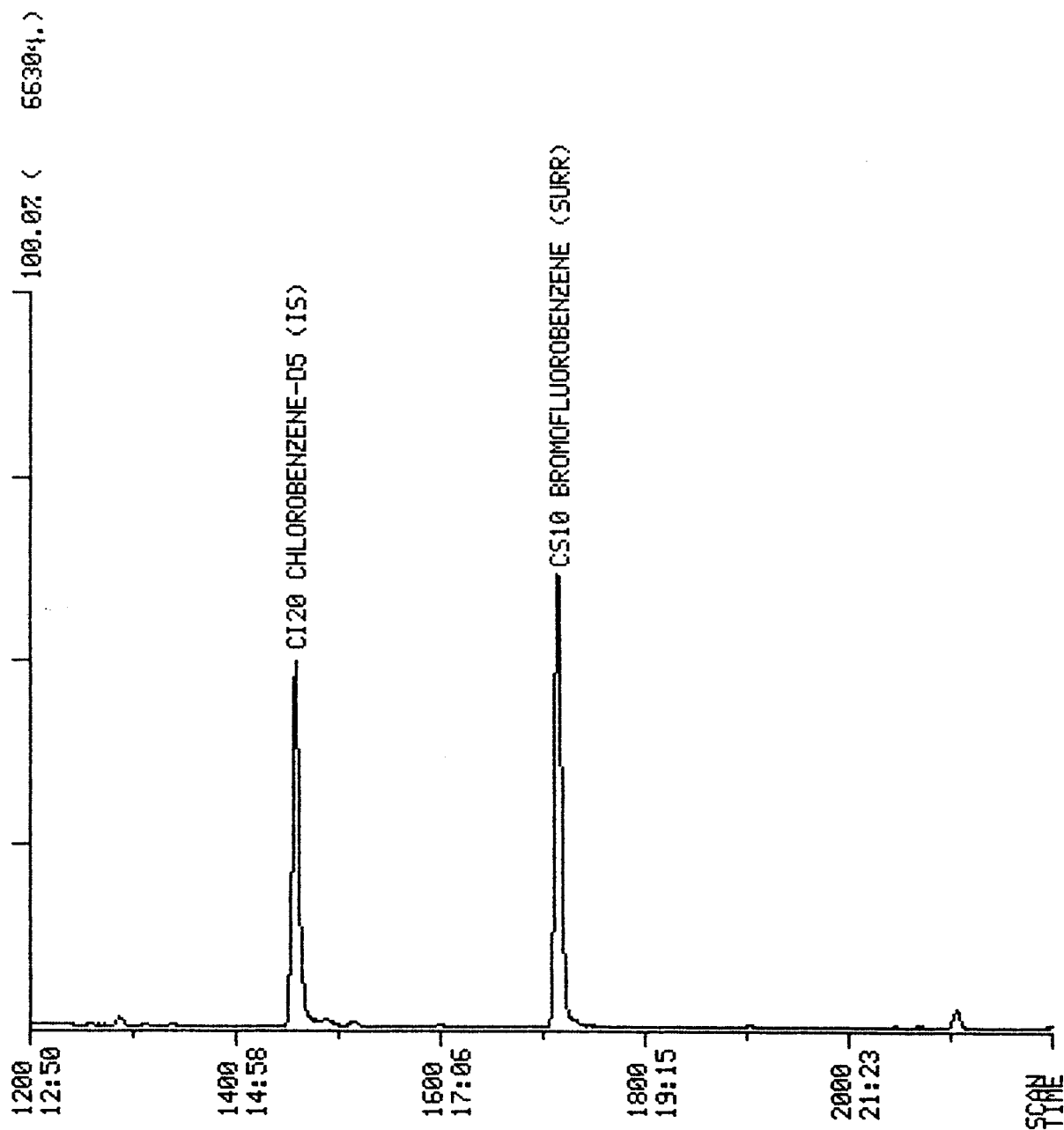
U - Compound analyzed for but not detected. The reported value is the minimum attainable detection limit for the sample.

DATA FROM FILE: I012501 SCANS 200 TO 1200 ACQUIRED: 01/25/94 14:45:00
SAMPLE: 9401283-12A AND IX VOA CONTROL 2ML CALI: I012501 #3 OUT OF 200 TO 2200
CONDS.: 40(3) 40-180 @ 6/MIN



007798

DATA FROM FILE: I012501 SCANS 1200 TO 2200 ACQUIRED: 01/25/94 14:45:00
CALI: I012501 #3 OUT OF 200 TO 2200
SAMPLE: 9401283-12A AWD IX UOA CONTROL 2ML
CONDS.: 40(3) 40-180 @ 6/MIN



Analysis Request and Chain of Custody Record

Page 1 of 2

SOUTHWESTERN LABORATORIES

- ☒ HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151
☐ DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700
☐ MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no. Longhorn		Client/Project AWD / Longhorn				Walt Precourt				
Lab ID No.	Field Sample No./ Identification	Date and Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative	ANALYSIS REQUESTED	LABORATORY REMARKS	
1	HCR - 2.0	1/21/94	✓		500 ml plastic	water	none	Filter sample to remove debris		
2	HCR - 1.5							Aluminum, Cu, Pb, Ca,		
3	HCR - 1.0							Magnesium, Ba		
4	HCR - 0.5							* need detection		
5	HCR - 0.02							limit of 0.02 mg/l		
6	MSCI - 2.0							on Cu		
7	MSCI - 1.5									
8	MSCI - 1.0									
9	MSCI - 0.5									
10	MSCI - 0.02									
Samplers: (Print) W Precourt		Relinquished by: (Signature) Walt Precourt		Date: 1/21/94 Time:		Received by: (Signature)		Date: Time:		COC Seal No. None
Affiliation WD		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		REC'D. ON ICE Yes No
suits by 1/27/94		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		Date: Time:		Intact: <u>WPA</u>
Rush Charges Authorized		REMARKS: see note on copper detection limits filter resin from all but vort sample 2		Data Results To: 1. Walter Precourt		Laboratory No. 04401-282799				



SOUTHWESTERN LABORATORIES

☒ HOUSTON EAS

222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151

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☐ **MIDLAND EAS** 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

[illegible]



SOUTHWESTERN LABORATORIES 007801

222 CAVALCADE * P.O. BOX 8768, HOUSTON, TEXAS 77249 * 713 692-9151

Client AWD TECHNOLOGIES, INC.
400 W. SAM HOUSTON PKWY SOUTH
HOUSTON, TEXAS 77042

Client No. 2_0686_00
Report No. 94-01-376
Report Date 02/03/94 15:54

Attn: WALT PRECOURT

Project LONGHORN

Date Sampled 01/25/94 01/28/94

Sampled By CLIENT

Sample Type LIQUID SAMPLES

Transported by CLIENT

P.O. # _____

Date Received 01/31/94

Lab No.

94-01-376-01
94-01-376-02
94-01-376-03
94-01-376-04
94-01-376-05
94-01-376-06
94-01-376-07
94-01-376-08
94-01-376-09
94-01-376-10
94-01-376-11
94-01-376-12
94-01-376-13
94-01-376-14
94-01-376-15
94-01-376-16
94-01-376-17
94-01-376-18
94-01-376-19
94-01-376-20
94-01-376-21
94-01-376-22
94-01-376-23
94-01-376-24
94-01-376-25
94-01-376-26

Sample Identification

IX1-60
IX1-126
IX1-180
IX1-240
IX1-270
IX1-300
IX1-312
IX1-324
IX1-336
IX1-342
IX1-360
IX1-372
IX1-384
IX1-396
IX1-408
IX1-456
IX1-560
IX1-620
IX1-MISC A
TX1-1ST 500 ML REGEN
IX1-BAL REGEN
IX1-CONTROL
EW1 W/ 0.0 HCR
EW1 W/ 1.5 HCR
EW1 W/ 0.5 HCR
COL C - GAC

Ion Exchange Column Data

SOUTHWESTERN LABORATORIES

Order # 94-01-376

02/03/94 15:54

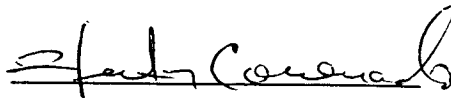
Client: AWD TECHNOLOGIES, INC.

Page 2

007802

Reviewed By

SOUTHWESTERN LABORATORIES



HECTOR CORONADO

SOUTHWESTERN LABORATORIES

Order # 94-01-376

02/03/94 15:54

Client: AWD TECHNOLOGIES, INC.

TEST RESULTS BY SAMPLE

Page 1007803

Sample: 01A IX1-60

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	0.016	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	<0.007	mg/L	0.007	02/02/94	GLM

Sample: 02A IX1-126

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	<0.010	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	<0.007	mg/L	0.007	02/02/94	GLM

Sample: 03A IX1-180

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	<0.010	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	<0.007	mg/L	0.007	02/02/94	GLM

Sample: 04A IX1-240

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	<0.010	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	<0.007	mg/L	0.007	02/02/94	GLM

Sample: 05A IX1-270

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	<0.010	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	0.869	mg/L	0.007	02/02/94	GLM

Sample: 06A IX1-300

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	0.169	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	7.12	mg/L	0.007	02/02/94	GLM

Sample: 07A IX1-312

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	0.403	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	15.5	mg/L	0.007	02/02/94	GLM

Sample: 08A IX1-324

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	0.799	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	29.0	mg/L	0.007	02/02/94	GLM

Sample: 09A IX1-336

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	1.34	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	46.4	mg/L	0.007	02/02/94	GLM

Sample: 10A IX1-342

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	1.63	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	54.4	mg/L	0.007	02/02/94	GLM

Sample: 11A IX1-360

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	2.62	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	85.9	mg/L	0.007	02/02/94	GLM

Sample: 12A IX1-372

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	3.86	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	114	mg/L	0.007	02/02/94	GLM

Sample: 13A IX1-384

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	5.08	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	133	mg/L	0.007	02/02/94	GLM

Sample: 14A IX1-396

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	6.45	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	150	mg/L	0.007	02/02/94	GLM

Sample: 15A IX1-408

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	8.20	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	158	mg/L	0.007	02/02/94	GLM

Order # 94-01-376

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TEST RESULTS BY SAMPLE

Client: AWD TECHNOLOGIES, INC.

Sample: 16A IX1-456

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	16.9	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	139	mg/L	0.007	02/02/94	GLM

Sample: 17A IX1-560

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	62.2	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	132	mg/L	0.007	02/02/94	GLM

Sample: 18A IX1-620

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	90.2	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	119	mg/L	0.007	02/02/94	GLM

Sample: 19A IX1-MISC A

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 208.1	<0.22	mg/L	0.22	02/03/94	JP
CALCIUM	EPA 200.7	1.11	mg/L	0.010	02/02/94	GLM
MAGNESIUM	EPA 200.7	28.9	mg/L	0.007	02/02/94	GLM

Order # 94-01-376

02/03/94 15:54

Client: AWD TECHNOLOGIES, INC.

TEST RESULTS BY SAMPLE

Page 7 007807

Sample: 20A TX1-1ST 500 ML REGEN

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 200.7	12.6	mg/L	0.22	02/03/94	GLM
CALCIUM	EPA 200.7	256	mg/L	0.010	02/03/94	GLM
COPPER	EPA 200.7	<0.04	mg/L	0.04	02/03/94	GLM
MAGNESIUM	EPA 200.7	73.5	mg/L	0.007	02/03/94	GLM
SODIUM	EPA 200.7	48,350	mg/L	0.03	02/03/94	GLM

Sample: 21A IX1-BAL REGEN

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 200.7	72.5	mg/L	0.22	02/03/94	GLM
CALCIUM	EPA 200.7	2910	mg/L	0.010	02/03/94	GLM
COPPER	EPA 200.7	<0.04	mg/L	0.04	02/03/94	GLM
MAGNESIUM	EPA 200.7	1080	mg/L	0.007	02/03/94	GLM
SODIUM	EPA 200.7	36,800	mg/L	0.03	02/03/94	GLM

Sample: 22A IX1-CONTROL

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
BARIUM	EPA 200.7	3.80	mg/L	0.22	02/03/94	GLM
CALCIUM	EPA 200.7	118	mg/L	0.010	02/03/94	GLM
COPPER	EPA 200.7	<0.04	mg/L	0.04	02/03/94	GLM
MAGNESIUM	EPA 200.7	102	mg/L	0.007	02/03/94	GLM
pH	EPA 150.1	8.26	pH UNITS		01/31/94	RF

Sample: 23A EW1 W/ 0.0 HCR

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.13	mg/L	0.05	02/03/94	GLM
DISSOLVED CALCIUM	EPA 200.7	51.8	mg/L	0.010	02/03/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	42.6	mg/L	0.007	02/03/94	GLM

Sample: 24A EW1 W/ 1.5 HCR

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.12	mg/L	0.05	02/03/94	GLM
DISSOLVED CALCIUM	EPA 200.7	2.79	mg/L	0.010	02/03/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	2.85	mg/L	0.007	02/03/94	GLM

Sample: 25A EW1 W/ 0.5 HCR

Collected: 01/28/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.38	mg/L	0.05	02/03/94	GLM
DISSOLVED CALCIUM	EPA 200.7	11.8	mg/L	0.010	02/03/94	GLM
DISSOLVED MAGNESIUM	EPA 200.7	11.6	mg/L	0.007	02/03/94	GLM

Sample: 26A COL C - GAC

Collected: 01/25/94

<u>Test Name</u>	<u>Method</u>	<u>Result</u>	<u>Units</u>	<u>Detection Limit</u>	<u>Date Started</u>	<u>Analyst</u>
DISSOLVED ALUMINUM	EPA 200.7	0.69	mg/L	0.05	02/03/94	GLM
DISSOLVED BARIUM	EPA 200.7	<0.15	mg/L	0.15	02/03/94	GLM
DISSOLVED COPPER	EPA 200.7	<0.04	mg/L	0.04	02/03/94	GLM
DISSOLVED IRON	EPA 200.7	0.622	mg/L	0.010	02/03/94	GLM

Analysis Request and Chain of Custody Record

Page 1 of 3

SOUTHWESTERN LABORATORIES

☒ HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151

☐ DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700

☐ MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no.		Client/Project				ANALYSIS REQUESTED		LABORATORY REMARKS	
Longhorn		A&D - Longhorn				W. Precourt			
Lab ID No.	Field Sample No./ Identification	Date and Time	Grab	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative		
	IX1 - 60	1-28-94			300ml plastic	water	none	Ca, Ba, mg	
	IX1 - 126								
	IX1 - 180								
	IX1 - 240								
	IX1 - 270								
	IX1 - 300								
	IX1 - 312								
	IX1 - 324								
	IX1 - 336								
	IX1 342								
Samplers: (Print)		Relinquished by: (Signature)		Date: 1-31-94		Time: 8:00 AM		Received by: (Signature)	
Precourt - wp		Water Demand						Date: Time:	
Affiliation		Relinquished by: (Signature)		Date: Time:				Received by: (Signature)	
A&D		Relinquished by: (Signature)		Date: Time:				Date: 1-31-94	
Results by 3dmg								Time: 0800	
Rush Charges Authorized		REMARKS:						Intact: Yes No	
Yes No		1. W. Precourt						Laboratory No. 94-01-376	
		2.						COC Seal No. None	
								REC'D ON ICE	
								007809	

Analysis Request and Chain of Custody Record

Page 2 of 3

SOUTHWESTERN LABORATORIES

☒ HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151

☐ DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700

☐ MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no.		Client/Project				ANALYSIS REQUESTED		LABORATORY REMARKS	
Longhorn		Auld - Longhorn				W. Precourt			
Lab ID No.	Field Sample No./ Identification	Date and Time	Comp	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative			
	IX1 - 360	1-28-94		300ml Plastic	water	none	Ca, Ba, mg		
	IX1 - 372								
	IX1 - 384								
	IX1 - 396								
	IX1 - 408								
	IX1 - 456								
	IX1 - 560								
	IX1 - 620								
	IX1 - 620								
	IX1 - Misc A						Ca, Ba, mg		
Samplers: (Print)		Relinquished by: (Signature)		Date: 1-31-94 Time: 8:00pm		Received by: (Signature)		Date: _____ Time: _____	
Precourt, wp		Walter Precourt				Received by: (Signature)		Date: 1-31-94 Time: 0800	
Affiliation		Relinquished by: (Signature)				Received by: (Signature)		Date: _____ Time: _____	
Auld		Relinquished by: (Signature)				Received by: (Signature)		Date: _____ Time: _____	
Results by <u>3 day</u>		REMARKS:				Data Results for:		Laboratory No.	
Rush Charges Authorized						1. <u>Walt Precourt</u>		<u>94-01-3710</u>	
Yes _____ No <u>X</u>									

007810

Analysis Request and Chain of Custody Record

Page 3 of 3

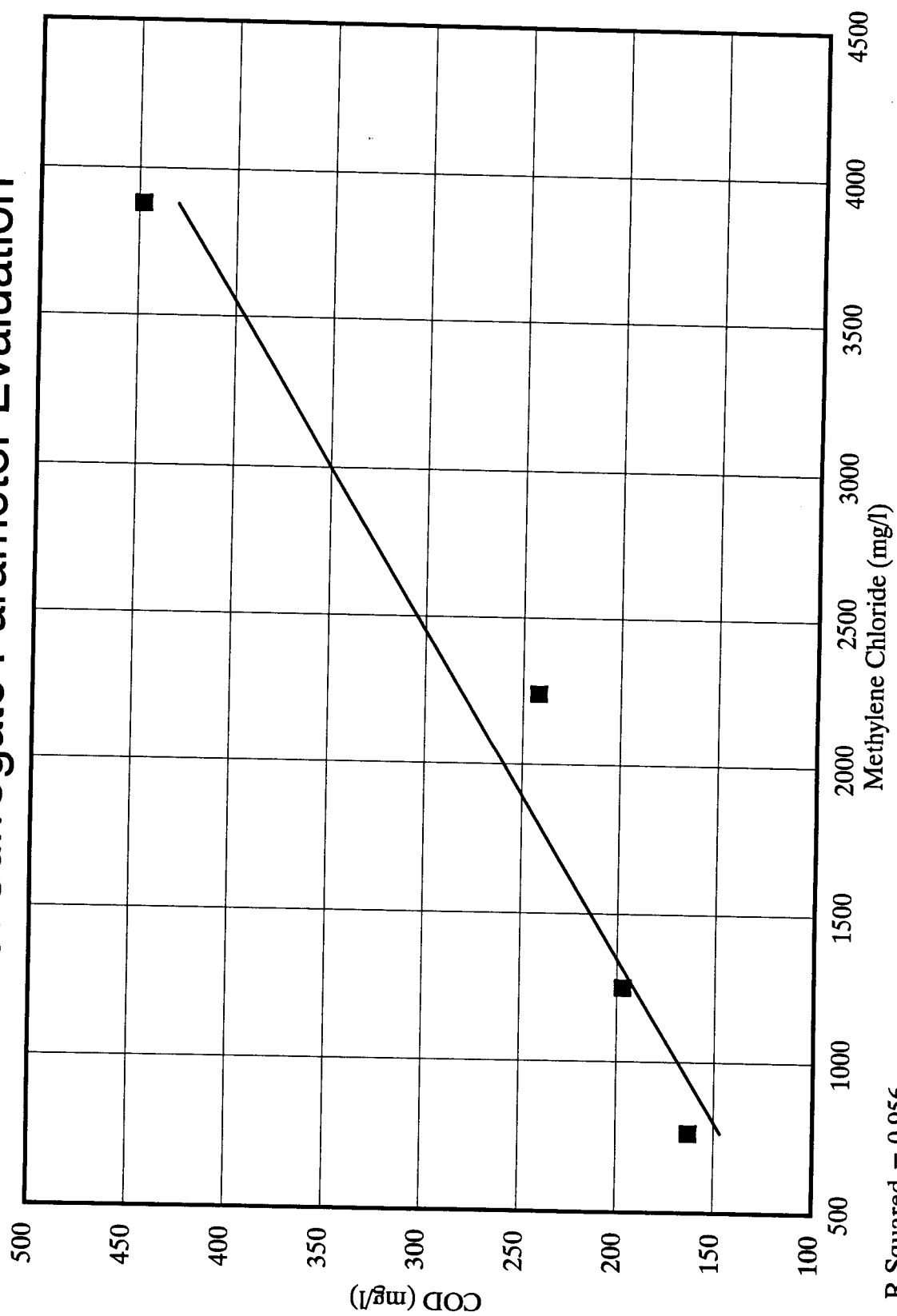
SOUTHWESTERN LABORATORIES

☒ HOUSTON EAS 222 CAVALCADE ST., HOUSTON, TEXAS 77009 (713) 692-9151
☐ DALLAS EAS 2575 LONE STAR DR., DALLAS, TEXAS 75212 (214) 631-2700
☐ MIDLAND EAS 1703 WEST INDUSTRIAL, MIDLAND, TEXAS 79701 (915) 683-3349

Project no.		Client/Project				Analysis Requested		Laboratory Remarks	
Longhorn		AWD - Longhorn				W. Precourt			
Lab ID No.	Field Sample No./ Identification	Date and Time	QTY	Sample Container (Size/Mat'l)	Sample Type (Liquid Sludge, Etc.)	Preservative	Analysis Requested	Laboratory Remarks	
	TX 1 - 1st 500ml regen	1-28	1	500ml plastic	Water	none	Ca, Mg, Ba, Cu, Na	Cu detection limits	
	TX 1 - 2nd regen	1-28	1	500ml plastic			Ca, Mg, Ba, Cu, Na	"	
	TX 1 - Control	1-28	1	300ml plastic			Ca, Mg, Ba, Cu, (PH)	"	
	EW 1 w/ 0.0 HCR	1-28	1	500ml plastic			Al, Ca, Mg		
	EW 1 w/ 1.5 HCR		1				Al, Ca, Mg	filter residue only	
	EW 1 w/ 0.5 HCR		1				Al, Ca, Mg	Sample	
	Cal C - GAC	1-25	1	500ml plastic		X	Ba, Cu, Al, Fe	Cu detection limits	
							filter and carbon		
Samplers: (Print)		Relinquished by: (Signature)		Date: 1-31-54		Received by: (Signature)		COC Seal No.	
precourt - wp		Walter Precourt		Time: 7:00 AM				None	
Affiliation		Relinquished by: (Signature)		Date: Time:		Received by: (Signature)		REC'D ON ICE	
AWD		Relinquished by: (Signature)		Date: Time:				Yes No	
Results by 3 day		Relinquished by: (Signature)		Date: 1-31-54		Received by: (Signature)		Intact	
Rush Charges Authorized				Time: 0800				N/A	
Yes No		Data Results to:		1. Walter Precourt		Laboratory No.		94-01-376	
		REMARKS:		Samples w/ copper & O. O. Z. detection limits - these samples may behave the same as previous samples during digestion					

Appendix C
COD - Methylene Chloride
Calibration Curves

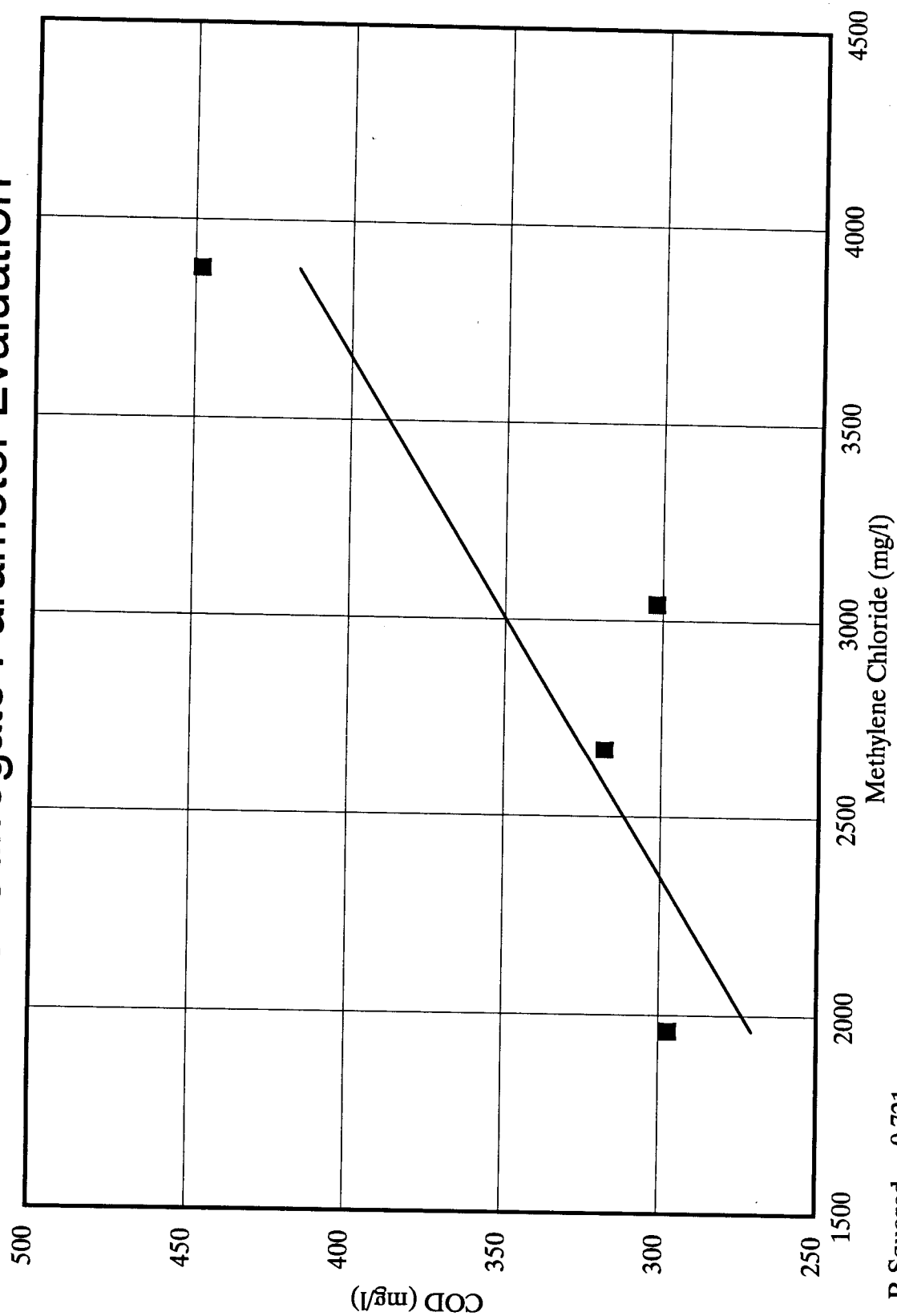
MeCl Surrogate Parameter Evaluation



R Squared = 0.956

Control and Norit adsorption data

MeCl Surrogate Parameter Evaluation

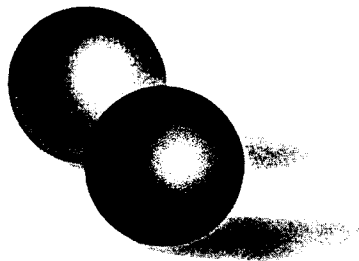


R Squared = 0.721

Control and Westveco adsorption data

007815

Appendix D
Vendor Supplied Information



DOWEX MSC-1 Cation Resin

A macroporous cation resin for demineralization and softening

Description

DOWEX[®] MSC-1 resin is a high-capacity, macroporous, strong acid cation exchange resin having normal (Gaussian) particle size distribution. It is based on a macroporous S-DVB (styrene-divinylbenzene) copolymer matrix with sulfonic acid functional groups. The degree and type of cross-linking result in a high-capacity, efficiently regenerable resin demonstrating superior osmotic shock and oxidative stability. The resin is ideally suited for operation in aggressive softener or demineralizer systems. With higher levels of cross-linkage than gel structures, macroporous structures are better suited for use in highly oxidative systems. This

degree of cross-linkage and the macroporous structure yield inherently lower capacity than gel-type resins. The lower capacity per cubic foot of resin means that, for a fixed regenerant dosage per cubic foot of resin, each active capacity site is contacted with more regenerant. This results in lower sodium ion leakage than with the 8% or 10% DVB gel-type resins with Gaussian particle distribution.

The Gaussian particle size distribution of DOWEX MSC-1 resin (ranging between 16 and 50 mesh) provides hydraulic properties appropriate for standard column operation needs. Pressure drop is sufficient to facilitate good distribution of flow across a resin bed. Backwash expansion characteristics allow for cleanup by bed fluidization.

DOWEX MSC-1 cation resin is available in the sodium and hydrogen forms. Physical and chemical properties are listed in Table 1.

Applications

DOWEX MSC-1 resin is used extensively in aggressive demineralization operations, both in mixed-bed and in multiple-bed configurations. It can operate effectively over the entire pH range, under high flow rate conditions, and at high temperatures. DOWEX MSC-1 resin is also suitable for use in industrial water softening. Its combined physical and chemical stability makes it suitable for the most aggressive softening applications.

DOWEX MSC-1 cation exchange resin meets the requirements of FDA Food Additive Regulation 21 CFR 173.25.

*Trademark of The Dow Chemical Company

Figure 1. Operating Capacity and Sodium Leakage—H₂SO₄ Regeneration—DOWEX MSC-1 Resin

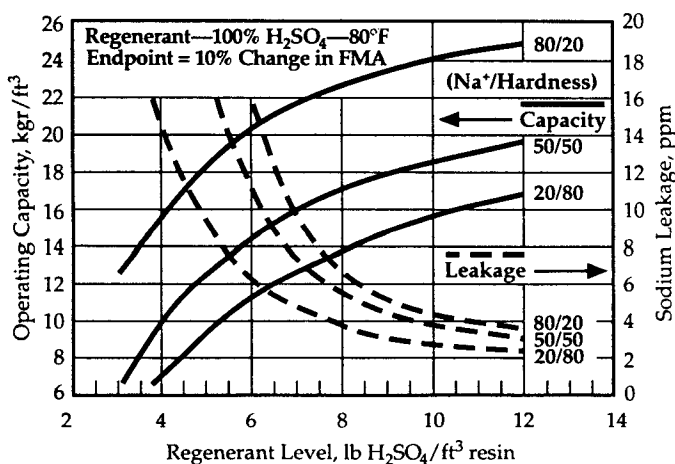
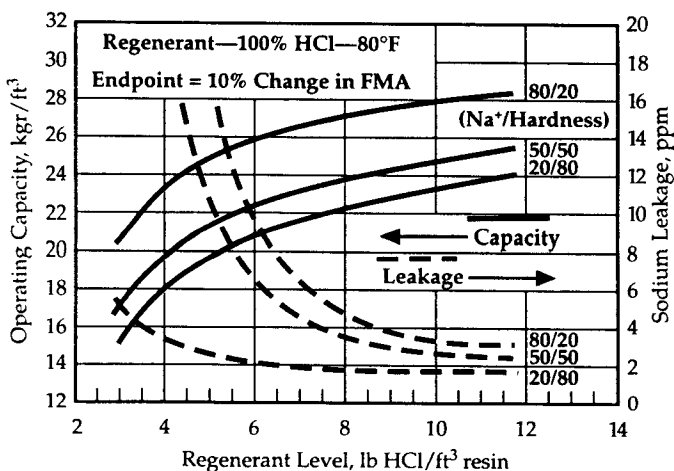


Figure 2. Operating Capacity and Sodium Leakage—HCl Regeneration—DOWEX MSC-1 Resin



PROPERTIES AND OPERATING INFORMATION

Table 1. Typical Physical and Chemical Properties for DOWEX MSC-1 Resin[†]

Chemical Form Physical Form	Na ⁺		H ⁺	
	Sodium Opaque, light-tan beads		Hydrogen Opaque, light-tan beads	
Resin Grade	Standard	Condensate	Standard	Condensate
Total Exchange Capacity as CaCO ₃	1.7 meq/ml 37.1 kgr/ft ³	1.7 meq/ml 37.1 kgr/ft ³	1.6 meq/ml 35 kgr/ft ³	1.6 meq/ml 35 kgr/ft ³
Water Retention Capacity Range	44–50%	44–50%	50–56%	50–56%
Particle Size (U.S. Standard Sieves)				
% through +14 mesh, minimum	—	100%	—	100%
% on +16 mesh, maximum	8%	2%	8%	2%
% through +40 mesh, maximum	5%	1%	5%	1%
Shipping Weight	50 lb/ft ³	50 lb/ft ³	47 lb/ft ³	47 lb/ft ³
Whole Perfect Beads	>95%	>95%	>95%	>95%
Color Throw, APHA No., maximum	50	50	—	—
Friability, average, minimum	—	350 g/bead	—	350 g/bead
Friability, >200 g/bead, minimum	—	95%	—	95%
Acidity, pH Range	—	7.0–9.5	—	—

[†]Contact your local sales representative to receive updated comprehensive Sales Specifications and Material Safety Data Sheets.

Operating Capacity and Leakage

Suggested operating conditions and parameters for use of DOWEX MSC-1 resin in demineralizers or softeners are presented in Table 2. Examples of operating capacity and sodium ion leakage for sulfuric acid and hydrochloric acid, respectively, at various levels of hardness are shown in Figures 1 and 2. Calcium sulfate precipitation within the resin bed is likely when sulfuric acid is used to re-

generate a resin bed containing a significant percentage of calcium ions. DOWEX MSC-1 resin offers higher selectivity for calcium ion, relative to sodium ion, than do 8 or 10% DVB gel-type resins. Therefore, the likelihood of calcium sulfate precipitation is increased. When calcium content is moderate to high relative to the total cations present, use stepwise regeneration techniques with sulfuric acid regenerant or use hydrochloric acid regenerant. Capacity and hardness leakage data for DOWEX MSC-1 resin in water softening applications are presented in Figure 3 using salt (NaCl solution) at three dosages.

More complete computer-generated capacity and leakage ratings, particular to your operating conditions, can be obtained from your Dow Sales or Technical Service and Development Representative.

Hydraulic Characteristics

The particle size distribution of DOWEX MSC-1 resin is a carefully selected Gaussian range to give hydraulic properties appropriate to the needs of standard demineralizer and softening system designs. The properties of prime concern are pressure drop across the bed and backwash expansion during resin cleanup.

Pressure Drop

Pressure drop across a resin bed can vary with bead size, flow, temperature, and the interstitial space in the packed bed. In resins with Gaussian distribution, interstitial space can vary from the classified to the mixed-resin state. In a mixed bed, the small beads tend to fill the spaces between the larger beads, thus, the pressure drop is greater than across a classified bed. Except for mixed-bed demineralizers, the resins are operated following a backwash step. Therefore, the data described below are for single-resin beds in the classified condition. Normally, the pressure drop across a resin bed in demineralizer service is quite low because of the low flow rates utilized.

Figure 4 shows the variation of pressure drop with flow rate for the exhausted form of the resin at various temperatures. As water viscosity decreases with increasing temperature, so does the pressure drop. This is most apparent when seasonal changes significantly affect the influent water temperature.

Table 2. Suggested Demineralization Operating Conditions and Parameters for DOWEX MSC-1 Resin

Maximum Temperature	300°F	
pH Range	0–14	
Minimum Bed Depth	30 inches	
Service Flow Rate	2–4 gpm/ft ³	
Velocity	5–10 gpm/ft ²	
Pressure Drop	(See Figure 4) 0.4 psi/ft at 5 gpm/ft ² , 77°F	
Backwash Flow Rate	(See Figures 5 and 6)	
Flow at 50% Expansion, Na ⁺ Form	6.8 gpm/ft ² at 77°F	
Flow at 100% Expansion, Na ⁺ Form	13.5 gpm/ft ² at 77°F	
Type of Operation	H ⁺ Cycle	Na ⁺ Cycle
Regenerant, typically	H ₂ SO ₄ or HCl	NaCl (Salt)
Regenerant Level	Dependent on desired capacity and leakage (See Figures 1 and 2)	Dependent on desired capacity and leakage (See Figure 3)
Concentration	2–8% H ₂ SO ₄ , stepwise, or 4–10% HCl	10–26% NaCl
Flow Rate	0.5–2 gpm/ft ³	2 min/lb salt/ft ³
Contact Time	30 minutes, minimum	30 minutes, minimum
Temperature	Ambient	Ambient
Rinse Water Requirement	40–100 gal/ft ³	20–40 gal/ft ³
Displacement	0.5–2 gpm/ft ³	Adjust to 30-minute regenerant contact time
Rinse Rate		
Fast Rinse Rate	2–4 gpm/ft ³	2–4 gpm/ft ³

Figure 3. Softening Capacity and Hardness Leakage—DOWEX MSC-1 Resin

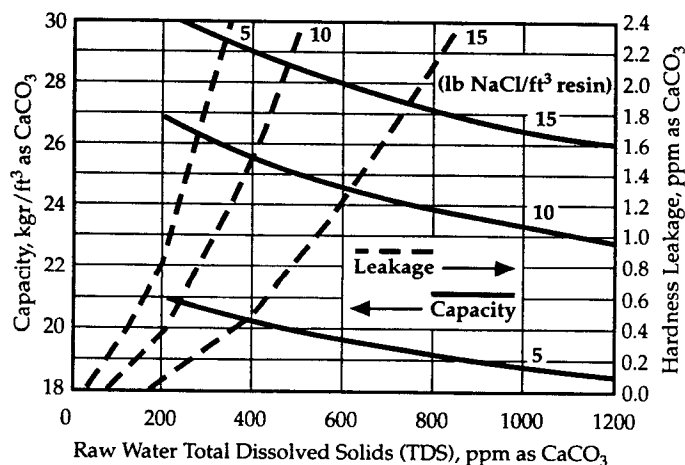
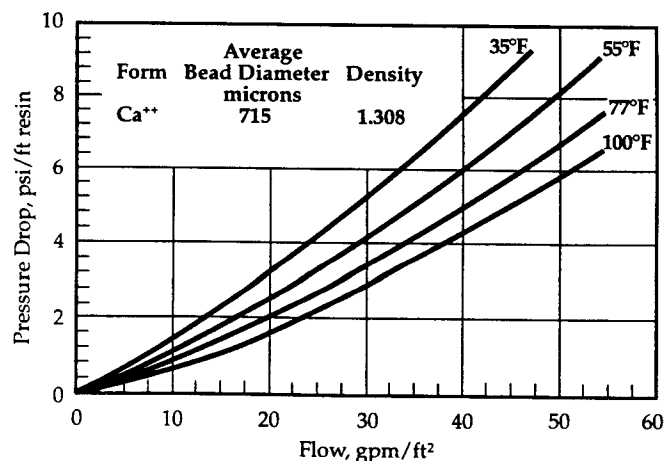


Figure 4. Pressure Drop vs. Flow Rate—Effect of Temperature—DOWEX MSC-1 Resin



(continued on back page)

Backwash Expansion

Maintaining bed cleanliness is of utmost concern in the operation of a softener or a demineralizer. The standard method for bed cleanup is to remove particulate materials and reclassify the resin bed by backwash expansion. This fluidization of the resin is affected by the bead size, bead density, water flow rate, and water temperature. Figure 5 shows the relationship of backwash expansion characteristics to flow rate at a constant tempera-

ture. Because the backwash operation is usually conducted with the resin in the exhausted state, data are presented for the calcium form. Also included are the hydrogen form normally used in demineralizers and the sodium form used in softeners. The flow rate needed to expand the resin bed to a given percentage above the settled volume can be estimated. An expansion of approximately 50% for at least 20 minutes is normally suggested to achieve a flow rate sufficient to remove the particulate matter from the resin bed.

Figure 6 shows backwash expansion data for the calcium form at several temperatures. The temperature of the water has a significant effect on the bed expansion during backwash. Hence, backwash flow rates may require adjustments to compensate for seasonal temperature changes. Failure to do so may result in either insufficient backwash or resin losses.

Figure 5. Backwash Expansion vs. Flow Rate—DOWEX MSC-1 Resin

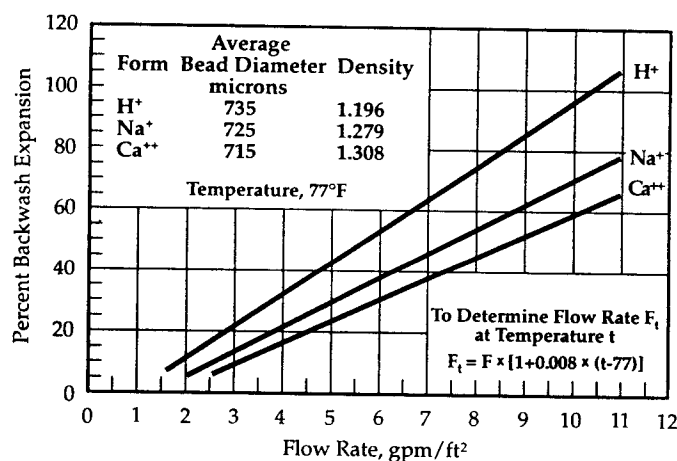
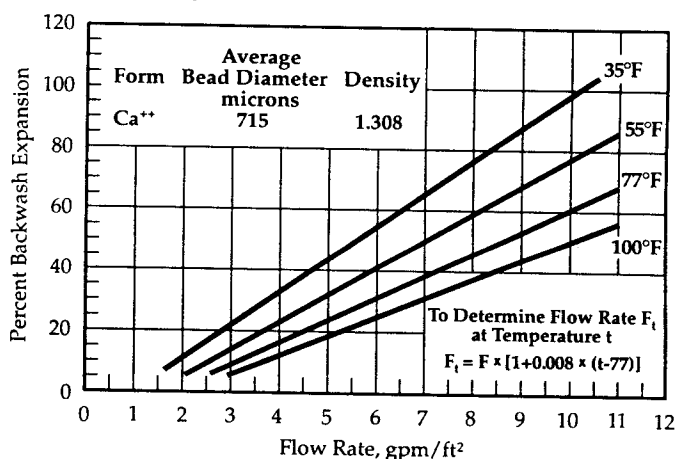


Figure 6. Backwash Expansion vs. Flow Rate—Effect of Temperature—DOWEX MSC-1 Resin

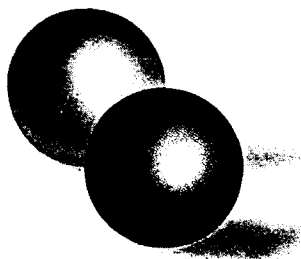


**For further information, call 1-800-447-4369
(1-800-363-6250 in Canada)
Ask for DOWEX Ion Exchange Resins**

WARNING: Oxidizing agents such as nitric acid attack organic ion exchange resins under certain conditions and could result in a slightly degraded resin up to an explosive reaction. Before using strong oxidizing agents, consult sources knowledgeable in handling such materials.

NOTICE: Dow believes the information and recommendations herein to be accurate and reliable as of September, 1992. However, since any assistance furnished by Dow with reference to the proper use and disposal of its products is provided without charge, and since use conditions and disposal are not within its control, Dow assumes no obligation or liability for such assistance and does not guarantee results from use of such products or other information herein; no warranty, express or implied, is given nor is freedom from any patent owned by Dow or others to be inferred. Information herein concerning laws and regulations is based on U.S. federal laws and regulations except where specific reference is made to those of other jurisdictions. Since use conditions and governmental regulations may differ from one location to another and may change with time, it is the Buyer's responsibility to determine whether these products are appropriate for Buyer's use, and to assure Buyer's workplace and disposal practices are in compliance with laws, regulations, ordinances, and other governmental enactments applicable in the jurisdiction(s) having authority over Buyer's operations.





007820



DOWEX HCR-S Cation Resin

*An 8% cross-linked, high-capacity resin
for demineralization and softening*

Description

DOWEX* HCR-S resin is a high-capacity, gel-type, strong acid cation exchange resin with Gaussian (normal) particle size distribution. It is based on a S-DVB (styrene-divinylbenzene) copolymer matrix with sulfonic acid functional groups. The degree of cross-linkage (approximately 8% DVB content) is chosen to yield a high-capacity, efficiently regenerable resin with adequate physical, osmotic shock and oxidative stability for operation in typical nonaggressive softener or demineralizer systems. For more highly oxidative systems, gel resins with higher levels of cross-linkage, or macroporous structures are required. The degree of cross-linkage in DOWEX HCR-S resin yields lower sodium ion leakage than resins having 10% DVB cross-linkage.

*Trademark of The Dow Chemical Company

The Gaussian particle size distribution of DOWEX HCR-S resin (ranging between 16 and 50 mesh) provides hydraulic properties appropriate for standard column operation needs. Pressure drop is sufficient to permit good distribution of flow across the resin bed. Backwash expansion characteristics allow for cleanup by bed fluidization.

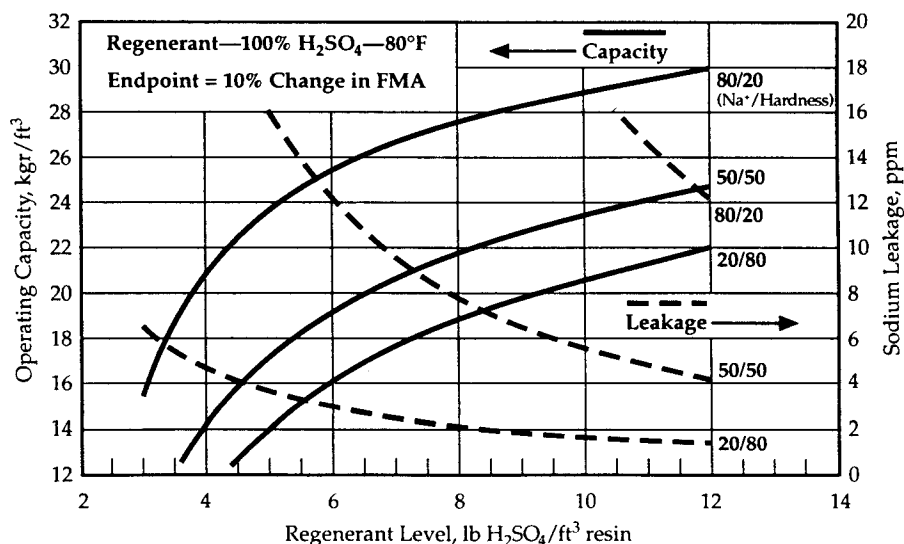
DOWEX HCR-S cation resin is available in the sodium and hydrogen forms. Physical and chemical properties are listed in Table 1. Suggested operating conditions and parameters for use of DOWEX HCR-S resin in demineralizers or softeners is presented in Table 2.

Applications

DOWEX HCR-S resin is used extensively in mixed- and multiple-bed demineralizers. It can operate effectively over the entire pH range, under high flow rate conditions, and at high temperatures. DOWEX HCR-S resin is also suitable for use in softener operations, including municipal, industrial, and home water softening. Its combined physical and chemical stability makes it suitable for virtually any but the most aggressive softening applications.

DOWEX HCR-S cation resin meets the requirements of FDA Food Additive Regulations Title 21, Subpart A, 173.25.

**Figure 1. Operating Capacity and Sodium Leakage—
H₂SO₄ Regeneration—DOWEX HCR-S Resin**



PROPERTIES AND OPERATING INFORMATION

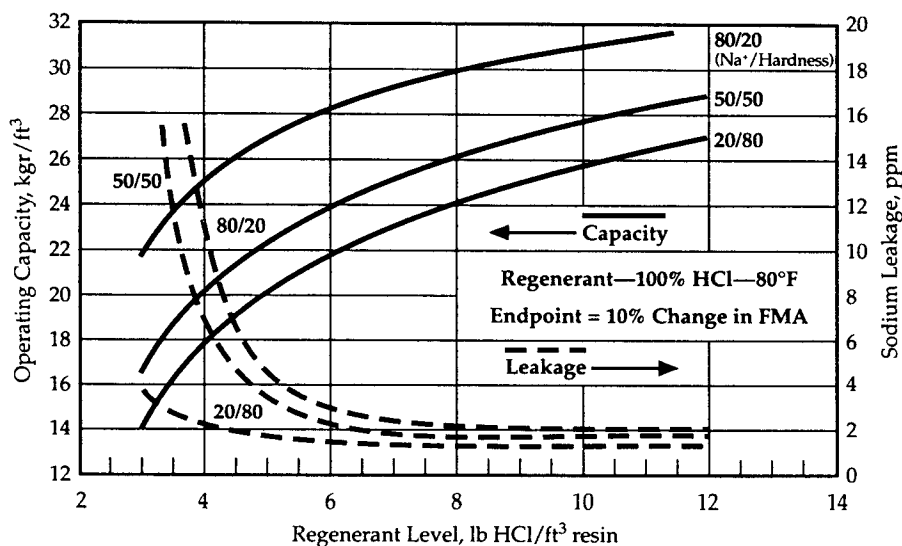
Table 1. Typical Physical and Chemical Properties for DOWEX HCR-S Resin[†]

	Na ⁺	H ⁺
Chemical Form	Sodium	Hydrogen
Physical Form	Hard, golden-colored, spherical beads	Hard, golden-colored, spherical beads
Total Exchange Capacity as CaCO ₃	2.0 meq/ml 43.5 kgr/ft ³	1.8 meq/ml 39 kgr/ft ³
Water Retention Capacity Range	44–48%	50–56%
Particle Size (U.S. Standard Sieves) ^{††}		
% on +16 mesh, maximum	5%	5%
% on +20 mesh, maximum	6%	6%
% through +50 mesh, maximum	1%	1%
Shipping Weight	53 lb/ft ³	50 lb/ft ³
Whole Perfect Beads	>90%	>90%
Color Throw, APHA No., maximum	20	40

[†]Contact your local technical sales representative to receive updated comprehensive Sales Specifications and Material Safety Sheets.

^{††}Condensate-grade sizes are also available—DOWEX HCR-W2.

Figure 2. Operating Capacity and Sodium Leakage—HCl Regeneration—DOWEX HCR-S Resin



Operating Capacity and Leakage

Figure 1 shows the operating capacity in terms of kgr/ft³ (CaCO₃) of DOWEX HCR-S resin as a function of sulfuric acid regenerant dosages at three levels of hardness. If the resin bed contains a significant amount of calcium cations, regenerating with sulfuric acid can cause calcium sulfate to precipitate and possibly foul the resin. Therefore, stepwise regeneration with sulfuric acid or regeneration with hydrochloric acid is recommended for beds with high calcium content. Figure 2 shows the operating capacity in terms of kgr/ft³ (CaCO₃) of DOWEX HCR-S resin as a function of hydrochloric acid regeneration at three levels of hardness.

Capacity and hardness leakage data for DOWEX HCR-S resin use in water softening applications are presented in Figure 3 using salt (NaCl solution) at three dosages.

More complete computer-generated capacity and leakage ratings, particular to your operating conditions, can be obtained from your Dow Sales or Technical Service Representative.

Hydraulic Characteristics

The particle size distribution of DOWEX HCR-S resin is a carefully selected Gaussian range to give hydraulic properties appropriate to the needs of standard demineralizer and softener design. The properties of prime concern are pressure drop across the bed and backwash expansion during resin cleanup.

Pressure Drop

The pressure drop across a resin bed can vary with bead size, flow, temperature, and the interstitial space in the packed bed. The interstitial space can vary from the classified to the mixed resin state in resins with Gaussian distribution. When resins are mixed, the small beads tend to fill the spaces between the larger beads, thus, the pressure drop is greater than across a classified bed. Except for mixed-bed demineralizers, resins are operated following a backwash step. Thus, the data presented in Figure 4 is for single-resin beds in the classified condition. Normally, the pressure drop across a resin bed in demineralizer service is quite low because of the low flow rates involved.

Figure 4 shows the variation of pressure drop with flow rate for the exhausted form of the resin. And it charts the effect of temperature on the pressure drop across a resin bed. As water viscosity decreases with increasing temperature, so does the pressure drop. This effect is most apparent when seasonal changes significantly modify the influent water temperature.

Table 2. Suggested Demineralization Operating Conditions and Parameters for DOWEX HCR-S Resin

Maximum Temperature	300°F
pH Range	0–14
Minimum Bed Depth	30 inches
Service Flow Rate	2–4 gpm/ft ³
Velocity	5–10 gpm/ft ²
Pressure Drop	(See Figure 4) 0.4 psi/ft at 5 gpm/ft ² , 77°F
Backwash Flow Rate	(See Figures 5 and 6)
Flow at 50% Expansion, Na ⁺ Form	8 gpm/ft ² at 77°F
Flow at 100% Expansion, Na ⁺ Form	14 gpm/ft ² at 77°F

Type of Operation	H ⁺ Cycle	Na ⁺ Cycle
Regenerant, typically	H ₂ SO ₄ or HCl	NaCl (Salt)
Regenerant Level	Dependent on desired capacity and leakage (See Figures 1 and 2)	Dependent on desired capacity and leakage (See Figure 3)
Concentration	2–8% H ₂ SO ₄ , stepwise or 4–10% HCl	10–26% NaCl
Flow Rate	0.5–2 gpm/ft ³	2 min/lb salt/ft ³
Contact Time	30 minutes, minimum	30 minutes, minimum
Temperature	Ambient	Ambient
Rinse Water Requirement	40–100 gal/ft ³	20–40 gal/ft ³
Displacement	0.5–2 gpm/ft ³	Adjust to 30-minute regenerant contact time
Rinse Rate		
Fast Rinse Rate	2–4 gpm/ft ³	2–4 gpm/ft ³

Figure 3. Softening Capacity and Hardness Leakage—DOWEX HCR-S Resin

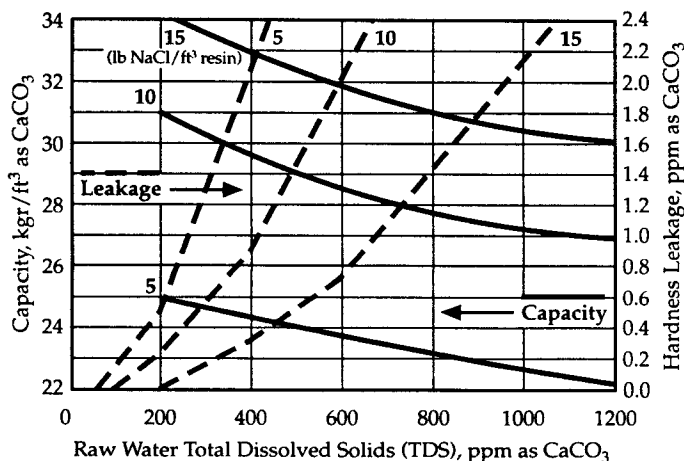
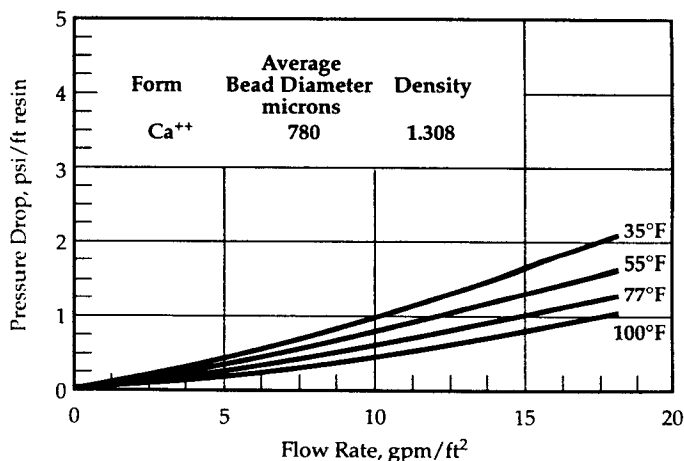


Figure 4. Pressure Drop vs. Flow Rate—Effect of Temperature—DOWEX HCR-S Resin



(continued on back page)

DOWEX HCR-S Cation Resin

007823

Backwash Expansion

Of utmost concern in the operation of a softener or a demineralizer is the ability to keep the resin bed clean. The standard method for bed cleanup is removal of particulate materials and reclassification of the resin bed by backwash expansion. Fluidization of the resin is affected by the bead size, bead density, water flow rate, and water temperature. Figure 5 shows the relationship of the backwash expansion characteristics to flow rate

at a constant temperature. Because the backwash operation is most often done with the resin in the exhausted state, data presented are for the calcium form. Also included are the hydrogen form normally used in demineralizers, and the sodium form used in softeners. The flow rate needed to expand the resin bed to a given percentage above the settled volume can be estimated. An expansion of approximately 50% for a period of at least 20 minutes is normally suggested to achieve a flow rate sufficient to remove the particulate matter from the resin bed.

Figure 6 shows the backwash expansion data for the calcium form at several temperatures. The temperature of the water has a significant effect on the bed expansion during backwash. Hence, backwash flow rates may require adjustments to compensate for seasonal temperature changes. Failure to do so may result in either insufficient backwash or resin losses.

Figure 5. Backwash Expansion vs. Flow Rate—DOWEX HCR-S Resin

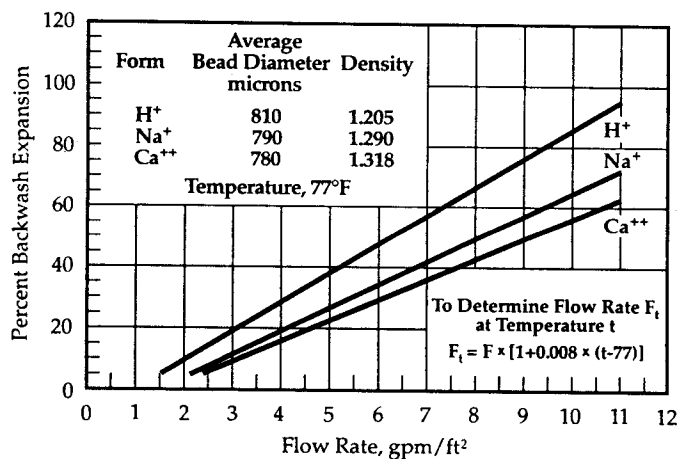
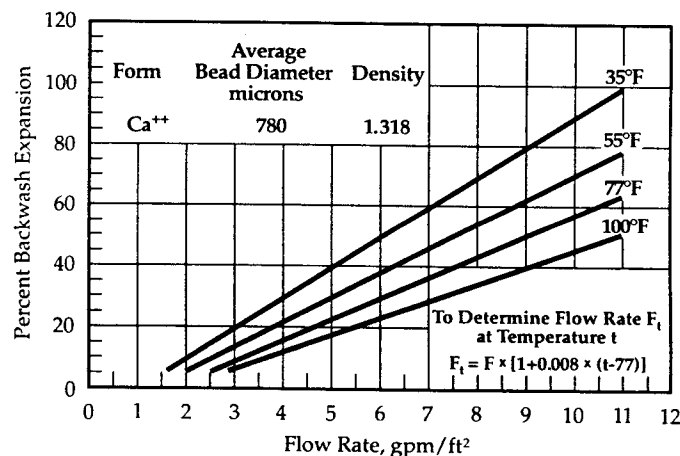


Figure 6. Backwash Expansion vs. Flow Rate—Effect of Temperature—DOWEX HCR-S Resin



**For further information, call 1-800-447-4369
(1-800-363-6250 in Canada)
Ask for DOWEX Ion Exchange Resins**

WARNING: Oxidizing agents such as nitric acid attack organic ion exchange resins under certain conditions and could result in a slightly degraded resin up to an explosive reaction. Before using strong oxidizing agents, consult sources knowledgeable in handling such materials.

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AMERICAN NORIT COMPANY, INC.**ACTIVATED CARBON****PRODUCT INFORMATION**

Bulletin No. 3212

Revised 6/93

**HYDRODARCO GCW
8X30 AND 12X40 MESH
GRANULAR ACTIVATED CARBON**

HYDRODARCO GCW is designed for water treating applications and is available in 8x30 and 12x40 mesh sizes. It is produced by high temperature steam activation of bituminous coal. **HYDRODARCO GCW** is a microporous activated carbon making it especially suitable for adsorption of small organic molecules. This dense grade of activated carbon provides high adsorptive capacity per unit volume. **HYDRODARCO GCW** is an exceptionally hard activated carbon providing minimal abrasion losses during handling and operation.

Potable Water

HYDRODARCO GCW adsorbs taste, odor, color and toxic organic compounds from drinking water. It has high capacity for synthetic and volatile organic carbons and adsorbs precursors for trihalomethane (THM) formation. **HYDRODARCO GCW** effectively removes pesticides, herbicides, and many other suspected carcinogenic compounds which may find their way into water supplies. **HYDRODARCO GCW** meets all AWWA B-604-90 carbon standards.

Wastewater and Contaminated Groundwater

Whether applied at a point source or in a polishing filter, **HYDRODARCO GCW** can be used to meet discharge limits for most regulated organics. The high surface area in small pores allows **HYDRODARCO GCW** to be especially effective for treating low molecular weight priority pollutants.

Typical Properties⁽¹⁾

	<u>8x30</u>	<u>12x40</u>
Tannin value, ppm	430	400
Molasses number	230	240
Molasses decolorizing efficiency	40	45
Surface area, m ² /g	975	1050
Total pore volume, ml/g	0.75	0.8
Mean pore radius, Å	15	15
Dechlorination number, gCl ₂ /kgGAC/hr	4.2	7.2
pH, water extract	Alkaline	Alkaline
Apparent density, vibrating feed, g/ml	0.48	0.48
Particle density, wetted in water, g/ml	1.4	1.4
Bed density, backwashed & drained, lbs. / cu. ft.	28	28
Voids in packed bed, %	50	50

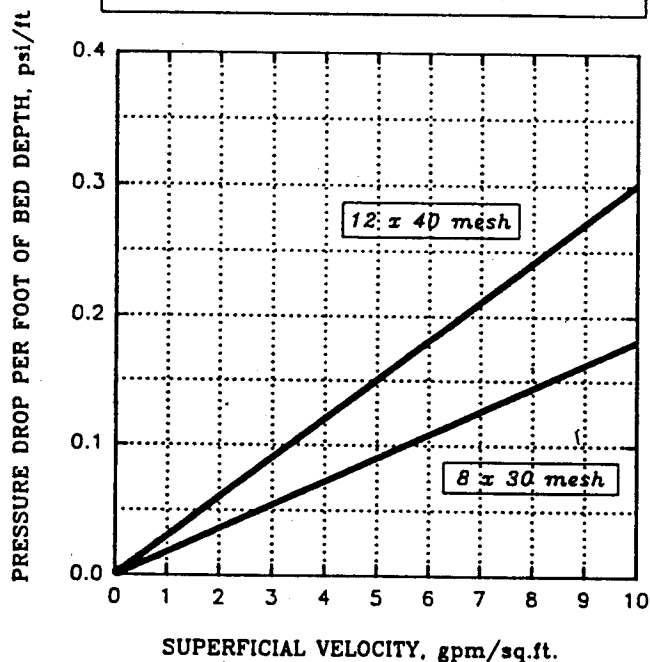
(1) For general information only, not to be used for purchase specifications.

(continued on reverse side)

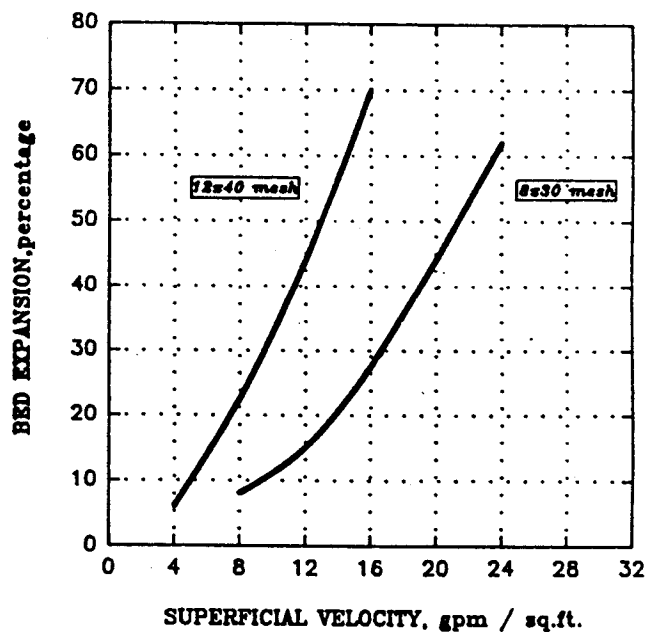
Product Specifications**8x30****12x40**

	Specification Value	Typical Value	Specification Value	Typical Value
Iodine number	900 min.	975	1000 min.	1050
Moisture, % as packed	2 max.	1	2 max.	1
Abrasion number (ASTM)	80 min.	88	80 min.	88
Dust, %	0.3 max.	0.1	0.3 max.	0.1
Sieve analysis (U.S. Sieve Series)				
larger than 8 mesh (2.38 mm), %	15 max.	6		
smaller than 30 mesh (0.60 mm), %	4 max.	2		
larger than 12 mesh (1.68 mm), %			5 max.	2
smaller than 40 mesh (0.42 mm), %			4 max.	2
Effective size, mm	0.8 - 1.0	0.9	0.55 - 0.75	0.65
Uniformity coefficient	2.1 max.	1.9	1.9 max.	1.7

**PRESSURE DROP CURVE FOR
HYDRODARCO GCW**



**BED EXPANSION CURVE FOR
HYDRODARCO GCW**

**Packaging**

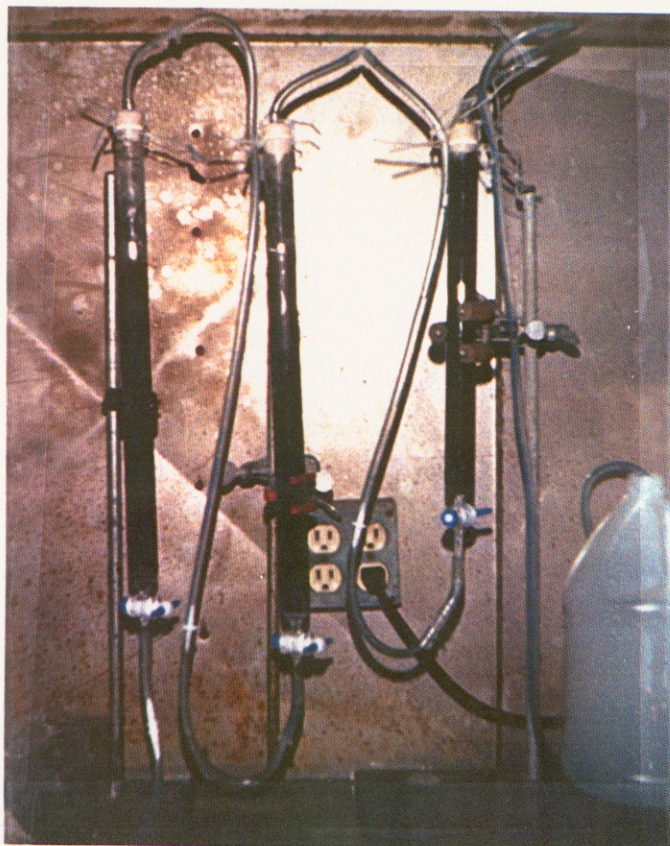
Standard packaging is 50 lb. bags, 40 bags per pallet for a net pallet weight of 2000 lbs. Also available in bulk trucks, bulk polypropylene bags (1000 lbs. net) and bulk corrugated boxes (1000 lbs. net).

Safety

Caution, activated carbon adsorbs oxygen from air. Use appropriate work and safety practices for low oxygen environments when entering vessels and confined areas.

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Appendix E
Photographs of Equipment

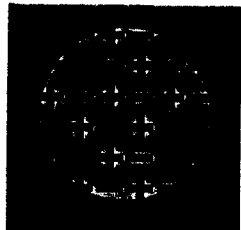


Photograph 1.0
Carbon Columns



Photograph 2.0
Ion Exchange Column

Appendix F
Ion Exchange Fundamentals



IDEA ± EXCHANGE

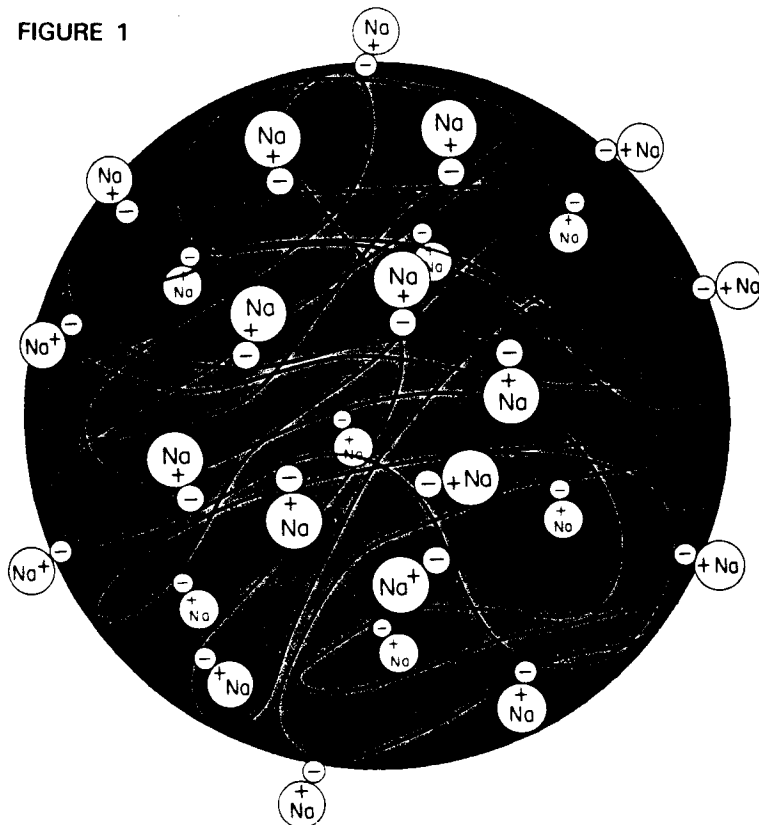
ideas you can use about ion exchange

007829
VOLUME 1 • NUMBER 1

Fundamentals of ion exchange*

One of the most versatile tools of the industrial water engineer is the process of ion exchange. The principles involved are fundamental in water conditioning.

FIGURE 1



Model of a cation exchanger, showing negatively charged exchange sites on the skeleton holding sodium ions like grapes on a vine.

Ion Exchange Is Not New

The process was studied by agricultural chemists more than a hundred years ago. They found that certain types of soil containing silica and aluminum compounds had the ability of exchanging ions with those in water. These soils, called zeolites, were adapted for use in softening water in the

early 1900's. The technology has grown rapidly. Today, ion exchange plays a fundamental role in industrial water engineering.

Concepts and Terms

The conventional ion exchange materials used in water conditioning can be visualized as skeleton-like structures having many attached "exchange sites" (Figure 1). The skeleton is insoluble in water but is electrically charged, holding ions of opposite charge at the exchange sites.

Exchange materials with negatively charged skeletons are referred to as cation exchangers since they attract positive ions; anion exchangers are positively charged and, consequently, attract anions. The porous structure of ion exchange materials permits water to permeate the particle, affording good contact with the exchange sites.

If calcium ions, or cations of other species than sodium should approach a cation exchanger particle saturated with sodium ions, some of them may be captured by the exchanger. This would release sodium ions previously held at the exchange sites on the skeleton. An equilibrium is soon established between the distribution of these species on the exchanger and in the water surrounding the exchanger.

Laboratory studies of such equilibria show that an ion exchanger has a preference or "selectivity" for one species over another. This selectivity depends on ionic charge, molecular weight, and solution concentration, (Figure 2). For example, a cation exchanger holds calcium ions more firmly than sodium ions when immersed in a weak solution, such as a typical natural water. For this reason, if a cation exchanger is originally saturated with sodium ions, it can be used to soften water, taking calcium out of the water and releasing sodium in exchange.

Fortunately, the selectivity between these species is reversed at high concentrations.

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so that a strong solution of brine can readily displace calcium from the exchange sites, "regenerating" the exchanger by returning sodium ions to their original positions on the exchanger skeleton.

The Measure of Exchange Capacity

Ion exchange materials in aqueous systems contain a large proportion of water. We might consider the ion exchange particle containing water to be a tiny vessel holding a salt solution. The number of ion exchange sites in a unit volume, which is a measure of the "exchange capacity" of the ion exchange material, can be expressed in the same terms the chemist uses in defining the strength of a salt solution. The chemist speaks of these solutions in terms of their "normality." "One normal solution" contains one equivalent weight of salt dissolved in a liter of solution. The ion exchange technologist speaks of the capacity of an ion exchanger in terms of "milliequivalents of exchange sites per milliliter of resin beads in a graduate." (Which is mathematically identical to equivalents per liter or normality.) The normality of typical styrene-base cation exchangers is close to 2.0; that of typical strongly basic anion exchangers is about 1.3.

The long tradition in water chemistry of expressing hardness in "grains per gallon," has saddled ion exchange with a jargon all its own. One of the unfortunate results has been the expression of ion exchange capacity in "kilograins per cubic foot," (Kgr./cu. ft.). The factor for converting normality to kilograins per cubic foot is approximately 22. Most commercial styrene-type cation exchangers have a total capacity close to 40 Kgr./cu. ft. The strongly basic anion resins have capacities in the range of 28-30 Kgr./cu. ft.

Ion Exchange Materials

The earliest ion exchange materials were either natural or synthetic zeolites — minerals produced from mixtures of aluminum salts and silicates. When these materials were converted to the sodium form by treatment with brine, they were capable of softening water quite effectively. However, capacity was low, and the mineral tended to dissolve, increasing the silica content of the finished water. Research in the late 1930's developed plastic materials (resins) which could be converted to ion exchangers by chemical processing. These resins greatly expanded the applications of ion exchange leading to such modern processes as demineralization — processes unattainable with the zeolite-type materials.

		Cation Exchanger (sulfonic acid type)	Anion Exchanger (quaternary type)
Decreasing Preference	↓	Barium	Iodide
		Strontium	Nitrate
		Calcium	Bisulfate
		Copper	Chloride
		Zinc	Bicarbonate
		Magnesium	Hydroxide
		Titanium	Fluoride
		Potassium	Bisilicate
		Ammonia	
		Sodium	
	↓	Hydrogen	

FIGURE 2
Selectivity of exchangers

As an example of an ion exchanger fabricated of plastic materials, Figure 3 illustrates the construction of a cation exchanger built of two organic molecules, styrene and divinyl benzene. When a group of styrene molecules are treated under proper conditions of temperature and pressure, they will line up in a long chain, called a "polymer."

The styrene polymer would be too water-soluble after ion exchange sites have been added and not rigid enough to make a suitable plastic for use in water-treating systems. But its structure can be made rigid and insoluble by mixing a certain proportion of divinyl benzene with the styrene, forming "crosslinks" between the long styrene polymer chain, like the crosslinks of a tire chain. This permits the plastic to grow in three dimensions to form a tight, rigid network.

Reacting these materials in water emulsion forms the plastic into the shape of a bead, like oil droplets in salad dressing. The finished beads can be converted either to cation exchangers or anion exchangers by suitable chemical reactions. In making a cation exchanger, the bead is treated with a material such as sulfuric acid, which adds an ion exchange site at each hexagonal ring. Anion exchangers are formed by attaching positively charged groups, such as amines, to each hexagonal structure.

By far the largest user of ion exchange materials in this country is the domestic water softening industry. The simplicity of the ion exchange process has so accelerated the growth of this industry, that today, water softeners are sold through appliance stores, much as refrigerators, washers, and ranges. The large volume of ion exchange material consumed by this industry has, to some extent, set the standards for ion ex-

WARNING: Oxidizing agents such as nitric acid attack organic Ion Exchange resins under certain conditions and could result in a slightly degraded resin up to an explosive reaction.

Before using strong oxidizing agents, consult sources knowledgeable in handling such materials.

changers used in industrial plants. However, experiences in industry have shown that the performance of domestic water softening material is not always consistent with the needs of industry for high quality finished water and operating economy. Industry now favors the more durable ion exchangers available for its own special requirements. There are, consequently, many types of industrial ion exchange materials for specific uses.

Water Conditioning Processes

There are many ways to use cation exchangers, anion exchangers, or combinations of both, using different chemicals for their regeneration, to produce a variety of water treating processes (Figure 4). The simplest of these processes, serving as an excellent example of how ion exchange works, is water softening using only a cation exchanger, regenerated with brine.

Another important ion exchange process using cation exchangers is operated with acid regeneration. This makes it possible to remove sodium from raw water as well as calcium and magnesium. This is the only chemical treatment process which can remove sodium from water solutions economically.

The most significant process using anion exchange resins employs the strongly basic type exchanger regenerated with caustic soda for complete removal of all anions from water. If the water being treated has first been passed through an acid-regenerated cation exchanger, the finished water is essentially mineral-free. So little dissolved matter remains in this water that it may have an electrical resistance of over 1,000,000 ohms per cubic centimeter, as compared to a range of 1,000-5,000 for many natural water supplies.

Another important anion exchange process uses strongly basic resin regenerated with salt. Resin so treated is able to remove alkalinity from water for such uses as make-up to boilers or to cooling tower systems.

Conclusions

The process of ion exchange is basically simple. The application of ion exchange in water conditioning can become complex, however, because of the variables in equipment, resins, chemicals, operations, and people. A basic understanding of the process itself is a big step in making ion exchange work properly in industrial water conditioning. Future issues will discuss the various operations and techniques developed for the practical use of DOWEX* resins in water and process ion exchange applications.

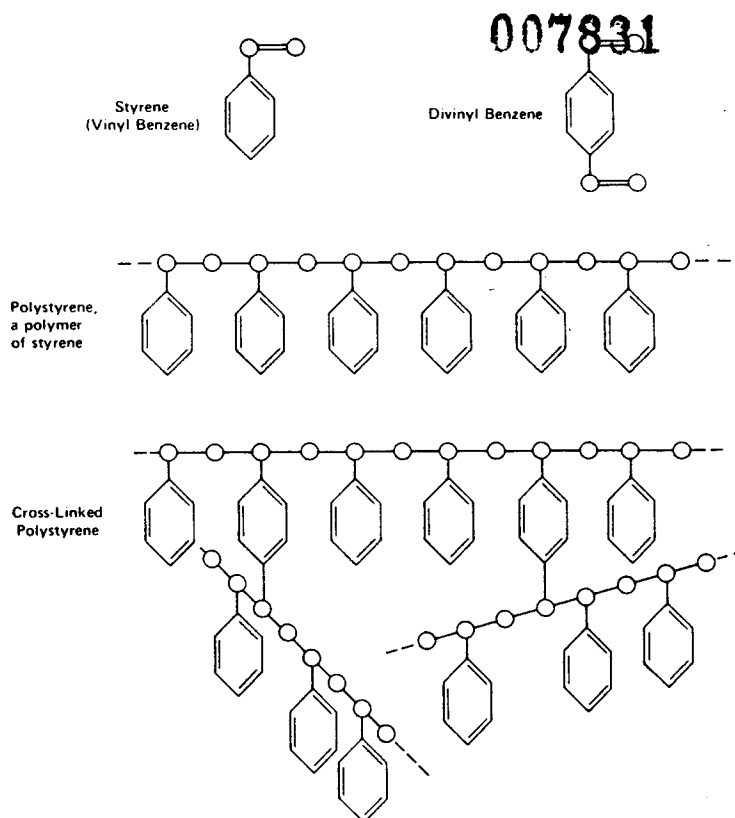


FIGURE 3

The production of a stable, rugged plastic by cross-linking polymer chains.

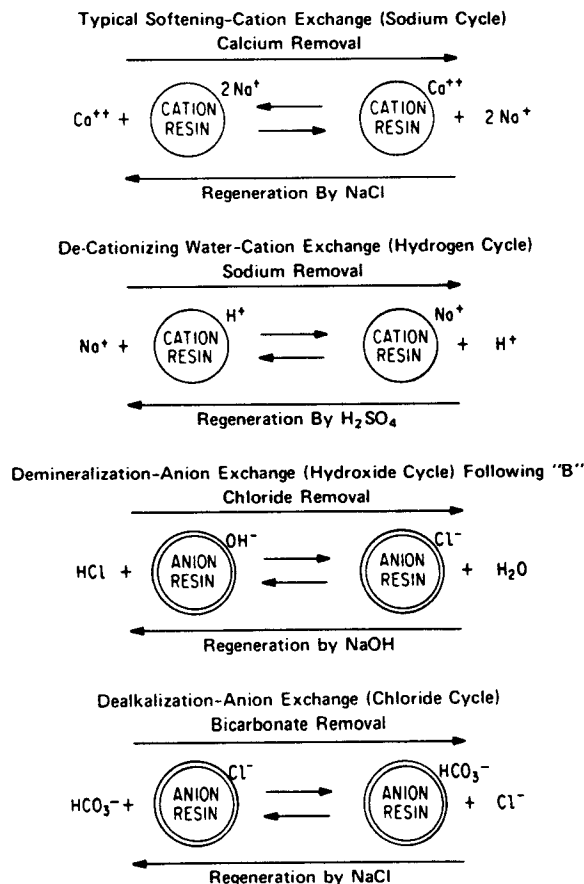


FIGURE 4

Examples of ion exchange processes

Fundamentals of ion exchange

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Appendix G
Water Chemistry Information

Water:	Well MW1					12/15/93
		As given	Adjusted			
Tot. hardness	as CaCO3	704.6	705		Total Dissolved Solids	2042
Calcium	mg/l	108	108			
Magnesium	mg/l	106	106		Ionic Strength (Molar)	0.04039
Potassium	mg/l	4.2	4.2			
Sodium	mg/l	385	490		pH at CaCO3 Saturation	7.29
Ammonia	mg/l		0			
Alkalinity	as CaCO3	155	155		Langelier index SI	-1.19
Chloride	mg/l	1110	1110			
Sulphate	mg/l	6.3	6.3		Stability Index RI	8.49
Nitrate	mg/l	62.4	62.4			
Bromide	mg/l		0		CaCO3 Scaling?	Unlikely
SiO2	mg/l		0			
Sulfide	mg/l	0	0		Ryznar Prediction:	Corrosive
pH	Units	6.1				
Temp	Deg F	77	77		Date:	12/29/93
	Deg C	25	25			

Water:	Well MW2					12/15/93
		As given	Adjusted			
Tot. hardness	as CaCO ₃	573	574		Total Dissolved Solids	1479
Calcium	mg/l	93	93			
Magnesium	mg/l	83.2	83		Ionic Strength (Molar)	0.03082
Potassium	mg/l	2	2			
Sodium	mg/l	295	324		pH at CaCO ₃ Saturation	7.39
Ammonia	mg/l		0			
Alkalinity	as CaCO ₃	135	135		Langelier index SI	-1.14
Chloride	mg/l	774	774			
Sulphate	mg/l	6.07	6.07		Stability Index RI	8.52
Nitrate	mg/l	61.6	61.6			
Bromide	mg/l		0		CaCO ₃ Scaling?	Unlikely
SiO ₂	mg/l		0			
Sulfide	mg/l	0	0		Ryznar Prediction:	Corrosive
pH	Units	6.25				
Temp	Deg F	77	77		Date:	12/29/93
	Deg C	25	25			

Water:	Well EW1					12/15/93
		As given	Adjusted			
Tot. hardness	as CaCO ₃	83.9	84		Total Dissolved Solids	546
Calcium	mg/l	16	16			
Magnesium	mg/l	10.7	11		Ionic Strength (Molar)	0.00839
Potassium	mg/l	2.3	2.3			
Sodium	mg/l	130	137		pH at CaCO ₃ Saturation	9.91
Ammonia	mg/l		0			
Alkalinity	as CaCO ₃	0	0		Langelier index SI	-5.41
Chloride	mg/l	130	130			
Sulphate	mg/l	0	0		Stability Index RI	15.32
Nitrate	mg/l	250	250			
Bromide	mg/l		0		CaCO ₃ Scaling?	Unlikely
SiO ₂	mg/l		0			
Sulfide	mg/l	0	0		Ryznar Prediction:	Hi Corrosion
pH	Units	4.5				
Temp	Deg F	77	77		Date:	12/29/93
	Deg C	25	25			

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Appendix H
Equivalents - meq/l

Equivalent Weight

The concentration of ions in solution is commonly expressed in terms of mili equivalent per liter (meq/l). To convert from mg/l to meq/l, divide the mg/l concentration by the equivalent weight. The equivalent weight of an element equals the molecular weight divided by the elemental charge. Equivalent weights are presented in Table H.0.

Example

Problem: Convert 2.07 mg/l to meq/l.

Solution: Molecular wt. Ba = 137.4
Charge of Ba = +2
Equivalent wt. Ba = $137.4 / 2 = 68.7$

$$(2.07) / (68.7) = 0.03 \text{ meq/l}$$

Table H.0
Equivalent Weights

Element	Equivalent Wt.
Aluminum	9.0
Barium	68.7
Calcium	20.0
Copper	31.8
Magnesium	12.2
Potassium	39.1
Sodium	23.0

007839

Appendix I
DOWEX MSC-1 Selectivity Calculations

Absorption of Metal Ions - MW-1 waters with various solution/resin ratios							
gm Dowex MSC-1 Resin/300 ml		0	0.2		0.5		
solution		Initial conc.	Final Conc.	Meq Exch.	Final Conc.	Meq Exch.	
Element		meq/liter					
Al		0.005889	0.008333	-0.0007332	0.008667	-0.0008334	
Ba		0.030131	0.01603	0.0042303	0.005124	0.0075021	
Ca		8.05	5.95	0.63	3.59	1.338	
Mg		8.77	8.11	0.198	6.53	0.672	
Na		16.741314	20.8988		20.774651		
K		0.1074169					
Total Cations - meq/liter		33.704751	35.090579		31.015859		
Total Exchange Capacity of resin - meq/dry gram				7.37		7.37	
Total Exchanged/gm resin = meq/l Na into solution				4.1574855		4.0333374	
Al	meq onto resin / gm resin			-0.003666		-0.0016668	
Ba	meq onto resin / gm resin			0.0211515		0.0150042	
Ca	meq onto resin / gm resin			3.15		2.676	
Mg	meq onto resin / gm resin			0.99		1.344	
Na	meq/gm resin by difference			3.2125145		3.3366626	
			sol/total sol	resin/tot resin	sol/total sol	resin/tot resin	
Al			0.0002375	-0.000497422	0.0002794	-0.00022616	
Ba			0.0004568	0.002869946	0.0001652	0.002035848	
Ca			0.1695612	0.427408412	0.1157472	0.363093623	
Mg			0.2311162	0.134328358	0.2105375	0.182360923	
Na			0.5955672	0.435890706	0.6698074	0.452735767	
Total			0.9969389	1	0.9965367	1	
Al	resin selectivity			-2.094662853		-0.809340039	
Ba	resin selectivity			6.282474021		12.32310232	
Ca	resin selectivity			2.520673758		3.136952853	
Mg	resin selectivity			0.581215774		0.866168565	
Na	resin selectivity			0.731891675		0.675919347	

Adsorption of metal ions							
gm Dowex MSC-1 Resin/300 ml			0	1		1.5	
solution			Initial conc.	Final Conc.	Meq Exch.	Final Conc.	Meq Exch.
Element			meq/liter				
Al			0.005889	0.004556	0.0003999	0.003444	0.0003354
Ba			0.030131	0.000742	0.0088167	0.001092	0.0087117
Ca			8.05	1.16	2.067	0.595	2.2365
Mg			8.77	3.59	1.554	1.92	2.055
Na			16.741314	20.371531		19.608611	
K			0.1074169				
Total Cations - meq/liter			33.704751	25.234246		22.235564	
Total Exchange Capacity of resin - meq/dry gram					7.37		7.37
Total Exchanged/gm resin = meq/l Na into solutio					3.6302166		2.8672968
Al	meq onto resin / gm resin				0.0003999		0.000489
Ba	meq onto resin / gm resin				0.0088167		0.0058078
Ca	meq onto resin / gm resin				2.067		1.491
Mg	meq onto resin / gm resin				1.554		1.37
Na	meq/gm resin by difference				3.7397834		4.5027032
				sol/total sol	resin/tot resin	sol/total sol	resin/tot resin
Al				0.0001805	5.42605E-05	0.0001549	6.63501E-05
Ba				2.94E-05	0.001196296	4.911E-05	0.000788033
Ca				0.0459693	0.28046133	0.0267589	0.202306649
Mg				0.142267	0.210854817	0.0863482	0.185888738
Na				0.807297	0.507433297	0.881858	0.610950231
	Total			0.9957432	1	0.9951691	1
Al	resin selectivity				0.300531865		0.428377225
Ba	resin selectivity				40.68412645		16.04610653
Ca	resin selectivity				6.101060401		7.560340142
Mg	resin selectivity				1.48210647		2.152781713
Na	resin selectivity				0.628558385		0.692798837

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Adsorption of metal ions					
gm Dowex MSC-1 Resin/300 ml solution		0	2		
Element		Initial conc. meq/liter	Final Conc.		Meq Exch.
Al		0.005889	0.004667		0.0003666
Ba		0.030131	0.001208		0.0086769
Ca		8.05	0.3745		2.30265
Mg		8.77	1.3		2.241
Na		16.741314	19.017661		
K		0.1074169			
Total Cations - meq/liter		33.704751	20.805453		
Total Exchange Capacity of resin - meq/dry gram					7.37
Total Exchanged/gm resin = meq/l Na into solutio					2.27634675
Al	meq onto resin / gm resin				0.0001833
Ba	meq onto resin / gm resin				0.00433845
Ca	meq onto resin / gm resin				1.151325
Mg	meq onto resin / gm resin				1.1205
Na	meq/gm resin by difference				5.09365325
			sol/total sol	resin/tot resin	
Al			0.0002243	2.48711E-05	
Ba			5.806E-05	0.000588664	
Ca			0.0180001	0.156217775	
Mg			0.0624836	0.152035278	
Na			0.914071	0.691133412	
Total			0.9948371	1	
Al	resin selectivity				0.110875182
Ba	resin selectivity				10.13858496
Ca	resin selectivity				8.678722366
Mg	resin selectivity				2.433202147
Na	resin selectivity				0.756104742