GROUNDWATER ASSESSMENT WORKPLAN

VICKSBURG CHEMICAL COMPANY
VICKSBURG, MISSISSIPPI

Prepared for
Vicksburg Chemical Company
Vicksburg, Mississippi

December 1995

WCC File 92B007C-4001

Woodward-Clyde

Woodward-Clyde Consultants
2822 O'Neal Lane
Baton Rouge, Louisiana 70816

TABLE OF CONTENTS

LIST OF ACRONYMS

ACRONYM	MEANING
CCC	Cedar Chemical Corporation
VCC	Vicksburg Chemical Company
RFI	RCRA Facility Investigation
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
SWMU	Solid Waste Management Unit
AOC	Area of Concern
PECMT	Preinvestigation - Evaluation of Corrective Measures Technologies
EPA	United States Environmental Protection Agency
MSDEQ	Mississippi Department of Environmental Quality
CMS	Corrective Measures Study
SWMU 1	Hazardous Waste Container Storage Area
SWMU 17	Off-specification Product Storage Area
SWMU 2	Inactive Landfill will include AOC 4
SWMU 7	Former Dinoseb Production Area
SWMU 14	Former Toxaphene Production Area
SWMU 4	Activated Carbon Treatment Unit
SWMU 5	South Plant Drainage System
SWMU 8	Dinoseb Loading/Unloading Area
SWMU 9	Dinoseb Drumming Area
SWMU 11	Former MSMA Production Area
SWMU 12	Former MSMA Unloading Area
SWMU 13	South Plant Drainage Ditches
SWMU 15	Former Methyl Parathion Production Area
SWMU 16	Former Atrazine Production Area
SWMU 17	Returned Product Storage Area
SWMU 18	Former Blue Tank
SWMU 20	Railroad Car Loading/Unloading Station
SWMU 22	North Plant Neutralization System Concrete Sump
SWMU 25	North Plant Subsurface Wastewater Pipes
SWMU 29	Floor under North Plan Oil Collection Unit
SWMU 30	North Plant Waste Accumulation Area
SWMU 31	North Plant No. 6 Fuel Oil Area
bgs	below ground surface
TCL	Toxic Compound List
TAL	Toxic Analyte List

TABLE OF CONTENTS

Section			Page
1.0	INTRODUCTION		1
2.0	GROUNDWATER ASSESSMENT OBJECTIVES		3
	2.1	BACKGROUND INFORMATION - AREA GEOLOGY	3
		2.1.1 Regional Geology	3
		2.1.2 Site Geologic Features	3
	2.2	EXISTING MONITORING PROGRAM	5
	2.3	OBJECTIVES FOR THE GROUNDWATER ASSESSMENT PROGRAM	5
3.0	TECHNICAL APPROACH		7
	3.1	ADDITIONAL MONITOR WELL INSTALLATION AND SAMPLING	7
	3.2	EXPANDED QUARTERLY SAMPLING	7
	3.3	GROUNDWATER HYDROLOGY	8
		3.3.1 Regional Groundwater Hydrology	8
		3.3.2 Shallow Groundwater Hydrology Beneath the Facility	8
	3.4	NATURE AND EXTENT OF CONTAMINATION	10
		3.4.1 Contamination Plume	10
		3.4.2 Source of Groundwater Contamination	10
4.0	PROJECT SCHEDULE AND SUBMITTAL		11
	4.1	GROUNDWATER ASSESSMENT PROJECT SCHEDULE	11
	4.2	REPORTING REQUIREMENTS	11
		4.2.1 Progress Reports	11
		4.2.2 Annual Groundwater Assessment Reports	12
5.0	PROJECT MANAGEMENT PLAN		13
	5.1	PROJECT TASK DEFINITION	13
	5.2	PROJECT PERSONNEL	13
		5.2.1 EPA and MSDEQ Project Coordinator	13
		5.2.2 Project Director	13
		5.2.3 WCC Project Manager	14
		5.2.4 WCC Field Investigation Site Coordinator	14
		5.2.5 WCC Health and Safety Officer	14
		5.2.6 QA/QC Manager	15

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Table 1	Groundwater Level Measurements
Table 2	Target Compound List (TCL)
Table 3	Target Analyte List (TAL)

LIST OF FIGURES

Figure 1	SWMU Locations, RFI Solid and Concrete Sample Points, Groundwater Monitor Well Locations
Figure 2	Monitor Well and Piezometer Locations, Potentiometric Contours
Figure 3	Cross Section of Geology Beneath the South Plant
Figure 4	Project Schedule

LIST OF APPENDICES

Appendix A	Relevant Information on Wells Located in 1-Mile Radius Area (From Appendix F Preliminary Report)
Appendix B	Not Used
Appendix C	Monitor Well and Piezometer Locations and Stratigraphic Sections - (From Appendix C Preliminary Report)
Appendix D	Monitor Well and Piezometer Logs (From Appendix D Preliminary Report)
Appendix E	RFI Data Collection Quality Assurance Plan
Appendix F	RFI Data Management Plan
Appendix G	RFI Health and Safety Plan
Appendix H	Groundwater Analytical Data Summary (From Appendix H Preliminary Report)

1.0
INTRODUCTION

This Workplan defines and describes the Groundwater Assessment to be executed by Vicksburg Chemical Company (VCC) at its facility in Vicksburg, Mississippi. The purpose of Groundwater Assessment is to evaluate the groundwater quality, monitoring system and program, as well as the abatement system at the facility.

The Groundwater Assessment program consists of the following tasks:

- Groundwater Assessment Workplan
- Implementation of the Workplan
- Annual Groundwater Assessment Reports

The Groundwater Assessment program activities are intended to be executed concurrently with a RCRA Facility Investigation Corrective Measures Study (RFI/CMS). Data needed for Groundwater Assessment activities and requisite activities such as borings and well installations will be obtained during the RFI implementation programs.

The Groundwater Assessment Workplan is due within 60 days of the approval of the Preliminary Report (Report of Current Conditions). The RFI Workplan and Preinvestigation - Evaluation of Corrective Measures Technologies (PECMT) are due at the same time. These reports and programs are in response to a Consent Decree effective July 1, 1991. The Groundwater Assessment Workplan includes the following elements:

- Number, location, depth of wells, and the rationale for the well placement
- Construction logs for each monitoring well
- List of the monitoring parameters

- Geologic cross-sections
- Sampling and analytical methods for those hazardous wastes or hazardous constituents at the facility
- Evaluation procedures, including any use of previously-gathered groundwater quality information
- Schedule of implementation

2.0
GROUNDWATER ASSESSMENT OBJECTIVES

Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) have been identified in the RCRA Facility Assessment and the Preliminary Report. Each of these units is labeled on Figure 1. A monitoring system of wells and piezometers exist to monitor groundwater. The location of the active monitoring wells is shown in Figure 2. Information about the construction of these wells is available in Appendix D of the Preliminary Report as revised by VCC and subsequently approved by the EPA and MSDEQ in November 1995.

2.1 BACKGROUND INFORMATION - AREA GEOLOGY

2.1.1 Regional Geology

The Vicksburg area lies on the eastern flank, near the axis, of the Mississippi Embayment. Containing unconsolidated sediments of Cretaceous to Quaternary Age, the sediments thicken in the structural trough toward the axis of the Embayment and the Gulf of Mexico.

Wind-borne deposited silty sediments form loess. The Pleistocene loess in the Vicksburg area is a homogeneous, massive silt with variable clay content. The loess underlies the ground surface through the local region. Loess generally is characterized by a higher vertical permeability in comparison to its horizontal permeability.

Underlying the Pleistocene loess is the Oligocene Vicksburg formation. This formation consists of alternating beds of sandy marl, clay marl, montmorillonitic clay and thin beds of limestone.

2.1.2 Site Geologic Features

In 1981, Vertac commissioned the first hydrogeologic investigation. The report of that investigation provides descriptions of the geology of the site. A silty clay (fill) extends from the surface to a depth of less than 10 feet. Pleistocene loess (silty clay - clayey silt) extends from about 6 to 48 feet below the surface across the site. Immediately below the loess, a

thin layer (1 to 2 feet) of greenish-gray sandy clay is usually present. Underlying the sandy clay is a marl from the Vicksburg formation. The top of the marl varies across the site from 60 to 65 feet mean sea level (msl). This marl serves as the bottom of a shallow confined aquifer. Relevant information on wells located in a 1-mile radius is found in Appendix A. A cross section of the geology beneath the South Plant is shown in Figure 3. Additional stratigraphic sections are found in Appendix C.

The sandy-clay deposit grades across the zone to a clayey-sand above the marl. This deposit could be the Citronelle Formation or weathered marl. The Citronelle has been interpreted as Pleistocene terrace deposits. Regardless, these deposits are absent in some areas underlying the site. but where present are characterized by relatively fine-grained sediments. They do not represent a continuous permeable unit across the site.

The Byram marl has been described as representing mixed clastic and carbonate sedimentation in an open shelf or platform environment. The argillaceous, massive and medium dense character of the marl would inhibit any significant movement of water through this unit, and there is no indication of secondary permeability.

The bedrock underlying the facility is a layer of Glendon limestone of the Vicksburg Formation and, beneath the limestone, is the Jackson Formation. The top of the Glendon limestone is expected to be 80 to 100 feet beneath the plant site and ranges from 25 to 65 feet thick. The Glendon is a dark gray to brown, dense, fine-grained limestone. The underlying non-permeable Jackson Formation is 40 to 150 feet thick.

The North Pond RFI field program executed in November and December 1993 confirmed the geologic observations of previous investigations. The North Pond was constructed in an elevated area with a surface elevation at 133 feet msl, whereas the railroad track area (SWMU 20), surface pond (SWMU 3) and area surrounding the inactive disposal area (SWMU 2) are located at surface elevations of approximately 110 feet msl. The South Plant is constructed at surface elevation approximately 120 feet msl, the North Plant is constructed at surface elevation approximately 115 feet msl and the inactive disposal area at surface elevation approximately 135 feet msl.

2.2 EXISTING MONITORING PROGRAM

The data determined from the monitoring wells, indicate that groundwater flows basically to the southeast and south in the area of the effluent ponds, the inactive disposal area, and the South Plant. Groundwater flows directly toward Stouts Bayou in the southeasterly direction from the North Plant area. Based on sampling of the monitoring wells, very shallow groundwater is present at an average piezometric depth of 4 feet, with a range of 1 to 9 feet under the site. Monitor well and piezometer logs are found in Appendix D.

VCC has endeavored to maintain a groundwater monitoring program equivalent to the RCRA program. Results of groundwater monitoring indicated that groundwater assessment is required; therefore, a Groundwater Assessment Report was prepared in 1985. VCC's groundwater assessment focused on the area around the Surface Impoundment (SWMU 3) and the Inactive Landfill (SWMU 2). A summary of the groundwater analytical data is found in Appendix H.

Additionally, VCC provided corrective action activities; for example, by replacing the broken underground inlet line to the Surface Impoundment (SWMU 3). The line is suspected as a potential source of contaminants found in Monitor Well 1A. Another example is the construction of a blanket drain adjacent to the double synthetic liner on the east wall of Pond A in the Surface Impoundment (SWMU 3) to intercept groundwater. Of course, the corrective action at SWMU 3, that of removing contaminated sludge and retrofitting the impoundment with geosynthetic liners is very significant.

2.3 OBJECTIVES FOR THE GROUNDWATER ASSESSMENT PROGRAM

The objective of the Groundwater Assessment Program is for VCC to prepare and submit to the EPA and MSDEQ, a Groundwater Assessment Report containing information on the following:

- Whether hazardous waste or hazardous waste constituents have entered the groundwater;

- The rate and extent of migration of hazardous waste or hazardous waste constituents in the groundwater; and

- The concentrations of hazardous waste or hazardous waste constituents in the groundwater.

The fundamental difference between this Groundwater Assessment program and previous programs is the inclusion of the geographical areas surrounding the SWMUs and AOCs. The program requires an understanding of groundwater flow across the entire site. Subsequent submittals of yearly Groundwater Monitoring Reports are discussed in Section 4.2.

3.0
TECHNICAL APPROACH

3.1 ADDITIONAL MONITOR WELL INSTALLATION AND SAMPLING

Based on information and present understanding of the groundwater flow, the installation of additional groundwater monitoring wells to immediately detect releases from Solid Waste Management Units (SWMUs) or Other Areas of Concern (AOCs) is not necessary.

There is little direct geologic and hydrogeologic information on the former production areas of the South Plant; therefore, during RFI field activities, three monitor wells will be installed in locations shown in Figures 1 and 2. Prior to installing the monitor wells, three borings will be made down to the marl (50-60 below ground level). Groundwater samples will be obtained from each well and analyzed for the Toxic Compound List (TCL), Toxic Analyte List (TAL), dioxin, atrazine, cyanazine and dinoseb. The TCL and TAL are found in Tables 2 and 3.

Since another objective is to be certain that the existing groundwater monitoring program is consistent with or equivalent to a RCRA program a Data Collection Plan for the existing groundwater monitoring system was prepared and is attached as Appendix E. A Data Management Plan was also prepared and is attached as Appendix F.

3.2 EXPANDED QUARTERLY SAMPLING

At the request of MSDEQ, VCC expanded their quarterly groundwater monitoring program. The initial program involved several wells; however, only four compounds were included in the analysis. These compounds are methyl chloride, dinitrobutyl phenol, arsenic, and toxaphene. As of the second quarter of 1991, VCC added four more compounds to be analyzed. These four compounds are carbon tetrachloride, chloroform, TCE, and Methyl Ethyl Ketone. Recent quarterly sampling has also tested for volatile compounds using the SW846b Method 8240 (GC/MS). The results of the sampling has been reported to the MSDEQ and is included in the Groundwater Analytical Data Summary provided as Appendix H of the Preliminary Report.

3.3 GROUNDWATER HYDROLOGY

3.3.1 Regional Groundwater Hydrology

A shallow confined loess aquifer underlying the VCC plant is on top of a marl formation. Reported wells in the area are the upgradient of the plant and are producing water from deeper, more productive aquifers such as the Catahoula and Forrest Hill formation. These deeper aquifers are apparently hydraulically separated from the shallow groundwater aquifer.

The shallow aquifer underlying the VCC plant is, however, hydraulically connected to Stouts Bayou and Hennesseys Bayou. Hatcher Bayou and Stouts Bayou merge southeast of the plant site to form Hennesseys Bayou, which flows to the Mississippi River. Noted as intermittent streams on USGS topographical maps these bayous are limited to fresh water fish and wildlife habitat. They are not drinking water or recreational water sources. The major use of the Mississippi River downstream of its confluence with Hennesseys Bayou is as a marine transportation route. There are no drinking water intakes in these waters within three miles downstream of the facility.

3.3.2 Shallow Groundwater Hydrology Beneath the Facility

The marl in the Vicksburg Formation constitutes the bottom of the uppermost water-bearing zone underlying the facility. This aquifer is approximately 40 feet thick consisting almost exclusively of Pleistocene loess (silt). The clayey fill material placed atop the loess is acting as a "cap" inhibiting the vertical migration of the groundwater. The marl on the bottom of the aquifer is impermeable, thus creating a slightly artesian confined aquifer which is not hydraulically connected to any potential water-bearing zones at greater depths. The artesian property is characteristic of an aquifer which is under pressure from above and below. The background water quality of this aquifer is marginally acceptable for drinking water, however due to its low lateral flow and yield characteristics its usefulness as a domestic water supply is severely limited. At a depth of 40 feet, the hydraulic conductivity ranged from 7.5×10^{-4} to 4.3×10^{-7} centimeters per second on boring samples. The hydraulic conductivity of the aquifer decreases significantly with depth.

Several groundwater monitoring wells and piezometers have been installed across the plant site. The results of groundwater level measurements from piezometers installed at the North Pond area in December 1993 combined with groundwater level measurements from the entire VCC site are tabulated in Table 1.

Figure 2 is a comprehensive potentiometric contour of the uppermost aquifer with the potentiometric contour of the perched water table in the vicinity of the North Pond superimposed on it. The direction of groundwater flow is generally toward Stouts Bayou or Hennesseys Bayou. The evidence of the perched water table atop the clay lens in the North Pond area was established by the installation of shallow piezometers. The perched water table merges with or stops in the vicinity of the roadway that connects the North Plant with the South Plant. Even though there is a mixed stratigraphy in the area to the east of the road connecting the North Plant with the South Plant, including the Railroad Area, Surface Impoundment Area and Inactive Disposal Area there is no evidence of more than one zone in the uppermost aquifer in those areas, that is, the mixed stratigraphic areas are well connected.

Aquifer properties obtained during various investigations prior to 1993 are summarized below:

Monitor Well No.	Porosity (%)	Standard Thickness (ft)	Hydraulic Gradient (ft/ft)	Hydraulic Conductivity (gal/day)(ft^2)	Velocity (ft/day)	Transmissivity (gal/day)(ft)
1*	46	30	0.04	1.93	0.022	58
6	45	20.5	0.025	1.97	0.015	40
11	44	42	0.11	5.52	0.184	232
12	42	41	0.011	2.83	0.01	116

NOTES:

* MW-1 was replaced by MW-1A in 1986

3.4 NATURE AND EXTENT OF CONTAMINATION

Samples of groundwater will be obtained from the three new monitor wells installed in the south plant. The samples will be analyzed for TCL and dioxin, TAL, atrazine, cyanazine and dinoseb. This data will be combined with the data in Appendix H of the Preliminary Report plus groundwater data accumulated since preparation of Appendix H.

3.4.1 Contamination Plume

Sampling data will be used to construct maps of any contamination plumes in the uppermost aquifer. These maps will be developed from groundwater sampling data. Any detected hazardous waste or hazardous waste constituents in the uppermost aquifer will be mapped to show the extent of the contamination plume and the concentration of each specific constituent groundwater. Based on the location and concentration of the hazardous waste or hazardous waste constituent, the rate of migration (velocity) and migration direction (flowpath) will be identified.

3.4.2 Source of Groundwater Contamination

If areal analysis of the groundwater sampling data as discussed in Section 3.4.1 detects a groundwater contamination plume, the source of will be identified. Over the course of the South Plant's history, various construction activities have occurred at the site. A previously broken pipe is though to be the source for the dinoseb constituents in Monitor Well 1A. Contamination sources, such as broken pipes, which can easily be repaired will be or have been corrected. Of course the surface impoundments (SWMU 3) have been retrofitted with double geosynthetic liners. Prior to the retrofit contaminated sludge was removed, solidified, stabilized and placed in an aboveground vault constructed to RCRA standards; SWMU 3 could have been a source of contamination. Other sources of contamination will be studied in conjunction with the investigation of SWMUs and AOCs.

4.0
PROJECT SCHEDULE AND SUBMITTAL

4.1 GROUNDWATER ASSESSMENT PROJECT SCHEDULE

A proposed Groundwater Assessment project schedule is shown as Figure 4. This schedule shows milestones mandated by the Consent Decree as well as additional details for the planned activities on site.

4.2 REPORTING REQUIREMENTS

Several reports are mandated by the Consent Decree. Due dates for these reports are also mandated in the Consent Decree. The schedule presented in Figure 4 incorporates these required reports.

4.2.1 Progress Reports

Monthly progress reports dated the 15th of the month have been and will continue to be provided to EPA and MSDEQ containing:

- Description and estimate of the percentage of the RFI completed
- Summaries of all findings
- Summaries of all changes made in the RFI during the reporting
- Summaries of all contacts with representatives of the local community, public interest groups, or State government during the reporting period
- Actions being taken to rectify problems
- Changes in personnel during the reporting period
- Projected work for the next reporting period
- Copies of daily reports, inspection reports, laboratory/monitoring data, etc.

4.2.2 Annual Groundwater Assessment Reports

VCC will begin submission of annual Groundwater Assessment Reports to EPA and MSDEQ on or before March 1 of each calendar year. This monitoring report will include the following information:

- Groundwater surface elevations measured on a quarterly basis, for each well specified in the Groundwater Assessment Program
- Annual determination of the rate of groundwater flow and direction in the uppermost aquifer
- Concentrations or values of the indicator parameters obtained from quarterly analysis at each groundwater monitoring well
- Evaluation of the indicator parameter as outlined within the facility's Groundwater Assessment Program Workplan
- Results of the analysis from each groundwater monitoring well as indicated in the Groundwater Assessment Program Workplan
- Calculated hydraulic conductivity and effective porosity
- Summary of results

5.0
PROJECT MANAGEMENT PLAN

The Project Management Plan consists of the following elements:

- Project task definition
- Specific personnel positions within the project organizational structure

5.1 PROJECT TASK DEFINITION

Two EPA/MSDEQ approved workplans (RFI and Groundwater Assessment) will be implemented simultaneously at the Vicksburg facility. VCC has retained the services of WCC to develop the Groundwater Assessment Workplan. Following approval of these documents by EPA and MSDEQ, WCC will assist VCC in implementing the workplans.

5.2 PROJECT PERSONNEL

Duties of key personnel are described below.

5.2.1 EPA and MSDEQ Project Coordinator

The EPA and MSDEQ project coordinators or designated agents will observe workplan activities to any extent deemed necessary to confirm that the requirements of the Consent Decree, and the Groundwater Assessment Workplan are met.

5.2.2 Project Director

The Project Director is Mr. Steve Boswell. He is an employee of and is the official representative for VCC. He is in charge of administration of the work and the completion of the project.

5.2.3 WCC Project Manager

The WCC Project Manger will develop the plans required by the Consent Decree and oversee work implementing the Workplan on behalf of VCC, and will be the primary contact with VCC. The WCC Project Manager is Richard D. Karkkainen. Mr. Karkkainen is a Vice President and Principal in WCC.

5.2.4 WCC Field Investigation Site *Coordinator*

The WCC Field Investigation Site Coordinator will handle day to day activities and coordinate them with other (RFI) activities. He will coordinate both efforts and oversee their implementation.

5.2.5 WCC Health and Safety Officer

A Health and Safety (H & S) officer will be responsible for the administration and implementation of the site Health and Safety for Groundwater Assessment activities. A Health and Safety Plan is found in Appendix G. The H & S officer will have the overall responsibility for safety and health and will:

- Ensure that and employee medial surveillance program which meets the requirements of 29 CFR 1910.120 is instituted and maintained.

- Be responsible for the initial pre-construction indoctrination of all on-site personnel with regard to the H & S Plan and other safety requirements to be observed during the construction, including but not limited to:

  - potential hazards
  - personal hygiene principles
  - personnel protective equipment
  - respiratory protection equipment usage and fit testing, and
  - emergency response including site evacuation, dealing with fire and medical situations.

- Be responsible for the maintenance of separate exclusion, contamination reduction, and support zones as described in the Contractor's H & S Plan and on the drawings.

- Ensure that personnel exposure air monitoring is properly conducted and recorded.

- Maintain a recordkeeping system which will include daily records of all site activity, waste quantities produced, waste transportation activity information, laboratory results, and other information.

5.2.6 QA/QC Manager

The QA/QC Manager will be responsible for coordination with the analytical laboratory and for the validation of data.

TABLES

TABLE 1

GROUNDWATER DATA LEVEL MEASUREMENTS

Piezometer or Well Number	Casing Elevation (ft msl)	Bottom Elevation (ft msl)	Top of Screen (ft msl)	November 1993 Groundwater Elevation (ft msl)
MW 1 A	113.01	83.01	93.51	108.39
MW 2	108.21	68.21	78.71	98.87
MW 3	99.33	69.33	79.83	
MW 4	114.70	94.70	105.20	106.89
MW 5	100.30	80.30	85.80	84.01
MW 6	100.76	73.78	79.28	86.48
MW 7	99.66	69.33	74.83	92.39
MW 8	110.83	80.83	86.33	103.14
MW 9	116.02	58.02	73.02	110.89
MW 10	114.73	61.73	74.73	107.40
MW 11	105.62	57.62	70.62	98.16
MW 12	112.06	64.56	80.06	109.32
MW 13	113.52	63.52	73.52	109.51
MW 14	113.9	57.9	67.9	107.64
MW 15	Plugged and abandoned during surface impoundment retrofit			
MW 16	111.84	58.84	68.84	108.84
PZ 12A (R)	137.87	66.97	72.97	107.64
PZ 12B (R)	137.27	105.27	111.27	123.48
PZ 19A	140.34	64.34	70.34	107.59
PZ 19B	140.22	120.22	126.22	124.46
PZ 20A	136.25	65.25	71.25	107.68
PZ 20B	136.43	103.43	109.43	114.50
PZ 21A	115.22	61.22	67.22	107.75
PZ 22A	112.71	61.71	67.71	107.11
PZ 22B	113.51	88.17	94.17	108.17
PZ 23A	112.49	66.49	72.49	107.27
PZ 23B	113.10	91.10	97.10	109.79
PZ 24B	113.16	85.16	91.16	107.21
PZ 25B	113.96	77.96	83.96	110.44

TABLE 2

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMIT (CRQL)*

	Quantitation Limits[a]	
	Groundwater µg/L	Low Soil/ Sediment µg/Kg[b]
Volatile Organics		
Chloromethane	10	10
Bromomethane	10	10
Vinyl Chloride	10	10
Chloroethane	10	10
Methylene Chloride	5	5
Acetone	10	10
Carbon Disulfide	5	5
1,1-Dichloroethene	5	5
1,1-Dichloroethane	5	5
1,2-Dichloroethene (Total)	5	5
Chloroform	5	5
1,2-Dichloroethane	5	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinly Acetate	10	10
Bromodichloromethane	5	5
1,2-Dichloropropane	5	5
cis-1,3-Dichloropropane	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
trans-1,2-Dichloropropane	5	5
Bromoform	5	5
4-Methyl-2-pentanone	10	10
2-hexanone	10	10

TABLE 2 (Continued)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMIT (CRQL)*

	Quantitation Limits[a]	
	Groundwater µg/L	Low Soil/ Sediment µg/Kg[b]
Tetrachloroethene	5	5
Toluene	5	5
1,1,2,2-Tetrachloroethane	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Xylenes (Total)	5	5
Semivolatile Organics		
Phenol	10	330
bis-2-Chlorophenol	10	330
2-Chlorophenol	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
Benzyl Alcohol	10	330
1,2-Dichlorobenzene	10	330
2-Methylphenol	10	330
bis(2-Chloroisopropyl)ether	10	330
4-Methylphenol	10	330
N-Nitro-di-n-dipropylamine	10	330
Hexachloroethane	10	330
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic Acid	50	1600
bis(2-Chloroethoxy)methane	10	330
2,4-Dichlorophenol	10	330
1,2,4-Trichlorobenzene	10	330

TABLE 2 (Continued)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMIT (CRQL)*

	Quantitation Limits[a]	
	Groundwater µg/L	Low Soil/ Sediment µg/Kg[b]
Naphthalene	10	330
4-Chloroaniline	10	330
Hexachlrobutadiene	10	330
4-Chloro-3-methylphenol(para-chloro-meta-cresol)	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1600
Dimethylphthalate	10	330
Acenaphthylene	10	330
2,6-Dinotrotoluene	10	330
3-Nitroaniline	50	1600
Acenaphthene	10	330
2,4-Dinorophenol	50	1600
4-Nitrophenol	50	1600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenyl-phenyl-ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1600
4,6-Dinitro-2-methylphenol	50	1600
N-Nitrosodiphenylamine	10	330
4-Bromophenyl-phenylether	10	330
Hexachlorobenzene	10	330
Pentachlorophenol	50	1600

TABLE 2 (Continued)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMIT (CRQL)*

	Quantitation Limits[a]	
	Groundwater µg/L	Low Soil/ Sediment µg/Kg[b]
Anthracene	10	330
Di-n-butylphthalate	10	330
Fluoranthene	10	330
Pyrene	10	330
Butyl Benzyl Phthalate	10	330
3,3'-Dichlorobenzidine	20	660
Benzo(a)anthracene	10	330
Chrysene	10	330
bis(2-Ethylhexyl)phthalate	10	330
Di-n-octylphthalate	10	330
Benzo-(b)fluoranthene	10	330
Benzo-(k)fluoranthene	10	330
Benzo(a)pyrene	10	330
Ideno(1,2,3-cd)pyrene	10	330
Dibenz(a,h)anthracene	10	330
Benzo(g,h,i)perylene	10	330
Pesticide/PCBs		
alpha-BHC	0.05	8.0
beta-BH	0.05	8.0
delta-BHC	0.05	8.0
gamma-BHC	0.05	8.0
Heptachlor	0.05	8.0
Aldrin	0.05	8.0
Heptachlor Epoxide	0.05	8.0
Endosulfan I	0.05	8.0
4,4'-DDE	0.10	16.0
Endrin	0.10	16.0
Endosulfan II	0.10	16.0

TABLE 2 (Continued)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMIT (CRQL)*

	Quantitation Limits[a]	
	Groundwater µg/L	Low Soil/ Sediment µg/Kg[b]
4,4'DDD	0.10	16.0
Endosulfan Sulfate	0.10	16.0
4,4'-DDT	0.10	16.0
Methoxychlor	0.05	80.0
Endrin ketone	0.10	16.0
alpha-Chlordane	0.05	80.0
gamma-Chlordane	0.05	80.0
Toxaphene	1.0	160.0
Aroclor-1242	0.5	80.0
Aroclor-1248	0.5	80.0
Aroclor-1061	0.5	80.0
Aroclor-1221	0.5	80.0
Aroclor-1232	0.5	80.0
Aroclor-1254	1.0	160.0
Aroclor-1260	1.0	160.0

NOTES:

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

[b] Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Volatile TCL Compounds are 125 times the individual Low Soil/Sediment CRDL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may no always be achievable.

SOURCE: Statement of Work for Organic Analysis Multi-Media Multi-Concentration SOW 2/88, Revisions 9/88, 4/89 and 5/89, Office of Solid Waste and Emergency Response, U.S. Environmental Agency, Washington, D.C., May 1989.

TABLE 3

TARGET ANALYTE LIST (TAL) INORGANICS

Analyte	Contract Required Detection Limits* (µg/l)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

NOTE:

* The reporting limits are instrument detection limits obtained in pure water. The detection limits for samples may be considerably higher depending on the sample matrix.

SOURCE: Statement of Work for Inorganic Analysis Multi-Media Multi-Concentration SOW No. 788, Revisions 2/89 and 6/89, Office of Solid Waste and Emergency Response, U.S. *Environmental Protection Agency*

FIGURES

LEGEND:

- MONITOR WELL OR PIEZOMETER LOCATION
- POTENTIOMETRIC CONTOURS (UPPERMOST AQUIFER)
- POTENTIOMETRIC CONTOURS PERCHED WATER TABLE IN NORTH POND AREA
- CREEK
- NEW MONITOR WELL LOCATIONS

FIGURE 2

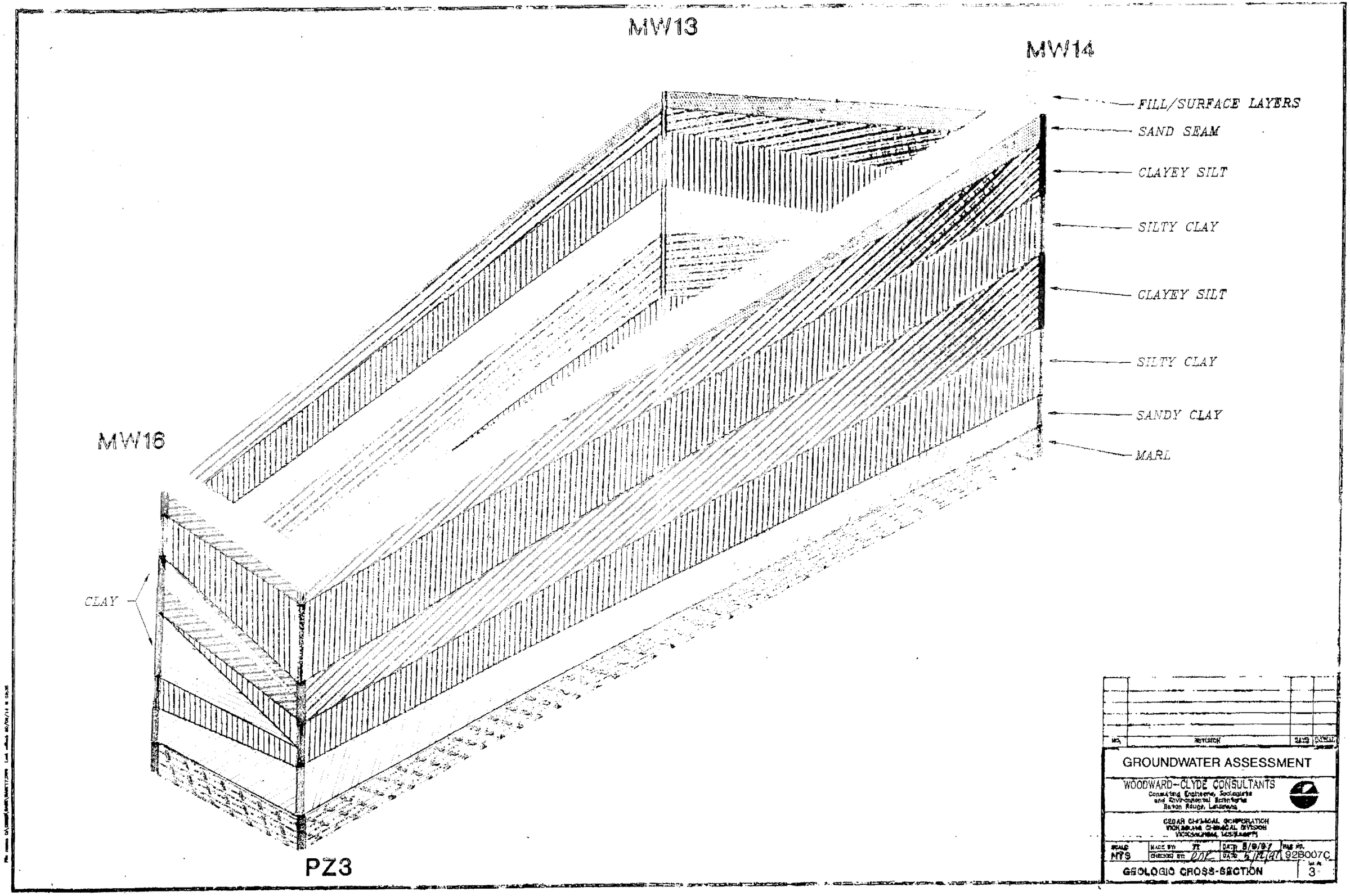
GROUNDWATER ASSESSMENT

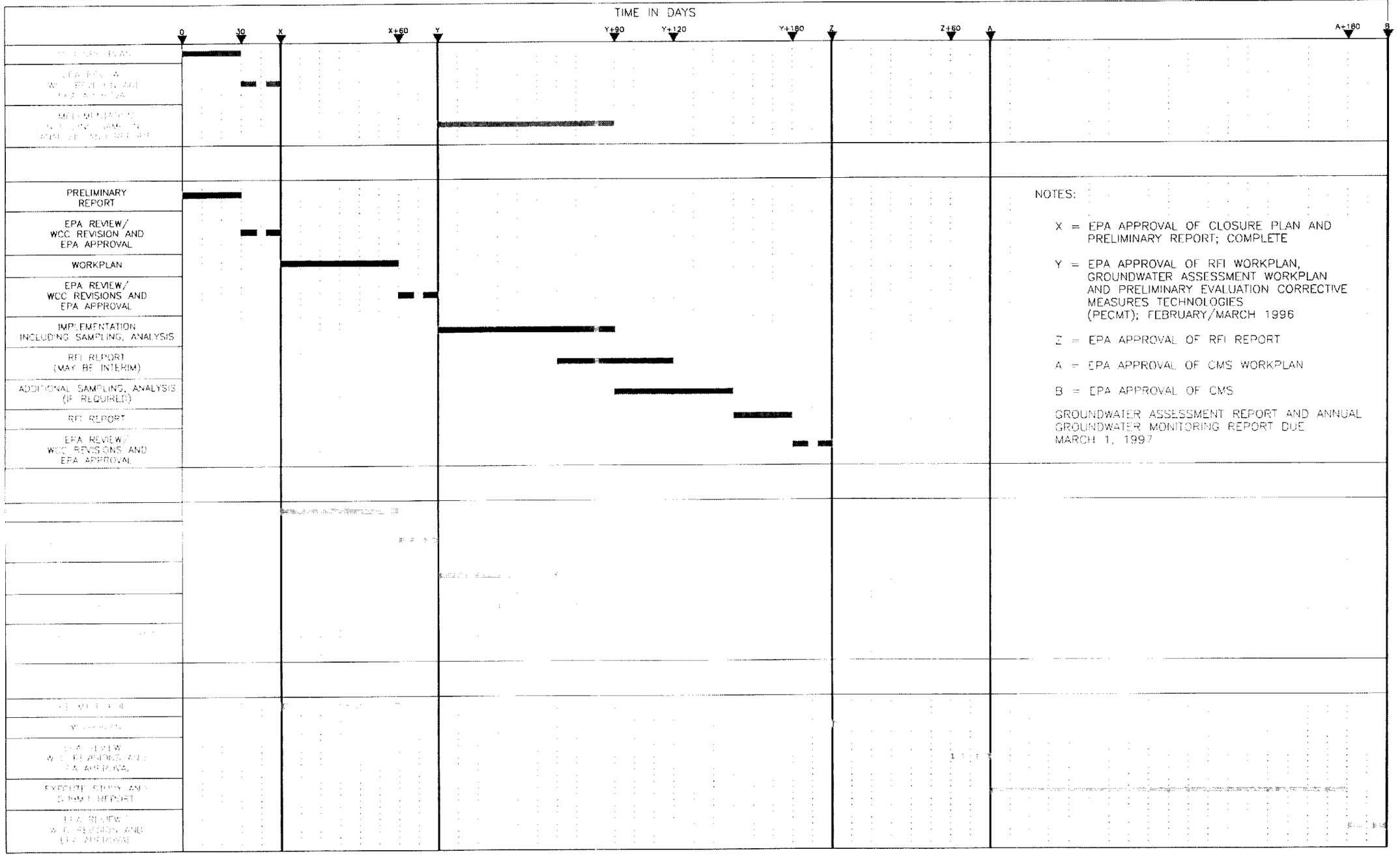
Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists
Baton Rouge, Louisiana

VICKSBURG CHEMICAL CORPORATION
VICKSBURG, MISSISSIPPI

MADE BY: SDH	DATE 10/93	FILE NO
CHECKED BY	DATE	928007C

MONITOR WELL AND PIEZOMETER LOCATIONS, POTENTIOMETRIC CONTOURS, DECEMBER 1993


MW13
MW14
MW16
PZ3
FILL/SURFACE LAYERS
SAND SEAM
CLAYEY SILT
SILTY CLAY
CLAYEY SILT
SILTY CLAY
SANDY CLAY
MARL
CLAY
GROUNDWATER ASSESSMENT
WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists
Baton Rouge, Louisiana
CEDAR CHEMICAL CORPORATION
VICKSBURG CHEMICAL DIVISION
VICKSBURG, MISSISSIPPI
SCALE NTS
MADE BY: TT
CHECKED BY: DDC
DATE: 5/9/97
DATE: 5/12/97
FILE NO. 92B007C
GEOLOGIC CROSS-SECTION
3



REV	DESCRIPTION OF REVISION	BY	DATE
△			
△			
△			
△			
△			
△			

VICKSBURG CHEMICAL COMPANY
VICKSBURG, MISSISSIPPI

Woodward-Clyde Consultants
Engineering & sciences applied to the earth & its environment
2822 O'Neal Lane
Baton Rouge, Louisiana 70816

SCALE	NONE
DESIGNED	RDK
DRAWN	GAT
CHECKED	
PEER REVIEWED	
DATE	11/29/95

PROJECT SCHEDULE

REVISION △
PROJECT 92B007C
FIGURE 4

K: \CAD-GIS\CEDAR\92B007S Wed Nov 29 16:32:20 1995

APPENDIX A

RELEVANT INFORMATION ON WELLS LOCATED IN 1-MILE RADIUS AREA (FROM APPENDIX F PRELIMINARY REPORT)

EXPOSURE INFORMATION REPORT
VERTAC CHEMICAL CORPORATION
VICKSBURG, MISSISSIPPI
OCTOBER, 1985

4.0 GROUNDWATER PATHWAY

4.1 GROUNDWATER BACKGROUND INFORMATION

Information on subsurface conditions at Vertac Chemical is presented in Sections E-1, E-2, and E-3 of the RCRA Part B Permit Application. Data collected by the ongoing groundwater monitoring program indicates the presence of groundwater contamination at one of the twelve monitoring wells. Work is continuing to further characterize the aquifer which underlies the facility and to determine the source of the contamination.

4.1.1 Regional Groundwater Data

A list of water wells, based upon USGS data, within a three mile radius of the facility is shown on Table 1. A map locating these water wells is included as Figure 1. This table and associated map may not indicate a complete tabulation of all water wells within the three miles radius of the plant. Shallower, smaller diameter water wells are not typically included in the USGS inventory, nor does the State of Mississippi maintain records on such wells.

Based on this inventory the following information was compiled:

- Five wells are located within a three mile radius of the approximate center of the facility.
- All of the abovementioned wells are generally east of the facility.
- The nearest well is located approximately one mile to the east-southeast; this well is listed as No. 82.
- There are no wells within three miles to the south, west, or north.
- The Mississippi River is approximately one mile to the northwest.

4.1.2 Regional Precipitation Data

The average annual precipitation in the Vicksburg, Mississippi area is 59 inches. The average annual gross lake surface evaporation rate for the region is 44 inches. Therefore, the net annual precipitation (rainfall minus evaporation) is approximately +15 inches.

TABLE 1

WATER WELLS WITHIN A THREE MILE RADIUS OF FACILITY

OWNER	WELL NUMBER
USCE	72
USCE WGC 2	73
Jack B. Smith	78
George Lee	82
USCE WES	83

SMR/Vertac-T1

TABLE 5

BACKGROUND GROUNDWATER QUALITY

Parameter	Vertac MW-4(1)	Recommended Limit	Source of Recommendation
pH	6.7	5-9	EPA, 1976
TDS(2)	632 mg/l	500 mg/l	NTAC, 1968
Hardness	600 mg/l	100 mg/l (as $CaCO_3$)	McKee & Wolf, 1978
Alkalinity	300 mg/l	400 mg/l (as $CaCO_3$)	NAS, 1974
Sodium	17 mg/l	115 mg/l	McKee & Wolf, 1978
Chloride	23 mg/l	250 mg/l	EPA, 1976
Sulfates	48 mg/l	250 mg/l	EPA, 1976
Nitrate	<1 mg/l	10 mg/l (as N)	EPA, 1976
Iron	0.3-0.7 mg/l	0.3 mg/l	EPA, 1976
Manganese	0.2-1.4 mg/l	0.05 mg/l	EPA, 1976

(1) Upgradient well; sampled on December 17, 1985.
(2) Total dissolved solids.

Sources:

National Technical Advisory Committee to the Secretary of the Interior, 1968, Water Quality Criteria, U.S. Government Printing Office, Washington, D.C.

U.S. Environmental Protection Agency, 1976, Quality Criteria for Water, U.S. Government Printing Office, Washington, D.C.

McKee & Wolf, Water Quality Criteria, Second Edition, 1978, California State Water Resources Control Board (originally published in 1963, data is used by reference).

National Academy of Sciences, National Academy of Engineering, 1974, Water Quality Criteria, 1972, U.S. Government Printing Office, Washington, D.C.

GMC/Vertac-T5

APPENDIX B

NOT USED

APPENDIX C

MONITOR WELL AND PIEZOMETER LOCATIONS AND STRATIGRAPHIC SECTIONS (FROM APPENDIX C PRELIMINARY REPORT)

APPENDIX C

GROUNDWATER ASSESSMENT

MONITOR WELL AND PIEZOMETER LOCATION

LIST OF FIGURES

Figure 1	Monitor Well and Piezometer Locations, Potentiometric Contours, December 1993
Figure 2	Boring Locations and Stratigraphic Sections, North Pond Area
Figure 3	Section A-A, North Pond Area
Figure 4	Section B-B, North Pond Area
Figure 5	Section C-C, North Pond Area
Figure 6	Site Plan and Stratigraphic Sections
Figure 7	Section A-A, Inactive Disposal Area
Figure 8	Section B-B, Section C-C, Inactive Disposal Area
Figure 9	Plant Potentiometric Contours, Fall 1985
Figure 10	Potentiometric Contours, Inactive Disposal Area, Fall 1985
Figure 11	Plant Potentiometric Contours, February 1985
Figure 12	Potentiometric Contours, Inactive Disposal Area, February 1985
Figure 13	Plant Potentiometric Contours, December 1984
Figure 14	Potentiometric Contours, Inactive Disposal Area, December 1984
Figure 15	Local Groundwater Flow Net, MW-1, MW-11
Figure 16	Flow Net After Purging MW-11

NOT IN BORDEN CHEMICAL COMPANY OWNERSHIP

MW-10

MW-1A

MW-6

MW-5

MW-3

NORTH POND

LEGEND:

- ① – MONITOR WELL OR PIEZOMETER LOCATION
- 105 – POTENTIOMETRIC CONTOURS (UPPERMOST AQUIFER)
- – POTENTIOMETRIC CONTOURS PERCHED WATER TABLE IN NORTH POND AREA
- – CREEK
- ⊕ – NEW MONITOR WELL LOCATIONS

APPENDIX C – FIGURE 1	Woodward-Clyde Consultants Consulting Engineers, Geologists and Environmental Scientists Baton Rouge, Louisiana
GROUNDWATER ASSESSMENT	VICKSBURG CHEMICAL CORPORATION VICKSBURG, MISSISSIPPI
	MADE BY: SCH DATE 10/93 FILE NO CHECKED BY: DATE 928007C
MONITOR WELL AND PIEZOMETER LOCATIONS, POTENTIOMETRIC CONTOURS, DECEMBER 1993	

NORTH POND

LEGEND:

- GEOTECHNICAL BORINGS
- ENVIRONMENTAL BORINGS & PIEZOMETER LOCATION

SCALE: 1 INCH=100 FEET

100' 0 100'

FIGURE 2

DATE	REVISION	DRWN/CHKD

RCRA FACILITY INVESTIGATION
NORTH POND RFI REPORT

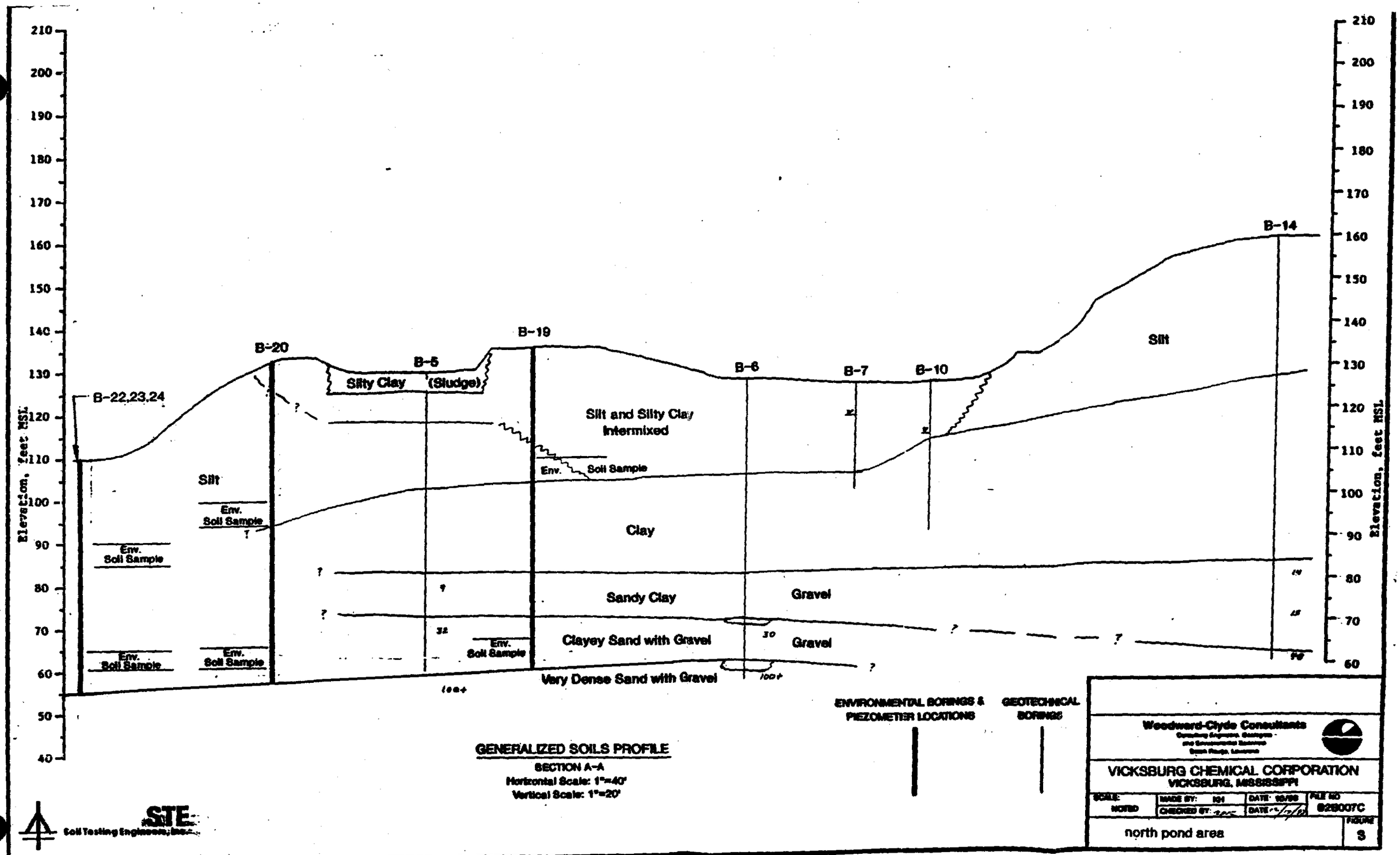
Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists
Baton Rouge, Louisiana

VICKSBURG CHEMICAL
VICKSBURG, MISSISSIPPI

SCALE:	MADE BY:	DATE:	FILE NO.
NOTED	CHECKED BY: MDK	DATE: 12/17/93	92B007C

BORING LOCATIONS AND STRATIGRAPHIC SECTIONS, NORTH POND AREA

Location: B.R.,LA File name: K:\DRWG\CEDAR\TASK4001\2B007C02.DWG Last edited: 12/14/93 @ 14:10



ENVIRONMENTAL BORINGS & PIEZOMETER LOCATIONS

GEOTECHNICAL BORINGS

GENERALIZED SOILS PROFILE

SECTION A-A
Horizontal Scale: 1"=40'
Vertical Scale: 1"=20'

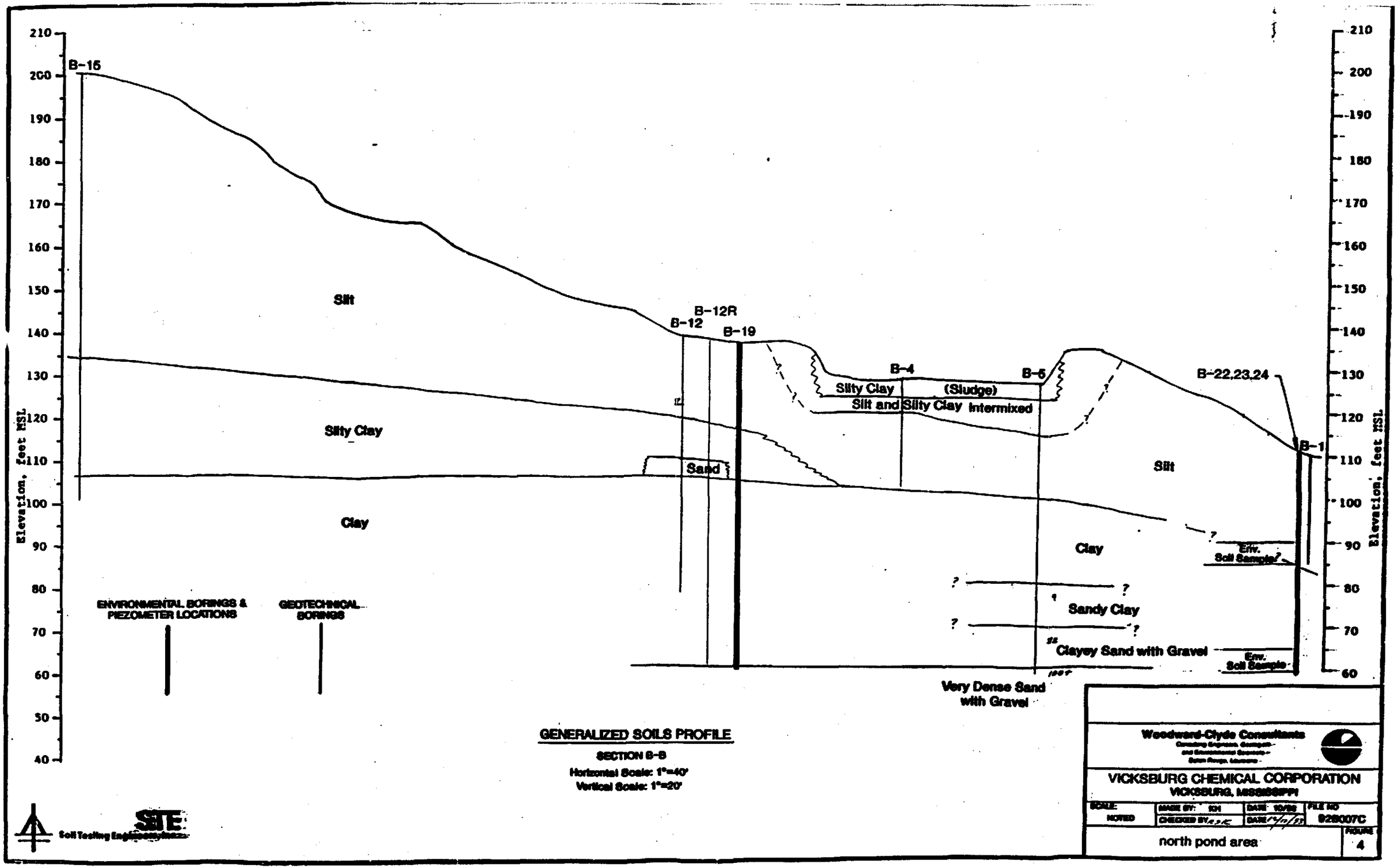
Soil Testing Engineers, Inc.

Woodward-Clyde Consultants

VICKSBURG CHEMICAL CORPORATION
VICKSBURG, MISSISSIPPI

SCALE: NOTED	MADE BY: RH	DATE: 10/88	FILE NO 928007C
	CHECKED BY:	DATE: 1/10/89	FIGURE 3

north pond area



GENERALIZED SOILS PROFILE

SECTION B-B

Horizontal Scale: 1"=40'

Vertical Scale: 1"=20'

Soil Testing Engineers, Inc.

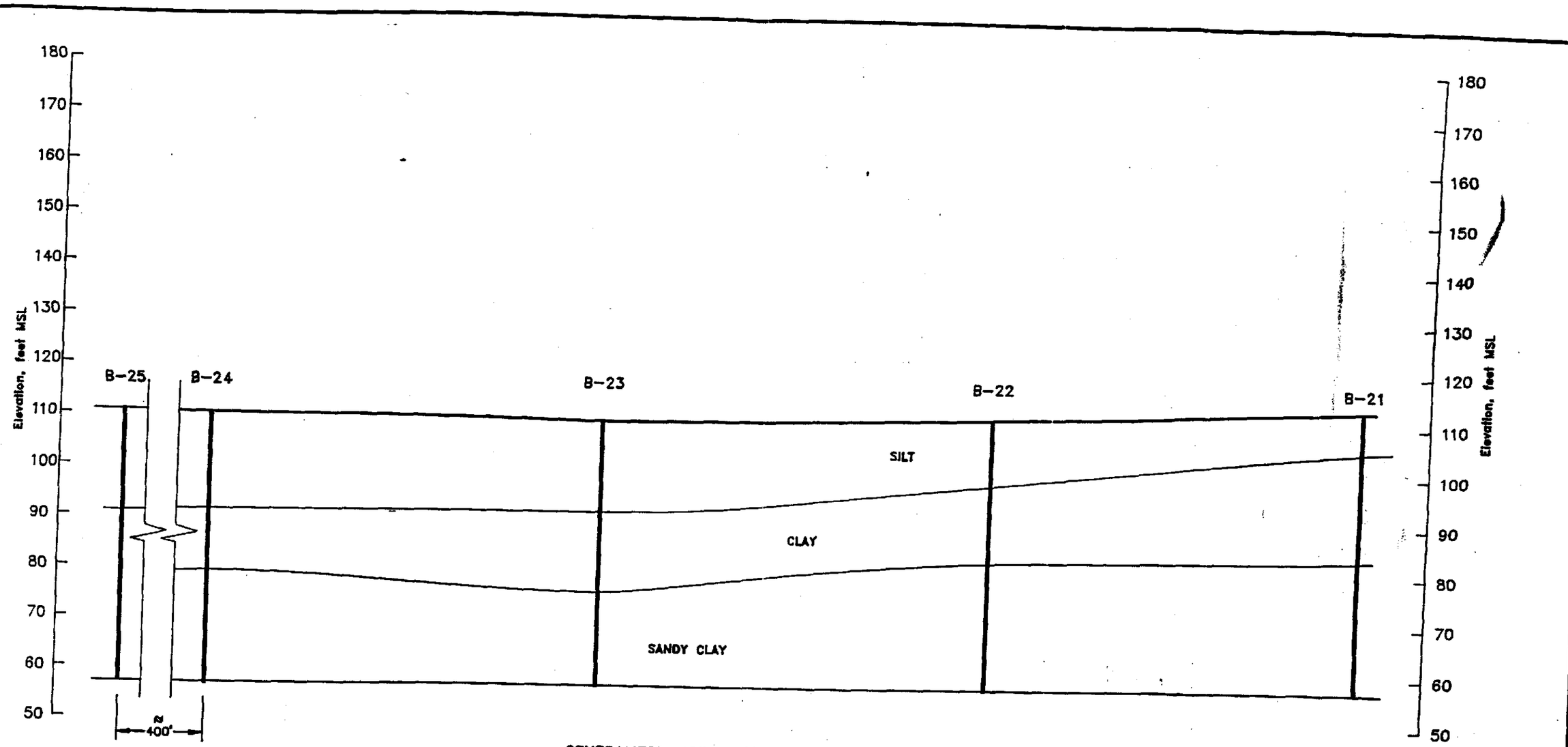
Woodward-Clyde Consultants

VICKSBURG CHEMICAL CORPORATION

VICKSBURG, MISSISSIPPI

SCALE: NOTED	MADE BY: TCH	DATE: 10/88	FILE NO 928007C
	CHECKED BY:	DATE: 11/10/88	FIGURE 4

north pond area



GENERALIZED SOIL PROFILE

SECTION C – C

HORIZONTAL SCALE: 1"=40'
VERTICAL SCALE: 1"=20'

ENVIRONMENTAL BORINGS & PIEZOMETER LOCATIONS

GEOTECHNICAL BORINGS

DATE	REVISION	DRWN/CHKD

Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists
Baton Rouge, Louisiana

VICKSBURG CHEMICAL CORPORATION
VICKSBURG, MISSISSIPPI

SCALE	DRAWN BY G.T.	DATE 12/93	FILE NO. 92B007C
	CHECKED BY [illegible]	DATE [illegible]	

north pond area

FIGURE 5

Location: B.R.,LA File name: K:\DRWG\CEDAR\TASK4001\2B007C03.DWG Last edited: 12/16/93 @ 13:34

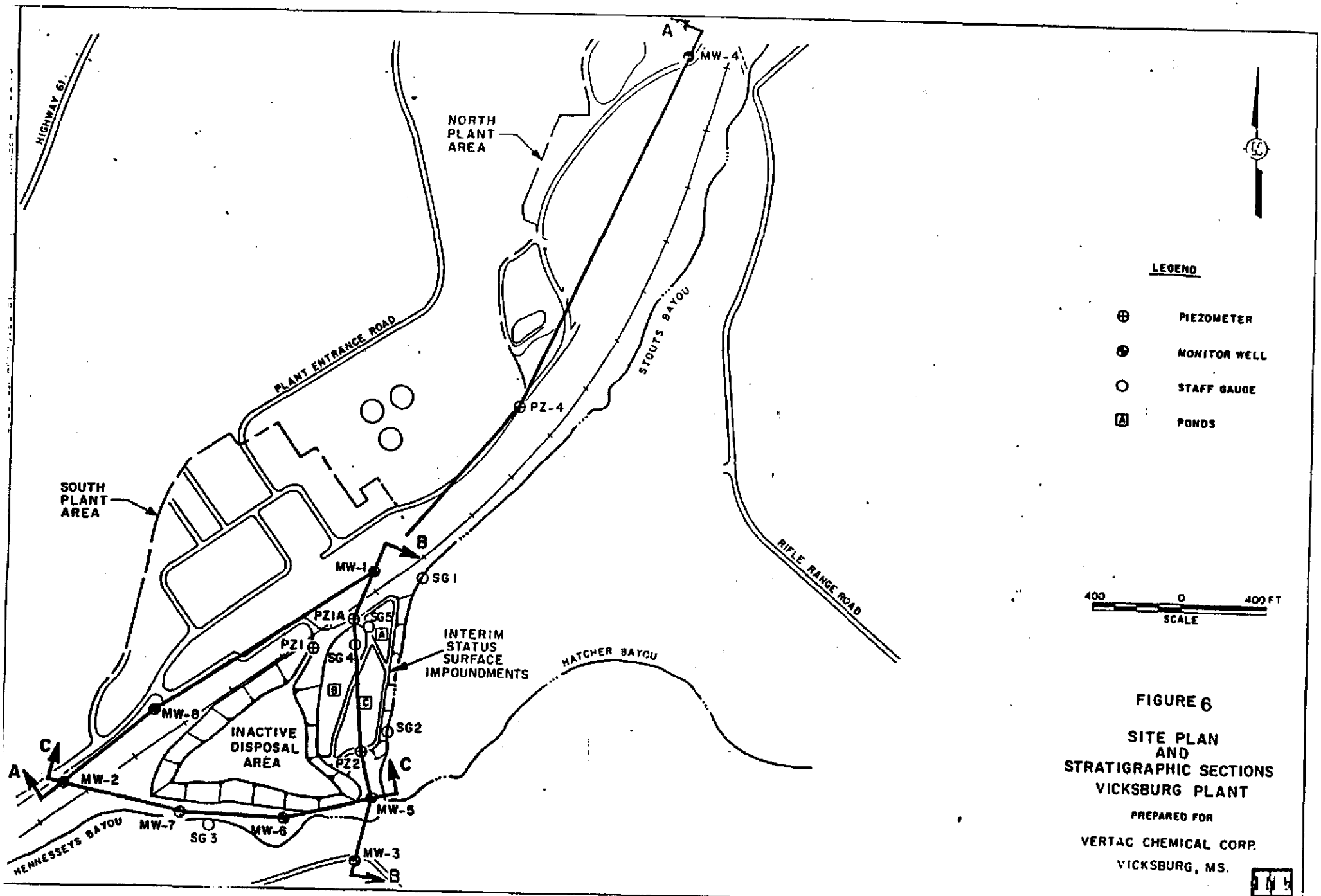
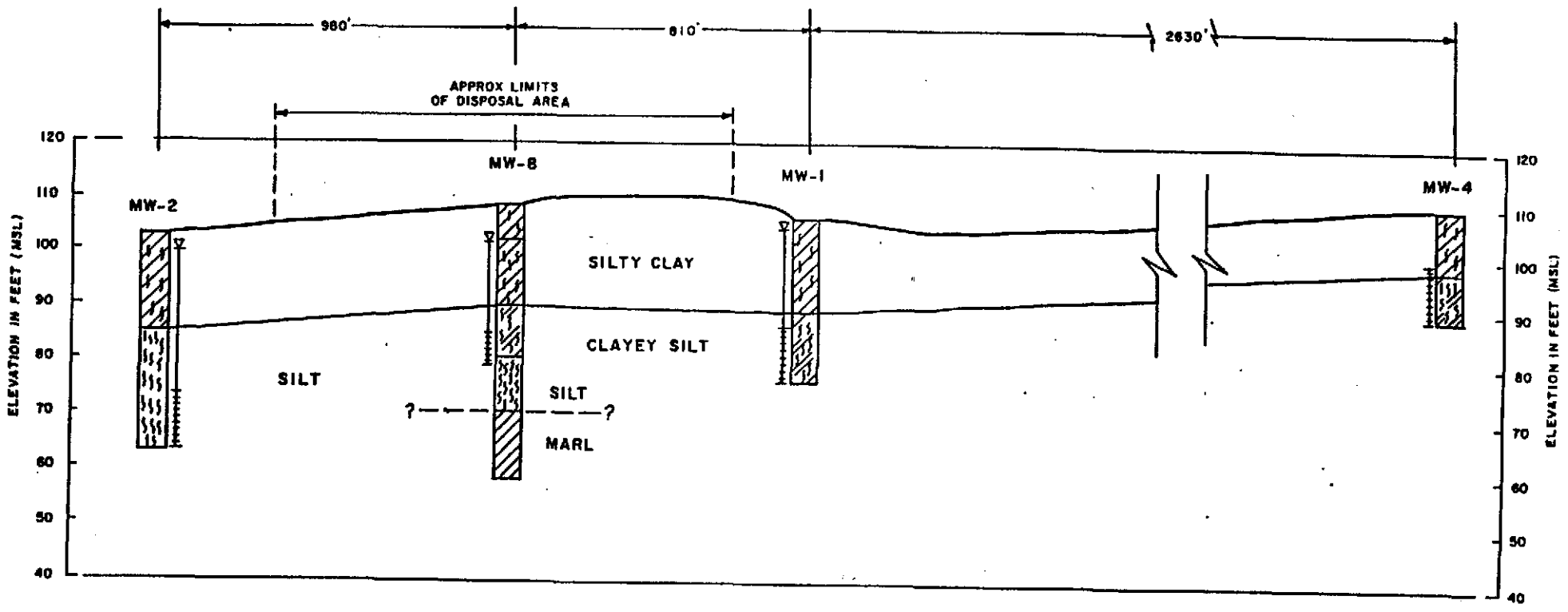


FIGURE 6

SITE PLAN
AND
STRATIGRAPHIC SECTIONS
VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.



SECTION A-A

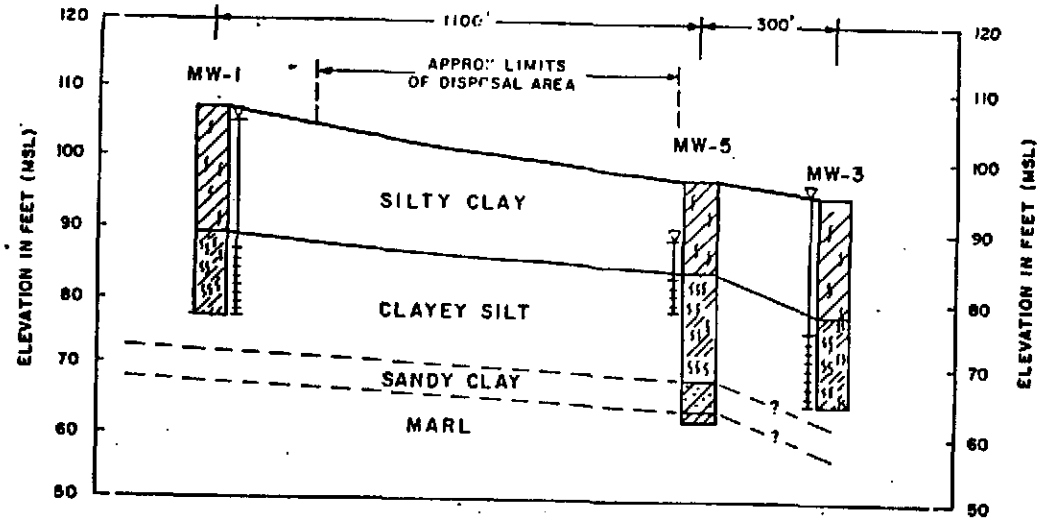
00 0 00 FT
HORIZONTAL SCALE

20 0 20 FT
VERTICAL SCALE

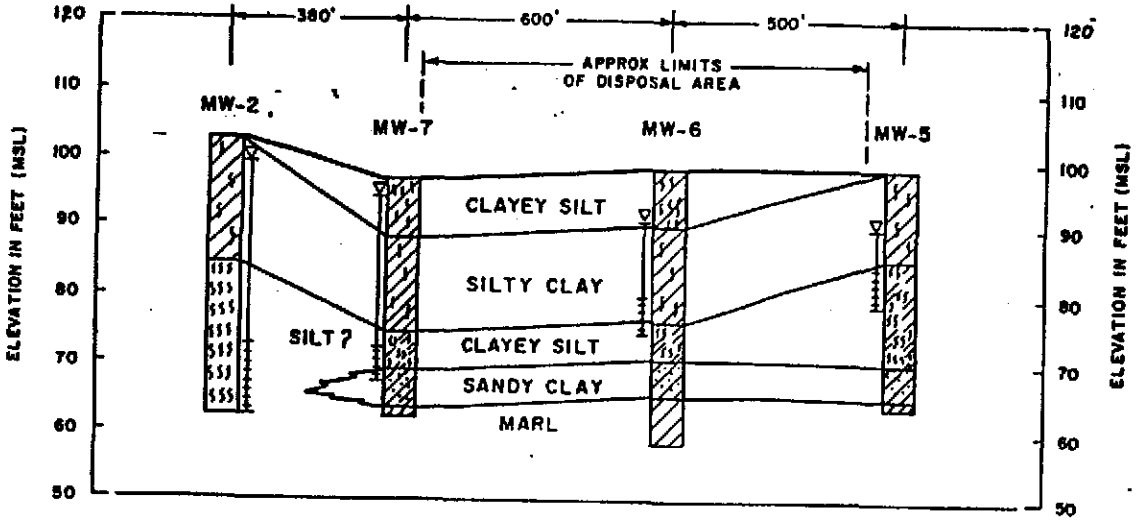
NOTES: 1. WATER LEVELS ARE THOSE REPORTED FOR MARCH 4, 1983.

2. STRATIGRAPHY SHOWN IS INTERPRETATION OF EXISTING BORING LOGS. SUBTLE VARIATIONS IN REPORTED SILT CONTENT ARE SHOWN.

FIGURE 7
inactive disposal area
SECTIONS A-A
VICKSBURG PLANT
PREPARED FOR
VERTAC CHEMICAL CORP
VICKSBURG, MS.



SECTION B-B



SECTION C-C

NOTES: 1. WATER LEVELS ARE THOSE REPORTED FOR MARCH 4, 1983.

2. STRATIGRAPHY SHOWN IS INTERPRETATION OF EXISTING BORING LOGS. SUBTLE VARIATIONS IN REPORTED SILT CONTENT ARE SHOWN.

300 0 300 FT
HORIZONTAL SCALE

20 0 20 FT
VERTICAL SCALE

FIGURE 8
inactive disposal area
SECTIONS B-B & C-C
VICKSBURG PLANT
PREPARED FOR
VERTAC CHEMICAL CORP.
VICKSBURG, MS.

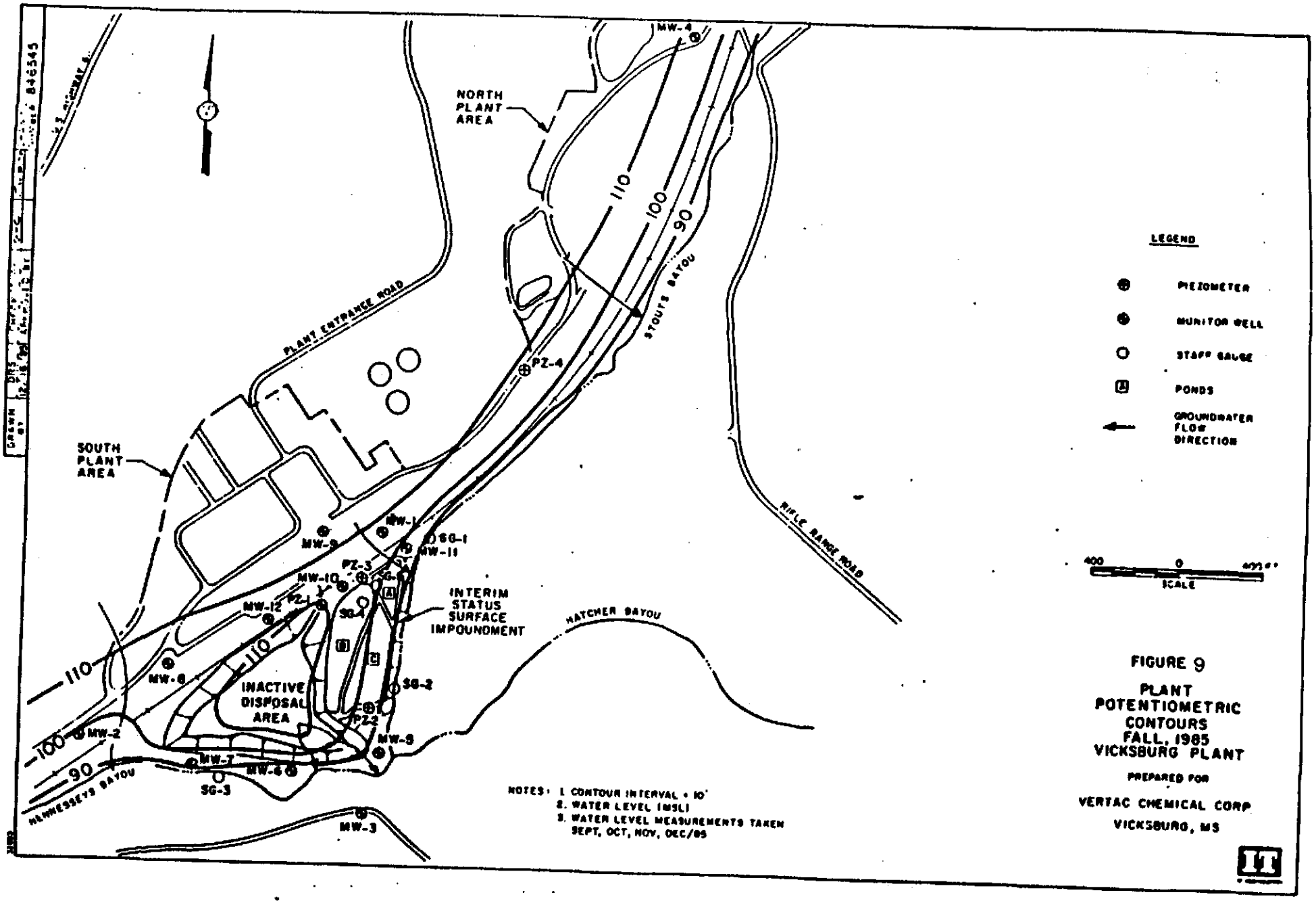


FIGURE 9

PLANT POTENTIOMETRIC CONTOURS FALL, 1985 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP

VICKSBURG, MS

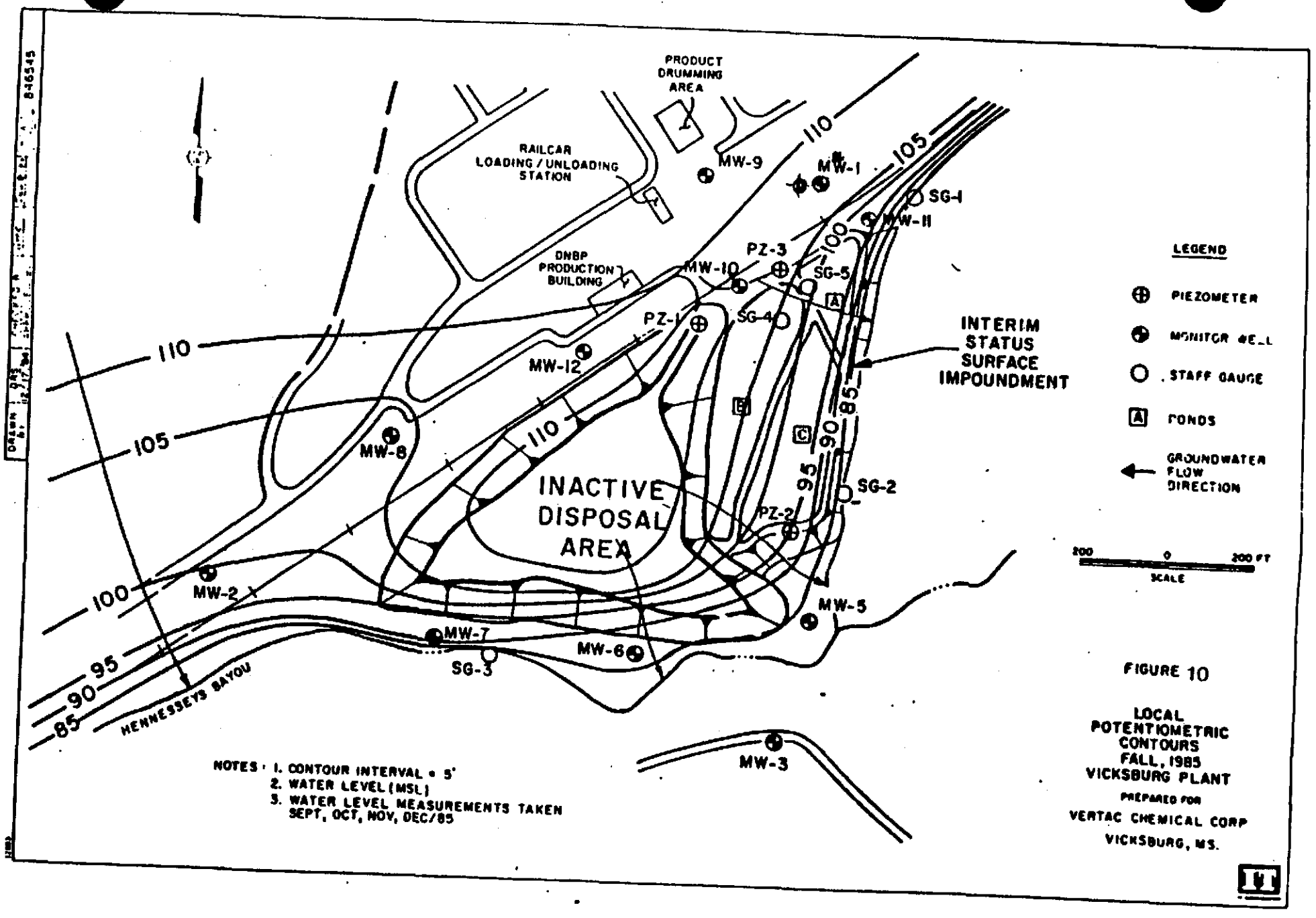


FIGURE 10

LOCAL POTENTIOMETRIC CONTOURS FALL, 1985 VICKSBURG PLANT

PREPARED FOR VERTAC CHEMICAL CORP VICKSBURG, MS.

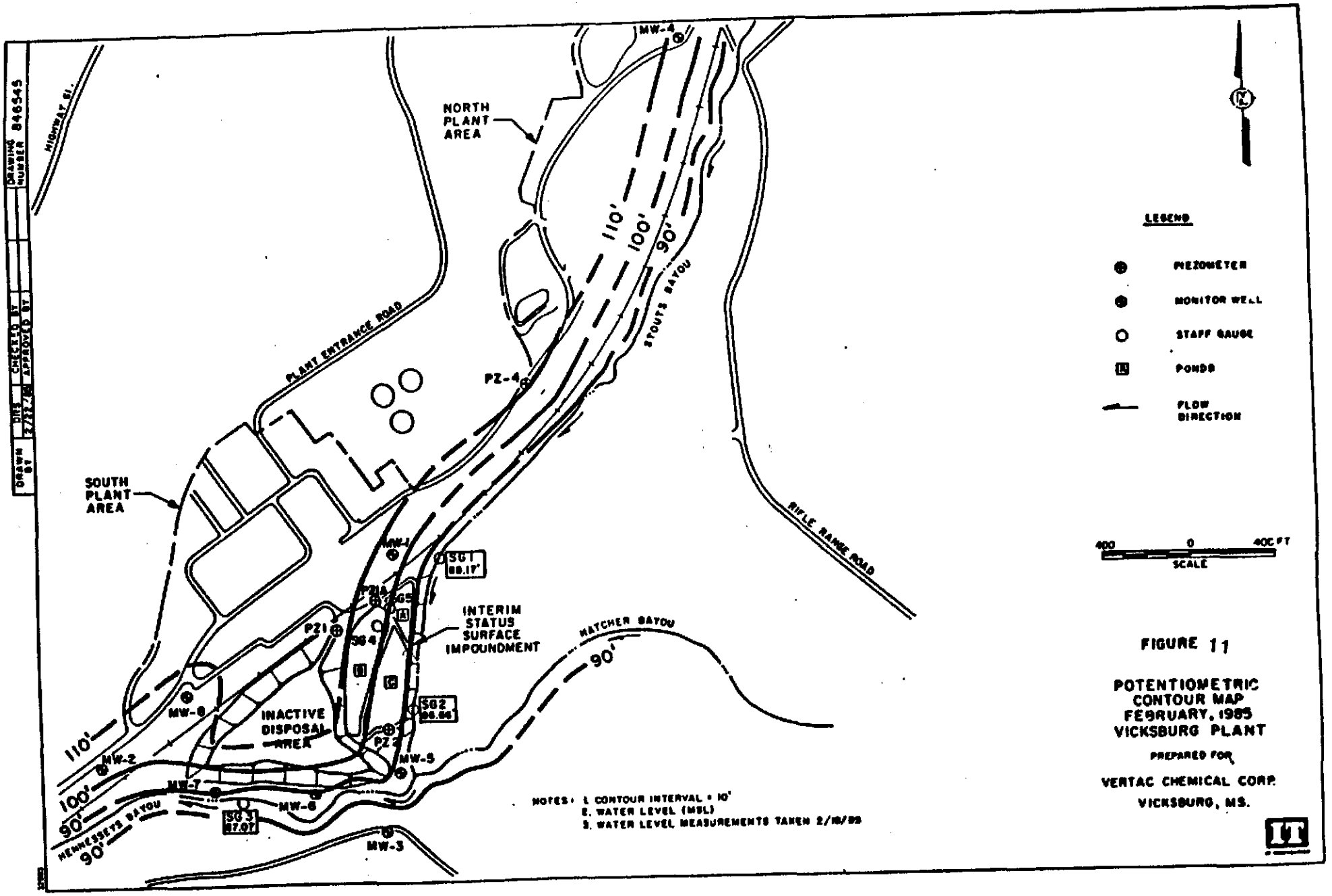


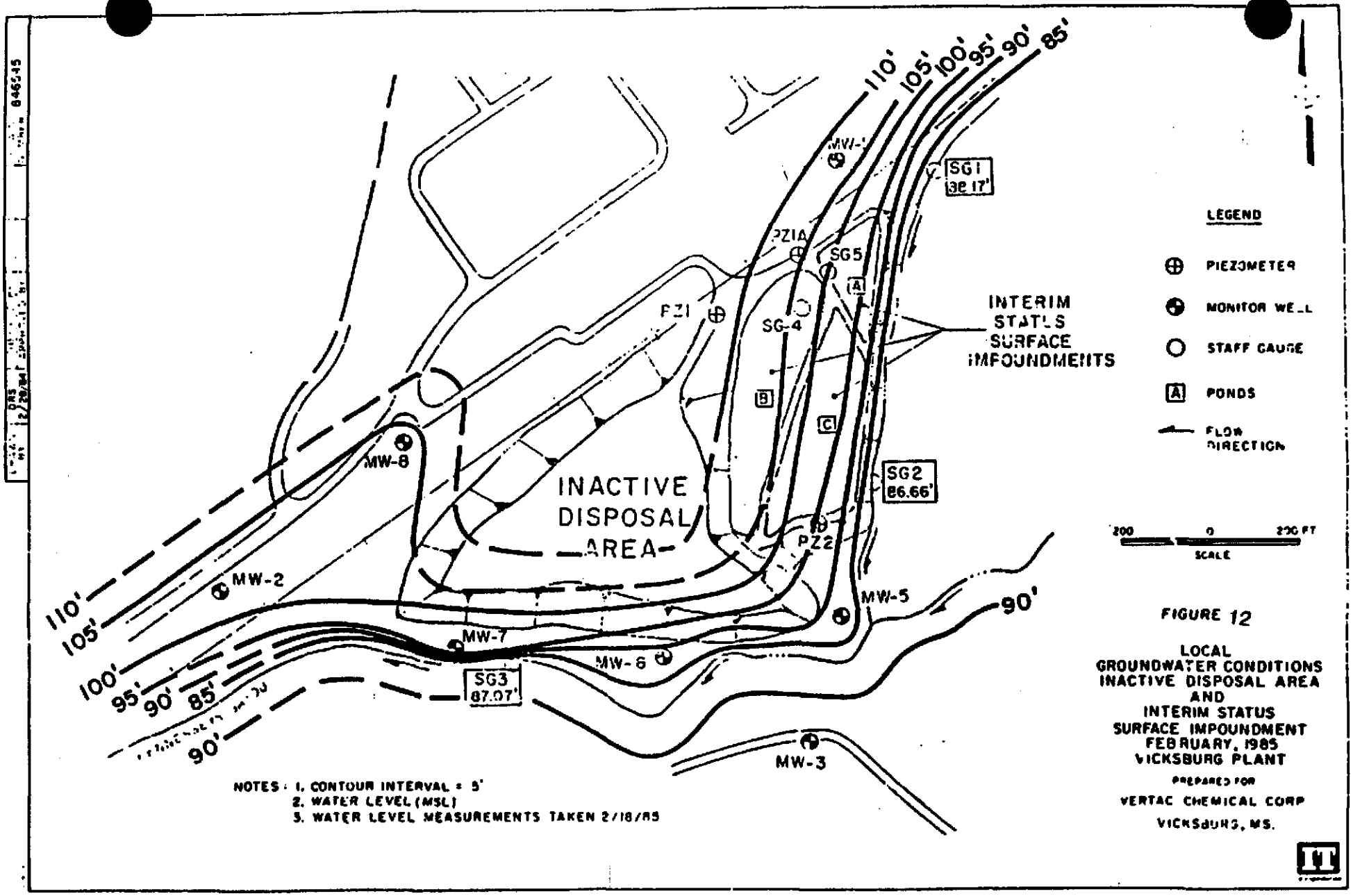
FIGURE 11

POTENTIOMETRIC CONTOUR MAP FEBRUARY, 1985 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.



NOTES: 1. CONTOUR INTERVAL = 5'
2. WATER LEVEL (MSL)
3. WATER LEVEL MEASUREMENTS TAKEN 2/18/85

FIGURE 12

LOCAL
GROUNDWATER CONDITIONS
INACTIVE DISPOSAL AREA
AND
INTERIM STATUS
SURFACE IMPOUNDMENT
FEBRUARY, 1985
VICKSBURG PLANT

PREPARED FOR
VERTAC CHEMICAL CORP
VICKSBURG, MS.

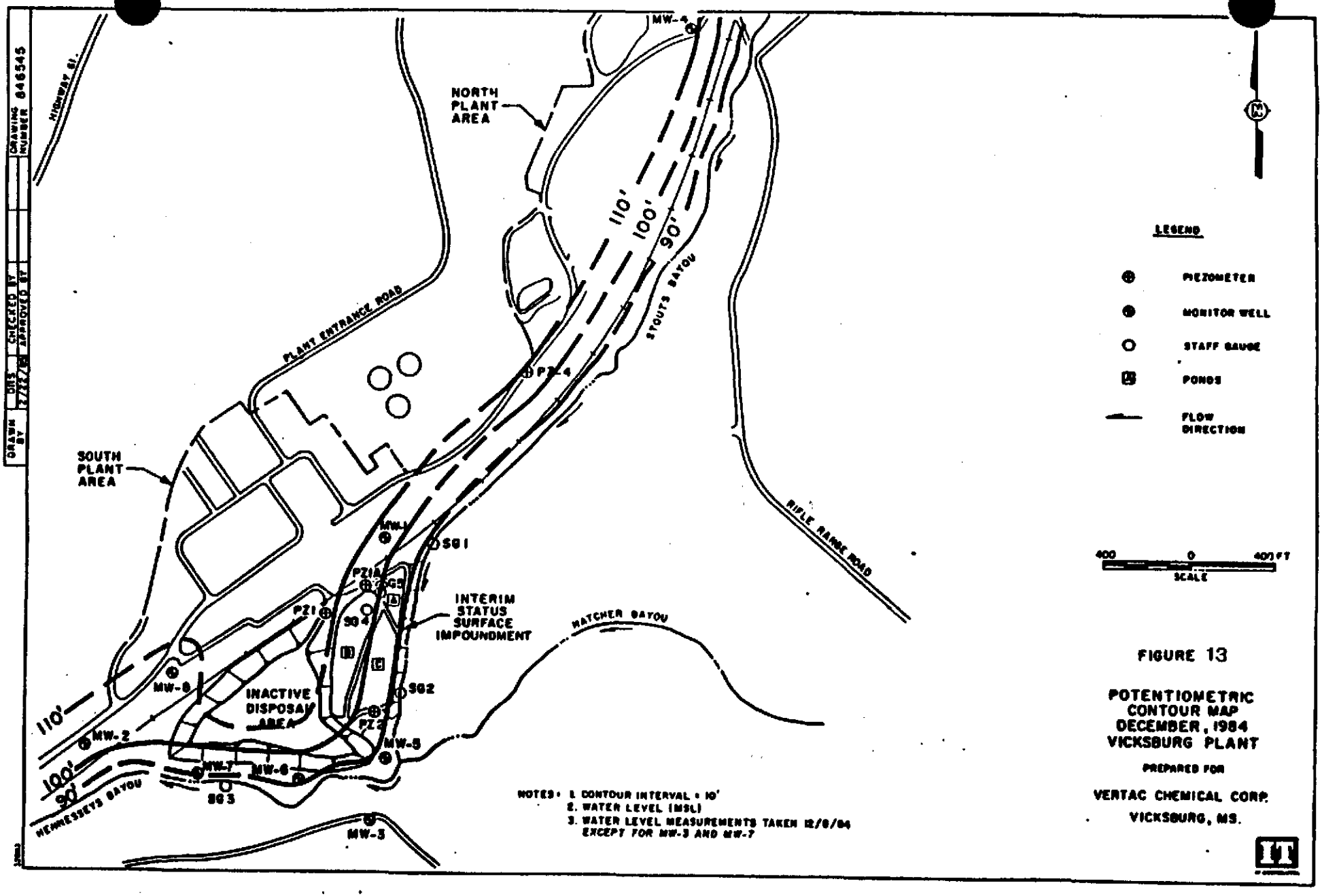


FIGURE 13

POTENTIOMETRIC CONTOUR MAP DECEMBER, 1984 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

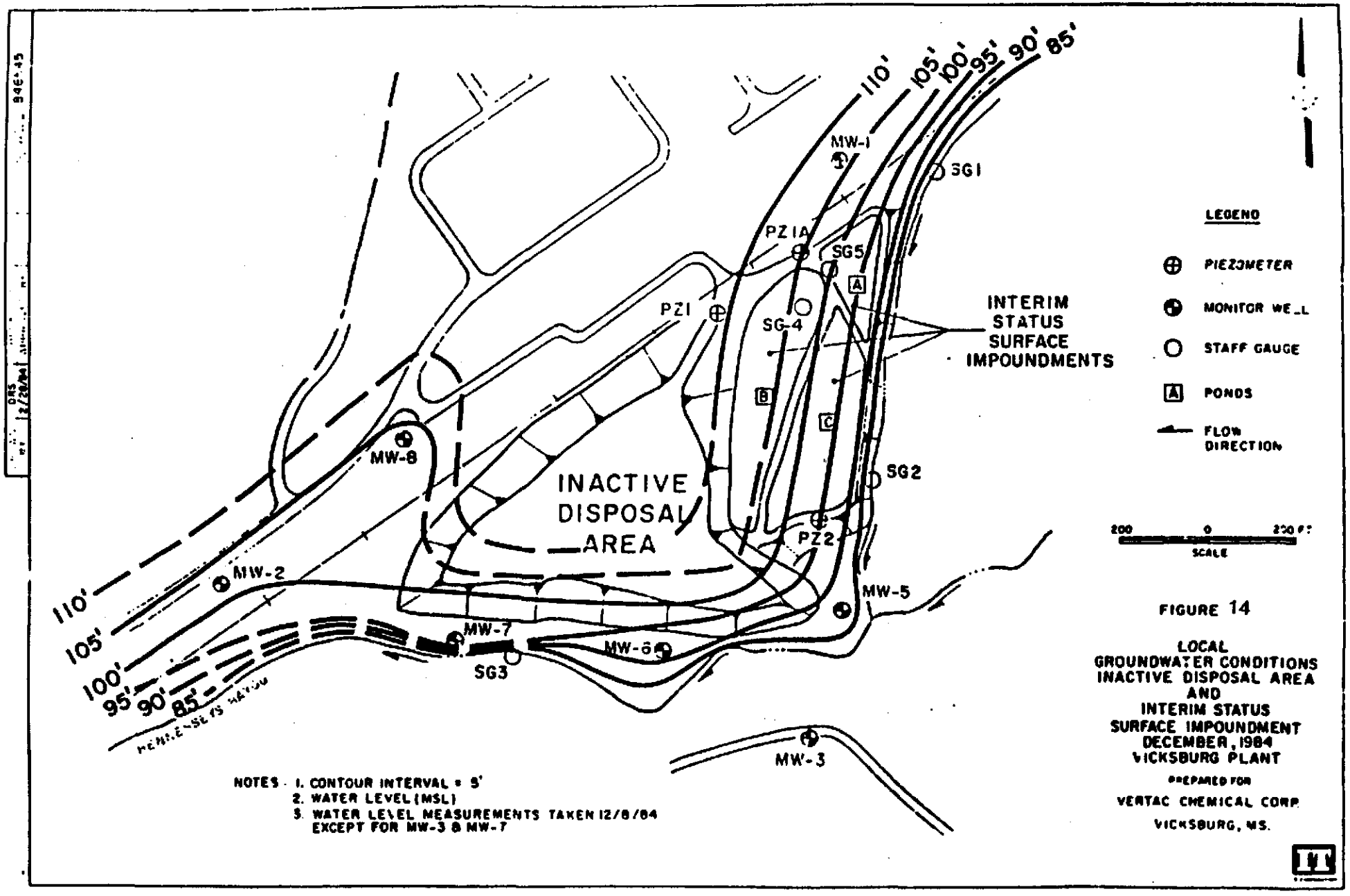


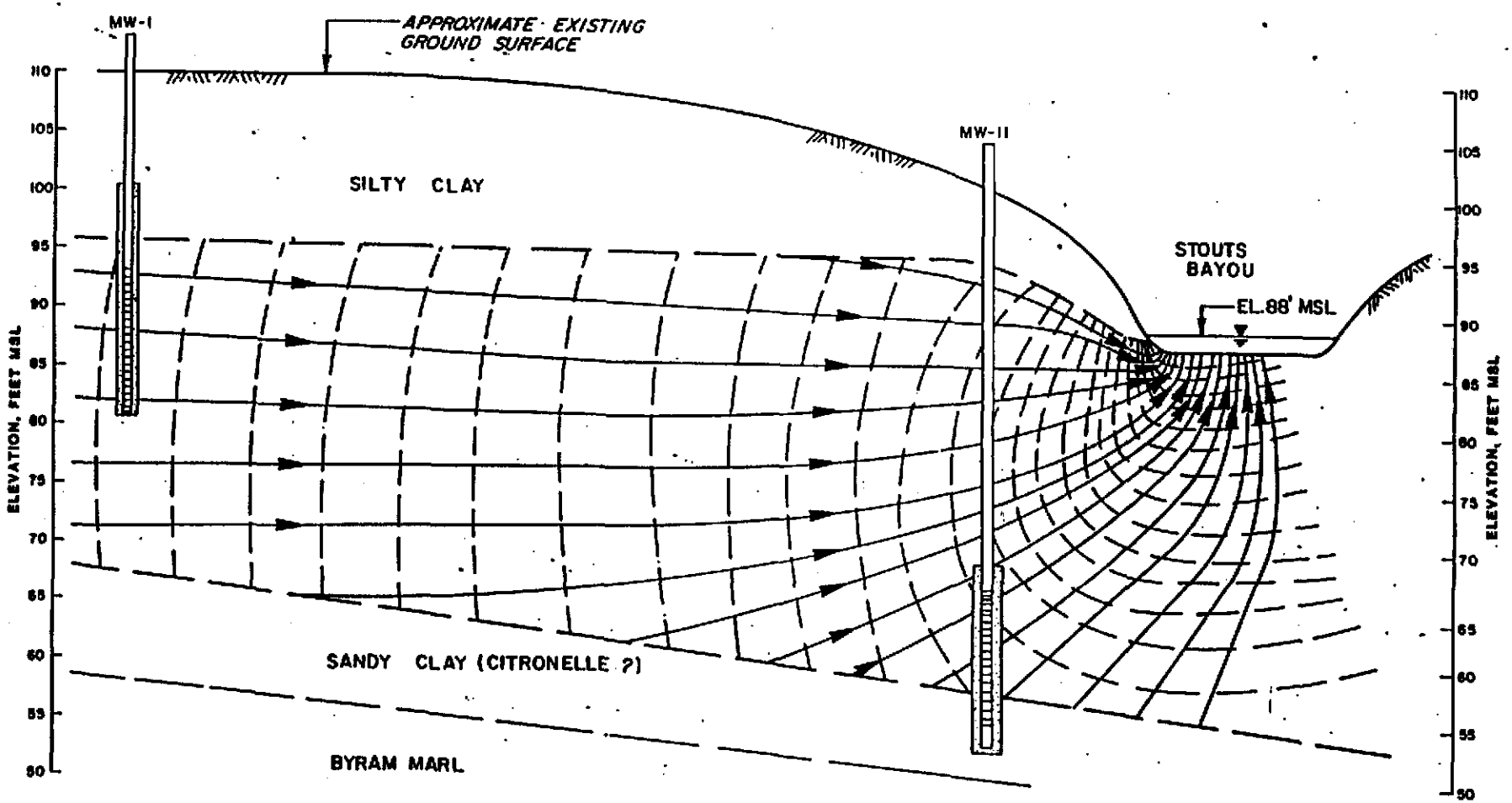
FIGURE 14

LOCAL GROUNDWATER CONDITIONS INACTIVE DISPOSAL AREA AND INTERIM STATUS SURFACE IMPOUNDMENT DECEMBER, 1984 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.



LEGEND

FLOW LINES

EQUIPOTENTIAL LINES

REFERENCE: FREEZE, R.A. and CHERRY, J.A., 1979, GROUNDWATER, PRENTICE-HALL INC., ENGLEWOOD CLIFFS, N.J. 604p.

FIGURE 15

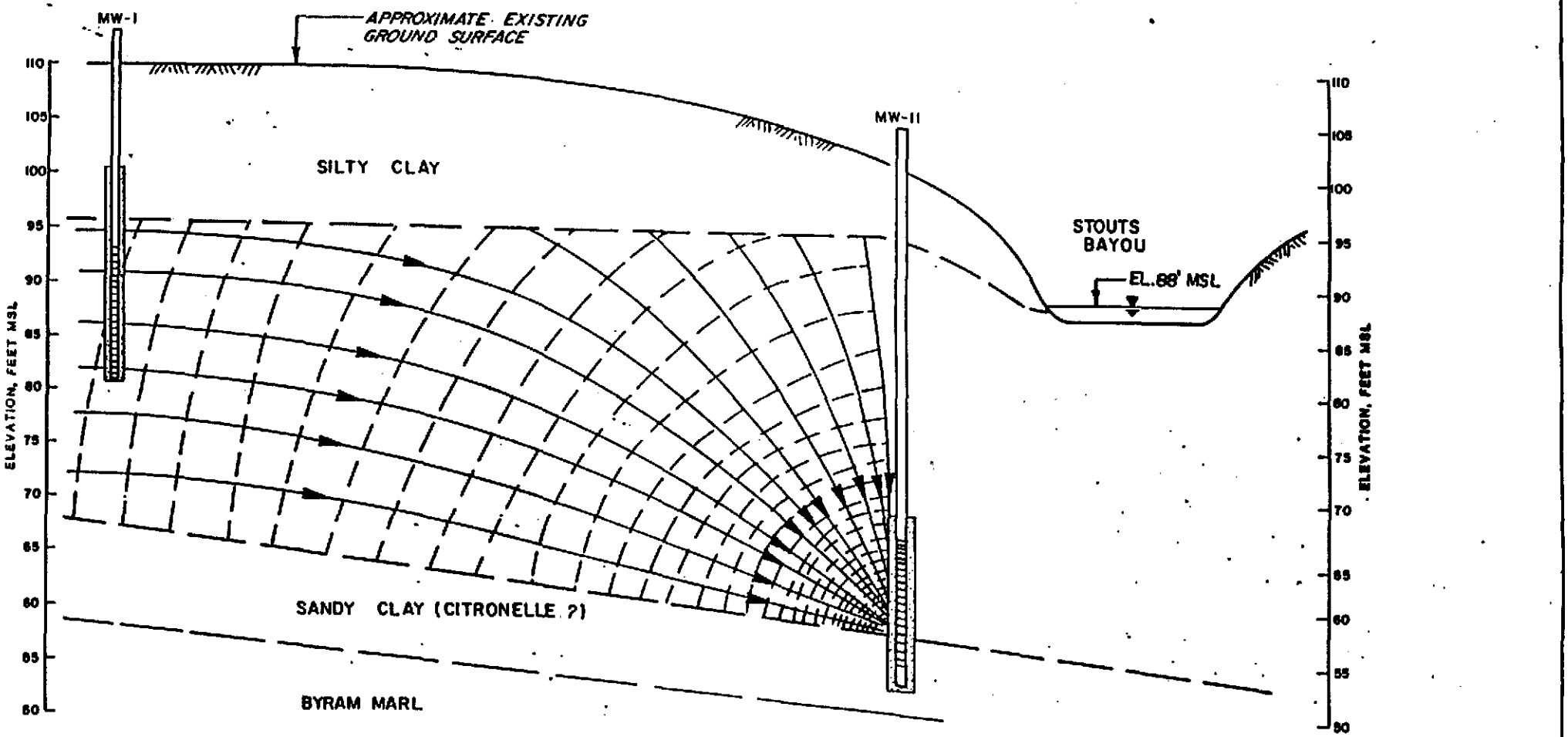
LOCAL GROUND WATER FLOW NET IN VICINITY OF MW-1 AND MW-11

PREPARED FOR

CEDAR CHEMICAL COMPANY
VICKSBURG, MISSISSIPPI

...RATT CORPORATION
...ALL RIGHTS RESERVED

...Creating a Safer Tomorrow



LEGEND

FLOW LINES

EQUIPOTENTIAL LINES

NOTE: WELL IS BAILED DRY PRIOR TO SAMPLING.

FIGURE 16

FLOW NET AROUND MW-11 AFTER PURGING

PREPARED FOR

CEDAR CHEMICAL COMPANY VICKSBURG, MISSISSIPPI

REFERENCE: FREEZE, R.A. and CHERRY, J.A., 1979, GROUNDWATER, PRENTICE-HALL INC., ENGLEWOOD CLIFFS, N.J. 604p.

...ALT CORPORATION
...COPYRIGHTS RESERVED

IT ... Creating a Safer Tomorrow

APPENDIX D

MONITOR WELL AND PIEZOMETER LOGS (FROM APPENDIX D PRELIMINARY REPORT)

APPENDIX D
(PRELIMINARY REPORT)

MONITOR WELL AND PIEZOMETER LOGS

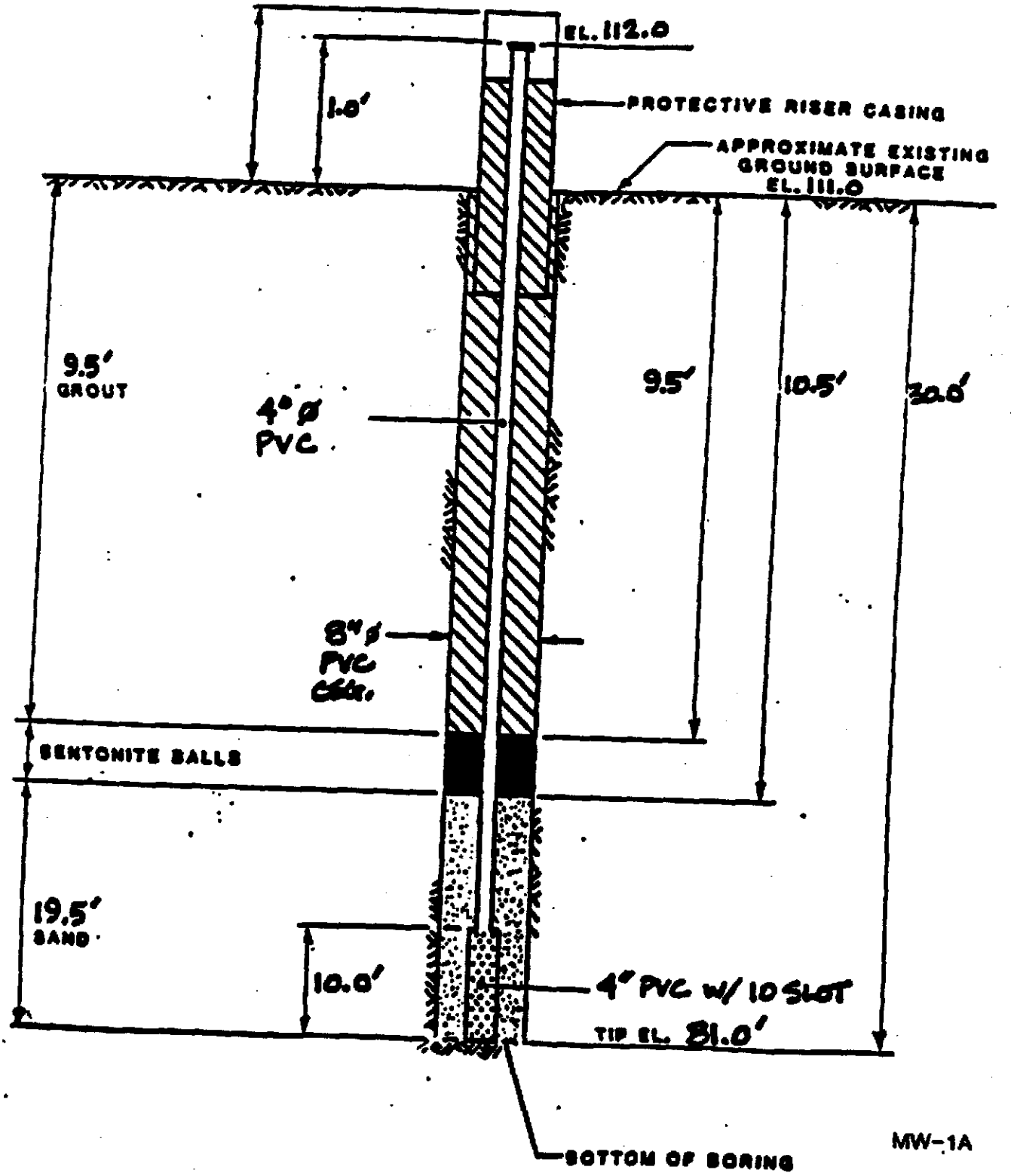
MW-1A
MW-2
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
MW-11
MW-12
MW-13
MW-14
MW-16
PZ-19B
PZ-19A
PZ-12(R)B
PZ-12(R)A
PZ-20B
PZ-20A
PZ-21A
PZ-22B
PZ-22A
PZ-23B
PZ-23A
PZ-24B
PZ-24A
PZ-25B

IT ... Creating Water Tomorrow

MONITOR WELL INSTALLATION SKETCH

PROJECT NAME Cedar
PROJECT NO. 435130
BORING NO. B-1A
MONITOR WELL NO. MW-1A

INSTALLED BY W-L DATE 7-25-86
CHECKED BY JJC DATE 7-25-86



MW-1A

IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 435130	PROJECT NAME: Cedar Chemical-Vicksburg		
BORING NUMBER: B-1A/MW-1A	COORDINATES:	DATE: 7/24/86	
ELEVATION: Approx. 111 ft. MSL	GWL: Depth 9 ft Date/Time 1300/7-24	DATE STARTED: 7/24/86	
ENGINEER/GEOLOGIST: J. B. Cange	Depth Date/Time	DATE COMPLETED: 7/24/86	
DRILLING METHODS: Dry Auger to 11 ft.; Wash Bore to 30 ft.		PAGE 1 OF 2	

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (ft)	RECOVERY (ft)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	ST			Very Stiff Brown CLAYEY SILT with SILTY CLAY. Fe Staining, Roots; Very Dry; Silt Laminae;			Moderate to Strong Effervescence
2	ST						
3	ST			Stiff Brown and Tan CLAYEY SILT Mottled, Black Specks, Fe Staining; Oxide Coatings on Bedding Planes; Massive Texture, Softer at 5 ft.			Strong Effervescence
4	ST						
5							
6	ST			Soft Brown and Gray Silt, Becoming Hard Lower 6" with Black/Tan Inclusions, Calc. Concretions Mottled Texture Throughout			Moderate Effervescence Except Gray Areas- No Effervescence
7							
8	ST			Soft Brown and Gray Silt, CLAYEY SILT; Mottled with Lower 6" Dark Brown Firm Silt; Becoming Stiffer Downward Swirling Texture			Same with Dark Brown Area with No Effervescence
9							
10	ST			Soft to Medium Stiff Brown CLAYEY SILT with Rootlets, Plant Matter, Gray Swirls in Dark Brown Areas; Massive Texture			Moderate Effervescence
11	ST			Soft To Stiff Brown CLAYEY SILT, Black Specks (Organic Matter)			No Effervescence
12							
13	ST			Same, with Mottled Zone in Center Having Tan, Black Color; Becoming Softer, Very Silty Below; Mottled Zone Plastic			No Effervescence
14							
	ST			Same; Incr. in Silt Content Less Plastic; Incr. Tan Mottles			No Effervenscence

NOTES:

Started drilling @ 11:30 am 7/24/86.
Encountered obstruction @ 1 ft.; Skidded rig 3 ft. to NE
Reamed hole to 10" down to 9 ft.; Set surface csg to 9.5 (pushed last 6") with 1 ft. stickup; Grouted in place
Resumed drilling 7/25/86

MW-1A

IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 435130	PROJECT NAME: Cedar Chemical-Vicksburg		
BORING NUMBER: B-1A/MW-1A	COORDINATES:	DATE: 7/24/86	
ELEVATION: Approx. 111 ft. MSL	GWL: Depth / Date/Time	DATE STARTED: 7/24/86	
ENGINEER/GEOLOGIST: J. B. Cange	Depth / Date/Time	DATE COMPLETED: 7/24/86	
DRILLING METHODS: Dry Auger to 11 ft.; Wash Bore to 30 ft.		PAGE 2 OF 2	

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (ft)	RECOVERY (ft)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	ST			With Black Specks Throughout			No Effervescence
17	ST			Same; Mottling Heavier with Increase in Root Traces and Organic Matter (Black Specks)			No Effervescence Fe Staining?
18				Same (Brown CLAYEY SILT) with Lower 1 ft. Being Tan Mottled Silt			No Effervescence
19	ST						
20				Same; Coarser at Top and Bottom, Pobably Due to Increase in Silt Content			
21	ST						No Effervescence
22				Brown CLAYEY SILT with Increase Mottling; Gray and Tan Mixed with Brown; Abundant Root Traces and Organic Material (Black)			No Effervescence
23	ST						
24				Brown, Tan and Gray CLAYEY SILT, Extensively Mottled, with Fe-Staining, Root Traces, Oxidation Layers			No Effervescence
25	ST						
26				Firm Gray and Tan Silt (Mostly Gray) with Abundant Gastropad Shell Fragments (Unbroken); Very Massive; Root Traces with Black and Iron Concentric Staining			Moderate Effervescence
27							
28							
29							

NOTES

Boring Terminated at 30 feet.

Location of Well # 2

ED NO. 872

Project Vertac Chemical Corporation

Vicksburg, Mississippi

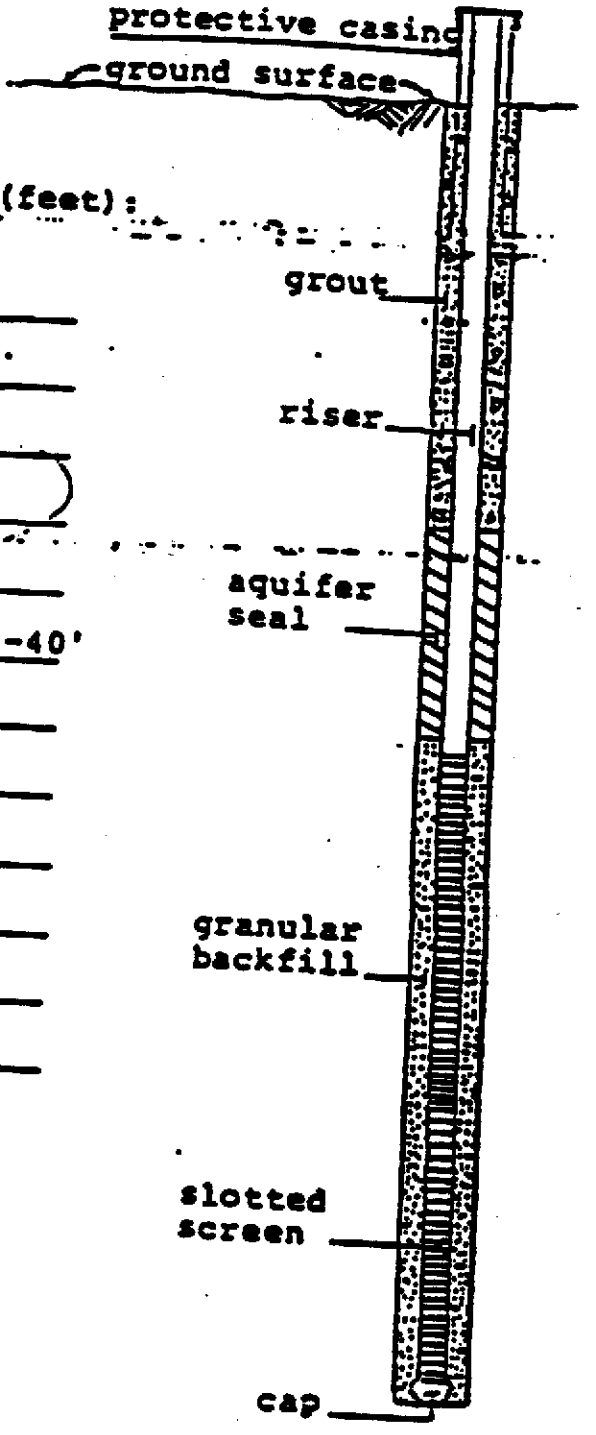
Date: Installed 29 Sept.

Completed 29 Sept.

Developed 01 Oct.

Locations below ground surface (feet):

Bottom of Boring	40'
Bottom of Well	40'
Well Specification	4" PVC-Schd. 40
Screen Slot and Location	0.010" 30'-40'
Coupling Location	0', 10', 30'
Granular Backfill	Concrete Sand 10'-40'
Seals	Bentonite 8'-10'
Grout	Concrete 0-8'
Cave-in	None
Height of Riser	2'
Protective Casing	None
Elevation-top casing	105.0 MSL



MW-2

USC

LOG OF BORING

PROJECT Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	DRILLING RIG B-40	JOB. NO. 872	BORING NO. B-2 SHEET 1 OF 1
GROUND SURFACE ELEVATION 103.0 DATUM MSL	BORING LOCATION SEE PLAN		
BORING TYPE 3 1/4" Hollow Auger 2" Spilt Spoon	GROUND WATER LEVEL 26' at drilling	DATE 29 September 1981 WEATHER clear and warm DRILLER Bill Barnes INSPECTOR Terry Primm BORING TERMINATED AT 40'	

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	7	25	Firm tan silty CLAY
2	8.5-10.0	7	24	Firm tan silty CLAY
3	13.5-15.0	6	24	Firm tan silty CLAY
4	18.5-20.0	6	25	Firm gray silt
5	23.5-25.0	6	23	Firm gray silt
6	28.5-30.0	8	23	Firm gray silt
7	33.5-35.0	7	23	Firm gray silt
8	38.5-40.0	8	32	Firm gray silt

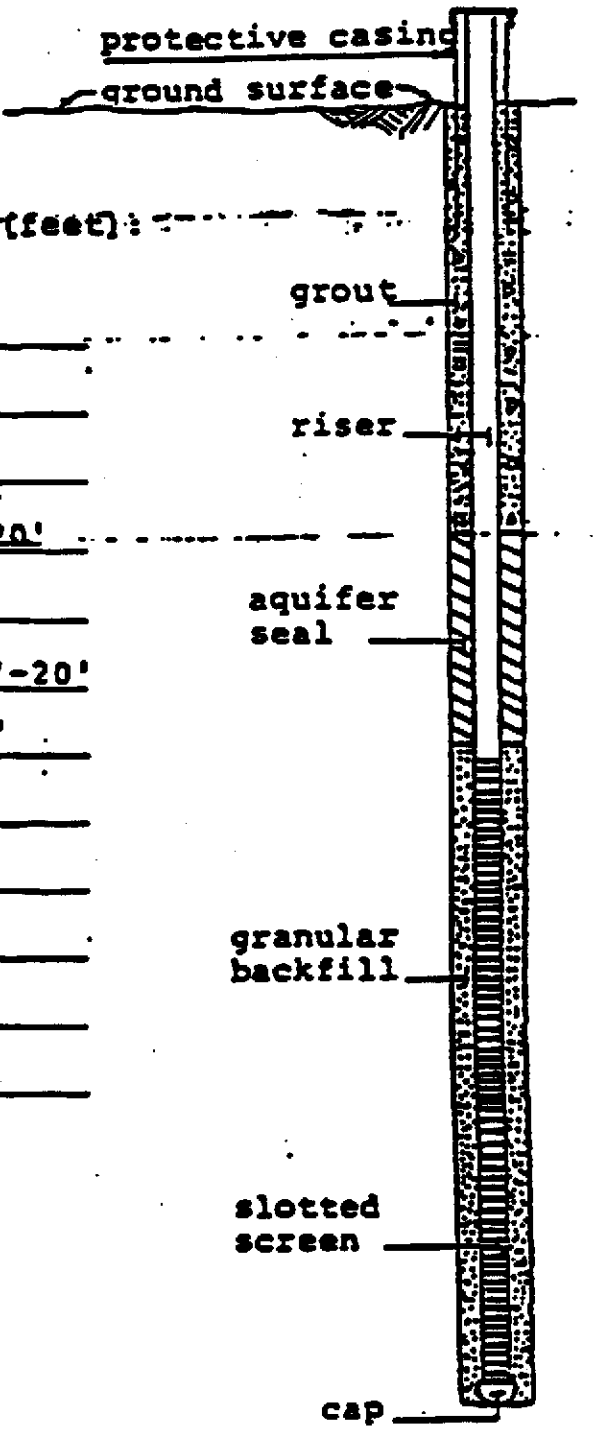
tion of Well # 4

No. 872

Project Vertac Chemical Corporation

Vicksburg, Mississippi

Date: Installed 01 Oct. 1981
Completed 01 Oct. 1981
Developed 01 Oct. 1981



Locations below ground surface (feet):

tom of Boring	20'
tom of Well	20'
Specification	4" PVC-Schd. 40
een Slot and Location	0.010" 10'-20'
ling Location	0.10'
ular Backfill	Concrete Sand 8'-20'
als	Bentonite 6'-8'
t	Concrete 0-6'
-in	None
ght of Riser	2'
ective Casing	None
evation-top casing	111.6 MSL

LOG OF BORING

NSC

PROJECT Monitoring Wells
Vertac Chemical Corp.
Vicksburg, Mississippi

DRILLING RIG B-40

JOB. NO. 872

BORING NO. B-4

SHEET 1 OF 1

GROUND SURFACE ELEVATION 109.6
MSL

DATUM

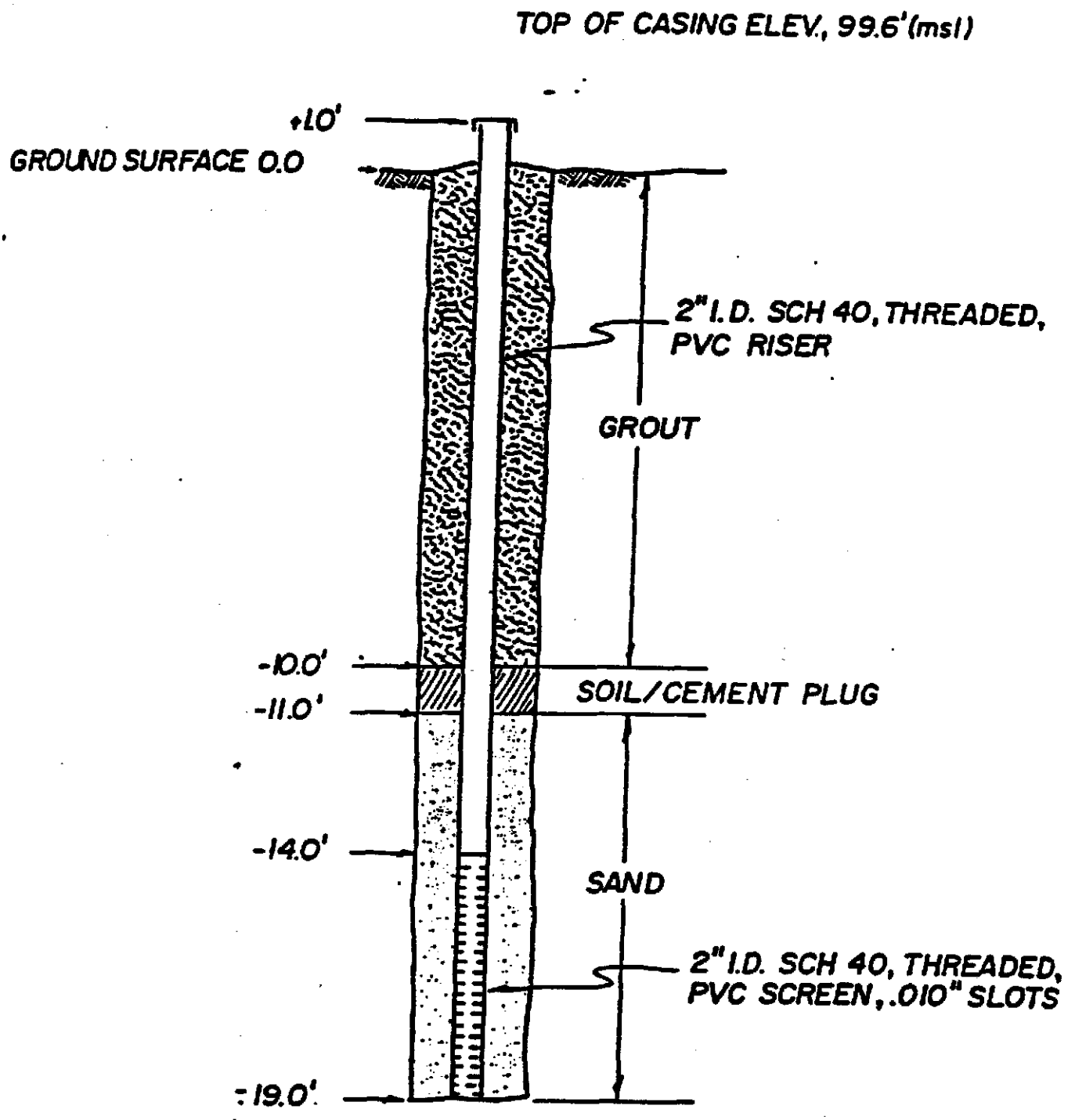
BORING LOCATION
SEE PLAN

BORING TYPE
1 1/4" Hollow Auger
2" Split Spoon

GROUND WATER LEVEL
9' at drilling

DATE 01 October 1981
WEATHER clear and warm
DRILLER Bill Barnes
INSPECTOR Terry Primm
BORING TERMINATED AT 20

Sample No.	Sample Depth ft From — To	Stand. Penet. Test Blow/ft	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	5	25	Firm tan silty CLAY w/gray silt marbeling
2	8.5-10.0	10	25	Stiff brown silty CLAY w/gray silt marbeling
3	13.5-15.0	11	27	Stiff dark brown silty CLAY w/gray silt marbeling
4	18.5-20.0	9	26	Stiff dark brown silty CLAY w/gray silt marbeling



MCI CONSULTING ENGINEERS
Nashville, Tennessee

MONITORING WELL No. 5
AS COMPLETED
VERTAC CHEMICAL CORP.
VICKSBURG, MS.
NO SCALE 12/2/83

MW-5

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters:
Nashville, Tennessee

Branch Offices:
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

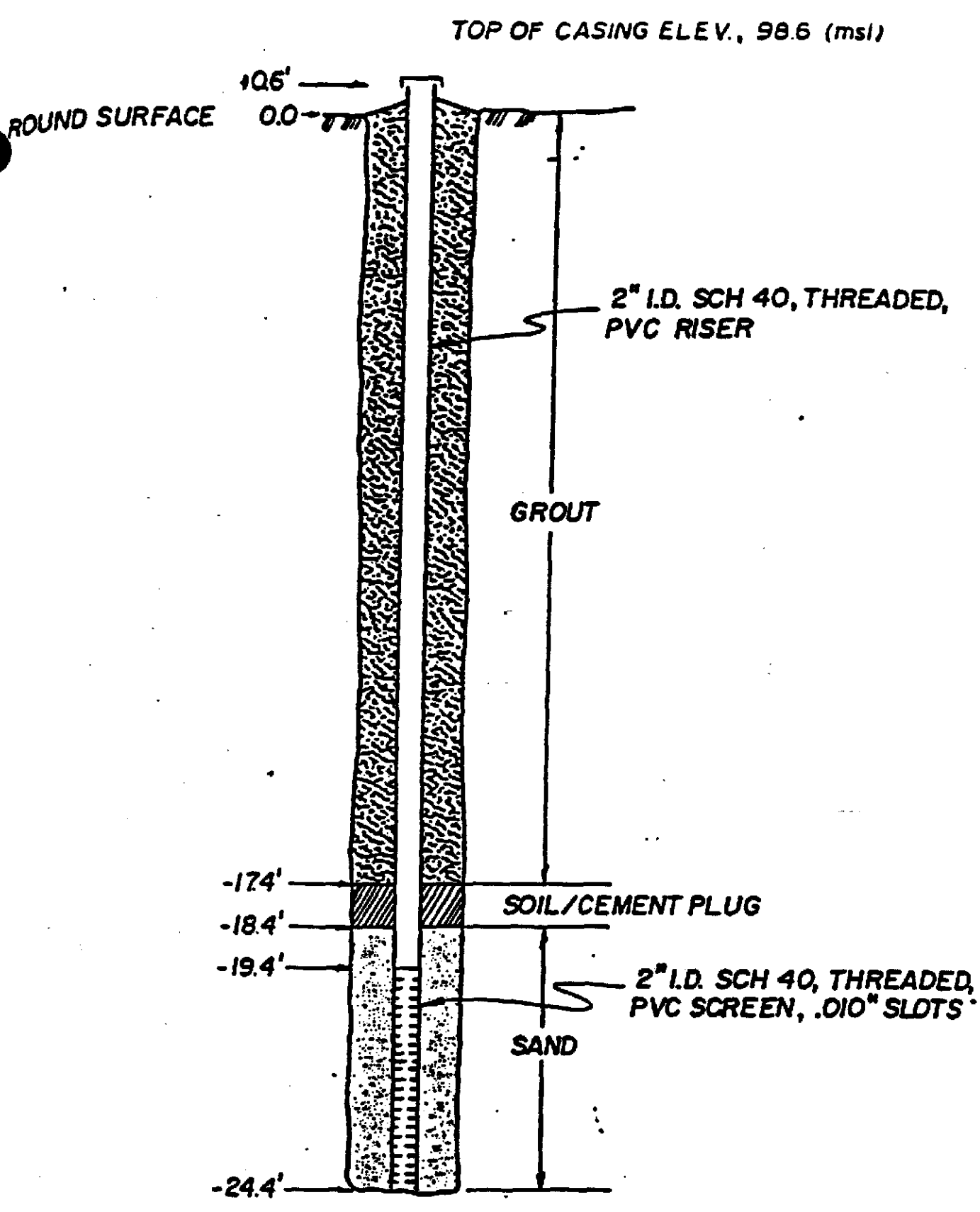
SHIFT REPORT OF DRILLING OPERATIONS AT	Vertac Chemical Corporation (VCC) Vicksburg, MS		SITE
HOLE LOCATION	See Site Sketch Map	SHIFT	DATE 3-2-83
SURFACE ELEVATION	98.6' (msl)	RIG NO.	HOLE NO. 5
DEPTH AT BEGINNING OF SHIFT		TOP ROCK	
FOOTAGE TIGHTAILED		BOTTOM OF HOLE	
FOOTAGE SAMPLED		DRILLER	C. Nelson - H.B.A.
FOOTAGE CORED		HELPER	
DEPTH AT END OF SHIFT		DRILLED FOR	

SAMPLING RECORD

LOGGED BY: GDM

SPLIT NO	FROM	TO	SPLIT BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown silty CLAY, v. moist
2	10.0	11.0		Brown v. silty CLAY, Moist
3	15.0	16.0		Brown sl. clayey SILT, with gray mottles
				Stratum change at 17.0 feet - by driller
				Saturated returns at 19.0'
4	20.0	21.0		Brown and gray sl. clayey SILT, saturated
5	25.0	26.0		Gray sl. clayey SILT, saturated
				Hard drilling at 29 feet
6	30.0	31.0		Greenish gray clayey SAND
7	34.0	35.0		Greenish gray MARL

NOTES: (1) Monitoring Well # 5 set in test boring at 19.0'
(2) Top of casing Elev. = 99.6' (msl)
Bottom of casing Elev. = 79.6' (msl)



MCI CONSULTING ENGINEERS
Nashville, Tennessee

MONITORING WELL No. 6
AS COMPLETED
VERTAC CHEMICAL CORP.
VICKSBURG, MS.
NO SCALE 12/2/83

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters:
Nashville, Tennessee

Branch Offices:
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

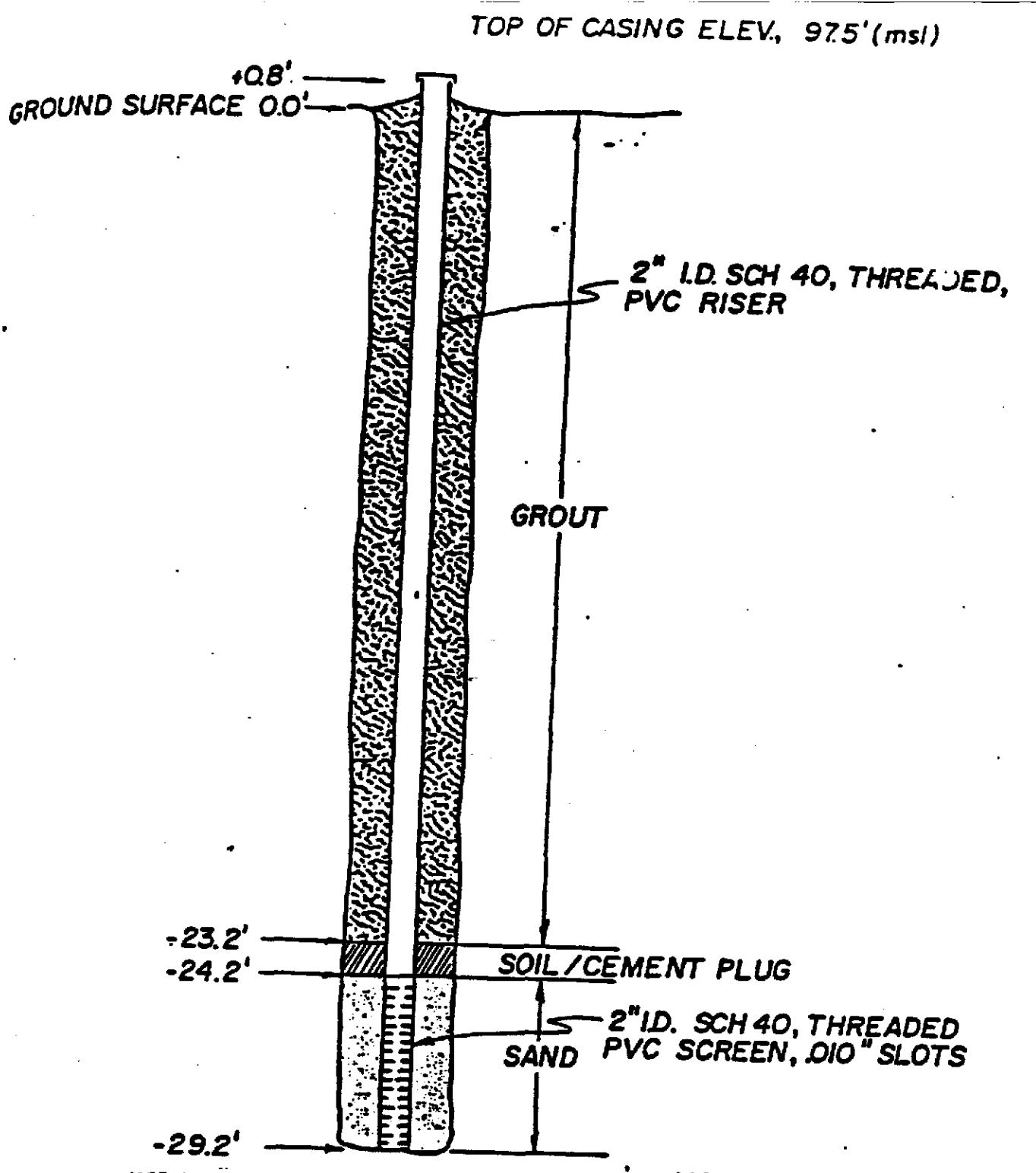
SHIFT REPORT OF DRILLING OPERATIONS AT	VCC, Vicksburg, MS		SITE
HOLE LOCATION	See Site Sketch Map	SHIFT	DATE 3-1-83
SURFACE ELEVATION	98.0' (msl)	RIG NO.	HOLE NO. 6
DEPTH AT BEGINNING OF SHIFT		TOP ROCK	
FOOTAGE FISHTAILED		BOTTOM OF HOLE	
FOOTAGE SAMPLED		DRILLER	C. Nelson, HBA
FOOTAGE CORED		HELPER	
DEPTH AT END OF SHIFT		DRILLED FOR	

SAMPLING RECORD

LOGGED BY: GDM

SPLE NO.	FROM	TO	SPLE BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown clayey SILT, v. moist
2	10.0	11.0		Brown v. silty CLAY, moist
				Saturated returns at 14.5'
3	15.0	16.0		Brown v. silty CLAY, lam. lignite, wet.
4	20.0	21.0		Brown silty, clay with gray mottles
				Stratum change at 22.0' - by driller
5	25.0	26.0		Gray sl. clay SILT, saturated
				Hard drilling at 28.0'
6	30.0	31.0		Greenish gray sandy CLAY
7	35.0	36.0		Greenish gray MARL
8	39.0	40.0		Greenish gray MARL

NOTES: (1) Monitoring Well #6 in additional borings, 5' southwest of test boring at 24.5'
(2) Top of casing elev. = 98.6' (msl)
Bottom of casing elev. = 73.6' (msl)



MCI CONSULTING ENGINEERS
Nashville, Tennessee

MONITORING WELL No. 7
AS COMPLETED
VERTAC CHEMICAL CORP.
VICKSBURG, MS.
NO SCALE 12/2/83

MW-7

MCI/CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters:
Nashville, Tennessee

Branch Offices
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

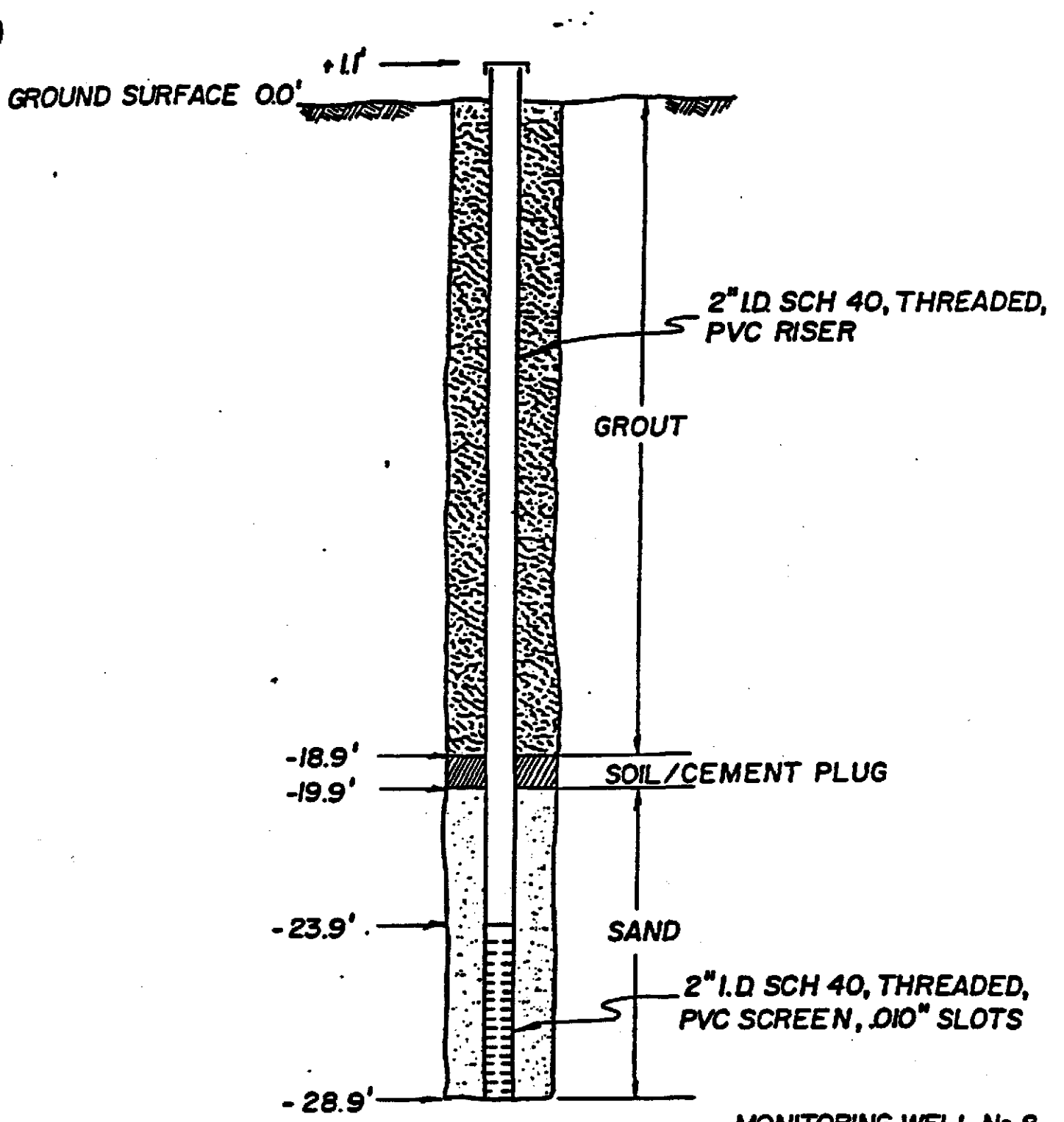
SHIFT REPORT OF DRILLING OPERATIONS AT	VCC, Vicksburg, MS		
HOLE LOCATION	See Site Sketch Map	SHIFT	SITE / DATE 3-1-83
SURFACE ELEVATION	96.7' (msl)	RIG NO.	HOLE NO. 7
DEPTH AT BEGINNING OF SHIFT		TOP ROCK	
FOOTAGE FISHTAILED		BOTTOM OF HOLE	
FOOTAGE SAMPLED		DRILLER	C. Nelson - HBA
FOOTAGE CORED		HELPER	
DEPTH AT END OF SHIFT		DRILLED FOR	

SAMPLING RECORD

LOGGED BY: GDM

SPLT NO	FROM	TO	SPLT BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown Clayey SILT, v. moist
				Saturated returns at 8.2'
2	10.0	11.0		Brown v. silty CLAY, wet
3	15.0	16.0		Brown silty CLAY, with gray mottles, saturated
4	20.0	21.0		Brown v. silty CLAY, saturated
5	25.0	26.0		Brown and gray sl. clay SILT, saturated
				Hard drilling at 28.0'
6	30.0	31.0		Greenish gray sandy CLAY, with small gravel
7	34.0	35.0		Greenish gray MARL

NOTES: (1) Monitoring Well #7 set in test boring at 29'
(2) Top of casing Elev. = 97.5' (msl)
Bottom of casing Elev. = 67.5' (msl)



MCI CONSULTING ENGINEERS
Nashville, Tennessee

MONITORING WELL No. 8
AS COMPLETED
VERTAC CHEMICAL CORP.
VICKSBURG, MS.
NO SCALE 12/2/83

MW-8

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters:
Nashville, Tennessee
Branch Offices:
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

SHIFT REPORT OF DRILLING OPERATIONS AT	VCC, Vicksburg, MS		SITE
HOLE LOCATION	See Site Sketch Map	SHIFT	DATE 3-2-83
SURFACE ELEVATION	108.6 (msl)	RIG NO.	HOLE NO 8
DEPTH AT BEGINNING OF SHIFT		TOP ROCK	
FOOTAGE FISHTAILED		BOTTOM OF HOLE	
FOOTAGE SAMPLED		DRILLER	C. Nelson - MBA
FOOTAGE CORED		HELPER	
DEPTH AT END OF SHIFT		DRILLED FOR	

SAMPLING RECORD

LOGGED BY: GDM

SPLT NO.	FROM	TO	SPLT BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown silty CLAY
2	10.0	11.0		Brown clayey SILT, with lt. brown mottles, moist
3	15.0	16.0		Brown clayey SILT
				Stratum change at 18.0' - by driller
4	20.0	21.0		Gray silty CLAY,with small roots, wet
5	25.0	26.0		Gray silty CLAY, saturated
				Water rising at 29.0'
6	30.0	31.0		Gray SILT, saturated
7	35.0	36.0		Gray SILT, saturated
				Hard drilling at 38.5'
8	39.0	40.0		Brownish orange MARL, hard
	40.0	49.5		Pushed split spoon refused at 49.5'

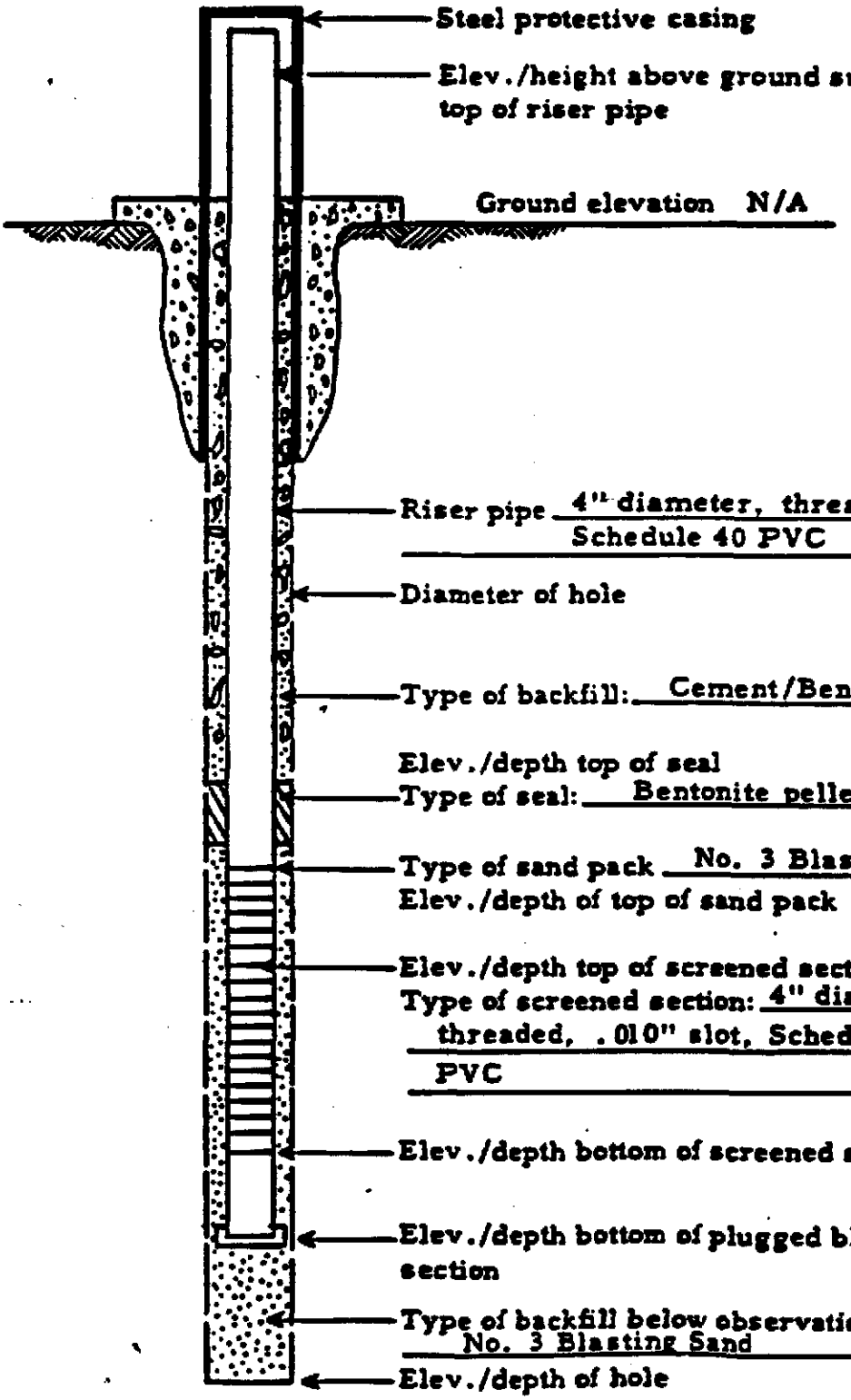
NOTES: (1) Monitoring Well #8 set in additional borings, 8' east of test boring, at 29' on 3-3-83
(2) Top of casing elev. = 109.7' (msl)
Bottom of casing elev. = 79.7' (msl)

GROUNDWATER OBSERVATION WELL REPORT

Project: Vertac Chemical Corporation

Location: Vicksburg, Mississippi

Well No.: MW-9 Date Completed: 10/9/85 Technician: J. Malanchak



Steel protective casing

Elev./height above ground surface top of riser pipe — Approx. 4 ft

Ground elevation N/A

Riser pipe: 4" diameter, threaded, Schedule 40 PVC

Diameter of hole — 8 in.

Type of backfill: Cement/Bentonite

Elev./depth top of seal — 36 ft

Type of seal: Bentonite pellets

Type of sand pack: No. 3 Blasting Sand

Elev./depth of top of sand pack — 39 ft

Elev./depth top of screened section — 43 ft

Type of screened section: 4" diameter, threaded, .010" slot, Schedule 40 PVC

Elev./depth bottom of screened section — 53 ft

Elev./depth bottom of plugged blank section — 58 ft

Type of backfill below observation pipe: No. 3 Blasting Sand

Elev./depth of hole — 58.5 ft

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg		
BORING NUMBER: MW-9	COORDINATES:		DATE:
ELEVATION: 116.02 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 10-9-85
ENGINEER/GEOLOGIST: L.W. Cronk	Depth	Date/Time	DATE COMPLETED: 10-9-85
DRILLING METHODS: Rotary Wash			PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
			Gravelly clay fill at surface			
5						
10	QT-1		Brown & Gray Silt			
15			Shell fragments @ 14'			
20			Becoming Gray Silt @ 19' w/occasional Shell Fragments			
25						
	QT-3		Gray Silt			

NOTES

MW-9

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg	
BORING NUMBER: MW-9	COORDINATES:	DATE:
ELEVATION: 116.02 Ft. MSL (TofC)	GWL: Depth / Date/Time	DATE STARTED: 10-9-85
ENGINEER/GEOLOGIST: L.W. Cronk	Depth / Date/Time	DATE COMPLETED: 10-9-85
DRILLING METHODS: Rotary Wash		PAGE 2 OF 2

DEPTH (FT.)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30						
35						
40			Becoming Brown & Gray Silt w/Numerous Shell Fragments @ 41'			
45	QT-5		Dark Gray Clayey Silt @ 43.5'		2.25	Penetrometer
50			Marl @ 52'			
55						

NOTES

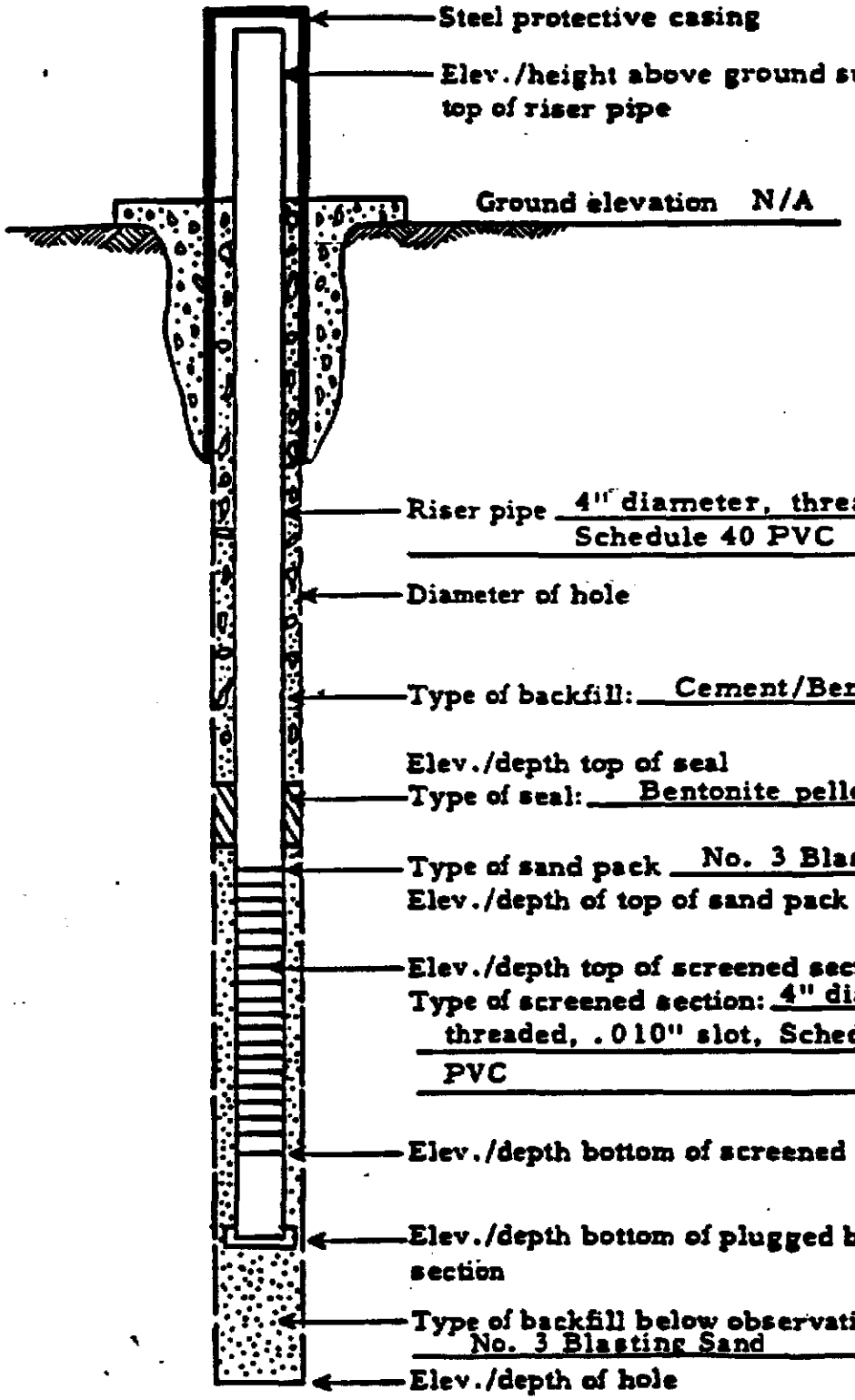
Completion Depth @ 58'

GROUNDWATER OBSERVATION WELL REPORT

Project Vertac Chemical Corporation

Location Vicksburg, Mississippi

Well No. MW-10 Date Completed 10/7/85 Technician J. Malanchak



Steel protective casing	
Elev./height above ground surface top of riser pipe	Approx. 2.5 ft
Ground elevation N/A	
Riser pipe 4" diameter, threaded, Schedule 40 PVC	
Diameter of hole	8 in.
Type of backfill: Cement/Bentonite	
Elev./depth top of seal	33 ft
Type of seal: Bentonite pellets	
Type of sand pack No. 3 Blasting Sand	
Elev./depth of top of sand pack	35 ft
Elev./depth top of screened section	40 ft
Type of screened section: 4" diameter, threaded, .010" slot, Schedule 40 PVC	
Elev./depth bottom of screened section	50 ft
Elev./depth bottom of plugged blank section	53 ft
Type of backfill below observation pipe No. 3 Blasting Sand	
Elev./depth of hole	53.5 ft

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg		
BORING NUMBER: MW-10	COORDINATES:		DATE:
ELEVATION: 114.73 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 10-7-85
ENGINEER/GEOLOGIST: G. M. Combs	Depth	Date/Time	DATE COMPLETED: 10-7-85
DRILLING METHODS: Rotary Wash			PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
			Clayey fill at surface			
5						
10	QT-1		Tan and Light Gray Slightly Clayey Silt		1.5 1.6	Penetrometer Torvane
15						
20			Becoming More Clayey @ 22'			
25						
	QT-3		Gray Silt w/Shell Fragments		1.75	Penetrometer

NOTES:

VISUAL CLASSIFICATION OF SOILS

CT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg	
G NUMBER: MW-10	COORDINATES:	DATE:
ELEVATION: 114.73 Ft. MSL (TofC)	GWL: Depth Date/Time	DATE STARTED: 10-7-85
ENGINEER/GEOLOGIST: G.M. Combs	Depth Date/Time	DATE COMPLETED: 10-7-85
DRILLING METHODS: Rotary Wash		PAGE 2 OF 2

DEPTH (FT.)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31						
35						
40	QT-5		Dark Gray Slightly Clayey Silt w/shell Fragments		1.0 0.43	Penetrometer Torvane
45						
50			Marl below 48.5 Clayey Sand Seam 48.5'-49.5' Gravel from 49.0' to 52.0'			
55						

NOTES:

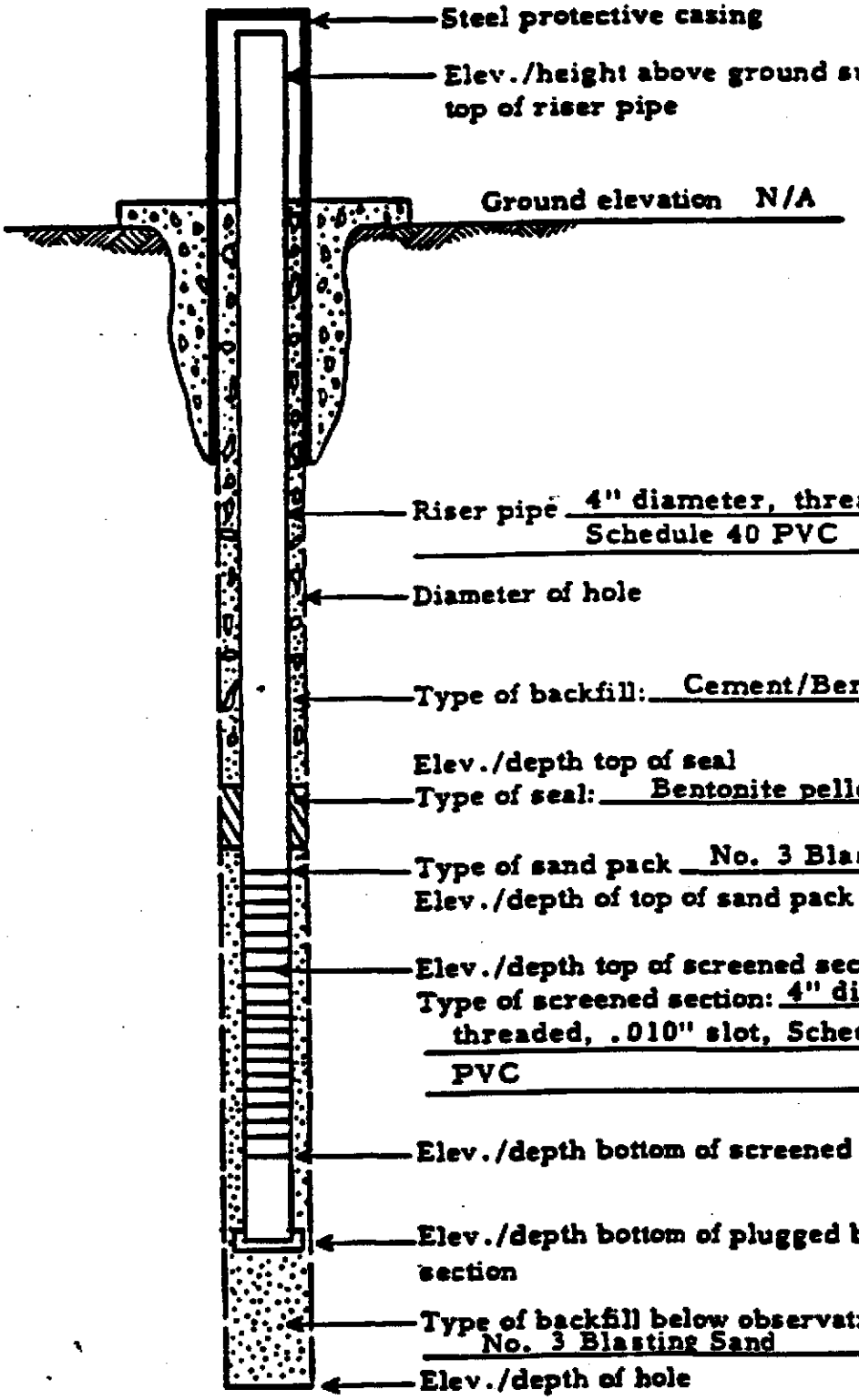
Completion Depth 52.0'

GROUNDWATER OBSERVATION WELL REPORT

Project: Vertac Chemical Corporation

Location: Vicksburg, Mississippi

Well No.: MW-11 Date Completed: 10/8/85 Technician: J. Malanchak



Steel protective casing

Elev./height above ground surface top of riser pipe — Approx. 4.5 ft

Ground elevation N/A

Riser pipe: 4" diameter, threaded, Schedule 40 PVC

Diameter of hole — 8 in.

Type of backfill: Cement/Bentonite

Elev./depth top of seal — 29 ft

Type of seal: Bentonite pellets

Type of sand pack: No. 3 Blasting Sand

Elev./depth of top of sand pack — 33 ft

Elev./depth top of screened section — 35 ft

Type of screened section: 4" diameter, threaded, .010" slot, Schedule 40 PVC

Elev./depth bottom of screened section — 45 ft

Elev./depth bottom of plugged blank section — 48 ft

Type of backfill below observation pipe: No. 3 Blasting Sand

Elev./depth of hole — 48.5 ft

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg	
BORING NUMBER: MW-11	COORDINATES:	DATE:
ELEVATION: 105.62 Ft. MSL (TofC)	GWL: Depth / Date/Time	DATE STARTED: 10-8-85
ENGINEER/GEOLOGIST: L.W. Cronk	Depth / Date/Time	DATE COMPLETED: 10-8-85
DRILLING METHODS: Rotary Wash		PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
			Dark Gray Clayey Silt to 5.0			
5	QT-1		Dark Gray Silt @ 5.0			
10						
15						
20						
25						
	QT-3		Tan & Gray Silt @ 29.5'		2.5	Penetrometer

NOTES.

MW-11

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg	
BORING NUMBER: MW-11	COORDINATES:	DATE:
ELEVATION: 105.62 Ft. MSL (TofC)	GWL: Depth Date/Time	DATE STARTED: 10-8-85
ENGINEER/GEOLOGIST: L.W. Cronk	Depth Date/Time	DATE COMPLETED: 10-8-85
DRILLING METHODS: Rotary Wash		PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30						
35			Gray & Tan Sandy Clay @ 43.0' - 44.0'			
40						
45	QT-5		Gray and Tan Clay @ 44.0' to 51.0'		2.5	Penetrometer
50			Marl @ 51'			
55						

NOTES:

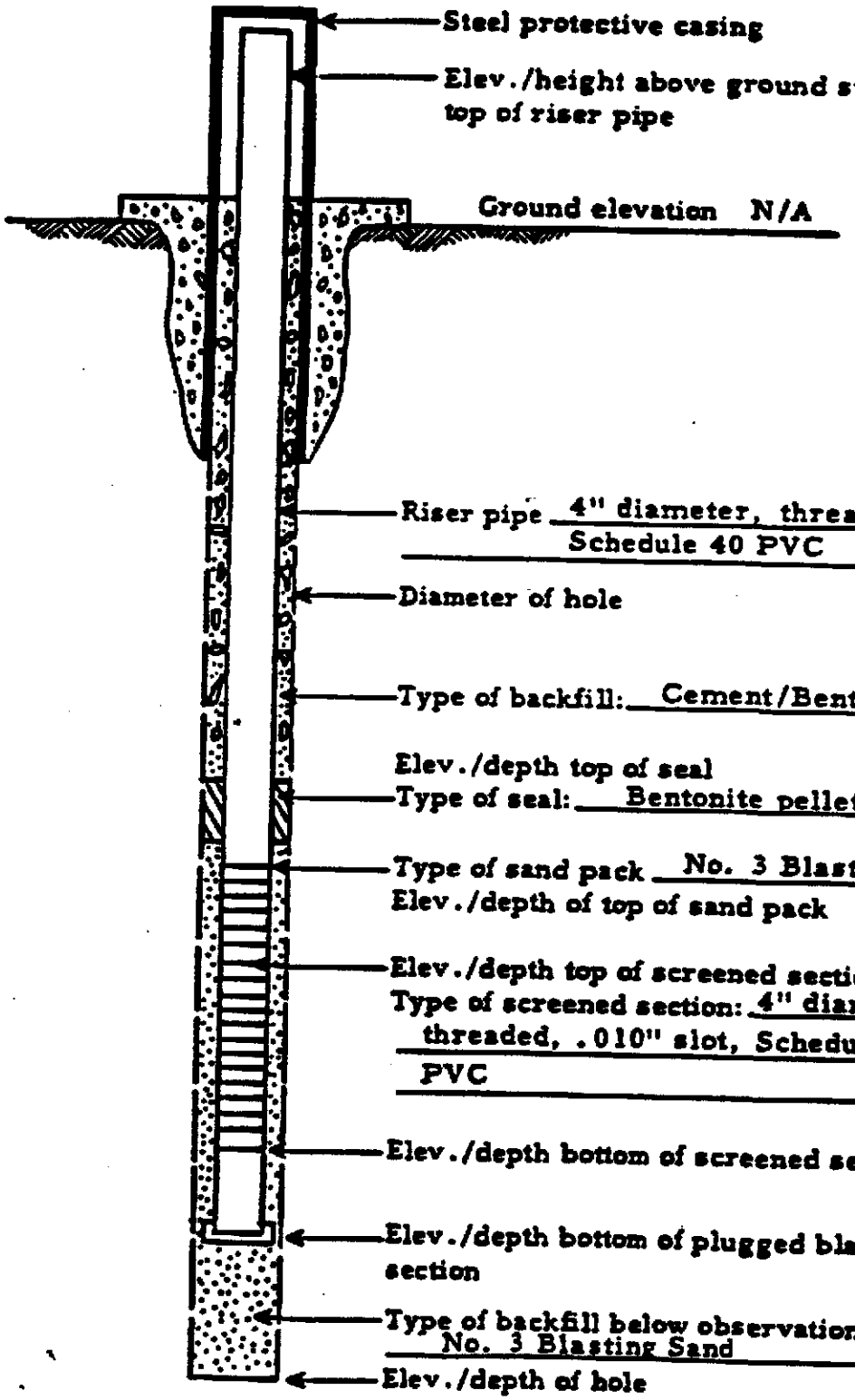
Completion Depth 56'

GROUNDWATER OBSERVATION WELL REPORT

Project Vertac Chemical Corporation

Location Vicksburg, Mississippi

Well No. MW-12 Date Completed 10/8/85 Technician J. Malanchak



Steel protective casing

Elev./height above ground surface top of riser pipe — Approx. 3 ft

Ground elevation N/A

Riser pipe 4" diameter, threaded, Schedule 40 PVC

Diameter of hole — 7 in.

Type of backfill: Cement/Bentonite

Elev./depth top of seal — 20 ft

Type of seal: Bentonite pellets

Type of sand pack No. 3 Blasting Sand

Elev./depth of top of sand pack — 26 ft

Elev./depth top of screened section — 32 ft

Type of screened section: 4" diameter, threaded, .010" slot, Schedule 40 PVC

Elev./depth bottom of screened section — 42 ft

Elev./depth bottom of plugged blank section — 47.5 ft

Type of backfill below observation pipe No. 3 Blasting Sand

Elev./depth of hole — 48 ft

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg		
BORING NUMBER: MW-12	COORDINATES:		DATE:
ELEVATION: 112.06 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 10-8-85
ENGINEER/GEOLOGIST: G.M. Combs	Depth	Date/Time	DATE COMPLETED: 10-8-85
DRILLING METHODS: Rotary Wash			PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
			Fill Material to 4'			
5			Tan Silt (Slightly Clayey) @ 4'			
10			Tan Silt		1.25	Penetrometer
15						
20						
25	QT-3		Becoming Gray & Tan Silt @ 27'		1.1	Penetrometer

NOTES:

MW-12

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg	
BORING NUMBER: MW-12	COORDINATES:	DATE:
ELEVATION: 112.06 Ft. MSL (TofC)	GWL: Depth Date/Time	DATE STARTED: 10-8-85
ENGINEER/GEOLOGIST: G.M. Combs	Depth Date/Time	DATE COMPLETED: 10-8-85
DRILLING METHODS: Rotary Wash		PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30			--			
35						
40			Shell Fragments @ 40'			
45	QT-5		Gray Clayey Sand w/Sand Pkts and Gravel 44'-46' Beginning of Marl @ 46'		1.24	Penetrometer
50						
55						

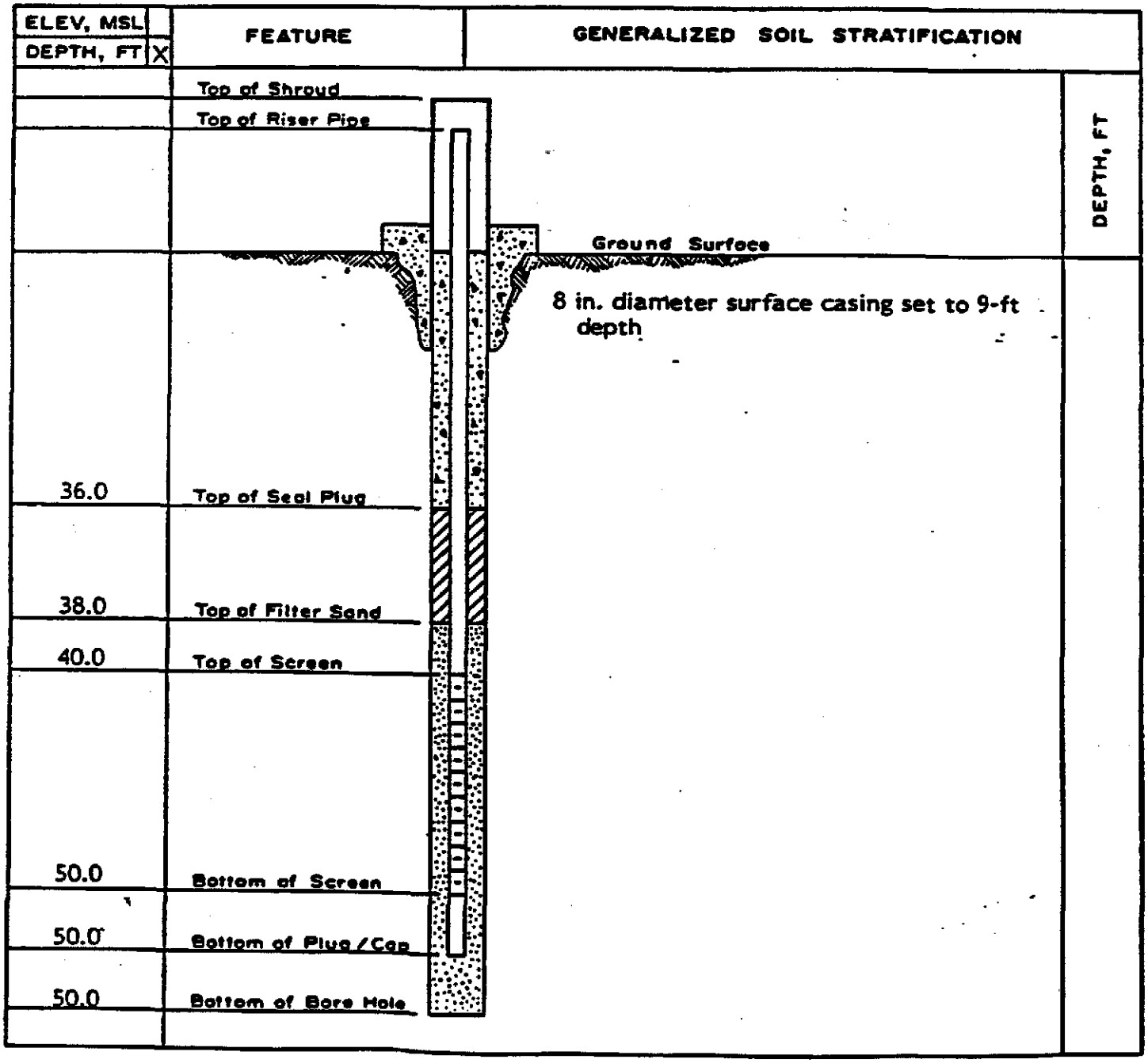
NOTES:

Completion Depth @ 48.5'

LOG OF GROUNDWATER OBSERVATION WELL

Project & Location: Vertac Chemical Corporation, Vicksburg, Mississippi
Client: Vertac Chemical Corporation Date of Report: _____

Observation Well No. MW-13 Date Completed 12/3/86 Technician J. Malanchak
Riser Pipe: Material Sch 40 PVC Diameter 4 in. Type of Joints Threaded
Screen: Material Sch 40 PVC Slot Size .010" Diameter 4 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 blasting sand
Method of Placement of Filter Material Tremie
Type of Seal Above Screen Bentonite pellets Backfill Above Seal Cement/bent. grout
Drilling Mud was used. Fresh Water Flush Before Setting Well Screen No
Well Developed by _____ Development Time _____ hrs
Groundwater Level @ 2 hrs _____ @ 24 hrs _____ Other _____



IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 435130	PROJECT NAME: Cedar Chemical		
BORING NUMBER: MW-13	COORDINATES:		DATE: 12-1-86
ELEVATION:	GWL: Depth 8.5 Date/Time 12-1-86		DATE STARTED: 12-1-86
ENGINEER/GEOLOGIST: HES	Depth 2.0 Date/Time 12-3-86		DATE COMPLETED: 12-3-86
DRILLING METHODS: Dry Auger to 8.5', Wet Rotary to 50.0			PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (FT)	RECOVERY (FT)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				Brown Clayey Silt with Roots			No Odor
5	ST-1		2.0	Brown Silty Clay with Ferrous Nodules Below 4.0'		1.0	No Odor
				Light Brown Clayey Sand			
10	ST-2		2.0	Brown & Light Brown Silty Sand -With Clay Pockets Below 10.0' -Reddish Brown Below 19.0'			
15	ST-3		2.0				No Odor
20	ST-4		2.0				
25	ST-5		2.0	Bluish Gray Clay with Slickensides -Greenish Gray with Red Streaks Below 28.0'		3.5	
	ST-6		2.0			3.5	No Odor

NOTES:

IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 435130	PROJECT NAME: Cedar Chemical		
BORING NUMBER: MW-13	COORDINATES:	DATE: 12-1-86	
ELEVATION:	GWL: Depth 8.5 Date/Time 12-1-86	DATE STARTED: 12-1-86	
ENGINEER/GEOLOGIST: HES	Depth 2.0 Date/Time 12-3-86	DATE COMPLETED: 12-3-86	
DRILLING METHODS: Dry Auger to 8.5', Wet Rotary to 50.0		PAGE 2 OF 2	

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (FT)	RECOVERY (FT)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				Blueish Gray Clay with Slickensides -with Sand Pockets 28.0 to 33.0'			No Odor
35	ST-7		2.0	Light Brown & Greenish Gray Silty Sand with Silt Pockets & Seams		2.5	No Odor
	ST-8		2.0	Greenish Gray Silty Clay with Sand Seams & Partings		2.0	
40	ST-9		2.0			3.5	No Odor
	ST-10		2.0			3.5	
45	ST-11		2.0			3.5	
	ST-12		2.0	Greenish Gray & Gray Sandy Clay with Silt Partings & Pockets		4.0	No Odor
50							

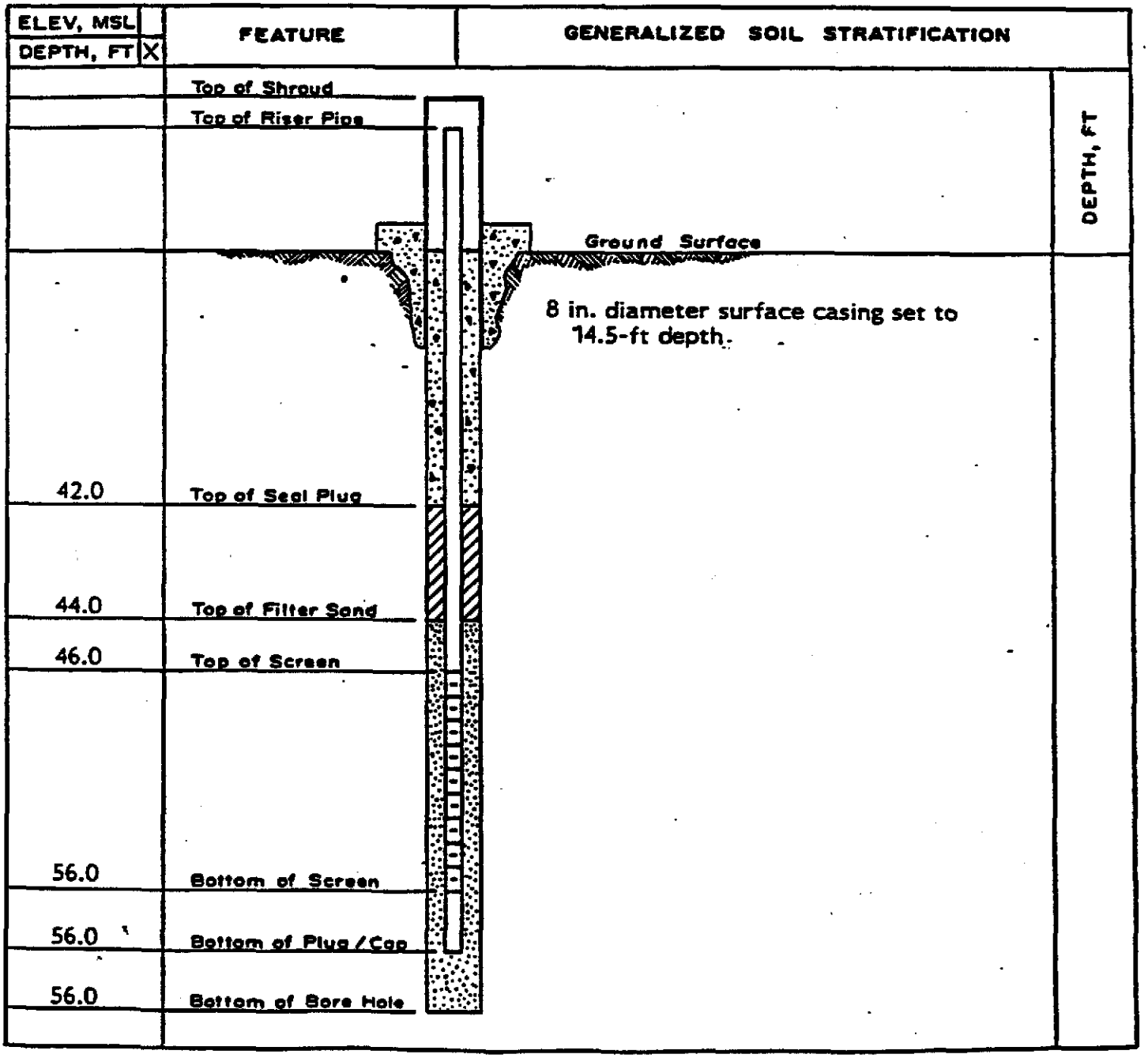
NOTES:

Bottom of Boring - 48.0'
Bottom of Well - 50.0'

LOG OF GROUNDWATER OBSERVATION WELL

Project & Location Vertac Chemical Corporation, Vicksburg, Mississippi
Client Vertac Chemical Corporation Date of Report

Observation Well No. MW-14 Date Completed 12/4/86 Technician J. Malanchak
Riser Pipe: Material Sch 40 PVC Diameter 4 in. Type of Joints Threaded
Screen: Material Sch 40 PVC Slot Size .010" Diameter 4 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 blasting sand
Method of Placement of Filter Material Tremie
Type of Seal Above Screen Bentonite pellets Backfill Above Seal Cement/bent. grout
Drilling Mud was used. Fresh Water Flush Before Setting Well Screen Yes
Well Developed by Development Time hrs
Groundwater Level @ 2 hrs @ 24 hrs Other



MW-14

IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 435130	PROJECT NAME: Cedar Chemical		
BORING NUMBER: MW-14	COORDINATES:	DATE: 12-1-86	
ELEVATION:	GWL: Depth 13.0 Date/Time 12-1-86	DATE STARTED: 12-1-86	
ENGINEER/GEOLOGIST: HES	Depth 9'8" Date/Time 12-3-86	DATE COMPLETED: 12-4-86	
DRILLING METHODS: Dry Auger to 13.0'. Wet Rotary to 56.0		PAGE 1 OF 2	

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (')	RECOVERY (FT)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
5	ST-1		1.5	Brown Clayey Silt with Sand Partings & Silt Seams -Bluish Gray Below 9.0' -with Sand Seams Below 9.5' -with Wood Fragments & Roots Below 18.0'		2.0	
10	ST-2		1.5			4.5	No Odor
15	ST-3		1.5			2.0	
20	ST-4		1.5			2.0	
25	ST-5		2.0	Greenish Gray Silty Clay with Silty Fine Sand -with Silt Partings Below 28.0'		0.5	
	ST-6		2/0			0.5	No Odor

NOTES:

IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 435130	PROJECT NAME: Cedar Chemical		
BORING NUMBER: MW-14	COORDINATES:	DATE: 12-1-86	
ELEVATION:	GWL: Depth 13.0 Date/Time 12-1-86	DATE STARTED: 12-1-86	
ENGINEER/GEOLOGIST: HES	Depth 9'8" Date/Time 12-3-86	DATE COMPLETED: 12-4-86	
DRILLING METHODS: Dry Auger to 13.0', Wet Rotary to 56.0'		PAGE 2 OF 2	

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (-)	RECOVERY (FT)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				-with Shell from 33.0' to 40.0'			No Odor
	ST-7		2.0			0.5	
35				Greenish Gray Clayey Silt with Silty Fine Sand -with Calcareous Nodules Below 43.0'			
	ST-8		2.0			0.5	
40							
	ST-9		2.0			2.0	No Odor
45	ST-10		2.0			2.0	
	ST-11		2.0			4.0	
50	ST-12		2.0			4.0	
				Greenish Gray Sandy Clay with Silt Pockets			
	ST-13		1.5			4.0	
55							

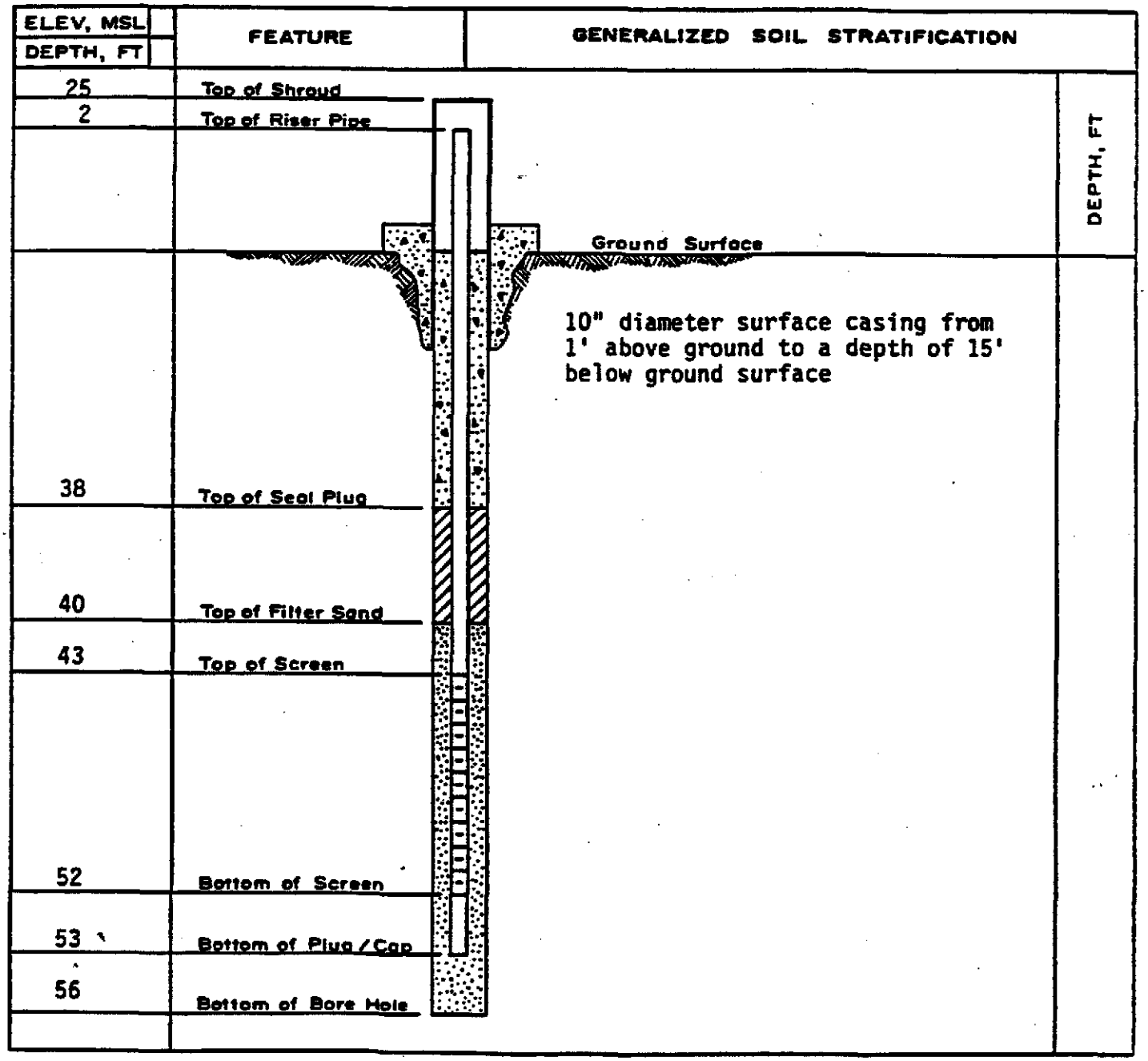
NOTES:

Bottom of Boring - 55.0'
Bottom of Well - 56.0'

LOG OF GROUNDWATER OBSERVATION WELL

Project & Location Vicksburg Chemical Vicksburg, Mississippi
Client Vicksburg Chemical Date of Report 7/15/88

Observation Well No. 16 Date Completed 7/16/88 Technician J. Malanchak
Riser Pipe: Material PVC Diameter 4 in. Type of Joints thread
Screen: Material PVC Slot Size .010" Diameter 4 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 blasing sand
Method of Placement of Filter Material 1¼" PVC tremie pipe
Type of Seal Above Screen bentonite pellets Backfill Above Seal cement/bentonite
Drilling Mud _____ used. Fresh Water Flush Before Setting Well Screen yes
Well Developed by air lift Development Time 1½ hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs _____ Other _____



LOG OF BORING NO. MW-16
VICKSBURG CHEMICAL
VICKSBURG, MISSISSIPPI

TYPE: Rotary wash & Shelby tube

LOCATION: See Plate 1

DEPTH, FT.	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT LB/CU FT	COHESION, KIPS/SQ FT (1, 2, 3, 4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (20, 40, 60, 80)	ELEVATION, FT
			Meduim dense tan silt				
10			Loose tan clayey silt -brown clayey silt, occasional wood below 12'				
15			Firm tan silty clay -stiff below 17'				
20							
25			Very stiff gray clay				
30			Medium dense tan clayey silt, with silty fine sand seams				
35			Stiff gray clay -light grayish green clay below 37'				
40							
50			Medium dense green silty fine sand w/shell fragments				
60			Hard light grayish green silty clay, w/shell fragments and occasional lithified ledges				

No Scale Change

COMPLETION DEPTH: 56 ft
DATE: 7/5/88

DEPTH TO WATER IN BORING: 7.4 ft after 20 min.
DATE: 7/5/88

NARE LIND FURLOW ENGINEERS

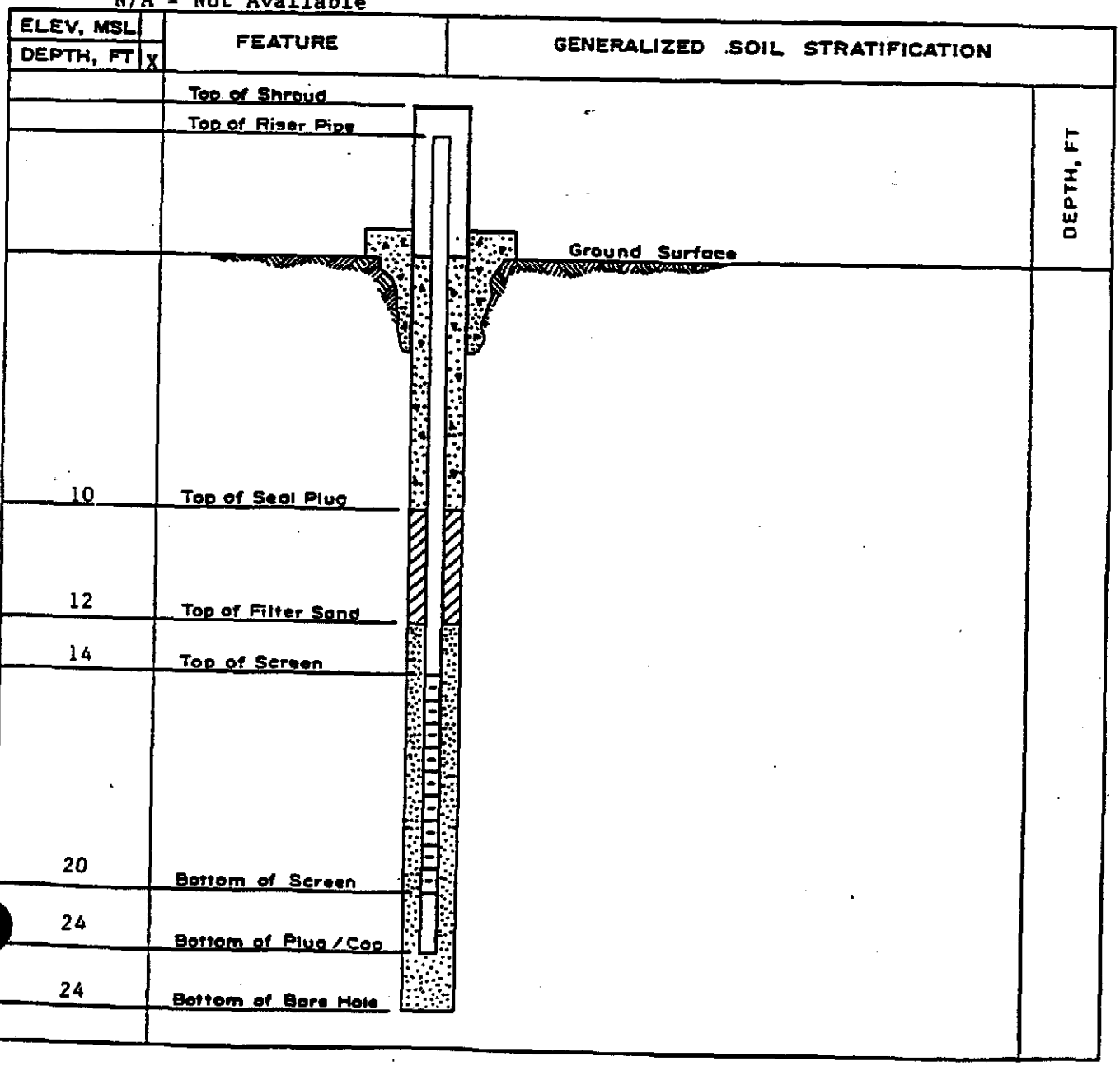
STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report

Observation Well No. 19B Date Completed 11/2/93 Technician B. Till
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs Other N/A

*N/A = Not Available



PZ-19B

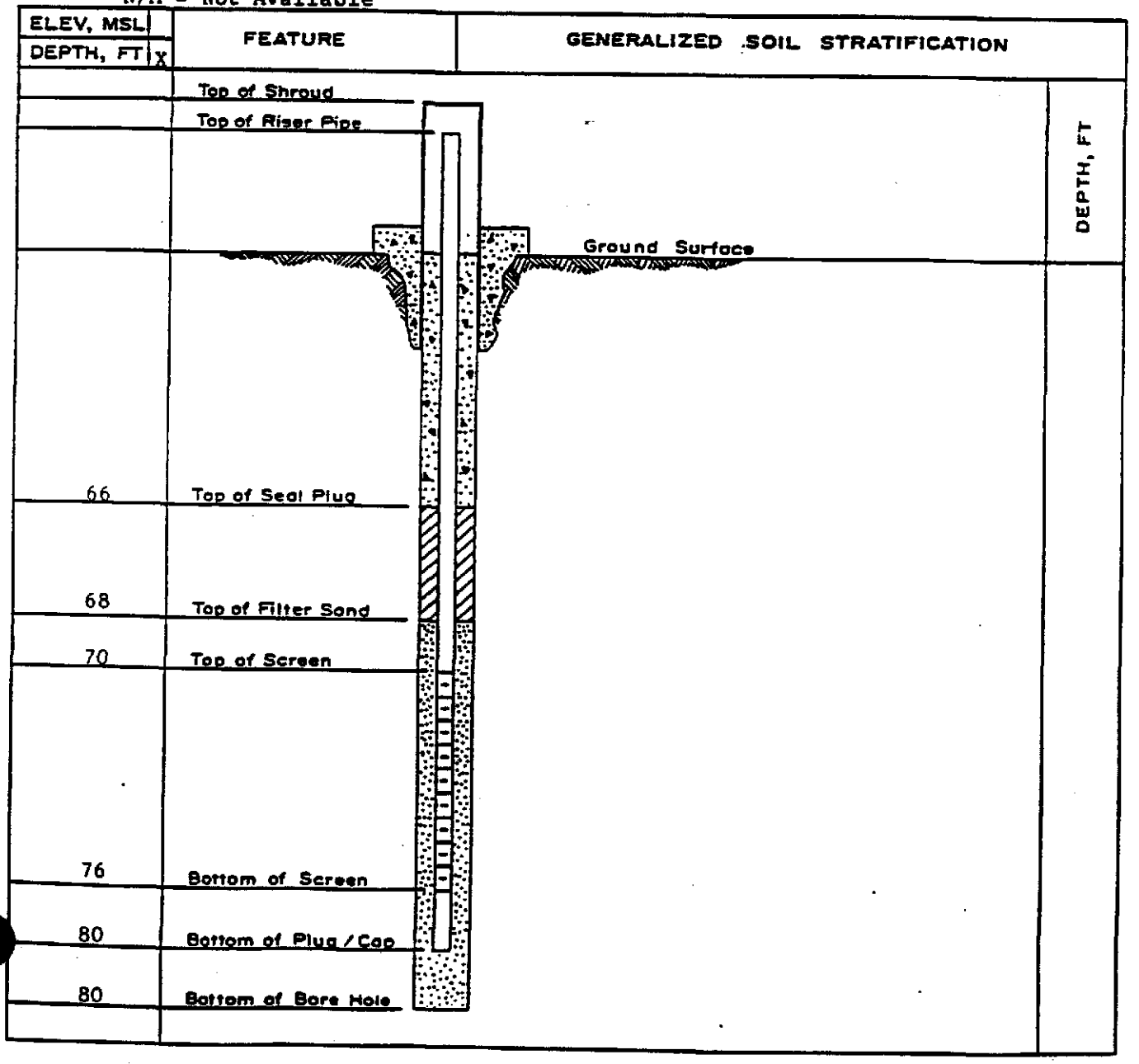
STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 11/2/93

Observation Well No. 19A Date Completed 11/2/93 Technician B. Till
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs _____ Other N/A

*N/A = Not Available



PZ-19A

LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-19A
FILE: 92B007C-4001
DATE: 11/1/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 1 of 2

Hollow-stem Augered: Full Depth

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
0		3.0		12	Stiff tan Silty CLAYS (CL)
		1.5		18	—medium, 2'- 4'
5		>4.0		18	Very stiff tan Clayey SILTS / Silty CLAYS (ML/CL)
		0.75			—soft below 5'
		0.75		24	Soft tan and light gray Clayey SILTS, damp to wet (ML)
		2.25		24	—stiff, 8'- 9'
		<0.25			—very soft, 9'- 10'
10		1.00		24	—tan below 9'
					—wet, 9'- 16'
		1.25		24	—firm to dense below 10'
					—with ferrous streaks, 10'- 14'
					—with white specks, 12'- 16'
		1.75		24	—with a trace of organics, 14'- 16'
15		1.25		24	—damp, 16'- 24'
		1.25		18	
20		1.25		24	—with a trace of shell fragments, 20'- 24'
		1.25		24	
		1.50		18	—less clayey below 24'
25		1.50		24	
		2.25			Stiff gray Clayey SILTS / Silty CLAYS (ML/CL)
		2.50		16	*Stiff light gray Silty CLAYS with silt pockets and ferrous streaks* (CL)
30					
		1.75		24	Stiff light gray CLAYS (CH)
35					—with silt seams and calcareous nodules, slickensides, 33'- 35'
		1.75		24	—with silt and ferrous stains, organics, 38'- 40'
40					

Continued Next Page

Unified Soil Classifications based on visual observations.

LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-19A
FILE: 92B007C-4001
DATE: 11/1/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 2 of 2

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
40					Stiff light gray CLAYS with silt seams and ferrous stains, organics (CH)
		1.75		24	—tan and light gray, slickensides, 43'- 45'
45					—with ferrous stains, 43'- 50'
		2.75		24	—with white vertical streaks, 48'- 50'
50					
		2.5		24	—gray, slickensides, 53'- 55'
55					
		2.25		24	Dense light gray SANDS (SP)
60					—with traces of silt and clay below 59.5'
					—with wood and alternating layers of clay and sandy clay below 60'
65					
70					
75					

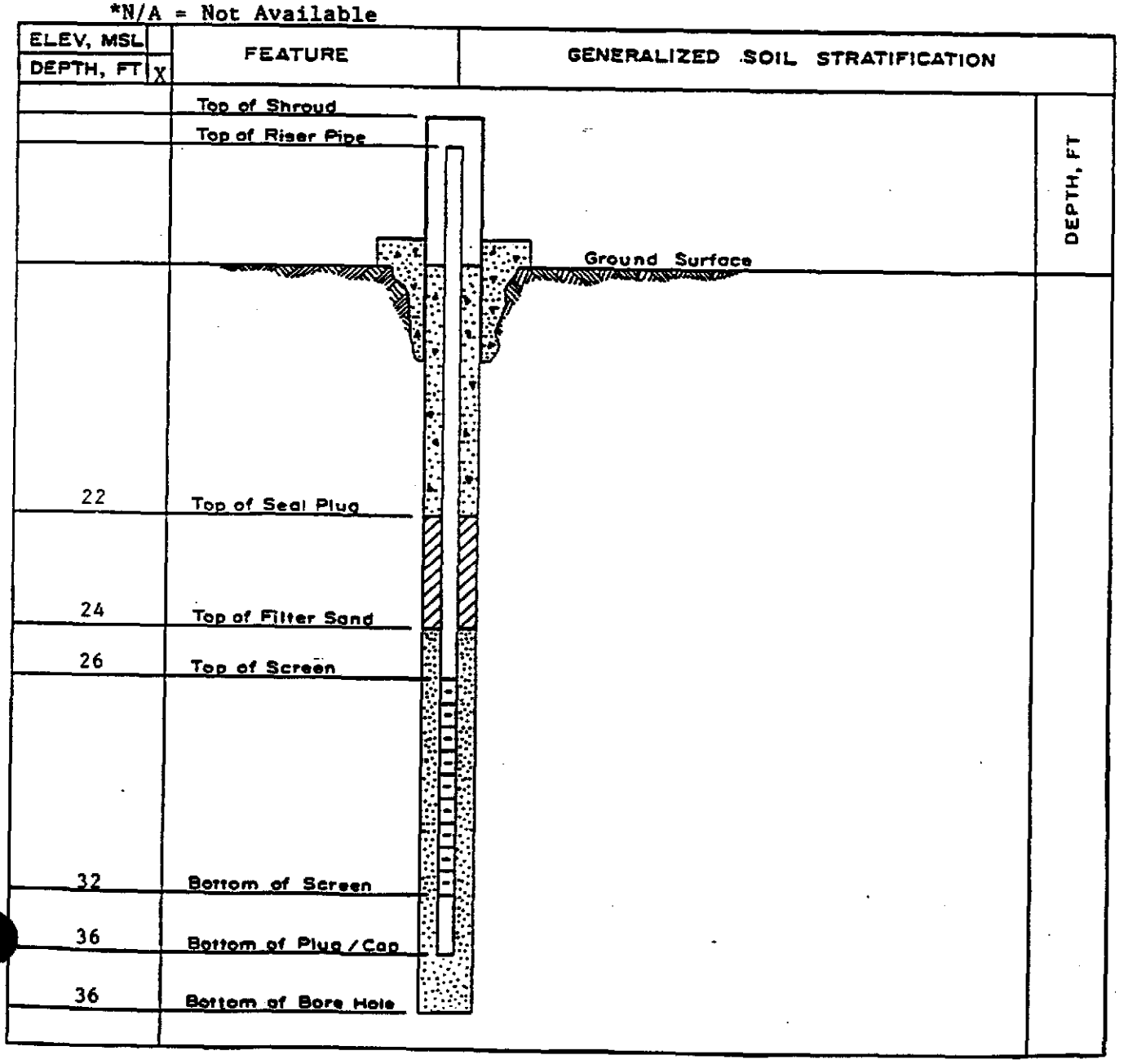
Bottom of boring at 79'.
Borehole grouted full depth.

Unified Soil Classifications based on visual observations.

STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 11/10/93
Observation Well No. 12 26B Date Completed 11/10/93 Technician M. Biglane
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs _____ Other N/A
*N/A = Not Available



LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-12B(R)
FILE: 92B007C-4001
DATE: 11/10/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 1 of 1

Hollow-stem Augered: Full Depth

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
0					Augered down to 12' B.L.S.
10		NR			Firm tan Clayey SILTS, wet (ML)
15		1.00		14	—with a trace of organics and white specks, 14'- 16'
		0.75		24	—tan and light gray below 16'
		0.50		24	—with a trace of rootlets, 18'- 20'
20		0.50		24	—with a trace of organics below 20'
		1.25		16	—firm to dense, with a trace of ferrous nodules, 22'- 26'
25		1.50		20	—damp, 24'- 28' —light gray below 25'
		2.00		24	—dense, 26'- 28'
		<0.25		14	—loose to firm, 28'- 30' —wet below 28'
30		0.25		24	—firm, 30'- 32'
		2.25		20	—dense below 32' —with a trace of organics and shell fragments, 32'- 34'
35		3.50		14	Dense to stiff light gray Clayey SILTS / Silty CLAYS (ML/CL)
					Bottom of boring at 36'. Boreholes grouted full depth. Set piezometer with screen interval at 26'- 36' BLS.

NR = No Recovery

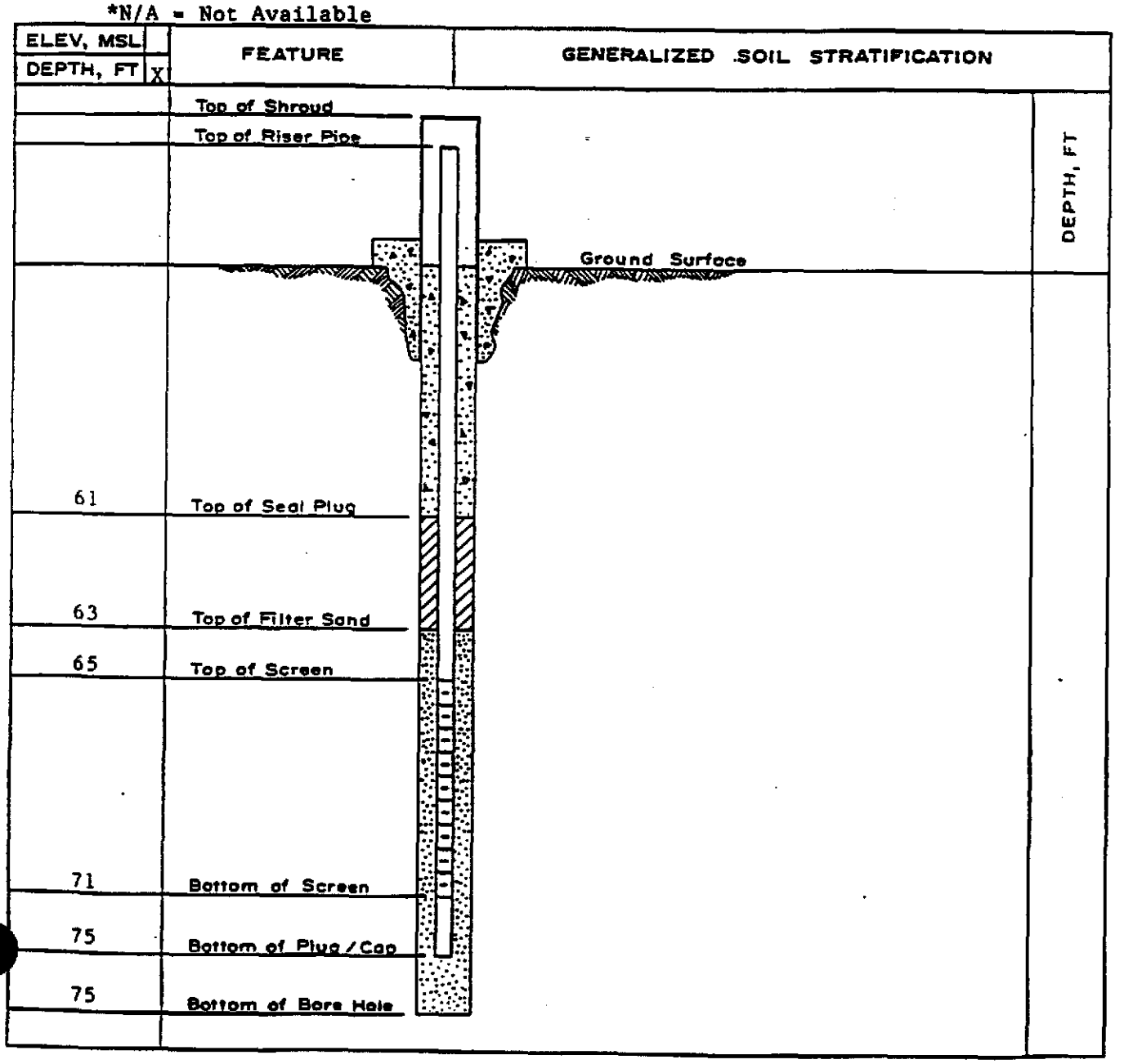
Unified Soil Classifications based on visual observations.

STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 11/11/93
Observation Well No. 26A (12) Date Completed 11/11/93 Technician M. Biglane
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs ____ Other N/A

*N/A = Not Available



PZ-12(R)A

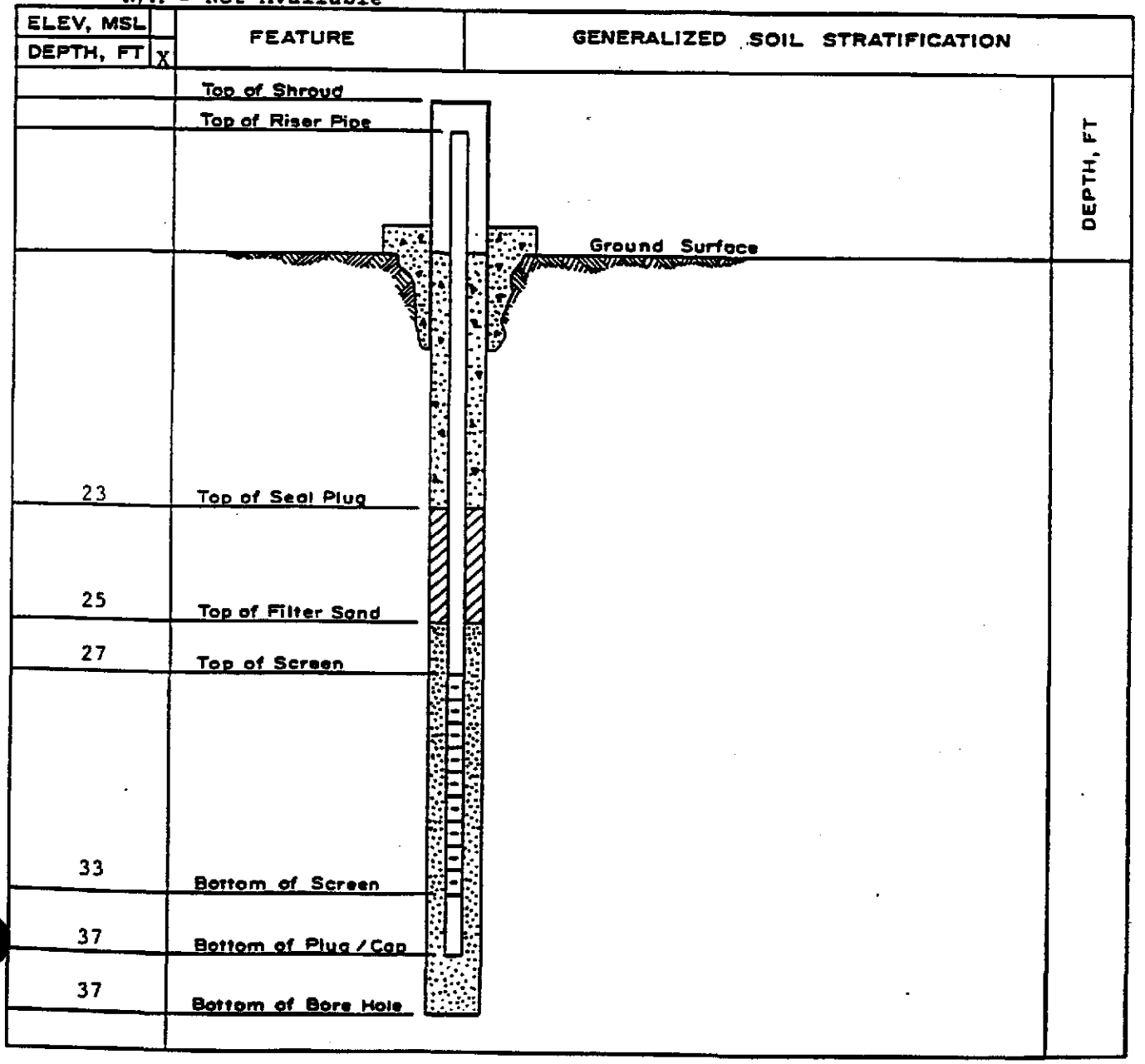
STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 10/28/93

Observation Well No. 20B Date Completed 10/28/93 Technician R. Sanders
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs _____ Other N/A

*N/A = Not Available



PZ-20B

LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-20B
FILE: 92B007C-4001
DATE: 10/28/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 1 of 1

Hollow-stem Augered: Full Depth

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
0					Medium tan SILTS with white streaks (ML)
15				9	
35		1.25		24	Medium CLAYEY SILTS with little moisture (ML)
		1.25		24	Medium light gray fine SILTS (ML)

Bottom of boring at 39'.
Borehole grouted full depth.

Unified Soil Classifications based on visual observations.

DEC 13 93 ENVIR84 28007

Woodward-Clyde Consultants

PZ-20B

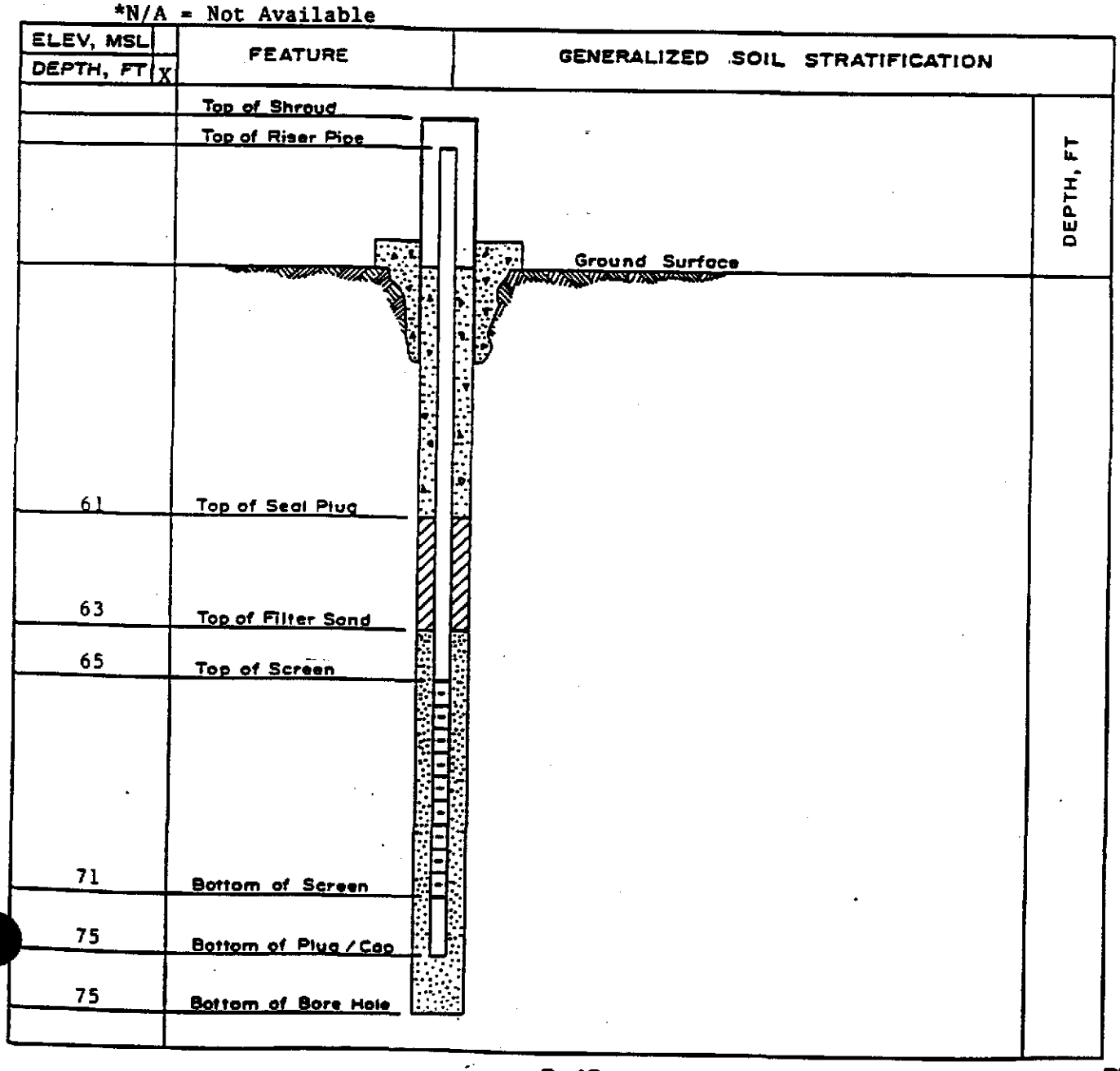
STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 10/28/93

Observation Well No. 20A Date Completed 10/28/93 Technician R. Sanders
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs Other N/A

*N/A = Not Available



PZ-20A

LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-20A
FILE: 92B007C-4001
DATE: 10/26/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 1 of 2

Hollow-stem Augered: Full Depth

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)				Description of Stratum
0		4.5		6				Stiff tan and light gray Silty CLAYS (CL)
		–		2				
5		0.75		12				—soft, 4'- 8'
		1.75		12				—medium, tan, 8'- 10'
		>4.5		14				
10		>4.5		0				Soft, brown and tan Silty CLAYS / Clayey SILTS (CL/ML)
		1.50PT 0.25PB		24				
15		>0.25		24				—firm, with ferrous nodules below 16'
		1.25PT 0.75PB		24				
20								—becomes medium to stiff at 20' —brown, 20'- 21' —soft, 21'- 22'
				24				—tan below 21' —firm to dense, 22'- 33'
25				24				
				24				—with shell fragments and traces of ferrous nodules below 26'
30				6				
				12				Medium to dense, light gray and tan Clayey SILTS (ML)
35								
		2.5		24				Stiff light gray Silty CLAYS with silt pockets (CL)
40								

Continued Next Page

Unified Soil Classifications based on visual observations.

LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-20A
FILE: 92B007C-4001
DATE: 10/26/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 2 of 2

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
40					Stiff light gray Silty CLAYS with silt pockets (CL)
		3.75		24	
45					—with shells and sandy clay at 45'
		2.25		24	—slickensided, with ferrous stains and silt pockets, 48'- 50'
50					
		1.75		24	—with more silt below 53'
55					
		–		24	—with a layer of medium light gray silty sand at 58'
60					
		–		18	—medium, with organics, becoming more clayey, 63'- 65'
65					
		NR			Firm to dense gray medium to coarse SANDS with a trace of gravel and clay (SP)
70					
				24	Alternating layers of CLAYS and Clayey SILTS with shells (CH/ML)
75					Bottom of boring at 75'. Borehole grouted full depth.

Unified Soil Classifications based on visual observations.

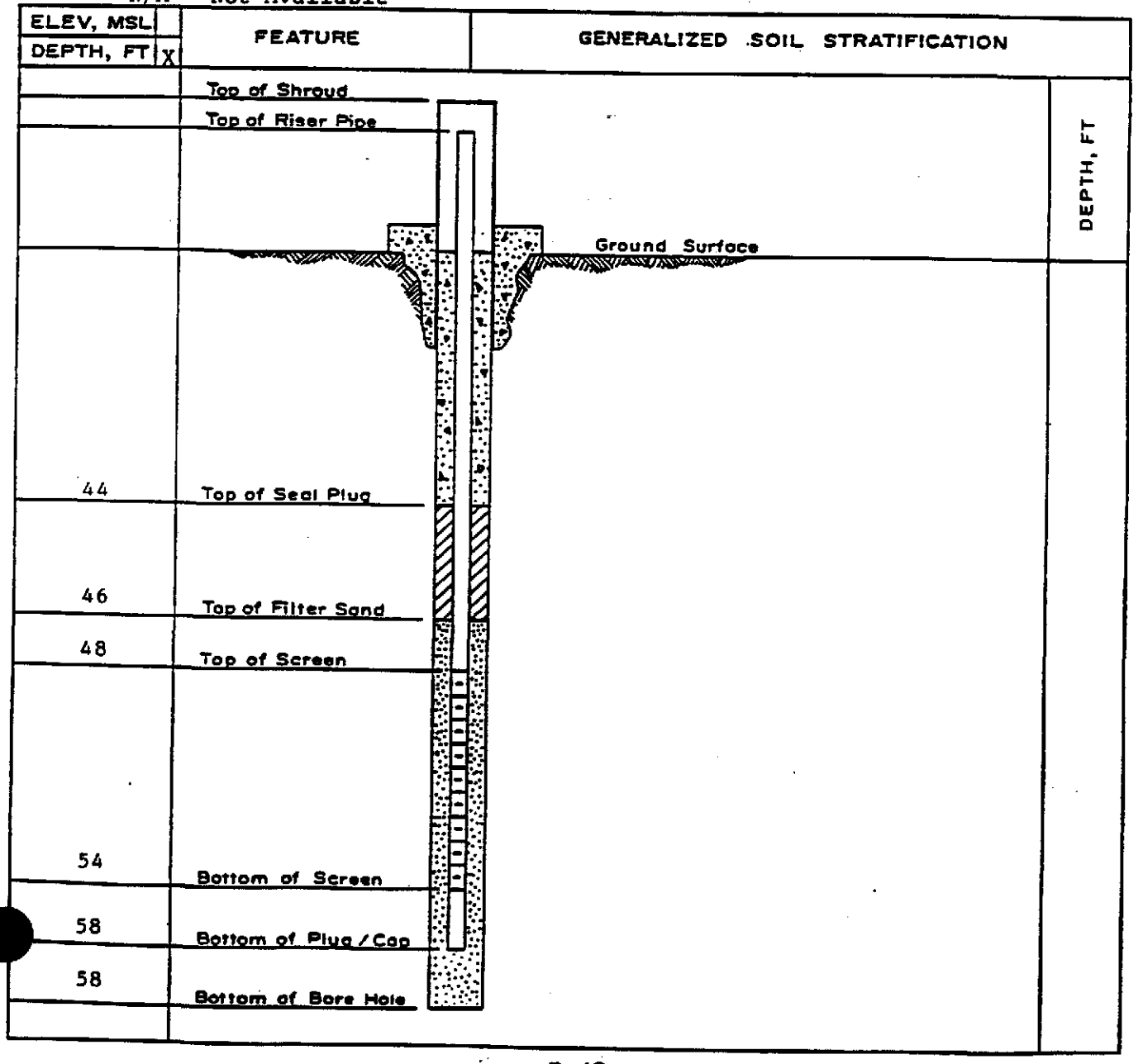
STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 11/5/93

Observation Well No. 21A Date Completed 11/5/93 Technician M. Biglane
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs _____ Other N/A

*N/A = Not Available



PZ-21A

LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-21A
FILE: 92B007C-4001
DATE: 11/3/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 1 of 2

Hollow-stem Augered: Full Depth

Free water was encountered at a depth of 33' during hollow stem augering. The water level rose to depths of 33.1' and 32.9' after observation periods of 10 and 15 minutes, respectively.

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
0					CLAYS, shell and gravel (FILL)
5		>4.0		24	Very dense tan Clayey SILTS (ML)
		2.5			
		2.0		24	—becoming firm to dense at 5.75'
		2.5			—with a trace of ferrous stains below 6'
		2.25		24	Stiff light gray and tan Silty CLAYS (CL)
10		1.5		24	—with a trace of organics and ferrous stains, 8'- 15.5'
					—medium below 10'
		1.75		24	
15		1.75		24	
		2.5		24	—stiff, gray below 15.5'
					—with rootlets, 15.5'- 18'
					—with silt pockets below 16'
		2.5		24	—with ferrous stains, 16'- 26'
20		2.25		24	
		2.25		24	
25		1.75		24	
		–		24	—with white vertical seams and streaks, 25'- 26'
		3.0		24	—light gray and tan, 28'- 30'
30					
		2.25		24	Alternating layers of stiff gray Silty CLAYS and firm to dense light gray Clayey SANDS (CL/SC)
35					
		–		24	—with a layer of wood at 39.5'
40					

Continued Next Page

Unified Soil Classifications based on visual observations.

LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-21A
FILE: 92B007C-4001
DATE: 11/3/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 2 of 2

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
40					Alternating layers of stiff gray Silty CLAYS and firm to dense light gray Clayey SANDS (CL/SC)
45		–		22	Firm to dense light gray medium to coarse SANDS becoming stiff light gray Silty Sandy CLAYS (SP/CL)
50		0.50		24	—soft, gray below 48'
55		NR			
		NR			Bottom of boring at 58.5'. Borehole grouted full depth. Piezometer installed in borehole.

Unified Soil Classifications based on visual observations.

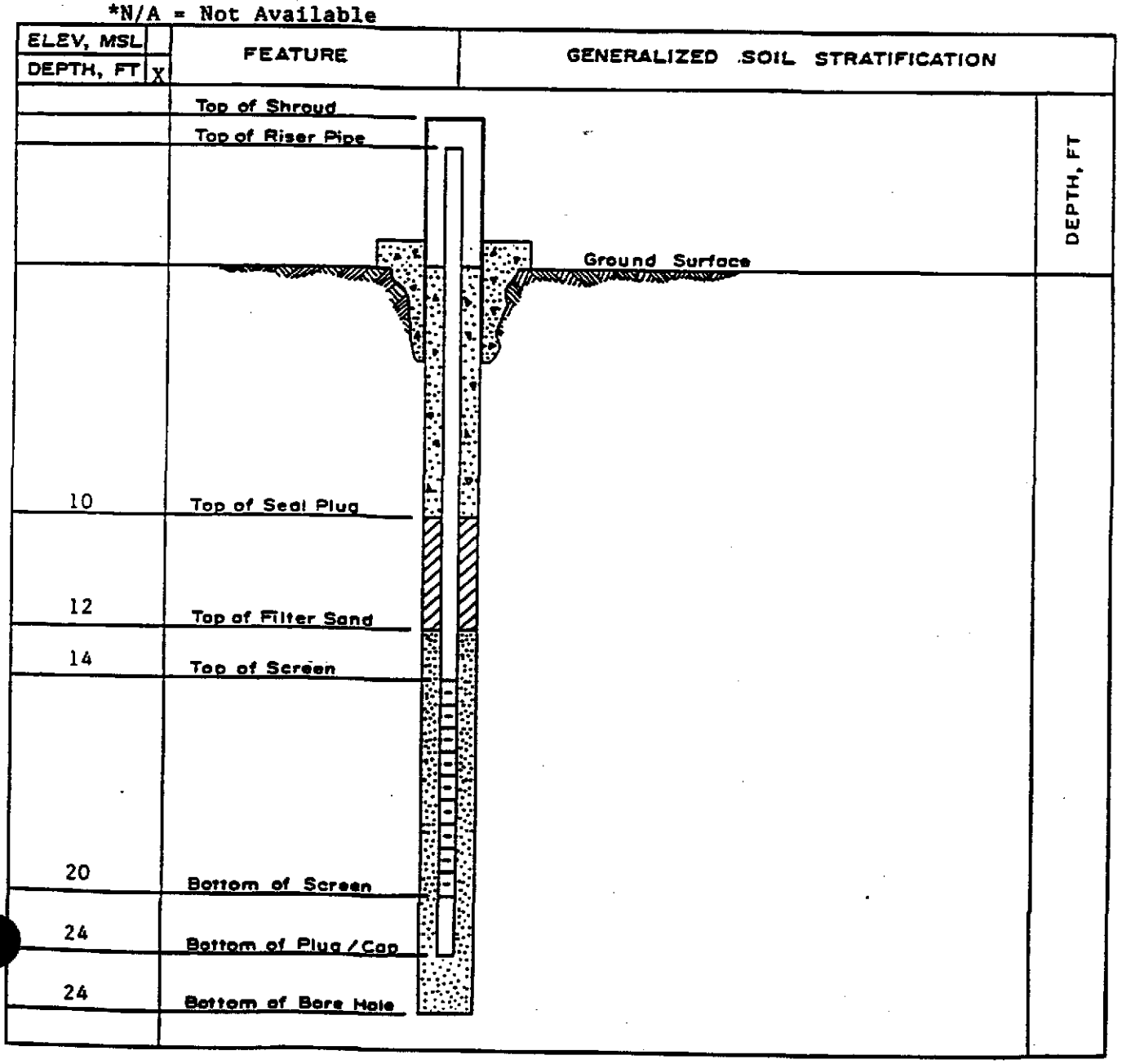
STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 11/8/93

Observation Well No. 22B Date Completed 11/8/93 Technician M. Biglane
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs ____ Other N/A

*N/A = Not Available



PZ-22B

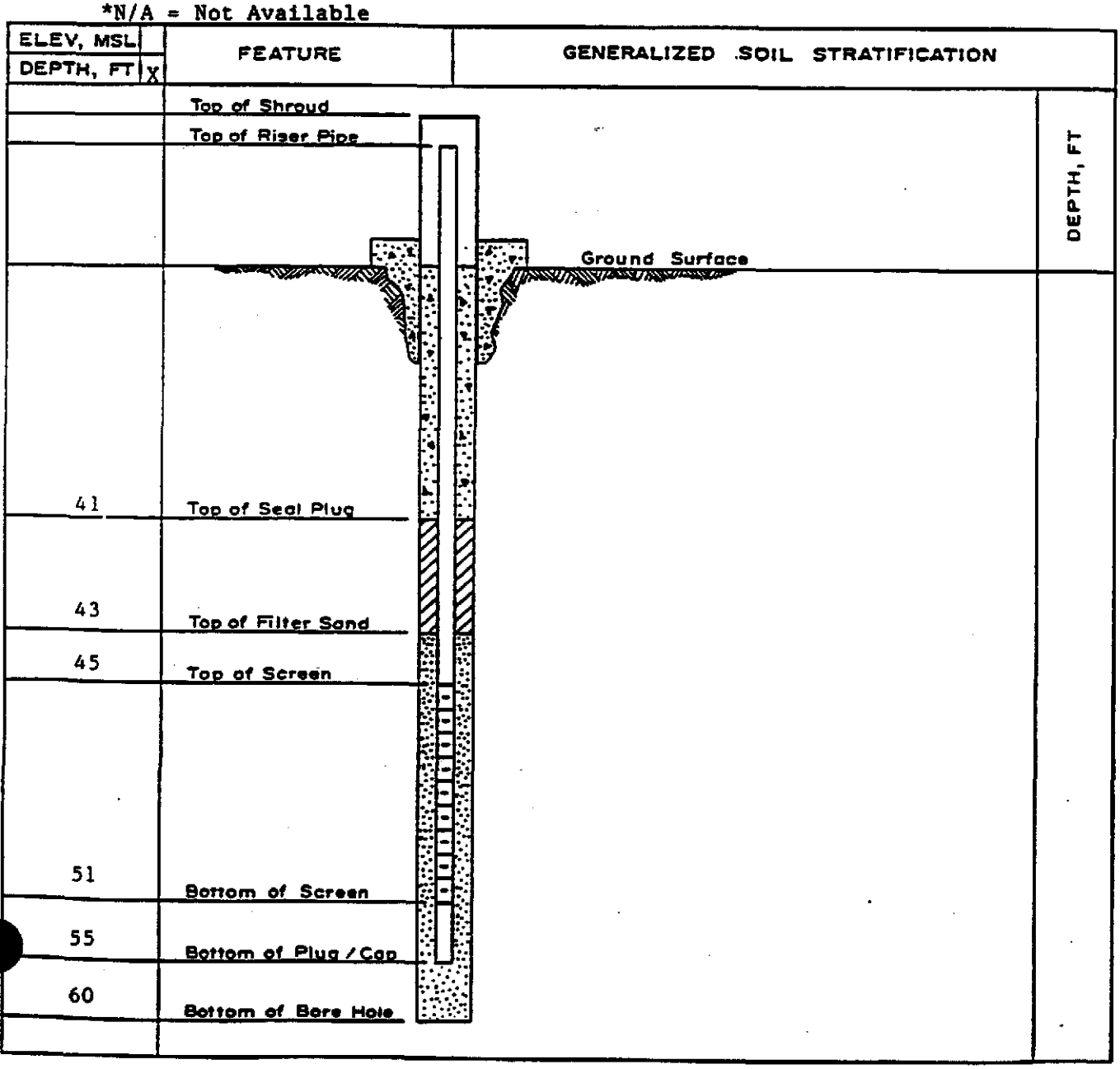
STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 11/6/93

Observation Well No. 22A Date Completed 11/6/93 Technician M. Biglane
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs Other N/A

*N/A = Not Available



LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-22A
FILE: 92B007C-4001
DATE: 11/6/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 1 of 2

Hollow-stem Augered: Full Depth

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
0					Toe of slope and Drainage Ditch Fill Material (FILL)
5		2.25		20	Firm to dense tan and light gray Clayey SILTS with ferrous stains (ML)
		2.25		22	—with more silt, 6'- 8'
		2.25		22	—tan, with more ferrous stains, 8'- 10'
10		2.50		24	—tan and light gray with more silt, 10'- 12'
		3.00		24	—light gray below 12' —with shell fragments, 12'- 18' —damp to wet, 12'- 22'
15		2.75		24	
		1.75		22	—gray, with a trace of organics, 16'- 20'
		1.50		24	
20		1.50		24	—gray and tan, with more clay, 20'- 22'
		1.75		24	—light gray, with a trace of shell fragments below 22'
25					
		2.75		24	Dense to stiff light gray Clayey SILTS / Silty CLAYS with silt pockets and a trace of shell fragments (ML/CL)
30					
35					
40					

Continued Next Page

Unified Soil Classifications based on visual observations.

LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-22A
FILE: 92B007C-4001
DATE: 11/6/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 2 of 2

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
40					Dense to stiff light gray Clayey SILTS / Silty CLAYS with silt pockets and a trace of shell fragments (ML/CL)
45					
50					Bottom of boring at 52'. Borehole grouted full depth. Set piezometer in borehole.

Unified Soil Classifications based on visual observations.

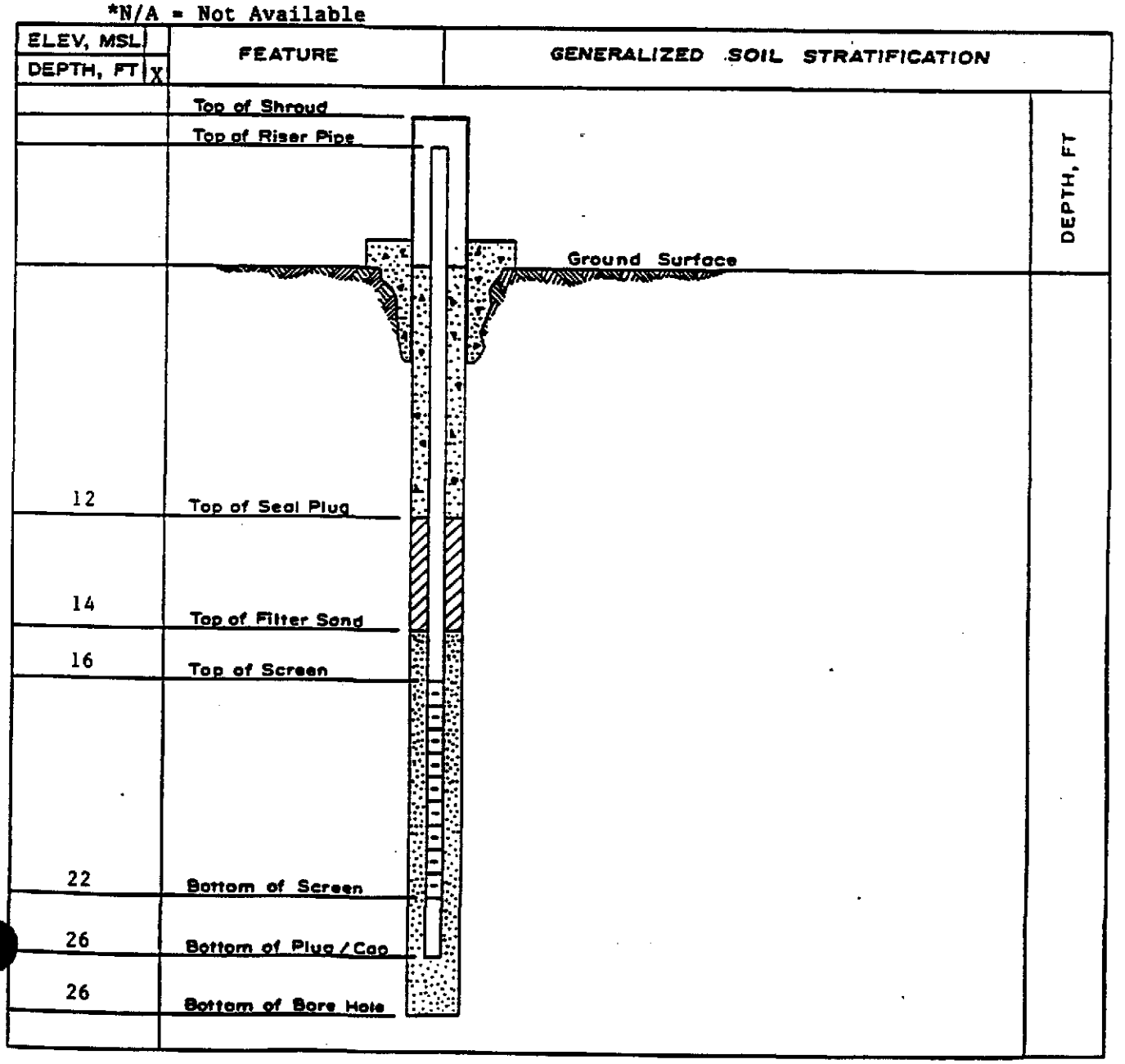
STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 11/8/93

Observation Well No. 23B Date Completed 11/8/93 Technician M. Biglane
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs _____ Other N/A

*N/A = Not Available



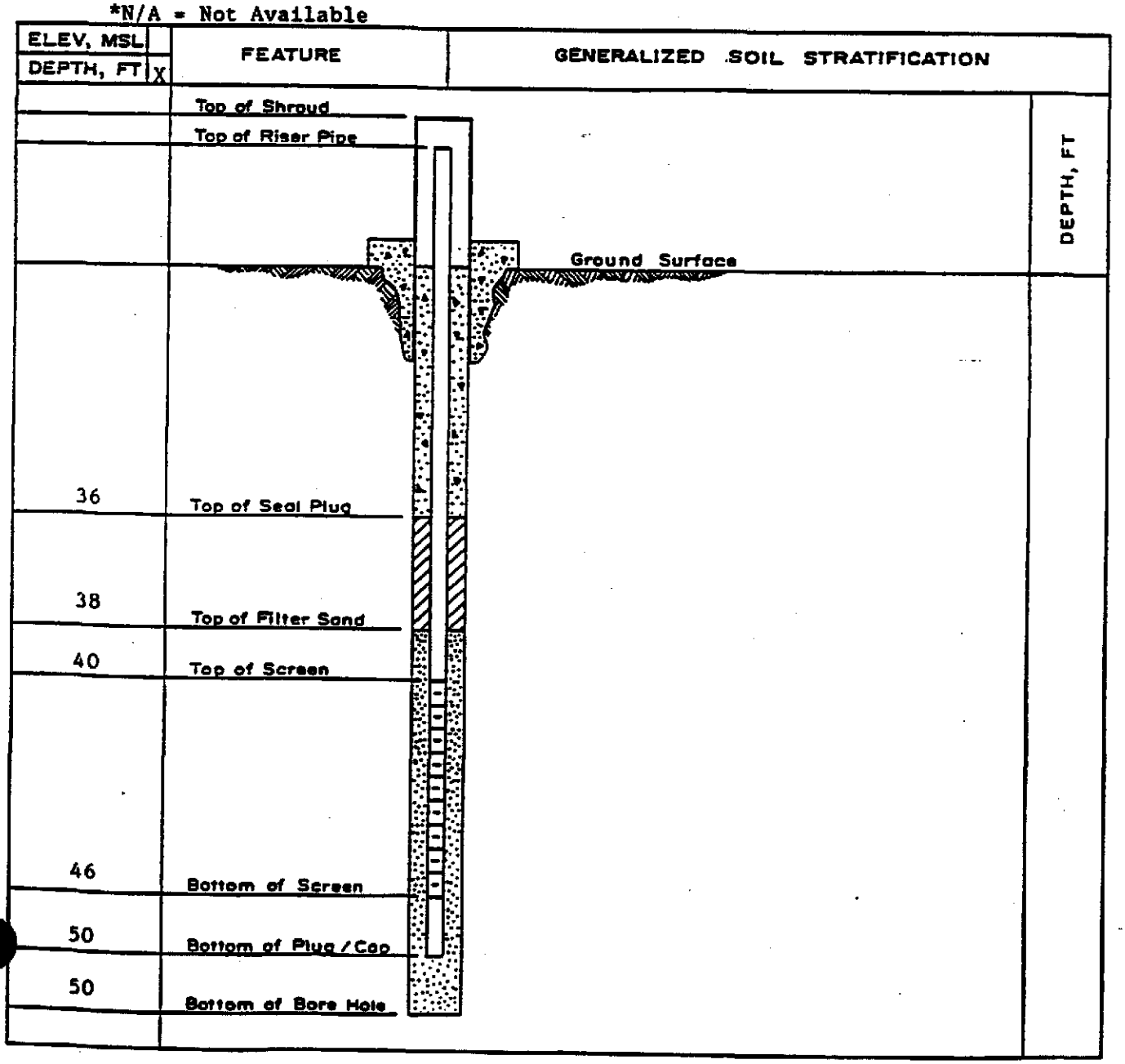
STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 11/7/93

Observation Well No. 23A Date Completed 11/7/93 Technician M. Biglane
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs _____ Other N/A

*N/A = Not Available



PZ-23A

LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-23A
FILE: 92B007C-4001
DATE: 11/7/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 1 of 2

Hollow-stem Augered: Full Depth

Free water was encountered at a depth interval of 16'- 18' during hollow stem augering. The water level rose to depths of 15.65' and 15.25' after observation periods of 15 and 20 minutes, respectively.

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
0					Limestone and FILL (FILL)
5		1.25		22	Firm to dense tan and dark gray Clayey SILTS, damp (ML)
		1.00		24	—with organics, 4'- 6'
					—tan below 6'
		1.00		20	
10		2.25		24	—tan and light gray, with a traces of rootlets, 10'- 12'
		3.00		24	Dense to stiff light gray and tan Clayey SILTS / Silty CLAYS with traces of ferrous stains
		3.00		24	(ML/CL)
15		4.25			—dense, 15'- 16'
		<4.50		24	—dense to stiff, light gray with greenish gray streaks, 16'- 20'
		2.00		16	
20		2.00		18	—stiff, light gray below 20'
		–		16	Dense light gray medium to coarse SANDS, wet
		2.00			(SP)
		2.00		14	Stiff light gray and gray Silty CLAYS
25					(CL)
		2.50		24	—with silt pockets and traces of ferrous stains, slightly slickensided and blocky fractures, 24' - 31.5'
		2.00		24	—with a trace of calcareous nodules, 26'- 31.5'
30		2.00		24	—with a trace of organics at 30'
		0.50			
					Firm to dense light gray and tan Clayey SANDS
35					(SC)
		2.00		24	Stiff light gray and tan Silty Sandy CLAYS with a trace of ferrous nodules
40					(CL)

Continued Next Page

Unified Soil Classifications based on visual observations.

DEC 13 93 ENVIRS4 28007

LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi

CLIENT: Vicksburg Chemical Corporation

BORING: B-23A
FILE: 92B007C-4001
DATE: 11/7/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 2 of 2

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
40					Stiff light gray and tan Silty Sandy CLAYS with a trace of ferrous nodules (CL)
		2.50		24	
		0.50			
45					Stiff gray Silty CLAYS with fine sand layers (CL)
		3.00		18	
					—greenish gray, slightly blocky fractures and a trace of gravel below 48'
50					Bottom of boring at 50'. Borehole grouted *full* depth. Piezometer installed in borehole.

Unified Soil Classifications based on visual observations.

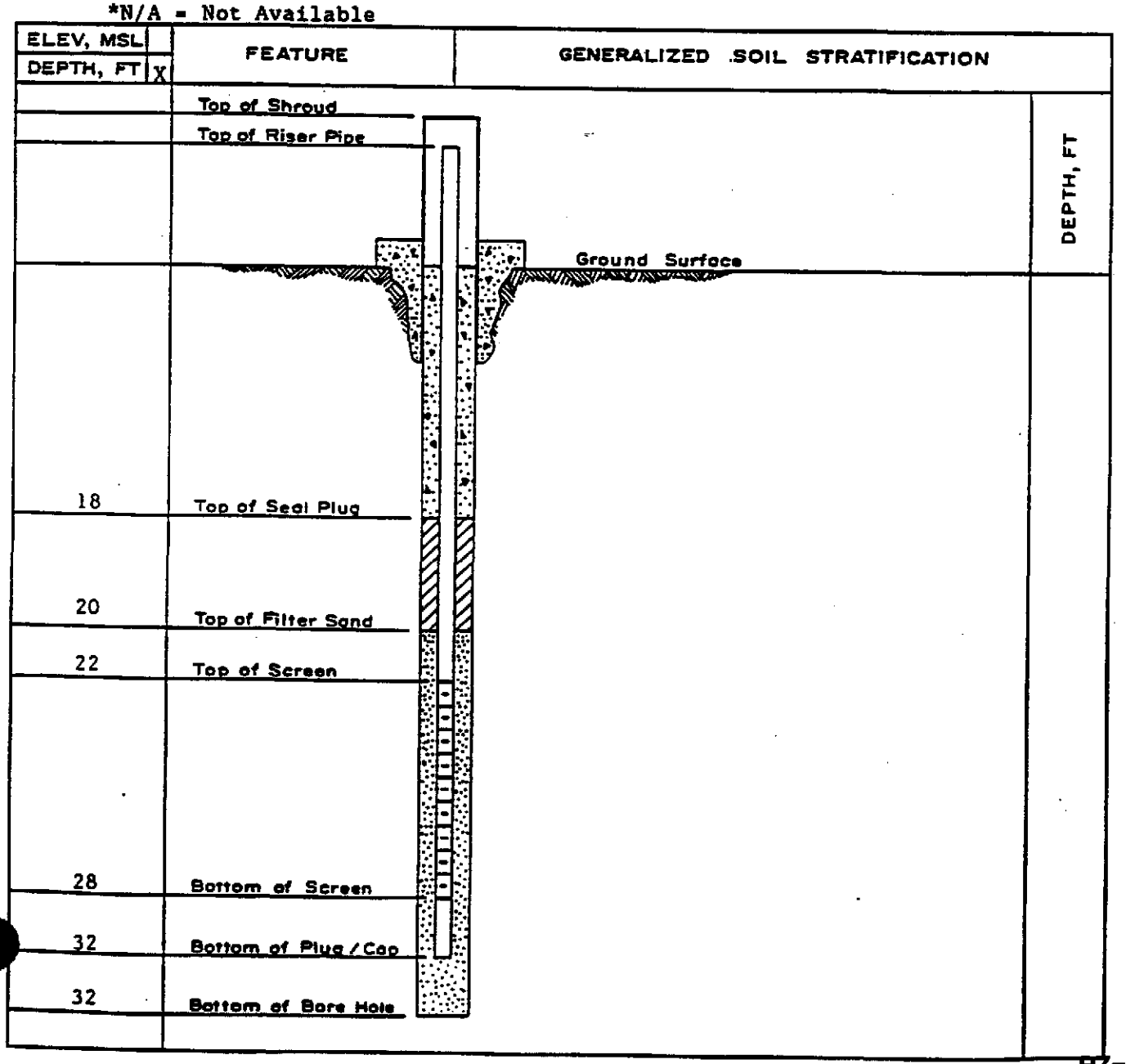
STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 11/9/93

Observation Well No. 24B Date Completed 11/9/93 Technician M. Biglane
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs _____ Other N/A

*N/A = Not Available



PZ-24B

LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-24B
FILE: 92B007C-4001
DATE: 11/9/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 1 of 1

Hollow-stem Augered: Full Depth

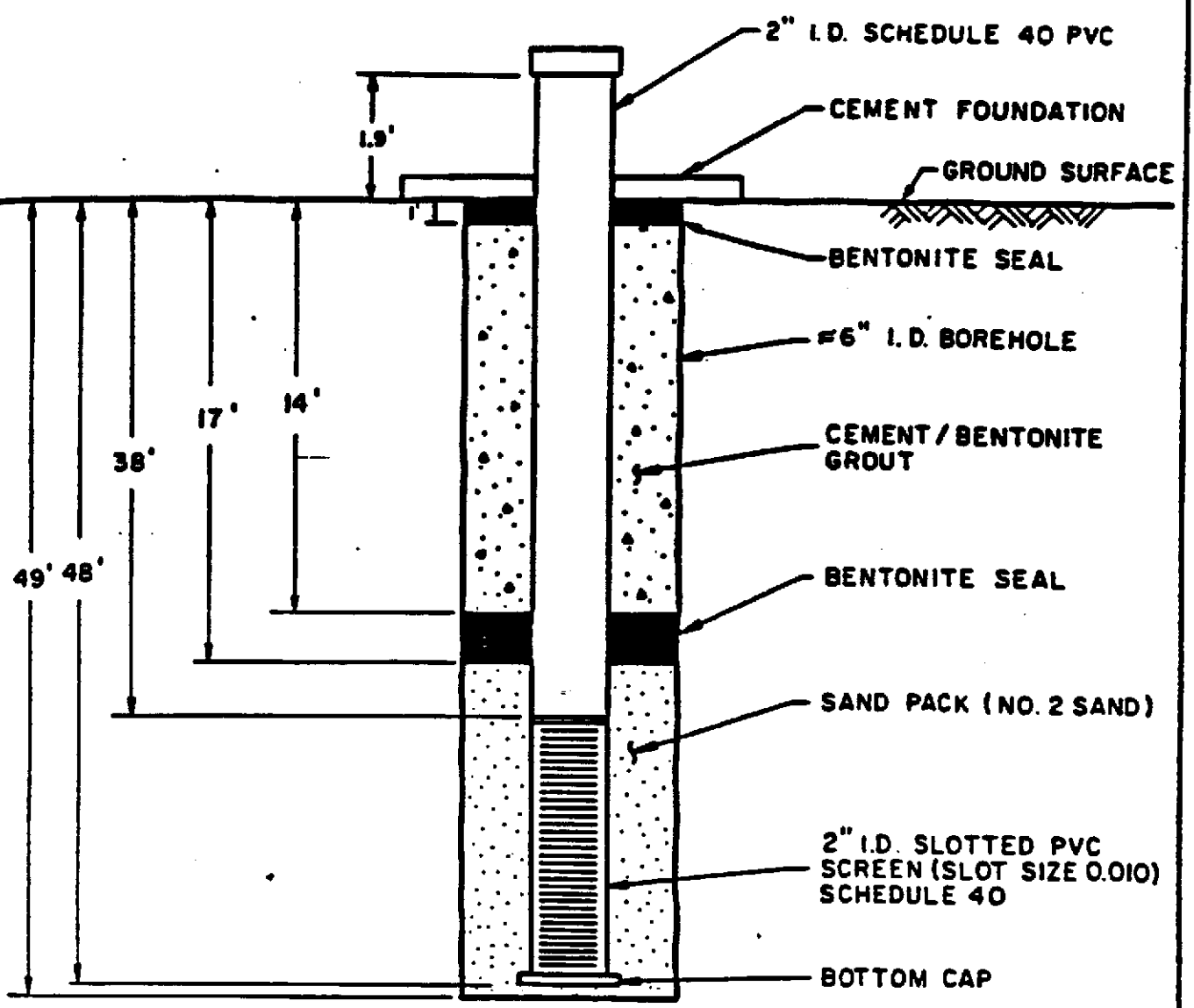
DEPTH (FEET)	GRAPHIC	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)				Description of Stratum
0								Limestone / Gravel FILL (FILL)
5		1.50		24				Firm to dense tan Clayey SILTS with a trace of gravel (FILL)
		2.25		12				
		3.25		20				Firm to dense tan Clayey SILTS (ML)
10		2.00		24				—with 6" layer of dark brown layer at 10.7'
								—moist to damp below 10'
		2.00		24				—with a trace of organics, 12'- 18'
								—with ferrous stains below 12'
		0.25		24				—tan and light gray, 14'- 21'
15		0.50						
		2.25		24				
		1.75		24				
20		0.75		20				
		0.50		22				Medium gray and dark gray Silty CLAYS with a trace of ferrous stains (CL)
25		1.00		22				Medium to stiff light gray Sandy CLAYS (CL)
		0.75		24				—with ferrous stains and a trace of white specks to 26'
								—medium, with a trace of organics, 26'- 28'
		0.25		24				—damp below 26'
								—soft, gray, 28'- 30'
30		1.75		24				Stiff light gray Silty Sandy CLAYS with a trace of ferrous stains and blocky fractures (CL)
								Bottom of boring at 32.5'.
								Borehole grouted full depth.
								Piezometer installed in borehole.

Unified Soil Classifications based on visual observations.

DEC 13 93 ENVIRS4 28007

Woodward-Clyde Consultants

PZ-24B



DRAWING NUMBER PZ-4
CHECKED BY
APPROVED BY
DATE 12/10/84
DRAWN BY DMS

DATE INSTALLED: 12/7/84

ELEVATION, TOP OF CASING: 114.24'

FIGURE

PIEZOMETER PZ-4
CONSTRUCTION DETAILS

PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.

DRAWING NOT TO SCALE

IT

© 1983 HERCULENE ADD SMITH CO PRW PA

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 846545	PROJECT NAME VERTAC Chemical		
BORING NUMBER PZ-4	COORDINATES:	DATE: 12/7/84	
ELEVATION 114.24 Ft. MSL (TofC)	GWL: Depth / Date/Time	DATE STARTED: 12/7/84	
ENGINEER/GEOLOGIST JDD	Depth / Date/Time	DATE COMPLETED: 12/7/84	
DRILLING METHODS Auger & Rotary Wash		PAGE 1 OF 2	

DEPTH (FT)	SAMPLE TYPE & NO	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0			Gravel mixed w/shells 4.0'-5.0'			
5			Brown, Silty-clay, w/gravel	CL		
10						
15			Gray-tan color 12'-18' Clayey-Silt	ML		
20	ST-1		Dark gray, organics		.75	Sample 19.5'-20.0', moist, Light grey silt seams
25						
30						

NOTES:

Used 6" auger from 0'-15'. Rotary wash from 15'-49'. Lost water between 4.0'-5.0' and therefore used 6' of surface casing to block it off while drilling.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical		
BORING NUMBER: P7-4	COORDINATES:		DATE: 12/7/84
ELEVATION: 114.24 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 12/7/84
ENGINEER/GEOLOGIST: JDD	Depth	Date/Time	DATE COMPLETED: 12/7/84
DRILLING METHODS: Auger & Rotary Wash			PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30			Wood & grass cuttings @ 30.0'			
35			Light gray, silt w/clay @ 37.0'			
40						
45	ST-2		Gray, clayey-sand, very calc., brown mottled areas	SC	1.5	Sample 44.0'-44.5'
			Hit marl @ 49.0'			
50			Bottom of boring @ 49.0'			

NOTES:

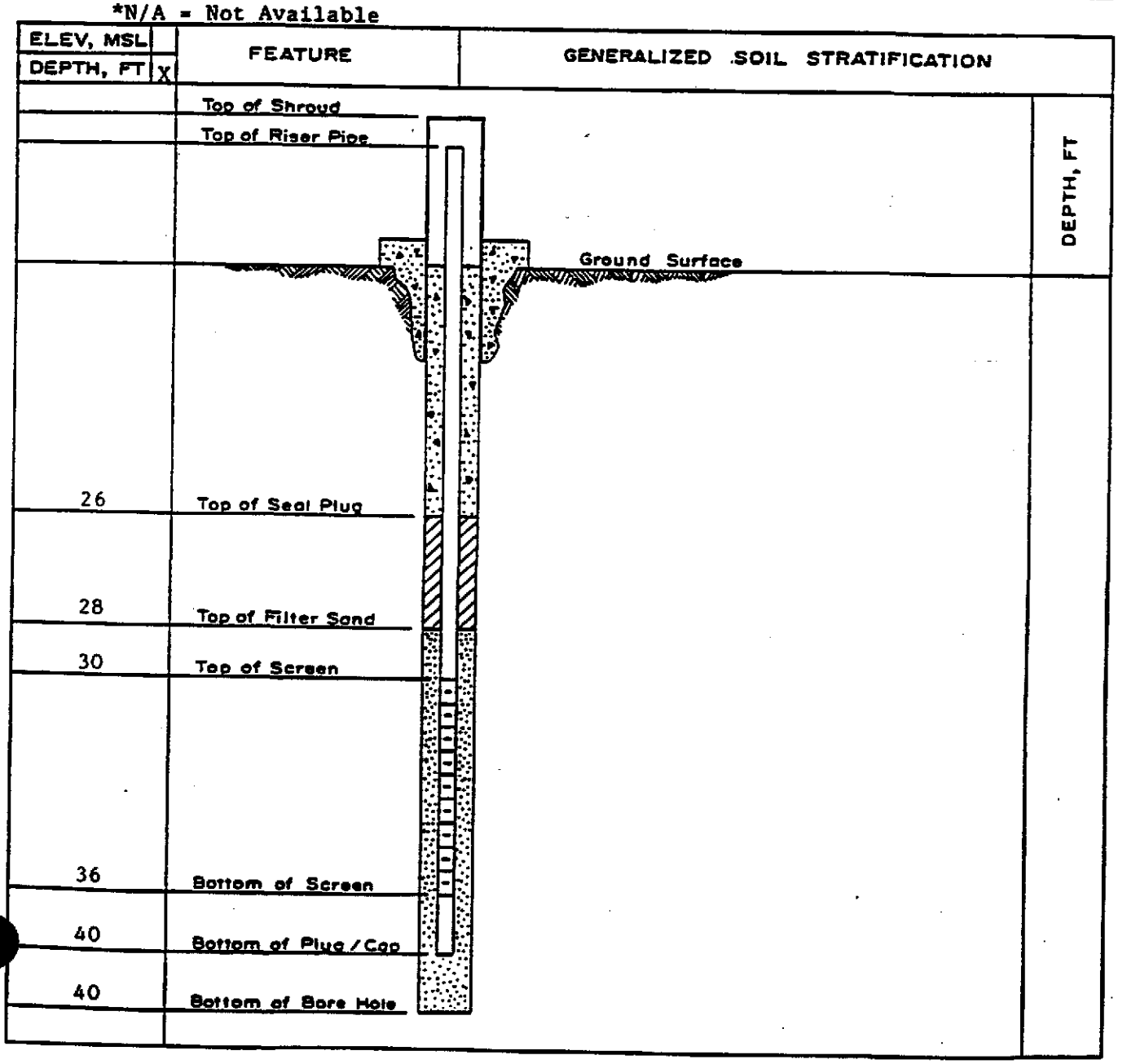
STE
Soil Testing Engineers, Inc.

MONITOR WELL LOG

Project & Location Vicksburg Chemical Company North Pond Investigation
Client Woodward-Clyde Consultants Date of Report 11/12/93

Observation Well No. 25B Date Completed 11/12/93 Technician M. Biglane
Riser Pipe: Material PVC Diameter 2 in. Type of Joints Threaded
Screen: Material PVC Slot Size 0.01 Diameter 2 in. Length 10 ft
Diameter of Borehole 8 in. Type of Filter Pack No. 3 Blasting Sand
Method of Placement of Filter Material Pour from Top of Hollow Stem Auger
Type of Seal Above Screen Bentonite 1/2 Pellets Backfill Above Seal Grout
Drilling Mud 0 used. Fresh Water Flush Before Setting Well Screen 0
Well Developed by Woodward-Clyde Consultants Development Time N/A hrs
Groundwater Level @ 2 hrs N/A @ 24 hrs _____ Other N/A

*N/A = Not Available



LOG OF BORING

PROJECT: North Pond RFI
LOCATION: Vicksburg, Mississippi
CLIENT: Vicksburg Chemical Corporation

BORING: B-25B
FILE: 92B007C-4001
DATE: 11/12/93
TECHNICIAN: M. Olson
APPROVED:
PAGE: 1 of 1

Hollow-stem Augered: Full Depth

DEPTH (FEET)	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
0					Fill Material (FILL)
		<0.25		20	Loose tan Clayey SILTS, wet (ML)
		<0.25		20	—with a trace of ferrous nodules, 2'- 4'
5					—with a trace of organics, 4'- 14'
		<0.25		24	
		<0.25		24	—with ferrous seams, 8'- 10'
10		<0.25		24	—tan and light gray, 10'- 23'
		<0.25		24	—with a trace of ferrous nodules, 12'- 23'
		1.25		24	—firm, 14'- 16'
15		0.25		24	—loose below 16'
		<0.25		24	
20		<0.25		24	
		<0.25		24	
		0.25		24	—light gray below 23'
		0.25		24	—with a trace of shells, 23'- 26'
25		0.25		24	
		<0.25		24	—with a trace of organics, 28'- 30'
30		0.25		24	
		0.75		24	—firm below 40'
		0.75		24	—with a trace of shells, 34'- 38'
35		0.75		24	
		0.75		24	
40					Firm to medium, light gray and tan Clayey fine SANDS / Sandy CLAYS with ferrous stains and a trace of organics (SC/CL)

Bottom of boring at 40'.
Borehole grouted full depth.
Piezometer installed in borehole.

Unified Soil Classifications based on visual observations.

DEC 13 93 ENVIR84 28007

Woodward-Clyde Consultants

PZ-25B

APPENDIX E

RFI DATA COLLECTION QUALITY ASSURANCE PLAN

RFI DATA COLLECTION QUALITY ASSURANCE PLAN

VICKSBURG CHEMICAL COMPANY VICKSBURG, MISSISSIPPI

Prepared for
Vicksburg Chemical Company
Vicksburg, Mississippi

December 1995

WCC File 92B007C-3003

Woodward-Clyde

Woodward-Clyde Consultants
2822 O'Neal Lane
Baton Rouge, Louisiana 70816

TABLE OF CONTENTS

Section			Page
1.0	INTRODUCTION		1
2.0	DATA COLLECTION OBJECTIVES		2
	2.1	DATA OBJECTIVES	2
	2.2	QUALITY ASSURANCE OBJECTIVES	2
		2.2.1 Definitions of Quality Assurance Terms	3
		2.2.1.1 Precision	3
		2.2.1.2 Accuracy	3
		2.2.1.3 Completeness	4
		2.2.1.4 Representativeness	4
		2.2.1.5 Comparability	4
		2.2.2 Accuracy, Precision, and Sensitivity of Laboratory Analysis	5
		2.2.3 Quality of Field Samples	6
		2.2.4 Accuracy of Field Measurements	7
3.0	SAMPLING OBJECTIVES		9
	3.1	GROUNDWATER SAMPLING DATA OBJECTIVES	9
	3.2	AQUIFER TESTING OBJECTIVES	10
	3.3	SURFACE SOIL SAMPLING DATA OBJECTIVES	11
	3.4	SUBSURFACE SOIL SAMPLING DATA OBJECTIVES	11
	3.5	SAMPLING ACTIVITIES	11
4.0	SAMPLING EQUIPMENT, PROCEDURES, AND MEASUREMENTS		13
	4.1	SUBSURFACE SOIL SAMPLING	13
		4.1.1 Equipment	13
		4.1.2 Procedure	14
		4.1.3 Documentation	16
	4.2	SURFACE SOIL	18
		4.2.1 Equipment	18
		4.2.2 Procedure	18
		4.2.3 Documentation	19
	4.3	GROUNDWATER SAMPLING	19
		4.3.1 Water Level Measurement	19
		4.3.1.1 Water Level Determination	19
		4.3.1.2 Cross-Contamination Minimization	20
		4.3.1.3 Calculation of the Volume of Standing Water	20
		4.3.1.4 Free-Phase Immiscible Contamination	21

TABLE OF CONTENTS (Continued)

Section			Page
		4.3.2 Well Evacuation - Purging	21
		4.3.2.1 Bailer Purging	22
		4.3.2.2 Mechanical Pump Purging	23
		4.3.2.3 Submersible Pump Purging	23
		4.3.2.4 Bladder Pump Purging	24
		4.3.2.5 Inertia Pump Purging	24
		4.3.3 Well Sampling	25
		4.3.3.1 Sample Collection	25
		4.3.3.2 Cross-Contamination Minimization	27
		4.3.3.3 Collection for Metal Analysis	27
		4.3.3.4 Use of Dedicated Equipment	27
		4.3.3.5 Collection for Volatile Organic Analysis	28
	4.4	QUALITY CONTROL SAMPLES	28
		4.4.1 Trip Blanks	28
		4.4.2 Rinsate Blanks	28
		4.4.3 Sample Preservation and Shipment	29
	4.5	GROUTING	29
	4.6	AQUIFER TESTING (To be implemented prior to detailed design of corrective action)	30
		4.6.1 Equipment	31
		4.6.2 Procedure	31
		4.6.3 Documentation	33
5.0		INSTALLATION	34
	5.1	EQUIPMENT	34
		5.1.1 Procedure	34
		5.1.2 Documentation	38
6.0		DOCUMENTATION	40
	6.1	BORING LOGS	40
	6.2	PIEZOMETER INSTALLATION/DEVELOPMENT REPORTS	41
	6.3	GROUNDWATER SAMPLING REPORT	41
	6.4	SAMPLE CUSTODY DOCUMENTATION	41
	6.5	ANALYSIS REQUEST	43
7.0		DECONTAMINATION	44
	7.1	CROSS-CONTAMINATION CONTROL PROCEDURES	44
	7.2	SAMPLING EQUIPMENT DECONTAMINATION	45

TABLE OF CONTENTS (Continued)

Section			Page
	7.3	PUMP DECONTAMINATION	45
	7.4	DOWNHOLE EQUIPMENT DECONTAMINATION	46
8.0	SAMPLE ANALYSIS		47
	8.1	ANALYTICAL PROCEDURES	47
	8.2	CALIBRATION PROCEDURES AND FREQUENCY	48
		8.2.1 Calibration Procedures	48
		8.2.2 Field Equipment Calibration	49
		8.2.3 Laboratory Equipment Calibration	50
9.0	DATA REDUCTION, REPORTING, AND VALIDATION		51
	9.1	DATA REDUCTION	51
	9.2	DATA REPORTING	52
		9.2.1 Sampling Record Keeping	52
		9.2.2 Sample Custody and Shipment	53
		9.2.3 Laboratory Response	53
	9.3	DATA VALIDATION	55
10.0	INTERNAL QUALITY CONTROL		58
	10.1	DATA TRANSCRIPTION	58
	10.2	FIELD SAMPLING QUALITY CONTROL	58
	10.3	VERIFICATION AND REVIEW	58
11.0	PERFORMANCE AND SYSTEM AUDITS		60
	11.1	FIELD ACTIVITY AUDITS	60
	11.2	LABORATORY PERFORMANCE AUDITS	60
12.0	PREVENTIVE MAINTENANCE		62
	12.1	FIELD INSTRUMENTATION	62
	12.2	ANALYTICAL INSTRUMENTATION	63
13.0	CORRECTIVE ACTION		64
	13.1	CORRECTIVE ACTION FOR FIELD SITUATION	64
	13.2	CORRECTIVE ACTION FOR LABORATORY SITUATIONS	65
14.0	QUALITY ASSURANCE REPORTS TO MANAGEMENT		66

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Table 1	RFI Workplan Sample Summary
Table 2	RFI Groundwater Assessment Workplan Sample Summary
Table 3	Target Compound List (TCL) and Contract Required Quantitation Limits
Table 4	Target Analyte List (TAL) and Contrast Required Detection Limits
Table 5	Detection Limits for Metals
Table 6	Precision, Accuracy, and Completeness Objectives
Table 7	Quality Control Level of Effort
Table 8	Surrogate Spike Recovery Limits
Table 9	Matrix Spike Recovery and Relative Percent Difference Control Limits
Table 10	Field Quality Control Sample Frequency

LIST OF FIGURES

Figure 1	Log of Boring Form
Figure 2	Monitor Well Installation Report
Figure 3	Groundwater Collection Report
Figure 4	Chain of Custody
Figure 5	Sample Analysis Request Form

1.0 INTRODUCTION

The Vicksburg Chemical Corporation manufacturing facility (VCC) is located in Vicksburg, Mississippi. The facility is a manufacturer of chemicals. An U.S. Environmental Protection Agency (EPA) Determination of Release was issued for the facility in December, 1989. Negotiations for a Consent Decree began in January, 1990.

VCC has retained Woodward-Clyde Consultants (WCC) to perform a RCRA Facility Investigation (RFI) at the Vicksburg facility. WCC will conduct the investigation in compliance with the guidelines of the Consent Decree. Among the requirements and/or guidelines includes in the decree are procedures to control the quality of data acquired in during the investigation. This document presents the overall approach that WCC will undertake to verify that the information, data, and procured results meet the quality objectives. A detailed discussion of sampling procedures and methodologies for specific media is also given. For information on the description and background of the RFI for the entire facility, refer to the Preliminary Report.

2.0
DATA COLLECTION OBJECTIVES

2.1 DATA OBJECTIVES

The primary objectives of the North Pond RFI are as follows:

- Identify or verify the contaminants of concern for each SWMU requiring further investigation.
- Determine whether or not the SWMU's in question are releasing hazardous constituents into the environment.
- Identify the source of contamination
- Determine vertical and horizontal extent of contamination.
- Collect data to be used in determining the necessity and feasibility of corrective action measures.

To meet the overall objectives of the investigation, WCC will collect subsurface soil and groundwater samples. The following sections present the data requirements and strategy for collection of samples from each media.

2.2 QUALITY ASSURANCE OBJECTIVES

The objectives of the Quality Assurance/Quality Control (QA/QC) procedures are to produce data that meet (or exceed) the requirements of standard analytical methods and satisfies the project requirements. The objectives of the QA efforts for this project are as follows:

- To provide the mechanism for ongoing control and evaluation of the quality of data measurement throughout the project.
- Utilizing quality control data to define data quality for various measurement parameters in terms of precision and accuracy.
- To verify that all chemical samples are accurately and precisely collected, analyzed and documented so that proper treatment and/or disposal of waste material can occur.

- To verify compliance with the Department of Transportation and other agency requirements.
- To verify that samples are properly collected, analyzed and documented to provide data as part of the H&S Plan.

2.2.1 Definitions of Quality Assurance Terms

Definitions of precision, accuracy, completeness, representativeness, and comparability are presented in Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans (QAMS-0050/80, Office of Monitoring Systems and Quality Assurance and Office of research and Development, U.S. Environmental Protection Agency, Washington, D.C. 20460, December 29, 1980).

2.2.1.1 Precision

Precision is "a measure of mutual agreement among individual measurements of the same property. It is a measure of variability of individual sample measurements. Precision will be assessed from the laboratory duplicate analyses of field samples and from the set of duplicate matrix spiked samples. Precision will be measured as the percent difference in the duplicate measurements.

Average precision and its standard deviation of the concentration data for individual parameters will be used to evaluate the data collected and its acceptability for the objectives of the sampling. Data to be used in evaluation will meet the criteria defined in this QAP. Confidence intervals will be derived for data sets using standard statistical methods.

2.2.1.2 Accuracy

Accuracy is "the degree of agreement of a measurement with an accepted reference or true value" and is a measure of a system bias. Bias is the difference between the mean of the true sample values and the mean of the laboratory analysis. Accuracy will be assessed using laboratory spiked standard matrix samples in conjunction with field and trip blank samples and laboratory method and reagent blanks. Average accuracy and its standard deviation of

the concentration data will be used if sufficient data are collected for a specific sampling activity.

2.2.1.3 Completeness

Completeness is "a measure of the amount of the valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions." The completeness of data objectives reflect the degree to which required samples specified in the appropriate sampling plan have been collected and the necessary analysis performed, in order to create a sufficient data base to meet the objectives. If the completeness objective is not met, an evaluation will be undertaken to determine if resampling is required to provide adequate data to meet specific task objectives.

2.2.1.4 Representativeness

Representativeness "expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition." Representativeness is a function of the sample site selection and sample collection and analysis techniques. The objective of this program is to obtain samples which are representative of the media to be measured. The rationale of the selection of sample sites is provided in the project plans (including this QAP).

2.2.1.5 Comparability

Comparability "expresses the confidence with which one set of data can be compared with another." Comparability can be related to precision and accuracy since these quantities are measures of data reliability. Qualitatively, data subjected to strict QA/QC procedures will be deemed more reliable than data obtained from another project or previous study. To maintain comparability, the sampling method used, chain-of-custody procedures, EPA analytical methods and qualified laboratories and establishment of strict QA procedures and sampling guidelines provide the basis for uniformity in all data collection and analysis activities.

2.2.2 Accuracy, Precision, and Sensitivity of Laboratory Analysis

The QA objective with respect to accuracy, precision, and sensitivity of laboratory analytical data is to achieve the QC acceptance criteria of the analytical protocols.

During the RFI field work there will be analyses performed for constituents of concern from the following list:

Parameter or group of parameters:

A. Atrazine, cyanazine, arsenic, dinoseb, toxaphene, toluene
B. TCL, TAL, atrazine, cyanazine, dinoseb
C. Atrazine, cyanazine
D. TCL, dioxin, TAL, atrazine, cyanazine, dinoseb
E. BTEX, TPH
F. BTEX, TPH, atrazine, cyanazine, arsenic, dinoseb, toxaphene

A table listing the SWMU Number, number of samples to be taken and the analytical parameter or group of parameters is presented as Table 1 for the RFI Workplan and Table 2 from the Groundwater Assessment Workplan.

A summary of the parameter and possible methods to be employed by the offsite laboratory are as follows:

Parameter	Protocol
Toxaphene, Atrazine and Cyanazine	EPA SW-846, Method 8080
Dinotrobytyl Phenol (Dinoseb)	EPA SW-846, Preparation Method 3550, Analysis Method 8015
Arsenic	EPA SW-846, Method 7060
Toluene	EPA SW-846, Method 8020
TAL, Dioxin (See Table 3)	Statement of Work for Organic Analysis Multi-Media Multi-Concentration, SOW 2/88, Revision 9/88, 4/89, and 5/89, Office of Solid Waste and Emergency Response, U.S. EPA, Washington, D.C., May 1989

Parameter	Protocol
TAL (See Table 4)	Statement of Work for Inorganic Analysis Multi-Media Multi-Concentration, Sow No 788, Revisions 2/89 and 6/89, Office of Solid Waste and Emergency Response, U.S. EPA, Washington, D.C., June 1989

The TCL parameters and contract required quantitaion limits are listed in Table 3. The detection limits for metals analyses in accordance with SW-846, 3rd Edition are presented on Table 4. Accuracy and precision criteria for the parameters to be tested in accordance with EPA CLP protocols and SW-846 is shown in Table 5. The accuracy and precision of laboratory analyses for samples tested in accordance with CLP and SW-846 protocols will be determined by testing of laboratory blanks, duplicates, and spiked samples in accordance with the frequencies shown in Table 6. Compounds that are often used as matrix and surrogate spikes for CLP and SW-846 organic analyses, and their control limits from CLP Protocols, are included in Tables 7, 8 and 9.

2.2.3 Quality of Field Samples

Field duplicates, rinsate blanks, trip blanks, and matrix spikes/matrix spike duplicates will be taken in the field and submitted to the analytical laboratory to provide a means to assess the quality of the data resulting from field investigation tasks. Field duplicate samples will be analyzed to check for sampling and analytical reproducibility. Field and trip blank samples will be analyzed to check for procedural contamination and cross-contamination during shipment and storage of samples. Matrix spike/matrix spike duplicate samples will be analyzed to verify that recoveries falling outside acceptance windows are attributable to sample matrix interferences and not to laboratory analytical errors.

Field duplicates for groundwater will be obtained at the frequencies indicated in Table 10. The samples will consist of obtaining a duplicate sample set for analysis from the sample. Rinsate samples will be prepared by rinsing decontaminated equipment with deionized water and collecting the rinsate sample. Matrix spike and matrix spike duplicates will be collected in the field but they will be spiked in the laboratory. Trip blanks will be prepared by the

laboratory and shipped with the sample containers. The trip blanks will be kept with collected samples and shipped back to the laboratory for analysis.

2.2.4 Accuracy of Field Measurements

Measurement data will be generated in many field activities that are incidental to collecting samples for analytical testing or unrelated to sampling. These activities include, but are not limited to, the following:

- Documenting time and weather conditions
- Determining depths in a borehole or piezometer and static water levels
- Measuring pH and conductivity of ground water samples
- Screening samples with an organic vapor analyzer (OVA) or photoionization detector (PID)

The general QA objective for such measurement data is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the intended use of such data through the documented use of standard procedures.

The QC level of effort for the field measurement of pH consists of pre-measurement calibration and post-measurement verification using two standard reference solutions each time to sample pH. This procedure will be performed for each sample tested. The QC effort for field conductivity measurements will include daily calibration of the instrument using standard solutions of known conductivity.

The accuracy of field measurements of pH will be assessed through pre-measurement calibrations and pH-measurements verifications using at least two standard buffer solutions. The two measurements must each be within $\pm$ 0.1 standard unit of buffer solution values. If measurements not within $\pm$ 0.1, the problem will be evaluated. A fresh portion of buffer solution will be utilized. If the problem persists, a different (new) buffer solution will be used. Precision will be assessed through replicate measurements. (The electrode will be withdrawn, rinsed and de-ionized water and re-immersed between each replicate). The instrument used will be capable of providing measurements to 0.1 standard unit. A total of four replicates for pH and conductivity will be performed.

The accuracy of measuring depths (for boreholes and static water levels) will be assessed by using a measuring device (weighted tape or electronic water level indicator such as an M-scope) that has been calibrated before use by measuring two known lengths. Any measurements taken with the device will be adjusted by the difference (if any) in length over the appropriate depth interval. At least three replicate depth measurements will be made and the average depth measurement will be used.

The data from the OVA or PID is used for screening only to select samples for analysis. After receiving laboratory data the OVA or PID and lab data will be evaluated for comparability.

3.0
SAMPLING OBJECTIVES

The specific objectives of the collection of the data are further discussed in the subsequent paragraphs.

3.1 GROUNDWATER SAMPLING DATA OBJECTIVES

As stated in the Preliminary Report water-bearing zones have been identified in previous investigations. Additional groundwater data may be needed to characterize these zones if contamination is found. Groundwater data needed could include:

- Approximate vertical boundaries of zones and stratigraphic relationships.
- Basic flow characteristics of each zone (direction, lateral flow rate, hydraulic conductivity, transmissivity and storage capacity).
- Hydraulic inter-relationships of the zones (vertical interconnection transmissivity between zones, etc).
- Effect of stratigraphic variations within each zone on contaminant transport.
- Nature and extent of contamination in each zone (approximate boundaries of contaminant accumulation).

Identification of water-bearing zone boundaries and relevant soil strata will required a detailed description of soil features (such as color, lithology, bedding, identifying features and relative degree of water saturation) to a depth sufficient to identify the base of the deepest contaminated water-bearing zone. The description will require accuracy to the nearest foot and professional geologic judgment to recognize and describe pertinent features.

The zones to be monitored will require sufficient screening intervals to characterize each zone. For low density immiscible contaminants (floaters), the screen will extend approximately two feet above the top of the zone to provide for fluctuations in water levels. If dense non aqueous phase contaminants are the concern (sinkers) the screen will cover the base of the upper pervious zones and extend slightly below the base of the zone ($\pm$ 6 inches).

If dissolved constituents are the concern, the screened interval will correspond to that portion of the zone which is judged to have the highest hydraulic conductivity. If required, deeper zones will be monitored utilizing similar approaches as describe above.

Determination of groundwater flow direction will require measurement of elevations of the top of the piezometric surface of each zone. A sufficient number and spacing of measurement stations will be installed to construct idealized contours of the piezometric surface elevations. The locations of measuring stations will be established such that they can be plotted on a site location map. Locations should be to the nearest 0.1 foot. Water level measurements should be made to the nearest 0.01 foot accuracy and reported in feet mean sea level (MSL). This data will be evaluated to verify the designated upgradient shallow well location and to identify upgradient background wells. As additional samplings are performed, the data will be reevaluated to verify results of previous sampling.

Determination of the nature and extent of groundwater contamination will require sampling and chemical analysis of groundwater from each water-bearing zone. A sufficient number of samples will be required to identify approximate lateral limits of contamination and establish and nature and concentrations of contaminants. Investigation of zones below the upper pervious zone will be performed if data does not define the vertical extent of groundwater contamination. The sample will require analysis for parameters noted in Table 2.

3.2 AQUIFER TESTING OBJECTIVES

Determination of lateral and vertical flow rates, hydraulic conductivities, transmissivities, storage capacities and vertical interconnection will require in situ flow testing data. Lateral hydraulic conductivity/transmissivity data should be collected by at least two different methods in order to evaluate the credibility of the data and subsequent calculations. Storage capacity calculations and vertical interconnection determinations should be based on field pumping test data. Aquifer testing will be done in conjunction with detailed design of corrective action, if required.

3.3 SURFACE SOIL SAMPLING DATA OBJECTIVES

The primary purpose of collecting surface soil data is to aid in determining potential for contamination of site runoff-water, potential for off-site migration of contaminated sediments (water transported) and/or potential for human/animal contact and/or ingestion. Consequently, sampling need not extend beyond about 12 inches below the natural ground surface. Background samples at 0 to 12 inches to 12 to 36 inches will be obtained in the site vicinity. The background sample locations are selected based upon the lack of hazardous waste activities in those areas. Laboratory analysis for contaminant content for each SWMU shall consist of those parameters listed in Table 1.

3.4 SUBSURFACE SOIL SAMPLING DATA OBJECTIVES

The primary purpose of collecting subsurface soil (vadose zone) and soil structure data is to aid in determining the potential for downward percolation of contaminants into the shallow groundwater. Consequently sampling must be of sufficient quantity to identify lateral limits of contamination and must extent to a sufficient depth of identify and quantify accumulation of contaminants above and within the first occurring water-bearing zone. The data shall consist of laboratory analyses of the contaminated soil. Laboratory analyses for each SWMU shall consist of analysis for those parameters listed in Table 1.

3.5 SAMPLING ACTIVITIES

The sampling activities will occur during the RFI to address the data objectives for the media of concern identified above. A map of the site is presented as Figure 1 of the RFI Strategy, Characterization, Schedule and Management Plan and sampling locations are presented on the Figure. The field investigation tasks to obtain the data will generally consist of the following:

- Obtaining sampling location characteristic information from topographic and information surveys.
- Obtaining background and current groundwater quality data from the existing site monitor wells (already completed).

- Subsurface soil sampling to evaluate the vertical and horizontal extent of contamination and constituents if released.
- Groundwater assessment and sampling (installation of three wells, sampling and evaluation) pursuant to the Groundwater Assessment Workplan.

4.0 SAMPLING EQUIPMENT, PROCEDURES, AND MEASUREMENTS

The sampling locations, depths, type (grab vs. composite), number of samples, and analytical parameters were discussed in the RFI Work Plan. The procedures and equipment to perform the sampling for the RFI were discussed only in general terms in that document and are presented in more detail herein. In addition, procedures for piezometer or monitor well installation and aquifer testing are presented. The sampling procedures presented below will be implemented as appropriate. Changes in the procedures discussed here in will be documented. Additional specifications with respect to documentation, equipment, and procedures as required by VCC standard policies and manuals which do not affect data quality objectives may be incorporated into the work plan as appropriate.

4.1 SUBSURFACE SOIL SAMPLING

Subsurface soil sampling will be performed to characterize the wastes and to evaluate the extent of subsurface soil contamination, if any. The equipment and methods are discussed below.

4.1.1 Equipment

Subsurface sampling will be performed by rotary auger or hollow-stem drilling methods or use of "Geoprobe" soil boring equipment. The drilling apparatus will consist of a truck-mounted drilling rig. Samples will be obtained by drilling using a 3-inch diameter Shelby tube, or 2-inch diameter split spoon sampler.

"Geoprobe" soil boring equipment is typically mounted on the rear of a pickup truck or on the rear of an all terrain vehicle. The "Geoprobe" system uses the direct-push method to hydraulically advance small diameter hollow steel probe rods to the desired sampling depth. The probe rods are typically one or three feet in length and 1 to 2 inches in diameter. The soil boring can be sampled continuously or can be advanced to a desired depth to collect discrete soil and/or groundwater samples. The working depth for the system is dependent upon subsurface conditions and is typically about 30 feet below ground surface (bgs).

Only petroleum jelly, teflon tape, lithium grease, or vegetable-based lubricants shall be used on the threads of downhole drilling equipment. Additives containing lead or copper shall not be used. Any hydraulic or other fluids used in the drilling rig, pumps, or other field equipment/vehicles shall not contain any polychlorinated biphenyls (PCBs).

If antifreeze is added to any pump, hose, etc., in an area in contact with drilling fluids, this antifreeze shall be completely purged prior to the equipment's use in drilling, mud mixing, or any other part of the overall drilling operation. Only antifreeze without rust inhibitors and/or sealants may be used.

Drilling equipment that has a visible loss of grease, hydraulic fluids, oils, fuels and/or transmission oil to drilling fluids to the borehole will not be allowed for borings and/or well installation until the problem is corrected.

Hydraulic rotary drilling operations will use portable recirculation tanks/pans for the "mud pit" and for mixing grout. Dug pits or sumps will not be used.

4.1.2 Procedure

The borings shall be continuously sampled with a thin-walled Shelby tube sampler or split-spoon sampler, extruded in the field and described or logged, following the guidelines of the appropriate and most current American Society for Testing and Materials (ASTM) Standards:

- D 1452 Practice for Soil Investigation and Sampling by Auger Borings,
- D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils,
- D 1587 Practice for Thin-Walled Tube Sampling of Soils,
- D 2487 Test Method for Classification of Soils for Engineering Purposes, and
- D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure).

All borings shall be sampled and described by a qualified WCC representative. The qualified WCC representative is to be on-site during all boring and sampling operations. Samples taken from borings will be handled as described later in this section.

All soil borings will be advanced with rotary or hollow-stem drilling techniques with continuous soil sampling techniques unless it is determined to be unnecessary for strata identification and sample collection by the qualified WCC representative based on consistent site conditions. If the borehole becomes unstable and caving or sloughing of the walls develop, temporary surface casing may be used in the drilling operations. Dry rotary auger or hollow-stem techniques will utilize an auger and cut and clear the borehole for sampling. Rotary wash will utilize potable water that is recirculated through the borehole to remove cuttings. Bentonite drilling mud (organic free) will be used only if required to maintain borehole stability.

The samples obtained from the borings will be screened in the field for head-space analysis using an on-site OVA or PID. Immediately upon removal of the soil sample from the Shelby tube or split spoon, the field geologist will visually log it. The visual logging will describe soil type and secondary color, penetration resistance and inclusions as described above. A portion of the sample will then be shaved with a clean knife or spatula to remove at a minimum the outer approximately one-fourth inch which may have come in contact with the downhole fluids. This shaved sample will then be divided into two parts, each of which will be labeled based on boring number and sample depth. One portion of the sample will be placed in a glass jar, labeled, and placed on ice. The other portion will be placed in a wide mouth glass jar covered with aluminum foil and capped. The headspace will be sampled by inserting the probe of the OVA into a predrilled hole in the cap through the aluminum foil. The OVA or PID reading will be made immediately and the reading recorded on the boring log.

Based on the OVA or PID readings or visible contamination or the RFI Strategy, Characterization, Schedule and Management Plan , the qualified WCC representative will select samples for chemical analysis to consist of parameters for each SWMU listed in Table 1 or monitoring well listed in Table 2. Samples will be retained on ice or refrigerated until delivery to the laboratory. One sample in 20 will be split to provide field duplicate samples for analysis and one rinsate blank will be collected for analysis from each drilling rig decontamination during drilling.

Shallow rotary borings will be drilled to the water table and will be advanced by dry-auger methods until free water is encountered. For borings drilled for shallow piezometer

installation, drilling operations will be stopped for ten minutes when water is encountered to allow the water level to rise. Both the initial and second water level will be measured and recorded. Borings drilled for shallow piezometer installation will be drilled to the base of the first water-bearing zone encountered.

As an alternative, subsurface soil samples may be collected from discrete intervals or continuously by soil probe sampling with a "Geoprobe" sampler. The sample tools are stainless steel thin wall sample tubes or split spoon samplers. The sampling tools are typically 1- to 2-foot in length and 1 1/2 to 2 inches in diameter. Different types of "Geoprobe" samplers are also available.

The soil probe uses a direct-push method that consists of a small diameter hollow steel rod with a stainless steel sampling tool fitted to the base of the rod. The borehole can be continuously sampled or a discrete sample can be collected at a desired sample interval. Soil samples are collected by pushing or driving the sampler to the desired sampling depth. The drive tip is then mechanically released and the thin wall sample tube or split spoon sampler is pushed into the soil at the base of the borehole. The sampler uses a plastic polybutyrate liner which is extruded upon retrieval of the sampler from the borehole.

The soil samples will be handled in the same manner as described previously. The sampling devices and probe rods will be decontaminated prior to each use in the same manner as described for other sampling equipment described in the RFI Data Collection Quality Assurance Plan.

4.1.3 Documentation

Subsurface soil sampling will be documented in the filed log book as well as on a boring log form for each boring drilled. The boring log will be of a form equal to or similar to Figure 5. Pertinent information will, at a minimum, include boring number, date, logger, lithologic description, core recover, OVA or HNu readings, depth of water table and boring completion data.

The following information shall be routinely entered or attached to the soil boring log:

- Depths/heights shall be recorded in feet and fractions thereof (tenths).
- Soil classifications shall be in accordance with the Unified Soil Classification System (equivalent to ASTM D 2487 and 2488).
- Soil classifications which have been prepared in the field at the time of sampling by a WCC representative and are subject to change based upon laboratory tests and/or subsequent review. Factors to consider before changing a field determination include the expertise of the field geologist and laboratory personnel, representative character of the tested sample, labeling errors, etc.

Each soil sample taken shall be fully described in the log. The descriptions of intact samples shall include the following parameters:

- Lithologic Classification and Unified Soil Classification
- Color
- Plasticity
- Consistency (cohesive soil)
- Density (noncohesive soil)
- Moisture Content. Use relative term.

Other information to be placed on the soil boring logs, as appropriate, include:

- The drilling equipment used will be generally described either on each log or in a general legend.
- Each log will record the drilling sequence.
- All special problems and their resolution will be recorded on the log; e.g., hole caving, recurring problems at a particular depth, sudden tool drops, excessive grout takes, drilling fluid losses, unrecovered tools in hole, lost casing, etc.
- The dates for the start and completion of borings shall be recorded on the log.

- Each sequential boundary between the various soils and individual lithologies shall be noted on the log by depth. When depths are estimated, the estimated range shall be noted along the boundary.
- The depth of first encountered free water shall be indicated along with the method of determination. In addition, when free water is first encountered the following procedure will be followed; Allow the first encountered water to partially stabilize (10 to 15 minutes) and record this secondary level and time between measurements before proceeding.
- The estimated depth interval for each soil sample taken, classified, and/or retained shall be noted on the log. For each driven (split spoon), thin wall (shelby), and cored sample, the length of sample recovery and the sampler type and size (diameter and length) will be recorded.
- For thin wall samplers it should be indicated whether the sampler was pushed or driven. Blow counts shall be recorded in half foot increments when standard (1 3/8" ID by 2" OD) samplers are used. For penetration of less than a half foot, it will be noted in the log along with the blow count and the distance over which the count was taken.
- Special abbreviations used on a soil boring log and/or well diagram will be defined either in the log/diagram where used, or in a general legend.

4.2 SURFACE SOIL

Soil samples will be obtained from areas that are potential pathways for surficial contaminant migration.

4.2.1 Equipment

Sampling equipment will consist of hand sampling tools such as trowels, shovels, a drive tube sampler or a hand auger. Stainless steel or PVC sampling tools will be used.

4.2.2 Procedure

The sample locations will be referenced to site coordinates. The sampling area will be first cleared of vegetation and/or debris. The sample will be collected to a depth of 12 inches

such that minimal volatilization is allowed and then transferred in the appropriate container. The hole will be backfilled with native soils and vegetation.

4.2.3 Documentation

As previously stated, the sampling point will be referenced to the site coordinate system and ,if taken with an areal grid, the node number will be recorded. Visual classification and other observations will also be noted in the field log book along with sample number, time, date, and other pertinent information.

4.3 GROUNDWATER SAMPLING

4.3.1 Water Level Measurement

4.3.1.1 Water Level Determination

The elevation at the top of the casing (TOC) should be established at each piezometer. This information will be used to determine the water level elevation. To calculate the water level elevation, the distance to the water level from the TOC needs to be measured. This can be achieved by either of the following procedures:

4.3.1.1.1 **Weighted Tape Procedure.** A weighted tape must be decontaminated prior to use and between wells by procedures detailed in Standard Operating Procedures (SOP) 3.5. The weight should consist of an inert, open-ended object that will create a distinct sound when tapped on the water's surface. The weight should be lowered gently into the well until it is heard to have touched the water. The water level measurement from top of casing to water level should be determined to the ± 0.01 foot and recorded in a logbook. A measurement of well depth from the top of the casing to the bottom of the well should also be made. This measurement can be used to determine if a significant silt build-up has occurred at the bottom of the well or that the well casing is not blocked. NOTE: When using a weighted tape, be sure that the weight is not secured using an adhesive tape (duct tape, strapping tape, etc.) as the adhesive may contain organic compounds which could contaminate the well.

4.3.1.1.2 **Electronic Water Level Indicator Procedure.** An electronic water level indicator must also be decontaminated prior to use and between wells. The indicator probe, connected to a graduated wire is lowered down the well casing. A light turning on or a meter deflection occurs when the electrical circuit is closed indicating that the probe tip has touched the water. The reading should be taken to the nearest 0.01 foot by recording the length of graduated wire between the TOC and the water level (probe tip) in a logbook. Additionally, a measurement of well depth should be made from TOC to the bottom of the well using the probe.

4.3.1.2 Cross-Contamination Minimization

In areas of known contamination, the sequence of water level measurement should be done, whenever possible, from the well least likely to be contaminated to the well most likely contaminated to reduce the potential for cross-contamination. If this information is not available, an attempt should be made to sample upgradient wells first and then downgradient wells.

4.3.1.3 Calculation of the Volume of Standing Water

The water level measurement is used to calculate the volume of standing water in the well from the linear feet of standing water and the well diameter. This calculation is then used to determine the volume of water to be purged from the well prior to sampling. To calculate the linear feet of water in the well, subtract the depth to the water from the total depth of the well. Form the table below determine the appropriate factor for the specific well inside diameter; multiply the linear feet by the appropriate factor listed on the table below to get the gallons of water present in the well.

Casing Diameter	Casing Volume
2 inches	0.163 gallons/foot
3 inches	0.367 gallons/foot
4 inches	0.653 gallons/foot

For example, if depth to water is 7.5 feet, and the total depth of the 2-inch diameter well is 20 feet, then 12.5 feet of standing water is in the well. Volumetrically, 0.163 x 12.5 (2-inch well), or 2.04 gallons of standing water are in the well.

4.3.1.4 Free-Phase Immiscible Contamination

If contamination of groundwater by free-phase immiscible chemicals is suspected, procedures for the detection of immiscible, or nonaqueous phase liquids (NAPL) should be employed. The presence of dense NAPL (heavier than water) or light NAPL (less dense than water) can be determined by the use of an electrical interface probe. The probe should be carefully and slowly lowered into the well. A deflection of the needle on the scale of the probe will indicate the air/light NAPL interface, light NAPL/water interface, and water/dense NAPL interface, respectively. The thickness of immiscible contaminants is to be recorded in a logbook.

4.3.2 Well Evacuation - Purging

In order to obtain a representative sample of groundwater, the standing water in the well casing should be purged or evacuated. Evacuation allows fresh or formation groundwater to enter the well. The optimum method to ensure that formation water is sampled, is to monitor the water being purged by field measurements of pH, temperature and conductivity. For each volume of standing water purged from the well (as calculated earlier) a measurement of these three indicator parameters should be taken. When the subsequent sample are observed to have less that ± 10 percent variation in these parameters, the well is presumed to be adequately flushed. At a minimum, three standing water volumes as should be removed; however, in wells with very low recoveries this goal may not be practical. When full recovery exceeds two hours, the well should be purged to dryness. If the well is evacuated to dryness, samples of the groundwater should be collected within 24 hours of evacuation.

Evacuation rates should be kept well below 10 gallons per minute and in most cases should be below 5 gallons per minute. At no time should a well be pumped to dryness if recharge rates cause groundwater to vigorously cascade down the sides of the screen which can potentially cause an accelerated loss of volatiles. If at all possible, the water should be

drawn down from above the screen in the uppermost part of the water column in high yield formation to ensure that fresh water from the formation will move upward in the screen. In low yield formations, water should be purged so that it is removed from the bottom of the screen.

Evacuation of a well can be accomplished in several different ways. In any instance it is paramount to ensure that the evacuation procedure does not cause cross-contamination from one well to the next. Therefore, the preferred method employs dedicated equipment whenever possible. The selection of an evacuation method often relies on the depth of the water in the well, as discussed below. The following are potential evacuation methods:

4.3.2.1 Bailer Purging

Bailers can be used to evacuate shallow wells, and through there are no prohibitive factors preventing their use in deeper wells, the time required and physical strain on the individual purging the well makes hand bailing a less desirable evacuation method for deeper wells. Ideally, if a bailer is used, it is dedicated to one well and often remains hanging from the well cap in the well between use. Regardless of whether the bailer is dedicated or not, it should be decontaminated before use. Decontamination procedures should be followed.

The preferable materials of bailer construction are teflon, stainless steel, polypropylene, polyethylene, vitron, and polyvinyl chloride (PVC). The bailer should be lowered into the well using a nonporous rope made out of material such as polypropylene or teflon-coated cord. Caution should be used when lowering the bailer into the water so as to avoid aeration of the well water. Retrieve the bailer after it is filled and pour water into a graduated container to measure the amount of water removed from the well. Care should be taken to keep the rope and bailer from touching the ground or other potentially contaminated surfaces. When the first standing water volume has been removed, a groundwater sample should be collected from the bailer for field measurements of pH, temperature, and conductivity. These field measurements should be repeated for each subsequent standing water volume removed.

4.3.2.2 Mechanical Pump Purging

Suction lift pumps such as centrifugal, diaphragm, or peristaltic pumps can be used to evacuate wells if the static water level is within 25 feet of ground surface. These pumps are utilized at ground surface with the intake line connected to dedicated teflon or high-density polyethylene tubing inserted into the well. The tubing should be equipped with a foot valve to avoid having aerated water from the pump fall back in the well. The outlet tubing should be placed so that the purge water is collected in a graduated container, and can be measured. Deionized water should be used if priming is necessary. Measurements of pH, conductivity, and temperature should be taken for each standing water volume evacuated from the well. If the well is pumped dry and the recharge rate is sufficiently rapid to cause water to cascade into the well, the well should be allowed to recover. Then the pumping rate should be adjusted to a slower rate and the well re-evacuated of two standing water volumes before sampling.

4.3.2.3 Submersible Pump Purging

Portable submersible pumps are an option for evacuating wells with water levels greater than 25 feet below land surface. One such pump is an electrically powered (110 or 230 V AC) centrifugal pump with an isolated motor. Another is an air displacement pump in which a stainless steel reservoir with check valves at each end alternately fills from the bottom with water from the well, and evacuates when air or compressed gas (nitrogen) is discharged into the reservoir from the top. The decontaminated pump should be carefully lowered into the well, trailing a discharge hose, electrical cables or air liens, and a stainless steel security cable (which should bear most of the weight). If these items are to be bundled, use plastic ties and not electrical tape or duct tape.

If the pump is connected to a portable gasoline generator or air compressor, the generator should be placed some distance away from the well where fumes can not affect sample quality. An inline air filtration system at the discharge line should be used when an air compressor is used in conjunction with an air displacement pump. The submersible pump provides the advantage of high flow rates, however, care should be taken when operating to keep the flow rate within an acceptable limit for the particular well yield (recharge capacity).

As with the suction lift pumps, these pumps should be equipped with a foot valve and fitted with dedicated tubing.

To evacuate, simply turn the pump on, prime with de-ionized water if needed, and measure the outlet water quantities. As with all other evacuation methods, pH, temperature, and conductivity should be measured for each standing water volume removed. These pumps need to be decontaminated prior to sampling and between sampling points.

4.3.2.4 Bladder Pump Purging

A bladder pump or gas squeeze pump consists of a housing that encloses a flexible membrane (bladder) that has check valves above and below. The pump is connected to either bottled gas or an air compressor. When in operation, water enters the membrane/bladder through the bottom check valve; compressed gas is injected into cavity between the housing and the bladder, squeezing the bladder and forcing the water through the top check valve and ultimately out of the well. Another type of bladder pump is also available that works on the same principle except that the water enters the chamber between the membrane and the casing, and the gas is injected into bladder. Similar to the submersible pumps, the bladder pump should be carefully lowered into the well by a security cable. In low-yielding wells (i.e., wells incapable of producing three well volumes), the bladder pump should be placed at the bottom of the well screen so that water is removed from the bottom of the well screen.

The outlet tubing from the bladder pump should be placed so that purge water can be collected into a graduated container. Field measurements of temperature, pH, and conductivity should be taken for each standing water volume evacuated from the well.

4.3.2.5 Inertia Pump Purging

An inertia pump consists of a PTFE footing which is essentially a reservoir with check valves at the bottom inlet and top outlet, and a tube rising to the wellhead. An up-and-down movement of the tube pumps water through inertia derived from the upward movement of water with each stroke. The whole system is dedicated and can be pumped by hand, by the use of a hand-operated lever, or by using an electrically powered (110 V AC) motor. An

optional bellows attachment provides suction to the tubing and greatly increases the pumping capacity.

To evacuate, simply pump by hand, or connect the motor. If a portable generator is used, take care to place it some distance away from the well where fumes cannot affect sample quality. Field measurements of pH, temperature, and specific conductivity should be taken for each standing water volume removed.

4.3.3 Well Sampling

After evacuation of an adequate volume of water from the piezometer sampling can begin. Sampling of the piezometer should occur as soon as possible after evacuation, preferably immediately and must occur within 24 hours of completion of purging activities. Of the methodologies used for monitor well evacuation it is recommended that samples be collected only by using either the bailer, inertia pump, or the bladder pump. Due to the manner in which the other pumps (suction lift and submersible pumps) operate and the potential effect on the quality of the samples, it is not advisable to collect samples for volatile organic analysis with them.

4.3.3.1 Sample Collection

Prior to collecting the groundwater samples, the appropriate sample containers and preservatives should be set out and readily available for sample collection. Ideally, the sample containers should be cleaned and prepared by the laboratory that is going to conduct the analysis. Some of the parameters for which samples are to be collected will require a preservative.

The monitor well cap of each well will be removed carefully to avoid the incorporation of any contaminants in the well. Any plants or small trees that will be close to the well will also be removed, if possible. Prior to sampling, the initial static water elevation will be measured and recorded. The water level will be measured from the top of the riser piper to the nearest 0.01 foot using a calibrated electronic probe water level sensor (M-scope) or weighted tape (with sounder). Three replicate measurements will be made to verify accuracy. The probe or tape will be cleaned with deionized water after each use.

Following water level measurements, the well will be purged to remove stagnant water which would otherwise bias a representative sample. The purging will be performed using a dedicated bailer. The well will be purged until water parameters of pH, specific conductance, and temperature have stabilized and at least three well volumes or the well is purged to dryness. Purged water will be containerized for treatment. Measurements of pH, specific conductance, and temperature will be taken and recorded during the purging.

Vehicles or any other equipment that might be a potential source of contamination will be placed at a distance far enough from the wells during purging or sampling.

After purging, the well will be sampled with a dedicated or clean bailer. Clean plastic sheeting will be placed on the ground around each well to prevent contamination of the ground or any sampling equipment which is dropped. Care will be taken so that the sample is taken from the screened interval of the well. Samples will be retained in appropriately preserved laboratory containers. No head space will be allowed in VOA vials.

Samples will be collected and containerized in the order of the parameters volatilization sensitivity. Samples for organic compounds should be collected initially. Care will be taken not to allow the bailer to come into contact with the container while pouring the samples.

The following are potential sampling methods:

4.3.3.1.1 **Bailer Sample Collection.** If a bailer is used for sample collecting, the same bailer used to purge the well may be used to sample it. An effort will be made to keep the rope from touching the ground or the casing. The bailer will be lowered slowly into the water. Do no let the bailer free fall into the water. Attempt to lower the bailer to the same depth in the well each time. Retrieve the bailer smoothly but quickly and empty the water into the sample container in a steady stream. Samples should be collected in the following order: Volatile Organics, Total Organic Carbon, Semivolatile Organics, and any other compounds. Once collected, the samples should be labeled using a waterproof label and waterproof ink, sealed in plastic bags, and placed on ice in an ice chest and cooled to 4°C. The sample number, amount collected, and time collected should be recorded on a chain-of-custody form and in a logbook.

4.3.3.1.2 **Bladder or Inertia Pump Sample Collection.** If a bladder pump or an inertia pump is used, the same tubing that was used to purge the well may be used to sample it. The samples should be collected in the following order: Volatile Organics, Total Organic Carbon, Semivolatile Organics, and any other compounds. When collecting samples for the analysis of volatile compounds, the pumping rate should not exceed 100 milliliters per minute. After these samples are collected the pumping rate can be increased for collection of other samples. Once collected, the samples should be labeled using a waterproof label and waterproof ink, sealed in plastic bags, and placed on ice in an ice chest cooled to 4°C. The sample number, amount collected, and time collected should be recorded on a chain-of-custody form and in a logbook.

4.3.3.2 Cross-Contamination Minimization

As with purging, the sequence of monitor well sampling should be done, whenever possible, from the well least likely to be contaminated to the well most likely contaminated to reduce the potential for cross-contamination. If this information is not available, an attempt should be made to sample upgradient wells first and then downgradient wells.

4.3.3.3 Collection for Metal Analysis

If analysis for metals is required, water samples that contain high concentrations of sediment may be field filtered before the sample is collected for metal analysis. A hand pump and a filter device can be used, or an in-line filter (0.45 micron) in conjunction with the bladder or inertia pump. The groundwater sample should be run through the filter and collected in a clean sample container. it is recommended that a second sample should be sent to the laboratory for analysis. All equipment should be decontaminated before filtering and between sampling locations.

4.3.3.4 Use of Dedicated Equipment

If possible, the equipment used to sample a well should be dedicated equipment. If a bailer is used, each well should have a dedicated bailer that is stored in the well. Another alternative which is preferred over nondedicated sampling equipment is a disposable bailer which may be used for a single well sampling. If a bladder pump is used, each well should

have dedicated tubing. Dedicated equipment should still be decontaminated prior to use. By using dedicated equipment, the chances of cross-contamination are greatly reduced.

4.3.3.5 Collection for Volatile Organic Analysis

Special care should be taken when collecting samples to be analyzed for volatile compounds. The water should be transferred slowly from the bailer, bladder, or inertia pump to the sample container to reduce the potential for aeration of the samples. Samples requiring the analysis for organics should not be filtered or transferred from one container to another because losses of organic compounds onto the walls of the containers or aeration may occur. Samples to be analyzed for Total Organic Carbon (TOC) should be handled and analyzed as materials containing volatile organics. No headspace should exist in the sample containers for volatile compounds or TOC to minimize the possibility of volatilization of organics.

4.4 QUALITY CONTROL SAMPLES

To attain the project quality assurance objectives discussed in this document, certain Quality Control (QC) samples need to be collected and sent to the laboratory. The following is a discussion of those samples:

4.4.1 Trip Blanks

These samples consist of laboratory-prepared VOA vials, filled with volatile organic-free water which are shipped with the sample containers. These vials remain in the sample cooler and are not to be opened. They will be analyzed in the same manner as the collected samples, and are used to monitor volatile organic compounds due to container contributions or contamination during shipment. A trip blank shall accompany each sampling event (defined as the duration of the sampling of the wells in the plant) for which sample for volatile organic analysis are being collected.

4.4.2 Rinsate Blanks

These samples are used to monitor contamination resulting from the sampling equipment and also to monitor the effectiveness of equipment decontamination procedures. Rinsate samples

are collected by pouring reagent grade water over decontaminated sampling equipment, in such a manner as to contact the same surfaces as the samples and collecting that water for analysis. Rinsate blanks will be collected at a minimum of one per sampling event. If there is more than one type of parameter being monitored in that sampling event, the rinsate blank will be analyzed for only the organic constituents (volatile and semivolatile, if applicable).

4.4.3 Sample Preservation and Shipment

The appropriate preservative will be added to each sample bottle by the laboratory prior to being taken into the field. Table 8 lists containers, preservatives, and holding times for the parameters being analyzed in this program.

Once the sample is placed in the bottle, a label should be affixed to the bottle. The label shall contain the following information: plant area, sample number (monitor well number), date, time of sample collection, parameter for analysis, preservative (if any), and the collector's name. The samples shall be placed in an ice chest containing an adequate volume of ice to maintain samples at 4°C. The ice chest should be sealed for shipment.

All samples will be continuously tracked in the field and while in transit. A chain-of - custody form shall accompany the samples at all times. The sample custody procedures are further described in Section 4.4 of this document.

4.5 GROUTING

Following completion of each borehole, the borehole will be grouted with a cement/bentonite grout (4 to 8 percent bentonite by dry weight). The grout shall consist of Portland cement and powdered sodium bentonite. The grout mix will consist of a pumpable cement/bentonite slurry. The grout shall be mixed in clean, above ground, rigid containers with an appropriate quantity of water. The mixing of each component will be achieved by a mechanical paddle device or recirculation with a grout pump. Mixing activities will continue until a smooth, lump free consistency is achieved.

The grout mixture shall be pumped through a rigid, side discharge tremie pipe placed approximately 6 inches above the bentonite seal for monitor well installation or on the

bottom of the hole for plugging and abandonment of soil borings. The grout mixture shall be pumped until undiluted grout flows from the annulus at the ground surface. The tremie pipe may be slowly withdrawn during grouting operations. The estimated volume of grout will be computed for each boring or well, based upon borehole dimensions and well dimensions. If actual grout placed is less than or exceeds 50 percent of the computed volume, the grouting for that boring or well will be evaluated to determine if grouting problems are present (i.e. caving or excessive grout takes).

After a minimum 24-hour period, the boring or well will be inspected for settlement of the grout and more grout will be added as needed. This process shall be repeated until firm grout is at or within one foot of the ground surface.

The specifications for the materials making up the grout are:

- Bentonite will be powdered, granular, or chipped sodium montmorillonite furnished in moisture resistant sacks and without additives.
- Cement will be a low-alkaline Portland Cement, Type I in conformance with ASTM C-150 and without additives.

4.6 AQUIFER TESTING (To be implemented prior to detailed design of corrective action)

Single well tests are referred to as slug tests. These tests are performed by suddenly adding or removing a slug (known volume) of water from a monitor well and observing the recovery of the water surface to its original level. In systems where the entire depth of the aquifer formation is screened, such tests provide information on the horizontal component of hydraulic conductivity. When only a portion of the aquifer depth is screened, the slug test results give a hydraulic conductivity containing both horizontal and vertical components. Most of the pressure loss (head loss) is dissipated in a horizontal direction, therefore, the value of hydraulic conductivity evaluated is assumed to be most horizontal. Bower (1978) discusses a slug-test procedure applicable to fully or partially penetrating wells in unconfined aquifers. He discusses the use of dimensionless solutions of the Thiem equation to determine the hydraulic conductivity from observed values of water level and elapsed time.

4.6.1 Equipment

Slug testing equipment will consist of:

- Pressure transducer(s)
- Suspended weight of known volume (slug).
- Electric water level probe and/or steel tape.
- Data logger (recorder)
- Field data printer.

Since the pumping test program will be developed as needed after performing the slug testing, it is not possible to identify equipment to be used in conducting the pumping test(s) at this time. A listing of such equipment will be compiled when the pumping test program has been developed.

4.6.2 Procedure

The specific slug test performed will be a falling head test followed by a rising head test. Measurements of the behavior of the piezometer system as it returns to equilibrium are then made and used for analysis. The test will be run until the system has achieved 90 percent equalization. Field procedures for slug testing are as follows:

- The magnitude of instantaneous head change resulting from introduction or removal of the slug shall not cause water to overflow the casing. To assure meeting these requirements, magnitude of head change shall be determined prior to introduction of the slug. The magnitude determination shall be based on the calculated volume of the slug and the inside diameter of the casing. The test shall proceed only when these requirement are met.

- All equipment shall be decontaminated prior to placing into the piezometer. Decontamination shall consist of triple rinsing with deionized water.

- The static water level shall be measured using an electronic water level sensor or weighted tape.

- When the transducer is lowered into the piezometer and in place, the slug shall be introduced as rapidly as possible without causing undue splashing or turbulence so as to produce an instantaneous head increase. The instant the slug is set in place, the reference time will be time zero.

- Water levels shall be measured continuously (millisecond intervals) with the transducer and recorded with the data logger unit. Measurements shall be terminated when the water level stabilizes or when the water level has reached a level within 10 percent of static level.

- Water level measurements recorded shall be checked for credibility before proceeding to the next testing stage (removal of the slug).

- When checking of data has been completed and the previous testing has been determined to be acceptable, the slug shall be removed as rapidly as possible to produce an instantaneous head reduction. The instant the slug is removed from the water, the reference time will be time zero.

- Water levels shall be measured continuously (as in the previous testing stage) using the transducer and shall be recorded using the data logger unit. Measurements shall be terminated when the water level stabilizes or reaches a level within 10 percent of initial static water level.

- When measurements are terminated, the transducer shall be removed.

- Water level measurements recorded shall be checked for credibility before proceeding.

- Any test or test stage shall be repeated if review of the recorded data indicates questionable validity.

The data from the slug test will be reduced to evaluated time versus change in water level using the methods of Cooper, et al. (1967) or Bower and Rice (1976). Upon evaluating the results of the slug test, a pumping test plan may be developed.

4.6.3 Documentation

Water level data shall be recorded with the data logger and preserved for offloading at the Woodward-Clyde Consultants office in Baton Rouge, Louisiana. To the extent possible, print outs shall be obtained for each set of tests during the data checking phase of testing. Printouts obtained shall be properly labelled to indicated the following and shall be preserved as raw field data:

- Piezometer location
- Piezometer number
- Date of Test
- Elevation of Base of Test Section
- Elevation of Top of Test Section
- Testing Stage (i.e., slug-in or slug-out)

If a printout cannot be obtained, the data shall be hand recorded in the field log book, if possible or the piezometer will be retested.

5.0
WELL INSTALLATION

Upon completion of the drilling and sampling as described above for borings three wells will be installed at locations noted in Figure 1 and Figure 2 of the RFI Strategy, Characterization, Schedule and Management Plan.

5.1 EQUIPMENT

In addition to drilling and sampling equipment described previously, the material required for installation will consist of:

- A screen to allow entry of ground water.
- A bentonite pellet seal above the filter pack to prevent downward migration into the filter media.
- A filter pack to fill the space between the borehole and the screen with a stable material and to limit entry of fine materials into the well.
- Blank pipe or casing connecting the screen to the ground surface.
- A low permeability grout seal between the casing and the borehole to isolate the screened interval from the ground surface.
- Intermediate casings to seal off permeable zones above the target stratum, as needed.
- A protective casing at the surface.
- A surface slab.
- Protective posts.

5.1.1 Procedure

The construction for well involves drilling of borehole to the total depth and backfilling the hole in succession with the screen (with a cap and sump on the bottom), the blank pipe above the screen, a filter pack around the screen, a bentonite pellet layer and cement bentonite grout to the surface.

In the event that it is necessary to "case off" contamination from being carried further subsurface, the following procedure may be followed. Such wells will be constructed by drilling a borehole through the base of the upper permeable zone and one to three feet, at the discretion of the qualified WCC representative, into the underlying clay. A Schedule 40 PVC casing is lowered into the borehole and pushed about one foot into the clay at the base of the boring. The casing is then grouted in place by pumping a cement bentonite grout through a tremie pipe into the borehole between the outer casing wall and borehole wall. At completion of the grouting, the grout is allowed to cure for 24 hours and the downhole drilling equipment is decontaminated. During the grout set period the casing will be capped to prevent tampering until well installation is resumed. After the grout has set, the inside of the 12 inch casing is thoroughly flushed with clean water. The borehole and installation are then completed through the casing. Wells will be surveyed upon completion prior to sampling.

Screen.

Screens will be 2-inch diameter Schedule 40 PVC with No. 10 slot size. Connections between the screen and the casing will be threaded. No glues, solvents, epoxies, thermal processes (except welding) or rivets will be used.

A direct measurement of borehole depth by the use of a clean, chemically inert, weighted measuring tape shall be made before screen placement. The depth, to the nearest tenth of a foot shall be recorded on the construction log.

The borehole shall be purged or flushed with water, to the extent practical of drill cuttings and any bentonite drilling mud used during construction. If during construction unstable soils or other factors resulting in side wall caving or "blow-in", were encountered, the use of temporary casing will be required. The temporary casing shall be steam cleaned and free of coatings and rinsed with water prior to use.

The screen shall be new, commercially fabricated continuously wound or slotted screen with a four-inch nominal diameter. No fittings shall obstruct the inside diameter. The screen will be free of foreign matter and steam cleaned prior to use.

Screens shall be 0.01 inch slot and no longer than 10 feet in length nor shorter than five feet. Screens will be placed based on the qualified WCC representative's description of formation materials.

Filter Pack.

After the screen is placed in the borehole the filter pack will be placed around it. The filter pack material will consist of a clean graded sand (typically 20-40 mesh sand).

None of the filter pack aggregate is to come in contact with the ground surface. Any aggregate that comes in contact with the ground surface or is otherwise contaminated shall not be introduced into the well. Filter aggregate may be placed directly from the bag; however, care will be exercised not to include the dust and fines from the bottom of the sack.

The filter pack is to be placed by either tremie pipe or poured down and around the annulus in such a manner as to be distributed around the screen at a uniform height and density.

If temporary casing is used, the filter pack will be placed first and then the casing partially withdrawn to allow the filter pack to slump against the side walls of the boring. Additional filter aggregate will be added to allow for the slight increase in volume.

The filter pack will extend 1 to 2 feet above the top of the screen unless this height prevents proper placement of the bentonite seal. Placement of an adequate bentonite seal shall override the filter pack thickness except that the filter pack will come at least one foot over the top of screen. In no case shall the filter pack extend such that separate permeable zones are connected.

Pipe and Casing.

Blank pipe or casing made of 2-inch diameter Schedule 40 PVC will extend from the top of the screen to between three and four feet above ground surface. This blank pipe will be attached to the screen by a threaded connection. The casing will be capped with a vented top cap.

Grout Seals.

A bentonite pellet seal shall be 2 or 3 feet in thickness and will be placed in such a manner as to be uniform in thickness around the casing. In placing the bentonite pellets, care will be exercised so as not to incorporate any of the accumulated bentonite fines from the bottom of the packaging container into the annulus.

However, if the soils in this area are unstable to the degree that slumping or collapse of these soils against the permanent wall casing is highly probable, then the bentonite pellet seal shall be placed first and the temporary casing withdrawn as expeditiously as practical. After placement of the bentonite seal, the seal will be given adequate time to hydrate as determined by the qualified WCC representative. After the hydration period, the top of the bentonite seal shall be determined by direct measurement and recorded on the construction log.

The annular space above the bentonite seal will be grouted. All grout materials shall be placed by pumping through rigid, side discharge tremie pipe.

Protective Casing

A 8-inch locking protective casing shall be placed around the PVC riser pipe as soon as possible after grout inspection has been completed. The protective casing shall be provided with a threaded, 1/4-inch hole and drain plug at a base of the exposed portion of the protective casing. The protective casing shall fit such that there is sufficient clearance for cap accessibility.

The inside of the locking cover of the protective casing shall have the following inscribed, stamped or otherwise permanently affixed:

- Identification number
- Top of casing elevation
- Depth
- Screen length
- Date of well installation

- Construction contractor's name

The locking protective casing, at a minimum, shall be five feet in length and extend just over the riser pipe, and be manufactured of new black iron, steel, or stainless steel pipe or will be protective covers commercially manufactured for that purpose. Prior to placement, the casing shall be steam cleaned and free of any asphaltic or resinous coatings except paint or primer applied by the manufacturer. The casing shall be provided with a locking cap that telescopes or in some similar manner extends over and down the casing to prevent the entrance of rainwater, wind-blown dust particles, or insects into the casing. All protective casings shall be provided with a padlock, which shall be locked until the time of sampling.

Surface Slab.

A concrete slab will be poured at the ground surface around each well after installation. The slab will be at least four inches thick and five feet square and sloped gently away from the well in all directions.

Protective Posts.

Wells located in areas of traffic will be further protected by the erection of four steel posts, or approved alternate, each radially located 4 feet from each well, placed 2 to 3 feet below ground surface, having 3 feet minimally above ground surface. Guard posts shall not be made a part of any protective slab constructed around the well.

5.1.2 Documentation

Each installed well shall be depicted in an installation report. This report shall be attached to the boring log for that installation and shall graphically denote, by depth from ground surface (unless otherwise specified):

- The bottom of the boring (that part of the boring most deeply penetrated by drilling and/or sampling) and borehole diameter;
- Screen location;
- Granular filter pack;

- Bentonite pellet seal;
- Grout;
- Cave-in(s);
- Height of riser (without cap/plug) above ground surface;
- Protective casing detail;
  - height of protective casing without cap/cover
  - base of protective casing
  - drainage port location and size
  - guard post configuration

The construction report will include:

- The actual quantity and composition of the grout, seals, and granular filter pack used for each well.
- The screen slot size (in inches), outside diameter, schedule/thickness, composition, and manufacturer.
- The outside diameter, schedule/thickness, composition, and manufacturer of the well casing.
- The joint design and composition.
- Location of placement of bentonite pellet seal.
- Location of placement of annular grout.
- Protective casing composition and nominal inside diameter.
- Special problems and their resolutions; e.g., grout in wells, lost casing and/or screens, bridging, etc.
- Dates and times for the start and completion of well installation.

All abbreviations used on the boring logs/well diagrams shall be designated on the log-diagram or in an attached general legend.

6.0 DOCUMENTATION

For documentation purposes, all information pertinent to field observations and sampling will be recorded in a field logbook with consecutively numbered pages. Entries in the log book will include at least the following:

- Location and sampling activity and address,
- Purpose of sampling,
- Number and approximate volume of samples taken,
- Description of sampling point,
- Date and time of collection,
- Collector's sample identification number(s),
- Sample distribution (e.g., chemical laboratory, geotechnical laboratory, etc.),
- Sample preservation,
- Field observations,
- Any field measurements made, such as pH, temperature, specific conductivity, or other field parameters,
- Weather conditions.

The documentation in the log book will be sufficient to reconstruct the sampling situation without relying on the collector's memory.

6.1 BORING LOGS

Field boring logs of a type similar to that presented in Figure 5 will include at a minimum the following information for each boring location:

- Project name and number
- Boring number
- Location of boring (including measured offset and reason for offset)

- Drilling method
- Name of WCC representative

Each log will also include:

- Sample location number and depth
- Water levels and the respective times of each reading
- Description of subsurface materials using the Unified Soil Classification System (USCS) including classification, consistency, texture, plasticity, moisture content, color, stratification, etc.
- Sample recovery in inches
- Results of organic vapor monitoring, if required
- Sample interval

6.2 PIEZOMETER INSTALLATION/DEVELOPMENT REPORTS

A piezometer installation report will be completed for each newly installed piezometer at the site. Information on these reports shall include the screening interval, depth to sand pack and bentonite seal, and grout backfill. The report will be documented using a form as shown on Figure 7.

6.3 GROUNDWATER SAMPLING REPORT

A sample collection log specific to groundwater sampling will be completed for each monitor well sampled at the site. These reports shall include static groundwater elevation, volumes purged, weather conditions, etc. The report will be on a form similar to Figure 8.

6.4 SAMPLE CUSTODY DOCUMENTATION

Chain-of-custody will be maintained for each sample collected. The chain-of-custody will provide an accurate written record which can be used to trace the possession and holding of samples from the time of collection through data analysis and reporting. The following information will be specified for each sample on the chain-of-custody form:

- Sample number
- Sample date
- Sample time
- Sample location and depth where appropriate
- Analyses to be performed

The chain-of-custody form will be signed by the sample custodian. It will be placed in a water-tight plastic bag and taped to the underside of the lid of the cooler containing the samples designated on the form. The lid of the cooler will be securely taped shut and signed custody seals will be placed on the opening of the cooler lid to allow detection of any possible tampering. Upon arrival in the laboratory, samples will be received by the analytical laboratory representative. Samples contained in the shipment will be compared of the chain-of-custody form to verify that all samples designated have been received. Sample custody within the laboratory will be maintained on internal tracking forms.

The chain-of-custody procedures document sample possession from the time of collection to final disposition. A Sample Analysis Request Form will accompany the Chain-of-Custody form and will document the requested sample analysis.

For the purpose of these procedures, a sample is considered in custody if it is:

- In one's actual possession
- In view, after being in physical possession
- Locked so that no one can tamper with it, after having been in physical custody
- In a secured area, restricted to authorized personnel

A chain-of-custody record will be initiated in the field, and the original will accompany the samples with copies retained at intermediate steps.

Each time responsibility for custody of the sample changes, the new custodian will sign the record and denote the date. A copy of the signed record will be made and retained by the immediately previous custodian to allow tracking of sample possession. All changes of custody of samples must be a person-to-person change of physical possession.

6.5 ANALYSIS REQUEST

Analysis of the samples collected shall be in accordance with the EPA CLP protocol. All samples shipped for analytical testing shall be accompanied by a Chain-of-Custody form and Sample Analysis Request form for document requested analyses. A copy of a sample Analysis Request form is presented as Figure 5.

7.0
DECONTAMINATION

Personnel will wear appropriate protective clothing during decontamination as required by the Health and Safety Plan. All protective equipment (gloves, boots, etc.) will be decontaminated after use or they will be disposed in drums, labeled, dated, and stored until disposed at an approved facility.

7.1 CROSS-CONTAMINATION CONTROL PROCEDURES

In order to minimize the possibility of cross-contamination, strict cross-contamination control procedures should be followed. These procedures include:

- Sample jars should be kept in limited access areas until used.
- Clean equipment should be wrapped in aluminum foil or plastic sheeting prior to use.
- Clean plastic sheeting shall be placed at the sampling area and all equipment should be placed on the sheets. This plastic shall be discarded after each use.
- Equipment refueling shall be performed in designated areas. These areas should be at a distance from any sampling points, to minimize the potential that vapors from fuel will affect sample quality.
- All purge water, decontamination water, and discarded gloves should be containerized for disposal.

To prevent contamination prior to drilling operations, the following will be applied:

- Only new materials will be used. Only bagged cement, powdered bentonite in bags or bentonite pellets in well protectors will be used.
- PVC pipe for riser and well screen will be cured and free of plasticizers and oils.

- Workers will wear clean cotton or surgical gloves when handling riser and well screen.
- Electrical tape will not be used to band pumps.

7.2 SAMPLING EQUIPMENT DECONTAMINATION

All equipment used to collect groundwater samples should be decontaminated prior to the collection of the samples and in between sample locations. Decontamination of this equipment will be accomplished by the following procedures:

- Wash equipment thoroughly with laboratory, phosphate free detergent (i.e., Alconox) and de-ionized water using a brush to remove any particular matter or surface film.
- Triple rinse equipment thoroughly with clean deionized water.
- Rinse equipment thoroughly with methanol.
- Triple rinse with clean deionized water.

In the event that metals become a primary concern, sampling equipment will be rinsed with HCl prior to the methanol rinse. The sampling equipment will be wrapped in aluminum foil or visqueen after decontamination until reuse. This equipment will be decontaminated in areas established near the perimeter of the sampling area. Rinsate samples well be collected as indicated in the Quality Assurance Plan.

7.3 PUMP DECONTAMINATION

If a monitor well has been purged or sampled using any of the pumps as discussed, the pumps used need to be decontaminated between sample points. Decontamination of the pumps includes washing with soap and rinsing the outside portion of the pumps (especially those pumps that are placed inside the wells) as well as running water through the pump. It is recommended that a sufficient volume of distilled water or de-ionized water be run through the pumps to clean them out.

7.4 DOWNHOLE EQUIPMENT DECONTAMINATION

The drilling rig with associated tools and all sampling equipment will be decontaminated before entering the site and leaving the site. Downhole equipment (i.e., augers, bits, samplers, etc.) will be cleaned between boring or other sampling locations at a decontamination/washdown pad. Wash water will be containerized or transported to the wastewater treatment facility.

The equipment will be cleaned as described below:

- The drill rig, all auger flights, auger bits, drilling rods, drill bits, core barrel samplers, Shelby tubes, or other parts of the drilling and well development equipment that will contact the soil or groundwater should be cleaned with a steam cleaner or hand washed with a brush and detergent to remove oil, grease, and any contamination that has accumulated on the equipment.
- Any sampling equipment which can be safely steam cleaned shall be decontaminated as described above.
- These units should then be rinsed thoroughly with potable water

8.0
SAMPLE ANALYSIS

8.1 ANALYTICAL PROCEDURES

During the RFI field work there will be analyses performed for constituents of concern form the following list:

List:	Parameter or Group of Parameters:
A	Atrazine, cyanazine, arsenic, dinoseb, toxaphene, toluene
B	TCL, TAL, atrazine, cyanazine, dinoseb
C	Atrazine, cyanazine, arsenic, dinoseb, toxaphene
D	TCL, dioxin, TAL, atrazine, cyanazine, dinoseb
E	BTEX, TPH
F	BTEX, TPH, atrazine, cyanazine, arsenic, dinoseb, toxaphene

A table listing the SWMU Number, number of samples to be taken and the analytes and parameter or group of parameters is presented as Table 1 for the RFI Workplan and Table 2 for the Groundwater Assessment Workplan.

A summary of the parameter and possible methods to be employed by the offsite laboratory are as follows:

Parameter:	Protocol
Toxaphene, Atrazine and Cyanazine	EPA SW-846, Method 8080
Dinitrobytyl Phenol (Dinoseb)	EPA SW-846, Preparation Method 3550, Analysis Method 8015
Arsenic	EPA SW-846, Method 7060
Toluene	EPA SW-846, Method 8020
TCL, Dioxin (see Table 3)	Statement of Work for Organic Analysis Multi-Media Multi-Concentration, SOW 2/88, Revision 9/88, 4/89, and 5/89, Office of Solid Waste and Emergency Response, U.S. EPA, Washington, D.C., May 1989

Parameter:	Protocol
TAL (see Table 4	Statement of Work for Organic Analysis Multi-Media Multi-Concentration, SOW No. 788, Revisions 2/89 and 6/89, Office of Solid Waste and Emergency Response, U.S. EPA, Washington, D.C., June 1989

8.2 CALIBRATION PROCEDURES AND FREQUENCY

Measuring and test equipment used in the field and laboratory shall be controlled by a formal calibration program. The program shall provide equipment of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results. Calibration of measuring and test equipment may be performed internally using in-house reference standards, or externally by agencies or manufacturers.

8.2.1 Calibration Procedures

Documented and approved procedures shall be used for calibrating measuring and test equipment. Whenever possible, widely accepted procedures, such as those published by the ASTI or U.S. EPA, or procedures provided by manufacturers in equipment manuals, shall be adopted.

Calibrated equipment shall be uniquely identified by using either the manufacturer's serial number, an equipment identification number, or other means. This identification, along with a label indicating when the next calibration is due (only for equipment not requiring daily calibration), shall be attached to the equipment. If this is not possible, records traceable to the equipment shall be readily available for reference. It is the responsibility of all personnel to check the calibration status from the due date labels or records prior to using the equipment.

Measuring and test equipment shall be calibrated at prescribed intervals and/or as part of operational use. Frequency shall be based on the type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, intended use, and experience. Equipment shall be calibrated, whenever possible, using reference standards having known relationships to nationally recognized standards (e.g., National Bureau of

Standards) or accepted values of physical constants. If national standards do not exist, the basis for calibration shall be documented.

Reference standards (physical and chemical) shall be used only for calibration. Physical standards shall be stored separately from working measuring and test equipment. Equipment that fails calibration or becomes inoperable during use shall be removed from service and segregated to prevent inadvertent use and shall be tagged to indicate it is out of calibration.

Records shall be prepared and maintained for each piece of calibrated measuring and test equipment to indicate that established calibration procedures have been followed. Laboratory calibration records shall be maintained by the laboratory.

8.2.2 Field Equipment Calibration

Field calibration procedures will be performed on field instrumentation as follows:

- pH Meter - Premeasurement calibration and post-measurement verification using at least two standard buffer solutions for each sample tested. The buffer solutions should bracket the sample pH. The two measurements must be within ± 0.05 standard unit of buffer solution values.

- Conductivity Meter - Daily calibration using potassium chloride (KCl) standard solution. The meter measurement must read ± 10 percent of the standard to be considered in control.

- Temperature - Temperature is measured using a thermostat built into the conductivity meter. The readings will be checked at least once at the start of the field use of the instrument using a quality grade thermometer.

- OVA - The instrument will be calibrated daily to a methane in air standard.

Calibration of field equipment shall be documented in the field log book for reference and maintained in the project files.

8.2.3 Laboratory Equipment Calibration

Laboratory calibration procedures for analytical testing will be performed in accordance with SW-846, 3rd Edition and EPA CLP protocols, as appropriate.

9.0
DATA REDUCTION, REPORTING, AND VALIDATION

To ensure that the analytical DQOs for the project are met and to evaluate the overall acceptability of the analytical data, a review of the laboratory analytical report will be conducted. This review will consist of a check of "external" and "internal" laboratory QA/QC results.

The external quality assurance review will include a check of contaminants in the field-collected QA samples (trip blank, rinsates and duplicate samples) submitted with the environmental samples. Evidence of contaminants in these QA samples will be compared against the environmental sample results to evaluate whether detected constituents are related to field or laboratory artifacts.

The internal quality assurance review will include a review of the laboratory QA/QC results to determine if holding times, initial and/or continuing calibration curves, surrogate recoveries, matrix spikes and matrix spike duplicates and blank contamination objectives have been met according to the laboratory's internal quality assurance program.

9.1 DATA REDUCTION

All concentration associated with samples or prepared sample extracts or digestates will be taken directly from multiplied quantitation reports. Multiplied quantitation reports relate the instrumentally measured extract or digestate concentrations to those of the original sample. GC/MS concentration data will be taken, to the extent possible, directly from the data systems following an internal standard calibration for both the volatile and semivolatile base/neutral/acid compounds and following an external calibration for both the pesticide and herbicide compounds.

9.2 DATA REPORTING

The intention of these sampling data reporting procedures is to maintain accurate records of all samples taken and to follow the status of the sample location and analytical results, while minimizing the duplication of record keeping activities and the possibilities for errors.

The tabulation and flow of all data reporting information can be broken down into the following activities:

- Assignment of sample numbers, sample label preparation, and initial permanent record keeping,
- Preparation and labeling of all sample bottles,
- Sampling and in-the-field-record keeping,
- Sample receiving and preparation for shipping, and
- Complete sample record book.

9.2.1 Sampling Record Keeping

Prior to collecting a group of samples, a sample coordinator will assign a sample number and a description to all samples to be collected within the group. Sample numbers will be assigned to all divisions of the original sample, all of which have the same identification number with letters denoting subset containers. The sample number and corresponding description will be entered into a permanent record book. The information in the record book will then be written onto the appropriate sample label. When written, the sample labels will be given to the individual responsible for preparing the sample bottles.

The typed/printed labels for a group of sequentially numbered samples and a copy of the data book pages that include these numbers will be given to the sample bottle preparer and/or the sampler. This individual is responsible for applying all labels on the appropriate types of bottles. The sample preparer may also be the person who will be doing the sampling. A copy of the data book pages that include information about the samples will also be given to the person doing the sampling in order to provide a list of samples to check off during the sampling activity.

The individual(s) doing the sampling is (are) responsible for verifying that each sample is put in the appropriate sample bottle. At the time of sampling this person must fill in the time sampled, the date sampled, and sign and complete the sample's label. By the end of the sampling day, the sampler must return all samples to the geologist or engineer, who will oversee preparation of the samples for shipment (i.e., review chain-of-custody formes, inspect packaging, etc.

The person responsible for shipping the full sample bottles will compare the sample bottles with the appropriate sample data book pages. This person will then prepare the samples for shipping. Chain-of-custody forms must be completed for each sample; the originals must be sent with the samples, and copies will be sent to the sample coordinator to include in the appropriate project files.

9.2.2 Sample Custody and Shipment

When the samples are ready to be sent to the laboratory, the sample coordinator will examine the samples and note their condition. Information including the date sampled, time sampled, and method of preservation,for each sample will be entered in the sample record book.

At the time the samples are shipped, the sample coordinator will have a copy of the pages in the sample record book that include information on the sample numbers and the corresponding information on the date sampled, time sampled, and the date shipped.

The chain-of-custody record will document the fact that the evidentiary integrity of the samples was maintained.

9.2.3 Laboratory Response

The laboratory will be responsible for reviewing all sample analyses according to their internal QA/QC procedures. Data validation will be completed by the laboratory prior to the delivery of the data package. Completed data packages will be available for review by the project data validation coordinator. Any problems will be resolved and all data will be validated before the data are reported.

Laboratory data for all CLP TCL and TAL parameters will be maintained sufficient to be able to generate the standard CLP forms, if necessary at a later date. The quality control data and sample data results will be presented in a concise and convenient tabulated summary. The calibration data, raw quality control data, and raw sample data will be sufficient to permit reproduction of the calculation of any of the reported values. In addition, routine laboratory reports will include the following:

- Chain-of-Custody Records
- Quality Control Summary
- Sample Data Results

When generated, each hard copy CLP data package will provide thorough coverage according to the following areas:

- Case Narrative
- Chain-of-Custody
- Quality Control Summary
- Sample Data Results
- Calibration Data
- Raw Quality Control Data
- Raw Sample Data

The case narrative will provide the following information:

- Sample Identification
- Parameters Characterized
- Analytical Methods Employed
- Any Deviation from the Project Work Plan
- All Problems Encountered
- Any Corrective Actions Taken

9.3 DATA VALIDATION

Data validation, according to Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans (QAMS-0050/80, Office of Monitoring System and Quality Assurance and Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 20460, December 29, 1980), is "a systematic process for reviewing a body of data against a set of criteria to provide assurance that data are suitable for their intended use", and entails editing, screening, checking, auditing, verification, certification, and review.

The purpose of data validation is to determine if the data conform to specifications and are suitable for the intended project usage. Therefore, all data will be potentially subjected to screening in terms of conformance to project specifications and suitability for use. After completing a sampling program, the field data package (calibration records, chain-of-custody, field logs, etc), will be reviewed for completeness and accuracy. The validation process described below will be done separately from the laboratory performing the analytical work as a separate process from internal laboratory data validation.

The following is a brief description of the methods that will be used if validation of the CLP laboratory data is required. These data will be reported in a summary data package and evaluated for conformance to the analytical limits set forth in Functional Guidelines for Evaluating Organic Analyses (Hazardous Site Evaluation Division, U.S. Environmental Protection Agency, February, 1988) and Functional Guidelines for Evaluating Inorganic Analyses (Hazardous Site Evaluation Division, U.S. Environmental Protection Agency, July, 1988). These checks will be performed on all samples analyzed, and the results will be summarized in a report for each lot of reported sample data. Qualified data will be reported as such and the appropriate qualifiers will be used for reporting. Non-CLP data and CLP data not required to be validated will be reviewed with respect to holding times, initial and continuing calibrations, method blanks, laboratory control samples, samples, matrix spikes and matrix spike duplicates or duplicates.

If problems occur which would reject data, the following outline of procedures should detect these problems and the problem data will not be reported. However, rejected data will be addressed in a validation report.

- Compile a list of all investigative samples.

- Compile a list of all QC samples, including but not limited to:
  - Trip blanks
  - Laboratory blanks
  - Laboratory duplicates
  - Performance samples
  - Matrix spikes
  - Matrix spike duplicates
  - Laboratory control spikes
  - Laboratory control spike duplicate

- Review chain-of-custody documents for completeness and correctness.

- Review laboratory analytical procedures and instrument performance criteria.
  - Sample media identification
  - Sample location and descriptions
  - Proper concentration units
  - Proper significant figures

- This data summary will be reviewed for potential data quality problems including:
  - Unexpected results
  - Common laboratory contaminants
  - Unusual spacial concentration/identification relationships
  - Samples in which dilution was necessary
  - Samples which may have exhibited "carry over"

- A sample summary will be prepared to access precision, accuracy and completeness of the analytical data.

- Laboratory records and data package requirements will be checked to assess completeness of the data package.

Laboratory performance results will be documented from the validation procedures or from precision or accuracy evaluations. The validation personnel will provide a means to notify the laboratory and initiate the appropriate corrective actions.

10.0
INTERNAL QUALITY CONTROL

10.1 DATA TRANSCRIPTION

All data transcriptions for final reports will be reviewed before reporting. Data transcription requirements may vary, but should be monitored in accordance with requirements for accuracy and legibility.

10.2 FIELD SAMPLING QUALITY CONTROL

Quality control for field sampling includes duplicate samples, field blanks and rinsate blanks. Steps and checks used to validate precision and accuracy of the measured parameters and to support the representativeness, comparability, and completeness of the work include:

- Description of the calibration of methods and instruments,
- Description of routine instrument checks (noise levels, drift, linearity, etc).,
- Documentation of traceability of instrument standards, samples and data,
- Documentation on analytical methodology and QC methodology,
- Description of applicable performance audits with appropriate audit materials,
- Description of controls for interference contaminants in analytical methods (use of reference blanks and check standards for method accuracy and precision),
- Description of levels of routine maintenance to verify analytical reliability, and
- Documentation of sample preservation and transport.

10.3 VERIFICATION AND REVIEW

The laboratory analyst should review data to verify that where appropriate, the laboratory:

- Calculates the recoveries of surrogate spikes,

- Verifies that there are no contaminants in all associated blanks,
- Compares samples and duplicates for matches in data results,
- Reviews surrogate and spike recovery data to make sure they are within quality acceptance limits,
- Verifies calibration performance for acceptability,
- Reviews and verifies instrument tuning,
- Reviews internal areas of response for acceptability.
- Makes sure the surrogate recovery section has been completed
- Makes sure that all analyzed compounds have been properly recorded
- Confirms identified sample spectra with standard spectra
- Verifies accuracy of calculations on compound quantities.

The supervisor examines the entire sample folder to verify that all data transcriptions and documentation included meets WCC requirements. The supervisor also reviews all data enclosed to verify that the data transcriptions are error free and that all documents are legible and in contractual order.

11.0
PERFORMANCE AND SYSTEM AUDITS

Audits may help to verify that the integrity of the data and related information is maintained.

11.1 FIELD ACTIVITY AUDITS

A senior project personnel or designee may periodically conduct an audit of the collection activities to verify that proper sampling protocol is being followed. Some of the items to evaluate include: sampling operations, sampling labelling, sample handling, field notes, decontamination procedures, and chain-of-custody. The auditor will prepare a summary audit report containing the result of the evaluation and recommendations for any corrective actions.

The auditor may check the following items to determine the completeness and accuracy of field activities:

- Sample Labels: A selected number of sample labels will be examined to determine if they were filled out properly and completely.

- Chain-of-Custody Procedures: Several chain-of-custody records will be examined to determine if they were properly filled out; if parameters for analysis were properly identified; all custody transfers were documented; and date and time of transfer were recorded.

- Field Notebooks: The notebooks will be examined to determine if proper recording format is being followed; if all in situ measurements and field observations are being documented suitably to explain and reconstruct field activities.

11.2 LABORATORY PERFORMANCE AUDITS

The performance of laboratories in the U.S. EPA Contract Laboratory Program is monitored by the agency by using quarterly blind performance samples. Should the laboratory

employed to analyze samples be in the CLP, then acceptable results on the most recent quarterly blind performance evaluation sample will be accepted as demonstrating laboratory capability to perform volatile, semivolatile and pesticide/PCB analyses. Performance evaluation samples may be obtained from a commercial supplier for laboratories that are not part of the EPA Contract Laboratory Program.

An on-site laboratory evaluation helps to verify that all the necessary quality control is being applied by the laboratory in order to deliver a high quality product. A laboratory audit of the laboratory used for sample analysis may be performed during the program.

Quality assurance evaluations allow the evaluators to determine that:

- The organization and personnel are qualified to perform assigned tasks.
- Adequate facilities and equipment are available.
- Complete documentation, including chain-of-custody of samples, is being implemented
- Required analytical methodology is being used.
- Adequate analytical quality control, calibration including reference samples, control charts, and documented corrective action measures, is being provided.
- Acceptable data handling, documentation techniques, and data review are being used.

12.0
PREVENTIVE MAINTENANCE

In order to timely and effectively complete a measurement effort, an attempt should be made to minimize downtime of all instrumentation. This is achieved by regular inspections of equipment and the availability of spare parts or supplemental instrumentation should the equipment fail.

WCC's preventative maintenance program is designed to minimize the down time of crucial sampling and/or analytical equipment due to expected or unexpected component failure. In implementing this program, efforts are focused in three primary areas:

- Establishment of maintenance responsibilities
- Establishment of maintenance schedules for major and/or critical instrumentation and apparatus, and documentation of maintenance activities in equipment logs.
- Establishment of an adequate inventory of critical spare parts and equipment.

12.1 FIELD INSTRUMENTATION

All instrumentation to be used in collecting or testing the groundwater samples will be regularly serviced and at a minimum, inspected prior to going out in the field to collect samples.

When laboratory or field equipment is damaged or it cannot be verified that it will produce acceptable data, the equipment will be removed from service to be repaired or replaced. The equipment will not be returned to service until it has been verified that it is capable of producing acceptable data. Acceptable data as referenced here is data which meets quality assurance criteria for precision, accuracy, and representativeness. Equipment leased or purchased to replace damage equipment shall be capable of producing equivalent data. The WCC site managers will be responsible for the repair and/or replacement of damaged field equipment and filed equipment provided by its subcontractors.

If nonanalytical type field equipment is damaged, it will be repaired immediately such that work may progress, or be replaced with similar or equivalent equipment such that the project objectives and the approved work plan will be met. The laboratory manager and site manager will retain documentation for the repair and/or replacement of laboratory and field equipment, respectively.

12.2 ANALYTICAL INSTRUMENTATION

The laboratory is expected to maintain and inspect their equipment. Instrument redundance, to the extent possible, coupled with an extensive stock of spare parts and expendable materials on-site will serve to minimize downtime.

Subcontract laboratories may be inspected to verify that similar preventive maintenance programs are in operation, and are properly documented including the following:

- Accepting data with an acknowledged level of uncertainty.
- Resampling and analyzing.
- Recalibration of instruments using freshly prepared calibration standards.
- Replacement of solvent or other reagents that give unacceptable blank values.
- Additional training of laboratory personnel in correct implementation of sample preparation and analysis methods.

The laboratory manager will be responsible for the repair and/or replacement of damaged laboratory equipment.

13.0
CORRECTIVE ACTION

During the course of this investigation, it will be the responsibility of the sampling team members to see that all measurement and sampling procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. In the event a problem is discovered, it is imperative that prompt and prescribed action to be taken to correct the problem. Corrective action will be initiated, for instance, if QC data are found to exceed acceptability limits.

Whenever corrective action is necessary to eliminate the cause of nonconformance, a closed-loop corrective action system will be used. The analytical coordinator will verify that all of these steps are followed:

- The problem will be defined,
- Responsibility for investigating the problem will be assigned,
- The cause of the problem will be investigated and determined,
- A corrective action to eliminate the problem will be determined,
- Responsibility for implementing the corrective action will be assigned and accepted,
- The effectiveness of the corrective action will be established, and
- The fact that the corrective action has eliminated the problem will be verified.

13.1 CORRECTIVE ACTION FOR FIELD SITUATION

If problems become apparent that are identified as originating in the field, corrective action will take place. If corrective action does not resolve the problem, appropriate personnel will be assigned to investigate and evaluate the cause of the problem. Once a corrective action is implemented, the effectiveness of the action will be verified.

13.2 CORRECTIVE ACTION FOR LABORATORY SITUATIONS

The need for corrective action will be initiated in consultation with the environmental lab personnel. Corrective Action may include, but is not limited to :

- Accepting data with an acknowledged level of uncertainty,
- Resampling and analyzing,
- Recalibration of instruments using freshly prepared calibration standards,
- Replacement of solvent or other reagents that give unacceptable blank values,
- Additional training of laboratory personnel in correct implementation of sample preparation and analysis methods.

14.0
QUALITY ASSURANCE REPORTS TO MANAGEMENT

Quality Assurance reports, if required, will include a tabulation of the analytical data and an explanation of any sampling conditions or QA/QC problems and their possible effects on data quality.

The laboratory analytical program manager and the data validation coordinator will communicate as needed to verify that all QA/QC practices are being carried out and to review possible or potential problem areas. Data anomalies are to be investigated to assess whether they are a result of operator or instrument deviation, or if they are a true reflection of the site or task function.

Analytical QA reports, if required, will contain a discussion of QA/QC evaluations summarizing the quality of the data collected an/or used as appropriate to each phase of the project and the following information:

- Tabulated results of the analytical data.
- Work sheets from the data personnel evaluating the validity of any analytical data with respect to accuracy, precision, and completeness.
- A summary of significant QA problems with the corrective actions taken to rectify the situation.

TABLES

TABLE 1

RFI WORKPLAN SAMPLE SUMMARY

SWMU Number	Sample Points	Samples (Soil or Concrete)	Analyte List
1/17	12	34	A
2 - Landfill	10	23	B
4 - Activated Carbon Treatment	6	6	B
5 - South Plant Drainage	16	16	C
7/20 - Former Dinoseb Production Area/Railroad Car Loading/Unloading Station	21	42	A
8 - Dinoseb Loading/Unloading Area	2	6	A
11/12/15 MSMA-Methyl Production Area	5	13	D
13 - West Drainage	9	9	C
14 - Toxaphene	3	6	C
16 - Atrazine	5	13	C
18 - Blue Tank	3	3	C
30 - Waste Oil	3	3	E
34 - Junkyard	6	6	F

LEGEND:

A Atrazine, cyanazine, arsenic, dinoseb, toxaphene, toluene
B TCL, TAL, atrazine, cyanazine, dinoseb
C Atrazine, cyanazine, arsenic, dinoseb, toxaphene
D TCl, dioxin, TAL, atrazine, cyanazine, dinoseb
E BTEX, TPH
F BTEX, TPH, atrazine, cyanazine, arsenic, dinoseb, toxaphene

TABLE 2

GROUNDWATER ASSESSMENT WORKPLAN SAMPLE SUMMARY (IMPLEMENTED CONCURRENTLY WITH RFI)

	Samples (Groundwater)	Analyte List
3 New Wells in South Plant	3	TCL, dioxin, TAL, atrazine, cyanazine, dinoseb

TABLE 3

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMIT (CRQL)*

	Quantitation Limits[a]	
	Groundwater µg/L	Low Soil/ Sediment µg/Kg[b]
Volatile Organics		
Chloromethane	10	10
Bromomethane	10	10
Vinyl Chloride	10	10
Chloroethane	10	10
Methylene Chloride	5	5
Acetone	10	10
Carbon Disulfide	5	5
1,1-Dichloroethene	5	5
1,1-Dichloroethane	5	5
1,2-Dichloroethene (Total)	5	5
Chloroform	5	5
1,2-Dichloroethane	5	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinly Acetate	10	10
Bromodichloromethane	5	5
1,2-Dichloropropane	5	5
cis-1,3-Dichloropropane	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5

TABLE 3 (Continued)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMIT (CRQL)*

	Quantitation Limits[a]	
	Groundwater µg/L	Low Soil/ Sediment µg/Kg[b]
trans-1,2-Dichloropropane	5	5
Bromoform	5	5
4-Methyl-2-pentanone	10	10
2-hexanone	10	10
Tetrachloroethene	5	5
Toluene	5	5
1,1,2,2-Tetrachloroethane	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Xylenes (Total)	5	5
Semivolatile Organics		
Phenol	10	330
bis-2-Chlorophenol	10	330
2-Chlorophenol	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
Benzyl Alchol	10	330
1,2-Dichlorobenzene	10	330
2-Methylphenol	10	330
bis(2-Chloroisopropyl)ether	10	330
4-Methylphenol	10	330
N-Nitro-di-n-dipropylamine	10	330
Hexachloroethane	10	330

TABLE 3 (Continued)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMIT (CRQL)*

	Quantitation Limits[a]	
	Groundwater µg/L	Low Soil/ Sediment µg/Kg[b]
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic Acit	50	1600
bis(2-Chloroethoxy)methane	10	330
2,4-Dichlorophenol	10	330
1,2,4-Trichlorobenzene	10	330
Naphthalene	10	330
4-Chloroaniline	10	330
Hexachlrobutadiene	10	330
4-Chloro-3-methylphenol(para-chloro-meta-cresol)	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1600
Dimethylphthalate	10	330
Acenaphthylene	10	330
2,6-Dinotrotoluene	10	330
3-Nitroaniline	50	1600
Acenaphthene	10	330
2,4-Dinorophenol	50	1600

TABLE 3 (Continued)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMIT (CRQL)*

	Quantitation Limits[a]	
	Groundwater µg/L	Low Soil/ Sediment µg/Kg[b]
4-Nitrophenol	50	1600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenyl-phenyl-ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1600
4,6-Dinitro-2-methylphenol	50	1600
N-Nitrosodiphenylamine	10	330
4-Bromophenyl-phenylether	10	330
Hexachlorobenzene	10	330
Pentachlorophenol	50	1600
Anthracene	10	330
Di-n-butylphthalate	10	330
Fluoranthene	10	330
Pyrene	10	330
Butyl Benzyl Phthalate	10	330
3,3'-Dichlorobenzidine	20	660
Benzo(a)anthracene	10	330
Chrysene	10	330
bis(20Ethylhexyl)phthalate	10	330
Di-n-octylphthalate	10	330
Benzo-(b)fluoranthene	10	330
Benzo-(k)fluoranthene	10	330

TABLE 3 (Continued)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMIT (CRQL)*

	Quantitation Limits[a]	
	Groundwater µg/L	Low Soil/ Sediment µg/Kg[b]
Benzo(a)pyrene	10	330
Ideno(1,2,3-cd)pyrene	10	330
Dibenz(a,h)anthracene	10	330
Benzo(g,h,i)perylene	10	330
Pesticide/PCBs		
alpha-BHC	0.05	8.0
beta-BH	0.05	8.0
delta-BHC	0.05	8.0
gamma-BHC	0.05	8.0
Heptachlor	0.05	8.0
Aldrin	0.05	8.0
Heptachlor Epoxide	0.05	8.0
Endosulfan I	0.05	8.0
4,4'-DDE	0.10	16.0
Endrin	0.10	16.0
Endosulfan II	0.10	16.0
4,4'DDD	0.10	16.0
Endosulfan Sulfate	0.10	16.0
4,4'-DDT	0.10	16.0
Methyoxychlor	0.05	80.0
Endrin ketone	0.10	16.0
alpha-Chlordane	0.05	80.0
gamma-Chlordane	0.05	80.0
Toxaphene	1.0	160.0

TABLE 3 (Continued)

TARGET COMPOUND LIST (TCL) AND CONTRACT REQUIRED QUANTITATION LIMIT (CRQL)*

	Quantitation Limits[a]	
	Groundwater µg/L	Low Soil/ Sediment µg/Kg[b]
Aroclor-1242	0.5	80.0
Aroclor-1248	0.5	80.0
Aroclor-1061	0.5	80.0
Aroclor-1221	0.5	80.0
Aroclor-1232	0.5	80.0
Aroclor-1254	1.0	160.0
Aroclor-1260	1.0	160.0

NOTES:

[a] Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.

[b] Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Volatile TCL Compounds are 125 times the individual Low Soil/Sediment CRDL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may no always be achievable.

SOURCE: Statement of Work for Organic Analysis Multi-Media Multi-Concentration SOW 2/88, Revisions 9/88, 4/89 and 5/89, Office of Solid Waste and Emergency Response, U.S. Environmental Agency, Washington, D.C., May 1989.

TABLE 4

TARGET ANALYTE LIST (TAL) INORGANICS

Analyte	Contract Required Detection Limits* (µg/l)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

NOTE:

* The reporting limits are instrument detection limits obtained in pure water. The detection limits for samples may be considerably higher depending on the sample matrix.

SOURCE: Statement of Work for Inorganic Analysis Multi-Media Multi-Concentration SOW No. 788, Revisions 2/89 and 6/89, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency

TABLE 5

DETECTION LIMITS FOR METALS[1]

	Nominal Water Detection Limit, mg/L			
Metal	**Flame AA**	**Furnace AA**	**Other AA**	**ICP**
Aluminum	0.1	0.003	--	0.05*
Antimony	0.2	0.002**	--	0.30*
Arsenic	0.5	0.002*	0.002	0.05*
Barium	0.1	0.002	--	0.005*
Beryllium	0.002	0.0001	--	0.001*
Cadmium	0.005	0.0001**	--	0.002*
Calcium	0.01	--	--	0.01*
Chromium	0.05	0.001	--	0.005*
Cobalt	0.05	0.001	--	0.003*
Copper	0.02	0.001	--	0.002*
Iron	0.03	0.001	--	0.01*
Lead	0.1	0.001*	--	0.02
Magnesium	0.05	0.001	--	0.01*
Manganese	0.01	0.0002	--	0.005*
Mercury	--	--	0.00002	--
Nickel	0.01	0.001	--	0.01*
Potassium	0.001	--	--	0.3*
Selenium	--	0.002*	0.002	0.075
Silver	0.01	0.0001**	--	0.003*
Sodium	0.002	--	--	0.5*
Thallium	0.1	0.001*	--	0.040
Tin	1	0.05	--	0.03*
Vanadium	0.2	0.004	--	0.002*
Zinc	0.005	0.00005	--	0.004*

NOTES:

* Recommended method for analyses (RMAL).
** More sensitive method sometimes used.
[1] Based upon SW846, 3rd Edition Methods.

TABLE 6

PRECISION, ACCURACY, AND COMPLETENESS OBJECTIVES

Measurement Parameters	Experimental Conditions	Surrogate Percent Recovery	Precision (Relative Percent Difference)	Accuracy (Percent Recovery)	Completeness (Percent)	Other EPA CLP Control Limits
Volatile (Purgeable) Organic Target Compounds[1]	Spiked and unspiked field samples	Compound Specific[2]	Compound Specific[3]	Compound Specific[3]	90	Laboratory Blank: ±D.L. Laboratory Duplicate: ±35% RPD Initial Calibration: RRF[4] > .05 and ≤ 25% D[6] *Continuing Calibration: >.05 RRF and ≤* 25% D[6] Internal Standard GC/MS: -50 to + 100%
Semivolatile (Base/Neutral and acid) Organic Target Compounds[1]	Spike and unspiked field samples	Compound Specific[2]	Compound Specific[3]	Compound Specific[3]	90	Laboratory Blank: ±D.L. Laboratory Duplicate: ±35% RPD Initial Calibration: RRF[4] > .05 and ≤ 30% D[6] Continuing Calibration: >.05 RRF and ≤ 25% D[6] Internal Standard GC/MS: -50 to + 100%
Pesticides and PCBs[1]	Spike and unspiked field samples	Compound Specific[2]	Compound Specific[3]	Compound Specific[3]	90	Laboratory Blank: ±D.L. Laboratory Duplicate: ±35% RPD Initial Calibration: 10% RSD Continuing Calibration: 15 or 20% RSD Internal Standard GC/MS: < 20%
Mercury[4]	Spike and unspiked field samples		±20 percent provided bothe sample and duplicate greater than 5 tiems CRDL ±CRDL if either sample or duplicate less than CRDL	75 to 125 percent unless the sample exceeds the spike concentration by a factor of four or more Not calculated if sample concentration exceeds spike concentration by a factor of four or more	90	Calibration Blank: ±D.L. Calibration Verification: 80-120% Preparation Blank: ±D.L. Duplicate Sample Analysis: ±D.L. or 20% RPD Lab QC Sample Analysis: 80-120%
Cyanide Total[4]	Spike and unspiked field samples		±20 percent provided bothe sample and duplicate greater than 5 tiems CRDL ±CRDL if either sample or duplicate less than CRDL	75 to 125 percent unless the sample exceeds the spike concentration by a factor of four or more	90	Calibration Blank: ±D.L. Calibration Verification: 85-115% Preparation Blank: ±D.L. Duplicate Sample Analysis: ±D.L. or 20% RPD Lab QC Sample Analysis: 80-120%

Woodward-Clyde

TABLE 6 (Continued)

PRECISION, ACCURACY, AND COMPLETENESS OBJECTIVES

Measurement Parameters	Experimental Conditions	Surrogate Percent Recovery	Precision (Relative Percent Difference)	Accuracy (Percent Recovery)	Completeness (Percent)	Other EPA CLP Control Limits
Target Analyte List (TAL) Metals Other than Mercury[4]	Spike and unspiked field samples		±20 percent provided bothe sample and duplicate greater than 5 tiems CRDL ±CRDL if either sample or duplicate less than CRDL	75 to 125 percent unless the sample exceeds the spike concentration by a factor of four or more Not calculated if sample concentration exceeds spike concentration by a factor of four or more	90	Calibration Blank: ±D.L. Calibration Verification: 90-110% Preparation Blank: ±D.L. Duplicate Sample Analysis: ±D.L. or 20% RPD Lab QC Sample Analysis: 85-115%
Restricted Target Analyte List (TAL) Metals[4] Calcium, Magnesium, Potassium, Sodium	Unspiked field samples		±20 percent provided bothe sample and duplicate greater than 5 tiems CRDL ±CRDL if either sample or duplicate less than CRDL	Not applicable. Matrix spikes not employed with these analytes.	90	Calibration Blank: ±D.L. Calibration Verification: 90-110% Preparation Blank: ±D.L. Duplicate Sample Analysis: ±D.L. or 20% RPD Lab QC Sample Analysis: 85-115%

Woodward-Clyde

TABLE 7

QUALITY CONTROL LEVEL OF EFFORT

Parameters		Frequency of EPA CLP Analysis	Frequency for SW846 Analysis
Cyanide	Calibration Blank	One per analytical run or at least one per setup	One per analytical run or at least one per setup
	Matrix Spike Analysis	One per analytical run or at least one per setup	One per analytical run or at least one per setup
	Duplicate Sample Analysis	One per analytical run or at least one per setup	One per analytical run or at least one per setup
	Laboratory QC Sample Analysis	One per analytical run or at least one per setup	One per analytical run or at least one per setup
Organics (GC/MS)	Laboratory Blank	One per case or one per 20 samples received	One per case or one per 20 samples received
VOA, Semivolatile, Pesticide/PCBs	Matrix Spike Analysis	One per case or one per 20 samples received	One per case or one per 20 samples received
	Matrix Spike Duplicate Analysis	One per case or one per 20 samples received	One per case or one per 20 samples received
	Surrogate Spike	Each sample	Each sample

Woodward-Clyde

TABLE 8

SURROGATE SPIKE RECOVERY LIMITS

Analytical Fraction	Surrogate Compound	Recovery Limits (%)
Volatile	4-Bromofluorobenzene	86 - 115
	1,2-Dichloroethane-d_4	76 - 114
	Toluene-d_5	88 - 110
Base/Neutral	Nitrobenzene-d_5	35 - 114
	2-Fluorobiphenyl	43 - 116
	p-Terphyenyl-d_{14}	33 - 141
Acid	Phenol-d_6	10 - 94
	2-Flurorphenol	21 - 100
	2,4,6-Tribromophenol	10 - 123
Pesticide	Dibutylchlorendate[1]	24 - 15

NOTE:

[1] Recovery limits are for advisory purposes only. They are not used to determine if a sample should be reanalyzed.

SOURCE: Statement of Work for Organic Analysis Multi-Media Multi-Concentration SOW 2/88, Revisions 9/88, 4/89 and 5/89, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C., May 1989.

TABLE 9

MATRIX SPIKE RECOVERY AND RELATIVE PERCENT DIFFERENCE CONTROL LIMITS

Analytical Category	Matrix Spike Compound	Relative Percent Difference	Recovery Limits (%)
Volatile	1,1-Dichloroethene	14	61 - 145
	Trichloroethene	14	71 - 120
	Chlorobenzene	13	75 - 130
	Toluene	13	76 - 125
	Benzene	11	76 - 127
Base/Neutral	1,2,4-Trichlorobenzene	28	39 - 98
	Acenaphthene	31	46 - 118
	2,4-Dinitrotoluene	38	24 - 96
	Di-n-Butylphthalate	40	11 - 117
	Pyrene	31	26 - 127
	N-Nitroso-Di-n-Propylamine	38	41 - 116
	1,4-Dichlorobenzene	28	36 - 97
Acid	Pentachlorophenol	50	9 - 103
	Phenol	42	12 - 89
	2-Chlorophenol	40	27 - 123
	4-Chloro-3-Methylphenol	42	23 - 97
	4-Nitrophenol	50	10 - 80
Pesticide	Lindane	15	56 - 123
	Heptachlor	20	40 - 131
	Aldrin	22	40 - 120
	Dieldrin	18	52 - 126
	Endrin	21	56 - 121
	4,4'-DDT	27	38 - 127

SOURCE: Statement of Work for Organic Analysis Multi-Media Multi-Concentration SOW 2/88, Revisions 9/88, 4/89 and 5/89, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C., May 1989.

TABLE 10

FIELD QUALITY CONTROL SAMPLE FREQUENCY GROUNDWATER MONITOR WELLS[1]

Matrix	*Field Duplicate*	*Rinsate Blank*	*Trip Blank*[2]	*MS/MSD*[3]
Groundwater	1	1	1	1
Analytical Parameter	All Parameters	VOA and Semivolatile	VOA	Spike

NOTES:

1 There are less than 20 monitor wells. A sampling event or sample delivery group shall consist of a groundwater sample from each well plus the 5 quality control samples.

2 Trip blanks will be prepared by the laboratory and shipped with the sample containers. One trip blank will be kept with the collected samples and shipped back to the laboratory in the last shipment.

3 Matrix Spiked/Matrix Spiked Duplicate samples will be spiked in the laboratory.

FIGURES

FIGURES

LOG OF BORING

PROJECT:
LOCATION:
CLIENT:
DRILLER:

BORING:
FILE: 01234
DATE:
TECHNICIAN:
APPROVED:
PAGE: 1 of 1

DEPTH (FEET)	SYMBOL	SAMPLE	S.P.T.(b/ft) or P.Pen.(tsf)	OVA (ppm)	Recovery (inch)	Description of Stratum
0						
5						
10						
15						
20						
25						
30						
35						
40						

FIGURE 1

MONITOR WELL INSTALLATION REPORT

PROJECT _____ PAGE _____ OF _____
LOCATION _____ WELL NO. _____
DATE COMPLETED _____ ORIGINAL DEPTH _____ AQUIFER _____
INSPECTED BY _____ DATE _____ _____
CHECKED BY _____ DATE _____ DEPTH INTERVAL _____

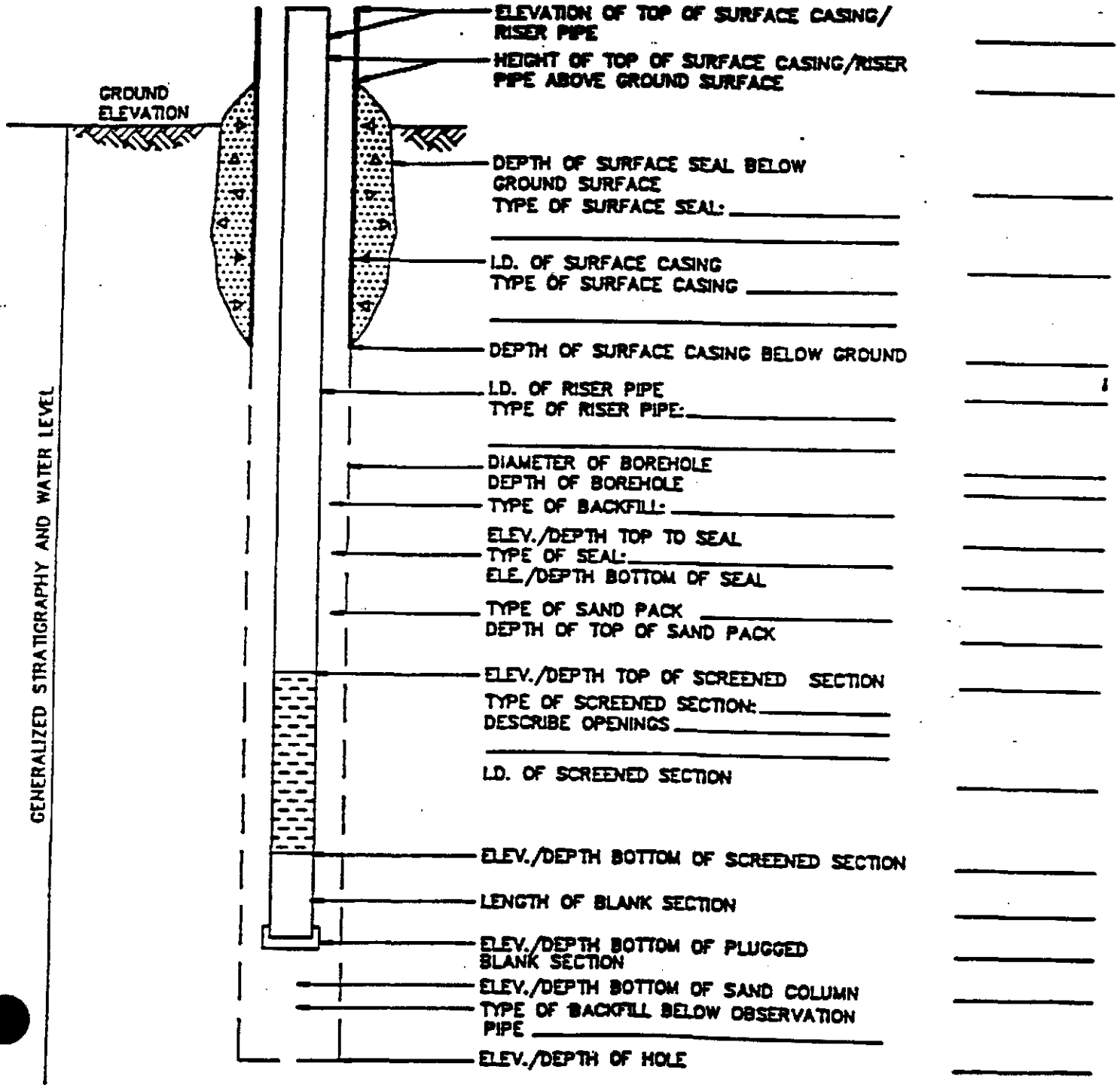


FIGURE 2

GROUND WATER COLLECTION REPORT

PROJECT NUMBER AND NAME _____ LOCATION _____
COLLECTOR/OPERATOR _____ WELL NO. _____
TYPE OF SAMPLE _____ ( ) GRAB ( ) COMPOSITE ( ) OTHER _____
METHOD OF SAMPLING IF OTHER THAN MONITOR WELL _____ SHUTTLE NO. _____

MONITOR WELL INFORMATION

EVACUATION: DATE/TIME _____ METHOD OF EVACUATION _____
INITIAL DEPTH TO WATER LEVEL _____ TOP OF CASING TO BOTTOM _____
GALLONS PER WELL VOLUME _____ TOTAL GALLONS EVACUATED _____
FINAL DEPTH TO WATER _____ ELEVATION TOP OF CASING _____

SAMPLING: DATE/TIME _____ METHOD OF SAMPLING _____
DEPTH TO WATER LEVEL _____

SAMPLE DATA

FIELD REPLICATE #1 TEMP. _____ pH _____ CONDUCTIVITY _____
FIELD REPLICATE #2 TEMP. _____ pH _____ CONDUCTIVITY _____
FIELD REPLICATE #3 TEMP. _____ pH _____ CONDUCTIVITY _____
FIELD REPLICATE #4 TEMP. _____ pH _____ CONDUCTIVITY _____

GENERAL INFORMATION

WEATHER CONDITIONS AT TIME OF SAMPLING _____
SAMPLING CHARACTERISTICS _____
CONTAINERS AND PRESERVATIVES _____
_____
RECOMMENDATIONS _____
_____
_____
_____

SAMPLING PERSONNEL TIME _____ TO _____

_____ DATE _____

(SIGNED)

LOCK OR SERIAL NUMBER _____ REPLACEMENT SERIAL NUMBER _____

FIGURE 10

FIGURE 3

Woodward-Clyde Consultants

CHAIN - OF - CUSTODY RECORD

PHASE NO._____

SAMPLE NO.	MATRIX	YR:___ DATE MM/DD	TIME	SAMPLE DEPTH FROM	SAMPLE DEPTH TO	STATION LOCATION	TOTAL NO. CONTAINERS					

SAMPLE COLLECTION:

PROJECT NO. AND NAME _____

LOCATION OF SAMPLE: _____

TEAM LEADER: _____ TELEPHONE:(___) _____

COMPANY NAME: _____

ADDRESS: _____

WITNESS: _____ COMPANY NAME: _____

FIELD INFORMATION:

TYPES OF SAMPLES: LIQUID (LI) FISH (FI) SLUDGE (SL) SOIL (SO)
(MATRIX) WIPE (WI) SEDIMENT (SE) OTHER (SPECIFY) _____

FIELD NOTES: _____

TRANSPORTER: _____ AIRBILL/INVOICE: _____ DESTINATION: _____

SAMPLE TRANSFER (Original must be retained with sample at all times)

		RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME
1	NAME:				
	COMPANY:				
2	NAME:				
	COMPANY:				
3	NAME:				
	COMPANY:				

TERMINATION OF CHAIN-OF-CUSTODY:

AUTHORIZED BY: _____ DATE: _____ TIME: _____

COMPANY NAME: _____

SAMPLE DISPOSTION: STORAGE_____ DISPOSAL _____ OTHER ____

FIGURE 4

Woodward-Clyde Consultants

SAMPLE ANALYSIS REQUEST FORM

PROJECT NAME _____ LOCATION _____
PROJECT NUMBER _____ SAMPLING TEAM _____
PROJECT CONTACT _____ PURCHASE ORDER NO. _____
REPORTING ADDRESS _____ PROJECT CONTACT PHONE NO. _____
_____ REQUESTED TURNAROUND _____
_____ LABORATORY DESTINATION _____

SAMPLE NO.	SAMPLE TYPE	SAMPLE VOLUME	PRESERVATIVE	REQUESTED ANALYSIS	COMMENTS

SPECIAL HANDLING (e.g. ICE, DRYROOM, FLAMMABLE, ETC.) _____

DATE SHIPPED: _____ PACKAGED BY: _____
SHIPPING METHOD: _____ AIRBILL/INVOICE: _____
CHAIN – OF – CUSTODY ATTACHED? YES _____ NO _____

FIGURE 5

APPENDIX F

RFI DATA MANAGEMENT PLAN

RFI DATA MANAGEMENT PLAN

VICKSBURG CHEMICAL COMPANY
VICKSBURG, MISSISSIPPI

Prepared for
Vicksburg Chemical Company
Vicksburg, Mississippi

December 1995

WCC File 92B007C-3003

Woodward-Clyde

Woodward-Clyde Consultants
2822 O'Neal Lane
Baton Rouge, Louisiana 70816

TABLE OF CONTENTS

Section			Page
1.0	DATA MANAGEMENT PLAN		1
	1.1	INTRODUCTION	1
2.0	PROJECT ORGANIZATION AND RESPONSIBILITIES		2
	2.1	AUTHORITY AND RESPONSIBILITIES	2
		2.1.1 Project Manager	2
		2.1.2 Site Coordinator	2
		2.1.3 Task Leaders	2
	2.2	PROJECT COMMUNICATIONS	3
		2.2.1 Record Control	3
		2.2.2 Record Status	3
		2.2.3 Record Retention	4
		2.2.4 Onsite Records	5
		2.2.5 Change Control	5
3.0	PRINCIPLES OF DATA MANAGEMENT		7
	3.1	GENERAL PRINCIPLES	7
	3.2	OBJECTIVES OF THE SYSTEM	7
4.0	TECHNICAL APPROACH		9
	4.1	DATA MANAGEMENT	9
	4.2	DATA VALIDATION	9
5.0	DATA MANAGEMENT		10
	5.1	PROJECT MENU	11
	5.2	CHEMICAL MENU	13
	5.3	GEOLOGICAL MENU	14
	5.4	QUERY MENU	14
	5.5	WINDOW MENU	15
	5.6	UTILITIES MENU	15

1.0
DATA MANAGEMENT PLAN

1.1 INTRODUCTION

During the RCRA Facility Investigation (RFI), various types of data will be generated. At a minimum, data gathered will consist of field data sheets, field log books, boring logs, chemical data from analysis of soil and groundwater, field parameter measurements, maps and drawings. This Data Management Plan describes procedures that will be used to physically manage project related information. The Data Management Plan addresses:

- Project organization and responsibilities
- Technical approach to data management
- Flow of data (tracking)
- Data validation and reduction
- Data presentation

2.0
PROJECT ORGANIZATION AND RESPONSIBILITIES

A description of primary project personnel and their responsibilities is presented below. Changes in procedures presented below will be documented.

2.1 AUTHORITY AND RESPONSIBILITIES

2.1.1 Project Manager

Richard D. Karkkainen, Woodward-Clyde Consultants (WCC), Vice President and Principal, will serve as Project Manager. The Project Manager will be the prime contact with Mr. Steve Boswell, the Vicksburg Chemical Company (VCC) Project Director and official representative for VCC, concerning all the work that is done by WCC. Project organization and management procedures will be established by the Project Manager, including reviews and approval of work scope, budget, schedules and reports. The Project Manager will also direct financial reporting and subcontractor recommendations for VCC's approval.

2.1.2 Site Coordinator

The Site Coordinator's primary responsibility is to oversee all field phases of the RFI activities under the direction of the Project Manager. Additionally, the Site Coordinator will monitor quality assurance in the field.

2.1.3 Task Leaders

The task leader for data management validation and analytical services is Dr. Charles Westerman. He will be assisted by Anna Saucier.

2.2 PROJECT COMMUNICATIONS

2.2.1 Record Control

The control of records provides for the flow of information both internal and external to WCC.

Following receipt of information from external sources, completion of analyses, and issuance of reports or other transmittals; associated records shall be submitted to the WCC office central project files. This shall include any records generated for WCC by subcontractors. Records shall be legible and easily identifiable. In addition, field records and records transmitted between WCC and contractor offices shall be adequately protected from damage and loss during transfer (e.g., hand carrying or making copies prior to shipment).

Field records, laboratory data summaries, numerical calculations, reports and other data transmittals, copies of proposals, purchase orders, contracts, correspondence, memorandums, telephone records, photographs, and reference material shall be transferred to the project central file.

Records submitted to the project central file, with the exception of correspondence, should be bound, placed in folders or binders, or otherwise secured for filing.

2.2.2 Record Status

All individuals on the Project Staff shall be responsible for reporting obsolete or superseded project-related information to the Project Manager on a periodic basis. In turn, the Project Manager shall notify the Project, Laboratory Staff, and Quality Assurance personnel of the resulting status change in project documents, such as drawings and project procedures. Notification of personnel of status changes in quality assurance procedures shall be the responsibility of the Project Manager.

In general, outdated drawings and other documents shall be marked "void." Any copy of void documents maintained for the project files shall state the reasons for and date of voiding.

To denote that calculations, drawings, and other material which have not been formally checked are preliminary, they shall be marked "preliminary".

2.2.3 Record Retention

Information associated with the project shall be retained in the WCC office central project files. These files will include the following:

- Project central file (project material except drawing originals, records related to laboratory analysis
- Original drawing file
- Generic quality assurance file

Project records shall be received at the various storage areas by designated personnel. Designated personnel shall check that incoming records have proper identification for filing, are legible, and are in suitable condition for storage. Indexing and filing of records shall be performed only by the designated personnel.

For the project central file, the individual file folders shall be divided into appropriate categories based on content and numbered and filed sequentially within each category.

A numbered index for the project central file shall list the individual file folders and identify the records therein to facilitate locating the records. The index shall be kept in a separate folder at the front of the project file. If appropriate, information on project material not stored in the project central file should be included with the index.

For the original drawing and quality assurance files, all material shall be filed only by project number.

The record storage in the central files shall utilize facilities that provide a suitable environment to minimize deterioration or damage and that prevent loss. The facilities shall, where possible, have controlled access and shall provide protection from excess moisture and temperature extremes. Records shall be secured in binders, placed in folders or envelopes, or otherwise secured for storage in containers (e.g., steel file cabinets).

Storage systems shall provide for the prompt retrieval of information for reference or use outside the storage areas. For the project central file, sign out sheets shall be maintained so that a record of files removed is available.

2.2.4 Onsite Records

Appropriate requirements for the field control and retention of records generated as a result of site investigation, sampling, and testing shall be followed. Upon completion of the field program or program phase, onsite files will be transferred to, and integrated with, the WCC office central project files.

2.2.5 Change Control

It is imperative that the status of work items be up-to-date. A status system includes:

- Formal document and design drawing revision
- Nonconformance identification, documentation, and reporting
- Change documentation and approval

Change from original design documents, procedures, and specifications must be expected. Change does not imply a nonconformance to the work, but simply means that original plans must be altered because of information or events that occur during the work.

Change must be documented, evaluated, and reported as necessary. It is necessary to manage change so that the actual course of the project, not the original plan, can be demonstrated and justified. Changes must be documented so that the actual course of work is known and the effect of the change upon the course of work can be evaluated.

It is the responsibility of project personnel to appropriately record the change and to make the documentation available as appropriate to project or laboratory management. The effect of the change upon the project shall be evaluated by the project or laboratory management, quality assurance personnel, and/or subcontractor management.

Review and written approval for changes which affect the project activities should be provided by the Project Manager. Following the review and approval process, notification of the change should be made to appropriate personnel and affected documents revised as necessary to reflect the work as actually performed.

Project documents and design drawings must be reviewed, approved, distributed, and revised as necessary. This control will provide approved, up-to-date information and drawings.

3.0
PRINCIPLES OF DATA MANAGEMENT

3.1 GENERAL PRINCIPLES

Three major approaches to database design are the Network, the Hierarchial and the Relational approaches. These three approaches have their respective strengths and weaknesses and in some applications, one approach is more suited than the others. Of the three methods, the relational approach is gaining momentum in the database market and is used in various applications. Because of its popularity, versatility, ease of use and the availability of many commercial relational database packages, WCC has chosen the relational approach for its design of the VCC database.

In the relational approach, the information is stored in tables and columns. A table is called a relation and columns are the attributes of the relation. A good relational design of a database management system minimizes data redundancy, maintains data consistency and ensures data integrity. Data redundancy refers to the storing of the same information in multiple tables. Redundancy can rarely be totally eliminated but can be reduced. Data consistency refers to maintaining redundant data in the same form at all locations in the system. That is, if data is changed at one location, the system should propagate similar changes in that data in other related tables. This action ensures the integrity of the data in the database.

3.2 OBJECTIVES OF THE SYSTEM

The data management, as defined herein for this project, refers to the actual management of the data, but also includes data validation. The RFI Data Collection Quality Assurance Plan deals with data validation procedures. WCC has identified the following objectives for effectively managing the field data and the laboratory results data from the VCC site:

- Store and organize all field, analytical and other data.
- Track the samples for extraction and analysis holding time deadlines.

- Validate the analytical results pursuant to the RFI Data Collection Quality Assurance Plan.
- Make provisions for transmission of data to VCC.

4.0
TECHNICAL APPROACH

The objectives are accomplished through a data management, validation and analytical services task leader.

4.1 DATA MANAGEMENT

The task leader is responsible for the following:

- Utilize a system to store and organize all field and analytical data.
- Establish procedures to follow as the data arrives from the field and the laboratory.
- Produce tables for reports to VCC, regulatory agencies and other appropriate groups.
- Maintain and administer the system utilized.

The need to use an organized system which facilitates easy and instant access to the information desired, is obvious because a large volume of data is generated by this project. Establishment of procedures streamline the operation of data collection, organization and presentation.

4.2 DATA VALIDATION

The task leader is responsible for the following:

- Review the QA/QC information for the samples.
- Validate the analytical results pursuant to the RFI Data Collection Quality Assurance Plan.
- Contact the laboratory, if inconsistencies exist.
- Interface with the data management system.
- Maintain records.

5.0
DATA MANAGEMENT

WCC utilizes Site Manager Pro (SMPro), a database management application used to expedite the processes involved in administering chemical and geological/soil sampling. It is a PC-based Windows application that runs locally on the PC. It uses client-server technology to access project data residing on a local or remote database server. The client-server technology enable SMPro to consolidate project data into a centralized storage place to be accessed by multiple users.

SMPro includes seven menu options from the main window. WCC will utilize SMPro on this project to the extent it enhances the efficiency of the overall project. The menu items contain options from which users access the necessary selections to complete their tasks. The main menu categories are the following:

- **File**
  Allows user access to log in and exit SMPro.

- **Project**
  Allows chemical and geological users to set up the structure of their sampling program. The project module includes options for choosing a project, creating and updating a project chemical list, indicating sites and locations for sampling, creating geological data entry forms, and creating lookups for expediting data entry. It also includes a customized data-importing feature.

- **Chemical**
  Allows users to print out chain of custodies, worksheets and sample bottle labels, enter field and lab data, track the process of sending samples to the lab, electronically and manually enter data, and examine and edit the analytical data returned from the lab.

- **Geological**
  Allows users to expedite and standardize the record keeping of geological data. Geo/Field tests are recorded here, e.g., water levels, temperatures, pH, and conductivity.

- **Query**
  Allows users to query both chemical and geological data according to specific criterion. With Advanced Query, users can bridge across chemical and geological fields and obtain both types of data. With Quick query, users can query either basic chemical or geological information. Query results can be exported to Excel, CSV, Lotus, SYLK, DBF, and DIF formats.

- **Window**
  Allows users to access and arrange operative windows and icons to suit their viewing needs. Windows information is included in the Navigating section.

- **Utilities**
  System administrators use this option to set up and maintain system default tables, create new projects, add new users to the system and give them access privileges, and update the SMPro program. Utilities information is included in the Appendix B hard-copy document.

5.1 PROJECT MENU

The following paragraphs include a brief overview of each of the topics within the Project menu.

Choose Project

The Project menu option is the first section of the menu that a general user accesses when starting work on a project. Users begin by indicating the project on which they will work and viewing their access privileges.

Chemical List

The Project Chemical List lists all the unique methods, chemicals, and CAS numbers associated with a project.

Site/Locations

Each project requires a summary list of all sites and/or locations that will be or have been sampled or bored. The site/location combination forms a unique identifier for both chemical and geological sampling points. In addition to identifying sampling locations, the site/location identifiers are used to query data by a given site/location. The site/location list with its corresponding X, Y, Z fields provides the location information for exporting project data to mapping software.

Lookups

Lookups consist of data commonly used in projects and are used to expedite entering data into the system. Examples of lookups include Sample Types, QA/QC Types, and Laboratory Names.

Data Entry Forms

For users working on a project requiring geological data input and collection, the Data Entry Forms option allows them to create their forms, including the fields and site/locations to be included on each geological sampling data form.

Import Data Exchange File

Data Exchange File is an ASCII text file allowing data to be imported into the current project from a database site to another database site. Users can also import information into any of the SMPro tables if the file is in the syntax required by SMPro.

Update Project Chemical List

With this feature, the project administrator can create/update the project chemical list from data obtained from the lab.

Project Status

The Project Status option allows both chemical and geological project users to access numerical summaries for their project's major fields. Project managers may use this function to tract their project's progress, e.g., a quick counting of the fields.

5.2 CHEMICAL MENU

The Chemical menu consists of four options: Sampling Plan, Chain of Custody, Data Entry, and Data Production. The following information contains a synopsis of tasks related to the Chemical menu options.

Sampling Plan

Sampling plan tasks include entering header information such as site, location, and field ID. It also includes information such as lab(s) that will be used to analyze the sample, requested methods of analysis, and containers used for holding the samples.

After the sampling plan is completed, users print the plan that will then serve as worksheets for field technicians. They can also print bottle labels to identify the sampling containers.

Chain of Custody (COC)

The COC efforts take place either during or after collecting the samples. COC efforts involve entering the project's field sample data from the worksheets completed at the sampling site and preparing the samples to be sent to the lab for evaluation. COCs are chronologically generated by selecting samples from the sampling plan as they are sampled in the field. This information is recorded at the end of each day. COC numbers used for tracking purposes may be generated in the module. Quality Assurance and Quality Control

(QAQC) coverage is assigned to samples collected at the sampling site. Reports are available for tracking samples, COCs, and field QAQC coverage. To help maintain accuracy and validity, a COC audit trail records all changes made to the production status chemical data. COCs can be exported between hub and stand-alone sites.

Production Chemical Data

Data that are in production status are available for editing in this module. They include the analytical data from the lab that have been sent back to be loaded into SMPro. The production data are used in reports.

Data Entry

With the Data Entry module, users can enter chemical analysis data received from the lab either electronically (from a disk delivered by the lab) or manually (by typing it in from lab deliverables). Data that are loaded both manually or electronically are initially logged as having data entry status. A user entering the data moves the data to production status when the new data entry is completed and checked.

5.3 GEOLOGICAL MENU

The Geological menu contains only the Production option, mostly included as a place holder for accessing geological data. Geological data are placed into production mode after they have been entered and have passed SMPro's field characteristics checks.

5.4 QUERY MENU

The Query menu consists of the Quick Query and the Advanced Query options. These options allow users to examine chemical and geological data by selecting the fields to include in the report output and then indicating selection (search) criteria (i.e., sites, locations, field IDs, and chemicals).

The quick and advanced queries have many similar characteristics. Fields available in the query process are identical. Queries can be saved to a file and loaded and run at a later time.

The query results can be sorted (placed in a different order according to specified characteristics), filtered, and grouped within the query module.

Quick Query

Quick Query allows users to define a query for chemical modules or geological modules separately. Module queries cannot be interrelated. Quick Query can query information across projects and has predefined selection (search) criteria such as location, field ID, and chemical group from which to choose.

Advanced Query

Advanced Query allows users to define a combined query for chemical and geological data. Because it can take into account both chemical and geological simultaneously, the process involved in setting up the query is different form that of the simple query.

The Advanced Query includes a special criteria option that allows users to enter more specific selection (search) criteria than in Quick Query.

5.5 WINDOW MENU

The Window menu option is a standard Microsoft Windows feature that allows users to arrange active windows in a manner suiting their purposes so they can move easily between them.

5.6 UTILITIES MENU

The Utilities menu option is used only by system administrators to maintain system operation.

TABLE 1

VICKSBURG CHEMICAL COMPANY
SCHEDULE OF COMMUNITY RELATIONS ACTIVITIES

Community Relations Activity	During RFI	Completion of RFI	During CMS	Proposed Plan Announced	Corrective Action Activities
To Establish Information Repository	X	X	X	X	X
Summary Paper		X		X	
Publish Public Notice				X	
Contact Local Officials					
Distribute Fact Sheets	X	X		X	
Conduct Comment Period				X	
Public Meeting					

Woodward-Clyde

APPENDIX G

RFI HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

VICKSBURG CHEMICAL CORPORATION
VICKSBURG, MISSISSIPPI

October 1993

Woodward-Clyde Consultants

Consulting Engineers, Geologists, and Environmental Scientists
2822 O'Neal Lane, Baton Rouge, LA 70896

TABLE OF CONTENTS

Section			Page
1.0	HEALTH AND SAFETY PLAN		1
2.0	INTRODUCTION		2
	2.1	KEY PERSONNEL	2
	2.2	SITE LOCATION	7
	2.3	SITE DESCRIPTION	7
	2.4	SITE HISTORY	7
3.0	PURPOSE AND SCOPE OF PROPOSED WORK		9
4.0	HAZARD ASSESSMENT		10
	4.1	BIOLOGICAL HAZARDS	10
	4.2	HEAT STRESS HAZARDS	10
	4.3	PHYSICAL HAZARDS	10
	4.4	CHEMICAL HAZARDS	11
5.0	GENERAL HEALTH AND SAFETY REQUIREMENTS		14
	5.1	PERSONAL PROTECTIVE EQUIPMENT	14
	5.2	WORK ZONES	15
	5.3	DECONTAMINATION PROCEDURES	16
		5.3.1 *Equipment Decontamination*	16
		5.3.2 Personnel Decontamination	17
	5.4	MEDICAL EXAMINATION	17
	5.5	SAFETY TRAINING DOCUMENTATION	18
	5.6	COMPLIANCE AGREEMENT	18
	5.7	PROJECT MANAGER NOTIFICATION	18
	5.8	PROJECT SAFETY LOG	18
	5.9	PROHIBITIONS	19
	5.10	SITE SAFETY MEETINGS	19
6.0	LABORATORY CONSIDERATIONS		20
7.0	PERSONAL PROTECTIVE EQUIPMENT		21
	7.1	HEAD PROTECTION	21
	7.2	EYE PROTECTION	21
	7.3	SKIN PROTECTION	21
	7.4	FOOTWEAR	21
	7.5	RESPIRATORY PROTECTION	22

TABLE OF CONTENTS (Continued)

Section		Page
8.0	AIR QUALITY MONITORING	23
	8.1 AIR QUALITY SURVEY	23
9.0	EMERGENCIES/ACCIDENTS	25
	9.1 EMERGENCY NUMBERS	26
10.0	PERSONNEL ASSIGNMENTS	27
	10.1 PROJECT SAFETY PERSONNEL	27
11.0	SAFETY PLAN COMPLIANCE AGREEMENT	28

1.0
HEALTH AND SAFETY PLAN

Client:	Vickburg Chemical Corporation
Project:	RFI Field Investigation, Groundwater Assessment, and Interim Measures
Project Manager:	Richard D. Karkkainen
Project Number:	92B007C
Date of Plan:	Revised October 22, 1993
Estimated Dates of Work:	North Pond, October 25, 1993 through November 5, 1993, Additional Pending EPA and MSDEQ
Expiration Date:	Pending EPA and MSDEQ

1.1 HEALTH AND SAFETY PLAN APPROVALS

Richard D. Karkkainen
Project Manager
(504) 751-1873

10/22/93
Date

Tanya Pawley
Health and Safety Officer
Baton Rouge Business Unit
(318) 439-2683

10/22/93

Charles Self, C. I. H.
Corporate Health and Safety Officer
(318) 439-2683

10/22/93
Date

2.0 INTRODUCTION

This Health and Safety Plan establishes guidelines and requirements for the safety of field personnel during the conduct of the field activities associated with the referenced project. The specific activities addressed by this plan are defined in Section 3.0. All employees of Woodward-Clyde Consultants (WCC) involved in this project are required to abide by the provisions of this plan. They are required to read this plan and sign the attached Compliance Agreement.

The health and safety guidelines and requirements presented are based on a review of available information and an evaluation of potential hazards. This plan outlines the health and safety procedures and equipment required for activities at this site to minimize the potential for exposures of field personnel. This plan may be modified by the project manager, the corporate health and safety officer, and the Baton Rouge health and safety officer in response to additional information obtained regarding the potential hazards to field investigative personnel. This plan has been prepared for the exclusive use of WCC Personnel and WCC subcontractors. WCC liability is extended to WCC Personnel and WCC Subcontractors only.

2.1 KEY PERSONNEL

Project management will be handled out of the Baton Rouge Operating Unit of WCC. The following is a description of job responsibilities and authorities:

Project Manager: Richard D. Karkkainen

For this project, the Project Manager has the following responsibilities:

- To see that the project is performed in a manner consistent with the WCC Health and Safety Program.

- To have an approved Health and Safety Plan prepared and properly implemented for this project.

- To provide the Business Unit Health and Safety Officer with project information related to health and safety matters and development of the Health and Safety Plan.

- To implement the Health and Safety Plan.

- To insure compliance with the Health and Safety Plan by WCC and contractor personnel.

- To coordinate with the Business Unit Health and Safety Officer on health and safety matters.

The Project Manager has the authority to take the following actions:

- To determine matters relating to schedule, cost, and personnel assignments on hazardous waste management projects.

- To temporarily suspend field activities, if the health and safety of personnel are endangered, pending further consideration by the Business Unit Health and Safety Officer.

- To temporarily suspend an individual from field activities for infractions of Health and Safety Plan, pending further consideration by the Business Unit Health and Safety Officer.

Health and Safety Officer: Tanya Pawley

The Health and Safety Officer has the following responsibilities:

- To interface with the Project Manager as may be required in matters of health and safety.

- To approve a Health and Safety Plan for the project.
- To appoint or approve a Site Safety Officer to assist in implementing the Health and Safety Plan.
- To monitor compliance with the approved Health and Safety Plan.
- To assist the Project Manager in seeing that proper health and safety equipment is available for the project.
- To approve personnel to work on this site with regard to medical examinations and health and safety training.

The Health and Safety Officer has the authority to take the following actions:

- To suspend work or otherwise limit exposures to personnel, if a Health and Safety Plan appears to be unsuitable or inadequate.
- To direct personnel to change work practices, if they are deemed to be hazardous to health and safety of personnel.
- To remove personnel from the project, if their actions or condition endangers their health and safety or the health and safety of co-workers.

WCC Site Safety Officer: Yong Goh

The Site Safety Officer (SSO) has the following responsibilities:

- To direct health and safety activities on-site.
- To report safety-related incidents or accidents to the Project Manager and Business Unit Health and Safety Officer.

- To assist the Project Manager in all aspects of implementing the Health and Safety Plan.

- To maintain health and safety equipment on-site, as specified in Health and Safety Plan.

- To perform health and safety activities on-site, as specified in the Health and Safety Plan, and report results to the Project Manager and the Business Unit Health and Safety Officer.

The SSO has the authority to take the following actions:

- To temporarily suspend field activities, if the health and safety of personnel are endangered, pending further consideration by the Business Unit Health and Safety Officer.

- To temporarily suspend an individual from field activities for infractions of the Health and Safety Plan, pending further consideration by the Business Unit Health and Safety Officer.

WCC Corporate Health and Safety Officer: Charles Self

The WCC CHSO has the following responsibilities:

- Direct the implementation of the Health and Safety Program of the operating group and provide recommendations for improvement of the program.

- Coordinate health and safety activities of the operating units in the operating group.

- Determine need for project Health and Safety Plans.

- Review and approve Health and Safety Plans.

- Monitor implementation of Health and Safety Plans.

- Investigation reports of incidents or accidents and report accidents or incidents to the CHSA and EVPP.

- Assist CHSA with employee health and safety training in the operating group.

- Determine whether an accidental exposure or injury merits a change in the affected individual's work assignments and whether changes in work practices are required.

- Coordinate business units with regard to health and safety equipment needs.

The WCC CHSO has the authority to take the following actions:

- Approve or disapprove Health and Safety Plans.

- Direct operating unit HSO to prepare project Health and Safety Plans.

- Access project files.

- Direct changes in personnel work practices to improve health and safety of employeees involved in hazardous waste management projects.

- Remove individuals from projects, if their conduct jeopardized their health and safety or that of co-workers.

- Suspend work on any project that jeopardizes the health and safety of personnel involved.

2.2 SITE LOCATION

Vicksburg Chemical Corporation (VCC) is located less than a mile south of Interstate 20 bordering the City of Vicksburg, Mississippi. To the north and west of the site is light residential properties. To the East of the site is light industrial properties including the Vicksburg water treatment facility and an asphalt mixing and gravel drying operation. To the South of the site is light residential to rural properties.

2.3 SITE DESCRIPTION

VCC is located off Highway 61 on Rifle Range Road. The facility is comprised of a North Plant and a South Plant and occupies approximately 640 acres. Currently, the only active areas of the plant include the nitric acid and potassium nitrate plants. All other portion of the plant are no longer in operation. Resources such as a potable water supply, electricity, and telephone service are available at the plant office located at the facility entrance on Rifle Range Road. Chemical on-site relative to the aforementioned active plants include anhydrous ammonia, nitric acid, potassium chloride, chlorine, and occasional nitrogen tetroxide, and nitrogen dioxide. Chemical on-site related to past production activities include atrazine, dinoseb, methyl parathion, monosodium methane arsenate (MSMA), and toxaphene. Other chemicals that have been detected on-site include carbon tetrachloride, chloroform, 1,1-dichloroethylene, ethylbenzene, methylene chloride, toluene, and xylene.

The work sites concerning this plan are associated with the South and North Plants (Figure 1) and include several Solid Waste Management Units (SWMUs) and Other Areas of Concern (OACs).

2.4 SITE HISTORY

In the past, VCC produced various types of pesticides and herbicides such as dinoseb, toxaphene, atrazine, and monosodium methane arsenate. All of these chemicals have been detected in the soil and water by VCC and the state of Mississippi. Concentrations range from less than extractable products on hazardous wastes to an average of about 5 part per million (ppm). Chlorinated solvents have been detected in

sludge sediments in the ppm range for carbon tetrachloride, methylene chloride, chloroform, and 1,1,-dichloroethylene. The source of the chlorinated solvents is unknown as well as the source of xylene toluene, and ethylbenzene, which have been detected in the range of 2-15 ppm.

3.0
PURPOSE AND SCOPE OF PROPOSED WORK

WCC will perform work as required in a Consent Decree effective April 17, 1992. This Consent Decree requires Interim Measures activities, a Groundwater Assessment Program, and a RCRA Facility Investigation be conducted at the facility. These three workplans require geophysical borings, monitor well sampling and installation, subsurface soil sampling, and surface soil sampling. Some construction in conjunction with sump closure may be included in the Interim Measures activities.

4.0
HAZARD ASSESSMENT

The following hazards have been identified and will be protected against:

- Heat stress.
- Biological hazardous.
- Physical hazards.
- Skin contact with organic contaminants.

4.1 BIOLOGICAL HAZARDS

If clearing has not been conducted or if biological hazards develop during work activities, practical guidelines for prevention of exposure to pests should be implemented.

4.2 HEAT STRESS HAZARDS

If heat stress becomes a concern, the heat stress casualty prevention plan, presented in Appendix A shall be implemented.

4.3 PHYSICAL HAZARDS

Personnel should be cognizant of the fact that when protective equipment such as respirators, gloves, and protective clothing are worn, visibility and manual dexterity are impaired. In addition, personnel should be alert to physical hazards such as slipping/tripping/falling potentially associated with dismantled process equipment and piping remnants/ladders/stairways in various stages of disrepair, and uneven ground surface due to foundation fragments distributed throughout the site. Drilling personnel should abide by standard safety guidelines applicable to drilling operation presented in Appendix B.

4.4 CHEMICAL HAZARDS

Due to past production activities at the facility, pesticides, herbicides, chlorinated solvents, and volatile organic solvents have been detected on-site during site characterization efforts conducted by VCC and the state of Mississippi. The constituents detected included dinoseb, toxaphene, atrazine, carbon tetrachloride, methylene chloride, chloroform, 1,1-dichloroethylene, xylene, toluene, and ethylbenzene at concentration report in the parts per million range. Of the constituents detected on-site, carbon tetrachloride, methylene chloride, and chloroform are classified by OSHA and/or ACGIH as known or suspected human carcinogens.

The constituents detected on-site are present in low concentrations. However, exposure to these chemicals may potentially occur through inhalation, ingestion, and/or direct contact. Chemical exposure via multiple exposure pathways is cumulative, therefore it is important to recognize potential exposure situations and to take precautions to minimize exposure to chemical hazards by all routes.

The following potential exposure routes and associated health hazards have been identified:

Inhalation: Chemical hazards associated with inhalation exposures may include irritation of the mucous membranes and respiratory tract or with more sever exposures, may include systemic effects. Table 1 presents recommended exposure limits for potential airborne constituents.

Ingestion. Ingestion of chemical will be controlled on-site by prohibiting eating, smoking, or drinking in the Exclusion Zone and by requiring all field personnel to conduct decontamination procedures prior to leaving the Exclusion Zone.

Direct Contact: Skin and eye contact with chemical hazards may potentially result in irritation, rashes, or burns. If a person should exhibit symptoms of eye or skin irritation, he/she should report to the SSO for immediate medical attention.

Potential hazards may be minimized by utilizing appropriate personal equipment designed to protect the body against contact with known or anticipated chemical hazards. Personal protective equipment is classified by the EPA by the level of protection afforded and is divided into four categories designated as Level A, B, C, and D with Level A providing the most extensive level of protection.

The levels of protection required for the field activities specified by the work scope are presented in Section 5.1

Chemical information sheets for each constituent known to be present at the site are presented in Appendix C. These sheets provide important information concerning physical/chemical properties, chemical/reactive hazards, exposure potentials, health hazards and symptoms of exposures, and appropriate treatment following exposure.

Table 1
Exposure Limits for Potential Airborne Contaminants

Constituent	ACGIH TWA	OSHA PEL-TWA	STEL	IDLH
+Toxaphene	0.5 mg/m^3	0.5 mg/m^3	1 mg/m^3	200 mg/m^3
Atrazine	5 mg/m^3	5 mg/m^3	--	--
+Carbon Tetrachloride	5 ppm	2 ppm	--	Ca
Methylene Chloride	50 ppm	500 ppm	--	Ca
Chloroform	10 ppm	2 ppm	--	Ca
Xylene	100 ppm	100 ppm	150 ppm	1000 ppm
Toluene	100 ppm	100 ppm	150 ppm	2000 ppm
Ethylbenzene	100 ppm	100 ppm	125 ppm	2000 ppm
Lime Kiln Dust	10 mg/m^3	10 mg/m^3	--	--
Ammonia	25 ppm	50 ppm	35 ppm	500 ppm

\+ Potential Skin Irritant
Ca Potential Human Carcinogen (Cancer Causing);
-- No IDLH level established.

5.0
GENERAL HEALTH AND SAFETY REQUIREMENTS

5.1 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) required to prevent contact with known or anticipated chemical hazards has been divided into four categories by the USEPA, Levels A, B, C and D, according to the degree of protection afforded. The following personnel protective equipment will be provided to personnel involved in site characterization work at the site.

Mobilization - Level D Protection

- Boots, steel toe and shank
- Hard hat
- safety glasses with side shields

Modified Level D Protection

- Coveralls, chemical resistant; tyvek (polycoated tyvek if splash hazard exists)
- Gloves (outer), chemical resistant, Polyvinyl Alcohol (PVAL)
- Gloves (inner), chemical-resistant, latex
- Boots, chemical-resistant (or bootie covers), steel toe and shank
- Safety glasses with side shields
- Hard hat (with faceshield if splash hazard exists)

Modified Level C Protection

- To include Modified Level D; PPE mentioned above
- Full-face air purifying respirators with organic vapor/pestiide/HEPA combination filter cartridges.

Tyvek coveralls will be discarded after each use or when they become worn or punctured. Suit materials are resistant to all known or anticipated chemicals at the site. If the disposable protective suits appear to be deteriorating under chemical action, the Site Safety Officer should be notified.

In addition to the personal protective equipment listed above, general safety equipment available for use will include a first aid kit, portable eye wash and fire extinguisher.

5.2 WORK ZONES

During activities conducted in Modified Level D PPE, management of this project shall be conducted in such a manner which will restrict access to the job site by unauthorized personnel. If Level D action levels established in Table 2 are exceeded resulting in an upgrade to Level C PPE, work zones as described in the following paragraphs shall be implemented.

To minimize the movement of contaminants from the site to uncontaminated areas, three work zones will be set up during activities conducted under Level C PPE. The three work zones will include the following:

Zone 1:	Exclusion Zone
Zone 2:	Contamination Reduction Zone
Zone 3:	Support Zone

The exclusion zone is the zone where contamination does or could occur. Observations by the site safety officer will determine the extent of the zones. All persons entering this zone must wear at a minimum the level of protection set forth in Section 5.1 (Level C PPE).

Between the exclusion zone and support zone is the personnel contamination reduction zone (CRZ) which provides a transition zone between the contaminated and clean areas of the site. This zone will be located directly outside of the exclusion zone and will be defined as 10-foot zone directly outside the exclusion zone.

The support zone will be an uncontaminated area from which operations will be directed. It is essential that contamination from the site be kept out of this area. Included in this area will be a storage area for decontaminated clothing, additional personal protective equipment, etc.

One additional work zone will be set up for decontaminating equipment.

5.3 DECONTAMINATION PROCEDURES

VCC will have a minimum of one personnel decontamination station, strategically located or in the contamination reduction zone (CRZ) if applicable. The decontamination station will have at least the following items:

- An adequate-sized plastic sheet for flooring
- Boot wash equipment
  - Water/alconox solution container
  - Rinse water container
  - Long-handled plastic brush
- Waste container (disposable PPE, tape, etc.)
- Hand wash equipment
  - Water/alconox solution container
  - Rinse water container
  - Paper towels

5.3.1 Equipment Decontamination

Decontamination of sample collection equipment will be accomplished by the following procedure:

- Washing in a detergent solution (Alconox)
- Triple rinsing with clean deionized water
- Rinsing with methanol
- Triple rinsing with clean deionized water

Decontamination of equipment shall be conducted in Modified Level D PPE as listed in Section 5.1. While utilizing methanol for deconning equipment, personnel shall position themselves upwind of decontamination operations to minimize inhalation exposures to methanol vapors. If this is not feasible, respiratory protection as listed under level C PPE is Section 5.1 shall be worn during methanol use.

5.3.2 Personnel Decontamination

Decontamination of personnel will be performed at a designated location at the perimeter of the work area. Decontamination will consists primarily of soap and water washings and water rinse of exterior protective gear to remove contaminants, followed by doffing of the gear.

Coveralls should be removed by turning the clothing inside out. A general sequence of doffing procedures is outlined below. The extent of washing required, or modifications to the sequence, may be specified as appropriate.

Personnel will be decontaminated by the following procedure:

- Wash and rinse outer protective coverall
- Wash work gloves and boots
- Remove outer protective clothing
- Rinse respirator if worn
- Wash hands and face

Contaminated disposable PPE and all decontamination fluids shall be containerized on-site for subsequent disposal by the direction of VCC.

5.4 MEDICAL EXAMINATION

Before commencing any of the field or laboratory activities defined in Section 3.0, all WCC personnel and all WCC subcontractors must take an annual WCC-approved medical examination as part of WCC's medical surveillance program.

5.5 SAFETY TRAINING DOCUMENTATION

Prior to commencing any of the field activities defined in Section 3.0, all WCC personnel working on-site will supply certificate or equivalent, attesting to completing 40 hours of training as required by OSHA, in 29 CFR 1910.120, to the SSO. Site supervisors will be required to supply documentation indicating that an additional 8 hours of training has been completed. Escorted visitors may be allowed in a defined area without 40 hours training at the discretion of the WCC SSO and the WCC site coordinator.

Documentation concerning respirator fit testing, in accordance with OSHA, 29 CFR 1910.134 shall be required of any WCC employee wearing a respirator.

5.6 COMPLIANCE AGREEMENT

The Project Manager and the Baton Rouge Health and Safety Officer shall hold meetings with all WCC field personnel before work commences. During the meeting, all personnel shall be provided with a copy of this safety plan; the plan shall be reviewed and discussed and questions answered. Signed Compliance Agreement Forms shall be collected by the Project Manager and filed by the Baton Rouge Health and Safety Officer. Individuals refusing to sign the form will not be allowed to work on the site.

5.7 PROJECT MANAGER NOTIFICATION

All field personnel must inform the Project Manager or his designated representative before entering the site. The "buddy system" will be employed during all project work. This means that at least two members of the field crew must be on-site whenever work is performed. Personnel must be in visual contact with each other or carry two-way radios at all times.

5.8 PROJECT SAFETY LOG

A project safety log will be used to record the names, entry and exit dates and times of all WCC and subcontractor personnel and of project site visitors; accidents, injuries, and illnesses; incidence of safety infractions by field personnel; air quality and personal exposure monitoring data; and other information related to safety matters. All accidents, illnesses or other incidence shall be reported immediately to the WCC Project Manager, and the WCC Baton Rouge Health and Safety Officer and subsequently documented for filing on the HS-502 Incident Report Form.

5.9 PROHIBITIONS

- Smoking, eating, drinking, chewing gum or tobacco, storing food or food containers shall not be permitted on the work site. Good personal hygiene should be practiced by field personnel to avoid ingestion of contaminants or spread of contaminated materials.

- Ignition of flammable liquids within, on, or through improvised heating devises or space heaters.

- Approach or entry into areas or spaces where toxic of explosive concentrations of gases or dust may exist without proper equipment available to enable safety entry.

- Conduct of on-site operations without off-site back up personnel.

5.10 SITE SAFETY MEETINGS

During all site characterization activities, daily safety meetings will be held by the site safety officer to review and plan the specific health and safety aspects of scheduled work for that day.

6.0
LABORATORY CONSIDERATIONS

The laboratory director must be informed of any contaminant level in the samples that would require special handling procedures to prevent risk to the health and safety of laboratory personnel.

7.0
PERSONAL PROTECTIVE EQUIPMENT

This section outlines the general usage guidelines for personal protective equipment.

7.1 HEAD PROTECTION

Hard hats must be worn by all personnel working on-site.

7.2 EYE PROTECTION

Safety glasses with side shields or goggles must be worn by all personnel performing activities where potential for eye or face exposure exists due to splash, dust, or vapor, etc. An eyewash station will be set up by the site safety officer prior to commencing field activities and should be placed so that it could be used quickly in an emergency.

7.3 SKIN PROTECTION

Due to the potential for skin absorption and carcinogenic properties chemical resistant gloves and coveralls shall be worn by all personnel during subsurface and sample handling activities. These will be disposed of in a designated sealable drum after each use of when they become worn or punctured.

7.4 FOOTWEAR

Chemical-resistant boots with steel toes and shanks will be worn by field personnel engaged in the field activities at the site. Chemical-resistant booties can be substituted for chemical resistant boots, although work boots to be covered must always maintain steel toes and shanks.

7.5 RESPIRATORY PROTECTION

For respiratory protection against possible volatile organics, full-face air purifying respirators (APR) will be required if Level D air monitoring action levels are exceeded. Specific cartridges to be utilized with the APRs will be combination organic vapor/ammonia filter cartridges. All personnel must be properly fit-tested for the specific brand and size respirator to be used. Documentation of fit testing is to be provided to WCC SSO prior to commencement of work. A respirator which has not been successfully fit-tested cannot be used by an individual on the project. To ensure a proper fit, no facial hair will be allowed that will interfere with mask operation. The site safety officer will determine if facial hair represents such an interference. Air purifying respirators will only be used if the following conditions are met:

- The oxygen content of the air is greater than 19.5 percent.
- Concentration of air contaminants are known and monitored.
- The contaminants of concern all have good warning properties (i.e., odor threshold below PEL value).
- The protection factor is adequate and PELs are not exceeded.
- If concentrations of air contaminants exceed IDLH value, personnel must immediately evacuate.
- Cartridges are changed daily or whenever breakthrough occurs, which ever occurs first.
- Each person has been fit-tested for the specific brand and size of respirator used.
- The respirator is MSHA- and/or NIOSH-approved.

8.0
AIR QUALITY MONITORING

The primary goal of on-site air quality monitoring will be compliance with the specified contaminant action levels. The secondary goal will be documentation of personal exposures as required by OSHA 1920.120.

8.1 AIR QUALITY SURVEY

During modified Level D field activities at the site, an air quality survey will be performed utilizing an HNu-photoionization detector (PID) equipped with an 11.7 ev probe, or equivalent instrument to characterize volatile organics and ammonia concentrations on-site. Standard operating procedures for this instrument are attached as Appendix E. During Level C filed activities, additional sampling utilizing colorimetric tubes specific for detecting chloroform, methylene chloride, and carbon tetrachloride will be used along with the HNu for total organic vapors. At least two sampling events utilizing each of these tubes will be conducted in the breathing zone of personnel closest to the subsurface activities at the site. Table 2 lists air monitoring action levels for Level D and C work.

TABLE 2
AIR MONITORING ACTION LEVELS FOR LEVEL C AND D WORK

Contaminant	Instrument*	Reading	Action Taken
Volatile Organic	HNu or equivalent	<5 ppm	Continued Work in Modified D Level
		5 - 25 ppm	Upgrade to Level C and Expand Work Zones; Commence additional colorimetric tube sampling
		>25 ppm	Evacuate Area

* Sustained reading above background (for 15 minutes continuous) which shall not be exceeded within worker breathing zones or exclusion zones.

9.0
EMERGENCIES/ACCIDENTS

A site map and direction to Vicksburg Hospital are included in Figure 1. Illnesses, injuries, and accidents occurring on-site must be attended to immediately in the following manner:

- Remove the injured or exposed person(s) from immediate danger.
- Render FIRST AID if necessary. Decontaminate affected personnel, if necessary.
- Call ambulance for transport to local. This procedure should be followed even if there is no apparent serious injury. Emergency numbers are listed on the following section.
- Evacuate other personnel on-site to a safe place until the engineer (assisted by the Site Safety Officer) determines that it is safe for work to resume.
- Report the accident to the Health and Safety Officer immediately.
- Develop procedures, in accordance with the Health and Safety Officer, Site Safety Officer, and Project Manager to prevent a recurrence.

In the event that an emergency site evacuation should be necessary for any reason, the Site Safety Officer will render an alarm using a horn and all personnel shall leave the site. The assembly point will be designated in the filed. Personnel will not return to the site until an all-clear has been received from the Site Safety Officer

9.1 EMERGENCY NUMBERS

For any on-site Emergency dial 911.

Emergency Service	Telephone
Fire Department	636-1121
Ambulance	911
Sheriff	636-1761
Vicksburg Police Department	636-2511
National Response Center (NRC)	1-800-424-8802
Poison Control Center	1-800-535-0525
Vicksburg Medical Center	636-2611
Mercy Regional Medical Center	631-2250

10.0
PERSONNEL ASSIGNMENTS

WCC personnel and subcontractors authorized to work on this project and enter the site are:

Project Manager:	**Richard D. Karkkainen**
Baton Rouge Health and Safety Officer:	**Charles Self**
Site Safety Officer:	Yong Goh
Field Personnel:	Mike Olson
Subcontractor:	Soil Testing Engineers, Inc.

10.1 PROJECT SAFETY PERSONNEL

Personnel responsible for implementing this Safety Plan are the Project Manager and Site Safety Officer. Their specific responsibilities and authorities for all accountable WCC personnel are listed in this plan as well as Table 2-1 of the WCC Health and Safety manual dated November 1990.

11.0
SAFETY PLAN COMPLIANCE AGREEMENT

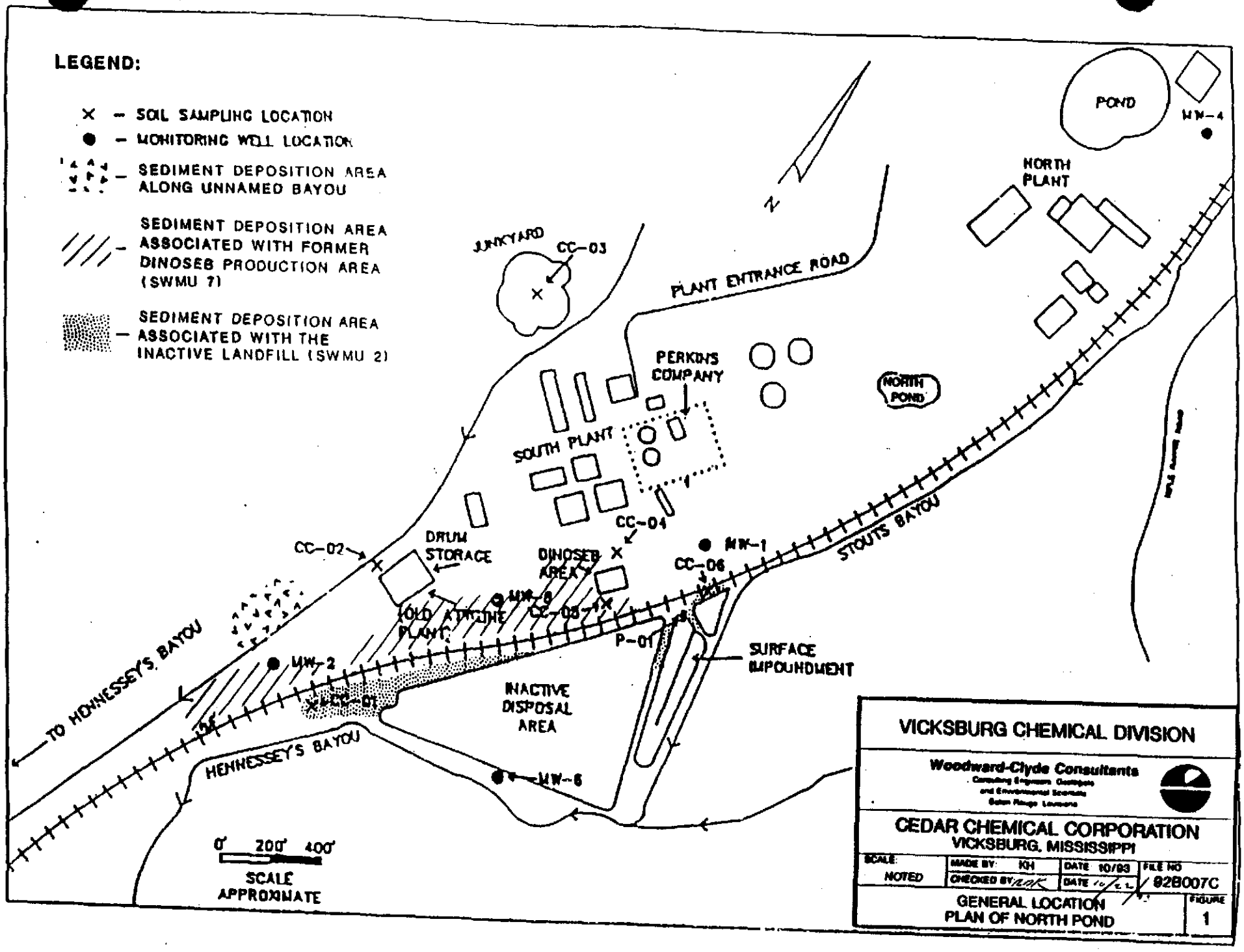
I, _____(print name), have received a copy of the Safety Plan for the Interim Measures, Groundwater Assessment, and RFI Field Investigation Workplans for VCC, Vicksburg, Mississippi (WCC Project No. 90B451C). I have read the plan, understand it, and agree to comply with all of its provisions. I understand that I could be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Signed:

_____ _____

Signature Date

Firm:_____


LEGEND:
× – SOIL SAMPLING LOCATION
● – MONITORING WELL LOCATION
– SEDIMENT DEPOSITION AREA ALONG UNNAMED BAYOU
– SEDIMENT DEPOSITION AREA ASSOCIATED WITH FORMER DINOSEB PRODUCTION AREA (SWMU 7)
– SEDIMENT DEPOSITION AREA ASSOCIATED WITH THE INACTIVE LANDFILL (SWMU 2)
POND
MW-4
NORTH PLANT
JUNKYARD
CC-03
PLANT ENTRANCE ROAD
PERKINS COMPANY
NORTH POND
SOUTH PLANT
CC-04
CC-02
DRUM STORAGE
DINOSEB AREA
MW-1
CC-06
STOUTS BAYOU
MW-3
OLD ATRAZINE PLANT
CC-05
P-01
SURFACE IMPOUNDMENT
TO HENNESSEY'S BAYOU
MW-2
CC-01
INACTIVE DISPOSAL AREA
HENNESSEY'S BAYOU
MW-6
0' 200' 400'
SCALE APPROXIMATE
VICKSBURG CHEMICAL DIVISION
Woodward-Clyde Consultants
CEDAR CHEMICAL CORPORATION
VICKSBURG, MISSISSIPPI
SCALE: NOTED
MADE BY KH
DATE 10/93
FILE NO 92B007C
CHECKED BY
DATE
GENERAL LOCATION PLAN OF NORTH POND
FIGURE 1

APPENDIX A

HEAT STRESS CASUALTY PREVENTION PLAN

APPENDIX A

HEAT STRESS CASUALTY PREVENTION PLAN

Due to the increase in ambient air temperatures and the affects of protective outer wear decreasing body ventilation, there exists an increase in the potential for injury, specifically, heat casualties. Site personnel will be instructed in identification of a heat stress victim, the first-aid treatment procedures for the victim and the preventing of heat stress casualties.

A. IDENTIFICATION AND TREATMENT

1) Heat Exhaustion

a) Symptoms: Usually begins with muscular weakness, dizziness, nausea, and staggering gait. Vomiting is frequent. The bowels may move involuntarily. The victim is very pale, his skin is clammy skin, and he may perspire profusely. The pulse is weak and fast, his breathing is shallow. He may faint unless he lies down. This may pass, but sometimes it remains and death could occur.

b) First Aid: Immediately remove the victim to the Personnel Decontamination Reduction Zone in a shady or cool area with good air circulation. Remove all protective outer wear. Call a physician. Treat the victim for shock. (Make him lie down, raise his feet 6 to 12 inches and loosen all clothing.) Transport victim to a medical facility as soon as possible.

2) Heat Stroke

a) Symptoms: This is the most serious of heat casualties due to the fact that the body excessively overheats. Body temperatures often are between 107 degrees to 110 degrees Fahrenheit. First there is often pain in the head, dizziness, nausea, oppression, and the skin is dry, red and hot. Unconsciousness follows quickly and death is imminent if exposure continues. The attack will usually occur suddenly.

b) First Aid: Immediately evacuate the victim to a cool and shady area in the Personnel Decontamination Reduction Zone. Remove all protective outer wear and all personal clothing. Lay him on his back with his head and shoulders slightly elevated. It is imperative that the body temperature be lowered immediately. This can be accomplished by applying cold wet towels, ice bags, etc., to the head. Sponge off bare skin with cool water or place him in a tub of cool water. The main objective is to cool him without chilling him. Give no stimulants. Transport the victim to a medical facility as soon as possible.

B. PREVENTION OF HEAT STRESS

1) One of the major causes of heat casualties is the depletion of body fluids. On the site there will plenty of fluids available. Personnel should replace water and salts loss from sweating. Salts can be replaced by either 0.1 percent solution, more heavily salted foods, or commercial mixes such as Gatorade. The commercial mixes are advised for personnel on low sodium diets.

2) A work schedule should be established so that the majority of the work day will be during the morning hours of the day before ambient air temperature levels reach their highs.

3) A work/rest guideline will be implemented for personnel required to wear Level B or Level C protection. This guideline is as follows:

Ambient Temperatures	Maximum Working Time
Above 90°F	1/2 hour
80°-90°F	1 hour
70°-80°F	2 hours
60°-70°F	3 hours
50°-60°F	4 hours
40°-50°F	5 hours
30°-40°F	6 hours
Below 30°F	8 hours

A sufficient period will be allowed for personnel to "cool down". This may require shifts of workers during operations.

C. HEAT STRESS MONITORING

For monitoring the body's recuperative ability to excess heat, one or more of the following techniques should be used as a screening mechanism. Monitoring of personnel wearing protective clothing should commence when the ambient temperature is 70 degrees Fahrenheit or above. Frequency of monitoring should increase as the ambient temperature increases or if slow recovery rates are indicated. When temperatures exceed 80 degrees Fahrenheit, workers must be monitored for heat stress after every work period.

- Heart rate should be measured at the radial pulse for 30 seconds as early as possible in the resting period. The heart rate at the beginning of the rest period should not exceed 110 beats per minute. If the heart rate is higher, the next work period should be shortened by 10 minutes (or 33 percent), while the length of the rest period stays the same. If the pulse rate is 100 beats per minute at the beginning of the next rest period, the following work cycle should be shortened by 33 percent.

- Body temperature should be measured orally with a clinical thermometer as early as possible in the resting period. Oral temperature at the beginning of the rest period should not exceed 99 degrees Fahrenheit. If it does, the next work period should be shortened by 10 minutes (or 33 percent), while the length of the rest period stays the same. However, if the oral temperature exceeds 99.7 degrees Fahrenheit at the beginning of the next period, the following work cycle should be further shortened by 33 percent. Oral temperature should be measured again at the end of the rest period to make sure that it has dropped below 99 degrees Fahrenheit.

- Body water loss due to sweating should be measured by weighing the worker in the morning and in the evening. The clothing worn should be similar at both weighings; preferably, the worker should be weighed nude. The scale should be accurate to plus or minus one-quarter pound. Body water loss should not exceed 1.5 percent of the total body weight. If it does, workers should be instructed to increase their daily intake of fluids by the weight lost.

Ideally, body fluids should be maintained at a constant level during the work day. This requires replacement of salt lost in sweat as well.

Good hygiene standards must be maintained by frequent changes of clothing and daily showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should immediately consult medical personnel.

APPENDIX B

SAFETY GUIDELINES FOR DRILLING

APPENDIX B

SAFETY GUIDELINES FOR DRILLING

Drill rig maintenance and safety is the responsibility of the drill rig operator. However, safety requires the attention and cooperation of every worker and visitor to the job. The following is provided as a general guideline for safe drilling practices onsite.

OFF-ROAD MOVEMENT OF DRILL RIGS

The following safety guidelines relate to off-road movement:

- Before moving a drill rig, first walk the route of travel, inspecting for depressions, slumps, gullies, ruts and similar obstacles.
- Always check the brakes of a drill rig carrier before traveling, particularly on rough, uneven or hilly ground.
- Discharge all passengers before moving a drill rig on rough or hilly terrain.
- Engage the front axle (for 4x4, 6x6, etc., vehicles or carriers) when traveling off-highway on hilly terrain.
- Use caution when traveling side-hill. Conservatively evaluate side-hill capability of drill rigs because the arbitrary addition of drilling tools may raise the center of mass. When possible, travel directly uphill or downhill.
- Attempt to cross obstacles such as small logs and small erosion channels or ditches squarely, not at an angle.
- Use the assistance of someone on the ground as a guide when lateral or overhead clearance is narrow.

- After the drill rig has been moved to a new drilling site, set all brakes and/or locks. When grades are steep, block the wheels.

- Never travel off-road with the mast (derrick) of the drill rig in the raised or partially raised position.

- Tie-down loads on the drill rig and support trucks during transport.

OVERHEAD AND BURIED UTILITIES

The use of a drill rig near electrical power lines and other utilities requires that special precautions be taken by both supervisors and members of the exploration crew. Electricity can shock, it can burn and it can cause death.

Overhead and buried utilities should be located, noted and emphasized on all boring location plans and boring assignment sheets.

Before raising the drill rig mast (derrick) on a site in the vicinity of power lines, walk completely around the drill rig. Determine what the minimum distance from any point on the drill rig to the nearest power line will be when the mast is raised and/or being raised. Do not raise the mast or operate the drill rig if this distance is less than 20 feet.

Keep in mind that both hoist lines and overhead power lines can be moved toward each other by the wind.

CLEARING THE WORK AREA

Prior to drilling, adequate site cleaning and leveling should be performed to accommodate the drill rig and supplies and provide a safe working area. Drilling should not be commenced when tree limbs, unstable ground or site obstructions cause unsafe tool handling conditions.

NOTE: In coordination with the Drilling Crew, the Site Health and Safety Manager will review the precautions taken to insure that the drill rig is leveled and stabilized.

HOUSEKEEPING ON AND AROUND THE DRILL RIG

The first requirement for safe field operations is that the drilling crew safety supervisor understands and fulfills the responsibility for maintenance and "housekeeping" on and around the drill rig.

Suitable storage locations should be provided for all tools, materials and supplies so that they can be conveniently and safely handled without hitting or falling on a member of the drill crew or a visitor.

Avoid storing or transporting tools, materials or supplies within or on the mast (derrick) of the drill rig.

Pipe, drill rods, bits casing, augers and similar drilling tools should be orderly stacked on racks or sills to prevent spreading, rolling or sliding.

Penetration or other driving hammers should be placed at a safe location on the ground or be secured to prevent movement when not in use.

Work areas, platforms, walkways, scaffolding and other accessways should be kept free of materials, obstructions and substances such as ice, excess grease or oil that could cause a surface to become slick or otherwise hazardous.

Keep all controls, control linkages, warning and operation lights and lenses free of oil, grease and/or ice.

Do not store gasoline in any portable container other than a non-sparking, red container with a flame arrester in the fill spout and having the word "gasoline" easily visible.

SAFE USE OF HAND TOOLS

There are almost an infinite number of hand tools that can be used on or around a drill rig. "Use the tool for its intended purpose" is the most important rule. The following are a few specific and some general suggestions which apply to safe use of several hand tools that are often used on and around drill rigs.

- When a tool becomes damaged, either repair it before using it again or get rid of it.
- When using a hammer, any kind of hammer for any purpose, wear safety glasses and require all others near you to wear safety glasses.
- When using a chisel, any kind of chisel, for any purpose, wear safety glasses and require all others around you to wear safety glasses.
- Keep all tools cleaned and orderly stored when not in use.
- Replace hook and heel jaws when they become visibly worn.
- When breaking tool joints on the ground or on a drilling platform, position your hands so that your fingers will not be smashed between the wrench handle and the ground or the platform, should the wrench slip or the joint suddenly let go.

SAFE USE OF WIRE LINE HOISTS, WIRE ROPE AND HOISTING HARDWARE

The use of wire line hoists, wire rope, and hoisting hardware should be as stipulated by the American Iron and Steel Institute's Wire Rope Users Manual.

All wire ropes and fittings should be visually inspected during use and thoroughly inspected at least once a week for abrasion, broken wires, wear, reduction in rope diameter, reduction in wire diameter, fatigue, corrosion, damage from heat, improper weaving, jamming, crushing, bird caging, kinking, core protrusion, and damage to lifting

hardware and any other feature that would lead to failure. Wire ropes should be replaced when inspection indicates excessive damage according to the wire rope users manual.

If a ball-bearing-type hoisting swivel is used to hoist drill rods, swivel bearings should be inspected and lubricated daily to assure that the swivel freely rotates under load.

If a rod slipping device is used to hoist drill rods, do not drill through or rotate drill rods through the slipping device, do not hoist more than 1 foot (0.3m) of the drill rod column above the top of the mast (derrick), do not hoist a rod column with loose tool joints and do not make up, tighten or loosen tool joints while the rod column is being supported by a slipping device. If drill rods should slip back into the borehole, do not attempt to break the fall of the rods with your hands.

Most sheaves on drill rigs are stationary with a single-part line. The number of parts of line should never be increased without first consulting with the manufacturer of the drill rig. Wire ropes must be properly matched with each sheave.

The following procedures and precautions must be understood and implemented for safe use of wire ropes and rigging hardware.

Use tool-handling hoists only for vertical lifting of tools (except when angle-hole drilling). Do not use tool-handling hoists to pull on objects away from the drill rig; however, drills may be moved using the main hoist as the wire rope is spooled through proper sheaves according to the manufacturer's recommendations.

When stuck tools or similar loads cannot be raised with a hoist, disconnect the hoist line and connect the stuck tools directly to the feed mechanism of the drill. Do not use hydraulic leveling jacks for added pull to the hoist line or the feed mechanism of the drill.

When attempting to free a mired vehicle or drill rig carrier, only use a winch on the front or rear of the vehicle or drill rig carrier and stay as far away as possible from the wire rope. Do not attempt to use tool hoists to free a mired vehicle or drill rig carrier.

To minimize shock loading of a wire rope, always apply loads smoothly and steadily.

Some additional safety guidelines that should be followed are:

- Protect wire rope from sharp corners or edges.
- Replace faulty guides and rollers.
- Replace worn sheaves or worn sheave bearings.
- Replace damaged safety latches on safety hooks before use.
- Know the safe working load of the equipment and tackle being used. Never exceed this limit.
- Periodically inspect and test clutches and brakes of hoists.
- Know and do not exceed the rated capacity of hooks, rings, links, swivels, shackles and other lifting aids.
- Always wear gloves when handling wire ropes.
- Do not guide wire ropes on hoist drums with your hands.
- After installation of a new wire rope, lift a light load to allow the wire rope to adjust.
- Never carry out any hoisting operations when the weather conditions are such that hazards to personnel, the public or property are created.
- Never leave a load suspended when the hoist is unattended.

- Keep your hands away from hoists, wire rope, hoisting hooks, sheaves and pinch points as slack is being taken up and when the load is being hoisted.

- Never hoist a load over members of the crew.

SAFE USE OF AUGERS

The following general procedures should be used when advancing a boring with continuous-flight or hollow-stem augers:

- Prepare to start an auger boring with the drill rig level, the clutch or hydraulic rotation control disengaged, the transmission in low gear and the engine running at low RPM.

- The operator and tool handler should establish a system of responsibility for the various activities required for auger drilling, such as connecting and disconnecting auger sections and inserting and removing the auger fork. The operator must assure that the tool handler is well away from the auger column and that the auger fork is removed before starting rotation.

- Use only the manufacturer's recommended method of securing the auger to the power coupling. *Do not touch the coupling or the auger with your* hands, a wrench or any other tools during rotation.

- Whenever possible, use tool hoists to handle auger sections.

- Never place hands or fingers under the bottom of an auger section when hoisting the auger over the top of the auger section in the ground or other hard surfaces such as the drill rig platform.

- Never allow feet to get under the auger section that is being hoisted.

- When rotating augers, stay clear of the rotating auger and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason whatever.

- Never use your hands or feet to move cuttings away from the auger.

- When cleaning augers, be sure the drill rig is in neutral and the augers are stopped from rotating.

SAFETY DURING ROTARY AND CORE DRILLING

Rotary drilling tools should be safety-checked before use. In particular, check for the following:

- See that water swivels and hoisting plugs are lubricated and checked for frozen bearings before use.

- Check rod chuck jaws periodically and replace them when necessary.

- Check the capacities of hoists and sheaves against the anticipated weight on the drill rod string plus other expected hoisting loads. Inspect all cables daily.

These other special precautions should be taken for safe rotary or core drilling:

- Drill rods should not be braked during lowering into the hole with drill rod chuck jaws.

- Drill rods should not be held or lowered into the hole with pipe wrenches.

- If a string of drill rods are accidently or inadvertently released into the hole, do not attempt to grab the falling rods with your hands or a wrench.

- In the event of a plugged bit or other circulation blockage, the high pressure in the piping and hose between the pump and the obstruction should be relieved or bled down before breaking the first tool joint.

- When drill rods are hoisted from the hole, they should be cleaned for safe handling with a rubber or other suitable rod wiper. Do not use your hands to clean drilling fluids from drill rods.

- If work must progress over a portable drilling fluid (mud) pit, do not attempt to stand on narrow sides or cross members. The mud pit should be equipped with a rough surface and fitted cover panels of adequate strength to hold drill rig personnel.

- Drill rods should not be lifted and leaned unsecured against the mast. Either provide some method of securing the upper ends of the drill rod sections for safe vertical storage or lay the rods down.

- Inspect all hydraulic lines periodically and replace as needed.

START-UP

All drill rig personnel and visitors should be instructed to "stand-clear" of the drill rig immediately prior to and during starting of an engine.

Make sure all gear boxes are in neutral, all hoist levers are disengaged, all hydraulic levers are in the correct, non-actuating positions, and the cathead rope is not on the cathead before starting a drill rig engine.

SAFETY DURING DRILLING OPERATIONS

Safety requires the attention and cooperation of every worker and site visitor.

Do not drive the drill rig from hole to hole with the mast (derrick) in the raised position.

Before raising the mast (derrick) look up to check for overhead obstructions.

Before raising the mast (derrick), all drill rig personnel and visitors (with exception of the operator) should be cleared from the area immediately to the rear and the sides of the mast. All drill rig personnel and visitors should be informed that the mast is being raised prior to raising it.

Before the mast (derrick) of a drill rig is raised and drilling is commenced, the drill rig must be first leveled and stabilized with leveling jacks and/or solid cribbing. The drill rig should be releveled if it settles after initial set up. Lower the mast (derrick) only when leveling jacks are down and do not raise the leveling jack pads until the mast (derrick) is lowered completely.

Before starting drilling operations, secure and/or lock the mast (derrick) if required according to the drill manufacturer's recommendations.

The operator of a drill rig should only operate a drill rig from the position of the controls. The operator should shut down the drill engine before leaving the vicinity of the drill.

Do not consume alcoholic beverages or other depressants or chemical stimulants prior to starting work on a drill rig or while on the job.

Watch for slippery ground when mounting dismounting from the platform.

All unattended boreholes must be adequately covered or otherwise protected to prevent drill rig personnel, site visitors or animals from stepping or falling into the hole. All open boreholes should be covered, protected, or backfilled adequately and according to local or state regulations on completion of the drilling project.

"Horsing around" within the vicinity of the drill rig and tool and supply storage areas should never be allowed, even when the drill rig is shut down.

Be careful when lifting heavy objects.

Before lifting a relatively heavy object, approach the object by bending at the knees, keeping your back vertical and unarched while obtaining a firm footing. Grasp the object firmly with both hands and stand slowly and squarely while keeping your back vertical and unarched. In other words, perform the lifting with the muscles in your legs, not with the muscles in your lower back.

Drilling operations should be terminated during an electrical storm.

APPENDIX C

CHEMICAL INFORMATION SHEETS

AMMONIA

- Hazardous substance (EPA)

Description: NH_3, ammonia is a colorless, strongly alkaline, and extremely soluble gas with a characteristic pungent odor.

Code Numbers: CAS 7664-41-7 RTECS BO0875000 UN 1005

DOT Designation: Nonflammable gas.

Synonyms: Anhydrous ammonia.

Potential Exposures: Ammonia is used as a nitrogen source for many nitrogen-containing compounds. It is used in the production of ammonium sulfate and ammonium nitrate for fertilizers and in the manufacture of nitric acid, soda, synthetic urea, synthetic fibers, dyes, and plastics. It is also utilized as a refrigerant and in the petroleum refining and chemical industries. It is used in the production of many drugs (A-41) and pesticides (A-32).

Other sources of occupational exposure include the silvering of mirrors, gluemaking, tanning of leather, and around nitriding furnaces. Ammonia is produced as a by-product in coal distillation and by the action of steam on calcium cyanamide, and from the decomposition of nitrogenous materials.

Incompatibilities: Strong oxidizers, calcium, hypochlorite bleaches, gold, mercury, silver, halogens.

Permissible Exposure Limits in Air: The Federal standard for ammonia is an 8-hour time-weighted average of 50 ppm (35 mg/m^3). NIOSH has recommended 50 ppm expressed as a ceiling and determined by a 5-minute sampling period. ACGIH as of 1983/84 has set TWA values of 25 ppm (18 mg/m^3). The tentative STEL value is 35 ppm (27 mg/m^3). The IDLH level is 500 ppm.

Determination in Air: Collection by midget impinger and colorimetric analysis using Nessler's reagent (A-10). Ammonia may also be determined using long-duration detector tubes (A-11).

Permissible Concentration in Water: EPA in 1976 (A-3) proposed a limit of 0.02 mg/ℓ (as unionized ammonia) for the protection of freshwater aquatic life. As of 1980, EPA (2) first proposed adding ammonia to the list of priority toxic pollutants and developing criteria for it, but then withdrew the proposal. NAS/NRC proposed (A-2) a limit of 0.5 mg/ℓ for drinking water.

Routes of Entry: Inhalation of gas, ingestion, skin and eye contact.

Harmful Effects and Symptoms: *Local* — Contact with anhydrous liquid ammonia or with aqueous solutions is intensely irritating to the mucous membranes, eyes, and skin. Eye symptoms range from lacrimation, blepharospasm, and palpebral edema to a rise of intraocular pressure, and other signs resembling acute-angle closure glaucoma, corneal ulceration, and blindness. There may be corrosive burns of skin or blister formation. Ammonia gas is also irritating to the eyes and to moist skin.

Systemic — Mild to moderate exposure to the gas can produce headache, salivation, burning of throat, anosmia, perspiration, nausea, vomiting, and substernal pain. Irritation of ammonia gas in eyes and nose may be sufficiently intense to compel workers to leave the area. If escape is not possible, there may be severe irritation of the respiratory tract with the production of cough, glottal edema, bronchospasm, pulmonary edema, or respiratory arrest. Bronchitis or pneumonia may follow a severe exposure if patient survives. Urticaria is a rare allergic manifestation from inhalation of the gas.

Points of Attack: Lungs, respiratory system, eyes.

Medical Surveillance: Preemployment physical examinations for workers in ammonia exposure areas should be directed toward significant changes in the skin, eyes, and respiratory system. Persons with corneal disease, and glaucoma, or chronic respiratory diseases may suffer increased risk. Periodic examinations should include evaluation of skin, eyes, and respiratory system, and pulmonary function tests to compare with baselines established at preemployment examination.

First Aid: If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, flush with water immediately. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Do not induce vomiting.

Personal Protective Methods: Where ammonia hazards exist in concentrations above the standard, respiratory, eye, and skin protection should be provided. Fullface gas masks with ammonia canister or supplied air respirators, both with full facepieces, afford good protection. In areas where exposure to liquid ammonia occurs, goggles or face shields, as well as protective clothing impervious to ammonia and including gloves, aprons, and boots should be required. Where ammonia gas or concentrated ammonia solution is splashed in eyes, immediate flooding of the eyes with large quantities of water for 15 minutes or longer is advised, followed at once by medical examination.

In heavy concentrations of ammonia gas, workers should be outfitted with complete self-contained protective suits impervious to ammonia, with supplied air source, and full headpiece and facepiece. Appropriate clothing should be worn to prevent any possible skin contact with liquids of >10% content or reasonable probability of contact with liquids of <10% content. Wear eye protection to prevent any possibility of eye contact with liquids of >10% NH_3 content. Employees should wash immediately when skin is wet or contaminated with liquids of >10% content. Remove nonimpervious clothing immediately if wet or contaminated with liquids containing >10% and promptly remove if liquid contains <10% NH_3. Provide emergency showers and eyewash if liquids containing >10% NH_3 are involved.

Respirator Selection:

100 ppm: CCRS/SA/SCBA
300 ppm: CCRSF
500 ppm: GMS/SAF/SCBAF
Escape: GMS/SCBA

Disposal Method Suggested: Dilute with water, neutralize with HCl and discharge to sewer (A-38). Recovery is an option to disposal which should be considered for paper manufacture, textile treating, fertilizer manufacture and chemical process wastes (A-57).

References

(1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Ammonia*, NIOSH Doc. No. 74-136, Washington, DC (1974).

(2) U.S. Environmental Protection Agency, "Toxic Pollutant List: Proposal to Add Ammonia," *Federal Register*, 45, No. 2, 803-806 (January 3, 1980) Rescinded by *Federal Register*, 45, No. 232, 79692-79693 (December 1, 1980).

(3) National Research Council, Committee on Medical and Biologic Effects of Environmental Pollutants, *Ammonia*, Baltimore, MD, University Park Press (1979).

(4) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 2*, No. 1, 65-68, New York, Van Nostrand Reinhold Co. (1982).

(5) See Reference (A-61).

(6) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 3*, No. 3, 49-63, New York, Van Nostrand Reinhold Co. (1983).

(7) See Reference (A-60).

(8) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety*, Third Edition, Vol. 1, pp 148-150, Geneva, International Labour Office (1983).

ATRAZINE

ATZ

Common Synonyms 2-Chloro-4-ethylamino-6-isopropylamino-s-triazine Aatrex Herbicide	Solid crystals White Soluble in water.

AVOID CONTACT WITH SOLID AND DUST
PEOPLE Away
Wear goggles and self-contained breathing apparatus
Stay upwind. Use water spray to "knock down" dust
Isolate and remove discharged material
Notify local health and pollution control agencies

Fire	Not Combustible POISONOUS GASES MAY BE PRODUCED WHEN HEATED
Exposure	CALL FOR MEDICAL AID DUST POISONOUS IF INHALED. Wear goggles and self-contained breathing apparatus Remove victim to fresh air If not breathing, give artificial respiration If breathing is difficult, give oxygen SOLID POISONOUS IF SWALLOWED Wear goggles to prevent eye contact Remove contaminated clothing and shoes. Flush affected areas with plenty of water IF IN EYES, hold eyelids open and flush with plenty of water IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Issue warning-water contaminant
Shield as required
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: To be developed
3.2 Formula: $C_8H_{14}ClN_5$
3.3 BOD/UN Designations 6.1/1699
3.4 DOT ID No.: 1699
3.5 CAS Registry No.: 1912-24-9

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (at shipping): Solid
4.2 Color: White
4.3 Odor: Data not available

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Dust mask, goggles, rubber gloves
5.2 Symptoms Following Exposure: Irritates eyes and skin. If ingested, irritates mouth and stomach
5.3 Treatment of Exposure: EYES: flush with copious amounts of water for 15 min. SKIN: wash with large amounts of water. INGESTION: no specific antidote, induce vomiting and give a saline laxative and adsorptive therapy
5.4 Threshold Limit Value: 5 mg/m³
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 2; oral rat LD_{50} = 3080 mg/kg
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors are nonirritating to eyes and throat
5.9 Liquid or Solid Irritant Characteristics: Causes smarting of the eyes and tenderness burns on short exposure and may cause second-degree burns on long exposure
5.10 Odor Threshold: Data not available
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not explosive
6.3 Fire Extinguishing Agents: Not pertinent
6.4 Fire Extinguishing Agents Not to be Used: Data not available
6.5 Special Hazards of Combustion: Products: irritating hydrogen chloride and toxic oxides of nitrogen may be formed
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: Not pertinent
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not pertinent
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity With Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: 12.5 mg/l/48 hr/rainbow trout/TL$_m$/fresh water
8.2 Waterfowl Toxicity: >2000 mg/kg LD_{50}
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Various grades, 70-95%. Mixtures with calcium arsenate and sodium monosilicate
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
E

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Not listed
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	0
Health	
Water Vapor	0
Liquid or Solid Vapors	2
Poisons	0
Water Pollution	
Human Toxicity	3
Aquatic Toxicity	2
Aesthetic Effect	3
Reactivity	
Other Chemicals	1
Water	1
Self Reaction	0

11.3 NFPA Hazard Classification: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Solid
12.2 Molecular Weight: 215.7
12.3 Boiling Point at 1 atm: Decomposes
12.4 Freezing Point: 347°F = 175°C = 448°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: (solid 1.2 at 20°C (water))
12.8 Liquid Surface Tension: Not pertinent
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: (solid) −3,000 Btu/lb = −6,980 cal/g = −292 X 10³ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.17 Heat of Fusion: Data not available
12.18 Limiting Value: Data not available
12.19 Reid Vapor Pressure: Data not available

NOTES

Material Safety Data Sheet
from Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 22

CALCIUM OXIDE

(Revision C)
Issued: September 1978
Revised: April 1989

SECTION 1. MATERIAL IDENTIFICATION

28

Material: CALCIUM OXIDE

Description (Origin/Uses): Used in the manufacture of steel, aluminum, glass, and paper; also found in plaster, mortar, bricks, stucco, and in other building and construction materials.

Other Designations: Lime; Quicklime; Burnt Unslaked Lime; High-Calcium Lime; CaO;
CAS No. 1305-78-8

Manufacturer: Contact your supplier or distributor. Consult the latest edition of *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA

HMIS	
H 1	R 1
F 1	I 2
R 0	S 3
PPG*	K 0

*See sect. 8

SECTION 2. INGREDIENTS AND OCCUPATIONAL EXPOSURE LIMITS

Calcium Oxide, ca 100%

OSHA PEL
8-hr TWA: 5 mg/m³

ACGIH TLV, 1988-89
TLV-TWA: 2 mg/m³

Toxicity Data
Not Listed*

*Monitor NIOSH, *RTECS* (EW3100000), for future data.

SECTION 3. PHYSICAL DATA

Boiling Point: 5162 °F (2850 °C)
Melting Point: 4658 °F (2570 °C)
pH: >10 (Strongly Basic)

Molecular Weight: 56 g/mol
Solubility in Water (%): Reacts
Specific Gravity (H_2O = 1): 3.2 to 3.4

Appearance and Odor: A white or grayish white solid (it can appear yellowish or brownish if iron impurities are present; commercial calcium oxide is available in a wide variety of forms such as lumps, pellets, pebbles, and powders); odorless.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: *	Autoignition Temperature: *	LEL: *	UEL: *

Extinguishing Media: *Calcium oxide will not burn. Use an extinguishing agent that will put out the surrounding fire. Water reacts dangerously with calcium oxide and is not recommended as an extinguishing agent for fires that involve it. If water must be used, prevent it from coming into direct contact with the calcium oxide. If such contact is unavoidable, apply the water in flooding amounts to safely absorb the heat that will be generated. **Unusual Fire or Explosion Hazards:** Do not allow water to get inside containers of calcium oxide; reaction with the water will cause the calcium oxide to swell, generate heat, and burst its container. The heat generated by this reaction may ignite nearby combustible materials. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Calcium oxide is stable in closed, airtight containers during routine work operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Calcium oxide can react dangerously with boric oxide and calcium chloride, boron trifluoride, chlorine trifluoride, fluorine, hydrofluoric acid, phosphorus pentoxide, and water. **Conditions to Avoid:** Control exposure to incompatible chemicals. Always establish the compatibility of calcium oxide with another material before using it in bulk operations by testing small quantities under appropriate conditions. Avoid exposing calcium oxide to air because it reacts with the ambient moisture and carbon dioxide. **Hazardous Products of Decomposition:** Oxides of calcium may be produced when calcium oxide reacts with other materials during fires.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Calcium oxide is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Calcium oxide is a strongly alkaline material; its contact with the skin, eyes, or inhalation results in severe irritation. Dust containing 25 mg/m³ of this material causes strong nasal irritation; dust containing 9 to 10 mg/m³ does not. The presence of moisture on the skin or on the mucous membrane of the respiratory system increases the possibility of corrosive tissue damage (chemical burns). Dehydration and thermal effects (the heat generated from reaction with water) are contributing factors to the irritating properties of calcium oxide. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, nose, and respiratory system. **Primary Entry:** Inhalation and contact with skin and eyes. **Acute Effects:** Irritation and burns to the skin, eyes, and nose; irritation and inflammation of the respiratory system; coughing; and sneezing. **Chronic Effects:** Ulceration and perforation of the nasal septum, pneumonia. May cause nails to become brittle and fissure (split). *(Cont'd.)*

Copyright © 1989 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION, continued

FIRST AID

Eyes: Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. An occupational ophthalmologist should monitor and treat the eye for calcium oxide burns. **Skin:** Do not rinse the affected area with water because severe skin damage is likely to occur if water is applied directly to the calcium oxide on the skin. Before wetting the calcium oxide, try to remove it from the skin with oil or grease; then apply water in a forcefully directed, powerful stream in flooding amounts that will mechanically and immediately remove the calcium oxide particles from the skin. **Inhalation:** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion:** Unlikely. Get in plant, paramedic, or community medical help for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Severe exposure indicates hospitalization for 72 hours with careful monitoring for the delayed onset of pulmonary edema.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, prevent accidental contact between the spilled calcium oxide and water, and avoid generating dust. Cleanup personnel need protection against its contact with skin or eyes as well as against inhalation of its dust (see sect. 8). Carefully pick up the solid, creating a minimum of dust, and collect it in metal containers with covers for disposal. Flush the trace residue in the spill area to a drain, using plenty of water.

Waste Disposal: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Follow all applicable Federal, state, and local regulations. Large amounts of calcium oxide may require neutralization by acid before disposal. Flush any residue to a sewer after diluting it properly. Alternatively, the waste calcium oxide can be used for neutralizing plant acid waste.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z)

EPA Designations

Assigned the RCRA Hazardous Waste No. D003 (40 CFR 261.23)

Assigned the CERCLA Reportable Quantity (RQ): 100 lb (45.4kg) (40 CFR 302.5 [b])

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Consult Genium reference 88 for recommendations on selecting the proper respirator for use around calcium oxide. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres.

Other: Wear *dry* rubber gloves, boots, aprons, gauntlets, and coveralls.

Ventilation: Install and operate general and local ventilation systems powerful enough to maintain airborne concentrations of calcium oxide below the OSHA PEL standard cited in section 2.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas.

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment.

Other: Design all work operations in a way that does not generate dust and prevents water from being accidentally introduced into any part of a production system that contains calcium oxide.

Comments: Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store calcium oxide in sealed, dry, airtight containers in a cool, dry, well-ventilated area separate from incompatible chemicals (see sect. 5). Store it away from strong oxidizing agents, acids, organic materials, water, and combustibles.

Special Handling/Storage: Protect containers of calcium oxide from physical damage. Prevent water from contacting stored calcium oxide. To maintain the full effectiveness of this material, avoid extended contact with air.

Comments: Calcium oxide generates substantial heat when mixed with water. Prevent accidental mixing by following planned work procedures in all shipping, receiving, transferring, and production operations. When calcium oxide is deliberately mixed with water, undertake proper precautions to ensure that the resulting heat can be safely generated. *Always add calcium oxide to water; never add water to calcium oxide.*

Hazardous Materials Table (49 CFR 172.101)

DOT Shipping Name: Calcium Oxide
DOT Hazard Class: ORM-B
DOT ID No.: UN1910
DOT Label: None

References: 1, 26, 38, 84-94, 100, 116

Prepared by: PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

Copyright © 1989 by Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited. Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN STREET
SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

NO. 410

CARBON TETRACHLORIDE

Revision A

Date December 1980

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: CARBON TETRACHLORIDE
OTHER DESIGNATIONS: Tetrachlormethane, Perchlormethane, Methane Tetrachloride, CCl_4, GE Material D5B50, CAS #000 056 235
MANUFACTURER: Available from several suppliers, including:
Linden Chemicals & Plastics
PO Drawer J,
Moundsville, WV 26041 Phone: (314) 843-1310

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Carbon Tetrachloride *ACGIH (1980 Intended Changes List). OSHA 8-hr TWA is 10 ppm. NIOSH has proposed a 10-hr TWA of 2 ppm. ACGIH and NIOSH recommend labeling as a suspected human carcinogen. (skin) notation indicates absorption through the skin can contribute significantly to overall exposure.	ca 100	8-hr TWA 5 ppm (skin) or 30 mg/m^3* Human, oral LDlo 43 mg/kg Human, inhalation LCLo 1000 ppm TCLo 20 ppm (CNS) Hamsters and mice have developed cancer on long term feeding.

SECTION III. PHYSICAL DATA

Boiling point at 1 atm, deg C	76.7	Specific gravity, 25/4 C	1.585
Vapor pressure @ 20 C, mm Hg	ca 91	Melting point, deg C	-23
Vapor density (Air=1)	5.3	Volatiles, %	ca 100
Solubility in water @ 20 C, wt %	0.08	Molecular weight	153.8

Appearance & Odor: A clear, colorless liquid with a characteristic sweetish odor. Odor recognition threshold (100% of test panel): 21.4 ppm in air when prepared from CS_2; 100 ppm in air when prepared from CH_4. Odor may not be objectionable at acutely toxic levels.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER

Extinguishing Media: It is nonflammable. Use that which is appropriate for the surrounding fire. Use water spray to cool fire-exposed containers.
When involved in a fire situation, this material will emit highly toxic and irritating fumes and gases. Metals, such as aluminum and magnesium, can react violently with carbon tetrachloride when hot or burning.
Firefighters must wear self-contained breathing apparatus and full protective gear to fight fires involving this material.

SECTION V. REACTIVITY DATA

This material is stable under normal conditions of handling and use. It does not polymerize.
Thermal-oxidative decomposition will produce toxic, corrosive fumes, including phosgene and hydrogen chloride.
Violent reactions or explosions can occur with incompatible materials, such as barium, lithium, sodium, and potassium metal, powdered aluminum, magnesium, dimethylformamide (above 65 C), fluorine, etc. (See NFPA, "Manual of Hazardous Chemical Reactions".)

Copyright © 1980 Genium Publishing Corporation
Any commercial use without publisher's specific permission is prohibited.

SECTION VI. HEALTH HAZARD INFORMATION

TLV 5 ppm (skin) (See Sect. II)

Carbon tetrachloride is highly toxic and irritating by inhalation and ingestion (mean lethal dose is 5-10 ml). It is toxic by skin absorption. Excessive exposure may result in CNS depression and/or gastrointestinal symptoms.* It is irritating to skin and eyes. Eye contact or systemic effects can produce visual disturbances (haze, blind spots, narrowing of visual field, etc.). Skin contacts can cause defatting & dermatitis.

Kidney & liver damage can occur from severe acute or chronic exposure. It is a suspected carcinogen in humans.

FIRST AID:

Eye Contact: Flush eyes with running water for 15 minutes, including under the eyelids. Get medical help if irritation persists or when visual disturbances occur.

Skin Contact: Remove contaminated clothing promptly. Wash exposed skin with soap and water. Get medical help for repeated or gross exposures.

Inhalation: Remove to fresh air. Restore and/or support breathing; have qualified person administer oxygen if needed. Get medical help.

Ingestion: Contact physician for gastric lavage. (If medical help and advice is not readily available, give water to drink and induce vomiting.)

*Also cardic arrhythmias.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel when large spills occur. Evacuate area. Provided maximum exhaust ventilation. Clean-up personnel must use protection against contact and inhalation (see Sect.VIII). Contain spill; pick up liquid for disposal. Small spills and residues can be absorbed on paper, vermiculite, etc. and allowed to evaporate in a hood. Prevent release of CCl_4 to surface water or sewers. Spills or discharges in 24 hours of 5000 lb or more (proposed RQ* is 1000 lb) must be reported to U.S. Government.

DISPOSAL: Consider recovery and reuse, if feasible. Scrap may be burned in approved, high temperature incinerator with scrubber or it may be disposed of as hazardous waste (EPA number U211 or F001 as a spent degreasing solvent under RCRA). Follow Federal, State and Local regulations.

*Reportable Quantity.

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV. Exhaust hoods need 100 lfm min. face velocity. Ventilate sumps and low lying areas. Use air-supplied or self-contained respirators above TLV, with full face piece above 100 ppm.

PVA or neoprene gloves and protective clothing needed to prevent skin contact. Wear safety goggles and/or face shield for eye protection.

An eyewash station and chemical safety shower should be readily accessible.

Provide preplacement and twice a year medical exams. Workers with obesity, diabetes, alcoholism or pulmonary problems should have a physician's approval before working with CCl_4. Retain medical records for 30 years after termination of employment.

Provide training to those exposed to CCl_4 in the workplace. Monitor vapor levels in the workplace.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated, low fire-risk area. Protect containers against physical damage. Keep away from sources of heat, direct sunlight, and incompatible materials (see Sect. V). Prevent exposure of vapors to high temperature to prevent decomposition to toxic and corrosive gases and vapors. No smoking in areas where vapors may be present.

Prevent contact with the skin or eyes. Avoid exposure to vapors. Use good personal hygiene.

CCl_4 toxicity is markedly increased by the synergistic effects of alcohol. When possible, substitute a less hazardous solvent for CCl_4.

DOT Classification - ORM-A

DATA SOURCE(S) CODE: 1-12,15,16,21-26,31,37,38,41

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

APPROVALS: MIS J. M. Nielsen

Industrial Hygiene and Safety 12-9-80

MEDICAL REVIEW: 16 Dec. 1980

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 53

CHLORINE
(Revision B)
Issued: July 1979
Revised: April 1988

SECTION 1. MATERIAL IDENTIFICATION

25

Material Name: CHLORINE

Description (Origin/Uses): Used mainly to manufacture chlorinated lime for bleaching fabrics; as a versatile reagent in organic chemistry; in water purification; and as a military poison gas (bertholite).

Other Designations: Bertholite; Molecular Chlorine; Cl_2; NIOSH *RTECS* No. FO2100000; CAS No. 7782-50-5

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS			
H	3		
F	0	R	1
R	1	I	4
PPG*		S	4
*See sect. 8		K	0

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Chlorine, CAS No. 7782-50-5	ca 100	IDLH* Level: 30 ppm **OSHA PEL** Ceiling: 1 ppm, 3 mg/m³ TLV-STEL: 3 ppm, 9 mg/m³ **NIOSH REL** 15-Min Ceiling: 0.5 ppm, 1.45 mg/m³ **Toxicity Data**** Rat, Inhalation, LC_{50}: 293 ppm (1 Hr) Mouse, Inhalation, LC_{50}: 137 ppm (1 Hr)

*Immediately dangerous to life and health
**See NIOSH, *RTECS*, for additional data with references to irritative and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: ca -29°F (-34°C)
Vapor Pressure: >760 Torrs (Normal Atmospheric Pressure)
Vapor Density (Air = 1): 1.4085 at 68°F (20°C)
Melting Point: ca -150°F (-101°C)
Molecular Weight: 71 Grams/Mole
Water Solubility: Slight

Appearance and Odor: A greenish yellow, noncombustible gas; pungent, suffocating, nauseating odor. Its odor-recognition threshold is reported to be ca 0.3 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Chlorine will not burn, but it supports combustion of materials already involved in a fire. Use agents that will extinguish the surrounding fire. Use a water spray to cool fire-exposed tanks and to protect personnel attempting to stop a chlorine leak.
Unusual Fire or Explosion Hazards: Chlorine is a reactive/explosive gas. Fight fires involving it from the maximum possible distance; this gas greatly increases the flammability hazards of other combustibles that are present. **Warning:** Flammable gases, vapors, and mists form dangerously explosive mixtures with chlorine gas.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Fire fighters must use the maximum personal protective equipment available. If possible, have specially trained personnel remove intact cylinders of chlorine from the fire area and protect them with any available resource such as directed water spray.

SECTION 5. REACTIVITY DATA

Chlorine is stable in closed, pressurized containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.
Chemical Incompatibilities: Chlorine reacts dangerously with acetylene, ammonia, hydrogen, ether, fuel gas, hydrocarbons, turpentine, finely divided metals, diborane, benzene, and acetaldehyde (see Genium ref. 84, pp. 49-28 and 491M-53 to 491M-56).
Conditions to Avoid: Do not allow open flame, unprotected heaters, lighted tobacco products, electric sparks, or excessive heat in work areas because chlorine gas can form explosive mixtures with other gases. Do not heat pressurized storage tanks or cylinders containing chlorine because they may explode. Do not allow chlorine to be directly exposed to incompatible chemicals (see above).
Hazardous Products of Decomposition: Toxic gases such as carbon monoxide, phosgene, and hydrogen chloride (Genium Industrial MSDSs 35, 66, 30) can be produced in fires involving chlorine and other combustibles.

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

Chlorine is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks, Warning: This material is a powerful respiratory irritant. The most important acute health effect of exposure is lung damage from hydrochloric acid (HCl) caused by the reaction of chlorine with the moisture in the upper respiratory tract (URT). Fatal pulmonary edema (lungs filled with fluid) may be delayed from 24 to 48 hours after exposure. Erosion of teeth, decreased lung capacity, and increased susceptibility to tuberculosis are chronic effects in workers who handle this gas. **Medical Conditions Aggravated by Long-Term Exposure:** Cardiac, pulmonary, or respiratory problems. Administer preplacement and periodic medical exams emphasizing the respiratory system to workers who regularly handle chlorine. **Target Organs:** Respiratory system. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Burning and severe irritation of the eyes, skin, and URT; wheezing, shortness of breath; nausea; vomiting; headache; dizziness; and (delayed) pulmonary edema. **Chronic Effects:** Reduced respiratory capacity may result from chronic low-level exposure to chlorine.

FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Skin contact with chlorine causes severe damage from frostbite (cryogenic injury) as well as chemical burns. Irrigate the area with water and treat the exposed person accordingly. **Inhalation.** Remove exposed person to fresh air; restore and/or support his or her breathing as needed. Recommended treatment includes administering pure oxygen gas (O_2) as soon as symptoms of exposure develop (Genium ref. 39, p. 1975). Observe exposed person for respiratory effects. **Ingestion.** This type of exposure to chlorine is highly unlikely because it is a gas.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Preplan and carefully explain proper emergency procedures to relevant personnel. Notify safety personnel, evacuate all nonessential personnel, provide maximum explosion-proof ventilation, and eliminate all sources of ignition immediately. Cleanup personnel must wear protection against contact with and inhalation of vapor (see sect. 8). Try to shut off the flow of chlorine gas. Use a water spray to protect personnel attempting to stop the leak.

Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z): Not Listed

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste: Listed without Number

CERCLA Hazardous Substance, Reportable Quantity: 10 lbs (4.54 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow the eye- and face-protection guidelines in 29 CFR 1910.133. **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks) wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves; boots; aprons; and clean, impervious, body-covering clothing to prevent any possibility of skin contact. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne levels of chlorine gas strictly below the OSHA PEL standard cited in section 2. Make all ventilation systems of maximum explosion-proof design, e.g., nonsparking, electrically grounded and bonded, etc. **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. **Other:** Use enclosed-containment processing operations; otherwise, the ventilation systems may not be able to keep airborne levels of chlorine below the legal ceiling limit of 1 ppm (3 mg/m³) set by OSHA. Automatic air-monitoring sensing equipment connected to an alarm system is recommended for continual-use operations. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Avoid prolonged skin contact with this material.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store chlorine in a cool, dry, well-ventilated area away from organics, sources of ignition, any flammable or explosive materials, cylinders containing oxygen, and incompatible chemicals (see sect. 5). Use outside or detached storage. Store cylinders upright and secure them tightly. **Special Handling/Storage:** Chlorine is shipped/stored as a pressurized gas in cylinders or tank cars. Protect them against physical damage and regularly inspect them for cracks, leaks, or faulty valves. Follow standard safety procedures for handling compressed, corrosive gases. Electrically ground and bond all containers used in shipping and transferral operations to prevent static sparks. Do not drag or slide cylinders containing chlorine; move them in a carefully supervised manner with a suitable hand truck. Do not smoke in use or storage areas. **Engineering Controls:** All engineering systems (ventilation, production, etc.) must be of maximum explosion-proof design. Use chlorine in closed engineering systems to prevent dispersion of this gas into general work areas. Monitor all piping systems, reactor vessels, and holding tanks for unwanted moisture contamination or buildup. Liquid chlorine levels should be less than 85% of a tank's or cylinder's capacity. **Comments:** Perform all operations with chlorine carefully to prevent accidental ignition of explosive mixtures. Prevent any contact with incompatible chemicals (see sect. 5). Keep the valve-protection cap in place until immediately before using chlorine. Insert a check valve or trap into the transferral line to prevent a dangerous backflow into the original container. Use a pressure-reducing regulator when connecting a storage vessel to a lower-pressure piping system. A trained chemist or safety specialist familiar with the physical and chemical properties of this gas should be present during all work operations.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Chlorine
DOT Class: Nonflammable Gas
References: 1, 2, 12, 73, 84-94, 100, 103.

DOT Label: Nonflammable Gas *and* Poison
DOT ID No. UN1017

IMO Label: Poison Gas
IMO Class: 2.3

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 315

CHLOROFORM
(Revision D)
Issued: August 1979
Revised: April 1988

SECTION 1. MATERIAL IDENTIFICATION

25

Material Name: CHLOROFORM

Description (Origin/Uses): Used as a solvent for fats, oils, rubber, alkaloids, waxes, and resins; as a cleansing agent.

Other Designations: Trichloromethane; $CHCl_3$; NIOSH *RTECS* No. FS9100000; CAS No. 0067-66-3

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS			
H	2		
F	0	R	1
R	0	I	3
PPG*		S	2
*See sect. 8		K	0

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Chloroform, CAS No. 0067-66-3	Ca 100	**OSHA PEL** Ceiling: 50 ppm, 240 mg/m³ **ACGIH TLV, 1987-88** TLV-TWA: 10 ppm, 50 mg/m³ **NIOSH REL** Ceiling: 2 ppm, 9.78 mg/m³ **Toxicity Data*** Human, Oral, LD_{Lo}: 140 mg/kg Rat, Oral, LD_{50}: 908 mg/kg
*See NIOSH, *RTECS*, for additional toxicity data with references to mutagenic, reproductive, tumorigenic, and irritative effects.		

SECTION 3. PHYSICAL DATA

Boiling Point: 142°F (61°C)
Melting Point: -82.3°F (-63.5°C)
Vapor Pressure: 158.4 Torrs at 68°F (20°C)
Vapor Density (Air = 1): 4.13

Water Solubility (%): 0.822 ml of $CHCl_3$ per 100 ml of H_2O at 68°F (20°C)
% Volatile by Volume: 100
Molecular Weight: 119 Grams/Mole
Specific Gravity (H_2O = 1): 1.484 at 68°F (20°C)

Appearance and Odor: A heavy, colorless, clear, volatile liquid; characteristic, pleasant, ethereal, sweet odor (recognition threshold: 0.3 mg/m³); sweet taste.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Chloroform does not burn. Use an agent that will put out the surrounding fire.

Unusual Fire or Explosion Hazards: None reported.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Chloroform is stable if kept in closed containers and protected from air and sunlight. It does not undergo hazardous polymerization; however, even when stabilized with ethanol, this material develops acidity from prolonged exposure to air and light.

Chemical Incompatibilities: This material is incompatible with strong alkalies.

Conditions to Avoid: Avoid prolonged exposure to air and light and to strong alkalies.

Hazardous Products of Decomposition: Toxic and corrosive gases like hydrochloric acid (HCl), chlorine (Cl_2), carbon monoxide (CO), and oxides of chlorine (ClO_2) can be produced during fires.

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

Chloroform is listed as a suspected human carcinogen by ACGIH.

Summary of Risks: Exposure to this material affects the central nervous system (anesthesia); heart (arrhythmia, ventricular tachycardia, bradycardia); liver (necrosis, hepatoma); kidney (necrosis); and it is an embryonic toxin. Fatalities are associated with cardiovascular depression and ventricular fibrillation.
Medical Conditions Aggravated by Long-Term Exposure: Ailments of the heart, liver, and kidneys may be worsened by exposure to chloroform. **Target Organs:** Liver, kidneys, heart, skin, eyes. **Primary Entry:** Skin contact, inhalation.
Acute Effects: Dizziness, mental dullness, nausea, headache, fatigue, and anesthesia. **Chronic Effects:** Possible cancer.
FIRST AID
Eyes: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes.
Skin: Immediately wash the affected area with soap and water. **Inhalation:** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed.
Ingestion: Never give anything by mouth to someone who is unconscious or convulsing. If the exposed person is responsive, give him or her several glasses of milk or water to drink and induce vomiting. Repeat if large quantities were ingested.
Comments: Workers who are regularly exposed to chloroform require preplacement and periodic medical exams emphasizing kidney, liver, skin, and central nervous system functions. Carefully evaluate each exposure that produces a noticeable effect to determine the extent to which factors like alcohol or drugs have affected it.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel of a chloroform spill or leak. Provide ventilation. Cleanup personnel need protection against contact with and inhalation of vapor (see sect. 8). Chloroform vapor is heavier than air and will collect in low-lying areas. Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.
Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U044
CERCLA Hazardous Substance, Reportable Quantity: 5000 lbs (2270 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield as a supplementary protective measure. Follow the eye- and face-protection guidelines in 29 CFR 1910.133. **Respirator:** Wear a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** To prevent contact with skin, wear impervious gloves, boots, aprons, gauntlets, etc., as required by the specific work environment. **Ventilation:** Install and operate general and local ventilation systems that are powerful enough to maintain airborne levels of chloroform below the OSHA PEL standard cited in section 2.
Safety Stations: Make eyewash stations, washing facilities, and safety showers available in use and handling areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Avoid inhalation of vapor!

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store chloroform in closed containers away from light and alkalies.

Special Handling/Storage: Protect containers from physical damage. Do not transfer chloroform through plastic or rubber hoses or pipes.

Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: Chloroform
DOT Class: ORM-A
DOT Label: None
DOT ID No. UN1888
IMO Label: Poison
IMO Class: 6.1

References: 1, 2, 12, 73, 84-94, 100, 103.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: MJ Hardies, MD

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

CEDAR CHEMICAL CORPORATION
MEMPHIS, TENNESSEE

MATERIAL SAFETY DATA SHEET
Equivalent to OSHA form 174

PRODUCT NAME: TECHNICAL DINOSEB DATE: 08/15/86 PAGE 1
EPA REG. NO.: 56077-3

SECTION I

Manufacturer's Name: Cedar Chemical Corporation
5100 Poplar Ave. 24th Floor
Memphis, TN 38137
Emergency Phone Number: 1-800-424-9300
Information Phone Number: 1-601-636-1231
Prepared by: M. S. Bernard

SECTION II HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

INGREDIENT	OSHA PEL	ACGIH TLV	PERCENT
Dinoseb	n/d	0.3mg/m³	95.00
Dinoseb (2-sec-butyl-4,6-dinitrophenol) CAS # 88-85-7			
Impurities	n/d	n/d	5.00

SECTION III PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point(°F)	above 212	Specific Gravity	1.258
Vapor Pressure(mm Hg.)	below 1	Melting Point(°F)	90
Vapor Density(Air=1)	n/a	Evaporation Rate	n/d

Solubility in Water: 0.0052g/100ml
Appearance and Odor: Brown solid, organic acid odor

SECTION IV FIRE AND EXPLOSION HAZARD DATA

Flash Point(Method Used): 350.6°F TCC
Flammable Limits: LEL- n/d UEL- n/d
Extinguishing Media:
Water Fog, Foam, Alcohol Foam, CO_2, and Dry Chemical

CONTINUED ON PAGE 2

Special Fire Fighting Procedures:
Self-contained air supply. Confine water used in fire fighting.
Unusual Fire and Explosion Hazards:
Noxious fumes may form. Material undergoes rapid exothermic decomposition at 190°C. Vapors may ignite.

SECTION V REACTIVITY DATA

Stability: Stable in normal use and storage.
Conditions to Avoid: Heating above 100°C. Product undergoes rapid exothermic decomposition at 190°C. Avoid ignition sources.
Incompatibility: Strong Bases and Strong Oxidizers
Hazardous Decomposition or Byproducts: Oxides of Nitrogen
Hazardous Polymerization: Will not occur. No known conditions to avoid.

SECTION VI HEALTH HAZARD DATA

Route(s) of Entry: Inhalation: Moderate Toxicity
Skin: Readily Absorbed
Ingestion: Highly Toxic
Health Hazards (Acute and Chronic):
Oral Ingestion: High Single Dose Oral Toxicity. LD_{50} for Rats 25 mg/kg. May be fatal if swallowed.
Eye Contact: May cause severe irritation and corneal injury. Corneal injury should heal in 1-2 weeks.
Skin Contact: May cause slight irritation or mild burn. Colors the skin yellow.
Skin Absorption: Readily absorbed through skin, high toxicity. LD_{50} rabbits 80mg/kg.
Inhalation: May be irritating. Cedar industrial guide for Dinoseb is 0.3 mg/m^3.
Carcinogenicity: NTP: Negative
IARC Monographs: Negative
OSHA Regulated: Negative
Signs and Symptoms of Exposure:
Fatigue, sweating, thirst, and fever. Increased metabolic rate.
Medical Conditions Generally Aggravated by Exposure:
Liver and kidney problems may be aggravated by extreme exposure.

Emergency and First Aid Procedures:

Oral Ingestion: Toxic by ingestion. Induce vomiting and seek medical help immediately.

Eye Contact: Flush immediately with continuous irrigation with flowing water for at least thirty minutes. Seek medical consultation immediately.

Skin Contact: Immediately flush skin with plenty of water for at least fifteen minutes while removing contaminated clothing. Consult physician. Wash clothing before reuse.

Inhalation: Remove to fresh air if effects occur. Consult physician.

Note to Physician:

Eyes: Stain for evidence of corneal injury. If cornea is burned, instill antibiotic steroid preparation frequently. Consult ophthalmologist. May cause temporary injury.

Overexposure: Treat for symptoms. No specific antidote. Human effects not established.

SECTION VII PRECAUTIONS FOR SAFE HANDLING AND USE

Steps to Be Taken in Case Material Is Released or Spilled:

Use proper safety equipment. Absorb spill with absorbant inert material such as oil-dry. Dike area for large spills. Keep out of streams and water supplies.

Waste Disposal Method:

Dispose of in non-crop area away from water supplies or in an approved landfill in accordance with State, Federal, and local regulations.

Precautions to Be Taken in Handling and Storing:

Do not get on skin, on clothing, or in eyes. Keep out of reach of children.

Other Precautions:

Do not breathe spray mists. Keep away from heat or flame.

SECTION VIII CONTROL MEASURES

Respiratory Protection:

None normally needed. During spraying use organic vapor respirator.

Ventilation: Required to control level of dinoseb.

Protective Gloves: Impervious rubber gloves

Eye Protection: Chemical workers' goggles

Other Protective Clothing or Equipment: Rubber boots and apron and body-covering clothing.

Work/Hygenic Practices: Shower after handling.

THE INFORMATION HEREIN IS SUPPLIED IN GOOD FAITH. BUT NO WARRANTY, EXPLICITE OR IMPLIED, IS MADE.

Material Safety Data Sheet

from Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 385

ETHYL BENZENE

(Revision A)
Issued: August 1978
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: ETHYL BENZENE

Description (Origin/Uses): Used as a solvent and as an intermediate in the production of styrene monomer.

Other Designations: Phenylethane; Ethylbenzol; $C_2H_5C_6H_5$; CAS No. 0100-41-4

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA

HMIS	
H 2	R 1
F 3	I 3
R 0	S 2
PPG*	K 4

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Ethyl Benzene, CAS No. 0100-41-4	Ca 100	**OSHA PELs** 8-Hr TWA: 100 ppm, 435 mg/m³ 15- Min STEL: 125 ppm, 545 mg/m³ **ACGIH TLVs, 1988-89** TLV-TWA: 100 ppm, 435 mg/m³ TLV-STEL: 125 ppm, 545 mg/m³ **Toxicity Data*** Human, Inhalation, TC_{Lo}: 100 ppm (8 Hrs) Rat, Oral, LD_{50}: 3500 mg/kg

*See NIOSH, *RTECS* (DA0700000), for additional data with references to reproductive, irritative, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 277°F (136°C)
Melting Point: -139°F (-95°C)
Vapor Pressure: 7.1 Torrs at 68°F (20°C)
Vapor Density (Air = 1): 3.7
% Volatile by Volume: Ca 100

Molecular Weight: 106 Grams/Mole
Solubility in Water (%): Slight
Specific Gravity (H_2O = 1): 0.86258 at 77°F (25°C)

Appearance and Odor: A clear, colorless, flammable liquid; characteristic aromatic hydrocarbon odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method: 64°F (18°C) CC	Autoignition Temperature: 810°F (432.22°C)	LEL: 1% v/v	UEL: 6.7% v/v

Extinguishing Media: Use foam, dry chemical, or carbon dioxide to put out ethyl benzene fires. A water spray may be ineffective in extinguishing the fire, because it can scatter and spread the burning liquid. Use water spray to cool fire-exposed containers of ethyl benzene, to disperse ethyl benzene vapor, and to protect personnel attempting to stop an ethyl benzene leak. **Unusual Fire or Explosion Hazards:** This liquid can readily form explosive vapor-air mixtures, especially when heated. Ethyl benzene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back to its origin. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Ethyl benzene is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Hazardous chemical reactions can occur between ethyl benzene and strong oxidizing agents, acids, ammonia, and bases. **Conditions to Avoid:** Avoid any exposure to sources of ignition such as heat, sparks, open flame, and lighted tobacco products, etc., and to incompatible chemicals. Use caution when entering confined spaces, particularly low-lying areas where explosive concentrations of ethyl benzene vapor may be present. Provide good ventilation to such areas to prevent the concentration of this vapor. **Hazardous Products of Decomposition:** Thermal-oxidative degradation can include toxic gases such as carbon monoxide and/or aromatic hydrocarbon gases.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Ethyl benzene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Ethyl benzene vapor is severely irritating to the eyes and to the mucous membranes of the respiratory system. Sustained inhalation of excessive levels can cause depression of the central nervous system (CNS) characterized by dizziness, headache, narcosis, and coma. Skin contact with liquid ethyl benzene causes irritation; dermatitis and defatting can also develop. The acute oral toxicity of ethyl benzene is low; however, ingestion of it presents a serious aspiration hazard. Aspirating even a small amount into the lungs can result in extensive edema (lungs filled with fluid) and hemorrhaging of the lung tissue. No systemic effects are expected at the levels that produce pronounced, unignorable, disagreeable skin and eye irritation. The TLVs cited in section 2 are set to prevent this intolerable irritation. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, and CNS. **Primary Entry:** Inhalation, skin contact **Acute Effects:** Irritation of the skin, eyes, and respiratory system. Also, cardiac-rhythm disturbance due to sensitization: acute bronchitis, bronchospasm, pulmonary and laryngeal edema; euphoria; headache; giddiness; dizziness; and incoordination, as well as possible depression; confusion; and coma. **Chronic Effects:** None reported. **First Aid:** Eyes. Immediately

Copyright © 1988 by Genium Publishing Corporation

SECTION 6. HEALTH HAZARD INFORMATION, cont.

flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. Skin. Rinse the affected area with plenty of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** Unlikely. Should this type of exposure occur, the aspiration hazard must be considered. Do not induce vomiting unless directed to do so by a physician. To prevent aspiration by spontaneous vomiting, keep the victim's head low (between his or her knees). Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Professional judgment is required as to whether or not to induce vomiting because of the possibility of aspiration. A gastric lavage may be administered, followed by saline catharsis, if this procedure is appropriate to the specific incident. Monitor cardiac and pulmonary functions.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against skin or eye contact with this liquid as well as inhalation of its vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

EPA Designations (40 CFR 302.4)
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), §§ 311 (b) (4) and 307 (a).

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying *respirators will not protect workers in oxygen-deficient atmospheres.* ***Other:*** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with this material. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale ethyl benzene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store ethyl benzene in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. **Special Handling/Storage:** Outside, isolated, detached, or remote storage is recommended for large quantities of ethyl benzene. Isolate bulk storage areas from acute fire hazards. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. To prevent static sparks, electrically ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations. **Other:** Use safety cans for transferring small amounts of ethyl benzene.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Ethyl Benzene
DOT Hazard Class: Flammable Liquid
ID No. UN1175
DOT Label: Flammable Liquid
DOT Packaging Exceptions: 49 CFR 173.118
DOT Packaging Requirements: 49 CFR 173.119

IMO Shipping Name: Ethylbenzene
IMO Hazard Class: 3.2
IMO Label: Flammable Liquid
IMDG Packaging Group: II

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: W Silverman, MD

Copyright © 1988 by Genium Publishing Corporation
Any unauthorized use or reproduction without the publisher's permission is prohibited

METHANEARSONIC ACID, SODIUM SALT

MSA

Common Synonyms	Solid	Colorless solid, solution may be red or green	Odorless
Disodium methane arsonate Monosodium methane arsonate MSMA DSMA Disodium methyl arsonate Monosodium methyl arsonate	Solid may form dust or gels in water; solid and solution mix with water.		

Toxic gases may be released in a fire involving this material.
Avoid contact with solid and solution.
Isolate and remove unprotected workers.
Notify local health and pollution control agencies.

Fire	Not flammable POISONOUS GASES ARE PRODUCED WHEN HEATED Wear oxygen and full-protective clothing (positive pressure).
Exposure	CALL FOR MEDICAL AID SOLID OR SOLUTION Irritating to skin and eyes. If swallowed, will cause nausea, vomiting, or loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.
Water Pollution	Dangerous to aquatic life in high concentrations. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue a "long-distance" water spill or alert.
Should not consume.
Chemical and physical treatment.

2. LABEL

2.1 Category: Poison
2.2 Class: 6

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $CH_3AsO(OH)ONa$ ($CH_4AsO_4Na \cdot 6H_2O$)
3.3 IMO/UN Designation: 6.1/1557
3.4 DOT ID No.: 1557
3.5 CAS Registry No.: 2163-80-6

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (at ambient): Solid or water solution
4.2 Color: Colorless, solutions may contain red or green dyes
4.3 Odor: None

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Protective clothing to prevent contact with skin; chemical goggles.
5.2 Symptoms Following Exposure: Substance irritating by prolonged contact with skin; burning in eyes and stomach, and intestinal pain. Acute poisoning evidenced by headache, vomiting, diarrhea, convulsions, and coma. About 1 ounce to 1 pound must be taken to cause these symptoms.
5.3 Treatment of Exposure: INGESTION: induce vomiting; give water and repeat; give 8 tablespoons Epsom salt (sodium sulfate). SKIN: wash with soap and water. EYES: wash with water; consult physician if irritation persists.
5.4 Threshold Limit Value: Data not available
5.5 Short Term Inhalation Limits: Not pertinent
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5-5 g/kg (rat)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: None
5.9 Liquid or Solid Irritant Characteristics: Repeated contact may cause skin sensitivity.
5.10 Odor Threshold: Not pertinent
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not flammable
6.3 Fire Extinguishing Agents: Not pertinent
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Toxic gases may be generated in fire.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: Not flammable
6.8 Electrical Hazards: Not pertinent
6.9 Burning Rate: Not flammable
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: None
7.2 Reactivity with Common Materials: None
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibition of Polymerization: Not pertinent
7.7 Water Reactivity (Reactivity to Products): Data not available
7.8 Reactivity Groups: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: >1000 ppm/48 hr/fish/ $CaSO_4/LC_{50}$/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: The solid dissolves with (DSMA) complete water crystallization. Salts are often ordered as solutions in water with concentrations up to about 50% solids.
9.2 Storage Temperature: Ambient
9.3 Inert Atmospheric: No requirement
9.4 Venting: Open

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

DS

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Poison, B
11.2 NAS Hazard Rating for Bulk Water Transportation: Not rated
11.3 EPPA Hazard Classification: Not rated

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Solid or water solution
12.2 Molecular Weight: 162 (MSMA); 202 (DSMA hexahydrate)
12.3 Boiling Point at 1 atm: Decomposes
12.4 Freezing Point:
(MSMA) 243°F = 117°C = 390°K
(DSMA) 127°F = 53°C = 332°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity:
(DSMA) 1.6 at 20°C (solid)
(MSMA solutions) 1.0-1.5 at 20°C (liquid)
12.8 Liquid Surface Tension: Not pertinent
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.17 Heat of Fusion: Data not available
12.18 Limiting Value: Data not available
12.19 Reid Vapor Pressure: Data not available

NOTES

Material Safety Data Sheet

from Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 310
METHYLENE CHLORIDE
(Revision F)

Issued: September 1985
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: METHYLENE CHLORIDE

Description (Origin/Uses): Used widely in paint removers, as a solvent for plastics, as a degreasing agent, in propellant mixtures for aerosol sprays, and as a blowing agent in foams.

Other Designations: Dichloromethane; Freon 30®; Methane Dichloride; Methylene Bichloride; Methylene Dichloride; CH_2Cl_2; CAS No. 0075-09-2

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS				NFPA
H	2	R	1	
F	1	I	3	
R	0	S	3	
PPG*		K	1	

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS/EXPOSURE LIMITS

Methylene Chloride, ca 100%

OSHA PEL
8-Hour TWA: 500 ppm
Ceiling: 1000 ppm Acceptable Maximum Peak above the Ceiling: 2000 ppm for 5 Minutes in Any 2-Hour Period

ACGIH TLV, 1988-89
TLV-TWA: 50 ppm, 175 mg/m³
(Adopted 1988-89)

Toxicity Data*
Rat, Oral, LD_{50}: 2136 mg/kg
Human, Inhalation, TC_{Lo}: 500 ppm (8 Hours)

*See NIOSH, *RTECS* (PA8050000), for additional data with references to irritative, reproductive, mutagenic, and tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 103.55°F (39.75°C) at 76 Torrs
Melting Point: -142°F (-96.7°C)
Vapor Density (Air = 1): 2.9
Vapor Pressure: 440 Torrs at 77°F (25°C)

Molecular Weight: 84.94 Grams/Mole
Solubility in Water (%): 1% by Weight
Specific Gravity (H_2O = 1): 1.3255 at 68°F (20°C)
% Volatile by Volume: Ca 100

Appearance and Odor: A clear, colorless, volatile liquid; distinctive, penetrating, ethereal odor. The odor will not serve as a useful warning property because concentrations of 100 ppm are not easily perceptible. Most persons can detect this odor at above 300 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature: 1033°F (556°C)	LEL: 12% v/v	UEL: 19% v/v

Extinguishing Media: *Methylene chloride is not flammable under ordinary conditions. However, flammable vapor-air mixtures can form at approximately 212°F (100°C). Use water spray to cool fire-exposed containers and to flush spills away from exposures. Use extinguishing agents that will put out the surrounding fire. **Unusual Fire or Explosion Hazards:** Methylene chloride vapor is heavier than air and may collect and concentrate in low-lying, confined spaces. The high vapor pressure of methylene chloride means that when it is spilled, its vapor concentration in air can increase rapidly. If this vapor is heated, an explosion hazard is associated with the vapor-air mixture. Containers of this material may rupture violently if they are involved in fires. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Methylene chloride is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Methylene chloride can react dangerously with nitrogen tetroxide, liquid oxygen, potassium, sodium, sodium-potassium alloys, lithium, potassium hydroxide with N-methyl-N-nitroso urea, potassium *t*-butoxide, and finely powdered aluminum and magnesium. **Conditions to Avoid:** Avoid all exposure to sources of ignition, heat, and incompatible chemicals. Prolonged exposure to water may cause hydrolysis to highly corrosive hydrochloric acid when the temperature is above 140°F (60°C). In oxygen-enriched atmospheres or when heated (>212°F [100°C]), methylene chloride vapor can be readily ignited. ***Hazardous Products of Decomposition:*** Exposure to high temperature (from open flame, hot surfaces, uninsulated steam lines, welding arcs, etc.) can produce toxic and corrosive thermal-oxidative products of decomposition such as hydrogen chloride, carbon monoxide, and even small quantities of phosgene gas, which is extremely poisonous.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Methylene chloride is listed as a suspected human carcinogen by the ACGIH (which classifies it as a group A2 carcinogen). **Summary of Risks:** Accidental contact of liquid methylene chloride with skin or eyes causes painful irritation and possible burns if not promptly removed. Exposure by way of contaminated gloves, clothing, or paint remover formulations can produce these same irritant effects. Long-term exposure to mild or moderate doses of methylene chloride may cause a delayed (24 to 48 hours) onset of dizziness, headache, mental confusion, slurred speech, double vision, and sleeplessness. Medical recovery can be slow. Overexposure to methylene chloride can cause elevated levels of carboxy hemoglobin in the blood (this same effect results from overexposure to carbon monoxide). ***Medical Conditions Aggravated by Long-Term Exposure:*** None reported. **Target Organs:** Skin, eyes, respiratory system, CNS, liver, kidneys, and blood. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Headache, giddiness, stupor, irritability, fatigue, tingling in the limbs, and narcosis that is not usually fatal if the exposure is terminated before anesthetic death occurs. **Chronic Effects:** The ACGIH classification of this material as a suspected human carcinogen implies that cancer is a possible effect of chronic exposure to methylene chloride. **FIRST AID:** Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with

Copyright © 1988 Genium Publishing Corporation
Any commercial use or reproduction without the publisher's permission is prohibited

SECTION 6. HEALTH HAZARD INFORMATION, cont.

flooding amounts of running water for at least 15 minutes. Skin. Rinse the affected area with flooding amounts of water and then wash it with soap and water. Inhalation. Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Note to Attending Physician: Do not administer adrenalin. Ingestion. Unlikely. Should this type of exposure occur, do not induce vomiting because of the danger of aspiration. If spontaneous vomiting should occur, position exposed person's head below his or her trunk to resist aspiration. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. Note to Physician: Absorbed methylene chloride is stored in body fat and metabolizes to carbon monoxide. This produced carbon monoxide increases and sustains carboxyhemoglobin levels in the blood, which concommitantly reduces the oxygen-carrying capacity of the blood. NIOSH advises preplacement and annual medical exams that emphasize liver, kidney, eye, skin, CNS, and respiratory system functions and a complete blood count. Simultaneous exposure to tobacco smoke, alcohol, and carbon monoxide, along with heavy manual labor, increases the body burden of a worker as well as the toxic hazards of the methylene chloride. In significant exposures, serum methylene chloride levels are of no clinical importance. Neurologic and hepatic status as well as carboxy hemoglobin should be monitored.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against this liquid's contact with the skin or eyes as well as inhalation of its vapor. Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, NO. U080
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), § 307 (a), and the Resource Conservation and Recovery Act (RCRA), § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). Respirator: Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. Warning: Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. Other: Wear impervious neoprene, PVA, or Viton gloves, boots, aprons, and gauntlets, etc., to prevent any skin contact with liquid methylene chloride. Ventilation: Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of acetone below the exposure limits cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. Floor or sump ventilation may be necessary. Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. Other: Because the health effects of carbon monoxide and methylene chloride are additive (see sect. 6), workplaces should be equipped with automatic sensing equipment that identifies workroom atmospheric levels of both of these materials. Comments: Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale methylene chloride vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store methylene chloride in closed, moisture-proof containers in a cool, dry, well-ventilated area away from sources of ignition, strong oxidizers, caustics, and incompatible chemicals (see sect. 5). Protect containers from physical damage. Special Handling/Storage: Prevent moist air from entering storage containers. Provide ventilation at the floor level in storage areas because methylene chloride vapor is denser than air. Installation of a dryer and a safety seal on each tank is recommended. Aluminum is not recommended for use as a storage material; appropriate storage materials include galvanized iron, black iron, or steel. Engineering Controls: Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers and pipelines used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks.

Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: Dichloromethane *or* Methylene Chloride
DOT Hazard Class: ORM-A
ID No. UN1593
DOT Packaging Requirements: 49 CFR 173.605
DOT Packaging Exceptions: 49 CFR 173.505

IMO Shipping Name: Dichloromethane
IMO Hazard Class: 6.1
IMO Label: Saint Andrew's Cross (X)*
IMDG Packaging Group: III

*Harmful-Stow away from Foodstuffs.

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: MJ Hardies, MD

Copyright © 1988 Genium Publishing Corporation
Any commercial use or reproduction without the publisher's permission is prohibited

METHYL PARATHION

MPT

Common Synonyms	Solid crystals	With a solid or liquid	Poisons eggs or garlic odor
Metacid 50PT Partizol Abbott Nitrox Wintox O, O-Dimethyl O-p-nitrophenyl thiophosphate Parathion-methyl	Solid and liquid sink in water; solution floats on water. Melting (freezing) point is 45°F.		

AVOID CONTACT WITH LIQUID AND SOLID. WEAR PROTECTIVE CLOTHING.
WEAR CHEMICAL PROTECTIVE SUIT WITH SELF-CONTAINED BREATHING APPARATUS.
STOP LEAK IF NO RISK.
USE WATER SPRAY.
REMOVE AND ISOLATE CONTAMINATED MATERIAL.
NOTIFY LOCAL HEALTH AND POLLUTION CONTROL AGENCIES.

Fire

COMBUSTIBLE.
POISONOUS GASES ARE PRODUCED IN FIRE AND WHEN HEATED.
CONTAINERS MAY EXPLODE IN FIRE.
AVOID CHEMICAL DISTRICTS. WEAR SELF-CONTAINED BREATHING APPARATUS.
LARGE FIRES: USE WATER SPRAY OR PROTECTED MONITOR.
EXTINGUISH WITH WATER.
COOL EXPOSED CONTAINERS WITH WATER.

Exposure

CALL FOR MEDICAL AID.

LIQUID OR SOLID
POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED.
AVOID ALL CONTACT.
WORK IN OVER
WORKERS CONTAMINATED CLOTHING AND SHOES
FLUSH AFFECTED AREAS WITH PLENTY OF WATER
IF EYES: RINSE IMMEDIATELY WITH PLENTY OF WATER
IF SWALLOWED AND VICTIM IS CONSCIOUS: HAVE VICTIM DRINK WATER OR MILK. DO NOT HAVE VICTIM INDUCE VOMITING
IF SWALLOWED AND VICTIM IS UNCONSCIOUS OR HAVING CONVULSIONS: DO NOTHING EXCEPT KEEP VICTIM WARM

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS
Solution is toxic to crustacea
May be dangerous if it enters water intakes
NOTIFY LOCAL HEALTH AND WILDLIFE OFFICIALS
NOTIFY OPERATORS OF NEARBY WATER INTAKES

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Issue warning-evacuate
Water contaminated
Restrict access
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Poison
2.2 Class: 6

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $(CH_3O)_2PSOC_6H_4NO_2$-p
3.3 IMO/UN Designation: 6.1/2783
3.4 DOT ID No.: 2783
3.5 CAS Registry No.: 298-00-0

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (at ambient): Solid (dust), or colorless
4.2 Color: Colorless solid or brownish liquid
4.3 Odor: Characteristic, like rotten eggs or garlic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Approved mask or respirator; natural rubber gloves, overalls, protective clothing, goggles
5.2 Symptoms Following Exposure: Exposure to fumes from a fire, or to the liquid, causes headache, narrow vision, constricted pupils of the eyes, weakness, nausea, cramps, diarrhea, and dizziness in the chest. Muscle twitch and convulsions may follow. Symptoms may develop over a period of 2 hrs.
5.3 Treatment of Exposure: Solid or liquid INGESTION: call a doctor. If victim is not breathing, immediate artificial respiration by mouth-to-mouth, mouth-to-nose, or mouth-to-endotracheal method, which ought to be developed, give milk, water, or bicarbonate and induce vomiting repeatedly. SKIN OR EYES: flood and wash exposed areas thoroughly with water, remove contaminated clothing under a shower.
5.4 Threshold Limit Value: 0.2 mg/m³
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by ingestion: Grade 4, LD_{50} between 50 mg/kg and
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Not pertinent
5.9 Liquid or Solid Irritant Characteristics: Poisonous when absorbed through skin
5.10 Odor Threshold: Data not available
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 145°F C.C.
6.2 Flammable Limits in Air: Data not available
6.3 Fire Extinguishing Agents: Water
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Toxic gases are produced in fire.
6.6 Behavior in Fire: Drums may explode violently
6.7 Ignition Temperature: Data not available
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Data not available
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: Will decompose in 6 days at 68°C
7.2 Reactivity With Common Materials: Is absorbed on wood, dirt, which must be exposed to corrosive poison hazard.
7.3 Stability During Transport: Decomposes above 59°C with possible explosive force.
7.4 Neutralizing Agents for Acids and Caustics: Apply caustic or soda ash slurry with proper alarm equipment.
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Groups: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity:
1.8 ppm/96 hr/bluegill/TL_m/fresh water
0.5 ppm/96 hr/goldfish/TL_m/fresh water
8.2 Waterfowl Toxicity: LD_{50} = 10 mg/kg
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Pure (solid, technical (liquid) 65% in xylene
9.2 Storage Temperature: Below 50°F
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-E-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Poison, B
11.2 NAS Material Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification:

Category	Classification*	
Health Hazard (Blue)	4	4
Flammability (Red)	3	1
Reactivity (Yellow)	2	2

*Four indicates the severest, zero the least

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Solid
12.2 Molecular Weight: 263.2
12.3 Boiling Point at 1 atm: Very high
12.4 Freezing Point: 45°F = 18°C = 291°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.358 at 20°C (liquid)
12.8 Liquid Surface Tension: Data not available
12.9 Liquid Water Interfacial Tension: Data not available
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: Data not available
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.17 Heat of Fusion: Data not available
12.18 Limiting Value: Data not available
12.17 Reid Vapor Pressure: Data not available

NOTES

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 7

NITRIC ACID
(Revision C)
Issued: October 1980
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: NITRIC ACID

Description (Origin/Uses): Used to dissolve noble metals, for etching and cleaning metals, to make organic nitrates and nitrocompounds, to destroy residues of organic matter, and in explosives.

Other Designations: Red Fuming Nitric Acid; HNO_3; CAS No. 7697-37-2

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA

HMIS	
H 3	R 1
F 0	I 4
R 1	S 4
PPG*	K 0
*See sect. 8	

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Nitric Acid, CAS No. 7697-37-2	*	**OSHA PEL** 8-Hr TWA: 2 ppm, 5 mg/m³ **ACGIH TLVs, 1987-88** TLV-TWA: 2 ppm, 5 mg/m³ TLV-STEL: 4 ppm, 10 mg/m³ **Toxicity Data**** Mouse, Inhalation, LC_{50}: 67 ppm/4 Hrs

*Contact your supplier to determine the percent by weight of nitric acid in the purchased product. Water is the other component of the product.
**See NIOSH, *RTECS* (QU5775000, QU5900000), for additional data with references to reproductive effects.

SECTION 3. PHYSICAL DATA

Boiling Point: Ca 251°F (122°C)*
Specific Gravity (H_2O = 1): 1.4*
pH: Very Acidic

Water Solubility (%): Complete
Molecular Weight: 63 Grams/Mole
Melting Point: Ca -30°F (-34°C)*

Appearance and Odor: A water white to slightly yellow liquid that darkens to a brownish color on aging and exposure to light; characteristic nitrogen dioxide (NO_2) odor.

*These properties are for the approximately 68%-by-weight nitric acid that is commercially available.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Nitric acid does not burn. Use extinguishing agents that will put out the surrounding fire. Use a water spray to dilute nitric acid during fires and to absorb liberated oxides of nitrogen.

Unusual Fire or Explosion Hazards: Although nitric acid does not burn, it is a strong oxidizing agent that can react with combustible materials to cause fires. Also, it can react with metals to liberate extremely flammable hydrogen gas. If this happens, direct fire-fighting procedures at this evolved hydrogen gas.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Choose protective equipment carefully (see sect. 5, Conditions to Avoid).

SECTION 5. REACTIVITY DATA

Nitric acid is stable in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

Chemical Incompatibilities: Nitric acid reacts explosively with metallic powders, carbides, hydrogen sulfide, and turpentine. Contact with organic materials such as wood, paper, sawdust, or alcohol, etc., may cause fires. Combustible materials can attain an increased flammability after being exposed to nitric acid even if they do not immediately catch fire.

Conditions to Avoid: Avoid any contact with incompatible chemicals. Because it is so reactive, always establish another material's compatibility with nitric acid before mixing the two materials. This applies to the selection of safety and handling equipment, because nitric acid can attack some forms of coatings, plastics, and rubber.

Hazardous Products of Decomposition: Various nitrogen oxides, including nitric oxide (NO), nitrogen dioxide (NO_2), nitrous oxide (N_2O), as well as nitric acid mist or vapor, can be produced by the decomposition reactions that can affect the nitric acid during fires.

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

Nitric acid is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: This material is corrosive to any body tissue it contacts. Dental erosion is also reported.
Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** Skin, eyes, mucous membranes of the respiratory tract, teeth. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** *Irritation and/or corrosive burns of skin, eyes, and upper respiratory tract (URT), delayed pulmonary edema, pneumonitis, bronchitis, and dental erosion.* **Chronic Effects:** None reported.

FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Treat for eye burns. **Skin.** Immediately wash the affected area with soap and water. Watch for chemical skin burns and treat them accordingly. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. If the exposure is severe, hospitilization with careful monitoring by trained medical personnel to detect the delayed onset of severe pulmonary edema (lungs filled with fluid) is recommended for at least 72 hours. **Ingestion.** Call a poison control center. Never give *anything by mouth to someone who is unconscious or convulsing. Do not induce vomiting. If* the exposed person is responsive, give him or her one or two glasses of milk or water to drink as quickly as possible after exposure.
GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. **NOTE TO PHYSICIAN:** Wash affected skin areas with a 5% solution of sodium bicarbonate ($NaHCO_3$). If ingested, the risk versus the benefit of the passage of a naso-gastric tube is debatable. Activated charcoal is of *no* value. Do *not* give the exposed person bicarbonate to neutralize the material.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately in case contact with metals *should produce highly flammable hydrogen gas. Cleanup personnel need protection against contact with and inhalation of nitric acid* (see sect. 8). Contain large spills and collect waste. Use water sprays to direct nitric acid away from incompatible chemicals (see sect. 5). Neutralize the spilled nitric acid with soda ash or sodium bicarbonate. Use an absorbent such as sand, earth, or vermiculite on the resulting slurry and place the neutralized nitric acid material into containers suitable for eventual disposal, reclamation, or destruction.
Waste Disposal: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per Clean Water Act (CWA), Section 311 (b) (4)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of nitric acid solution is possible, wear a full face shield as a supplementary protective measure. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Consult the *NIOSH Pocket Guide to Chemical Hazards* (Genium ref. 88) for general recommendations on proper respiratory procedures. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent skin contact with nitric acid. Choose protective equipment carefully (see sect. 5, *Conditions to Avoid*).
Ventilation: Install and operate both general and local exhaust-ventilation systems powerful enough to maintain airborne concentrations of nitric acid below the OSHA PEL standard cited in section 2. Construct exhaust ducts and systems with material such as fiberglass, which resists attack by nitric acid. **Safety Stations:** Make emergency eyewash stations, washing facilities, and safety/quickdrench showers available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean nitric acid from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Provide preplacement and annual medical exams with emphasis on skin irritation to workers who are regularly exposed to nitric acid. Workers must receive training before handling this material in the workplace; even experienced workers should undergo refresher training periodically.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store nitric acid in a cool, dry, well-ventilated area away from incompatible chemicals (see sect. 5). Consider outside, isolated, or detached storage. Protect containers from direct sunlight.
Special Handling/Storage: Build all storage facilities of nonflammable materials that are resistant to chemical attack by nitric acid. Protect containers from physical damage. Preplan for routine use and emergency response.
Engineering Controls: Proper ventilation is essential in bulk storage areas; consider installing an automatic monitoring system to detect hazardous levels of nitrogen oxides that can develop from this material.
Comments: Separate nitric acid from hydrazine, diethylenetriamine, fluorides, and all other corrosives except sulfuric acid and sulfur *trioxide when shipping or transferring it.*
Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: (I) Nitric Acid, Fuming or (II) Nitric Acid, Over 40% or (III) Nitric Acid, 40% or Less
DOT Label: (I) Oxidizer and Poison or (II) Oxidizer and Corrosive or (III) Corrosive
DOT Hazard Class: (I) and (II) Oxidizer or (III) Corrosive Material
DOT ID Nos. (I) UN2032; (II) UN2031; (III) NA1760
IMO Class: 8 (All Types of Nitric Acid)
IMO Label: (I) Corrosive, Oxidizer, Poison; or (II) and (III) Corrosive
References: 1, 2, 26, 38, 84-94, 100, 112, 113, 114.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: MJ Hardies, MD

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

NITROGEN TETROXIDE

NOX

Common Synonyms	Liquefied compressed gas	Red-brown gas	Stays, compressed gas under water

Stays and reacts with water. Poisonous fumes vapor is produced.

AVOID CONTACT WITH LIQUID AND VAPOR. Keep people away.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Stop discharge if possible.
Evacuate area in case of large discharge.
Apply water from side to reduce vapors (gases).

Fire

Not flammable.
May cause fire and explosion on contact with combustibles.
POISONOUS GASES ARE PRODUCED IN FIRE AND WHEN HEATED.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Flood discharge area with water.
Stop flow of gas if safe.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.
VAPOR
POISONOUS IF INHALED.
Irritating to eyes.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.
LIQUID
Will burn skin and eyes.
POISONOUS IF SWALLOWED.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
If in EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Wear compressed air equipment, water spray/curtain, and fire fighting clothing.
Remove victims.
Evacuate area.

2. LABEL

2.1 Category: Poison gas; Oxidizer
2.2 Class: 2 and 5

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: N_2O_4
3.3 IMO/UN Designation: 2/1067
3.4 DOT ID No.: 1067
3.5 CAS Registry No.: 10102-44-0

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (at ordinary): Liquid
4.2 Color: Red-brown at ordinary temperature; colorless below about 14°F
4.3 Odor: Pungent, acrid, mildly irritating

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Rubber gloves; safety goggles and face shield; protective clothing; self-contained breathing apparatus.
5.2 Symptoms Following Exposure: Very concentrated fumes produce coughing, choking, headache, nausea, pain in chest and abdomen; otherwise, no symptoms appear at time of exposure. After symptomless period of 5-72 hours, pulmonary edema gradually develops, causing fatigue, restlessness, coughing, difficulty in breathing, moist concentration, cyanosis (bluish skin), and chills, rapid pulse. Small NOX mixtures with gas exchange in lungs, unconsciousness, coma and death by suffocation can result, usually within a few hours after onset of pulmonary edema.
5.3 Treatment of Exposure: INHALATION: Remove person to fresh air and have him breathe as deeply as possible; call a doctor; oxygen sometimes must be given; keep victim warm; give oxygen if coughing starts. EYES AND SKIN: Flush with water for at least 15 min.
5.4 Threshold Limit Value: 3 ppm
5.5 Short Term Inhalation Limits: 25 ppm for 5 min.
5.6 Toxicity by Ingestion: Data not available
5.7 Lone Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause severe irritation of eyes and throat and can cause eye and lung injury. They cannot be tolerated even at low concentrations.
5.9 Liquid or Solid Irritant Characteristics: Severe skin irritant. Causes second- and third-degree burns on short contact and is very injurious to the eyes.
5.10 Odor Threshold: 5 ppm
5.11 IDLH Value: 50 ppm

6. FIRE HAZARDS

6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not flammable
6.3 Fire Extinguishing Agents: Stop flow of gas
6.4 Fire Extinguishing Agents: Not to be used: Not pertinent
6.5 Special Hazards of Combustion Products: Products exist gas when heated.
6.6 Behavior in Fire: Gas will burn, but ordinary combustion of combustible materials does not result. May cause fire or explosion on contact with other materials.
6.7 Ignition Temperature: Not flammable
6.8 Electrical Hazard: Data not available
6.9 Burning Rate: Not flammable
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: Reacts to form nitric acid and nitric oxide. Nitric oxide reacts with air to form more nitrogen dioxide.
7.2 Reactivity with Common Materials: Very corrosive to metals when wet. Reacts vigorously with combustible materials both as vapor.
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Flush with water. Dike and store with dry lime.
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity:
72 ppm/96 hr/mosquito fish/TL_m/fresh water
330-1000 ppm/48 hr/sailfish/LC_{50}/salt water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): None
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Data not available
9.2 Storage Temperature: Ambient. Storage and transfer structure must be equipped with emergency ventilation systems.
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure relief valves or equivalent

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-4-J-O

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Poison, A
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	0
Health	
Vapor Inhalat.	4
Liquid or Solid Irritant	4
Poisons	4
Water Pollution	
Human Toxicity	3
Aquatic Toxicity	0
Aesthetics (Odor)	4
Reactivity	
Other Chemicals	2
Water	0
Self Reaction	

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	3
Flammability (Red)	0
Reactivity (Yellow)	0
	oxy

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Solution
12.2 Molecular Weight: 92.02
12.3 Boiling Point at 1 atm: 70.1°F = 21.2°C = 294°K
12.4 Freezing Point: 11.8°F = −11.2°C = 262°K
12.5 Critical Temperature: 317.5°F = 158.5°C = 431.6°K
12.6 Critical Pressure: 1470 psia = 100 atm = 10.1 MN/m²
12.7 Specific Gravity: 1.45 at 32°C (Gas)
12.8 Liquid Surface Tension: Not pertinent
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: 3.2
12.11 Ratio of Specific Heats of Vapor (Gas): (est.) 1.322
12.12 Latent Heat of Vaporization: 170 Btu/lb = 94.1 cal/g = 4.15 X 10⁵ J/kg
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Data not available
12.16 Heat of Polymerization: Not pertinent
12.17 Heat of Fusion: 62.2 cal/g
12.18 Limiting Value: Data not available
12.19 Reid Vapor Pressure: 60 psia

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 205

POTASSIUM NITRATE

Issued: January 1987

SECTION 1. MATERIAL IDENTIFICATION

22

MATERIAL NAME: POTASSIUM NITRATE
DESCRIPTION/USES: Used in pyrotechnics; explosives; matches; as a specialty fertilizer; reagent; to modify burning properties of tobacco; in glass manufacture; tempering steel; curing foods; as an oxidizer in solid rocket propellants.
OTHER DESIGNATIONS: Nitric Acid, Potassium Salt; Niter; Saltpeter; KNO_3; CAS #7757-79-1
MANUFACTURER/SUPPLIER: Available from several suppliers, including: Aldrich Chemical Co., Inc., PO Box 355, Milwaukee, WI 53201; Telephone: (414) 273-3850

Nonfire

Fire

HMIS			
H	1		
F	0	R	1
R	1	I	–
PPE*		S	2
*See Sect. 8		K	0

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Potassium Nitrate, CAS #7757-79-1	>99%	ACGIH TLV: None Established OSHA PEL: None Established Oral, Rat, LD_{50}: 3750 mg/kg Oral, Rabbit, LD_{50}: 1901 mg/kg

SECTION 3. PHYSICAL DATA

Melting Point ... 633°F (334°C)
Boiling Point ... 400°C (Decomposes)
Specific Gravity @ 16°C ... 2.11
Vapor Pressure @ 20°C ... Negligible
% Volatiles ... 0
Evaporation Rate ... Not Found

Solubility in Water, at 0°C ... 13.3 g/100 cc
at 100°C ... 247 g/100 cc
pH of 5% Solution, at 25°C ... 4.5-7.0
Molecular Weight ... 101.1

Appearance and odor: White crystalline powder or granules. No odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
Not Found	Not Found	Not Found	--	--

Potassium nitrate is not combustible. However, it is a strong oxidizer and can initiate and intensify combustion of flammable materials.
EXTINGUISHING AGENTS: Flood fires involving this material with water. Keep fire-exposed containers cool with water spray. Remove containers from the fire area if it can be done safely.
UNUSUAL FIRE/EXPLOSION HAZARDS: At high temperatures this material can fuse or melt; application of water when large quantities are involved can result in extensive scattering of molten material.
SPECIAL FIRE-FIGHTING PROCEDURES: Toxic fumes/gases can be evolved in a fire situation. Fire fighters should use self-contained breathing apparatus and wear full protective gear.

SECTION 5. REACTIVITY DATA

Potassium nitrate is stable at room temperature. It does not polymerize.

Violent reactions (including fire and explosion) may occur on its contact with organic materials, combustible materials, and reducing agents. Specific incompatibles under various conditions include aluminum, titanium, antimony, germanium, zinc, zirconium (and other metals), calcium disilicide, chromium nitride, metal sulfides, boron, carbon, sulfur, phosphorus, phosphides, sodium phosphinate, sodium thiosulfate, citric acid, tin chloride, sodium acetate, and thorium carbide.

Potassium nitrate decomposes at approximately 752°F (400°C) with the evolution of oxygen and oxides of nitrogen (toxic).

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

Potassium nitrate has not been identified as a known or suspected carcinogen by the NTP, IARC, or OSHA.
This material can enter the body if it is inhaled or swallowed.

EFFECTS OF OVEREXPOSURE: Inhalation of excessive concentrations may be irritating to the nose, throat, and respiratory tract. Prolonged exposure may cause anemia, methemoglobinemia (the presence of methemoglobin, a soluble brown crystalline blood pigment that differs from hemoglobin in that it contains ferric iron and is unable to combine reversibly with molecular oxygen), and kidney injury (nephritis). Ingestion can cause severe gastrointestinal distress with abdominal pain, nausea, vomiting, and diarrhea. Eye contact may cause irritation.

FIRST AID: EYE CONTACT: Flush eyes, including under the eyelids, with a gentle flow of running water. Get medical help.* SKIN CONTACT: Wash affected area with mild soap and water. If irritation persists, prevent further contact and get medical help.* INHALATION: Remove victim from exposure. Get medical help if irritation or discomfort persists.* INGESTION: Give victim a large quantity of water to drink. Induce vomiting and get prompt medical help.* Keep him warm and at rest.
NOTE: Never give anything by mouth or induce vomiting if the victim is unconscious.
* GET MEDICAL ASSISTANCE = In plant, community, paramedic. Get medical help for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Ventilate the potassium nitrate spill area. Prevent contact of spilled material with combustible and incompatible materials. Cleanup personnel should wear personal protective equipment as necessary to prevent skin/eye contact and dust inhalation. Carefully scoop spilled material into a suitable container for reclamation or disposal. Avoid generating dust during cleanup. Absorb small solution spills on inert (noncombustible) material such as dry sand or earth.
Disposal: Potassium nitrate requires disposal as a hazardous waste. Reclaim material when possible. Contact your supplier or a licensed chemical waste disposal contractor for treatment and disposal instructions. Follow all applicable Federal, state, and local regulations.

Reportable Spill Quantity: Not listed in 40 CFR 117.3, "Reportable Quantities of Hazardous Substances."
EPA Hazardous Waste Number: D001 (Ignitable, 40 CFR 261.21)

SECTION 8. SPECIAL PROTECTION INFORMATION

Use local exhaust ventilation to control airborne levels where potassium nitrate dust, mist, or fumes are generated.

Use an appropriate NIOSH-approved respirator for protection against potassium nitrate dust/mist where airborne levels are excessive. Respirator usage must be in accordance with OSHA requirements (29 CFR 1910.134).

Wear protective clothing (aprons, coveralls, etc.) where the possibility of skin or clothing contamination exist. Wear rubber gloves and safety goggles when handling this material.

Eyewash stations and washing facilities should be readily accessible to workers handling this material.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Particles may adhere to contact lenses and cause corneal damage.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store potassium nitrate in closed containers in a cool, dry location on a noncombustible surface. Store it away from flammable and combustible materials, reducing agents, and other incompatible materials (see sect. 5). Protect containers from physical damage.

Practice good housekeeping. Clean up spills promptly. Use procedures and techniques that minimize dust generation. Practice good personal hygiene. Wash thoroughly after handling this material and before eating, drinking, and smoking. Do not eat, drink, or smoke in the work area. Remove contaminated clothing promptly. Launder it before wearing it again. Do not take this material out of your work area or to your home on your clothing or equipment.

DOT Hazard Classification: Oxidizer (49 CFR 172.101) DOT ID No. UN1486 DOT Label: Oxidizer

Data Source(s) Code: 4, 5, 6, 9, 25, 49, 58, 77, 82, CV

Judgements as to the suitability of information herein for purchaser's purpose are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals	
Indust. Hygiene/Safety	4/87
Medical Review	

Copyright © 1986 Genium Publishing Corporation. Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © January 1, 1987

Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

No. 317
TOLUENE
(Revision D)

Issued: August 1979
Revised: April 1986

SECTION 1. MATERIAL IDENTIFICATION

MATERIAL NAME: TOLUENE

OTHER DESIGNATIONS: Methyl Benzene, Methyl Benzol, Phenylmethane, Toluol, C_7H_8, CAS #0108-88-3

MANUFACTURER/SUPPLIER: Available from many suppliers, including:
Allied Corp., PO Box 2064R, Morristown, NJ 07960; Telephone: (201) 455-4400
Ashland Chemical Co., Industrial Chemicals & Solvents Div., PO Box 2219, Columbus, OH; Telephone: (614) 889-3844

HMIS
H: 2
F: 3
R: 0
PPE*
*See sect. 8

R 1
I 3
S 2
K 4

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Toluene	ca 100	8-hr TLV: 100 ppm, or 375 mg/m^3* (Skin)** Man, Inhalation, TCLo: 100 ppm: Psychotropic*** Rat, Oral, LD_{50}: 5000 mg/kg Rat, Inhalation, LCLo: 4000 ppm/4 hrs. Rabbit, Skin, LD_{50}: 14 gm/kg Human, Eye: 300 ppm

* Current (1985-86) ACGIH TLV. The OSHA PEL is 200 ppm with an acceptable ceiling concentration of 300 ppm and an acceptable maximum peak of 500 ppm/10 minutes.

** Skin designation indicates that toluene can be absorbed through intact skin and contribute to overall exposure.

*** Affects the mind.

SECTION 3. PHYSICAL DATA

Boiling Point ... 231°F (111°C)
Vapor Pressure @ 20°C, mm Hg ... 22
Water Solubility @ 20°C, wt. % ... 0.05
Vapor Density (Air = 1) ... 3.14

Evaporation Rate (BuAc = 1) ... 2.24
Specific Gravity (H_2O = 1) ... 0.866
Melting Point ... -139°F (-95°C)
Percent Volatile by Volume ... ca 100
Molecular Weight ... 92.15

Appearance and odor: Clear, colorless liquid with a characteristic aromatic odor. The odor is detectable to most individuals in the range of 10 to 15 ppm. Because olfactory fatigue occurs rapidly upon exposure to toluene, odor is not a good warning property.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
40°F (4°C) CC	896°F (480°C)	% by Volume	1.27	7.1

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, alcohol foam. Do not use a solid stream of water because the stream will scatter and spread the fire. Use water spray to cool tanks/containers that are exposed to fire and to disperse vapors.

UNUSUAL FIRE/EXPLOSION HAZARDS: This OSHA class IB flammable liquid is a dangerous fire hazard. It is a moderate fire hazard when exposed to oxidizers, heat, sparks, or open flame. Vapors are heavier than air and may travel a considerable distance to an ignition source and flash back.

SPECIAL FIRE-FIGHTING PROCEDURES: Fire fighters should wear self-contained breathing apparatus with full facepiece operated in a positive-pressure mode when fighting fires involving toluene.

SECTION 5. REACTIVITY DATA

CHEMICAL INCOMPATIBILITIES: Toluene is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization. This material is incompatible with strong oxidizing agents, dinitrogen tetraoxide, silver perchlorate, tetranitromethane, and uranium hexafluoride. Contact with these materials may cause fire or explosion. Nitric acid and toluene, especially in the presence of sulfuric acid, will produce nitrated compounds that are dangerously explosive.

CONDITIONS TO AVOID: Avoid exposure to sparks, open flame, hot surfaces, and all sources of heat and ignition. Toluene will attack some forms of plastics, rubber, and coatings. Thermal decomposition or burning produces carbon dioxide and/or carbon monoxide.

Copyright © 1986 Genium Publishing Corporation.
Any [illegible] use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION TLV

Toluene is not considered a carcinogen by the NTP, IARC, or OSHA. SUMMARY OF RISKS: Vapors of toluene may cause irritation of the eyes, nose, upper respiratory tract, and skin. Exposure to 200 ppm for 8 hours causes mild fatigue, weakness, confusion, lacrimation (tearing) and paresthesia (a sensation of prickling, tingling, or creeping on the skin that has no objective cause). Exposure to higher concentrations may cause headache, nausea, dizziness, dilated pupils, and euphoria, and, in severe cases, may cause unconsciousness and death. The liquid is irritating to the eyes and skin. Contact with the eyes may cause transient corneal damage, conjunctival irritation, and burns if not promptly removed. Repeated and/or prolonged contact with the skin may cause drying and cracking. It may be absorbed through the skin in toxic amounts. Ingestion causes irritation of the gastrointestinal tract and may cause effects resembling those from inhalation of the vapor. Chronic overexposure to toluene may cause reversible kidney and liver injury. FIRST AID: EYE CONTACT: Immediately flush eyes, including under eyelids, with running water for at least 15 minutes. Get medical attention if irritation persists.* SKIN CONTACT: Immediately flush skin (for at least 15 minutes) while removing contaminated shoes and clothing. Wash exposed area with soap and water. Get medical attention if irritation persists or if a large area has been exposed.* INHALATION: Remove victim to fresh air. Restore and/or support breathing as required. Keep victim warm and quiet. Get medical help.* INGESTION: Give victim 1 to 2 glasses of water or milk. Contact a poison control center. Do not induce vomiting unless directed to do so. Transport victim to a medical facility. Never give anything by mouth to a person who is unconscious or convulsing. * GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Limit access to spill area to necessary personnel only. Remove leaking containers to safe place if feasible. Cleanup personnel need protection against contact with liquid and inhalation of vapor (see sect. 8).
WASTE DISPOSAL: Absorb small spills with paper towel or vermiculite. Contain large spills and collect if feasible, or absorb with vermiculite or sand. Place waste solvent or absorbent into closed containers for disposal using nonsparking tools. Liquid can be flushed with water to an open holding area for handling. Do not flush to sewer, watershed, or waterway.
COMMENTS: Place in suitable container for disposal by a licensed contractor or burn in an approved incinerator. Consider reclaiming by distillation. Contaminated absorbent can be buried in a sanitary landfill. Follow all Federal, state, and local regulations. TLm 96: 100-10 ppm. Toluene is designated as a hazardous waste by the EPA. The EPA (RCRA) HW No. is U220 (40 CFR 261). The reportable quantity (RQ) is 1000 lbs/454 kg (40 CFR 117).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV requirements. Ventilation fans and other electrical service must be nonsparking and have an explosion-proof design. Exhaust hoods should have a face velocity of at least 100 lfm (linear feet per minute) and be designed to capture heavy vapor. For emergency or nonroutine exposures where the TLV may be exceeded, use an organic chemical cartridge respirator if concentration is less than 200 ppm and an approved canister gas mask or self-contained breathing apparatus with full facepiece if concentration is greater than 200 ppm.
Safety glasses or splash goggles should be worn in all work areas. Neoprene gloves, apron, face shield, boots, and other appropriate protective clothing and equipment should be available and worn as necessary to prevent skin and eye contact. Remove contaminated clothing immediately and do not wear it until it has been properly laundered.

Eyewash stations and safety showers should be readily available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store in a cool, dry, well-ventilated area away from oxidizing agents, heat, sparks, or open flame. Storage areas must meet OSHA requirements for class IB flammable liquids. Use metal safety cans for handling small amounts. Protect containers from physical damage. Use only with adequate ventilation. Avoid contact with eyes, skin, or clothing. Do not inhale or ingest. Use caution when handling this compound because it can be absorbed through intact skin in toxic amounts. SPECIAL HANDLING/STORAGE: Ground and bond metal containers and equipment to prevent static sparks when making transfers. Do not smoke in use or storage areas. Use nonsparking tools. ENGINEERING CONTROLS: Preplacement and periodic medical exams emphasizing the liver, kidneys, nervous system, lungs, heart, and blood should be provided. Workers exposed to concentrations greater than the action level (50 ppm) should be examined at least once a year. Use of alcohol can aggravate the toxic effects of toluene.
COMMENTS: Emptied containers contain product residues. Handle accordingly!
Toluene is designated as a hazardous substance by the EPA (40 CFR 116). DOT Classification: Flammable liquid. UN1294.
Data Source(s) Code: 1-9, 12, 16, 20, 21, 24, 26, 34, 81, 82. CR

Judgements as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Approvals J.O. Peterson, 11/86.
Indust. Hygiene/Safety [signature] 12-86
Medical Review [signature] 12-86

Copyright © 1986 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

Copyright © April 1, 1986

TOXAPHENE

TXP

Common Synonyms
Chlorinated camphene

Vapor cloud or in Amber
solution

Solid sinks in water; solution floats on water.

Use dikes/traps if solution. Keep product away.
Call fire department
Avoid contact with solid and solution.
Isolate and remove endangered material
Notify local health and pollution control agencies.

Fire

Solid not flammable. Not usually dangerous in combustible
area.
POISONOUS GASES ARE PRODUCED IN FIRE
Wear goggles, self-contained breathing apparatus, and rubber protective clothing
including gloves.
Extinguish with foam, dry chemical or carbon dioxide.
Water may be ineffective on fire
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

SOLID OR SOLUTION
POISONOUS IF SWALLOWED.
AVOID CONTACT WITH SOLID AND SOLUTION.
IF ON SKIN, wash with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim quiet and warm.

Water Pollution

HARMFUL TO AQUATIC LIFE in VERY LOW CONCENTRATIONS.
Solution is toxic to mammals
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Wear protective gloves, boots and respirator.
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $C_{10}H_{10}Cl_8$
3.3 EEC/UN Designations: Not listed
3.4 DOT ID No.: 2761
3.5 CAS Registry No.: 8001-35-2

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Waxy solid
4.2 Color: Amber
4.3 Odor: Mild turpentine odor

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Chemical-type respirator; rubber gloves; chemical goggles or face shield

5.2 Symptoms Following Exposure: May be absorbed through skin, lungs, or intestinal tract. Symptoms include depression, leg and back muscle spasms, nausea, vomiting, hyperexcitability, tremors, shivering, clonic convulsions, brain injury, convulsions of all skeletal muscles. Lethal doses cause respiratory failure. Respirators, affected as a result of the convulsions both vomiting or convulsions, or brief epileptic seizures or tonic-clonic convulsions. Pain experienced in both amplitude and rate as the muscles relax.

5.3 Treatment of Exposure: If symptoms of poisoning appear, promptly remove the contaminated materials from the exposure by inducing vomiting (with warm salty or soapy water (if the patient is conscious) or from the skin with soap and water. Keep patient warm and quiet. Call a physician.

5.4 Threshold Limit Value: 0.5 mg/m³

5.5 Short Term Exposure Limit: Not pertinent

5.6 Toxicity by Ingestion: Grade 4, LD_{50}: Below 50 mg/kg (dog)

5.7 Late Toxicity: Data not available

5.8 Vapor (Gas) Irritant Characteristics: The solid is non-volatile. For solutions, see note-volatile.

5.9 Liquid or Solid Irritant Characteristics: Minimum hazard if spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.

5.10 Odor Threshold: Not pertinent

5.11 IDLH Value: 200 mg/m³

6. FIRE HAZARDS

6.1 Flash Point: 64°F C.C. (solution)

6.2 Flammable Limits in Air: 1.1%-6.0% (toluene only)

6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide

6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective.

6.5 Special Hazards of Combustion Products: Toxic vapors are generated when heated.

6.6 Behavior in Fire: Solution in xylene may produce corrosive products when heated.

6.7 Ignition Temperature: 880°F (solution)

6.8 Electrical Hazard: Not pertinent

6.9 Burning Rate: 5.0 mm/min.

6.10 Adiabatic Flame Temperature: Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction

7.2 Reactivity with Common Materials: No reaction

7.3 Stability During Transport: Stable

7.4 Neutralizing Agents for Acids and Caustics: Not pertinent

7.5 Polymerization: Not pertinent

7.6 Inhibitor of Polymerization: Not pertinent

7.7 Water Ratio (Reactant to Product): Data not available

7.8 Reactivity Groups: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity:
0.05 ppm/30 days/goldfish/100% kill/fresh water
0.02 ppm/*/bluegill/100% kill/fresh water
0.0002 ppm/24 hr/trout/100% kill/salt water
*Time period not specified.

8.2 Waterfowl Toxicity: 30.0 mg/kg

8.3 Biological Oxygen Demand (BOD): Data not available

8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Technical: 65% dust concentrate; 90% solution in xylene

9.2 Storage Temperature: Ambient

9.3 Inert Atmosphere: No requirement

9.4 Venting: Closed containers in well-ventilated area

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
S-A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: CFR-A

11.2 DOT Hazard Rating for Bulk Water Transportation: Not listed

11.3 NFPA Hazard Classification: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Waxy solid

12.2 Molecular Weight: 414 (avg.)

12.3 Boiling Point at 1 atm: Decomposes

12.4 Freezing Point:
149—158°F
= 65—69°C = 338—342°K

12.5 Critical Temperature: Not pertinent

12.6 Critical Pressure: Not pertinent

12.7 Specific Gravity:
1.6 at 15°C (solid)

12.8 Liquid Surface Tension: Not pertinent

12.9 Liquid Water Interfacial Tension: Not pertinent

12.10 Vapor (Gas) Specific Gravity: Not pertinent

12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent

12.12 Latent Heat of Vaporization: Not pertinent

12.13 Heat of Combustion: Not pertinent

12.14 Heat of Decomposition: Not pertinent

12.15 Heat of Solution: Not pertinent

12.16 Heat of Polymerization: Not pertinent

12.17 Heat of Fusion: Data not available

12.18 Limiting Value: Data not available

12.19 Reid Vapor Pressure: Data not available

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available

6.12 Flame Temperature: Data not available

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 318

XYLENE (Mixed Isomers)
(Revision D)
Issued: November 1980
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

Material Name: XYLENE (Mixed Isomers)

Description (Origin/Uses): Used as a raw material for the production of benzoic acid, phthalic anhydride, isophthalic and terephthalic acids and their dimethyl esters in the manufacture of polyester fibers; in sterilizing catgut; with Canadian balsam as oil-immersion in microscopy; and as a cleaning agent in microscopic techniques.

Other Designations: Dimethylbenzene; Xylol; C_8H_{10}; CAS No. 1330-20-7

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: Although there are three different isomers of xylene (*ortho*, *meta*, and *para*), the health and physical hazards of all three isomers are very similar. This MSDS is written for a xylene mixture of all three isomers, which is usually commercial xylene.

NFPA

HMIS	
H	2
F	3
R	0
PPG*	
*See sect. 8	

R	1
I	3
S	2
K	3

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Xylene (Mixed Isomers), CAS No. 1330-20-7*	**	IDLH*** Level: 1000 ppm
o-Xylene, CAS No. 0095-47-6 *m*-Xylene, CAS No. 0108-38-3 *p*-Xylene, CAS No. 0106-42-3		**OSHA PEL** 8-Hr TWA: 100 ppm, 435 mg/m³ **ACGIH TLVs, 1987-88** TLV-TWA: 100 ppm, 435 mg/m³ TLV-STEL: 150 ppm, 655 mg/m³
**Check with your supplier to determine if there are additions, contaminants, or impurities (such as benzene) that are present in reportable quantities per 29 CFR 1910.		**Toxicity Data** Human, Inhalation, TC_{Lo}: 200 ppm Man, Inhalation, LC_{Lo}: 10000 ppm/6 Hrs Rat, Oral, LD_{50}: 4300 mg/kg
***Immediately dangerous to life and health.		
**** See NIOSH, *RTECS* (No. ZE2100000), for additional data with references to reproductive, irritative, and mutagenic effects.		

SECTION 3. PHYSICAL DATA

Boiling Point: 275°F to 293°F (135°C to 145°C)*
Melting Point: -13°F (-25°C)
Evaporation Rate: 0.6 Relative to BuAc = 1
Specific Gravity (H_2O = 1): 0.86

Water Solubility (%): Insoluble
Molecular Weight: 106 Grams/Mole
% Volatile by Volume: Ca 100
Vapor Pressure: 7 to 9 Torrs at 68°F (20°C)
Vapor Density (Air = 1): 3.7

Appearance and Odor: A clear liquid; aromatic hydrocarbon odor.

*Materials with wider and narrower boiling ranges are commercially available.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
81°F to 90°F (27°C to 32°C)	867°F (464°C)	% by Volume	1%	7%

Extinguishing Media: Use foam, dry chemical, or carbon dioxide. Use water sprays to reduce the rate of burning and to cool containers.

Unusual Fire or Explosion Hazards: Xylene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flashback.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Xylene is stable in closed containers during routine operations. It does not undergo hazardous polymerization.

Chemical Incompatibilities: This material may react dangerously with strong oxidizers.

Conditions to Avoid: Avoid any exposure to sources of ignition and to strong oxidizers.

Hazardous Products of Decomposition: Carbon monoxide (CO) may be evolved during xylene fires.

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

SECTION 6. HEALTH HAZARD INFORMATION

Xylene is not listed as a carcinogen by the IARC, NTP, or OSHA.

Summary of Risks: Liquid xylene is a skin irritant and causes erythema, dryness, and defatting; prolonged contact may cause blistering. Inhaling xylene can depress the central nervous system (CNS), and ingesting it can result in gastrointestinal disturbance; and possibly hematemesis (vomiting blood). Effects on the eyes, kidneys, liver, lungs, and the CNS are also reported. **Medical Conditions Aggravated by Long-Term Exposure:** Problems with eyes, skin, central nervous system, kidneys, and liver may be worsened by exposure to xylene. **Target Organs:** CNS, eyes, gastrointestinal tract, blood, liver, kidneys, skin. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Dizziness; excitement; drowsiness; incoordination; staggering gait; irritation of eyes, nose, and throat; corneal vacuolization; anorexia; nausea; vomiting; abdominal pain; and dermatitis. **Chronic Effects:** Reversible eye damage, headache, loss of appetite, nervousness, pale skin, and skin rash.

FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have a trained person administer oxygen. **Ingestion.** Never give anything by mouth to someone who is unconscious or convulsing. Vomiting may occur spontaneously, but do not induce it. If vomiting should occur, keep exposed person's head below his or her hips to prevent aspiration (breathing the liquid xylene into the lungs). Severe hemorrhagic pneumonitis with grave, possibly fatal, pulmonary injury can occur from aspiring very small quantities of xylene.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. If exposure is severe, hospitilization for at least 72 hours with careful monitoring for delayed onset of pulmonary edema is recommended.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately. Cleanup personnel need protection against contact with and inhalation of xylene vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.

Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, No. U239

CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), section 311 (b) (9)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield as a supplementary protective measure. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., as required by the specifics of the work operation to prevent prolonged or repeated skin contact with xylene. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of xylene below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of xylene into general work areas by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make eyewash stations, safety/quick-drench showers, and washing facilities available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean xylene from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale xylene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store xylene in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage.

Special Handling/Storage: Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Xylene
DOT ID No. UN1307
DOT Label: Flammable Liquid
DOT Hazard Class: Flammable Liquid
IMO Label: Flammable Liquid
IMO Class: 3.2 or 3.3

References: 1, 2, 12, 73, 84-94, 100, 103.

Judgments as to the suitability of information herein for purchaser's purposes are necessarily purchaser's responsibility. Therefore, although reasonable care has been taken in the preparation of such information, Genium Publishing Corp. extends no warranties, makes no representations and assumes no responsibility as to the accuracy or suitability of such information for application to purchaser's intended purposes or for consequences of its use.

Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: MJ Hardies, MD

Copyright © 1988 Genium Publishing Corporation.
Any commercial use or reproduction without the publisher's permission is prohibited.

APPENDIX D

INCIDENT REPORT FORM

Woodward-Clyde Consultants

APPENDIX D
FORM HS-502
HAZARDOUS WASTE INCIDENT REPORT

DATE _____ PROJECT/LOCATION _____ BUSINESS UNIT _____

DESCRIPTION OF INCIDENT, INCLUDING INJURIES, PROPERTY DAMAGE AND EMERGENCY ACTION TAKEN AND PERSONNEL INVOLVED (use additional sheets if needed):

_____

_____

_____

_____

_____

WITNESSES OF INCIDENT:

_____

_____

_____

POSSIBLE OR KNOWN CAUSES:

_____

_____

_____

WHAT ACTIONS ARE NEEDED TO PREVENT A SIMILAR INCIDENT?

_____

_____

_____

_____
REPORTER

_____
BUSINESS UNIT SAFETY OFFICER

_____
PROJECT MANAGER

_____
CORPORATE HEALTH AND SAFETY OFFICER

APPENDIX E

HNU PHOTOIONIZATION DETECTOR

APPENDIX E

HNU PHOTOIONIZATION DETECTOR (MODEL PI 101)

The instrument is turned to the battery check position first. Assuming proper charge, the main control switch is set to the standby position using the zero knob. The instrument is then allowed to warm up for above five minutes in the standby mode. The calibration gas (usually isobutylene from the HNU factory) is attached. The proper range setting is selected (usually 0-200 ppm) and the calibration gas turned on.

The gas flows through a critical orifice which reduces its flow rate to the proper rate for calibration purposes. The normal factory calibration of this instrument is for benzene in air. Isobutylene is used for normal calibration because it is less toxic. The relative response of isobutylene as compared to benzene is about 70 percent with the 10.2 eV and 11.7 eV lamps (there is a slight difference between the relative response of the two different energy probes, but it is not considered significant for most field calibration purposes). Accordingly, a bottle of isobutylene calibration gas that contains 100 ppm isobutylene will read out as about 70 ppm on a factory calibrated instrument. A bottle of factory calibration gas will state the proper readout on the instrument "as benzene".

If the instrument does not calibrate exactly, the span pot knob is normally adjusted to bring the instrument into calibration. The normal "factory" settings are 9.8 for the 10.2 eV lamp and 5.90 for the 11.7 eV lamp. If the instrument cannot be brought into calibration by using the span pot, the lamp may need to be cleaned or other maintenance items performed so that the unit will calibrate accurately.

APPENDIX H

GROUNDWATER ANALYTICAL DATA SUMMARY
(FROM APPENDIX H PRELIMINARY REPORT)

APPENDIX H

GROUNDWATER ANALYTICAL DATA SUMMARY

MW-1A
MW-2
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
MW-11
MW-12
MW-13
MW-14
MW-16
PZ-19B
PZ-19A
PZ-12(R)B
PZ-12(R)A
PZ-20B
PZ-20A
PZ-21A
PZ-22B
PZ-22A
PZ-23B
PZ-23A
PZ-24B
PZ-24A
PZ-25B

Vicksburg Chemical Corporation Groundwater Monitoring for **trans-1,3-Dichloropropene** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **trans-1,3-Dichloropropene** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below Detection Limit

NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Trichlorofluoromethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NTQ
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Trichlorofluoromethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	*Detection Limit*
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Trichloroethene** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
June 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Sept 1991	11	2	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	9	2	NT	NT	BDL	BDL	NT	NT
Nov 1991	10	2J	NT	NT	BDL	BDL	NT	NT
Dec 1991	9	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	13	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	9	2	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	8	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	12	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	9	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Trichlorofluoromethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
June 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.1
Sept 1991	BDL	BDL	20	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	14	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	16	BDL	BDL	BDL	BDL	
Mar 1992	BDL	BDL	18	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	13	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	20	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	25	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	27	BDL	BDL	BDL	BDL	1

NOTES:

BDL	Below Detection Limit
NT	Not Tested
J	Result is less than quantitation limit but greater than zero

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Vinyl Acetate** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Vinyl Acetate** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	50
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Vinyl Chloride** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	3	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	4	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	3J	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	4
Dec 1992	BDL	BDL	NT	BDL	BDL	2	BDL	2
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Vinyl Chloride** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	10
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL	Below Detection Limit
NT	Not Tested
J	Result is less than quantitation limit but greater than zero

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Total Xylenes** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	10	7	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	5	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Total Xylenes** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	4
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4
Sept 1992	BDL	BDL	BDL	5	BDL	BDL	BDL	4
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **1,1,1-Trichloroethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **1,1,1-Trichloroethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **1,1,2,2-Tetrachloroethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **1,1,2,2-Tetrachloroethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **1,1,2-Trichloroethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **1,1,2-Trichloroethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **1,1-Dichloroethene** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **1,1-Dichloroethene** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **1,1-Dichloroethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **1,1-Dichloroethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **1,2,3-Trichloropropane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **1,2,3-Trichloropropane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **1,4-Dichloro-2-butene** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **1,4-Dichloro-2-butene** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **2-Butanone (MEK)** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **2-Butanone (MEK)** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	3
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	100
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **2-Chloroethyl Vinyl Ether** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	4	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **2-Chloroethyl Vinyl Ether** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	10
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5

NOTES:

BDL Below Detection Limit
NT *Not Tested*

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **2-Hexanone** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **2-Hexanone** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	3
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	50
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **4-Methyl-2-Pentanone** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **4-Methyl-2-Pentanone** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	3
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	50
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Acetone** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	100	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BLD	BLD	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BLD	BLD	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Acetone** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	116	BDL	BDL	10
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	10
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	50
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10

NOTES:

BDL Below listed detection limit
NT Not tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Acrolein** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Acrolein** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	100
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100
Dec 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100

NOTES:

BDL Below listed detection limit
NT Not tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Acrylonitrile** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Acrylonitrile** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	100
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	100

NOTES:

BDL Below listed detection limit
NT Not tested

Woodward-Clyde

Vicksburg Chemical Corporation
Groundwater Monitor Results for Arsenic, Total (mg/l)

Sampling Date	MW 1	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7
Dec 1981	0.015	NT	NT	0.003	NT	NT	NT	NT
April 1982	0.003	NT	0.003	0.0048	0.0039	NT	NT	NT
Jan 1983	NT	NT	0.002	0.018	0.0089	NT	NT	NT
Jan 1985	NT	NT	NT	NT	NT	NT	NT	NT
July 1985	BDL	NT	BDL	BDL	BDL	0.019	0.015	0.030
June 1987	NT	NT	NT	NT	NT	NT	NT	NT
Sept 1987	NT	0.054	BDL	NT	BDL	BDL	0.003	0.010
Nov 1987	NT	NT	NT	0.022	NT	NT	NT	NT
Dec 1987	NT	0.003	0.003	NT	BDL	0.007	0.005	0.013
Mar 1988	NT	BDL	BDL	NT	BDL	BDL	BDL	0.005
June 1988	NT	BDL	BDL	NT	BDL	0.006	BDL	0.009
Aug 1988	NT	0.003	0.003	NT	0.006	NT	0.007	0.012
Dec 1988	NT	BDL	BDL	NT	BDL	0.010	0.003	0.014
Mar 1989	NT	0.009	0.005	NT	0.007	0.009	0.012	0.020
June 1989	NT	BDL	BDL	NT	0.003	BDL	BDL	BDL
Sept 1989	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Nov 1989	NT	BDL	BDL	NT	BDL	BDL	BDL	0.008
Mar 1990	NT	BDL	BDL	NT	BDL	BDL	0.005	0.011
June 1990	NT	0.003	BDL	NT	BDL	BDL	BDL	0.006
Sept 1990	NT	BDL	BDL	NT	BDL	NT	BDL	BDL
Dec 1990	NT	0.003	0.003	NT	BDL	BDL	BDL	BDL
Mar 1991	NT	BDL	BDL	NT	BDL	BDL	BDL	0.009
June 1991	NT	BDL	BDL	NT	BDL	BDL	BDL	0.010
Sept 1991	NT	BDL	BDL	NT	BDL	0.012	BDL	0.011
Dec 1991	NT	BDL	BDL	BDL	BDL	0.008	BDL	0.009
Mar 1992	NT	BDL	BDL	BDL	BDL	0.006	BDL	0.011
Sept 1992	NT	BDL	BDL	NT	BDL	0.005	BDL	0.014
Dec 1992	NT	BDL	BDL	NT	BDL	0.008	BDL	0.020
April 1993	NT	BDL	BDL	NT	BDL	BDL	BDL	0.012
July 1993	NT	BDL	BDL	NT	BDL	0.008	BDL	0.014

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitor Results for **Arsenic**, Total (mg/l)									
Sampling Date	MW 8	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 15	MW 16
Dec 1981	NT	NT	NT	NT	NT	NT	NT	NT	NT
April 1982	NT	NT	NT	NT	NT	NT	NT	NT	NT
Jan 1983	NT	NT	NT	NT	NT	NT	NT	NT	NT
Jan 1985	NT	NT	NT	NT	NT	NT	NT	NT	NT
July 1985	.080	NT	NT	NT	NT	NT	NT	NT	NT
June 1987	NT	NT	NT	NT	NT	NT	NT	NT	NT
Sept 1987	0.017	0.004	BDL	0.010	0.006	0.018	BDL	BDL	NT
Nov 1987	NT	NT	NT	NT	NT	NT	NT	NT	NT
Dec 1987	0.039	0.004	0.005	BDL	0.005	0.023	BDL	0.005	NT
Mar 1988	BDL	BDL	BDL	0.005	BDL	BDL	BDL	0.016	NT
June 1988	0.015	0.003	BDL	0.003	BDL	0.006	BDL	0.007	NT
Aug 1988	BDL	0.006	0.003	0.007	BDL	0.011	0.003	NT	0.010
Dec 1988	0.027	BDL	0.006	0.012	0.005	0.009	0.003	NT	0.006
Mar 1989	0.040	0.009	0.014	0.011	0.020	0.032	0.007	NT	0.021
June 1989	0.007	0.003	0.008	0.008	0.010	0.007	BDL	NT	0.005
Sept 1989	BDL	BDL	BDL	0.003	BDL	BDL	BDL	NT	BDL
Nov 1989	0.033	BDL	0.005	BDL	0.009	BDL	BDL	NT	0.005
Mar 1990	0.040	0.003	0.004	BDL	0.006	0.005	0.003	NT	0.008
June 1990	0.042	0.004	0.005	0.004	0.008	0.008	BDL	NT	BDL
Sept 1990	0.003	BDL	BDL	BDL	BDL	0.004	BDL	NT	0.005
Dec 1990	BDL	BDL	BDL	BDL	0.004	0.014	0.004	NT	0.003
Mar 1991	0.048	BDL	0.015	BDL	0.008	BDL	0.004	NT	0.005
June 1991	0.049	BDL	0.009	BDL	BDL	0.007	0.003	NT	BDL
Sept 1991	0.043	BDL	0.005	BDL	0.008	BDL	BDL	NT	0.005
Dec 1991	0.049	BDL	0.006	BDL	0.011	0.003	BDL	NT	0.005
Mar 1992	0.039	BDL	0.006	BDL	0.009	BDL	BDL	NT	BDL
Sept 1992	0.051	BDL	0.006	BDL	0.017	BDL	BDL	NT	0.005
Dec 1992	0.062	BDL	0.007	BDL	0.013	0.006	BDL	NT	0.008
April 1993	0.040	BDL	0.006	BDL	0.009	0.006	BDL	NT	0.006
July 1993	0.050	BDL	0.006	BDL	0.008	0.005	BDL	NT	0.006

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Benzene** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Benzene** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below detection limit
NT Not tested

Woodward-Clyde

Vicksburg Chemical Corporation *Groundwater Monitoring for* **Bromodichloromethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation *Groundwater Monitoring for* **Bromodichloromethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL *Below Detection Limit*
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Bromoform** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Bromoform** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Bromomethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Bromomethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	10
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Carbon Disulfide** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Carbon Disulfide** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Carbon Tetrachloride** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
June 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Carbon Tetrachloride** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
June 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.1
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Chlorobenzene** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Chlorobenzene** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Chlorodibromomethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Chlorodibromomethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Chloroethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Chloroethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	10
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Chloroform** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
June 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Sept 1991	4	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	4	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	4	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	4	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Chloroform** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
June 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.1
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	4
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Chloromethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	3	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	5	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Chloromethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Nov 1991	NT	NT	BDL	NT	BDL	NTL	NT	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	10
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **cis-1,3-Dichloropropene** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **cis-1,3-Dichloropropene** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Dibromomethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Dibromomethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Dichlorodifluoromethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Dichlorodifluoromethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitor Results for **Dinitrobutyl Phenol** (µg/l)								
Sampling Date	MW 1	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7
Oct 1983	**117**	NT	BDL	NT	NT	NT	**75.0**	**4.5**
Nov 1983	**1200**	NT	NT	NT	NT	NT	NT	NT
Nov 1983	BDL	BDL	NT	NT	NT	BDL	BDL	BDL
Dec 1984	**1000**	NT	NT	NT	NT	NT	NT	NT
July 1985	**1130**	NT	BDL	BDL	BDL	BDL	BDL	BDL
June 1987	NT	NT	BDL	NT	BDL	BDL	BDL	BDL
Sept 1987	NT	**340**	BDL	NT	BDL	BDL	BDL	BDL
Nov 1987	NT	NT	**32**	BDL	BDL	**12**	NT	BDL
Dec 1987	NT	**5500**	BDL	NT	BDL	BDL	BDL	BDL
Mar 1988	NT	**4000**	BDL	NT	BDL	BDL	BDL	BDL
June 1988	NT	**3500**	BDL	NT	BDL	BDL	BDL	BDL
Aug 1988	NT	ND	BDL	NT	BDL	NT	BDL	BDL
Dec 1988	NT	**61**	BDL	NT	BDL	BDL	BDL	BDL
Mar 1989	NT	**390**	BDL	NT	BDL	BDL	BDL	BDL
June 1989	NT	**103**	BDL	NT	BDL	BDL	BDL	BDL
Sept 1989	NT	**283**	BDL	NT	BDL	BDL	BDL	BDL
Nov 1989	NT	**504**	BDL	NT	BDL	BDL	BDL	BDL
Mar 1990	NT	**371**	BDL	NT	BDL	BDL	BDL	BDL
June 1990	NT	**362**	BDL	NT	BDL	BDL	BDL	BDL
Sept 1990	NT	**441**	BDL	NT	BDL	NT	BDL	BDL
Dec 1990	NT	**164**	BDL	NT	BDL	BDL	BDL	BDL
Mar 1991	NT	**177**	BDL	NT	BDL	BDL	BDL	BDL
June 1991	NT	**297**	BDL	NT	BDL	BDL	BDL	BDL
Sept 1991	NT	**163**	BDL	NT	BDL	BDL	BDL	BDL
Dec 1991	NT	**67**	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	NT	**237**	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	NT	**164J**	BDL	NT	NT	NT	NT	NT
Dec 1992	NT	**84**	BDL	NT	BDL	BDL	BDL	BDL
April 1993	NT	**260**	BDL	NT	BDL	BDL	BDL	BDL
July 1993	NT	**540**	BDL	NT	BDL	BDL	BDL	BDL

Woodward-Clyde

Vicksburg Chemical Corporation
Groundwater Monitor Results for **Dinitrobutyl Phenol** (µg/l)

Sampling Date	MW 8	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 15	MW 16
Oct 1983	BDL	NT	NT	NT	NT	NT	NT	NT	NT
Nov 1983	NT	NT	NT	NT	NT	NT	NT	NT	NT
Nov 1983	BDL	NT	NT	NT	NT	NT	NT	NT	NT
Dec 1984	NT	NT	NT	NT	NT	NT	NT	NT	NT
July 1985	BDL	NT	NT	NT	NT	NT	NT	NT	NT
June 1987	BDL	NT	NT	NT	NT	NT	NT	NT	NT
Sept 1987	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT
Nov 1987	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT
Dec 1987	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT
Mar 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT
June 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT
Aug 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Dec 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1989	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
June 1989	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Sept 1989	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Nov 1989	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
June 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Sept 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Dec 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
June 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
July 1993	BDL	BDL	BDL	0.90	BDL	BDL	BDL	NT	BDL

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Ethanol** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Ethanol** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	50
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	50
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	50
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	50
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	50
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	50
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	50
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	50

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Ethylbenzene** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	2	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Ethylbenzene** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Ethyl Methacrylate** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Ethyl Methacrylate** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Iodomethane** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Iodomethane** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Methyl Ethyl Ketone*** (µg/l)								
Sampling Date	**MW 1A**	**MW 2**	**MW 3**	**MW 4**	**MW 5**	**MW 6**	**MW 7**	**MW 8**
June 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Methyl Ethyl Ketone** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
June 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	10

NOTES:

BDL	Below Detection Limit
NT	Not Tested
*	2-Butanone

Woodward-Clyde

Cedar Chemical Corporation, Vicksburg Chemical Division Groundwater Monitoring for Methyl Chloride (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
June 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Cedar Chemical Corporation, Vicksburg Chemical Division Groundwater Monitoring for Methyl Chloride (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	DETECTION LIMIT
June 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.1

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitor Results for **Methylene Chloride** (µg/l)								
Sampling Date	MW 1	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7
Dec 1981	NT	NT	NT	NT	NT	NT	NT	NT
Jan 1983	NT	NT	NT	NT	NT	NT	NT	NT
April 1983	NT	NT	NT	NT	NT	NT	NT	NT
Jan 1985	NT	NT	NT	NT	NT	NT	NT	NT
July 1985	BDL	NT	BDL	8.0	BDL	15	11.4	14.6
June 1987	NT	NT	NT	NT	NT	NT	NT	NT
Sept 1987	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Nov 1987	NT	NT	NT	NT	NT	NT	NT	NT
Dec 1987	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Mar 1988	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
June 1988	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Aug 1988	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Dec 1988	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Mar 1989	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
June 1989	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Sept 1989	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Nov 1989	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Mar 1990	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
June 1990	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Sept 1990	NT	BDL	BDL	NT	BDL	NT	BDL	BDL
Dec 1990	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Mar 1991	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
June 1991	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Sept 1991	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Nov 1991	NT	BDL	BDL	NT	NT	BDL	BDL	NT
Nov 1991	NT	BDL	BDL	NT	NT	BDL	BDL	NT
Dec 1991	NT	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	NT	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Dec 1992	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
April 1993	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
July 1993	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitor Results for **Methylene Chloride** (µg/l)									
Sampling Date	MW 8	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 15	MW 16
Dec 1981	NT	NT	NT	NT	NT	NT	NT	NT	NT
Jan 1983	NT	NT	NT	NT	NT	NT	NT	NT	NT
April 1983	NT	NT	NT	NT	NT	NT	NT	NT	NT
Jan 1985	NT	NT	NT	NT	NT	NT	NT	NT	NT
July 1985	BDL	NT	NT	NT	NT	NT	NT	NT	NT
June 1987	NT	NT	NT	NT	NT	NT	NT	NT	NT
Sept 1987	BDL	BDL	BDL	BDL	BDL	400	BDL	BDL	NT
Nov 1987	NT	NT	NT	NT	NT	7269	NT	NT	NT
Dec 1987	BDL	BDL	BDL	BDL	BDL	175	BDL	BDL	NT
Mar 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	13,000	NT
June 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	19,000	NT
Aug 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Dec 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1989	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
June 1989	BDL	BDL	BDL	BDL	BDL	0.1	BDL	NT	BDL
Sept 1989	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Nov 1989	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
June 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Sept 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Dec 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
June 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Nov 1991	NT	NT	NT	BDL	NT	BDL	NT	NT	NT
Nov 1991	NT	NT	NT	BDL	NT	BDL	NT	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for Styrene (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for Styrene (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	2
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Tetrachloroethene** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Tetrachloroethene** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	1
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Toluene** (µg/l)								
Sampling Date	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
Sept 1991	BDL	BDL	NT	BDL	6	BDL	BDL	BDL
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Nov 1991	BDL	BDL	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	BDL	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Toluene** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitoring for **Total 1,2-Dichloroethylene** (µg/l)								
Sampling Date	**MW 1A**	**MW 2**	**MW 3**	**MW 4**	**MW 5**	**MW 6**	**MW 7**	**MW 8**
Sept 1991	BDL	12	NT	BDL	BDL	BDL	BDL	BDL
Nov 1991	BDL	10	NT	NT	BDL	BDL	NT	NT
Dec 1991	BDL	11	BDL	BDL	BDL	BDL	BDL	BDL
Mar 1992	BDL	8	BDL	BDL	BDL	BDL	BDL	BDL
Sept 1992	BDL	9	NT	BDL	BDL	BDL	BDL	BDL
Dec 1992	BDL	10	NT	BDL	BDL	BDL	BDL	BDL
April 1993	BDL	10	NT	BDL	BDL	BDL	BDL	BDL
July 1993	BDL	8	NT	BDL	BDL	BDL	BDL	BDL

Vicksburg Chemical Corporation Groundwater Monitoring for **Total 1,2-Dichloroethylene** (µg/l)								
Sampling Date	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 16	Detection Limit
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Nov 1991	NT	NT	BDL	NT	BDL	NT	NT	5
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5

NOTES:

BDL Below Detection Limit
NT Not Tested

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitor Results for Toxaphene (µg/l)								
Sampling Date	MW 1	MW 1A	MW 2	MW 3	MW 4	MW 5	MW 6	MW 7
Dec 1981	NT	NT	NT	NT	NT	NT	NT	NT
Oct 1983	BDL	NT	BDL	NT	NT	NT	BDL	BDL
Nov 1983	BDL	NT	BDL	NT	NT	NT	BDL	BDL
Jan 1985	NT	NT	NT	NT	NT	NT	NT	NT
June 1987	NT	NT	BDL	NT	BDL	BDL	BDL	BDL
Sept 1987	NT	BDL	BDL	NT	NT	BDL	BDL	BDL
Nov 1987	NT	BDL	NT	BDL	BDL	NT	NT	NT
Dec 1987	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Mar 1988	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
June 1988	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Aug 1988	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Dec 1988	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Mar 1989	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
June 1989	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Sept 1989	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Nov 1989	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Mar 1990	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
June 1990	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Sept 1990	NT	BDL	BDL	NT	BDL	NT	BDL	BDL
Dec 1990	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Mar 1991	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
June 1991	NT	BDL	BDL	NT	BDL	BDL	BDL	BDL
Sept 1991	NT	BDL	BDL	NT	BDL	BDL	25	BDL
Dec 1991	NT	BDL	BDL	NT	BDL	BDL	18.8	BDL
Mar 1992	NT	BDL	BDL	BDL	BDL	BDL	12.3	BDL
Sept 1992	NT	BDL	BDL	NT	BDL	BDL	2.5	BDL
Dec 1992	NT	BDL	BDL	NT	BDL	BDL	4.7	BDL
April 1993	NT	BDL	BDL	NT	BDL	BDL	2.1	BDL
July 1993	NT	BDL	BDL	NT	BDL	BDL	14.0	BDL

Woodward-Clyde

Vicksburg Chemical Corporation Groundwater Monitor Results for **Toxaphene** (µg/l)									
Sampling Date	MW 8	MW 9	MW 10	MW 11	MW 12	MW 13	MW 14	MW 15	MW 16
Dec 1981	NT	NT	NT	NT	NT	NT	NT	NT	NT
Oct 1983	BDL	NT	NT	NT	NT	NT	NT	NT	NT
Nov 1983	BDL	NT	NT	NT	NT	NT	NT	NT	NT
Jan 1985	NT	NT	NT	NT	NT	NT	NT	NT	NT
June 1987	BDL	NT	NT	NT	NT	NT	NT	NT	NT
Sept 1987	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT
Nov 1987	NT	NT	NT	NT	NT	NT	NT	NT	NT
Dec 1987	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT
Mar 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT
June 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT
Aug 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Dec 1988	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1989	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
June 1989	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Sept 1989	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Nov 1989	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
June 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Sept 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Dec 1990	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
June 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Sept 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Dec 1991	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Mar 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Sept 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
Dec 1992	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
April 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL
July 1993	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NT	BDL

Woodward-Clyde

SAMPLING, PIEZOMETER INSTALLATION AND RESULTS OF ANALYSES (NORTH POND AREA)

Location (See Figures 2, 3, 4 and 5)* Approximate Surface Elevation (msl)	Environmental Soil Sampling for Lab Analysis (Discussion)	Significant[1, 4] Results of Analysis of Soil Samples (ppb)	Piezometer Installation	Significant[2] Results of Analysis of Groundwater (ppb)
x 130 feet	Composited sample within pond through 5 feet of sludge. Four sample points-one composite sample for TCLP analysis.	Carbon Tetrachloride = 29 ppb Chloroform = 440 ppb (Waste is not hazardous by characteristic)	None	Not applicable
B-19 140 feet	Drilled to refusal (marl at approximately 55 feet msl)		Nested Piezometers	
19-B	Soil sampled for analysis at approximately 120 to 122 feet msl. (If during field screening there was greater contamination evident from 130 to 109 feet msl, then the 5-foot interval with the highest reading would have been submitted for analysis.)	Clean[3] Ca = 86,100,000 Mg = 39,000,000 Ma = 112,000 K = 537,000	140 to 109 msl screen bottom 10 feet	Ca = 232,000 Mg = 88,400 Na = 33,000 K = 5,140
19-A	Soil Sample for analysis at approximately 60 to 65 feet msl. (If during field screening there was greater contamination evident from 100 to 55 feet msl, then the 5-foot interval with the highest reading would have been submitted for analysis.)	Clean[3]	140 to 55 feet msl screen bottom 10 feet	Ca = 175,000 Mg = 95,800 Na = 70,300 K = 3,650
B-12 R 137 feet			Nested Piezometers	
12(R)-B	Soil sampled for analysis at approximately 105 to 110 msl.	Clean[3] Ca = 79,600,000 Mg = 39,500,000 Na = 104,000 K = 628,000	137 to 960 msl screen bottom 10 feet	Ca = 149,000 Mg = 75,200 Na = 23,000 K = 3,480
12(R)-A	Soil sampled for analysis at approximately 65 to 70 feet msl.	Clean[3]	134 to 60 msl screen bottom 10 feet	Ca = 319,000 Mg = 123,200 Na = 34,000 K = 5,830

Woodward-Clyde

SAMPLING, PIEZOMETER INSTALLATION AND RESULTS OF ANALYSES (NORTH POND AREA)

Location (See Figures 2, 3, 4 and 5)* Approximate Surface Elevation (msl)	Environmental Soil Sampling for Lab Analysis (Discussion)	Significant[1,4] Results of Analysis of Soil Samples (ppb)	Piezometer Installation	Significant[2] Results of Analysis of Groundwater (ppb)
B-20 136 feet	Drilled to refusal (marl at approximately 60 feet msl).		Nested Piezometers	
20-B	Soil sample for analysis at approximately 93 to 95 feet msl. (If during field screening there was greater contamination evident from 130 to 93 feet msl, then the 5-foot interval with the highest reading would have been submitted for analysis.)	Chloroform = 45 ppb Ca = 80,900,000 Mg = 38,700,000 Na = 704,000 K = 537,000	136 to 100 msl screen bottom 10 feet	Chloroform = 1700 Carbontetrachloride = 4 Bromodichloromethane = 36 Trichloroethene = 1 Dibromochloromethane = 14 Bromoform = 18 Ca = 216,000 Mg = 226,000 Na = 3,700,000 K = 152,000
20-A	Soil Sample for analysis at approximately 50 to 55 feet msl. (If during field screening there was greater contamination evident from 93 to 65 feet msl, then the 5-foot interval with the highest reading would have been submitted for analysis.)	Chloroform = 13 ppb	136 to 65 msl screen bottom 10 feet	Ca = 216,000 Mg = 85,600 Na = 50,200 K = 6,630
B-21 113 feet	Drilled to refusal (marl at approximately 60 feet msl). Clay lens near ground surface. Shallow sample was obtained at 105 to 107 feet msl.	Clean[3]	Piezometer No shallow piezometer installed	No sample
21-A	Soil Sample for analysis at approximately 60 to 65 feet msl. (If during field screening there was greater contamination evident from 95 to 65 feet msl, then the 5-foot interval with the highest reading would have been submitted for analysis.)	Clean[3]	113 to 60 msl screen bottom 10 feet	Ca = 101,000 Mg = 34,700 Na = 29,600 K = 5,570

Woodward-Clyde

SAMPLING, PIEZOMETER INSTALLATION AND RESULTS OF ANALYSES (NORTH POND AREA)

Location (See Figures 2, 3, 4 and 5)* Approximate Surface Elevation (msl)	Environmental Soil Sampling for Lab Analysis (Discussion)	Significant[1,4] Results of Analysis of Soil Samples (ppb)	Piezometer Installation	Significant[2] Results of Analysis of Groundwater (ppb)
B-22 113 feet	Drilled to refusal (marl at approximately 60 feet msl).		Permanent Nested Piezometers	
22-B	Soil sample for analysis at approximately 86 to 88 feet msl. (If during field screening there was greater contamination evident from 110 to 90 feet msl, then the 5-foot interval with the highest reading would have been submitted for analysis.)	Chloroform = 830 ppb Ca = 70,600,000 Mg = 35,100,000 Na = 7,010,000 K = 700,000	113 to 85 feet msl screen bottom 10 feet	Chloroform = 1600 Bromodichloromethane = 66 Dibromochloromethane = 78 Bromoform = 160 Ca = 624,000 Mg = 124,000 Na = 16,500,000 K = 273,000
22-A		No Sample	113 to 60 feet msl screen bottom 10 feet	Chloroform = 44 Ca = 131,000 Mg = 39,100 Na = 73,500 K = 5,000

Woodward-Clyde

SAMPLING, PIEZOMETER INSTALLATION AND RESULTS OF ANALYSES (NORTH POND AREA)

Location (See Figures 2, 3, 4 and 5)* Approximate Surface Elevation (msl)	Environmental Soil Sampling for Lab Analysis (Discussion)	Significant[1,4] Results of Analysis of Soil Samples (ppb)	Piezometer Installation	Significant[2] Results of Analysis of Groundwater (ppb)
B-23 113 feet	Drilled to refusal (marl at approximately 60 feet msl).		Permanent Piezometers	
23-B	Soil sample for analysis at approximately 90 to 92 feet msl. (If during field screening there was greater contamination evident from 110 to 90 feet msl, then the 5-foot interval with the highest reading would have been submitted for analysis.)	Clean[3] Ca = 607,000 Mg = 366,000 Na = 29,500 K = 69,000	113 to 90 feet msl screen bottom 10 feet	Chloroform = 79 2-Butanone = 440 Bromoform = 8 Ca = 408,000 Mg = 228,000 Na = 376,000 K = 10,100
23-A	Soil Sample for analysis at approximately 65 to 70 feet msl. (If during field screening there was greater contamination evident from 85 to 65 feet msl, then the 5-foot interval with the highest reading would have been submitted for analysis.)	Chloroform = 26 ppb Ca = 6,420,000 Mg = 2,200,000 Na = 119,000 K = 487,000	113 to 65 feet msl screen bottom 10 feet	Ca = 139,000 Mg = 45,200 Na = 116,000 K = 11,100
B-24 113 feet			Permanent Piezometers	
24-B	Soil sample for analysis at approximately 85 to 88 feet msl. (If during field screening there was greater contamination evident from 110 to 90 feet msl, then the 5-foot interval with the highest reading would have been submitted for analysis.)	Clean[3] Ca = 29,400,000 Mg = 10,100,000 Na = 80,000 K = 680,000	110 to 85 feet msl screen bottom 10 feet	Ca = 198,000 Mg = 82,700 Na = 27,000 K = 19,800
24-A	Soil Sample for analysis at approximately 55 to 65 feet msl. (If during field screening there was greater contamination evident from 85 to 65 feet msl, then the 5-foot interval with the highest reading would have been submitted for analysis.)	Clean[3] Ca = 15,400,000 Mg = 1,360,000 Na = 53,000 K = 414,000	An existing piezometer (PZ-4) which exists at B-24 location from 110 to 60 feet msl is screened in the bottom 10 feet	No sample

Woodward-Clyde

SAMPLING, PIEZOMETER INSTALLATION AND RESULTS OF ANALYSES (NORTH POND AREA)

Location (See Figures 2, 3, 4 and 5)* Approximate Surface Elevation (msl)	Environmental Soil Sampling for Lab Analysis (Discussion)	Significant[1, 4] Results of Analysis of Soil Samples (ppb)	Piezometer Installation	Significant[2] Results of Analysis of Groundwater (ppb)
B-25 114 feet 25-B	Soil Sample for analysis at approximately 78 to 80 feet msl. (If during field screening there was greater contamination evident from 85 to 65 feet msl, then the 5-foot interval with the highest reading would have been submitted for analysis.)	Clean[3] Ca = 52,100,000 Mg = 25,500,000 Na = 94,000 K = 698,000	Permanent Piezometers 110 to 60 feet msl is screened in the bottom 10 feet	Ca = 518,000 Mg = 332,000 Na = 27,200 K = 4,250

NOTES:

[1] Data summary sheets for soil are attached as Appendix D.
[2] Data summary sheets for groundwater are attached as Appendix C.
[3] Essentially free of man made organics.
[4] TCLP data summary sheets for soil (sludge) in pond are attached as Appendix F.
[5] Appendices referenced in notes are included in "North Pond RCRA Facility Investigation Report (February 1994)".
* Figures 2, 3, 4 and 5 are found in Appendix C of "Amended and Supplemental Preliminary Report RCRA Facility Investigation (this volume)" and also in "North Pond RCRA Facility Investigation Report (February 1994)".

Woodward-Clyde

INTERNATIONAL TECHNOLOGY CORPORATION

August 1, 1986

Mr. John Hill
Cedar Chemical Company
Rifle Range Road
P. O. Box 3
Vicksburg, Mississippi 39180

Project No. 435130

Transmittal
Response to Agency Comments
Cedar Chemical Company
Vicksburg, Mississippi

Dear Mr. Hill:

International Technology Corporation (IT) transmits herein six (6) copies of the Response to Agency Comments concerning the Ground Water Assessment for the Vicksburg facility.

If you have any questions, please do not hesitate to call me. I can be reached next week by leaving a message at the office.

Very truly yours,

Jeffrey B. Cange
Project Hydrogeologist

Enclosures

JBC:cag

TABLE OF CONTENTS

	PAGE
LIST OF TABLES	i
LIST OF FIGURES	ii
LIST OF APPENDICES	iii
LIST OF REFERENCES	iv
RESPONSE TO AGENCY COMMENTS (DRAFT)	
I. COMMENTS ON THE VERTAC GROUND WATER ASSESSMENT	1
A. Monitoring Well System	1
B. Assessment of Ground Water Flow and Aquifer Characteristics	3
C. Evaluation of Extent of Contamination	7
D. Geolgoy	11
II. RECOMMENDATIONS	13
A. Monitoring Well System	13
B. Ground Water Flow and Aquifer Characteristics	14
C. Extent of Contamination	15
D. Geology	17
E. Additional Information	18
APPENDIX A: BACKGROUND INFORMATION ON MIGRATION OF DNBP CONTAMINANTS	
APPENDIX B: BORING LOGS	
APPENDIX C: MONITOR WELL INSTALLATION DETAILS	
APPENDIX D: GEOLOGIC CROSS-SECTIONS AND POTENTIOMETRIC MAPS FROM PREVIOUS REPORTS	

LIST OF TABLES

Table No.	Title
1	Monitor Well Details
2	Piezometer Details
3	Physical and Chemical Properties of DNBP
4	Locations of Proposed Monitor Wells

LIST OF FIGURES

Figure No.	Title
1	Local Ground Water Flow Net in the Vicinity of MW-1 and MW-11
2	Ground Water Flow Net after Purging MW-11
3	Structure Contour Map on Top of Byram Marl

LIST OF APPENDICES

Appendix	Title
A	Background Information on Potential Migration of DNBP Contaminants
B	Boring Logs
C	Monitor Well Installation Details
D	Geologic Cross-Sections and Potentiometric Maps from Previous Reports

LIST OF REFERENCES

Bicker, A.R., Dinkins, T.H. Jr., Williams, C.H. Jr., and McCutcheon, T.E., 1966, Claiborne County geology and mineral resources: Mississippi Geological Survey Bulletin 107, 117 p.

Coleman, J.L., Jr. 1978, Stratigraphy and depositional environments of the carbonates of the Vicksburg Group (Oligocene) in Mississippi and adjacent areas: Master's Thesis, Mississippi State University - Department of Geology and Geography.

Cooke, C.W., 1922, The Byram Calcareous Marl of Mississippi: U.S. Geological Survey Prof. Paper 129, pp. 78-83.

Fisk, H.N., 1945, Pleistocene age of the "Citronelle" (abstract): Geological Society of America Bulletin, Volume 56, p. 1158-1159.

Gandl, L.A., 1979, The Oligocene aquifer system in Mississippi: U.S. Geological Survey Water-Resources Investigation Map 77-28.

Gandl, L.A., 1982, Characterization of aquifers designated as potential drinking water sources in Mississippi: U.S. Geological Survey Open File Report 81-550, 90 p.

IT Corporation, 1985, Interim Report, Groundwater Assessment Program, Vertac Chemical Corporation, Vicksburg, Mississippi.

IT Corporation, 1986, Final Report, Groundwater Assessment Program, Vertac Chemical Corporation, Vicksburg, Mississippi.

Krinitzsky, E.L., and Turnbull, W.J., 1967, Loess deposits of Mississippi: Special GSA Papers, Number 94, 61 p.

Mellen, F.F., and McCutcheon, T.E., 1941, Warren County mineral resources: Mississippi Geology Survey Bulletin 43, 140 p.

Miller, B.J., Lewis, G.C., Alford, J.J. and Day, W.J., 1984, Loesses in Louisiana and at Vicksburg, Mississippi: in Guidebook for the Friends of the Pleistocene Field Trip, April 12-14, 1984, 126 p.

Moore, W.H., Bicker, A.R., McCutcheon, T.E., and Parks, W.S., 1965, Hinds County geology and mineral resources: Mississippi Geology Survey Bullen 105, 244 p.

Russell, R.J., 1944, Lower Mississippi Valley loess: U.S. Geological Survey Bulletin 55, pp. 1-40.

Shows, T.N., 1970, Water resources of Mississippi: Mississippi Geological Survey Bulletin 114, 161 p.

LIST OF REFERENCES
(CONTINUED)

Simpson, L.W., Jr., 1965, A foraminiferal and sedimentary analysis of the Vicksburg Group (Oligocene) in Warren and Hinds Counties, Mississippi: Master's Thesis, Mississippi State University, Department of Geology and Geography.

Snowden, J.O., 1966, Petrology of Mississippi loess: Ph.D. dissertation, University of Missouri Graduate School, Columbia, Missouri.

Snowden, J.O., and Priddy, R.R., 1968, Geology of Mississippi loess, in Loess Investigations in Mississippi: Mississippi Geological Survey Bulletin 111, pp. 13-203.

RESPONSE TO AGENCY COMMENTS

I. COMMENTS ON THE VERTAC GROUNDWATER ASSESSMENT REPORT

I. A. MONITORING WELL SYSTEM

I. A. 1. The installation details and drilling logs for the following monitoring wells were not included in the assessment report:

a. MW-1

b. MW-2

c. MW-3

d. MW-4

Monitor well installation diagrams and boring logs for the wells MW-1 through MW-4 are included in Appendices B and C, respectively.

I. A. 2. The depth of screen installation of Vertac's monitoring well system is inadequate for contaminant detection relative to the aquifer's large vertical extent.

Pertinent details concerning the 13 monitor wells at the Cedar Chemical facility in Vicksburg are listed in Table 1. As indicated on the table, these wells monitor the entire saturated interval, including the sandy clay unit beneath the loess. It is important to note that the monitored interval for each well includes not only the screened interval but the entire length of the sand pack; the wells are open to the formation from the base of the bentonite seal to the bottom of the hole.

Cedar [illegible] installed this monitor well system with the intention of providing representative water quality data from the loess and sandy clay units at the site. Although individual wells may not be open to the entire saturated interval, the vertical homogeneity of the loess ensures that representative water samples can be drawn from each well, whether it is screened in the upper or lower portions of the unit.

This condition is depicted graphically in the flow nets included as Figures 1 and 2. Purging of the well prior to sampling, either to dryness or through three (3) well volumes, creates a cone of depression in which the hydraulic head in the well is less than the hydraulic head in the surrounding aquifer. This head differential (gradient) induces flow into the well from the entire saturated thickness of the aquifer.

Consequently, water quality samples drawn from these wells will be representative of the water quality throughout the vertical and horizontal extent of the aquifer in the vicinity of the well.

I. A. 3. Vertac has not installed a sufficient number of wells to adequately define the extent of subsurface contamination.

a. The DNBP contaminant plume associated with MW-1 and MW-9 has not been adequately defined.

b. The arsenic contamination associated with MW-8 has not been adequately defined.

c. The pentachlorophenol contamination associated with MW-1 has not been adequately defined.

Cedar believes that it has adequately defined the subsurface contamination at the Vicksburg plant. These efforts are documented in the Interim and Final Reports for the Ground Water Assessment Program. Field investigations and analytical testing have revealed the following:

- The current levels of contamination are very low (DNBP approximately 1 mg/l in MW-1.
- Subsequent sampling of MW-9 has not detected DNBP; the low levels of DNBP (125 ug/l) detected in an earlier sample (December 1985) has disappeared.
- The DNBP contamination is restricted to an anomalous, relatively small area in the vicinity of upgradient well MW-1; it has not been detected in wells downgradient of either the process area or RCRA units.
- Both the State of Mississippi and Cedar agree that the pentachlorophenol contamination can be attributed to the infiltration of leachate from adjoining railroad beds. The Vicksburg plant has never produced or disposed of pentachlorophenol or products containing penta.
- Arsenic concentrations are highly variable and may reflect some degree of sampling error (cross-contamination). A full characterization of the arsenic contamination in MW-8 is not possible at this time, pending the results of an on-going sample and analysis program.

- o Cedar believes that the arsenic concentrations detected at MW-8 can be attributed to the application of MSMA in the area of the well.

As part of the aggressive action approach that Cedar has undertaken, the company is proposing to continue the sampling of existing wells and install additional monitor wells to define more closely the extent of contamination in the vicinity MW-1 and MW-1A. Specific aspects of the action plan include:

- o Continued sampling of MW-1A, MW-10, and MW-11 to define fully the nature of the contamination in terms of concentrations and to determine the effect of temporal variations in contaminant concentrations.

- o Installation of two (2) additional monitor wells in order to delineate more closely the extent of DNBP contamination detected in the upgradient wells MW-1 and MW-1A. (Note: the locations for the wells to be installed will be selected with the approval of the State of Mississippi).

I. B. ASSESSMENT OF GROUNDWATER FLOW AND AQUIFER CHARACTERISTICS

I. B. 1. The areas of recharge and discharge for the shallow, confined, saturated silt and the deeper saturated sand have not been adequately defined.

A saturated sand unit has not been identified at the site. The sediment above the marl is either the loess unit or a unit described as greenish-gray clayey sand, sandy clay, clay and clayey sand with gravel and sand pockets. These have not been separated into two distinct water-bearing zones because the unit between the loess and marl is generally clayey, and is absent in some areas (MW-8, PZ-2, MW-9).

The existing ground water monitoring system includes wells that are screened both in the loess and the sediment between the loess and the underlying Byram marl. These are treated as a single hydrogeologic unit; the potentiometric maps for this unit are presented in Appendix D and in the Groundwater Assessment Program.

Ground water flow is to the southeast with the equipotential lines generally parallelling the local streams. These streams are interpreted

as the local discharge areas of the site with recharge occurring in the upland areas to the northwest.

I. B. 2. The vertical groundwater flow direction and velocity in the shallow aquifer has not been evaluated.

The boring logs indicate that the site is overlain by fill material, generally a silty clay to clayey silt. Beneath the fill is the loess deposit, a well sorted silt with varying amounts of clay generally between 15 and 40 feet thick at the site. The loess overlies either the sandy clay unit or the Byram Marl.

Sand and gravel deposits of the Citronelle Formation commonly overly the Byram marl disconformably and underly the Pleistocene loess (Mellen and McCutcheon, 1941). The Citronelle has been interpreted as Pleistocene terrace deposits. These deposits are reportedly as thick as 50 feet in Warren County. However, it also has been recognized that in a few areas in Mississippi the Citronelle is absent and loess directly overlies the Teritary bedrock formations (Snowden and Priddy, 1968).

At the plant site, the clayey sand deposits and intermittent sands and gravels encountered above the marl could be the Citronelle Formation, weathered marl or possibly a combination (the weathered material from the underlying marl incorporated with Citronelle). Regardless, these deposits are absent in areas underlying the site (MW-8, PZ-2, MW-9), and where present commonly are characterized by relatively fine-grained sediments. They do not representative a continuous permeable unit across the site.

Generally the water elevations of the wells screened in the loess are above the loess/fill contact, indicating that the fill acts as a semi-confining unit. The flow is horizontal within the loess because the two confining units cannot transmit significant quantities of water. Evidence of this horizontal flow is demonstrated further by the fact that the loess unit is saturated. Generally when the underlying Citronelle (or terrace deposit) is permeable and can transmit water, the loess will drain to the Citronelle. Because the Citronelle is coarse grained and thicker in most area, the overlying loess is typically well drained and oxidized (brown). The loess deposits encountered at the site are gray below depths of approximately 20 feet, indicating saturation and reduced conditions. This interpretation has been supported by Snowden (1986, pers. comm.). The only areas at the site where appreciable vertical flow components might be found would be in local recharge or discharge areas, such as discharge into the Stouts Bayou where there is a flux of water out of the loess unit.

The general horizontal flow through the loess is illustrated in Figure 1. The localized vertical components are also shown in the vicinity of Stouts Bayou.

I. B. 3. Vertac has not characterized the sand unit in terms of the following parameters:

a. Permeability

b. Hydraulic conductivity

c. Groundwater flow direction and velocity.

The sandy clay/ clayey sand unit beneath the marl has been interpreted as an erosional remnant of the post-Oligocene, pre-loess (late Pleistocene) sedimentation. According to Snowden and Priddy (1968), these deposits have been classified as belonging to the Citronelle Formation of Pleistocene age. The Citronelle is a terrace deposit as defined by Fisk (1945). Compositionally, it generally consists of gravel and fill with lesser amounts of silt and clay (Snowden, pers. comm., 1986; Miller, pers. comm., 1986). Clay content is apparently affected by the paleotopography with the terraces deposits at lower elevations being composed of fine-grained material (Bicker et. al., 1966).

The terrace deposits are texturally and compositionally heterogeneous, as evidenced by the materials encountered in the Cedar soil borings as well as by data from test holes completed for the Mississippi Sate Geological Survey (MGS) Bulletin 43 by Mellen et. al (1941).

On-site borings encountered greenish-gray clayey sand, sandy clay, clay and clayey sand with gravel and sand pockets. The drillers reported "hard drilling" when the unit was encountered in monitor wells MW-5, MW-6 and MW-7; pocket penetrometer tests on the IT borings indicated that the sandy clay unit is generally stiff to very stiff. MGS test holes E17, E46, E160, and E164 encountered either clay, clay with sand/gravel or Tertiary bedrock (terrace deposit absent) beneath the loess. Other test holes encountered sands, and gravel, Snowden and Priddy (1968) found the texture of the Citronelle and "loess-Citronelle" mixtures to be highly variable, with the Citronelle varying from almost pure gravel to silty clay (p. 91).

I. B. 4. The permeability of the Byram Member Marl has not been determined.

I. B. 5. The aquifer beneath the Byram Member Marl has not been identified.

I. B. 6. The absence or presence of hydraulic interconnectivity between the shallow aquifer and the unidentified aquifer beneath the Byram Member Marl has not been demonstrated.

The Byram unit (marl facies) has been described by Coleman (1978) and Simpson (1965) as representing mixed clastic and carbonate sedimentation in an open shelf or platform environment.

An outcrop of the marl, approximately one mile southwest of the site (SW 1/4, SE 1/4, Sec. 8, T15N, R3E) is described as dominantly a massive argillaceous, highly calcareous, glauconitic sand marl (Mellen and McCutcheon, 1941). This exposure was also observed by an IT geologist and is described as a weathered, dark gray medium to coarse-grained fossiliferous, argillaceous grainstone (marl). The rock was very hard where fresh, with no discernible voids, fractures or other types of porosity. The contract with the underlying Glendon limestone was also observed. The Glendon was a dark gray to brown, dense, fine-grained limestone.

The standard penetration resistance, measured at PZ-7 of the Byram marl, was 29 blows; there was refusal of the split spoon (greater than 50 blows per 6 inches) at MW-8.

The argillaceous, massive and medium dense character of the marl would inhibit any significant movement of water through this unit, and there is no indication of secondary permeability.

The outcrop of the marl described is approximately 10 feet thick. The contact between the marl and the underlying Glendon member is exposed at this out crop. A test boring in the same section as the Cedar facility (Section 9, T15N, R3E) encountered 40 feet of marl (Mellen and McCutcheon, 1941).

The Glendon member ranges from 26 to 62 feet in Warren County and consists of beds of semi-crystalline limestone and marl-- areneceous, argillaceous, glauconitic and abundantly fossiliferous (Mellen and McCutcheon, 1941). Simpson (1965; p. 18) describes the Glendon as alternating beds of fossiliferous, glauconitic limestone, marl and clay. The Byram Formation and Glendon Member do not produce water in the area for domestic purposes (Sims, 1986, pers. comm.). Therefore, the nearest potential aquifer beneath the Byram marl is within the Mint Spring Formation, estimated from electric logs to lie at approximately 100 feet below the ground surface. The Mint Springs is generally a massive bed of highly fossiliferous sand marl. There reportably are low-yield wells that derive water from the Mint Springs. (Mellen and McCutcheon, 1941).

The relatively impermeable nature and thickness of the Byram and Glendon units preclude a direct hydraulic connection between the shallow groundwater beneath the site and the potential water-bearing zones of the Mint Springs Formation. According to Shows (1970) and Gandl (1979 and 1982), fresh water is available in the Vicksburg area down to depths of 1,000 feet or more. Principal aquifers include the Alluvium of the Mississippi River, the Forest Hill Sand, the Cockfield and other Claiborne aquifers, and the Wilcox.

I. B. 7. **The permeability of the clay fill unit overlying the site has not been determined.**

This issue has been resolved in that due the heterogeneity of the fill material (sand, gravel, clay, silt, debris) discrete permeability measurements would be of little value for characterization of the unit as a whole. For example, a permeability test in the vicinity of PZ-4, where the fill contains mostly gravel, would probably yield permeability values two or three orders of magnitude greater than the results from a test conducted on the fill at MW-10, where the material is predominantly clay.

I. C. EVALUATION OF EXTENT OF CONTAMINATION

I. C. 1. **Chemical scans contained in Vertac's Groundwater Assessment Report indicate the presence of moderate concentrations of 2-sec-butyl-4, 6-dinitrophenol (DNBP), as well as significant concentrations of arsenic and pentachlorophenol.**

I. C. 2. **As noted earlier, inherent inadequacies in the design and installation of Vertac's monitoring system preclude rigorous contaminant detection and plume delineation.**

Cedar rebuts the premise that the current monitoring system contains inherent inadequacies in its design and installation. A considerable degree of preparation, care, and consultation with the State preceded the installation of this system.

The potential source areas of the site include the interim status impoundments, inactive disposal area, product drumming area, the DNBP production building and the railcar station. All these sources are hydraulically upgradient from all or a significant portion of the monitoring system.

The wells are situated to monitor flow through the loess and the underlying clayey sand deposit. There is no evidence of any other permeable zones within the near-surface sediments. The wells have 10 to 15-foot screens that are situated at different depths. As discussed in the response to I.A.1., after purging wells the ground water sample

should be representative of the unit because flow will be from all depths within the unit to the screened interval. This situation is illustrated in Figure 2.

There is no evidence that DNBP is present as a non-aqueous phase liquid (NAPL). The solubility of DNBP is 50 mg/l, and the highest solute concentration historically detected in any of the wells was 1.1 mg/l (at MW-1). If a NAPL plume does exist it would tend to move downward through the loess and migrate along the upper contact of the sandy clay unit or Byram marl. Migration would be affected by both the hydraulic gradient and the structural gradient of the marl unit. The Byram marl generally slopes to the southeast, as indicated in Figure 3. Monitor well MW-11 is hydraulically and structurally downgradient from MW-1, and is screened 10 feet near the base of the upper marl contact. Therefore, any NAPL migration associated with the contamination at MW-1 would be detected at MW-11. Monitor wells MW-7, MW-10, and MW-12 are also screened near the upper contact of the marl, structurally and hydraulically downgradient from the source areas.

I. C. 3. Vertac has made an inadequate assessment of the areal and vertical extent of DNBP, arsenic and pentachlorophenol contamination.

See response to I.A.3. above. Cedar believes that its assessment program has been adequate to define the extent of contamination at the Vicksburg plant. The anomalous DNBP contamination associated with MW-1 and MW-1A has been isolated from all known source areas at the facility (e.g. surface impoundments, disposal area, loading racks, drumming area). The reasons for the low levels of contamination in this area are not known at this time.

More stringent sampling procedures have been recently adopted at MW-8. Through the elimination of sampling error these new procedures will enable a more accurate assessment of the arsenic concentrations. As was discussed in the meeting of July 17, 1986, Cedar believes that this contamination is the result of MSMA applications in the area of the well (the material was believed to be sprayed directly on the well on at least one occasion).

Arsenic concentrations in MW-5, 6, 7, and 8 have been shown to vary significantly but generally are well below the ground water protection standard of 50 ug/l. These variations, observed in both up and downgradient wells (relative to the RCRA units) probably reflect natural variations in background water quality. Cedar is considering the installation of an additional upgradient well to define more closely these background variations. Monitor well 4 is located over 2,500 feet from the remainder of the monitor well system, and may be too far away to serve as an effective background well.

The pentachlorophenol contamination has been attributed to the infiltration of leachate from adjacent railroad beds. The Cedar facility has never produced or disposed of pentachlorophenol or related products at any time in its history of operations.

I. C. 4. The physical and chemical properties of the contaminants have not been discussed.

Table 3 lists the pertinent chemical and physical properties of DNBP.

I. C. 5. The aqueous and non-aqueous mobility of the contaminants have not been discussed.

A complete discussion on the aqueous and non-aqeous mobility of the contaminants is included Appendix A, Background Information on Potential Migration of DNBP contaminants.

I. C. 6. The contaminant migration pathways have not been discussed.

A discussion of the typical contaminant migration pathways for DNBP is included in Appendix A. The primary site-specific pathway is the saturated loess unit. DNBP contaminants have been detected at concentrations up to 1.1 mg/l, well below the solubility limit of 50 mg/l. Based on these concentrations, DNBP contamination at the site appears to be restricted solely to the aqueous (solute) phase. Solute migration pathways are governed by ground water flow and the processes of advection and dispersion. Therefore, beneath the Cedar facility, migration rates through the loess unit would be largely a function of ground water flow velocities, which have been estimated to range from 0.01 to 0.18 feet per day (Table 6 of the Final Report). Actual migration rates of solute DNBP will be slower than the ground water velocities due to attenuation (retardation) processes as it moves through the aquifer. For reasons explained below, DNBP is likely to be highly attenuated in its migration through the loess. Appendix A contains a more complete discussion of the relationship between ground water velocity, retardation factor, and solute contaminant velocity.

DNBP is not a very mobile constituent in the unsaturated environment either. It is rapidly degraded by sunlight and is easily broken down by soil bacteria. The compound has a great affinity for soils (a desirable trait for a herbicide) and will adhere to the soil particles rather than pass through the soil media. For these reasons, DNBP migration through the vadose zone is considered highly unlikely.

Surface pathways are also limited because the Cedar plant has a chemical and storm sewer system that channels all site runoff into its onsite

wastewater treatment plant. Surface waters in nearby Stouts Bayou or Hennessey Bayou are not currently being impacted by operation of or contamination derived from the facility. This assertion has been substantiated with recent (week of 7/28/86) analyses of water samples from the Bayous. The analyses of samples collected upstream and downstream from the facility did not detect DNBP.

I. C. 7. Despite the low solubility constants of DNBP and pentachlorophenol, Vertac has failed to implement a sampling program capable of detecting variable density non-aqueous phase liquids in contaminated wells.

Monitor wells that comprise the ground water monitoring system at the Cedar facility have been completed at locations and depths that are adequate for the detection of variable density, non-aqueous phase liquids (NAPLs). Of 13 wells, 5 are screened in the lower part of the formation (MW-7, MW-9, MW-10, MW-11, MW-12). Monitor well MW-11 is located structurally downgradient of the area where low concentrations of contamination have been confirmed and in fact is located in a structural "trough" in the surface of the underlying bedrock (see Figure 3). If NAPL contamination was present it would, following the structural gradient, flow into this trough and be detected at MW-11, which screens the lower portion of the loess, the clay and also a portion of the underlying marl.

The presence of NAPL contamination at the Vicksburg facility has not been established, nor is there reason to believe such contamination exists. There has never been bulk disposal of concentrated DNBP wastes. Solute concentrations are well below the solubility limits for DNBP; if a NAPL plume of DNBP was present, it would be acting as an active source of solute DNBP contamination within the loess. The concentrations of solute would be considerably higher than are currently being detected by the monitoring system.

Ground water is moving through the loess, as indicated by the hydraulic gradients measured in the unit. If a NAPL plume was present, this ground water flow would carry DNBP contamination (at or below the solubility limit) away from the plume. Again, it is highly unlikely that NAPL contaminants are present in the subsurface at the Cedar facility, given the low concentrations and limited areal extent of aqueous-phase DNBP contamination.

I. C. 8. The quality of groundwater discharge into Stout's Bayou and Hennessey's Bayou has not been determined.

Recent sampling of Stout's Bayou (July 1986) has shown that it is free of DNBP contamination. This was not unexpected as none of the monitor

wells nearest to the bayou had ever detected DNBP contaminants. In general, the Cedar facility is not impacting nearby surface water bodies.

I. D. GEOLOGY

I. D. 1. Vertac has not submitted an adequate description of the depositional environment of the following horizons:

a. The loess unit (account for the presence of shells and wood chips reported on the drilling logs).

The shells are pulmonate gastropods. The occurrence of these snails in the loess is well-documented in the literature. (Snowden and Priddy, 1968; Krinitzsky and Turnbull, 1967). These gastropods are erratic in their habitat and also gregarious. Therefore they are concentrated in zones within the loess (Snowden and Priddy, 1968). The gastropods are better preserved and more common in loess deposits that have not undergone extensive weathering or leaching.

The wood fragments probably were brought down from the overlying fill area during drilling. Although roots are common in the loess deposits, these roots are represented by thin rootlets or by casts infilled with calcium carbonate, and would not be described as wood fragments.

b. The sand subunit located between the loess and the Byram Member Marl.

The sandy clay unit beneath the Byram Marl represents a terrace deposit, possibly the Citronelle formation, that has been classified as an alluvial deposit (Snowden and Priddy, 1968; Moore et. al., 1965). The sediments are typical fluvial deposits with a wide range of grain sizes and facies.

Beneath the site, the sandy clay unit consists of predominantly fine-grained material (clays) with lesser sands. Gravel was reported in only three borings. Due to its high clay content, the unit could represent a "clay lens" as reported by Moore et. al. (1965; p. 86) or a transitional zone between the loess or Citronelle and the underlying marl (Miller, 1986, pers. comm.). As such, it is not representative of the "typical" terrace deposits which are characterized by sands and gravels.

I. D. 2. Vertac has not characterized the Byram Member Marl in terms of the following parameters:

a. Structural competency.

b. Dissolution Features.

c. Mineralogy.

The response to I.B.2 includes descriptions of the Byram marl from the literature in addition to descriptions of a nearby outcrop. The contact of the Byram with the underlying Glendon is exposed at the outcrop near the plant site (Mellen and McCutcheon 1941). Therefore, it is believed that the lower portion of the Byram as present in the plant area. This lower portion of the Byram generally is alternating, fossiliferous beds of sand-marl, clay-marl, montmorillonite clay, and locally thin beds of bentonite and one or more beds of water-born lignite (Mellen and McCutcheon, 1941).

The Byram marl encountered in a boring near the plant (northcentral part of Section 9, T15N, R3E) indicated the Byram is massive, argillaceous highly calcareous, glauconitic sand marl.

The detailed lithologic descriptions of the marl presented in Mellen and McCutcheon (1941) indicate some localized structures including weathering, and lamination of the detrital sediment; however, generally the marl is described as massive. The massive character of the marl is also indicated at the outcrop near the plant site.

The published descriptions do not mention widescale dissolution features. Dissolution would occur in the weathered zone and along discontinuities, but these zones are probably very localized, and the occurrence is not prevalent enough to be cited in the literature.

The detrital portion of the marl generally is quartz (Simpson, 1965). gypsum and pyrite have also been reported in the marl. The clay minerals include bentonite, glauconite, and montmorillonite. The bulk of the marl is composed of foramniferal material and shell fragments (Simpson, 1965). The megafossils are dominantly corals, mollusks and echinoderms (White, 1921).

I. D. 3. Vertac has not submitted a detailed site topography map of the clay fill material overlying the loess unit.

Cedar understands that the State is currently reviewing their files for maps previously furnished to the State. If a suitable map is not located, Cedar will furnish a detailed site topographic map to the State of Mississippi.

I. D. 4. Vertac has not characterized the inactive disposal site or the interim status impoundment in term so the following parameters:

a. **The vertical extent of these sites. (Based on geologic correlations and plant records, does either the inactive disposal site or the interim status impoundment extend into the saturated zone?)**

b. **Seepage analysis and site water balance of the interim status impoundment.**

The low concentrations of contamination detected in monitor wells MW-1 and MW-1A cannot be attributed to leakage from the RCRA units (interim status impoundments or inactive disposal area). This is based upon an interpretation of hydraulic gradients and the fact that none of the wells between the RCRA units and the contaminated wells have detected any contamination. Both Cedar and the State of Mississippi agree that the issues raised in D.4.a), b), and c) are more appropriately addressed in the Site Closure Plan or the Part B Permit Application.

I. D. 5. **The geologic cross sections contained in Vertac's groundwater assessment report are inadequate in design, insufficient in number and should contain the following data:**

a. **Contact zones between all geologic units and subunits.**

b. **Lithology.**

c. **Geologic correlations between wells.**

d. **Depth to saturated zone.**

e. **Piezometric surface.**

f. **Screened interval.**

g. **Topographic features.**

A complete set of all geologic and hydrologic cross sections from the previously submitted Part B, March 1985 Interim Report and January 1986 Final Report has been included in Appendix D. These cross sections contain all the pertinent data as requested in D.5.a) through g).

II. RECOMMENDATIONS

II. A. MONITORING WELL SYSTEM

II. A. 1. **Submit the installation details and drilling logs for all monitoring wells.**

A complete set of boring logs and monitor well installation diagrams from previously submitted documents is included in Appendices B and C.

II. A. 2. Design and install a monitoring well and boring system capable of delineating the areal and vertical extent of contamination in the saturated zone.

See the response for comments I.A.2, I.A.3, and I.C.2. Cedar believes that the current monitor well system has delineated the areal and vertical extent of contamination in the saturated zone. Additional wells are to be located in the vicinity of MW-1 and MW-1A, both upgradient and laterally (cross-gradient) from the contaminated wells. These additional wells will more closely define the anomalous contamination detected at MW-1/1A. The proposed well locations are shown in Figure 4. Determination of optimal well locations was accomplished through consideration of existing hydraulic gradients and estimation of the expected radius of influence induced by pumping at MW-1/1A. Calculation of the radius of influence was made using an analytical solution.

II. A. 3. Design and install a clustered piezometer system capable of determining vertical groundwater flow direction beneath the facility.

As stated previously, the component of flow within the loess is predominantly horizontal, with the upper silty clay and lower sandy clay units acting as confining units. Vertical flow components may be present within the loess in the areas of recharge or discharge; however, installation of a nested piezometer system to define these areas is not necessary for an understanding of the ground water regime at the site. Water level (potentiometric) contours (Appendix D) are adequate to define the local recharge and discharge.

II. B. GROUNDWATER FLOW AND AQUIFER CHARACTERISTICS

II. B. 1. Define and recharge/discharge areas for the loess and sand units.

See the response to I.B.1. and II.A.3.

II. B. 2. Submit cross sections depicting the vertical groundwater flow direction in the loess unit.

Cross-sections depicting vertical ground water flow have been submitted; refer to figures 1 and 2.

II. B. 3. Determine the vertical groundwater velocity in the loess unit.

See the response to I.B.2. Cedar has adequately defined the hydraulic parameters of the loess unit. Flow is predominantly horizontal; the loess acts as a single hydrologic unit bounded above and below by relatively impervious strata. The vertical flow components are negligible.

II. B. 4. Determine the horizontal groundwater flow direction and velocity in the sand unit.

The sandy clay unit is not transmitting appreciable quantities of ground water at the site, as evidenced by the presence of saturation within the loess and other factors. See the response for I.B.3.

II. B. 5. Identify the aquifer beneath the Byram Member Marl and demonstrate a lack of hydraulic interconnectivity between the upper and lower aquifers.

The Mint Springs is a potential source of water beneath the Byram Marl and Glendon Limestones. It is separated from the loess by at least 40 feet of indurated, impervious limestone and marl. See the response for I.B.5 and I.B.6.

II. B. 6. Determine the permeability of the clay fill unit.

Determination of permeability within the fill material is not required at this time; see the response for I.B.7.

II. C. EXTENT OF CONTAMINATION

II. C. 1. Delineate the areal and vertical extent of contamination in the saturated zone. Determine migration rates for the contaminants.

Cedar has delineated the areal and vertical extent of contamination in the saturated zone. Low concentrations of DNBP contaminants have been detected in wells MW-1 and MW-1A, which are screened in the loess unit. None of the wells screened through the sandy clay unit have detected contamination. Thus, the vertical extent of contamination has been defined. Monitor wells MW-1 and MW-1A are located upgradient from the RCRA units and all other known DNBP source areas. Contamination has not been detected in wells that lie downgradient of MW-1/1A and these source areas. Therefore, with regard to the known DNBP sources (including areas where the product was manufactured or stored), the areal extent of contamination has been defined. It is restricted to a

very limited portion of the plant. Installation of additional wells will facilitate refinement of the areal extent of contamination within this limited portion of the plant. (Note: For a more complete discussion of the extent of contamination, see the response to I.A.2.)

II. C. 2. Submit a table that lists the physical and chemical properties of the contaminants.

Table 3 lists the chemical and physical properties of DNBP. An unsuccessful attempt was made to locate a value for Kow (logarithm of the octanol-water distribution coefficient). DNBP is known to be a very immobile constituent in the soil/ground water environment. It can be deduced, therefore, that the compound likely has a very high Kow value and would be expected to be highly retarded (attenuated) as it migrates through the loess material. (Note: For a more complete discussion of the relationship between Kow and contaminant migration rates, refer to Appendix A.

II. C. 3. Submit a narrative that relates the physical and chemical properties of the contaminants to their aqueous and non-aqueous mobility and possible migration pathways.

This narrative has been included as Appendix A.

II. C. 4. Design and implement a sample and analysis plan capable of *detecting variable density non-aqueous phase liquids in* wells that show contamination.

Cedar currently operates a ground water monitoring system capable of detecting variable density, non-aqueous phase liquids (NAPLs) in wells that show contamination. This is based on the interpretation that monitor wells screened anywhere within the saturated loess interval are capable of drawing in vertically representative samples from the loess. The loess possesses a very distinct vertical permeability derived in part from its mode of deposition (eolian) that is uncommon in fluvial or marine sediments. Stratification, even where present (e.g., between successive loess sheets) typically does not have a significant impact on this vertical permeability. Were this not to be the case, perched water tables would be a common occurrence within the loess. According to Krinitzsky and Turnbull (1967; p. 45), perched water tables are not present within the loess.

II. C. 5. Evaluate the impact of groundwater discharge on the quality of surface water in Stout and Hennessey Bayou.

Cedar has sampled the surface water in Stout Bayou and has detected no water quality degradation that can be attributed to the Vicksburg

facility. The State of Mississippi indicated in the meeting of July 17, 1986 that sampling Stout Bayou would be sufficient to evaluate the impact of ground water discharge on the quality of surface water at the site. (Note: see response to I.C.8).

II. C. 6. Sample existing piezometers for contaminants.

Piezometers PZ-1 through PZ-4 were installed to obtain potentiometric (water level) data only. They were neither drilled nor constructed with the necessary care for or the intention of utilizing them as monitor wells.

II. D. GEOLOGY

II. D. 1. Submit an environment of deposition analysis for the loess and sand units.

The loess unit represents eolian deposition, as documented by Snowden (1966), Snowden and Priddy (1968), Krinitzsky and Turnbull (1967), Moore et. al. (1965) and others (see the list of references). The sandy clay is either an erosional remnant of a terrace (Citronelle?) deposit or the product of weathering of the exposed Tertiary bedrock or perhaps a combination of both. Further studies, such as petrographic and mineralogic analyses would be required to determine whether the sediment is part of the Citronelle (in which case it would be a fluvial deposit) or the result of weathering of the marl. Cedar believes that such a study is beyond the scope of this investigation. The sandy clay unit has been adequately characterized for the purposes of the Ground Water Assessment.

(Note: See the response to I.D.3.).

II. D. 2. Characterize the Byram Marl in terms of structural competency, dissolution and mineralogy.

The Byram marl has been characterized in the literature and from site-specific evidence, as a hard, indurated rock unit. It does not yield water in the vicinity of the Vicksburg plant and is considered a continuous unit. Dissolution features have not been noted in samples taken from the marl with split spoons in borings at the site. There are no references to dissolution in the literature. The mineralogy of the Byram is discussed in the response to I.D.2.c. (as are structural competency and dissolution features).

II. D. 3. Submit a detailed topographic map of the site.

Cedar understands that the State is currently reviewing their files for a suitable map. If none is found, Cedar will submit a detailed topographic map of the site to the State.

II. D. 4. Implement and submit the results of a seepage analysis and site water balance study for the interim status impoundment.

This analysis has jointly been deemed inappropriate by the State of Mississippi and Cedar.

II. D. 5. Resubmit geologic cross sections A-A' and B-B'; include all pertinent geologic and hydrologic data.

A complete set of all geologic cross sections from previously submitted documents is included in Appendix D.

II. D. 6. Construct and submit two additional geologic cross sections, the first section should cut across the inactive disposal site and the second should cut across the interim status surface impoundment. Both cross sections should be normal to cross section A-A' and depict all pertinent geologic and hydrologic data.

Cross sections through the interim status impoundment are included in the Part B Permit Application (Closure Plan). A cross section through the inactive disposal site would not be relevant to the current assessment as all available water quality data indicate that the disposal area is not impacting ground water at the site.

II. E. ADDITIONAL INFORMATION

II. E. 1. Submit a narrative that discusses the site history. How long has the plant been in operation? How long has the interim status impoundment been in existence? What has been disposed of in the inactive disposal site?

This information is contained within the Part B Permit Application; reference is made to that document to answer the above questions.

II. E. 2. Submit a list of references used in writing the groundwater assessment. Incorporate reference citations into the report.

A list of references is included at the end of this report. These references were utilized in the preparation of this supplementary report and in the earlier reports.

TABLES

TABLE 1

MONITOR WELL DETAILS

WELL NUMBER	DEPTH (FEET)	DATE INSTALLED	GROUND ELEVATION[2]	TOP OF CASING ELEVATION	TOP OF SAND PACK ELEVATION	TOP OF SCREEN ELEVATION	BOTTOM OF SCREEN ELEVATION	BOTTOM OF SAND PACK ELEVATION	TOP OF SILT (LOESS) ELEVATION	TOP OF SANDY CLAY	TOP OF MARL ELEVATION
1	30	1981	111.55	113.01	101.55	91.55	81.55	81.55	93	NP[3]	NP
2	40	1981	107.57	108.21	97.57	77.57	67.57	67.57	89	NP	NP
3	30	1981	98.44	99.33	88.44	78.44	68.44	68.44	80	NP	NP
4	20	1981	112.28	114.70	104.28	102.28	92.28	92.28	94	NP	NP
5	19	1983	99.70	100.30	88.70	85.70	80.70	80.70	84	70.7	65.7
6	24.4	1983	98.68	100.76	80.28	79.28	74.28	74.28	84	70.7	63.7
7	29.2	1983	99.13	99.66	74.93	74.93	69.93	69.93	84	71.1	65.1
8	28.9	1983	109.83	110.83	89.93	85.93	80.93	80.93	99	71.3	70.8
9	58.5	1985	112.02	116.02	73.02	69.02	59.02	53.52	102[4]	NS[5]	60
10	53.5	1985	112.23	114.73	77.23	72.23	62.23	58.73	102[4]	63.7	60.2
11	48.5	1985	101.12	105.62	68.12	66.12	56.12	52.62	96[4]	58.1	40.12
12	48	1985	109.06	112.06	83.06	77.06	67.06	61.06	105	65.1	63.1
1A	30	1986	111.5[2]	113[2]	101.5[2]	91.5[2]	81.5[2]	81.5[2]	100	NP	NP

NOTES: (1) Based on 1985 survey data.

(2) Estimated well is 15 feet northwest of MW-1.

(3) NP = Not Penetrated.

(4) Estimated; fill/loess contact not recorded on boring log.

(5) NS = Not sampled at depth interval where contact would be expected.

TABLE 2

PIEZOMETER DETAILS

PIEZOMETER NUMBER	DEPTH (FEET)	DATE INSTALLED	GROUND ELEVATION[2]	TOP OF CASING ELEVATION	TOP OF SAND PACK ELEVATION	TOP OF SCREEN ELEVATION	BOTTOM OF SCREEN ELEVATION	BOTTOM OF SAND PACK ELEVATION	TOP OF SILT (LOESS) ELEVATION	TOP OF SANDY CLAY	TOP OF MARL ELEVATION
1	54	1984	116.64	118.74	81.64	79.64	64.64	62.64	110.6[1]	68.6	64.6
2	56	1984	110.55	112.45	80.55	75.55	60.55	54.55	103.5[1]	NS[2]	54.5
3	52	1984	111.03	113.03	80.03	75.03	60.03	59.03	103.0[1]	68	60.5
4	49	1984	112.34	114.24	95.34	74.34	64.34	63.34	100.3[1]	69.3	63.3

NOTES: (1) Estimated; boring augered with no sampling at loess/fill contact.

(2) NS = Not sampled at depth interval where contact would be expected.

TABLE 3

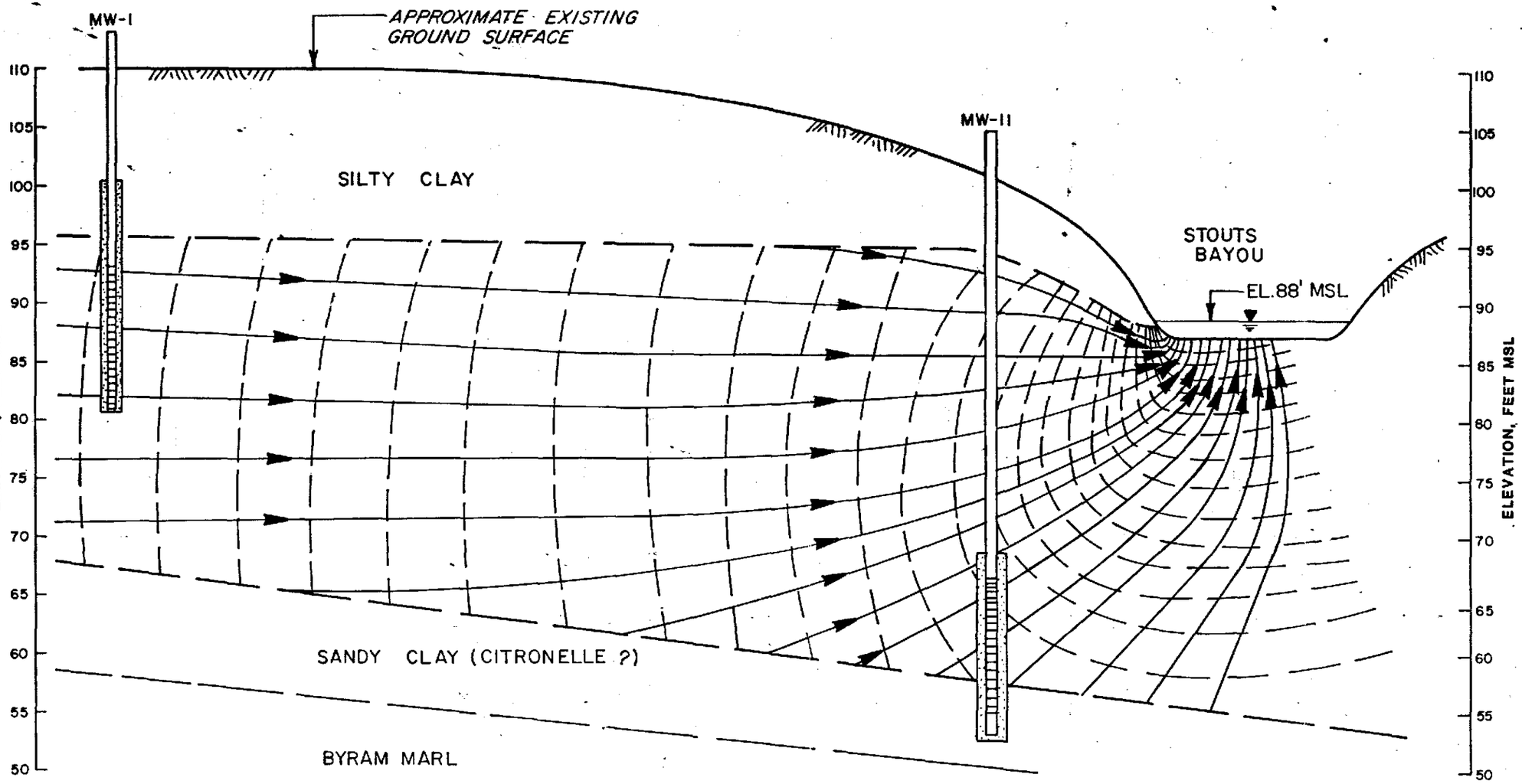
CHEMICAL AND PHYSICAL PROPERTIES
OF DNBP
CEDAR CHEMICAL COMPANY
VICKSBURGH, MISSISSIPPI

COMPOUND	MOLECULAR WEIGHT	SPECIFIC GRAVITY	MELTING POINT (°C)	BOILING (POINT (°C)	VAPOR PRESSURE (TEMP. °C)	SOLUBILITY MG/L	LOGARITHM OF OCTANOL/WATER DISTRIBUTION COEFFICIENTS (TEMP. °C)
2,4-dinitro-6-sec-butylphenol (Dinoseb;DNBP	240.2	1.29 @ 30°C	32°	N/A	1mm @ 151°C	50	N/A

FIGURES

DRAWING NUMBER 435130 B1

DRAWN BY	CHECKED BY
CAL 7/29/86	APPROVED BY



LEGEND

FLOW LINES

EQUIPOTENTIAL LINES

REFERENCE: FREEZE, R.A. and CHERRY, J.A., 1979, GROUNDWATER, PRENTICE-HALL INC., ENGLEWOOD CLIFFS, N.J. 604p.

FIGURE 1

LOCAL GROUND WATER FLOW NET IN VICINITY OF MW-1 AND MW-11

PREPARED FOR

CEDAR CHEMICAL COMPANY VICKSBURG, MISSISSIPPI

CORPORATION
COPYRIGHTS RESERVED
Use This Drawing

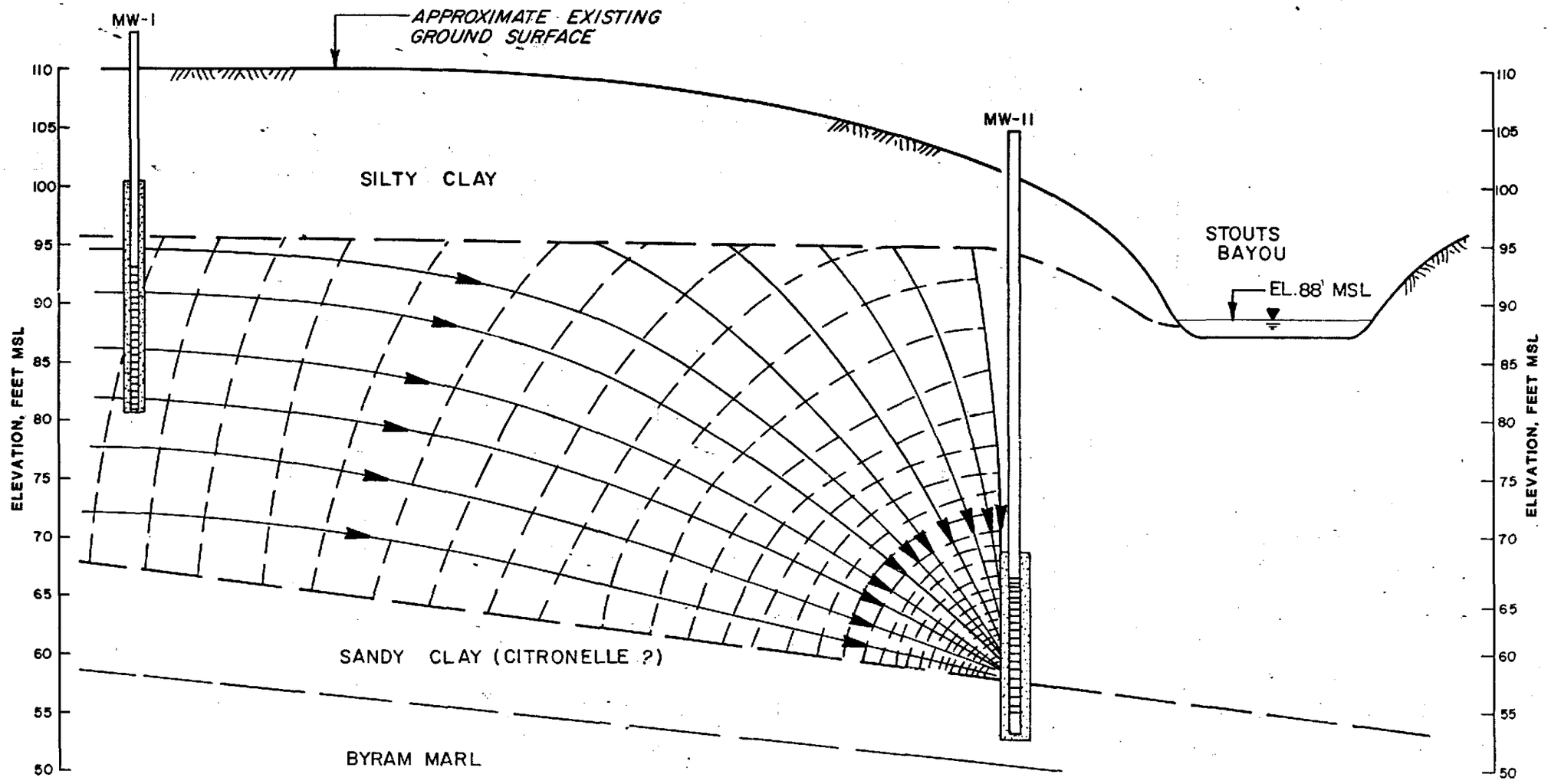
Creating a Safer Tomorrow

DRAWING NUMBER 435130 B2

DRAWN BY GAL 7/30/86

CHECKED BY

APPROVED BY



LEGEND

FLOW LINES

EQUIPOTENTIAL LINES

NOTE: WELL IS BAILED DRY PRIOR TO SAMPLING.

FIGURE 2

FLOW NET AROUND MW-11 AFTER PURGING

PREPARED FOR

CEDAR CHEMICAL COMPANY VICKSBURG, MISSISSIPPI

REFERENCE: FREEZE, R.A. and CHERRY, J.A., 1979, GROUNDWATER, PRENTICE-HALL INC., ENGLEWOOD CLIFFS, N.J. 604p.

© 1984 IT CORPORATION
ALL COPYRIGHTS RESERVED
Do Not Scale This Drawing

122293

IT ... Creating a Safer Tomorrow

DRAWN BY	CAL	CHECKED BY		DRAWING NUMBER 435130 B3
	7/30/86	APPROVED BY		

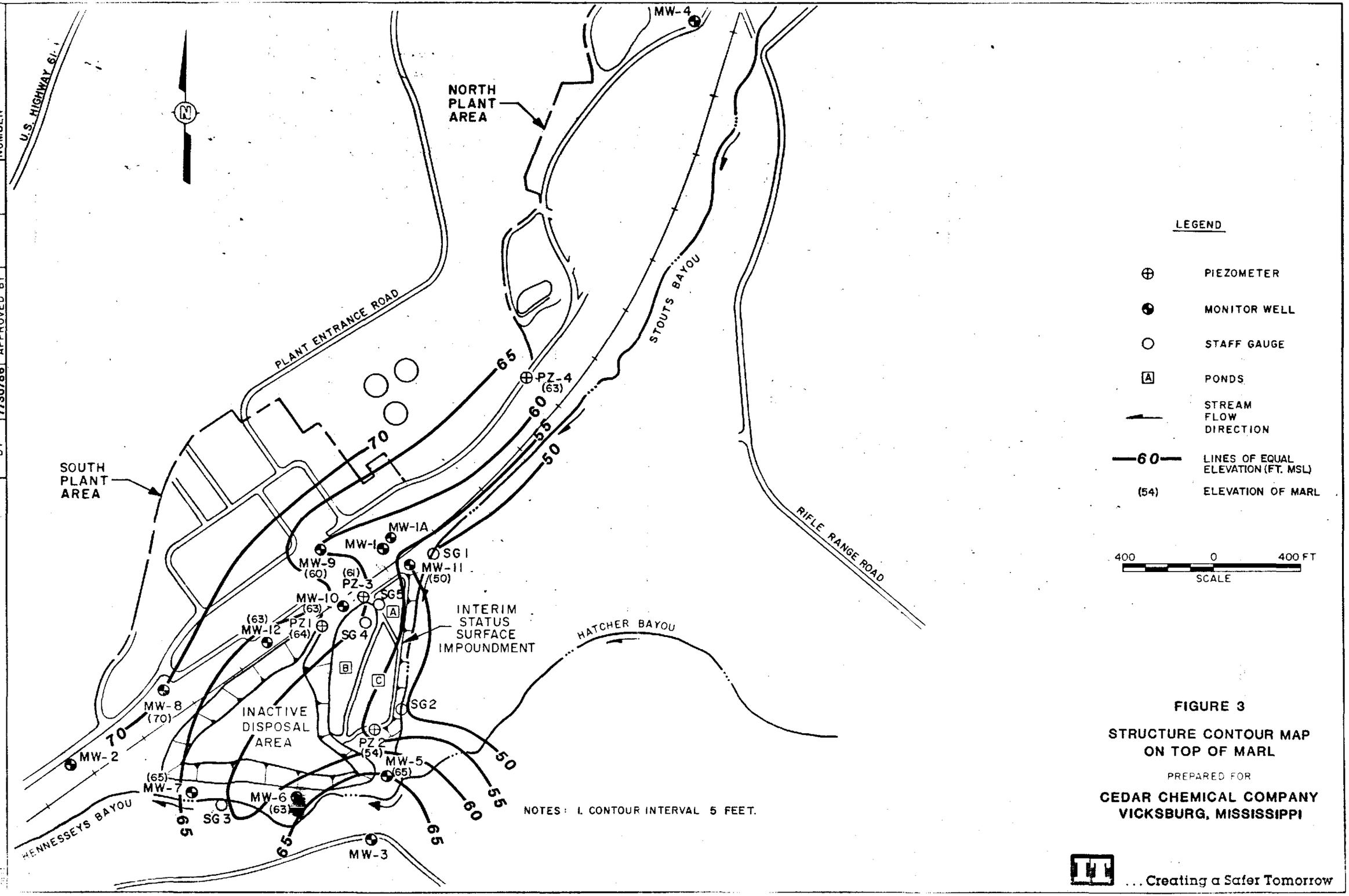


FIGURE 3

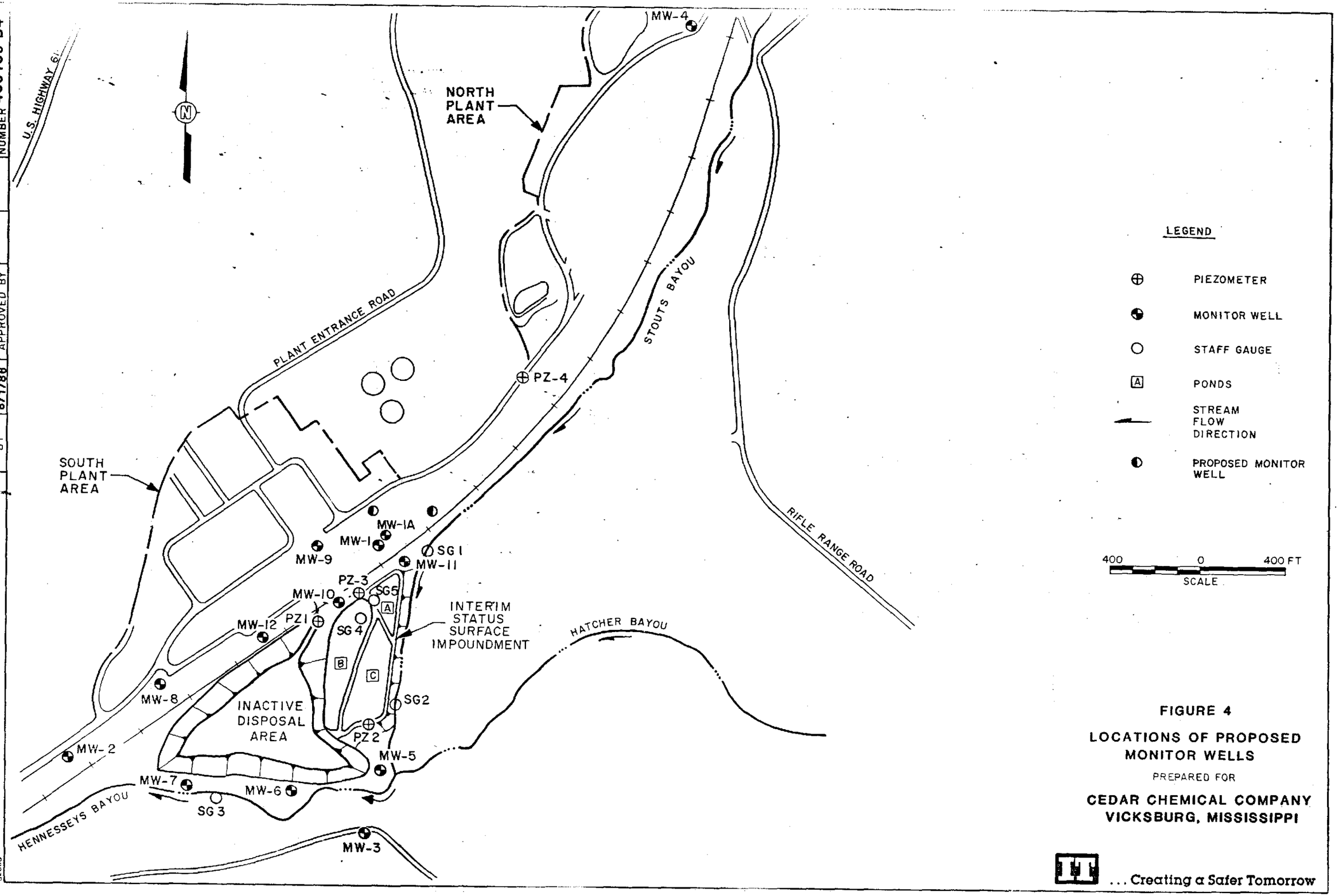
STRUCTURE CONTOUR MAP ON TOP OF MARL

PREPARED FOR

CEDAR CHEMICAL COMPANY
VICKSBURG, MISSISSIPPI

IT ...Creating a Safer Tomorrow

DRAWN BY	CHECKED BY	DRAWING NUMBER
CAL 8/1/88	APPROVED BY	435130 B4



32803

FIGURE 4

LOCATIONS OF PROPOSED MONITOR WELLS

PREPARED FOR

CEDAR CHEMICAL COMPANY
VICKSBURG, MISSISSIPPI

IT ... Creating a Safer Tomorrow

APPENDIX A

BACKGROUND INFORMATION ON MIGRATION OF DNBP CONTAMINANTS

BACKGROUND INFORMATION
ON POTENTIAL MIGRATION OF DNBP CONTAMINANTS

BACKGROUND INFORMATION ON POTENTIAL MIGRATION OF DNBP CONTAMINANTS

The migration of DNPB contaminants in soil/groundwater regimes is controlled by four major factors, which are summarized in the following sections:

- o The Concentration State, Section 1.0
- o Geologic Features, Section 2.0
- o Fluid Flow, Section 3.0
- o Reaction Factors, Section 4.0

1.0 CONCENTRATION STATE OF CONTAMINANTS

Depending upon the concentration and solubility of the contaminant, there are essentially three physical states the contaminant may assume in the subsurface:

- o Two-phased flow
- o Suspended mixtures
- o Dissolved mixtures

The migration of a separate Non-Aqueous Phase Liquid (NAPL) in a subsurface aqueous environment is determined by such contaminant properties as density, viscosity, and the surface tension, capillary pressures and pore radii of the media. Subsurface structural gradients are often a greater predictor of dense, second phase contaminant movement than hydraulic gradients alone. In cases the predominant contaminant is a NAPL, phased pools will tend to collect in low spots along the basal contact between permeable sand and silt zones and

underlying clays. Heavy liquids also migrate rapidly through vertical conduits, such as those provided by biogenic structures, fractures, and roots. However, if the contaminant has high surface tension and viscosity, or if capillary pressures are relatively high, the velocity of the phased contaminant can be much slower than that of the aqueous phase (groundwater).

The migration of contaminants in suspended, immiscible mixtures is controlled by the behavior of microscopic aggregates known as micelles (a unit of structure built up from complex molecules in colloids). The behavior of micelles, in turn, is determined by the porosity of the permeable zone through which they are transported and the same contaminant physical factors that govern phase movement (density, viscosity, and surface tension). If the pore sizes in the permeable zone are sufficiently large, the micelles are transported much like ideal solutes. An exception occurs when density contrasts between the micelles and water influences micelle transport, resulting typically in slower movement of the micelles. If the pores are not large enough, the micelles behave as miniature two-phased flow. Micelles of creosote may accumulate in low spots where they can concentrate into a phased fluid.

The migration of solutes, such as DNBP at concentrations below 50 mg/l and various trace metals, is a function of groundwater velocity (advection) and the natural hydrodynamic mixing (dispersion) which causes spreading in directions longitudinal and transverse to the lines of flow. The advection/dispersion equation for groundwater flow is a differential equation. Simple one-dimensional and two-dimensional problems can be approached using hand calculated analytical solutions. However, more complex problems, involving boundary conditions, changing hydrologic parameters, or mass losses require computer-aided solutions.

The solubility and migration of both inorganic and organic constituents in groundwater is controlled largely by variations in temperature, pressure, pH, redox potential (Eh), content of natural organic matter, aquifer composition (mineralogy), and the relative concentration(s) of other substances in solution.

2.0 GEOLOGIC FEATURES

Within sedimentary rock terranes, the geological history includes the depositional and diagenetic history of the sediments as well as the tectonic history of the area. Sediments originally deposited as horizontal layers can, with time and pressure, become distorted. The dip (angle from the horizontal) of a semi-impervious layer (aquitard) plays a major factor in determining the velocity of contaminant flow. Structurally low trends in dipping strata also serve as pathways for horizontal movement of NAPLs and may cause these contaminants to flow in a direction contrary to the hydraulic gradient.

On a smaller scale, clay microfractures may form due to the shrinking/swelling properties of certain clay minerals. These microfractures may become both vertical and horizontal conduits for contaminant migration. Some microfractures are caused by small openings in the clay which result from the burrowing activities of benthic organisms and the burial and subsequent decay of roots, branches, and other plant debris. Clays that are subjected to frequent wetting and drying cycles, and which respond by shrinking and swelling, will also possess microscopic fissures. As further overlying deposition occurs, the overburden pressured reduces the size of the fractures. At shallow depths, the presence of microfractures will be dictated by the mineralogic composition and the depositional environment of the clays. The microfractures exhibit permeabilities that typically are several

orders of magnitude higher than the surrounding clays and their volume may comprise up to 10 percent of the clay unit. Their presence is usually evidenced by precipitated minerals such as iron oxides.

Heterogeneities related to lithologic and facies changes both in the horizontal and vertical direction influence contaminant migration by providing preferential pathways (increased hydraulic conductivity) for the contaminant to follow. These pathways may take the form of interfingering coarse and fine sediments such as those attributable to deltaic sedimentation or intermittant deposition of a selective stratum, such as a lignite seam, within a particular lithologic unit.

3.0 FLUID FLOW

3.1 GROUNDWATER FLOW AND SOLUTE TRANSPORT

The factor which has the greatest influence on the movements of soluble contaminants is the groundwater velocity. Seepage velocity of a fluid can be described by:

$$v = \frac{Ki}{n_e}$$

where v = average linear velocity (L/T)
K = hydraulic conductivity or permeability (L/T)
i = hydraulic gradient, $h_1 - h_2/l$ (Dimensionless)
n_e = effective porosity (Dimensionless)

The process by which solutes and small micelles are transported by the bulk motion of the flowing groundwater is known as advection. Advection causes contaminants to be carried at an average rate which can approach the average linear velocity, v, of the water. However, contaminants also spread out along the path of flow due to a transport process called hydrodynamic dispersion.

Dispersion causes dilution of the solute and occurs due to mechanical mixing during fluid advection. Molecular diffusion, which results from the thermal-kinetic energy of the solute particles, is a dispersion process of importance at low velocities.

Mechanical mixing is most easily viewed as a microscopic process which is caused by three mechanisms. The first occurs in individual pore channels because molecules travel at different velocities at different points across the flow field due to the drag exerted on the fluid by the roughness of the pore surfaces. The second process is caused by the difference in pore sizes along the flow paths of the water molecules. Because of differences in surface area and roughness relative to the volume of water in individual pore channels, different pore channels have different bulk fluid velocities. The third process is related to the tortuosity, branching and interfingering of pore channels (Freeze and Cherry, 1979).

Coefficients of dispersion can be estimated for spreading in the longitudinal and transverse direction. Longitudinal dispersion occurs in the direction of flow and is caused by different microscopic velocities as contamination moves differently through wider and less tortuous pore spaces. As a result, some of the groundwater and contaminant molecules travel faster than the average linear velocity, and some travel more slowly. The different rates of advance produce the typical S-shaped breakthrough curves of the contaminants at some distance from the source.

Differential equations have been developed to describe the transport of solutes in porous materials by considering the flux of a solute into and out of a fixed elemental volume. A conservation of mass statement for this elemental volume is:

net rate of change of mass of solute within the element	=	flux of solute out of the element	-	flux of solute in- to the element	+	loss or gain of solute mass due to reactions

The physical processes that control the flux into and out of the elemental volume are advection and hydrodynamic dispersion. Loss or gain of solute mass in the elemental volume can occur as a result of chemical or biochemical reactions (Freeze and Cherry, 1979). Investigators have derived approximate solutions to the differential equation for one-dimensional dispersion, and have developed analytic and computer models to simulate one, two, and three dimensional problems (Javandel et. al., 1984).

Solute contaminants entrained in the groundwater will move at an average velocity (V_c) which is some fraction of the average groundwater flow rate. The average solute velocity is a function of the chemical and/or physical interaction of the contaminant and the aquifer material it flows through. This contaminant velocity can be a calculated using the following equation:

$$V_c = V_s/R_d$$

Where V_c = velocity of the contaminant
V_s = average linear velocity for the groundwater
R_d = retardation factor

The retardation factor (R_d) is used to describe the transfer by adsorption or other chemical processes of contaminant mass from the groundwater to the solid part of the aquifer (Dunlap et. al., 1983). This process causes the rate of advance of the contaminant front to decrease (i.e., to be retarded). The retardation factor is a relative measure of the reactivity of the solute; the more it reacts with the solid part of the aquifer, the more it is retarded.

For adsorption reactions Rd can be determined from the equation:

$$R_d = 1 + \frac{Ps \ (Kd)}{n_e}$$

where R_d = retardation factor (dimensionless)
Ps = bulk mass density of aquifer system (M/L^{-3})
n_e = effective porosity percent
Kd = distribution coefficient (V/M)

To calculate the average contaminant velocity it is necessary to determine the retardation factor (R_d) for individual contaminants of concern.

3.2 NAPL FLOW

The movement of dense NAPL in the subsurface is dependent upon a series of complex forces. Downward gravitational forces due to the weight of the NAPL's act against both capillary pressure and viscous shear forces. Under hydrostatic conditions, the NAPL must attain a certain height (critical height), and thus mass, to allow for the gravitational forces to overcome the resisting forces, and for downward migration to occur. In the subsurface, the mass is attained by vertical stringers within the interconnecting pores of the soil. The critical height can be calculated by the use of Hobson's formula (Villaume, 1985):

$$h_o = \frac{[2z \quad \cos B \quad (\frac{1}{r_t} - \frac{1}{r_p})]}{g \ (Pw - Ph)}$$

h_o = critical height (cm)
r_t = pore throat radius (cm)
r_p = pore radius (cm)
Pw = density of water (g/cm^3)
Ph = density of hydrocarbon (g/cm^3)
z = interfacial tension between fluids (dynes/cm)
B = wetting or contact angle (degrees)
g = gravity (cm/sec^2)

The rate of horizontal migration can be calculated from the following relationship: (Davis and Deweist, 1966).

$$V_{NAPL} = \left[-\sin A + \frac{1}{K_w} \frac{P_w}{P_{NAPL} - P_w} V_w \right] \left(\frac{P_{NAPL} - P_w}{P_{NAPL}} \right) K_{NAPL}$$

A = angle of interface (degrees)
K_{NAPL} = hydraulic conductivity of NAPL (L/T)
K_w = hydraulic conductivity of water (L/T)
P_{NAPL} = density of NAPL (M/V)
P_w = density of water (M/V)
V_w = velocity of water (L/T)
V_{NAPL} = specific discharge of NAPL's (L/T)

For this calculation, it is assumed that both the NAPL's and water have the same principal component of velocity, and that flow follows a uniform structural gradient that is the same as the interfacial angle between the NAPL's and the water. After obtaining V_{NAPL}, the seepage velocity of the NAPL (V_{S-NAPL}) can be calculated with the following equation:

$$V_{S-NAPL} = \frac{V_{NAPL}}{n_e}$$

Where n_e is the porosity.

4.0 REACTION FACTORS

The types and degree of reactions occurring within the subsurface environment are a function of the type of contaminant, the hydrogeologic regime, and the existing flow field(s). Varied physical, chemical, and biological effects (eg, dispersion, oxidation-reduction, microbial degradation, etc.) determine the rate of reaction. The principal geochemical processes impacting the migration of contaminants in the soil and groundwater regime include:

- o Ion exchange,
- o Adsorption,

- o Oxidation-Reduction (Redox) and
- o Biological Degradation.

Each of these geochemical processes is pH dependent to varying degrees, with the exception of redox reactions which are governed more by Eh conditions. All of these processes are discussed in further detail below.

Ion Exchange

The exchange reaction of two ionic species A and B between aqueous solution and a solid can be described generally by the following chemical balance equation:

$$A^{+}(aq) + mB(s) = mB^{+}(aq) + A(s)$$

where (aq) and (s) denote the solution and solid surface and m is the stoichiometric coefficient.

The structure of certain alumino-silicate minerals, clays in particular, results in a negatively charged surface layer. This charge balance is overcome by cation adsorption from the surrounding aqueous solution. Some typical cations include:

- o sodium
- o calcium
- o magnesium
- o ammonium

Generally, monovalent (+1) ions will undergo the exchange reaction before higher valence ions. Other properties of contaminants can also effect the

reaction, such as the hydrated ionic radius. Certain soluble contaminants may bond with metals in solution and subsequently are removed by ion exchange.

The exchange capacity varies among clay species with smectites having a very high cation exchange capacity (CEC) of 120-300 meq/100g to kaolinite with a CEC of 7-12 meq/100g. Based on the charge arrangement of the contaminant, the presence of high CEC clays would predict an appreciable sink for certain contaminant species.

Adsorption

Adsorption takes place as a consequence of the attraction of ions or molecules to the surface of a solid. The attractions may result from weak van der Waals type forces (physical adsorption), or it may involve the formation of strong chemical bonds, giving rise to chemisorption. Clays, metallic oxides and hydroxides, and organic matter all account for adsorption of selected contaminant species.

Adsorption of organic chemicals and trace metals on the solids of native organic particles and minerals can have a profound effect on the contaminant velocity through the unsaturated and the saturated zone. Considerable information pertaining to the adsorption of inorganic and organic constituents to surface soils and aquatic sediments has been developed in the past 20 years.

Adsorption of organic and inorganic constituents by these sediments can generally be described by the Freundlich isotherm:

$$C^* = KC^n$$

where: C^* = concentration of adsorbed solute on sediment
C = concentration of solute in solution
K = retardation coefficient
n = constant for a given temperature

The amount of contaminant that can be adsorbed at a mineral surface depends upon the surface area exposed to solution. Thus, expanding minerals (e.g., smectites, chlorites, vermiculites) usually contain a greater capacity to adsorb molecules than non-expanding minerals. This swelling property is a function of hydration energy of the interlayer cation. However, even non-swelling clay minerals such as kaolinite, illite, and micas can adsorb organic/inorganic molecules in interlayer positions.

The sorption of many nonionic organic chemicals has been shown to be reversible and follow a linear isotherm. Also, it has been demonstrated that the sorption of many organics results almost entirely from the interaction between immobile native organic material in the soil and the solute molecules. Karichkoff (1984) presents the following relationship between the octanol-water distribution coefficient (Kow) and the organic carbon distribution coefficient (Koc) for aromatics and polynuclear aromatics.

$$\log Koc = 1.0 \log Kow - 0.21$$

The distribution coefficient (Kd) for the retardation equation then can be estimated from the fraction of organic carbon (Foc) in the soil.

$$Kd = Koc\ Foc$$

The Retardation Factor (R_d) is then calculated from K_d as shown in Section 3.1.

The adsorption of phenol by different soils was examined by Scott et al., (1983). Adsorption can be quantitatively assessed by the use of the Freundlich isotherm. The amount adsorbed varied as a function of time and concentration. At low concentrations (40 mg/l) the adsorption efficiency in a sterile soil is approximately 40 percent. As an example of soil adsorption capabilities, data from creosote/penta studies will be examined.

It has been concluded in a study of 13 soils that adsorption of pentachlorophenol primarily depends on the pH of the system. The more acidic the soil, the more complete was the "apparent adsorption" of pentachlorophenol. Different mechanisms of adsorption dominate at different pH values. In acid clays, "apparent adsorption" involved the adsorption on colloids, and precipitation in the micelle and in the external liquid phase.

Organic matter content of soils is important to adsorption of pentachlorophenol at all pH values. Later investigations have led to the conclusion that adsorption of pentachlorophenol by humus is important when the concentration is low, but at higher concentrations the inorganic fraction of the soil increases in importance.

Three (3) of four (4) allophanic soils showed a significant increase in pentachlorophenol adsorption at higher temperatures, while the fourth soil showed a decrease. The difference between the three soils and the fourth soil could be explained by assuming that the soils chiefly adsorb pentachlorophenol as anions, whereas, the major factor influencing pentachlorophenol adsorption by the fourth soil, showing a decrease with increasing temperature, is a Van der Waals force. Decreasing the concentration of chlorides or sulfate ions also increases the adsorption of pentachlorophenol to soil. These results indicate the occurrence of competition between inorganic anions and pentachlorophenol anions for adsorption sites on the soil colloid.

Oxidation-Reduction (Redox) Reactions

Redox reactions involve either the gain or loss of electrons of a substance. As an example, oxygen is combined to substances in an "oxidizing" environment and removed in a "reducing" environment. This process can affect the fate of both free ionic species and organic compounds in the groundwater. The parameters Eh and pH are useful for indicating the redox conditions in

soils. Often, as contaminants are added to groundwater, the available oxygen is used up and the contaminants are degraded by a series of redox reactions. Various types of redox reactions can affect the fate of contaminants. Two examples are denitrification and sulfate reduction.

In denitrification, bacteria utilize (in a complex series of reactions) the oxygen in the nitrate ion to oxidize organic carbon to CO_2. The CO_2 may escape as a gaseous phase or become involved in the subsequent incorporation and precipitation of carbonate minerals. The precipitation of carbonate minerals would be a sink for manganese, magnesium, iron, strontium, calcium and sodium.

Sulfate reduction is a bacterial reaction in which bacteria use the oxygen in the sulfate ion to oxidize organic matter to CO_2, producing sulfide species as a by-product. HS will form rather than H_2S if the pH is above 7, and if any reactive iron compounds are present, the sulfide species will react with them to form solid sulfides. In addition, heavy metals that are released from adsorption on ferric hydroxides are very insoluble in the presence of the dissolved sulfide species.

Biological Degradation

The role of microorganisms in the biotransformation or degradation of contaminants, particularly certain organic chemicals, is becoming increasingly recognized. Originally, most microbiologists assumed that the deeper regions of the subsurface were essentially devoid of life. The basis of this assumption was early plate count information which indicated that the numbers of microorganisms decreased rapidly with soil depth. However, recent studies employing new techniques which allow enumeration of all living organisms in soils and underlying subsurface solids, rather than just those that can grow

on a particular growth media, have shown clearly the presence of very significant populations of microorganisms in both unsaturated and saturated subsurface environments lying below the root zone.

Biodegradation, or more properly fermentation, is a type of oxidation-reduction reaction and can be affected by many geochemical properties of the subsurface environment. In particular, available supplies of nutrients such as nitrogen and phosphorus, and electron acceptors, primarily oxygen, may become limiting. It may be possible to use the quantities of these substances present in the subsurface region to estimate an upper boundary for the quantity of organic pollutant that can be biodegraded. For example, normal groundwater often contains 0.1 to 10 mg/l of nitrate, which is equivalent to approximately 0.02 to 2.2 mg/l nitrogen. Since bacteria are about 15 percent nitrogen on a dry weight basis, approximately 0.15 to 15 mg/l of cell mass could be produced from the available nitrogen. Assuming an efficiency of incorporation of 50 percent then 0.3 to 30 mg/l of an organic compound could be degraded before nitrogen becomes limiting.

Rees, et. al. (1981) empirically measured phenol degradation through a green sand in an anaerobic environment. Degradation activity takes place at concentrations ranging upward to 8,200 mg/l, but decomposition was increasingly inhibited above 3,000 mg/l. The maximum rates of decomposition were observed at concentrations between 1,500 and 3,000 mg/l.

Rees found that degradation of phenolics increased with increasing flow rate and was able to develop predictions regarding phenol degradation rates based on groundwater velocity. The degradation rate reaction equation developed by Rees suggests a limit on the distance to which phenols will move. The degradation equation is:

$$tVmax = Km \ln \frac{(Ci)}{Co} + (Ci - Co)$$

where: t = time
Vmax = maximum rate of phenol degradation
Km = Michaelis Constant
Ci = Initial Concentration of Phenol
Co = Steady State phenol concentration (Desired Limiting Concentration)

A typical degradation rate in a sandy to silty-clay type regime for example, might be 0.21 mg/l per hour. Using this rate, Rees has suggested how to calculate the time for an initial concentration to be lowered to an acceptable concentration, and how far the phenol might migrate.

Baker et al. (1980) has conducted experiments on microbial (aerobic) and non-biological decomposition of phenols and chlorophenols in silty soils. Phenols in an anaerobic zone in contact with silica are found to rapidly decompose even in the absence of micro-organisms. Phenols in contact with quartz and silt are found to degrade in a near linear manner as a function of time and temperature. An initial concentration of 100 mg/l was degraded to 30 mg/l over the course of 32 days at 25°C. The phenols are degraded by the process of auto-oxidation at the surface of the silica matrix.

REFERENCES

Baker, M.D., and C.I. Mayfield, (1980). Microbial and non-biological decomposition fo chlorophenols and phenol in soil. Water, Air and Soil Pollution Vol. 13, pp 441-424.

Davis, S.N. and DeWiest, R.J.M., (1966). Hydrogeology, John Wiley and Sons, Inc., New York, 463 p.

Dunlap, W.J., Wilson, J.T., Piwoni, M.D., and Enfield, C.G., 1983. Transport and fate of organic pollutants in the subsurface - current perspectives. USEPA Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma, 34 p.

Freeze, R.A. and Cherry, J.A. (1979) Groundwater. Prentice-Hall, Inc., Englewood Cliffs, N.J., 604 p.

Javandel, I., Doughty, C. and Tsang, C.F., (1984). Groundwater Transport Handbook of Mathematical Models, American Geophysical Union, Washington, D.C., pp 129-132.

Karickhoff, S.W. (1984), Organic Pollutant Sorption i Aquatic Systems, Journal of Hydraulic Engineering, Vol. 110, No. 6, pp. 707-735.

Rees, J.F., and J.W. King, (1981). The dynamics of anaerobic phenol biodegradation in lower greensand, J. Chem. Technol, Biotechnol., Vol. 31, No. 5 pp 306-310.

Scott, H.D, D.C., Wolf, and T.L. Lavy, (1983). Adsorption and degradation of phenol at low concentrations in soil. J. Environ. Qual., Vol. 12, No. 1, pp 91-95

Villaume, J.F., (1985), Investigations at Sites Contaminanted with Dense, Non-Aqueous Phase Liquids (NAPLs), Ground-Water Monitoring Review. pp. 60-74.

REFERENCES

Baker, M.D., and C.I. Mayfield, (1980). Microbial and non-biological decomposition fo chlorophenols and phenol in soil. Water, Air and Soil Pollution Vol. 13, pp 441-424.

Davis, S.N. and DeWiest, R.J.M., (1966). Hydrogeology, John Wiley and Sons, Inc., New York, 463 p.

Dunlap, W.J., Wilson, J.T., Piwoni, M.D., and Enfield, C.G., 1983. Transport and fate of organic pollutants in the subsurface - current perspectives. USEPA Robert S. Kerr Environmental Research Laboratory, Ada, Oklahoma, 34 p.

Freeze, R.A. and Cherry, J.A. (1979) Groundwater. Prentice-Hall, Inc., Englewood Cliffs, N.J., 604 p.

Javandel, I., Doughty, C. and Tsang, C.F., (1984). Groundwater Transport Handbook of Mathematical Models, American Geophysical Union, Washington, D.C., pp 129-132.

Karickhoff, S.W. (1984), Organic Pollutant Sorption in Aquatic Systems, Journal of Hydraulic Engineering, Vol. 110, No. 6, pp. 707-735.

Rees, J.F., and J.W. King, (1981). The dynamics of anaerobic phenol biodegradation in lower greensand, J. Chem. Technol, Biotechnol., Vol. 31, No. 5 pp 306-310.

Scott, H.D, D.C., Wolf, and T.L. Lavy, (1983). Adsorption and degradation of phenol at low concentrations in soil. J. Environ. Qual., Vol. 12, No. 1, pp 91-95

Villaume, J.F., (1985), Investigations at Sites Contaminanted with Dense, Non-Aqueous Phase Liquids (NAPLs), Ground-Water Monitoring Review. pp. 60-74.

APPENDIX B

BORING LOGS

PROJECT Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	DRILLING RIG B-40	JOB. NO. 872	BORING NO. B-1 SHEET 1 OF 1

GROUND SURFACE ELEVATION 107.1 DATUM MSL	BORING LOCATION See Plan

BORING TYPE 3 1/4" Hollow Auger 2" Split Spoon	GROUND WATER LEVEL 13' at drilling 9' at completion	DATE 29 September 1981 WEATHER Clear, warm DRILLER Bill Barnes INSPECTOR John Walton BORING TERMINATED AT 30'

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	14	25	Stiff brown silty CLAY
2	8.5-10.0	6	23	Firm brown silty CLAY
3	13.5-15.0	8	27	Firm brown silty CLAY
4	18.5-20.0	3	31	Soft brown silty CLAY, with gray silt marbeling
5	23.5-25.0	8	27	Firm brown silty CLAY, with gray silt marbeling
6	28.5-30.0	4	28	Soft brown silty CLAY

DISC

LOG OF BORING

PROJECT Monitoring Wells, Vertac Chemical Corp., Vicksburg, Mississippi	DRILLING RIG B-40	JOB. NO. 872	BORING NO. B-2, SHEET 1 OF 1
GROUND SURFACE ELEVATION 103.0, DATUM MSL	BORING LOCATION SEE PLAN		
BORING TYPE 3 1/4" Hollow Auger, 2" Spilt Spoon	GROUND WATER LEVEL 26' at drilling	DATE 29 September 1981, WEATHER clear and warm, DRILLER Bill Barnes, INSPECTOR Terry Primm, BORING TERMINATED AT 40'	

Sample No.	Sample Depth ft. From — To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	7	25	Firm tan silty CLAY
2	8.5-10.0	7	24	Firm tan silty CLAY
3	13.5-15.0	6	24	Firm tan silty CLAY
4	18.5-20.0	6	25	Firm gray silt
5	23.5-25.0	6	23	Firm gray silt
6	28.5-30.0	8	23	Firm gray silt
7	33.5-35.0	7	23	Firm gray silt
8	38.5-40.0	8	32	Firm gray silt

DISC

LOG OF BORING

PROJECT Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	DRILLING RIG B-40	JOB. NO. 872	BORING NO. B-3 SHEET 1 OF 1

GROUND SURFACE ELEVATION 95.5
DATUM MSL

BORING LOCATION
SEE PLAN

BORING TYPE
3 1/4" Hollow Auger
2" Split Spoon

GROUND WATER LEVEL
20' at drilling

DATE 30 September 1981
WEATHER clear and warm
DRILLER Bill Barnes
INSPECTOR Terry Primm
BORING TERMINATED AT 30'

Sample No.	Sample Depth ft. From — To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	5	24	Firm brown silty CLAY
2	8.5-10.0	8	20	Firm brown silty CLAY
3	13.5-15.0	2	33	Soft brown silty CLAY
4	18.5-20.0	5	31	Firm brown silty CLAY,w/gray silt marbeling
5	23.5-25.0	3	29	Soft brown silty CLAY,w/gray silt marbeling
	28.5-30.0	7	28	Firm brown silty CLAY,w/gray silt marbeling

LOG OF BORING

PROJECT Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	DRILLING RIG B-40	JOB. NO. 872	BORING NO. B-3A SHEET 1 OF 1
GROUND SURFACE ELEVATION 95.5 DATUM MSL	BORING LOCATION See Plan		
BORING TYPE 3 1/4" Hollow Auger 2" Split Spoon	GROUND WATER LEVEL 20' at drilling	DATE 30 September 1981 WEATHER Clear & Warm DRILLER Bill Barnes INSPECTOR Terry Primm BORING TERMINATED AT 30'	

Sample No.	Sample Depth ft. From — To	Stand. Penet. Test Blow/ft	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
ST-1	5.0-7.0	--	25	Brown Silty CLAY
ST-2	8.0-10.0	--	23	Brown Silty CLAY
ST-3	18.0-20.0	--	32	Brown Silty CLAY w/gray silt marbeling

NOTE: ST = Shelby Tube

DISC

LOG OF BORING

PROJECT	DRILLING RIG	JOB. NO.	BORING NO.
Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	B-40	872	B-4 SHEET 1 OF 1

GROUND SURFACE ELEVATION / DATUM	BORING LOCATION
109.6 MSL	SEE PLAN

BORING TYPE	GROUND WATER LEVEL	
3 1/4" Hollow Auger 2" Split Spoon	9' at drilling	DATE 01 October 1981 WEATHER clear and warm DRILLER Bill Barnes INSPECTOR Terry Primm BORING TERMINATED AT 20

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	5	25	Firm tan silty CLAY w/gray silt marbeling
2	8.5-10.0	10	25	Stiff brown silty CLAY w/gray silt marbeling
3	13.5-15.0	11	27	Stiff dark brown silty CLAY w/gray silt marbeling
	18.5-20.0	9	26	Stiff dark brown silty CLAY w/gray silt marbeling

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters
Nashville, Tennessee
Branch Offices
Knoxville Tennessee
Arvada, Colorado

DRILLER'S LOG

SHEET REPORT OF DRILLING OPERATIONS AT Vertac Chemical Corporation (VCC) Vicksburg, MS		SITE
HOLE LOCATION See Site Sketch Map	SHIFT	DATE 3-2-83
SURFACE ELEVATION 98.6' (msl)	RIG NO	HOLE NO 5
DEPTH AT BEGINNING OF SHIFT	TOP ROCK	
FOOTAGE PERFORATED	BOTTOM OF HOLE	
FOOTAGE SAMPLED	DRILLER C. Nelson - H.B.A.	
FOOTAGE CORED	HELPER	
DEPTH AT END OF SHIFT	DRILLED FOR	

SAMPLING RECORD

LOGGED BY: GDM

SPLIT NO	FROM	TO	SPLIT BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown silty CLAY, v. moist
2	10.0	11.0		Brown v. silty CLAY, Moist
3	15.0	16.0		Brown sl. clayey SILT, with gray mottles
				Stratum change at 17.0 feet - by driller
				Saturated returns at 19.0'
4	20.0	21.0		Brown and gray sl. clayey SILT, saturated
5	25.0	26.0		Gray sl. clayey SILT, saturated
				Hard drilling at 29 feet
6	30.0	31.0		Greenish gray clayey SAND
7	34.0	35.0		Greenish gray MARL

NOTES: (1) Monitoring Well # 5 set in test boring at 19.0'
(2) Top of casing Elev. = 99.6' (msl)
Bottom of casing Elev. = 79.6' (msl)

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters
Nashville, Tennessee
Branch Offices
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

SHEET REPORT OF DRILLING OPERATIONS AT VCC, Vicksburg, MS

HOLE LOCATION See Site Sketch Map	SHEET	DATE 3-1-83
SURFACE ELEVATION 98.0' (msl)	RIG NO	HOLE NO 6
DEPTH AT BEGINNING OF SHIFT	10" HOCS	
FOOTAGE DRILLED	BOTTOM OF HOLE	
FOOTAGE SAMPLED	DRILLER C. Nelson, HBA	
FOOTAGE CORED	HELPER	
DEPTH AT END OF SHIFT	DRILLED FOR	

SAMPLING RECORD

LOGGED BY: GDM

SPLIT NO	FROM	TO	SPLIT BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown clayey SILT, v. moist
2	10.0	11.0		Brown v. silty CLAY, moist
				Saturated returns at 14.5'
3	15.0	16.0		Brown v. silty CLAY, lam. lignite, wet.
4	20.0	21.0		Brown silty, clay with gray mottles
				Stratum change at 22.0' - by driller
5	25.0	26.0		Gray sl. clay SILT, saturated
				Hard drilling at 28.0'
6	30.0	31.0		Greenish gray sandy CLAY
7	35.0	36.0		Greenish gray MARL
8	39.0	40.0		Greenish gray MARL

NOTES: (1) Monitoring Well #6 in additional borings, 5' southwest of test boring at 24.5'
(2) Top of casing elev. = 98.6' (msl)
Bottom of casing elev. = 73.6' (msl)

MCI/ CONSULTING ENGINEERS, INC.
4301 Harding Road
Suite 224
Nashville Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters
Nashville, Tennessee
Branch Offices
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

SHIFT REPORT OF DRILLING OPERATIONS AT	VCC, Vicksburg, MS		SITE
HOLE LOCATION	See Site Sketch Map	SHIFT	DATE 3-1-83
SURFACE ELEVATION	96.7' (msl)	RIG NO	HOLE NO 7
DEPTH AT BEGINNING OF SHIFT		TOP ROCK	
FOOTAGE DRILLED		BOTTOM OF HOLE	
FEET CORE SAMPLED		DRILLER C. Nelson - HBA	
FOOTAGE CORED		HELPER	
DEPTH AT END OF SHIFT		DRILLED FOR	

SAMPLING RECORD

LOGGED BY: GDH

SAMPLE NO	FROM	TO	CORE RECOVERY	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown Clayey SILT, v. moist
				Saturated returns at 8.2'
2	10.0	11.0		Brown v. silty CLAY, wet
3	15.0	16.0		Brown silty CLAY, with gray mottles, saturated
4	20.0	21.0		Brown v. silty CLAY, saturated
5	25.0	26.0		Brown and gray sl. clay SILT, saturated
				Hard drilling at 28.0'
6	30.0	31.0		Greenish gray sandy CLAY, with small gravel
7	34.0	35.0		Greenish gray MARL

NOTES: (1) Monitoring Well #7 set in test boring at 29'
(2) Top of casing Elev. = 97.5' (msl)
Bottom of casing Elev. = 67.5' (msl)

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters
Nashville, Tennessee
Branch Offices
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

SHEET REPORT OF DRILLING OPERATIONS AT	VCC, Vicksburg, MS		
HOLE LOCATION	See Site Sketch Map	SHEET	DATE 3-2-83
SURFACE ELEVATION	108.6 (msl)	RIG NO	HOLE NO 5
DEPTH AT BEGINNING OF SHIFT		TOP FROM	
FOOTAGE DRILLED		BOTTOM OF HOLE	
FOOTAGE SAMPLED		DRILLER	C. Nelson - HBA
FOOTAGE CORED		HELPER	
DEPTH AT END OF SHIFT		DRILLED FOR	

SAMPLING RECORD

LOGGED BY: GDM

SPLIT NO	FROM	TO	SPLIT BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown silty CLAY
2	10.0	11.0		Brown clayey SILT, with lt. brown mottles, moist
3	15.0	16.0		Brown clayey SILT
				Stratum change at 18.0' - by driller
4	20.0	21.0		Gray silty CLAY, with small roots, wet
5	25.0	26.0		Gray silty CLAY, saturated
				Water rising at 29.0'
6	30.0	31.0		Gray SILT, saturated
7	35.0	36.0		Gray SILT, saturated
				Hard drilling at 38.5'
8	39.0	40.0		Brownish orange MARL, hard
	40.0	49.5		Pushed split spoon refused at 49.5'

NOTES: (1) Monitoring Well #8 set in additional borings, 8' east of test boring, at 29' on 3-3-83
(2) Top of casing elev. = 109.7' (msl)
Bottom of casing elev. = 79.7' (msl)

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical		
BORING NUMBER: PZ-1	COORDINATES:		DATE: 12/5/84
ELEVATION: 118.74 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 12/5/84
ENGINEER/GEOLOGIST: JDD	Depth	Date/Time	DATE COMPLETED: 12/5/84
DRILLING METHODS: Auger & Rotary Wash			PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0			Brown, Silty clay w/sl. gravel & sl. organics			Moist
5			Fill			
			Light gray-brown, Silt			
10			Mottled Red area @ 12.0'			
15			More gray color @ 15.0'			
			Mottled black area @ 17.0' & more broen color w/grey			
	ST-1		Tan		.75	Sample 18.5'-19.0', Moist
20			Gray 20.5'-48.0', Shell frag.'s 20.0'-28.0'			
25						
	ST-2				1.25	Sample 28.5'-29.0', shell frag.'s, moist
30						

NOTES:

Used 6" Auger from o'-25.0'. Rotary wash from 25.0'-54.0'. NO natural ground water was encountered. Cave-in occurred between 6.0'-8.0' where fill meets natural ground while augering to 25.0'.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical	
BORING NUMBER: P2-1	COORDINATES:	DATE: 12/5/84
ELEVATION: 118.74 Ft. MSL (TofC)	GWL: Depth Date/Time	DATE STARTED: 12/5/84
ENGINEER/GEOLOGIST: JDD	Depth Date/Time	DATE COMPLETED: 12/5/84
DRILLING METHODS: Auger & Rotary Wash		PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30			SILT			
35						
	ST-3				1.25	Sample 38.5'-39.0', shell frag's., Moist
40						
45						
	ST-4		Greenish-gray, clayey-sand, w/sl. Brown mottled areas	SC	2.50	Sample 49.0'-49.5', Moist
50			Hit Marl @ 52.0'			
	SB-1		Greenish-gray, calcarcous clay w/sand and gravel (marl)			Blows 17-12-18
55			Bottom of boring @ 54.0'			

NOTES:

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical		
BORING NUMBER: PZ-2	COORDINATES:		DATE: 12/7/84
ELEVATION: 112.45 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 12/7/84
ENGINEER/GEOLOGIST: JDD	Depth	Date/Time	DATE COMPLETED: 12/7/84
DRILLING METHODS: Auger & Rotary Wash			PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0			Brown, silt, w/sl. clay, organics			Moist
5			FILL			
10						
15			Shell frag.'s @ 15.0'			
20			SILT, w/SL. CLAY			
25						
30						

NOTES:

Used 6" Auger from 0'-23'. Rotary wash from 23'-56'. Around 35' down, we noticed water leaking out of slope about 12' down off the side. Therefore, losing water 12'-15' down the hole horizontally.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical		
BORING NUMBER: PZ-2	COORDINATES:		DATE: 12/7/84
ELEVATION: 112.45 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 12/7/8-
ENGINEER/GEOLOGIST: JDD	Depth	Date/Time	DATE COMPLETED: 12/7/8-
DRILLING METHODS: Auger & Rotary Wash			PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30			Wood cuttings 32.0'-38.0'			
35			SILT, w/SL. CLAY			
40						
			Wood cuttings @ 44.0'			
45						
	ST-1		Grey, SL. calc.		1.25	Sample 48.5'-49.0', very moist
50						
55			Hit marl @ 56.0'			
			Bottom of boring @ 56.0'			
60						

NOTES:

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical	
BORING NUMBER: PZ-~~KK~~ 3	COORDINATES:	DATE: 12/6/84
ELEVATION: 113.03 Ft. MSL (TofC)	GWL: Depth Date/Time	DATE STARTED: 12/6/84
ENGINEER/GEOLOGIST: JDD	Depth Date/Time	DATE COMPLETED: 12/6/84
DRILLING METHODS: Auger & Rotary Wash		PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0			Brown, Silty clay, Gravel			Moist
5			Gray & chem. odor 4.0'-8.0'			
			FILL			
			Brown color @ 8.0'			
10						
			SILTY CLAY	CL		
15						
20						
25						
30						

NOTES:

Used 6" Auger from 0'-18.0'. Rotary wash from 18.0'-52.0'. Water seeping in below 7.0' causing cave-in.

IT

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical		
BORING NUMBER: PZ-~~XXX~~ 3	COORDINATES:		DATE: 12/6/84
ELEVATION: 113.03 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 12/6/84
ENGINEER/GEOLOGIST: JDD	Depth	Date/Time	DATE COMPLETED: 12/6/84
DRILLING METHODS: Auger & Rotary Wash			PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30			SILT			
35			Greenish-gray, med. to coarse sand, w/gravel 35.0'-38.0'	SP		
			Gray, Silty clay	CL		
40						
	ST-1		Greenish-gray, clayey-sand, w/brown mottled areas, calc.	SC	2.25	Sample 44.0'-44.5'
45						
50			Marl @ 50.5'			
			Bottom of boring @ 52.0'			
55						

NOTES:

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 846545	PROJECT NAME VERTAC Chemical		
BORING NUMBER PZ-4	COORDINATES:		DATE: 12/7/84
ELEVATION 114.24 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED 12/7/84
ENGINEER/GEOLOGIST JDD	Depth	Date/Time	DATE COMPLETED 12/7/84
DRILLING METHODS Auger & Rotary Wash			PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0			Gravel mixed w/shells 4.0'-5.0'			
5			Brown, Silty-clay, w/gravel	CL		
10						
15			Gray-tan color 12'-18'			
			Clayey-Silt	ML		
	ST-1		Dark gray, organics		.75	Sample 19.5'-20.0', moist, Light grey silt seams
20						
25						
30						

NOTES:

Used 6" auger from 0'-15'. Rotary wash from 15'-49'. Lost water between 4.0'-5.0' and therefore used 6' of surface casing to block it off while drilling.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical		
BORING NUMBER: P7-4	COORDINATES:		DATE: 12/7/84
ELEVATION: 114.24 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 12/7/84
ENGINEER/GEOLOGIST: JDD	Depth	Date/Time	DATE COMPLETED: 12/7/84
DRILLING METHODS: Auger & Rotary Wash			PAGE: 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30			Wood & grass cuttings @ 30.0'			
35			Light gray, silt w/clay @ 37.0'			
40						
	ST-2		Gray, clayey-sand, very calc., brown mottled areas	SC	1.5	Sample 44.0'-44.5'
45			Hit marl @ 49.0'			
50			Bottom of boring @ 49.0'			

NOTES:

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg	
BORING NUMBER: MW-9	COORDINATES:	DATE:
ELEVATION: 116.02 Ft. MSL (TofC)	GWL: Depth Date/Time	DATE STARTED: 10-9-85
ENGINEER/GEOLOGIST: L.W. Cronk	Depth Date/Time	DATE COMPLETED: 10-9-85
DRILLING METHODS: Rotary Wash		PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
			Gravelly clay fill at surface			
5						
10	QT-1		Brown & Gray Silt			
15			Shell fragments @ 14'			
20			Becoming Gray Silt @ 19' w/occasional Shell Fragments			
25						
	QT-3		Gray Silt			

NOTES:

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg	
BORING NUMBER: MW-9	COORDINATES:	DATE:
ELEVATION: 116.02 Ft. MSL (TofC)	GWL: Depth Date/Time	DATE STARTED: 10-9-85
ENGINEER/GEOLOGIST: L.W. Cronk	Depth Date/Time	DATE COMPLETED: 10-9-85
DRILLING METHODS: Rotary Wash		PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30						
35						
40			Becoming Brown & Gray Silt w/Numerous Shell Fragments @ 41'			
45	QT-5		Dark Gray Clayey Silt @ 43.5'		2.25	Penetrometer
50			Marl @ 52'			
55						

NOTES:

Completion Depth @ 58'

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg		
BORING NUMBER: MW-10	COORDINATES:		DATE:
ELEVATION: 114.73 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 10-7-85
ENGINEER/GEOLOGIST: G. M. Combs	Depth	Date/Time	DATE COMPLETED: 10-7-85
DRILLING METHODS: Rotary Wash			PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
			Clayey fill at surface			
5						
10	QT-1		Tan and Light Gray Slightly Clayey Silt		1.5 1.6	Penetrometer Torvane
15						
20						
			Becoming More Clayey @ 22'			
25						
	QT-3		Gray Silt w/Shell Fragments		1.75	Penetrometer

NOTES:

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg		
BORING NUMBER: MW-10	COORDINATES:		DATE:
ELEVATION: 114.73 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 10-7-85
ENGINEER/GEOLOGIST: G.M. Combs	Depth	Date/Time	DATE COMPLETED: 10-7-85
DRILLING METHODS: Rotary Wash			PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31						
35						
40	QT-5		Dark Gray Slightly Clayey Silt w/shell Fragments		1.0 0.43	Penetrometer Torvane
45						
50			Marl below 48.5 Clayey Sand Seam 48.5'-49.5' Gravel from 49.0' to 52.0'			
55						

NOTES:

Completion Depth 52.0'

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg	
BORING NUMBER: MW-11	COORDINATES:	DATE:
ELEVATION: 105.62 Ft. MSL (TofC)	GWL: Depth / Date/Time	DATE STARTED: 10-8-85
ENGINEER/GEOLOGIST: L.W. Cronk	Depth / Date/Time	DATE COMPLETED: 10-8-85
DRILLING METHODS: Rotary Wash		PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
			Dark Gray Clayey Silt to 5.0			
5	QT-1		Dark Gray Silt @ 5.0			
10						
15						
20						
25						
	QT-3		Tan & Gray Silt @ 29.5'		2.5	Penetrometer

NOTES:

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg		
BORING NUMBER: MW-11	COORDINATES:		DATE:
ELEVATION: 105.62 Ft. MSL (TofC)	GWL: Depth	Date/Time	DATE STARTED: 10-8-85
ENGINEER/GEOLOGIST: L.W. Cronk	Depth	Date/Time	DATE COMPLETED: 10-8-85
DRILLING METHODS: Rotary Wash			PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30						
35			Gray & Tan Sandy Clay @ 43.0' - 44.0'			
40						
45	QT-5		Gray and Tan Clay @ 44.0' to 51.0'		2.5	Penetrometer
50			Marl @ 51'			
55						

NOTES:

Completion Depth 56'

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg	
BORING NUMBER: MW-12	COORDINATES:	DATE:
ELEVATION: 112.06 Ft. MSL (TofC)	GWL: Depth Date/Time	DATE STARTED: 10-8-85
ENGINEER/GEOLOGIST: G.M. Combs	Depth Date/Time	DATE COMPLETED: 10-8-85
DRILLING METHODS: Rotary Wash		PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
			Fill Material to 4'			
5			Tan Silt (Slightly Clayey) @ 4'			
10			Tan Silt		1.25	Penetrometer
15						
20						
25						
	QT-3		Becoming Gray & Tan Silt @ 27'		1.1	Penetrometer

NOTES:

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545-2	PROJECT NAME: Vertac-Vicksburg	
BORING NUMBER: MW-12	COORDINATES:	DATE:
ELEVATION: 112.06 Ft. MSL (TofC)	GWL: Depth Date/Time	DATE STARTED: 10-8-85
ENGINEER/GEOLOGIST: G.M. Combs	Depth Date/Time	DATE COMPLETED: 10-8-85
DRILLING METHODS: Rotary Wash		PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30						
35						
40			Shell Fragments @ 40'			
45	QT-5		Gray Clayey Sand w/Sand Pkts and Gravel 44'-46' Beginning of Marl @ 46'		1.24	Penetrometer
50						
55						

NOTES:

Completion Depth @ 48.5'

IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 435130	PROJECT NAME: Cedar Chemical-Vicksburg		
BORING NUMBER: B-1A/MW-1A	COORDINATES:	DATE: 7/24/86	
ELEVATION: Approx. 111 ft. MSL	GWL: Depth 9 ft Date/Time 1300/7-24	DATE STARTED: 7/24/86	
ENGINEER/GEOLOGIST: J. B. Cange	Depth Date/Time	DATE COMPLETED: 7/24/86	
DRILLING METHODS: Dry Auger to 11 ft.; Wash Bore to 30 ft.		PAGE 1 OF 2	

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (ft)	RECOVERY (ft)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	ST			Very Stiff Brown CLAYEY SILT with SILTY CLAY. Fe Staining, Roots; Very Dry; Silt Laminae;			Moderate to Strong Effervescence
2	ST						
3	ST			Stiff Brown and Tan CLAYEY SILT Mottled, Black Specks, Fe Staining; Oxide Coatings on Bedding Planes; Massive Texture, Softer at 5 ft.			Strong Effervescence
4	ST						
5							
6	ST			Soft Brown and Gray Silt, Becoming Hard Lower 6" with Black/Tan Inclusions, Calc. Concretions Mottled Texture Throughout			Moderate Effervescence Except Gray Areas- No Effervescence
7							
8	ST			Soft Brown and Gray Silt, CLAYEY SILT; Mottled with Lower 6" Dark Brown Firm Silt; Becoming Stiffer Downward Swirling Texture			Same with Dark Brown Area with No Effervescence
9							
10	ST			Soft to Medium Stiff Brown CLAYEY SILT with Rootlets, Plant Matter, Gray Swirls in Dark Brown Areas; Massive Texture			Moderate Effervescence
11	ST			Soft To Stiff Brown CLAYEY SILT, Black Specks (Organic Matter)			No Effervescence
12				Same, with Mottled Zone in Center Having Tan, Black Color; Becoming Softer, Very Silty Below; Mottled Zone Plastic			
13	ST						No Effervescence
14							
	ST			Same; Incr. in Silt Content Less Plastic; Incr. Tan Mottles			No Effervenscence

NOTES:

Started drilling @ 11:30 am 7/24/86.
Encountered obstruction @ 1 ft.; Skidded rig 3 ft. to NE
Reamed hole to 10" down to 9 ft.; Set surface csg to 9.5 (pushed last 6") with 1 ft. stickup; Grouted in place
Resumed drilling 7/25/86

IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 435130	PROJECT NAME: Cedar Chemical-Vicksburg		
BORING NUMBER: B-1A/MW-1A	COORDINATES:	DATE: 7/24/86	
ELEVATION: Approx. 111 ft. MSL	GWL: Depth / Date/Time	DATE STARTED: 7/24/86	
ENGINEER/GEOLOGIST: J. B. Cange	Depth / Date/Time	DATE COMPLETED: 7/24/86	
DRILLING METHODS: Dry Auger to 11 ft.; Wash Bore to 30 ft.		PAGE 2 OF 2	

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (ft)	RECOVERY (ft)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	ST			With Black Specks Throughout			No Effervescence
16				Same; Mottling Heavier with Increase in Root Traces and Organic Matter (Black Specks)			No Effervescence Fe Staining?
17	ST						
18				Same (Brown CLAYEY SILT) with Lower 1 ft. Being Tan Mottled Silt			No Effervescence
19	ST						
20				Same; Coarser at Top and Bottom, Pobably Due to Increase in Silt Content			
21	ST						No Effervescence
22				Brown CLAYEY SILT with Increase Mottling; Gray and Tan Mixed with Brown; Abundant Root Traces and Organic Material (Black)			No Effervescence
23	ST						
24				Brown, Tan and Gray CLAYEY SILT, Extensively Mottled, with Fe-Staining, Root Traces, Oxidation Layers			No Effervescence
25	ST						
26				Firm Gray and Tan Silt (Mostly Gray) with Abundant Gastropad Shell Fragments (Unbroken); Very Massive; Root Traces with Black and Iron Concentric Staining			Moderate Effervescence
27							
28							
29							

NOTES:

Boring Terminated at 30 feet.

APPENDIX C

MONITOR WELL INSTALLATION DETAILS

Location of Well # 1

Date: Installed 29 Sept. 1981
Completed 29 Sept. 1981
Developed 01 Oct. 1981

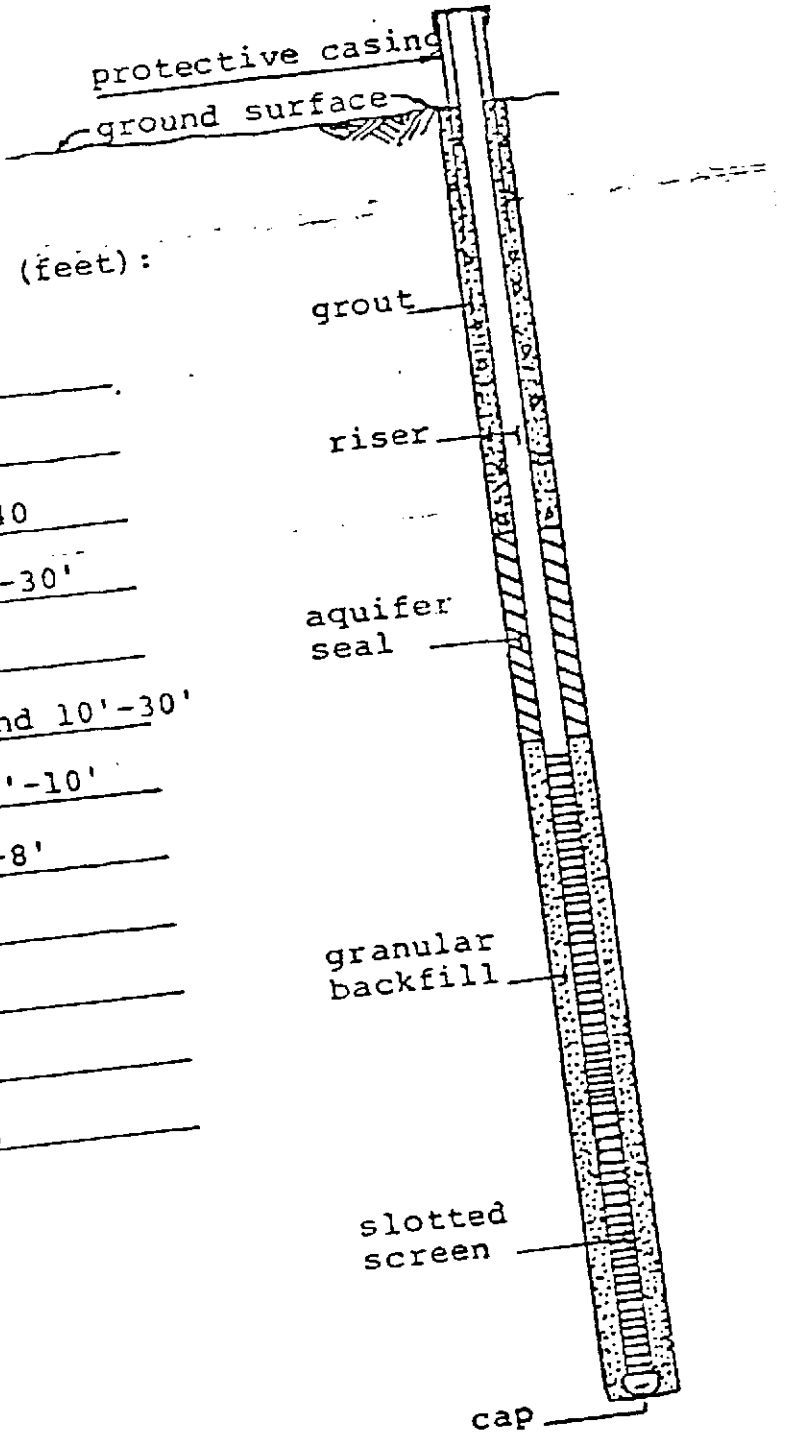
No. 872

Project Vertac Chemical Corporation

Vicksburg, Mississippi

Locations below ground surface (feet):

Bottom of Boring	30'
Bottom of Well	30'
Well Specification	4" PVC-Schd.40
Screen Slot and Location	0.010" 20'-30'
Coupling Location	0,20'
Granular Backfill	Concrete Sand 10'-30'
Seals	Bentonite 8'-10'
Grout	Concrete 0-8'
Cave-in	None
Height of Riser	2'
Protective Casing	None
Elevation-top casing	109.1 MSL

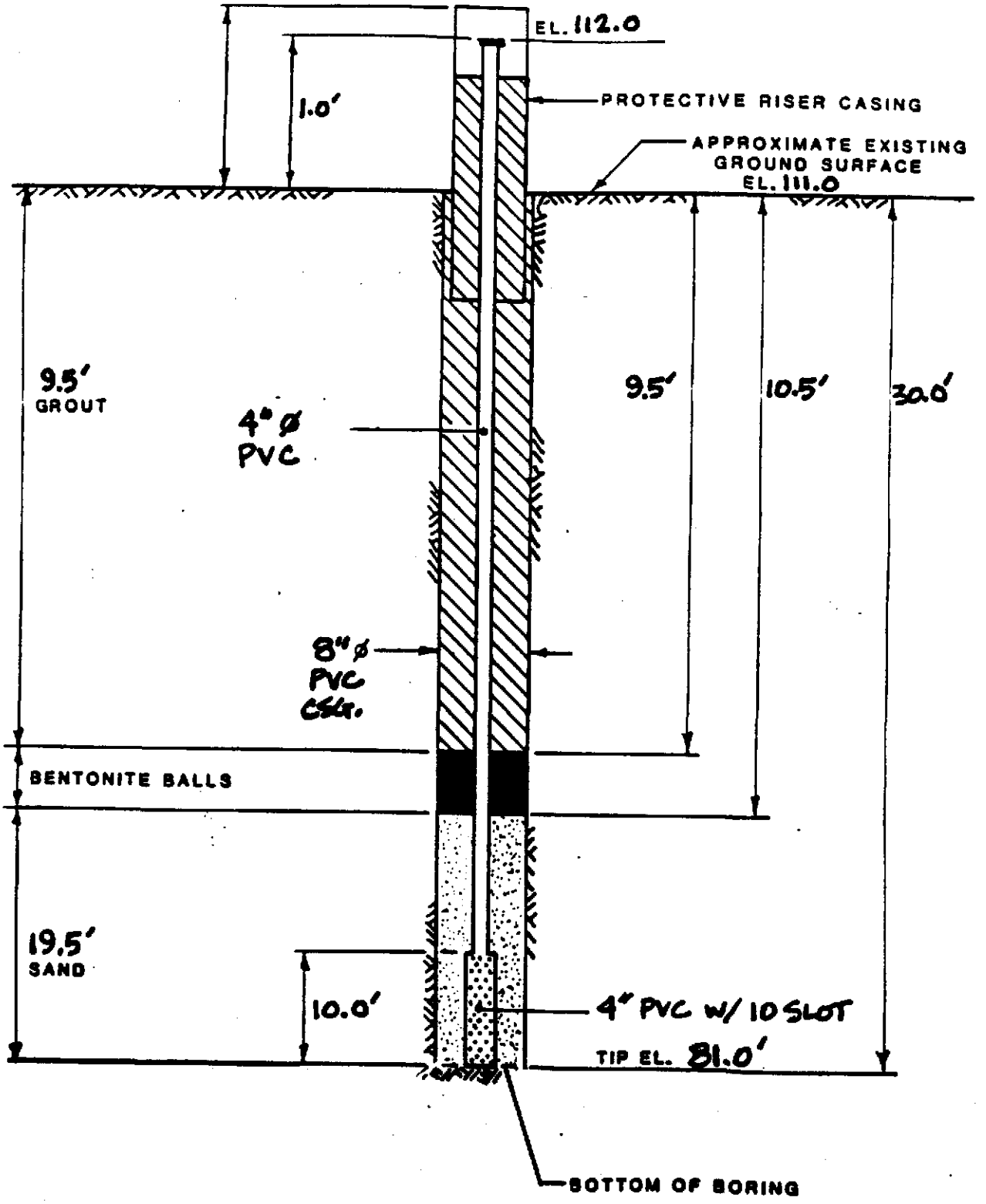


IT ... Creating a Safer Tomorrow

MONITOR WELL INSTALLATION SKETCH

PROJECT NAME Cedar
PROJECT NO. 435130
BORING NO. B-1A
MONITOR WELL NO. MW-1A

INSTALLED BY W-L DATE 7-25-86
CHECKED BY JBC DATE 7-25-86



[redacted]llation of Well # 2

Job No. 872

Project Vertac Chemical Corporation

Vicksburg, Mississippi

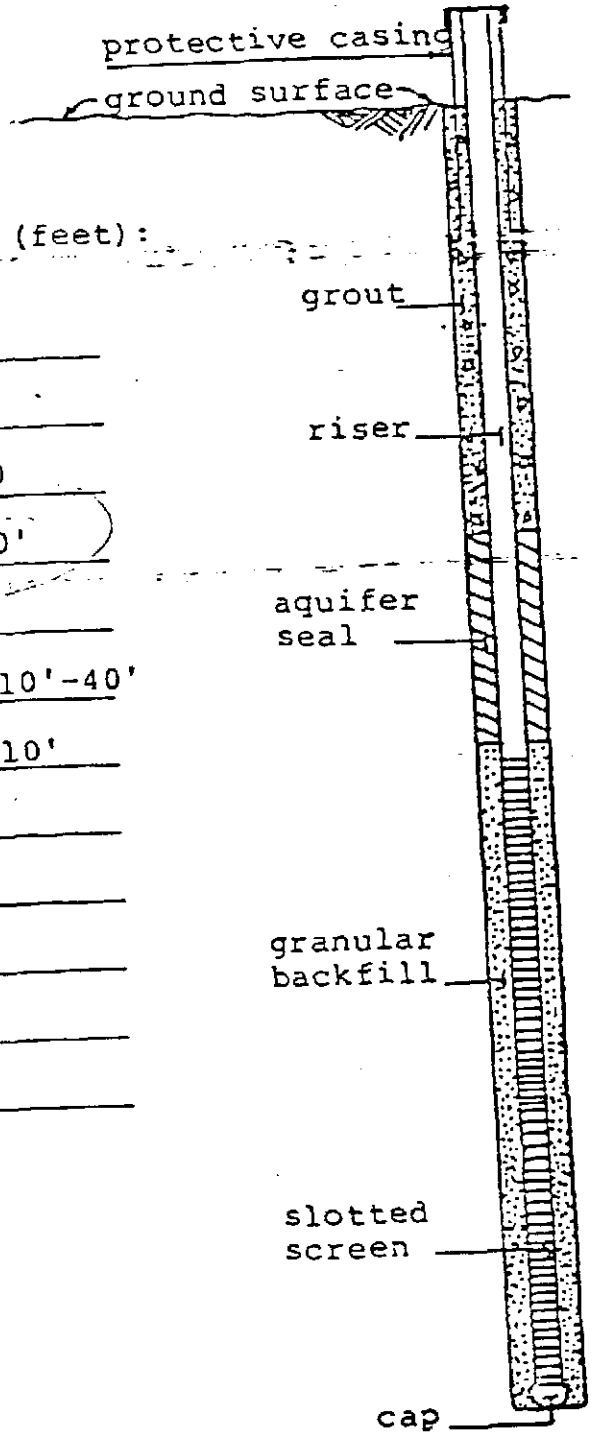
Date: Installed [redacted]

Completed 29 Sept. 1981

Developed 01 Oct. 1981

Locations below ground surface (feet):

Bottom of Boring	40'
Bottom of Well	40'
Well Specification	4" PVC-Schd. 40
Screen Slot and Location	0.010" 30'-40'
Coupling Location	0', 10', 30'
Granular Backfill	Concrete Sand 10'-40'
Seals	Bentonite 8'-10'
Grout	Concrete 0-8'
Cave-in	None
Height of Riser	2'
Protective Casing	None
Elevation-top casing	105.0 MSL



[redacted]tion of Well # 3

[redacted]o. 872

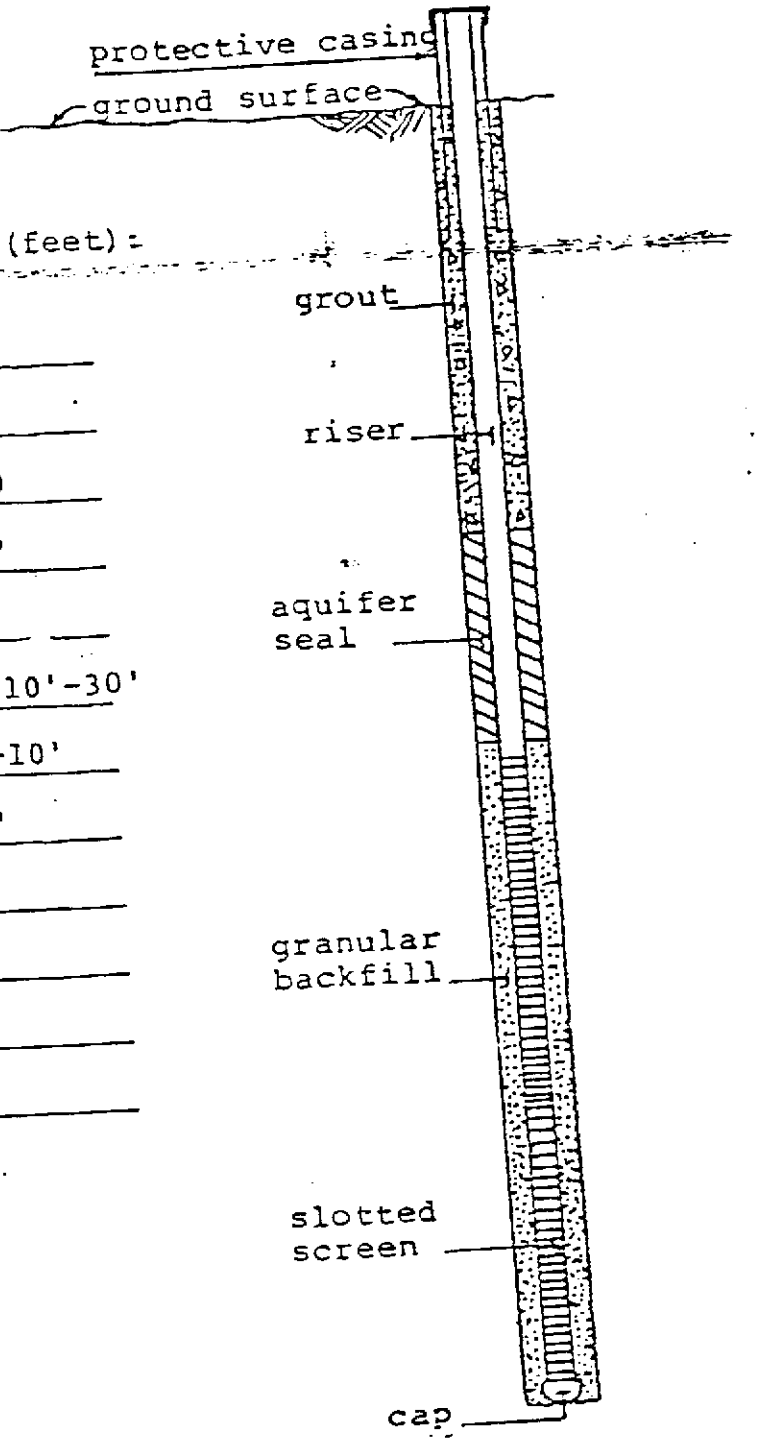
[redacted]oject Vertac Chemical Corporation

Vicksburg, Mississippi

Date: Installed [redacted] Sept. 1981
Completed 30 Sept. 1981
Developed 01 Oct. 1981

Locations below ground surface (feet):

[redacted]ttom of Boring	30'
[redacted]ttom of Well	30'
Well Specification	4" PVC-Schd. 40
[redacted]reen Slot and Location	0.010" 20'-30'
Coupling Location	0', 20'
Granular Backfill	Concrete Sand 10'-30'
[redacted]eals	Bentonite 8'-10'
Grout	Concrete 0-8'
[redacted]ave-in	None
[redacted]eight of Riser	2'
Protective Casing	None
[redacted]levation-top casing	97.5 MSL



tion of Well # 4

Date: Installed 01 Oct. 1981
Completed 01 Oct. 1981
Developed 01 Oct. 1981

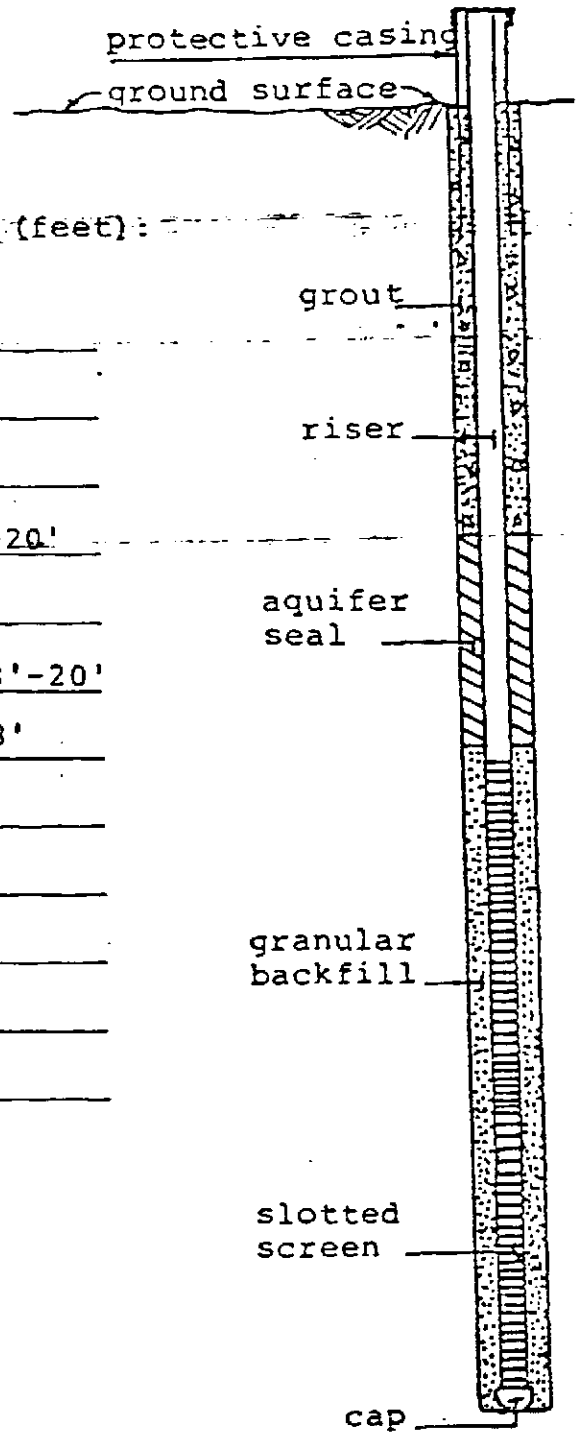
o. 872

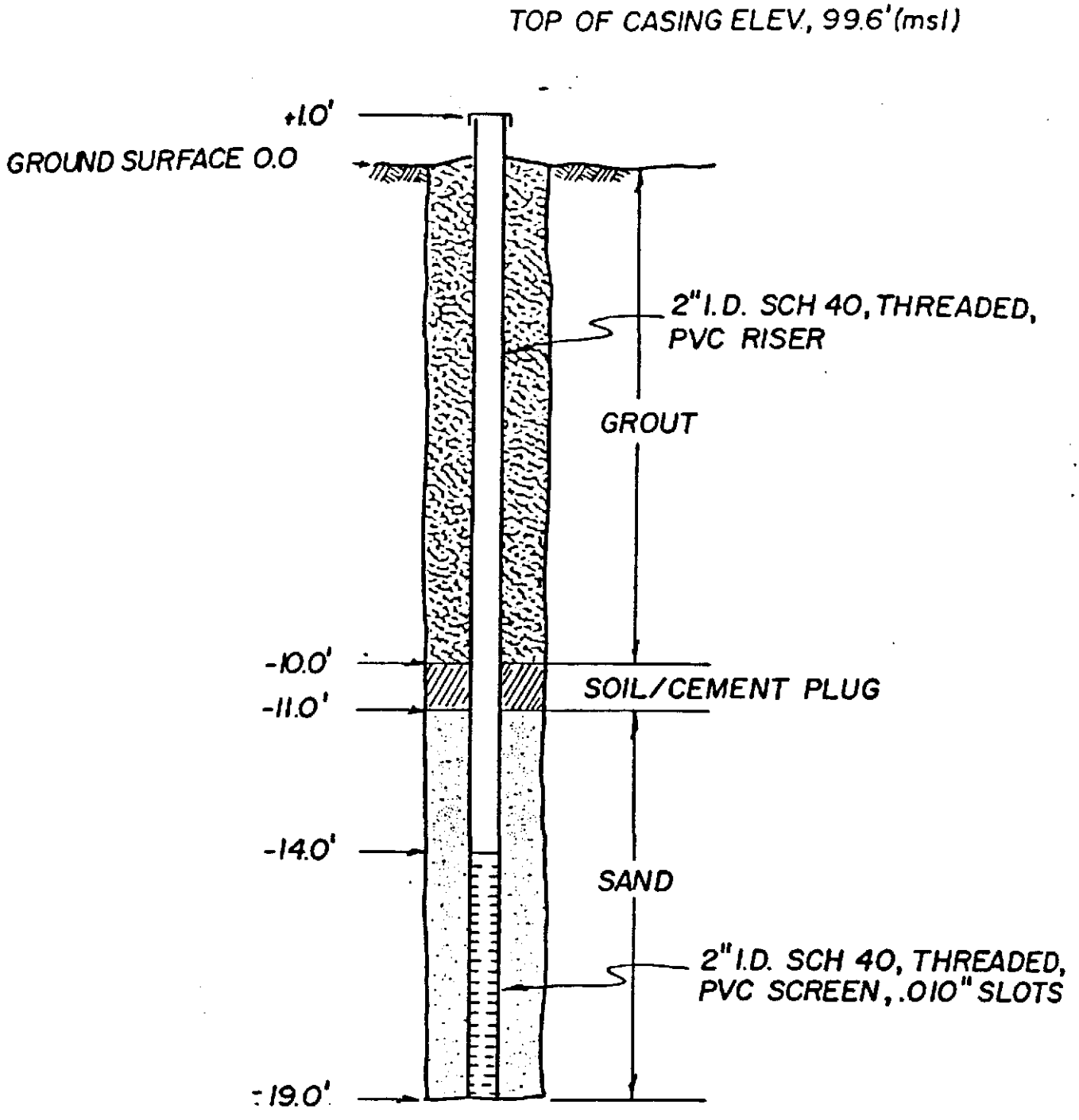
oject Vertac Chemical Corporation

Vicksburg, Mississippi

Locations below ground surface (feet):

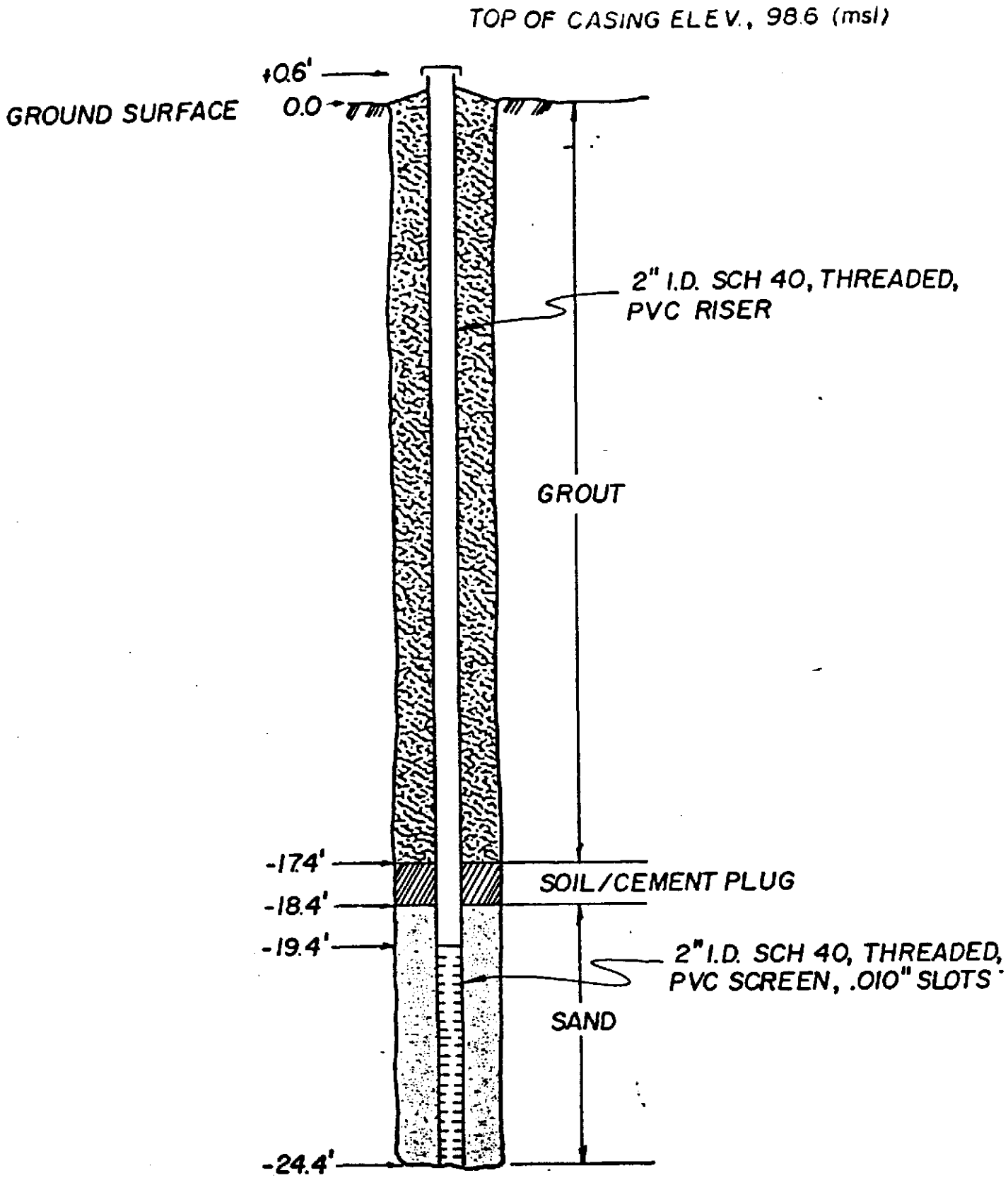
tom of Boring	20'
om of Well	20'
l Specification	4" PVC-Schd. 40
een Slot and Location	0.010" 10'-20'
ling Location	0,10'
anular Backfill	Concrete Sand 8'-20'
s	Bentonite 6'-8'
t	Concrete 0-6'
ve-in	None
ht of Riser	2'
tective Casing	None
evation-top casing	111.6 MSL





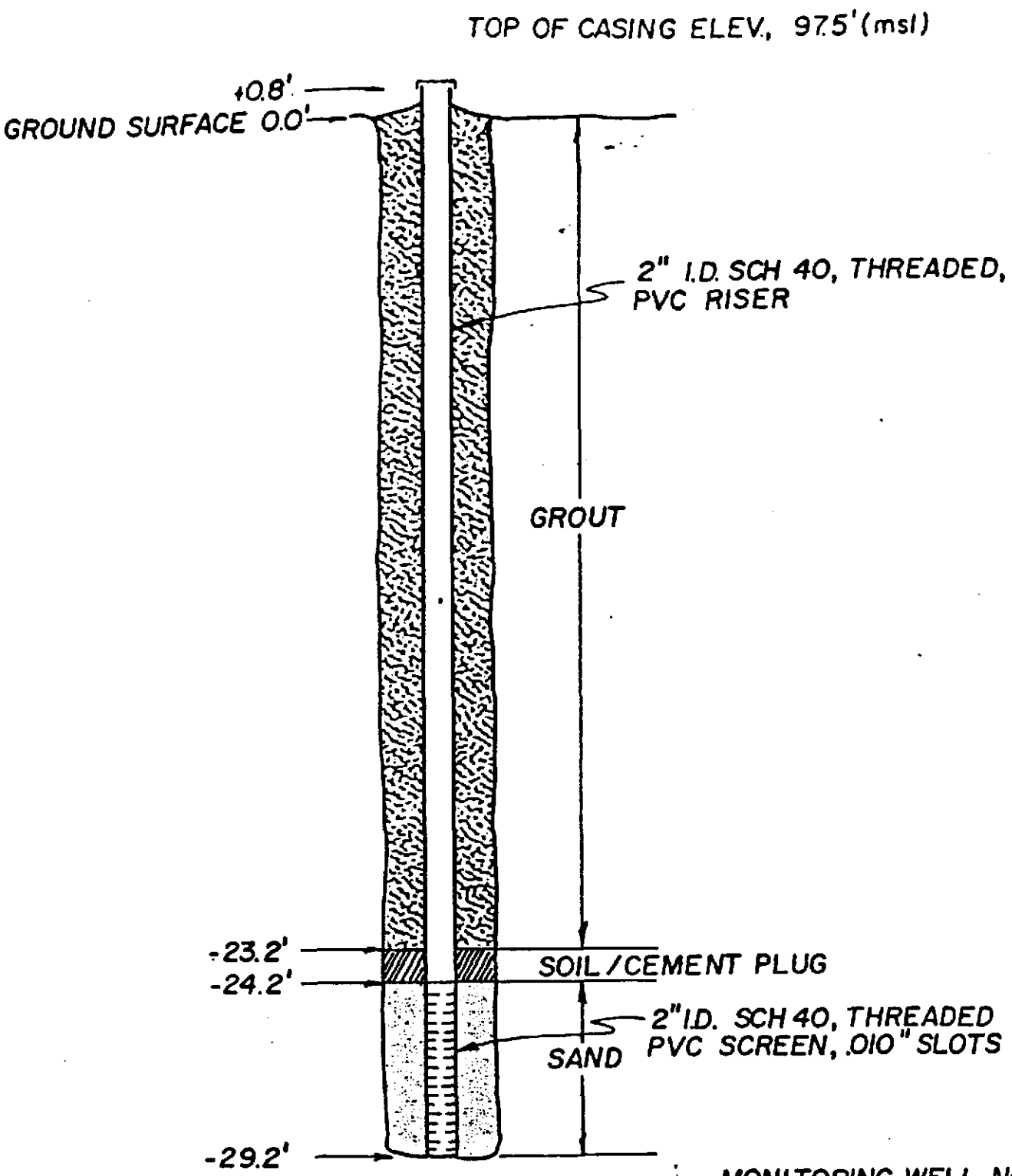
MCI CONSULTING ENGINEERS
Nashville, Tennessee

MONITORING WELL No. 5
AS COMPLETED
VERTAC CHEMICAL CORP.
VICKSBURG, MS.
NO SCALE 12/2/83



MCI CONSULTING ENGINEERS
Nashville, Tennessee

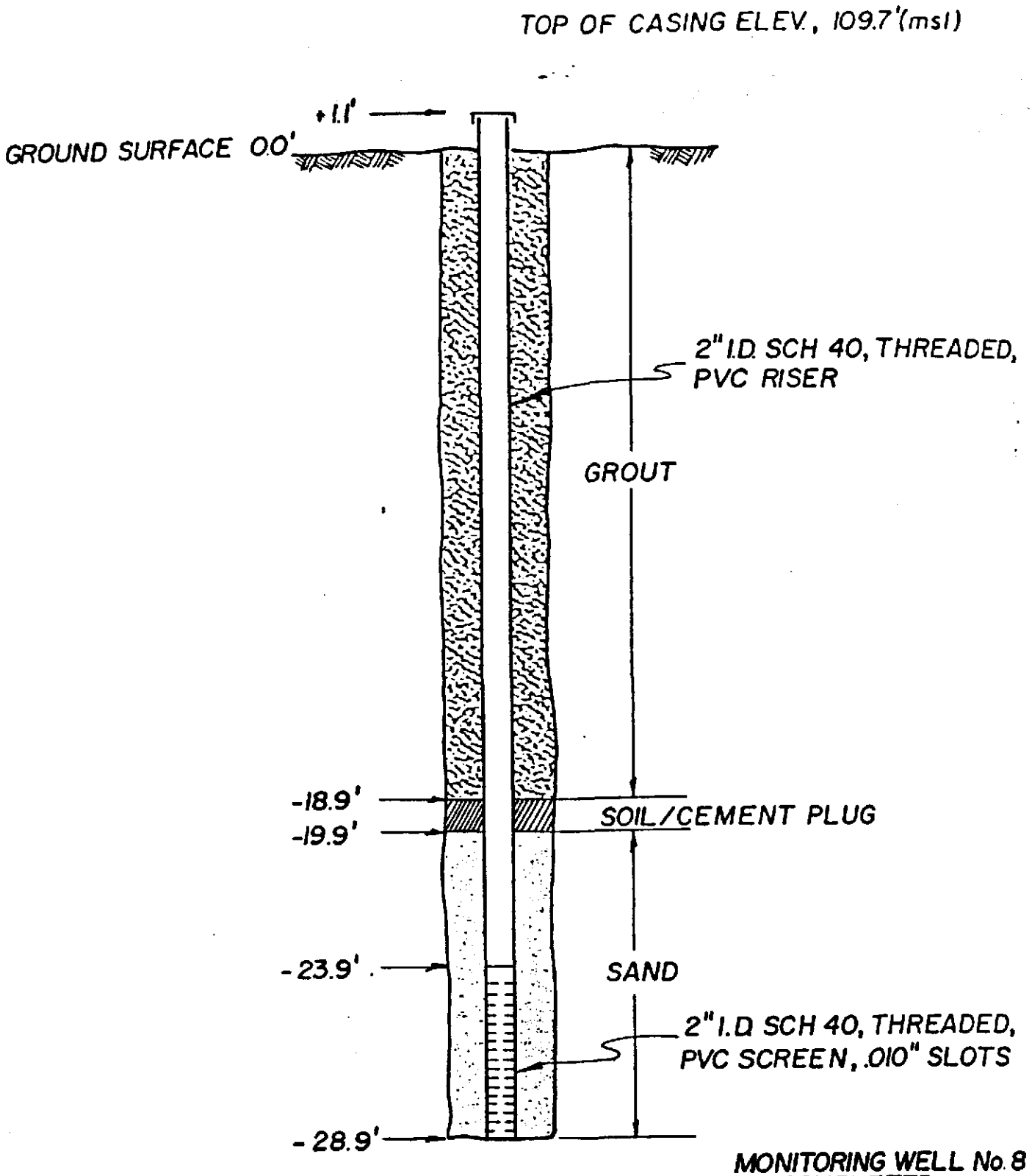
MONITORING WELL No.6
AS COMPLETED
VERTAC CHEMICAL CORP.
VICKSBURG, MS.
NO SCALE 12/2/83



MCI CONSULTING ENGINEERS

Nashville, Tennessee

MONITORING WELL No. 7
AS COMPLETED
VERTAC CHEMICAL CORP.
VICKSBURG, MS.
NO SCALE 12/2/83



MCI CONSULTING ENGINEERS

Nashville, Tennessee

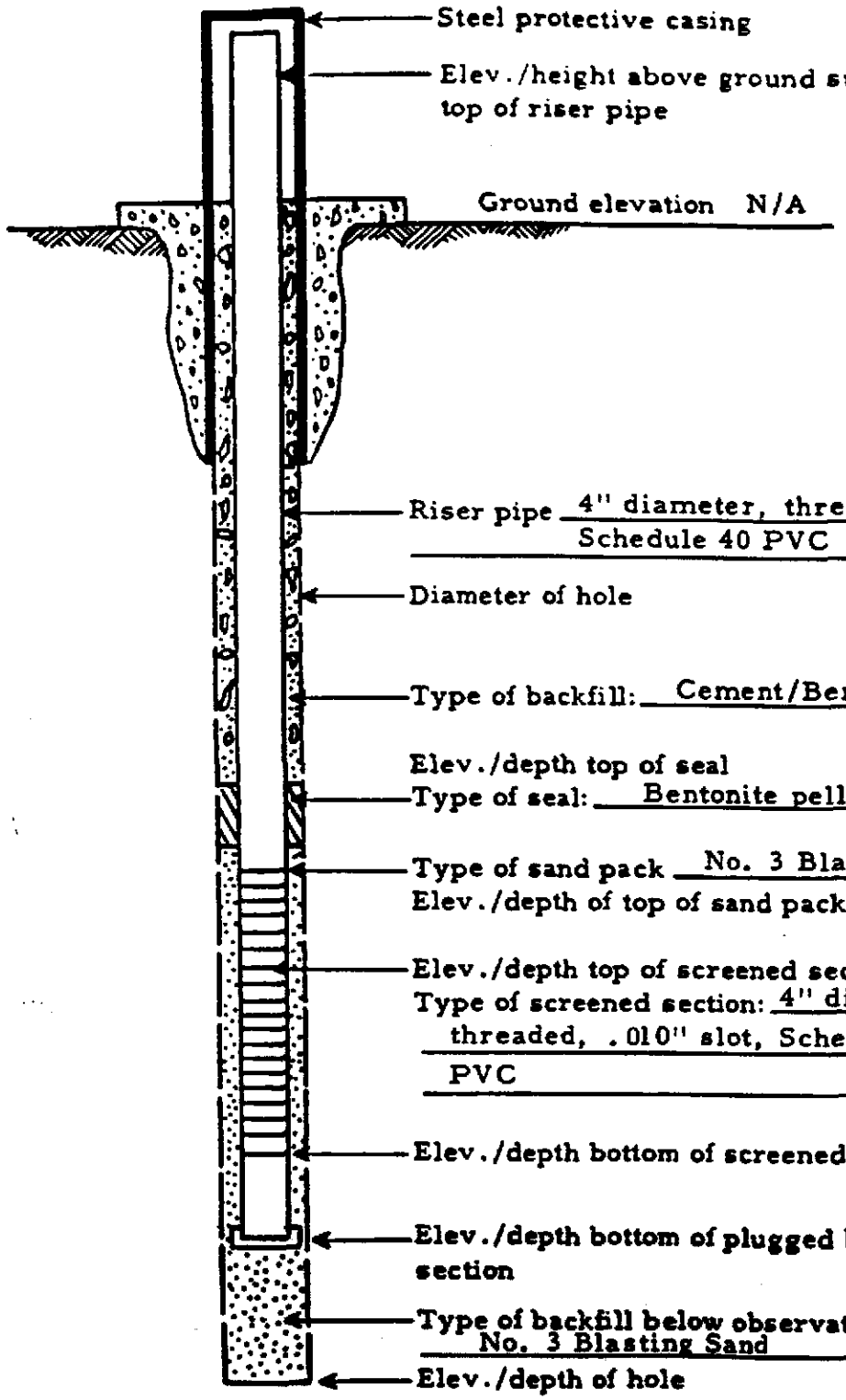
MONITORING WELL No. 8
AS COMPLETED
VERTAC CHEMICAL CORP.
VICKSBURG, MS.
NO SCALE 12/2/83

GROUNDWATER OBSERVATION WELL REPORT

Project: Vertac Chemical Corporation

Location: Vicksburg, Mississippi

Well No.: MW-9 Date Completed: 10/9/85 Technician: J. Malanchak



Steel protective casing

Elev./height above ground surface top of riser pipe — Approx. 4 ft

Ground elevation N/A

Riser pipe: 4" diameter, threaded, Schedule 40 PVC

Diameter of hole — 8 in.

Type of backfill: Cement/Bentonite

Elev./depth top of seal — 36 ft

Type of seal: Bentonite pellets

Type of sand pack: No. 3 Blasting Sand

Elev./depth of top of sand pack — 39 ft

Elev./depth top of screened section — 43 ft

Type of screened section: 4" diameter, threaded, .010" slot, Schedule 40 PVC

Elev./depth bottom of screened section — 53 ft

Elev./depth bottom of plugged blank section — 58 ft

Type of backfill below observation pipe: No. 3 Blasting Sand

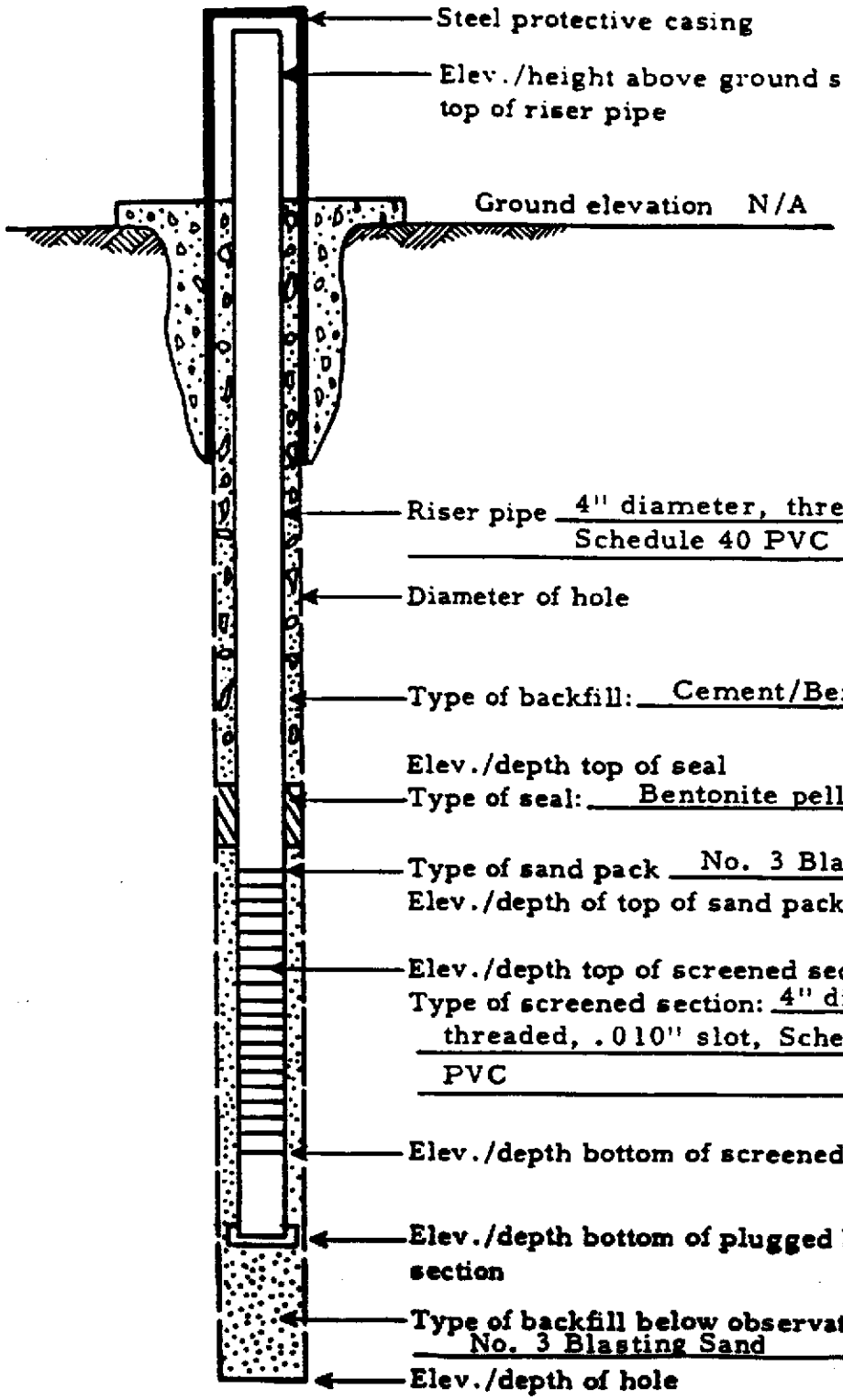
Elev./depth of hole — 58.5 ft

GROUNDWATER OBSERVATION WELL REPORT

Project Vertac Chemical Corporation

Location Vicksburg, Mississippi

Well No. MW - 10 Date Completed 10/7/85 Technician J. Malanchak



Steel protective casing

Elev./height above ground surface top of riser pipe — Approx. 2.5 ft

Ground elevation N/A

Riser pipe 4" diameter, threaded, Schedule 40 PVC

Diameter of hole — 8 in.

Type of backfill: Cement/Bentonite

Elev./depth top of seal — 33 ft

Type of seal: Bentonite pellets

Type of sand pack No. 3 Blasting Sand

Elev./depth of top of sand pack — 35 ft

Elev./depth top of screened section — 40 ft

Type of screened section: 4" diameter, threaded, .010" slot, Schedule 40 PVC

Elev./depth bottom of screened section — 50 ft

Elev./depth bottom of plugged blank section — 53 ft

Type of backfill below observation pipe No. 3 Blasting Sand

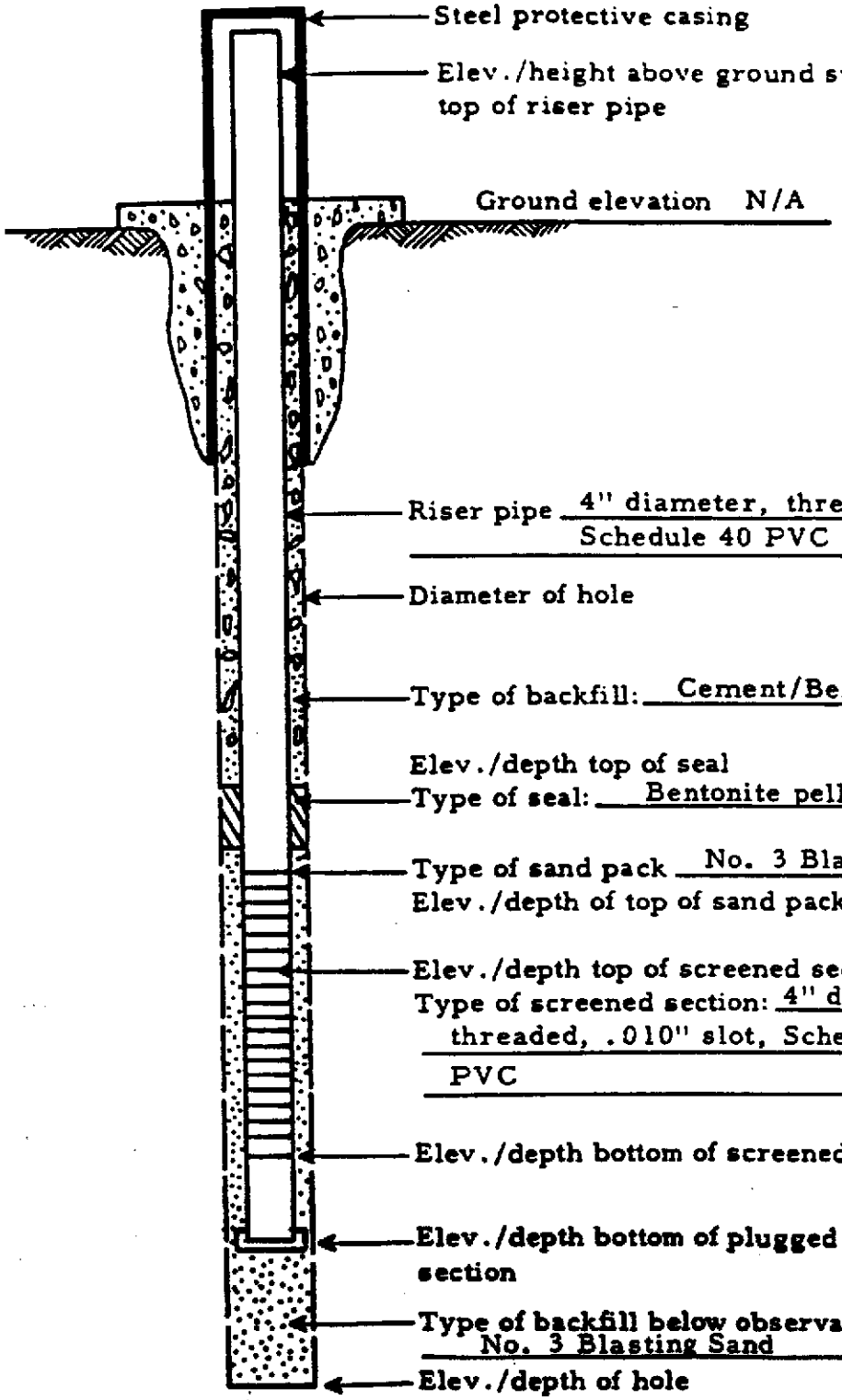
Elev./depth of hole — 53.5 ft

GROUNDWATER OBSERVATION WELL REPORT

Project Vertac Chemical Corporation

Location Vicksburg, Mississippi

Well No. MW-11 Date Completed 10/8/85 Technician J. Malanchak



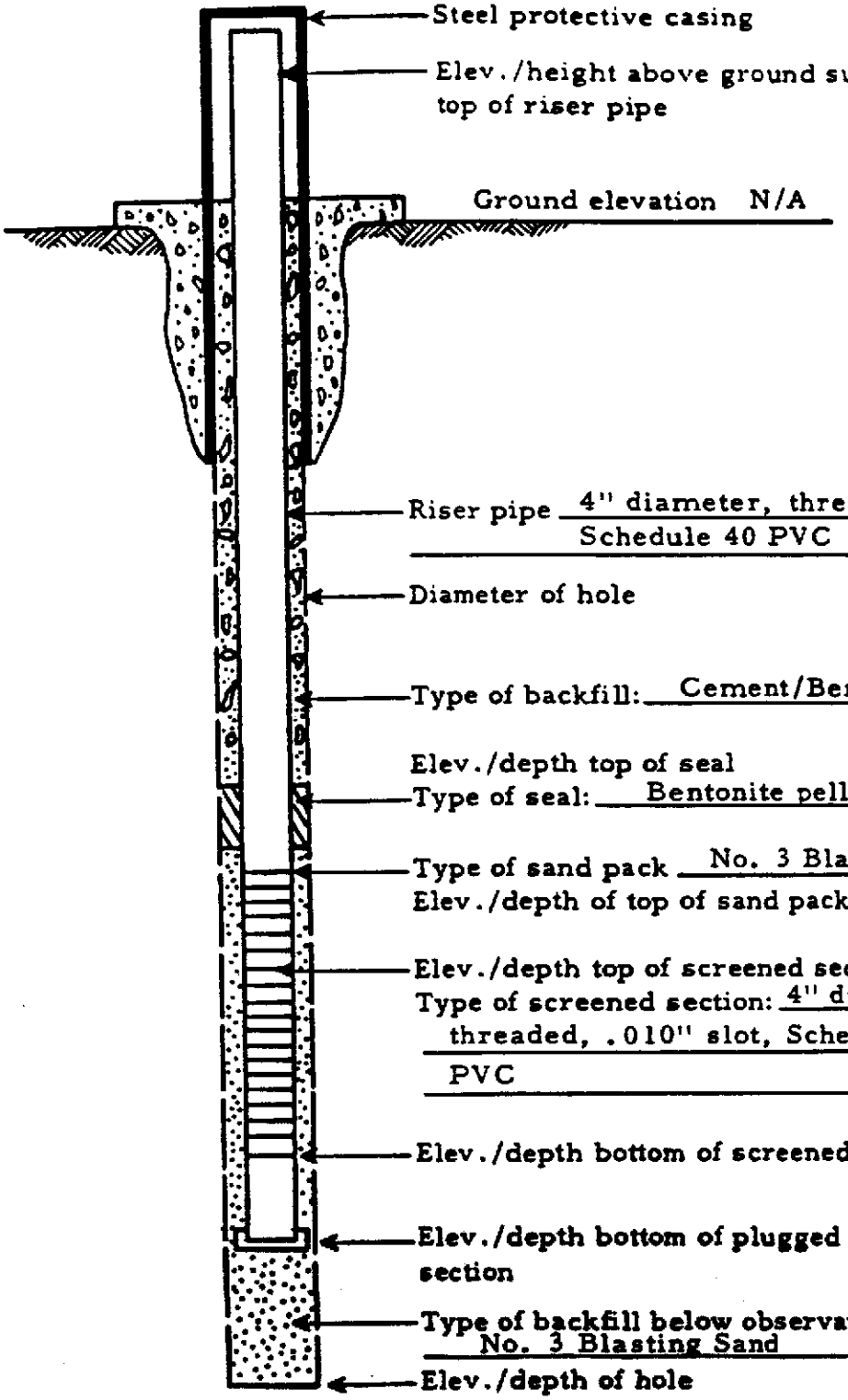
Steel protective casing	
Elev./height above ground surface top of riser pipe	Approx. 4.5 ft
Ground elevation N/A	
Riser pipe 4" diameter, threaded, Schedule 40 PVC	
Diameter of hole	8 in.
Type of backfill: Cement/Bentonite	
Elev./depth top of seal	29 ft
Type of seal: Bentonite pellets	
Type of sand pack No. 3 Blasting Sand	
Elev./depth of top of sand pack	33 ft
Elev./depth top of screened section	35 ft
Type of screened section: 4" diameter, threaded, .010" slot, Schedule 40 PVC	
Elev./depth bottom of screened section	45 ft
Elev./depth bottom of plugged blank section	48 ft
Type of backfill below observation pipe No. 3 Blasting Sand	
Elev./depth of hole	48.5 ft

GROUNDWATER OBSERVATION WELL REPORT

Project Vertac Chemical Corporation

Location Vicksburg, Mississippi

Well No. MW-12 Date Completed 10/8/85 Technician J. Malanchak



Steel protective casing

Elev./height above ground surface top of riser pipe — Approx. 3 ft

Ground elevation N/A

Riser pipe 4" diameter, threaded, Schedule 40 PVC

Diameter of hole — 7 in.

Type of backfill: Cement/Bentonite

Elev./depth top of seal — 20 ft

Type of seal: Bentonite pellets

Type of sand pack No. 3 Blasting Sand

Elev./depth of top of sand pack — 26 ft

Elev./depth top of screened section — 32 ft

Type of screened section: 4" diameter, threaded, .010" slot, Schedule 40 PVC

Elev./depth bottom of screened section — 42 ft

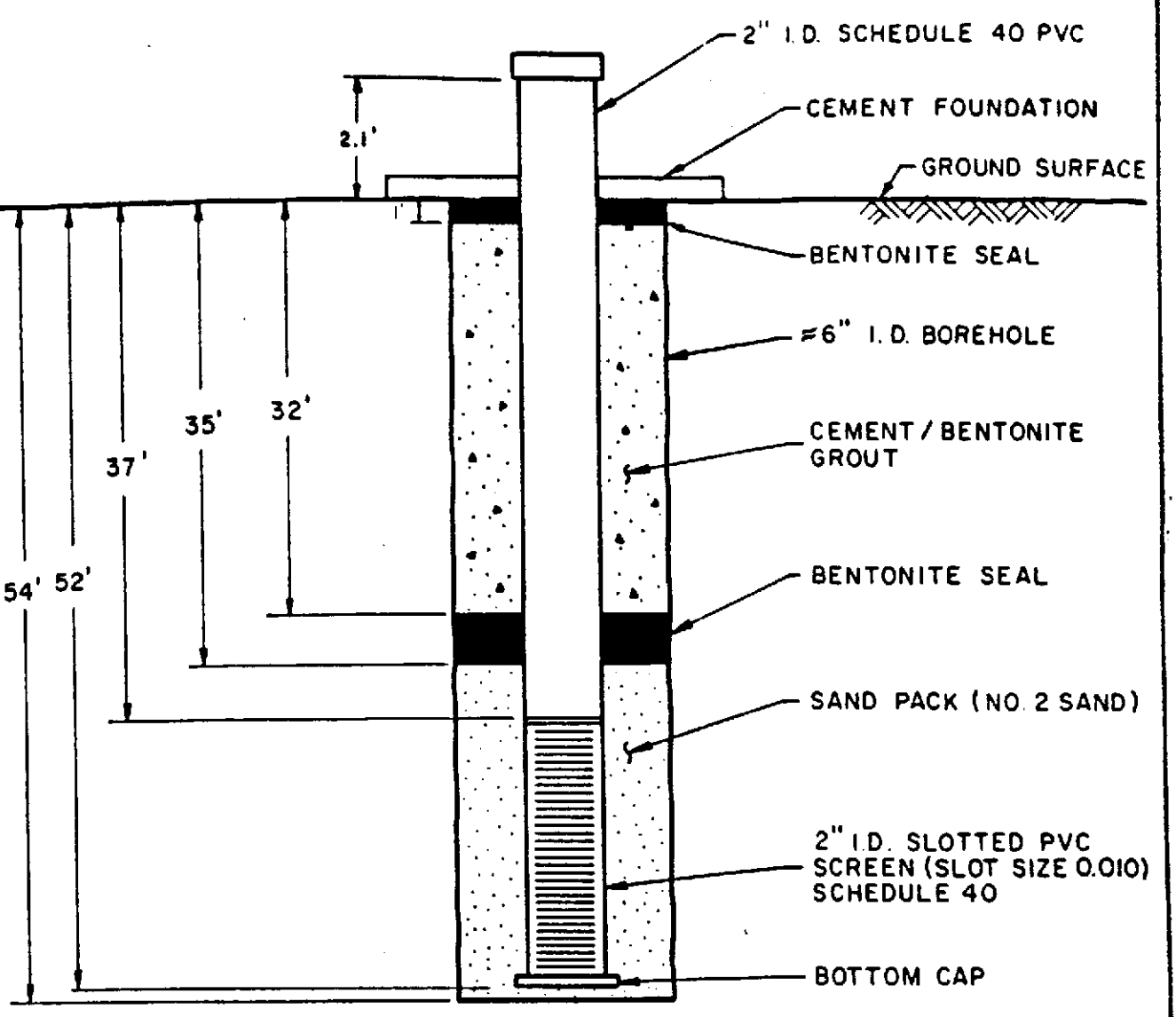
Elev./depth bottom of plugged blank section — 47.5 ft

Type of backfill below observation pipe No. 3 Blasting Sand

Elev./depth of hole — 48 ft

DRAWING NUMBER 846545-A

DRAWN BY DJS 12/10/84 CHECKED BY APPROVED BY



DATE INSTALLED: 12/5/84

ELEVATION, TOP OF CASING: 118.74'

FIGURE

PIEZOMETER PZ-1
CONSTRUCTION DETAILS

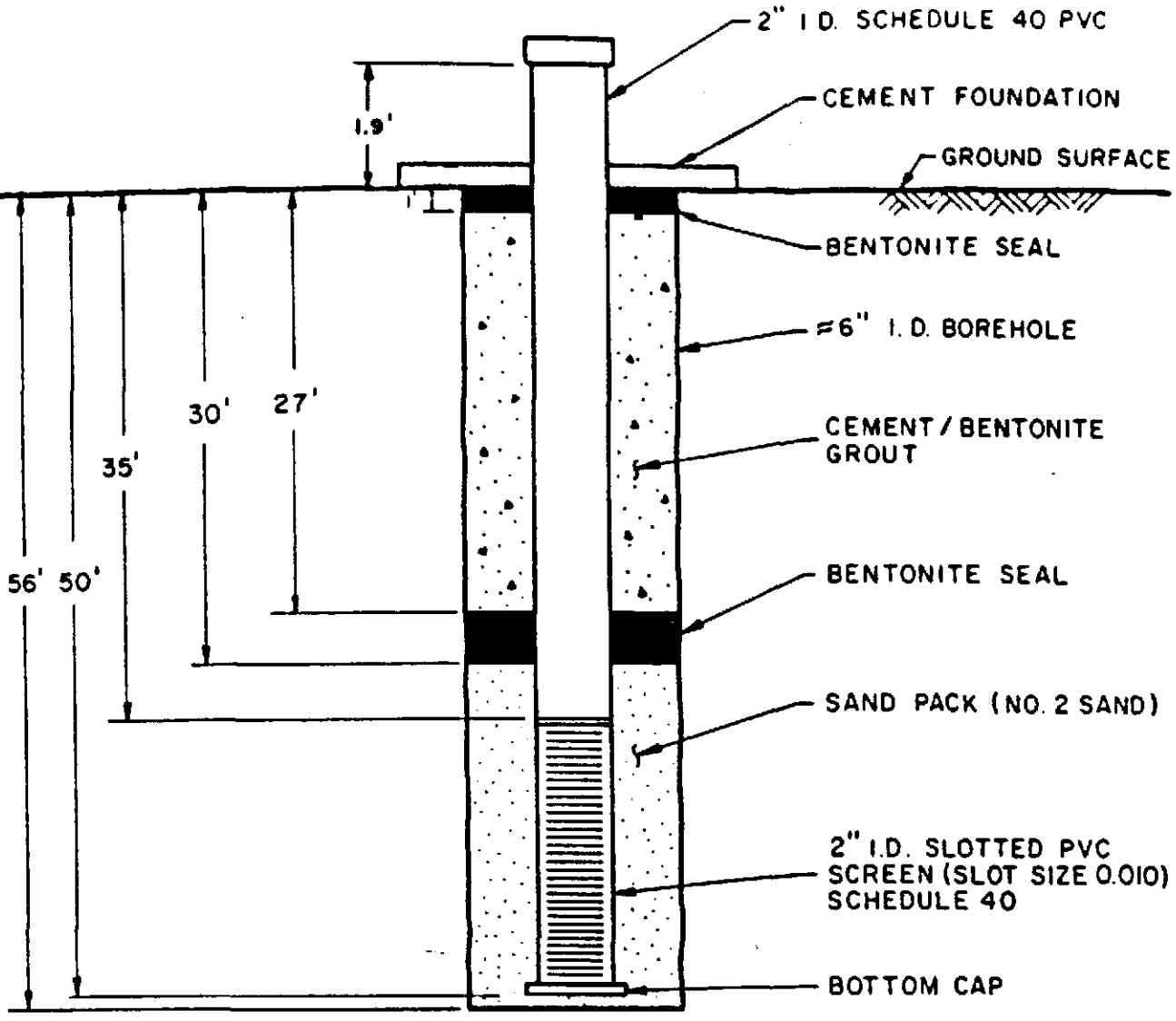
PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

DRAWING NOT TO SCALE

DRAWING NUMBER	846545-A
CHECKED BY	
APPROVED BY	
DRS	12/10/84
DRAWN BY	



DATE INSTALLED: 12/7/84

ELEVATION, TOP OF CASING: 112.45'

FIGURE

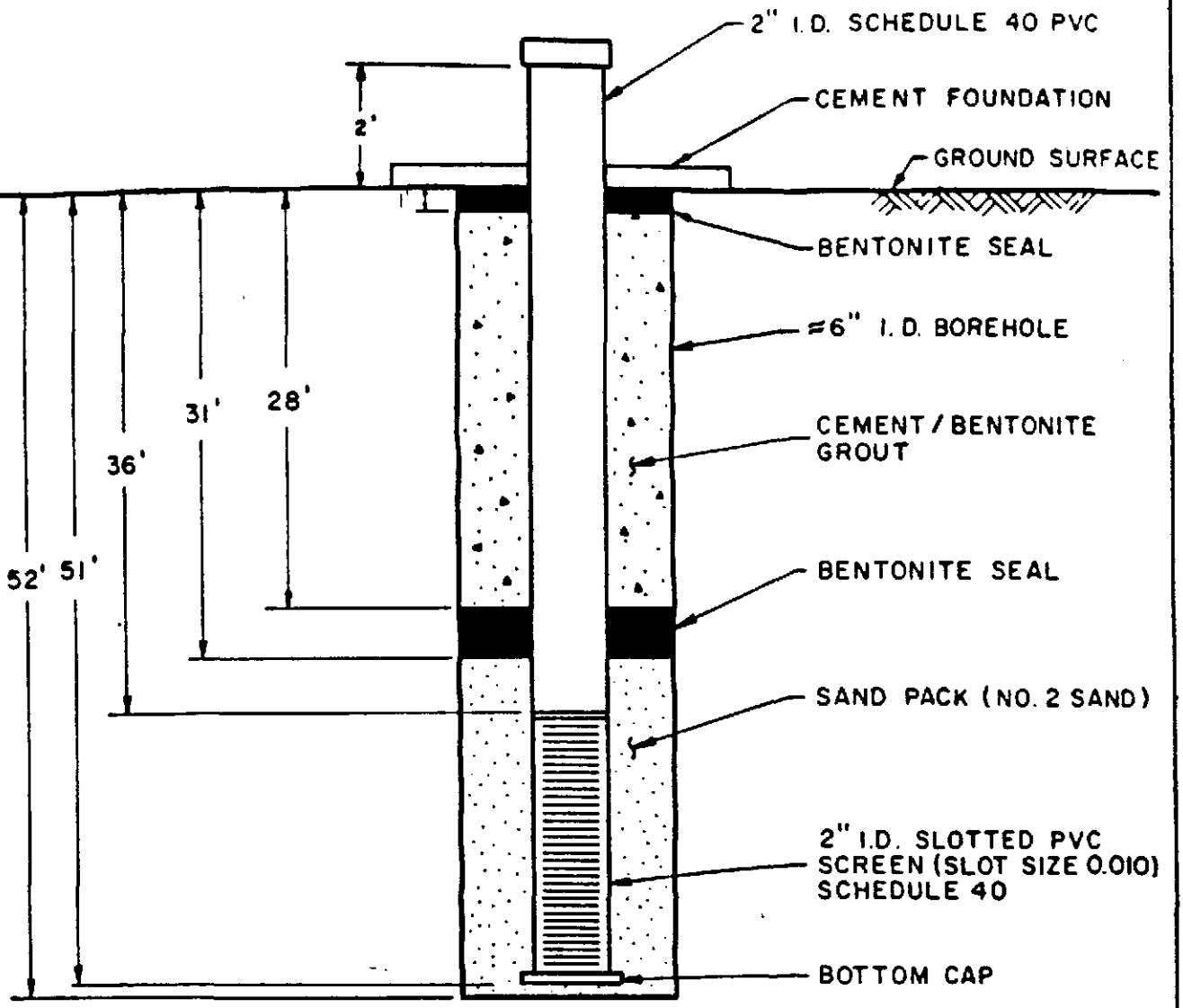
PIEZOMETER PZ-2
CONSTRUCTION DETAILS

PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.

DRAWING NOT TO SCALE

© 1983 HERCULENE A&S SMITH CO PGH PA



DRAWING NUMBER 846545-A

DRAWN BY	CHECKED BY	APPROVED BY
DRS 12/10/84		

DATE INSTALLED: 12/6/84

ELEVATION, TOP OF CASING: 113.03

FIGURE

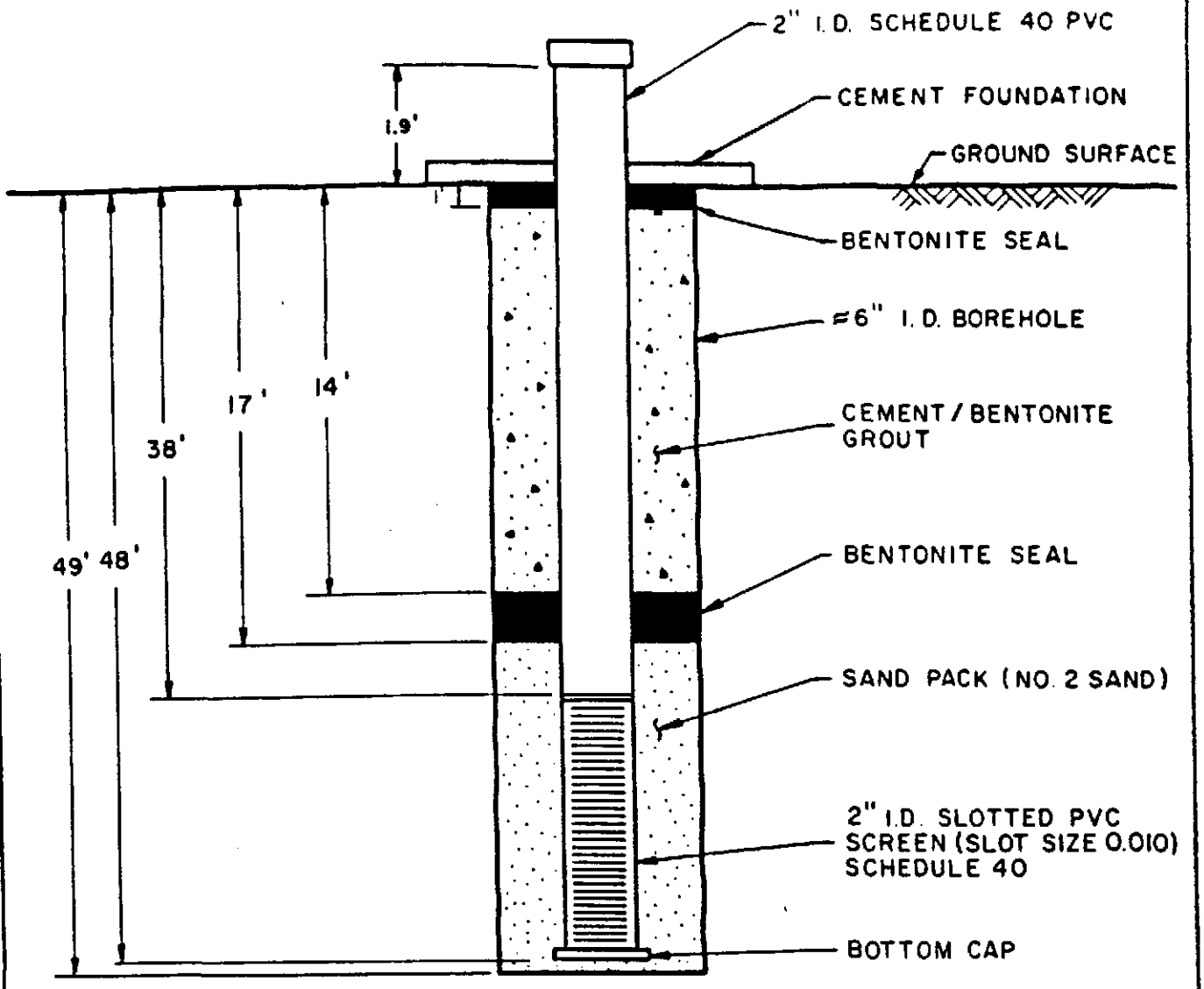
PIEZOMETER PZ ~~10K~~ 3
CONSTRUCTION DETAILS

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

DRAWING NOT TO SCALE



DATE INSTALLED: 12/7/84

ELEVATION, TOP OF CASING: 114.24'

FIGURE

PIEZOMETER PZ-4
CONSTRUCTION DETAILS

PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.

DRAWING NOT TO SCALE

IT CORPORATION

DRAWING NUMBER 846545-A

CHECKED BY

APPROVED BY

DRS 12/10/84

DRAWN BY

19 1253 HERCULENE. A&B SMITH CO. PGH PA

APPENDIX D

GEOLOGIC CROSS-SECTIONS AND POTENTIOMETRIC MAPS FROM PREVIOUS REPORTS

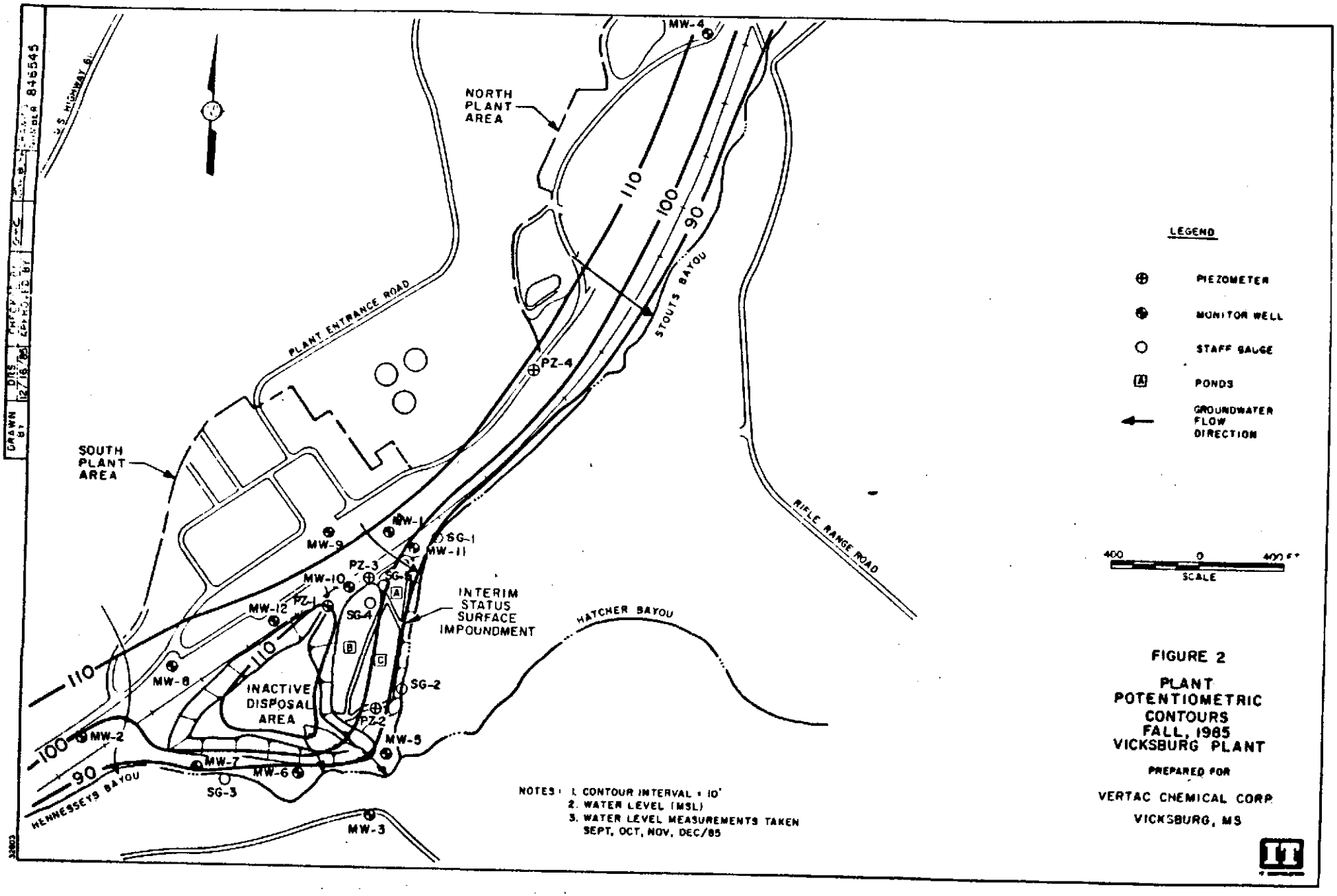


FIGURE 2

PLANT POTENTIOMETRIC CONTOURS FALL, 1985 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS

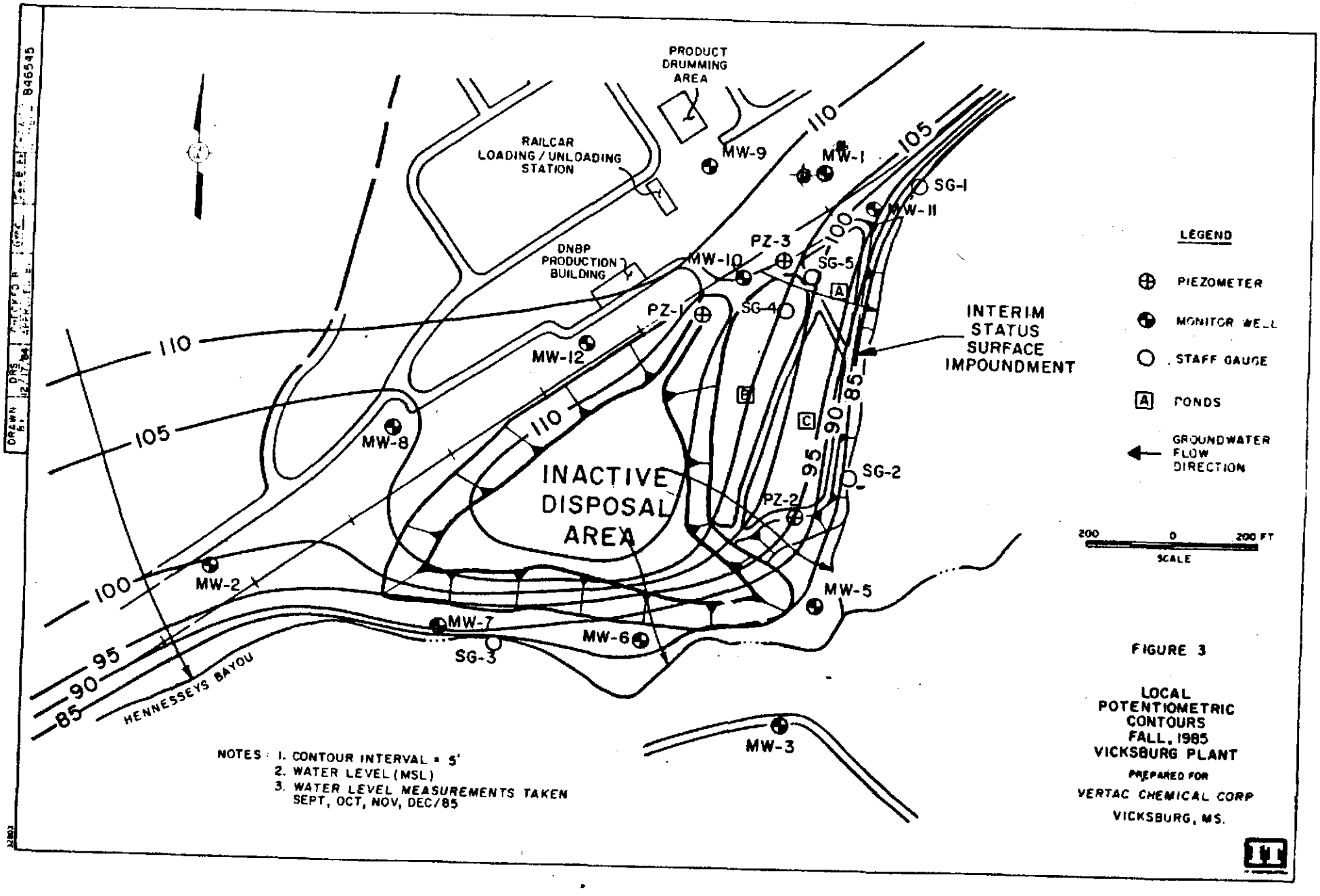


FIGURE 3

LOCAL POTENTIOMETRIC CONTOURS FALL, 1985 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP

VICKSBURG, MS.

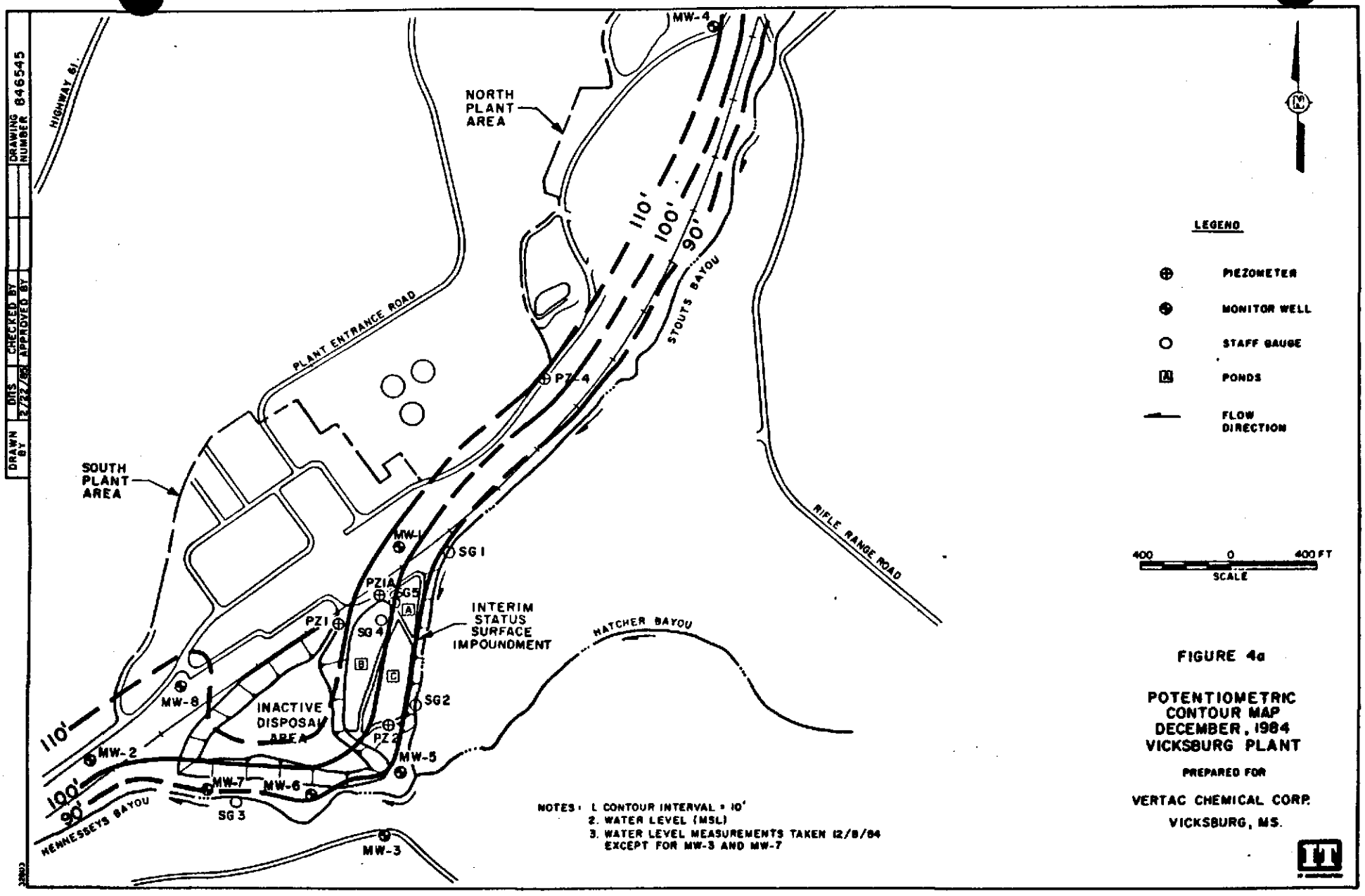


FIGURE 4a

POTENTIOMETRIC CONTOUR MAP DECEMBER, 1984 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

IT

APPENDIX C

APPENDIX B

APPENDIX A

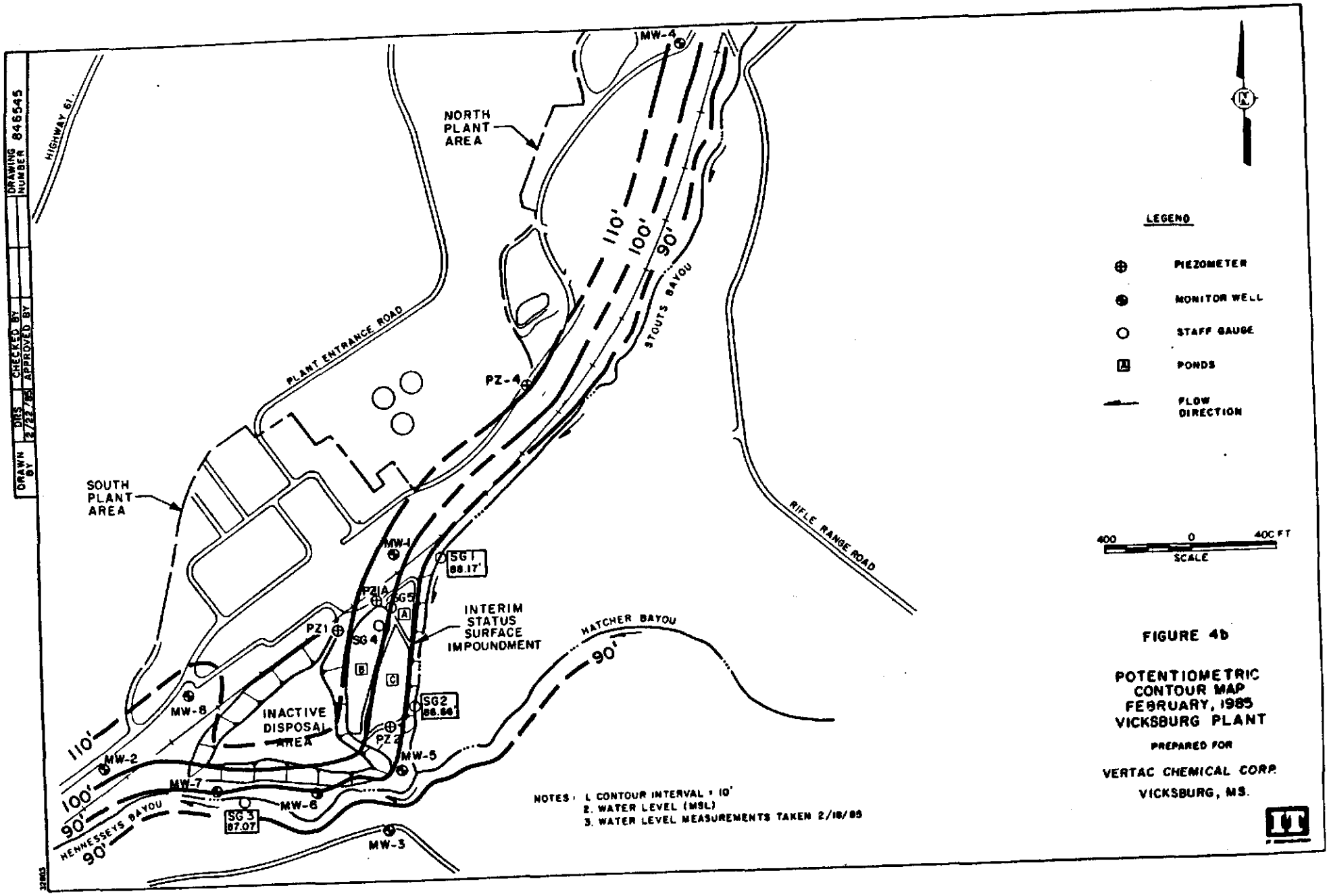


FIGURE 4b

POTENTIOMETRIC CONTOUR MAP FEBRUARY, 1985 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

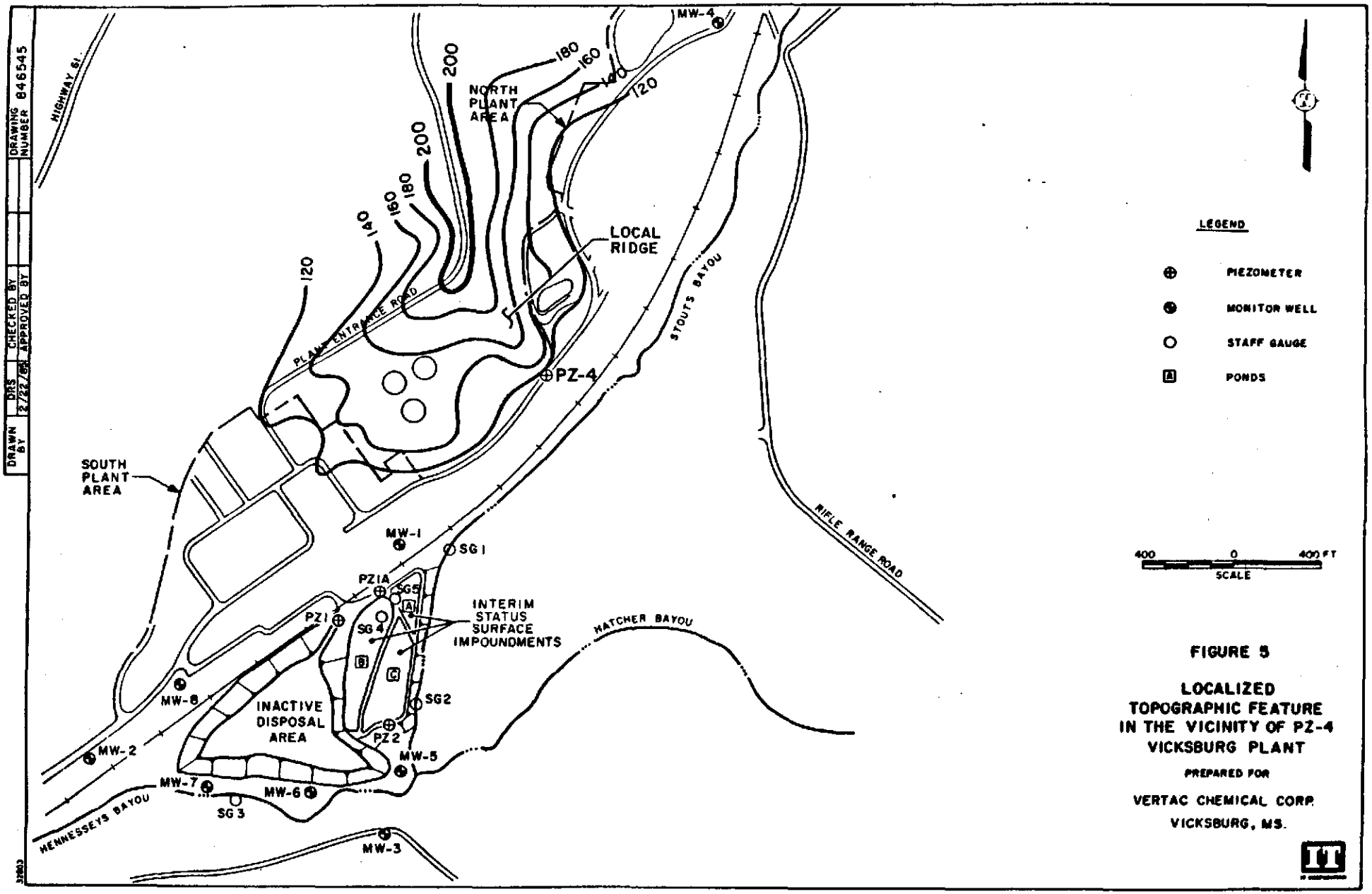


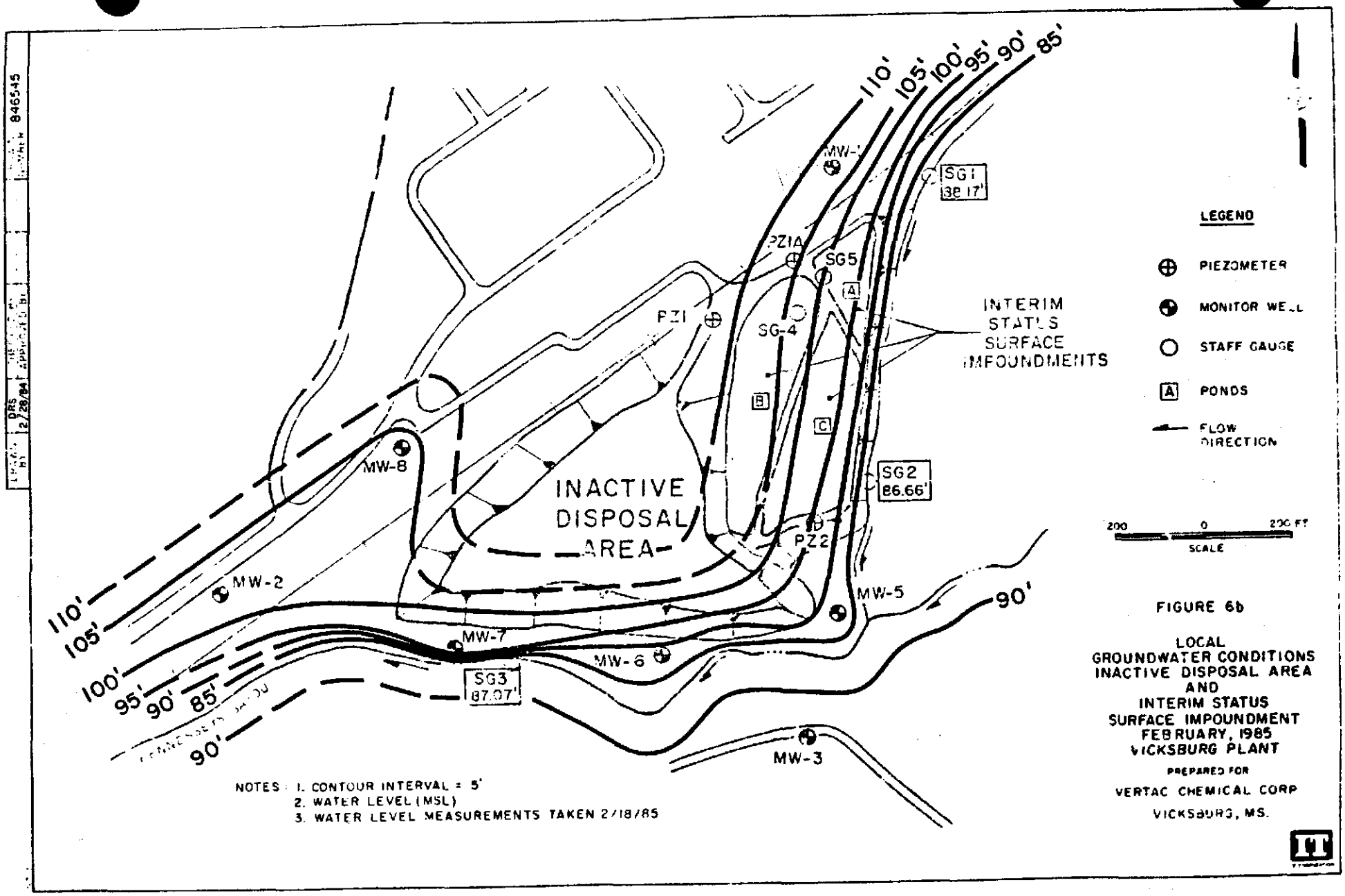
FIGURE 5

LOCALIZED TOPOGRAPHIC FEATURE IN THE VICINITY OF PZ-4 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.



NOTES: 1. CONTOUR INTERVAL = 5'
2. WATER LEVEL (MSL)
3. WATER LEVEL MEASUREMENTS TAKEN 2/18/85

FIGURE 6b

LOCAL
GROUNDWATER CONDITIONS
INACTIVE DISPOSAL AREA
AND
INTERIM STATUS
SURFACE IMPOUNDMENT
FEBRUARY, 1985
VICKSBURG PLANT

PREPARED FOR
VERTAC CHEMICAL CORP
VICKSBURG, MS.

IT

APPENDIX C APPENDIX B APPENDIX A

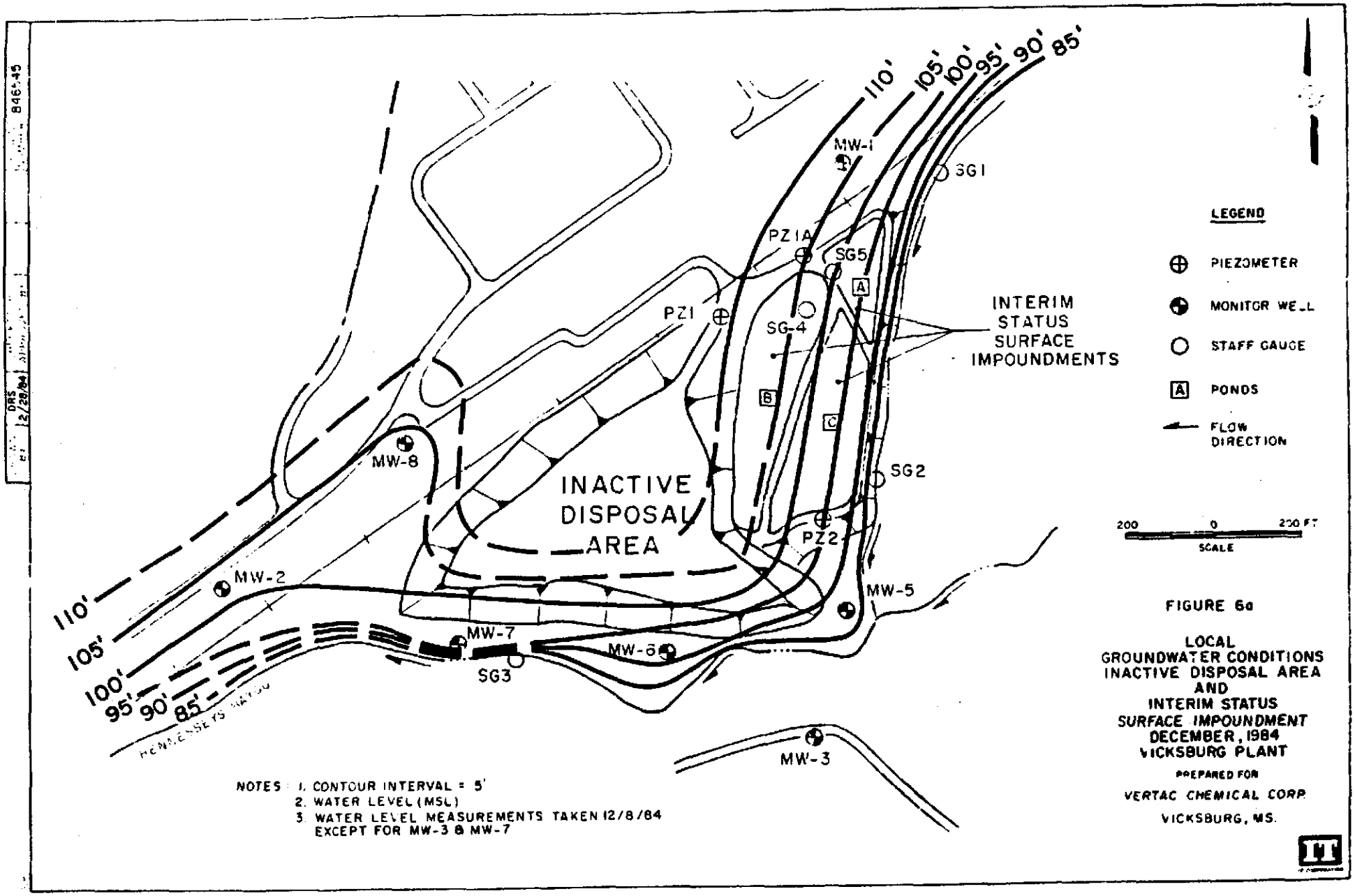


FIGURE 6a

LOCAL GROUNDWATER CONDITIONS INACTIVE DISPOSAL AREA AND INTERIM STATUS *SURFACE IMPOUNDMENT* DECEMBER, 1984 VICKSBURG PLANT

PREPARED FOR

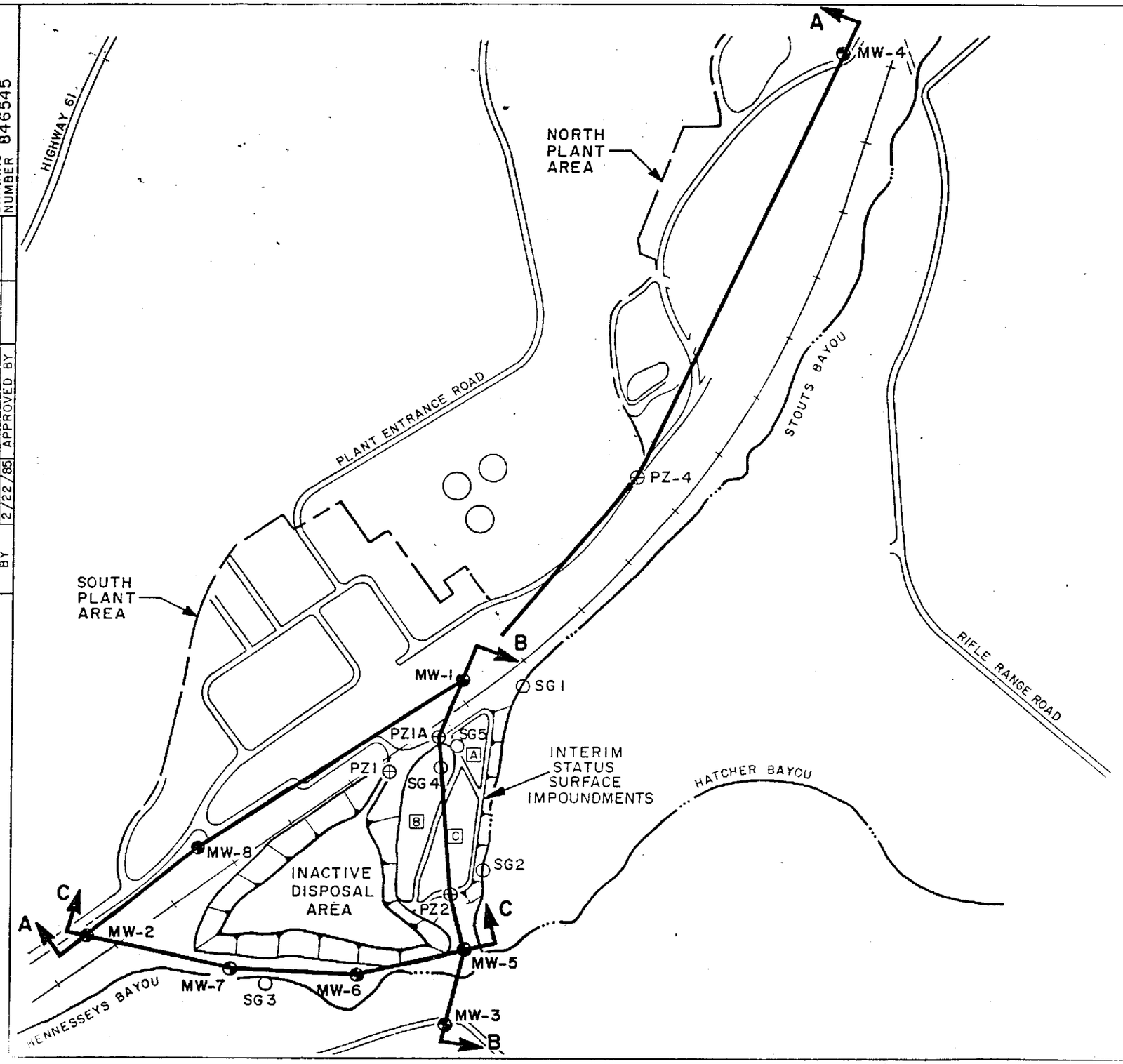
VERTAC CHEMICAL CORP.

VICKSBURG, MS.

IT

APPENDIX APPENDIX APPENDIX

DRAWN BY	DRS	DRAWING NUMBER 846545
	2/22/85	
CHECKED BY		
APPROVED BY		



LEGEND

- ⊕ PIEZOMETER
- ◕ MONITOR WELL
- ○ STAFF GAUGE
- [A] PONDS

400 0 400 FT
SCALE

FIGURE 1

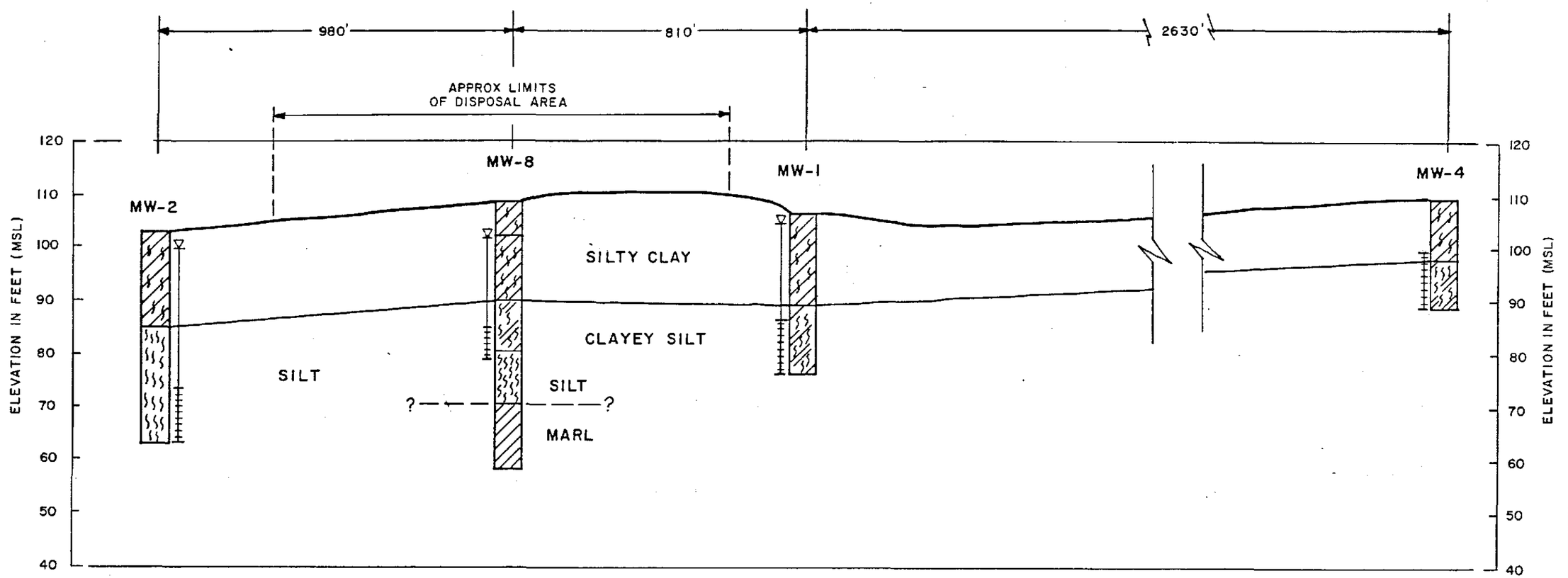
SITE PLAN
AND
STRATIGRAPHIC SECTIONS
VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.

IT CORPORATION

DRAWN BY	DATE	CHECKED BY	DRAWING NUMBER
DRS	10/19/84	APPROVED BY	846545-B



SECTION A-A

00 0 00 FT
HORIZONTAL SCALE

20 0 20 FT
VERTICAL SCALE

NOTES: 1. WATER LEVELS ARE THOSE REPORTED FOR MARCH 4, 1983.

2. STRATIGRAPHY SHOWN IS INTERPRETATION OF EXISTING BORING LOGS. SUBTLE VARIATIONS IN REPORTED SILT CONTENT ARE SHOWN.

FIGURE C

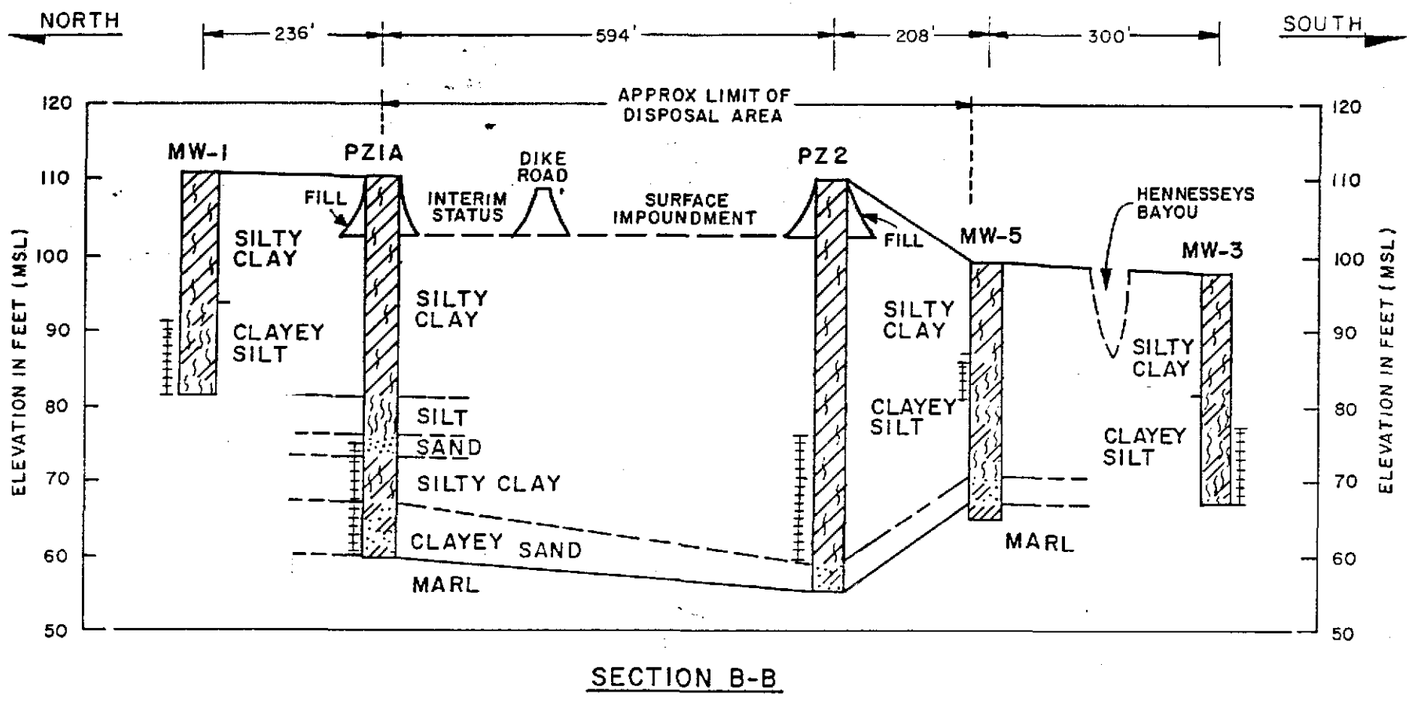
SECTIONS A-A
VICKSBURG PLANT
PREPARED FOR
VERTAC CHEMICAL CORP.
VICKSBURG, MS.

IT CORPORATION

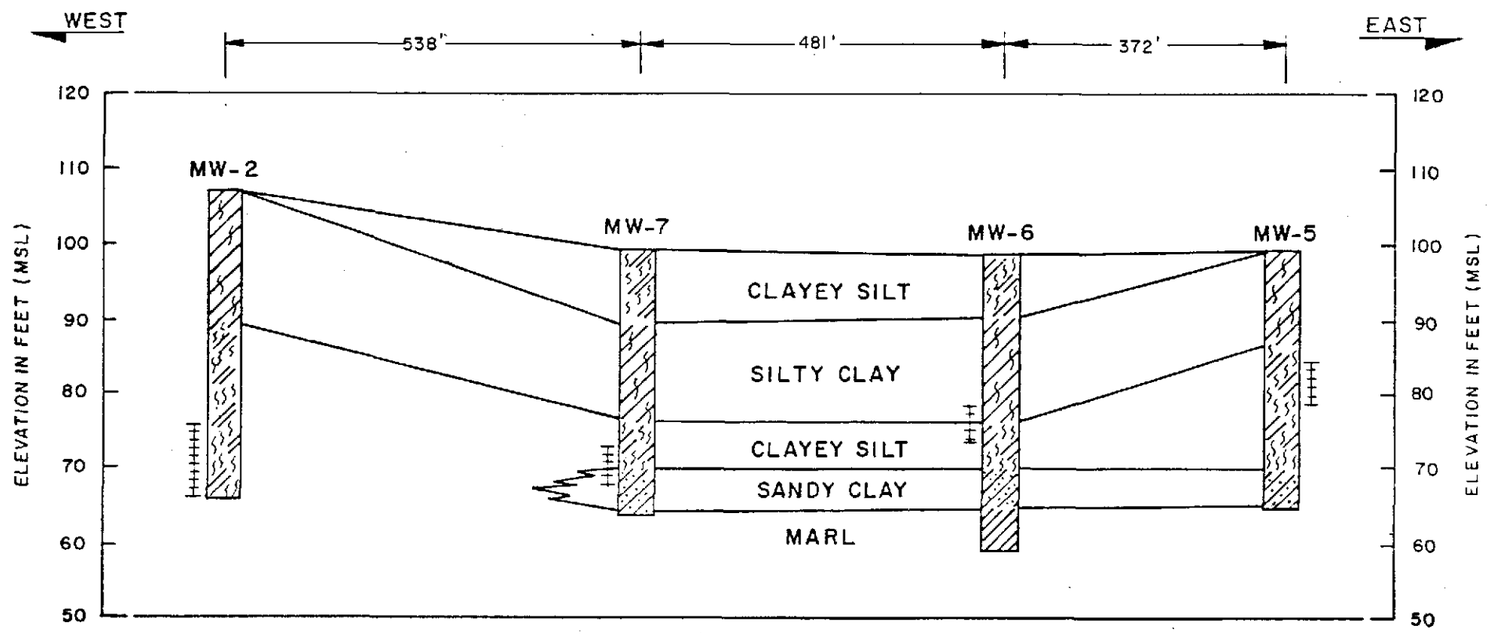
19 1253 HERCULENE. A&B SMITH CO PGH., PA

DRAWN BY	DRS	CHECKED BY	
	2/7/85	APPROVED BY	

DRAWING NUMBER 846545



SECTION B-B



SECTION C-C

200 0 200 FT
HORIZONTAL SCALE

20 0 20 FT
VERTICAL SCALE

FIGURE 3

SECTION B-B & C-C
VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.

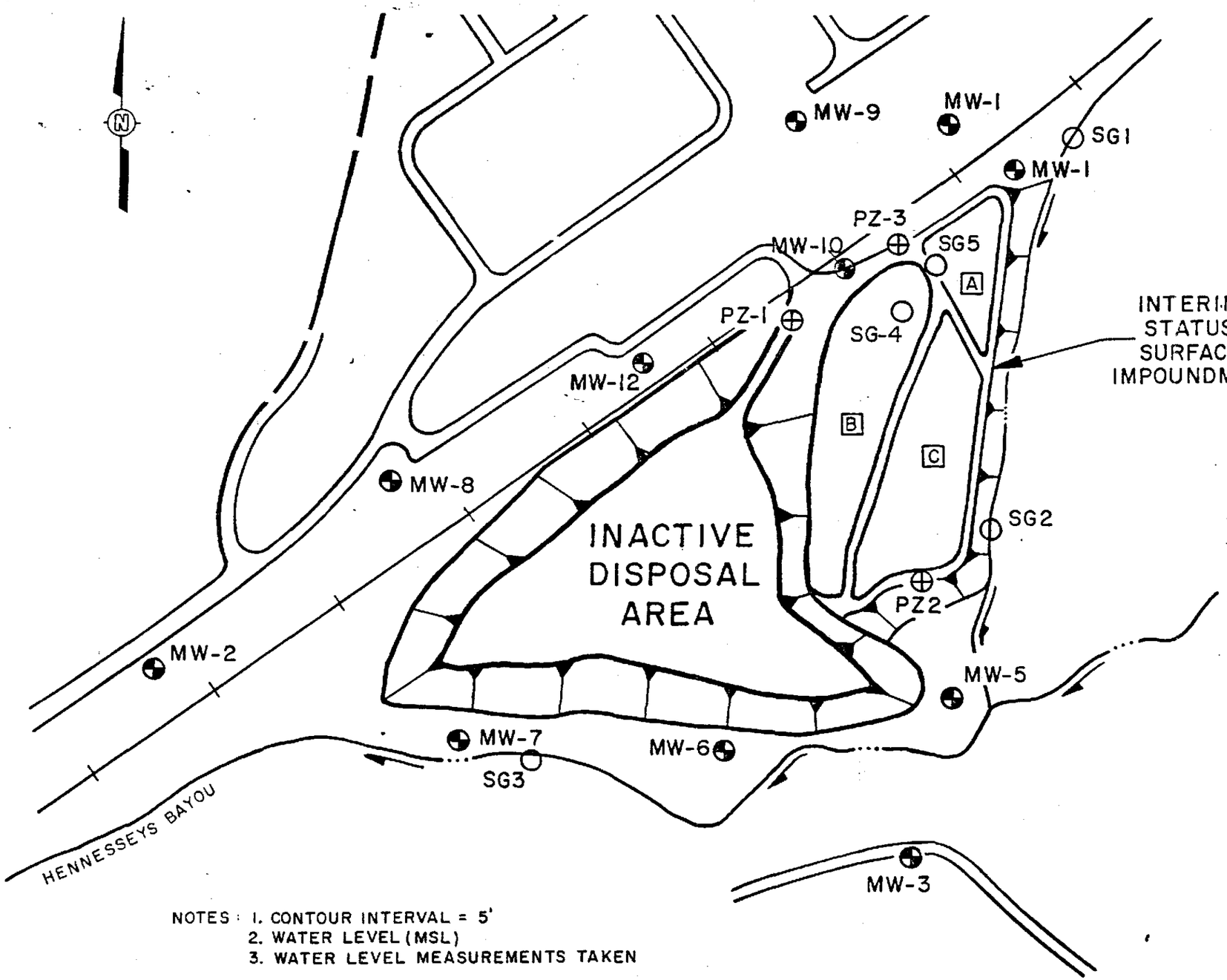
IT CORPORATION

32803

DRAWING NUMBER 846545

DRS 7/84 | CHECKED BY | APPROVED BY

DRAWN BY



LEGEND

- ⊕ PIEZOMETER
- ◓ MONITOR WELL
- ○ STAFF GAUGE
- [A] PONDS
- ← GROUNDWATER FLOW DIRECTION

200 0 200 FT
SCALE

FIGURE 3

LOCAL

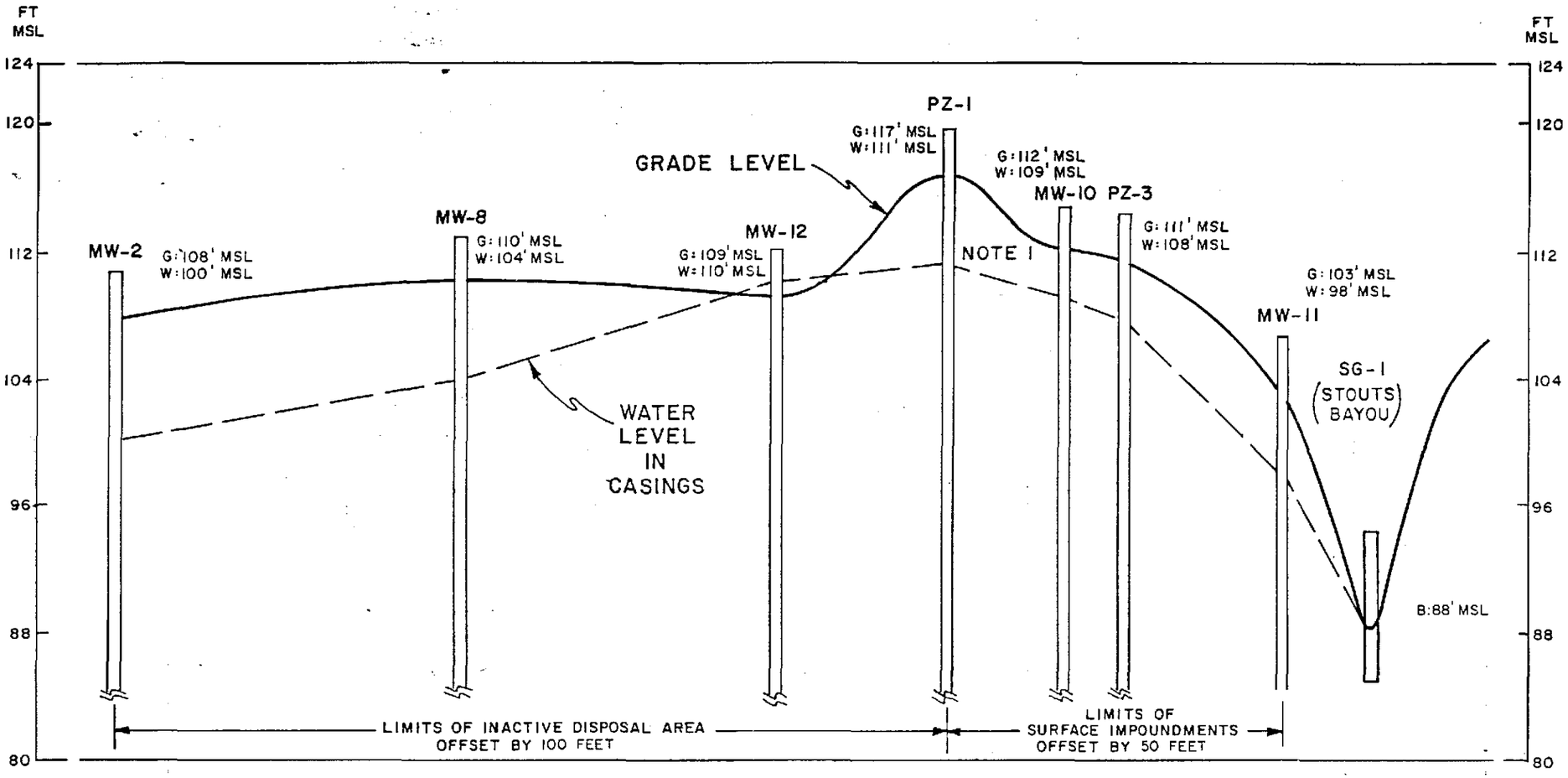
VICKSBURG PLANT
PREPARED FOR
VERTAC CHEMICAL CORP.
VICKSBURG, MS.

IT CORPORATION

NOTES: 1. CONTOUR INTERVAL = 5'
2. WATER LEVEL (MSL)
3. WATER LEVEL MEASUREMENTS TAKEN

32803

DRAWN BY DNS 12/18/85 | CHECKED BY | APPROVED BY | DRAWING NUMBER 846545



NOTES: 1. PZ-1 LOCATED ON SLOPE LEADING TO TOP OF INACTIVE DISPOSAL AREA

200 0 200 FT
HORIZONTAL SCALE

8 0 8 FT
VERTICAL SCALE

FIGURE 4

GROUNDWATER
SECTION A-A'
FALL, 1985

PREPARED FOR

VERTAC CHEMICAL CORP
VICKSBURG, MS.

IT ... Creating a Safer Tomorrow

© 1984 IT CORPORATION
ALL COPYRIGHTS RESERVED
"Do Not Scale This Drawing"

65360

DRAWN BY DRS 12/18/85 | CHECKED BY | APPROVED BY | Jan 8, 86 | DRAWING NUMBER 846545-B

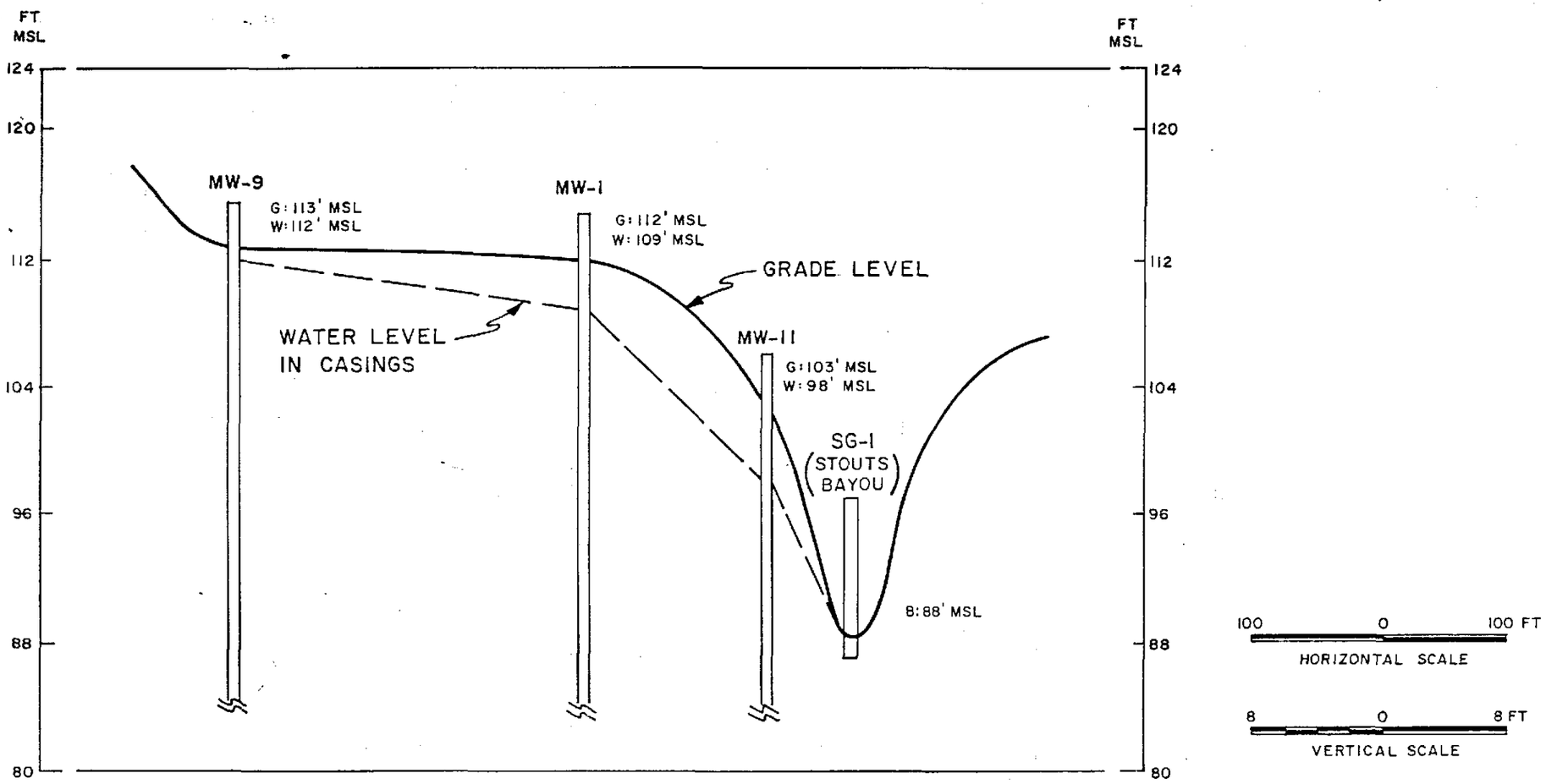


FIGURE 5

GROUNDWATER
SECTION B-B'
FALL, 1985

PREPARED FOR

VERTAC CHEMICAL CORP
VICKSBURG, MS.

© 1984 IT CORPORATION
ALL COPYRIGHTS RESERVED
"Do Not Scale This Drawing"

65360

IT ... Creating a Safer Tomorrow

DRAWN BY	DATE	CHECKED BY	DRAWING NUMBER
	10/18/84	APPROVED BY	846545-B

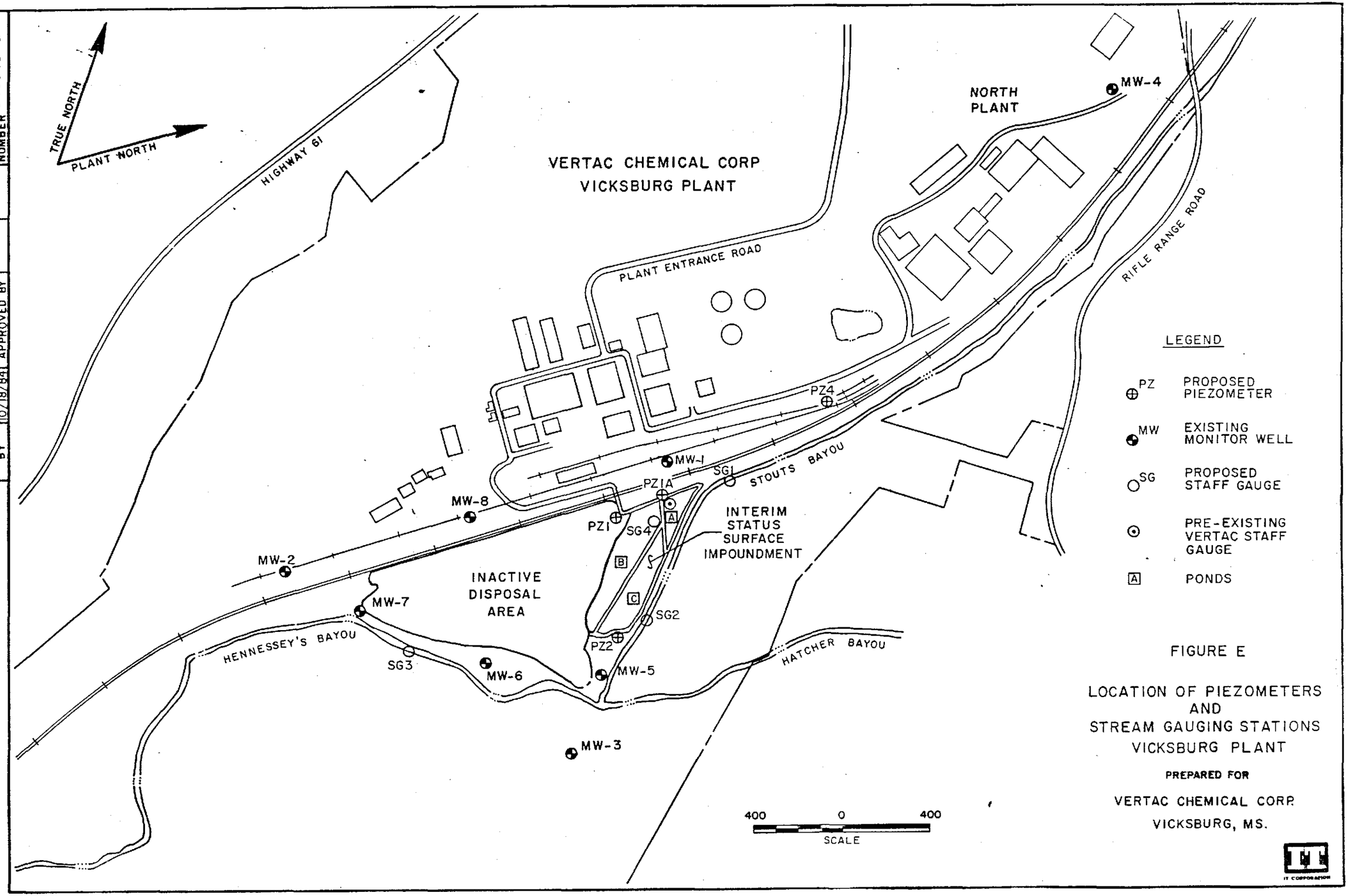


FIGURE E

LOCATION OF PIEZOMETERS
AND
STREAM GAUGING STATIONS
VICKSBURG PLANT

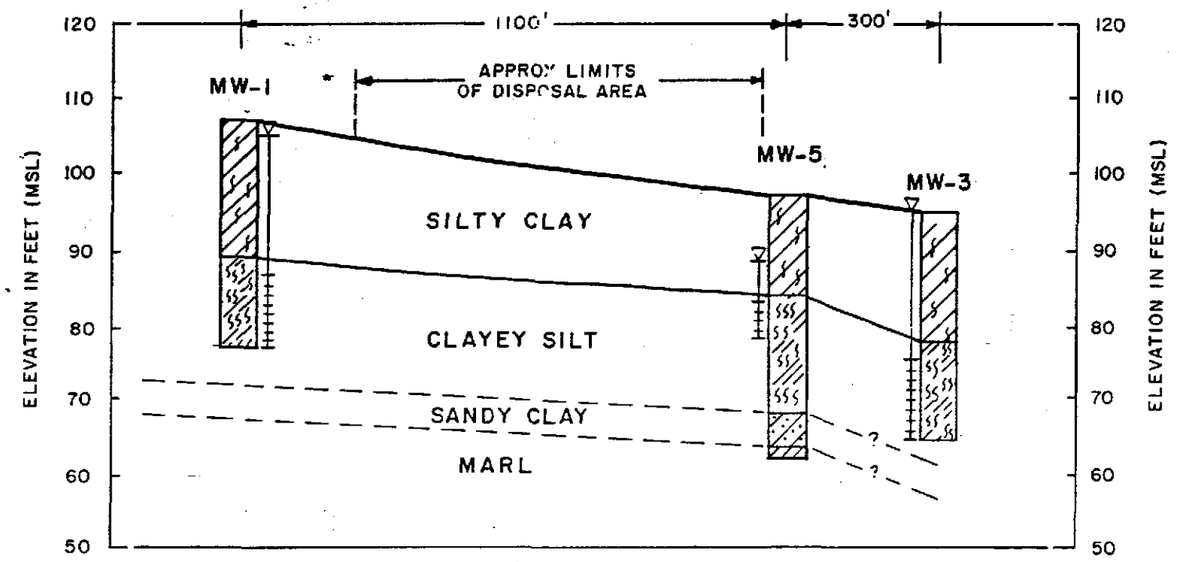
PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.

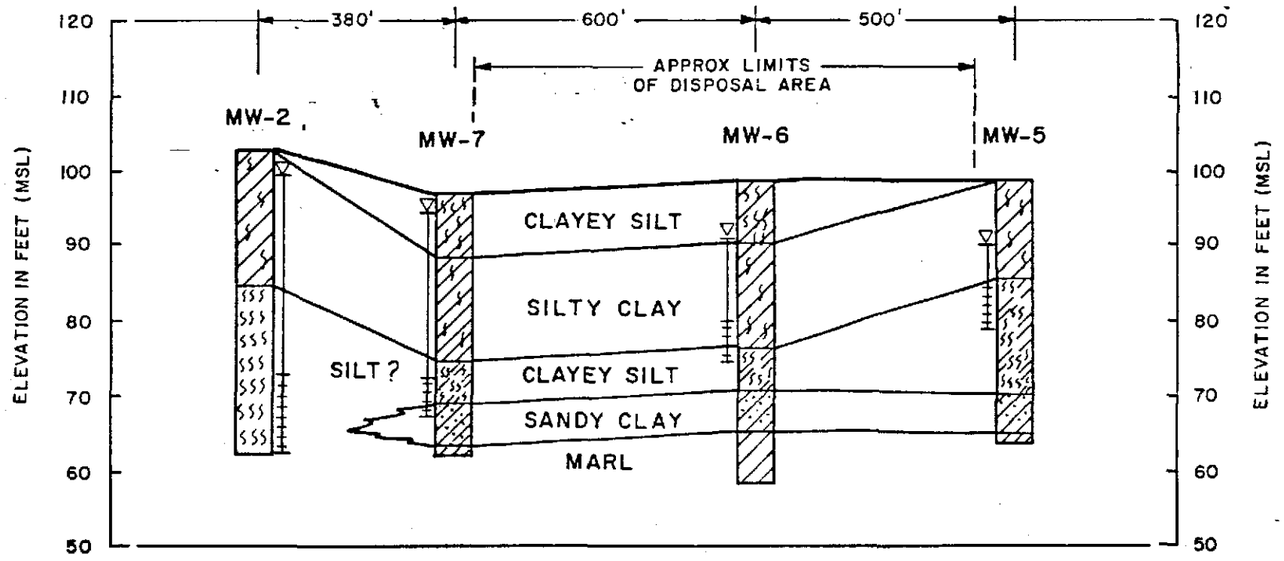
IT CORPORATION

© 1983 HERCULENE ... SMITH CO., PGH., PA.

DRAWN BY	DRS	CHECKED BY		DRAWING NUMBER 846545-B
	10/22/84	APPROVED BY		



SECTION B-B



SECTION C-C

NOTES: 1. WATER LEVELS ARE THOSE REPORTED FOR MARCH 4, 1983.

2. STRATIGRAPHY SHOWN IS INTERPRETATION OF EXISTING BORING LOGS. SUBTLE VARIATIONS IN REPORTED SILT CONTENT ARE SHOWN.

300 0 300 FT
HORIZONTAL SCALE

20 0 20 FT
VERTICAL SCALE

FIGURE D

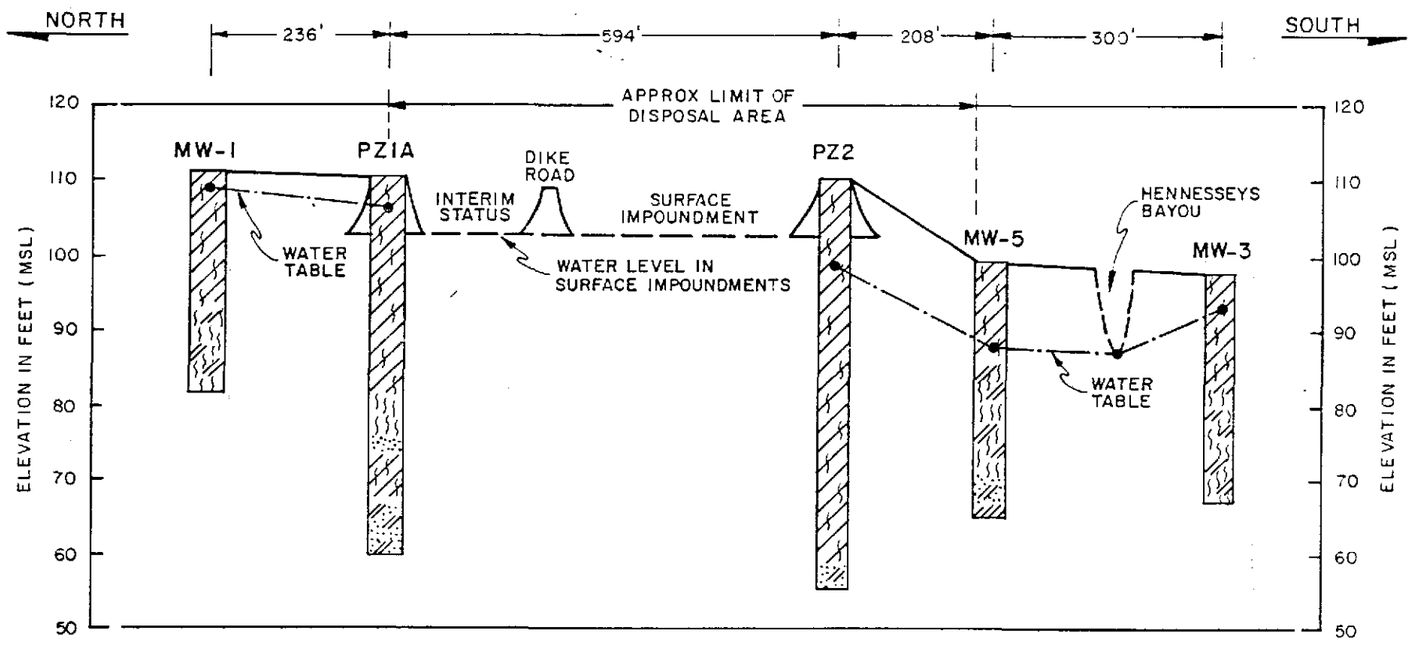
SECTIONS B-B & C-C
VICKSBURG PLANT
PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.

IT CORPORATION

19 1253 HERCULENE. A&B SMITH CO., PGH., PA

	MW-1	PZ-1A	PZ-2	MW-5	MW-3
DEPTH TO WATER	3.75'	6.25'	14.0'	12.0'	5.75'
PVC STICK-UP	1.46'	2.00'	1.90'	0.60'	.89'
GROUND ELEVATION	111.55'	111.03'	110.55'	99.70'	98.44'
WATER ELEVATION	109.26'	106.78'	98.45'	88.30'	92.69'



SECTION B-B

FIGURE EI-1

GROUNDWATER ELEVATIONS
VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

DRAWING NUMBER HE1034-B

DRAWN BY | DRS 6-16-85 | CHECKED BY | APPROVED BY

32803

DRAWN BY SL 12/18/85 | CHECKED BY | APPROVED BY | DRAWING NUMBER 846545

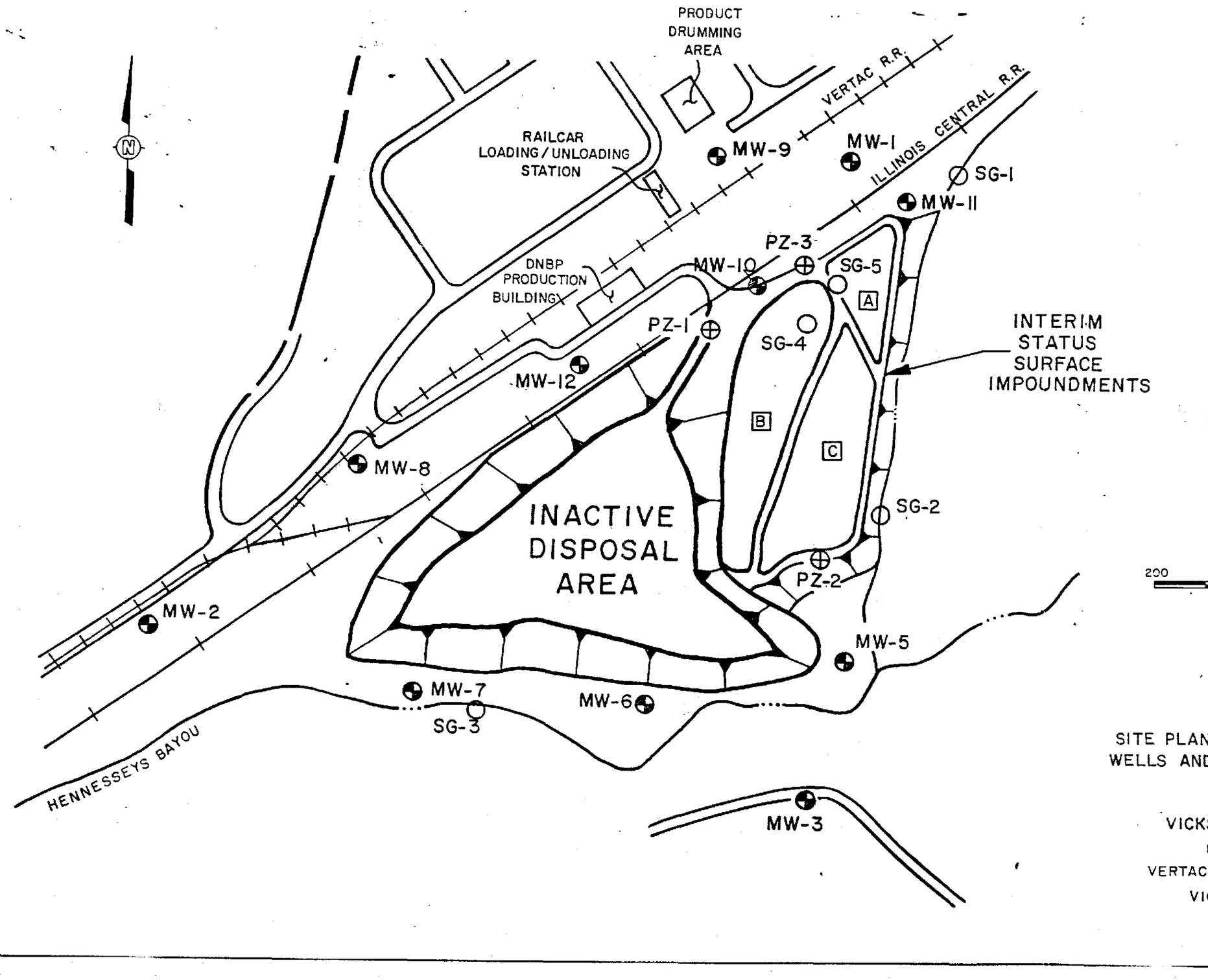


FIGURE 1

SITE PLAN SHOWING MONITOR WELLS AND POSSIBLE SOURCES OF DNBP

VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

32803

VERTAC CHEMICAL CORPORATION
24th Floor • 5100 Poplar • Memphis, TN 38137 • 901-767-6851 TELEX 53927

April 12, 1985

DIVISION OF SOLID WASTE
REVIEWED BY CE
DATE 4/19/85
COMMENTS May be helpful to sample and analyze Piezometers for organics.

Mr. Chuck Estes
Mississippi Department of
Natural Resources
Bureau of Pollution Control
2350 Highway 80 West
Jackson, MS 39209

Dear Mr. Estes:

Attached is a copy of the interim report on the Groundwater Assessment Program for our Vicksburg Plant.

Best regards,

Dick Karkkainen
Director of Environment and Safety

RDK/bh

Project No. 846545
March, 1985

IT CORPORATION

Interim Report

Groundwater Assessment Program

Vertac Chemical Corporation
Vicksburg, Miss.

IT CORPORATION

March 15, 1985

Project No. 846535

Richard D. Karkkainen
Vertac Chemical Company
5100 Poplar Street
Memphis, Tennessee 38137

Letter of Transmittal
Interim Report
Ground Water Assessment Program

Dear Mr. Karkkainen:

Please find enclosed two (2) copies of our Interim Report on the Ground Water Assessment Program at the Vertac-Vicksburg Plant. The activities described in this report primarily cover Task A of the Ground Water Assessment Program Outline which was agreed to by the State of Mississippi.

Generally, the following activities describe our work to date:

- Review of Existing Data;
- Design and Implementation of Water Level Monitoring Field Program;
- Preparation of the Interim Report

The field activities which occurred during the period of December 3 through December 8, 1984 included the following:

- Installation of four two inch water level piezometers;
- Installation of four stream level staff gauges;
- Soil sampling during the installation of the four piezometers;
- Well development of four piezometers; and,
- Water level measurements in all new piezometers and existing monitor wells.

Since their installation in December, three of the staff gauges have been rendered unusable by climatic conditions. If the need arises we will replace these PVC gauges with heavier steel pipe.

The attached report also includes our technical interpretations of the water level and soil data. In summary, these data indicate some mounding of shallow ground water under the Inactive Disposal Area but no mounding under the Interim Status Impoundments.

We hope this report is suitable for presentation to representatives of the Mississippi Department of Natural Resources. It you have any questions please contact me at (713) 784-2800.

Sincerely,

Alan P. Gradet
Project Manager

gd:APG

cc: John Hill, Vertac-Vicksburg

Executive Summary

A field program has been initiated at the Vertac Chemical Plant in Vicksburg, Mississippi as part of an ongoing ground water assessment program. This part of the assessment involved characterization of subsurface soil and hydrogeologic conditions.

Four new 2" water level monitoring piezometers have been installed at the plant, primarily in the vicinity of the Inactive Disposal Area and Interim Status Surface Impoundment. Soil samples collected during installation of the piezometers have been characterized (visual classification, particle size) and were used in combination with previous data to prepare soil stratigraphic cross-sections.

Water level measurements have been collected from the four new piezometers and the existing on-site monitor wells.

These data have been used to characterize the direction of the shallow ground water flow across this area. Anomalies in gradient and direction have been correlated to natural and man-made topographic features.

Table of Contents

Executive Summary

1.0 Introduction

2.0 Field Program
- 2.1 Introduction
- 2.2 Field Activities

3.0 Data Analysis
- 3.1 Site Stratigraphy
- 3.2 Soil Samples
- 3.3 Water Level Measurements

4.0 Conclusions
- 4.1 Subsurface Soil Conditions
- 4.2 Hydrogeologic Conditions

List of Tables

List of Figures

Appendices
- A. Assessment Outline
- B. Laboratory Data
- C. Boring Logs and Well Sketches

LIST OF TABLES

TABLE 1	SOIL SAMPLES, CLASSIFICATION AND PARTICLE SIZE ANALYSES
TABLE 2	WATER LEVEL DATA, DECEMBER 1984
TABLE 3	WATER LEVEL DATA, FEBRUARY 1985

LIST OF FIGURES

FIGURE 1	SITE PLAN AND STRATIGRAPHIC SECTIONS
FIGURE 2	SECTION AA
FIGURE 3	SECTION BB & CC
FIGURE 4a	POTENTIOMETRIC CONTOUR MAP, DECEMBER 1984
FIGURE 4b	POTENTIOMETRIC CONTOUR MAP, FEBRUARY 1985
FIGURE 5	LOCALIZED TOPOGRAPHIC FEATURE IN THE VICINITY OF PZ-4
FIGURE 6a	LOCAL GROUNDWATER CONDITIONS DECEMBER 1984
FIGURE 6b	LOCAL GROUNDWATER CONDITIONS FEBRUARY 1985

1.0 INTRODUCTION

This report is being presented as an interim report of the Ground Water Assessment Plan for the Vertac Vicksburg facility as approved by the Mississippi Department of Natural Resources (letter to Dick Karkkainen from Charles Estes, October 3, 1984). This particular report predominantly completes Task A of the approved plan which has been described, as follows:

TASK A HYDROGEOLOGIC CONDITIONS
Purpose: Establish the rate and extent of potential contaminant migration.
A.1 Soil Stratigraphy
A.2 Existing Hydrogeologic Data
A.3 Description of Hydrogeologic Conditions
A.4 Water Level Monitoring Program

Parts of Task A were completed prior to this report and those items were submitted in a letter report (letter to Dick Karkkainen from Alan Gradet, November 8, 1984 copy attached as Appendix A). The items presented in that report directly applicable to the Task A scope of work are:

- A set of preliminary stratigraphic cross-secions (Task A.1);
- A brief review of the existing hydrogeologic data (Task A.2); and
- The proposed locations of four new water level recording piezometers and four stream water level measuring staff gauges.

During the phase of the Task A work described in this report we have completed the field work associated with the installation of piezometers and staff gauges as well as collecting two sets of water level measurements as per the assessment plan. The new data has been used to update the previously submitted information relative to the stratigraphic cross-sections and the hydrogeologic conditions. Finally, a new aerial

photograph of the site has allowed us to refine the site plan and more accurately display the spatial relationships between the plant, closed landfill, impoundments, monitor wells, piezometers and adjacent natural surface waters.

2.2 FIELD ACTIVITIES

Drilling - Sampling

No major problems were encountered while drilling and installing the four piezometers. The drilling procedure was to auger down until the natural water table was reached or borehole collapse became a problem. Augering depths were from 15 to 25 feet below ground surface and the natural water table was not encountered. When augering became difficult, a rotary wash drilling technique was utilized until the final borehole depth was achieved. The final depth was determined by the location of the "marl". The marl occurred at depths from 49 to 56 feet below ground surface. Samples were collected to describe the soils encountered while drilling. Sample intervals were selected based on observed material characteristics so that samples of apparently different soil horizons were collected.

Piezometer Installation

The four piezometers installed were made of 2" P.V.C. (Schedule 40) material. Well screen slot size was 0.010 inches. PZ-1, PZ-1A, and PZ-2 have 15' of well screen while PZ-4 had 10' of screen. Number 2 sand was set around the well screen from the bottom of the hole to 2-5 feet above the top of the screen to provide a filter pack. However, in PZ-4 the sand was raised to 21 feet above the screen. During the drilling phase of PZ-4 water was encountered at 4 feet below the ground surface and augering was therefore an impossibility. The sand was raised 21 feet above the screen in order to capture the near surface ground water. A three foot layer of bentonite was placed above the sand to provide a fast setting seal to vertical migration within the borehole annulus. Grout was placed above the bentonite layer to one foot below ground surface. A one foot bentonite cap was placed above the grout to prevent any possible vertical migration downward from ground surface runoff. A concrete foundation box was placed above the one foot bentonite cap to protect the piezometer from possible damage. Average

2.0 FIELD PROGRAM

2.1 INTRODUCTION

The proposed locations of the four piezometers and four staff gauges were originally presented in the November letter report (see Figure E in Appendix A). During the course of installation, the location of two of the piezometers and one staff gauge was changed because of severe access problems. These changes were:

- The original location of PZ-1 was changed because of the severe slope between the eastern edge of the Inactive Disposal Area and the impoundments. As shown in Figure 1 of this report PZ-1 was moved to the northern end of the impoundment system and renumbered PZ-1A.

- The original location of PZ-3 was changed because of the severe slope between the northern edge of the Inactive Disposal Area and the railroad. As shown in Figure 1 of this report the location was moved to the northeast access road to the Inactive Disposal Area and renumbered PZ-1.

- The staff gauge designated SG-4 is actually located in Pond B as displayed on Figure 1. The original site plan did not differentiate between the three impoundments.

The original intent of the piezometer locations was to identify anomalies in the general direction of ground water flow as previously determined. Specifically, it was necessary to identify any ground water mounding which might alter normal ground water flow directions in the vicinity of either the Inactive Disposal Area or the impoundments. The new locations were selected in order to provide data addressing the same spatial and elevation interpretations.

PVC stick-up above the ground surface is two feet. Piezometer locations are shown on Figure 1.

Piezometer Development

The four piezometers were developed using a small air compressor. Each piezometer was developed on an average of one to two hours until the "fines" in the water produced from the well were considerably reduced.

Staff Gauges

All four staff gauges were installed according to the proposed location (see Figure 1). Staff gauge No. 4 was placed next to the intake structure in Pond B about eight feet from the dike-road. Staff gauge No. 3 was placed two to three feet out from the edge of Hennessey's Bayou because the water was to deep.

Staff Gauge Installation

The four staff gauges are made of 2" PVC schedule 40 material. A section of PVC was driven into the bayou bottom as far as possible. Then another section of PVC was connected with a coupling to the base PVC. The top section of PVC had strips of duct tape placed 3" apart starting from the top and spaced to the bottom. In addition, each staff gauge was perforated to facilitate water flow.

Update of Staff Gauges

SG-1, SG-2, and SG-3 have been destroyed by surging water between the time of installation and the date of this report. To resolve this problem we suggest that future staff gauges be constructed of steel pipe. This can be done with several 5' sections connected with threaded steel couplings. The bottom section will be driven as far as possible and then joined to another section with a coupling. These sections will be marked with duct tape 3" apart starting from the top.

Location of Piezometers

PZ-1 was placed in the northeast corner of the Inactive Disposal Area because of substantial overgrowth and uneven ground between the "mound" and Pond A. Ground water was not encountered in the upper 25 feet of soil in boring PZ-1. PZ-1A was placed on the north side of the dike road between Ponds A and B to provide additional water level data between the Inactive Disposal Area and MW-1 and due to access problems further west at the original location of PZ-3. PZ-2 was placed on the south side of the dike road on the south side of Pond C. It was placed here due to the access problems to the north of MW-5 caused by the sidewall slope of the Inactive Disposal Area. PZ-4 was placed according to its original planned location with no access problems.

Existing Monitor Wells

Monitor Wells No. 5,6, and 8 are 2" inside diameter (I.D.) wells while Monitor Wells No. 1,2, and 4 are 4" (I.D.) wells. MW-7 completed near grade couldn't be located for the December measurements by its placement on the map due to substantial overgrowth, mud, and water. MW-3 was not measured in December because of high water in Hennessey's Bayou.

Existing Ponds

The "Interim Status Surface Impoundment" has been sub-divided by two dike-roads into three separate ponds labeled A,B, and C. Pond A is fed by a discharge pipe from the plant. In turn, Ponds A and B are joined by an intake-discharge structure. Pond C is joined to Pond A by a 10 foot cutaway section of the dike road. These two ponds are only joined when the water level rises above EL. 103 MSL.

3.0 DATA ANALYSIS

3.1 SITE STRATIGRAPHY

The site stratigraphy was developed in three cross-sections from the borings drilled as part of this project and the available boring logs from previous studies. Figures 2 and 3 present the three cross-sections. The shallow stratigraphy at the site can be characterized by the following general horizons:

- A silty clay (fill) extends from the land surface to a depth of 6 to 7 feet.
- A silty clay-clayey silt to silt at depths ranging from 7 to 48 feet below ground surface.
- The third horizon is primarily a "marl" of undetermined thickness starting at a depth of 38 to 49 feet. Above this zone is a thin layer of sandy clay to clayey sand averaging 4 to 8 feet thick.

Pleistocene loess underlies the ground surface at the Vertac plant and vicinity. Loess is a depositional product of eolian, or wind blown, transport of silty sediments. The loess in the Vicksburg area is, typically, homogeneous, massive silt with variable clay content. Underlying the loess is a sandy clay and marl which constitutes the Bryam member of the Vicksburg Formation. The bed-rock, which underlies this region, consists of the Glendon limestone of the Vicksburg formation and under the limestone is the Jackson formation. This report is only concerned with the loess and the sandy clay/marl zones.

3.2 SOIL SAMPLES

Three soil samples taken during the installation of PZ-1 at depths of 18.5'-19.0',28.5'-29.0', and 38.5'-39.0' were selected for hydrometer and grain size laboratory testing. The purpose of these tests was to confirm the subsurface geologic conditions related to the possible

location of water bearing zones versus aquitards. The results of the grain size testing are shown on Table 1.

The laboratory tests reveal a predominately silt layer throughout the entire zone above the confining marl. There is a small percentage of clay present within the silt. Although characterized as a silt, this layer could be called a clayey-silt zone. This condition suggests that the ground water beneath the site is bounded by a lower confining layer (marl) and an upper clayey loess acting as only a semi-confining layer.

3.3 WATER LEVEL MEASUREMENTS

Two sets of water level measurements were made (December 1984 and February 1985) using both the existing monitor wells and the recently installed piezometers. The results of the measurement program are in Table 2 and Table 3. Potentiometric contour maps are presented displayed graphically in Figures 4a and 4b. Generally, the shallow ground water moves in a north to south direction as previously determined; however, the results of this program provide additional detail concerning ground water flow in the vicinity of the Interim Status Surface Impoundment and the Inactive Disposal Area.

Mounding is apparent in the vicinity of both PZ-4 and PZ-1. Both features can be associated with attendant topographic highs. In the case of PZ-4 a natural ridge line extending west to east is judged the cause of the localized mounding (see Figure 5). In the case of PZ-1, the local topographic feature is the above-grade Inactive Disposal Area. The consistently high water levels associated with PZ-1 are judged to be caused by mounding within the Inactive Disposal Area.

Finally, as shown in Figures 4a and 4b the local surface water bodies (Stout's Bayou, Hennessey's Bayou) directly affect gradient and flow direction in the shallow ground water.

4.0 CONCLUSIONS

4.1 SUBSURFACE SOIL CONDITIONS

The initial characterization of subsurface soil conditions (see data presented in Appendix A) is reasonably accurate. The shallow loess material which overlies the marl can be characterized as clayey silt and silty clay. The specific particle size and classification data on the special soil samples from boring PZ-1 do not identify any stratigraphic changes with depth; however, this could be due to artificial disturbance of the surface soils or very localized conditions. The fact that there is no apparent ground water mound under the Interim Status Surface Impoundments strongly suggests a silty clay layer (see Figures 2 and 3) which retards or prevents vertical migration of leachate.

4.2 HYDROGEOLOGIC CONDITIONS

The gradient and flow direction of the ground water contained within the loess above the marl are affected by natural and man-made topographic features. As shown in Figures 6a and 6b, Stout's Bayou and Hennessey's Bayou definitely cause localized increases in gradient. The elevation differential between the stream bottoms (80-90' FT MSL) and the ground water levels (90-100 FT MSL) will tend to draw down the water table in the vicinity of the bayous.

The elevated water levels consistently recorded in PZ-1 have been interpreted as a localized mound under the Inactive Disposal Area. For health and safety reasons, no piezometers have been installed directly into the landfill and PZ-1 is believed to be located on the edge of the identified mound. The interpretation of this feature as it effects ground water contours is displayed on Figures 6a and 6b. These data show that MW-1 is, in fact, down gradient of PZ-1 and any leachate mound associated with the Inactive Disposal Area. However, in order to effect ground water quality in MW-1, the leachate plume would have to move perpendicular to the gradient or experience significant lateral dispersion along its flowpath.

TABLE 1

SOIL SAMPLES
CLASSIFICATION AND PARTICLE SIZE ANALYSES

(FROM BORING PZ-1)

SAMPLE NO.	ST-1	ST-2	ST-3
DEPTH, FT	18.5-19.0	28.5-29.0	38.5-39.0
DESCRIPTION	TAN SILT	GRAY SILT	LIGHT TAN SILT
SAND, %	0	0	0
CLAY-SILT, % (Fines)	100	100	100

TABLE 2
WATER LEVEL DATA[1]
DECEMBER, 1984
VERTAC CHEMICAL CORPORATION
VICKSBURG, MISSISSIPPI

	PZ-1	PZ-1A	PZ-2	PZ-4	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	SG-3	SG-4
DEPTH TO WATER[2]	8.48	5.97'	14.70'	4.50'	3.12'	6.69'	-[3]	4.55'	13.63'	8.10'	-[3]	6.08'	-	-
PVC STICK-UP	2.10'	2.00'	1.90'	1.90'	1.46'	0.64'	-[3]	2.42'	0.60'	0.10'	-[3]	1.00'	-	-
GROUND ELEVATION	116.64'	111.03'	110.55'	112.34'	111.55'	107.57'	-[3]	112.28'	99.70'	98.68'	-[3]	109.83'	83.97'	-
WATER ELEVATION	110.26'	107.06'	97.75'	109.74'	109.89'	101.53'	-[3]	110.15'	86.67'	90.68'	-[3]	104.75'	89.15'	106.12'

(1) Water level measurements recorded on December 8, 1984.
(2) Depth to water from top of PVC.
(3) MW-3 and MW-7 could not be located in the field.

Note: SG-1 and SG-2 were destroyed several weeks after placement.

TABLE 3
WATER LEVEL DATA(1)
FEBRUARY, 1985
VERTAC CHEMICAL CORPORATION
VICKSBURG, MISSISSIPPI

	PZ-1	PZ-1A	PZ-2	PZ-4	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	SG-1	SG-2	SG-3
DEPTH TO WATER(2)	7.5'	6.25'	14.0'	3.91'	3.75'	7.08'	5.75'	4.83'	12.0'	8.91'	2.95'	6.16'	-	-	-
PVC STICK-UP	2.10'	2.00'	1.90'	1.90'	1.46'	0.64'	.89'	2.42'	0.60'	0.10'	.20'	1.00'	-	-	-
GROUND ELEVATION	116.64'	111.03'	110.55'	112.34'	111.55'	107.57'	98.44'	112.28'	99.70'	98.68'	99.13'	109.83'	87.56'(3)	85.86'(3)	83.97'(3)
WATER ELEVATION	111.24'	106.78'	98.45'	110.33'	109.26'	101.13'	92.69'	109.87'	88.30'	89.87'	96.38'	104.67'	88.17'	86.66'	87.07'

(1) Water level measurements recorded on February 18, 1985.
(2) Depth to water from top of PVC.
(3) Elevation of bayou bottom where staff gauges were placed.

Note: SG-3 was destroyed since 12/84.

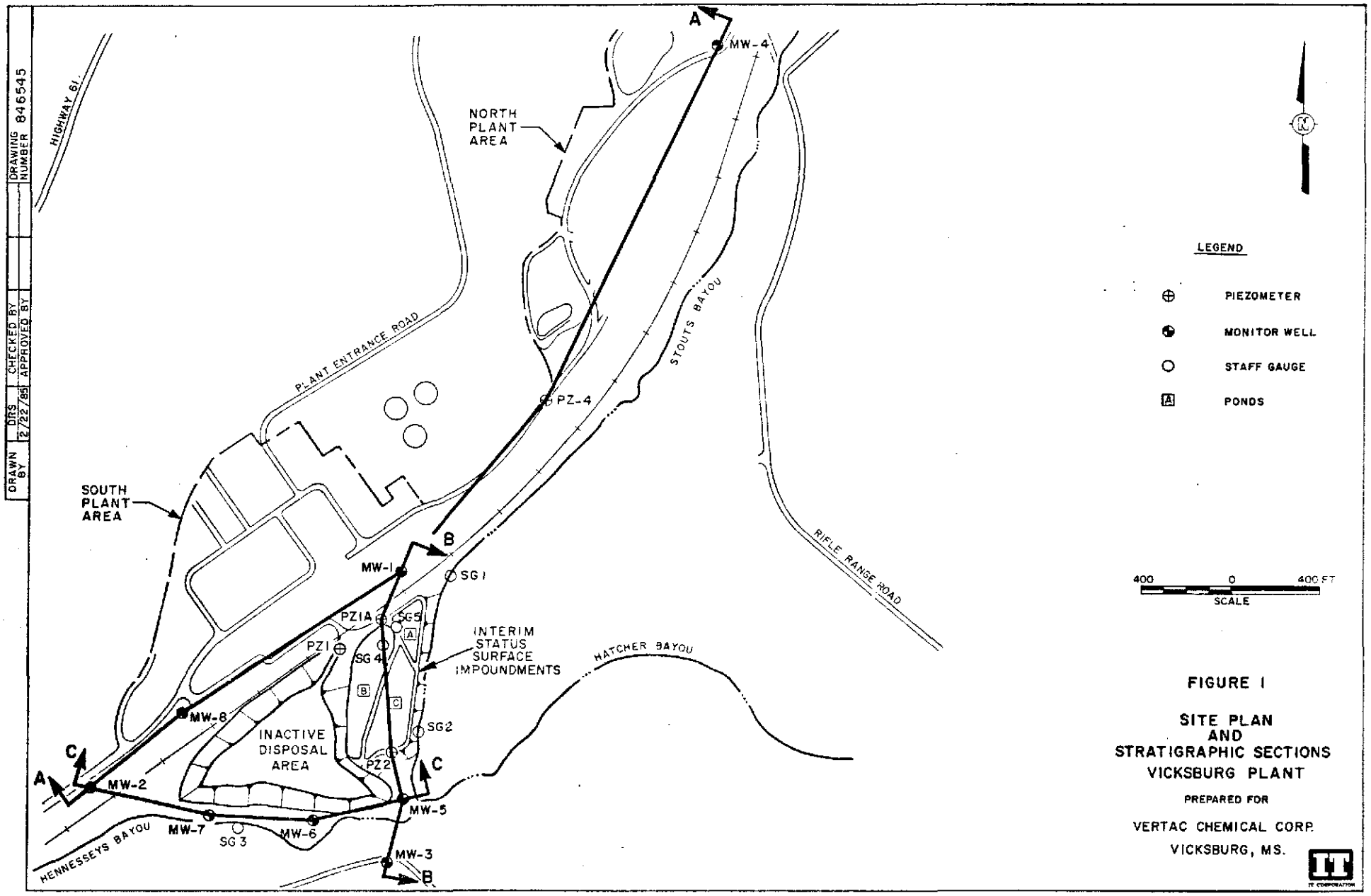
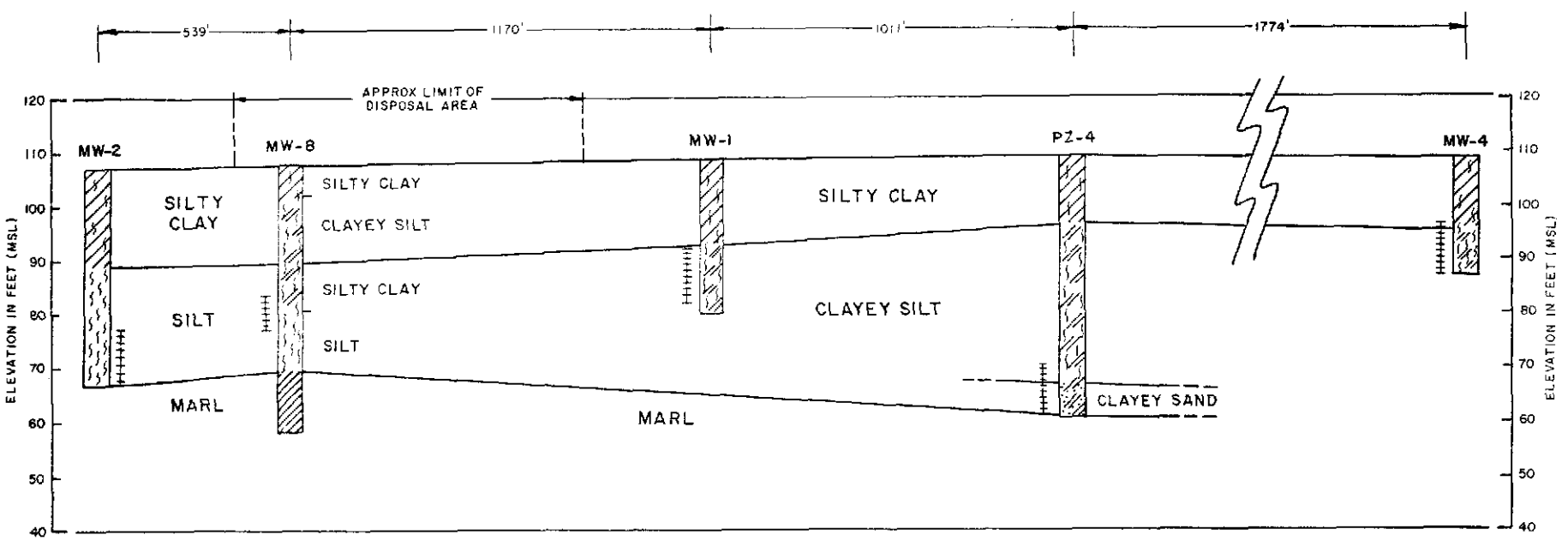


FIGURE 1

SITE PLAN
AND
STRATIGRAPHIC SECTIONS
VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.



SECTION A-A

300 0 300 FT
HORIZONTAL SCALE

20 0 20 FT
VERTICAL SCALE

FIGURE 2

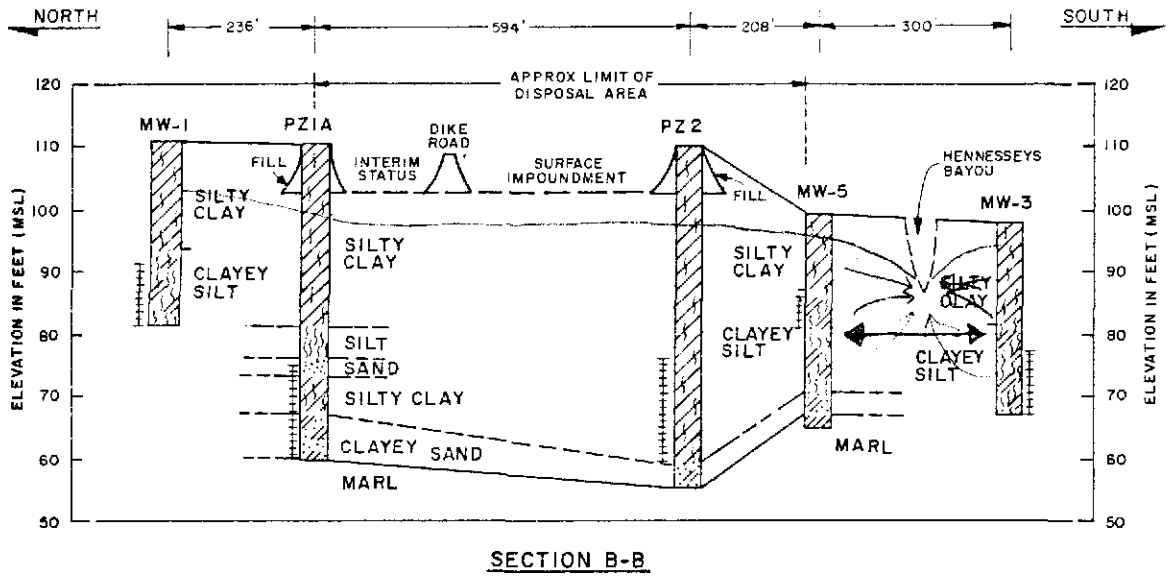
SECTION A-A
VICKSBURG PLANT

PREPARED FOR

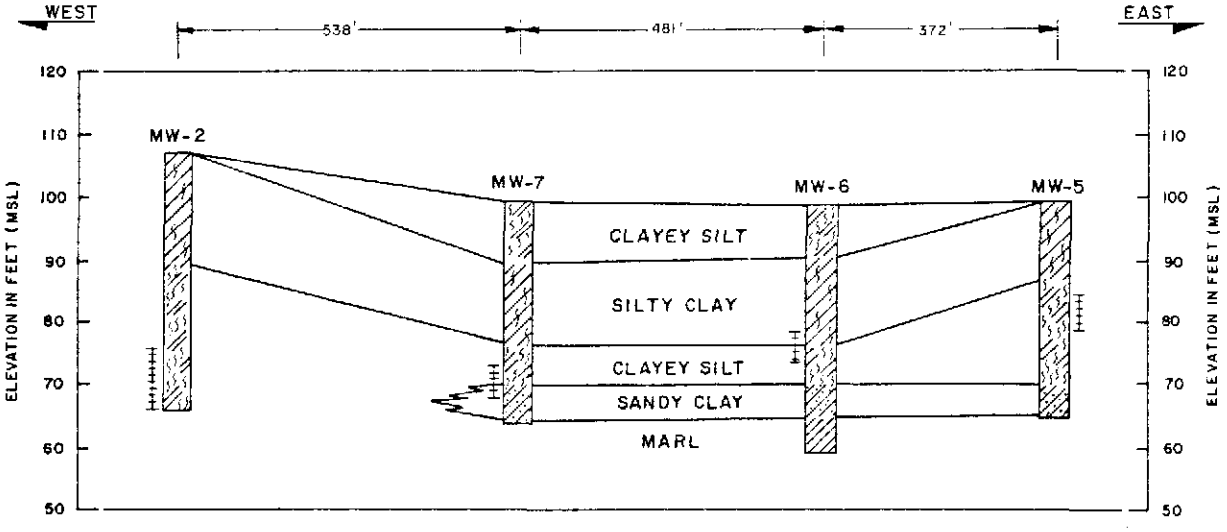
VERTAC CHEMICAL CORP.
VICKSBURG, MS.

DRAWN BY | DRS | 2/6/86
CHECKED BY | APPROVED BY
DRAWING NUMBER

32803



SECTION B-B



SECTION C-C

200 0 200 FT
HORIZONTAL SCALE

20 0 20 FT
VERTICAL SCALE

FIGURE 3

SECTION B-B & C-C
VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.

IT CORPORATION

DRAWN BY | DRS 2/7/85 | CHECKED BY | APPROVED BY | DRAWING NUMBER 846545

32803

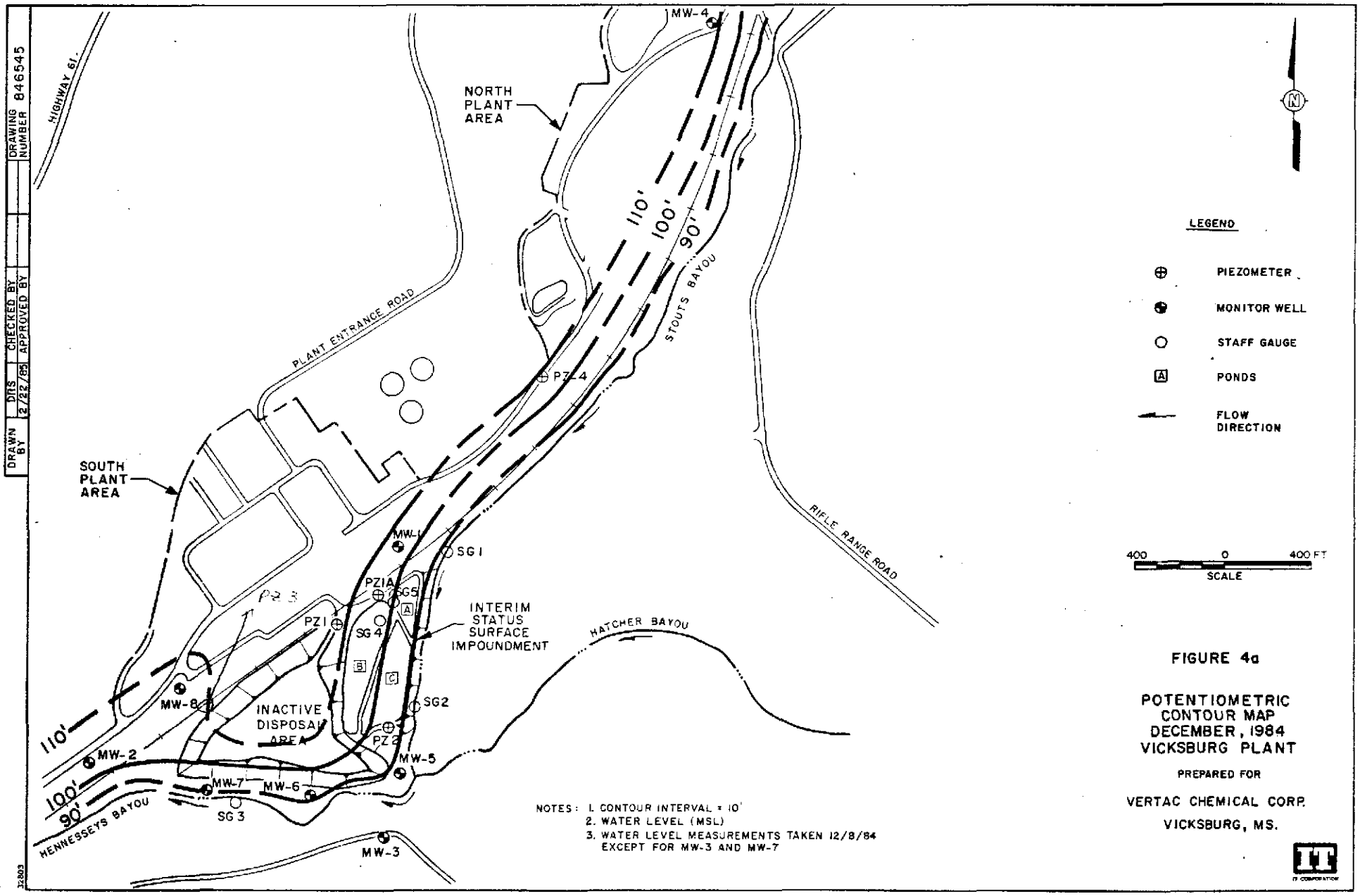


FIGURE 4a

POTENTIOMETRIC CONTOUR MAP DECEMBER, 1984 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

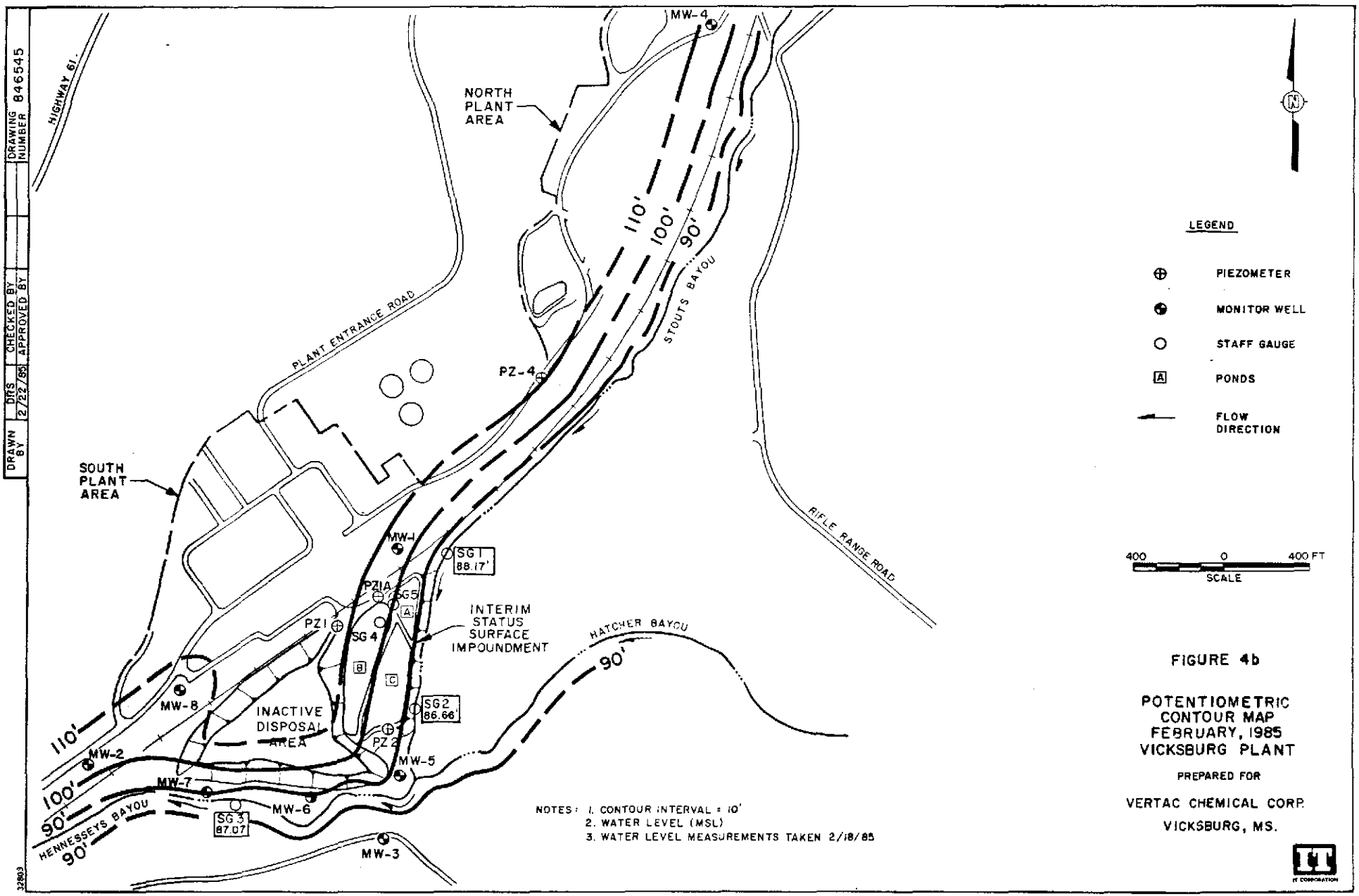


FIGURE 4b

POTENTIOMETRIC CONTOUR MAP FEBRUARY, 1985 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

IT CORPORATION

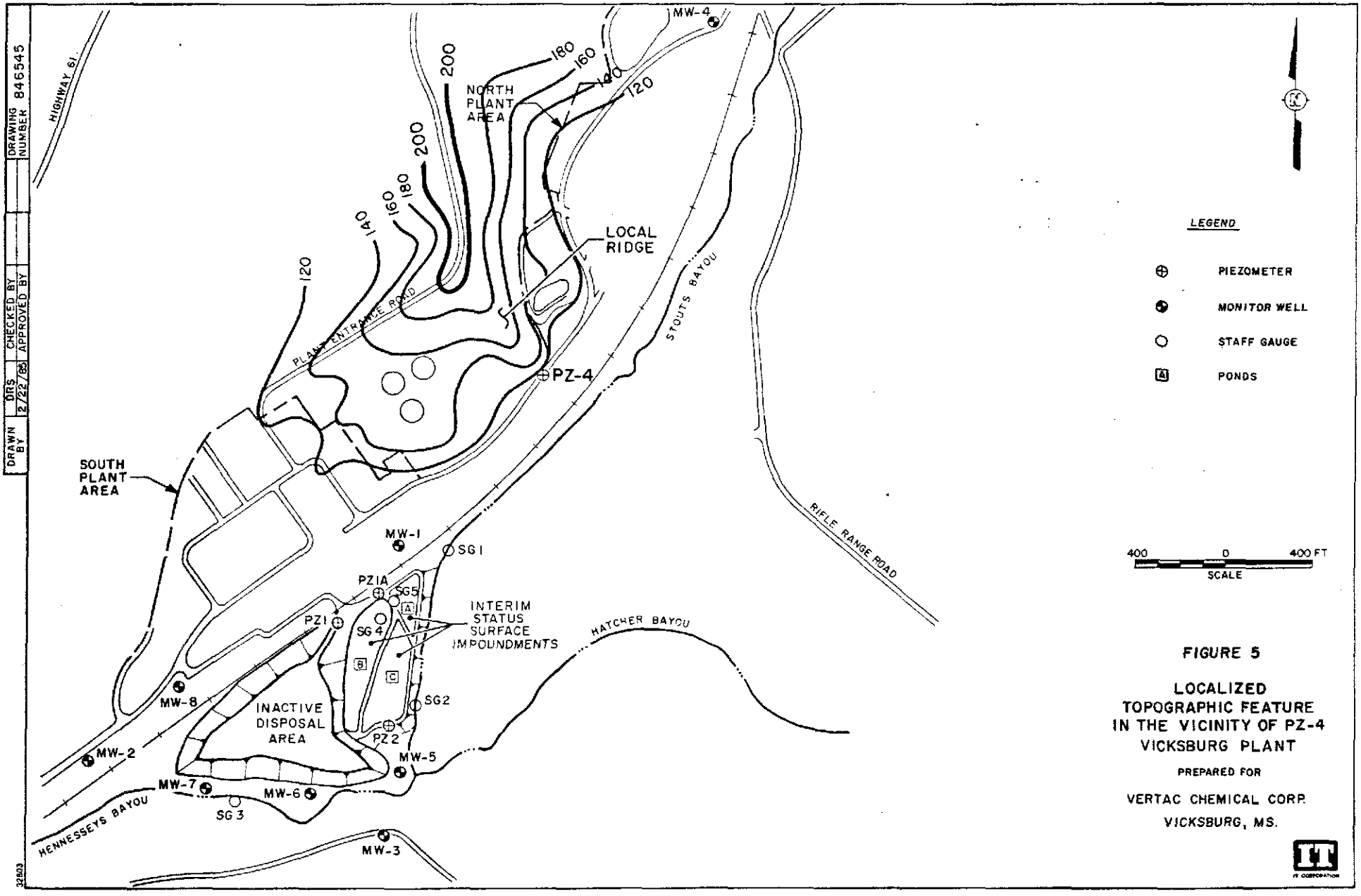


FIGURE 5

LOCALIZED TOPOGRAPHIC FEATURE IN THE VICINITY OF PZ-4 VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

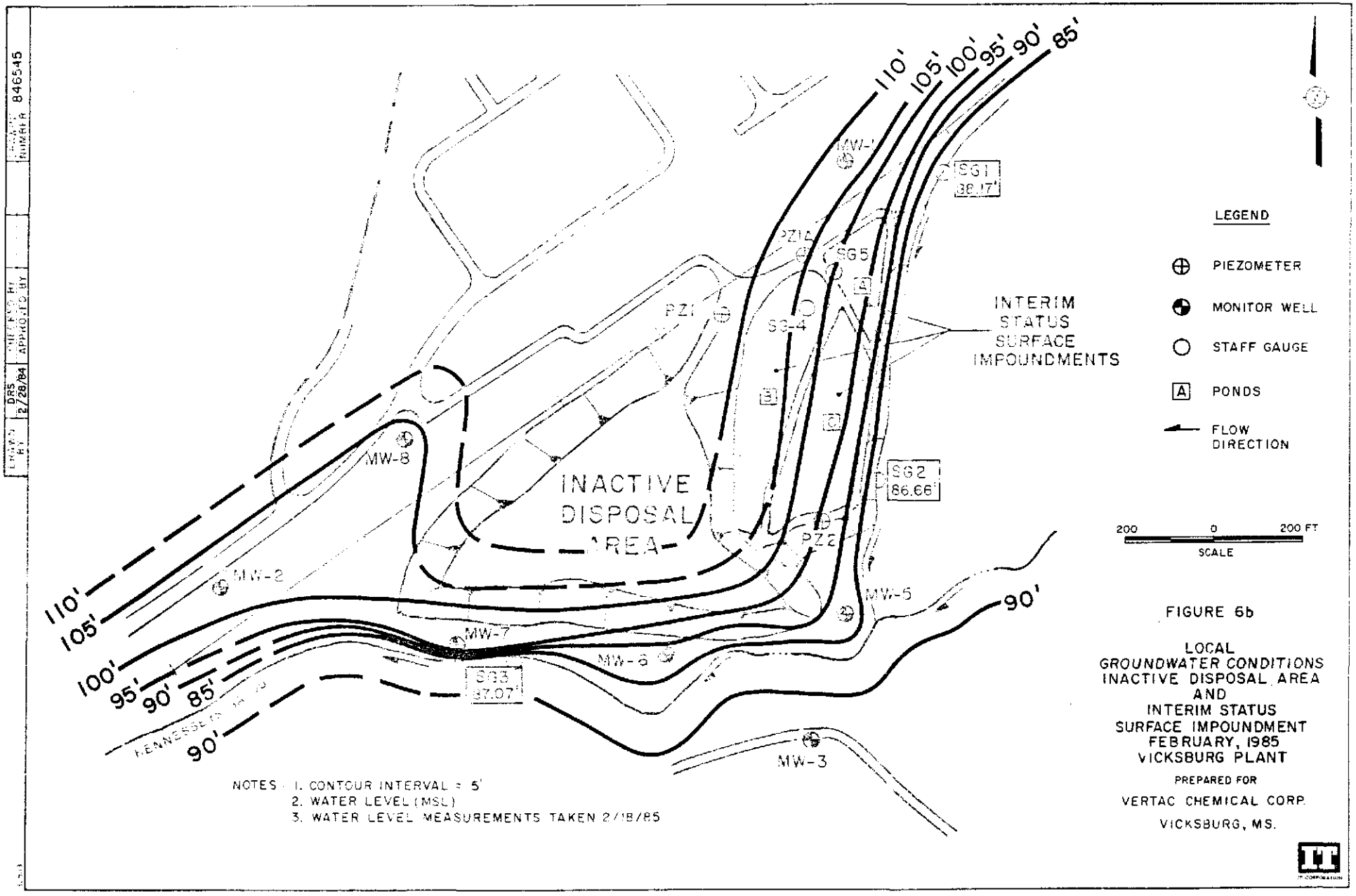


FIGURE 6b

LOCAL
GROUNDWATER CONDITIONS
INACTIVE DISPOSAL AREA
AND
INTERIM STATUS
SURFACE IMPOUNDMENT
FEBRUARY, 1985
VICKSBURG PLANT

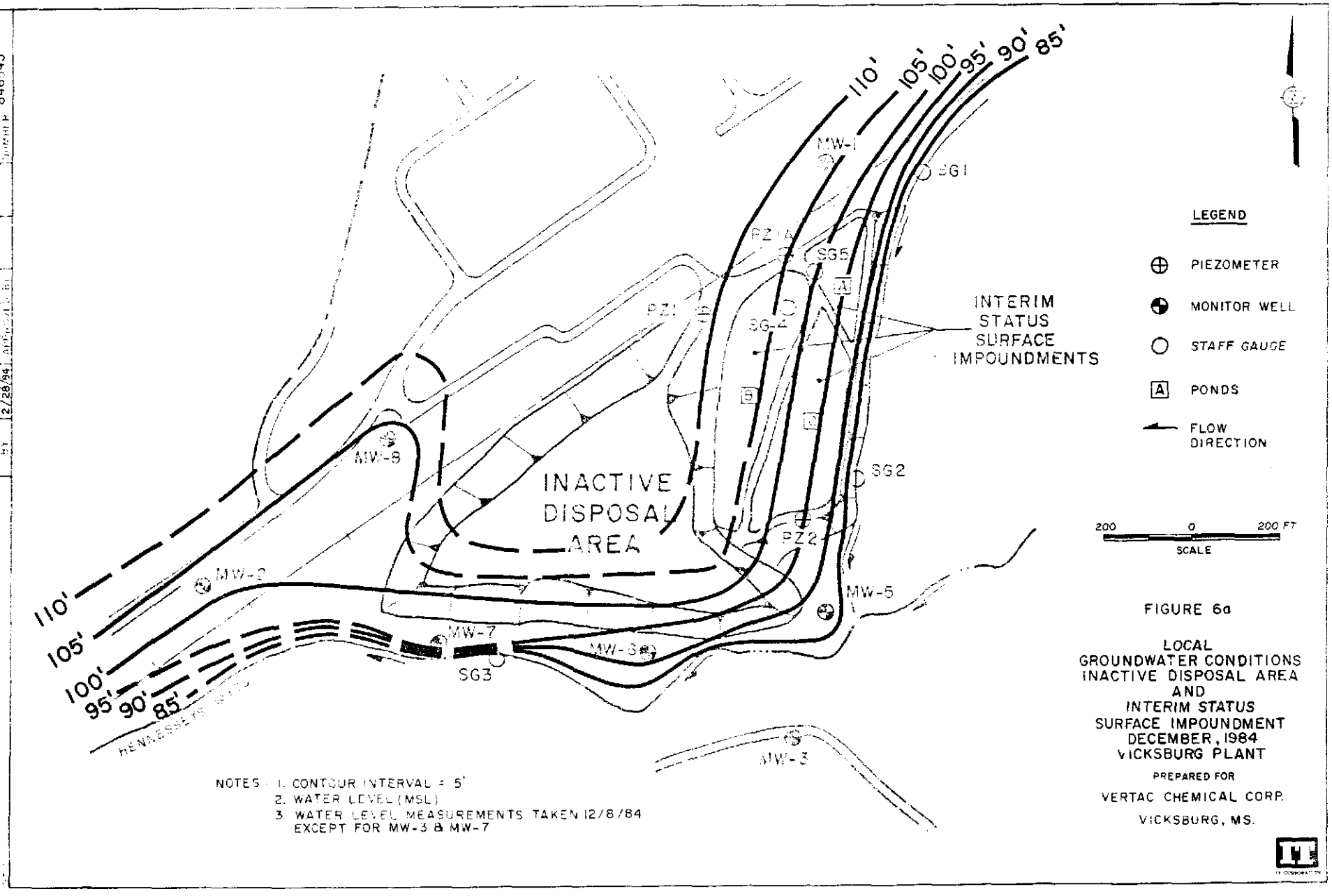
PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

DRS 2/28/84

DRAWING NUMBER 846545



NOTES: 1. CONTOUR INTERVAL = 5'
2. WATER LEVEL (MSL)
3. WATER LEVEL MEASUREMENTS TAKEN 12/8/84 EXCEPT FOR MW-3 & MW-7

FIGURE 6a

LOCAL
GROUNDWATER CONDITIONS
INACTIVE DISPOSAL AREA
AND
INTERIM STATUS
SURFACE IMPOUNDMENT
DECEMBER, 1984
VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.

VICKSBURG, MS.

Alan

IT CORPORATION

November 8, 1984

Mr. R. D. Karkkainen
Director-Environment & Safety
Vertac Chemical Corporatin
5100 Poplar, 24th Floor
Memphis, TN 38137

Project No. 846545

VICKSBURG GROUNDWATER ASSESSMENT

Dear Dick:

In accordance with your letter of October 5, 1984, we have completed several of the required work tasks as outlined in the Groundwater Assessment Plan. More specifically we have completed the following items:

1. Stratigraphic Cross-Sections (Figures B,C, and D). We have prepared three cross-sections using the existing boring data. The soil boring logs prepared by both previous contractors were used for this task. It should be noted that the change from silty clay to clayey silt is subtle and more detailed information from the new piezometers will better define this interface. The stratigraphic sections attached to this letter also show the well screening interval and the water levels recorded on March 4, 1983. Please note that wells #1-#4 were installed by one contractor while wells #5-#8 were installed by another contractor.

2. Existing Hydrogeologic Data. The compilation of water level measurements (made on March 4, 1983) is included on the attached stratigraphic logs. These data and their presentation also suggest that MW-1 is an upgradient well relative to the impoundment and the inactive disposal area. You might note that there is a significant distance between MW-1 and MW-5 (section B-B). If there is a gradient change in the vicinity of the Interim Status Impoundment, the additional piezometers proposed for that area should detect an elevated in water level.

   We have also reviewed the data contained in the contractors' reports concerning soil permeability. We feel that their calculations are appropriate given the

geologic conditions at the site; however, there are inconsistencies based on different interpretations of soil stratigraphy. In addition, groundwater flow velocity will be affected if hydraulic gradient changes are present across the site. Data from the new piezometers should resolve these inconsistencies.

3. Monthly water level measurements. We are proposing that four new piezometers be installed at the locations shown in Figure E. We are also proposing that three stream level gauging stations and one pond level station be established as shown in Figure E. When the piezometers are installed, an elevation survey should be performed to establish benchmark elevations for the new piezometers, to check the elevations of the existing wells and establish the levels for the four staff gauges. The first set of water level measurements can then be taken at all stations (eight (8) monitor wells, four (4) piezometers, four (4) staff gauges).

4. Appendix VIII Constituents. Also attached is a memo summerizing my discussions with analytical laboratories capable of testing for Appendix VIII constituents. We can use this as a basis for selecting the appropriate lab and for identifying target parameters.

5. Well Samples. This task should be completed as soon as a lab is selected. The lab should be required to provide sample kits (bottles, coolers, preservative). The actual sampling could be done by either John Hill or IT. We do recommend that a detailed sampling prcedure be documented and followed.

Following completion of items 3, 4 and 5 we will be in a much better position to evaluate the outcome of the groundwater assessment. If you have any questions, please contact me at (713) 784-2800.

Sincerely,

Alan Gradet
Project Manager

APG:gd

Attachment

IT CORPORATION

Memorandum

To R. D. Karkkainen, Vertac Chemical

Date November 6, 1984

From A. P. Gradet, IT-Houston

Project No. 846545

Subject GROUNDWATER TESTING FOR APPENDIX VIII CONSTITUENTS - VICKSBURG PLANT

Several analytical laboratories have been contacted concerning test protocols and projected costs for the analysis of Appendix 'VIII constituents in groundwater. None of the facilities contacted has implemented the Hierarchial Analysis Protocol (HAP) proposed by EPA on October 1, 1984. Based on the information gathered, three other approaches are potentially feasible at this time.

1. MODIFIED SCREENING ANANYSIS FOR ALL APPENDIX VIII CONSTITUENTS

The protocols used for testing groundwater for all Appendix VIII constituents do include some screening procedures. For example, Appendix VIII includes 51 metals and metal compounds. Under this method only the total metal concentrations will be quantified as an indicator of the possible concentrations of the 51 metal compounds. Similarly, one analysis for total cyanides will be used to indicate concentrations of the fourteen cyanide compounds.

This procedure would not include analyses for the 23 compounds which are unstable in water or for which there are no analyticl methods. Analysis for dioxin (2,3,7,8-TCDD) and formaldehyde is included. The estimated cost is $4060.00 per sample.

2. MODIFIED APPENDIX VIII

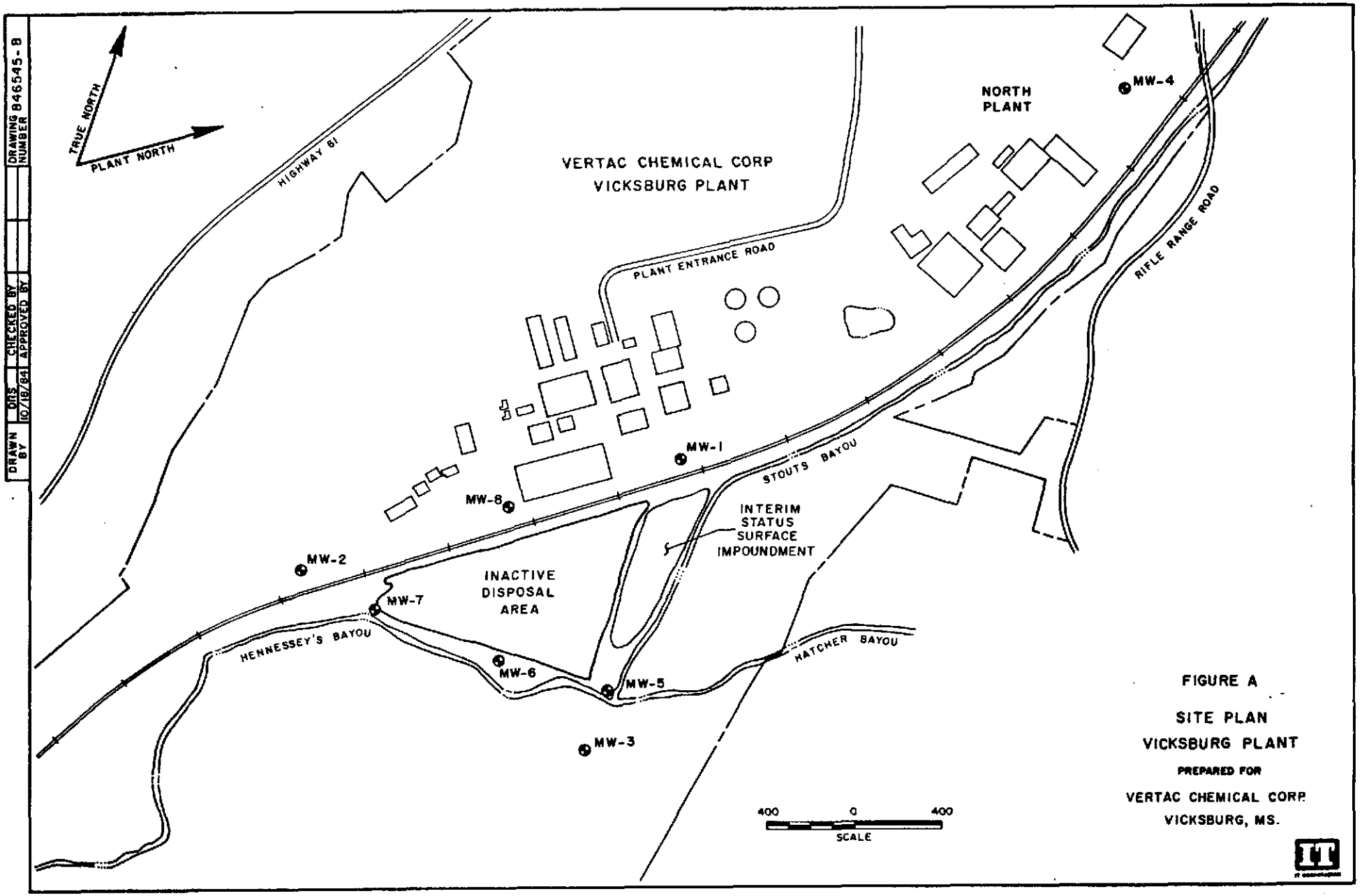
This protocol is based on a procedure recently prepared for the petroleum industry. In this case, twenty-four specific Appendix VIII constituents were identified as being of importance in addition to those constituents which are also Priority Pollutants. The significance of the priority pollutants is that most analytical laboratories with GC/MS capability are set up to efficiently analyze water samples for priority pollutants. The cost is normally on the order of $1000.00.

In this case it would be necessary to identify compounds of interest beyond the standard priority pollutant list. An additional fee of $20.00 per parameter would be charged. The anticipated total cost would be on the order of $2000-3000 based on identifying 50 to 100 additional parameters. Costs could be controlled by using classes of compounds (i.e. dichlorobenzenes for all possible isomers) and total methods as indicators of similar compounds; however, the qualitative selection process must still be performed.

3. DIRECT TESTING FOR ALL APPENDIX VIII CONSTITUENTS

No laboratories have been contacted to estimate the cost for direct testing because the above two techniques are available and direct testing would be economically unacceptable (expect costs on the order of $5000-10,000 per sample).

Either of the first two methods will probably be acceptable to the state of Mississiippi and the Region IV, EPA. Once a technique is selected a brief review of the proposed screening procedure with the appropriate state personnel is probably advisable.



© 1983 HERCULANE, AGE SMITH CO., PGH., PA

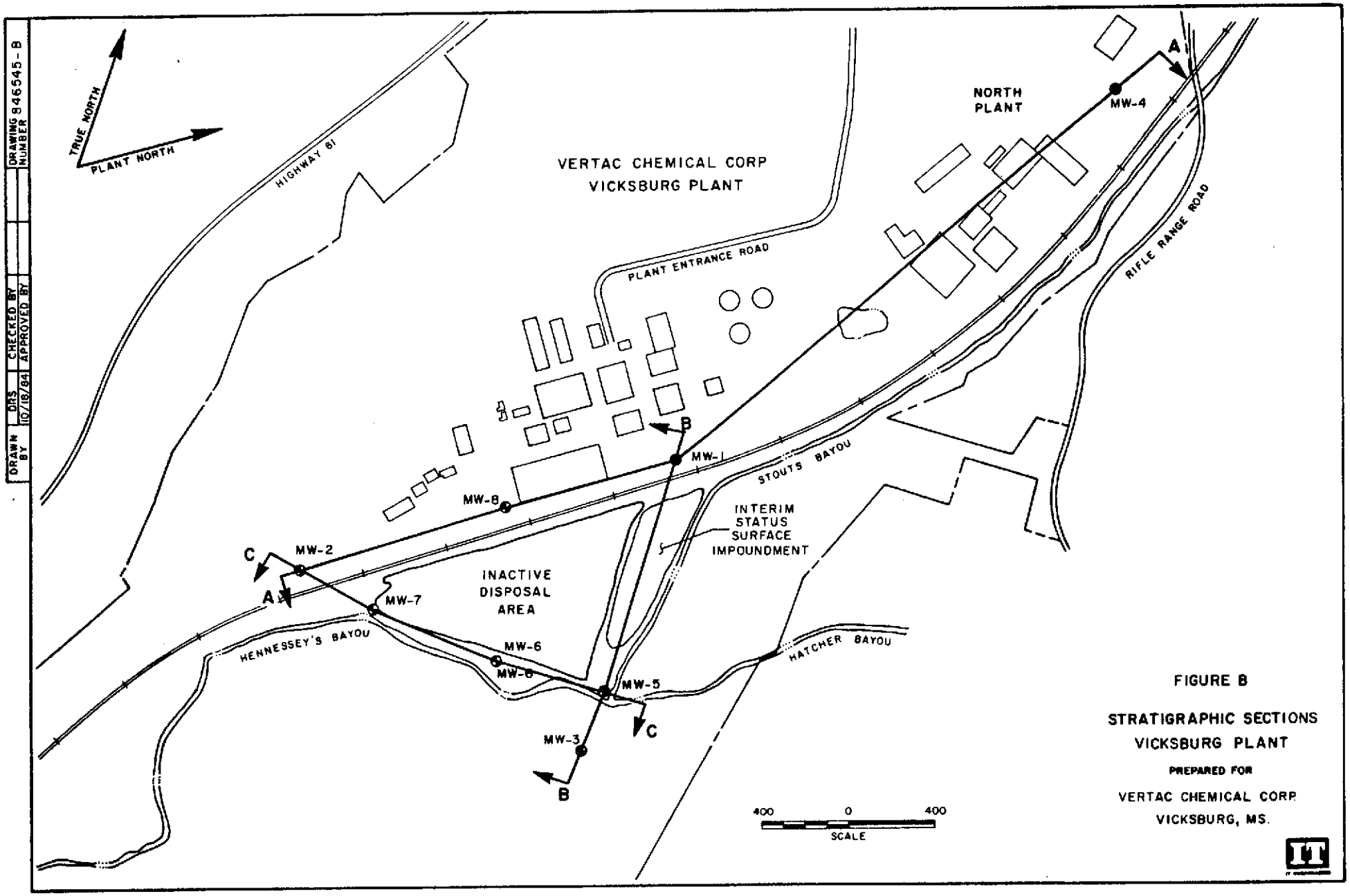


FIGURE 8

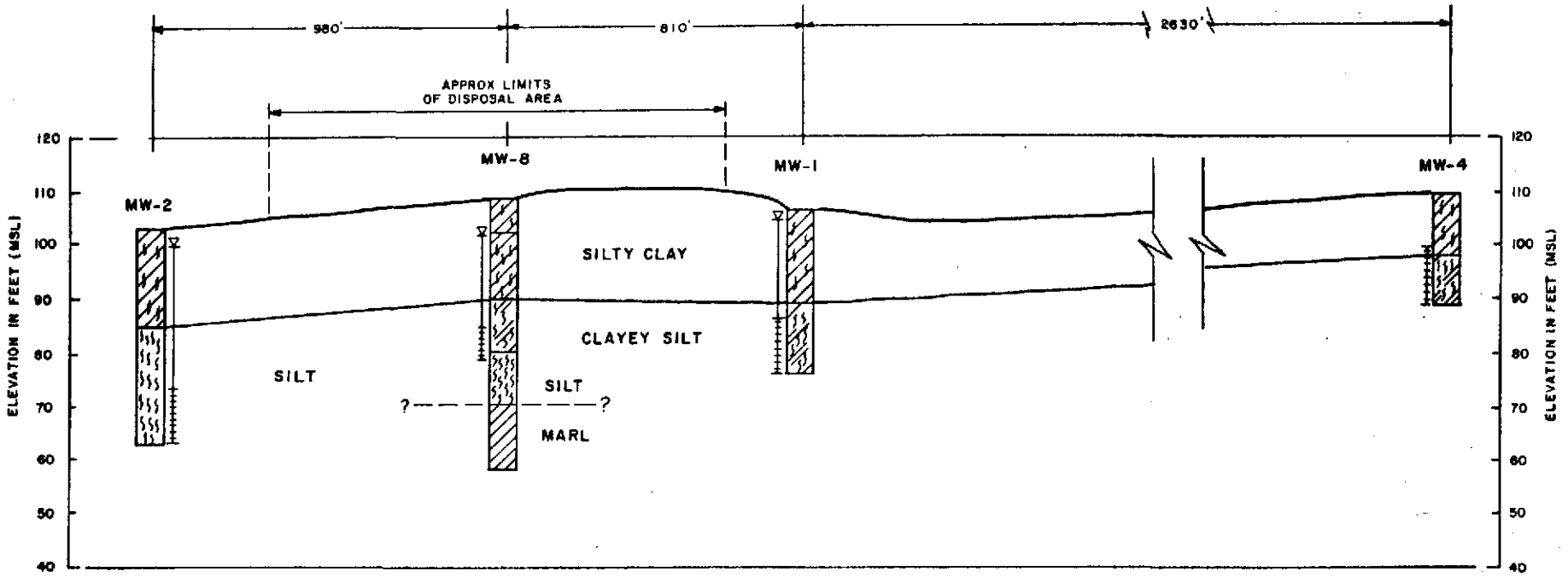
STRATIGRAPHIC SECTIONS
VICKSBURG PLANT

PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.

© 1983 HERCULENE A&B SMITH CO. - PGH. PA.

DRAWN BY	DRS	CHECKED BY	DRAWING NUMBER 846545-B
	10/19/84	APPROVED BY	



SECTION A-A

00 0 00 FT
HORIZONTAL SCALE

20 0 20 FT
VERTICAL SCALE

NOTES: 1. WATER LEVELS ARE THOSE REPORTED FOR MARCH 4, 1983.

2. STRATIGRAPHY SHOWN IS INTERPRETATION OF EXISTING BORING LOGS. SUBTLE VARIATIONS IN REPORTED SILT CONTENT ARE SHOWN.

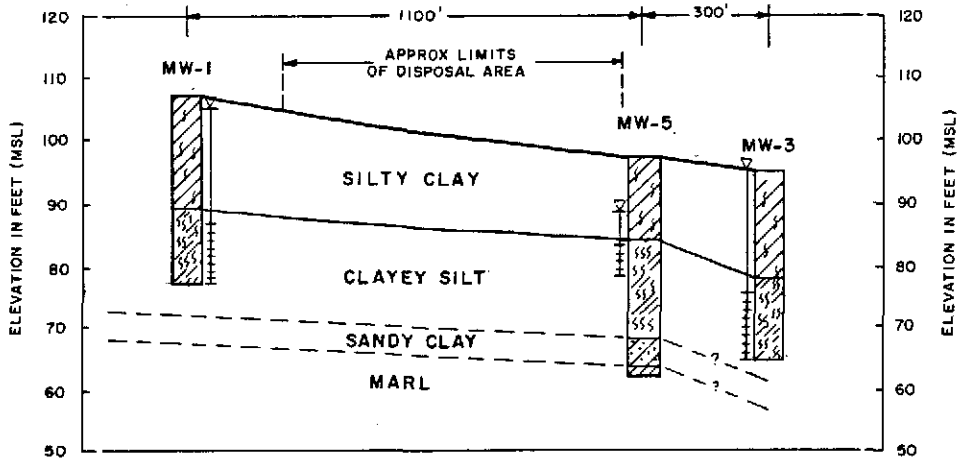
FIGURE C

SECTIONS A-A
VICKSBURG PLANT
PREPARED FOR
VERTAC CHEMICAL CORP.
VICKSBURG, MS.

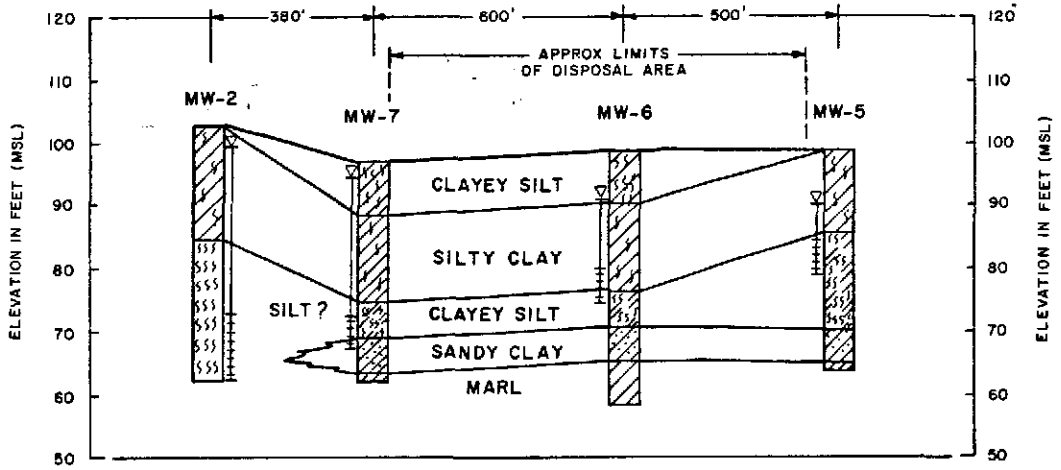
IT

© 1983 HERCULENE A&B SMITH CO PGH., PA

DRAWN BY	DRS 10/22/84	CHECKED BY	APPROVED BY	DRAWING NUMBER 846545-B



SECTION B-B



SECTION C-C

NOTES: 1. WATER LEVELS ARE THOSE REPORTED FOR MARCH 4, 1983.

2. STRATIGRAPHY SHOWN IS INTERPRETATION OF EXISTING BORING LOGS. SUBTLE VARIATIONS IN REPORTED SILT CONTENT ARE SHOWN.

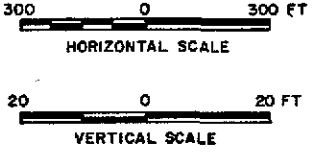
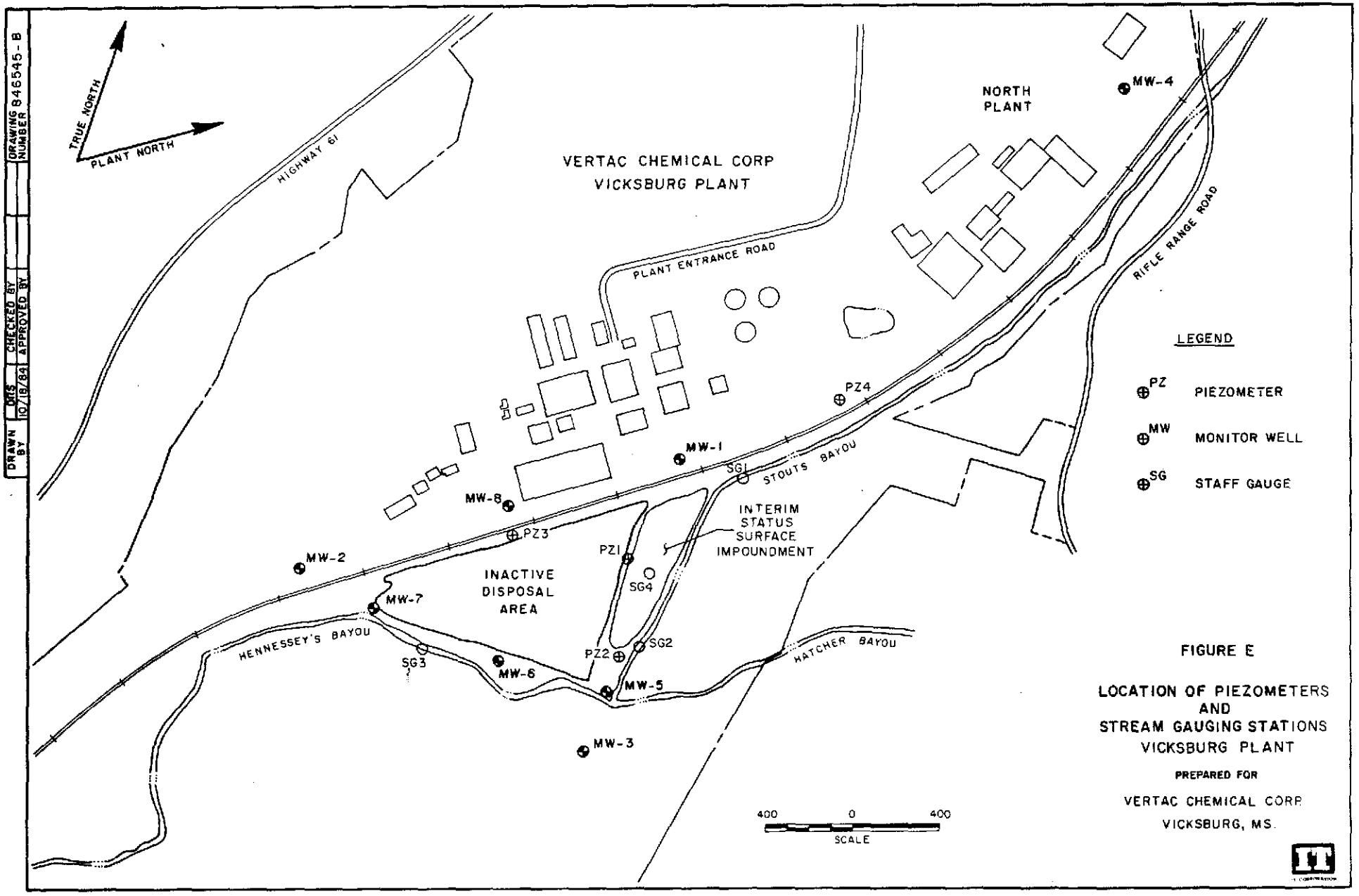


FIGURE D

SECTIONS B-B & C-C
VICKSBURG PLANT
PREPARED FOR
VERTAC CHEMICAL CORP.
VICKSBURG, MS.

IT CORPORATION

IG 1288 HERCULENE, A&B SMITH CO., PGH PA


DRAWN BY
DATE 10/18/84
CHECKED BY
APPROVED BY
DRAWING NUMBER 846545-B
TRUE NORTH
PLANT NORTH
HIGHWAY 61
VERTAC CHEMICAL CORP
VICKSBURG PLANT
NORTH PLANT
MW-4
PLANT ENTRANCE ROAD
RIFLE RANGE ROAD
PZ4
MW-1
SG1
STOUTS BAYOU
MW-8
PZ3
INTERIM STATUS SURFACE IMPOUNDMENT
PZ1
MW-2
SG4
INACTIVE DISPOSAL AREA
MW-7
HENNESSEY'S BAYOU
SG3
MW-6
PZ2
SG2
HATCHER BAYOU
MW-5
MW-3
LEGEND
PZ PIEZOMETER
MW MONITOR WELL
SG STAFF GAUGE
400 0 400
SCALE
FIGURE E
LOCATION OF PIEZOMETERS AND STREAM GAUGING STATIONS VICKSBURG PLANT
PREPARED FOR
VERTAC CHEMICAL CORP
VICKSBURG, MS.

Professional Service Industries, Inc.
National Soil Services Division

IT Corporation
2925 Briarpark, Suite 400
Houston, Texas 77042

Report No. 286-45209
December 28, 1984

Attention: Mr. John Daniels

HYDROMETER AND GRAIN SIZE ANALYSIS
VERTAC CHEMICAL

Gentlemen:

We are pleased to submit the results of the testing specified above. This testing was authorized by your Purchase Order No. H084-156 dated December 18, 1984.

Three copies of the gradation curves are being transmitted herewith.

We trust that the results will assist in the completion of your project. We appreciate the opportunity to perform this testing. Please call upon us if you have any questions.

Very truly yours,

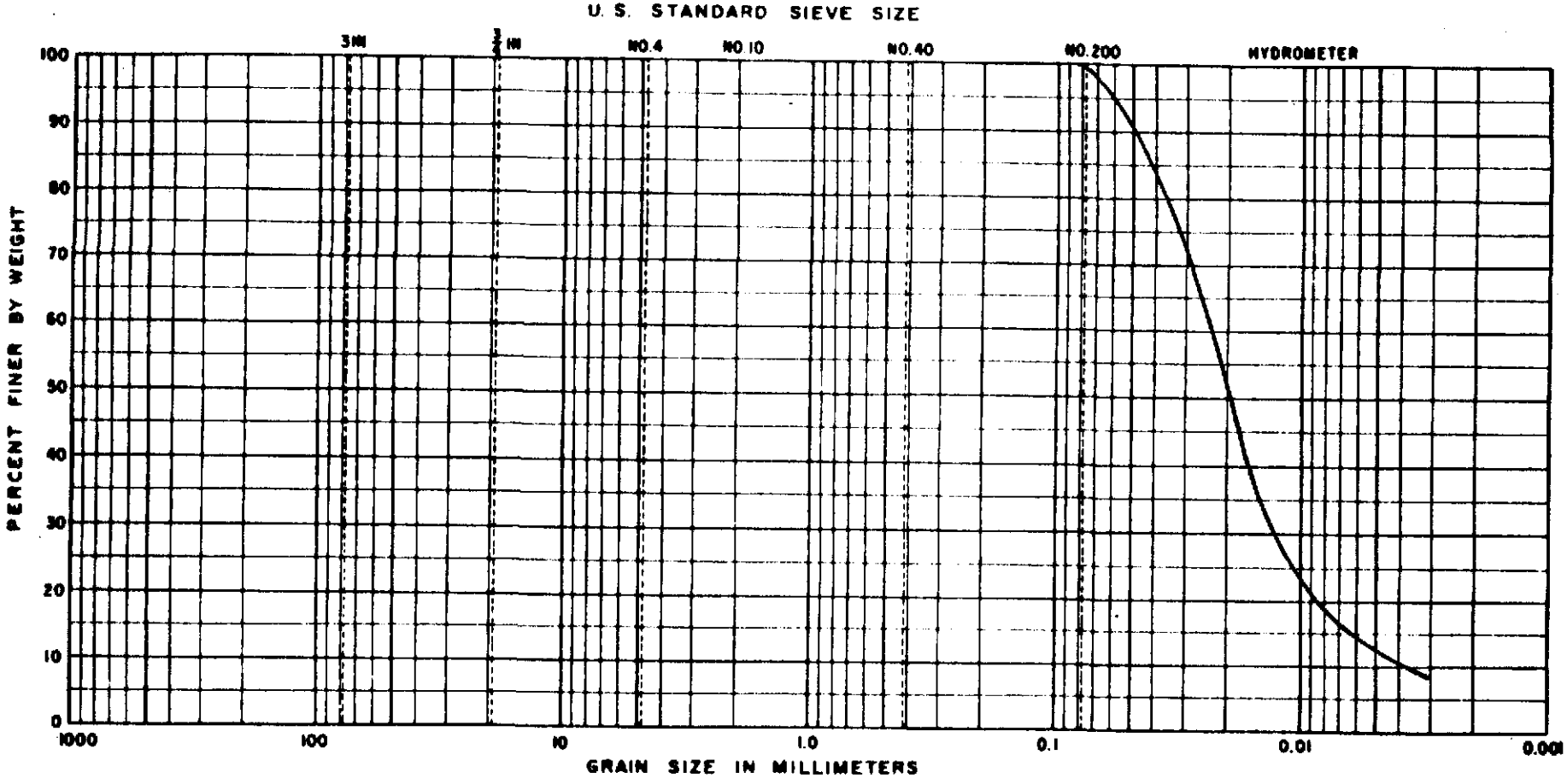
NATIONAL SOIL SERVICES DIVISION

Ron H. Pitts

Ron H. Pitts, P.E.,
Project Engineer

RHP:ig
Copies submitted: 3

NATIONAL SOIL SERVICES
CONSULTING ENGINEERS



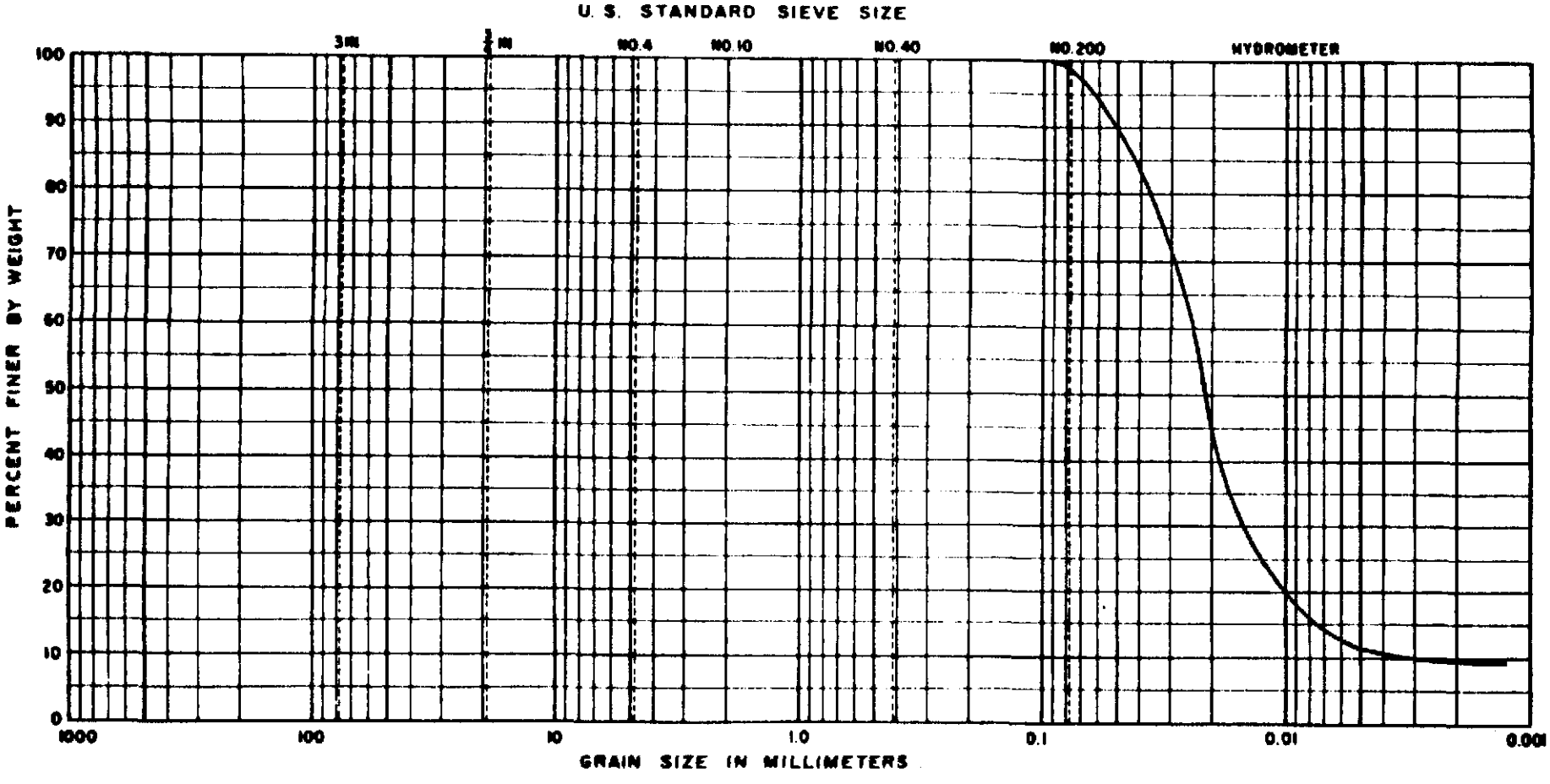
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE	ELEV-DEPTH	CLASSIFICATION	NAT. WC	LL	PL	PI	

Boring No: PZ-1
Sample No: ST-1
Depth, Ft: 18.5 - 19.0
Description: Tan silt

GRADATION CURVES

PLATE 1



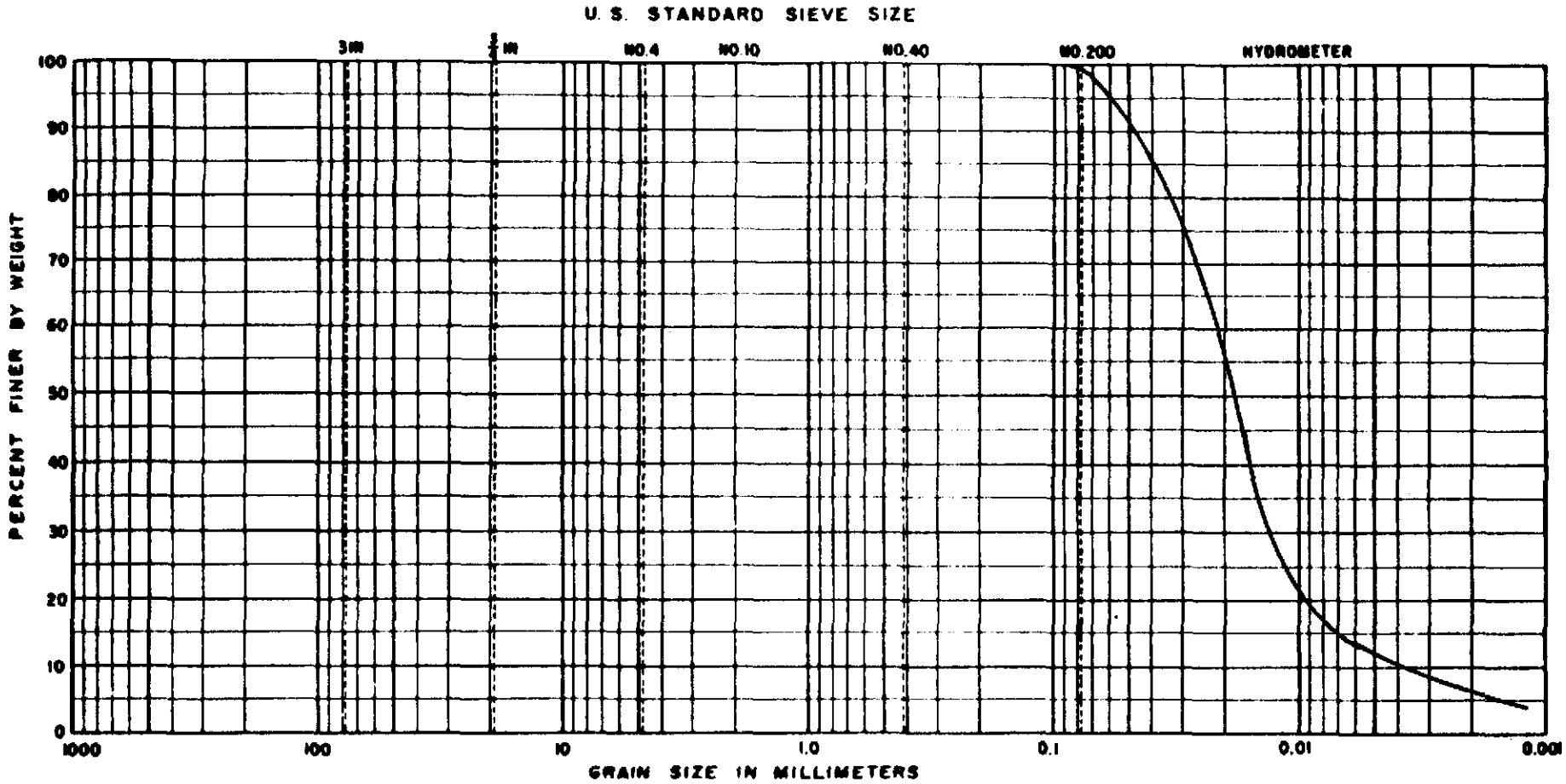
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE	ELEV-DEPTH	CLASSIFICATION	NAT. WC	LL	PL	PI	

Boring No: PZ-1
Sample No: ST-2
Depth, Ft: 28.5 - 29.0
Description: Gray silt

GRADATION CURVES

PLATE 2



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE	ELEV-DEPTH	CLASSIFICATION	NAT. WC	LL	PL	PI	

Boring No: PZ-1
Sample No: ST-3
Depth, Ft: 38.5 - 39.0
Description: Light tan silt

GRADATION CURVES

PLATE 3

IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical		
BORING NUMBER: PZ-1	COORDINATES:	DATE: 12/5/84	
ELEVATION:	GWL: Depth / Date/Time	DATE STARTED: 12/5/84	
ENGINEER/GEOLOGIST: JDD	Depth / Date/Time	DATE COMPLETED: 12/5/84	
DRILLING METHODS: Auger & Rotary Wash		PAGE 1 OF 2	

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0			Brown, Silty clay w/sl. gravel & sl. organics			Moist
5			Fill			
			Light gray-brown, Silt			
10			Mottled Red area @ 12.0'			
15			More gray color @ 15.0'			
			Mottled black area @ 17.0' & more broen color w/grey			
	ST-1		Tan		.75	Sample 18.5'-19.0', Moist
20			Gray 20.5'-48.0', Shell frag.'s 20.0'-28.0'			
25						
	ST-2				1.25	Sample 28.5'-29.0', shell frag.'s, moist
30						

NOTES:

Used 6" Auger from o'-25.0'. Rotary wash from 25.0'-54.0'. NO natural ground water was encountered. Cave-in occurred between 6.0'-8.0' where fill meets natural ground while augering to 25.0'.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical		
BORING NUMBER: PZ-1	COORDINATES:	DATE: 12/5/84	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/5/84	
ENGINEER/GEOLOGIST: JDD	Depth Date/Time	DATE COMPLETED: 12/5/84	
DRILLING METHODS: Auger & Rotary Wash		PAGE 2 OF 2	

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30			SILT			
35						
	ST-3				1.25	Sample 38.5'-39.0', shell frag's., Moist
40						
45						
	ST-4		Greenish-gray, clayey-sand, w/sl. Brown mottled areas	SC	2.50	Sample 49.0'-49.5', Moist
50			Hit Marl @ 52.0'			
	SB-1		Greenish-gray, calcarcous clay w/sand and gravel (marl)			Blows 17-12-18
55			Bottom of boring @ 54.0'			

NOTES:

IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical	
BORING NUMBER: PZ-1A	COORDINATES:	DATE: 12/6/84
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/6/84
ENGINEER/GEOLOGIST: JDD	Depth Date/Time	DATE COMPLETED: 12/6/84
DRILLING METHODS: Auger & Rotary Wash		PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0			Brown, Silty clay, Gravel			Moist
			Gray & chem. odor 4.0'-8.0'			
5			FILL			
			Brown color @ 8.0'			
10						
			SILTY CLAY	CL		
15						
20						
25						
30						

NOTES:

Used 6" Auger from 0'-18.0'. Rotary wash from 18.0'-52.0'. Water seeping in below 7.0' causing cave-in.

IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical		
BORING NUMBER: PZ-1A	COORDINATES:	DATE: 12/6/84	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/6/84	
ENGINEER/GEOLOGIST: JDD	Depth Date/Time	DATE COMPLETED: 12/6/84	
DRILLING METHODS: Auger & Rotary Wash		PAGE 2 OF 2	

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30			SILT			
35			Greenish-gray, med. to coarse sand, w/gravel 35.0'-38.0'	SP		
40			Gray, Silty clay	CL		
45	ST-1		Greenish-gray, clayey-sand, w/brown mottled areas, calc.	SC	2.25	Sample 44.0'-44.5'
50			Marl @ 50.5'			
			Bottom of boring @ 52.0'			
55						

NOTES:

IT CORPORATION

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical	
BORING NUMBER: PZ-2	COORDINATES:	DATE: 12/7/84
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/7/84
ENGINEER/GEOLOGIST: JDD	Depth Date/Time	DATE COMPLETED: 12/7/84
DRILLING METHODS: Auger & Rotary Wash		PAGE 1 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0			Brown, silt, w/sl. clay, organics			Moist
5			FILL			
10						
15			Shell frag.'s @ 15.0'			
20			SILT, w/SL. CLAY			
25						
30						

NOTES:

Used 6" Auger from 0'-23'. Rotary wash from 23'-56'. Around 35' down, we noticed water leaking out of slope about 12' down off the side. Therefore, losing water 12'-15' down the hole horizontally.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical	
BORING NUMBER: PZ-2	COORDINATES:	DATE: 12/7/84
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/7/84
ENGINEER/GEOLOGIST: JDD	Depth Date/Time	DATE COMPLETED: 12/7/84
DRILLING METHODS: Auger & Rotary Wash		PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30			Wood cuttings 32.0'-38.0'			
35			SILT, w/SL. CLAY			
40			Wood cuttings @ 44.0'			
45						
	ST-1		Grey, SL. calc.		1.25	Sample 48.5'-49.0', very moist
50						
55			Hit marl @ 56.0'			
			Bottom of boring @ 56.0'			
60						

NOTES:

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical		
BORING NUMBER: PZ-4	COORDINATES:	DATE: 12/7/84	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 12/7/84	
ENGINEER/GEOLOGIST: JDD	Depth Date/Time	DATE COMPLETED: 12/7/84	
DRILLING METHODS: Auger & Rotary Wash		PAGE 1 OF 2	

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0			Gravel mixed w/shells 4.0'-5.0'			
5			Brown, Silty-clay, w/gravel	CL		
10						
15			Gray-tan color 12'-18' Clayey-Silt	ML		
20	ST-1		Dark gray, organics		.75	Sample 19.5'-20.0', moist, Light grey silt seams
25						
30						

NOTES:

Used 6" auger from 0'-15'. Rotary wash from 15'-49'. Lost water between 4.0'-5.0' and therefore used 6' of surface casing to block it off while drilling.

VISUAL CLASSIFICATION OF SOILS

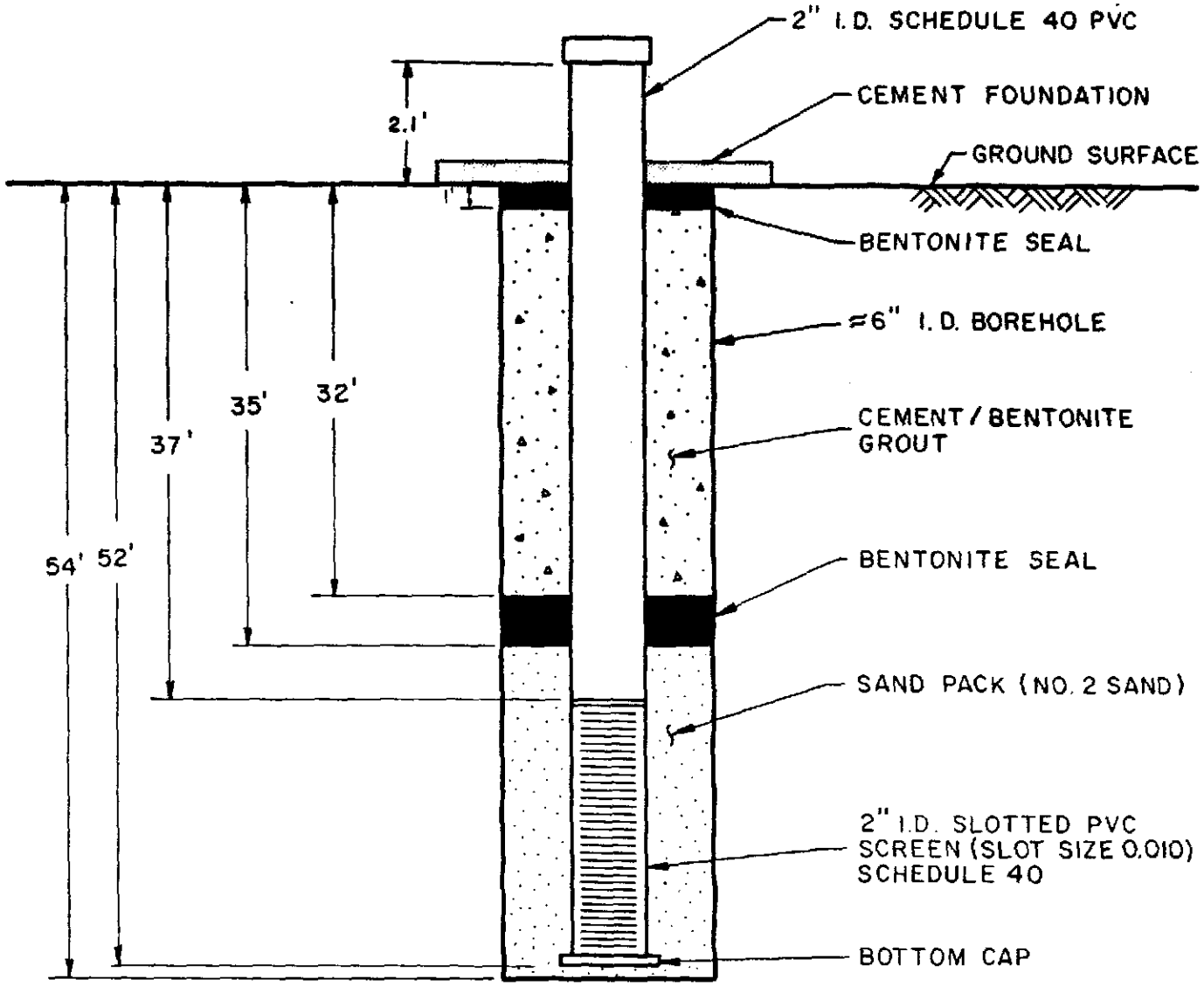
PROJECT NUMBER: 846545	PROJECT NAME: VERTAC Chemical		
BORING NUMBER: PZ-4	COORDINATES:		DATE: 12/7/84
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 12/7/84
ENGINEER/GEOLOGIST: JDD	Depth	Date/Time	DATE COMPLETED: 12/7/84
DRILLING METHODS: Auger & Rotary Wash			PAGE 2 OF 2

DEPTH (FT)	SAMPLE TYPE & NO.	PROFILE	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30			Wood & grass cuttings @ 30.0'			
35			Light gray, silt w/clay @ 37.0'			
40						
	ST-2		Gray, clayey-sand, very calc., brown mottled areas	SC	1.5	Sample 44.0'-44.5'
45			Hit marl @ 49.0'			
50			Bottom of boring @ 49.0'			

NOTES:

DRAWING NUMBER 846545-A

DRAWN BY	CHECKED BY	APPROVED BY
DRS 12/10/84		



DATE INSTALLED: 12/5/84

ELEVATION, TOP OF CASING: 118.74'

FIGURE

PIEZOMETER PZ-1
CONSTRUCTION DETAILS

PREPARED FOR

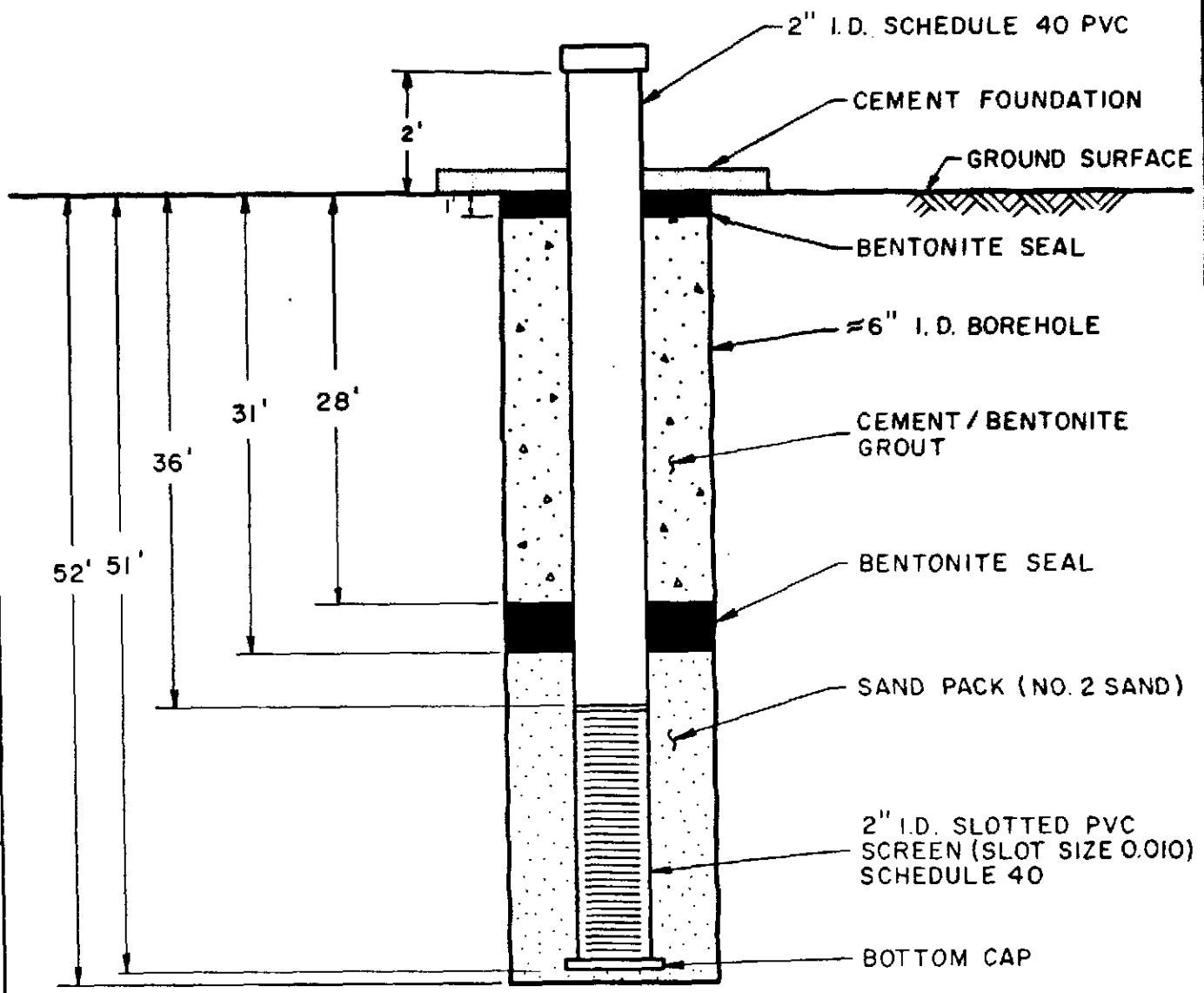
VERTAC CHEMICAL CORP.
VICKSBURG, MS.

DRAWING NOT TO SCALE

IT CORPORATION

IS 1253 HERCULENE. A&B SMITH CO., PGH., PA

DRAWING NUMBER	846545-A
DRAWN BY	DRS
	12/10/84
CHECKED BY	
APPROVED BY	



DATE INSTALLED: 12/6/84

ELEVATION, TOP OF CASING: 113.03

FIGURE

PIEZOMETER PZ-1A
CONSTRUCTION DETAILS

PREPARED FOR

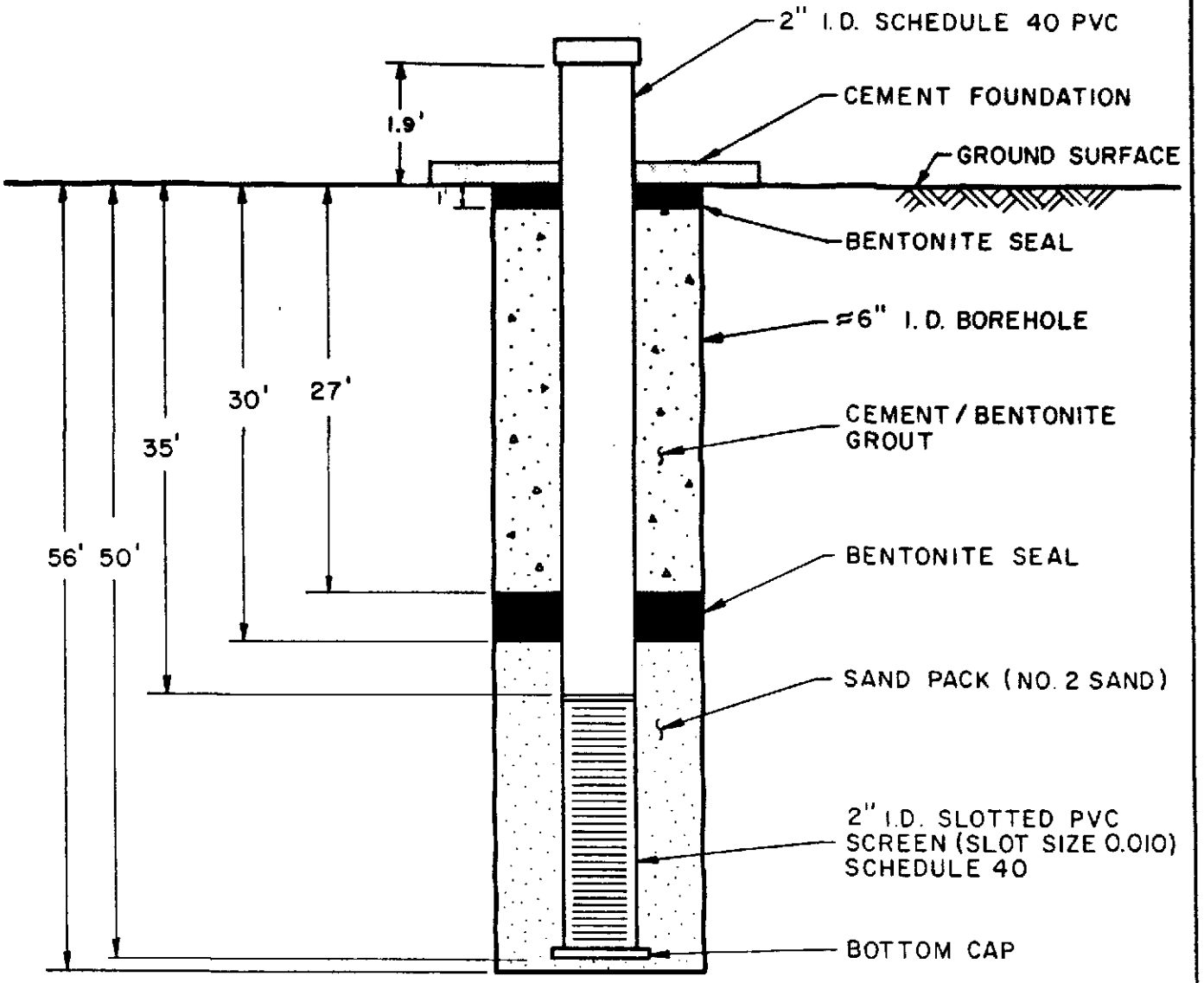
VERTAC CHEMICAL CORP.
VICKSBURG, MS.

DRAWING NOT TO SCALE

IT CORPORATION

10 1293 HERCULENE, A&B SMITH CO., PGH PA

DRAWING NUMBER	846545-A
CHECKED BY	APPROVED BY
DRS	12/10/84
DRAWN BY	



DATE INSTALLED: 12/7/84

ELEVATION, TOP OF CASING: 112.45'

FIGURE

PIEZOMETER PZ-2
CONSTRUCTION DETAILS

PREPARED FOR

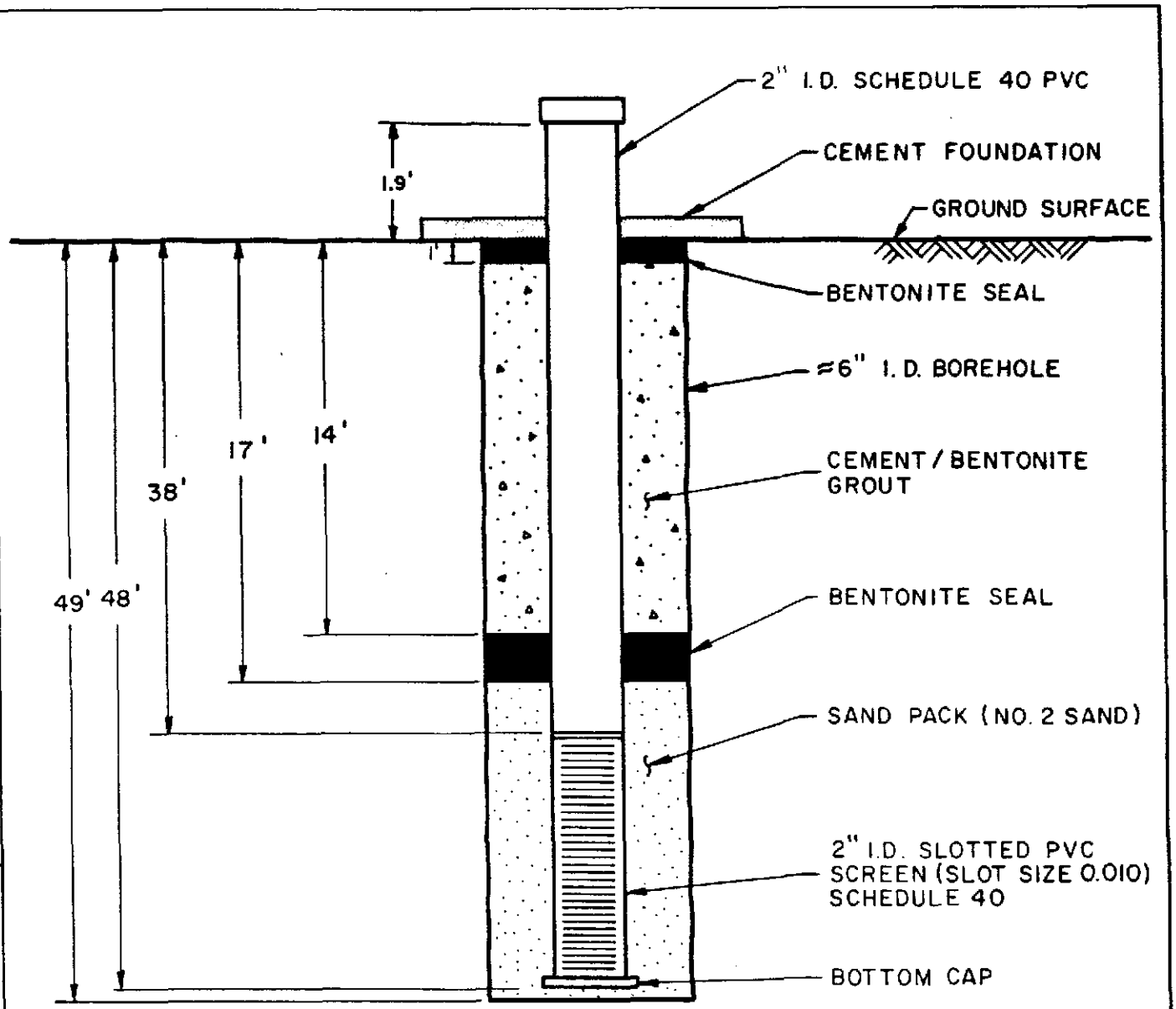
VERTAC CHEMICAL CORP.
VICKSBURG, MS.

DRAWING NOT TO SCALE

IT CORPORATION

19 1253 HERCULENE A&B SMITH CO. PGH PA

DRAWING NUMBER	846545-A
CHECKED BY	
APPROVED BY	
DRS	
12/10/84	
DRAWN BY	



DATE INSTALLED: 12/7/84

ELEVATION, TOP OF CASING: 114.24'

FIGURE

PIEZOMETER PZ-4
CONSTRUCTION DETAILS

PREPARED FOR

VERTAC CHEMICAL CORP.
VICKSBURG, MS.

DRAWING NOT TO SCALE

IT CORPORATION

19 1353 HERCULENE. A&B SMITH CO. PGH. PA

PROJECT Monitoring Wells
Vertac Chemical Corp.
Vicksburg, Mississippi

DRILLING RIG B-40

JOB. NO. 872

BORING NO. B-1
SHEET 1 OF 1

GROUND SURFACE ELEVATION 107.1
DATUM MSL

BORING LOCATION
See Plan

BORING TYPE
3 1/4" Hollow Auger
2" Split Spoon

GROUND WATER LEVEL
13' at drilling
9' at completion

DATE 29 September 1981
WEATHER Clear, warm
DRILLER Bill Barnes
INSPECTOR John Walton
BORING TERMINATED AT 30'

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	14	25	Stiff brown silty CLAY
2	8.5-10.0	6	23	Firm brown silty CLAY
3	13.5-15.0	8	27	Firm brown silty CLAY
4	18.5-20.0	3	31	Soft brown silty CLAY, with gray silt marbeling
5	23.5-25.0	8	27	Firm brown silty CLAY, with gray silt marbeling
6	28.5-30.0	4	28	Soft brown silty CLAY

DISC

LOG OF BORING

PROJECT	DRILLING RIG	JOB. NO.	BORING NO. B-2
Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	B-40	872	SHEET 1 OF 1

GROUND SURFACE ELEVATION 103.0
DATUM MSL

BORING LOCATION
SEE PLAN

BORING TYPE
3 1/4" Hollow Auger
2" Spilt Spoon

GROUND WATER LEVEL
26' at drilling

DATE 29 September 1981
WEATHER clear and warm
DRILLER Bill Barnes
INSPECTOR Terry Primm
BORING TERMINATED AT 40'

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	7	25	Firm tan silty CLAY
2	8.5-10.0	7	24	Firm tan silty CLAY
3	13.5-15.0	6	24	Firm tan silty CLAY
4	18.5-20.0	6	25	Firm gray silt
5	23.5-25.0	6	23	Firm gray silt
6	28.5-30.0	8	23	Firm gray silt
7	33.5-35.0	7	23	Firm gray silt
8	38.5-40.0	8	32	Firm gray silt

DISC

LOG OF BORING

PROJECT Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	DRILLING RIG B-40	JOB. NO. 872	BORING NO. B-3 SHEET 1 OF 1

GROUND SURFACE ELEVATION 95.5
DATUM MSL

BORING LOCATION
SEE PLAN

BORING TYPE
3 1/4" Hollow Auger
2" Split Spoon

GROUND WATER LEVEL
20' at drilling

DATE 30 September 1981
WEATHER clear and warm
DRILLER Bill Barnes
INSPECTOR Terry Primm
BORING TERMINATED AT 30'

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	5	24	Firm brown silty CLAY
2	8.5-10.0	8	20	Firm brown silty CLAY
3	13.5-15.0	2	33	Soft brown silty CLAY
4	18.5-20.0	5	31	Firm brown silty CLAY,w/gray silt marbeling
5	23.5-25.0	3	29	Soft brown silty CLAY,w/gray silt marbeling
6	28.5-30.0	7	28	Firm brown silty CLAY,w/gray silt marbeling

LOG OF BORING

PROJECT Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	DRILLING RIG B-40	JOB. NO. 872	BORING NO. B-3A SHEET 1 OF 1
GROUND SURFACE ELEVATION 95.5 DATUM MSL	BORING LOCATION See Plan		
BORING TYPE 3 1/4" Hollow Auger 2" Split Spoon	GROUND WATER LEVEL 20' at drilling	DATE 30 September 1981 WEATHER Clear & Warm DRILLER Bill Barnes INSPECTOR Terry Primm BORING TERMINATED AT 30'	

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
ST-1	5.0-7.0	--	25	Brown Silty CLAY
ST-2	8.0-10.0	--	23	Brown Silty CLAY
ST-3	18.0-20.0	--	32	Brown Silty CLAY w/gray silt marbeling

NOTE: ST = Shelby Tube

DISC

LOG OF BORING

PROJECT Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	DRILLING RIG B-40	JOB. NO. 872	BORING NO. B-4 SHEET 1 OF 1

GROUND SURFACE ELEVATION 109.6
DATUM MSL

BORING LOCATION
SEE PLAN

BORING TYPE
3 1/4" Hollow Auger
2" Split Spoon

GROUND WATER LEVEL
9' at drilling

DATE 01 October 1981
WEATHER clear and warm
DRILLER Bill Barnes
INSPECTOR Terry Primm
BORING TERMINATED AT 20

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	5	25	Firm tan silty CLAY w/gray silt marbeling
2	8.5-10.0	10	25	Stiff brown silty CLAY w/gray silt marbeling
3	13.5-15.0	11	27	Stiff dark brown silty CLAY w/gray silt marbeling
4	18.5-20.0	9	26	Stiff dark brown silty CLAY w/gray silt marbeling

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters
Nashville, Tennessee

Branch Offices
Knoxville Tennessee
Arvada, Colorado

DRILLER'S LOG

SHIFT REPORT OF DRILLING OPERATIONS AT Vertac Chemical Corporation (VCC) Vicksburg, MS — SITE

HOLE LOCATION	See Site Sketch Map	SHIFT	DATE 3-2-83
SURFACE ELEVATION	98.6' (msl)	RIG NO	HOLE NO. 5
DEPTH AT BEGINNING OF SHIFT		TOP ROCK	
FOOTAGE FISHTAILED		BOTTOM OF HOLE	
FOOTAGE SAMPLED		DRILLER	C. Nelson - H.B.A.
FOOTAGE CORED		HELPER	
DEPTH AT END OF SHIFT		DRILLED FOR	

SAMPLING RECORD — LOGGED BY: GDM

SPLIT NO	FROM	TO	SPLIT BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown silty CLAY, v. moist
2	10.0	11.0		Brown v. silty CLAY, Moist
3	15.0	16.0		Brown sl. clayey SILT, with gray mottles
				Stratum change at 17.0 feet - by driller
				Saturated returns at 19.0'
4	20.0	21.0		Brown and gray sl. clayey SILT, saturated
5	25.0	26.0		Gray sl. clayey SILT, saturated
				Hard drilling at 29 feet
6	30.0	31.0		Greenish gray clayey SAND
7	34.0	35.0		Greenish gray MARL

NOTES: (1) Monitoring Well # 5 set in test boring at 19.0'
(2) Top of casing Elev. = 99.6' (msl)
Bottom of casing Elev. = 79.6' (msl)

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters:
Nashville, Tennessee

Branch Offices:
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

SHEET REPORT OF DRILLING OPERATIONS AT	VCC, Vicksburg, MS	SHEET	DATE 3-1-83
HOLE LOCATION	See Site Sketch Map	RIG NO	HOLE NO. 6
SURFACE ELEVATION	98.0' (msl)	TOP ROCK	
DEPTH AT BEGINNING OF SHIFT		BOTTOM OF HOLE	
FOOTAGE FISHTAILED		DRILLER	C. Nelson, HBA
FOOTAGE SAMPLED		HELPER	
FOOTAGE CORED		DRILLED FOR	
DEPTH AT END OF SHIFT			

LOGGED BY: GDM

SAMPLING RECORD

SPLIT NO	FROM	TO	SPLIT BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown clayey SILT, v. moist
2	10.0	11.0		Brown v. silty CLAY, moist
				Saturated returns at 14.5'
3	15.0	16.0		Brown v. silty CLAY, lam. lignite, wet.
4	20.0	21.0		Brown silty, clay with gray mottles
				Stratum change at 22.0' - by driller
5	25.0	26.0		Gray sl. clay SILT, saturated
				Hard drilling at 28.0'
6	30.0	31.0		Greenish gray sandy CLAY
7	35.0	36.0		Greenish gray MARL
8	39.0	40.0		Greenish gray MARL

NOTES: (1) Monitoring Well #6 in additional borings, 5' southwest of test boring at 24.5'
(2) Top of casing elev. = 98.6' (msl)
Bottom of casing elev. = 73.6' (msl)

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters
Nashville, Tennessee
Branch Offices
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

SHIFT REPORT OF DRILLING OPERATIONS AT	VCC, Vicksburg, MS	SHIFT	DATE 3-1-83
HOLE LOCATION	See Site Sketch Map	RIG NO	HOLE NO 7
SURFACE ELEVATION	96.7' (msl)	TOP ROCK	
DEPTH AT BEGINNING OF SHIFT		BOTTOM OF HOLE	
FOOTAGE DRILLED		DRILLER	C. Nelson - HBA
FOOTAGE SAMPLED		HELPER	
FOOTAGE CORED		DRILLED FOR	
DEPTH AT END OF SHIFT			

SAMPLING RECORD LOGGED BY: GDM

SPLIT NO	FROM	TO	SPLIT BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown Clayey SILT, v. moist
				Saturated returns at 8.2'
2	10.0	11.0		Brown v. silty CLAY, wet
3	15.0	16.0		Brown silty CLAY, with gray mottles, saturated
4	20.0	21.0		Brown v. silty CLAY, saturated
5	25.0	26.0		Brown and gray sl. clay SILT, saturated
				Hard drilling at 28.0'
6	30.0	31.0		Greenish gray sandy CLAY, with small gravel
7	34.0	35.0		Greenish gray MARL

NOTES: (1) Monitoring Well #7 set in test boring at 29'
(2) Top of casing Elev. = 97.5' (msl)
Bottom of casing Elev. = 67.5' (msl)

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters:
Nashville, Tennessee

Branch Offices
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

SHEET REPORT OF DRILLING OPERATIONS AT	VCC, Vicksburg, MS		SITE
HOLE LOCATION	See Site Sketch Map	SHEET	DATE 3-2-83
SURFACE ELEVATION	108.6 (msl)	SIZE HOLE	HOLE NO 8
DEPTH AT BEGINNING OF SHIFT		TOP ROCK	
FOOTAGE TRIPPED		BOTTOM OF HOLE	
FOOTAGE SAMPLED		DRILLER	C. Nelson - HBA
FOOTAGE CORED		HELPER	
DEPTH AT END OF SHIFT		DRILLED FOR	

SAMPLING RECORD LOGGED BY: GDM

SPLIT NO	FROM	TO	SPLIT BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown silty CLAY
2	10.0	11.0		Brown clayey SILT, with lt. brown mottles, moist
3	15.0	16.0		Brown clayey SILT
				Stratum change at 18.0' - by driller
4	20.0	21.0		Gray silty CLAY, with small roots, wet
5	25.0	26.0		Gray silty CLAY, saturated
				Water rising at 29.0'
6	30.0	31.0		Gray SILT, saturated
7	35.0	36.0		Gray SILT, saturated
				Hard drilling at 38.5'
8	39.0	40.0		Brownish orange MARL, hard
	40.0	49.5		Pushed split spoon refused at 49.5'

NOTES: (1) Monitoring Well #8 set in additional borings, 8' east of test boring, at 29' on 3-3-83
(2) Top of casing elev. = 109.7' (msl)
Bottom of casing elev. = 79.7' (msl)

FINAL REPORT

MONITORING WELL INSTALLATION PROGRAM
VERTAC CHEMICAL CORPORATION
March 21, 1983

Submitted to:

Vertac Chemical Corporation
Memphis, Tennessee

Prepared By:

MCI/Consulting Engineers, Inc.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215

TABLE OF CONTENTS

INTRODUCTION ..... Page 1

PURPOSE AND SCOPE ..... Page 1

General ..... Page 1
Site Specific Methodology ..... Page 2

GEOLOGIC CONDITIONS ..... Page 3

General Geology ..... Page 3
Subsurface Conditions ..... Page 4

HYDROGEOLOGIC CONDITIONS ..... Page 5

Potentiometric Surface ..... Page 5
Aquifer Transmissivity ..... Page 5
Table 1 - Ground Water Elevations ..... Page 6

CONCLUSIONS ..... Page 7

RECOMMENDATIONS ..... Page 8

REFERENCES ..... Page 10

APPENDIX I - Test Boring Logs

APPENDIX II - Hvorslev Aquifer Test Analysis

INTRODUCTION

Presented herein is a summary of the activities undertaken by MCI/Consulting Engineers, Inc., (MCI) in conjunction with a monitoring well installation program at the Vertac Chemical Corporation manufacturing facility in Vicksburg, Mississippi. Of primary concern in this project were the location and installation of monitoring wells to monitor ground water quality downgradient from an inactive disposal site and an active hazardous waste surface impoundment. The surface impoundment is an Interim Status storage facility permitted under the Resource Conservation and Recovery Act (RCRA). Figure 1 is a site location map of the Vertac plant.

PURPOSE AND SCOPE

General

Subsurface investigation and subsequent installation of ground water monitoring wells in a theoretically potentiometric downgradient direction from the closed disposal site and the surface impoundment were of primary importance to this project, due to concern that previously installed monitoring wells did not adequately provide monitoring of downgradient ground water quality. Therefore, the project sought to review available, existing data and acquire new field data to ascertain adequate monitoring for contaminants potentially migrating from the site via the groundwater route.

The ground water flow directions that provided the basis for the MCI subsurface exploration and monitoring well locations were derived from monitoring wells installed during a previous investigation conducted by Developers, International Services Corporation (DISC). In conjunction with the installation and development of the MCI wells, water level elevations were obtained from the MCI wells and three of the DISC wells to develop an updated, general potentiometric surface map for the ground water.

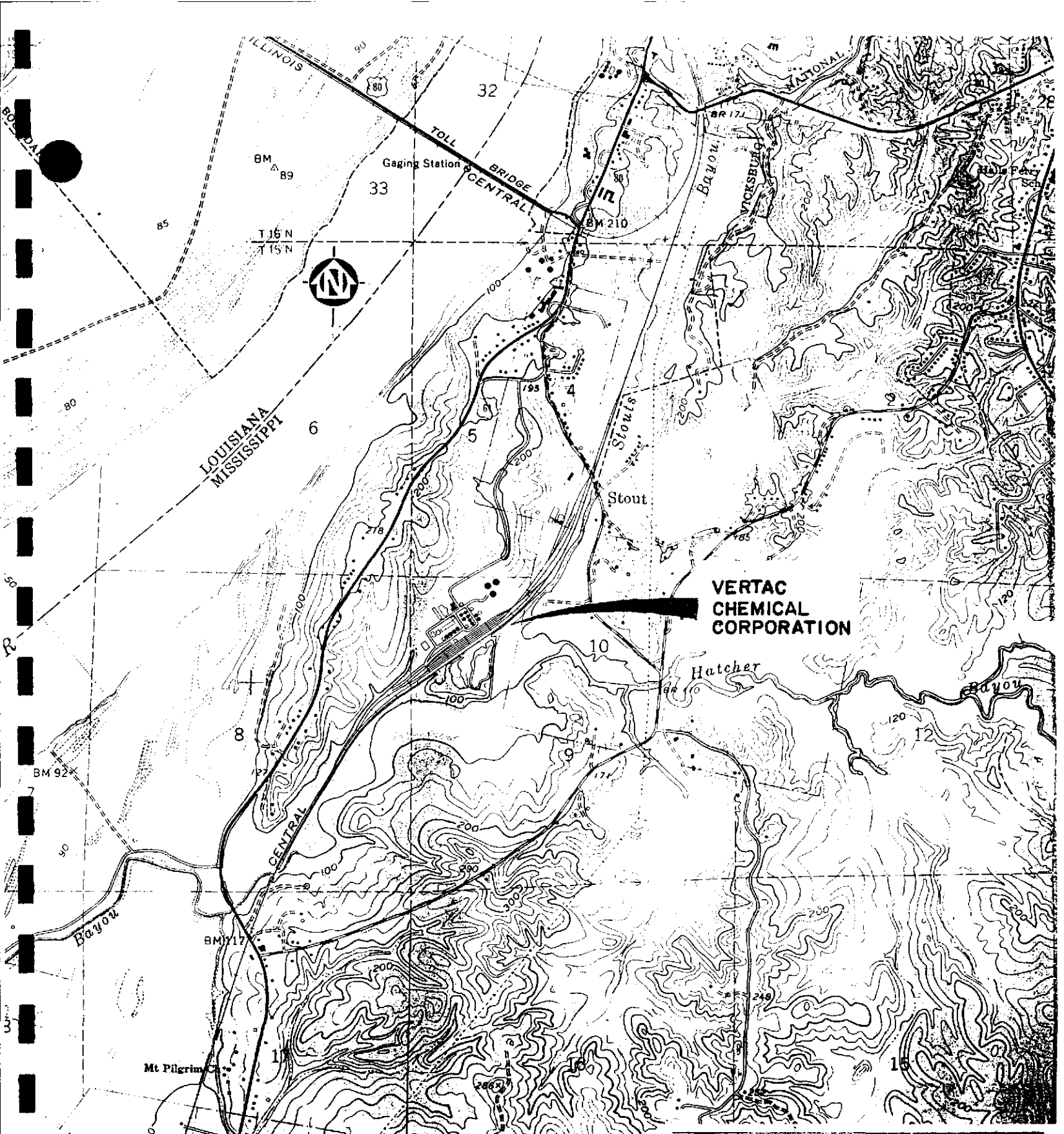


Figure 1
SITE LOCATION MAP
Vertac Chemical Corporation
Vicksburg, MS

SCALE: 1" = 2000' | DATE 3-21-83

MCI / CONSULTING ENGINEERS, INC.
Nashville, & Knoxville, Tennessee

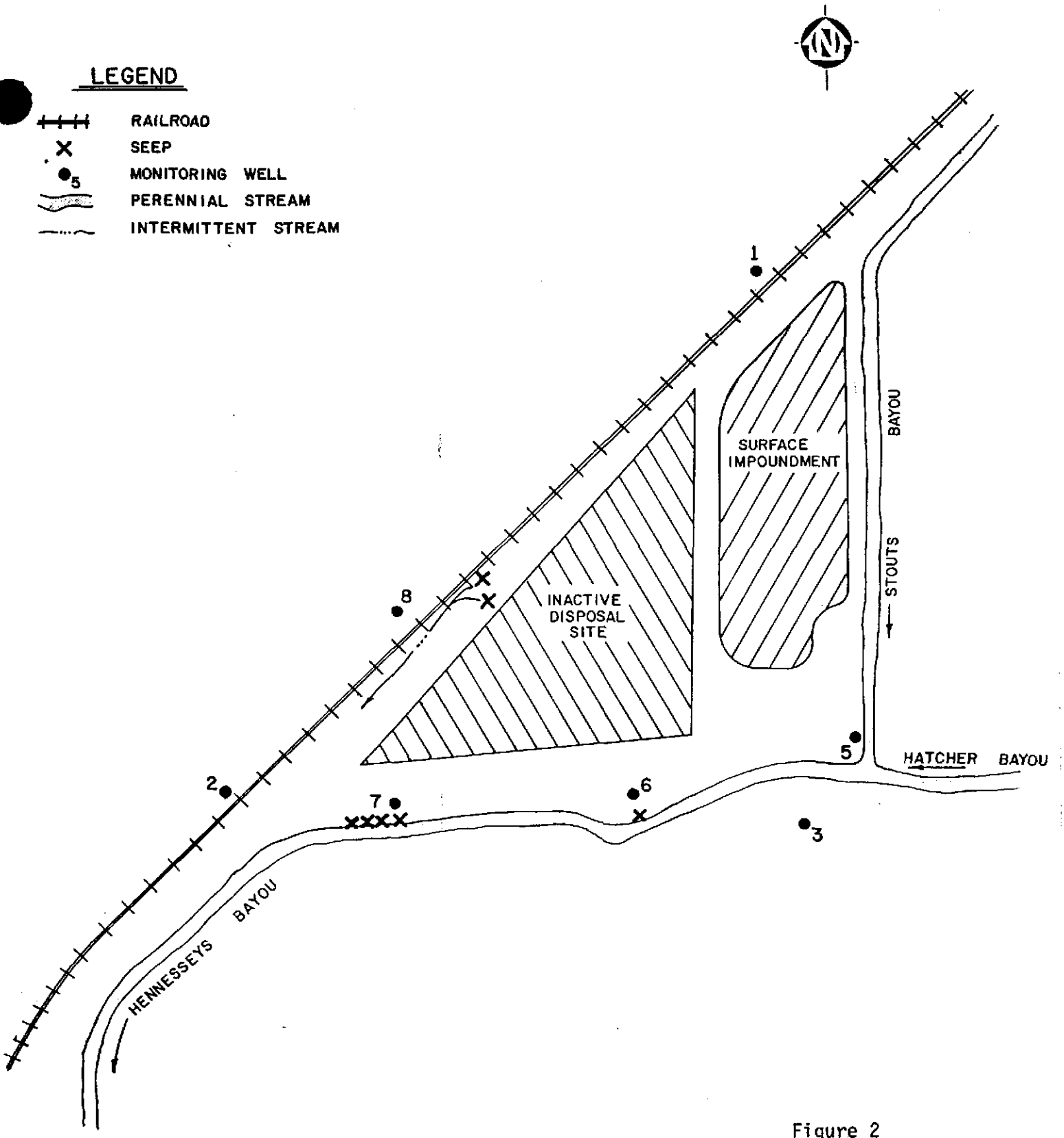
Four ground water monitoring wells were installed in this project. Three wells were placed east of the site between the site and Hennesseys Bayou, an assumed hydrologic divide. The fourth well was installed west of the site between two of the existing monitoring wells. Precautions were taken to assure the analytical integrity of the project wells. In addition, the project wells were sufficiently developed to remove the effects of drilling.

Site Specific Methodology

During the week of February 28 through March 4, 1983, a series of four test borings were drilled to define subsurface conditions in relation to shallow ground water flow in the vicinity of the site. Subsequent to drilling each test boring, two-inch (I.D.), polyvinyl chloride (PVC) monitoring wells were installed either in the test boring or in an adjacent additional boring. Figure 2 shows the relative locations of the MCI monitoring wells and test borings and three of the wells installed prior to this project.

Hall, Brazille, and Associates, of Memphis, Tennessee, provided the field drilling and sampling services for the project. Split-spoon samples of the subsurface were obtained at an interval of every five feet of depth in each of the test borings.

Precautions were taken during well installation to prevent extraneous contamination of each monitoring well. The borings were advanced without drilling fluids to exclude contamination from this source. Riser and screen sections with threaded joints were used to preclude organic contamination from solvent glue. The well materials were rinsed with isopropyl alcohol and sealed in protective plastic by the manufacturer prior to shipment to Vicksburg. At each monitoring well



NOTE: ELEVATION DATUM IS MEAN SEA LEVEL

Figure 2

Well Location
Sketch Map
Vertac Chemical Corporation
Vicksburg, MS

82-529

SCALE: No scale	DATE 3-21-83

MCI / CONSULTING ENGINEERS, INC.
Nashville, & Knoxville, Tennessee

location, the protective plastic was removed immediately prior to installation from only the materials needed for that well. Packaged, clean, concrete sand was used for the sand pack interval around the well screens. The annulus above the sand pack of each well was sealed with a combination of soil-cement and grout to preclude contact of surface water with the intake area.

GEOLOGIC CONDITIONS

General Geology

The Vicksburg area lies on the eastern flank, near the axis, of the Mississippi Embayment. The Mississippi Embayment is a large, regional, structural trough that contains generally unconsolidated sediments of Cretaceous to Quaternary Age. These sediments thicken toward the axis of the Embayment and the Gulf of Mexico.

Pliestocene loess underlies the ground surface of the Vertac plant and vicinity. Loess is a depositional product of eolian, or wind-borne, transport of silty sediments. The loess in the Vicksburg area is, typically, homogeneous, massive silt with variable clay content. Loess has, in general, a relatively higher vertical permeability in comparison to its horizontal permeability.

Review of the published literature concerning the Vicksburg area (Mellen, 1941, p. 38) suggests the loess is underlain by the Oligocene Vicksburg Formation. This formation in the Vertac plant vicinity is reported by Mellen to be "alternating beds of fossiliferous sandy marl, clay marl, montmorillonitic clay, and thin beds of limestone and coquina ...".

Subsurface Conditions

In general, the subsurface conditions encountered at depth during the four test boring investigations are similar. The ground surface is underlain by variable loess thickness overlying stiff to hard sandy clay and marl. The variability of the loess thickness is a probable result of erosion. The thickness is less in the floodplain of Hennesseys Bayou, while thicker in the topographically higher areas near the plant and railroad.

Two distinct zones of loess were encountered in each test boring. The upper zone consists of approximately twenty feet of silty clay and clayey silt with variable moisture content. A second zone of saturated silt underlies the upper zone. This lower zone in the loess appears to be transmitting shallow ground water.

The loess-marl contact was encountered at the same approximate elevation (70± feet) across the site. The contact is marked by a lithologic change from the relatively homogeneous, saturated loess to a hard clay with variable sand and fossil fragment content. A seam of sand with small gravel is associated with this initial clayey layer. These upper clayey and sandy sediments overlie hard marl.

Boring logs for the four test holes are found in Appendix I.

HYDROLOGIC CONDITIONS

Potentiometric Surface

Saturated conditions were encountered during drilling in the loess at variable depths from the ground surface. After completion of the monitoring wells, the water levels were observed to have risen several feet from their level during drilling. This suggests an artesian condition exists for the ground water beneath the site with the upper clayier loess acting as an upper semi-confining layer and the marl as a lower confining layer.

Ground water elevations in the four new monitoring wells and three of the existing monitoring wells were determined as part of the field activities. These ground water elevations are found in Table 1 on the following page. A generalized potentiometric surface map derived from the elevation measurements is shown in Figure 3. This potentiometric map shows a general potentiometric gradient toward Stouts Bayou and Hennesseys Bayou. The lack of ground water elevation data points on the higher topographic and side-slope areas of the inactive disposal site render a precise determination of the potentiometric surface unattainable. Data from these general areas would be necessary to define ground water mounding associated with this area.

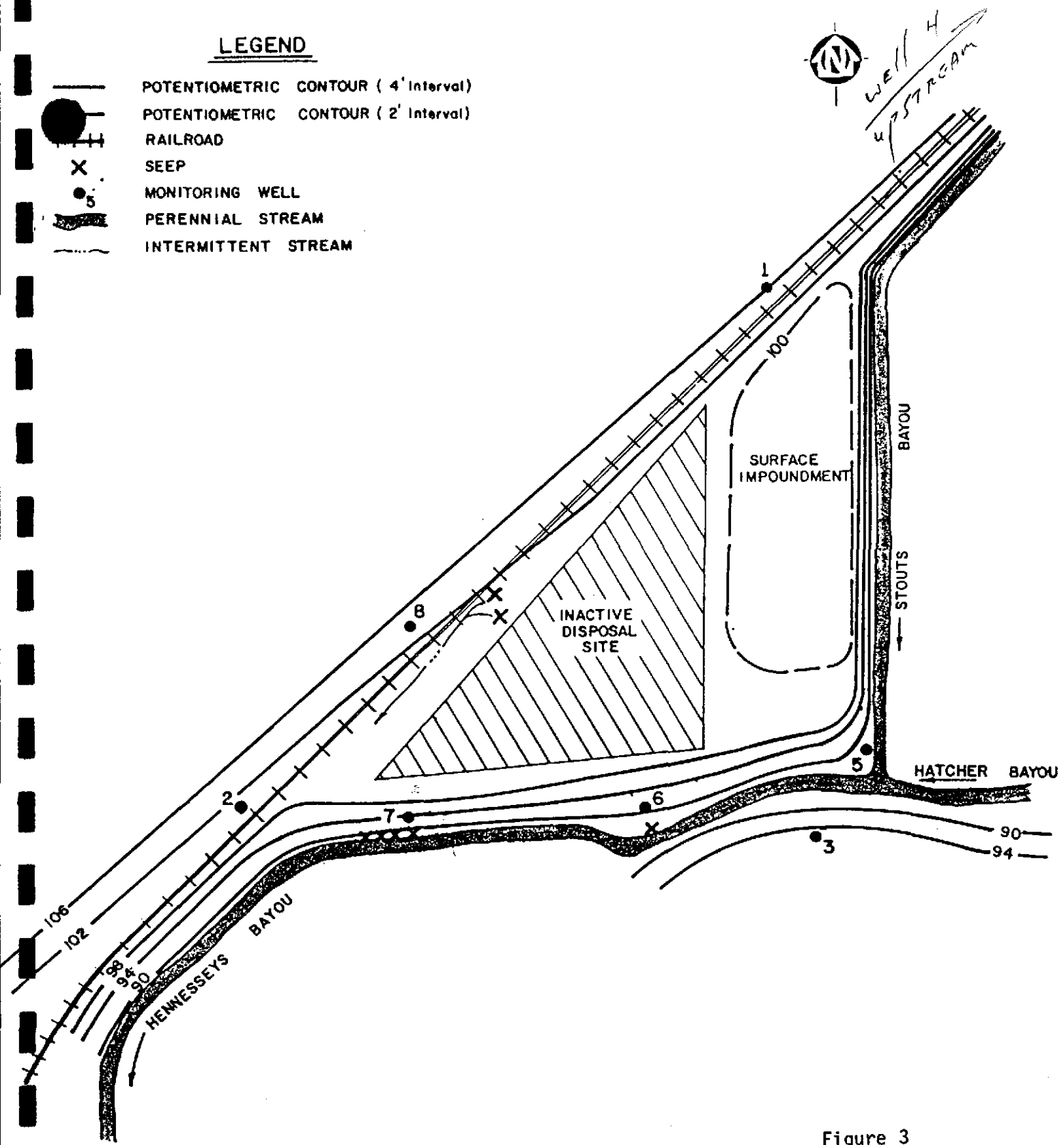
Aquifer Transmissivity

Subsequent to installation, each new monitoring well was developed to remove formation sediments and the effects of drilling from the intake area around the well screens. Bailing, surging, and slugging were the development techniques used in this project.

TABLE 1
GROUND WATER ELEVATIONS
March 4, 1983

MONITORING WELL	WATER ELEVATION *
1	106.0'
2	100.5'
3	95.3'
5	89.6'
6	90.6'
7	94.5'
8	102.7'

* Above mean sea level



NOTE: ELEVATION DATUM IS MEAN SEA LEVEL

Figure 3

General Potentiometric Surface
March 4, 1983
Vertac Chemical Corporation
Vicksburg, MS
82-520

SCALE:	DATE

MCI / CONSULTING ENGINEERS, INC.
Nashville, & Knoxville, Tennessee

The wells were developed as adequately as possible during the field activities. However, owing to the fine-grained nature of the zone of saturation, inflow of suspended silt through the intake area of the well screen will probably continue. Consequently, care should be exercised in the evacuation and sampling of the wells to prevent unrepresentative turbidity in ground water quality samples.

After development, a limited, recovery aquifer test was conducted on Well 7. Aquifer tests yield information on aquifer characteristics by contrasting time and drawdown/recovery of water levels in a well during/after pumping. During this test, Well 7 was bailed dry at approximately 0.3 gallons per minute. Then, the recovery of the water level in the well was measured for 140 minutes. The results of this test are shown as a Hvorslev recovery curve in Appendix II. Also, as calculated in Appendix II, the hydraulic conductivity is 7.2×10^{-2} ft/day or 2.5×10^{-5} cm/sec. Consequently, the aquifer transmissivity at Well 7 is calculated to be 15.3 gallons per day per foot.

CONCLUSIONS

After review of the information and data contained in this report, MCI concludes the following:

1. A shallow, semi-confined, aquifer probably exists in the subject area. Vertical flow within the aquifer appears to be restricted at depth by a sandy clay and clayey marl lower confining layer. The saturated zone is located within a lower silty portion of the loess thickness at the site. The upper portion of the loess thickness is clayier and appears to act as a leaky, upper, semi-confining layer.

2. Ground water mounding from either natural topographic effects or artificially induced recharge, may exist beneath the inactive disposal site and the surface impoundment. However, lack of ground water elevation data associated with the above areas prevents conclusive mounding determination.

3. Review of the ground water elevation data obtained during the field activities indicates Wells 5, 6, and 7 are located in a downgradient position from the inactive disposal site and the surface impoundment. Well 8 is located in an upgradient position.

4. The transmissivity of the shallow aquifer is calculated to be 15.3 gallons per day per foot. This value is the result of a Hvorslev method analysis of a limited, recovery aquifer test. A transmissivity on this order is relatively low which is the expected nature of a silty aquifer.

5. Owing to the fine grained nature of the sediments composing the saturated zone, even extensive well development will probably not prevent silt suspended in the ground water from entering the intake area of the well screens. As a consequence, care should be exercised in evacuation and sampling of the ground water to prevent unrepresentative turbidity of ground water quality samples.

RECOMMENDATIONS

Based on the conclusions stated above, MCI makes the following recommendations:

1. When Vertac initiates a ground water sampling program, MCI recommends sampling of Wells 5, 6, 7, and 8. The locations and

depths of these wells are more representative of the downgradient/upgradient aquifer conditions than those of the previously installed wells. In addition, the analytical integrity of the MCI wells is documented by the precautions taken to install analytically representative wells.

2. In sampling these wells strict sampling procedures and protocols should be designed and implemented.

3. Determinations of water elevations are recommended on a routine basis prior to and after the grading and capping plan for the inactive disposal site is implemented. If there is ground water mounding beneath the inactive disposal site, the downgradient water elevations may decline through time with reduced recharge after the cap is in place.

REFERENCES

1. Cushing, E. M., E. H. Boswell, R. L. Hosman, General Geology of the Mississippi Embayment: U.S.G.S. Professional Paper 448-B, 1964.

2. Gandl, L. A., The Oligocene Aquifer System in Mississippi, U.S.G.S., Open-file report 79-28, 1979.

3. Howman, R. L., T. W. Lambert, A. T. Long and others, Tertiary Aquifers in the Mississippi Embayment, with discussions of the quality of the water by H. G. Jeffery: U.S.G.S., Professional Paper 448-D, 1968.

4. Mellen, F. F., T. E. McCutcheon, and M. R. Livingston, Warren County Mineral Resources: Mississippi State Geological Survey, Bulletin 43, 1941.

5. Newcome, Roy, Jr., the Miocene Aquifer System in Mississippi, U.S.G.S. Open-file report 46-75, 1975.

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters:
Nashville, Tennessee

Branch Offices:
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

SHIFT REPORT OF DRILLING OPERATIONS AT Vertac Chemical Corporation (VCC) Vicksburg, MS		SITE
HOLE LOCATION See Site Sketch Map	SHIFT	DATE 3-2-83
SURFACE ELEVATION 98.6' (msl)	RIG NO.	HOLE NO. 5
DEPTH AT BEGINNING OF SHIFT	TOP ROCK	
FOOTAGE FISHTAILED	BOTTOM OF HOLE	
FOOTAGE SAMPLED	DRILLER C. Nelson - H.B.A.	
FOOTAGE CORED	HELPER	
DEPTH AT END OF SHIFT	DRILLED FOR	

SAMPLING RECORD

LOGGED BY: GDM

SPLE NO.	FROM	TO	SPLE BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown silty CLAY, v. moist
2	10.0	11.0		Brown v. silty CLAY, Moist
3	15.0	16.0		Brown sl. clayey SILT, with gray mottles
				Stratum change at 17.0 feet - by driller
				Saturated returns at 19.0'
4	20.0	21.0		Brown and gray sl. clayey SILT, saturated
5	25.0	26.0		Gray sl. clayey SILT, saturated
				Hard drilling at 29 feet
6	30.0	31.0		Greenish gray clayey SAND
7	34.0	35.0		Greenish gray MARL

NOTES: (1) Monitoring Well # 5 set in test boring at 19.0'
(2) Top of casing Elev. = 99.6' (msl)
Bottom of casing Elev. = 79.6' (msl)

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters:
Nashville, Tennessee

Branch Offices:
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

SHIFT REPORT OF DRILLING OPERATIONS AT	VCC, Vicksburg, MS		SITE
HOLE LOCATION	See Site Sketch Map	SHIFT	DATE 3-1-83
SURFACE ELEVATION	98.0' (msl)	RIG NO.	HOLE NO. 6
DEPTH AT BEGINNING OF SHIFT		TOP ROCK	
FOOTAGE FISHTAILED		BOTTOM OF HOLE	
FOOTAGE SAMPLED		DRILLER	C. Nelson, HBA
FOOTAGE CORED		HELPER	
DEPTH AT END OF SHIFT		DRILLED FOR	

LOGGED BY: GDM

SAMPLING RECORD

SPLE NO.	FROM	TO	SPLE BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown clayey SILT, v. moist
2	10.0	11.0		Brown v. silty CLAY, moist
				Saturated returns at 14.5'
3	15.0	16.0		Brown v. silty CLAY, lam. lignite, wet.
4	20.0	21.0		Brown silty, clay with gray mottles
				Stratum change at 22.0' - by driller
5	25.0	26.0		Gray sl. clay SILT, saturated
				Hard drilling at 28.0'
6	30.0	31.0		Greenish gray sandy CLAY
7	35.0	36.0		Greenish gray MARL
8	39.0	40.0		Greenish gray MARL
				NOTES: (1) Monitoring Well #6 in additional borings, 5' southwest of test boring at 24.5'
				(2) Top of casing elev. = 98.6' (msl)
				Bottom of casing elev. = 73.6' (msl)

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters:
Nashville, Tennessee

Branch Offices:
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

SHIFT REPORT OF DRILLING OPERATIONS AT	VCC, Vicksburg, MS		SITE
HOLE LOCATION	See Site Sketch Map	SHIFT	DATE 3-1-83
SURFACE ELEVATION	96.7' (msl)	RIG NO.	HOLE NO. 7
DEPTH AT BEGINNING OF SHIFT		TOP ROCK	
FOOTAGE FISHTAILED		BOTTOM OF HOLE	
FOOTAGE SAMPLED		DRILLER	C. Nelson - HBA
FOOTAGE CORED		HELPER	
DEPTH AT END OF SHIFT		DRILLED FOR	

SAMPLING RECORD

LOGGED BY: GDM

SPLE NO.	FROM	TO	SPLE BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown Clayey SILT, v. moist
				Saturated returns at 8.2'
2	10.0	11.0		Brown v. silty CLAY, wet
3	15.0	16.0		Brown silty CLAY, with gray mottles, saturated
4	20.0	21.0		Brown v. silty CLAY, saturated
5	25.0	26.0		Brown and gray sl. clay SILT, saturated
				Hard drilling at 28.0'
6	30.0	31.0		Greenish gray sandy CLAY, with small gravel
7	34.0	35.0		Greenish gray MARL
				NOTES: (1) Monitoring Well #7 set in test boring at 29'
				(2) Top of casing Elev. = 97.5' (msl)
				Bottom of casing Elev. = 67.5' (msl)

MCI/ CONSULTING ENGINEERS, INC.
4301 Hillsboro Road
Suite 224
Nashville, Tennessee 37215
Telephone (615) 383-4807

Corporate Headquarters:
Nashville, Tennessee

Branch Offices:
Knoxville, Tennessee
Arvada, Colorado

DRILLER'S LOG

SHIFT REPORT OF DRILLING OPERATIONS AT	VCC, Vicksburg, MS		SITE
HOLE LOCATION	See Site Sketch Map	SHIFT	DATE 3-2-83
SURFACE ELEVATION	108.6 (msl)	RIG NO.	HOLE NO. 8
DEPTH AT BEGINNING OF SHIFT		TOP ROCK	
FOOTAGE FISHTAILED		BOTTOM OF HOLE	
FOOTAGE SAMPLED		DRILLER	C. Nelson - HBA
FOOTAGE CORED		HELPER	
DEPTH AT END OF SHIFT		DRILLED FOR	

SAMPLING RECORD

LOGGED BY: GDM

SPLE NO.	FROM	TO	SPLE BLOWS	DESCRIPTION AND REMARKS
	0.0	0.5		Topsoil
1	5.0	6.0		Brown silty CLAY
2	10.0	11.0		Brown clayey SILT, with lt. brown mottles, moist
3	15.0	16.0		Brown clayey SILT
				Stratum change at 18.0' - by driller
4	20.0	21.0		Gray silty CLAY,with small roots, wet
5	25.0	26.0		Gray silty CLAY, saturated
				Water rising at 29.0'
6	30.0	31.0		Gray SILT, saturated
7	35.0	36.0		Gray SILT, saturated
				Hard drilling at 38.5'
8	39.0	40.0		Brownish orange MARL, hard
	40.0	49.5		Pushed split spoon refused at 49.5'

NOTES: (1) Monitoring Well #8 set in additional borings, 8' east of test boring, at 29' on 3-3-83
(2) Top of casing elev. = 109.7' (msl)
Bottom of casing elev. = 79.7'(msl)

AQUIFER HYDRAULIC CONDUCTIVITY AND TRANSMISSIVITY CALCULATIONS

Hvorslev Formula for hydraulic conductivity:

$$K = \frac{r^2 \ln (L/R)}{2L\ T_o}$$

For Well 7: r = .08' (radius of riser I.D.)
L = 5.0' (length of screen)
R = .08' (radius of screen I.D.)

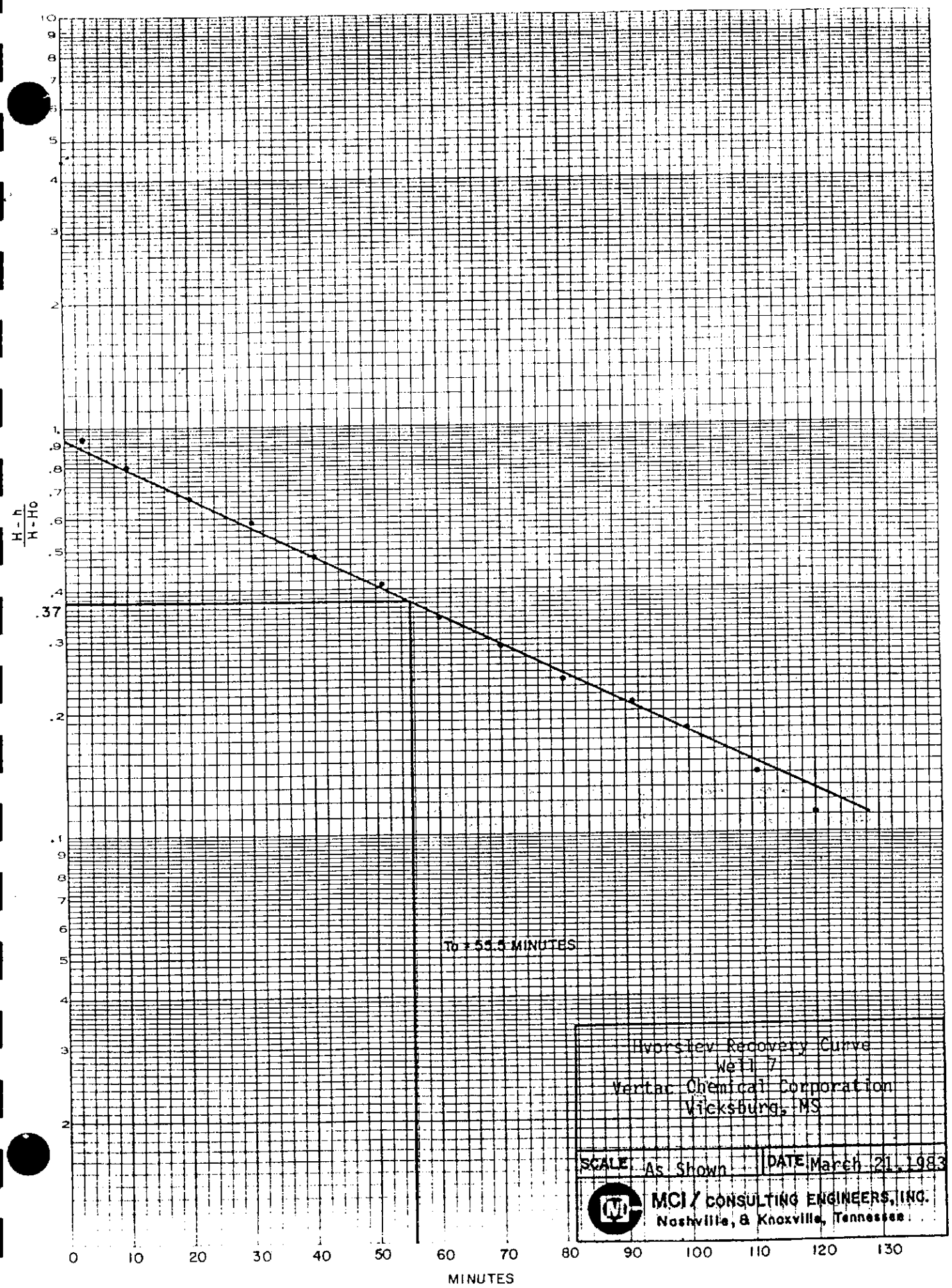
From Recovery Curve - T_o = 55.5 minutes (following page)

Then: $K = \frac{(.08)^2 \ln (5/.08)}{(2)\ (5)\ (55.5)} = 5 \times 10^{-5}$ ft/min or 7×10^{-2} ft/day

In metric units: $K = 2.5 \times 10^{-5}$ centimeters/second
In American Hydrologic Units: $K = 0.53$ gallons/day/foot^2

Transmissivity (T) = Kb; where b = saturated thickness

$$T = \frac{.53 \text{ gpd}}{\text{ft}^2} \times 29 \text{ feet} = 15.3 \text{ gpd/ft.}$$


H - h / H - Ho
.37
To = 55.5 MINUTES
0
10
20
30
40
50
60
70
80
90
100
110
120
130
MINUTES
Hvorslev Recovery Curve
Well 7
Vertac Chemical Corporation
Vicksburg, MS
SCALE As Shown
DATE March 21, 1983
MCI / CONSULTING ENGINEERS, INC.
Nashville, & Knoxville, Tennessee

HYDROGEOLOGICAL INVESTIGATION

VERTAC CHEMICAL CORPORATION FACILITY

VICKSBURG, MISSISSIPPI

Prepared by:

Developers, International
Services Corporation
Memphis, Tennessee

Job No. 872
21 November 1981

TABLE OF CONTENTS

I. Introduction

1. Authority
2. Location
3. General
4. Description of Site
5. Scope of Study

II. Geologic Setting

1. General Description
2. Description of Upper Stratum
3. Characteristics of Glendon Limestone

III. Hydrology

1. Surface Water Runoff
2. Groundwater Flow Parameters
3. Groundwater Flow Estimate

IV. Sampling and Testing

1. Soil Borings
2. Laboratory Tests

V. Placement and Construction of Monitoring Wells

1. Placement
2. Construction

VI. Conclusions and Recommendations

1. Evaluation of Potential Hazard
2. Monitoring Program

Appendices

A Soil Borings

B Laboratory Tests

C Well Logs

I. INTRODUCTION

1. Authority

This study was made at the request of Mr. R. D. Karkkainen, Director of Environment and Safety, Vertac Chemical Corporation, Memphis, Tennessee. Information used in the preparation of this report was obtained from Vertac Chemical Corporation; United States Geologic Survey, Jackson, Mississippi; Mississippi State Geological Survey, Jackson, Mississippi; and the United States Army Corps of Engineers, Vicksburg, Mississippi.

2. Location

The Vertac plant is situated on a tract of land on the southern outskirts of Vicksburg, Mississippi as shown on Figure 1 and on Drawing 1 accompanying this report.

3. General

The Vicksburg facility has been operated by Vertac for a number of years as a producer of agricultural and industrial chemicals. Raw materials and residues from manufacturing processes are currently stored on site. These materials represent a possible source of ground and surface water contamination.

At this time there is no evidence of any chemical constituents associated with production processes being in waters migrating from the site. It is the intent of the plant operator to further investigate this possibility and to prevent or eliminate any environmental pollution related to conditions at the Vicksburg plant.

4. Description of Site

The plant is located on a large site which is irregularly shaped and extends roughly two miles in the north-south direction. The maximum east-west length is slightly less than one mile. The area includes portions on the Vicksburg bluff as well as part of the alluvial vallies of several streams. Although

there are some dwellings in the vicinity, they are fairly remote from the plant location as are old and new U. S. Highways 61, which bound the site.

Drawing No. 1, attached, shows topographic and cultural features. The geological setting is covered in a later section.

5. Scope of Study

By agreement with Vertac Chemical Corporation, Developers, International Services Corporation has undertaken a study to determine parameters needed to evaluate possible contaminant transport in ground and surface waters. These parameters include direction and slope of the water table, values of hydraulic conductivity, properties of subsoils and rock formations, surface drainage patterns and stream flow characteristics.

More specifically, the work involved in this project consisted of assembling and evaluating geologic and topographic data; making a visual site inspection test drilling, collecting samples and performing physical testing on soil samples; surveying to establish vertical and horizontal control for borings and wells and other field measurements; installation of groundwater monitoring wells, and; preparing an engineering report on the above along with conclusions and recommendations.

II. GEOLOGIC SETTING

1. General Description

Ground surface elevations along the geologic section through the plant area vary from about 80 to 150 ft. MSL as ahown on Drawing No. 2, attached. The bed-rock, which underlies this region, consists of the Glendon limestone of the Vicksburg formation and under the limestone is the Jackson formation.

Reportedly, the top of the Glendon limestone ranges from 80 to 100 ft. MSL beneath the plant site as shown on the geologic section. Auger borings (described in a later section) failed to reach the Glendon limestone at an elevation of approximately 60 ft. MSL. However, the limestone outcrops at the expected elevation at the Illinois Central Railroad bridge over Hennessey's Bayou near the southerly boundary of Vertac property.

The Glendon limestone in Warren County, generally has a thickness of 25 to 65 feet while the dense, non-permeable Jackson Formation is from 40 to 100 ft. thick.

2. Description of Upper Stratum

The upper stratum consists of 50 to 70 feet of a cross-bedded and heterogeneous collection of silts and clays ranging from dark brown and tan where oxidized to bluish-gray where unoxidized. This appears to be the Bryam member of the Vicksburg group. The thickness is reported to be 30 to 100 feet.

The Bryam member is comprised of marine-clay and sand-marl, montorillonitic and bentonitic clays, lignites and massive silts. The permeability of this zone is expected to fall within 10^{-5} to 10^{-9} cm/sec and to decrease significantly with depth.

3. Characteristics of Glendon Limestone

The Glendon Limestone directly under the silty clay material is made up of alternating strata

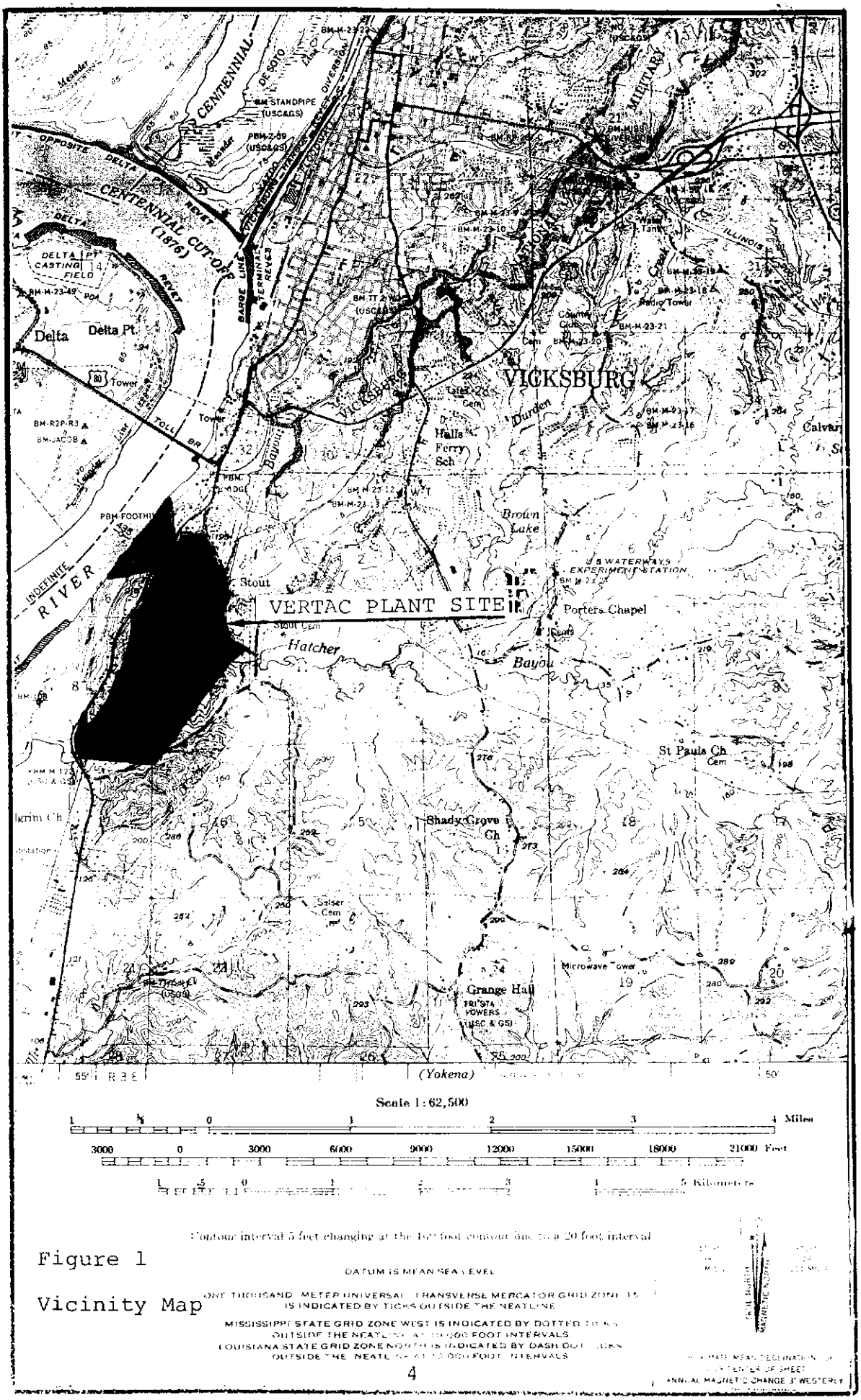


Figure 1

Vicinity Map

of hard arenaceous limestone and glauconitic, argillaceous, arenaceous marl with bentonite interstratified locally. Waterfalls and springs are common in areas where this member intercepts the ground surface. The bentonite and marl materials form an impermeable barrier, in places, to the upward migration of groundwater, thus, contributing to the formation of springs at the base of the limestone.

Water supply wells are not often successful in the vicinity of the plant site due to the low permeability of the upper silty clay layer and the limestone. However, there are a few water yielding wells in this formation. This occurance can be explained as follows.

Surface water percolating into the soil is generally acidic with pH from 5 to 6.5. This water will tend to enlarge openings in the stone along joints and bedding planes by solution. These openings interconnect to form channels for the flow of water. The sketch shown on Drawing No. 2 illustrates the general groundwater flow patterns in this material. As can be seen, these patterns account for the presence of some successful and some unsuccessful wells and the springs mentioned in previous paragraphs.

III. HYDROLOGY

1. Surface Water Runoff

The plant site varies in elevation from 100 to 200 feet MSL with the plant entrance drive running along a surface runoff divide (see Drawing No. 1, attached). The area is bounded by Stouts Bayou on the east. Stouts Bayou flows into Hatcher Bayou immediately south of the plant. The latter stream meanders in a southwesterly direction across the Vertac property for a distance of about 1000 feet and there flows south for a number of miles before it empties into the Mississippi River.

The beds of these streams are on a relatively flat gradient and range in elevation from 80 to 100 feet MSL in the vicinity of the plant. The surface drainage pattern at the plant is to the east and south to these two bayous. The site is high enough so that no problems should occur due to flooding.

2. Groundwater Flow Parameters

Hydraulic conductivity (coefficient of permeability) as determined by a falling-head permeability laboratory test is 1.4×10^{-6} cm/sec. This test was run on a sample taken at a depth of approximately 20 feet (elevation 75 feet MSL) from Boring No. 3.

The coefficient of permeability was also calculated from data recorded in laboratory consolidation tests. These tests were performed on samples taken from auxiliary Boring No. 3. Values thus obtained are given in the following table.

Depth (ft)	Coef. of Perm. (cm/sec)	Porosity
7	2.6×10^{-6}	.42
20	4.5×10^{-7}	.46

These results tend to confirm the literature values for this geologic stratum i.e., 10^{-5} to 10^{-9} cm/sec and decreasing with depth.

The variation in results from the two test methods is $(1.4 \times 10^{-6} - 4.5 \times 10^{-7})/(1.4 \times 10^{-6}) = .68$ or 68%. This is within an acceptable range. It is generally believed that the values calculated based on consolidation tests are more dependable than the directly determined values, because calculated values are free of errors caused by piping along the sides of the specimens.

Porosities were calculated for the material taken from two depths at Boring No. 3. These calculations are based on void ratio information taken from the consolidation tests. These values are given in the above table.

3. Groundwater Flow Estimate

Water table elevations were measured at the time of completion of the monitoring wells shown on Drawing No. 1. Although such levels are time dependent, the relative gradients will not vary as greatly as the water table elevations. Because of this, the velocity of movement through the saturated portion of the subsoil can be estimated fairly closely by assuming steady flow steady state conditions.

Shown by dashed lines on Drawing No. 1 are contours of groundwater levels based on measured depths to the water table. The maximum gradient is approximately 9%. Average groundwater movement velocities can be determined by the relation

$$V = Ki/n$$

where K is the hydraulic conductivity, i is the gradient and n is the porosity.

Taking K to be the average of the values given for the coefficient of permeabilities calculated from consolidation test data i.e., 1.5×10^{-6} cm/sec, then the maximum average velocity is 3×10^{-7} cm/sec which is equivalent to about .3 ft./yr.

Groundwater flow patterns in the material beneath the Bryam layer is covered in a previous section on geology.

IV. SAMPLING AND TESTING

1. Soil Borings

Undisturbed sample type soil test borings were drilled at the four well locations shown on Drawing No. 1 during the period of 29 September and 01 October 1981 using a truck mounted rotary type drill rig. Borings were advanced by means of a continuous flight, hollow stem auger. Samples were obtained through the hollow stem using split barrel and thin wall tube samplers. Detailed descriptive logs of the individual borings are included in Appendix A.

Boring Nos. 1 and 3 were drilled to a final depth of 30 feet below the existing ground surface; No. 2 was drilled to a dpeth of 40 feet; No. 4 was terminated at a 20 foot depth. An auxiliary boring, designated as Boring 3A, was made near boring No. 3 for the purpose of obtaining thin wall tube samples.

Standard Penetration Tests were made in each of the borings at depths shown on the Boring Logs. This test consists of counting the number of a 140-pound hammer dropped 30 inches required to drive a 2-inch diameter sampling barrel one foot into the undisturbed soil after first being seated six inches. Representative specimens taken from the sampling barrel were placed in moisture proof containers for preservation prior to laboratory testing.

Undisturbed samples of cohesive or pseudo-cohesive soils were obtained at selected depths using a 3-inch diameter thinwall tube sampling barrels. Samples were properly sealed within the sampling tubes and transported to the laboratory for later extrusion and testing.

All test borings were later converted to monitoring wells as described in a later section of this report.

2. Laboratory Tests

Soil mechanics laboratory tests consisting of visual classification, moisture content, Atterberg

Limits, Falling Head Permeability, and Consolidation tests were performed on the samples retrieved from the soil borings. On all samples taken, visual classification and natural water content determinations were performed and are shown on the Boring Logs of Appendix A. Other laboratory tests were performed on selected representative samples. These, together with the natural water content determinations aid in classifying and establishing relevant engineering properties of the soils.

Results of Laboratory tests are presented in Appendix B. Table A of Appendix B shows the specifications of sampling and testing for each tests performed, gives the sample location and serves as an index to the individual test reports.

V. PLACEMENT AND CONSTRUCTION OF MONITORING WELLS

1. Placement

Well locations were selected during a joint inspection by a DISC engineer and a representative of Vertac. The number, locations, and depths were chosen so that (i) RCRA requirements would be fulfilled, (ii) geologic and hydrogeologic parameters could be determined, and (iii) normal plant operations would not be obstructed by drilling equipment or well casings.

Well locations are shown on Drawing No. 1. Well No. 4 was installed hydraulically upgradient from the limit of the plant waste management area. Well Nos. 1, 2 and 3 were positioned at downgradient locations.

2. Construction

Construction details are shown on the well logs of Appendix C. Compliance with RCRA guidelines for groundwater contamination prevention was accomplished by placement of a two foot thick layer of bentonite above the granular filter material in each bore hole. The remaining annular space was filled with portland cement concrete.

VI. CONCLUSIONS AND RECOMMENDATIONS

1. Evaluation of Potential Hazard

Although the determination of present groundwater quality is beyond the scope of this study, the probability of groundwater contamination seems remote. The depth of the upper stratum, the low permeability of the material and the pollution attenuating characteristics of the type of soil all tend to preclude contamination.

However, the relatively high water table and the hydraulic properties of the underlying limestone are such that a monitoring system is recommended. Also, of course, current regulations appear to stipulate such a system.

2. Monitoring Program

The monitoring wells, described in Section V, are installed in accordance with RCRA requirements. Water quality sampling and analysis should be carried out quarterly and records kept in accordance with published EPA and State of Mississippi regulations.

Monthly measurement of water table depths should be accomplished. It is not contemplated that any future groundwater studies will be necessary at this location. Nevertheless, the cost of collecting this water level data is not great and would be very useful if a future study should become needed.

APPENDIX A

SOIL BORINGS

VERTAC CHEMICAL CORPORATION FACILITY

VICKSBURG, MISSISSIPPI

DISC

LOG OF BORING

PROJECT Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	DRILLING RIG B-40	JOB. NO. 872	BORING NO. B-1 SHEET 1 OF 1

GROUND SURFACE ELEVATION 107.1 DATUM MSL	BORING LOCATION See Plan

BORING TYPE 3 1/4" Hollow Auger 2" Split Spoon	GROUND WATER LEVEL 13' at drilling 9' at completion	DATE 29 September 1981 WEATHER Clear, warm DRILLER Bill Barnes INSPECTOR John Walton BORING TERMINATED AT 30'

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	14	25	Stiff brown silty CLAY
2	8.5-10.0	6	23	Firm brown silty CLAY
3	13.5-15.0	8	27	Firm brown silty CLAY
4	18.5-20.0	3	31	Soft brown silty CLAY, with gray silt marbeling
5	23.5-25.0	8	27	Firm brown silty CLAY, with gray silt marbeling
6	28.5-30.0	4	28	Soft brown silty CLAY

DISC

LOG OF BORING

PROJECT	DRILLING RIG	JOB. NO.	BORING NO. B-2
Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	B-40	872	SHEET 1 OF 1

GROUND SURFACE ELEVATION 103.0	BORING LOCATION
DATUM MSL	SEE PLAN

BORING TYPE	GROUND WATER LEVEL	
3 1/4" Hollow Auger 2" Spilt Spoon	26' at drilling	DATE 29 September 1981 WEATHER clear and warm DRILLER Bill Barnes INSPECTOR Terry Primm BORING TERMINATED AT 40'

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	7	25	Firm tan silty CLAY
2	8.5-10.0	7	24	Firm tan silty CLAY
3	13.5-15.0	6	24	Firm tan silty CLAY
4	18.5-20.0	6	25	Firm gray silt
5	23.5-25.0	6	23	Firm gray silt
6	28.5-30.0	8	23	Firm gray silt
7	33.5-35.0	7	23	Firm gray silt
8	38.5-40.0	8	32	Firm gray silt

DISC

LOG OF BORING

PROJECT	DRILLING RIG	JOB. NO.	BORING NO.
Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	B-40	872	B-3 SHEET 1 OF 1

GROUND SURFACE ELEVATION	BORING LOCATION
95.5	SEE PLAN
DATUM MSL	

BORING TYPE	GROUND WATER LEVEL	
3 1/4" Hollow Auger 2" Split Spoon	20' at drilling	DATE 30 September 1981 WEATHER clear and warm DRILLER Bill Barnes INSPECTOR Terry Primm BORING TERMINATED AT 30'

Sample No.	Sample Depth ft. From — To	Stand. Penet. Test Blow/ft	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	5	24	Firm brown silty CLAY
2	8.5-10.0	8	20	Firm brown silty CLAY
3	13.5-15.0	2	33	Soft brown silty CLAY
4	18.5-20.0	5	31	Firm brown silty CLAY,w/gray silt marbeling
5	23.5-25.0	3	29	Soft brown silty CLAY,w/gray silt marbeling
6	28.5-30.0	7	28	Firm brown silty CLAY,w/gray silt marbeling

DISC

LOG OF BORING

PROJECT	DRILLING RIG	JOB. NO.	BORING NO.
Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	B-40	872	B-3A SHEET 1 OF 1

GROUND SURFACE ELEVATION	BORING LOCATION
95.5 DATUM MSL	See Plan

BORING TYPE	GROUND WATER LEVEL	
3 1/4" Hollow Auger 2" Split Spoon	20' at drilling	DATE 30 September 1981 WEATHER Clear & Warm DRILLER Bill Barnes INSPECTOR Terry Primm BORING TERMINATED AT 30'

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
ST-1	5.0-7.0	--	25	Brown Silty CLAY
ST-2	8.0-10.0	--	23	Brown Silty CLAY
ST-3	18.0-20.0	--	32	Brown Silty CLAY w/gray silt marbeling

NOTE: ST = Shelby Tube

DISC

LOG OF BORING

PROJECT Monitoring Wells Vertac Chemical Corp. Vicksburg, Mississippi	DRILLING RIG B-40	JOB. NO. 872	BORING NO. B-4 SHEET 1 OF 1

GROUND SURFACE ELEVATION 109.6
DATUM MSL

BORING LOCATION
SEE PLAN

BORING TYPE
3 1/4" Hollow Auger
2" Split Spoon

GROUND WATER LEVEL
9' at drilling

DATE 01 October 1981
WEATHER clear and warm
DRILLER Bill Barnes
INSPECTOR Terry Primm
BORING TERMINATED AT 20

Sample No.	Sample Depth ft. From ___ To	Stand. Penet. Test Blow/ft.	Water Cont. %	SAMPLE DESCRIPTION AND REMARKS
1	3.5-5.0	5	25	Firm tan silty CLAY w/gray silt marbeling
2	8.5-10.0	10	25	Stiff brown silty CLAY w/gray silt marbeling
3	13.5-15.0	11	27	Stiff dark brown silty CLAY w/gray silt marbeling
4	18.5-20.0	9	26	Stiff dark brown silty CLAY w/gray silt marbeling

APPENDIX B

LABORATORY TESTS

VERTAC CHEMICAL CORPORATION FACILITY

VICKSBURG, MISSISSIPPI

TABLE A

Sheet No.	Description of Soil	Boring No.	Sample No.	Depth (ft.)	Spec. of Sampling	Spec. of Testing
A-1	Moisture Content	1	1	3.5-5.0	ASTM D1586	ASTM D2216
			2	8.5-10.0		
			3	13.5-15.0		
			4	18.5-20.0		
			5	23.5-25.0		
A-1		1	6	28.5-30.0		
A-2		2	1	3.5-5.0		
			2	8.5-10.0		
			3	13.5-15.0		
			4	18.5-20.0		
			5	23.5-25.0		
			6	28.5-30.0		
			7	33.5-35.0		
A-2		2	8	38.5-40.0		
A-3	Moisture Content	3	1	3.5-5.0	ASTM D1586	ASTM D2216

TABLE A

Sheet No.	Description of Soil	Boring No.	Sample No.	Depth (ft.)	Spec. of Sampling	Spec. of Testing
A-3	Moisture Content	3	2	8.5-10.0	ASTM D1586	ASTM D2216
			3	13.5-15.0		
			4	18.5-20.0		
			5	23.5-25.0		
A-3	Moisture Content	3	6	28.5-30.0	ASTM D1586	ASTM D2216
A-4	Shelby Tube	3A	ST-1	5.0-7.0	ASTM D1587	ASTM D2435
			ST-2	8.0-10.0		
A-4	Shelby Tube	3A	ST-3	18.0-20.0	ASTM D1587	ASTM D2435
A-5	Moisture Content	4	1	3.5-5.0	ASTM D1586	ASTM D2216
			2	8.5-10.0		
			3	13.5-15.0		
A-5	Moisture Content	4	4	18.5-20.0		ASTM D2216
B-4	Atterberg Limit	3A	ST-1	5.0-7.0		ASTM D423 & D424
		3A	ST-2	8.0-10.0		
B-4	Atterberg Limit	4	3	13.5-15.0	ASTM D1586	ASTM D423 & D424

Table A

Sheet No.	Description of Test	Boring No.	Sample No.	Depth (ft.)	Spec. of Sampling	Spec. of Testing
B-4	Atterberg Limits	3A	ST-3	18.0-20.0	ASTM D1586	ASTM D423 & D424
		2	5	23.5-25.0		
B-4	Atterberg Limits	1	6	28.5-30.0	ASTM D1586	ASTM D423 & D424

ATTERBERG LIMITS

Project Vertac, Inc., Vicksburg, Mississippi Job No. 872

Boring Number	Sample Number	Elev. or Depth, ft	Natural Water %	LL	PL	PI	% 200 (wash)	Unified. Class.	Soil Description
B-3A	ST-1	5.0-7.0	25	37	22	15		CL	Brown Silty CLAY
B-3A	ST-2	8.0-10.0	23	42	24	18		CL	Brown Silty CLAY
B-4	3	13.5-15.0	26	35	19	16		CL	Brown Silty CLAY
B-3A	ST-3	18.0-20.0	32	33	22	11		CL	Brown Silty CLAY
B-2	5	23.5-25.0	24	25	22	3		ML	Gray SILT
B-1	6	28.5-30.0	29	34	24	10		CL	Brown Silty CLAY

CONSOLIDATION TEST REPORT

PROJECT: VERTAC SITE - VICKSBURG, MS

TYPE OF SAMPLE- SHELBY TUBE JOB NO.- 872 DATE: OCTOBER 1981

BORING NO.- B-3 SAMPLE NO.- 1 ELEVATION,FT.- 18 TO 20

SOIL DESCRIPTION: BROWN SILTY CLAY

** NOTES **
ALL UNSPECIFIED INPUT UNITS ARE GRAMS OR INCHES
SPECIMEN DIAMETER IS 2.5 INCHES

THE WEIGHT OF THE RING IS 103.55
THE WEIGHT OF THE SPECIMEN PLUS TARE BEFORE TEST IS 217.53
THE WEIGHT OF THE TRIMMING TARE IS 25.03
THE WEIGHT OF THE WET TRIMMINGS PLUS TARE IS 115.85
THE WEIGHT OF THE DRY TRIMMINGS PLUS TARE IS 94.51
THE WEIGHT OF THE SPECIMEN TARE USED AFTER TEST IS 40.5
THE WEIGHT OF THE WET SPECIMEN PLUS TARE AFTER TEST IS 151.37
THE WEIGHT OF THE DRY SPECIMEN PLUS TARE AFTER TEST IS 127.94
THE SPECIFIC GRAVITY OF THE SPECIMEN IS 2.7
THE ORIGINAL HEIGHT OF THE SPECIMEN IS .75
THE TOTAL CHANGE IN HEIGHT OF THE SPECIMEN IS .0559

	BEFORE TEST	AFTER TEST
WATER CONTENT	30.7 %	26.8 %
SPECIMEN HEIGHT	.75 in.	.6941 in.
DRY DENSITY	90.5 pcf	97.8 pcf
VOID RATIO	.862	.723
DEGREE OF SAT.	96.2 %	100 %

CONSOLIDATION TEST REPORT

PROJECT: VERTAC SITE - VICKSBURG, MS

TYPE OF SAMPLE- SHELBY TUBE JOB NO.- 872 DATE: OCTOBER 1981

BORING NO.- B-3 SAMPLE NO.- 2 ELEVATION,FT.- 5 TO 7

SOIL DESCRIPTION: BROWN SILTY CLAY

** NOTES **
ALL UNSPECIFIED INPUT UNITS ARE GRAMS OR INCHES
SPECIMEN DIAMETER IS 2.5 INCHES

THE WEIGHT OF THE RING IS 104.85
THE WEIGHT OF THE SPECIMEN PLUS TARE BEFORE TEST IS 221.5
THE WEIGHT OF THE TRIMMING TARE IS 25.31
THE WEIGHT OF THE WET TRIMMINGS PLUS TARE IS 102.61
THE WEIGHT OF THE DRY TRIMMINGS PLUS TARE IS 84.91
THE WEIGHT OF THE SPECIMEN TARE USED AFTER TEST IS 40.57
THE WEIGHT OF THE WET SPECIMEN PLUS TARE AFTER TEST IS 150.69
THE WEIGHT OF THE DRY SPECIMEN PLUS TARE AFTER TEST IS 130.55
THE SPECIFIC GRAVITY OF THE SPECIMEN IS 2.7
THE ORIGINAL HEIGHT OF THE SPECIMEN IS .75
THE TOTAL CHANGE IN HEIGHT OF THE SPECIMEN IS .0875

	BEFORE TEST	AFTER TEST
WATER CONTENT	29.7 %	22.4 %
SPECIMEN HEIGHT	.75 in.	.6626 in.
DRY DENSITY	93.1 pcf	105.4 pcf
VOID RATIO	.809	.598
DEGREE OF SAT.	99.1 %	101 %

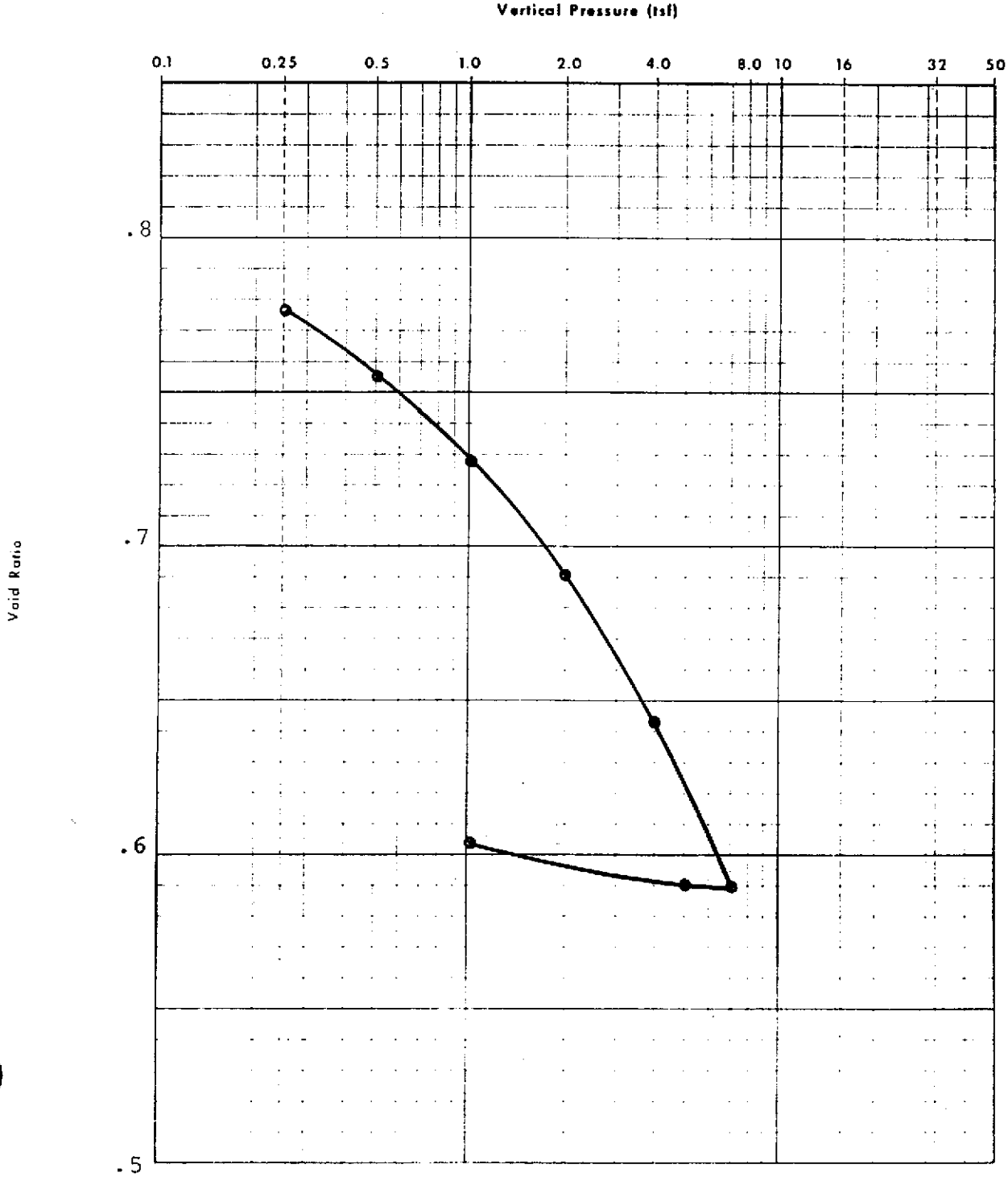
CONSOLIDATION TEST
(Void Ratio vs. Log Vertical Pressure)

Soil Description Brown Silty CLAY Project Vertac Inc., (Vicksburg, MS)

Boring No. 3 Surface Elev. 95.5 Sample No. ST-1 Sample Depth Interval 5' - 7'

LL 39.0 % w 30.4 % PL 22.0 % Date Tested October 28, 1981

Pocket Penetrometer, P.P. _____ tsf Specific Gravity, G_s 2.7 Dry Unit Weight, δ_d 92.6 pcf



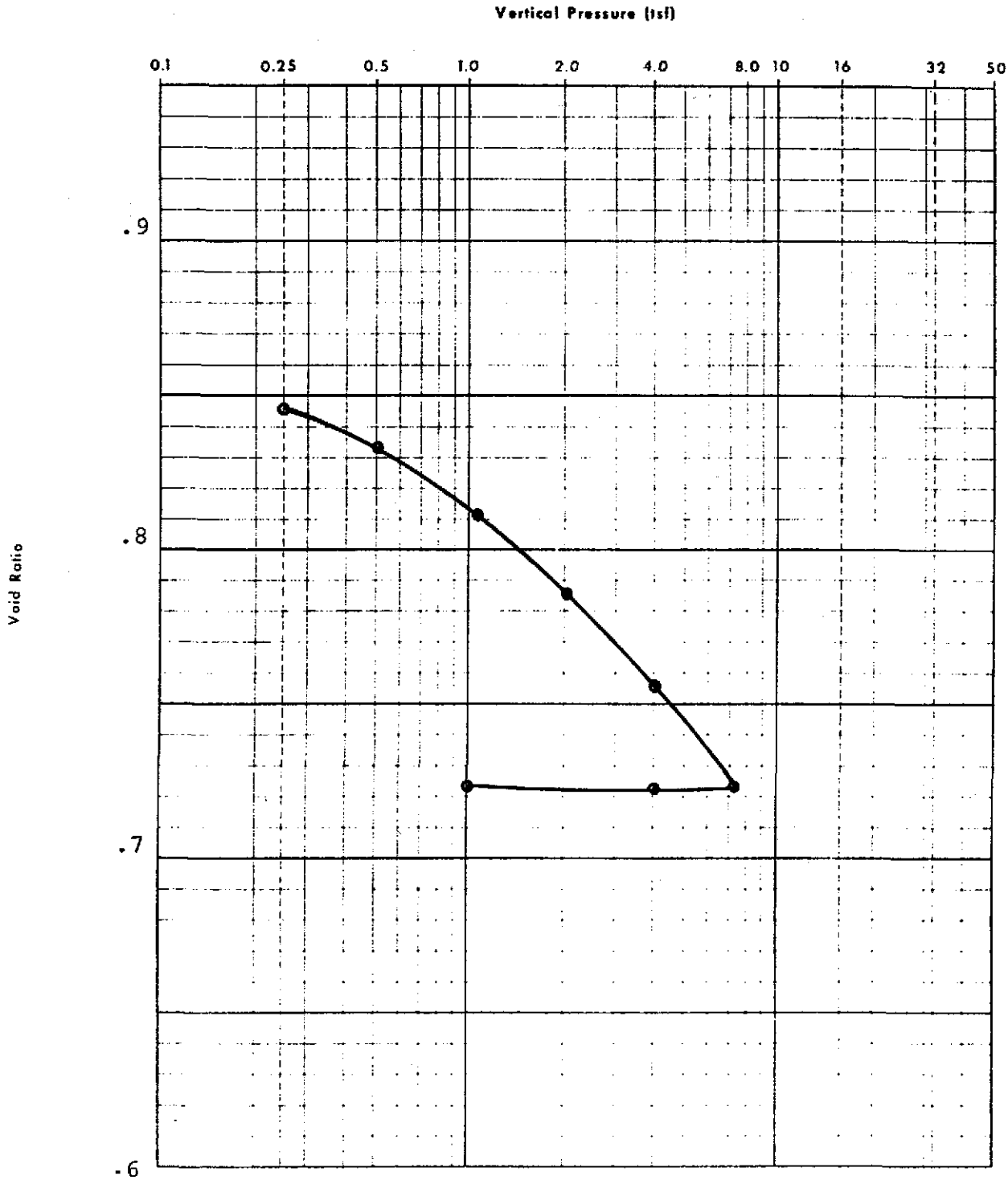
CONSOLIDATION TEST
(Void Ratio vs. Log Vertical Pressure)

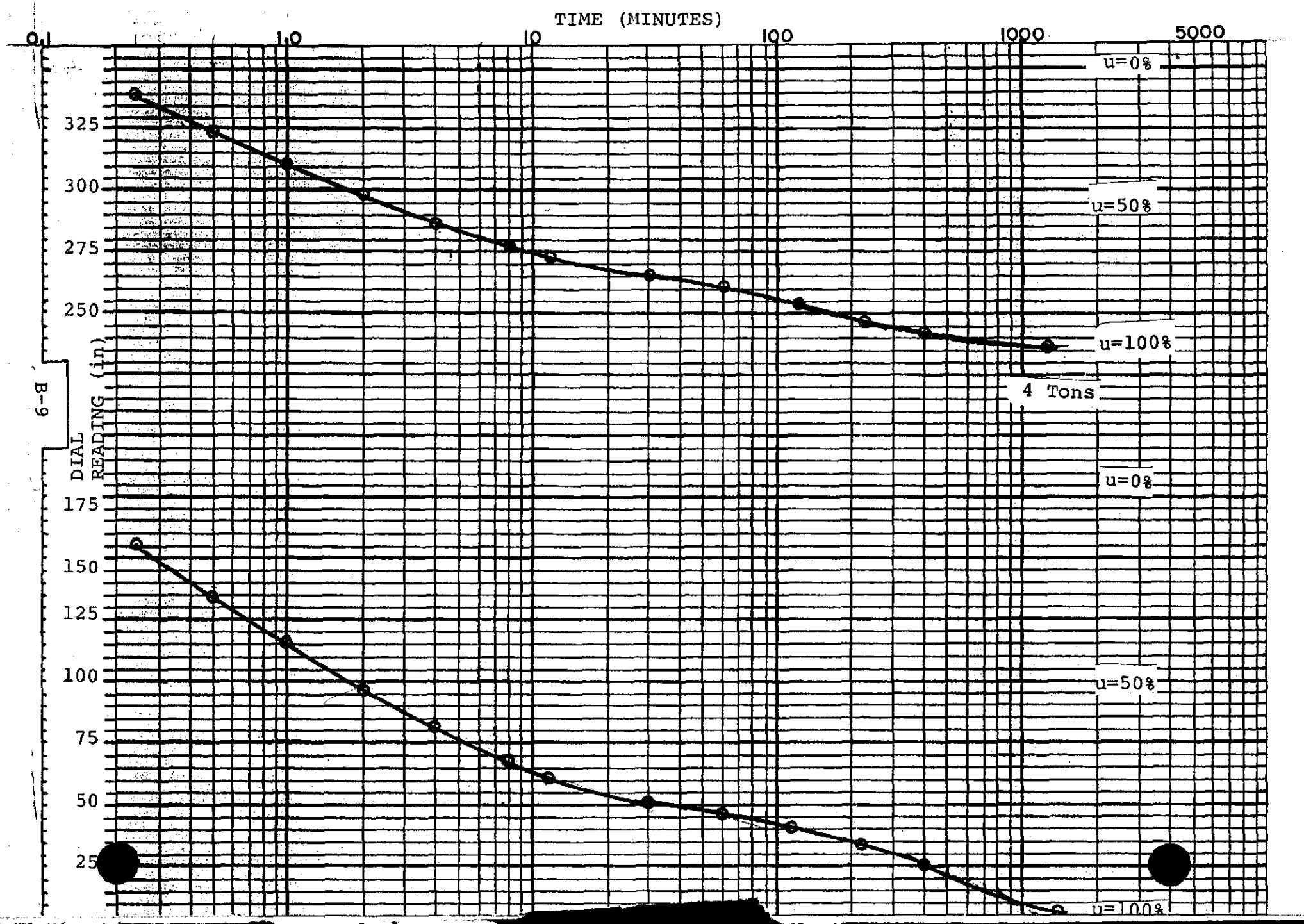
Soil Description Brown Silty CLAY Project Vertac Inc., (Vicksburg, MS)

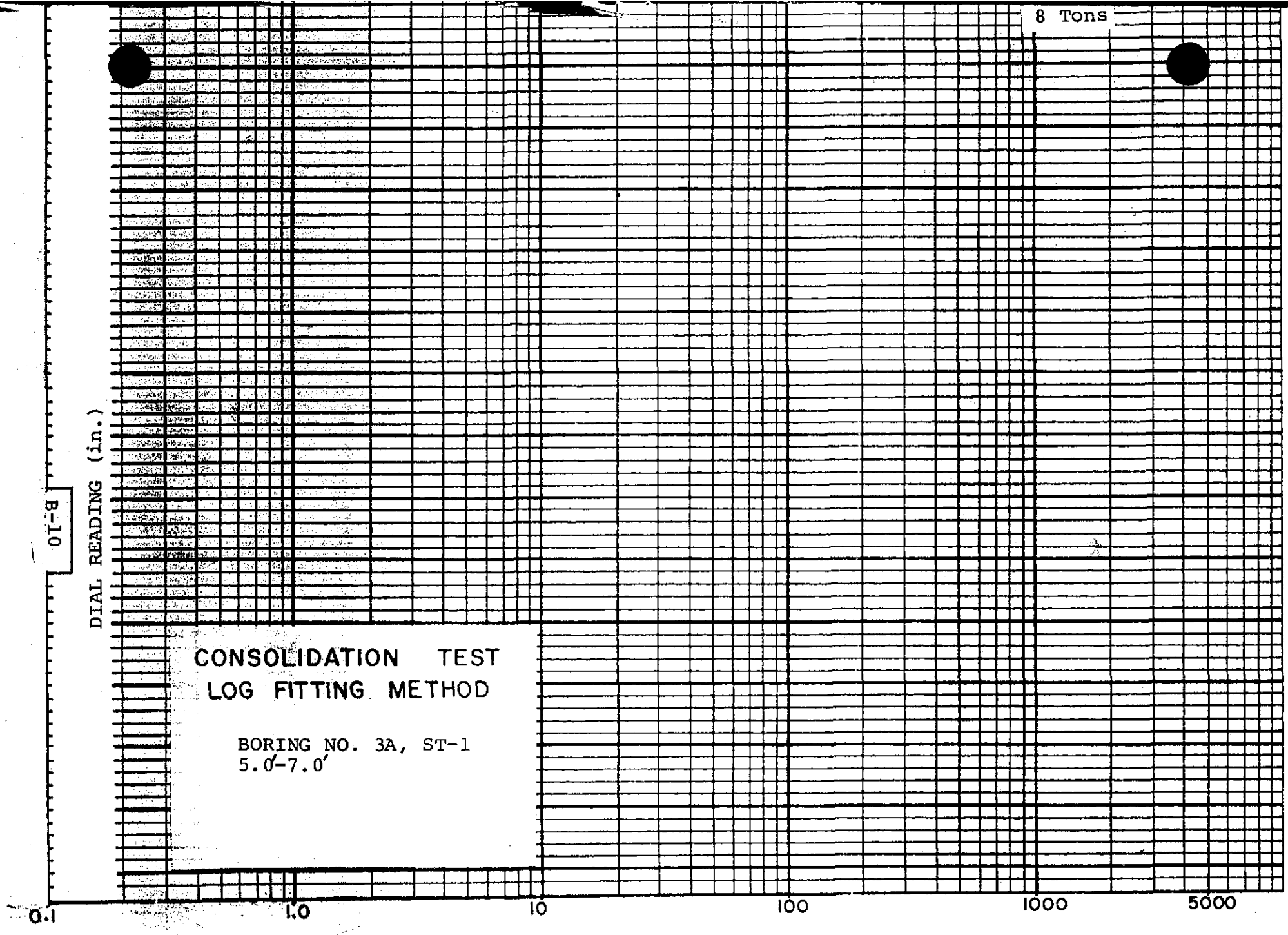
Boring No. B-3A Surface Elev. 95.5 Sample No. ST-3 Sample Depth Interval 18.0'-20.0'

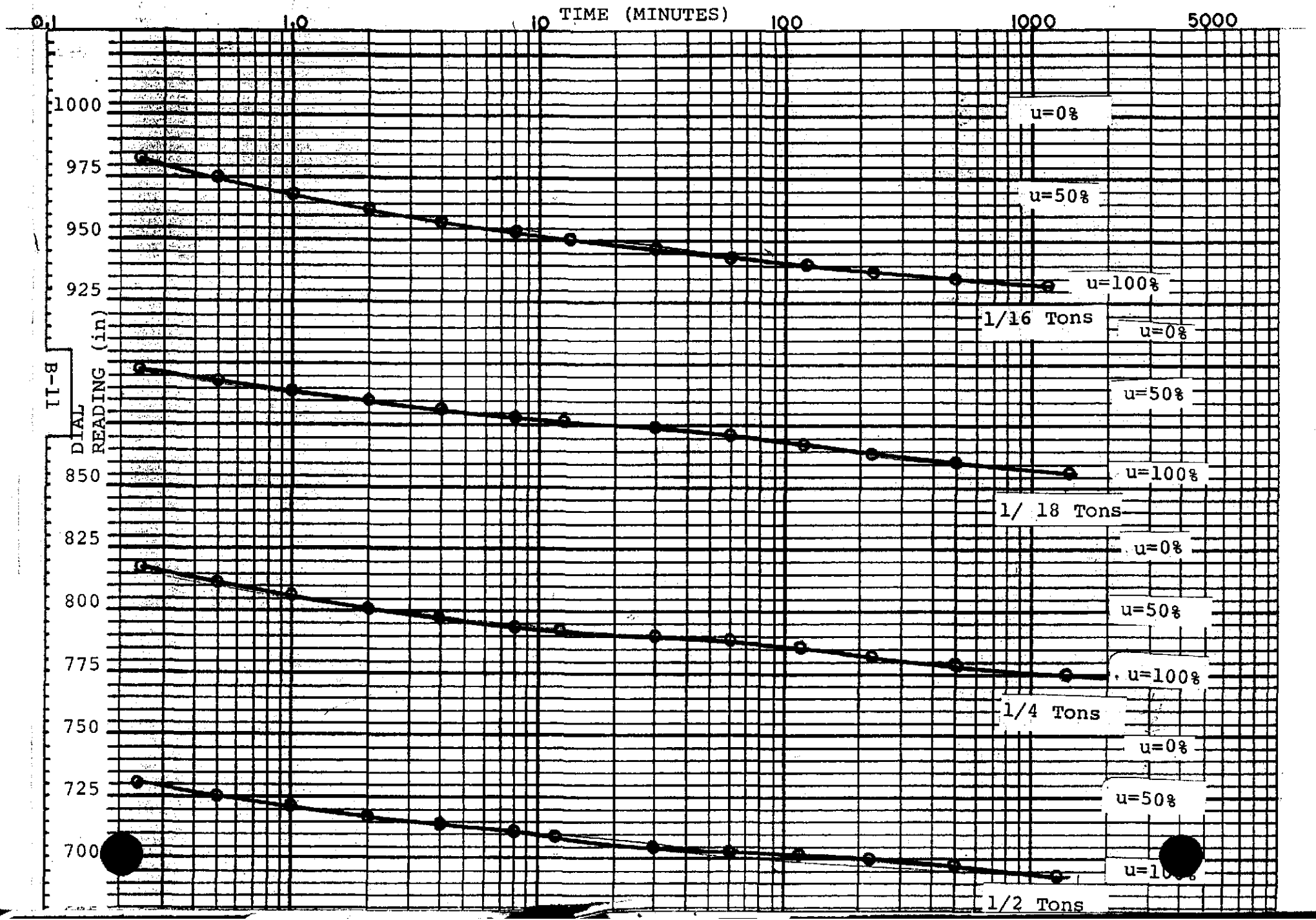
LL 33.0 % w 30.4 % PL 22.0 % Date Tested 28 October 1981

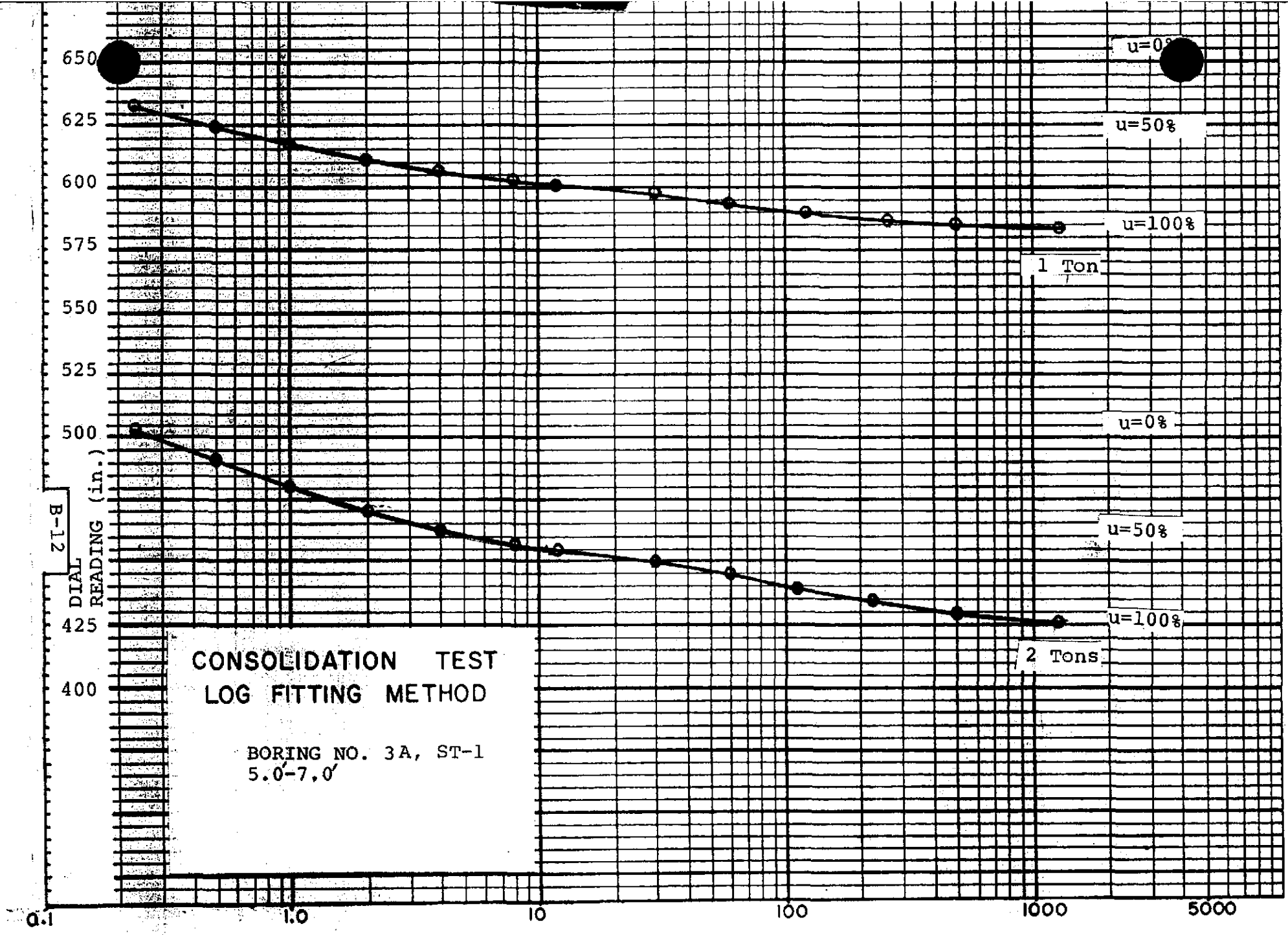
Pocket Penetrometer, P.P. _____ tsf Specific Gravity, G_s 2.7 Dry Unit Weight, γ_d 90.5 pcf

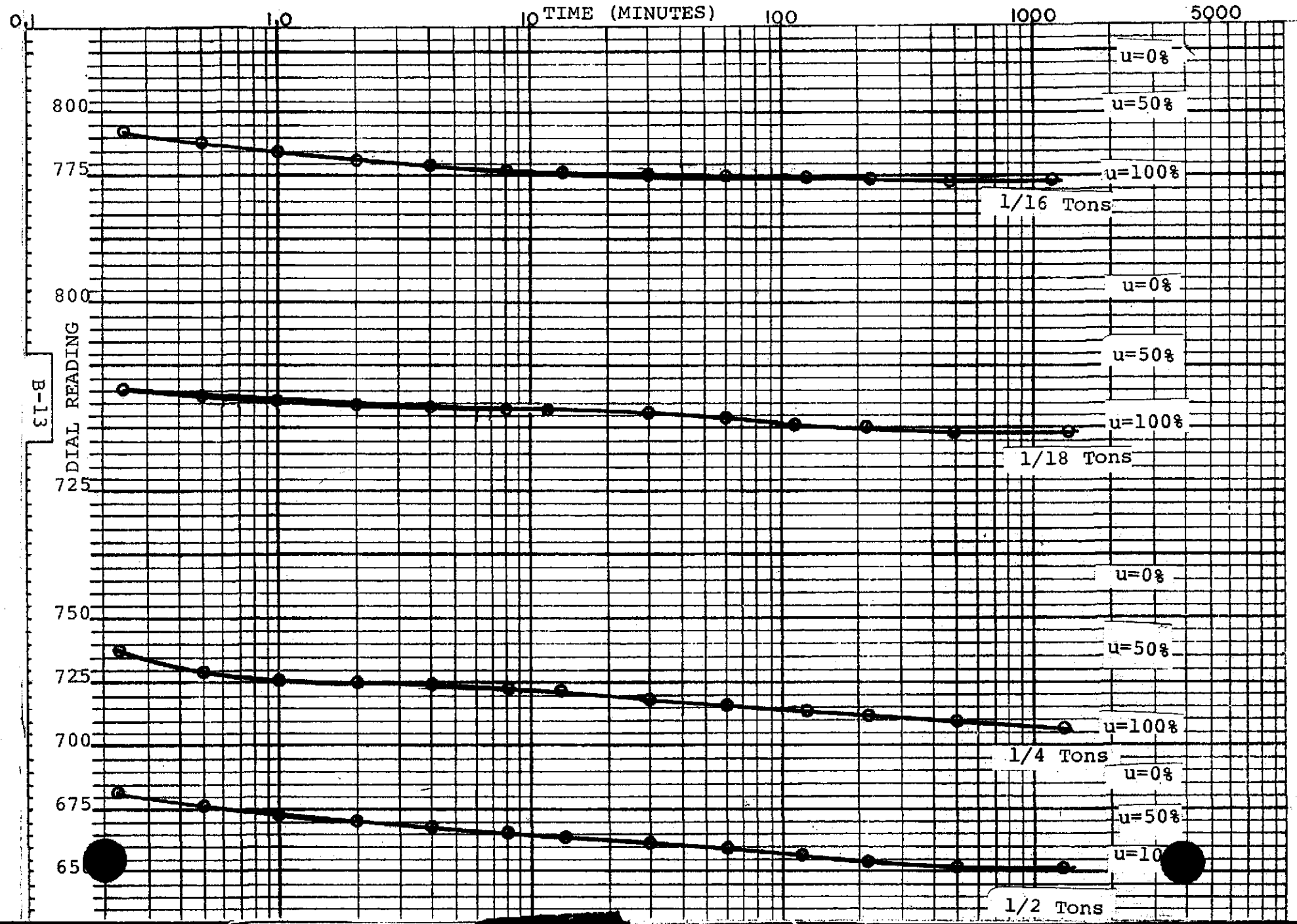


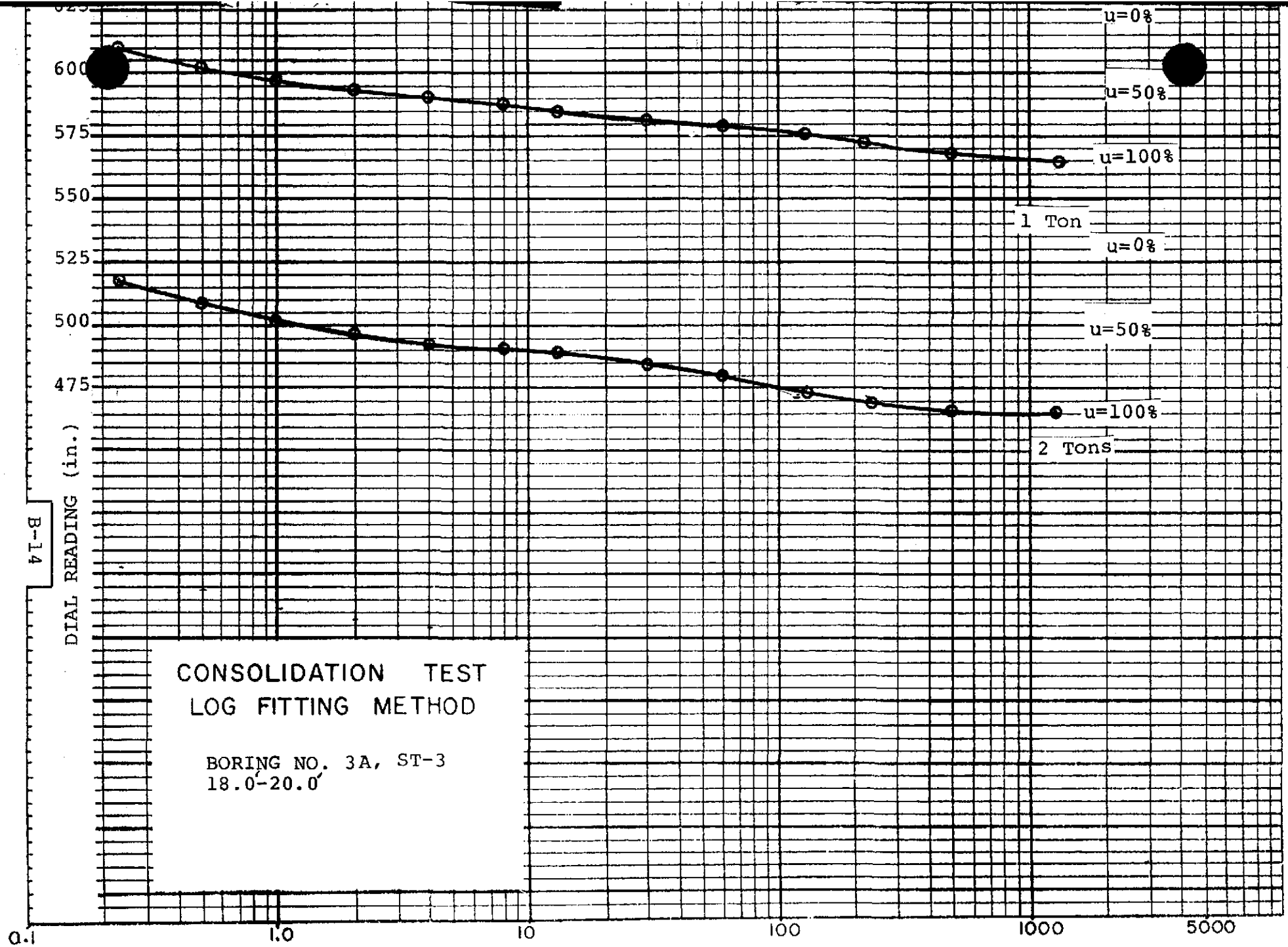

TIME (MINUTES)
0.1
1.0
10
100
1000
5000
DIAL READING (in)
325
300
275
250
175
150
125
100
75
50
25
u=0%
u=50%
u=100%
4 Tons
u=0%
u=50%
u=100%

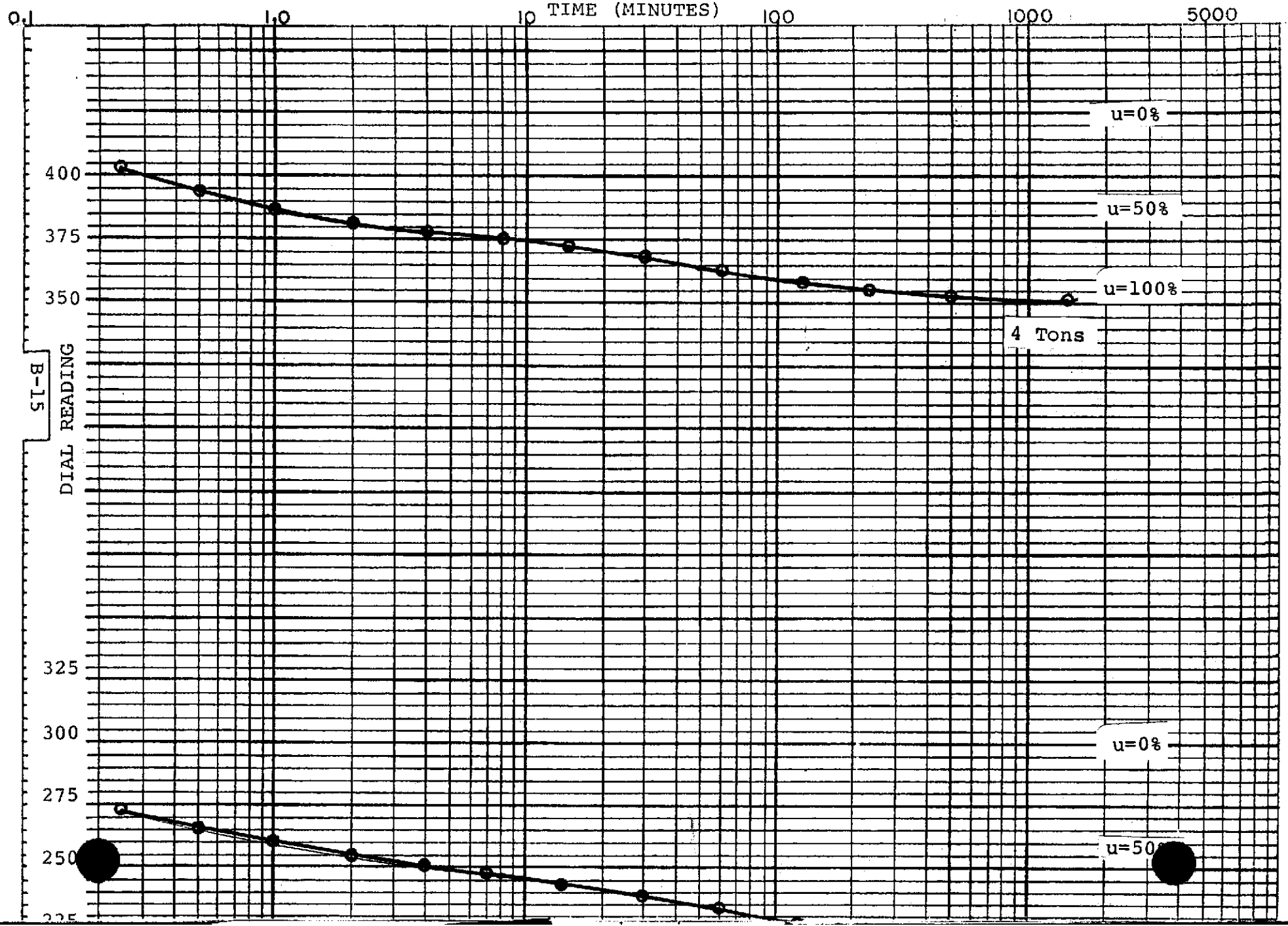

8 Tons
B-10
DIAL READING (in.)
CONSOLIDATION TEST
LOG FITTING METHOD
BORING NO. 3A, ST-1
5.0'-7.0'
0.1
1.0
10
100
1000
5000

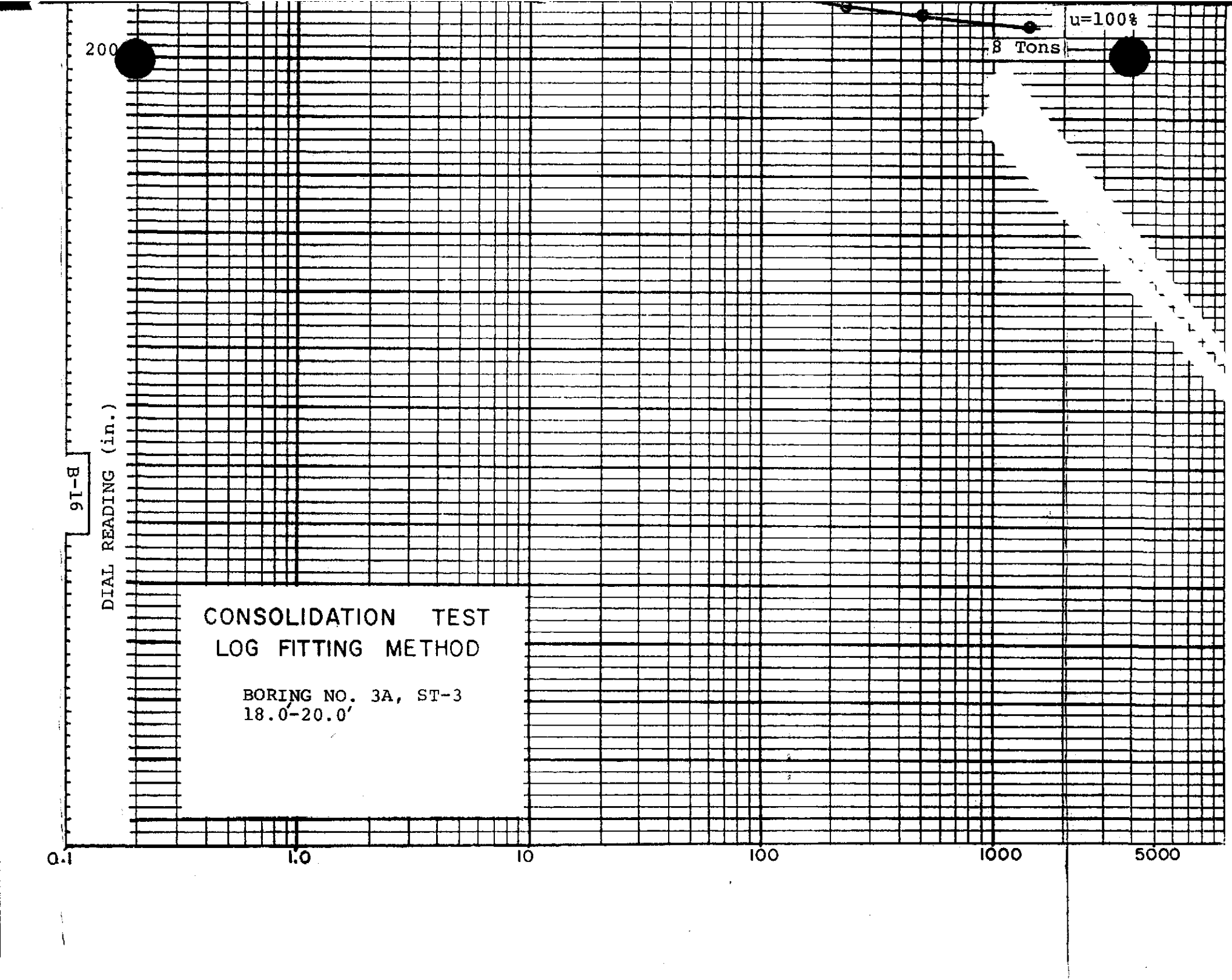

TIME (MINUTES)
0.1
1.0
10
100
1000
5000
DIAL READING (in)
1000
975
950
925
850
825
800
775
750
725
700
u=0%
u=50%
u=100%
1/16 Tons
u=0%
u=50%
u=100%
1/ 18 Tons
u=0%
u=50%
u=100%
1/4 Tons
u=0%
u=50%
u=100%
1/2 Tons


650
625
600
575
550
525
500
425
400
DIAL READING (in.)
B-12
u=0%
u=50%
u=100%
1 Ton
u=0%
u=50%
u=100%
2 Tons
CONSOLIDATION TEST
LOG FITTING METHOD
BORING NO. 3A, ST-1
5.0'-7.0'
0.1
1.0
10
100
1000
5000


TIME (MINUTES)
0.1
1.0
10
100
1000
5000
DIAL READING
800
775
800
725
750
725
700
675
65
u=0%
u=50%
u=100%
1/16 Tons
u=0%
u=50%
u=100%
1/18 Tons
u=0%
u=50%
u=100%
1/4 Tons
u=0%
u=50%
u=10
1/2 Tons
B-13


u=0%
u=50%
u=100%
1 Ton
u=0%
u=50%
u=100%
2 Tons
600
575
550
525
500
475
DIAL READING (in.)
0.1
1.0
10
100
1000
5000
CONSOLIDATION TEST
LOG FITTING METHOD
BORING NO. 3A, ST-3
18.0-20.0


TIME (MINUTES)
0.1
1.0
10
100
1000
5000
DIAL READING
400
375
350
325
300
275
250
B-15
u=0%
u=50%
u=100%
4 Tons
u=0%
u=50%


u=100%
8 Tons
200
DIAL READING (in.)
B-16
0.1
1.0
10
100
1000
5000
CONSOLIDATION TEST
LOG FITTING METHOD
BORING NO. 3A, ST-3
18.0'-20.0'

DISC
Developers, International Services Corp.

- CONSULTANTS
- LABORATORIES
- GEOTECHNICAL

P.O. BOX 1975
EL DORADO, ARK. 71730

P.O. BOX 161156
MEMPHIS, TENN. 38116
(901) 396-1120

LITTLE ROCK, ARK.
(501) 372-2519

VERTAC, INC., VICKSBURG, MISSISSIPPI

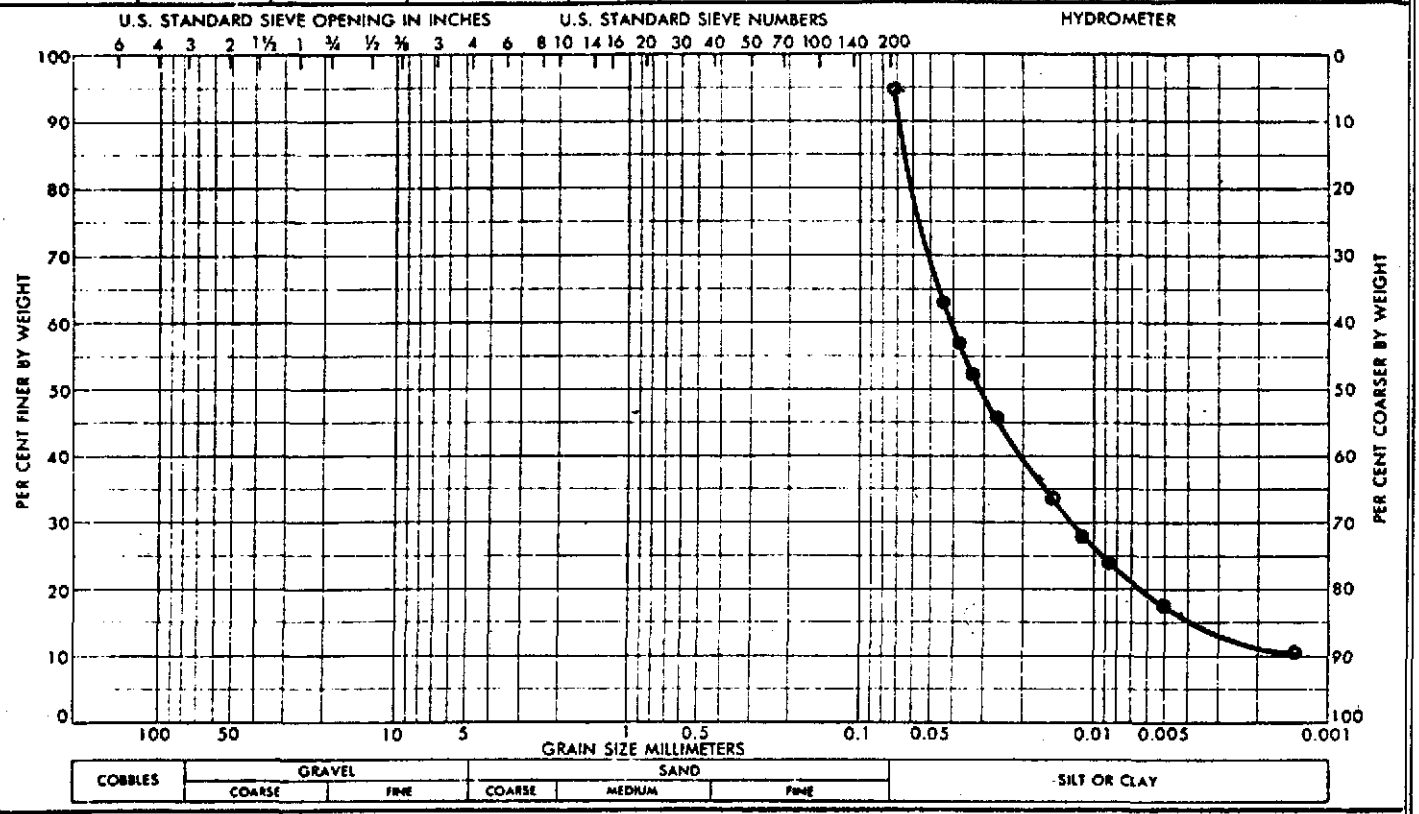
SOIL CLASSIFICATION TEST REPORT

Job No. 872

Soil Type CL Soil Description Brown Silty CLAY

Classification: UNIFIED X AASHO _____ Other _____

Plotting Symbol	Boring No.	Sample No.	Elev. or Depth, ft	Nat. W%	Liquid Limit	Plastic Limit	Plast. Index	%-200 (Wash)	
	B-3	ST-3	18.0-20.0	32	33	22	11	89.7	



Samples above represent, as a group, the following locations in the test borings:-

Boring No.	Depth Interval, ft.	Boring No.	Depth Interval, ft.	Boring No.	Depth Interval, ft.	Boring No.	Depth Interval, ft.
3	18.0-20.0'						

DISC
Developers, International Services Corp.

- CONSULTANTS
- LABORATORIES
- GEOTECHNICAL

P.O. BOX 1975
EL DORADO, ARK. 71730

P.O. BOX 161158
MEMPHIS, TENN. 38116
(901) 396-1120

LITTLE ROCK, ARK.
(501) 372-2519

VERTAC, INC., VICKSBURG, MISSISSIPPI

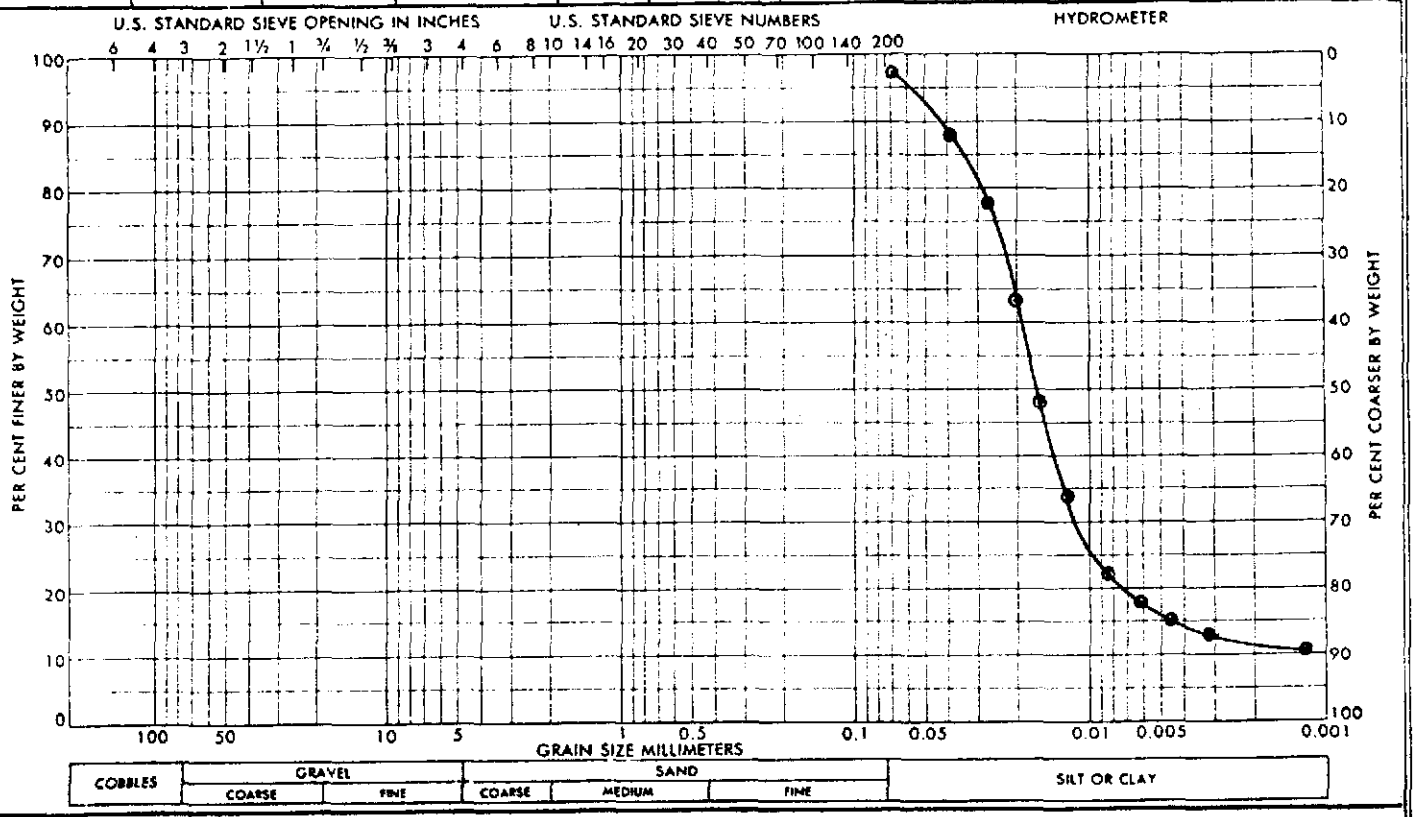
SOIL CLASSIFICATION TEST REPORT

Job No. 872

Soil Type CL Soil Description Brown Silty CLAY

Classification: UNIFIED X AASHO ____ Other ____

Plotting Symbol	Boring No.	Sample No.	Elev. or Depth, ft	Nat. W%	Liquid Limit	Plastic Limit	Plast. Index	%-200 (Wash)	
	B-3	ST-1	5.0-7.0	25	37	22	15	97.5	



Samples above represent, as a group, the following locations in the test borings:-

Boring No.	Depth Interval, ft.	Boring No.	Depth Interval, ft.	Boring No.	Depth Interval, ft.	Boring No.	Depth Interval, ft.
3	5.0-7.0'						

DISC
Developers, International Services Corp.

- CONSULTANTS
- LABORATORIES
- GEOTECHNICAL

P. O. Box 161158
Memphis, TN 38116-0294

Serial No. J-017

FALLING-HEAD PERMEABILITY TEST

PROJECT: Vertac, Inc.
Vicksburg, Mississippi

JOB NO: 872

CLIENT: Vertac, Inc.
5100 Poplar
Memphis, TN 38137

DATE: 10 November 1981

Pit No. B-3 Sample Depth 18.0-20.0 feet

Soil Description Brown Silty CLAY

AREA

Diameter of Sample 6.35 cm

Area of Sample 31.67 sq cm

Area of Standpipe 1.70 sq cm

Height of Sample: 2.8 cm

Initial Head : 76.0 cm

Final Head : 74.75 cm

Elapsed Time : 1800 sec

Temperature of Water: 20°C

Viscosity Correction Factor : 1.135

Hydraulic Conductivity (Coefficient of Permeability; for water @ 20°C)(K) = 1.4×10^{-6} cm/sec

Intrinsic (specific) permeability(k) = 9.56×10^{-6} cm^2

Respectfully submitted,

Developers, International Services Corporation

Robert D. Briggs
Laboratory Manager

A DIVISION OF DISC International

MEMPHIS, TENN (901) 396-1120 | LITTLE ROCK, ARK (501) 372-25[illegible] | EL DORADO, ARK. | GREENVILLE, MS. | RENO, NEV

APPENDIX C

WELL LOGS

VERTAC CHEMICAL CORPORATION FACILITY

VICKSBURG, MISSISSIPPI

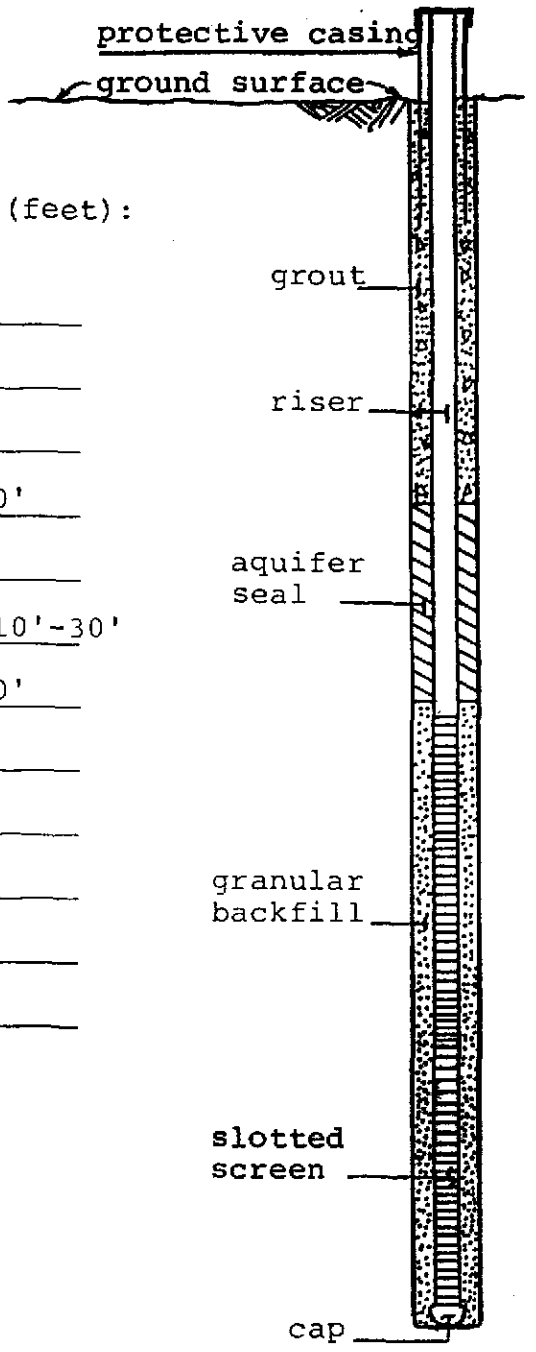
Installation of Well # 1

Job No. 872

Project Vertac Chemical Corporation

Vicksburg, Mississippi

Date: Installed 29 Sept. 1981
Completed 29 Sept. 1981
Developed 01 Oct. 1981



Locations below ground surface (feet):

Bottom of Boring	30'
Bottom of Well	30'
Well Specification	4" PVC-Schd.40
Screen Slot and Location	0.010" 20'-30'
Coupling Location	0,20'
Granular Backfill	Concrete Sand 10'-30'
Seals	Bentonite 8'-10'
Grout	Concrete 0-8'
Cave-in	None
Height of Riser	2'
Protective Casing	None
Elevation-top casing	109.1 MSL

Installation of Well # 2

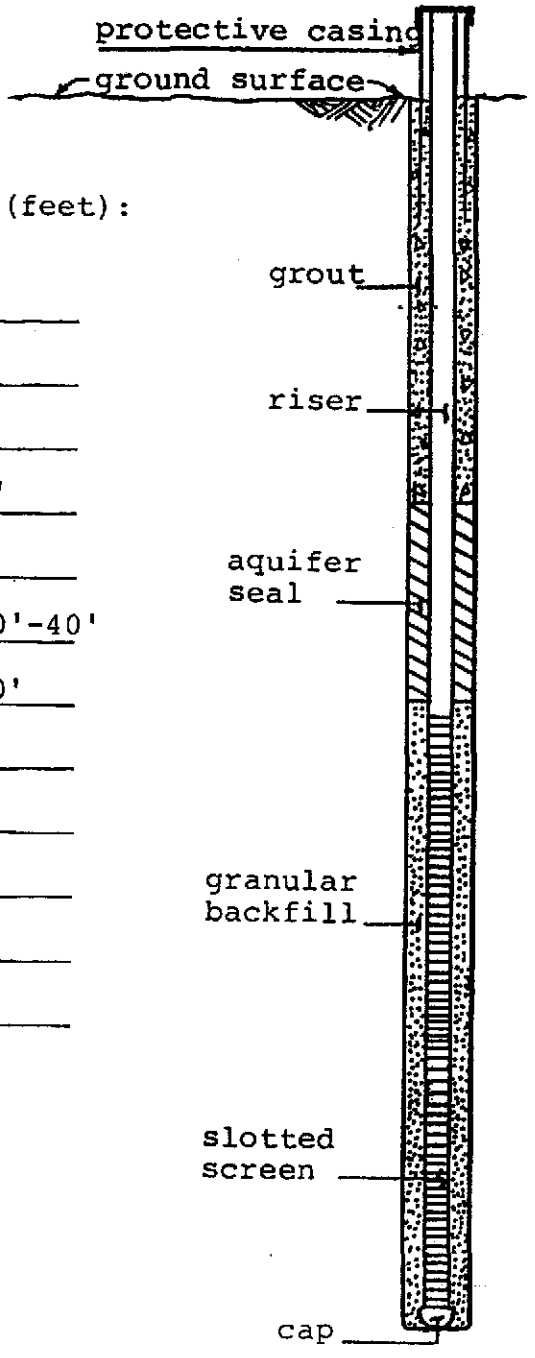
Job No. 872

Project Vertac Chemical Corporation
Vicksburg, Mississippi

Date: Installed 29 Sept. 1981
Completed 29 Sept. 1981
Developed 01 Oct. 1981

Locations below ground surface (feet):

Bottom of Boring	40'
Bottom of Well	40'
Well Specification	4" PVC-Schd. 40
Screen Slot and Location	0.010" 30'-40'
Coupling Location	0', 10', 30'
Granular Backfill	Concrete Sand 10'-40'
Seals	Bentonite 8'-10'
Grout	Concrete 0-8'
Cave-in	None
Height of Riser	2'
Protective Casing	None
Elevation-top casing	105.0 MSL



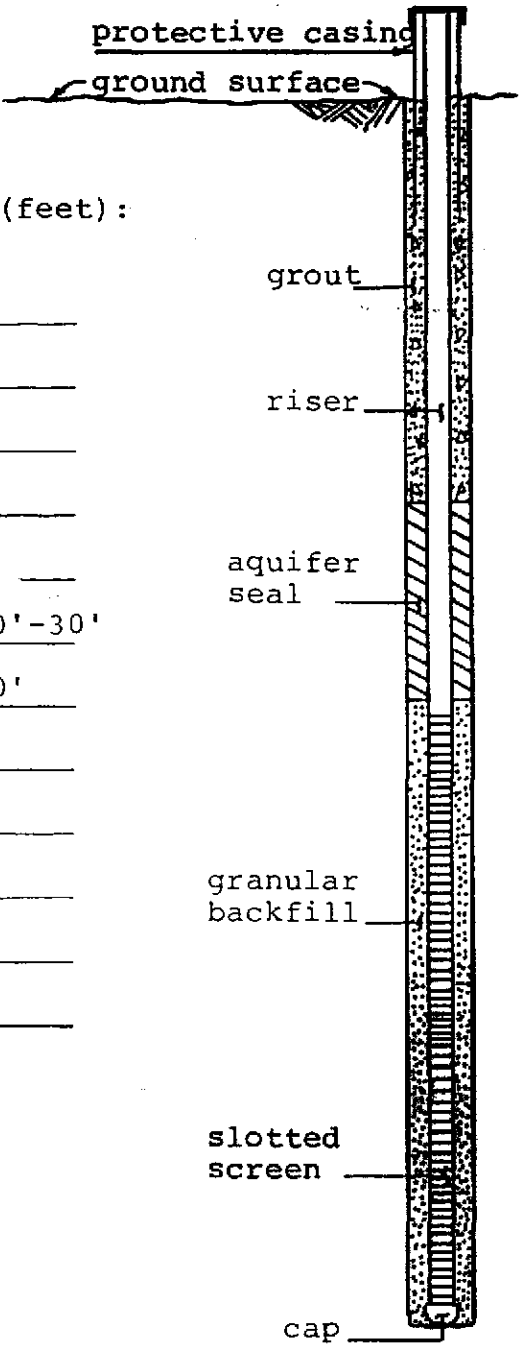
Installation of Well # 3

Job No. 872

Project Vertac Chemical Corporation

Vicksburg, Mississippi

Date: Installed 30 Sept. 1981
Completed 30 Sept. 1981
Developed 01 Oct. 1981



Locations below ground surface (feet):

Bottom of Boring	30'
Bottom of Well	30'
Well Specification	4" PVC-Schd. 40
Screen Slot and Location	0.010" 20'-30'
Coupling Location	0', 20'
Granular Backfill	Concrete Sand 10'-30'
Seals	Bentonite 8'-10'
Grout	Concrete 0-8'
Cave-in	None
Height of Riser	2'
Protective Casing	None
Elevation-top casing	97.5 MSL

Installation of Well # 4

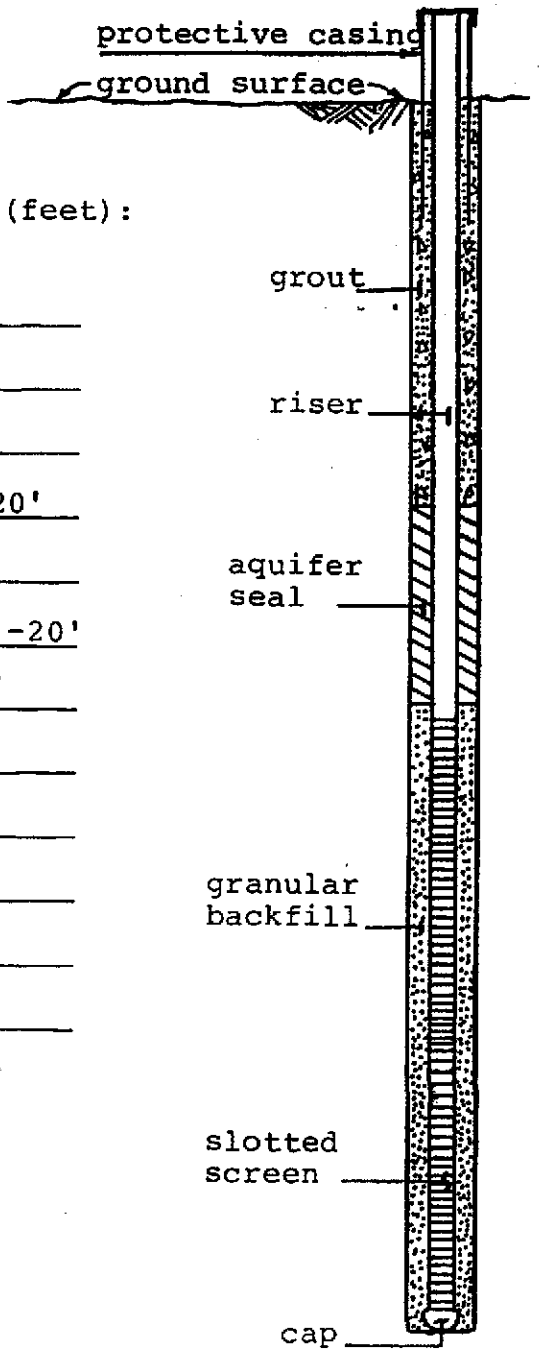
Job No. 872

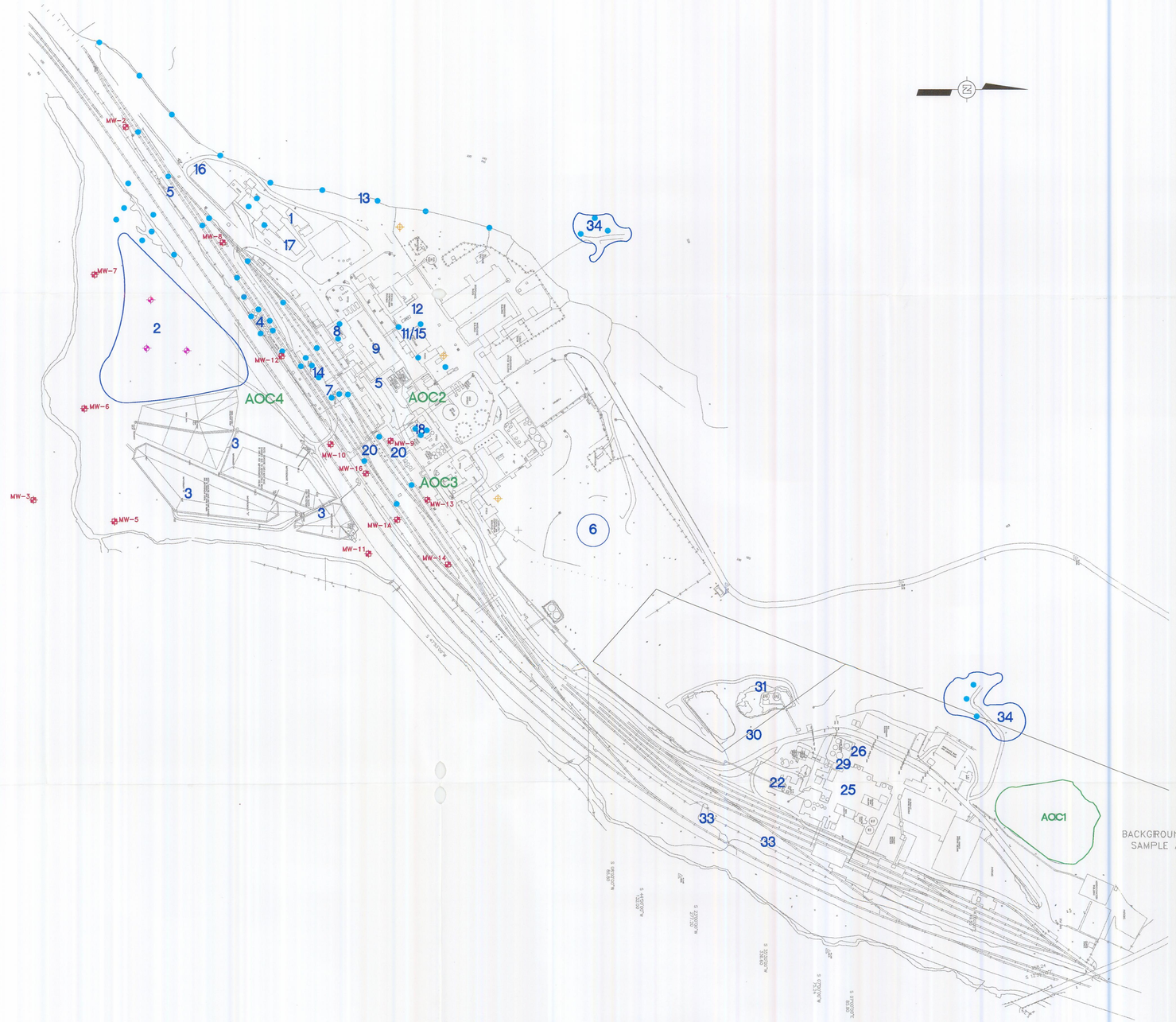
Project Vertac Chemical Corporation
Vicksburg, Mississippi

Date: Installed 01 Oct. 1981
Completed 01 Oct. 1981
Developed 01 Oct. 1981

Locations below ground surface (feet):

Bottom of Boring	20'
Bottom of Well	20'
Well Specification	4" PVC-Schd. 40
Screen Slot and Location	0.010" 10'-20'
Coupling Location	0,10'
Granular Backfill	Concrete Sand 8'-20'
Seals	Bentonite 6'-8'
Grout	Concrete 0-6'
Cave-in	None
Height of Riser	2'
Protective Casing	None
Elevation-top casing	111.6 MSL





SWMU NUMBER — SOUTH PLANT

1	CONTAINER (DRUM) STORAGE AREA
2	INACTIVE LANDFILL
3	SURFACE IMPOUNDMENT (SOUTH PLANT)
4	ACTIVATED CARBON TREATMENT UNITS
5	SOUTH PLANT DRAINAGE SYSTEMS
6	WASTEWATER STORAGE (HILL) TANKS
7	FORMER DINOSEB PRODUCTION AREA
8	DINOSEB LOADING/UNLOADING AREA
9	DINOSEB DRUMMING AREA
11	FORMER MSMA PRODUCTION AREA
12	FORMER MSMA SALT UNLOADING AREA
13	SOUTH PLANT DRAINAGE DITCHES
14	FORMER TOXAPHENE PRODUCTION AREA
15	FORMER METHYL PARATHION PRODUCTION AREA
16	FORMER ATRAZINE PRODUCTION AREA
17	RETURNED PRODUCT STORAGE AREA
18	FORMER BLUE TANK AREA
20	RAILROAD CAR UNLOADING STATION

NORTH PLANT

22	NORTH PLANT NEUTRALIZATION SYSTEM
23	EQUALIZATION/NEUTRALIZATION POND (NORTH PLANT)
25	NORTH PLANT WASTEWATER PIPES
26	C-10 SCRUBBER
29	OIL COLLECTION UNIT
30	NORTH PLANT WASTE OIL ACCUMULATION AREA
31	NO. 6 FUEL OIL AREA
33	NORTH PLANT DRAINAGE DITCHES

BOTH PLANTS

34	SURPLUS EQUIPMENT STORAGE (JUNKYARD)

AOC NUMBER	AOC NAME
1	FISH POND (NORTH PLANT)
2	DRUM STORAGE AREA
3	NEUTRALIZATION TANKS (SOUTH PLANT)
4	CHEMICAL CRYPT (SEPTIC TANKS)

LEGEND

- DEEP BORINGS
- NEW MONITOR WELL LOCATIONS
- SHALLOW BORINGS
- EXISTING MONITOR WELLS

SCALE
200 0 200 400 FEET

NO.	REVISION	DATE	INITIAL

RCRA FACILITY INVESTIGATION AND GROUNDWATER ASSESSMENT

WOODWARD-CLYDE CONSULTANTS
Consulting Engineers, Geologists and Environmental Scientists
Baton Rouge, Louisiana

VICKSBURG CHEMICAL COMPANY
VICKSBURG, MISSISSIPPI

SCALE:	MADE BY: GT	DATE: 11/28/95	FILE NO.
1"=200'	CHECKED BY: RDK	DATE: 7/19/96	92B007C

SWMU LOCATIONS, RFI SOIL AND CONCRETE SAMPLE POINTS, GWA MONITOR WELL LOCATIONS — FIGURE 1

K:\CAD-GIS\VICKSBUR\92B007CA Fri Jul 19 10:36:48 1996