SDMS US EPA Region V

Imagery Insert Form

Document ID: 165353

Some images in this document may be illegible or unavailable in SDMS. Please see reason(s) indicated below:

[ ] Illegible due to bad source documents. Image(s) in SDMS is equivalent to hard copy.

Specify Type of Document(s) / Comments:

[X] Includes _X_ COLOR or _X_ RESOLUTION variations.
Unless otherwise noted, these pages are available in monochrome. The source document page(s) is more legible than the images. The original document is available for viewing at the Superfund Records Center.

Specify Type of Document(s) / Comments:

APPENDIX 5 - SEDIMENT DEWATERING DESIGN DRAWINGS - DRAWING 1 -6

[ ] Confidential Business Information (CBI).
This document contains highly sensitive information. Due to confidentiality, materials with such information are not available in SDMS. You may contact the EPA Superfund Records Manager if you wish to view this document.

Specify Type of Document(s) / Comments:

[ ] Unscannable Material:
Oversized _____ or _____ Format.
Due to certain scanning equipment capability limitations, the document page(s) is not available in SDMS. The original document is available for viewing at the Superfund Records center.

Specify Type of Document(s) / Comments:

[ ] Document is available at the EPA Region 5 Records Center.

Specify Type of Document(s) / Comments:

Rev. 07/10/02

Time Critical Removal Action Work Plan

Dead Creek Sediment and Soil

Sauget and Cahokia, Illinois

DRAFT

June 30, 2000

Submitted to:

US Environmental Protection Agency
Chicago, Illinois

Submitted by:

Solutia Inc.
St. Louis, Missouri

SOLUTIA

Applied Chemistry, Creative Solutions

Solutia Inc.
575 Maryville Centre Drive
St. Louis, Missouri 63141

P.O. Box 66760
St. Louis, Missouri 63166-6760
Tel 314-674-1000

June 30, 2000

Kevin Turner-Environmental Scientist, OSC
U. S. Environmental Protection Agency
8588 Rt. 148
Marion, IL 62959

Re: Sauget Sites Area I - May 31, 2000 Unilateral Administrative Order
Docket No. V-W-99-C-554
Dead Creek Sediments & Soils Removal / Containment
- **Time Critical Removal Action Work Plan**

Mr. Turner,

On May 31, 2000 the United States Environmental Protection Agency issued a Unilateral Administrative Order ("Order") to Monsanto Company and Solutia Inc. requiring removal of soils and sediments from Dead Creek and placement within an onsite containment cell. Enclosed for USEPA's review and approval is the Time Critical Removal Action Work Plan ("TCRAWP") submittal pursuant to Section V.3.1 of the Order entitled, "Work Plan and Implementation". The TCRAWP provides a description of, and an expeditious schedule for, the activities required by Section V.3.B of the Order including:

- Section V.3.B.1 - Sediment and Soil Removal Requirements
- Section V.3.B.2 - Materials Handling, Dewatering and Treatment Requirements
- Section V.3.B.3 - Storm Water Management Requirements
- Section V.3.B.4 - Excavated Area Soil Sampling
- Section V.3.B.5 - Excavated Area Bottom Liner Requirements
- Section V.3.B.6 - Containment Cell Design Report Requirements

Solutia requests your timely comments and/or approval of this submittal.

Sincerely,

D. M. Light
Project Coordinator
Solutia Inc.

cc: (w/enclosure)

Thomas Martin, Esq. - USEPA
Michael McAteer - USEPA
Candi Morin - IEPA
Linda Tape, Esq. - Thompson Coburn

Table of Contents

1.0 Introduction **1-1**

1.1 Time Critical Removal Action Work Plan 1-3
1.2 Sediment and Soil Removal Requirements 1-3
1.3 Materials Handling, Dewatering and Treatment Requirements 1-5
1.4 Stormwater Management Requirements 1-5
1.5 Excavated Area Soil Sampling 1-6
1.6 Excavated Area Bottom Liner Requirements 1-6
1.7 Containment Cell Design Report Requirements 1-7

2.0 Site Description **2-1**

2.1 Dead Creek 2-1
2.1.1 Dead Creek Segments 2-8
2.1.2 Creek Segment A 2-8
2.1.3 Creek Segment B 2-9
2.1.4 Site M 2-10
2.1.5 Creek Segment C 2-11
2.1.6 Creek Segment D 2-11
2.1.7 Creek Segment E 2-12
2.1.8 Creek Segment F 2-12
2.2 Waste Disposal 2-13
2.3 Land Use 2-13
2.4 Climate 2-14
2.5 Hydrology 2-14
2.6 Geology 2-14
2.7 Water Resources 2-15
2.8 Groundwater Levels 2-16

3.0 Sediment Chemical Analyses and Bioassays **3-1**

3.1 Creek Segment B and Site M 3-1
3.1.1 E&E Sediment Chemical Analyses 3-1
3.1.2 SSP Sediment Chemical Analyses 3-3
3.1.3 SSP Sediment Bioassays 3-4
3.2 Creek Segment C 3-4
3.2.1 E&E Sediment Chemical Analyses 3-4
3.2.2 SSP Sediment Chemical Analyses 3-6
3.2.3 SSP Sediment Bioassays 3-7
3.3 Creek Segment D 3-7
3.3.1 E&E Sediment Chemical Analyses 3-7
3.3.2 SSP Sediment Chemical Analyses 3-8
3.3.3 SSP Sediment Bioassays 3-9
3.4 Creek Segment E 3-10

3.4.1 E&E Sediment Chemical Analyses 3-10
3.4.2 SSP Sediment Chemical Analyses 3-11
3.4.3 SSP Sediment Bioassays 3-12
3.5 Summary 3-12

4.0 Sediment and Soil Removal Plan **4-1**

4.1 Removal Volume 4-1
4.2 Sediment Removal Criteria 4-2
4.3 Sediment and Soil Removal 4-2
4.3.1 Creek Segment B 4-2
4.3.2 Site M 4-4
4.3.3 Creek Segment C 4-4
4.3.4 Creek Segment D 4-6
4.3.5 Creek Segment E 4-8

5.0 Sediment Handling, Dewatering and Treatment Plan **5-1**

6.0 Storm Water Management Plan **6-1**

7.0 Excavated Area Soil Sampling Plan **7-1**

7.1 Creek Segments B, D, D and E 7-1
7.2 Site M 7-2

8.0 Creek Segment B Liner Installation Plan **8-1**

9.0 Containment Cell Design Report **9-1**

9.1 Shallow Groundwater 9-1
9.2 Groundwater Usage 9-2
9.3 Leachate Migration 9-2
9.4 Flooding 9-3
9.5 Stormwater 9-4
9.6 Containment Cell Design 9-4

10.0 Schedule **10-1**

Figures

Figure 1 Site Location Map

Tables

Table 1 Summary of Sediment Chemical Analyses

Appendices

Appendix 1 Unilateral Administrative Order

Appendix 2 Village of Sauget Groundwater Use Ordinance

Appendix 3 SSP Sediment Chemical Analyses

Appendix 4 SSP Sediment Bioassays

Appendix 5 Sediment Dewatering System Drawings

Appendix 6 CS-B Channel Liner Design Drawings

Appendix 7 Containment Cell Design

Section 1

— Need command post
— " person to talk w/ for public

1.0 Introduction

On May 31, 2000, the United States Environmental Protection Agency issued a Unilateral Administrative Order to Monsanto Company and Solutia Inc. (Docket No. V-W-99-C-554) pursuant to section 106(a) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 as amended, 42 U.S.C. Section 9606(a). The Order, included in Appendix 1, requires the following response activities at Sauget Area 1 Creek Segments B and Site M and Creek Segments C, D and E, which are located in Sauget and Cahokia, Illinois:

- Preparation of a Time Critical Removal Action Work Plan;
- Implementation of the Removal Action in accordance with the Work Plan to mitigate the threats posed by presence of contamination in Dead Creek sediments and certain adjacent soils and their potential migration via overflow and flood waters from the Site;
- Removal of materials from CS-B (creek sediments, creek bed soils and flood plain soils); CS-C, D, and E (non-native creek sediments only); and Site M (pond sediments and pond bottom soils) in Sauget Area 1, while minimizing adverse impacts to area wetlands and habitat;
- Proper handling, dewatering, treatment and placement of such materials in the on-site Containment Cell;
- A plan for management of Dead Creek storm water;
- Sampling and analysis of areas where materials ~~has~~ have been removed, for the purpose of defining remaining contamination;
- Placement of membrane liner material over CS-B and in all other excavated areas where, based on post-removal sample results, such liner is determined to be necessary; and
- Design of a containment cell which will provide adequate protection to human health and the environment.

The Order requires Solutia to conduct these removal activities to abate a potential imminent and substantial endangerment to the public health, welfare or the environment that may be

presented by the actual or threatened release of hazardous substances at or from the site. A Time-Critical Removal Action is appropriate for the following reasons:

1) The threat of migration due to sediment mobilization and downstream transport during flood conditions in Creek Segment B and Site M. Sediments in CS-B and Site M contain Zinc, Copper, Lead, Barium, Nickel and PCBs with maximum concentrations of 71,000 ppm; 44,800 ppm; 24,000 ppm; 17,300 ppm; 3,500 ppm and 17,000 ppm, respectively.

2) Although the culvert at the downstream end of Creek Segment B was blocked sometime between 1940 and 1970, the Village of Cahokia has installed a high level overflow to mitigate flooding due to the plugged culvert. In addition, the Village has attempted to pump water from Creek Segment B to Creek Segment C to prevent flooding of residential areas and Judith Lane. These actions, taken to protect homes and transportation routes, create a threat of migration due to downstream movement of sediments during flood conditions.

3) The threat of migration due to sediment mobilization and downstream transport during flood conditions in Creek Segment C. Sediments in CS-C contain Zinc, Copper, Barium, Nickel, Lead and PCBs with maximum concentrations of 21,000 ppm; 17,200 ppm; 4,700 ppm; 2,300 ppm; 1,300 ppm and 23 ppm, respectively..

4) The threat of migration due to sediment mobilization and downstream transport during flood conditions in Creek Segment D. Sediments in CS-D contain Zinc, Copper, Nickel, Barium, Lead and PCBs with maximum concentrations of 6,950 ppm; 1,630 ppm; 665 ppm; 622 ppm; 480 ppm and 12 ppm, respectively.

5) The threat of migration due to sediment mobilization and downstream transport during flood conditions in Creek Segment E. Sediments in CS-E contain Zinc, Copper, Barium, Nickel, Lead and PCBs with maximum concentrations of 9,970 ppm; 8,540 ppm; 3,690 ppm; 2,130 ppm; 1,270 ppm and 60 ppm, respectively.

6) An evaluation of the factors identified in Section 300.415 of the National Contingency Plan and attendant concerns for risks posed by sediments in Creek Segment B and Site M and Creek Segments C, D and E.

1.1 Time Critical Removal Action Work Plan

Section V.3.1 of the Order requires Solutia to submit a draft Time Critical Removal Action Work Plan (TCRAWP) to USEPA for approval within fifteen (15) business days after the effective date of the Order. This TCRAWP is submitted to satisfy the specific requirements of Section V.3.1, Work Plan and Implementation, of the Order. The TCRAWP provides a description of, and an expeditious schedule for, the activities required by Section V.3.B of the Order, specifically:

- Section V.3.B.1 - Sediment and Soil Removal Requirements
- Section V.3.B.2 - Materials Handling, Dewatering and Treatment Requirements
- Section V.3.B.3 - Storm Water Management Requirements
- Section V.3.B.4 - Excavated Area Soil Sampling
- Section V.3.B.5 - Excavated Area Bottom Liner Requirements
- Section V.3.B.6 - Containment Cell Design Report Requirements

These sections of the Order are given verbatim below:

1.2 Sediment and Soil Removal Requirements

Respondents shall remove materials from CS-B (creek sediments, creek bed soils and flood plain soils); CS-C, D, and E (creek sediments only); and Site M (pond sediments and pond bottom pond soils) in Sauget Area One from Dead Creek and adjacent areas (collectively referred to as "materials") for disposal in the on-site Containment Cell. Such removal shall begin as soon as possible but no later than six months after the date of this Order. For the purposes of this Order, the approximate volumes of materials (both sediments and soils) to be removed and disposed of in the Cell are as follows:

CS-B and Site M contain an estimated volume of 25,500 cubic yards (cy) of metals and organic-containing sediment and soil:

CS-B Sediment	2000ft L x 50 ft W x 2 ft D = 7,400 y

CS-B Creek Bed Soil	2000 ft L x 50 ft W x 1 ft D = 3,700 cy
CS-B Flood Plain Soil	2000ft L x 100 ft W x 1 ft D = 7,400 cy
Site M Sediment	64,000 sq ft x 1.6 ft = 3,500 cy
Site M Pond Bottom Soil	64,000 sq ft x 1 ft = 3,500 cy
	Total = 25,500 cy

CS-C, D and E contain an estimated volume of 24,400 cubic yards of metal and organic-containing sediment:

CS-C Sediment	1400ft L x 50 ft W x 2 ft D = 5,200 cy
CS-D Sediment	1200ft L x 50 ft W x 2 ft D = 4,400 cy
CS-E Sediment	4000ft L x 50 ft W x 2 ft D = 14,800 cy
	Total = 24,400 cy

let's be specific as to where excav. ends (where is end of B)

The estimated volume of sediment and/or soil in CS-B and Site M is 25,500 cubic yards and CS-C, D and E contain an estimated volume of 24,400 cubic yards of sediment, a total of 49,900 cubic yards impacted sediment and soil. The above volumetric estimate for CS-B includes removal of one foot of creek bed soils and flood plain soils in addition to the sediments in CS-B. The estimate for Site M includes one foot of pond bottom soils in addition to the sediments. Only sediments are to be removed from CS-C, D, and E. In implementing such removal in CS-C, D and E, "sediments" shall be defined in accordance with the following criteria and procedure:

a. Four objective criteria shall be used to identify "sediment" subject to removal, as follows: criteria (i)-(iii) shall be employed to make the determination in the first instance; if application of these criteria are not determinant, then criteria (iv) shall be used. The OSC shall have the authority to require the use of criteria (iv) at any time during the project. However, in any case, criteria (iv) shall be employed every 200 feet as a control on the application of criteria (i)-(iii).

b. The four criteria:

(i) Origin – non-native vs. native sediments
(ii) Stratigraphy – sediments/soil boundary
(iii) Color – sediment color versus creek bottom soil color
(iv) Physical Characteristics
- Unconfined compressive strength less than 500 pounds per square foot (psf)
- Torvane shear strength less than 200 pounds psf
- Moisture content greater than the liquid limit.
- Moisture content greater than 60 percent

1.3 Materials Handling, Dewatering and Treatment Requirements

Once materials are removed from in and around CS-B, and from in CS-C, D, and E and Site M, Respondents shall, as necessary, dewater such materials, using one or more of the following dewatering methods:

- In-Situ Gravity Dewatering
- In-Situ Solidification
- On-Site Gravity Dewatering
- On-Site Solidification

At a minimum, dewatered materials shall pass the Paint Filter Test (as set out in 35 Illinois Administrative Code (IAC) § 724.414(c)) in the Containment Cell. A solidifying agent (meeting the requirements of 35 IAC § 724.414(e)) shall be added, if necessary, during compaction of the sediments in the Containment Cell in order to pass the Paint Filter Test.

Section 1.4 Storm Water Management Requirements

During the project, Respondents shall divert storm water around CS-B work areas using temporary berms, sheet piling or similar diversion structures, or storm water may be pumped around these work areas and discharged downstream. Runoff from disturbed work areas shall be routed to a gravel and sand filter dam at the downstream end of CS-B and then discharged downstream.

During the project, Respondents shall hydraulically isolate Site M from Dead Creek by closing the opening between CS-B and the southwestern corner of Site M using compacted soil, sheet pile or other suitable method. Impounded water shall be routed to a gravel and sand filter dam at the downstream end of CS-B and then discharged downstream.

1.5 Excavated Area Soil Sampling

After the sediment and soils removal has taken place, Respondents shall collect soil samples from, at a minimum, all excavated areas of CS-B, C, D and E at 100 ft. intervals (to be referred to as "transects"), starting at the upstream end of the channel at Queeny Road and terminating near the downstream end of the channel at Route 3. Each creek transect, and sample location, shall be identified and numbered for reference purposes. Sampling at each creek transect shall occur at a frequency of no less than 3 samples per transect. Of the 3 samples, one shall be located at the transect center line and the other two shall be located equidistant to the center and the edge of the excavation area. Due to the fact that soils leaching to groundwater is the primary concern, bottom soil samples shall be extracted using TCLP and analyzed for Total Compound List/Total Analyte List (TCL/TAL) parameters and dioxin/furans.

Soil samples shall be collected from the bottom of Site M at 100 ft. grid intervals covering the entire excavated area. Pond bottom soils will be extracted using the TCLP and analyzed for TCL/TAL parameters and dioxin/furans.

1.6 Excavated Areas Bottom Liner Requirements

After excavation and sampling, Respondents shall properly install and maintain a 40 mil, HDPE liner in CS-B of Dead Creek. A liner shall be installed in other excavated areas of Site M and CS-C, D and E as determined to be necessary based on post-excavation sampling to isolate impacted soils from surface water. An overflow structure shall be installed to allow accumulated rainwater to discharge into CS-B.

1.7 Containment Cell Design Report Requirements

Respondents' Work Plan shall include a Containment Cell Design Report for the on-site cell. Such Design Report, upon approval, shall become an enforceable part of this Order. The Design Report shall address applicable requirements of 35 IAC § 724.401, including, at a minimum, the following:

- Above grade construction
- Construction on a 3 ft. thick, permeable capillary barrier drain sloped to a collection sump
- Water from the capillary barrier drain collection sump shall be discharged to the American Bottoms Publicly Owned Treatment Works (POTW)
- Installation of a Bentomat layer on top of the capillary barrier drain
- Double-lined cell
- 60 mil HDPE primary membrane
- 60 mil HDPE secondary membrane
- Sand and/or gravel leachate collection system above primary liner
- Leachate shall be treated, if necessary, and discharged to the American Bottoms POTW
- Geosynthetic leak detection system above secondary liner
- Groundwater monitoring program in compliance with the requirements set forth at 35 IAC § 724, Subpart F and 40 C.F.R. Part 264, Subpart F. Such program shall also monitor to establish background levels and detect potential leachate migration for, at a minimum, TCL/TAL parameters
- Storm water downchutes off cap designed to handle 25 year, 24 hour storm
- Slopes designed to resist failure and erosion as flood waters recede
- Gravel or equivalent armoring of potentially flooded slopes
- Gravel or equivalent cover to resist floating and erosion during flooding
- Air venting to prevent cell floating during flooding
- Cell design and air venting to prevent polychlorinated biphenyl (PCB) releases into the air by way of dust, fumes or via hot weather vapors
- Construction in accordance with the Construction Quality Assurance Program requirements found at 35 IAC § 724.119, to the extent practicable.

In addition to including the requirements listed above, the Design Report shall, at a minimum, address the RCRA minimum technology requirements set forth in Exhibit 2, attached to this Order.

Section 2

2.0 Site Description

Dead Creek and its floodplain are part of Sauget Area 1 an area being investigated by Solutia Inc. under an AOC with USEPA Region 5. This AOC requires collection of sediment, surface water, soil, air and groundwater data as part of a site investigation program called the Support Sampling Plan. Data collection was started in September 1999 and completed in April 2000. Sediment, surface water, soil and air data will be incorporated into an Engineering Evaluation/Cost Analysis Report and groundwater data will be used to prepare a Remedial Investigation/Feasibility Study Report.

Parties identified in the Unilateral Administrative Order who generated wastes which were disposed of, released into and/or transported wastes to the Sauget Area 1, including parties whose wastes migrated from various disposal areas into other sites or segments of Dead Creek, include but are not limited to the following:

- Amax Zinc
- Cardinal Construction Company
- Cerro Copper Products
- Darling Fertilizer
- Ethyl Corporation
- Industrial Disposal, Inc.
- Midwest Rubber Reclaiming
- Midwest Rubber Trustees
- Monsanto Company/Solutia Inc.
- Olin Corporation
- Paul Sauget
- Rogers Cartage
- Ruan Transportation Corporation
- Sauget and Company
- Sterling Steel Casting Co.
- Village of Sauget
- Waggoner and Company

2.1 Dead Creek

Dead Creek is a channelized, intermittent stream that runs approximately 17,000 feet from its upstream end at Queeny Avenue in Sauget, Illinois to its downstream end at Old Prairie du Pont Creek in Cahokia, Illinois. It is an urban stream in its upstream, heavily-developed portions while its downstream, undeveloped portions run through a large wetland. During low water conditions in the Mississippi River, water discharges from Dead Creek through flap valves in the USACE flood control dike. When water levels in the Mississippi River are high enough,

discharge from Dead Creek is pumped over the dike and into Old Prairie du Pont Creek which flows approximately 2,000 feet west into a branch of the Mississippi River known as the Cahokia Chute.

On December 21, 1928, an easement agreement between local property owners and representatives of local business, municipal and property interests indicates work was planned to "improve the drainage in that District (Dead Creek) by improving Dead Creek so as to make it suitable for the disposal of wastewater, industrial waste, seepage and storm water." Thereafter, Dead Creek systematically received direct and indirect discharges from local businesses and the municipality for many years. As of 1929, the following industries were reported as operating in Sauget, Illinois:

- Cahokia Power Plant
- Darling & Co. Fertilizer
- Evans-Wallower Zinc (now Big River Zinc)
- Floyd Paint Co.
- Lewin Metals (now Cerro Copper)
- Lubrite Refining (later Mobil)
- Midwest Rubber
- Monsanto Chemical Works
- Sterling Steel Casting Co.
- T. J. Moss (now Kerr McGee)

Prior to the installation of public sewers in the Village of Sauget between 1932 and 1933, industrial process wastewater from many of the industries in Sauget and East St. Louis flowed directly into Dead Creek. As of 1942, all of the companies listed above were still in operation except for Floyd Paint Co.. Federal Chemical Co. and the US Chemical Warfare Service were also using Village sewers in 1942. Any and/or all of these industries could have directly discharged into Dead Creek.

The following descriptions give additional information on the industries that are known to have discharged into the Village of Sauget sewer system:

Amax Zinc - Zinc production started at the Amax Zinc facility in 1929. An electrolytic refinery operates at the Site which has over the years produced the following raw materials and products:

- Zinc
- Zinc alloys
- Zinc powders
- Zinc sulfate monohydrate
- Zinc oxide
- Zinc sulfide
- Cadmium products
- Sulfuric acid

The waste water discharged from the plant contained:

- Zinc
- Copper
- Iron
- Cadmium
- Magnesium
- PCBs

Chemical Warfare Service - The Chemical Warfare Service plant, owned and operated by the U.S. Government, was constructed in the summer of 1940 by Monsanto. After construction, Monsanto operated the plant under the direct supervision and direction of the Chemical Warfare Service. Spills and leaks at the plant were washed into the plant sewer which was connected to the village sewer. It is likely that process waste water was also discharged into the sewer.

Cerro Copper - Cerro has operated a copper smelting operation in Sauget since before 1929. It's predecessor company was Lewin Metals. Generally its operations involve the refining and smelting of copper. In the 1950's, for about 10 years, Cerro manufactured brass rod and tubing. The raw material came from scrap materials (i.e. scrap copper and brass).

Cerro's waste water was known to contain the following contaminants:

- Antimony
- Arsenic
- Beryllium
- Cadmium
- Chromium
- Copper
- Lead
- Nickel
- Silver
- Zinc
- Acetone
- Chloroform
- Methylene Chloride
- Toluene
- 1,1,1 Trichloroethane
- Trichloroethene
- Trichloroethylene
- Xylene
- Naphthalene
- Phenanthrene
- Oil and Grease

Darling Fertilizer - Darling was in the business of manufacturing chemical fertilizers. The process appears to have involved acidulation of phosphate rock and the subsequent blending of the rock with nitrates, lime, etc. Darling abandoned operations sometime after 1965. The waste water from the plant contained:

- Phosphorus
- Nitrogen.

Edwin Cooper & Company (now Ethyl) - Edwin Cooper & Company began operating in Sauget in 1969. Its sewer discharges included acid and oil.

Midwest Rubber - Midwest, located across the street from Site G, began operations in Sauget in 1928. The company reclaimed rubber, principally from discarded automobile tires by heating the tires in autoclaves with caustic solution or chloride solution. Midwest discharged waste directly into Dead Creek through an effluent pipe into CS-B. In 1971 sampling found rubber particles in the discharges as well as zinc. In addition, in sampling taken of waste waters of many Sauget area industries in 1971, it was found that Midwest's waste water flow contained 9 ppb PCBs. Waste water would have contained:

- Pine Tars
- Naphthalene
- Zinc
- Waste Oil

Mobil - Predecessor corporations to Mobil began operation of a refinery in Sauget in 1917. Operations included the production and storage of typical petroleum refining products including a wide range of fuels such as gasoline, kerosene, fuel oils, and residual fuels, and heavier products such as base oils and coke. In 1970 the refinery operations shut down while the terminal operation remained. Wastewater was discharged daily into the Village of Sauget sewer system plant when the refinery was in operation up to 1970, then intermittently when the fuels terminal was in operation. The wastewater was probably a combination of petroleum process water after primary separation, cooling water and storm water. Mobil's releases to the Village sewer ran down the "south trunk" which was the line that ran directly to the north of CS-

A. A May 6, 1982 EPA memo states that Mobil was one of many industries discharging wastes into Dead Creek. Contaminants in Mobil's waste water included:

- Phenols
- Ammonia
- PCBs

Monsanto - From 1917 to 1997 the Monsanto Willliam G. Krummrich plant in Sauget was engaged in the manufacture of various inorganic and organic chemicals including Adipic Acid, Alkylbenzene, Benzyl chloride, Butyl Benzyl Chloride, Calcium Benzene Sulfonate, Caustic Soda, Chlorine, Chlorinated Cyanuric Acid, Chlorophenols, Monochloroacetic Acid, Monochlorobenzene, 2,4-D, Fatty Acid Chloride, Muriatic Acid, Nitric Acid, 4-Nitrodiphenylamine, ortho-Dichlorobenzene, ortho-Nitrophenol, PCBs, para-Dichlorobenzene, Para-Nitroaniline, para-Nitrochlorobenzene, Pentachlorophenol, Phenol, Phosphoric Acid, Phosphorous Trichloride, Phosphorus Pentasulfide, Potassium Phenyl Acetate, Potash, Santoflex, Santomerse, Santolube 393, Sulfuric Acid, 2,4,5-T, Tricresyl Phosphate, Zinc Chloride . The waste water stream leaving the plant varied over the years, but may have contained the following:

- Nitric acid
- Sulfuric acid
- Hydrochloric acid
- Chlorine
- Chlorinated and nitrated aromatics

Rogers Cartage - Rogers Cartage owned and operated a fleet of tanker trucks. It hauled products for many companies in the metropolitan St. Louis area. During Rogers operations in Area 1, it washed out tanker trucks that had been used to transport product and some wastes for many of the industries in Sauget and the surrounding area. Trucks were washed with caustic solution. Rogers Cartage was a major user of the Village of Sauget sewer system. It began using the sewer in 1969. Rinse water was discharged into the Village sewer south trunk and traveled to the sewer connection at the north end of Dead Creek. Also, there was a 12 inch sewer overflow line that was located at the Rogers Cartage property and discharged

directly into Dead Creek. It was installed sometime before 1965. This line was installed to allow relief of the northward traveling sewer line at times of heavy flow. Thus, this line would have caused truck washing waste water to discharge into Dead Creek. A Monsanto Memo dated January 5, 1971 indicates that a significant quantity of PCBs in the Village sewer probably came from the Rogers Terminal.

The types of products Rogers hauled which were likely washed into the Village sewer including Dead Creek were:

- Muriatic Acid
- Phosphorus Oxychloride
- Phosphorus Trichloride
- Sulfuric Acid
- Zinc Sulphate
- Acetone
- Benzene
- Toluene
- Xylene
- Alkylbenzene
- Aroclors
- Dichlorobenzene
- Maleic Anhydride
- Monochloroacetic Acid
- Monochlorobenzene
- Nitrochlorobenzene
- Petroleum
- Phenol
- Oil Additives
- Therminol

Sauget & Co. - Sauget & Co. operated a landfill at Site I for a number of years. IEPA has reported that waste from Site I would routinely overflow and leach into Dead Creek.

Sterling Steel - Sterling Steel began steel casting operations in the Sauget area in 1922. Wastes from this foundry included spent foundry sand, popcorn slag and quench water scale. Cooling water from electric furnaces, compressors and air conditioning was discharged into the 24" sewer line at the north end of Dead Creek.

Waggoner - Waggoner started operations on Site L in 1964. Waggoner owned/operated approximately 23 stainless steel trucks and a couple of rubber-lined trucks. It washed its trucks at Site L and drained the tank washings into Dead Creek. In addition, floor drains from the building went directly to Dead Creek. In June 14, 1965 meeting minutes for the Monsanto

Village Plant Managers, the statement is made that Waggoner should be persuaded to cease dumping chemicals into Dead Creek. In a August 5, 1971 memo, IEPA states that tanker trucks labeled as corrosive were apparently discharging their contents to Dead Creek near Queeny Avenue. The Agency notified the company of the discharge and Waggoner responded that the discharges had been eliminated. After the IEPA required that discharges to CS-A cease, Waggoner excavated a pit which was used by Waggoner until 1974 when the company was sold to Ruan.

In 1973, the IEPA visited Waggoner and found that a hole had been dug nearby into which the tanker truck washwater discharged. Use of a second pit appears to have begun in 1973. According to an IEPA memo drafted by Tim Murphy (1992 to USEPA) these pits were designed to overflow into Dead Creek. Ruan reportedly continued using the pit until 1978. IEPA estimated that between 1971 and 1978, 164,000 gallons of wash water was disposed of in the pit. The pit was not lined and consisted of medium to coarse-grained sand.

The following materials were hauled by Waggoner and thus were likely washed into Dead Creek as rinsate from the truck washings:

- Caustic Metal Cleaners
- Muriatic Acid
- Oleum
- Phosphoric Acid
- Phosphorous Oxychloride
- Phostri (commercial name)
- Sulfuric Acid
- Benzene
- Alkylbenzene
- Alkylbenzene Sulfuric Acid
- Aroclors
- Biphenyl
- Chloryl Acetyl Chloride
- Chlorosulfuric Acid
- Monochloroacetic Acid
- Oil Additives
- Petroleum Additives
- Phenol
- Plasticizers
- Pyranols
- Santolubes
- Sulfonic Acid
- Zinc Dibutyldithiophosphate

2.1.1 Dead Creek Segments

IEPA divided the creek into six segments during a 1988 site investigation (Figure 1):

Creek Segment A	Alton & Southern Railroad to Queeny Avenue
Creek Segment B	Queeny Avenue to Judith Lane
Creek Segment C	Judith Lane to Cahokia Street
Creek Segment D	Cahokia Street to Jerome Lane
Creek Segment E	Jerome Lane to Route 157
Creek Segment F	Route 157 to Old Prairie du Pont Creek

This subdivision of Dead Creek is maintained in this Time Critical Removal Action Work Plan.

2.1.2 Creek Segment A - CS-A, the northernmost segment of Dead Creek, was approximately 1,800 feet long running from the Alton & Southern Railroad to Queeny Avenue. This segment of the creek originally consisted of two holding ponds which were periodically dredged. For several years, CS-A and available downstream creek segments (e.g., ones that were not blocked off) received direct wastewater discharges from industrial sources and served as a surcharge basin for the Village of Sauget (formerly Village of Monsanto) municipal sewer collection system. When the system became backed up or overflowed, untreated wastes from industrial users of the sewer system were discharged directly into CS-A. On several occasions, CS-A was dredged and impacted sediments were disposed in Site I (discussed below). In 1968, the Queeny Avenue culvert, which allowed creek water to pass from CS-A to CS-B, was permanently blocked by the Village of Sauget. Approximately 27,500 tons of impacted sediments were excavated by Cerro Copper in 1990/91 and sent to Resource Conservation and Recovery Act ("RCRA") and Toxic Substances Control Act ("TSCA") permitted facilities. After placement of an HDPE membrane at the bottom of the excavated area, the creek channel was backfilled with soil. CS-A is now covered with crushed gravel and used as a truck parking lot by Cerro Copper. Creek Segment A is not part of the Dead Creek Sediment and Soil Time Critical Removal Action.

2.1.3 Creek Segment B - CS-B extends for approximately 2000 ft. from its northern, upstream end at Queeny Avenue to its southern, downstream end at Judith Lane. Sometime between 1940 and 1970, the culvert at the southern end of CS-B (Judith Lane) was blocked to prevent downstream flow of water. Access to CS-B is currently controlled by a fence.

Sampling conducted by USEPA and the Illinois Environmental Protection Agency (IEPA) during the 1980s and 1990s detected a variety of organic and inorganic constituents in CS-B sediments and surface water:

Sediment Chemical Analyses - Volatile Organic Compounds (VOCs) and Semivolatile Organic Compounds (SVOCs) were detected in sediment samples collected from CS-B include Benzene (87 parts per billion ("ppb")), Toluene (810 ppb), Chlorobenzene (5,200 ppb), Ethylbenzene (3,600 ppb), Trichlorobenzene (3,700 parts per million ("ppm")), Dichlorobenzene (12,000 ppm), Chloronitrobenzene (240 ppm), Xylenes (540 ppm), 1,4-Dichlorobenzene (220,000 ppb), 1,2-Dichlorobenzene (17,000 ppb), Phenanthrene (15,000 ppb), Fluoranthene (11,000 ppb), Pyrene (13,000 ppb). PCBs were found at concentrations of up to 10,000 ppm. Metals detected included Arsenic (6,000 ppm), Cadmium (400 ppm), Copper (44,800 ppm), Lead (24,000 ppm), Mercury (30 ppm), Nickel (3,500 ppm), Silver (100 ppm), and Zinc (71,000 ppm).

Surface Water Chemical Analyses - Surface water samples collected from CS-B revealed concentrations of VOCs such as Chloroform (27 ppm), 1,1-Dichloroethene (3 ppb), Toluene (20 ppb), and Chlorobenzene (33 ppb). SVOCs detected in surface water included Phenol (28 ppb), 2-Chlorophenol (14 ppb), 1,4-Dichlorobenzene, 2-Methylphenol (4 ppb), 4-Methylphenol (35 ppb), 2,4-Dichlorophenol (150 ppb), Naphthalene (8 ppb), 3-Nitroaniline (9 ppb), and Pentachlorophenol (120 ppb). Pesticides were also detected including Dieldrin (.18 ppb), 4,4-DDT (.24 ppb), 2,4-D (47 ppb) and Silvex (3.4 ppb). PCBs (Aroclor 1260) was also detected at a level of 44 ppb. Metals detected included Auminum (9,080 ppb), Barium (7,130 ppb), Arsenic (31 ppb), Cadmium (25 ppb), Chromium (99 ppb), Copper (17,900 ppb), Lead (1,300 ppb), Mercury (8.6 ppb), Nickel (1,500 ppb), and Zinc (10,300 ppb).

detected at a level of 44 ppb. Metals detected included Auminum (9,080 ppb), Barium (7,130 ppb), Arsenic (31 ppb), Cadmium (25 ppb), Chromium (99 ppb), Copper (17,900 ppb), Lead (1,300 ppb), Mercury (8.6 ppb), Nickel (1,500 ppb), and Zinc (10,300 ppb).

2.1.4 Site M - Site M is located along the eastern side of Dead Creek CS-B at the western end of Walnut Street in the Village of Cahokia. Originally constructed as a sand borrow pit in the mid to late 1940's, Site M is approximately 64,000 square feet in size and previous investigations indicate that approximately 3,600 cubic yards of contaminated sediments are contained within the pit. It is estimated that the pit is approximately 14 feet deep and it is probable that there is a hydraulic connection between this pit water and the underlying groundwater. The pit is hydraulically connected to Dead Creek through an eight-foot opening at the southwest portion of the pit. The site is currently fenced.

Sampling conducted by USEPA and the Illinois Environmental Protection Agency (IEPA) during the 1980s and 1990s detected a variety of organic and inorganic constituents in Site M sediments and surface water:

Sediment Chemical Analyses - Sediment samples collected from Site M revealed VOCs such as 2-Butanone (14,000 ppb), Chlorobenzene (10 ppb) and Ethyl benzene (0.82 ppb). SVOCs detected in sediments included 1,4-Dichlorobenzene (40 ppm), 1,2-Dichlorobenzene (26 ppm), 1,2,4-Trichlorobenzene (14 ppm), Pyrene (27 ppm), Fluoranthene (21 ppm), Chrysene (12 ppm), and Benzo(b)fluoranthene (15 ppm). PCBs were detected at concentrations of up to 1,100 ppm. Metals were also detected in Site M sediments including Antimony (41.2 ppm), Barium (9,060 ppm), Cadmium (47.2 ppm), Copper (21,000 ppm), Nickel (2,490 ppm), Silver (26 ppm), Zinc (31,600 ppm), Lead (1,910 ppm), Arsenic (94 ppm). Cyanide was detected at a concentration of 1.3 ppm.

Surface Water Chemical Analyses - Surface water samples had VOCs such as Chloroform (27 ppb), Toluene (19 ppb) and Chlorobenzene (33 ppb). SVOCs detected in surface water included Phenol (28 ppb), 2-Chlorophenol (14 ppb), 2,4-Dimethylphenol (13 ppb),

2,4-Dichlorophenol (150 ppb), and Pentachlorophenol (120 ppb). Pesticides detected in surface water included Dieldrin (0.18 ppb), Endosulfan II (.06 ppb), 4,4-DDT (0.24 ppb), 2,4-D (47 ppb) and 2,4,5-TP (Silvex) (3.4 ppb). PCBs were detected in surface water at a maximum level of 0.0044 ppb.

2.1.5 Creek Segment C - CS-C, located between Judith Lane and Cahokia Street, is approximately 1200 feet long. Sampling conducted by USEPA and the Illinois Environmental Protection Agency (IEPA) during the 1980s and 1990s detected a variety of organic and inorganic constituents in Creek Segment C sediments and surface water:

Sediment Chemical Analyses - VOCs and SVOCs detected in this segment of Dead Creek included Fluoranthene (4,600 ppb), Pyrene (4,500 ppb), Benzo(a)anthracene (3,300 ppb), Chrysene (4,400 ppb), Benzo(b)fluoranthene (7,500 ppb), Benzo(a)pyrene (4,500 ppb), Indeno(1,2,3-cd pyrene (4,300 ppb), Benzo(g,h,l)perylene (1,500 ppb), Dibenzo(a,h)anthracene (4,000 ppb), and 4-Methyl-2-Pentanone (1,200 ppb). PCBs were detected at a maximum concentration of 27,500 ppb. Metals such as Copper (17,200 ppm), Lead (1,300 ppm), Nickel (2,300 ppm), Zinc (21,000 ppm) and Mercury (2.81 ppm) were also detected.

Surface Water Chemical Analyses - Surface water contained metals such as Lead (710 ppb), Mercury (1.9 ppb), and Nickel (83 ppb).

2.1.6 Creek Segment D - Approximately 1100 feet in length, CS-D runs from Cahokia Street to Jerome Lane. Sampling conducted by USEPA and the Illinois Environmental Protection Agency (IEPA) during the 1980s and 1990s detected a variety of organic and inorganic constituents in Creek Segment D sediments and surface water:

Sediment Chemical Analyses - VOCs and SVOCs in sediment samples collected from CS-D included 4-Methyl-2-Pentanone (1,200 ppb), Benzo(b)fluoranthene (500 ppb), Indeno(1,2,3-cd)pyrene (310 ppb), and Dibenzo(a,h)anthracene (360 ppb). PCBs were

detected at a maximum concentration of 2,000 ppb. Metals detected included cadmium (42 ppm), Copper (1,630 ppm), Lead (480 ppm), Mercury (1 ppm), and Zinc (6,590 ppm).

Surface Water Chemical Analyses - Surface water samples revealed concentrations of metals such as Cadmium (8.1 ppb), Lead (89 ppb), and Nickel (189 ppb).

2.1.7 Creek Segment E - Located between Jerome Land and Route 157, CS-E is approximately 4000 feet long. Sampling conducted by USEPA and the Illinois Environmental Protection Agency (IEPA) during the 1980s and 1990s detected a variety of organic and inorganic constituents in Creek Segment E sediments and surface water:

Sediment Chemical Analyses - VOCs and SVOCs were detected in CS-E sediments included Chlorobenzene (120 ppb), Pyrene (5,300 ppb), Benzo(b)fluoranthene (2,400 ppb), and Chrysene (2,800 ppb). PCBs were detected at a maximum concentration of 59,926 ppb. Metals detected included Cadmium (23.1 ppm), Copper (8,540 ppm), Lead (1,270 ppm), Mercury (1.53 ppm), Nickel (2,130 ppm), and Zinc (9,970 ppm).

2.1.8 Creek Segment F - CS-F is approximately 8700 feet along and extends from Route 157 to the Old Prairie du Pont Creek. CS-F is the widest segment of Dead Creek and a large wetland area extends several hundred feet out from the both sides of the creek. Sampling conducted by USEPA and the Illinois Environmental Protection Agency (IEPA) during the 1980s and 1990s detected a variety of organic and inorganic constituents in Creek Segment F sediments and surface water:

Sediment Chemical Analyses - VOCs and SVOCs such as Toluene (29 ppb), 4-Methylphenol (1,100 ppb), Fluoranthene (310 ppb), and Pyrene (340 ppb) were detected in CS-F. Pesticides such as 4,4-DDE (97 ppb), Endrin (66 ppb), Endosulfan II (203 ppb), and Methoxychlor (8 ppb) were also detected. PCBs were detected at a maximum concentration of 5,348 ppb. Metals detected in the sediments included Arsenic (276 ppm), Llead (199 ppm), Mercury (.55 ppm), Cadmium (23.5 ppm), Copper (520 ppm) Nickel (772 ppm) and Zinc (4,520 ppm). Elevated

Dioxins were also detected at a maximum concentration of 211 picograms per gram. Creek Segment F is not covered by the Dead Creek Sediment and Soil Time Critical Removal Action .

2.2 Waste Disposal

Waste disposal was a common land use throughout the history of Dead Creek. Six source areas exist within its headwaters: Site G, Site H, Site I, Site L, Site M and Site N (Figure 1). Site I, a closed municipal/industrial landfill is located in Creek Segment A. Sites G, H, L and M are located in Creek Segment B. Site G is a closed, uncontrolled disposal area stabilized and covered by EPA in a 1995 response action. Site H is a closed municipal/industrial landfill. Site L is a backfilled wastewater impoundment. Site M, a former borrow pit, is an impoundment hydraulically connected to Dead Creek. Site N, located in Creek Segment C, is a backfilled borrow pit.

Wastes in these source areas, which operated from the 1930s to the 1980s, came from a wide variety of municipal and industrial sources. Current Agency estimates indicate that these sites have an area of more than 30 acres and a volume in excess of 400,000 cubic yards.

2.3 Land Use

Land use surrounding CS-B and Site M is primarily commercial and agricultural. Commercial land use occurs along Route 3 (Mississippi Avenue), Queeny Road and Falling Springs Road. South of Sites G and L two small cultivated fields are used for soybean and winter wheat production. These fields separate Sites H and L from a small residential area of approximately 20 homes located on Walnut Street and Judith Lane in the southeastern corner of this creek segment. A small residential area is located immediately east of Sites H and I, across Falling Springs Road, with the nearest residence approximately 200 feet from these sites. The Sauget Village Hall is located immediately north of Site H on top of, or adjacent to, Site I.

Land use is primarily residential along both sides of Creek Segments C and D. Land use surrounding CS-E is predominantly commercial with some mixed residential use.

2.4 Climate

Climate is continental with hot, humid summers and mild winters. Periods of extreme cold are short. The average annual rainfall in the area for the period from 1903 to 1983 was 35.4 inches, however, precipitation increased to 39.5 inches per year during the period between 1963 and 1988. The average annual temperature is 56°F; the highest average monthly temperature (79 °F) occurs in July and the lowest average monthly temperature (32 °F) occurs in January.

2.5 Hydrology

Dead Creek lies in an area of the floodplain of the Mississippi River known as the American Bottoms. Generally, the land surface in undisturbed areas slopes from north to south, and from the east toward the river. Elevations in CS-B range from 400 to 410 feet above mean sea level (MSL) with little topographic relief except at Site G which was capped in 1995. Dead Creek serves as a surface water conduit for much of the Sauget and Cahokia area. It runs south and southwest through these villages and discharges to Old Prairie du Pont Creek which in turn discharges to the Cahokia Chute of the Mississippi River.

2.6 Geology

The Mississippi River floodplain contains unconsolidated valley fill deposits composed of recent alluvium (Cahokia Alluvium), which overlies glacial material (Henry Formation). The Cahokia Alluvium (recent deposits) consists of unconsolidated, poorly sorted, fine-grained materials with some local sand and clay lenses. These recent alluvium deposits unconformably overlie the Henry Formation which is Wisconsinian glacial outwash in the form of valley train deposits. The Henry Formation is about 100 feet thick. These valley-train materials are generally medium to

coarse sand and gravel and increase in grain size with depth. Unconsolidated deposits are underlain by bedrock of Pennsylvanian and Mississippian limestone and dolomite with lesser amounts of sandstone and shale.

2.7 Water Resources

Groundwater is not used as a drinking water source in Cahokia or Sauget. In fact, the Village of Sauget prohibits the use of groundwater as a water supply source (Appendix 2). The Village of Cahokia also prohibits the use of groundwater as a drinking water source. Drinking water is obtained from the public water supply system which has a surface water intake in the Mississippi River approximately 3 miles north of Creek Segment B. Ten private wells are located within a mile of the proposed containment cell. Four of the five closest wells, located in a residential area approximately 1000 feet south of cell, were sampled as part of the Sauget Area 1 Support Sampling Plan (SSP) and the samples are currently being validated. The SSP is an EE/CA and RI/FS investigation currently being conducted by Solutia under an AOC with the Agency. Conversations with the well owners during sampling indicate that water from these wells is used for lawn watering only.

Industrial groundwater usage was very extensive in the past with peak usage occurring in 1962 when groundwater pumpage exceeded 35 million gallons per day. None of the industries in the vicinity of the site, Big River Zinc, Ethyl Corporation, Solutia and Cerro Copper, currently use groundwater.

The nearest downstream surface water intake on the Illinois side of the Mississippi River is located approximately 64 miles south of CS-B. This intake supplies drinking water to residents in the Town of Chester and surrounding areas in Randolf County, Illinois. The nearest water intake on the Missouri side of the river is located approximately 28 miles south of Dead Creek where the Village of Crystal City, Missouri utilizes a Ranney well adjacent to the Mississippi River as drinking water source.

The nearest irrigated land, other than residential lawns and gardens, is located in the Schmids Lake-East Carondelet area south of Old Prairie du Pont Creek.

2.8 Groundwater Levels

Based on depth to water measurements made during the third and fourth quarters of 1999 and the first quarter of 2000 as part of the Sauget Area 1 Support Sampling Plan, depth to groundwater in the study area ranges from 7.3 to 25.5 feet below ground surface. Groundwater elevation ranges from 390.8 to 399.0 feet above mean sea level with ground surface elevations ranging from 405 to 416 feet above mean sea level. Groundwater level fluctuations of 2.4 feet and 4.6 feet were observed between Fall 1999 and Spring 2000 during SSP data collection activities. Highest and lowest depth to water and groundwater elevation data collected during the SSP are summarized below:

	Depth to Water (feet below ground surface)		Groundwater Elevation (feet above mean sea level)	
	Highest	**Lowest**	**Highest**	**Lowest**
Third Quarter 1999	7.3	20.9	399.0	395.4
Fourth Quarter 1999	8.6	23.7	397.7	392.6
First Quarter 2000	9.7	25.5	396.6	390.8

Historical records of groundwater levels during high surface water levels are limited, however, some information is available. In August 1993, surface water level in the Mississippi River at St. Louis peaked at 429.4 ft. above mean sea level (msl), the highest recorded flood level. Groundwater elevation at Solutia's W.G.Krummrich plant was 405 ft. msl during this flood. In 1981 and 1982, respectively, flood levels in the Mississippi River were 410 and 412 ft msl while groundwater levels at the Krummrich plant were 398 and 400 ft. msl.

Section 3

3.0 Sediment Chemical Analyses and Bioassays

3.1 Creek Segment B and Site M

3.1.1 E&E Sediment Chemical Analyses - In 1998 Ecology and Environment, at the request of the USEPA, compiled all existing analytical data for Dead Creek (Volume 1, Sauget Area 1 Data Tables/Maps, February 1998). A variety of organic and inorganic constituents were found in CS-B and Site M sediments including 39 SVOCs, 20 Metals, 10 VOCs, and PCBs. Of the 39 SVOCs, 16 were PAHs, 4 were Phthalates, 6 were Chorobenzenes, 5 were Chlorophenols and 2 were Methylphenols. Maximum detected constituent concentrations for CS-B and Site M sediment and soil are given below:

VOCs (parts per million)	
Acetone	5
Benzene	<1
2-Butanone	14
Carbon Disulfide	<1
Chlorobenzene	13
Ethylbenzene	4
4-Methyl-2-Pentanone	<1
Tetrachloroethane	<1
Toluene	5
Xylene	<1

PCBs (parts per million)	
PCBs	17,000

Metals/Inorganics (parts per million)	
Antimony	45
Arsenic	306
Barium	17,300
Beryllium	3
Boron	76
Cadmium	400
Chromium	400

SVOCs (parts per million)	
Acenapthene	3
Acenaphthylene	<1
Alkylbenzene	<1
Anthracene	4
Benzo(a)anthracene	9
Benzo(b)fluoranthene	30
Benzo(k)fluoranthene	15
Benzo(g,h,I)perylene	13
Benzo(a)pyrene	10
Bis(2-ethylhexyl)phthalate	18
Butylbenzylphthalate	2
Chrysene	12
Chloronitrobenzene	240
2-Chlorophenol	<1
Dibenzo(a,h)anthracene	4
Dibenzofuran	2
1,2-Dichlorobenzene	12,000
1,3-Dichlorobenzene	4
1,4-Dichlorobenzene	220
2,4-Dichlorophenol	<1
Di-n-butyl phthalate	<1
Di-ni-octyl phthalate	3
2,4-Dimethylphenol	<1
Fluoranthene	21
Fluorene	6

Metals/Inorganics (parts per million)		SVOCs (parts per million)	
Cobalt	100	Hexachlorobenzene	2
Copper	44,800	Indeno(1,2,3-cd)pyrene	9
Lead	24,000	Isophorone	<1
Mercury	30	2-Methylnapthalene	8
Nickel	3,500	4-Methylphenol	<1
Selenium	602	Napthalene	10
Silver	100	4-Nitrophenol	3
Strontium	430	Pentachlorophenol	2
Thallium	4	Phenanthrene	15
Tin	32	Pyrene	27
Vanadium	100	1,2,4-Trichlorobenzene	3,700
Zinc	71,000	1,2,4-Trichlorophenol	5
Cyanide	4	2,4,5-Trichlorophenol	<1
		2,4,6-Trichlorophenol	<1

80% (8 of 10) of the VOC maximum concentrations are between <1 and 10 ppm and two (20%) are between 10 and 20 ppm. SVOC maximum concentrations are grouped as follows: 26 of 39 (67%) between <1 and 10 ppm, 6 of 39 (15%) between 11 and 20 ppm, 3 of 39 (8%) between 21 and 50 ppm and 4 of 39 (10%) greater than 100 ppm. Metals maximum concentration distributions are 5 of 20 (25%) between 1 and 50 ppm, 5 of 20 (25%) between 51 and 100 ppm, 5 of 20 (25%) between 101 and 1,000 ppm and 5 of 20 (25%) greater than 1000 ppm.

Using organic concentrations of greater than 100 ppm and metals concentrations of greater than 1,000 ppm as a basis for focusing on constituents with the highest detected concentrations, the following summary statistics result:

	Maximum Concentration	95% Confidence Interval	Arithmetic Mean	Geometric Mean	Minimum Concentration
Organics (ppm)					
PCBs	17,000	5,200	9,706	108	<1
1,2-Dichlorobenzene	12,000	9,675	1,367	10	<1
1,2,4-Trichlorobenzene	3,700	1,679	342	11	<1
Chloronitrobenzene	240	236	203	201	170

	Maximum Concentration	95% Confidence Interval	Arithmetic Mean	Geometric Mean	Minimum Concentration
Inorganics (ppm)					
Zinc	71,000	53,350	14,126	5,047	30
Copper	44,800	36,050	11,186	2,890	27
Lead	24,000	2,795	1,313	319	6
Barium	17,300	8,578	2,400	1,089	41
Nickel	3,500	3,000	937	367	12

3.1.2 SSP Sediment Chemical Analyses - As required by the January 21, 1999 Administrative Order on Consent, signed by USEPA and Solutia Inc., an Engineering Evaluation Cost Assessment (EE/CA) for soil, sediment surface water and air and a Remedial Investigation/Feasibility Study (RI/FS) for groundwater are being conducted by Solutia. The data collection portion of this work, called the Support Sampling Plan (SSP), started in September 1999 and finished in April 2000. As part of this work, a total of thirteen sediment samples were collected from Creek Segments B, C, D, E and Site M to determine the extent of site-specific constituent migration. Sediment samples were analyzed for Metals, Mercury, Cyanide, Volatile Organic Compounds (VOCs), Semivolatile Organic Compounds (SVOCs), PCBs, Pesticides, Herbicides and Dioxin. These analytical results were submitted to the Agency with the April 10, 2000 Monthly Report covering the period March 1 to 31, 2000. Analytical results for industry-specific constituents (copper, zinc and PCBs) plus two metals (barium and nickel) that are prevalent throughout the Dead Creek watershed are summarized below. All analytical results are included in Appendix 3.

Sample Location	Sample Number	Copper (ppm)	Zinc (ppm)	Barium (ppm)	Lead (ppm)	Nickel (ppm)	PCB (ppm)
CS-B	1	5,100	2,000	950	630	88	162.2
	2	11,000	7,900	3,800	1,000	500	226.1
	3	6,700	4,800	1,700	750	380	67.7
Site M	1	4,200	2,400	700	530	190	12.2

Summary statistics are as follows:

Sample Location	Copper (ppm)	Zinc (ppm)	Barium (ppm)	Lead (ppm)	Nickel (ppm)	PCB (ppm)
CS-B						
• Maximum	11,000	7,900	3,300	1,000	500	226.1
• Average	7,600	4,900	1,988	793	323	152.0
• Minimum	5,100	2,000	950	630	88	67.7

3.1.3 SSP Sediment Bioassays - As part of the work required by the Sauget Area 1 Support Sampling Plan, sediment bioassays were performed on sediments collected from the same locations as the sediment samples collected for site-specific, broad-scan chemical analysis. Acute and chronic toxicity was observed for both amphipods (Hyallela) and midges (Chironomous) exposed to sediments from CS-B and Site M. The results of the sediment bioassays performed on CS-B and Site M sediments are summarized below. All bioassay results are included in Appendix 4.

Sample Location	Sample Number	Hyallela azteca		Chironomous tentans	
		Acute (% Survival)	Chronic (% Survival)	Acute (% Survival)	Chronic (% Survival)
CS-B	1	16*	8*	0*	-
	2	1*	-	0*	-
	3	64*	39*	100	52
Site M	1	10*	85	96	40

Note: * Statistically significant at p </= 0.05

3.2 Creek Segment C

3.2.1 E&E Sediment Chemical Analyses - A number of organic and inorganic constituents were found in CS-C sediments, however, there were fewer detected constituents than in CS-B. Detected constituents included 23 SVOCs, 15 Metals, 1 VOC, and PCBs. Of the 23 SVOCs,

16 were PAHs, 3 were Phthalates, 2 were Chorobenzenes and 1 was a Chlorophenol. No Methylphenols were detected. Maximum detected constituent concentrations for CS-C sediments reported in the 1998 Ecology and Environment report are given below:

VOCs (parts per million)	
4-Methyl-2-Pentanone	1.2

PCBs (parts per million)	
PCBs	23

Metals/Inorganics (parts per million)	
Barium	4,700
Beryllium	3
Boron	76
Cadmium	50
Chromium	68
Cobalt	32
Copper	17,200
Lead	1,300
Mercury	3
Nickel	2,300
Selenium	3
Silver	45
Strontium	140
Vanadium	50
Zinc	21,000

SVOCs (parts per million)	
Acenapthene	<1
Anthracene	<1
Benzo(a)anthracene	3.3
Benzo(b)fluoranthene	7.5
Benzo(k)fluoranthene	<1
Benzo(g,h,I)perylene	1.5
Benzo(a)pyrene	4.5
Bis(2-ethylhexyl)phthalate	<1
Butylbenzylphthalate	2
Chrysene	4.4
Dibenzo(a,h)anthracene	4
1,3-Dichlorobenzene	<1
1,4-Dichlorobenzene	<1
Di-ni-octyl phthalate	<1
Fluoranthene	4.6
Fluorene	<1
Indeno(1,2,3-cd)pyrene	4.3
2-Methylnapthalene	<1
Napthalene	<1
Phenanthrene	<1
Phenol	<1
Pyrene	4.5
1,2,4-Trichlorophenol	<1

Using organic concentrations of greater than 10 ppm and metals concentrations of greater than 100 ppm as a basis for focusing on constituents with the highest detected concentrations, the following summary statistics result:

Maximum	95% Confidence Concentration	Arithmetic Interval	Geometric Mean	Minimum Mean	Concentration
Organics (ppm)					
PCBs	23	22	8	2	<1
Inorganics (ppm)					
Zinc	21,000	21,000	12,047	8,643	1370
Copper	17,200	17,200	8,328	5,042	580
Barium	4,700	4,700	2,176	1,418	376
Nickel	2,300	2,300	1,276	955	177
Lead	1,300	1,300	883	819	467

3.2.2 SSP Sediment Chemical Analyses - Support Sampling Plan analytical results for industry-specific constituents Copper, Zinc and PCB and prevalent metals Barium and Nickel in CS-C sediments are summarized below. Average PCB concentration in CS-C is 50 times lower than the average PCB concentration in CS-B, 2.6 ppm versus 152 ppm. Average Copper concentrations in CS-C sediments (1900 ppm) is four times lower than the average concentration in CS-B (7600 ppm). Average Zinc and Lead concentrations are lower in CS-C than in CS-B (3567 vs. 4900 ppm and 360 vs. 793 ppm, respectively) while the average Nickel concentration is higher (500 vs. 323 ppm). Barium has an average concentration a factor of three lower than in CS-B (650 vs. 1998 ppm).

Sample Location	Sample Number	Copper (ppm)	Zinc (ppm)	Barium (ppm)	Lead (ppm)	Nickel (ppm)	PCB (ppm)
CS-C	1	1,400	2,000	470	270	370	0.2
	2	2,200	4,500	680	330	580	2.9
	3	2,100	3,300	800	480	550	4.6

Summary statistics are as follows:

Sample Location	Copper (ppm)	Zinc (ppm)	Barium (ppm)	Lead (ppm)	Nickel (ppm)	PCB (ppm)
CS-C						
• Maximum	2,200	4,500	800	480	580	4.6
• Average	1,900	3,567	650	360	500	2.6
• Minimum	1,400	2,900	470	270	370	0.2

3.2.3 SSP Sediment Bioassays - Sediment bioassays of CS-C sediments indicate that two of the three samples did not exhibit acute or chronic toxicity for amphipods. However, two of the three samples showed acute toxicity to midges. SSP bioassay results for CS-C are summarized below. All bioassay results are included in Appendix 4.

Sample Location	Sample Number	Hyallela azteca		Chironomous tentans	
		Acute (% Survival)	Chronic (% Survival)	Acute (% Survival)	Chronic (% Survival)
CS-C	1	90	87	30*	-
	2	71	73	0*	-
	3	68*	76	96	63

Note: * Statistically significant at p </= 0.05

3.3 Creek Segment D

3.3.1 E&E Sediment Chemical Analyses - Organic and inorganic constituents found in CS-C sediments included 10 SVOCs, 10 Metals, 1 VOC, and PCBs. Of the 10 SVOCs, 8 were PAHs and 2 were Phthalates. Chorobenzenes, Chlorophenols and Methylphenols were not detected. Maximum detected constituent concentrations for CS-D sediments reported in the 1998 Ecology and Environment report are given below:

VOCs (parts per million)		SVOCs (parts per million)	
4-Methyl-2-Pentanone	1.2	Benzo(b)fluoranthene	<1
		Benzo(a)pyrene	<1
		Bis(2-ethylhexyl)phthalate	<1

PCBs (parts per million)

PCBs	1.2

Metals/Inorganics (parts per million)

Barium	622
Cadmium	42
Chromium	48
Cobalt	12
Copper	1,630
Lead	480
Mercury	1
Nickel	665
Vanadium	37
Zinc	6,590

SVOCs (parts per million)

Chrysene	<1
Dibenzo(a,h)anthracene	<1
Di-ni-butyl phthalate	<1
Di-ni-octyl phthalate	<1
Fluoranthene	<1
Indeno(1,2,3-cd)pyrene	<1
Pyrene	<1

Using organic concentrations of greater than 10 ppm and metals concentrations of greater than 100 ppm as a basis for focusing on constituents with the highest detected concentrations, the following summary statistics result:

	Maximum Concentration	95% Confidence Interval	Arithmetic Mean	Geometric Mean	Minimum Concentration
Organics (ppm)					
PCB	12	11	7	7	2
Inorganics (ppm)					
Zinc	6,590	5,959	2,724	2,528	917
Copper	1,630	1,584	894	815	247
Nickel	665	646	403	397	174
Barium	622	565	319	328	199
Lead	480	454	245	220	44

3.3.2 SSP Sediment Chemical Analyses - Support Sampling Plan analytical results for industry-specific constituents Copper, Zinc and PCB and prevalent metals Barium and Nickel in

CS-D sediments are summarized below. Average PCB concentrations in CS-D are a factor of 3 lower than average PCB concentrations in CS-C, 0.9 ppm versus 2.6 ppm. Average Zinc concentration in CS-D sediments (2333 ppm) is a factor of 0.65 lower than in CS-C. The average Copper concentration of CS-D sediments is a factor of three lower than in CS-C. Barium, Lead and Nickel all have average concentrations that are about half the concentrations found in CS-C.

Sample Location	Sample Number	Copper (ppm)	Zinc (ppm)	Barium (ppm)	Lead (ppm)	Nickel (ppm)	PCB (ppm)
CS-D	1	740	2,500	380	260	260	0.7
	2	730	2,700	400	230	260	1.2
	3	320	1,800	310	170	150	0.7

Summary statistics are as follows:

Sample Location	Copper (ppm)	Zinc (ppm)	Barium (ppm)	Lead (ppm)	Nickel (ppm)	PCB (ppm)
CS-D						
• Maximum	730	2,700	400	260	260	1.2
• Average	597	2,333	363	220	223	0.9
• Minimum	320	1,800	310	170	150	0.7

3.3.3 SSP Sediment Bioassays - Amphipod toxicity was not observed in any of the CS-D sediment bioassays while midge toxicity was observed in all of the CS-D bioassays. SSP bioassay results for CS-D are summarized below:

Sample Location	Sample Number	Hyallela azteca		Chironomous tentans	
		Acute (% Survival)	Chronic (% Survival)	Acute (% Survival)	Chronic (% Survival)
CS-D	1	90	84	44*	-
	2	88	81	48*	-
	3	90	79	71*	42*

Note: * Statistically significant at p </= 0.05

3.4 Creek Segment E

3.4.1 E&E Sediment Chemical Analyses - Twelve metals were found in CS-E sediments. In addition to PCBs, six SVOCs and three VOCs were observed in CS-E. Of the six SVOCs, five were PAHs and one was a Chlorobenzene. No Phthalates, Chlorophenols or Methylphenols were detected. Maximum detected constituent concentrations for CS-E sediments reported in the 1998 Ecology and Environment report are given below:

VOCs (parts per million)	
Acetone	<1
Chlorobenzene	<1
Methylene Chloride	<1
PCBs (parts per million)	
PCBs	60
Metals/Inorganics (parts per million)	
Antimony	15
Arsenic	30
Barium	3690
Cadmium	23
Chromium	105
Cobalt	13
Copper	8,540
Lead	1,270
Mercury	2
Nickel	2,130
Vanadium	53
Zinc	9,970

SVOCs (parts per million)	
Benzo(b)fluoranthene	2.4
Chrysene	2.8
1,4-Dichlorobenzene	1.5
SVOCs (parts per million)	
Fluoranthene	<1
Phenanthrene	<1
Pyrene	5.3

Using organic concentrations of greater than 10 ppm and metals concentrations of greater than 100 ppm as a basis for focusing on constituents with the highest detected concentrations, the following summary statistics result:

	Maximum Concentration	95% Confidence Interval	Arithmetic Mean	Geometric Mean	Minimum Concentration
Organics (ppm)					
PCB	60				60
Inorganics (ppm)					
Zinc	9,970	8,659	3,233	1,195	382
Copper	8,540	6,518	1,807	697	108
Barium	3,690	3,003	931	499	174
Nickel	2,130	1,671	486	186	45
Lead	1,270	1,021	408	315	140

3.4.2 SSP Sediment Chemical Analyses - Support Sampling Plan analytical results for industry-specific constituents Copper, Zinc and PCB and prevalent metals Barium and Nickel in CS-D sediments are summarized below. Only one out of three samples in CS-E had a detectable PCB concentration and it was almost the same as the average concentration found in CS-D, 1 ppm versus 0.9 ppm. Zinc, Copper, Barium, Lead and Nickel all have average concentrations lower than those in CS-D.

Sample Location	Sample Number	Copper (ppm)	Zinc (ppm)	Barium (ppm)	Lead (ppm)	Nickel (ppm)	PCB (ppm)
CS-E	1	570	2,300	340	310	190	1.0
	2	350	1,800	290	190	130	BDL
	3	150	980	190	140	51	BDL

Summary statistics are as follows:

Sample Location	Copper (ppm)	Zinc (ppm)	Barium (ppm)	Lead (ppm)	Nickel (ppm)	PCB (ppm)
CS-E						
• Maximum	570	2,300	340	310	190	1.0
• Average	357	1,693	273	213	124	-
• Minimum	150	980	190	140	51	BDL

3.4.3 SSP Sediment Bioassays - Amphipod toxicity was observed in two of the three CS-E sediment bioassays while midge toxicity was observed in all of the CS-D bioassays. SSP bioassay results for CS-E are summarized below:

Sample Location	Sample Number	Hyallela azteca		Chironomous tentans	
		Acute (% Survival)	Chronic (% Survival)	Acute (% Survival)	Chronic (% Survival)
CS-E	1	23*	56*	91*	54
	2	76	91	16*	-
	3	85	50*	97	0*

Note: * Statistically significant at p </= 0.05

3.5 Summary

Only five metals, barium, copper, lead, nickel and zinc, and one organic, PCB, were found throughout the Time Critical Removal Action area at concentrations higher than 100 ppm and 1 ppm, respectively, during sampling conducted by USEPA and IEPA (Table 1). Copper and zinc smelting are ongoing operations. PCB, production of which was discontinued in the 1970s, was widely used by industries throughout the Sauget and Cahokia area. Average Copper, Zinc, Barium, Lead, Nickel and PCB concentrations for SSP sediment samples are summarized below:

and PCBs were produced by Monsanto at Sauget K. Facility

Constituent (ppm)	CS-B	Site M	CS-C	CS-D	CS-E
Metals					
Copper	7,600	4,200	1,900	597	357
Zinc	4,900	2,400	3,567	2,333	1,693
Barium	1,988	700	650	363	273
Lead	793	530	360	220	213
Nickel	323	190	500	223	124

Constituent (ppm)	CS-B	Site M	CS-C	CS-D	CS-E
Organics					
PCB	152.0	12.2	2.6	0.9	1.0

Sediment toxicity was observed in Creek Segment B and Site M and Creek Segments C, D and E (Appendix 4) which are all included in the Dead Creek Sediment and Soil Time Critical Removal Action UAO.

Section 4

4.0 Sediment and Soil Removal Plan

Approximately 50,000 cubic yards of sediment and soil will be removed from the channel bottom in Creek Segments B, C, D and E and Site M. Work will be done within the creek channel to minimize disturbances to adjacent property owners and vegetated channel slopes. Specialized equipment, as described below, will be used to excavate impacted sediments so that work can be conducted within the channel bottom. Excavation activities may need to be curtailed if sediments are removed during freezing weather conditions because frozen sediments may be difficult to remove from the creek bed and they can not be compacted properly in the containment cell.

Some portions of the Dead Creek have large trees along the banks, for example the downstream end of CS-E at Route 157 adjacent to the aptly named Cottonwood Park Apartments where a number of large cottonwoods are growing along the banks of the creek. At locations where large trees are growing on the creek banks, only branches overhanging the creek will be removed in order to prevent interference with equipment operation. In Creek Segment E between the Quail Run trailer park and the Parks College parking lot, the channel is less than 10 feet wide and trees 4 to 6-inches in diameter are growing in the creek bed. Small-diameter trees are also growing in the channel from the south end of the Parks College parking lot to Route 157. These trees will need to be removed in order to excavate impacted sediments. Care will be taken to remove no more trees than necessary to excavate sediments in a safe and responsible manner.

4.1 Removal Volume

Creek Segment B and Site M contain an estimated volume of 25,500 cubic yards of metal and organic-containing sediment and soil. CS-C, D and E contain an estimated volume of 24,000 cubic yards of metal and organic-containing sediment. The total estimated volume of metal and organic-containing sediment and soil to be removed as part of the Dead Creek Sediment and

Soil Time Critical Removal Action is 49,500 cubic yards. An on-site containment cell with a volume of 50,000 cubic yards will be used to contain excavated sediment and soil from CS-B and Site M and sediment from CS-C, D and E. Removal of sediment and soil will be terminated when 50,000 cubic yards are excavated and placed in the containment cell unless containment cell volume can be increased by using air space above the top of the containment cell berms. If containment cell volume can be increased in this manner, sediment and soil removal will continue until the air space is used up.

Terminate when all sediments are removed.

4.2 Sediment Removal Criteria

Three objective criteria will be used to identify sediment to be excavated from Creek Segments B, C, D and E and Site M:

1) Origin - Non-Native vs. Native Sediments
2) Stratigraphy - Sediment/Soil Boundary
3) Color - Sediment Color versus Creek Bottom Soil Color

If these three criteria are not definitive, then a fourth criterion will be used to identify sediment to be excavated:

4) Physical Characteristics - Unconfined compressive strength < 500 psf
   Torvane shear strength < 200 psf
   Moisture content > liquid limit
   Moisture content > 60 percent

Criterion 4 will also be used every 200 feet as a control on the application of Criteria 1, 2 and 3.

4.3 Sediment and Soil Removal

4.3.1 Creek Segment B - Sediment will be removed from Creek Segment B using a low ground-pressure Gradall excavator, or equivalent working within the confines of the Dead Creek channel. Removal will start at the north (upstream) end of CS-B and move toward its south

(downstream) end. Excavated sediment will be stockpiled within the creek channel adjacent to the location of the Gradall. Trees growing within the creek channel and branches hanging over the channel that might interfere with equipment operation will be chipped and incorporated in the impacted sediment. Most of the CS-B channel is clear of trees except for the north end immediately south of Queeny Avenue. These trees will need to be removed in/to conduct the sediment removal action. The east bank of CS-B is lined with trees from Queeny Avenue south to the north side of Site M. These trees will not be removed as part of the sediment removal action. Only branches hanging over the creek will be cut and chipped if they can interfere with the safe and efficient implementation of the sediment removal action. All of the work described above will be done within the exclusion zone. To the extent practicable, the existing fence around CS-B will be left in place during sediment removal. Any sections of fence removed to facilitate removal will be replaced once excavation is completed.

Stockpiled material will be removed by a tracked excavator located outside the exclusion zone and transferred to an off-road dump truck. Sediment will then be taken to the containment cell. Trucks transferring material to the containment cell will not use public roads. Once in the cell, impacted sediments will be compacted so that they can support the weight of the overlying material and containment cell cap. A solidifying agent, meeting the requirements of IAC 724.414(e), will be used, if necessary, during compaction of the sediments in the containment cell to ensure that compacted sediments pass the Paint Filter Test.

To restore stream flow to original conditions and preserve the storm water detention capacity of CS-B, the blocked primary culvert and the high level overflow culvert at Judith Lane culvert will be removed and replaced during installation of the CS-B HDPE liner. These culverts will be replaced with a single, new culvert of the same diameter as the blocked culvert. Installing a larger culvert is not appropriate at this time for a number of reasons. First, installing a larger culvert will move more stormwater down the channel at a faster rate. Downstream culverts are not sized to handle this increased flow and large and more frequent floods are likely to result. Second, a study will be conducted by the Village of Cahokia in the near future to determine the cause of flooding in Dead Creek and to identify potential solutions. One of the outcomes of this

study will be a channel and culvert design. Third, pushing a large volume of stormwater faster down Dead Creek will result in a rapid rise and fall of water levels in the large wetland at the downstream end of Creek Segment F. Such rapid fluctuations in water level will have an adverse impact on the wetland. Retaining the existing culvert size will detain storm water, reduce the stormwater discharge rate and minimize water level fluctuations in the CS-F wetland. Finally, culverts at Route 157 and Route 3, which are both heavily-traveled, multi-lane state highways, and the culvert at old Route 3 are not sized to handle increased flows from the upstream portion of Dead Creek. Replacing these three culverts, and the upstream culverts at Judith Lane, Cahokia Street, Kinder Street, Jerome Land and Kinder Street, with culverts designed to handle a 100 year design storm is a major public works project that will take a considerable period of time to engineer, fund and build.

4.3.2 Site M - Sediment will be removed from Site M using a low ground-pressure Gradall excavator, or equivalent, and low ground-pressure, off-road dump trucks working within the confines of the borrow pit. Sediment will be excavated with the Gradall and placed in a transfer point stockpile adjacent to a clean haul road constructed from the west bank of Dead Creek into Site M. All of the work described above will be done within the exclusion zone. Stockpiled material will be removed by a tracked excavator located on the clean haul road outside the exclusion zone and transferred to an off-road dump truck. Sediment will then be taken to the containment cell. Trucks transferring material to the containment cell will not use public roads. Once in the cell, impacted sediments will be compacted so that they can support the weight of the overlying material and containment cell cap. A solidifying agent, meeting the requirements of IAC 724.414(e), will be used, if necessary, during compaction of the sediments in the containment cell to ensure that compacted sediments pass the Paint Filter Test.

During installation of the liner in Creek Segment B, an overflow structure will be installed to allow accumulated rainwater to discharge into CS-B.

4.3.3 Creek Segments C - Sediment will be removed from Creek Segment C using a low ground-pressure Gradall excavator, or equivalent, and low ground-pressure, off-road dump

trucks working within the confines of the Dead Creek channel. While trees line a good portion of the creek banks of CS-C, the creek channel is clear of trees. Consequently, tree removal will not be necessary except where branches overhanging the channel might interfere with equipment operation. Such branches will be removed, chipped and incorporated in the impacted sediment. Sediment will be excavated with the Gradall and placed in a dump truck and transported to a transfer point stockpile located within the creek channel at the north end of the creek segment. Sediment removal will start at the south (downstream) end and move toward the north (upstream) end of CS-C because this excavation sequence minimizes truck traffic on local roads. All of the work described above will be done within the exclusion zone.

A load-out facility, consisting of a gravel pad large enough to accommodate a tracked excavator and an over the road truck, will be constructed at the north end of Creek Segment C. Stockpiled sediment will be removed by a tracked excavator located outside the exclusion zone and transferred to an over-the-road dump truck. Sediment will then be taken to the containment cell using over-the-road trucks that will only need to cross Judith Lane in order to reach the cell. Once in the cell, impacted sediments will be compacted so that they can support the weight of the overlying material and containment cell cap. A solidifying agent, meeting the requirements of IAC 724.414(e), will be used, if necessary, during compaction of the sediments in the containment cell to ensure that compacted sediments pass the Paint Filter Test.

To restore stream flow to original conditions and preserve the storm water detention capacity of CS-C, the culvert at Cahokia Street will be cleaned out during sediment removal. Installing a larger culvert is not appropriate at this time for a number of reasons. First, installing a larger culvert will move more stormwater down the channel at a faster rate. Downstream culverts are not sized to handle this increased flow and large and more frequent floods are likely to result. Second, a study will be conducted by the Village of Cahokia in the near future to determine the cause of flooding in Dead Creek and to identify potential solutions. One of the outcomes of this study will be a channel and culvert design. Third, pushing a large volume of stormwater faster down Dead Creek will result in a rapid rise and fall of water levels in the large wetland at the downstream end of Creek Segment F. Such rapid fluctuations in water level will have an

adverse impact on the wetland. Retaining the existing culvert size will detain storm water, reduce the stormwater discharge rate and minimize water level fluctuations in the CS-F wetland. Finally, culverts at Route 157 and Route 3, which are both heavily-traveled, multi-lane state highways, and the culvert at old Route 3 are not sized to handle increased flows from the upstream portion of Dead Creek. Replacing these three culverts, and the upstream culverts at Judith Lane, Cahokia Street, Kinder Street, Jerome Land and Kinder Street, with culverts designed to handle a 100 year design storm is a major public works project that will take a considerable period of time to engineer, fund and build.

4.3.4 Creek Segment D - Sediment will be removed from Creek Segment D using a low ground-pressure Gradall excavator, or equivalent, and low ground-pressure, off-road dump trucks working within the confines of the Dead Creek channel. While trees line a good portion of the creek banks of CS-C, the creek channel is clear of trees. Consequently, tree removal will not be necessary except where branches overhanging the channel might interfere with equipment operation. Such branches will be removed, chipped and incorporated in the impacted sediment.

Sediment in the stretch of CS-D between Cahokia Street and Kinder Street will be excavated with the Gradall, placed in a dump truck and transported to a transfer point stockpile located within the creek channel just south of Cahokia Street. Sediment removal in this portion of CS-D will start at its south (downstream) end and move toward the north (upstream) in order to reduce over-the-road truck traffic on Kinder Street. All of the work described above will be done within the exclusion zone.

Sediment in the stretch of CS-D between Kinder Street and Jerome Lane will be excavated with the Gradall, placed in a dump truck and transported to a transfer point stockpile located within the creek channel just south of Kinder Street. Sediment in this stretch of CS-D will be excavated with the Gradall, placed in a dump truck and transported to a stockpile located within the creek channel just south of Kinder Street. Sediment removal in this portion of CS-D will start at its south (downstream) end and move toward the north (upstream). A load-out pad will

be constructed within the creek channel just south of Kinder Street because bank heights of ten feet or more at Jerome Lane preclude construction of load out facilities at the downstream end of CS-D. All of the work described above will be done within the exclusion zone.

At each load-out facility, which will consist of a gravel pad large enough to accommodate a tracked excavator and an over-the-road truck, stockpiled sediment will be removed by a tracked excavator located outside the exclusion zone and transferred to an over-the-road dump truck. Sediment will then be taken to the containment cell on public highways. Trucks will travel west on Cahokia Street and Kinder Street to get to Route 3 (Mississippi Avenue), a four-lane highway. Trucks will then go north to Judith Lane the local road that leads to the containment cell. Once in the cell, impacted sediments will be compacted so that they can support the weight of the overlying material and containment cell cap. A solidifying agent, meeting the requirements of IAC 724.414(e), will be used, if necessary, during compaction of the sediments in the containment cell to ensure that compacted sediments pass the Paint Filter Test.

To restore stream flow to original conditions and preserve the storm water detention capacity of CS-D, the culverts at Kinder Street and Jerome Lane will be cleaned out during sediment removal. Installing larger culverts is not appropriate at this time for a number of reasons. First, installing a larger culvert will move more stormwater down the channel at a faster rate. Downstream culverts are not sized to handle this increased flow and large and more frequent floods are likely to result. Second, a study will be conducted by the Village of Cahokia in the near future to determine the cause of flooding in Dead Creek and to identify potential solutions. One of the outcomes of this study will be a channel and culvert design. Third, pushing a large volume of stormwater faster down Dead Creek will result in a rapid rise and fall of water levels in the large wetland at the downstream end of Creek Segment F. Such rapid fluctuations in water level will have an adverse impact on the wetland. Retaining the existing culvert size will detain storm water, reduce the stormwater discharge rate and minimize water level fluctuations in the CS-F wetland. Finally, culverts at Route 157 and Route 3, which are both heavily-traveled, multi-lane state highways, and the culvert at old Route 3 are not sized to handle increased flows from the upstream portion of Dead Creek. Replacing these three culverts, and

the upstream culverts at Judith Lane, Cahokia Street, Kinder Street, Jerome Land and Kinder Street, with culverts designed to handle a 100 year design storm is a major public works project that will take a considerable period of time to engineer, fund and build.

4.3.5 Creek Segment E - Sediment will be removed from the stretch of Creek Segment E between Jerome Lane and Edgar Street using a low ground-pressure Gradall excavator, or equivalent, and low ground-pressure, off-road dump trucks working within the confines of the Dead Creek channel. While trees line most of the east creek banks, the creek channel is clear of trees. Consequently, tree removal will not be necessary except where branches overhanging the channel might interfere with equipment operation. Such branches will be removed, chipped and incorporated in the impacted sediment. Sediment will be excavated with the Gradall, placed in a dump truck and transported to a stockpile located within the creek bed just north of Edgar Street. Sediment removal will start at the north (upstream) end and move toward the south (downstream) end of this portion CS-E. All of the work described above will be done within the exclusion zone.

Sediment will be removed from the stretch of Creek Segment E between Edgar Street and the second of the three streets in the Quail Run trailer park using a low ground-pressure Gradall excavator, or equivalent, and low ground-pressure, off-road dump trucks working within the confines of the Dead Creek channel. Trees line both banks of the creek, however, the creek channel is clear of trees. Consequently, tree removal will not be necessary except where branches overhanging the channel might interfere with equipment operation. Such branches will be removed, chipped and incorporated in the impacted sediment

Two load-out facilities, each consisting of a gravel pad large enough to accommodate a tracked excavator and an over-the-road truck, will be constructed at Edgar Street. One will be constructed just north of Edgar Street and the other will be constructed just south of Edgar Street. Stockpiled material will be removed by a tracked excavator located outside the exclusion zone and transferred to an over-the-road dump truck. Sediment will then be taken to the containment cell on public highways. Trucks will use Edgar Street to get to Route 3

(Mississippi Avenue), a four-lane highway, and will then go north to Judith Lane the local road that leads to the containment cell. Once in the cell, impacted sediments will be compacted so that they can support the weight of the overlying material and containment cell cap. A solidifying agent, meeting the requirements of IAC 724.414(e), will be used, if necessary, during compaction of the sediments in the containment cell to ensure that compacted sediments pass the Paint Filter Test.

Where is end of excav. ?

In the stretch of Dead Creek between the second street in the Quail Run trailer park and the north end of the Parks College parking lot, one to six-inch diameter trees are growing the channel bottom and line both banks of the channel. These trees will need to be removed in order to excavate impacted sediments. Care will be taken to remove no more trees than necessary to excavate sediments in a safe and responsible manner. Sediment will be removed from this section of CS-E using a small, tracked excavator because it is not feasible to use larger equipment. The channel is 10 to 20 feet wide here with trailer homes, businesses and trees on both banks. Sediment will be excavated with the small, tracked excavator, placed in a low ground-pressure dump truck and transported to a stockpile located within the creek bed just south of Edgar Street. Sediment removal will start at the south (downstream) end and move toward the north (upstream) end of this section of CS-E. All of the work described above will be done within the exclusion zone.

to Cargill ? - describe method for parking lot excavation.

Small-diameter trees are also growing in the CS-E channel from the south end of the Parks College parking lot to Route 157. These trees will be chipped and incorporated in the impacted sediment. Care will be ~~taken to~~ remove no more trees than necessary to excavate sediments in a safe and responsible manner. Large trees are growing on the banks it this stretch of the creek. Branches hanging over the channel that might interfere with equipment operation will be chipped and incorporated in the impacted sediment. Sediment will be removed from this section of CS-E using a small, tracked excavator because it is not feasible to use larger equipment. The channel is 10 to 20 feet wide here with trees on both banks and an apartment complex on the west bank. Sediment will be excavated, placed in a low ground-pressure dump truck and transported to a stockpile located within the creek bed just south of the Parks College

parking lot. All of this work will be done within the exclusion zone. Stockpiled sediment will then be transferred to an over-the-road truck using a tracked excavator both working in the clean zone. Sediment removal will start at the south (downstream) end and move toward the north (upstream) end of this section of CS-E. Trucks will use Falling Springs Road to get to Route 157 which connects to Route 3 (Mississippi Avenue), a four-lane highway, and will then go north to Judith Lane the local road that leads to the containment cell. Once in the cell, impacted sediments will be compacted so that they can support the weight of the overlying material and containment cell cap. A solidifying agent, meeting the requirements of IAC 724.414(e), will be used, if necessary, during compaction of the sediments in the containment cell to ensure that compacted sediments pass the Paint Filter Test.

To restore stream flow to original conditions and preserve the storm water detention capacity of CS-E, the culvert at Edgar Street will be cleaned out during sediment removal. Installing a larger culvert is not appropriate at this time for a number of reasons. First, installing a larger culvert will move more stormwater down the channel at a faster rate. Downstream culverts are not sized to handle this increased flow and large and more frequent floods are likely to result. Second, a study will be conducted by the Village of Cahokia in the near future to determine the cause of flooding in Dead Creek and to identify potential solutions. One of the outcomes of this study will be a channel and culvert design. Third, pushing a large volume of stormwater faster down Dead Creek will result in a rapid rise and fall of water levels in the large wetland at the downstream end of Creek Segment F. Such rapid fluctuations in water level will have an adverse impact on the wetland. Retaining the existing culvert size will detain storm water, reduce the stormwater discharge rate and minimize water level fluctuations in the CS-F wetland. Finally, culverts at Route 157 and Route 3, which are both heavily-traveled, multi-lane state highways, and the culvert at old Route 3 are not sized to handle increased flows from the upstream portion of Dead Creek. Replacing these three culverts, and the upstream culverts at Judith Lane, Cahokia Street, Kinder Street, Jerome Land and Kinder Street, with culverts designed to handle a 100 year design storm is a major public works project that will take a considerable period of time to engineer, fund and build.

Section 5

5.0 Sediment Handling, Dewatering and Treatment Plan

Sediments in Creek Segment B and Site M and Creek Segments C, D and E will be dewatered in place by gravity drainage and air drying. In order to dry sediments in CS-B, C and D in place, stormwater entering the upstream end of CS-B, C and D will be retained behind a small berm and pumped downstream. The retention berm will be designed to create a pool deep enough to allow operation of a 12-inch, 5000 gpm, float activated, electric-powered sump pump. In small storms, the float switch will activate the pump and discharge the stormwater through an 12-inch or larger HDPE pipe to the upstream end of the next creek segment. In large storms, the berm will be overtopped and storm flow will be routed downstream through both the channel and the discharge pipe. This stormwater diversion system will keep the channel of Creek Segments B, C and D dry during small storms and dewater them after large storms.

To reduce the amount of storm water entering each creek segment, storm water entering the creek segment along its banks will be diverted away from the channel using diversion structures such as earth berms and/or pumps. Care will be taken to ensure that diverted water does not flood buildings. Low spots in each channel will be dewatered with small, portable sump pumps tied into the main storm water discharge line. "T"s will be installed at regular intervals in the HDPE pipe to allow these tie-ins.

Each HDPE stormwater diversion pipe will discharge into a gravel energy dissipater constructed at the upstream end of the downstream creek segment in order to prevent entrainment of sediments. HPDE piping will be placed on the creek banks or the channel side slopes so that they will not interfere with sediment removal activities. It will be necessary to trench Judith Lane, Cahokia Street and Kinder Street and install sleeves for the HDPE stormwater discharge pipes to run through.

After standing water is pumped off and discharged downstream in each creek segment, drying sediments will be turned, if necessary, to facilitate dewatering. Dust from drying sediments will be controlled with a sprinkler system. A two-inch diameter water line will be installed on the

creek banks or the channel side slopes so that it will not interfere with sediment removal activities. "T"s will be installed at regular intervals and fitted with sprinkler heads.

Since it is difficult to predict how long it will take to dewater the sediments in CS-B, C and D, dewatering operations will start early in the project. An early start will allow ~~to~~ time to install an enhanced dewatering system or implement a different drying method, adding pozzolanic materials for example, should a change in approach become necessary to obtain a sediment moisture content suitable for placement in the containment cell.

Similar dewatering procedures will be used for sediments in Creek Segments E using equipment from CS-B, C and D after sediments are removed from these stretches of the Dead Creek channel.

Sediment dewatering system drawings are included in Appendix 4.

Section 6

6.0 Storm Water Management Plan

Prior to start of sediment removal in each creek segment, storm water entering the upstream end of each creek segment will be pumped to the upstream end of the next downstream creek segment as described in Section 5.0 Sediment Handling, Dewatering and Treatment Plan. Storm water entering the creek segment along its banks will be diverted away from the channel using diversion structures and/or pumps. If diversion of these inflows is not possible, temporary sump pumps will be used to route this water to the HDPE stormwater discharge pipe installed in each creek segment.

A gravel and sand filter dam will be constructed at the downstream end of each creek segment to retain sediments entrained in stormwater moving through the creek channel. These filter dams will be built early in the removal action to reduce the potential for downstream transport of sediments during sediment dewatering.

Sediment traps will be installed every 500 ft. in each creek sediment to retard sediment transport during storm conditions. Each one foot high trap will consist of gravel placed on geotexile.

Careful not to flood homes nearby

Site M will be hydraulically isolated from Dead Creek by closing the opening between Creek Segment B and the southwestern corner of Site M using compacted soil, sheet pile or other suitable method. Stormwater inflows along the north, east and south sides of Site M will be diverted with earth berms. A 12-inch, 5000 gpm, float activated, electric-powered sump pump will be installed in Site M to pump down accumulated water. Impounded water will be routed through a 12-inch diameter HDPE pipe to the gravel and sand filter dam constructed at the downstream end of CS-B and then will be discharged downstream.

Runoff from the containment cell will be routed to the gravel and sand filter dam at the downstream end of CS-B and then discharged downstream.

Section 7

7.0 Excavated Area Soil Sampling Plan

Excavated area soil sampling will be performed after removal of sediments in Creek Segment B, C, D and E and Site M using the sampling procedures and analytical methods approved by USEPA for the Sauget Area 1 EE/CA and RI/FS Support Sampling Plan. Specifically, sampling and analytical procedures in SSP Volume 2 Soil, Groundwater, Surface Water and Air FSP, QAPP and HASP and Laboratory Quality Assurance Plan will govern soil sample collection and analysis.

7.1 Creek Segments B, C, D and E

After sediment is removed, creek-bottom soil samples will be collected from all excavated areas of Creek Segments B, C, D and E. Sampling transects will be established every 100 ft. in each creek segment starting at Queeny Avenue, the upstream end of Creek Segment B, and terminating at Route 157, the downstream end of Creek Segment E, a channel length of approximately 6,900 feet:

Creek Segment	Channel Length	Number of Potential Sampling Transects
CS-B	1500 ft.	15
CS-C	1500 ft.	15
CS-D	800 ft.	8
CS-E	3100 ft.	31
Total	8300 ft.	69

Three samples will be collected on each transect: 1) one located at the centerline of the creek channel, 2) one located half way between the channel center line and the limit of sediment removal on the left bank of the channel and 3) one located half way between the channel center line and the limit of sediment removal on the right bank of the channel. If sediments are

removed from entire length of Creek Segments B, C, D and E, a total of 207 samples will be collected.

Each creek channel bottom soil sample will have a unique sample number using the following nomenclature:

- Matrix: CBS (Creek Bottom Soil)
- Creek Segment: CSB, CSC, CSD, CSE
- Transect Number: T1, T2, T3, T4, ...
- Sample Number: C1, L1, R1; C2, L2, R2; ....

Samples will be collected from 0 to 12 inches below the bottom of the excavated channel, TCLP extracted and the extract will be analyzed for TCL/TAL parameters and dioxin/furans.

?

7.2 Site M

Pond bottom soil samples will be collected from the excavated areas of Site M. Samples will be collected at the center points of a 100 ft. grid superimposed on the excavated area. With a surface area of approximately 60,000 square feet (200 by 300 ft), and assuming sediments are removed from the entire area of the pond, a total of six pond bottom soil samples will be collected.

Each pond bottom soil sample will have a unique sample number using the following nomenclature:

- Matrix: PBS (Pond Bottom Soil)
- Site: M
- Sample Number 1, 2, 3, 4, 5, 6

Samples will be collected from 0 to 12 inches below the bottom of the excavated channel, TCLP extracted and the extract will be analyzed for TCL/TAL parameters and dioxin/furans.

Section 8

8.0 Creek Segment B Liner Installation Plan

Channel liner design for Creek Segment B is included in Appendix 6. A 40 mil HDPE liner will be installed in CS-B immediately after sediments are removed. Prior to installing the geomembrane, the channel bottom and side slopes will be graded to a designed cross section. Cut and fills will be balanced to minimize generation of excess spoil. After completion of grading, a 40 mil HDPE geomembrane with thermally-welded seams will be installed from Queeny Avenue to Judith Lane. A geotextile will be laid on top of the geomembrane and articulated concrete mats will be laid on top of the geotextile.

If this has to be removed = big job.

These articulated concrete mats, the final component of the channel liner system, will protect the liner and resist upward hydrostatic forces. If hydrostatic forces allow, open block articulated mats will be used instead of solid block mats so that sediment can accumulate and the channel can revegetate voluntarily. If articulated concrete mats are not heavy enough to resist potential hydrostatic forces, other suitable materials such as rip rap will be used. It may be necessary to remove trees at the top of the channel banks in order to allow anchoring of the geomembrane, geotextile and articulated mat. If so, care will be taken to remove the minimum number of trees necessary for safe and efficient execution of the work.

Section 9

9.0 Containment Cell Design Report

The on-site containment cell is designed to achieve compliance with the substantive requirements of CFR 761.61(b) Performance-Based Disposal Regulations, CFR 761.75 Technical Requirements for a Chemical Waste Landfill and RCRA minimum technology requirements as set forth in Exhibit 2 of the Order. It is designed to ensure that on-site containment of sediments removed from Creek Segments B, C, D and E and Site M is protective of public health and the environment and will not cause unreasonable risk. Specific technical measures are included in the design to address risks associated with:

- Shallow Groundwater
- Groundwater Usage
- Leachate Migration
- Flooding
- Stormwater

These technical measures are discussed below.

9.1 Shallow Groundwater

Depth to groundwater at the site of the proposed containment cell ranges from 10 to 15 feet below ground surface. To mitigate risks associated with a depth to groundwater of less than 50 feet, a double-lined containment cell will be built above grade on top of a three ft. thick permeable, capillary barrier drain sloped to a collection sump. Bentomat® will be installed on top of the capillary barrier drain prior to construction of the containment cell. The cell will have a primary liner system with a leachate collection system and a secondary liner system with a leak detection system. Accumulated leachate will be removed regularly to minimize hydraulic head on the primary liner system. Three barriers will prevent any leachate generated in the containment cell from reaching the shallow water table: 1) the primary 60 mil HDPE liner and

leachate recovery system, 2) the secondary 60 mil HDPE liner and leak detection system and 3) the Bentomat® on top of the capillary barrier drain.

Since the capillary barrier drain and containment cell are being built above grade, it is unlikely that the water table will rise above the top of the drain. Sloping the capillary barrier drain so that accumulated water drains to a sump will prevent groundwater from reaching the bottom of the containment cell as will installation of the Bentomat® layer.

9.2 Groundwater Usage

Sauget and Cahokia are served by a public water supply system that obtains surface water from a Mississippi River intake located approximately three miles upstream of the proposed containment cell location. Groundwater is not used as a drinking water or industrial water supply source in Cahokia or Sauget. Since groundwater is not used as a water supply source, specific technical design measures are not needed to mitigate risks associated with groundwater use. If groundwater were used as a water supply source, technical measures taken to control risks associated with the shallow water table (described above) and leachate migration (described below) would also control risks associated with groundwater usage.

9.3 Leachate Migration

A number of technical measures are included in the design to mitigate risks associated with leachate migration: 1) containing dry solids (contained sediments will pass the Paint Filter Test) and not liquids, thereby preventing catastrophic release of liquids, 2) containing dewatered sediments in a double-lined cell with leachate collection and leak detection systems, 3) building the double-lined cell above grade and 4) placing a Bentomat® layer on top of the capillary barrier drain prior to construction of the overlying containment cell.

The cell will have a 60 mil, HDPE primary liner system with a leachate collection system and a 60 mil, HDPE secondary liner system with a leak detection system. HDPE is compatible with

PCBs. Demonstration of compatibility of liner materials with other constituents present in Dead Creek sediments, as required by Exhibit 2 of the Order, will be done by conducting compatibility tests using EPA test methods. Tests are currently underway to ensure that liner and drainage layer construction materials are compatible with sediments from Creek Segment B. CS-B sediments were selected for use in the compatibility tests because they have the largest number and highest detected concentrations of the organic and inorganic constituents found in Dead Creek. Geomembrane and geotextile samples are being tested using EPA Method 9090 and the geosynthetic clay liner is being tested using EPA Method 9100. These tests, which will take 180 days to complete, were started in late May 2000 and should be completed by the end of November 2000.

Any leachate draining from the fill will be collected and removed by the leachate collection system. Should the primary liner be breached, the secondary liner and leak detection system will allow collection and removal of leachate. Should the secondary liner system fail, the Bentomat® layer on top of the capillary barrier drain will act as an additional leachate migration barrier. Building the containment cell above grade will also mitigate the impact of any leachate migration because leachate will preferentially move horizontally when it encounters the Bentomat® layer. Should it move vertically into and through the Bentomat® layer, the capillary barrier drain will route it to a collection sump.

If leachate should reach the water table and migrate through the groundwater system, it will be detected in a timely fashion using monitoring wells. Appropriate responses will be initiated on detection. There are no downgradient groundwater users. Any impacted groundwater migrating beyond the site boundary would discharge to the Mississippi River which is about one mile west of the site.

9.4 Flooding

The proposed containment cell is not in a FEMA 100-year floodplain, however, it is located in the floodplain of the Mississippi River. Construction in a floodplain to improve environmental

conditions is allowed by Executive Order. In addition, a floodwall and levee system, constructed by the US Army Corps of Engineers (USACE), protects the site from flooding. During the July 1993 flood, the largest recorded flood in St. Louis history, the Corps' flood protection system performed as designed and prevented the site of the proposed containment cell from being flooded. Site R, a closed and capped landfill in Sauget Area 2 outside the floodwall, was inundated during the 1993 flood. Floodwaters reached to just below the top of its vegetated clay cap and the side slopes survived intact as the water receded.

To mitigate the risk of flooding due to failure of the floodwall and levee system and/or failure of the lift station at the downstream end of Dead Creek, the containment cell will be built with flat slopes that will not erode as flood waters recede. To prevent the cap from floating during inundation, trapped air will be vented and the cap will be covered with gravel. Gravel will be placed on the side slopes of the cell to prevent erosion during flooding.

9.5 Stormwater

Stormwater runoff will be routed to downchutes designed to handle flow from a 25 year, 24 hour storm.

9.6 Containment Cell Design

Containment cell design drawings, specifications and construction quality control plan are included in Appendix 7 along with the geotechnical investigation and design calculations. A number of technical measures are included in the containment cell design to ensure that it: 1) complies with the substantive requirements of CFR 761.61(b) and CFR 761.75, 2) meets the RCRA minimum technology requirements set forth in Exhibit 2 of the Order, 3) is protective of public health and the environment and 4) will not cause unreasonable risk. Specific technical measures incorporated in cell design include:

- Above grade construction
- Construction on a three ft. thick, permeable capillary barrier drain sloped to a collection sump
- Water from the capillary barrier drain collection sump discharged to the American Bottoms POTW
- Installation of a Bentomat® layer on top of the capillary barrier drain
- Double-lined cell
- 60 mil HDPE primary membrane
- 60 mil HDPE secondary membrane
- Sand and/or gravel leachate collection system above primary liner
- Leachate treatment, if necessary, and discharge to the American Bottoms POTW
- Geosynthetic leak detection system above secondary liner
- Storm water downchutes off cap designed to handle 25 year, 24 hour storm
- Slopes designed to resist failure and erosion as flood waters recede
- Gravel, or equivalent, armoring of potentially flooded slopes
- Gravel, or equivalent, cover to resist floating and erosion during flooding
- Air venting to prevent cell floating during flooding
- Cell design and air venting to prevent PCB releases into the air by way of dust, fumes or via hot weather vapors

If containment cell leachate volume is low, it will be removed with a vac truck or other suitable equipment and disposed at an appropriate facility. If volume is high, leachate will be filtered, passed through two GAC beds connected in series and discharged to an HDPE pipeline connected to the local sewer system at Judith Lane. Operational experience will be used to determine if a permanent treatment leachate treatment system is appropriate.

Off-gas from the containment cell vents will be passively collected with a header system, routed to two GAC beds connected in series and vented to the atmosphere.

These risk mitigation measures will ensure that the proposed on-site containment cell is protective of public health and the environment and does not cause unreasonable risk due to shallow groundwater, leachate migration, flooding or stormwater. No risks are associated with groundwater usage because groundwater is not used as a water supply source. If it were, the technical measures described above would ensure that the proposed on-site containment cell does not cause unreasonable risk to public health and the environment due to groundwater usage.

Section 10

10.0 Schedule

Work Element	Start	End	Duration
• Work Plan Approval	Jul 1, 2000	Aug 31, 2000	2 Months
• Sediment Dewatering	Sep 1, 2000	Apr 30, 2001	12 Months 8
• Cell Construction Bid	Sep 1, 2000	Sep 30, 2000	1 Month
• Cell Construction Award	Oct 1, 2000	Oct 31, 2000	1 Month
• Compatibility Tests	Jun 1, 2000	Nov 30, 2000	1 Month
• Mobilization	Dec 1, 2000	Dec 31, 2000	1 Month ? why 30 days to mob.?
• Cell Construction	Jan 1, 2001	Apr 30, 2001	4 Months
• Sediment Transfer	May 1, 2001	Aug 31, 2001	4 Months
• Cap Construction	Sep 1, 2001	Oct 39, 2001	2 Months
		Project Duration	16 Months

can transfer begin when cell is substantially complete?

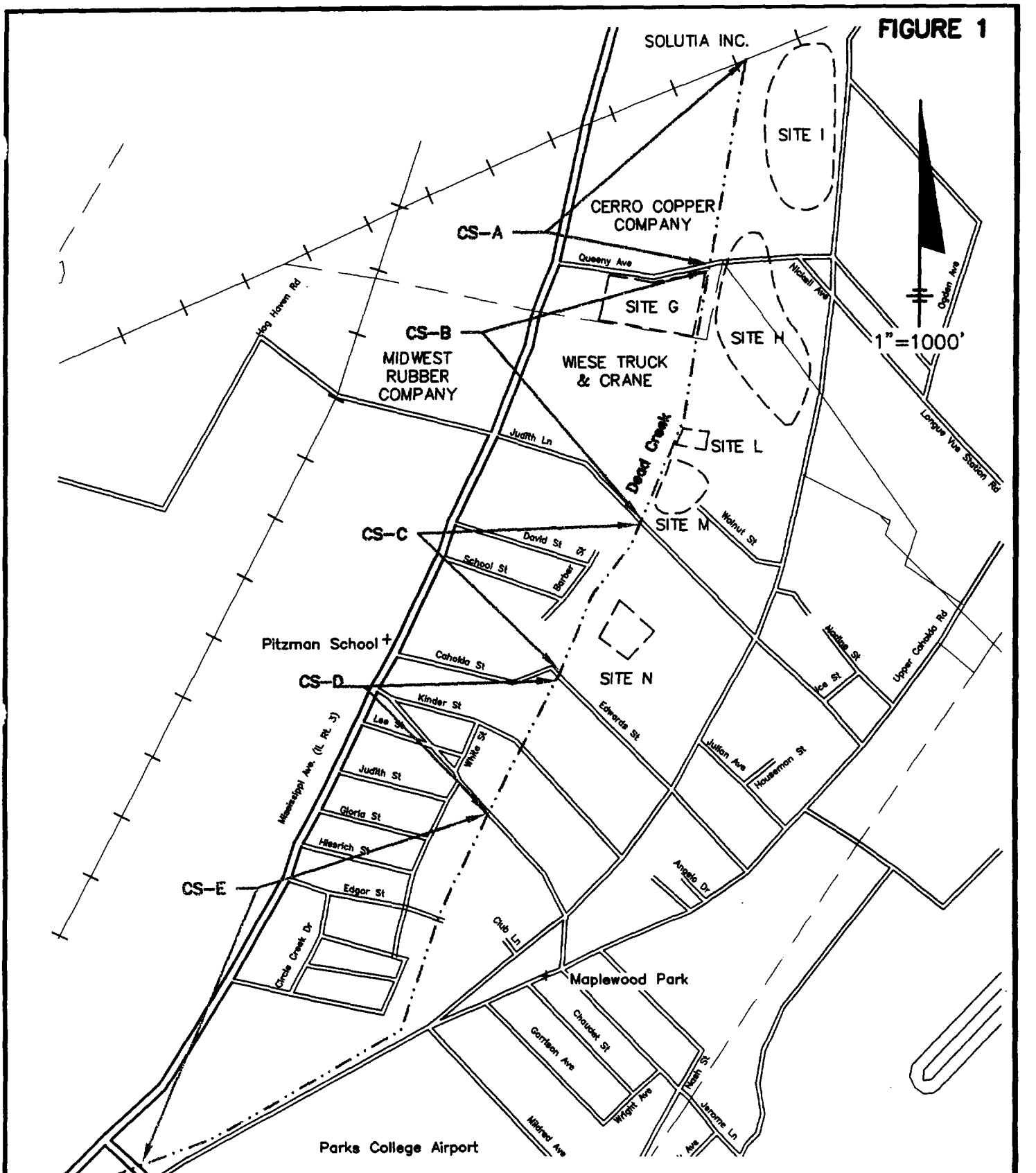
Notes:

1) Freezing weather during cell construction may prevent activities such as foundation and berm construction and liner installation from being performed. If freezing weather occurs during soil compaction or liner installation, activities will need to be suspended until temperatures rise to the point where work can resume.

2) CS-B will be lined immediately after completion of sediment excavation and channel bottom soil sampling.

3) Creek bottom soil sampling will be performed immediately after completion of sediment excavation in each creek segment.

Figures



Time Critical Removal Action Work Plan
Dead Creek Sediment and Soil
Sauget and Cahokia, IL

Site Location Map

Tables

Table 1 Summary of Chemical Analyses and Bioassay Results in Creek Segments B, C, D and E, Time Critical Removal Action, Dead Creek Sediment and Soil, Sauget and Cahokia, Illinois.

	CS-B	CS-C	CS-D	CS-E
Sediment Toxicity	•	•	•	•
Metals (> 100 ppm)				
Arsenic	•			
Barium	•	•	•	•
Cadmium	•			
Chromium	•			•
Cobalt	•			
Copper	•	•	•	•
Lead	•	•	•	•
Nickel	•	•	•	•
Selenium	•			
Silver	•			
Strontium	•	•		
Vanadium	•			
Zinc	•	•	•	•
VOCs (> 1 ppm)				
Acetone	•			
2-Butanone	•			
Chlorobenzene	•			
Ethylbenzene	•			
4-Methyl-2-Pentanone		•	•	
Toluene	•			
SVOCs (> 1 ppm)				
Acenapthene	•			
Anthracene	•			
Benzo(a)anthracene	•	•		
Benzo(b)fluoranthene	•	•		•
Benzo(k)fluoranthene	•			
Benzo(g,h,I)perylene	•	•		
Benzo(a)pyrene	•	•		
Bis(2-ethylhexyl)phthalate	•			
Butylbenzylphthalate	•	•		
Chrysene	•	•		•
Chloronitrobenzene	•			
Dibenzo(a,h)anthracene	•	•		

	CS-B	CS-C	CS-D	CS-E
SVOCs (> 1 ppm)				
Dibenzofuran	•			
1,2-Dichlorobenzene	•			
1,3-Dichlorobenzene	•			
1,4-Dichlorobenzene	•			•
Di-ni-octyl phthalate	•			
Fluoranthene	•	•		
Fluorene	•			
Hexachlorobenzene	•			
Indeno(1,2,3-cd)pyrene	•	•		
2-Methylnapthalene	•			
Napthalene	•			
4-Nitrophenol	•			
Pentachlorophenol	•			
Phenanthrene	•			
Pyrene	•	•		•
1,2,4-Trichlorobenzene	•			
PCBs	•	•	•	•

Appendix 1

Unilateral Administrative Order

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5

IN THE MATTER OF:	)	Docket No.: V-W-99-C-554
	)	
Sauget Area 1 Superfund Site	)	
Sauget and Cahokia, Illinois	)	ADMINISTRATIVE ORDER
	)	PURSUANT TO SECTION 106(a)
	)	OF THE COMPREHENSIVE
	)	ENVIRONMENTAL RESPONSE,
Respondents:	)	COMPENSATION, AND
	)	LIABILITY ACT OF 1980,
Monsanto Company and	)	AS AMENDED, 42 U.S.C.
Solutia, Inc.	)	SECTION 9606(a)
	)	

I. JURISDICTION AND GENERAL PROVISIONS

This Order is issued pursuant to the authority vested in the President of the United States by Section 106(a) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended ("CERCLA"), 42 U.S.C. § 9606(a), and delegated to the Administrator of the United States Environmental Protection Agency ("EPA") by Executive Order No. 12580, January 23, 1987, 52 Federal Register 2923, and further delegated to the Regional Administrators by EPA Delegation Nos. 14-14-A and 14-14-B, and to the Director, Superfund Division, Region 5, by Regional Delegation Nos. 14-14-A and 14-14-B.

This Order pertains to segments of Dead Creek and Site M, which are parts of a larger Superfund Site known as Sauget Area One. The Sauget Area One Site is currently the subject of a separate Administrative Order by Consent (AOC) signed by EPA and Solutia, Inc. and Monsanto Company on January 21, 1999, requiring a detailed Remedial Investigation and Feasibility Study (RI/FS) and Engineering Evaluation/Cost Assessment (EE/CA) of the Site. Dead Creek is approximately 3.5 miles long and flows southward through Sauget and Cahokia and empties into the Old Prairie du Pont Creek, which flows approximately 2,000 feet west into a branch of the Mississippi River known as the Cahokia Chute. Specifically, this Order pertains to Sauget Area One Dead Creek Segments (CS) B, C, D and E, as well as to site M, located within Sauget and Cahokia, St. Clair County, Illinois (the "Site"(see map attached as Exhibit 1)). It requires the emergency removal of contaminated sediments and soils from certain locations in and around Dead Creek. The Order also requires installation of a 40 millimeter (mil) high density polyethylene (HDPE) liner in CS-B and post removal sampling in all excavated areas. The post removal sampling results will be used in the Area One EE/CA and RI/FS processes to determine what, if any, excavated areas in addition to CS-B may require further remediation under the EE/CA process. Sediments and soils to be removed under this Order are required to be properly disposed of in a Resource Conservation and Recovery Act (RCRA)-compliant Containment Cell ("Containment Cell") located adjacent to CS-B. In addition to the requirements set forth in this Order concerning the construction, operation and maintenance of the containment cell, any necessary additional requirements associated with the long term operation and maintenance of the cell will be considered and addressed in the EE/CA and/or RI/FS processes for the Site. This

Order supplements the Unilateral Administrative Order issued on June 21, 1999, to Monsanto and Solutia requiring investigation and repair of Dead Creek culverts in the Cahokia and Sauget areas. Dead Creek segments B (and the area adjacent to CS-B upon which the Containment Cell is to be located), C, D and E, as well as Site M comprise the "Site" for the purposes of this Order. This Order requires the Respondents to conduct removal activities described herein to abate a potential imminent and substantial endangerment to the public health, welfare or the environment that may be presented by the actual or threatened release of hazardous substances at or from the Site.

EPA has notified the State of Illinois of this action pursuant to Section 106(a) of CERCLA, 42 U.S.C. § 9606(a).

II. PARTIES BOUND

This Order applies to and is binding upon Respondents and Respondents' heirs, receivers, trustees, successors and assigns. Any change in ownership or corporate status of Respondents including, but not limited to, any transfer of assets or real or personal property shall not alter such Respondents' responsibilities under this Order. Respondents are jointly and severally liable for carrying out all activities required by this Order. Compliance or noncompliance by one or more Respondent with any provision of this Order shall not excuse or justify noncompliance by any other Respondent.

Respondents shall ensure that their contractors, subcontractors, and representatives comply with this Order. Respondents shall be responsible for any noncompliance.

III. FINDINGS OF FACT

Based on available information, including the Administrative Record in this matter, EPA hereby finds that:

1. Dead Creek has historically been a repository for local area wastes. On December 21, 1928, an easement agreement between local property owners and representatives of local business, municipal and property interests was executed to "improve the drainage in that District (Dead Creek) by improving Dead Creek so as to make it suitable for the disposal of wastewater, industrial waste, seepage and storm water." Thereafter, Dead Creek systematically received direct and indirect discharges from local businesses and the municipality for many years.

2. Information on the types of wastes disposed of and the types and levels of contamination found at the Sauget Area One Site, including wastes and contamination found in Dead Creek, have been provided to EPA from various sources including, but not exclusively from: 1) CERCLA 103 (c) Submittals; 2) CERCLA 104(e) Responses; 3) Expanded Site Investigation Dead Creek Project Sites (E&E, 1988); 4) Removal Action Plan for Dead Creek Sites (Weston-SPER, 1987); 5) Description of Current Situation at the Dead Creek

Project Sites (E&E, 1986); 6) Site Investigations for Dead CS-B and Sites L and M (Geraghty & Miller, Inc. 1992); 7) Site Investigation/Feasibility Study for Creek Segment A (Advent Group, 1990); 8) Preliminary Ecological Risk Assessment for Sauget Area 1, Creek Segment F (E&E 1997); 9) EPA Removal Action Report for Site G (E&E 1994); 10) Area One Screening Site Inspection Report; and 11) Site Investigation Feasibility Study for CS-A (Avendt Group 1990).

3. Dead Creek stretches from the Alton & Southern Railroad at its northern end and flows south through Sauget and Cahokia for approximately 3.5 miles before emptying into the Old Prairie du Pont Creek, which flows approximately 2,000 feet west into a branch of the Mississippi River known as the Cahokia Chute. For sampling purposes, Dead Creek is subdivided into six separate segments labeled CS-A through CS-F. The segments are further described as follows:

CS-A is the northernmost segment of the creek and it is approximately 1,800 feet long and 100 feet wide running from the Alton & Southern Railroad to Queeny Avenue. This segment of the creek originally consisted of two holding ponds which were periodically dredged. For several years, CS-A and available downstream creek segments (e.g., ones that were not blocked off) received direct wastewater discharges from industrial sources and served as a surcharge basin for the Village of Sauget (formerly Village of Monsanto) municipal sewer collection system. When the system became backed up or overflowed, untreated wastes from industrial users of the sewer system were discharged directly into CS-A. On several occasions, CS-A was dredged and contaminated sediments were disposed of onto adjacent property (Site I of Sauget Area One Site). In 1968, the Queeny Avenue culvert, which allowed creek water to pass from CS-A to CS-B, was permanently blocked by the Village of Sauget. Remediation work was conducted by Cerro Copper in CS-A in 1990. Approximately 27,500 tons of contaminated sediments were excavated and sent to Resource Conservation and Recovery Act ("RCRA") and Toxic Substances Control Act ("TSCA") permitted facilities. CS-A is now filled and covered with crushed gravel and is not subject of this Order. Land use surround CS-A is industrial.

CS-B extends for approximately 1,800 feet from Queeny Avenue south to Judith Lane. Sites G, L, and M of the Sauget Area One Site border this creek segment. Land use surrounding CS-B is primarily commercial with a small residential area near the southern end of this segment. Agricultural land lies to the west of the creek and south of Site G. At some point after 1943, the Judith Lane culvert, which allowed creek water to pass from CS-B to CS-C, was blocked.

CS-C extends for approximately 1,300 feet from Judith Lane south to Cahokia Street. Land use is primarily residential along both sides of CS-C.

CS-D extends for approximately 1,100 feet from Cahokia Street to Jerome Lane. Land use is primarily residential along both sides of CS-D.

CS-E extends approximately 4,300 feet from Jerome Lane to the intersection of Illinois Route 3 and Route 157. Land use surrounding CS-E is predominantly commercial with some mixed residential use. Dead Creek temporarily passes through corrugated pipe at the southern end of CS-E.

CS-F is approximately 6,500 feet along and extends from Route 157 to the Old Prairie du Pont Creek. CS-F is the widest segment of Dead Creek and a large wetland area extends several hundred feet out from the both sides of the creek.

Site M: Located along the eastern side of Dead Creek CS-B (south of Site L) at the western end of Walnut Street in the Village of Cahokia. Site M was originally used as a sand borrow pit (dimensions = 220 feet by 320 feet) in the mid to late 1940's. The pit is hydraulically connected to Dead Creek through an eight-foot opening at the southwest portion of the pit. On information and belief, wastes from CS-B have in the past and potentially continue to migrate into Site M via this connection. The site is currently fenced.

4. Sediment and surface water samples collected by EPA and the Illinois Environmental Protection Agency (Illinois EPA) have detected a wide variety of organic and inorganic contaminants in each of the creek segments:

CS-B: Elevated levels of volatile organic compounds ("VOCs") and semi-volatile organic compounds ("SVOCs") were detected in sediments samples collected from CS-B such as benzene (87 parts per billion ("ppb")), toluene (810 ppb), chlorobenzene (5,200 ppb), ethylbenzene (3,600 ppb), trichlorobenzene (3,700 parts per million ("ppm")), dichlorobenzene (12,000 ppm), chloronitrobenzene (240 ppm), xylenes (540 ppm), 1,4-dichlorobenzene (220,000 ppb), 1,2-dichlorobenzene (17,000 ppb), phenanthrene (15,000 ppb), fluoranthene (11,000 ppb), pyrene (13,000 ppb). Elevated levels of PCBs exist within CS-B at levels as high as 10,000 ppm. Elevated levels of metals were also detected in sediments in CS-B including arsenic (6,000 ppm), cadmium (400 ppm), copper (44,800 ppm), lead (24,000 ppm), mercury (30 ppm), nickel (3,500 ppm), silver (100 ppm), and zinc (71,000 ppm).

Surface water samples collected from CS-B revealed elevated concentrations of VOCs such as chloroform (27 ppm), 1,1-dichloroethene (3 ppb), toluene (20 ppb), and chlorobenzene (33 ppb). SVOCs detected in surface water included phenol (28 ppb), 2-chlorophenol (14 ppb), 1,4-dichlorobenzene, 2-methylphenol (4 ppb), 4-methylphenol (35 ppb), 2,4-dichlorophenol (150 ppb), naphthalene (8 ppb), 3-nitroaniline (9 ppb), and pentachlorophenol (120 ppb). Pesticides were also detected in surface water samples including dieldrin (.18 ppb), 4,4-DDT (.24 ppb), 2,4-D (47 ppb) and silvex (3.4 ppb). An elevated level of PCBs (aroclor 1260) was also detected in the surface water of CS-B at a level of 44 ppb. Elevated levels of metals were detected in surface water such as aluminum (9,080 ppb), barium (7,130 ppb), arsenic (31 ppb), cadmium (25 ppb), chromium (99 ppb), copper (17,900 ppb), lead (1,300 ppb), mercury (8.6 ppb), nickel (1,500 ppb), and zinc (10,300 ppb).

CS-C: Elevated levels of VOCs and SVOCs were detected in sediments in this segment of Dead Creek including fluoranthene (4,600 ppb), pyrene (4,500 ppb), benzo(a)anthracene (3,300 ppb), chrysene (4,400 ppb), benzo(b)fluoranthene (7,500 ppb), benzo(a)pyrene (4,500 ppb), indeno(1,2,3-cd pyrene (4,300 ppb), benzo(g,h,l) perylene (1,500 ppb), dibenzo(a,h)anthracene (4,000 ppb), and 4-methyl-2-pentanone (1,200 ppb). PCBs (total) were also detected in sediments from CS-C at a maximum concentration of 27,500 ppb. Sediment samples also revealed elevated levels of metals such as copper (17,200 ppm), lead (1,300 ppm), nickel (2,300 ppm), zinc (21,000 ppm) and mercury (2.81 ppm)

Surface water samples collected from creek segment CS-C revealed elevated levels of metals such as lead (710 ppb), mercury (1.9 ppb), and nickel (83 ppb).

CS-D: Elevated concentrations of VOCs and SVOCs were detected in sediment samples collected from CS-D including 4-methyl-2-pentanone (1,200 ppb), benzo(b)fluoranthene (500 ppb), indeno(1,2,3-cd)pyrene (310 ppb), and dibenzo(a,h)anthracene (360 ppb). PCBs (total) were detected in sediments at a maximum concentration of 2,000 ppb. Elevated concentrations of metals were also detected such as cadmium (42 ppm), copper (1,630 ppm), lead (480 ppm), mercury (1 ppm), and zinc (6,590 ppm).

Surface water samples collected from CS-D revealed elevated concentrations of metals such as cadmium (8.1 ppb), lead (89 ppb), and nickel (189 ppb).

CS-E: Elevated concentrations of VOCs and SVOCs were detected in sediment samples collected from CS-E including chlorobenzene (120 ppb), pyrene (5,300 ppb), benzo(b)fluoranthene (2,400 ppb), and chrysene (2,800 ppb). Elevated levels of PCBs (total) were also detected at a maximum concentration of 59,926 ppb. Elevated levels of metals were also detected in the sediments of CS-E including cadmium (23.1 ppm), copper (8,540 ppm), lead (1,270 ppm), mercury (1.53 ppm), nickel (2,130 ppm), and zinc (9,970 ppm).

CS-F: Elevated concentrations of VOCs and SVOCs were detected in the sediments of CS-F such as toluene (29 ppb), 4-methylphenol (1,100 ppb), fluoranthene (310 ppb), and pyrene (340 ppb). Pesticides were also detected in the sediments such as 4,4-DDE (97 ppb), endrin (66 ppb), endosulfan II (203 ppb), and methoxychlor (8 ppb). PCBs (total) were also detected in sediments at a maximum concentration of 5,348 ppb. Elevated levels of metals were also detected in the sediments such as arsenic (276 ppm), lead (199 ppm), mercury (.55 ppm), cadmium (23.5 ppm), copper (520 ppm) nickel (772 ppm) and zinc (4,520 ppm). Elevated concentrations of dioxins were also detected in sediments in CS-F at a maximum concentration of 211 picograms per gram.

Site M:Originally constructed as a sand borrow pit in the mid to late 1940's, this pit is approximately 59,200 square feet in size and previous investigations indicate that approximately 3,600 cubic yards of contaminated sediments are contained within the pit. It is estimated that the pit is approximately 14 feet deep and it is probable that there is a

hydraulic connection between this pit water and the underlying groundwater. Surface water samples collected from Site M revealed elevated levels of VOCs such as chloroform (27 ppb), toluene (19 ppb) and chlorobenzene (33 ppb). SVOCs detected in surface water included phenol (28 ppb), 2-chlorophenol (14 ppb), 2,4-dimethyl phenol (13 ppb), 2,4-dichlorophenol (150 ppb), and pentachlorophenol (120 ppb). Pesticides detected in surface water include dieldrin (0.18 ppb), endosulfan II (.06 ppb), 4,4-DDT (0.24 ppb), 2,4-D (47 ppb) and 2,4,5-TP (Silvex) (3.4 ppb). PCBs were also detected in surface water at a maximum level of 0.0044 ppb.

Sediment samples collected from Site M revealed elevated levels of VOCs such as 2-butanone (14,000 ppb), chlorobenzene (10 ppb) and ethyl benzene (0.82 ppb). SVOCs detected in sediments included 1,4-dichlorobenzene (40 ppm), 1,2-dichlorobenzene (26 ppm), 1,2,4-trichlorobenzene (14 ppm), pyrene (27 ppm), fluoranthene (21 ppm), chrysene (12 ppm), and benzo(b)fluoranthene (15 ppm). Total PCB levels were detected as high as 1,100 ppm. Elevated levels of metals were also detected in sediments at Site M, including antimony (41.2 ppm), barium (9,060 ppm), cadmium (47.2 ppm), copper (21,000 ppm), nickel (2,490 ppm), silver (26 ppm), zinc (31,600 ppm), lead (1,910 ppm), arsenic (94 ppm) and cyanide (1.3 ppm).

5. On information and belief, parties which generated wastes which were disposed of, released into and/or transported wastes to the Sauget Area One Site (including parties whose wastes migrated from various disposal areas into other Sites or segments of Dead Creek) include but are not limited to the following:

CS-A: Monsanto Company/Solutia, Incorporated; Cerro Copper Products Company; Amax Zinc Corporation; Mobil Oil Corporation; Ethyl Petroleum; Rogers Cartage; Sterling Steel Casting Co.; Darling Fertilizer, the Village of Sauget; Cardinal Construction Company; and Olin Corporation.

CS-B: Monsanto Company/Solutia, Incorporated; Midwest Rubber Reclaiming (Division of Empire Chemical Incorporated) and Midwest Rubber Trustees Stanley Keitman, Richard M. Cohen, and Morris Weissman; Cerro Copper Products Company; Mobil Oil Corporation; Rogers Cartage Co.; Sterling Steel Casting Co.; Darling Fertilizer; Ruan Transportation Corporation; and Waggoner & Company; Industrial Salvage Disposal, Inc.; Sauget and Company; Paul Sauget; and Olin Corporation.

CS-C, D, E, OR F: Monsanto Company/Solutia, Incorporated; Cerro Copper Products Company; Mobil Oil Company; Amax Zinc Corporation; Midwest Rubber reclaiming (Division of Empire Chemical Incorporated) and Midwest Rubber Trustees Stanley Keitman, Richard M. Cohen, and Morris Weissman; Ruan Transportation Corporation; Rogers Cartage Co.; Sterling Steel Casting Co.; Darling Fertilizer; and Waggoner & Company; Industrial Disposal, Inc.; Sauget and Company; and Paul Sauget.

Site M: Monsanto Corporation/Solutia, Incorporated; Waggoner & Company; and Ruan Transportation; Mobil Oil Corporation; Cerro Copper Products, Inc.; Midwest Rubber

Reclaiming (Division of Empire Chemical Incorporated) and Midwest Rubber Trustees Stanley Keitman, Richard M. Cohen, and Morris Weissman.

6. On January 21, 1999, EPA, Solutia and Monsanto entered into to an AOC pursuant to CERCLA Sections 104, 107 and 122 to conduct an RI/FS and EE/CA to investigate the nature and extent of contamination at the Sauget Area One site and develop and evaluate potential remedial alternatives. Work under that AOC is currently on-going.

7. Several of the culverts on Dead Creek are inadequately sized, blocked or partially blocked with debris and thereby cause storm water in Dead Creek to back up behind these culverts and, at times, overflow into surrounding residential areas.

8. Dead Creek and the areas surrounding the Creek are located within an area known as the American Bottoms which is the flood plain for the Mississippi River. The water table in this area is very close to the ground surface and during storm events the soils quickly become saturated. During these same storm events, water backing up behind blocked or inadequately sized culverts in Dead Creek overflows and increases the severity of flooding conditions for nearby residents in Sauget and Cahokia. Contaminants, including hazardous substances, in surface water, sediments, and surrounding soils may migrate via the overflow and flood waters onto the properties of neighboring residents.

9. In the summer of 1999, Solutia undertook a hydraulic study of the flooding problems related to Dead Creek. That study concluded that removal of sediments and debris from blocked and inadequately sized culverts would not provide a long term reduction of Dead Creek's flooding of residential areas and the associated risks from the migration of contaminated sediments.

10. Dead Creek sediments and soils are the major potential source of contamination in Dead Creek flood waters. Contaminated creek sediments and soils must be removed as soon as possible to eliminate the imminent and substantial threat of exposure to the contamination via direct contact by nearby residents and via flooding from Dead Creek. Preliminary ecological assessment data also indicates significant damage to aquatic organisms in Dead Creek.

11. The removal action required under this Order is consistent with the remedial action to be taken pursuant to the January 21, 1999, RI/FS AOC.

IV. CONCLUSIONS OF LAW AND DETERMINATIONS

Based on the Findings of Fact set forth above, and the Administrative Record supporting these removal actions, EPA determines that:

1. Dead Creek and the impacted areas adjacent to Dead Creek is a "facility" as defined by Section 101(9) Of CERCLA, 42 U.S.C. § 9601(9).

2. The substances described in Section III, paragraph 4 are "hazardous substances" as defined by Section 101(14) of CERCLA, 42 U.S.C. § 9601(14).

3. Each Respondent is a "person" as defined by Section 101(21) of CERCLA, 42 U.S.C. § 9601(21).

4. A title search conducted by Solutia, Inc. in February, 1999, found no records indicating that title to Dead Creek had ever been deeded.

5. The conditions described in the Findings of Fact above constitute an actual or threatened "release" of a hazardous substance from the facility into the "environment" as defined by Sections 101(8) and (22) of CERCLA, 42 U.S.C. §§ 9601(8) and (22).

6. The conditions present at the Site constitute an imminent and substantial threat to public health, welfare, or the environment based upon the factors set forth in Section 300.415(b)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan, as amended ("NCP"), 40 C.F.R. § 300.415(b)(2). These factors include, but are not limited to, the following:

A) Actual or potential exposure to hazardous substances or pollutants or contaminants by nearby populations or the food chain.

This condition exists at the Site due to the high levels of organic and inorganic contaminants found in the sediments and surface water of Dead Creek which is located in close proximity to local populations and could potentially be released into residential areas via flood waters caused by the shallow water table in the area and the presence of blocked or inadequately sized culverts. Some of the contaminants in Dead Creek are known carcinogens or suspect carcinogens. Contaminants present in Dead Creek and potentially migrating from Dead Creek via overflow and flood waters to nearby residential areas are accessible to humans, specifically the residents and children who live and play on these potentially affected properties. These individuals could potentially be exposed to the contamination by direct skin contact with the sediments, soils and surface water in or released from Dead Creek.

B) Weather conditions that may cause hazardous substances or pollutants to migrate or be released.

This factor is present at the Site due to the fact that high levels of organic and inorganic contaminants are located within the sediments, certain adjacent soils and surface waters of Dead Creek. This area of St. Clair County is particularly prone to flooding due to a very shallow groundwater table. Storm water backing up behind culverts exacerbates the flooding conditions in this area.

C) Availability of other appropriate federal or state response mechanisms to respond to the release.

The Illinois EPA currently does not have the available funds to respond to this time-critical situation. In addition, EPA is in the lead agency for enforcement actions related to the Sauget Area One Site.

7. The actual or threatened release of hazardous substances from the Site may present an imminent and substantial endangerment to the public health, welfare, or the environment within the meaning of Section 106(a) of CERCLA, 42 U.S.C. § 9606(a).

8. The removal actions required by this Order are necessary to protect the public health, welfare, or the environment, and are not inconsistent with the NCP and CERCLA.

V. ORDER

Based upon the foregoing Findings of Fact, Conclusions of Law, Determinations, and the Administrative Record for this Site, EPA hereby orders that Respondents perform the following actions:

1. Notice of Intent to Comply

Respondents shall notify in writing within three (3) business days after the effective date of this Order of Respondents' irrevocable intent to comply with this Order. Failure of each Respondent to provide such notification within this time period shall be a violation of this Order.

2. Designation of Contractor, Project Coordinator, and On-Scene Coordinator

Respondents shall perform the removal actions themselves or retain contractors to implement the removal actions. Respondents shall notify EPA of Respondents' qualifications or the name and qualifications of such contractors, whichever is applicable, within five (5) business days of the effective date of this Order. Respondents shall also notify EPA of the name and qualifications of any other contractors or subcontractors retained to perform work under this Order at least five (5) business days prior to commencement of such work. EPA retains the right to disapprove of the Respondents or any of the contractors and/or subcontractors retained by the Respondents. If EPA disapproves a selected contractor, Respondents shall retain a different contractor within two (2) business days following EPA's disapproval and shall notify EPA of that contractor's name and qualifications within three (3) business days of EPA's disapproval.

Within five (5) business days after the effective date of this Order, the Respondents shall designate a Project Coordinator who shall be responsible for administration of all the Respondents' actions required by the Order and submit the designated coordinator's name, address, telephone number, and qualifications to EPA. To the greatest extent possible, the

Project Coordinator shall be present on-site or readily available during site work. EPA retains the right to disapprove of any Project Coordinator named by the Respondents. If EPA disapproves a selected Project Coordinator, Respondents shall retain a different Project Coordinator within three (3) business days following EPA's disapproval and shall notify EPA of that person's name and qualifications within four (4) business days of EPA's disapproval. Receipt by Respondents' Project Coordinator of any notice or communication from EPA relating to this Order shall constitute receipt by all Respondents.

The EPA has designated Kevin Turner of the Emergency Response Branch, Region 5, as its On-Scene Coordinator ("OSC"). Respondents shall direct all submissions required by this Order to the OSC at 8588 Rt. 148, Marion, Illinois 62959, by certified or express mail. Respondents shall also send a copy of all submissions to Thomas Martin, Associate Regional Counsel, 77 West Jackson Boulevard (C-14J), Chicago, Illinois 60604-3590. All Respondents are encouraged to make their submissions to EPA on recycled paper (which includes significant post-consumer waste paper content where possible) and using two-sided copies.

3. Work to be Performed

Respondents shall perform, at a minimum, the following response activities:

A) Prepare a Time Critical Removal Action Work Plan (also referred to herein as "Work Plan") and implement the Removal Action in accordance with the Work Plan to mitigate the threats posed by presence of contamination in Dead Creek sediments and certain adjacent soils and their potential migration via overflow and flood waters from the Site, as described in Section III, "Findings of Fact" of this Order. As more specifically described below, this Work Plan shall provide for: 1) the removal of materials from CS-B (creek sediments, creek bed soils and flood plain soils); CS-C, D, and E (non-native creek sediments only); and Site M (pond sediments and pond bottom soils) in Sauget Area One, while minimizing adverse impacts to area wetlands and habitat; 2) the proper handling, dewatering, treatment and placement of such materials in the on-site Containment Cell; 3) a plan for management of Dead Creek storm water; 4) the sampling and analysis of areas where materials has been removed, for the purpose of defining remaining contamination; 5) the placement of membrane liner material over
CS-B and in all other excavated areas where, based on post removal sample results, such liner is determined to be necessary; and 6) a design for the Containment Cell which will provide adequate protection to human health and the environment.

B) Respondents' Work Plan shall describe the implementation of the following actions, including associated implementation schedules:

1. Sediment and Soils Removal Requirements

Respondents shall remove materials from CS-B (creek sediments, creek bed soils and flood plain soils); CS-C, D, and E (creek sediments only); and Site M (pond sediments and pond bottom pond soils) in Sauget Area One from Dead Creek and adjacent areas (collectively referred to as "materials") for disposal in the on-site Containment Cell. Such removal shall begin as soon as possible but no later than six months after the date of this Order. For the purposes of this Order, the approximate volumes of materials (both sediments and soils) to be removed and disposed of in the Cell are as follows:

CS-B and Site M contain an estimated volume of 25,500 cubic yards (cy) of metals and organic-containing sediment and soil:

CS-B sediment	2000ft L x 50 ft W x 2 ft D = 7,400 cy
CS-B creek bed soil	2000 ft L x 50 ft W x 1 ft D = 3,700 cy
CS-B flood plain soil	2000ft L x 100 ft W x 1 ft D = 7,400 cy
Site M sediment	64,000 sq ft x 1.6 ft = 3,500 cy
Site M pond bottom soil	64,000 sq ft x 1 ft = 3,500 cy

Total = 25,500 cy

CS-C, D and E contain an estimated volume of 24,400 cubic yards of metal and organic-containing sediment:

CS-C sediment	1400ft L x 50 ft W x 2 ft D = 5,200 cy
CS-D sediment	1200ft L x 50 ft W x 2 ft D = 4,400 cy
CS-E sediment	4000ft L x 50 ft W x 2 ft D = 14,800 cy

Total = 24,400 cy

The estimated volume of sediment and/or soil in CS-B and Site M is 25,500 cubic yards and CS-C, D and E contain an estimated volume of 24,400 cubic yards of sediment, a total of 49,900 cubic yards impacted sediment and soil. The above volumetric estimate for CS-B includes removal of one foot of creek bed soils and flood plain soils in addition to the sediments in CS-B. The estimate for Site M includes one foot of pond bottom soils in addition to the sediments. Only sediments are to be removed from CS-C, D, and E. In implementing such removal in CS-C, D and E, "sediments" shall be defined in accordance with the following criteria and procedure:

a. Four objective criteria shall be used to identify "sediment" subject to removal, as follows: criteria (i)-(iii) shall be employed to make the determination in the first instance; if application of these criteria are not determinant, then criteria (iv) shall be used. The OSC shall have the authority to require the use of criteria (iv) at any time during the project.

However, in any case, criteria (iv) shall be employed every 200 feet as a control on the application of criteria (i)-(iii).

b. The four criteria:

(i) Origin – non-native vs. native sediments

(ii) Stratigraphy – sediments/soil boundary

(iii) Color – sediment color versus creek bottom soil color

(iv) Physical Characteristics

* Unconfined compressive strength less than 500 pounds per square foot (psf)
* Torvane shear strength less than 200 pounds psf
* Moisture content greater than the liquid limit.
* Moisture content greater than 60 percent

2. Materials Handling, Dewatering, And Treatment Requirements

Once materials are removed from in and around CS-B, and from in CS-C, D, and E and Site M, Respondents shall, as necessary, dewater such materials, using one or more of the following dewatering methods:

* In-Situ Gravity Dewatering
* In-Situ Solidification
* On-Site Gravity Dewatering
* On-Site Solidification

At a minimum, dewatered materials shall pass the Paint Filter Test (as set out in 35 Illinois Administrative Code (IAC) § 724.414(c)) in the Containment Cell. A solidifying agent (meeting the requirements of 35 IAC § 724.414(e)) shall be added, if necessary, during compaction of the sediments in the Containment Cell in order to pass the Paint Filter Test.

3. Storm Water Management Requirements

During the project, Respondents shall divert storm water around CS-B work areas using temporary berms, sheet piling or similar diversion structures, or storm water may be pumped around these work areas and discharged downstream. Runoff from disturbed work areas shall be routed to a gravel and sand filter dam at the downstream end of CS-B and then discharged downstream.

During the project, Respondents shall hydraulically isolate Site M from Dead Creek by closing the opening between CS-B and the southwestern corner of Site M using compacted soil, sheet pile or other suitable method. Impounded water shall be routed to a gravel and sand filter dam at the downstream end of CS-B and then discharged downstream.

4. Excavated Area Soil Sampling

After the sediment and soils removal has taken place, Respondents shall collect soil samples from, at a minimum, all excavated areas of CS-B, C, D and E at 100 ft. intervals (to be referred to as "transects"), starting at the upstream end of the channel at Queeny Road and terminating near the downstream end of the channel at Route 3. Each creek transect, and sample location, shall be identified and numbered for reference purposes. Sampling at each creek transect shall occur at a frequency of no less than 3 samples per transect. Of the 3 samples, one shall be located at the transect center line and the other two shall be located equidistant to the center and the edge of the excavation area. Due to the fact that soils leaching to groundwater is the primary concern, bottom soil samples shall be extracted using TCLP and analyzed for Total Compound List/Total Analyte List (TCL/TAL) parameters and dioxin/furans.

Soil samples shall be collected from the bottom of Site M at 100 ft. grid intervals covering the entire excavated area. Pond bottom soils will be extracted using the TCLP and analyzed for TCL/TAL parameters and dioxin/furans.

5. Excavated Areas Bottom Liner Requirements

After excavation and sampling, Respondents shall properly install and maintain a 40 mil, HDPE liner in CS-B of Dead Creek. A liner shall be installed in other excavated areas of Site M and CS-C, D and E as determined to be necessary based on post-excavation sampling to isolate impacted soils from surface water. An overflow structure shall be installed to allow accumulated rainwater to discharge into CS-B.

6. Containment Cell Design Report Requirement

Respondents' Work Plan shall include a Containment Cell Design Report for the on-site cell. Such Design Report, upon approval, shall become an enforceable part of this Order. The Design Report shall address applicable requirements of 35 IAC § 724.401, including, at a minimum, the following:

* Above grade construction
* Construction on a 3 ft. thick, permeable capillary barrier drain sloped to a collection sump
* Water from the capillary barrier drain collection sump shall be discharged to the American Bottoms Publicly Owned Treatment Works (POTW)
* Installation of a Bentomat layer on top of the capillary barrier drain
* Double-lined cell
* 60 mil HDPE primary membrane

* 60 mil HDPE secondary membrane
* Sand and/or gravel leachate collection system above primary liner
* Leachate shall be treated, if necessary, and discharged to the American Bottoms POTW
* Geosynthetic leak detection system above secondary liner
* Groundwater monitoring program in compliance with the requirements set forth at 35 IAC § 724, Subpart F and 40 C.F.R. Part 264, Subpart F. Such program shall also monitor to establish background levels and detect potential leachate migration for, at a minimum, TCL/TAL parameters
* Storm water downchutes off cap designed to handle 25 year, 24 hour storm
* Slopes designed to resist failure and erosion as flood waters recede
* Gravel or equivalent armoring of potentially flooded slopes
* Gravel or equivalent cover to resist floating and erosion during flooding
* Air venting to prevent cell floating during flooding
* Cell design and air venting to prevent polychlorinated biphenol (PCB) releases into the air by way of dust, fumes or via hot weather vapors
* Construction in accordance with the Construction Quality Assurance Program requirements found at 35 IAC § 724.119, to the extent practicable.

In addition to including the requirements listed above, the Design Report shall, at a minimum, address the RCRA minimum technology requirements set forth in Exhibit 2, attached to this Order.

C) Mitigation Plan

Sixty days after the completion of the sediment and soils removal activities required by this Order, Respondents shall submit to EPA a Mitigation Plan which contains a detailed statement describing the steps Respondents have taken and are taking to ensure that the actions required by this Order are implemented in such a way as to avoid and/or minimize adverse impacts to area wetlands and habitat. Respondents' Mitigation Plan shall also provide for the replacement of all habitat and wetlands unavoidably lost in the implementation of the project. Specifically, Respondents' Mitigation Plan shall provide an accounting of all wetlands and habitat adversely affected by the project and the specific actions Respondents will take, and an associated schedule, to provide replacement of the value and function associated with such lost wetlands and habitat.

D) Operations and Maintenance Plan

Sixty days after the completion of the construction of the on-site Containment Cell, Respondents shall submit to EPA an Operation and Maintenance Plan for the Cell complying with the requirements set forth in 40 C.F.R. § 761.75(b)(8) and 40 C.F.R. § 264.303. In addition, such operation plan shall specify the following minimum Containment Cell waste acceptance criteria:

* Metal and organic containing sediments, creek bottom soil and flood plain soil from Area One only shall be placed in the Containment Cell.

* No liquids or incompatible wastes shall be placed in the Containment Cell.

* Material placed in the Containment Cell shall pass the Paint Filter Test.

* One sample shall be collected for every 5,000 cubic yards of material place in the Cell and analyzed for TCL/TAL parameters and dioxin/furans to characterize the material placed in the Containment Cell.

Respondents' Containment Cell Operation and Maintenance Plan shall include provisions for record keeping and closure/post-closure procedures for the Cell complying with the requirements set forth at 40 C.F.R. § 264.309 and § 264.310.

Respondents' Containment Cell Operation and Maintenance Plan shall include Groundwater Monitoring and Corrective Action Program Plans for the cell that comply with the requirements of 35 IAC § 724, Subpart F, and 40 C.F.R. Part 264, Subpart F.

3.1 Work Plan and Implementation

Within fifteen (15) business days after the effective date of this Order, the Respondents shall submit to EPA for approval a draft Time Critical Removal Action Work Plan for performing the removal activities set forth in Subsections V.3.B) 1., 2., 3., 4., 5. and 6. above. The draft Work Plan shall provide a description of, and an expeditious schedule for, the activities required by the above subsections.

EPA may approve, disapprove, require revisions to, or modify the draft Work Plan. If EPA requires revisions, Respondents shall submit a revised draft Work Plan within seven (7) business days of notification. Respondents shall implement the Work Plan as finally approved in writing by EPA in accordance with the schedule approved by EPA. Once approved, or approved with modifications, the Work Plan, the schedule, and any subsequent modifications shall be fully enforceable under this Order. Respondents shall notify EPA at least 48 hours prior to performing any on-site work pursuant to the EPA approved Work Plan.

Respondents shall not commence or undertake any removal actions at the Site without prior EPA approval.

3.2 Health and Safety Plan

Within fifteen (15) calendar days after approval of the Work Plan required by Section V.3.B) of this Order, the Respondents shall submit a Health and Safety Plan for EPA review and comment that ensures the protection of the public health and safety during performance of on-site work under this Order. This Plan shall comply with applicable Occupational Safety and Health Administration regulations found at 29 C.F.R. Part 1910. This Plan shall also include a description of Department of Transportation (DOT) requirements to be used for the disruption of vehicular traffic as a result of this action. If EPA determines it is appropriate, the Plan shall also include contingency planning.

Respondents shall incorporate all changes to the plan recommended by EPA, and implement the Plan during the pendency of the removal action.

3.3 Quality Assurance and Sampling

All sampling and analyses performed pursuant to this Order shall conform to EPA direction, approval, and guidance regarding sampling, quality assurance/quality control ("QA/QC"), data validation, and chain of custody procedures. Respondents shall ensure that the laboratory used to perform the analyses participates in a QA/QC program that complies with EPA guidance. Upon request by EPA, Respondents shall have such a laboratory analyze samples submitted by EPA for quality assurance monitoring. Respondents shall provide to EPA the quality assurance/quality control procedures followed by all sampling teams and laboratories performing data collection and/or analysis.

Upon request by EPA, Respondents shall allow EPA or its authorized representatives to take split and/or duplicate samples of any samples collected by Respondents or their contractors or agents while performing work under this Order. Respondents shall notify EPA not less than three (3) business days in advance of any sample collection activity. EPA shall have the right to take any additional samples that it deems necessary.

3.4 Reporting

Respondents shall submit a monthly written progress report to EPA concerning activities undertaken pursuant to this Order, beginning thirty (30) calendar days after the date of EPA's approval of the Work Plan, until termination of this Order, unless otherwise directed by the OSC. These reports shall describe all significant developments during the preceding period, including the work performed and any problems encountered, analytical data received during the reporting period, and developments anticipated during the next reporting period, including a schedule of work to be performed, anticipated problems, and planned resolutions of past or anticipated problems.

Any Respondent that owns any portion of the Site, and any successor in title shall, at least thirty (30) days prior to the conveyance of any interest in real property at the Site, give written notice of this Order to the transferee and written notice of the proposed conveyance to EPA and the State. The notice to EPA and the State shall include the name and address of the transferee. The party conveying such an interest shall require that the transferee will provide access as described in Section V.4. (Access to Property and Information).

3.5 Final Report

Within sixty (60) calendar days after completion of all removal actions required under this Order, including completion of the Containment Cell and the disposal of the materials subject to this Order in the Cell, the Respondents shall submit for EPA review a Final Report summarizing the actions taken to comply with this Order. The Final Report shall conform to the requirements set forth in Section 40 C.F.R. § 300.165. The Final Report shall also include a good faith estimate of total costs incurred in complying with the Order, a listing of quantities and types of materials removed, a

discussion of removal and disposal options considered for those materials, a listing of the ultimate destinations of those materials, a presentation of the analytical results of all sampling and analyses performed, and accompanying appendices containing all relevant documentation generated during the removal action (e.g., manifests, invoices, bills, contracts, and permits).

The Final Report shall also include the following certification signed by a person who supervised or directed the preparation of that report:

Under penalty of law, I certify that, to the best of my knowledge, after appropriate inquiries of all relevant persons involved in the preparation of this report, the information submitted is true, accurate, and complete.

4. Access to Property and Information

Respondents shall provide or obtain access as necessary to the Site and all appropriate off-site areas, and shall provide access to all records and documentation related to the conditions at the Site and the activities conducted pursuant to this Order. Such access shall be provided to EPA employees, contractors, agents, consultants, designees, representatives, and State of Illinois representatives. These individuals shall be permitted to move freely at the Site and appropriate off-site areas in order to conduct activities which EPA determines to be necessary. Respondents shall submit to EPA, upon request, the results of all sampling or tests and all other data generated by Respondents or their contractors, or on the Respondents' behalf during implementation of this Order. Respondents shall make all required notifications and obtain all necessary permits from the State and local DOT offices for conducting working within public roadways.

Where work under this Order is to be performed in areas owned by or in possession of someone other than Respondents, Respondents shall obtain all necessary access agreements within fourteen (14) calendar days after the effective date of this Order, or as otherwise specified in writing by the OSC. Respondents shall immediately notify EPA if, after using their best efforts, they are unable to obtain such agreements. Respondents shall describe in writing their efforts to obtain access. EPA may then assist Respondents in gaining access, to the extent necessary to effectuate the response activities described herein, using such means as EPA deems appropriate.

5. Record Retention, Documentation, Availability of Information

Respondents shall preserve all documents and information, in their possession or in the possession of their contractors, subcontractors or representatives, relating to the work performed under this Order, or relating to the hazardous substances found on or released from the Site, for six years following completion of the removal actions required by this Order. At the end of this six year period and at least sixty (60) days before any document or information is destroyed, Respondents shall notify EPA that such documents and information are available to EPA for inspection, and upon request, shall provide the originals or copies of such documents and information to EPA. In addition, Respondents shall provide document and information retained under this Section at any time before expiration of the six year period at the written request of EPA.

6. Off-Site Shipments

All hazardous substances, pollutants or contaminants removed off-site pursuant to this Order for treatment, storage or disposal shall be treated, stored, or disposed of at a facility in compliance as determined by EPA, with the EPA Off-Site Rule, 40 C.F.R. § 300.440.

7. Compliance With Other Laws

All actions required pursuant to this Order shall be performed in accordance with all applicable local, state, and federal laws and regulations except as provided in CERCLA Section 121(e) and 40 C.F.R. § 300.415(I). In accordance with 40 C.F.R. § 300.415(I), all on-site actions required pursuant to this Order shall, to the extent practicable, as determined by EPA, considering the exigencies of the situation, attain applicable or relevant and appropriate requirements under federal environmental or state environmental or facility siting laws. EPA has determined that creek segments B, C, D, E and Site M along with the proposed TSCA cell are within the same Area of Concern (AOC) and therefore the consolidation of waste material within the cell, as described in this Order, does not invoke any of the Land Disposal Restrictions (LDRs) under RCRA.

8. Emergency Response and Notification of Releases

If any incident, or change in Site conditions, during the activities conducted pursuant to this Order causes or threatens to cause an additional release of hazardous substances from the Site (including the Containment Cell) or an endangerment to the public health, welfare, or the environment, the Respondents shall immediately take all appropriate action to prevent, abate or minimize such release, or endangerment caused or threatened by the release. Respondents shall also immediately notify the OSC or, in the event of his/her unavailability, shall notify the Regional Duty Officer, Emergency Response Branch, Region 5 at (312) 353-2318, of the incident or Site conditions.

Respondents shall submit a written report to EPA within seven (7) business days after each release, setting forth the events that occurred and the measures taken or to be taken to mitigate any release or endangerment caused or threatened by the release and to prevent the reoccurrence of such a release. Respondents shall also comply with any other notification requirements, including those in CERCLA Section 103, 42 U.S.C. § 9603, and Section 304 of the Emergency Planning and Community Right-To-Know Act, 42 U.S.C. § 11004.

VI. AUTHORITY OF THE EPA ON-SCENE COORDINATOR

The OSC shall be responsible for overseeing the implementation of this Order. The OSC shall have the authority vested in an OSC by the NCP, including the authority to halt, conduct, or direct any work required by this Order, or to direct any other response action undertaken by EPA or Respondents at the Site. Absence of the OSC from the Site shall not be cause for stoppage of work unless specifically directed by the OSC.

EPA and Respondents shall have the right to change their designated OSC or Project Coordinator. EPA shall notify the Respondents, and Respondents shall notify EPA, as early as possible before such a change is made, but in no case less than 24 hours before such a change. Notification may initially be made orally, but shall be followed promptly by written notice.

VII. PENALTIES FOR NONCOMPLIANCE

Violation of any provision of this Order may subject Respondents to civil penalties of up to $27,500 per violation per day, as provided in Section 106(b)(1) of CERCLA, 42 U.S.C. § 9606(b)(1). Respondents may also be subject to punitive damages in an amount up to three times the amount of any cost incurred by the United States as a result of such violation, as provided in Section 107(c)(3) of CERCLA, 42 U.S.C. § 9607(c)(3). Should Respondents violate this Order or any portion hereof, EPA may carry out the required actions unilaterally, pursuant to Section 104 of CERCLA, 42 U.S.C. § 9604, and/or may seek judicial enforcement of this Order pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606.

VIII. REIMBURSEMENT OF COSTS

Respondents shall reimburse EPA, upon written demand, for all response costs incurred by the United States in overseeing Respondents' implementation of the requirements of this Order.

EPA may submit to Respondents on a periodic basis a bill for all response costs incurred by the United States with respect to this Order. EPA's Itemized Cost Summary, or such other summary as certified by EPA, shall serve as the basis for payment.

Respondents shall, within (30) days of receipt of the bill, remit a cashier's or certified check for the amount of those costs made payable to the "Hazardous Substance Superfund," to the following address:

U.S. Environmental Protection Agency
Superfund Accounting
P.O. Box 70753
Chicago, IL 60673

Respondents shall simultaneously transmit a copy of the check to the Director, Superfund Division, U.S. EPA Region 5, 77 West Jackson Blvd., Chicago, Illinois 60604-3590. Payments shall be designated as "Response Costs – Sauget Area One Dead Creek Sediment Removal" and shall reference the payers' names and addresses, the EPA Site Identification Number (054V), and the docket number of this Order.

Interest at a rate established by the Department of the Treasury pursuant to 31 U.S.C. § 3717 and 40 C.F.R. § 102.13 shall begin to accrue on the unpaid balance from the day after the expiration of the 30 day period notwithstanding any dispute or an objection to any portion of the costs.

IX. RESERVATION OF RIGHTS

Nothing herein shall limit the power and authority of EPA or the United States to take, direct, or order all actions necessary to protect public health, welfare, or the environment or to prevent, abate, or minimize an actual or threatened release of hazardous substances, pollutants or contaminants, or hazardous or solid waste on, at, or from the Site. Further, nothing herein shall prevent EPA from seeking legal or equitable relief to enforce the terms of this Order. EPA also reserves the right to take any other legal or equitable action as it deems appropriate and necessary, or to require the Respondents in the future to perform additional activities pursuant to CERCLA or any other applicable law.

X. OTHER CLAIMS

By issuance of this Order, the United States and EPA assume no liability for injuries or damages to persons or property resulting from any acts or omissions of Respondents. The United States or EPA shall not be a party or be held out as a party to any contract entered into by the Respondents or their directors, officers, employees, agents, successors, representatives, assigns, contractors, or consultants in carrying out activities pursuant to this Order.

This Order does not constitute a pre-authorization of funds under Section 111(a)(2) of CERCLA, 42 U.S.C. § 9611(a)(2).

Nothing in this Order constitutes a satisfaction of or release from any claim or cause of action against the Respondents or any person not a party to this Order, for any liability such person may have under CERCLA, other statutes, or the common law, including but not limited to any claims of the United States for costs, damages and interest under Sections 106(a) or 107(a) of CERCLA, 42 U.S.C. §§ 9606(a) or 9607(a).

XI. MODIFICATIONS

Modifications to any plan or schedule may be made in writing by the OSC or at the OSC's oral direction. If the OSC makes an oral modification, it will be memorialized in writing within seven (7) business days; however, the effective date of the modification shall be the date of the OSC's oral direction. The rest of the Order, or any other portion of the Order, may only be modified in writing by signature of the Director, Superfund Division, Region 5.

If Respondents seek permission to deviate from any approved plan or schedule, Respondents' Project Coordinator shall submit a written request to EPA for approval outlining the proposed modification and its basis.

No information advice, guidance, suggestion, or comment by EPA regarding reports, plans, specifications, schedules, or any other writing submitted by the Respondents shall relieve Respondents or their obligations to obtain such formal approval as may be required by this Order, and to comply with all requirements of this Order unless it is formally modified.

XII. NOTICE OF COMPLETION

After submission of the Final Report, Respondents may request that EPA provide a Notice of Completion of the work required by this Order. If EPA determines, after EPA's review of the Final Report, that all work has been fully performed in accordance with this Order, except for certain continuing obligations required by this Order (e.g., record retention), EPA will provide written notice to the Respondents. If EPA determines that any removal activities have not been completed in accordance with this Order, EPA will notify the Respondents, provide a list of the deficiencies, and require that Respondents modify the Work Plan to correct such deficiencies. The Respondents shall implement the modified and approved Work Plan and shall submit a modified Final Report in accordance with the EPA notice. Failure to implement the approved modified Work Plan shall be a violation of this Order.

XIII. ACCESS TO ADMINISTRATIVE RECORD

The Administrative Record supporting these removal actions is available for review during normal business hours in the EPA Record Center, Region 5, 77 W. Jackson Blvd., Seventh Floor, Chicago, Illinois. Respondents may contact Thomas Martin, Associate Regional Counsel, at (312) 886-4273 to arrange to review the Administrative Record. An index of the Administrative Record is attached to this Order as Exhibit 3.

XIV. OPPORTUNITY TO CONFER

Within three (3) business days after issuance of this Order, Respondents may request a conference with EPA. Any such conference shall be held within five (5) business days from the date of the request, unless extended by agreement of the parties. At any conference held pursuant to the request, Respondents may appear in person or be represented by an attorney or other representative.

If a conference is held, Respondents may present any information, arguments or comments regarding this Order. Regardless of whether a conference is held, Respondents may submit any information, arguments or comments (including justifications for any assertions that the Order should be withdrawn against a Respondent), in writing to EPA within two (2) business days following the conference, or within seven (7) business days of issuance of the Order if no conference is requested. This conference is not an evidentiary hearing, does not constitute a proceeding to challenge this Order, and does not give Respondents a right to seek review of this

Order. Requests for a conference shall be directed to Thomas Martin, Associate Regional Counsel, at (312) 886-4273. Written submittals shall be directed as specified in Section V.2 of this Order.

XV. SEVERABILITY

If a court issues an order that invalidates any provision of this Order or finds that Respondents have sufficient cause not to comply with one or more provisions of this Order, Respondents shall remain bound to comply with all provisions of this Order not invalidated by the court's order.

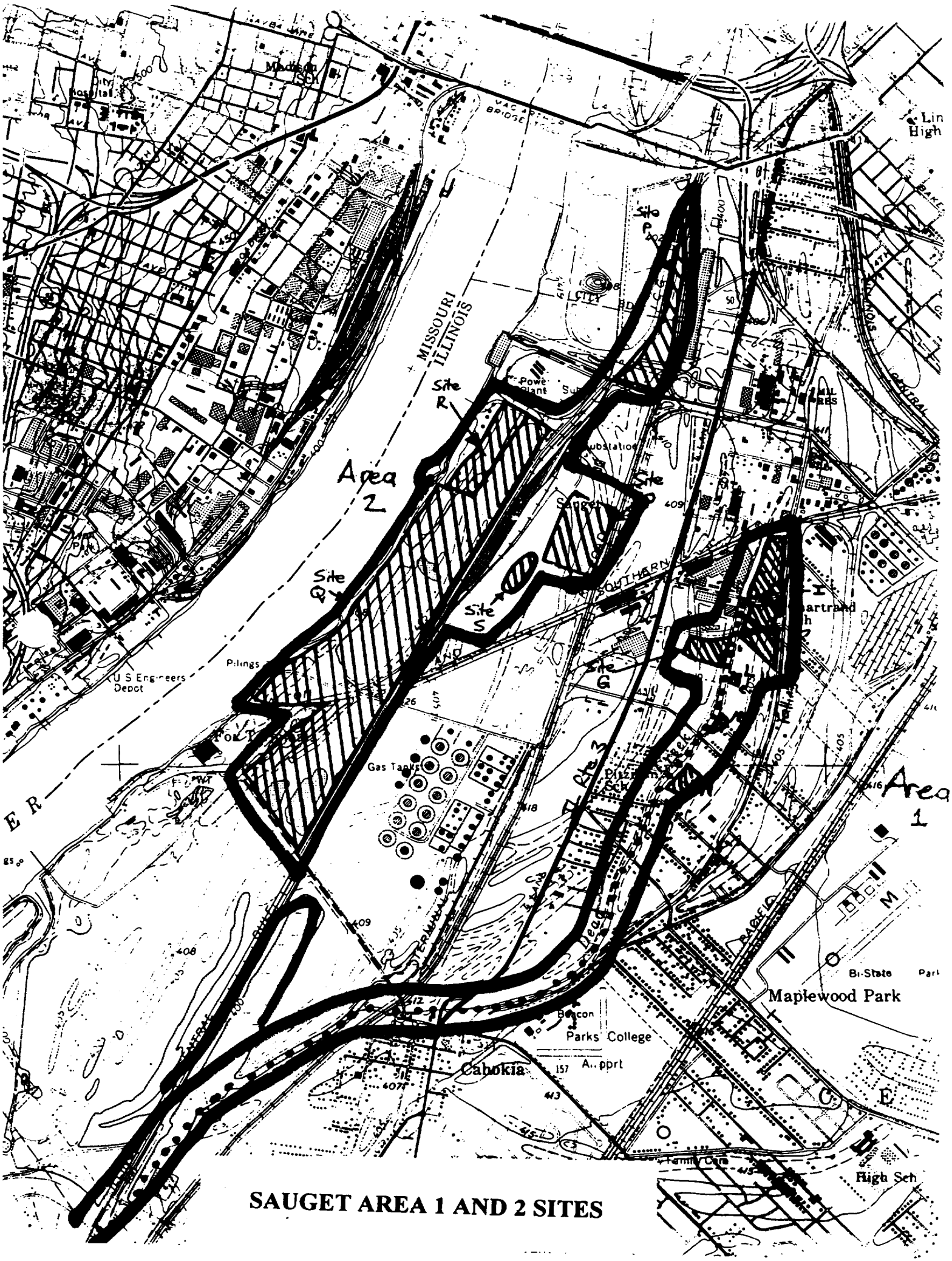
XVI. EFFECTIVE DATE

This Order shall be effective ten (10) business days following issuance unless a conference is requested as provided herein. If a conference is requested, this Order shall be effective five (5) business days after the day of the conference.

IT IS SO ORDERED

BY: _____ DATE: May 31, 2000

for William Muno, Director
Superfund Division
United States Environmental Protection Agency
Region 5



SAUGET AREA 1 AND 2 SITES

Exhibit 2

1. DESIGN, CONSTRUCTION, AND OPERATION REQUIREMENTS FOR CONTAINMENT CELL

a. SEDIMENT DESCRIPTION:

Provide a list of all constituents found in CS-B, C, D and E and Site M sediments and soils placed or to be placed in the Containment Cell.

b. LINER SYSTEM:

Provide a discussion of the following items which apply to the liner system as a whole.

Liner System Description:

Provide a description of the liner system, demonstrating (by description and drawings) that any flow of liquids into and through the liner(s) will be prevented. For each liner within the system (defined as a minimum of one synthetic liner and one soil liner) describe the type of liner, its material and its thickness. The liner system includes the liner foundation, bottom soil or composite liner, leachate detection system, top synthetic liner, leachate collection system and any protective layer placed to protect the leachate collection system from damage and clogging.

Liner System Location Relative to High Water Table:

Provide data showing seasonal fluctuations in the depth of the water table and the location of the seasonal high water table in relation to the base of the liner system. Groundwater levels and liner foundation elevations should be shown on geological cross sections.

Loads on Liner System:

Provide the results of calculations defining the minimum loads or stresses which will be placed on the liner system considering:

* Internal and external pressure gradients;
* Stresses resulting from settlement, compression or uplift;
* Both static and dynamic loads;
* Stresses due to installation or construction operations;
* Stresses resulting from operating equipment; and
* Stresses due to the maximum quantity of waste, cover, and proposed post-closure land use.

Liner System Coverage:

Demonstrate that the liner system will be installed to cover all surrounding earth likely to be in contact with the waste or leachate (i.e., construction, as built, or detailed drawings).

Liner System Exposure Prevention:

Demonstrate that the liner system will not be exposed to wind or sunlight or, if exposure of any part of the system is to be permitted, that such exposure will not result in unacceptable degradation of that portion of the system (i.e., drawings and/or liner specifications as appropriate). If the liner system will be exposed, provide calculations defining the stresses on the liner system due to thermal expansion and contraction.

c. **FOUNDATION:**

Foundation Description:

Describe the foundation for the liner system, including the foundation materials and indicate bearing elevations on geological and construction drawings. Indicate any load bearing embankments placed to support the liner system.

Subsurface Exploration Data:

The engineering characteristics of the liner system foundation materials, including subsurface soil, bedrock and hydrogeologic conditions, should be verified through subsurface explorations. These efforts should be fully described by including location plans and cross sections for test borings, test pits, etc., and explanations or references for the procedures used, and may include:

* Historical data;
* Test borings;
* Test pits or trenches;
* In situ tests; and/or
* Geophysical exploration.

Laboratory Testing Data:

Results from sufficient index testing must be provided to classify the site materials. Other lab test data should be provided to evaluate the engineering properties of the foundation materials, particularly for strength, hydraulic conductivity, compressibility (consolidation), and other important design parameters. Provide copies of the test methods used to test the material or provide references, as appropriate and with any revisions, to standard test procedures. ASTM, EPA or

other appropriate standard methods should be used when available. Contact Illinois EPA Division of Land Pollution Control for Agency approved hydraulic conductivity testing methods.

d. ENGINEERING ANALYSES:

Engineering analyses should be provided which are based on the data gathered through subsurface exploration and laboratory testing programs. Include a discussion of the methods used, assumptions, copies of calculations and appropriate references. This discussion may include:

* Settlement potential;
* Bearing capacity;
* Stability of the landfill slopes (cut or constructed);
* Potential for excess hydrostatic or gas pressure;
* Seismic conditions;
* Subsidence potential; and
* Sinkhole potential.

Settlement Potential:

Provide estimates of the total and differential settlement of the liner system foundation, including immediate settlement, primary consolidation and secondary consolidation. When performing the analyses, consider the stresses imposed by liners and the applicable stresses computed in the "Loads on Liner System" in subsection 1.b., above.

Bearing Capacity:

Provide an analysis of the allowable bearing capacity of the liner system foundation. Compare the allowable bearing capacity to the required bearing capacity based on the loads imposed by the liner system and the applicable loads computed loads on liner system.

Stability of Landfill Slopes:

Provide, as appropriate, analyses of the stability of:

* Excavated slopes for units or portions of units constructed below grade;
* Embankment slopes for units constructed with earthen dikes or berms to support the liner system or contain the waste; and
* Cell slopes consisting of the liner system or cover system placed on the waste.

Include in the analyses both static and dynamic cases.

Potential for Excess Hydrostatic or Gas Pressure:

Provide estimates of the potential for bottom heave or blow-out of the liner system due to unequal hydrostatic or gas pressure.

e. **SYNTHETIC LINERS:**

For each synthetic liner in the system provide the following general information:

* Thickness;
* Type;
* Material;
* Brand name; and
* Manufacturer.

Provide data for all synthetic liners under consideration.

Provide detailed synthetic liner material specifications.

Synthetic Liner Compatibility Data:

Provide information demonstrating liner compatibility with constituents found in CS-B, C, D, and E, and Site M.

Synthetic Liner Strength:

Provide data showing that the synthetic liners have sufficient strength to support the loads/stresses including tensile stresses resulting from settlement. Also demonstrate that the liner seams will have sufficient strength.

Synthetic Liner Bedding:

Demonstrate that sufficient bedding will be provided above and below the synthetic liners to prevent rupture of the synthetic liner during installation and operation (i.e., thickness and gradation). Note: The synthetic membrane of a bottom composite liner should be placed directly on the soil portion.

f. **GEOCOMPOSITE LINER (GCL):**

Provide a description of the liner.

Material Testing Data:

Provide information on the permeability, strength and shrink swell properties of the liner material.

GCL Liner Compatibility Data:

Provide information that demonstrates compatibility of GCL liners with constituents found in CS-B, C, D and E and Site M.

GCL Liner Strength:

Demonstrate that the GCL liner has sufficient strength to support the computed loads/stresses.

g. LINER SYSTEM, LEACHATE COLLECTION AND DETECTION SYSTEM:

Note: The leachate collection system is located above the top synthetic liner in the liner system and the leachate detection system is located between the liners in the liner system.

Provide the following information about the leachate collection/detection systems (also provide detailed material specifications):

System Operation and Design:

Describe the design features of the leachate collection and removal system and how the system will function to remove collected leachate in a timely manner. Describe the design features of the leachate detection system and how the system will function to detect any leakage through either liner in a timely manner. Describe how liquid can be removed from the leachate detection system. Describe any protective layer placed over the leachate collection system to protect it from damage caused by the sediment or placement operations.

Equivalent Capacity:

For leachate collection/detection systems which use synthetic drainage material to replace the granular drainage material, demonstrate that the proposed system has a drainage capacity (transmissivity), both in speed and volume, that is equal to or better than a 12-inch thick granular drainage layer that has a hydraulic conductivity of 1 x 10-2 cm/sec.

Grading and Drainage:

Indicate the slopes of the leachate collection/detection systems and provide a contour plan for the system along with a plan showing the layout and spacing of the piping system. For systems with slopes of less than 2%, demonstrate that the proposed system will drain as well as one with a minimum of 2% slopes (i.e., through the use of an alternative design). Provide complete details of the piping system along with any sumps, pumps, etc., used to collect, hold, and transport the leachate. Indicate the fate of the collected leachate. Demonstrate that the leak detection system (located between the liners) is appropriately graded to assure that leakage at any point in the liner system is detected in a timely manner.

Demonstrate that the pipe and pipe perforations are sized sufficiently to handle the expected flow of leachate. For design of the leachate detection system (located between the liners) provide sufficient piping to provide for rapid and timely detection of any leakage. The leachate detection system sumps must be separate from the leachate collection system sumps and provided with provisions for measuring the quantity of collected leachate or leakage.

Maximum Leachate Head:

Describe and demonstrate that the design and operating features will prevent the leachate depth over the top of the primary liner from exceeding one foot (i.e., one foot above the uppermost liner). Provide copies of calculations along with a justification of the assumed parameters and of the numerical technique used.

System Compatibility:

Provide information on the compatibility of the leachate collection/detection systems with the constituents found in CS-B, C, D and E, and Site M waste managed in the Containment Cell and the leachate expected to be generated.

Stability of Drainage Layers:

Demonstrate that the drainage layers of the leachate collection/detection systems have sufficient strength to support the computed loads and stresses (i.e., sufficient soil bearing capacity to support loads). Demonstrate by providing calculations that the drainage layer to be placed on sloped surfaces of the Cell or foundation will be stable during construction.

Strength of Piping:

Demonstrate that the pipe used in the piping systems has sufficient strength (crushing or deflection, as appropriate) to support the computed loads.

Prevention of Clogging:

Demonstrate that the leachate collection/detection systems are designed and operated to prevent clogging (due to piping) of the drainage layer material or the pipes throughout the active life of the Containment Cell. Consideration must be given to physical, chemical, and/or biological clogging. As an alternative, describe how clogging would be detected and what cleanup procedures would be used to restore the capacity of the systems. Include calculations demonstrating the effectiveness of the protection material or system.

h. LINER SYSTEM, CONSTRUCTION AND MAINTENANCE:

1. Material Specifications

Synthetic Liner Specifications:

Provide detailed material specifications for the specific synthetic liner or liners to be used.

GCL Liner Specifications:

Provide detailed material specifications for the GCL to be used.

Leachate Collection/Detection System:

Provide material specifications for:

* Drainage layer material;
* Filter fabric or filter layer;
* Piping; and
* Sumps.

2. Construction Specifications

Liner System Foundation:

For installed foundations, provide construction specifications of the foundation installation procedures. For units which use in-place material for the liner system foundation, provide construction specifications for preparation of the liner system foundation.

GCL Liner:

Describe the procedures for installing the GCL liner.

* Inspection of the synthetic liner bed for material which could puncture the liner (and removal of that material);
* Placement procedures;
* Techniques to be utilized to bond the liner seams; and
* Procedures for protection of the liner before and during placements of material on top of the liner.

Synthetic Liners:

Provide construction specifications for placement of the synthetic liners which include:

* Inspection of the synthetic liner bed for material which could puncture the liner (and removal of that material);
* Placement procedures;
* Techniques to be utilized to bond the liner seams; and
* Procedures for protection of the liner before and during placement of material on top of the liner.

Leachate Collection/Detection System:

Provide construction specifications for placement of all components of the leachate collection/detection system, including:

* Drainage layers;
* Piping;
* Sumps, pumps, etc.;
* Filter layers; and
* Any protective layer placed to protect the system during construction or operation.

i. CONSTRUCTION QUALITY CONTROL PROGRAM:

Provide complete details of the quality control program to be used during construction of the liner system to assure that it is built as designed. Include a description of all testing procedures such as testing of the synthetic liner seams. Indicate if the owner or the contractor will perform the testing and inspection and indicate the necessary qualifications of the testing and inspection personnel. The applicant should refer to the U.S. EPA Technical Guidance Document entitled "Construction Quality Assurance for Hazardous Waste Land Disposal Facilities", EPA/530-SW-031 and to the Construction Quality Assurance Program found in 724.119.

j. MAINTENANCE PROCEDURES FOR LEACHATE COLLECTION/DETECTION SYSTEM:

Describe the anticipated maintenance activities that will be used to assure proper operation of the leachate collection/detection systems throughout the Containment Cell's expected life.

k. LINER REPAIRS DURING OPERATION:

Describe the methods that will be used to repair any damage to the liner which occurs while the Cell is in operation during placement of the waste (e.g., a bulldozer ripping the liner).

l. RUN-OFF CONTROL SYSTEMS:

Describe the run-off control system to be used to collect and control run-off from active portions of the Cell.

Design and Performance:

Describe the run-off collection and control system design. Provide calculations demonstrating that the system has sufficient capacity to collect and hold the total run-off volume. Provide a plan view showing the locations of the run-off control system components, along with sufficient drawing details and cross sections. Indicate the fate of the collected run-off.

Calculation of Peak Flow:

Identify the total run-off volume expected to result from at least a 24-hour, 25-year storm. Describe data sources and methods used to make the peak flow calculation. Provide copies of the calculations and data, including appropriate references.

Management of Collection and Holding Units:

Describe how collection and holding facilities associated with run-on and run-off control systems will be emptied or otherwise managed expeditiously after storms to maintain system design capacity. Describe the fate of liquids discharged from these systems.

Construction:

Provide detailed construction and material specifications for the run-off control systems. Include descriptions of the construction quality control program that will be utilized to assure that construction is in accordance with design requirements.

Maintenance:

Describe any maintenance activities required to assure continued proper operation of the run-off control systems throughout the active life of the unit.

Control of Wind Dispersal:

If the Containment Cell contains any particulate matter which may be subject to wind dispersal, describe how the Cell is covered or otherwise managed to control wind dispersal.

2. CLOSURE AND POST-CLOSURE REQUIREMENTS

a. CLOSURE REQUIREMENTS:

1. Closure Plans:

Include a written closure plan including a description of the final cover to be established and its expected performance. Describe how the closure plan provided minimizes the need for post-closure maintenance and minimizes releases of wastes and hazardous constituents.

2. Closure Performance Standard:

Describe how the closure plan provided minimizes the need for post-closure maintenance and minimizes releases of wastes and hazardous constituents.

3. Cover Design:

The cover design and installation procedures should be thoroughly described. This submission should include:

* Drawings showing cover layers, thicknesses, slopes and overall dimensions;
* The common name, species and variety of the proposed cover crop;
* Descriptions of synthetic liners to be used, including chemical properties, strength, thickness and manufacturer's specifications;
* Description of rationale for cover selection;
* Descriptions of and specifications for protective materials placed above and below synthetic liners; and,
* GCL liner characteristics.

4. Minimization of Liquid Migration

For all cover designs provide engineering calculations showing that the proposed cover will provide long-term minimization of liquid migration through the cover.

5. Maintenance Needs:

Demonstrate that the cover system will function effectively with minimum maintenance needs.

6. Drainage and Erosion:

Provide the following information:

* Data demonstrating that the proposed final slopes will not cause significant cover erosion;
* Descriptions of drainage materials and their hydraulic conductivities;
* Engineering calculations demonstrating free drainage of precipitation off of and out of the cover; and
* Estimation of the potential for drainage-layer clogging.

7. Settlement and Subsidence:

Describe potential cover settlement and subsidence, considering immediate settlement, primary consolidation, secondary consolidation, and creep and liquefaction. Include the following information:

* Potential foundation compression;
* Potential soil liner compression; and
* Potential waste consolidation and compression resulting from waste dewatering, biological oxidation and chemical conversion of solids to liquids.

Describe the effects of potential subsidence/settlement on the ability of the final cover to minimize infiltration.

8. Freeze/Thaw Effects:

Identify the average depth of frost penetration and describe the potential effects of freeze/thaw cycles on the cover.

b. POST-CLOSURE REQUIREMENTS:

1. Post-Closure Plan:

Submit a copy of the post-closure plan.

2. Inspection Plan:

Describe the inspections to be conducted during the post-closure care period, their frequency, the inspection procedure, and the logs to be kept. The following items, as applicable, should be included in the inspection plan:

* Security control devices;
* Erosion damage;
* Cover settlement, subsidence and displacement;
* Vegetative cover condition;
* Integrity of run-on and run-off control measures;
* Cover drainage system functioning;
* Leak detection system;
* Leachate collection and removal system;
* Gas venting system;
* Well condition; and
* Benchmark integrity.

Provide the rationale for determining the length of time between inspections.

3. Post-Closure Monitoring Plan:

Describe the monitoring to be conducted during the post-closure care period, including, as applicable, the procedures for conducting and evaluating the data gathered from:

* Groundwater monitoring;
* Leachate collection and removal; and
* Leak detection between liners.

4. Post-Closure Maintenance Plan:

Describe the preventive and corrective maintenance procedures, equipment requirements and material needs. Include the following items in the maintenance plan, as applicable:

* Repair of security control devices;
* Erosion damage repair;
* Correction of settlement, subsidence and displacement;

* Mowing, fertilization and other vegetative cover maintenance;
* Repair of run-on and run-off control structures
* Leachate removal system maintenance; and
* Well replacement.

Describe the rationale to be used to determine the need for corrective maintenance activities.

5. Notice in Deed and Certification:

Existing facilities must submit a copy of the notice or notation recorded in the deed to the facility property, or on some other instrument which is normally examined during title search, that will in perpetuity notify any potential purchaser of the property that: (1) the land has been used to manage hazardous wastes; (2) its use is restricted; and (3) the survey plat and record of the type, location, and quantity of hazardous wastes disposed of within each cell or area of the facility has been filed with the County Recorder, to any local zoning authority or the authority with jurisdiction over local land use and with the Illinois EPA. For hazardous wastes disposed prior to January 12, 1981, identify the type, location and quantity of the hazardous waste to the best of the owner or operator's knowledge and in accordance with any records the owner or operator has kept. Submit a certification to the Illinois EPA, signed by the owner or operator, that the owner or operator has properly recorded this certification.

AR

EXHIBIT 3

U.S. ENVIRONMENTAL PROTECTION AGENCY
REMOVAL ACTION

ADMINISTRATIVE RECORD
FOR
SAUGET AREA 1
DEAD CREEK SEDIMENT REMOVAL SITE
CAHOKIA AND SAUGET, ILLINOIS

ORIGINAL
MAY 25, 2000

NO.	DATE	AUTHOR	RECIPIENT	TITLE/DESCRIPTION	PAGES
1	00/00/00	Illinois EPA	U.S. EPA	Area 1 Screening Site Inspection Report	306
2	00/00/87	Weston-SPER	U.S. EPA	Removal Action Plan for the Dead Creek Sites	18
3	00/00/88	Ecology and Environment, Inc.	U.S. EPA	Expanded Site Investigation Report for the Dead Creek Project Sites	1019
4	00/00/92	Geraghty & Miller,	U.S. EPA	Site Investigations Report for Dead Creek Segment B and Sites L and M	498
5	08/24/94	USDHHS/USPHS/ Agency for Toxic Substances and Disease Registry	U.S. EPA	ATSDR Health Report	22
6	00/00/98	Ecology and Environment, Inc.	U.S. EPA	Data Tables/Maps for the Sauget Area 1 and 2 Sites	759
7	00/00/99	URS Greiner/ Woodward Cycle	U.S. EPA	Hydrologic and Hydraulic Analysis of Dead Creek	212
8	06/09/99	Turner, K., U.S. EPA	Muno, W., U.S. EPA	Action Memorandum: Determination of Threat to Public Health, Welfare, or the Environment at the Sauget Area 1 Dead Creek Superfund Site [Culvert Replacement] (PORTIONS OF THIS DOCUMENT HAVE BEEN REDACTED)	11
9	11/08/99		U.S. EPA	Alternatives Analysis for Dead Creek Sediment Removal	27
10	01/05/00		U.S. EPA	Supplement to the Alter-tives Analysis for Dead Creek Sediment Removal	23

NO.	DATE	AUTHOR	RECIPIENT	TITLE/DESCRIPTION	PAGES
11	02/24/00		U.S. EPA	Letter re: Substantial Compliance with Toxic Substances Control Act	1
12	00/00/00	Turner, K., U.S. EPA	Muno, W., U.S. EPA	Action Memorandum: Determination of Threat to Public Health, Welfare, or the Environment at the Sauget Area 1 Dead Creek Superfund Site **(PENDING)**	

Appendix 2

Village of Sauget Groundwater Use Ordinance

ORDINANCE NO. 99-5

AN ORDINANCE PROHIBITING THE USE OF GROUNDWATER AS A POTABLE WATER SUPPLY BY THE INSTALLATION OR USE OF POTABLE WATER SUPPLY WELLS OR BY ANY OTHER METHOD

WHEREAS, certain properties in the Village of Sauget, Illinois, have been used over a period of time for commercial/industrial purposes; and

WHEREAS, because of said use, concentrations of certain chemical constituents in the groundwater beneath the Village may exceed Class I groundwater quality standards for potable resource groundwater, as set forth in 35 Illinois Administrative Code Part 620, or Tier 1 residential remediation objectives, as set forth in 35 Ill. Adm. Code Part 742; and

WHEREAS, the Village of Sauget desires to limit potential threats to human health from groundwater contamination while facilitating the redevelopment and productive use of properties that are the source of said chemical constituents;

NOW, THEREFORE, BE IT ORDAINED BY THE VILLAGE COUNCIL IN THE VILLAGE OF SAUGET, ILLINOIS:

Section One: Use of groundwater as a potable water supply prohibited.

The use or attempted use of groundwater from within the corporate limits of the Village as a potable water supply by the installation or drilling of wells or by any other method is hereby prohibited.

Section Two: Penalties

Any person violating the provisions of this ordinance shall be subject to a fine of up to $100.00 for each violation.

Section Three: Definitions.

"Person" is any individual, partnership, co-partnership, firm, company, limited liability company, corporation, association, joint stock company, trust, estate, political subdivision, or any other legal entity, or their representatives, agents or assigns.

"Potable water" is any water used for human or domestic consumption, including, but not limited to, water used for drinking, bathing, swimming, washing dishes, or preparing foods.

Section Four: Repealer.

All ordinances or parts of ordinances in conflict with this ordinance are hereby repealed insofar as they are in conflict with this ordinance.

Section Five: Severablity.

If any provision of this ordinance or its application to any person or under any circumstances is adjudged invalid, such adjudication shall not affect the validity of the ordinance as a whole or of any portion not adjudged invalid.

Section Six: Effective Date.

This ordinance shall be in full force and effect from and after its passage, approval and publication, as required by law.

INTRODUCED AND READ FOR THE FIRST TIME: October 12, 1999

READ FOR THE SECOND TIME:
(under suspension of rules): October 12, 1999

READ FOR THE THIRD TIME:
(under suspension of rules): October 12, 1999

ADOPTED AND ENACTED: October 12, 1999

ROLL CALL VOTE:
Ayes: Adele, McDaniel, Rich, Cates, Thornton, Sauget
Nays: NONE
Absent: NONE
Unfilled Vacancy:

APPROVED: October 12, 1999

APPROVED:
Paul Sauget
President (mayor) Pro Temore

ATTEST:
Betty Long Wilson
Village Clerk

Appendix 3

1999 Sauget Area 1 Support Sampling Plan

Sediment Chemical Analyses

'BRIEN & GERE
ENGINEERS, INC.

AFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 6010B/7471A/9010B Inorganic Data

Compound	Sample ID	BPL-ESED-S1-0.2FT	BPL-ESED-S1-0.2FT-FD	BPL-ESED-S2-0.2FT	BPL-ESED-S3-0.2FT	BSSED-PDC-DS-S-0-30IN	BSSED-PDC-US-N-0-20IN	BSSED-PDC-US-N-0-20INEB
	Sample Date	10/06/99	10/06/99	10/07/99	10/06/99	02/07/00	02/07/00	02/04/00
	Units	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/l
Aluminum		13000 J	15000 J	16000 J	11000 J	9800	11000	0.2 U
Antimony		1.9 J	R	R	1.5 J	2.7 UJ	2.5 UJ	0.02 U
Arsenic		16 J	17 J	17 J	13 J	7	6.6	0.01 U
Barium		360 J	410 J	420 J	240 J	140 J	130 J	0.01 U
Beryllium		0.72 J	0.76 J	0.82 J	0.58 J	0.48 J	0.54	0.004 U
Cadmium		1.9 J	2 J	2.7 J	1.6 J	0.67 U	0.62 U	0.005 U
Calcium		16000 J	17000 J	16000 J	11000 J	5300	3300	0.15
Chromium		20 J	22 J	26 J	18 J	15 J	16 J	0.01 U
Cobalt		9.3 J	10 J	10 J	7.1 J	6.7	7.4	0.01 U
Copper		43 J	48 J	64 J	36 J	14	14	0.02 U
Cyanide, Total		1.4 UJ	1.4 UJ	1.5 UJ	1.4 UJ	0.74 U	0.68 U	0.01 U
Iron		34000 J	37000 J	38000 J	28000 J	16000	16000	0.05 U
Lead		49 J	54 J	58 J	34 J	16	15	0.005 U
Magnesium		5500 J	5700 J	4800 J	3600 J	2900	2600	0.5 U
Manganese		1200 J	1300 J	1400 J	940 J	430 J	540 J	0.01 U
Mercury		0.091 J	0.11 J	0.16 J	0.11 J	0.025	0.023	0.0002 U
Molybdenum		0.52 J	0.47 J	0.92 J	0.37 J	0.45 J	0.58 J	0.01 U
Nickel		51 J	54 J	54 J	35 J	15	16	0.04 U
Potassium		2000 J	2300 J	2200 J	1500 J	1200 J	1200 J	1 U
Selenium		2.8 UJ	2.8 UJ	2.9 UJ	2.5 UJ	1.3 U	1.2 U	0.01 U
Silver		2.8 UJ	2.8 UJ	0.79 J	2.5 UJ	1.3 U	1.2 U	0.01 U
Sodium		200 UJ	180 UJ	230 UJ	140 UJ	92	80	0.58
Thallium		2.8 UJ	2.8 UJ	2.9 UJ	2.5 UJ	1.3 U	1.2 UJ	0.01 U
Tin		14 UJ	14 UJ	15 UJ	13 UJ	6.7 U	6.2 U	0.01 U
Vanadium		35 J	38 J	40 J	28 J	25	29	0.01 U
Zinc		290 J	320 J	370 J	250 J	58	59	0.02 U

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:28:42
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 6010B/7471A/9010B Inorganic Data

Sample ID	BSSED-PDC-US-N-0-20INFD	SED-CSB-0.2FTEB	SED-CSB-S1-0.2FT	SED-CSB-S1-0.2FTFD	SED-CSB-S2-0.2FT	SED-CSB-S3-0.2FT	SED-CSC-S1-0.2FT
Sample Date	02/07/00	10/05/99	10/05/99	10/05/99	10/05/99	10/05/99	10/04/99
Units	mg/kg dw	mg/l	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw
Compound							
Aluminum	13000	0.20 U	6900 J	6200 J	8300 J	12000 J	15000 J
Antimony	2.5 UJ	0.020 U	9.2 J	8.6 J	6.3 J	6.8 J	1.8 J
Arsenic	7.8	0.010 U	35 J	31 J	38 J	25 J	28 J
Barium	140 J	0.0030	950 J	550 J	3300 J	1700 J	470 J
Beryllium	0.58	0.0040 U	1 UJ	0.96 UJ	1 UJ	1.2 UJ	1.2 UJ
Cadmium	0.63 U	0.0050 U	17 J	13 J	25 J	25 J	20 J
Calcium	4000	0.41	180000 J	180000 J	87000 J	100000 J	28000 J
Chromium	18 J	0.010 U	49 J	34 J	76 J	78 J	50 J
Cobalt	7.7	0.010 U	7.2 J	6.7 J	9.9 J	12 J	17 J
Copper	15	0.0062	5100 J	4600 J	11000 J	6700 J	1400 J
Cyanide, Total	0.69 U	0.010 U	1.2 UJ	1.1 UJ	1.2 UJ	1.7 UJ	1.7 UJ
Iron	18000	0.042	14000 J	12000 J	29000 J	25000 J	27000 J
Lead	16	0.0019	630 J	490 J	1000 J	750 J	270 J
Magnesium	2800	0.50 U	20000 J	20000 J	10000 J	11000 J	5500 J
Manganese	670 J	0.010 U	250 J	240 J	210 J	230 J	290 J
Mercury	0.023	0.00020 U	0.96 J	0.56 J	1.5 J	1.4 J	0.66 J
Molybdenum	0.68 J	0.010 U	7.2 J	6.8 J	4.3 J	4.8 J	3.4 J
Nickel	17	0.040 U	88 J	67 J	500 J	380 J	370 J
Potassium	1500 J	1.0 U	1700 J	1600 J	1700 J	2400 J	3000 J
Selenium	1.3 U	0.010 U	4.1 J	1.7 J	5.1 J	3.5 J	2.8 UJ
Silver	1.3 U	0.010 U	6.7 J	6.7 J	15 J	8.9 J	1.2 J
Sodium	71	0.39	340 UJ	310 UJ	270 UJ	290 UJ	300 UJ
Thallium	1.3 U	0.010 U	2.5 UJ	2.2 UJ	2.3 UJ	2.1 J	3.1 UJ
Tin	6.3 U	0.010 U	---	---	---	---	---
Vanadium	33	0.010 U	29 J	26 J	37 J	41 J	48 J
Zinc	63	0.023	2000 J	1600 J	7900 J	4800 J	2900 J

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30 16:28:42
DBF File: N:\1004 \TEMPDATA.DBF
FXP File: N:\1004 \TABLEPRS.FXP

mber: 10040.25501

AFT
utia

Sauget Area 1
Broad Scan Sediments
Method 6010B/7471A/9010B Inorganic Data

Sample ID	SED-CSC-S2-0.2FT	SED-CSC-S3-0.2FT	SED-CSD-S1-0.2FT	SED-CSD-S2-0.2FT	SED-CSD-S3-0.2FT	SED-CSE-S1-0.2FT	SED-CSE-S2-0.2FT
Sample Date	10/04/99	10/04/99	10/04/99	10/04/99	10/04/99	10/06/99	10/06/99
Units	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw
Compound							
Aluminum	12000 J	9700 J	13000 J	16000 J	13000 J	15000 J	13000 J
Antimony	1.3 J	2.2 J	8.7 UJ	8.7 UJ	5.9 UJ	2.7 J	2 J
Arsenic	17 J	16 J	16 J	17 J	10 J	16 J	12 J
Barium	680 J	800 J	380 J	400 J	310 J	340 J	290 J
Beryllium	0.93 UJ	1 UJ	1.2 UJ	1.3 UJ	1 UJ	0.84 J	0.75 J
Cadmium	19 J	16 J	15 J	13 J	10 J	14 J	11 J
Calcium	23000 J	47000 J	28000 J	30000 J	26000 J	43000 J	80000 J
Chromium	93 J	47 J	56 J	60 J	67 J	71 J	49 J
Cobalt	12 J	9.7 J	12 J	12 J	8.8 J	10 J	9.2 J
Copper	2200 J	2100 J	740 J	730 J	320 J	570 J	350 J
Cyanide, Total	1.4 UJ	1.9 UJ	2.2 UJ	2.4 UJ	1.5 UJ	1.8 UJ	1.3 UJ
Iron	21000 J	24000 J	22000 J	25000 J	19000 J	24000 J	20000 J
Lead	330 J	480 J	260 J	230 J	170 J	310 J	190 J
Magnesium	3600 J	6400 J	6700 J	7500 J	6600 J	9200 J	13000 J
Manganese	240 J	330 J	250 J	320 J	270 J	310 J	320 J
Mercury	0.64 J	0.58 J	0.5 J	0.42 J	0.35 J	0.51 J	0.3 J
Molybdenum	2.2 J	1.7 UJ	3 UJ	2.6 UJ	1.7 UJ	2.6 J	1.6 J
Nickel	580 J	550 J	260 J	260 J	150 J	190 J	130 J
Potassium	2400 J	2100 J	2900 J	3200 J	2700 J	3100 J	2600 J
Selenium	13 UJ	2.4 UJ	2 UJ	2.5 UJ	2.9 UJ	2.6 UJ	1.5 UJ
Silver	1.8 J	1.6 J	4.3 UJ	4.3 UJ	2.9 UJ	1.1 J	0.67 J
Sodium	320 UJ	340 UJ	240 UJ	250 UJ	190 UJ	250 UJ	300 UJ
Thallium	2.6 UJ	3.5 UJ	4.3 UJ	4.3 UJ	2.9 UJ	1.9 J	2.6 UJ
Tin	---	---	---	---	---	19 J	12 J
Vanadium	36 J	34 J	44 J	51 J	37 J	51 J	40 J
Zinc	4500 J	3300 J	2500 J	2700 J	1800 J	2300 J	1800 J

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 6010B/7471A/9010B Inorganic Data

Sample ID	SED-CSE-S3-0.2FT	SED-CSF-S1-0.2FT	SED-CSF-S2-0.2FT	SED-CSF-S3-0.2FT	SED-M-S1-0.2FT	SED-RA1-S1-0.2FT	SED-RA1-S2-0.2FT
Sample Date	10/06/99	10/07/99	10/07/99	10/07/99	10/05/99	10/08/99	10/08/99
Units	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw	mg/kg dw
Compound							
Aluminum	11000 J	7800 J	14000 J	17000 J	8900 J	15000 J	12000 J
Antimony	6.1 UJ	R	2.6 J	R	6.6 J	R	1.3 J
Arsenic	9.3 J	8 J	19 J	15 J	35 J	8	7 J
Barium	190 J	150 J	250 J	270 J	700 J	230 J	210 J
Beryllium	0.9 UJ	0.53 J	0.85 J	0.89 J	1.3 UJ	0.8	0.7 J
Cadmium	7.7 J	7.4 J	47 J	14 J	17 J	0.38 J	0.34 J
Calcium	26000 J	11000 J	13000 J	11000 J	100000 J	18000 J	12000 J
Chromium	31 J	19 J	38 J	30 J	48 J	21 J	17 J
Cobalt	7.4 J	5.5 J	13 J	11 J	15 J	9.8	7.1 J
Copper	150 J	160 J	410 J	240 J	4200 J	20 J	17 J
Cyanide, Total	1.7 UJ	1.2 UJ	2.6 UJ	1.9 UJ	2.5 UJ	0.89 U	1.4 UJ
Iron	17000 J	14000 J	22000 J	26000 J	34000 J	22000 J	19000 J
Lead	140 J	110 J	320 J	110 J	530 J	23 J	22 J
Magnesium	7400 J	4100 J	6800 J	5300 J	7400 J	6500	5000 J
Manganese	170 J	170 J	230 J	510 J	370 J	720 J	770 J
Mercury	0.3 J	0.3 J	1.1 J	0.45 J	1 J	0.042	0.063 J
Molybdenum	3.2 J	0.7 J	3.7 J	0.76 J	17 J	0.37 J	0.49 J
Nickel	51 J	90 J	390 J	180 J	190 J	23	19 J
Potassium	2400 J	1600 J	2900 J	2700 J	2000 J	2300	1900 J
Selenium	3 UJ	2.3 UJ	4.8 UJ	3.7 UJ	3.8 J	1.8 U	2.5 UJ
Silver	3 UJ	2.3 UJ	4.8 UJ	3.7 UJ	7.3 J	1.8 U	2.5 UJ
Sodium	180 UJ	210 UJ	350 UJ	230 UJ	290 UJ	150 U	180 UJ
Thallium	3 UJ	2.3 UJ	4.8 UJ	3.7 UJ	5 UJ	1.8 U	2.5 UJ
Tin	---	12 UJ	24 UJ	19 UJ	---	8.9 U	12 UJ
Vanadium	37 J	25 J	51 J	41 J	45 J	36	30 J
Zinc	980 J	950 J	3700 J	1600 J	2400 J	95 J	82 J

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/3 16:28:42
DBF File: N:\100 \TEMPDATA.DBF
FXP File: N:\100 \TABLEPRS.FXP

Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Lutia

Sauget Area 1
Broad Scan Sediments
Method 6010B/7471A/9010B Inorganic Data

Compound	Sample ID	SED-RA2-S1-0.2FT	SED-RA2-S1-0.2FTEB	SED-RA2-S1-0.2FTFD	SED-RA2-S2-0.2FT
	Sample Date	10/08/99	10/08/99	10/08/99	10/09/99
	Units	mg/kg dw	mg/l	mg/kg dw	mg/kg dw
Aluminum		11000 J	0.2 U	13000 J	19000 J
Antimony		1 J	0.02 U	R	R
Arsenic		6.5 J	0.01 U	6.9 J	7 J
Barium		160 J	0.013	170 J	220 J
Beryllium		0.6 J	0.004 U	0.64 J	1 J
Cadmium		0.26 J	0.005 U	0.32 J	0.65 J
Calcium		11000 J	24	13000 J	12000 J
Chromium		16 J	0.01 U	18 J	25 J
Cobalt		7.3 J	0.01 U	7.7 J	10 J
Copper		16 J	0.0038	16 J	23 J
Cyanide, Total		1 UJ	0.01 U	1 UJ	1.1 UJ
Iron		17000 J	0.05 U	18000 J	24000 J
Lead		16 J	0.005 U	17 J	26 J
Magnesium		3100 J	8	3400 J	5800 J
Manganese		560 J	0.0026	580 J	770 J
Mercury		0.046 J	0.0002 U	0.048 J	0.04 J
Molybdenum		0.35 J	0.01 U	0.43 J	0.53 J
Nickel		17 J	0.04 U	18 J	26 J
Potassium		1500 J	2.3	1700 J	2600 J
Selenium		1.9 UJ	0.01 U	1.9 UJ	2 UJ
Silver		1.9 UJ	0.01 U	1.9 UJ	2 UJ
Sodium		140 UJ	13	130 UJ	210 J
Thallium		1.9 UJ	0.01 U	1.9 UJ	2 UJ
Tin		9.5 UJ	0.01 U	9.5 UJ	9.9 UJ
Vanadium		28 J	0.01 U	31 J	44 J
Zinc		57 J	0.0072	61 J	96 J

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:28:42
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8260B Volatile Organic Compound Data

Sample ID	BPL-ESED-S1-0.2FT	BPL-ESED-S1-0.2FT-FD	BPL-ESED-S2-0.2FT	BPL-ESED-S3-0.2FT	BSSED-PDC-DS-S-0-30IN	BSSED-PDC-US-N-0-20IN	BSSED-PDC-US-N-0-20INEB
Sample Date	10/06/99	10/06/99	10/07/99	10/06/99	02/07/00	02/07/00	02/04/00
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/l
Compound							
1,1,1-Trichloroethane	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
1,1,2,2-Tetrachloroethane	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
1,1,2-Trichloroethane	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
1,1-Dichloroethane	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
1,1-Dichloroethene	24 UJ	19 UJ	23 UJ	27 UJ	10 U	7.9 U	5 U
1,2-Dichloroethane	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
1,2-Dichloropropane	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
2-Butanone (MEK)	130 UJ	100 UJ	130 UJ	140 UJ	57 U	43 U	25 U
2-Hexanone	130 UJ	100 UJ	130 UJ	140 UJ	57 U	43 U	25 U
4-Methyl-2-pentanone (MIBK)	130 UJ	100 UJ	130 UJ	140 UJ	57 U	43 U	25 U
Acetone	260 UJ	210 UJ	250 UJ	290 UJ	41 J	86 U	50 U
Benzene	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	1.2 U
Bromodichloromethane	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Bromoform	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Bromomethane (Methyl bromide)	51 UJ	42 UJ	51 UJ	58 UJ	23 U	17 U	9.8 U
Carbon disulfide	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Carbon tetrachloride	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Chlorobenzene	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Chloroethane	51 UJ	42 UJ	51 UJ	58 UJ	23 U	17 U	10 U
Chloroform	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Chloromethane	51 UJ	42 UJ	51 UJ	58 UJ	23 U	17 U	10 U
Cis/Trans-1,2-Dichloroethene	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Dibromochloromethane	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Ethylbenzene	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Methylene chloride (Dichloromethane)	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	1.6
Styrene	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Tetrachloroethene	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Toluene	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
Trichloroethene	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	2.7 U
Vinyl chloride	51 UJ	42 UJ	51 UJ	58 UJ	23 U	17 U	10 U
Xylenes, Total	26 UJ	21 UJ	25 UJ	29 UJ	11 U	8.6 U	5 U
cis-1,3-Dichloropropene	20 UJ	17 UJ	20 UJ	23 UJ	9.2 U	6.8 U	1 U
trans-1,3-Dichloropropene	20 UJ	17 UJ	20 UJ	23 UJ	9.2 U	6.8 U	5 U
Total VOCs	ND	ND	ND	ND	41	ND	1.6

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:24:14
DBF File: N:\10[illegible]01\TEMPDATA.DBF
FXP File: N:\10[illegible]01\TABLEPRS.FXP

Number: 10040.25501

'BRIEN & GERE
ENGINEERS, INC.

(\FT
..utia

Sauget Area 1
Broad Scan Sediments
Method 8260B Volatile Organic Compound Data

Sample ID	BSSED-PDC-US-N-0-20INFD	SED-CSB-0.2FTEB	SED-CSB-S1-0.2FT	SED-CSB-S1-0.2FTFD	SED-CSB-S2-0.2FT	SED-CSB-S3-0.2FT	SED-CSC-S1-0.2FT
Sample Date	02/07/00	10/05/99	10/05/99	10/05/99	10/05/99	10/05/99	10/04/99
Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
1,1,1-Trichloroethane	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
1,1,2,2-Tetrachloroethane	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
1,1,2-Trichloroethane	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
1,1-Dichloroethane	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
1,1-Dichloroethene	8.9 U	5.0 U	24 UJ	18 UJ	18 UJ	35 UJ	25 UJ
1,2-Dichloroethane	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
1,2-Dichloropropane	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
2-Butanone (MEK)	48 U	25 U	130 UJ	99 UJ	98 UJ	190 UJ	31 J
2-Hexanone	48 U	25 U	130 UJ	99 UJ	21 J	190 UJ	130 UJ
4-Methyl-2-pentanone (MIBK)	48 U	25 U	130 UJ	99 UJ	98 UJ	190 UJ	130 UJ
Acetone	47 J	50 U	260 UJ	200 UJ	250 UJ	380 UJ	96 J
Benzene	9.6 U	1.2 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Bromodichloromethane	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Bromoform	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Bromomethane (Methyl bromide)	19 U	9.8 U	52 UJ	40 UJ	39 UJ	76 UJ	54 UJ
Carbon disulfide	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Carbon tetrachloride	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Chlorobenzene	9.6 U	5.0 U	86 J	17 J	26 J	20 J	27 UJ
Chloroethane	19 U	10 U	52 UJ	40 UJ	39 UJ	76 UJ	54 UJ
Chloroform	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Chloromethane	19 U	10 U	52 UJ	40 UJ	39 UJ	76 UJ	54 UJ
Cis/Trans-1,2-Dichloroethene	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Dibromochloromethane	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Ethylbenzene	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Methylene chloride (Dichloromethane)	9.6 U	0.90	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Styrene	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Tetrachloroethene	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Toluene	6.4 J	5.0 U	26 UJ	20 UJ	20 J	38 UJ	27 UJ
Trichloroethene	9.6 U	2.7 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
Vinyl chloride	19 U	10 U	52 UJ	40 UJ	39 UJ	76 UJ	54 UJ
Xylenes, Total	9.6 U	5.0 U	26 UJ	20 UJ	20 UJ	38 UJ	27 UJ
cis-1,3-Dichloropropene	7.7 U	1.0 U	21 UJ	16 UJ	16 UJ	30 UJ	22 UJ
trans-1,3-Dichloropropene	7.7 U	5.0 U	21 UJ	16 UJ	16 UJ	30 UJ	22 UJ
Total VOCs	53.4	0.9	86	17	67	20	127

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:24:14
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8260B Volatile Organic Compound Data

Sample ID	SED-CSC-S2-0.2FT	SED-CSC-S3-0.2FT	SED-CSD-S1-0.2FT	SED-CSD-S2-0.2FT	SED-CSD-S3-0.2FT	SED-CSE-S1-0.2FT	SED-CSE-S2-0.2FT
Sample Date	10/04/99	10/04/99	10/04/99	10/04/99	10/04/99	10/06/99	10/06/99
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
1,1,1-Trichloroethane	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
1,1,2,2-Tetrachloroethane	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
1,1,2-Trichloroethane	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
1,1-Dichloroethane	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
1,1-Dichloroethene	20 UJ	27 UJ	37 UJ	38 UJ	19 UJ	27 UJ	17 UJ
1,2-Dichloroethane	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
1,2-Dichloropropane	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
2-Butanone (MEK)	37 J	28 J	65 J	56 J	30 J	150 UJ	94 UJ
2-Hexanone	110 UJ	140 UJ	200 UJ	200 UJ	100 UJ	150 UJ	94 UJ
4-Methyl-2-pentanone (MIBK)	110 UJ	140 UJ	200 UJ	200 UJ	100 UJ	150 UJ	94 UJ
Acetone	130 J	100 J	190 J	170 J	84 J	430 UJ	190 UJ
Benzene	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Bromodichloromethane	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Bromoform	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Bromomethane (Methyl bromide)	45 UJ	58 UJ	80 UJ	82 UJ	41 UJ	60 UJ	38 UJ
Carbon disulfide	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Carbon tetrachloride	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Chlorobenzene	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Chloroethane	45 UJ	58 UJ	80 UJ	82 UJ	41 UJ	60 UJ	38 UJ
Chloroform	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Chloromethane	45 UJ	58 UJ	80 UJ	82 UJ	41 UJ	60 UJ	38 UJ
Cis/Trans-1,2-Dichloroethene	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Dibromochloromethane	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Ethylbenzene	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Methylene chloride (Dichloromethane)	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Styrene	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Tetrachloroethene	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Toluene	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Trichloroethene	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
Vinyl chloride	45 UJ	58 UJ	80 UJ	82 UJ	41 UJ	60 UJ	38 UJ
Xylenes, Total	22 UJ	29 UJ	40 UJ	41 UJ	20 UJ	30 UJ	19 UJ
cis-1,3-Dichloropropene	18 UJ	23 UJ	32 UJ	33 UJ	16 UJ	24 UJ	15 UJ
trans-1,3-Dichloropropene	18 UJ	23 UJ	32 UJ	33 UJ	16 UJ	24 UJ	15 UJ
Total VOCs	167	128	255	226	114	ND	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:24:14
DBF File: N:\1004 \TEMPDATA.DBF
FXP File: N:\100 \TABLEPRS.FXP

F Number: 10040.25501

AFT
utia

Sauget Area 1
Broad Scan Sediments
Method 8260B Volatile Organic Compound Data

Sample ID	SED-CSE-S3-0.2FT	SED-CSF-S1-0.2FT	SED-CSF-S2-0.2FT	SED-CSF-S3-0.2FT	SED-M-S1-0.2FT	SED-RA1-S1-0.2FT	SED-RA1-S2-0.2FT
Sample Date	10/06/99	10/07/99	10/07/99	10/07/99	10/05/99	10/08/99	10/08/99
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
1,1,1-Trichloroethane	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
1,1,2,2-Tetrachloroethane	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
1,1,2-Trichloroethane	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
1,1-Dichloroethane	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
1,1-Dichloroethene	23 UJ	16 UJ	38 UJ	24 UJ	38 UJ	8.7 U	17 UJ
1,2-Dichloroethane	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
1,2-Dichloropropane	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
2-Butanone (MEK)	520 J	85 UJ	200 UJ	130 UJ	270 UJ	47 U	40 J
2-Hexanone	130 UJ	85 UJ	200 UJ	130 UJ	210 UJ	47 U	94 UJ
4-Methyl-2-pentanone (MIBK)	130 UJ	85 UJ	200 UJ	130 UJ	210 UJ	47 U	94 UJ
Acetone	1200 J	200 UJ	410 UJ	260 UJ	920 UJ	95 U	160 J
Benzene	25 UJ	17 UJ	41 UJ	26 UJ	17 J	9.5 U	19 UJ
Bromodichloromethane	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
Bromoform	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
Bromomethane (Methyl bromide)	50 UJ	34 UJ	82 UJ	51 UJ	83 UJ	19 U	38 UJ
Carbon disulfide	25 UJ	17 UJ	41 UJ	26 UJ	49 J	9.5 U	19 UJ
Carbon tetrachloride	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
Chlorobenzene	25 UJ	17 UJ	41 UJ	26 UJ	100 J	9.5 U	19 UJ
Chloroethane	50 UJ	34 UJ	82 UJ	51 UJ	83 UJ	19 U	38 UJ
Chloroform	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
Chloromethane	50 UJ	34 UJ	82 UJ	51 UJ	83 UJ	19 U	38 UJ
Cis/Trans-1,2-Dichloroethene	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
Dibromochloromethane	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
Ethylbenzene	25 UJ	17 UJ	41 UJ	11 J	42 UJ	9.5 U	19 UJ
Methylene chloride (Dichloromethane)	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
Styrene	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
Tetrachloroethene	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
Toluene	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
Trichloroethene	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
Vinyl chloride	50 UJ	34 UJ	82 UJ	51 UJ	83 UJ	19 U	38 UJ
Xylenes, Total	25 UJ	17 UJ	41 UJ	26 UJ	42 UJ	9.5 U	19 UJ
cis-1,3-Dichloropropene	20 UJ	14 UJ	33 UJ	20 UJ	33 UJ	7.6 U	15 UJ
trans-1,3-Dichloropropene	20 UJ	14 UJ	33 UJ	20 UJ	33 UJ	7.6 U	15 UJ
Total VOCs	1720	ND	ND	11	166	ND	200

NOTES: *U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.*

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8260B Volatile Organic Compound Data

Sample ID	SED-RA2-S1-0.2FT	SED-RA2-S1-0.2FTEB	SED-RA2-S1-0.2FTFD	SED-RA2-S2-0.2FT
Sample Date	10/08/99	10/08/99	10/08/99	10/08/99
Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw
Compound				
1,1,1-Trichloroethane	13 UJ	5 U	13 UJ	11 UJ
1,1,2,2-Tetrachloroethane	13 UJ	5 U	13 UJ	11 UJ
1,1,2-Trichloroethane	13 UJ	5 U	13 UJ	11 UJ
1,1-Dichloroethane	13 UJ	5 U	13 UJ	11 UJ
1,1-Dichloroethene	12 UJ	5 U	12 UJ	10 UJ
1,2-Dichloroethane	13 UJ	5 U	13 UJ	11 UJ
1,2-Dichloropropane	13 UJ	5 U	13 UJ	11 UJ
2-Butanone (MEK)	11 J	25 U	67 UJ	14 J
2-Hexanone	65 UJ	25 U	67 UJ	56 UJ
4-Methyl-2-pentanone (MIBK)	65 UJ	25 U	67 UJ	56 UJ
Acetone	38 J	50 U	130 UJ	52 J
Benzene	13 UJ	1.2 U	13 UJ	11 UJ
Bromodichloromethane	13 UJ	5 U	13 UJ	11 UJ
Bromoform	13 UJ	5 U	13 UJ	11 UJ
Bromomethane (Methyl bromide)	26 UJ	9.8 U	27 UJ	22 UJ
Carbon disulfide	13 UJ	5 U	13 UJ	11 UJ
Carbon tetrachloride	13 UJ	5 U	13 UJ	11 UJ
Chlorobenzene	13 UJ	5 U	13 UJ	11 UJ
Chloroethane	26 UJ	10 U	27 UJ	22 UJ
Chloroform	13 UJ	5 U	13 UJ	11 UJ
Chloromethane	26 UJ	10 U	27 UJ	22 UJ
Cis/Trans-1,2-Dichloroethene	13 UJ	5 U	13 UJ	11 UJ
Dibromochloromethane	13 UJ	5 U	13 UJ	11 UJ
Ethylbenzene	13 UJ	5 U	13 UJ	11 UJ
Methylene chloride (Dichloromethane)	13 UJ	4.7 U	13 UJ	11 UJ
Styrene	13 UJ	5 U	13 UJ	11 UJ
Tetrachloroethene	13 UJ	5 U	13 UJ	11 UJ
Toluene	13 UJ	5 U	13 UJ	11 UJ
Trichloroethene	13 UJ	2.7 U	13 UJ	11 UJ
Vinyl chloride	26 UJ	10 U	27 UJ	22 UJ
Xylenes, Total	13 UJ	5 U	13 UJ	11 UJ
cis-1,3-Dichloropropene	10 UJ	1 U	11 UJ	9.1 UJ
trans-1,3-Dichloropropene	10 UJ	5 U	11 UJ	9.1 UJ
Total VOCs	49	ND	ND	66

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:24:14
DBF File: N:\100 \TEMPDATA.DBF
FXP File: N:\100 \TABLEPRS.FXP

Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

AFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8270C Semivolatile Organic Compound Data

Sample ID	BPL-ESED-S1-0.2FT	BPL-ESED-S1-0.2FT-FD	BPL-ESED-S2-0.2FT	BPL-ESED-S3-0.2FT	BSSED-PDC-DS-S-0-30IN	BSSED-PDC-US-N-0-20IN	BSSED-PDC-US-N-0-20INEB
Sample Date	10/06/99	10/06/99	10/07/99	10/06/99	02/07/00	02/07/00	02/04/00
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/l
Compound							
1,2,4-Trichlorobenzene	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
1,2-Dichlorobenzene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
1,3-Dichlorobenzene	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
1,4-Dichlorobenzene	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
2,2'-Oxybis(1-Chloropropane)	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
2,4,5-Trichlorophenol	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
2,4,6-Trichlorophenol	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	2.1 U
2,4-Dichlorophenol	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
2,4-Dinitrophenol	2300 UJ	2400 UJ	2500 UJ	2300 UJ	1200 U	1100 U	14 U
2,4-Dinitrotoluene	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
2,6-Dinitrotoluene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
2-Chloronaphthalene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
2-Chlorophenol	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
2-Methylnaphthalene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
2-Methylphenol (o-cresol)	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
2-Nitroaniline	2300 UJ	2400 UJ	2500 UJ	2300 UJ	1200 U	1100 U	50 U
2-Nitrophenol	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
3,3'-Dichlorobenzidine	910 UJ	910 UJ	960 UJ	910 UJ	480 U	450 U	20 U
3-Methylphenol/4-Methylphenol	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
3-Nitroaniline	2300 UJ	2400 UJ	2500 UJ	2300 UJ	1200 UJ	1100 U	50 U
4,6-Dinitro-2-methylphenol	2300 UJ	2400 UJ	2500 UJ	2300 UJ	1200 U	1100 U	13 U
4-Bromophenylphenyl ether	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	1 U
4-Chloro-3-methylphenol	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
4-Chloroaniline	910 UJ	910 UJ	960 UJ	910 UJ	480 U	450 U	20 U
4-Chlorophenylphenyl ether	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
4-Nitroaniline	2300 UJ	2400 UJ	2500 UJ	2300 UJ	1200 U	1100 U	50 U
4-Nitrophenol	2300 UJ	2400 UJ	2500 UJ	2300 UJ	1200 U	1100 U	50 U
Acenaphthene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Acenaphthylene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Anthracene	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
Benzo(a)anthracene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Benzo(a)pyrene	250 UJ	250 UJ	260 UJ	250 UJ	130 U	120 U	10 U
Benzo(b)fluoranthene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Benzo(g,h,i)perylene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	0.76
Benzo(k)fluoranthene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:25:11
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8270C Semivolatile Organic Compound Data

Sample ID	BPL-ESED-S1-0.2FT	BPL-ESED-S1-0.2FT-FD	BPL-ESED-S2-0.2FT	BPL-ESED-S3-0.2FT	BSSED-PDC-DS-S-0-30IN	BSSED-PDC-US-N-0-20IN	BSSED-PDC-US-N-0-20INEB
Sample Date	10/06/99	10/06/99	10/07/99	10/06/99	02/07/00	02/07/00	02/04/00
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/l
Compound							
Butylbenzylphthalate	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
Carbazole	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	3.4 U
Chrysene	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
Di-n-butylphthalate	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Di-n-octylphthalate	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Dibenzo(a,h)anthracene	250 UJ	250 UJ	260 UJ	250 UJ	130 UJ	120 U	10 U
Dibenzofuran	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Diethylphthalate	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Dimethylphthalate	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Fluoranthene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Fluorene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	1 U
Hexachlorobenzene	190 UJ	190 UJ	200 UJ	190 UJ	100 U	95 U	10 U
Hexachlorobutadiene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Hexachlorocyclopentadiene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
Hexachloroethane	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	1.9 U
Indeno(1,2,3-cd)pyrene	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	0.61
Isophorone	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
N-Nitroso-di-n-propylamine	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
N-Nitrosodiphenylamine	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	5 U
Naphthalene	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
Nitrobenzene	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	3.5 U
Pentachlorophenol	2300 UJ	2400 UJ	2500 UJ	2300 UJ	1200 U	1100 U	5 U
Phenanthrene	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
Phenol	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	10 U
Pyrene	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
bis(2-Chloroethoxy)methane	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
bis(2-Chloroethyl)ether	470 UJ	470 UJ	500 UJ	470 UJ	250 U	230 U	10 U
bis(2-Ethylhexyl)phthalate	470 UJ	470 UJ	500 UJ	470 UJ	250 UJ	230 U	1.8 U
Total Semivolatiles	ND	ND	ND	ND	ND	ND	1.37

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:25:11
DBF File: N:\10[illegible]01\TEMPDATA.DBF
FXP File: N:\10[illegible]01\TABLEPRS.FXP

Number: 10040.25501

DRAFT

Mutia

Sauget Area 1
Broad Scan Sediments
Method 8270C Semivolatile Organic Compound Data

Sample ID	BSSED-PDC-US-N-0-20INFD	SED-CSB-0.2FTEB	SED-CSB-S1-0.2FT	SED-CSB-S1-0.2FTFD	SED-CSB-S2-0.2FT	SED-CSB-S3-0.2FT	SED-CSC-S1-0.2FT
Sample Date	02/07/00	10/05/99	10/05/99	10/05/99	10/05/99	10/05/99	10/04/99
Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
1,2,4-Trichlorobenzene	230 U	10 U	2600 UJ	2200 UJ	770 J	3300 UJ	3400 UJ
1,2-Dichlorobenzene	230 U	10 U	370 J	2200 UJ	2600 UJ	3300 UJ	3400 UJ
1,3-Dichlorobenzene	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
1,4-Dichlorobenzene	230 U	10 U	1000 J	2200 UJ	520 J	3300 UJ	3400 UJ
2,2'-Oxybis(1-Chloropropane)	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
2,4,5-Trichlorophenol	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
2,4,6-Trichlorophenol	230 U	2.1 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
2,4-Dichlorophenol	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
2,4-Dinitrophenol	1200 U	14 U	13000 UJ	11000 UJ	13000 UJ	16000 UJ	17000 UJ
2,4-Dinitrotoluene	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
2,6-Dinitrotoluene	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
2-Chloronaphthalene	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
2-Chlorophenol	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
2-Methylnaphthalene	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
2-Methylphenol (o-cresol)	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
2-Nitroaniline	1200 U	50 U	13000 UJ	11000 UJ	13000 UJ	16000 UJ	17000 UJ
2-Nitrophenol	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
3,3'-Dichlorobenzidine	450 U	20 U	5000 UJ	4200 UJ	5000 UJ	6300 UJ	6600 UJ
3-Methylphenol/4-Methylphenol	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
3-Nitroaniline	1200 U	50 U	13000 UJ	11000 UJ	13000 UJ	16000 UJ	17000 UJ
4,6-Dinitro-2-methylphenol	1200 U	13 U	13000 UJ	11000 UJ	13000 UJ	16000 UJ	17000 UJ
4-Bromophenylphenyl ether	230 U	1.0 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
4-Chloro-3-methylphenol	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
4-Chloroaniline	450 U	20 U	5000 UJ	4200 UJ	830 J	6300 UJ	6600 UJ
4-Chlorophenylphenyl ether	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
4-Nitroaniline	1200 U	50 U	13000 UJ	11000 UJ	13000 UJ	16000 UJ	17000 UJ
4-Nitrophenol	1200 U	50 U	13000 UJ	11000 UJ	13000 UJ	16000 UJ	17000 UJ
Acenaphthene	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Acenaphthylene	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Anthracene	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Benzo(a)anthracene	230 U	10 U	960 J	600 J	870 J	680 J	530 J
Benzo(a)pyrene	120 U	10 U	1500 J	770 J	1200 J	730 J	1800 UJ
Benzo(b)fluoranthene	230 U	10 U	1700 J	1100 J	2000 J	1100 J	680 J
Benzo(g,h,i)perylene	230 U	10 U	1600 J	710 J	1600 J	790 J	3400 UJ
Benzo(k)fluoranthene	230 U	10 U	1500 J	920 J	1600 J	920 J	3400 UJ

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8270C Semivolatile Organic Compound Data

Sample ID	BSSED-PDC-US-N-0-20INFD	SED-CSB-0.2FTEB	SED-CSB-S1-0.2FT	SED-CSB-S1-0.2FTFD	SED-CSB-S2-0.2FT	SED-CSB-S3-0.2FT	SED-CSC-S1-0.2FT
Sample Date	02/07/00	10/05/99	10/05/99	10/05/99	10/05/99	10/05/99	10/04/99
Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
Butylbenzylphthalate	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Carbazole	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Chrysene	230 U	10 U	1600 J	990 J	1800 J	1100 J	640 J
Di-n-butylphthalate	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Di-n-octylphthalate	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Dibenzo(a,h)anthracene	120 U	10 U	1400 UJ	1200 UJ	1400 UJ	1700 UJ	1800 UJ
Dibenzofuran	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Diethylphthalate	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Dimethylphthalate	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Fluoranthene	230 U	10 U	2300 J	1700 J	1800 J	1900 J	780 J
Fluorene	230 U	1.0 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 U
Hexachlorobenzene	96 U	10 U	1000 UJ	900 UJ	1000 UJ	1300 UJ	1400 UJ
Hexachlorobutadiene	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Hexachlorocyclopentadiene	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Hexachloroethane	230 U	1.9 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Indeno(1,2,3-cd)pyrene	230 U	10 U	1300 J	2200 UJ	1000 J	3300 UJ	3400 UJ
Isophorone	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
N-Nitroso-di-n-propylamine	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
N-Nitrosodiphenylamine	230 U	5.0 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Naphthalene	230 U	10 U	2600 UJ	2200 UJ	380 J	3300 UJ	3400 UJ
Nitrobenzene	230 U	3.5 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Pentachlorophenol	1200 U	5.0 U	13000 UJ	11000 UJ	13000 UJ	16000 UJ	17000 UJ
Phenanthrene	230 U	10 U	2600 UJ	810 J	930 J	910 J	530 J
Phenol	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Pyrene	230 U	10 U	3000 J	1800 J	2200 J	2000 J	940 J
bis(2-Chloroethoxy)methane	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
bis(2-Chloroethyl)ether	230 U	10 U	2600 UJ	2200 UJ	2600 UJ	3300 UJ	3400 UJ
bis(2-Ethylhexyl)phthalate	230 U	1.8 U	3000 J	2200 UJ	2600 UJ	3300 UJ	3400 UJ
Total Semivolatiles	ND	ND	19830	9400	17500	10130	4100

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

'BRIEN & GERE
NGINEERS, INC.

FT
tia

Sauget Area 1
Broad Scan Sediments
Method 8270C Semivolatile Organic Compound Data

Sample ID	SED-CSC-S2-0.2FT	SED-CSC-S3-0.2FT	SED-CSD-S1-0.2FT	SED-CSD-S2-0.2FT	SED-CSD-S3-0.2FT	SED-CSE-S1-0.2FT	SED-CSE-S2-0.2FT
Sample Date	10/04/99	10/04/99	10/04/99	10/04/99	10/04/99	10/06/99	10/06/99
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
1,2,4-Trichlorobenzene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
1,2-Dichlorobenzene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
1,3-Dichlorobenzene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
1,4-Dichlorobenzene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
2,2'-Oxybis(1-Chloropropane)	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
2,4,5-Trichlorophenol	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
2,4,6-Trichlorophenol	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
2,4-Dichlorophenol	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
2,4-Dinitrophenol	14000 UJ	20000 UJ	22000 UJ	23000 UJ	15000 UJ	3000 UJ	2200 UJ
2,4-Dinitrotoluene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
2,6-Dinitrotoluene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
2-Chloronaphthalene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
2-Chlorophenol	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
2-Methylnaphthalene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
2-Methylphenol (o-cresol)	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
2-Nitroaniline	14000 UJ	20000 UJ	22000 UJ	23000 UJ	15000 UJ	3000 UJ	2200 UJ
2-Nitrophenol	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
3,3'-Dichlorobenzidine	5500 UJ	7600 UJ	8400 UJ	9100 UJ	5700 UJ	1200 UJ	860 UJ
3-Methylphenol/4-Methylphenol	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
3-Nitroaniline	14000 UJ	20000 UJ	22000 UJ	23000 UJ	15000 UJ	3000 UJ	2200 UJ
4,6-Dinitro-2-methylphenol	14000 UJ	20000 UJ	22000 UJ	23000 UJ	15000 UJ	3000 UJ	2200 UJ
4-Bromophenylphenyl ether	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
4-Chloro-3-methylphenol	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
4-Chloroaniline	5500 UJ	7600 UJ	8400 UJ	9100 UJ	5700 UJ	1200 UJ	860 UJ
4-Chlorophenylphenyl ether	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
4-Nitroaniline	14000 UJ	20000 UJ	22000 UJ	23000 UJ	15000 UJ	3000 UJ	2200 UJ
4-Nitrophenol	14000 UJ	20000 UJ	22000 UJ	23000 UJ	15000 UJ	3000 UJ	2200 UJ
Acenaphthene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Acenaphthylene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Anthracene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Benzo(a)anthracene	2800 UJ	890 J	4300 UJ	4700 UJ	420 J	100 J	120 J
Benzo(a)pyrene	1500 UJ	1400 J	2300 UJ	2500 UJ	560 J	150 J	170 J
Benzo(b)fluoranthene	600 J	2000 J	970 J	780 J	910 J	170 J	260 J
Benzo(g,h,i)perylene	2800 UJ	1400 J	4300 UJ	4700 UJ	660 J	140 J	170 J
Benzo(k)fluoranthene	390 J	1200 J	660 J	520 J	610 J	600 UJ	170 J

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8270C Semivolatile Organic Compound Data

Sample ID	SED-CSC-S2-0.2FT	SED-CSC-S3-0.2FT	SED-CSD-S1-0.2FT	SED-CSD-S2-0.2FT	SED-CSD-S3-0.2FT	SED-CSE-S1-0.2FT	SED-CSE-S2-0.2FT
Sample Date	10/04/99	10/04/99	10/04/99	10/04/99	10/04/99	10/06/99	10/06/99
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
Butylbenzylphthalate	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Carbazole	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Chrysene	500 J	1500 J	790 J	670 J	740 J	190 J	220 J
Di-n-butylphthalate	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Di-n-octylphthalate	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Dibenzo(a,h)anthracene	1500 UJ	2100 UJ	2300 UJ	2500 UJ	1600 UJ	320 UJ	240 UJ
Dibenzofuran	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Diethylphthalate	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Dimethylphthalate	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Fluoranthene	800 J	2200 J	1200 J	1000 J	1200 J	320 J	390 J
Fluorene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Hexachlorobenzene	1200 UJ	1600 UJ	1800 UJ	1900 UJ	1200 UJ	250 UJ	180 UJ
Hexachlorobutadiene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Hexachlorocyclopentadiene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Hexachloroethane	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Indeno(1,2,3-cd)pyrene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	130 J	150 J
Isophorone	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
N-Nitroso-di-n-propylamine	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
N-Nitrosodiphenylamine	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Naphthalene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Nitrobenzene	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Pentachlorophenol	14000 UJ	20000 UJ	22000 UJ	23000 UJ	15000 UJ	3000 UJ	2200 UJ
Phenanthrene	320 J	840 J	4300 UJ	4700 UJ	410 J	130 J	120 J
Phenol	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
Pyrene	660 J	2000 J	950 J	970 J	1100 J	250 J	310 J
bis(2-Chloroethoxy)methane	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
bis(2-Chloroethyl)ether	2800 UJ	3900 UJ	4300 UJ	4700 UJ	2900 UJ	600 UJ	440 UJ
bis(2-Ethylhexyl)phthalate	2800 UJ	3900 UJ	4300 UJ	4700 UJ	1200 J	600 UJ	260 J
Total Semivolatiles	3270	13430	4570	3940	7810	1580	2340

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

AFT
..lutia

Sauget Area 1
Broad Scan Sediments
Method 8270C Semivolatile Organic Compound Data

Sample ID	SED-CSE-S3-0.2FT	SED-CSF-S1-0.2FT	SED-CSF-S2-0.2FT	SED-CSF-S3-0.2FT	SED-M-S1-0.2FT	SED-RA1-S1-0.2FT	SED-RA1-S2-0.2FT
Sample Date	10/06/99	10/07/99	10/07/99	10/07/99	10/05/99	10/08/99	10/08/99
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
1,2,4-Trichlorobenzene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
1,2-Dichlorobenzene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
1,3-Dichlorobenzene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
1,4-Dichlorobenzene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
2,2'-Oxybis(1-Chloropropane)	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
2,4,5-Trichlorophenol	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
2,4,6-Trichlorophenol	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
2,4-Dichlorophenol	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
2,4-Dinitrophenol	2800 UJ	2000 UJ	4500 UJ	3100 UJ	25000 UJ	1500 U	2300 UJ
2,4-Dinitrotoluene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
2,6-Dinitrotoluene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
2-Chloronaphthalene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
2-Chlorophenol	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
2-Methylnaphthalene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
2-Methylphenol (o-cresol)	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
2-Nitroaniline	2800 UJ	2000 UJ	4500 UJ	3100 UJ	25000 UJ	1500 U	2300 UJ
2-Nitrophenol	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
3,3'-Dichlorobenzidine	1100 UJ	770 UJ	1700 UJ	1200 UJ	9700 UJ	590 U	880 UJ
3-Methylphenol/4-Methylphenol	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
3-Nitroaniline	2800 UJ	2000 UJ	4500 UJ	3100 UJ	25000 UJ	1500 U	2300 UJ
4,6-Dinitro-2-methylphenol	2800 UJ	2000 UJ	4500 UJ	3100 UJ	25000 UJ	1500 U	2300 UJ
4-Bromophenylphenyl ether	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
4-Chloro-3-methylphenol	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
4-Chloroaniline	1100 UJ	770 UJ	1700 UJ	1200 UJ	2400 J	590 U	880 UJ
4-Chlorophenylphenyl ether	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
4-Nitroaniline	2800 UJ	2000 UJ	4500 UJ	3100 UJ	25000 UJ	1500 U	2300 UJ
4-Nitrophenol	2800 UJ	2000 UJ	4500 UJ	3100 UJ	25000 UJ	1500 U	2300 UJ
Acenaphthene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Acenaphthylene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Anthracene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Benzo(a)anthracene	340 J	400 UJ	890 UJ	620 UJ	1300 J	300 U	450 UJ
Benzo(a)pyrene	420 J	210 UJ	470 UJ	330 UJ	1500 J	160 U	240 UJ
Benzo(b)fluoranthene	520 J	400 UJ	890 UJ	620 UJ	1500 J	300 U	450 UJ
Benzo(g,h,i)perylene	350 J	400 UJ	890 UJ	620 UJ	1300 J	300 U	450 UJ
Benzo(k)fluoranthene	600 J	400 UJ	890 UJ	620 UJ	1800 J	300 U	450 UJ

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8270C Semivolatile Organic Compound Data

Sample ID	SED-CSE-S3-0.2FT	SED-CSF-S1-0.2FT	SED-CSF-S2-0.2FT	SED-CSF-S3-0.2FT	SED-M-S1-0.2FT	SED-RA1-S1-0.2FT	SED-RA1-S2-0.2FT
Sample Date	10/06/99	10/07/99	10/07/99	10/07/99	10/05/99	10/08/99	10/08/99
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
Butylbenzylphthalate	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Carbazole	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Chrysene	660 J	74 J	890 UJ	620 UJ	1600 J	300 U	450 UJ
Di-n-butylphthalate	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Di-n-octylphthalate	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Dibenzo(a,h)anthracene	300 UJ	210 UJ	470 UJ	330 UJ	2600 UJ	160 U	240 UJ
Dibenzofuran	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Diethylphthalate	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Dimethylphthalate	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Fluoranthene	1200 J	120 J	890 UJ	130 J	3000 J	300 U	450 UJ
Fluorene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Hexachlorobenzene	230 UJ	160 UJ	370 UJ	260 UJ	2000 UJ	120 U	190 UJ
Hexachlorobutadiene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Hexachlorocyclopentadiene	R	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Hexachloroethane	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Indeno(1,2,3-cd)pyrene	430 J	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Isophorone	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
N-Nitroso-di-n-propylamine	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
N-Nitrosodiphenylamine	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Naphthalene	560 UJ	400 UJ	890 UJ	620 UJ	1100 J	300 U	450 UJ
Nitrobenzene	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Pentachlorophenol	2800 UJ	2000 UJ	4500 UJ	3100 UJ	25000 UJ	1500 U	2300 UJ
Phenanthrene	510 J	400 UJ	890 UJ	620 UJ	1300 J	300 U	450 UJ
Phenol	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
Pyrene	1000 J	400 UJ	890 UJ	620 UJ	2200 J	300 U	450 UJ
bis(2-Chloroethoxy)methane	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
bis(2-Chloroethyl)ether	560 UJ	400 UJ	890 UJ	620 UJ	5000 UJ	300 U	450 UJ
bis(2-Ethylhexyl)phthalate	250 J	400 UJ	890 UJ	620 UJ	1400 J	300 U	450 UJ
Total Semivolatiles	6280	194	ND	130	20400	ND	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

BRIEN & GERE
ENGINEERS, INC.

\FT
utia

Sauget Area 1
Broad Scan Sediments
Method 8270C Semivolatile Organic Compound Data

Compound	Sample ID	SED-RA2-S1-0.2FT	SED-RA2-S1-0.2FTEB	SED-RA2-S1-0.2FTFD	SED-RA2-S2-0.2FT
	Sample Date	10/08/99	10/08/99	10/08/99	10/09/99
	Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw
1,2,4-Trichlorobenzene		350 UJ	10 U	350 UJ	370 UJ
1,2-Dichlorobenzene		350 UJ	10 U	350 UJ	370 UJ
1,3-Dichlorobenzene		350 UJ	10 U	350 UJ	370 UJ
1,4-Dichlorobenzene		350 UJ	10 U	350 UJ	370 UJ
2,2'-Oxybis(1-Chloropropane)		350 UJ	10 U	350 UJ	370 UJ
2,4,5-Trichlorophenol		350 UJ	10 U	350 UJ	370 UJ
2,4,6-Trichlorophenol		350 UJ	2.1 U	350 UJ	370 UJ
2,4-Dichlorophenol		350 UJ	10 U	350 UJ	370 UJ
2,4-Dinitrophenol		1800 UJ	14 U	1800 UJ	1800 UJ
2,4-Dinitrotoluene		350 UJ	10 U	350 UJ	370 UJ
2,6-Dinitrotoluene		350 UJ	10 U	350 UJ	370 UJ
2-Chloronaphthalene		350 UJ	10 U	350 UJ	370 UJ
2-Chlorophenol		350 UJ	10 U	350 UJ	370 UJ
2-Methylnaphthalene		350 UJ	10 U	350 UJ	370 UJ
2-Methylphenol (o-cresol)		350 UJ	10 U	350 UJ	370 UJ
2-Nitroaniline		1800 UJ	50 U	1800 UJ	1800 UJ
2-Nitrophenol		350 UJ	10 U	350 UJ	370 UJ
3,3'-Dichlorobenzidine		680 UJ	20 U	690 UJ	710 UJ
3-Methylphenol/4-Methylphenol		350 UJ	10 U	350 UJ	370 UJ
3-Nitroaniline		1800 UJ	50 U	1800 UJ	1800 UJ
4,6-Dinitro-2-methylphenol		1800 UJ	13 U	1800 UJ	1800 UJ
4-Bromophenylphenyl ether		350 UJ	1 U	350 UJ	370 UJ
4-Chloro-3-methylphenol		350 UJ	10 U	350 UJ	370 UJ
4-Chloroaniline		680 UJ	1.2	690 UJ	710 UJ
4-Chlorophenylphenyl ether		350 UJ	10 U	350 UJ	370 UJ
4-Nitroaniline		1800 UJ	50 U	1800 UJ	1800 UJ
4-Nitrophenol		1800 UJ	50 U	1800 UJ	1800 UJ
Acenaphthene		350 UJ	10 U	350 UJ	370 UJ
Acenaphthylene		350 UJ	10 U	350 UJ	370 UJ
Anthracene		350 UJ	10 U	350 UJ	370 UJ
Benzo(a)anthracene		350 UJ	10 U	350 UJ	370 UJ
Benzo(a)pyrene		190 UJ	10 U	190 UJ	190 UJ
Benzo(b)fluoranthene		350 UJ	10 U	350 UJ	370 UJ
Benzo(g,h,i)perylene		350 UJ	10 U	350 UJ	370 UJ
Benzo(k)fluoranthene		350 UJ	10 U	350 UJ	370 UJ

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:25:11
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8270C Semivolatile Organic Compound Data

Sample ID	SED-RA2-S1-0.2FT	SED-RA2-S1-0.2FTEB	SED-RA2-S1-0.2FTFD	SED-RA2-S2-0.2FT
Sample Date	10/08/99	10/08/99	10/08/99	10/09/99
Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw
Compound				
Butylbenzylphthalate	350 UJ	10 U	350 UJ	370 UJ
Carbazole	350 UJ	10 U	350 UJ	370 UJ
Chrysene	350 UJ	10 U	350 UJ	370 UJ
Di-n-butylphthalate	350 UJ	10 U	350 UJ	370 UJ
Di-n-octylphthalate	350 UJ	10 U	350 UJ	370 UJ
Dibenzo(a,h)anthracene	190 UJ	10 U	190 UJ	190 UJ
Dibenzofuran	350 UJ	10 U	350 UJ	370 UJ
Diethylphthalate	350 UJ	10 U	350 UJ	370 UJ
Dimethylphthalate	350 UJ	10 U	350 UJ	370 UJ
Fluoranthene	350 UJ	10 U	350 UJ	370 UJ
Fluorene	350 UJ	1 U	350 UJ	370 UJ
Hexachlorobenzene	140 UJ	10 U	140 UJ	150 UJ
Hexachlorobutadiene	350 UJ	10 U	350 UJ	370 UJ
Hexachlorocyclopentadiene	350 UJ	10 U	350 UJ	370 UJ
Hexachloroethane	350 UJ	1.9 U	350 UJ	370 UJ
Indeno(1,2,3-cd)pyrene	350 UJ	10 U	350 UJ	370 UJ
Isophorone	350 UJ	10 U	350 UJ	370 UJ
N-Nitroso-di-n-propylamine	350 UJ	10 U	350 UJ	370 UJ
N-Nitrosodiphenylamine	350 UJ	5 U	350 UJ	370 UJ
Naphthalene	350 UJ	10 U	350 UJ	370 UJ
Nitrobenzene	350 UJ	3.5 U	350 UJ	370 UJ
Pentachlorophenol	1800 UJ	5 U	1800 UJ	1800 UJ
Phenanthrene	350 UJ	10 U	350 UJ	370 UJ
Phenol	350 UJ	10 U	350 UJ	370 UJ
Pyrene	350 UJ	10 U	350 UJ	370 UJ
bis(2-Chloroethoxy)methane	350 UJ	10 U	350 UJ	370 UJ
bis(2-Chloroethyl)ether	350 UJ	10 U	350 UJ	370 UJ
bis(2-Ethylhexyl)phthalate	350 UJ	1.8 U	350 UJ	370 UJ
Total Semivolatiles	ND	1.2	ND	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/1[illegible]00 16:25:11
DBF File: N:\10[illegible]01\TEMPDATA.DBF
FXP File: N:\10[illegible]01\TABLEPRS.FXP

Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT

Solutia

Sauget Area 1

Broad Scan Sediments

Method 680 Chlorinated Biphenyl Data

Compound	Sample ID	BPL-ESED-S1-0.2FT	BPL-ESED-S1-0.2FT-FD	BPL-ESED-S2-0.2FT	BPL-ESED-S3-0.2FT	BSSED-PDC-DS-S-0-30IN	BSSED-PDC-US-N-0-20IN	BSSED-PDC-US-N-0-20INEB
	Sample Date	10/06/99	10/06/99	10/07/99	10/06/99	02/07/00	02/07/00	02/04/00
	Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/l
Decachlorobiphenyl		230 UJ	46 UJ	49 UJ	46 UJ	24 U	23 U	0.5 U
Dichlorobiphenyl		46 UJ	9.2 UJ	9.7 UJ	9.2 UJ	4.8 UJ	4.5 U	0.1 U
Heptachlorobiphenyl		140 UJ	28 UJ	29 UJ	28 UJ	15 UJ	14 U	0.3 U
Hexachlorobiphenyl		95 UJ	19 UJ	20 UJ	19 UJ	9.8 UJ	9.2 U	0.2 U
Monochlorobiphenyl		46 UJ	9.2 UJ	9.7 UJ	9.2 UJ	4.8 UJ	4.5 U	0.1 U
Nonachlorobiphenyl		230 UJ	46 UJ	49 UJ	46 UJ	24 UJ	23 U	0.5 U
Octachlorobiphenyl		140 UJ	28 UJ	29 UJ	28 UJ	15 UJ	14 U	0.3 U
Pentachlorobiphenyl		95 UJ	19 UJ	20 UJ	19 UJ	9.8 UJ	9.2 U	0.2 U
Tetrachlorobiphenyl		95 UJ	19 UJ	20 UJ	19 UJ	9.8 UJ	9.2 U	0.2 U
Trichlorobiphenyl		46 UJ	9.2 UJ	9.7 UJ	9.2 UJ	4.8 UJ	4.5 U	0.1 U
Total PCBs		ND	ND	ND	ND	ND	ND	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:26:08
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT

Solutia
Sauget Area 1
Broad Scan Sediments
Method 680 Chlorinated Biphenyl Data

Sample ID	BSSED-PDC-US-N-0-20INFD	SED-CSB-0.2FTEB	SED-CSB-S1-0.2FT	SED-CSB-S1-0.2FTFD	SED-CSB-S2-0.2FT	SED-CSB-S3-0.2FT	SED-CSC-S1-0.2FT
Sample Date	02/07/00	10/05/99	10/05/99	10/05/99	10/05/99	10/05/99	10/04/99
Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
Decachlorobiphenyl	23 U	0.50 U	2500 UJ	2300 UJ	3400 J	2300 J	290 UJ
Dichlorobiphenyl	4.6 U	0.10 U	500 UJ	450 UJ	640 J	500 J	57 UJ
Heptachlorobiphenyl	14 U	0.30 U	980 J	1400 UJ	5300 J	1300 J	170 UJ
Hexachlorobiphenyl	9.3 U	0.20 U	5200 J	2600 J	21000 J	7600 J	160 J
Monochlorobiphenyl	4.6 U	0.10 U	500 UJ	450 UJ	500 UJ	670 UJ	57 UJ
Nonachlorobiphenyl	23 U	0.50 U	2500 UJ	2300 UJ	2500 UJ	3400 UJ	290 UJ
Octachlorobiphenyl	14 U	0.30 U	1500 UJ	1400 UJ	1800 J	2000 UJ	170 UJ
Pentachlorobiphenyl	9.3 U	0.20 U	34000 J	7500 J	66000 J	19000 J	110 UJ
Tetrachlorobiphenyl	9.3 U	0.20 U	88000 J	15000 J	98000 J	26000 J	110 UJ
Trichlorobiphenyl	4.6 U	0.10 U	34000 J	4800 J	30000 J	11000 J	57 UJ
Total PCBs	ND	ND	162180	29900	226140	67700	160

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

BRIEN & GERE
ENGINEERS, INC.

(\FT
.utia

Sauget Area 1
Broad Scan Sediments
Method 680 Chlorinated Biphenyl Data

Sample ID	SED-CSC-S2-0.2FT	SED-CSC-S3-0.2FT	SED-CSD-S1-0.2FT	SED-CSD-S2-0.2FT	SED-CSD-S3-0.2FT	SED-CSE-S1-0.2FT	SED-CSE-S2-0.2FT
Sample Date	10/04/99	10/04/99	10/04/99	10/04/99	10/04/99	10/06/99	10/06/99
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
Decachlorobiphenyl	2900 UJ	3900 UJ	170 J	230 J	300 UJ	140 J	440 UJ
Dichlorobiphenyl	570 UJ	770 UJ	87 UJ	96 UJ	59 UJ	12 UJ	87 UJ
Heptachlorobiphenyl	1700 UJ	2300 UJ	260 UJ	290 UJ	180 UJ	49 J	260 UJ
Hexachlorobiphenyl	720 J	2000 J	97 J	400 J	250 J	130 J	170 UJ
Monochlorobiphenyl	570 UJ	770 UJ	87 UJ	96 UJ	59 UJ	12 UJ	87 UJ
Nonachlorobiphenyl	2900 UJ	3900 UJ	440 UJ	480 UJ	300 UJ	60 UJ	440 UJ
Octachlorobiphenyl	1700 UJ	2300 UJ	260 UJ	290 UJ	180 UJ	36 UJ	260 UJ
Pentachlorobiphenyl	2200 J	2600 J	430 J	520 J	480 J	650 J	170 UJ
Tetrachlorobiphenyl	1200 UJ	1600 UJ	180 UJ	190 UJ	120 UJ	60 J	170 UJ
Trichlorobiphenyl	570 UJ	770 UJ	87 UJ	96 UJ	59 UJ	9.2 J	87 UJ
Total PCBs	2920	4600	697	1150	730	1038.2	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:26:08
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 680 Chlorinated Biphenyl Data

Sample ID	SED-CSE-S3-0.2FT	SED-CSF-S1-0.2FT	SED-CSF-S2-0.2FT	SED-CSF-S3-0.2FT	SED-M-S1-0.2FT	SED-RA1-S1-0.2FT	SED-RA1-S2-0.2FT
Sample Date	10/06/99	10/07/99	10/07/99	10/07/99	10/05/99	10/08/99	10/08/99
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
Decachlorobiphenyl	56 UJ	39 UJ	88 UJ	310 UJ	5100 UJ	30 U	45 UJ
Dichlorobiphenyl	11 UJ	7.7 UJ	17 UJ	60 UJ	1000 UJ	5.9 U	8.9 UJ
Heptachlorobiphenyl	33 UJ	23 UJ	53 UJ	180 UJ	3000 UJ	18 U	27 UJ
Hexachlorobiphenyl	22 UJ	22 J	17 J	120 UJ	3000 J	12 U	18 UJ
Monochlorobiphenyl	11 UJ	7.7 UJ	17 UJ	60 UJ	1000 UJ	5.9 U	8.9 UJ
Nonachlorobiphenyl	56 UJ	39 UJ	88 UJ	310 UJ	5100 UJ	30 U	45 UJ
Octachlorobiphenyl	33 UJ	23 UJ	53 UJ	180 UJ	3000 UJ	18 U	27 UJ
Pentachlorobiphenyl	22 UJ	61 J	66 J	120 UJ	4800 J	12 U	18 UJ
Tetrachlorobiphenyl	22 UJ	16 UJ	35 UJ	120 UJ	3100 J	12 U	18 UJ
Trichlorobiphenyl	11 UJ	7.7 UJ	17 UJ	60 UJ	1300 J	5.9 U	8.9 UJ
Total PCBs	ND	83	83	ND	12200	ND	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

O'BRIEN & GERE ENGINEERS, INC.

DRAFT

Sauget Area 1

Broad Scan Sediments

Method 680 Chlorinated Biphenyl Data

Sample ID	SED-RA2-S1-0.2FT	SED-RA2-S1-0.2FTEB	SED-RA2-S1-0.2FTFD	SED-RA2-S2-0.2FT
Sample Date	10/08/99	10/08/99	10/08/99	10/09/99
Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw
Compound				
Decachlorobiphenyl	35 UJ	0.5 U	35 UJ	36 UJ
Dichlorobiphenyl	6.9 UJ	0.1 U	6.9 UJ	7.1 UJ
Heptachlorobiphenyl	21 UJ	0.3 U	21 UJ	22 UJ
Hexachlorobiphenyl	14 UJ	0.2 U	14 UJ	14 UJ
Monochlorobiphenyl	6.9 UJ	0.1 U	6.9 UJ	7.1 UJ
Nonachlorobiphenyl	35 UJ	0.5 U	35 UJ	36 UJ
Octachlorobiphenyl	21 UJ	0.3 U	21 UJ	22 UJ
Pentachlorobiphenyl	14 UJ	0.2 U	14 UJ	14 UJ
Tetrachlorobiphenyl	14 UJ	0.2 U	14 UJ	14 UJ
Trichlorobiphenyl	6.9 UJ	0.1 U	6.9 UJ	7.1 UJ
Total PCBs	ND	ND	ND	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:26:08
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT

Solutia

Sauget Area 1

Broad Scan Sediments

Method 8081A Pesticide Data

Compound	Sample ID	BPL-ESED-S1-0.2FT	BPL-ESED-S1-0.2FT-FD	BPL-ESED-S2-0.2FT	BPL-ESED-S3-0.2FT	BSSED-PDC-DS-S-0-30IN	BSSED-PDC-US-N-0-20IN	BSSED-PDC-US-N-0-20INEB
	Sample Date	10/06/99	10/06/99	10/07/99	10/06/99	02/07/00	02/07/00	02/04/00
	Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/l
4,4'-DDD		18 UJ	9.1 UJ	19 UJ	18 UJ	4.8 U	4.5 U	0.1 U
4,4'-DDE		1.4 J	0.81 J	3.2 J	1.6 J	4.8 U	4.5 U	0.1 U
4,4'-DDT		1.9 J	0.38 J	19 UJ	1.4 J	4.8 U	4.5 U	0.1 U
Aldrin		9.4 UJ	4.7 UJ	9.9 UJ	9.4 UJ	2.4 U	2.3 U	0.05 U
Alpha Chlordane		0.52 J	0.43 J	3.2 J	1.2 J	2.4 U	2.3 U	0.05 U
Dieldrin		0.3 J	0.21 J	0.5 J	18 UJ	4.8 UJ	4.5 U	0.1 U
Endosulfan I		9.4 UJ	0.38 J	2.8 J	1 J	2.4 U	2.3 U	0.05 U
Endosulfan II		18 UJ	9.1 UJ	19 UJ	18 UJ	4.8 U	4.5 U	0.1 U
Endosulfan sulfate		18 UJ	0.94 J	1.4 J	18 UJ	4.8 U	4.5 U	0.1 U
Endrin		18 UJ	9.1 UJ	19 UJ	18 UJ	4.8 UJ	4.5 U	0.1 U
Endrin aldehyde		1.6 J	1.1 J	2.2 J	1.2 J	4.8 U	4.5 U	0.1 U
Endrin ketone		1 J	0.43 J	19 UJ	18 UJ	4.8 U	4.5 U	0.1 U
Gamma Chlordane		0.89 J	0.58 J	3 J	9.4 UJ	2.4 U	2.3 U	0.05 U
Heptachlor		9.4 UJ	4.7 UJ	9.9 UJ	9.4 UJ	2.4 U	2.3 U	0.05 U
Heptachlor epoxide		9.4 UJ	0.2 J	9.9 UJ	9.4 UJ	2.4 U	2.3 U	0.05 U
Methoxychlor		94 UJ	47 UJ	99 UJ	94 UJ	24 U	23 U	0.5 U
Toxaphene		940 UJ	470 UJ	990 UJ	940 UJ	240 U	230 U	5 U
alpha-BHC		2.8 UJ	1.4 UJ	2.9 UJ	2.8 UJ	0.72 U	0.68 U	0.039 U
beta-BHC		2.8 UJ	1.4 UJ	2.9 UJ	2.8 UJ	0.72 UJ	0.68 U	0.014 U
delta-BHC		2.8 UJ	1.4 UJ	2.9 UJ	2.8 UJ	2.4 U	2.3 U	0.012 U
gamma-BHC (Lindane)		9.4 UJ	0.16 J	9.9 UJ	9.4 UJ	2.4 U	2.3 U	0.019 U
Total Pesticides		7.61	5.62	16.3	6.4	ND	ND	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:27:00
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8081A Pesticide Data

Sample ID	BSSED-PDC-US-N-0-20INFD	SED-CSB-0.2FTEB	SED-CSB-S1-0.2FT	SED-CSB-S1-0.2FTFD	SED-CSB-S2-0.2FT	SED-CSB-S3-0.2FT	SED-CSC-S1-0.2FT
Sample Date	02/07/00	10/05/99	10/05/99	10/05/99	10/05/99	10/05/99	10/04/99
Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
4,4'-DDD	4.5 U	0.10 U	170 J	130 J	970 UJ	650 UJ	28 J
4,4'-DDE	4.5 U	0.10 U	970 UJ	860 UJ	970 UJ	650 UJ	51 J
4,4'-DDT	4.5 U	0.10 U	970 UJ	860 UJ	970 UJ	650 UJ	140 UJ
Aldrin	2.3 U	0.050 U	1200 J	1000 J	980 J	410 J	25 J
Alpha Chlordane	2.3 U	0.050 U	500 UJ	440 UJ	500 UJ	330 UJ	37 J
Dieldrin	4.5 U	0.10 U	970 UJ	860 UJ	970 UJ	650 UJ	140 UJ
Endosulfan I	2.3 U	0.050 U	500 UJ	440 UJ	500 UJ	330 UJ	70 UJ
Endosulfan II	4.5 U	0.10 U	970 UJ	860 UJ	970 UJ	650 UJ	140 UJ
Endosulfan sulfate	4.5 U	0.0014	970 UJ	84 J	130 J	98 J	9 J
Endrin	4.5 U	0.10 U	970 UJ	860 UJ	970 UJ	650 UJ	140 UJ
Endrin aldehyde	4.5 U	0.10 U	520 J	860 UJ	970 UJ	650 UJ	140 UJ
Endrin ketone	4.5 U	0.10 U	970 UJ	860 UJ	970 UJ	650 UJ	140 UJ
Gamma Chlordane	2.3 U	0.050 U	760 J	680 J	500 UJ	330 UJ	110 J
Heptachlor	2.3 U	0.050 U	500 UJ	440 UJ	500 J	330 UJ	70 UJ
Heptachlor epoxide	2.3 U	0.050 U	500 UJ	440 UJ	500 UJ	330 UJ	70 UJ
Methoxychlor	23 U	0.50 U	5000 UJ	4400 UJ	5000 UJ	3300 UJ	700 UJ
Toxaphene	230 U	5.0 U	50000 UJ	44000 UJ	50000 UJ	33000 UJ	7000 UJ
alpha-BHC	0.69 U	0.039 U	150 UJ	130 UJ	150 UJ	98 UJ	21 UJ
beta-BHC	0.69 U	0.014 U	150 UJ	130 UJ	150 UJ	98 UJ	21 UJ
delta-BHC	2.3 U	0.0096	150 UJ	130 UJ	150 UJ	98 UJ	21 UJ
gamma-BHC (Lindane)	2.3 U	0.019 U	500 UJ	440 UJ	500 UJ	330 UJ	70 UJ
Total Pesticides	ND	0.011	2650	1894	1610	508	260

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

O'BRIEN & GERE ENGINEERS, INC.

DRAFT

Mutia

Sauget Area 1
Broad Scan Sediments
Method 8081A Pesticide Data

Sample ID	SED-CSC-S2-0.2FT	SED-CSC-S3-0.2FT	SED-CSD-S1-0.2FT	SED-CSD-S2-0.2FT	SED-CSD-S3-0.2FT	SED-CSE-S1-0.2FT	SED-CSE-S2-0.2FT
Sample Date	10/04/99	10/04/99	10/04/99	10/04/99	10/04/99	10/06/99	10/06/99
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
4,4'-DDD	270 UJ	380 UJ	86 UJ	94 UJ	58 UJ	120 UJ	86 UJ
4,4'-DDE	270 UJ	380 UJ	20 J	14 J	4.4 J	15 J	3.4 J
4,4'-DDT	270 UJ	380 UJ	86 UJ	94 UJ	58 UJ	9.3 J	86 UJ
Aldrin	42 J	64 J	9.6 J	11 J	2.7 J	60 UJ	44 UJ
Alpha Chlordane	54 J	120 J	26 J	14 J	30 UJ	6.9 J	2.5 J
Dieldrin	270 UJ	380 UJ	86 UJ	94 UJ	58 UJ	9.4 J	1.7 J
Endosulfan I	140 UJ	200 UJ	44 UJ	48 UJ	30 UJ	60 UJ	44 UJ
Endosulfan II	270 UJ	380 UJ	86 UJ	94 UJ	58 UJ	12 J	2.3 J
Endosulfan sulfate	16 J	380 UJ	86 UJ	94 UJ	58 UJ	10 J	86 UJ
Endrin	270 UJ	380 UJ	86 UJ	94 UJ	58 UJ	4.6 J	86 UJ
Endrin aldehyde	270 UJ	380 UJ	86 UJ	94 UJ	16 J	22 J	3.6 J
Endrin ketone	270 UJ	380 UJ	86 UJ	94 UJ	5.5 J	17 J	6.8 J
Gamma Chlordane	140 J	250 J	49 J	29 J	6.7 J	14 J	5.9 J
Heptachlor	9.1 J	9.7 J	44 UJ	48 UJ	30 UJ	60 UJ	44 UJ
Heptachlor epoxide	140 UJ	200 UJ	44 UJ	48 UJ	30 UJ	5.2 J	44 UJ
Methoxychlor	1400 UJ	2000 UJ	440 UJ	480 UJ	300 UJ	39 J	440 UJ
Toxaphene	14000 UJ	20000 UJ	4400 UJ	4800 UJ	3000 UJ	6000 UJ	4400 UJ
alpha-BHC	41 UJ	58 UJ	13 UJ	14 UJ	8.8 UJ	18 UJ	13 UJ
beta-BHC	41 UJ	58 UJ	13 UJ	14 UJ	8.8 UJ	18 UJ	13 UJ
delta-BHC	41 UJ	18 J	16 J	14 UJ	1.5 J	1.3 J	13 UJ
gamma-BHC (Lindane)	140 UJ	200 UJ	44 UJ	48 UJ	30 UJ	60 UJ	44 UJ
Total Pesticides	261.1	461.7	120.6	68	36.8	165.7	26.2

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:27:00
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8081A Pesticide Data

Compound	Sample ID	SED-CSE-S3-0.2FT	SED-CSF-S1-0.2FT	SED-CSF-S2-0.2FT	SED-CSF-S3-0.2FT	SED-M-S1-0.2FT	SED-RA1-S1-0.2FT	SED-RA1-S2-0.2FT
	Sample Date	10/06/99	10/07/99	10/07/99	10/07/99	10/05/99	10/08/99	10/08/99
	Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
4,4'-DDD		22 UJ	3.8 J	35 UJ	24 UJ	770 UJ	5.8 U	8.8 UJ
4,4'-DDE		4.3 J	11 J	8.1 J	2.5 J	110 J	5.8 U	8.8 UJ
4,4'-DDT		22 UJ	4.5 J	35 UJ	24 UJ	44 J	5.8 U	8.8 UJ
Aldrin		11 UJ	4.1 J	18 UJ	12 UJ	120 J	3 U	4.6 UJ
Alpha Chlordane		3.9 J	4.6 J	5.3 J	0.84 J	400 UJ	3 U	4.6 UJ
Dieldrin		5.4 J	9.3 J	35 UJ	0.99 J	770 UJ	5.8 U	8.8 UJ
Endosulfan I		11 UJ	5.7 J	2 J	1.2 J	400 UJ	3 U	4.6 UJ
Endosulfan II		22 UJ	8.1 J	5.5 J	1.8 J	770 UJ	5.8 U	8.8 UJ
Endosulfan sulfate		22 UJ	2.8 J	35 UJ	24 UJ	50 J	5.8 U	8.8 UJ
Endrin		22 UJ	1.7 J	35 UJ	1.7 J	770 UJ	5.8 U	8.8 UJ
Endrin aldehyde		22 UJ	14 J	9 J	3.6 J	770 UJ	5.8 U	8.8 UJ
Endrin ketone		22 UJ	10 J	7.2 J	3.8 J	200 J	5.8 U	8.8 UJ
Gamma Chlordane		5.1 J	17 J	7.5 J	2.4 J	140 J	3 U	4.6 UJ
Heptachlor		0.53 J	7.8 UJ	18 UJ	0.93 J	59 J	3 U	4.6 UJ
Heptachlor epoxide		11 UJ	5.4 J	18 UJ	0.51 J	400 UJ	3 U	4.6 UJ
Methoxychlor		110 UJ	24 J	14 J	7.3 J	4000 UJ	30 U	46 UJ
Toxaphene		1100 UJ	780 UJ	1800 UJ	1200 UJ	40000 UJ	300 U	460 UJ
alpha-BHC		3.3 UJ	2.3 UJ	5.3 UJ	3.7 UJ	120 UJ	0.89 U	1.3 UJ
beta-BHC		3.3 UJ	2.3 UJ	5.3 UJ	3.7 UJ	120 UJ	0.89 U	1.3 UJ
delta-BHC		3.3 UJ	0.34 J	5.3 UJ	3.7 UJ	120 UJ	0.89 U	1.3 UJ
gamma-BHC (Lindane)		11 UJ	7.8 UJ	18 UJ	12 UJ	400 UJ	3 U	4.6 UJ
Total Pesticides		19.23	126.34	58.6	27.57	723	ND	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

O'BRIEN & GERE ENGINEERS, INC.

DRAFT

Mutia

Sauget Area 1
Broad Scan Sediments
Method 8081A Pesticide Data

Sample ID	SED-RA2-S1-0.2FT	SED-RA2-S1-0.2FTEB	SED-RA2-S1-0.2FTFD	SED-RA2-S2-0.2FT
Sample Date	10/08/99	10/08/99	10/08/99	10/09/99
Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw
Compound				
4,4'-DDD	6.8 UJ	0.1 U	6.8 UJ	7.2 UJ
4,4'-DDE	6.8 UJ	0.1 U	6.8 UJ	7.2 UJ
4,4'-DDT	6.8 UJ	0.1 U	6.8 UJ	7.2 UJ
Aldrin	3.5 UJ	0.05 U	3.5 UJ	3.7 UJ
Alpha Chlordane	3.5 UJ	0.05 U	3.5 UJ	3.7 UJ
Dieldrin	6.8 UJ	0.1 U	6.8 UJ	7.2 UJ
Endosulfan I	3.5 UJ	0.05 U	3.5 UJ	3.7 UJ
Endosulfan II	6.8 UJ	0.1 U	6.8 UJ	7.2 UJ
Endosulfan sulfate	6.8 UJ	0.1 U	6.8 UJ	7.2 UJ
Endrin	6.8 UJ	0.1 U	6.8 UJ	7.2 UJ
Endrin aldehyde	6.8 UJ	0.1 U	6.8 UJ	7.2 UJ
Endrin ketone	6.8 UJ	0.1 U	6.8 UJ	7.2 UJ
Gamma Chlordane	3.5 UJ	0.05 U	3.5 UJ	3.7 UJ
Heptachlor	3.5 UJ	0.05 U	3.5 UJ	3.7 UJ
Heptachlor epoxide	3.5 UJ	0.05 U	3.5 UJ	3.7 UJ
Methoxychlor	35 UJ	0.5 U	35 UJ	37 UJ
Toxaphene	350 UJ	5 U	350 UJ	370 UJ
alpha-BHC	1 UJ	0.039 U	1 UJ	1.1 UJ
beta-BHC	1 UJ	0.014 U	1 UJ	1.1 UJ
delta-BHC	1 UJ	0.0089	1 UJ	1.1 UJ
gamma-BHC (Lindane)	3.5 UJ	0.019 U	3.5 UJ	3.7 UJ
Total Pesticides	ND	0.0089	ND	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:27:00
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

(RAFT

Solutia

Sauget Area 1
Broad Scan Sediments
Method 8151A Herbicide Data

Compound	Sample ID	BPL-ESED-S1-0.2FT	BPL-ESED-S1-0.2FT-FD	BPL-ESED-S2-0.2FT	BPL-ESED-S3-0.2FT	BSSED-PDC-DS-S-0-30IN	BSSED-PDC-US-N-0-20IN	BSSED-PDC-US-N-0-20INEB
	Sample Date	10/06/99	10/06/99	10/07/99	10/06/99	02/07/00	02/07/00	02/04/00
	Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/l
2,4,5-T		23 UJ	23 UJ	24 UJ	23 UJ	12 U	11 U	0.5 U
2,4,5-TP (Silvex)		23 UJ	23 UJ	24 UJ	23 UJ	12 U	11 U	0.5 U
2,4-D		23 UJ	6.1 J	24 UJ	11 J	12 U	11 U	0.5 U
2,4-DB		23 UJ	23 UJ	24 UJ	23 UJ	12 U	11 U	0.5 U
Dalapon		180 UJ	180 UJ	190 UJ	180 UJ	97 U	90 U	120 U
Dicamba		55 UJ	55 UJ	58 UJ	56 UJ	30 U	27 U	1.2 U
Dichloroprop		280 UJ	270 UJ	290 UJ	280 UJ	140 U	140 U	6 U
Dinoseb		280 UJ	270 UJ	290 UJ	280 UJ	140 U	140 U	6 U
MCPA		5500 UJ	5500 UJ	5800 UJ	5600 UJ	2900 U	2700 U	120 U
MCPP		5500 UJ	5500 UJ	5800 UJ	5600 UJ	2900 U	2700 U	120 U
Pentachlorophenol		47 UJ	47 UJ	50 UJ	47 UJ	29 U	27 U	1 U
Total Herbicides		ND	6.1	ND	11	ND	ND	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:27:51
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8151A Herbicide Data

Sample ID	BSSED-PDC-US-N-0-20INFD	SED-CSB-0.2FTEB	SED-CSB-S1-0.2FT	SED-CSB-S1-0.2FTFD	SED-CSB-S2-0.2FT	SED-CSB-S3-0.2FT	SED-CSC-S1-0.2FT
Sample Date	02/07/00	10/05/99	10/05/99	10/05/99	10/05/99	10/05/99	10/04/99
Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
2,4,5-T	11 U	0.50 U	110 UJ	110 UJ	21 UJ	140 UJ	28 UJ
2,4,5-TP (Silvex)	11 U	0.50 U	110 UJ	110 UJ	21 UJ	140 UJ	28 UJ
2,4-D	11 U	0.50 U	110 UJ	110 UJ	21 UJ	140 UJ	28 UJ
2,4-DB	11 U	0.50 U	110 UJ	110 UJ	21 UJ	140 UJ	28 UJ
Dalapon	91 U	120 U	840 UJ	850 UJ	160 UJ	1100 UJ	220 UJ
Dicamba	28 U	1.2 U	260 UJ	260 UJ	50 UJ	350 UJ	68 UJ
Dichloroprop	140 U	6.0 U	1300 UJ	1300 UJ	250 UJ	1800 UJ	340 UJ
Dinoseb	140 U	6.0 U	1300 UJ	1300 UJ	250 UJ	1800 UJ	340 UJ
MCPA	2800 U	120 U	26000 UJ	26000 UJ	5000 UJ	35000 UJ	6800 UJ
MCPP	2800 U	120 U	26000 UJ	26000 UJ	5000 UJ	35000 UJ	6800 UJ
Pentachlorophenol	23 U	1.0 U	57 J	36 J	220 J	56 J	7.4 J
Total Herbicides	ND	ND	57	36	220	56	7.4

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

BRIEN & GERE ENGINEERS, INC.

FT

Solutia

Sauget Area 1
Broad Scan Sediments
Method 8151A Herbicide Data

Sample ID	SED-CSC-S2-0.2FT	SED-CSC-S3-0.2FT	SED-CSD-S1-0.2FT	SED-CSD-S2-0.2FT	SED-CSD-S3-0.2FT	SED-CSE-S1-0.2FT	SED-CSE-S2-0.2FT
Sample Date	10/04/99	10/04/99	10/04/99	10/04/99	10/04/99	10/06/99	10/06/99
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
2,4,5-T	24 UJ	180 UJ	190 UJ	220 UJ	24 UJ	170 U	130 UJ
2,4,5-TP (Silvex)	24 UJ	180 UJ	190 UJ	220 UJ	24 UJ	170 UJ	130 UJ
2,4-D	24 UJ	180 UJ	190 UJ	220 UJ	24 UJ	73 J	130 UJ
2,4-DB	24 UJ	180 UJ	190 UJ	220 UJ	24 UJ	150 J	130 UJ
Dalapon	180 UJ	1400 UJ	1500 UJ	1700 UJ	190 UJ	1300 UJ	990 UJ
Dicamba	57 UJ	440 UJ	460 UJ	13 J	59 UJ	410 UJ	300 UJ
Dichloroprop	280 UJ	2200 UJ	2300 UJ	2600 UJ	290 UJ	2100 UJ	1500 UJ
Dinoseb	280 UJ	2200 UJ	2300 UJ	2600 UJ	290 UJ	2100 UJ	1500 UJ
MCPA	5700 UJ	44000 UJ	46000 UJ	53000 UJ	5900 UJ	41000 UJ	30000 UJ
MCPP	5700 UJ	44000 UJ	46000 UJ	53000 UJ	5900 UJ	41000 UJ	30000 UJ
Pentachlorophenol	23 J	23 J	400 UJ	450 UJ	3.9 J	350 UJ	12 J
Total Herbicides	23	23	ND	13	3.9	223	12

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:27:51
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

DRAFT
Solutia
Sauget Area 1
Broad Scan Sediments
Method 8151A Herbicide Data

Sample ID	SED-CSE-S3-0.2FT	SED-CSF-S1-0.2FT	SED-CSF-S2-0.2FT	SED-CSF-S3-0.2FT	SED-M-S1-0.2FT	SED-RA1-S1-0.2FT	SED-RA1-S2-0.2FT
Sample Date	10/06/99	10/07/99	10/07/99	10/07/99	10/05/99	10/08/99	10/08/99
Units	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw	ug/kg dw
Compound							
2,4,5-T	140 UJ	110 UJ	240 UJ	30 UJ	220 UJ	15 U	22 UJ
2,4,5-TP (Silvex)	140 UJ	110 UJ	240 UJ	30 UJ	220 UJ	15 U	22 UJ
2,4-D	140 UJ	110 UJ	240 UJ	23 J	220 UJ	12 J	22 UJ
2,4-DB	140 UJ	110 UJ	240 UJ	30 UJ	220 UJ	15 UJ	22 UJ
Dalapon	1100 UJ	860 UJ	2000 UJ	240 UJ	1700 UJ	120 U	180 UJ
Dicamba	340 UJ	260 UJ	570 UJ	74 UJ	540 UJ	35 U	54 UJ
Dichloroprop	1700 UJ	1300 UJ	2900 UJ	370 UJ	2700 UJ	180 U	270 UJ
Dinoseb	R	1300 UJ	2900 UJ	370 UJ	2700 UJ	180 U	270 UJ
MCPA	34000 UJ	26000 UJ	57000 UJ	7400 UJ	54000 UJ	3500 UJ	5400 UJ
MCPP	34000 UJ	26000 UJ	57000 UJ	7400 UJ	54000 UJ	3500 U	5400 UJ
Pentachlorophenol	3.8 J	72 UJ	490 UJ	62 UJ	52 J	1.9 J	46 UJ
Total Herbicides	3.8	ND	ND	23	52	13.9	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/3[illegible] 16:27:51
DBF File: N:\100[illegible]\TEMPDATA.DBF
FXP File: N:\100[illegible]\TABLEPRS.FXP

File Number: 10040.25501

O'BRIEN & GERE ENGINEERS, INC.

(`AFT
.lutia
Sauget Area 1
Broad Scan Sediments
Method 8151A Herbicide Data

Compound	Sample ID	SED-RA2-S1-0.2FT	SED-RA2-S1-0.2FTEB	SED-RA2-S1-0.2FTFD	SED-RA2-S2-0.2FT
	Sample Date	10/08/99	10/08/99	10/08/99	10/09/99
	Units	ug/kg dw	ug/l	ug/kg dw	ug/kg dw
2,4,5-T		17 UJ	0.5 U	17 UJ	18 UJ
2,4,5-TP (Silvex)		17 UJ	0.5 U	17 UJ	18 UJ
2,4-D		17 UJ	0.5 U	17 UJ	18 UJ
2,4-DB		17 UJ	0.5 U	17 UJ	18 UJ
Dalapon		130 UJ	120 U	130 UJ	120 UJ
Dicamba		42 UJ	1.2 U	42 UJ	43 UJ
Dichloroprop		210 UJ	6 U	210 UJ	220 UJ
Dinoseb		210 UJ	6 U	210 UJ	220 UJ
MCPA		4200 UJ	120 U	4200 UJ	4300 UJ
MCPP		4200 UJ	120 U	4200 UJ	4300 UJ
Pentachlorophenol		35 UJ	---	35 UJ	36 UJ
Total Herbicides		ND	ND	ND	ND

NOTES: U - not detected, J - estimated value, N - tentatively identified, R - rejected, M - EMPC.

Date Printed: 05/30/00 16:27:51
DBF File: N:\10040\25501\TEMPDATA.DBF
FXP File: N:\10040\25501\TABLEPRS.FXP

File Number: 10040.25501

Appendix 4

1999 Sauget Area 1 Support Sampling Plan

Sediment Bioassays

EXECUTIVE SUMMARY

100.1HASG Amphipod, *Hyalella azteca* 10 Day Survival and Growth Test
Conducted October 7 - October 31, 1999
for Menzie-Cura & Associates
Dead Creek Site

Laboratory Sample ID	Client Sample ID	Mean Survival (%)	Mean Dry Weight (mg)
12546	BTOX-C-1	90	0.080*
12547	BTOX-C-2	71	0.064*
12548	BTOX-C-3	68*	--
12549	BTOX-D-1	90	0.172
12550	BTOX-D-2	88	0.134*
12551	BTOX-D-3	90	0.168
12552	Laboratory Control Sediment	86	0.223
12589	BTOX-B-1	16*	--
12590	BTOX-B-1 (DUPE)	19*	--
12591	BTOX-B-2	1*	--
12592	BTOX-B-3	64*	--
12593	BTOX-M	10*	--
12609	E-1 Dead Creek	23*	--
12610	E-2 Dead Creek	76	0.664
12611	E-3 Dead Creek	85	0.141*
12612	BP-1 Borrow Pit	89	0.156*
12613	BP-1 Borrow Pit (DUPE)	94	0.154*
12614	BP-3 Borrow Pit	91	0.154*
12622	Laboratory Control Sediment	86	0.202
12638	BP-2 Borrow Pit	96	0.172
12639	F-1 Dead Creek Section F	91	0.221
12640	F-2 Dead Creek Section F	86	0.219
12641	F-3 Dead Creek Section F	83	0.183
12664	Prairie DuPont Creek	98	0.254
12665	Prairie DuPont Creek 2	98	0.404
12666	Reference Creek	98	0.393
12668	Laboratory Control Sediment	98	0.268
12671	Ref 2-2 Reference Borrow Pit	98	0.335

* The response data were statistically significantly different from the corresponding laboratory control sediment ($p \leq 0.05$)

-- When a significant reduction in survival was detected, mean dry weight data were only reported in Appendix A (See Results).

EXECUTIVE SUMMARY

100.1HA Amphipod, *Hyalella azteca*, 42-day Chronic Survival, Growth, and Reproduction Test
Conducted October 19 - December 3, 1999
for Menzie-Cura & Associates
Solutia Site, Sauget Illinois

Lab Test ID	Sample ID	Day 28 Mean Survival (%)	Day 28 Mean Dry Weight (mg)	Day 35 Mean Survival (%)	Day 42 Mean Survival (%)	Day 42 Mean Dry Weight (mg)	Day 42 Mean Number of Neonates/ Female
12546	BTOX-C-1	93	0.766	92	87	0.510	11.5
12547	BTOX-C-2	88	0.456	76	73	0.489	3.7
12548	BTOX-C-3	90	0.656	80	76	0.402	3.3
12549	BTOX-D-1	89	0.571	85	84	0.414	5.1
12550	BTOX-D-2	87	0.684	85	81	0.428	4.0
12551	BTOX-D-3	80	0.731	79	79	0.400	3.5
12552	Laboratory Control	55	0.982	51	46	0.231	0.6
12589	BTOX-B-1	23*	--	8*	8*	--	--
12590	BTOX-B-1 (Dup)	22*	--	26*	26*	--	--
12591	BTOX-B-2	Acute Toxicity		--	--	--	--
12592	BTOX-B-3	49*	--	40*	39*	--	--
12593	BTOX-B-M	88	0.481	89	85	0.348	1.6
12609	E-1 Dead Creek	72*	--	63*	56*	--	--
12610	E-2 Dead Creek	97	0.612	94	91	0.462	4.6
12611	E-3 Dead Creek	67*	--	53	50*	--	--
12612	BP-1 Borrow Pit	93	0.594	88	83	0.380	4.1
12613	BP-1 (Dup) Borrow Pit	89	0.636	80	75	0.423	4.2
12614	BP-3 Borrow Pit	95	0.470	86	84	0.322	5.3
12615	Laboratory Control	62	0.296	36	33	0.299	1.8
12622	Laboratory Control	55	0.501	38	35	0.377	4.0
12638	BP-2 Borrow Pit	82	0.563	74	73	0.390	4.3
12639	F1 Dead Creek	91	0.639	89	84	0.397	4.8
12640	F2 Dead Creek	90	0.554	74	70	0.447	3.8
12641	F3 Dead Creek	89	0.661	85	76	0.406	4.8
12664	Prairie DuPont	90	0.443	83	79	0.346	2.6
12665	Praire Dupont 2	89	0.648	85	80	0.498	6.2
12666	Reference Creek	70*	--	64	65	0.459	2.3
12668	Laboratory Control	73	0.477	65	59	0.293	2.2
12671	Ref 2-2 Ref Borrow Pit	87	0.458	85	83	0.351	3.4

* A statistically significant reduction in the response was observed (relative to a corresponding Reference Site response, $P<0.05$).

-- When a significant reduction in survival on Days 28 or 42 was detected, mean dry weight and reproduction data were only reported in Appendix A (See Results).

EXECUTIVE SUMMARY

100.2CT Midge, *Chironomus tentans* 10-day Survival and Growth Test
Conducted October 7 - October 20, 1999
for Menzie-Cura & Associates
Dead Creek Site

Laboratory Sample ID	Client Sample ID	Mean Survival (%)	Mean Dry Weight (mg)
12546	BTOX-C-1	30 *	--
12547	BTOX-C-2	0 *	--
12548	BTOX-C-3	96	2.352
12549	BTOX-D-1	44 *	--
12550	BTOX-D-2	48 *	--
12551	BTOX-D-3	71 *	--
12552	Laboratory Control Sediment	98	2.558
12589	BTOX-B-1	0 *	--
12590	BTOX-B-1 (DUPE)	4 *	--
12591	BTOX-B-2	0 *	--
12592	BTOX-B-3	100 [1]	0.581[1]
12593	BTOX-M	96 *	--
12609	E-1 Dead Creek	91*	--
12610	E-2 Dead Creek	16 *	--
12615	Laboratory Control Sediment	100	1.922
12611	E-3 Dead Creek	97	2.240
12612	BP-1 Borrow Pit	64 *	--
12613	BP-1 Borrow Pit (DUPE)	40 *	--
12614	BP-3 Borrow Pit	53 *	--
12622	Laboratory Control Sediment	94	1.761
12638	BP-2 Borrow Pit	14 *	--
12639	F-1 Dead Creek Section F	31 *	--
12640	F-2 Dead Creek Section F	16 *	--
12641	F-3 Dead Creek Section F	10 *	--
12664	Prairie DuPont Creek	16 *	--
12665	Prairie DuPont Creek 2	55 *	--
12666	Reference Creek	13 *	--
12668	Laboratory Control Sediment	100	2.065
12671	Ref 2-2 Reference Borrow Pit	11 *	--

* The response data were statistically significantly different from the corresponding laboratory control sediment ($p \leq 0.05$).

-- When a statistically significant reduction in survival was detected, mean dry weight data were only reported in Appendix A (See Results).

[1] Indigenous *Chironomus tentans* were present in this sample, resulting in counts higer than the initial number. Statistical analysis of test data for Sample 12592 was not performed.

EXECUTIVE SUMMARY

100.1HA Amphipod, *Hyalella azteca*, 42-day Chronic Survival, Growth, and Reproduction Test
Conducted October 19 - December 3, 1999
for Menzie-Cura & Associates
Solutia Site, Sauget Illinois

Lab Test ID	Sample ID	Day 28 Mean Survival (%)	Day 28 Mean Dry Weight (mg)	Day 35 Mean Survival (%)	Day 42 Mean Survival (%)	Day 42 Mean Dry Weight (mg)	Day 42 Mean Number of Neonates/ Female
12546	BTOX-C-1	93	0.766	92	87	0.510	11.5
12547	BTOX-C-2	88	0.456	76	73	0.489	3.7
12548	BTOX-C-3	90	0.656	80	76	0.402	3.3
12549	BTOX-D-1	89	0.571	85	84	0.414	5.1
12550	BTOX-D-2	87	0.684	85	81	0.428	4.0
12551	BTOX-D-3	80	0.731	79	79	0.400	3.5
12552	Laboratory Control	55	0.982	51	46	0.231	0.6
12589	BTOX-B-1	23*	--	8*	8*	--	--
12590	BTOX-B-1 (Dup)	22*	--	26*	26*	--	--
12591	BTOX-B-2	Acute Toxicity		--	--	--	--
12592	BTOX-B-3	49*	--	40*	39*	--	--
12593	BTOX-B-M	88	0.481	89	85	0.348	1.6
12609	E-1 Dead Creek	72*	--	63*	56*	--	--
12610	E-2 Dead Creek	97	0.612	94	91	0.462	4.6
12611	E-3 Dead Creek	67*	--	53	50*	--	--
12612	BP-1 Borrow Pit	93	0.594	88	83	0.380	4.1
12613	BP-1 (Dup) Borrow Pit	89	0.636	80	75	0.423	4.2
12614	BP-3 Borrow Pit	95	0.470	86	84	0.322	5.3
12615	Laboratory Control	62	0.296	36	33	0.299	1.8
12622	Laboratory Control	55	0.501	38	35	0.377	4.0
12638	BP-2 Borrow Pit	82	0.563	74	73	0.390	4.3
12639	F1 Dead Creek	91	0.639	89	84	0.397	4.8
12640	F2 Dead Creek	90	0.554	74	70	0.447	3.8
12641	F3 Dead Creek	89	0.661	85	76	0.406	4.8
12664	Prairie DuPont	90	0.443	83	79	0.346	2.6
12665	Praire Dupont 2	89	0.648	85	80	0.498	6.2
12666	Reference Creek	70*	--	64	65	0.459	2.3
12668	Laboratory Control	73	0.477	65	59	0.293	2.2
12671	Ref 2-2 Ref Borrow Pit	87	0.458	85	83	0.351	3.4

* A statistically significant reduction in the response was observed (relative to a corresponding Reference Site response, $P<0.05$).

-- When a significant reduction in survival on Days 28 or 42 was detected, mean dry weight and reproduction data were only reported in Appendix A (See Results).

Appendix 5

Sediment Dewatering Design Drawings

NOTES:

1. 2" DIAMETER SPRINKLER FORCEMAINS ARE TO BE TIED INTO NEARBY MUNICIPAL WATER SOURCE.
2. DEWATERING PUMP FORCEMAIN IS TRENCHED UNDER ROAD CROSSINGS AS SHOWN IN DETAIL 2, SHEET 6.
3. MOBILE SUMP PUMP(DETAIL 5, SHEET 6) WILL BE USED IN DEPRESSED CREEK AREAS.

LEGEND:

2" SPRINKLER LINE

12" - 18" - 24" DEWATERING FORCEMAIN

PUMP LOCATIONS

ROAD CROSSING

DRAFT

REV.	DATE	DESCRIPTION	BY

ENGINEERS SEAL:

PREPARED FOR:

PREPARED FOR: SOLUTIA

PREPARED BY: MAVERICK CONSTRUCTION MANAGEMENT SERVICES, INC.

DRAWING TITLE:

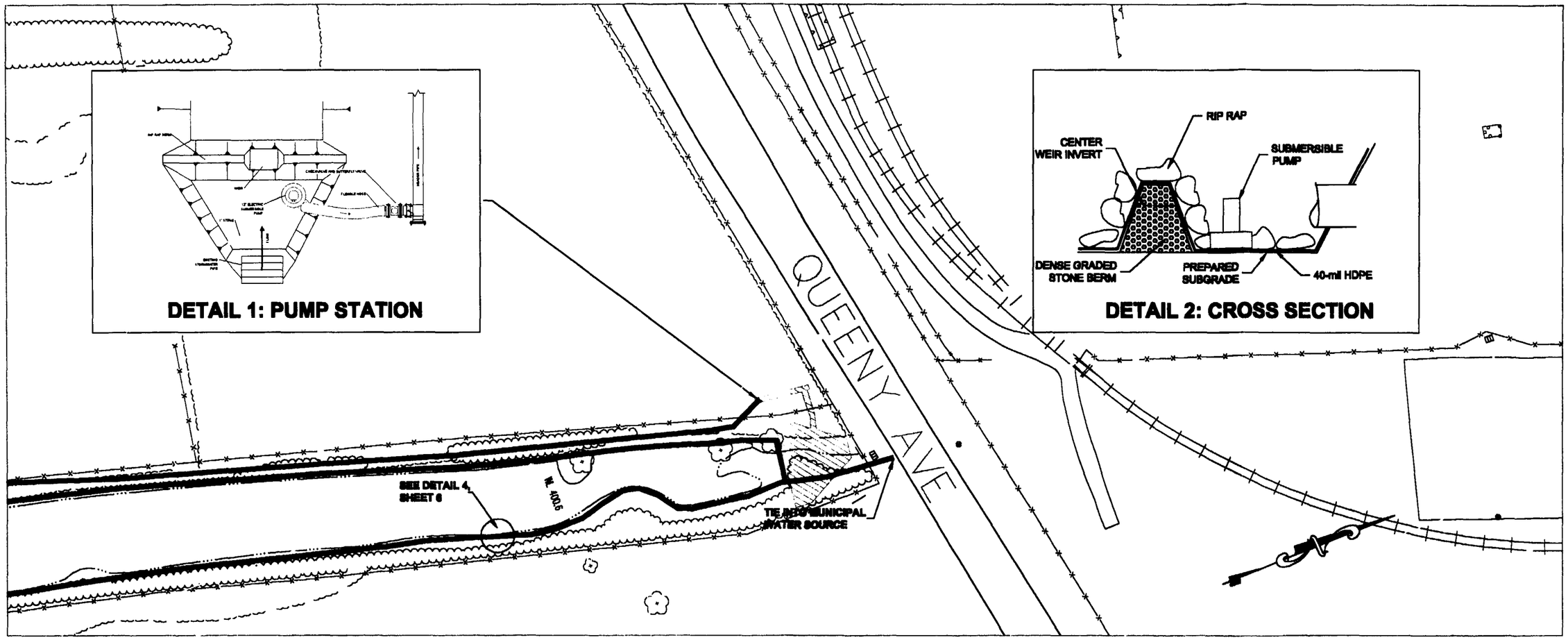
SEDIMENT DEWATERING PLAN

PROJECT TITLE:

DEAD CREEK SEDIMENT AND SOIL TIME CRITICAL REMOVAL ACTION

SAUGET AREA 1, SAUGET AND CAHOKIA, ILLINOIS

DESIGNED BY: JAF	DATE [illegible]	DRAWING NO. 1
DRAWN BY: AAT	CAD FILE SHEET1.DWG	
CHECKED BY: KGL	PROJECT NO. SAUGET	
APPROVED BY: JAF	SCALE 1" = 200'	SHEET 1 OF 6



NOTES:

1. 2" DIAMETER SPRINKLER FORCEMAINS ARE TO BE TIED INTO NEARBY MUNICIPAL WATER SOURCE.
2. DEWATERING PUMP FORCEMAIN IS TRENCHED UNDER ROAD CROSSINGS AS SHOWN IN DETAIL 2, SHEET 6.
3. MOBILE SUBMERSIBLE PUMP (DETAIL 6, SHEET 6) TO BE USED IN DEPRESSED CREEK AREAS.

LEGEND:

2" SPRINKLER LINE

12" - 16" - 24" DEWATERING FORCEMAIN

PUMP LOCATION

ROAD CROSSING

DRAFT

REV.	DATE	DESCRIPTION	BY

ENGINEER'S SEAL:

PREPARED FOR:

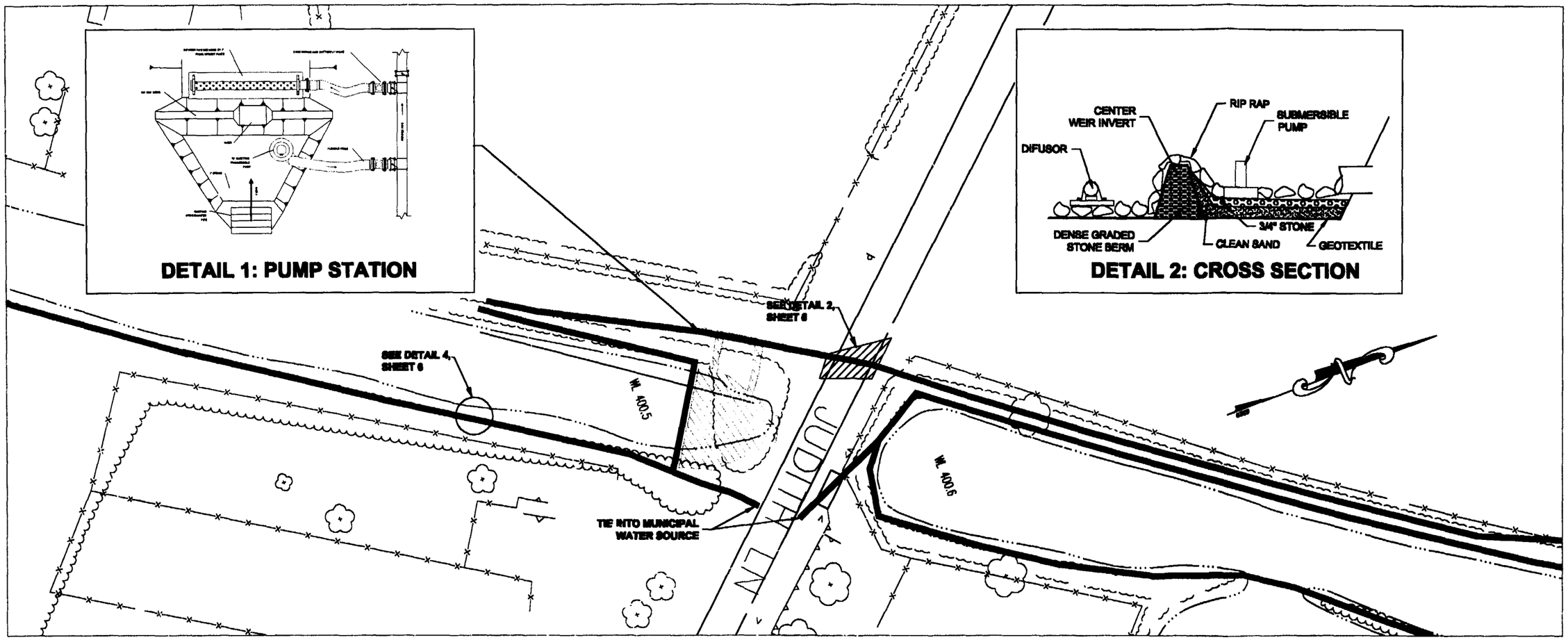
PREPARED FOR: SOLUTIA

PREPARED BY: MAVERICK CONSTRUCTION MANAGEMENT SERVICES, INC.

DRAWING TITLE: QUEENY AVE. DETAIL

PROJECT TITLE: DEAD CREEK SEDIMENT AND SOIL TIME CRITICAL REMOVAL ACTION
SAUGET AREA 1, SAUGET AND CAHOKIA, ILLINOIS

DESIGNED BY: JAF	DATE [illegible]	DRAWING NO. 2
DRAWN BY: AAT	CAD FILE SHEET1.DWG	
CHECKED BY: KML	PROJECT NO. SAUGET	
APPROVED BY: JAF	SCALE NOT TO SCALE	SHEET 2 OF 6



NOTES:

1. 2" DIAMETER SPRINKLER FORCEMAINS ARE TO BE TIED INTO NEARBY MUNICIPAL WATER SOURCES.
2. PUMP FORCEMAIN IS TRENCHED UNDER ROAD CROSSINGS AS SHOWN IN DETAIL 2, SHEET 6.
3. MOBILE SUBMERSIBLE PUMP (DETAIL 5, SHEET 6) WILL BE USED IN DEPRESSED CREEK AREAS.

LEGEND:

- 2" SPRINKLER LINE
- 12" - 18" - 24" DEWATERING FORCEMAIN
- PUMP LOCATION
- ROAD CROSSING

DRAFT

REV.	DATE	DESCRIPTION	BY

ENGINEERS SEAL:

PREPARED FOR:

PREPARED FOR: SOLUTIA

PREPARED BY: MAVERICK CONSTRUCTION MANAGEMENT SERVICES, INC.

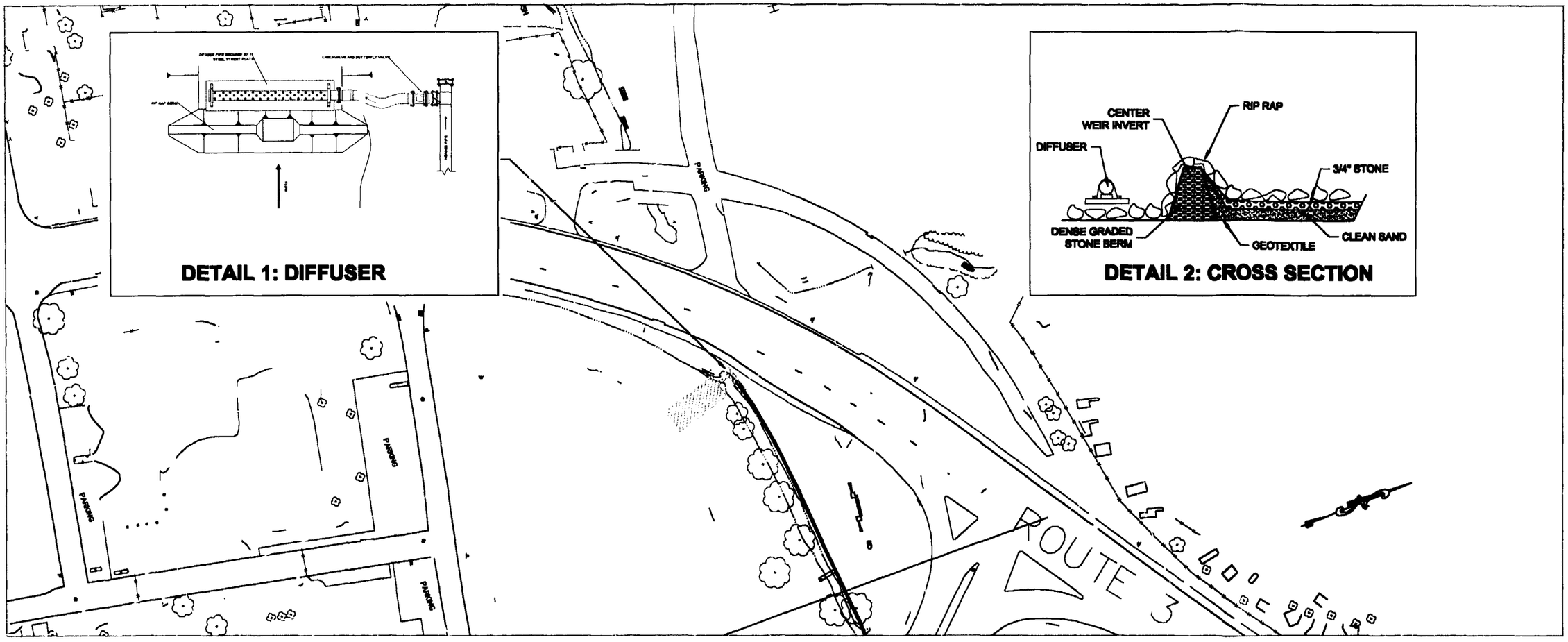
DRAWING TITLE: JUDITH LN DETAIL

PROJECT TITLE: DEAD CREEK SEDIMENT AND SOIL TIME CRITICAL REMOVAL ACTION
SAUGET AREA 1, SAUGET AND CAHOKIA, ILLINOIS

DESIGNED BY: JAF	DATE [illegible]	DRAWING NO. 3
DRAWN BY: AAT	CAD FILE [illegible]SHEET6.DWG	
CHECKED BY: KML	PROJECT NO. SAUGET	
APPROVED BY: JAF	SCALE NOT TO SCALE	SHEET 3 OF 6

DETAIL 1: DIFFUSER

DETAIL 2: CROSS SECTION



NOTES:

1. 2" DIAMETER SPRINKLER FORCEMAINS ARE TO BE TIED INTO NEARBY MUNICIPAL WATER SOURCE.
2. DEWATERING PUMP FORCEMAIN IS TRENCHED UNDER ROAD CROSSINGS AS SHOWN IN DETAIL 2, SHEET 6.
3. MOBILE SUMP PUMP(DETAIL 5, SHEET 6) WILL BE USED IN DEPRESSED CREEK AREAS.

LEGEND:

2" SPRINKLER LINE

12" - 18" - 24" DEWATERING FORCE MAIN

PUMP LOCATION

ROAD CROSSING

DRAFT

REV.	DATE	DESCRIPTION	BY

ENGINEERS SEAL:

PREPARED FOR:

PREPARED FOR: SOLUTIA

PREPARED BY: MAVERICK CONSTRUCTION MANAGEMENT SERVICES, INC.

DRAWING TITLE:

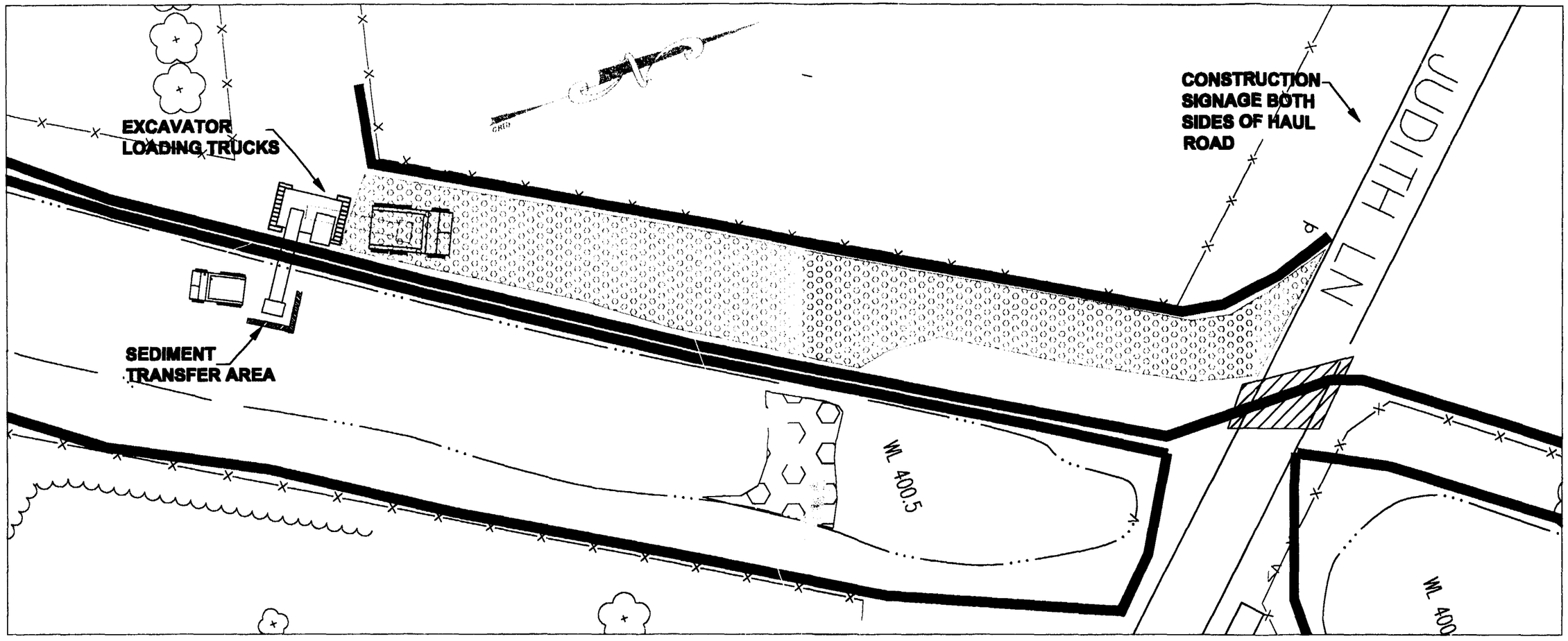
ROUTE 3 DIFFUSER DETAIL

PROJECT TITLE:

DEAD CREEK SEDIMENT AND SOIL TIME CRITICAL REMOVAL ACTION

SAUGET AREA 1, SAUGET AND CAHOKIA, ILLINOIS

DESIGNED BY: JAF	DATE: [illegible]	DRAWING NO. 4
DRAWN BY: AAT	CAD FILE: SHEETLDWG	
CHECKED BY: KML	PROJECT NO.: SAUGET	
APPROVED BY: JAF	SCALE: NOT TO SCALE	SHEET 4 OF 6



NOTES:

1. 2" DIAMETER SPRINKLER FORCEMAINS ARE TO BE TIED INTO NEARBY MUNICIPAL WATER SOURCE.
2. DEWATERING PUMP FORCEMAIN IS TRENCHED UNDER ROAD CROSSINGS AS SHOWN IN DETAIL 2, SHEET 6.
3. MOBILE SUMP PUMP(DETAIL 5, SHEET 6) WILL BE USED IN DEPRESSED CREEK AREAS.
4. EXCAVATOR AND WHEELED HAUL TRUCKS ARE LOCATED OUTSIDE THE EXCLUSION ZONE.
5. TRACKED MOUNTED HAUL TRUCKS ARE WITHIN THE CREEK LIMITS.
6. CONSTRUCTION SIGNS LOCATED ON BOTH SIDES OF STONE HAUL ROAD AND FLAG PERSON PRESENT DURING TRAFFIC ACTIVITY.

LEGEND:

2" SPRINKLER LINE

12" - 18" - 24" DEWATERING FORCEMAIN

ROAD CROSSING

TRAFFIC DIRECTION

SILT FENCE

STONE HAUL ROAD

RIP RAP ROAD

CONSTRUCTION SIGNS

DRAFT

REV.	DATE	DESCRIPTION	BY

ENGINEERS SEAL:

PREPARED FOR:

PREPARED FOR: SOLUTIA

PREPARED BY: MAVERICK CONSTRUCTION MANAGEMENT SERVICES, INC.

DRAWING TITLE:

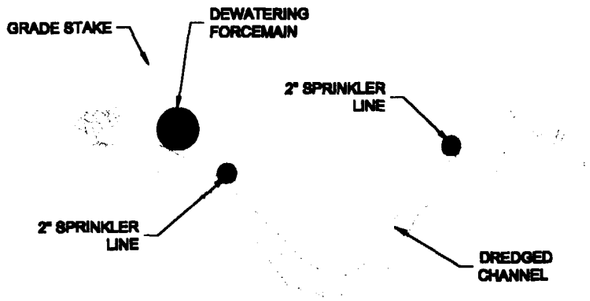
TYPICAL SEDIMENT TRANSFER DETAIL

PROJECT TITLE:

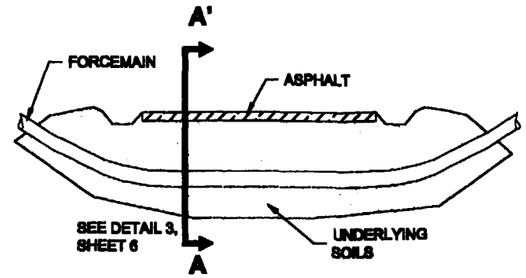
DEAD CREEK SEDIMENT AND SOIL TIME CRITICAL REMOVAL ACTION

SAUGET AREA 1, SAUGET AND CAHOKIA, ILLINOIS

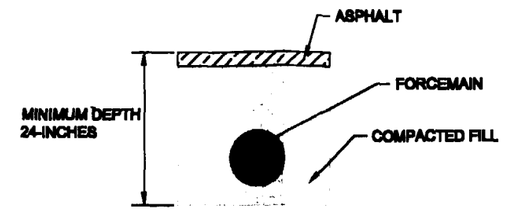
DESIGNED BY: JAF	DATE [illegible]	DRAWING NO. 5
DRAWN BY: AAT	CAD FILE SHEETS.DWG	
CHECKED BY: KML	PROJECT NO. SAUGET	
APPROVED BY: JAF	SCALE NOT TO SCALE	SHEET 5 OF 6



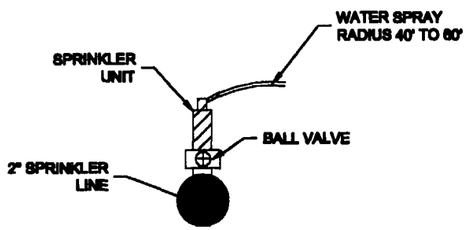
DETAIL 1: CHANNEL CROSS SECTION



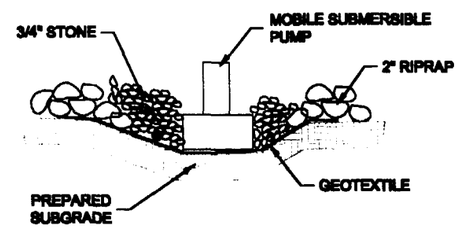
DETAIL 2: ROADWAY CROSSING



DETAIL 3: CROSS SECTION A-A'



DETAIL 4: SPRINKLER UNIT



DETAIL 5: MOBILE SUBMERSIBLE PUMP

NOTES:

1. MOBILE SUBMERSIBLE PUMP CAN CONNECT TO EXISTING DEWATERING FORCEMAIN AS NEEDED.
2. SPRINKLER UNITS ARE TO BE SPACED ACCORDINGLY TO OBTAIN 100% COVERAGE OF DREDGED CREEK SURFACE.

DRAFT

REV.	DATE	DESCRIPTION	BY

ENGINEERS SEAL:

PREPARED FOR:

PREPARED FOR: SOLUTIA

PREPARED BY: MAVERICK CONSTRUCTION MANAGEMENT SERVICES, INC.

DRAWING TITLE: DETAILS

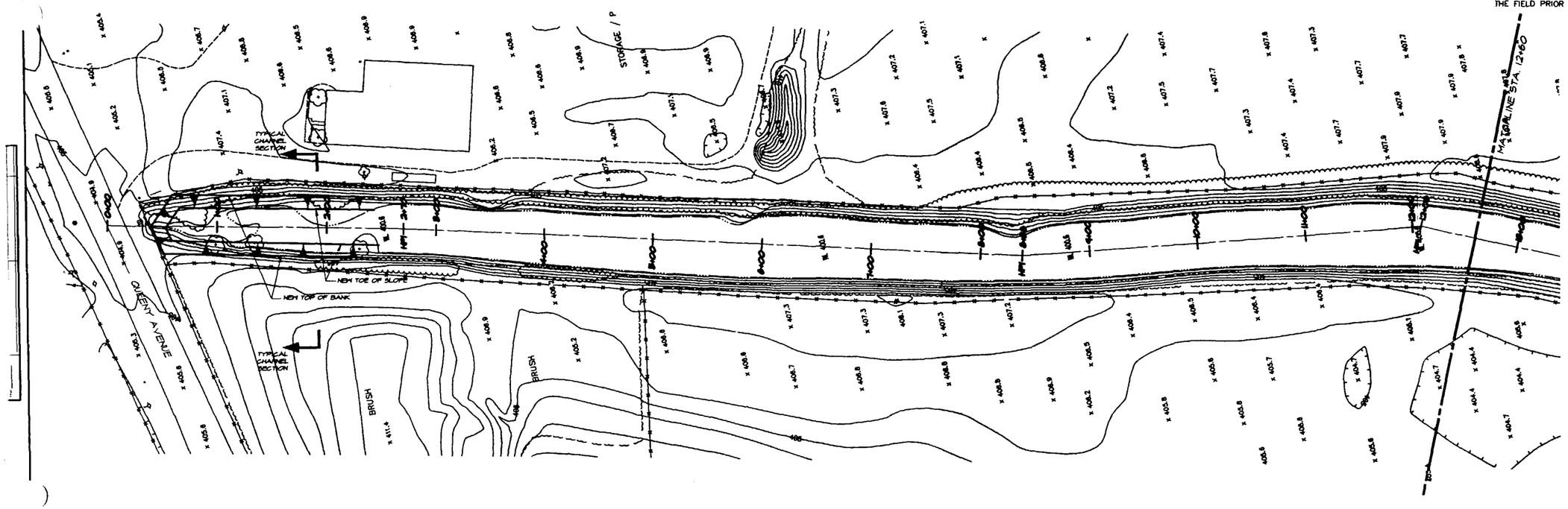
PROJECT TITLE: DEAD CREEK SEDIMENT AND SOIL TIME CRITICAL REMOVAL ACTION
SAUGET AREA 1, SAUGET AND CAHOKIA, ILLINOIS

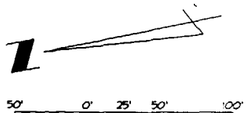
DESIGNED BY: JAF	DATE [illegible]	DRAWING NO. 6
DRAWN BY: AAT	CAD FILE SHEET1.DWG	
CHECKED BY: KML	PROJECT NO. SAUGET	
APPROVED BY: JAF	SCALE NOT TO SCALE	SHEET 6 OF 6

Appendix 6

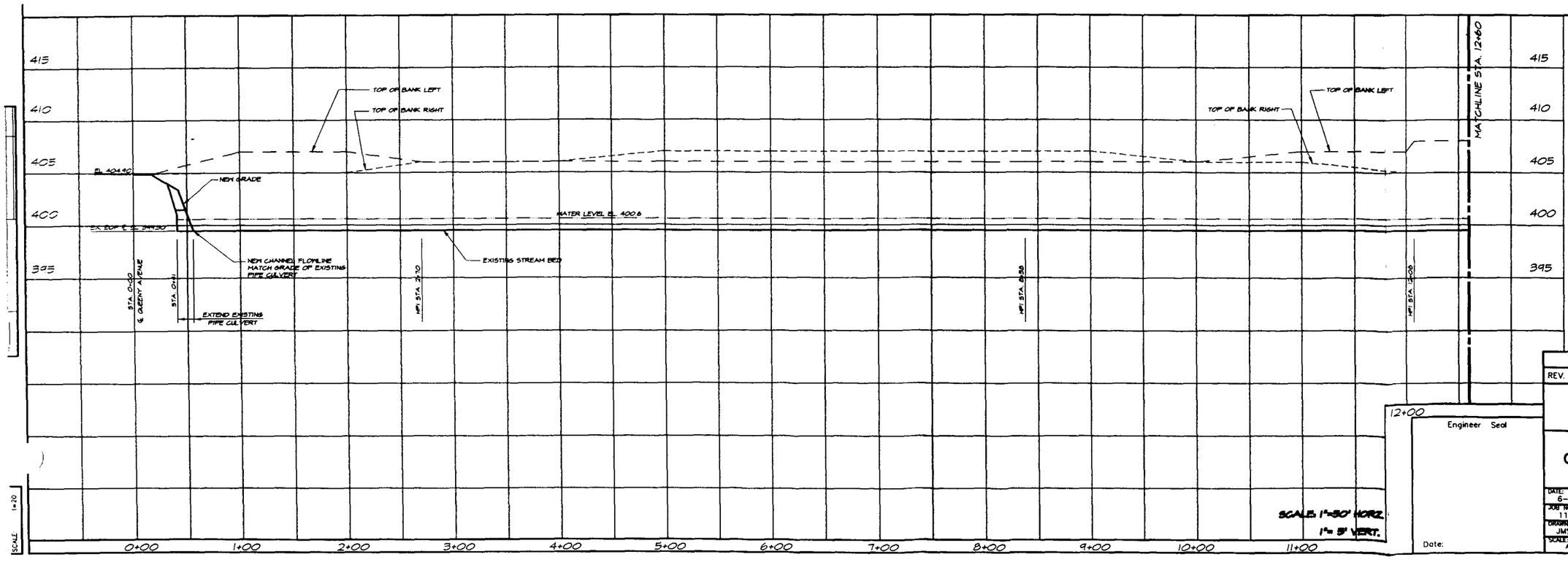
Channel Liner Design Drawings

NOTE:
UNDERGROUND FACILITIES, STRUCTURES AND UTILITIES, HAVE NOT BEEN LOCATED. THERE MAYBE SOME, THE EXISTANCE OF WHICH IS NOT PRESENTLY KNOWN. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO HAVE ALL UTILITIES LOCATED IN THE FIELD PRIOR TO EXCAVATION OR CONSTRUCTION.





SCALE: 1" = 50'



SCALE 1=20

REV.	DATE	DESCRIPTION	BY

Engineer Seal

Date:

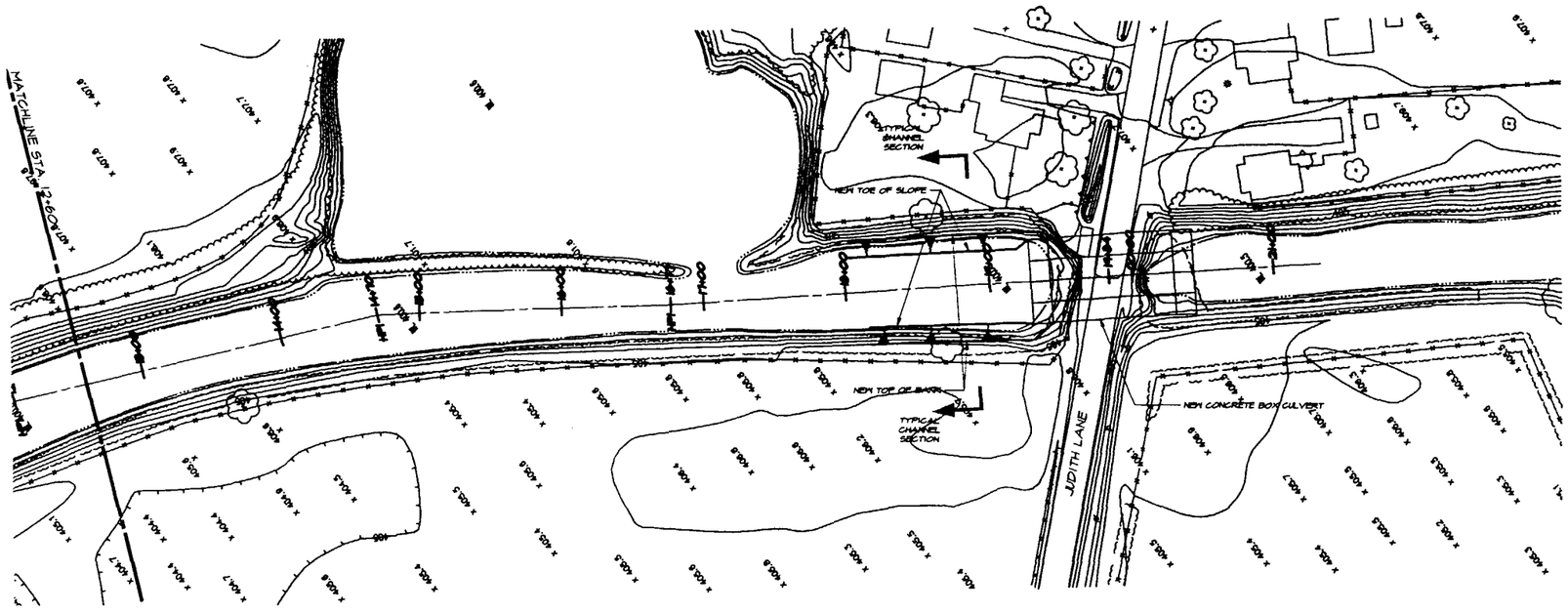
SOLUTIA

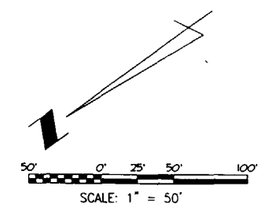
NEW DEAD CREEK CHANNEL
QUEENY AVE. TO JUDITH LANE
PLAN & PROFILE SHEET – 1

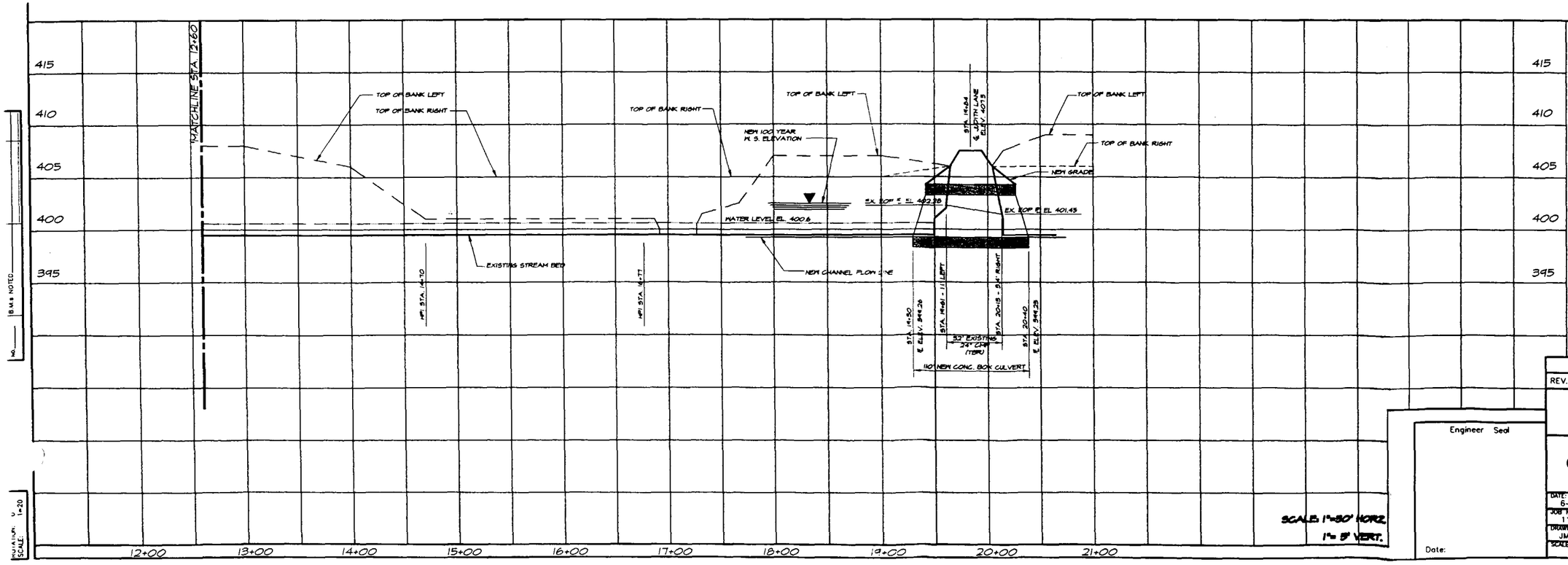
DATE: 6-28-2000
JOB NO.: 11035-700
DRAWN BY: JMS
CHK'D BY: MJB
SCALE: AS SHOWN

URS
2318 MILLPARK DRIVE
MARYLAND HEIGHTS, MISSOURI 63043
PHONE: 314-429-0100
FAX: 314-993-0462

NOTE:
UNDERGROUND FACILITIES, STRUCTURES AND UTILITIES, HAVE NOT BEEN LOCATED. THERE MAYBE SOME, THE EXISTANCE OF WHICH IS NOT PRESENTLY KNOWN. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO HAVE ALL UTILITIES LOCATED IN THE FIELD PRIOR TO EXCAVATION OR CONSTRUCTION.







SCALE: 1"=50' HORZ.
1"= 5' VERT.

Engineer Seal

Date:

REV.	DATE	DESCRIPTION	BY

SOLUTIA

NEW DEAD CREEK CHANNEL
QUEENY AVE. TO JUDITH LANE
PLAN & PROFILE SHEET – 2

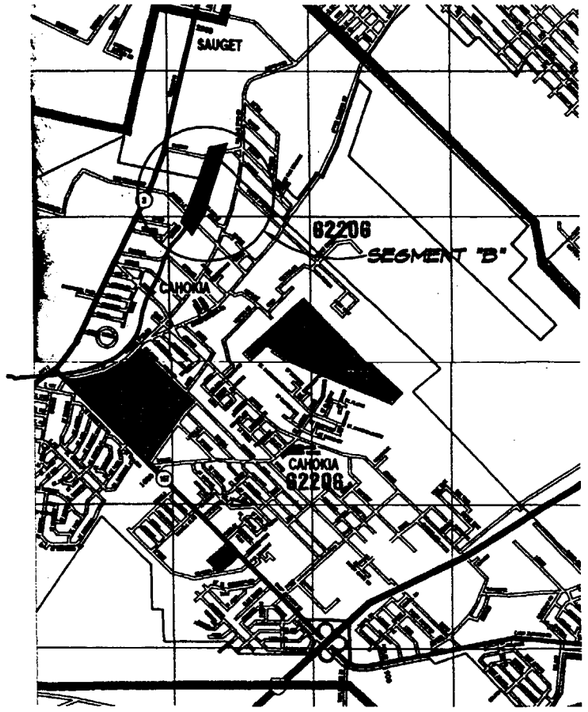
DATE: 6-28-2000
JOB NO.: 11035-700
DRAWN BY: JMS
CHK'D BY: MJB
SCALE: AS SHOWN

URS
2318 MILLPARK DRIVE
MARYLAND HEIGHTS, MISSOURI 63043
PHONE: 314-429-0100
FAX: 314-429-0462

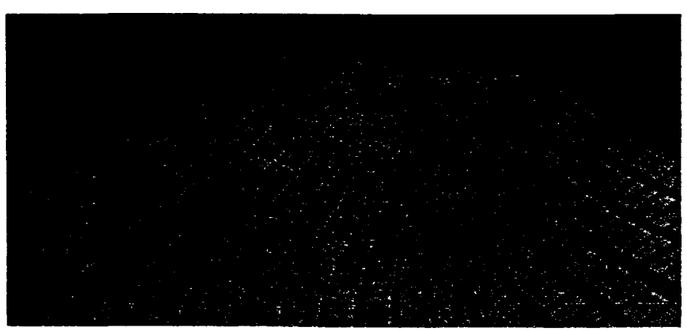
NO. ____ | R.O.W. & EASEMENT CHANGES

NO. ____ | B.M.'s NOTED

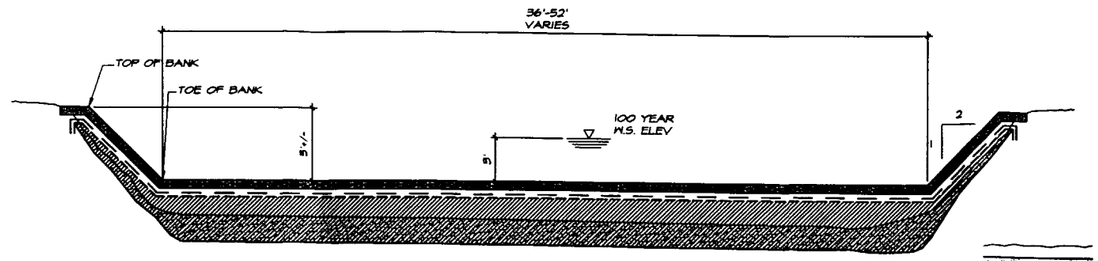
ROTATION: 0
SCALE: 1"=20'



SITE LOCATION
NOT TO SCALE

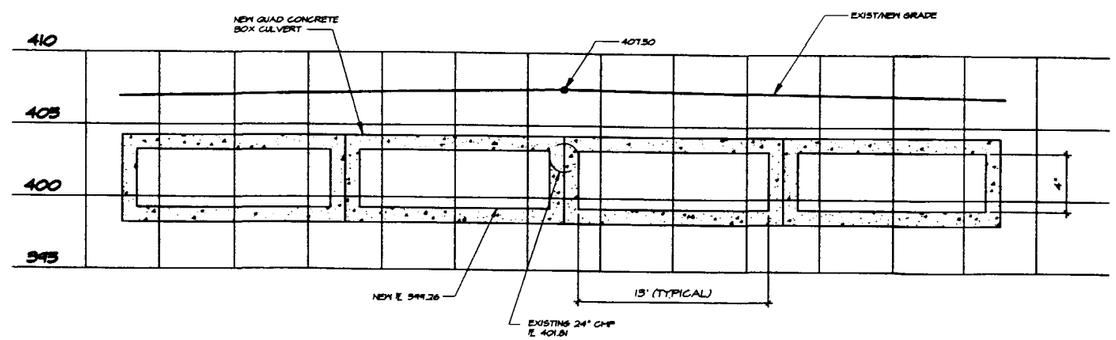


TYPICAL ARTICULATED CONCRETE MAT



TYPICAL CHANNEL SECTION
SCALE: 1" = 5'

LEGEND
- EXISTING CHANNEL BOTTOM
- SEDIMENT TO BE REMOVED
- CLEAN FILL
- HDPE LINER (40 MIL)
- GEOTEXTILE FABRIC
- ARTICULATED CONCRETE MAT



CULVERT SECTION AT JUDITH LANE
SCALE: 1" = 5'

REV.	DATE	DESCRIPTION	BY

SOLUTIA

NEW DEAD CREEK CHANNEL
QUEENY AVE. TO JUDITH LANE
DETAILS – SHEET 3

Engineer Seal

Date:

DATE: 6-28-2000
JOB NO.: 11035-700
DRAWN BY: JMS
CHK'D BY: MJB
SCALE: AS NOTED

URS
2318 MILLPARK DRIVE
MARYLAND HEIGHTS, MISSOURI 63043
PHONE: 314-429-0100
FAX: 314-429-0462

STRUCTURE NOTATIONS CHKD

SCALE: 1=20

Appendix 7

Containment Cell Design Report

SAUGET AREA 1 TSCA LANDFILL DESIGN REPORT SOLUTIA INC. CAHOKIA, ILLINOIS

Prepared for:

Solutia Inc.
575 Maryville Centre Drive
St. Louis, MO 63141

Prepared by:

URS Greiner Woodward Clyde

7650 West Courtney Campbell Causeway
Tampa, Florida 33607-1462
C100003899.00

June 30, 2000

Revision 0

TABLE OF CONTENTS

1.0 CERTIFICATION 1-1

2.0 INTRODUCTION 2-1

3.0 SITE CHARACTERIZATION 3-1

3.1 FIELD INVESTIGATION 3-1
3.2 GEOTECHNICAL LABORATORY TESTING 3-2
3.3 SUBSURFACE CONDITIONS 3-2
3.4 GROUNDWATER 3-2

4.0 LINER DESCRIPTION AND SYSTEM DESIGN 4-1

4.1 LINER SYSTEM 4-1
4.1.1 Description 4-1
4.1.2 Liner System Location Relative to the High Water Table 4-3
4.1.3 Loads on Lining System 4-3
4.1.4 Lining System Coverage 4-4
4.1.5 Lining System Exposure Prevention 4-5
4.2 ENGINEERING ANALYSES 4-5
4.2.1 Settlement Potential 4-5
4.2.2 Bearing Capacity 4-6
4.2.3 Containment Cell Slope Stability 4-6
4.2.4 Seismic Conditions 4-7
4.2.5 Subsidence and Sinkhole Potential 4-8
4.2.6 Potential for Excess Hydrostatic or Gas Pressure 4-8
4.3 SYNTHETIC LINERS 4-8
4.3.1 General Information 4-8
4.3.2 Synthetic Liner Strength 4-9
4.3.3 Synthetic Liner Bedding 4-9
4.4 GEOSYNTHETIC CLAY LINING (GCL) 4-10
4.4.1 General Information 4-10
4.4.2 GCL Strength 4-10
4.5 LINER SYSTEM, LEACHATE COLLECTION AND DETECTION SYSTEM 4-10
4.5.1 System Operation and Design 4-10
4.5.2 Equivalent Capacity of Geonet Drainage Composite 4-12
4.5.3 Grading and Drainage 4-12
4.5.4 Maximum Leachate Head 4-13
4.5.5 Stability of Drainage Layers 4-14
4.5.6 Strength of Piping 4-14
4.5.7 Prevention of Clogging 4-15

TABLE OF CONTENTS

5.0 COVER SYSTEM DESIGN AND OPERATION 5-1

5.1 CLOSURE PLANS 5-1
5.2 CLOSURE PERFORMANCE STANDARD 5-1
5.3 COVER SYSTEM DESCRIPTION 5-2
5.4 COVER DESIGN 5-2
5.4.1 General 5-2
5.4.2 Minimization of Liquid Migration 5-4
5.4.3 Maintenance Needs 5-4
5.4.4 Drainage and Erosion 5-4
5.4.5 Settlement and Subsidence 5-5
5.4.6 Freeze/Thaw Effects 5-6
5.4.7 Anchorage 5-7
5.5 RUN-OFF CONTROL SYSTEMS 5-7
5.5.1 Design and Performance 5-7
5.5.1.1 Calculation of Peak Flow 5-8
5.5.1.2 Management of Collection and Holding Units 5-8
5.5.1.3 Construction 5-8
5.5.1.4 Maintenance 5-8
5.6 CONTROL OF WIND DISPERSAL 5-9
5.7 POST-CLOSURE RUN-OFF 5-9
5.8 DRAINAGE STRUCTURES 5-9

6.0 LINER AND COVER SYSTEM CONSTRUCTION 6-1

6.1 SPECIFICATIONS 6-1
6.1.1 Material Specifications 6-1
6.1.2 Construction Specifications 6-1
6.2 CONSTRUCTION QUALITY CONTROL/QUALITY ASSURANCE 6-1

7.0 MATERIAL COMPATIBILITY STUDIES 7-1

8.0 ENGINEERING ANALYSES AND CALUCATIONS 8-1

Figures

Figure 2-1	Site Location
Figure 2-2	Project Vicinity Map
Figure 3-1	Existing Site Plan
Figure 3-2	Boring Profile A-A'
Figure 3-3	Boring Profile B-B'
Figure 4-1	Bottom Liner System Detail
Figure 4-2	Side Slope Liner System Detail
Figure 4-3	Site Preparation Plan
Figure 4-4	Secondary Geomembrane Layout
Figure 4-5	Primary Geomembrane Layout
Figure 4-6	Top of Primary Collection System Plan
Figure 4-7	Liner Details
Figure 4-8	Primary Leachate Collection System Side Slope Detail
Figure 4-9	Secondary Leachate Collection System Riser Pipe Detail
Figure 5-1	Cover System Plan
Figure 5-2	Cover System Detail
Figure 5-3	Typical Cover System Vent
Figure 5-4	Run-off Control Berm Detail
Figure 5-5	Final Cover Detail
Figure 5-6	Downlet Channel and Stilling Basin

Appendices

Appendix A	Site Characterization
Appendix B	Foundation Evaluation
Appendix C	Liner System Component Design
Appendix D	Cover System Component Design
Appendix E	Specifications
Appendix F	Construction Quality Assurance Manual for Installation of Geosynthetic Components
Appendix G	Construction Quality Assurance Manual for Installation of Soil Components of the Lining and Final Cover Systems

In accordance with the Illinois Statutes, the attached Sauget Area 1 TSCA Landfill Design Report for the Solutia Inc. Sauget Area I Superfund Site located in Cahokia, Illinois, was prepared by the undersigned Illinois Registered Professional Engineer or others under my direct supervision and control.

The attached detailed design report, construction plans, specifications and construction quality assurance documents were prepared by URS Greiner Woodward Clyde (URSGWC) within the limits prescribed by our client using standard engineering procedures in a manner consistent with the skill and level of professional care exercised by other professionals practicing in the same locality under similar circumstances. Information provided to URSGWC by client representatives, agents and other consultants has been accepted in good faith and is assumed to be accurate.

WM. L. DURBIN
NO. 62-040635
REGISTERED
PROFESSIONAL
ENGINEER
OF
ILLINOIS

Signed: William L. Durbin
William L. Durbin, P.E.
Registered Professional Engineer
Illinois License No. 62-040635

Date: June 27, 2000

Solutia Inc. has entered into a Unilateral Action Order (UAO) agreement with Region V of the U.S. Environmental Protection Agency (EP) to address concerns regarding affected sediments and soils in and adjacent to Dead Creek in Cahokia, Illinois. The sediments within Dead Creek are part of a larger Superfund Site known as Sauget Area One. The UAO requires removal of the affected sediments from the creek and transfer to a TSCA compliant disposal facility. The disposal facility will be located adjacent to Dead Creek on land owned by Solutia within the segment known as CS-B. Removal of the affected sediments and transfer to the disposal cell is being performed under the UAO on an emergency basis.

This report addresses the design, construction and operation of the disposal cell. The design was prepared to respond to Exhibit 2 of the UAO.

3.1 FIELD INVESTIGATION

A total of four borings were drilled and a piezometer installed on the property between November 8, 1999 through November 10, 1999. Two hand-auger borings were drilled on November 15, 1999. The approximate locations of the borings and the piezometer installed for this study are shown in Figure 3-1. The geotechnical borings are designated GB-1 through GB-3, the piezometer is PZ-1, and the hand-auger borings are HA-1 and HA-2. Two borings, GB-1 and GB-3, were drilled to depths of about 50 ft and GB-2 was drilled to a depth of about 75 ft. Boring GB-2 was drilled deeper to estimate the vertical extent of loose to medium dense alluvium to help assess settlement and liquefaction potential of the site. The piezometer boring was drilled to a depth of about 20 ft and a piezometer was installed to that depth. A URSGWC representative directed the field investigation, logged the borings and collected soil samples for geotechnical laboratory testing.

The work was conducted in accordance with Solutia's site policies and procedures and with a site-specific health and safety plan approved by URSGWC and Solutia.

The borings were drilled with a CME-55 truck-mounted drilling rig owned and operated by Roberts Environmental Drilling, Inc. (REDI) of Illinois. Borings were advanced using 4¼-inch I.D. hollow-stem augers. Once the water table was encountered, typically at a depth of between 9 to 14 ft below ground surface, borings were continued using a 3⅞-inch diameter roller bit and a bentonite-based drilling mud.

Soil samples were obtained from the borings using either a 1½-inch I.D. split-spoon sampler in accordance with the Standard Penetration Test (SPT) Method (ASTM D-1586) or a hydraulically pushed thin-walled sampler (Shelby tube) to obtain "undisturbed" samples.

Sampling was made at 2½-ft vertical intervals in the upper 10 ft and at 5-ft vertical intervals thereafter. Upon completion, the borings were tremmie-grouted with a cement-bentonite mixture. Drilling spoils and excess sample were placed in containers provided by Solutia along with drilling fluids displaced during grouting.

Field boring logs were prepared by a URSGWC representative based upon recovered soil samples, cuttings, drilling characteristics, and field conditions. The logs have been subsequently

modified to reflect laboratory test results. Detailed logs of borings and piezometer installation are included in Appendix A. Graphic boring logs depicting generalized subsurface conditions are shown in Figures 3-2 and 3-3.

3.2 GEOTECHNICAL LABORATORY TESTING

Geotechnical laboratory tests were performed on selected soil samples to characterize the index and strength properties of the subsurface soils. The tests performed included visual classification, water contents, liquid and plastic limits, unconfined compression strength and a consolidation test. Results of the laboratory tests are summarized in Appendix A and are also included on the detailed boring logs. Unconfined compression tests and consolidation test figures are also attached.

3.3 SUBSURFACE CONDITIONS

The subsurface conditions at this property primarily consist of about 5 ft of low plasticity silty clayey soil in borings GB-1 through GB-3 to about 20 ft of clayey silts in PZ-1. The upper 5 ft of clayey materials is underlain by alluvial non-plastic fine sandy silts to depths of about 20 ft in borings GB-1 and GB-3. Alluvial sands underlie the sandy silts to the drilled depths. The consistency of the upper cohesive material is typically firm to stiff. The silts within the upper 20 ft are typically loose and the alluvial sands immediately below the sandy silts are loose to medium dense, and become medium dense to dense with depth. In borings GB-1 and GB-2, the relative density indicates a loose to medium dense layer exists between elevation 370 and 360 (depth between 40 and 50 ft). Below elevation 360 ft, the relative density varies between medium dense to very dense.

3.4 GROUNDWATER

The water surface was encountered between 9 and 15 ft in all borings at the time of drilling on November 8, 1999. Groundwater was observed at a depth of about 9.5 ft below grade in the piezometer boring. A piezometer reading of 9.77 ft was recorded on November 15, 1999 and

9.95 ft on November 22, 1995. A piezometer reading of 10.22 ft was recorded on December 1, 1999. Further details are presented in Appendix A.

4.1 LINER SYSTEM

4.1.1 Description

The bottom liner system for the proposed containment cell will be a multi-component composite lining with leachate collection and leak detection layers. Figure 4-1 shows the proposed configuration of the bottom lining system. A description of the components is provided below. The components are described in a bottom to top order.

The subgrade soils will be graded to mirror the intended bottom grades for the completed bottom liner. An earthen berm will be constructed around the limits of the proposed containment cell to form the side walls of the containment cell. The upper 12 inches of the subgrade soils and all the earthen berm fill will be compacted to at least 95 percent of the soil's maximum dry density as determined by ASTM D698.

A capillary break layer consisting of 36 inches of gravel will be placed over the prepared subgrade. The gravel will conform to an ASTM C-33 gradation for coarse aggregates. The gravel will be tamped in place by the construction equipment. No additional compaction will be required. The capillary break layer will not be constructed on the containment cell side slopes.

A 6-inch native fill layer will be pushed and tracked into place over the capillary break layer. No additional compaction will be performed on this layer. The containment cell side slope berms will be constructed of compacted native fill. The native soil layer will serve as the foundation for a Geosynthetic Clay Liner (GCL). The GCL will be rolled into place and overlapped with adjacent panels.

A 60-mil High Density Polyethylene (HDPE) lining will be placed directly over the GCL to serve as the secondary lining system. The HDPE lining panels will be heat seamed to form a continuous membrane barrier. The seaming will be either pressure or vacuum tested to verify the integrity of the seams. Mechanical tests of the seam integrity will be performed by removing test samples from the completed lining and destructively testing the samples. The lining sample locations will be patched with an extrusion welded HDPE patch.

A geonet synthetic drainage composite will be installed over the secondary lining system to serve as the leak detection layer. A nonwoven geotextile will be placed over the geonet to prevent soil intrusion into the leak detection layer. The hydraulic transmissivity of geonet is at least 3×10^{-1} centimeters squared per second (cm^2/sec). At least 12 inches of native soil will be tracked in place over the leak detection layer on the cell bottom. No additional compaction will be performed on this layer. The native soil layer will not be installed on the containment cell side slopes.

A 60-mil HDPE lining will be placed on the native soil layer on the cell bottom to serve as the primary lining system. The HDPE lining will be placed directly over the geonet drainage composite on the cell's side slopes. The HDPE lining panels will be heat seamed to form a continuous membrane barrier. The seaming will be either pressure or vacuum tested to verify the integrity of the seams. Mechanical tests of the seam integrity will be performed by removing test samples from the completed lining and destructively testing the samples. The lining sample locations will be patched with an extrusion welded HDPE patch.

At least 12 inches of sand will be placed over the primary lining system in the bottom of the containment cell to serve as the leachate collection system. No additional compaction will be performed on the sand layer. The minimum hydraulic conductivity of the sand will be 1×10^{-2} cm^2/sec. Rounded pea gravel will be substituted for the sand around the perimeter of the cell bottom to provide higher transmissivity for leachate removal. Leachate collection on the cell's side slopes will be provided by a geonet drainage composite with an integrally-bonded geotextile facing to prevent soil clogging. The hydraulic transmissivity of geonet is at least 3×10^{-1} cm^2/sec. The geonet will intersect the sand or gravel leachate collection bottom layer. The wastes placed in the containment cell will directly contact the drainage composite on the side slopes.

A nonwoven geotextile will be placed over the sand or gravel leachate collection layer in the bottom of the cell. A 6-inch sand layer will be placed over the geotextile. No additional compaction will be performed on this layer. The minimum hydraulic conductivity of the sand will be 1×10^{-2} cm^2/sec. The wastes will be placed directly on this sand layer.

As indicated previously the liner system on the side slopes of the landfill will be similar to that designed for the bottom. The tracked in-place clay layer beneath the primary geomembrane liner will not extend up the side slope. In addition, the primary collection system will consist of a

geonet and geotextile placed directly on the primary geomembrane liner. Figure 4-2 presents this configuration.

The lining and geonet layers will be buried in anchor trenches at the top of slope around the containment cell.

The designed capacity of the containment cell is 50,000 yd^3. Calculations demonstrating this are provided in Appendix B.

4.1.2 Liner System Location Relative to the High Water Table

very dry period
43 = soaked

A piezometer installed at the proposed containment cell location has been used to monitor the groundwater depth at the site from November 1999 through April 2000. The groundwater level was observed fluctuating between 9.5 and 12.45 ft below ground surface (about elevations 392.5 and 389.55 ft). The minimum elevation of the secondary lining system will be 400 ft.

4.1.3 Loads on Lining System

The loads on the lining system were evaluated to determine if they could damage the lining system. The following paragraphs describe the various loads and results of calculations for those loads.

Internal and External pressure gradients were evaluated. Two methods for the cell to experience a pressure gradient are envisioned, gas evolution from waste decomposition and barometric pressure change. The containment cell cover system will incorporate a vent system to equalize the internal and external pressure and to vent gases generated in the wastes. The overburden soil on the cover system exerts a vertical stress of over 200 psf on the cover lining. Therefore, the cover lining is not likely to balloon due to barometric pressure change of less than 3 inches of mercury. Gas generation from the waste material is anticipated to be minor since the wastes are largely inorganic or previously decomposed. The vent system will allow generated gas to exit the cell without pressure buildup.

Lining systems may be ruptured by excessive deflection from foundation uplift or differential settlement. The 100-year flood elevation for this area is reported to be about elevation 406 ft.

Based on a minimum secondary lining elevation of 400 ft, the lining system should not uplift as long as there is at least 4 ft of soil lining components or waste over the secondary lining. Damage to the lining system by uplift is not likely.

Differential settlement of the containment cell bottom may elongate the HDPE linings beyond their strain capacity. As shown in the settlement analyses below, the differential settlement is expected to be less than 1-inch. The bottom settlement is anticipated to assume a spherical shape. The bottom lining along the side wall embankments will settle little while the lining settlement increases to the center of the cell. The bottom settlement produces a lining strain of less than 0.1 percent. This lining strain is well less than the elastic strain limit (about 4 percent) and the plastic strain limit (about 700 percent) of the HDPE lining material. Differential settlement should not damage the lining system.

Static and dynamic loads should not affect the lining system. The relatively minor waste thickness produces only minor static loads on the lining system. The loading from the wastes, cell cover, and proposed post-closure land use are well within the lining system's capability. Dynamic loads from construction and earthquakes are anticipated. Specifying a minimum cover soil thickness between any equipment and the lining will control dynamic loading of the lining system. Additionally, an engineered side slope protection layer will be incorporated in the cell where equipment traverses the slope or soil will be pushed or dumped down the slope. Earthquake accelerations in this area are minor and are not anticipated to cause any damage to the lining system. Earthquake analysis is provided later in this report.

4.1.4 Lining System Coverage

The lining system at this site is designed to cover the entire footprint of the proposed containment cell. Since this facility will be an above grade disposal unit, perimeter berms will completely surround the cell. Figure 4-3 presents a plan of the site preparation required to achieve the desired disposal capacity for the site. Figures 4-4 and 4-5 present the secondary and primary geomembrane layouts for the cell. A plan view of the primary collection system coverage is shown on Figure 4-6. Figure 4-7 presents the details of the liner and collection system including the proposed anchorage at the crest of the perimeter containment levee.

Wastes will only be placed within the lined containment cell. Leachate collection and leak detection systems will control and collect all liquids from the cell. No wastes or leachate will contact the surrounding ground.

4.1.5 Lining System Exposure Prevention

Certain synthetic components in the proposed lining system can be injured by certain environmental exposures. Sunlight can degrade unprotected plastics and polymers. The HDPE membrane linings used in this project can withstand at least 10 years of sunlight exposure without degradation. The HDPE linings will not be exposed for more than about 4 to 6 months on the containment cell side slopes.

Geotextile fabrics are susceptible to sunlight degradation. Several steps will be put into place to avoid extended sunlight exposure. Where possible, the geotextiles will be covered with soil as soon as possible after placement. The maximum sunlight exposure period will be 2 weeks. The geonet leachate collection layer on the cell's side slopes may not be covered with wastes for 4 to 6 months. Therefore, the side slope geonet drainage composite will be covered with an opaque plastic sheet until wastes are placed on the geonet. Sandbags will anchor the plastic sheeting over the geonet.

The GCL lining is composed of two geotextiles sandwiching bentonite clay. The GCL has sun and precipitation exposure limitations. The GCL installation will be conducted so that the GCL is covered with the HDPE lining within one day of placement.

4.2 ENGINEERING ANALYSES

4.2.1 Settlement Potential

As previously described, the soil conditions are relatively good with respect to settlement potential of the proposed containment cell. The relatively thin surficial clay and silt layers have little settlement potential. The underlying sands and silty sands are generally medium dense to dense with minor settlement potential. Regionally, the depth to bedrock is known to be about 120 ft below ground surface. These factors reduce the settlement potential at the site.

The small proportion of silt and clay soil thickness in the subsurface profile indicates that most deformation beneath the containment cell will be due to immediate settlement. Consolidation settlement will not be a significant factor at this site.

The proposed containment cell will be founded on the existing foundation soils between 397 and 407 ft elevation. The ground surface elevation at the proposed site was apparently about 407 ft. Portions of the site have apparently been previously excavated for borrow fill.

The embankment surrounding the cell will be constructed first and the lining system and wastes placed last. The embankment is expected to undergo most of its settlement during its construction. The embankment is expected to settle about 2.5 inches during its construction. The bottom lining system will settle about 2.5 inches at the center of the bottom and about 1.5 inches at the bottom perimeter. The differential bottom settlement is about 1-inch. The anticipated differential settlement of the bottom lining should produce a grade change of less than 0.05 percent. The differential settlement should not adversely affect the lining integrity or drainage. Details of this analysis are presented in Appendix B.

4.2.2 Bearing Capacity

The surficial clay and silt samples collected at the site were found to have undrained shear strengths ranging from 480 to 950 pounds per square foot (psf). Those strengths indicate soils with soft to firm consistency. The underlying sandy soils were observed to be loose to medium dense. The limiting bearing capacity strata was found to be the surficial clays and silts. Based on the minimum undrained shear strength above, the ultimate bearing capacity of the existing subgrade soils is about 2,400 psf. Details of this evaluation are presented in Appendix B.

4.2.3 Containment Cell Slope Stability

The embankment slopes for the containment cell will be constructed from compacted natural fill obtained onsite or imported to the site. The minimum undrained shear strength of the embankment fill is estimated to be 1000 psf. The peak horizontal ground acceleration used in the stability calculations is 0.1g.

Slopes excavated below existing grade will have a slope angle no steeper than 3 horizontal to 1 vertical (3:1). The maximum depth of excavated slopes is about 10 ft below existing grade. For an undrained shear strength of 480 psf, the stability of this slope is estimated to have a factor of safety of greater than 20 under both static and seismic conditions. Excavations with side slopes no steeper than 3:1 will have no stability concerns.

As shown in Figure 4-3, the containment cell will be constructed mostly above grade with an earthen embankment surrounding the cell. The exterior slopes of the embankment will be no steeper than 4:1. The maximum height of the 4:1 exterior embankment slopes will be about 20 ft. The factors of safety for the exterior embankment slope with a 200 psf surcharge at the top of slope are 2.2 and 1.6 for the static and seismic conditions, respectively.

The interior slopes of the containment cell will be no steeper than 3:1. The maximum height of the interior slopes prior to lining system placement is about 14.5 ft. The factors of safety for these slopes with a 200 psf surcharge at the top of slope are 2.8 and 2.1 for the static and seismic conditions, respectively. Although the interior slope angle is steeper than the exterior slope angle, the factors of safety for the interior slopes are greater due to the smaller slope height.

The containment cell lining system will not be constructed over any waste materials. The containment cell cover system will have a minimum and maximum surface slopes of 3 to 12 percent, respectively. The interface friction angle between the geonet drainage media and the HDPE lining was assumed to be about 11 degrees. The soil thickness above the cover lining is 2 ft. The factors of safety for the cover system at 3 percent slope were 8.8 and 2.0 for the static and seismic conditions, respectively. The factors of safety for the cover system fell to 2.2 and 1.2 for the static and seismic conditions at 12 percent slope. The minimum factor of safety recommended by the U.S. Army Corp of Engineers for embankment dams under seismic conditions is 1.0. The cover slope should not exceed 12 percent to maintain stability under seismic conditions.

4.2.4 Seismic Conditions

U.S. Geological Survey (USGS) Hazard Maps show this area has a peak ground acceleration (PGA) of 0.1g. The earthquake magnitude for this region is estimated as 6.5. The subgrade soils

at the site do not have liquefaction potential based on the PGA and magnitude estimated for this area. Details of our evaluation of seismic loading impacts are presented in Appendix A.

4.2.5 Subsidence and Sinkhole Potential

Subsidence and sinkholes are not expected in this region. Neither karstic geology nor mining activity are present in this region.

4.2.6 Potential for Excess Hydrostatic or Gas Pressure

Excess hydrostatic or gas pressure is not expected to affect the containment cell. The highest groundwater elevation observed at the site was over 8 ft below the proposed secondary lining elevation. The maximum flood elevation for this area is reportedly elevation 406. After the lining system is complete, the static weight of the soil layers in the lining system exceed the hydrostatic uplift pressure. No heaving of the lining system is anticipated.

The potential for gas pressure within the containment cell is low due to the relatively low quantity of decomposable matter in the wastes compared to a sanitary waste landfill. A venting system will be incorporated into the cover system to vent excess gas or barometric pressure from within the containment cell.

4.3 SYNTHETIC LINERS

4.3.1 General Information

The primary and secondary linings in the bottom lining system and the primary lining in the cover system will be constructed with 60-mil HDPE membrane. The HDPE linings will be smooth surfaced and all will contain ultraviolet protectants. Although the HDPE manufacturer for this installation is currently undefined, manufacturers such as GSE Lining Technology or Poly-Flex Inc. produce linings meeting the requirements of the State of Illinois.

4.3.2 Synthetic Liner Strength

The synthetic linings in the containment cell will not be subjected to significant tensile stress. Two loading conditions are anticipated for the synthetic linings, soil loading on side slopes and settlement of the bottom lining.

The linings on the cell's side slopes will be insulated from downdrag from the overlying waste material by a geonet drainage composite. Calculations for the lining stress due to the weight of soil sliding down the side slope show that the lining stress stays below the HDPE yield stress. Once wastes are placed and compacted in the cell, little down slope soil movement will be possible. This further limits the probability of lining downdrag. The cell construction specifications will prohibit dumping soil down unprotected side slopes. Where dumping is required, the slope will be protected by geogrid reinforcements and additional HDPE fly sheets. The side slope linings will not be overstressed. Lateral seams in the lining panels will be prohibited on the side slopes. The longitudinal seams are not expected to be significantly loaded.

Settlement of the bottom lining was previously identified to be minor. The strain in the bottom lining due to settlement is well within the elastic limit for the HDPE lining. The stress increase in the bottom lining is expected to be about 30 psi for the expected 0.1 percent strain assuming a HDPE modulus of 30,000 psi. It appears the bottom linings will not be overstressed.

Synthetic lining seaming will be performed using either hot-wedge or extrusion welding. Either method will be required to provide a film-tearing bond (FTB) in the parent HDPE linings. The strength of these seams will be required to achieve at least 90 and 50 percent of the HDPE lining tensile strength in shear and peel, respectively. The seams will be destructively tested periodically as provided in the Construction Quality Assurance Plan. All seams will be tested for hydraulic integrity using vacuum, air-pressure, or electrical methods. Appendix C presents details of this analysis.

4.3.3 Synthetic Liner Bedding

Synthetic linings will be placed on select soil layers, GCL, or geonet drainage composite for the containment cell construction. Figure 4-7 presents typical sections for the bottom lining system,

slope lining system, and cover system showing the proposed linings and bedding configurations. Soil bedding will be free of debris and particles prior to synthetic liner deployment.

4.4 GEOSYNTHETIC CLAY LINING (GCL)

4.4.1 General Information

The GCL used to construct the containment cell will be a commercially available material composed of two geotextile layers sandwiching bentonite clay granules. The hydraulic conductivity of the GCL will be no greater than 1x 10^{-8} cm/sec. Where high internal shear strength is required from the GCL, the geotextiles will be stitched together. The GCL placed on the containment cell side slopes will have an internal shear strength of 500 psf (nominal) and a tensile grab strength of at least 80 pounds. The GCL placed on the cell bottom and in the cover will have an internal shear strength of 50 psf (nominal) and a tensile grab strength of at least 50 pounds. Lateral and longitudinal seams will be completed by overlapping adjacent panels.

4.4.2 GCL Strength

The GCL material type will be tailored to meet the strength requirements of the location. The GCL used on side slopes will have 500 psf internal shear strength. Lateral seams will not be located on the side slopes, only continuous GCL panels. The lower internal shear strength GCL is suitable for all bottom and cover locations. The GCL material will not undergo any tensile loading. All tensile stresses will be transferred through the GCL via the internal shear strength to the underlying soil layers. Appendix C presents the results of this analysis.

4.5 LINER SYSTEM, LEACHATE COLLECTION AND DETECTION SYSTEM

The containment cell will incorporate a leachate collection and leak detection system. Details of the systems are provided below.

4.5.1 System Operation and Design

The leachate collection system over the primary lining system will consist of 12 inches of sand over most of the cell bottom area. A 12-inch thick by 36-inch wide gravel berm will be located

around the bottom perimeter of the cell. The gravel will be encased by a geotextile filter. The gravel and sand layer will be covered with a geotextile filter and an additional 6 inches of sand placed over the system as a protective measure. The minimum hydraulic conductivity of the sand will be 1 x 10^{-2} cm/sec. The gravel will be ⅜-inch pea gravel.

The side slopes will have a geonet drainage composite with a bonded geotextile cover placed directly on the primary HDPE lining. The geonet will intersect the gravel berm at the bottom perimeter. The geonet will be protected during construction by pushing waste material up to the geonet to provide a 2- to 4-ft buffer between the active waste placement and the lining systems on the side slopes.

The gravel berm will be expanded to a plan dimension of 5 ft by 5 ft to serve as a leachate collection sump. A perforated HPDE pipe will extend from the sump to the top of the completed cover system for periodic leachate removal. A flush-mounted vault will protect the pipe at ground surface.

The leak detection system will mirror the grading in the leachate collection system excepting that the elevation at the sump will drop an additional 12 inches to accommodate a gravel sump. The entire leak detection system will consist of a geonet drainage composite. A geotextile filter will be placed over the geonet where the soil layer between the primary and secondary lining systems is located. No geotextile will be placed over the geonet on the side slopes where the primary and secondary linings directly sandwich the geonet. A perforated HDPE pipe will extend from the gravel sump to the top of the completed cover system for periodic leachate removal. A flush-mounted vault will protect the pipe at ground surface.

A 36-inch thick gravel layer will be located beneath the secondary lining system to serve as a capillary break layer. The layer will mirror the grades of the overlying detection system, draining to one corner of the bottom area. The gravel layer will be located only beneath the bottom area of the cell. A perforated HDPE pipe will extend from the gravel sump to an elevation above the 100-year flood elevation where it will exit the cell embankment. A flush-mounted vault will protect the pipe at ground surface. Figures 4-8 and 4-9 present the detail bedding requirements for the primary and secondary collection system riser pipes.

Calculations were performed to establish the volume of sump required in the primary collection system. The sump size was based on a calculation of water balance for the cell. The hydraulic balance for the containment cell was performed using the USEPA computer program Hydrologic Evaluation of Landfill Performance (HELP), version 3.07. The results of the simulation are shown in Appendix C. The simulation shows that most precipitation is intercepted by the cover system with virtually no leachate being produced. The primary leachate source will be from precipitation during waste placement and entrained moisture in the wastes. The simulation indicates that annual measurement and removal of leachate from the collection and detection systems will be sufficient. A peristaltic pump or vacuum truck should be sufficient to remove the collected leachate. Details of the required sump size are shown in Appendix C.

4.5.2 Equivalent Capacity of Geonet Drainage Composite

The geonet drainage composite used for all side slope collection layers and the leak detection bottom layer will have a minimum transmissivity of 9×10^{-1} cm^2/sec. The geonet transmissivity is almost 3 times greater than the transmissivity of a 12-inch thick gravel layer with a hydraulic conductivity of 1×10^{-2} cm/sec.

4.5.3 Grading and Drainage

The bottom lining for the leachate collection system will slope at 2 percent beneath the sand layer toward the gravel berms. The gravel berms will slope at 1 percent to a single collection sump at one corner of the cell bottom. The grading for the leak detection system generally mirrors the collection system above. The sumps will be drained through HDPE pipes placed in each sump. The collection pipe will be unperforated from ground surface down to the gravel collection sump and perforated within the gravel collection sump. The piping will straight and will bend to transition from the slope to the bottom grade. End caps will be placed over the pipe ends to prevent foreign material and gravel entry.

The pipe perforations will be ¼-inch diameter. The entire length of piping within the gravel sump will be perforated. The ⅜-inch diameter gravel will provide adequate filter action to prevent clogging of the pipe perforations.

The HELP model results indicate that leachate production will be minimal after the cover system is in place. The transmissivity of the sand, gravel, and geonet layers are adequate to rapidly transmit the leachate to the collection sump. The leachate level in each sump will be measured annually. Any liquids found in the collection piping will be removed at that time and placed in drums or tanks for disposal.

4.5.4 Maximum Leachate Head

The HELP model was used to predict the leachate production and head levels within the cell during construction and after closure. The model results are shown in Appendix C.

The model results show that elevated leachate head may occur within the leachate collection layer during construction. The cell will have open catchment and stormwater will collect on the waste surface. The construction modeling assumed no stormwater will be pumped off the waste surface after rainfall events. The stormwater will actually be pumped off the waste surface as soon as possible to resume waste placement. The assumption of no surface water runoff and no pumping is therefore highly conservative for the modeling. The construction model assumed that the cell was half-filled with wastes. The maximum head in the leachate collection layer was greater than the 12-inch maximum. Therefore, the leachate collection sump will require pump out after each rainfall event during construction. The construction model indicates the peak leachate generation rate is about 4,000 gallons per day or 2.8 gallons per minute.

The model results show that the leachate leakage into the detection layer during construction is about ¾-inch per year which produces about 20,000 gallons of leachate in the expected 6-month construction period or about 110 gallons per day. Therefore, the leak detection layer will require checking and possibly pump out every other day during the construction period. The modeling assumed that the head in the leachate collection layer was not drawn down regularly, therefore the leachate leakage rate is conservative.

The model results show the leachate and leak production rates fall substantially after the cover system is installed over the cell. The leachate and leak production are essentially zero after the cell water balance has reached equilibrium. Some leachate production will continue for several months after the cell is covered. Monthly checks of the leachate and leak collection sumps will be conducted until the production rate has reduced. Annual checks will be conducted thereafter.

4.5.5 Stability of Drainage Layers

The containment cell drainage layers will support the loads in the system. The maximum vertical stress expected for the leak detection layer is about 2,500 psf. The geonet drainage composite is rated for vertical loadings over 20,000 psf. Therefore, the leak detection layer will not be affected by the loading.

The leachate collection system will have a maximum vertical stress of about 2,300 psf. The sand and gravel layers can support many times that vertical stress without crushing. Therefore, the leachate collection layer will not be affected by the loading.
The drainage layers on the side slopes will be geonet drainage composites. These layers will not support significant loading by soil or equipment moving down the slope. Therefore, additional engineering and construction measures are required to perform the cell construction and waste placement. Reinforced ramps to carry the soil and equipment loads may be used. A geogrid reinforcement with an underlying HDPE slip sheet will insulate the geonet and linings from tensile downslope loads. Calculations for the reinforcement are shown in Appendix C.

The geonet drainage composite on the side slopes will be protected during waste placement by pushing the wastes up to the slopes with a minimum separation of 2 to 4 ft between the equipment and side slopes. The wastes will be placed sequentially from the cell bottom to the top and little movement of the wastes on the side slopes is anticipated. Geotextiles used on the drainage composite can commonly reach 50 percent strain before failure and the geonet strain capacity is larger yet. The movement of the wastes due to settlement is not likely to exceed several percent. Therefore, the geonet drainage composite will perform adequately on the side slopes.

4.5.6 Strength of Piping

Piping in the containment cell is limited to the sump drains in the leachate collection, leak detection, and capillary break layers. In all three installations, 6-inch diameter HDPE piping with a SDR of 11 will be used. The worst case loading condition is anticipated to be a wheel loading from a construction vehicle. The tire pressure and width were assumed as 50 psi and 12 inches, respectively. The depth of soil cover was 1-ft. A 1,000 psi soil modulus is representative

of a soft clay material. The proposed piping provides factors of safety greater than 7 for the loading condition. The proposed piping will provide acceptable service in the containment cell. The pipe strength calculations are provided in Appendix C.

4.5.7 Prevention of Clogging

Clogging in the leachate collection and leak detection systems is unlikely to affect the performance of the systems. The systems will receive their highest loads during the waste placement with the loading expected to fall to near zero after the cover placement as reported in the Maximum Leachate Head section. The relatively short performance period for the system reduces the effect of clogging on the long-term performance of the cell.

A geotextile and 6-inch sand layer protect the underlying sand and gravel drainage layers in the leachate collection system from clogging due to the waste materials. A geotextile over the geonet drainage composite on the side slopes protects geonet from clogging with the waste materials. Clogging the geotextile on the side slope should not be a concern since the leachate will continue to flow downslope to the bottom collection layer without applying head to the lining system.

The hydraulic capacity of the leachate collection and leak detection systems is many times greater than the highest demand placed on the layers. Minor clogging is not expected, but the capacity of the systems should provide adequate liquid drainage. After the cell is covered, the flows are nearly zero and clogging will not significantly limit the systems' performance. An analysis of geotextile clogging is presented in Appendix C.

5.1 CLOSURE PLANS

The containment cell will incorporate an impermeable cover to reduce infiltration into the completed cell. The cover will be sloped to promote stormwater run-off and will incorporate structural features to direct and control the run-off from the elevated cover. The cover slope also provides for potential settlement of the contained wastes. The impermeable cover will be constructed to completely encapsulate the materials placed within the cell.

5.2 CLOSURE PERFORMANCE STANDARD

The cover system of this landfill is designed to:

- minimize the need for further maintenance, and
- control, minimize or eliminate the post closure escape of materials within the landfill to the ground or surface water surrounding the site.

The closure plan provides an engineered cover system that controls and routes stormwater to reduce cover erosion. The cover will incorporate an impermeable composite lining system that will reduce the infiltration into the wastes and subsequent leachate generation. A geonet drainage composite will intercept and route water infiltrating the cover soil layer to reduce the head on the cover lining system. The cover soil layer will be 24 inches thick to provide adequate rooting depth for the grassing on the cover. The grassing will reduce soil erosion.

A sand layer will be placed over the completed waste fill to provide a gas permeable zone for a gas vent system through the cover system. Vent pipes will penetrate the cover system to provide relief for gases generated by the wastes and to vent barometric pressure changes.

The impermeable cover composite lining system substantially reduces liquid infiltration into the wastes and subsequent leachate generation. The cover system will be installed after all waste materials have been interred there.

5.3 COVER SYSTEM DESCRIPTION

The landfill cover is designed to prevent infiltration of stormwater into the waste material and promote rapid run-off of stormwater during rainfall events. At a minimum, the cover system will include the following from bottom to top:

- 6 inches of tracked in-place soil
- geosynthetic clay liner
- 60-mil HDPE geomembrane
- geonet drainage layer
- geotextile fabric
- 24 inches of soil and drainage layer to support the vegetation cover

5.4 COVER DESIGN

5.4.1 General

The cover system for the proposed containment cell will be a multi-component composite lining with gas collection and subsurface drainage layers. The proposed cover system is designed to provide a degree of impermeability equivalent to the bottom lining system. Surface grades for the containment cell side slopes are no steeper than 4:1 for ease of mowing and maintenance. The central cover area will have a surface slope between 3 and 12 percent depending on the waste volume. A raised berm around the central cover area routes stormwater to an armored downchute on the 4:1 side slope. The total landfill plan area is about 5.4 acres. Figure 5-1 shows the proposed configuration of the cover system. Figure 5-2 shows a cross section of the proposed cover system. A description of the cover system components is provided below. The components are described in a bottom to top order.

The subgrade for the cover system will be the waste materials. The waste materials will be graded to mirror the final surface grades on the cover. Clean fill will be used if needed to provide the grades if there is not enough waste fill to meet the required grades. A 6-inch thick sand layer will be pushed and tracked into place over the graded subgrade to serve as the bedding

for the linings and serve as a gas collection layer. Four gas vent structures will be distributed around the cover to vent the sand layer to the atmosphere. The vent stack will be constructed of 6-inch diameter PVC piping capped with a hood to prevent precipitation infiltration. The portion of the vent stack below the lining elevation is slotted to provide pneumatic connection to the sand layer. Each vent will include a 20-ft by 20-ft geonet layer to create an enhanced collection zone around the vent. Each vent stack excavation will be backfilled with gravel to provide a stable foundation. Each vent pipe passes through a fabricated boot in the HDPE lining to prevent seepage from entering the cell. Figure 5-3 presents a detail of the vent structure.

A GCL will be placed over the sand layer. The GCL will be rolled into place and overlapped with adjacent panels. The GCL used in the cover will be a commercially available material composed of two geotextile layers sandwiching bentonite clay granules. The hydraulic conductivity of the GCL will be no greater than 1×10^{-8} cm/sec. The GCL will have an internal shear strength of 50 psf (nominal) and a tensile grab strength of at least 50 pounds. Lateral and longitudinal seams will be completed by overlapping adjacent panels.

A 60-mil High Density Polyethylene (HDPE) lining will be placed directly over the GCL. The GCL and HDPE composite lining system extends over the entire lined waste cell and is buried in an anchor trench just outside the limits of the bottom lining anchor trench. The HDPE lining panels will be heat seamed to form a continuous membrane barrier. The seaming will be either pressure or vacuum tested to verify the integrity of the seams. Mechanical tests of the seam integrity will be performed by removing test samples from the completed lining and destructively testing the samples. The sample locations from the lining will be patched with an extrusion welded HDPE patch. The primary lining in the cover system will be constructed with 60-mil HDPE membrane. The HDPE lining will be smooth surfaced and will contain ultraviolet protectants. Although the HDPE manufacturer for this installation is currently undefined, manufacturers such as GSE Lining Technology or Poly-Flex Inc. produce linings meeting the requirements of the State of Illinois.

A geonet drainage composite with a geotextile covering will be placed directly on the HDPE lining to serve as a subsurface drain. The geonet will extend over the entire cover area and connect to perforated piping at the edge of the cover area. The perforated piping is connected to gravel covered outlets at ground surface to drain the collected water. The gravel prevents access to the drainage piping by animals.

A 24-inch earthen cover soil layer will be constructed over the geonet drainage layer to provide a vegetated cover. The cover soil material will be a native soil suitable for grass growth and with a maximum particle size of ¼-inch. The cover soil layer will be compacted to at least 90 percent of the fill's maximum dry density as determined by ASTM D-698 to provide stability to the cover soil for mowing and maintenance. The grassing will be with local grasses native to the area.

5.4.2 Minimization of Liquid Migration

The proposed cover design provides a substantial long-term minimization of liquid migration through the cover system. Modeling of the cover system was performed using HELP. The model results indicate that the infiltration through the cover system is less than 1/1000 of 1 percent of the total precipitation falling on the cover system. The HELP results are provided in Appendix C.

5.4.3 Maintenance Needs

The proposed cover system was designed to minimize the amount of maintenance and to allow easy maintenance. The cover system incorporates relatively gentle slopes for ease of mowing. The lower portions of the side slopes include rip rap armoring to reduce erosion of the side slopes during flooding events in Dead Creek. The berm around the central cover area reduces the amount of stormwater flowing down the side slopes, reducing the erosion potential. The central cover area slopes are mild to reduce stormwater run-off velocity and erosion. The gravel covered subsurface drains on the cover help keep animals out of the drainage collection system to avoid gnawing injury to the system.

5.4.4 Drainage and Erosion

The cover system design incorporates a berm around the central cover area to route stormwater off the cover through an armored downchute. The velocity of sheet flow run-off on the cover varies between 0.25 and 0.44 ft per second for slopes between 3 and 12 percent, respectively.

Grassed surfaces are appropriate for these flow velocities. Calculations for the sheet flow velocities are provided in Appendix D.

The geonet drainage composite used as the subgrade drain has a transmissivity of 9×10^{-1} cm^2/sec. The geonet will be a 3-dimensional HDPE net with a single non-woven geotextile placed over the net. The geonet will directly contact the underlying HDPE lining. Calculations in Appendix C show that the geotextile will resist clogging by the native sandy silt soils expected for use as the cover soil layer.

Free drainage of the subgrade drain is confirmed in the HELP model calculations. The liquid head in the subgrade drain does not exceed 4.2 inches under peak daily conditions. The average annual head in the subgrade drain is 0.007 inches. The HELP model results are provided in Appendix C.

Free drainage of the cover surface is maintained by adequate drainage course slopes. The central cover area will have a minimum slope of 3 percent. A raised earthen berm around the entire central cover area will form a 1-ft deep swale to route the stormwater flow to the single stormwater downchute. The swale slope will be 1 percent. The peak flow from the central cover area during a 100-year, 24-hour storm is 14 cfs. The water depth in the cover swale does not exceed 9 inches during the 100-year, 24-hour storm. A paved downchute will carry the stormwater down the exterior slope of the cell. A stilling basin will be constructed at the foot of the downchute to dissipate the hydraulic energy. The downchute and stilling basin are designed to handle the 14 cfs peak flow. The stormwater calculations for the cover system are provided in Appendix D.

5.4.5 Settlement and Subsidence

The foundation soils beneath the proposed containment cell are primarily sandy soils with little potential for consolidation or creep settlement. Most settlement will be immediate. The settlement potential for the cell is described in a previous paragraph. Settlement potential for the soil lining is minimal due to the components receiving moderate compactive effort and the total overburden weight being minor.

The wastes placed in the cell are largely inorganic soils with limited digestible material. The wastes will be dried prior to placement in the cell and they will be compacted during placement. The degree of compaction will not be specified for waste placement. Consolidation of the waste mass is not likely to be significant. Consolidation testing on the proposed wastes has not been performed. Correlations for consolidation potential generally show that settlement potential decreases as the material's liquid limit and moisture content decrease. In addition, the mechanically compacted soil should behave as an over-consolidated soil that has significantly less settlement potential than a normally-consolidated soil. The 16-ft maximum waste thickness makes it unlikely that the overburden stress will approach the normally-consolidated range for the wastes, therefore the over-consolidated settlement behavior should be valid for this analysis. The duration of waste placement will allow some of the potential settlement to occur prior to cover placement, further limiting the cover settlement. The cover system settlement is estimated as about 1-inch at the center of the cover. That deflection produces no measurable reduction in the cover grade. The waste consolidation calculations are provided in Appendix D.

The potential settlement for the foundation and wastes will not measurably alter the surface grades of the cover system. The precipitation runoff should not be affected by any cover settlement and the infiltration predicted by the HELP modeling should be valid for the life of the cell.

5.4.6 Freeze/Thaw Effects

The frost penetration depth in this region is about 3 ft. The GCL in the cover system will be 2 ft below ground surface. The cover system GCL will be subject to freeze/thaw action.

Freeze/Thaw action can reduce the effectiveness of impermeable soil barriers. This cover system will use a GCL as the impermeable soil barrier. Testing performed by GeoServices Inc. for James Clem Corporation in 1988, showed that the GCL becomes about one-half order of magnitude more permeable when subjected to freeze/thaw cycling. The permeability of the GCL used in the HELP modeling does include this reduction for the freeze/thaw effects. The infiltration rate through the cover system should represent long-term performance.

5.4.7 Anchorage

The anchor trench around the perimeter of the landfill will be excavated and the liner segments placed such that the field welds will run up and down the side slopes of the berms. The liner will be placed into the anchor trench, the backfill soils will be placed and then compacted. A detail of the anchorage for the geosynthetic liner is shown on Figures 5-4 and 5-5.

5.5 RUN-OFF CONTROL SYSTEMS

Stormwater run-off control during containment cell construction and filling will be performed as follows.

5.5.1 Design and Performance

For most of the waste placement, stormwater is completely contained within the lined cell. All stormwater contacting the placed sediments will be handled by pumping to the filter dam at the downstream end of Creek Segment B.

During waste placement, the waste fill will be graded to create a collection sump from which stormwater will be pumped. Since the waste placement period is relatively short (about 6 months), the design storm for the open cell is a 1-year, 24-hour event. The rainfall amount is 2.71 inches. The stormwater volume from that storm is about 222,000 gallons. Approximately ¼ of the cell area would need to be left with a 1-ft depth to accommodate that stormwater volume.

For a 25-year, 24-hour storm, the rainfall amount is 6.02 inches. The stormwater volume from that storm is about 495,000 gallons. Approximately ¼ of the cell area would need to be left with a 2-ft depth to accommodate that stormwater volume.

Figure 5-4 presents the detail for run-off control during placement within the landfill. To reduce the stormwater volume, impermeable covers may be placed over the wastes to prevent contact with the stormwater. Stormwater ponded on the impermeable covers will be discharged to the ground without treatment. As the waste elevation approaches the perimeter berm elevations, impermeable covers will be required over the wastes to limit stormwater contact.

5.5.1.1 Calculation of Peak Flow

The peak flow from the containment cell was calculated using the Graphical Peak methodology described in Technical Release 55 (TR-55) developed by the U.S. Soil Conservation Service. Rainfall frequency distributions were taken from *Frequency Distributions and Hydroclimatic Characteristics of Heavy Rainstorms in Illinois*, by Huff and Angel.

The peak flow for the 25-year, 24-hour storm is 27 cfs. The computerized calculations for the peak flow are shown in Appendix D.

5.5.1.2 Management of Collection and Holding Units

The waste cell will be actively managed by the construction contractor to minimize delays to the work progress. The cell will be pumped out as soon as possible to resume the waste placement. Tank trucks, mobile tanks, or lined pools may be used to store stormwater and leachate that has contacted the wastes. The liquids will be treated onsite and discharged or will be transported to a publicly owned treatment works (POTW) for treatment and disposal.

5.5.1.3 Construction

The stormwater run-off control system will be constructed primarily of waste materials and will be contained within the lined containment cell. The run-off control system will incorporate requirements to maintain storage capacity in a portion of the waste fill area or provide impervious barriers to avoid waste contact. The requirements for run-off control are contained in Appendix D. A construction quality control program will only assure the retention volume is met since the configuration changes daily and the cell is lined. When impervious linings are used, the retention volume may be reduced in proportion to the area covered.

5.5.1.4 Maintenance

The run-off control system will require daily maintenance to accommodate the daily filling progress. Maintenance activities will be limited to providing the required retention volume within the waste area.

5.6 CONTROL OF WIND DISPERSAL

The waste materials will consist primarily of soil and organic materials. The materials may produce dust if allowed to become too dry. Dust will not be allowed from the operations and the waste fill will be sprinkled with water to reduce any dust generation.

5.7 POST-CLOSURE RUN-OFF

Surface water run-off will be controlled by landscaping and diversion structures to promote run off away from the landfill. Erosion control will be maintained by appropriate landfill contouring and establishment of grass vegetation to stabilize the soil cover.

Surface run-off occurring after closure will not contact the waste material and therefore will be considered non-contaminated. Following closure of the landfill, stormwater will be discharged directly off-site to Dead Creek.

5.8 DRAINAGE STRUCTURES

Drainage structures used in the engineering design for stormwater management may include half-round corrugated metal pipe (CMP) channels, earth berms and channels, and rip rap channels. Drainage structures will be specified that adequately manage the volume of stormwater. Earth berms and channels may be used to control on-site surface waters. Figure 5-5 presents the cover system swale and the drain to control stormwater run-off. The stormwater downlet channel and stalling basin are shown in Figure 5-6

6.1 SPECIFICATIONS

6.1.1 Material Specifications

Specifications for the materials proposed for the liner and cover systems are included as Appendix E. Details of material thicknesses, strength and physical properties are presented for:

- geomembrane liners and covers
- geosynthetic clay liners
- geotextiles, geonets and geogrids
- pipes and other appurtenances

In addition, material requirement for compacted fill, drainage media, tracked in-place clay and vegetated cover soil are also included.

6.1.2 Construction Specifications

Requirements for the installation or construction of each element of the landfill liner and cover system are included in the specifications in Appendix E. The specifications include construction requirements for:

- inspection prior to deployment or installation of geosynthetic materials
- placement/deployment procedures
- bonding and material interface/overlap requirements and
- procedures for protection before, during and after placement.

6.2 CONSTRUCTION QUALITY CONTROL/QUALITY ASSURANCE

As required by the specifications for the construction of this Landfill, a two step process will be used to document that the finished product was constructed in accordance with the Plans and Specifications. Construction quality control will be performed by the Contractor to verify the

work. Construction quality assurance will be the responsibility of the Owner. An independent registered professional engineer will monitor the placement, construction or installation of the liner and cover systems. Requirements for construction quality control are included in the Specifications for each component of the landfill in Appendix E. Solutia's Quality Assurance Manual for the Installation of Geosynthetic Lining Systems is presented in Appendix F. Solutia's Quality Assurance Manual for the Installation of the Soil Components of the Lining and Final Cover Systems is included as Appendix G.

EPA and Illinois regulations require that a landfill's liner and leachate collection system be constructed of materials that are chemically resistant to the wastes managed in the landfill and the leachate expected to be generated. Solutia has selected HDPE based on the results of chemical compatibility testing performed by the manufacturer. Solutia has selected Geosyntec to perform a site-specific compatibility evaluation of the materials proposed for this disposal unit. Geosynthetic materials (geomembrane and geotextiles) will be tested in accordance with EPA's proposed 120-day accelerated-life Test Method 9090 "Compatibility Test for Waste and Membrane Liners." A copy of that report will be provided upon completion of the testing program.

Compatibility of soil components proposed for the disposal cell is also under evaluation. Compacted clay and geosynthetic clay liner materials will be evaluated using the EPA 9100 test procedure to identify changes in material properties after exposure to the leachate. The results of this evaluation will also be presented upon completion of the test.

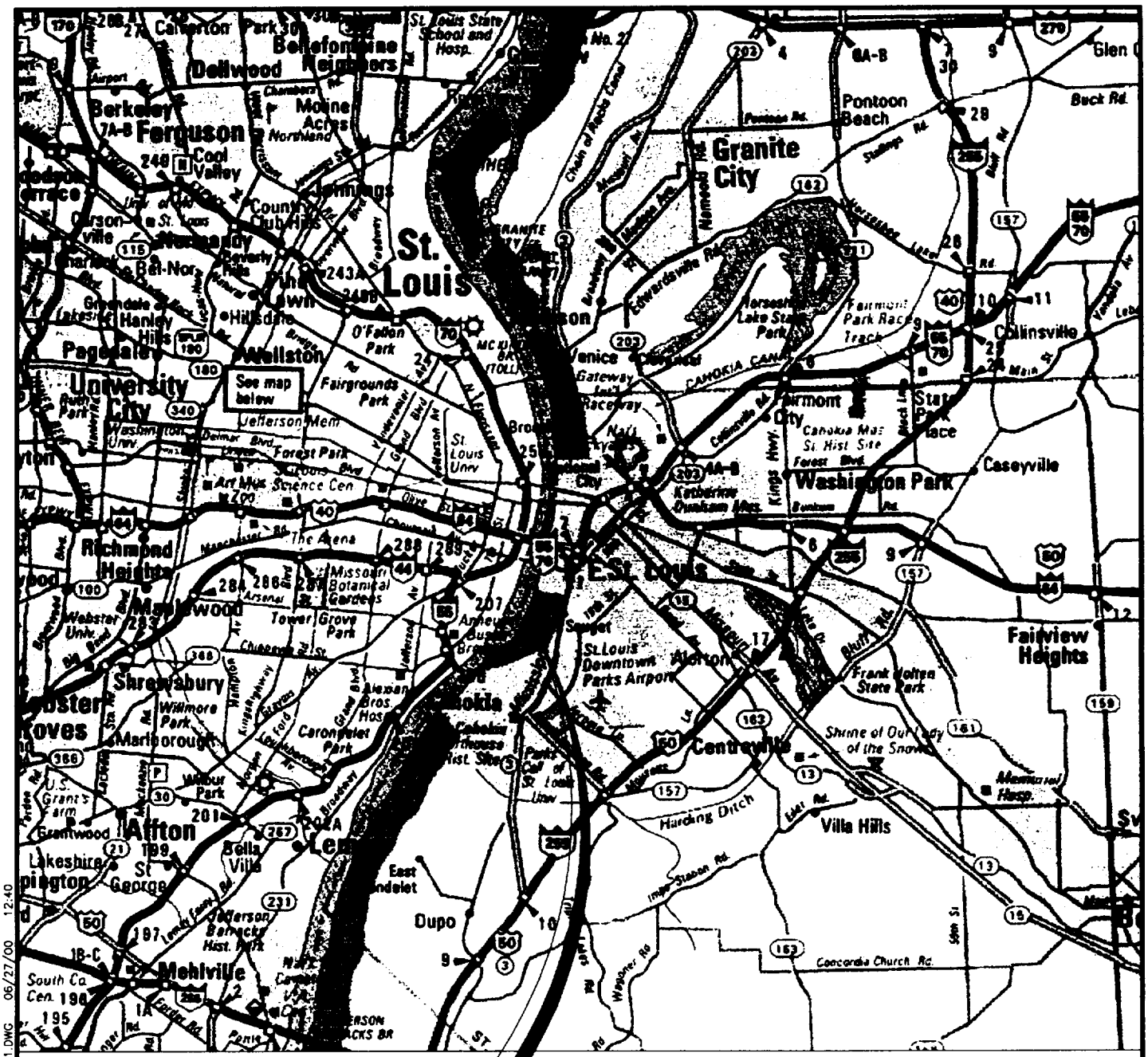
The engineering analyses and calculations used in the design of the landfill are presented in the following appendices:

- **APPENDIX B - FOUNDATION EVALUATION**
  - Containment Cell Capacity
  - Bearing Capacity
  - Settlement Potential
  - Slope Stability

- **APPENDIX C - LINER SYSTEM COMPONENT DESIGN**
  - Gravel Drain Sizing
  - Pipe Loading
  - Geotextile Clogging Potential
  - GCL Loading Calculations
  - Lining Tensile Stress
  - Sump Sizing
  - Access Ramp Stability
  - HELP Evaluation

- **APPENDIX D - COVER SYSTEM COMPONENT DESIGN**
  - Cover System Stormwater Control
  - Run-off Velocity/Sheet Flow
  - Waste Consolidation

Figures



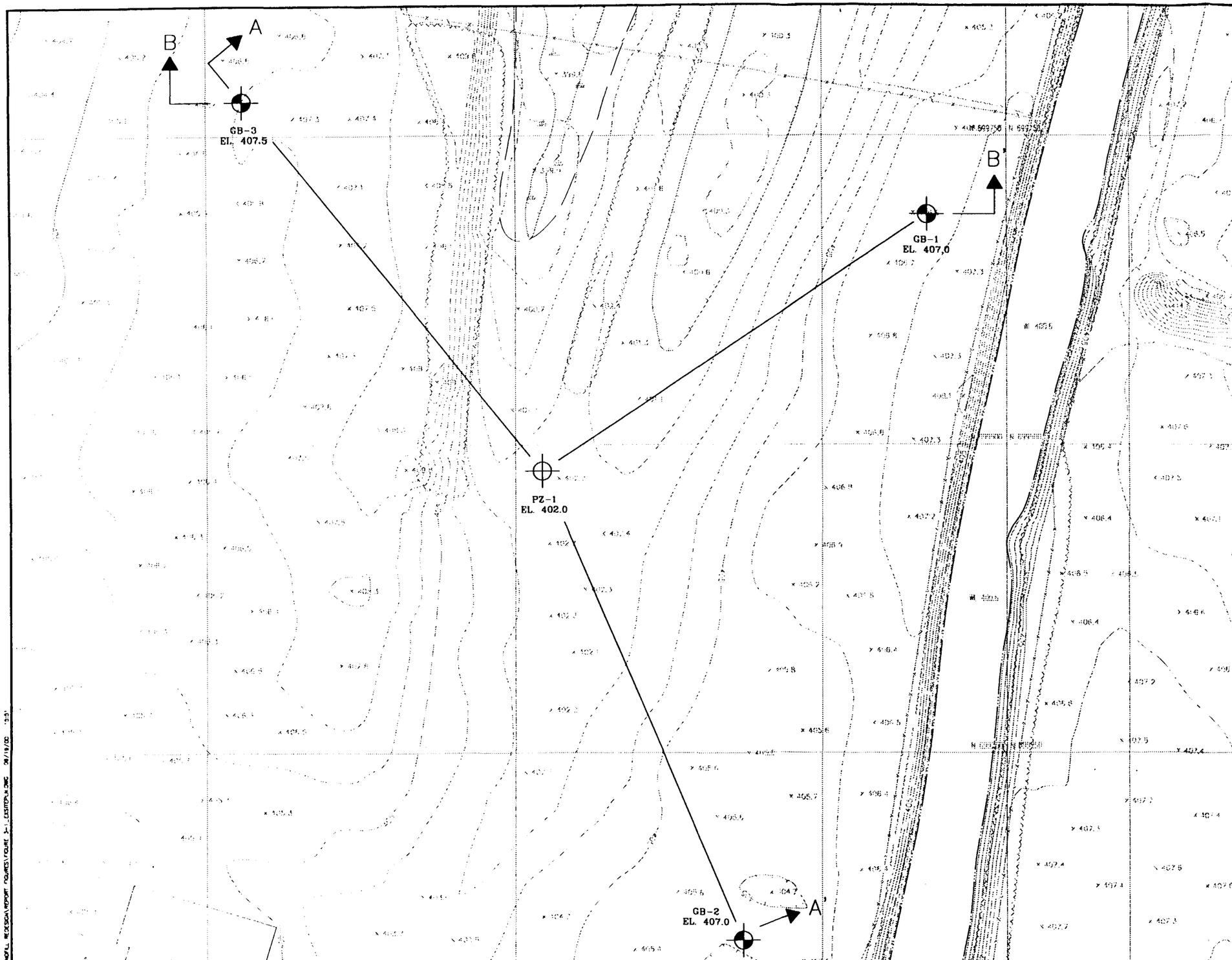
PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME	SOLUTIA INC. SAUGET AREA 1
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		FIGURE 2-1
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE	SITE LOCATION
	Date: JUNE 20, 2000		

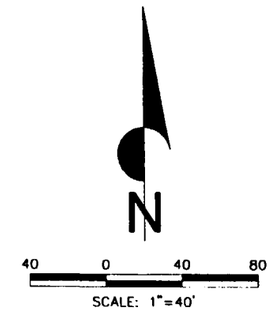
S:\C10000\3000\3899.00\LANDFILL REDESIGN\ADDENDUM FIGURES\FIGURE 2-1.DWG 06/27/00 12:40

SITE LOCATION

PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME **SOLUTIA INC.** SAUGET AREA 1	FIGURE 2-2
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE **PROJECT VICINITY MAP**	
	Date: JUNE 20, 2000		

S:\C10000\3000\3899.00\LANDFILL REDESIGN\ADDENDUM FIGURES\FIGURE 1-2.DWG 06/27/00 12:41





LEGEND

GEOTECHNICAL BORINGS LOCATIONS

PIEZOMETER LOCATION

REDUCED DRAWING – VERIFY SCALE

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: G. WANTLAND
DRAWN BY: B. DOUGLAS
CHECKED BY: P. CARTWRIGHT
PROJECT MANAGER: G. WANTLAND
DATE: DECEMBER 3, 1999

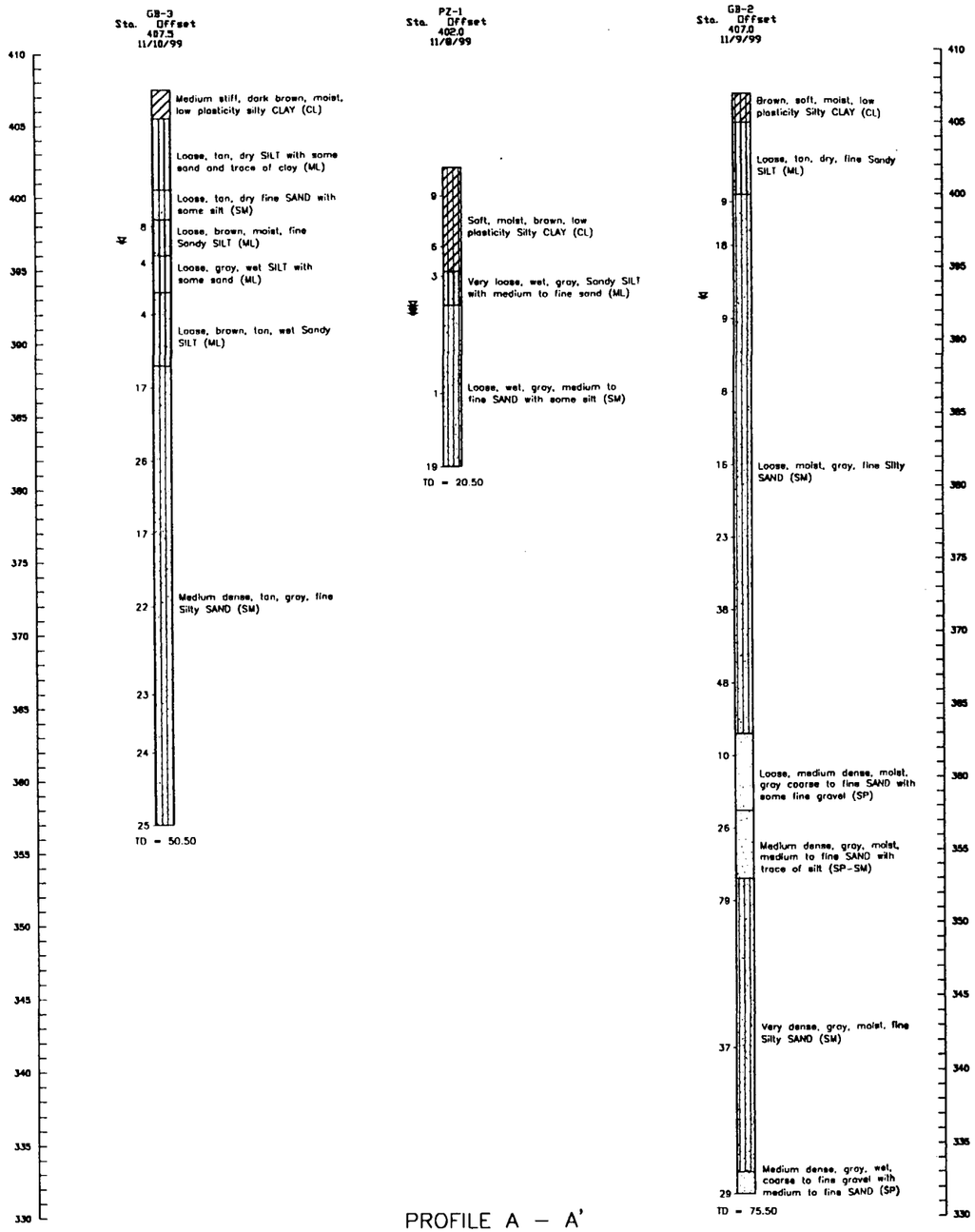
URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.288.1711 FAX: 813.287.8591

SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

EXISTING SITE PLAN

PROJECT NUMBER C100003899.00

FIGURE 3-1



PROFILE A – A'

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT "N" *
VERY LOOSE	0 TO 4
LOOSE	5 TO 10
MEDIUM DENSE	11 TO 30
DENSE	31 TO 50
VERY DENSE	OVER 50

* BLOWS PER FOOT MEASURED USING 140 POUND WEIGHT HAVING A FREE FALL OF 30 INCHES

II COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, QU, TSF	BLOW COUNT "N"
VERY SOFT	<1/4	0 TO 2
SOFT	1/4 TO 1/2	2 TO 4
MEDIUM STIFF	1/2 TO 1	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	OVER 4	OVER 30

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED	HAVING INCLINED PLANES OF WEAKNESS THAT ARE SLICK AND GLOSSY IN APPEARANCE.
FISSURED	CONTAINING SHRINKAGE CRACKS, FREQUENTLY FILLED WITH FINE SAND OR SILT; USUALLY MORE OR LESS VERTICAL.
LAMINATED	COMPOSED OF THIN LAYERS OF VARYING COLOR AND TEXTURE.
INTERBEDDED	COMPOSED OF ALTERNATE LAYERS OF DIFFERENT SOIL TYPES.
CALCAREOUS	CONTAINING APPRECIABLE QUANTITIES OF CALCIUM CARBONATE.
WELL GRADED	HAVING WIDE RANGE IN GRAIN SIZES AND SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES.
POORLY GRADED	PREDOMINANTLY OF ONE GRAIN SIZE, OR HAVING A RANGE OF SIZES WITH SOME INTERMEDIATE SIZE MISSING.

SOIL CLASSIFICATION LEGEND

N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
%-200	PERCENT PASSING NO. 200 SIEVE SIZE (PERCENT FINES)
50/3"	50 BLOWS FOR 3 INCHES PENETRATION INTO SOIL
▽	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
▽	GROUNDWATER LEVEL MEASURED AFTER DRILLING
w	IN-PLACE DRY DENSITY IN PCF
Su	UNDRAINED SHEAR STRENGTH IN KSF

SILT
SAND
CLAY
SHELL
GRAVEL
CLAYEY-SAND
CLAYEY-SILT
CLAYEY-GRAVEL
SANDY-SILT
SANDY-CLAY
SANDY-GRAVEL
SANDY-PEAT
SILTY-SAND
SILTY-CLAY
SILTY-GRAVEL
GRAVELLY-SAND
GRAVELLY-CLAY
HARD-LIMESTONE
WEATHERED-LIMESTONE
SHELLY-SAND
SHELLY-CLAY
SHELLY-GRAVEL
MUCK
PEAT
CONCRETE
ASPHALT
CAVITY

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: C. WANTLAND
DRAWN BY: W. WEBER
CHECKED BY: J. JONES
PROJECT MANAGER: C. WANTLAND
DATE: MAY 25, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.286.1711 FAX: 813.287.8591

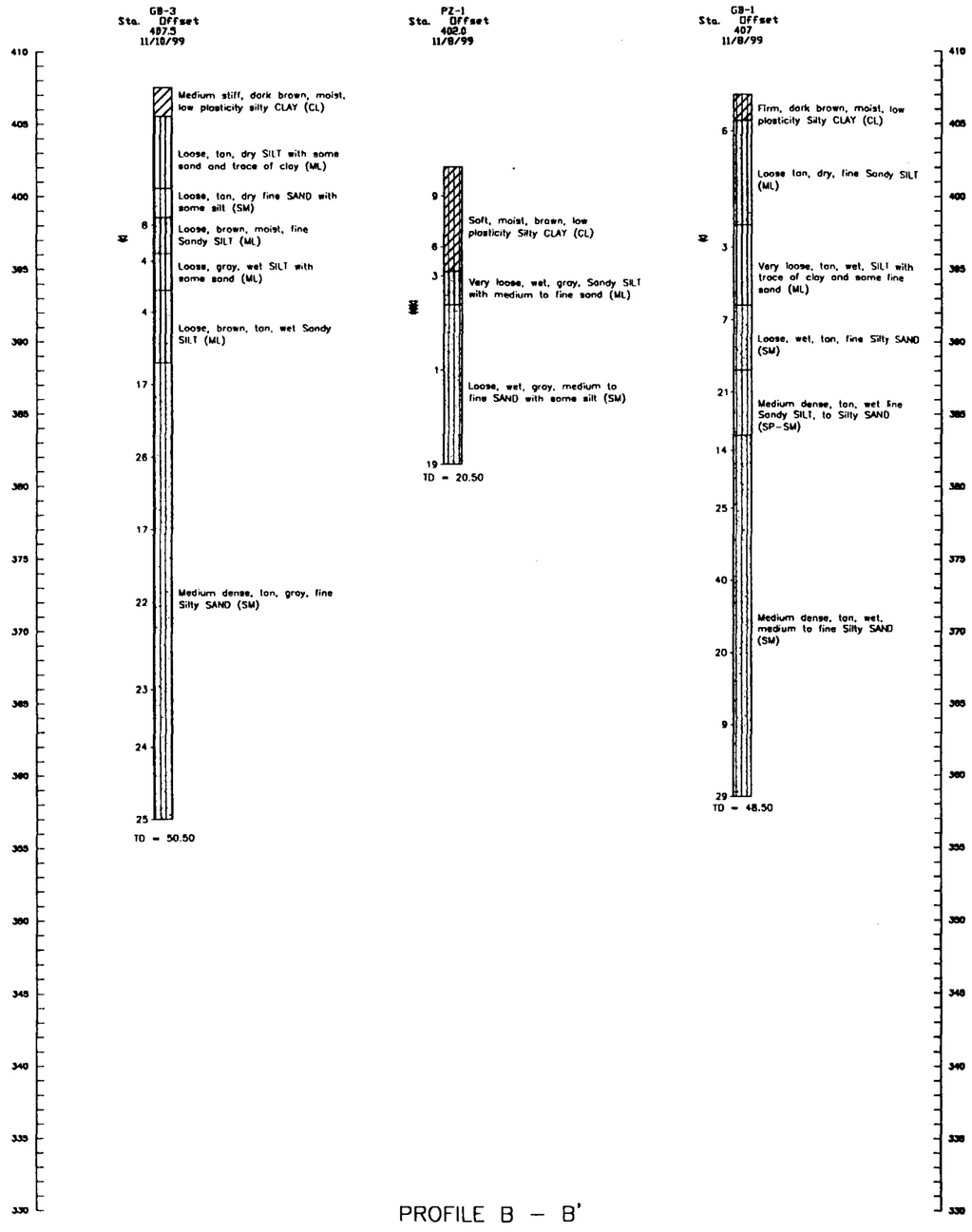
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

BORING PROFILE A - A'

PROJECT NUMBER
C100003899.00

FIGURE
3-2

\C100003\3000\3899.00\WORK\SOIL\REPORT FIGURES\FIGURE 3-2_ BORING PROFILE NORTH-SOUTH.DWG 06/19/00 13:52



PROFILE B – B'

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT "N" *
VERY LOOSE	0 TO 4
LOOSE	5 TO 10
MEDIUM DENSE	11 TO 30
DENSE	31 TO 50
VERY DENSE	OVER 50

* BLOWS PER FOOT MEASURED USING 140 POUND WEIGHT HAVING A FREE FALL OF 30 INCHES

II COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, QU, TSF	BLOW COUNT "N"
VERY SOFT	<1/4	0 TO 2
SOFT	1/4 TO 1/2	3 TO 4
MEDIUM STIFF	1/2 TO 1	5 TO 8
STIFF	1 TO 2	9 TO 15
VERY STIFF	2 TO 4	18 TO 30
HARD	OVER 4	OVER 30

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED	HAVING INCLINED PLANES OF WEAKNESS THAT ARE SLICK AND GLOSSY IN APPEARANCE.
FISSURED	CONTAINING SHRINKAGE CRACKS, FREQUENTLY FILLED WITH FINE SAND OR SILT; USUALLY MORE OR LESS VERTICAL.
LAMINATED	COMPOSED OF THIN LAYERS OF VARYING COLOR AND TEXTURE.
INTERBEDDED	COMPOSED OF ALTERNATE LAYERS OF DIFFERENT SOIL TYPES.
CALCAREOUS	CONTAINING APPRECIABLE QUANTITIES OF CALCIUM CARBONATE.
WELL GRADED	HAVING WIDE RANGE IN GRAIN SIZES AND SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES.
POORLY GRADED	PREDOMINANTLY OF ONE GRAIN SIZE, OR HAVING A RANGE OF SIZES WITH SOME INTERMEDIATE SIZE MISSING.

SOIL CLASSIFICATION LEGEND

N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
%-200	PERCENT PASSING NO. 200 SIEVE SIZE (PERCENT FINES)
50/3"	50 BLOWS FOR 3 INCHES PENETRATION INTO SOIL
▽	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
▼	GROUNDWATER LEVEL MEASURED AFTER DRILLING
w	IN-PLACE DRY DENSITY IN PCF
Su	UNDRAINED SHEAR STRENGTH IN KSF

SILT
SAND
CLAY
SHELL
GRAVEL
CLAYEY-SAND
CLAYEY-SILT
CLAYEY-GRAVEL
SANDY-SILT
SANDY-CLAY
SANDY-GRAVEL
SANDY-PEAT
SILTY-SAND
SILTY-CLAY
SILTY-GRAVEL
GRAVELLY-SAND
GRAVELLY-CLAY
HARD-LIMESTONE
WEATHERED-LIMESTONE
SHELLY-SAND
SHELLY-CLAY
SHELLY-GRAVEL
MUCK
PEAT
CONCRETE
ASPHALT
CAVITY

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: G. WANTLAND
DRAWN BY: W. WEBER
CHECKED BY: J. JONES
PROJECT MANAGER: G. WANTLAND
DATE: MAY 25, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1482
TEL: 813.286.1711 FAX: 813.287.8591

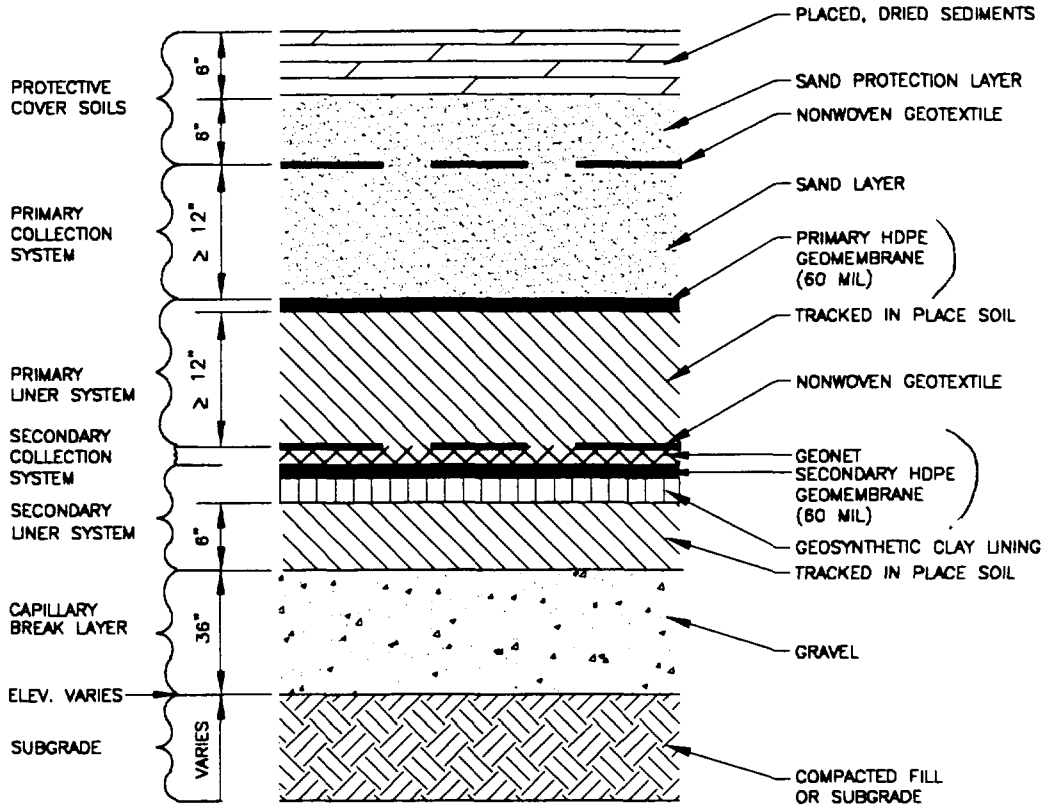
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

BORING PROFILE
B - B'

PROJECT NUMBER
C100003899.00

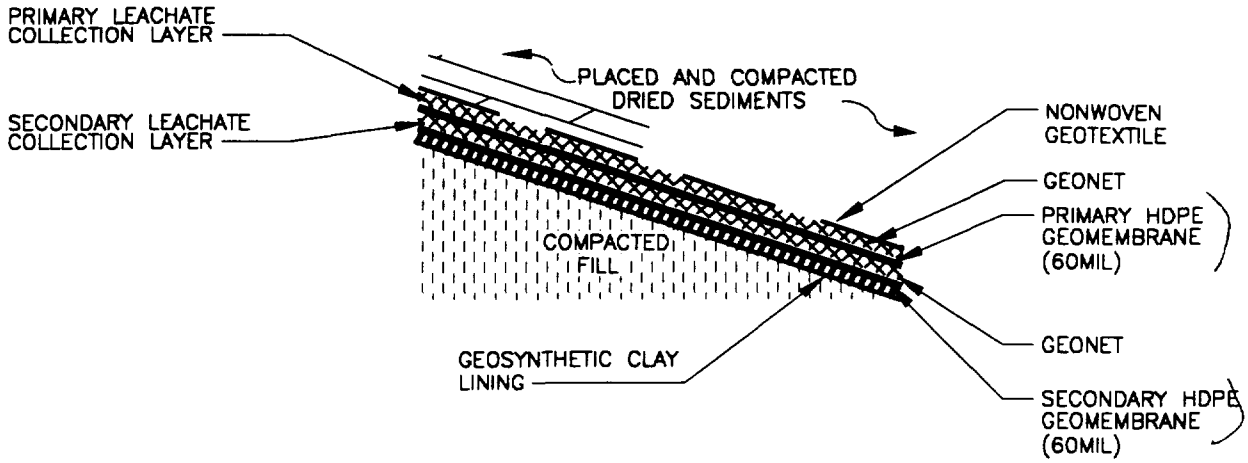
FIGURE
3-3

S:\C10000\3000\3899.00\LAN_DESIGN\REPORT FIGURES\FIGURE 3-3_BORING PROFILE EAST-WEST.DWG 08/19/00 15:52



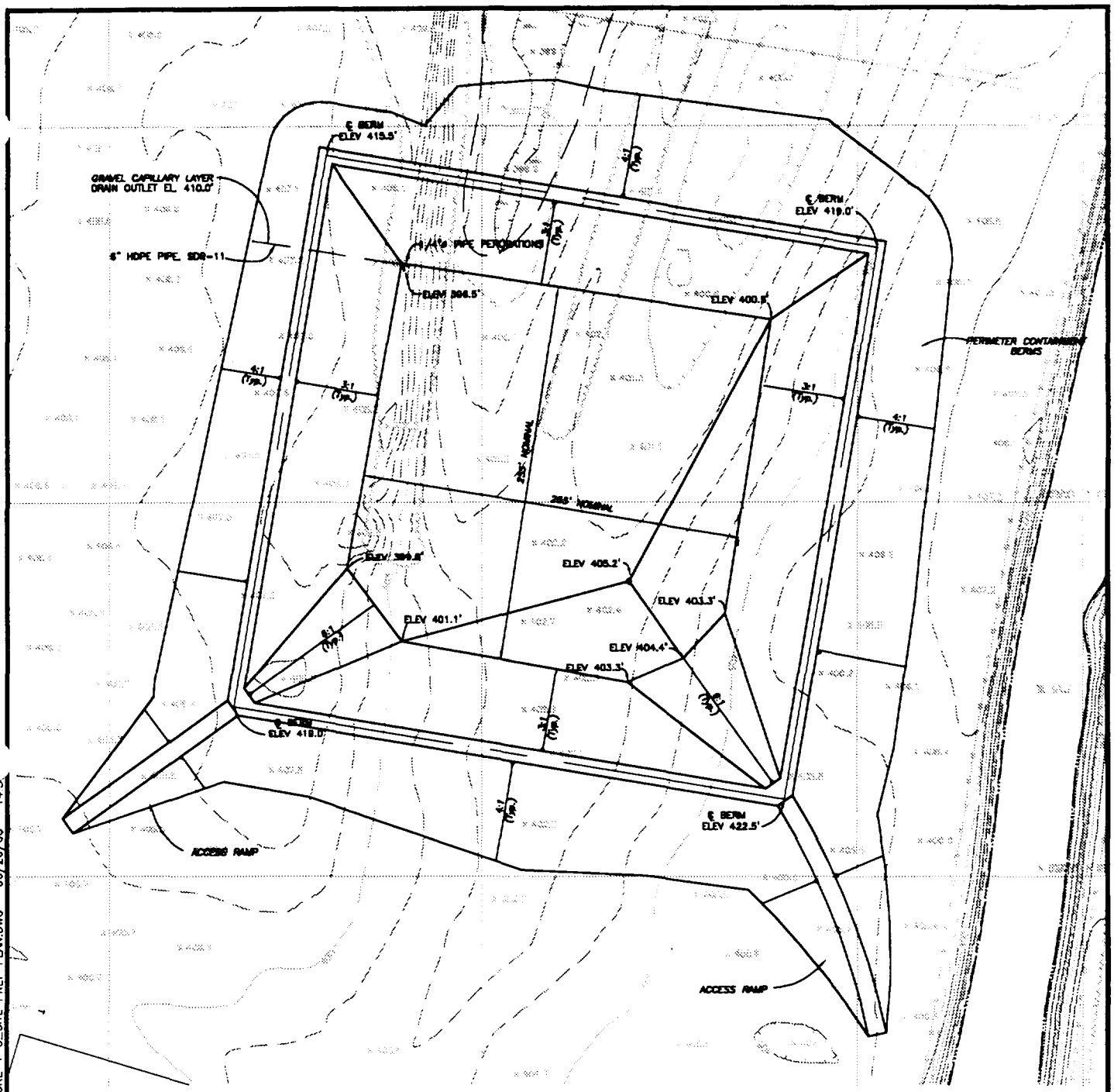
PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME SOLUTIA INC. SAUGET AREA 1	FIGURE 4-1
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE BOTTOM LINER SYSTEM DETAIL	
	Date: JUNE 20, 2000		

S:\C10000\30.39.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 4-1.DWG 06/20/00 14:36



PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME SOLUTIA INC. SAUGET AREA 1	FIGURE 4-2
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE SIDE SLOPE LINER SYSTEM DETAIL	
	Date: JUNE 20, 2000		

S:\C10000\3000\3899.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 4-2_SIDE SLOPE LINER SYS DETAIL.DWG 06/20/00 14:36



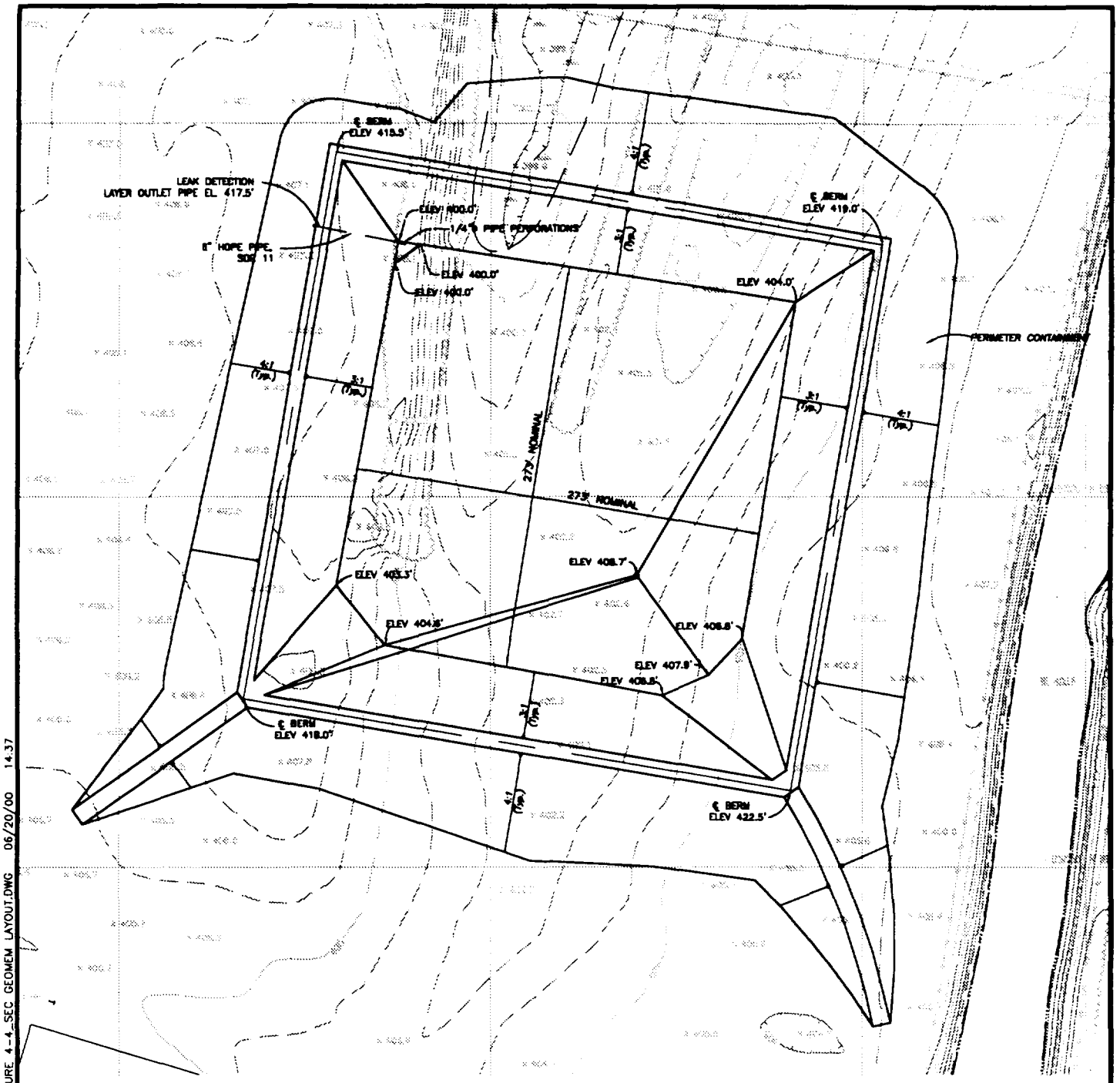
50 0 50 100

SCALE: 1"=100'

N

S:\C10000\30-9.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 4-3_SITE PREP PLAN.DWG 06/20/00 14:3

PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME	SOLUTIA INC. SAUGET AREA 1
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE	**SITE PREPARATION PLAN**
	Date: JUNE 20, 2000		FIGURE 4-3



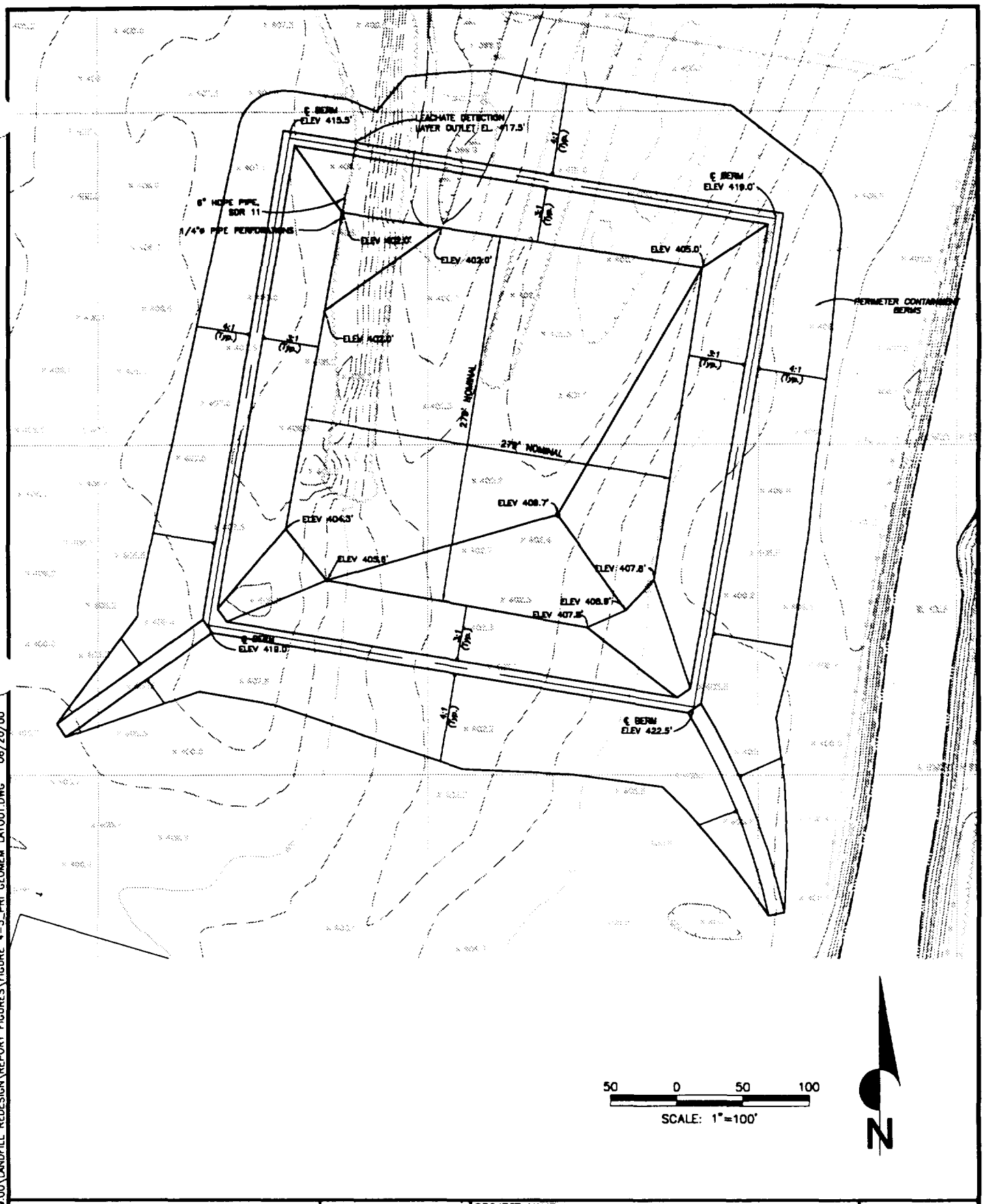
50 0 50 100

SCALE: 1"=100'

N

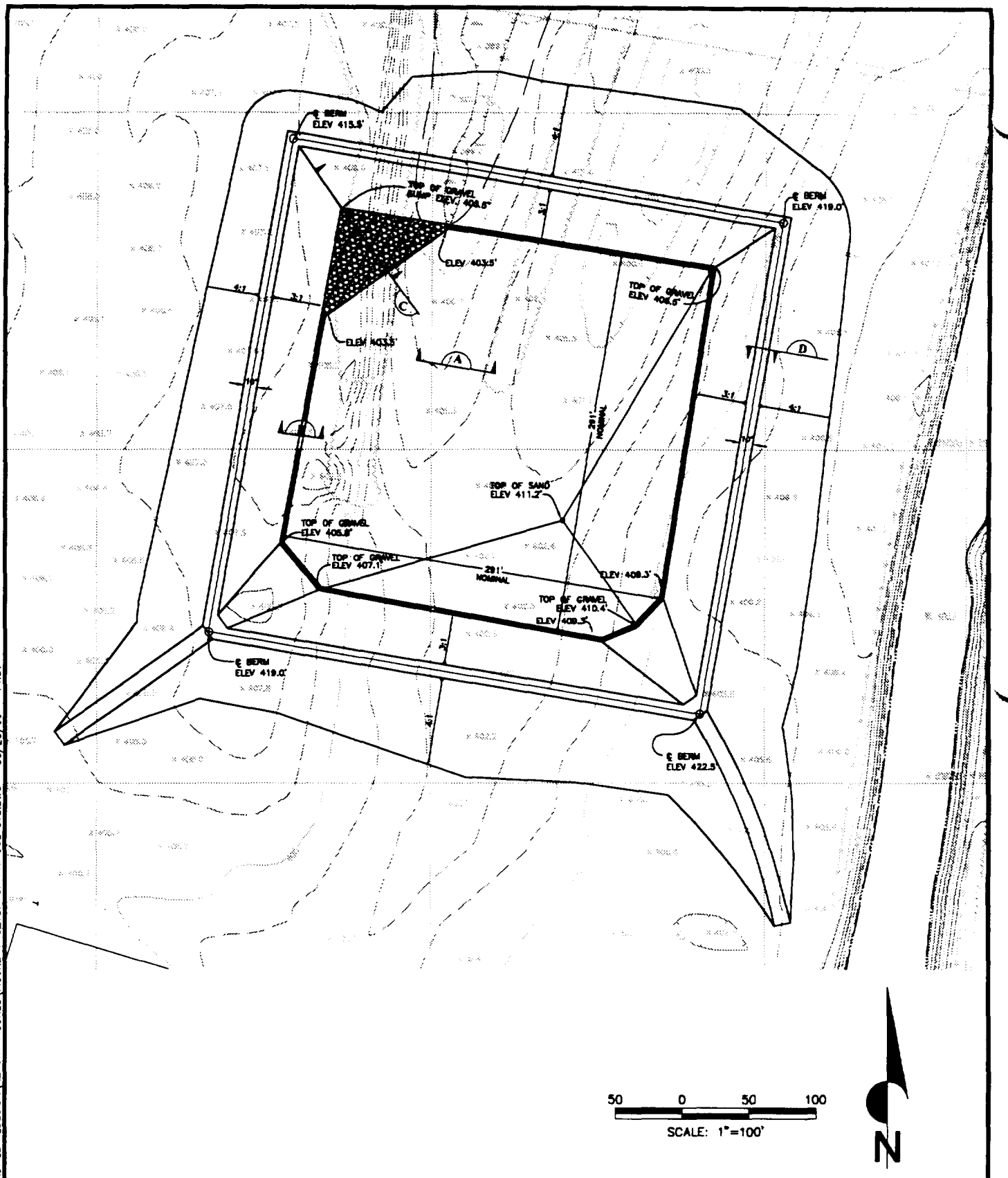
PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME SOLUTIA INC. SAUGET AREA 1	FIGURE 4-4
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE **SECONDARY GEOMEMBRANE LAYOUT**	
	Date: JUNE 20, 2000		

S:\C10000\3000\3899.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 4-4_SEC GEOMEM LAYOUT.DWG 06/20/00 14:37



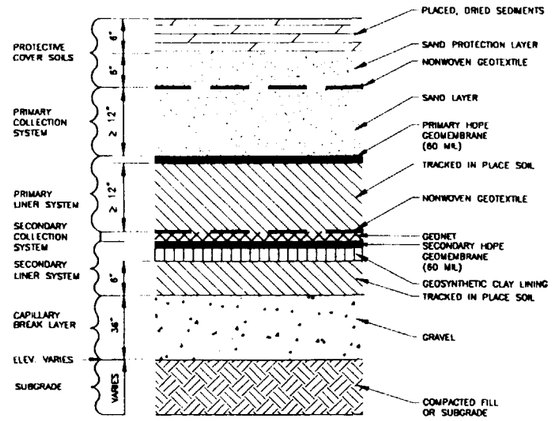
PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME SOLUTIA INC. SAUGET AREA 1	FIGURE 4-5
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE **PRIMARY GEOMEMBRANE LAYOUT**	
	Date: JUNE 20, 2000		

S:\C10000\3C...9.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 4-5_PRI GEOMEM LAYOUT.DWG 06/20/00



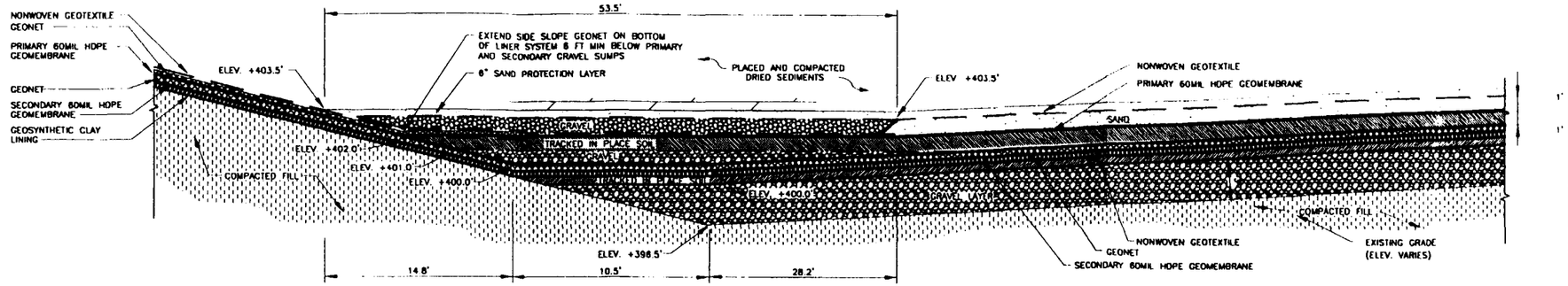
PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME	SOLUTIA INC. SAUGET AREA 1
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE	TOP OF PRIMARY COLLECTION SYSTEM PLAN
	Date: JUNE 20, 2000		FIGURE 4-6

S:\C10000\3000\3899.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 4-6_TOP OF PRI COL SYS.DWG 06/20/00 14:37



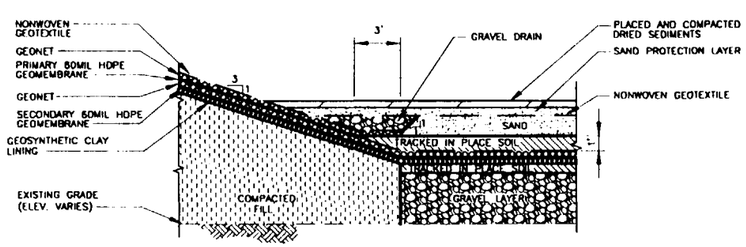
A BOTTOM LINER SYSTEM DETAIL

N.T.S.



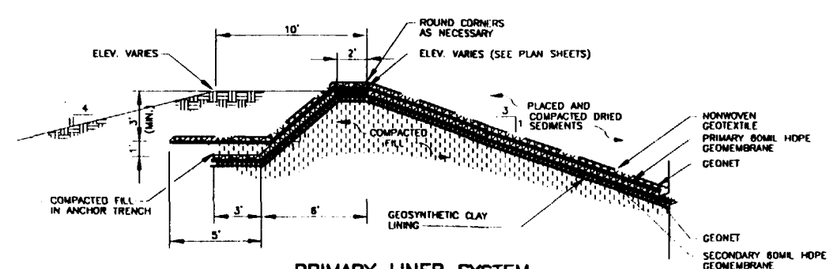
C COLLECTION SUMP DETAIL

NTS



B GRAVEL DRAIN DETAIL

APPROX. SCALE 1" = 5'



D PRIMARY LINER SYSTEM ANCHOR DETAIL

APPROX. SCALE: 1" = 5'

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: M. BRUNGARD
DRAWN BY: G. BRADFORD
CHECKED BY: G. WANTLAND
PROJECT MANAGER: G. WANTLAND
DATE: MAY 19, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.286.1711 FAX: 813.287.8591

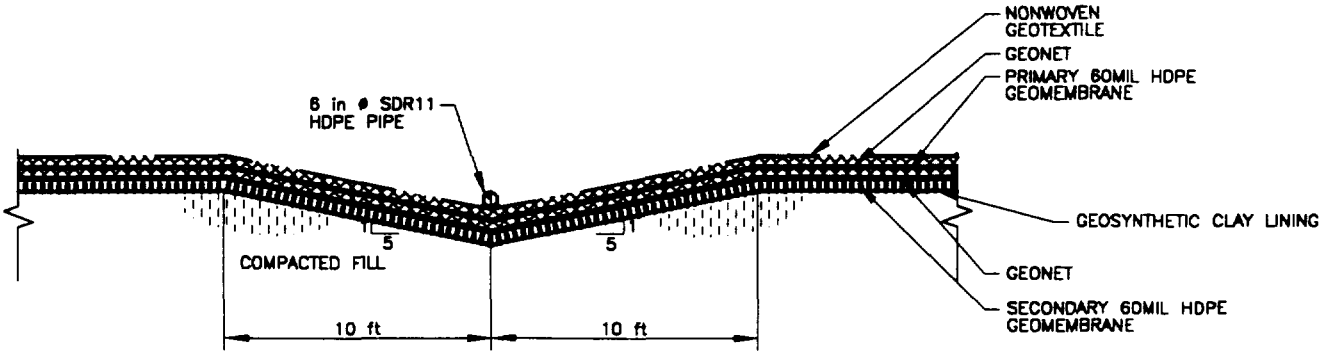
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

LINER DETAILS

PROJECT NUMBER C100003899.00

FIGURE 4-7

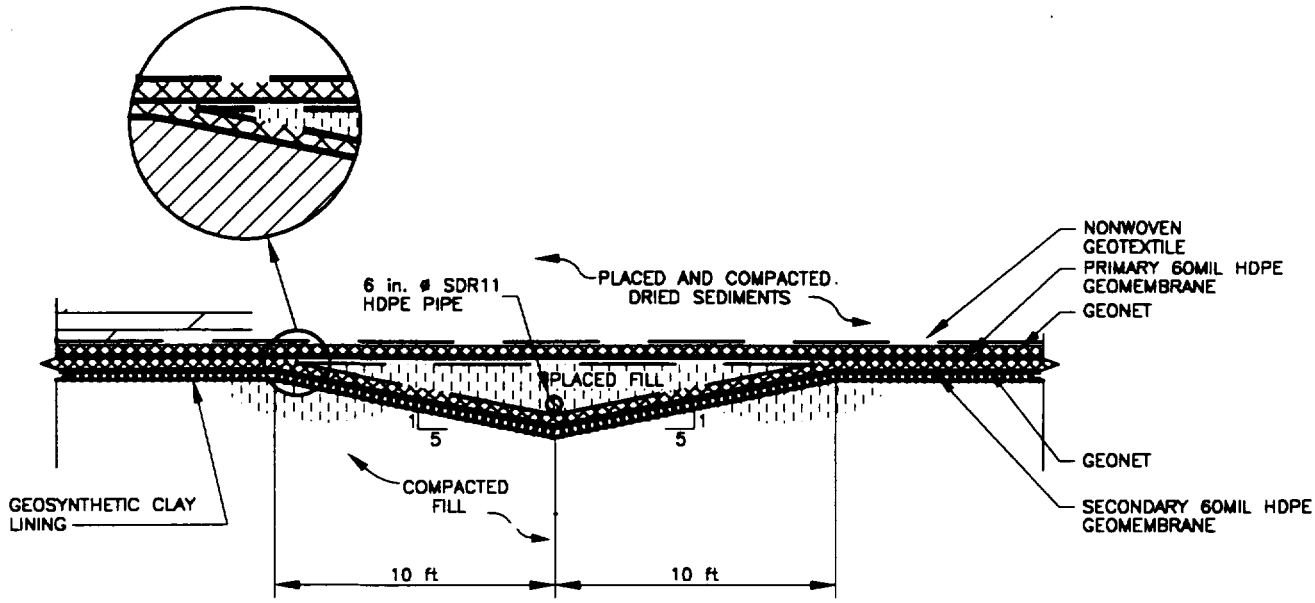
S:\C10000\3000\3899.00\LANCH
JGW\REPORT FIGURES\FIGURE 4-7_LINER DETAILS.DWG 08/20/00 14:19



J9.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 4-8_PRI RISE PIPE DETAIL.DWG 06/20/00

S:\C10000\3

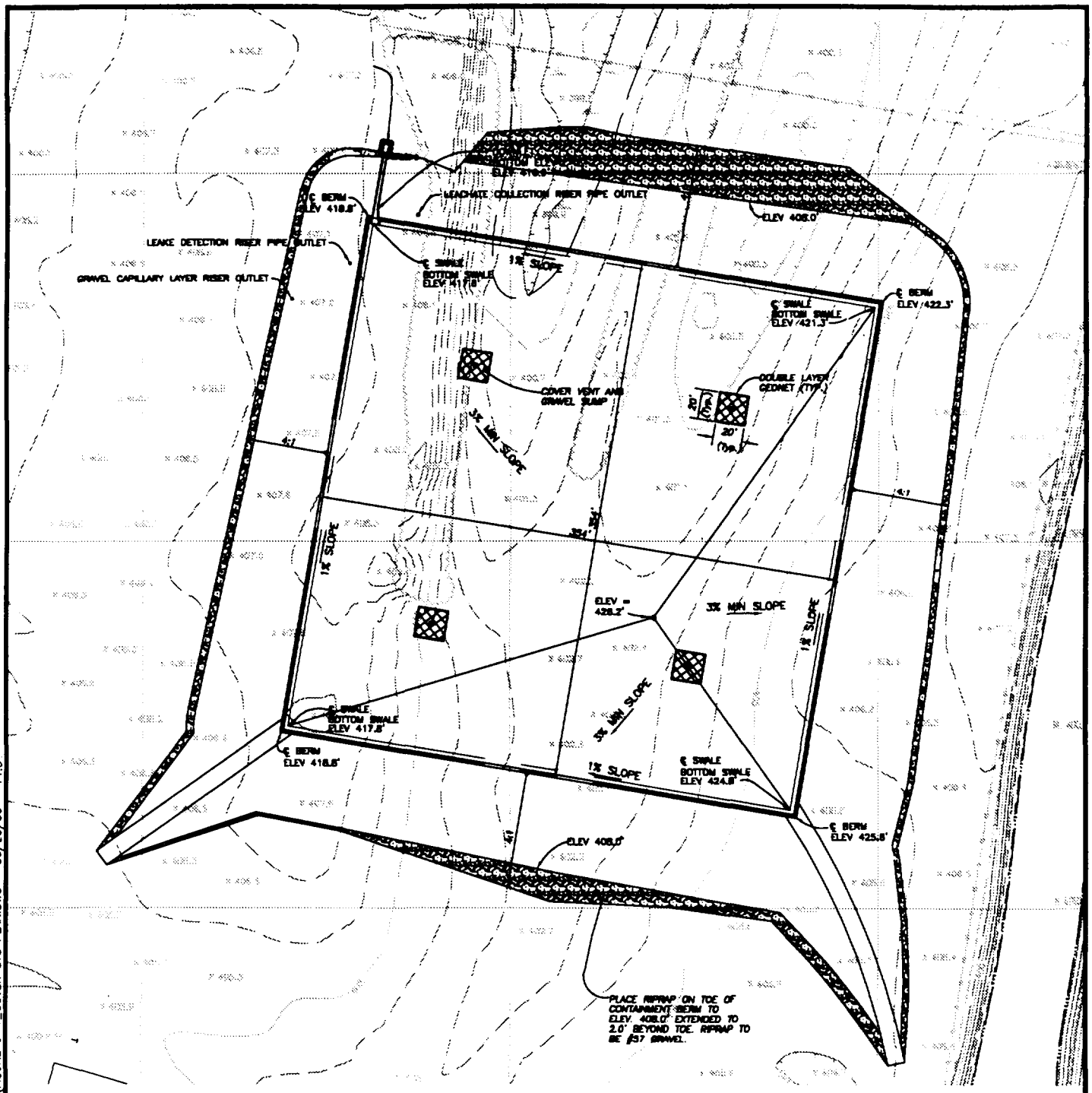
PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME	SOLUTIA INC. SAUGET AREA 1
JRSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		FIGURE 4-8
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE	PRIMARY RISER PIPE DETAIL
	Date: JUNE 20, 2000		



PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME	SOLUTIA INC.
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		SAUGET AREA 1
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE	**SECONDARY RISER PIPE DETAIL**
	Date: JUNE 20, 2000		

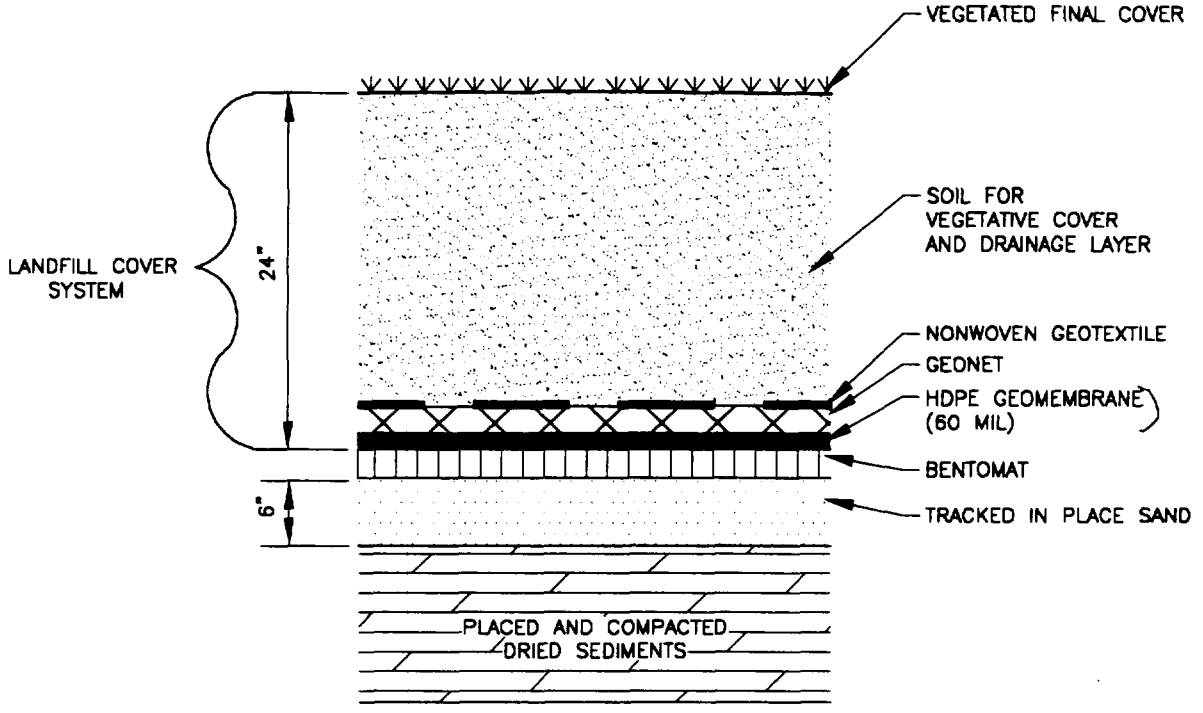
FIGURE 4-9

S:\C10000\3000\3899.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 4-9_SEC RISE PIPE DETAIL.DWG 06/20/00 14:37



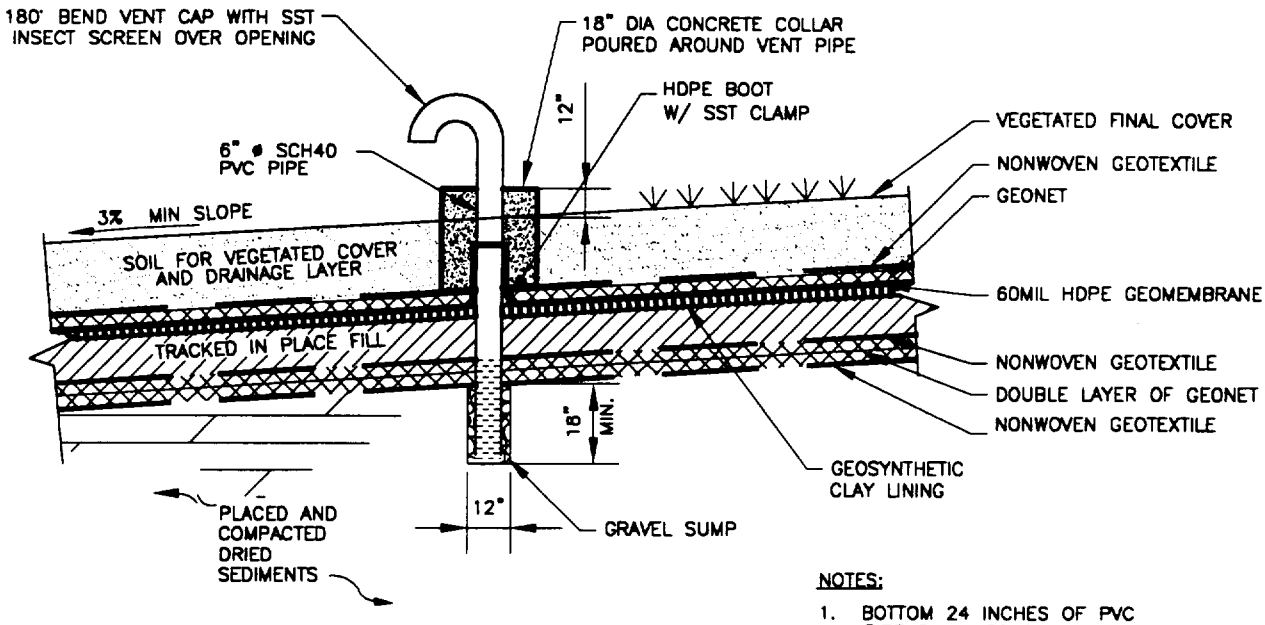
PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME SOLUTIA INC. SAUGET AREA 1	FIGURE 5-1
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde A Division of URS Corporation 7850 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE **COVER SYSTEM PLAN**	
	Date: JUNE 20, 2000		

S:\C10000\36 J99.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 5-1_COVER SYS PLAN.DWG 06/20/00 14:



PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME SOLUTIA INC. SAUGET AREA 1	FIGURE 5-2
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE COVER SYSTEM DETAIL	
	Date: JUNE 20, 2000		

S:\C10000\3000\3899.00\LANDFILL REDESIGN\8.5X11_TLBLKDWG.DWG 05/25/00 11:22



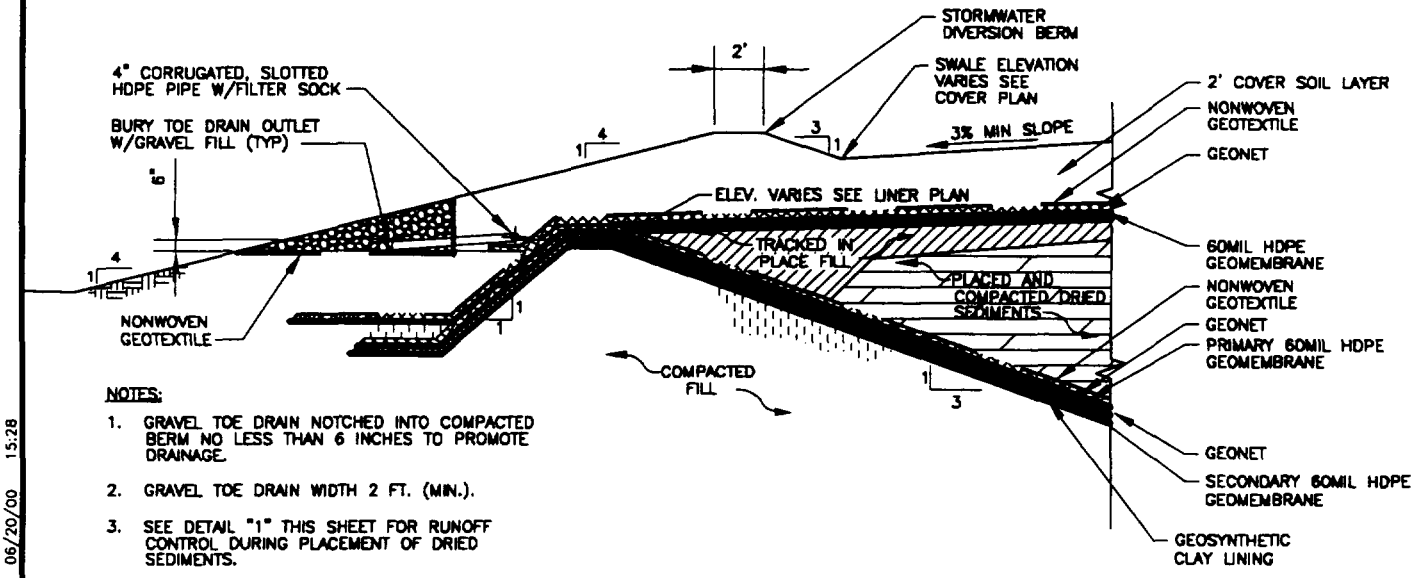
NOTES:

1. BOTTOM 24 INCHES OF PVC PIPE SHALL BE SLOTTED.
2. DOUBLE LAYER OF GEONET FOR VENT SHALL BE 20FT X 20FT IN PLAN.

J9.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 5-3_TYPICAL COVER VENT.DWG 06/20/00

S:\C100000\3

PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME SOLUTIA INC. SAUGET AREA 1	FIGURE 5-3
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde, A Division of URS Corporation, 7650 W. Courtney Campbell Causeway, Tampa, Florida 33607-1462, Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE TYPICAL COVER VENT	
	Date: JUNE 20, 2000		

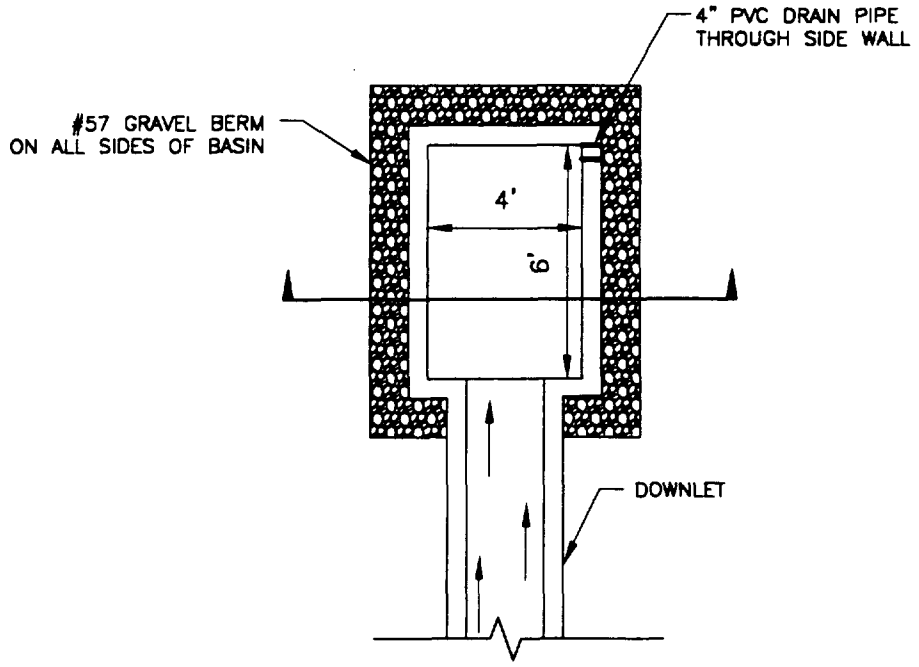


NOTES:

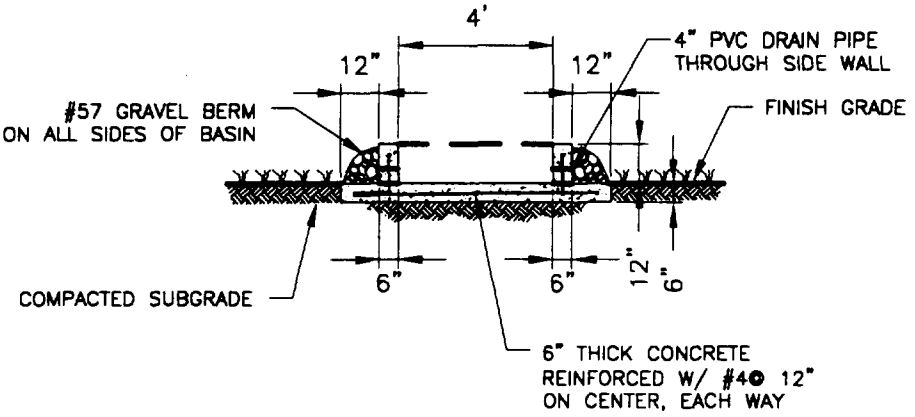
1. GRAVEL TOE DRAIN NOTCHED INTO COMPACTED BERM NO LESS THAN 6 INCHES TO PROMOTE DRAINAGE.
2. GRAVEL TOE DRAIN WIDTH 2 FT. (MIN.).
3. SEE DETAIL "1" THIS SHEET FOR RUNOFF CONTROL DURING PLACEMENT OF DRIED SEDIMENTS.

PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME SOLUTIA INC. SAUGET AREA 1	FIGURE 5-5
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE FINAL COVER DETAIL	
	Date: JUNE 20, 2000		

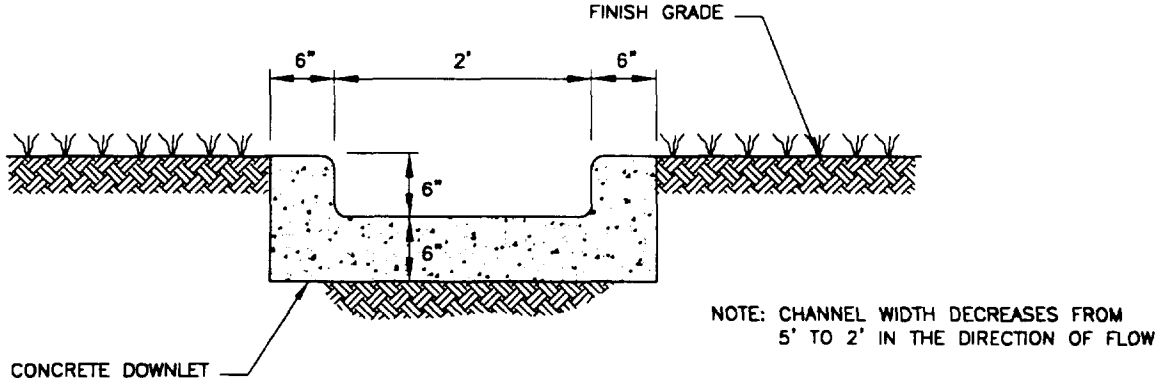
S:\C10000\3000\3899.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 5-5_FINAL COVER DETAIL.DWG 06/20/00 15:28



PLAN VIEW



SECTION VIEW

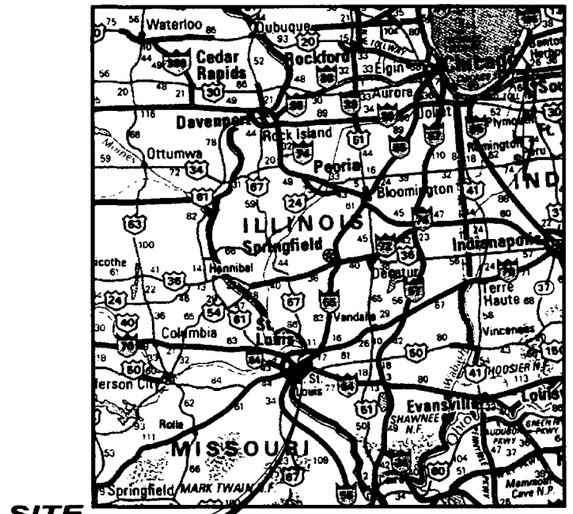


DOWNLET SECTION

PREPARED FOR: SOLUTIA	Drawn: W. WEBER	PROJECT NAME	SOLUTIA INC. SAUGET AREA 1
URSGWC JOB NUMBER: C100003899.00	Design: GARY WANTLAND		
URS Greiner Woodward Clyde A Division of URS Corporation 7650 W. Courtney Campbell Causeway Tampa, Florida 33607-1462 Tel: 813.286.1711 Fax: 813.287.8591	Checked: GARY WANTLAND	DRAWING TITLE	STILLING BASIN
	Date: JUNE 20, 2000		FIGURE 5-6

S:\C10000\30\9.00\LANDFILL REDESIGN\REPORT FIGURES\FIGURE 5-6_STILLING BASIN.DWG 06/20/00 15:26

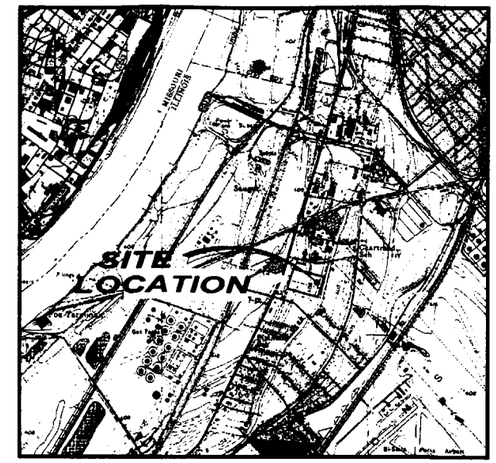
CONSTRUCTION PLANS FOR
SAUGET AREA 1
TSCA LANDFILL
CAHOKIA, ILLINOIS



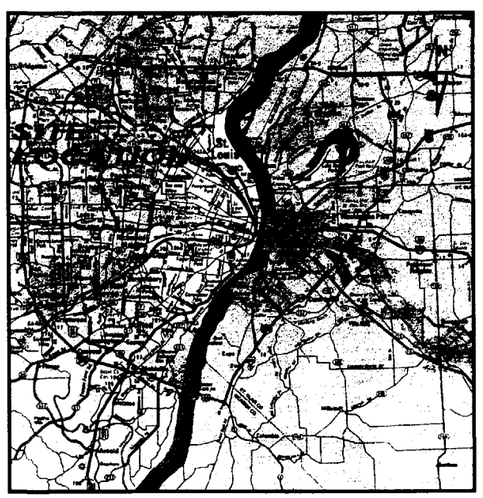
ILLINOIS MAP

SOLUTIA™

Applied Chemistry, Creative Solutions



PROJECT VICINITY MAP



SITE LOCATION MAP

INDEX OF DRAWINGS

SHEET	TITLE
G1.1	COVER SHEET
G1.2	EXISTING SITE PLAN
G1.3	BORING PROFILE NORTH-SOUTH
G1.4	BORING PROFILE EAST-WEST
C1.1	SITE PREPARATION PLAN
C1.2	SECONDARY COMPACTED GEOMEMBRANE LAYOUT
C1.3	PRIMARY GEOMEMBRANE LAYOUT
C1.4	TOP OF PRIMARY COLLECTION SYSTEM PLAN
C1.5	COVER SYSTEM PLAN
C1.6	LINER SYSTEM DETAILS
C1.7	COVER SYSTEM DETAILS

CERTIFICATION

ENGINEER: _____ DATE: _____ REG. NO. _____

NOT FOR CONSTRUCTION
FOR AGENCY REVIEW ONLY.

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: MB/CW
DRAWN BY: P. CARTWRIGHT
CHECKED BY: J. JONES
PROJECT MANAGER: C. WANTLAND
DATE: JUNE 28, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.286.1711 FAX: 813.287.8591

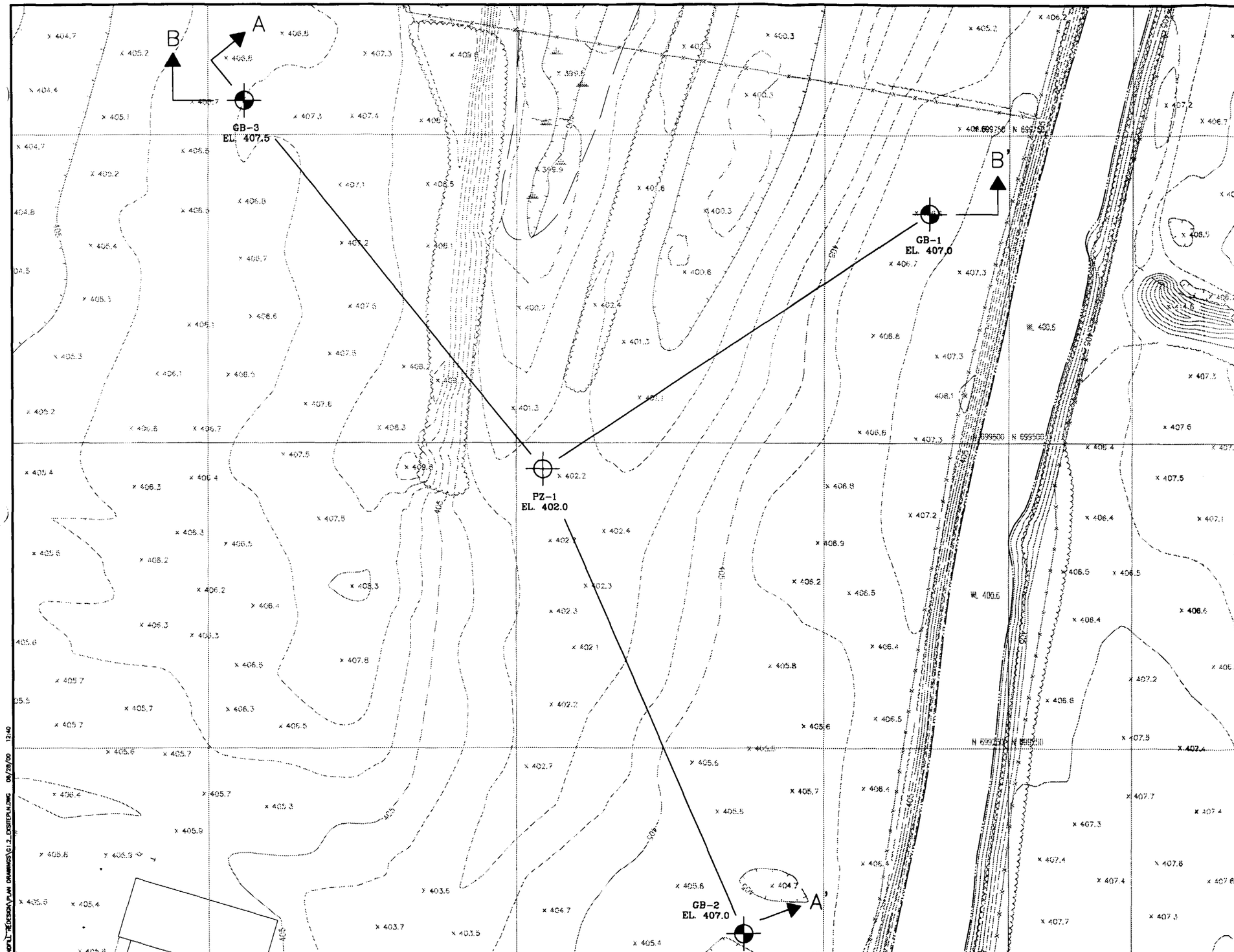
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

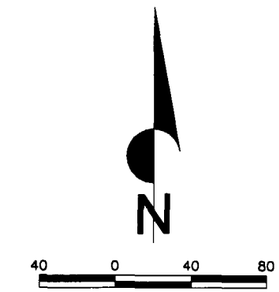
COVER SHEET

PROJECT NUMBER C1000003899.00

SHEET G1.1

S:\C10000\3000\3899.00\LANDFILL RE-DESIGN\PLAN DRAWINGS\G1.1_COVER.DWG 06/28/00 12:38





LEGEND

GEOTECHNICAL BORINGS LOCATIONS

PIEZOMETER LOCATION

REDUCED DRAWING – VERIFY SCALE

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: G. WANTLAND
DRAWN BY: B. DOUGLAS
CHECKED BY: P. CARTWRIGHT
PROJECT MANAGER: G. WANTLAND
DATE: JUNE 28, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.286.1711 FAX: 813.287.8591

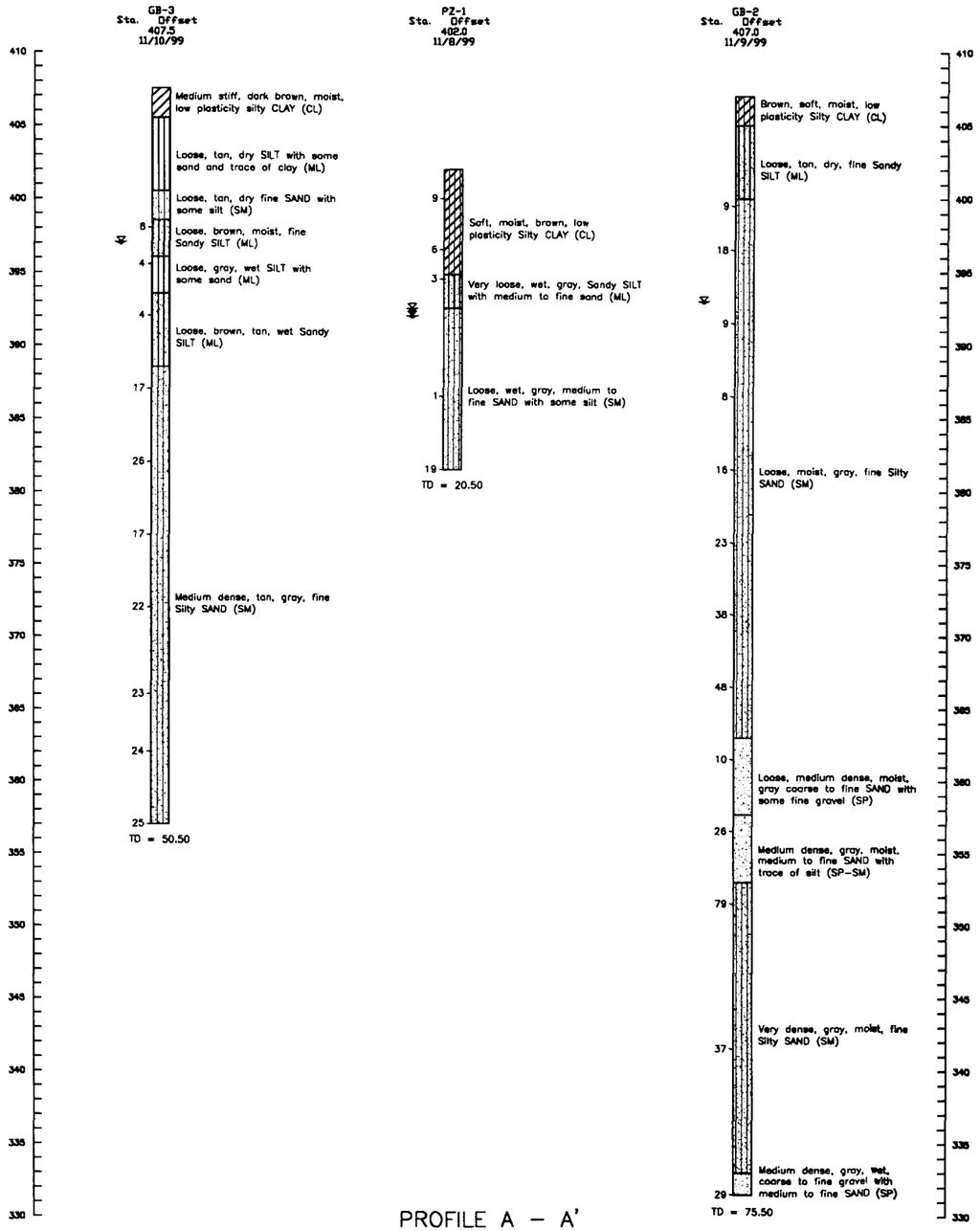
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

EXISTING SITE PLAN

PROJECT NUMBER C100003899.00

SHEET G1.2

S:\C10000\3000\3899.00\LANDFILL_REDESIGN\PLAN DRAWINGS\G1.2_EXSITEPLN.DWG 06/28/00 12:40



PROFILE A – A'

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT "N" *
VERY LOOSE	0 TO 4
LOOSE	5 TO 10
MEDIUM DENSE	11 TO 30
DENSE	31 TO 50
VERY DENSE	OVER 50

* BLOWS PER FOOT MEASURED USING 140 POUND WEIGHT HAVING A FREE FALL OF 30 INCHES

II COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, Qu, TSF	BLOW COUNT "N"
VERY SOFT	<1/4	0 TO 2
SOFT	1/4 TO 1/2	2 TO 4
MEDIUM STIFF	1/2 TO 1	4 TO 8
STIFF	1 TO 2	8 TO 15
VERY STIFF	2 TO 4	15 TO 30
HARD	OVER 4	OVER 30

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED	HAVING INCLINED PLANES OF WEAKNESS THAT ARE SLICK AND GLOSSY IN APPEARANCE.
FISSURED	CONTAINING SHRINKAGE CRACKS, FREQUENTLY FILLED WITH FINE SAND OR SILT; USUALLY MORE OR LESS VERTICAL.
LAMINATED	COMPOSED OF THIN LAYERS OF VARYING COLOR AND TEXTURE.
INTERBEDDED	COMPOSED OF ALTERNATE LAYERS OF DIFFERENT SOIL TYPES.
CALCAREOUS	CONTAINING APPRECIABLE QUANTITIES OF CALCIUM CARBONATE.
WELL GRADED	HAVING WIDE RANGE IN GRAIN SIZES AND SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES.
POORLY GRADED	PREDOMINANTLY OF ONE GRAIN SIZE, OR HAVING A RANGE OF SIZES WITH SOME INTERMEDIATE SIZE MISSING.

SOIL CLASSIFICATION LEGEND

N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
%-200	PERCENT PASSING NO. 200 SIEVE SIZE (PERCENT FINES)
50/3"	50 BLOWS FOR 3 INCHES PENETRATION INTO SOIL
▽	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
▼	GROUNDWATER LEVEL MEASURED AFTER DRILLING
γd	IN-PLACE DRY DENSITY IN PCF
Su	UNDRAINED SHEAR STRENGTH IN KSF

SILT
SAND
CLAY
SHELL
GRAVEL
CLAYEY-SAND
CLAYEY-SILT
CLAYEY-GRAVEL
SANDY-SILT
SANDY-CLAY
SANDY-GRAVEL
SANDY-PEAT
SILTY-SAND
SILTY-CLAY
SILTY-GRAVEL
GRAVELLY-SAND
GRAVELLY-CLAY
HARD-LIMESTONE
WEATHERED-LIMESTONE
SHELLY-SAND
SHELLY-CLAY
SHELLY-GRAVEL
MUCK
PEAT
CONCRETE
ASPHALT
CAVITY

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: G. WANTLAND
DRAWN BY: W. WEBER
CHECKED BY: J.JONES
PROJECT MANAGER: G. WANTLAND
DATE: JUNE 28, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1482
TEL: 813.286.1711 FAX: 813.287.8591

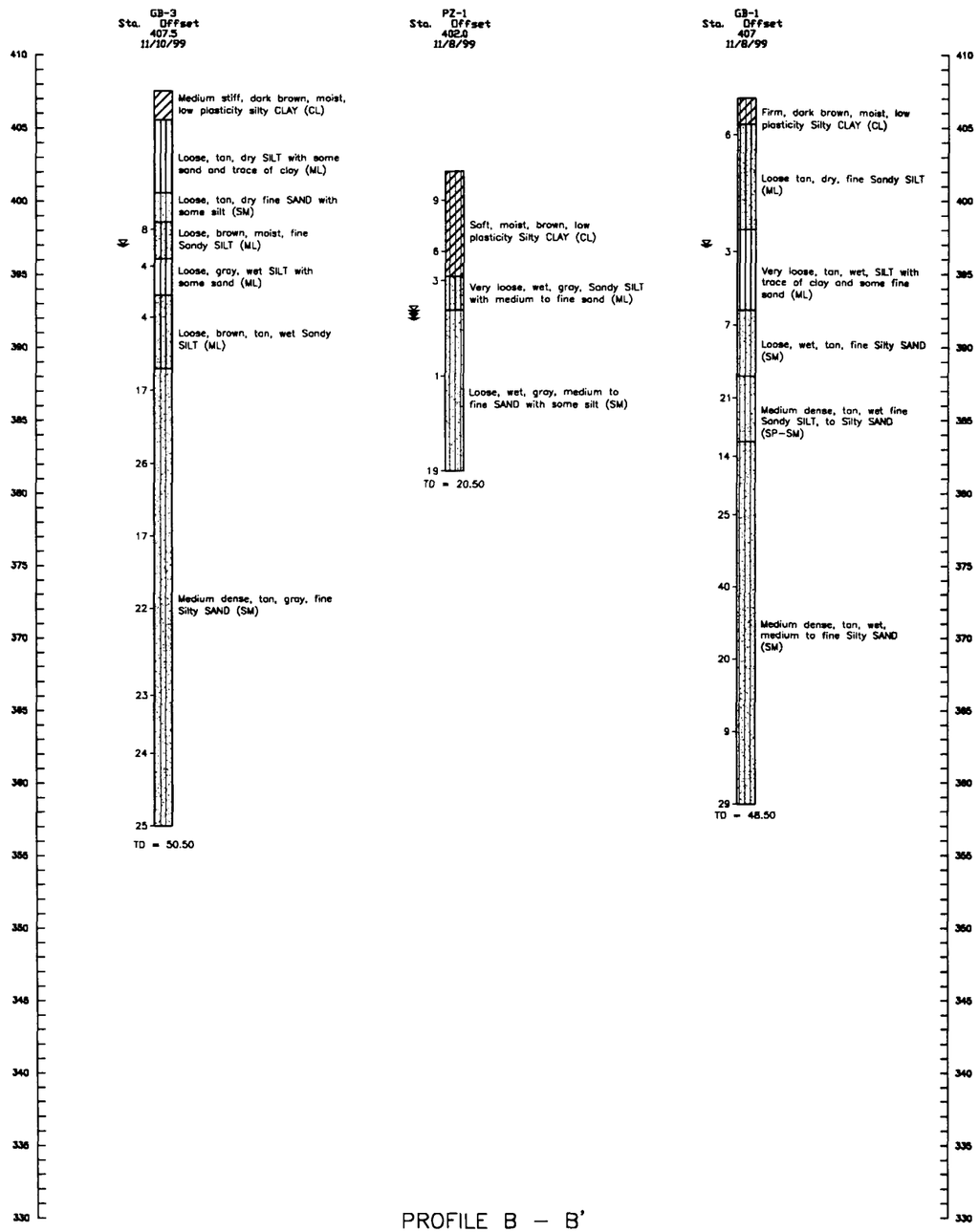
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

BORING PROFILE A - A'

PROJECT NUMBER C100003899.00

SHEET G1.3

S:\C10000\3000\3899.00\LAKE_DESIGN\PLAN DRAWINGS\G1.3 BORING PROFILE NORTH-SOUTH.DWG 06/28/00 12:59



PROFILE B – B'

ENGINEERING CLASSIFICATION

I COHESIONLESS SOILS

DESCRIPTION	BLOW COUNT "N" *
VERY LOOSE	0 TO 4
LOOSE	5 TO 10
MEDIUM DENSE	11 TO 30
DENSE	31 TO 50
VERY DENSE	OVER 50

* BLOWS PER FOOT MEASURED USING 140 POUND WEIGHT HAVING A FREE FALL OF 30 INCHES

II COHESIVE SOILS

DESCRIPTION	UNCONFINED COMPRESSIVE STRENGTH, QU, TSF	BLOW COUNT "N"
VERY SOFT	<1/4	0 TO 2
SOFT	1/4 TO 1/2	3 TO 4
MEDIUM STIFF	1/2 TO 1	5 TO 8
STIFF	1 TO 2	9 TO 15
VERY STIFF	2 TO 4	16 TO 30
HARD	OVER 4	OVER 30

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED	HAVING INCLINED PLANES OF WEAKNESS THAT ARE SLICK AND GLOSSY IN APPEARANCE.
FISSURED	CONTAINING SHRINKAGE CRACKS, FREQUENTLY FILLED WITH FINE SAND OR SILT; USUALLY MORE OR LESS VERTICAL.
LAMINATED	COMPOSED OF THIN LAYERS OF VARYING COLOR AND TEXTURE.
INTERBEDDED	COMPOSED OF ALTERNATE LAYERS OF DIFFERENT SOIL TYPES.
CALCAREOUS	CONTAINING APPRECIABLE QUANTITIES OF CALCIUM CARBONATE.
WELL GRADED	HAVING WIDE RANGE IN GRAIN SIZES AND SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES.
POORLY GRADED	PREDOMINANTLY OF ONE GRAIN SIZE, OR HAVING A RANGE OF SIZES WITH SOME INTERMEDIATE SIZE MISSING.

SOIL CLASSIFICATION LEGEND

N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
%-200	PERCENT PASSING NO. 200 SIEVE SIZE (PERCENT FINES)
50/3"	50 BLOWS FOR 3 INCHES PENETRATION INTO SOIL
▽	GROUNDWATER LEVEL MEASURED ON DATE DRILLED
▼	GROUNDWATER LEVEL MEASURED AFTER DRILLING
w	IN-PLACE DRY DENSITY IN PCF
Su	UNDRAINED SHEAR STRENGTH IN KSF

SILT
SAND
CLAY
SHELL
GRAVEL
CLAYEY-SAND
CLAYEY-SILT
CLAYEY-GRAVEL
SANDY-SILT
SANDY-CLAY
SANDY-GRAVEL
SANDY-PEAT
SILTY-SAND
SILTY-CLAY
SILTY-GRAVEL
GRAVELLY-SAND
GRAVELLY-CLAY
HARD-LIMESTONE
WEATHERED-LIMESTONE
SHELLY-SAND
SHELLY-CLAY
SHELLY-GRAVEL
MUCK
PEAT
CONCRETE
ASPHALT
CAVITY

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: G. WANTLAND
DRAWN BY: W. WEBER
CHECKED BY: J. JONES
PROJECT MANAGER: G. WANTLAND
DATE: JUNE 28 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.286.1711 FAX: 813.287.8591

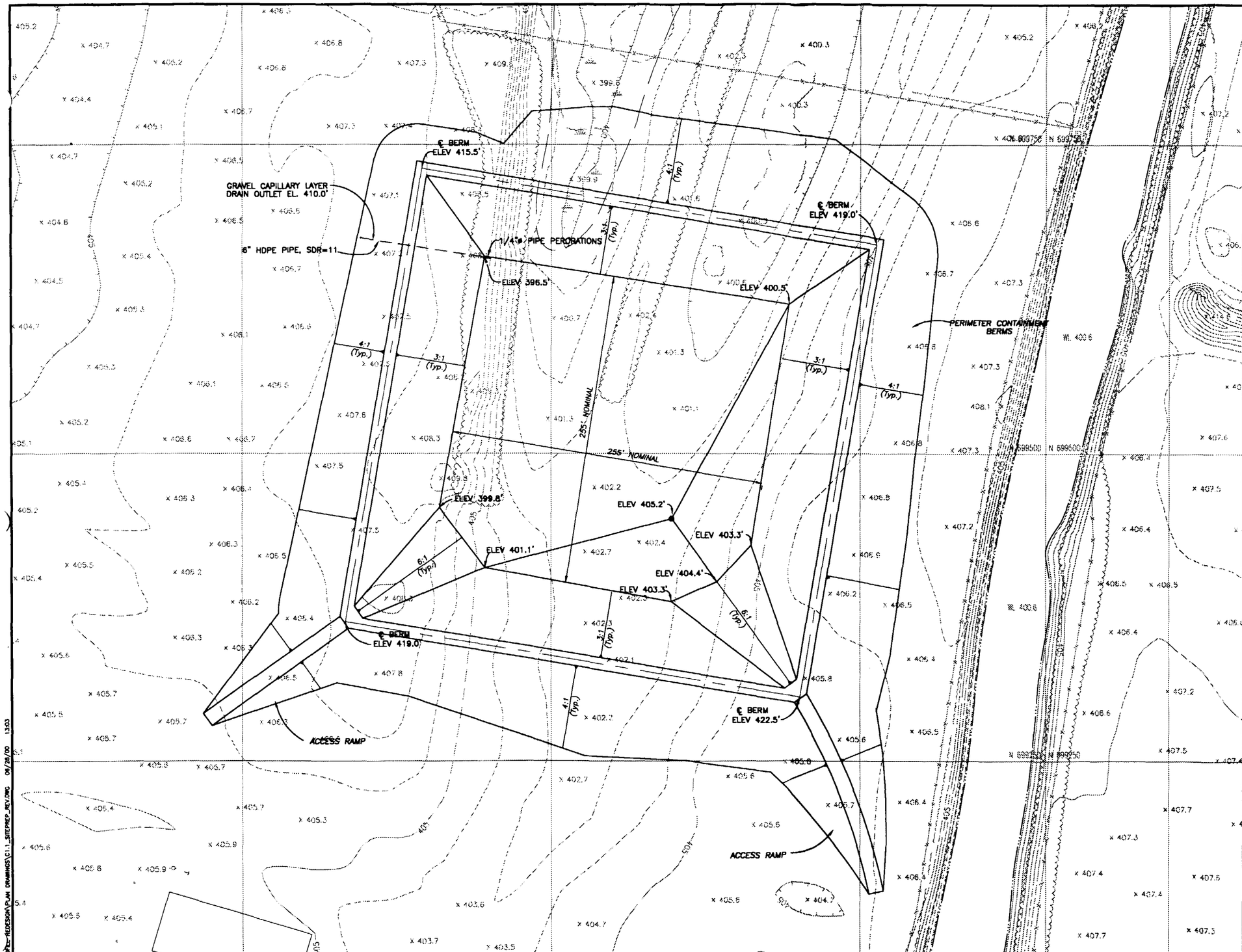
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

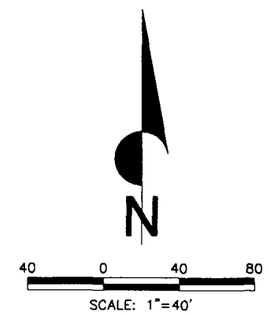
BORING PROFILE B - B'

PROJECT NUMBER C100003899.00

SHEET G1.4

S:\C10000\3000\3899.00\LANDFILL\DESIGN\PLAN DRAWINGS\G1.4 BORING PROFILE EAST-WEST.DWG 06/28/00 13:01





Notes:

1. Perimeter Containment Berms shall be constructed with compacted materials consisting of the following classification per ASTM D2487: SC, SP-SM, SC-SM, CL or CH.

2. Soils shall be compacted to 95% of Maximum Standard Proctor dry density at moisture contents of 2% below optimum moisture to 3% above optimum moisture.

REDUCED DRAWING – VERIFY SCALE

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: M. BRUNGARD
DRAWN BY: G. BRADFORD
CHECKED BY: G. WANTLAND
PROJECT MANAGER: G. WANTLAND
DATE: JUNE 28, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.286.1711 FAX: 813.287.8591

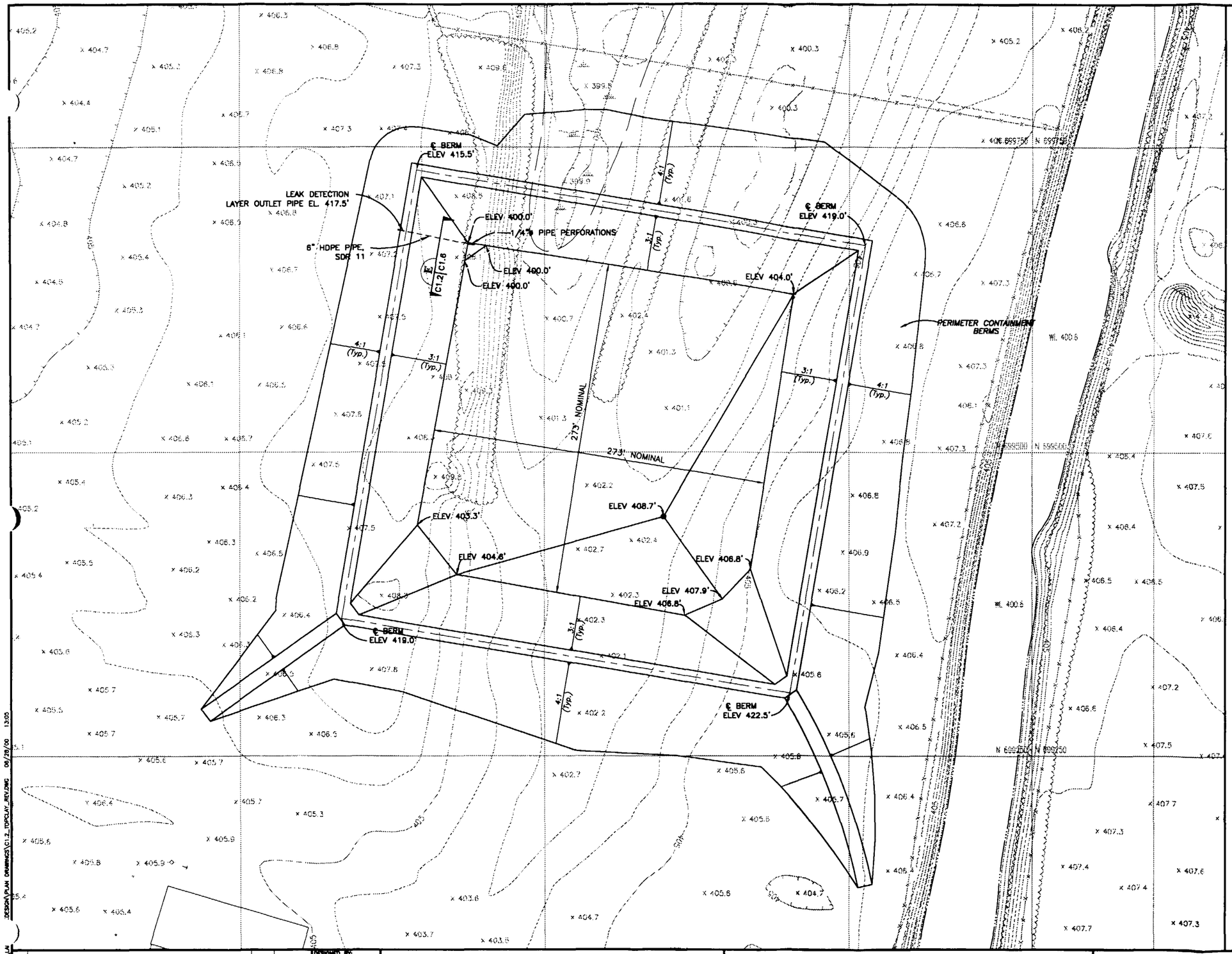
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

SITE PREPARATION PLAN

PROJECT NUMBER
C100003899.00

SHEET
C1.1

S:\C10000\3000\3899.00\LANDFILL-REDESIGN\PLAN DRAWINGS\C1.1_SITEPREP_REV.DWG 06/28/00 13:03



REDUCED DRAWING – VERIFY SCALE

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: M. BRUNGARD
DRAWN BY: G. BRADFORD
CHECKED BY: G. WANTLAND
PROJECT MANAGER: G. WANTLAND
DATE: JUNE 28, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.286.1711 FAX: 813.287.8591

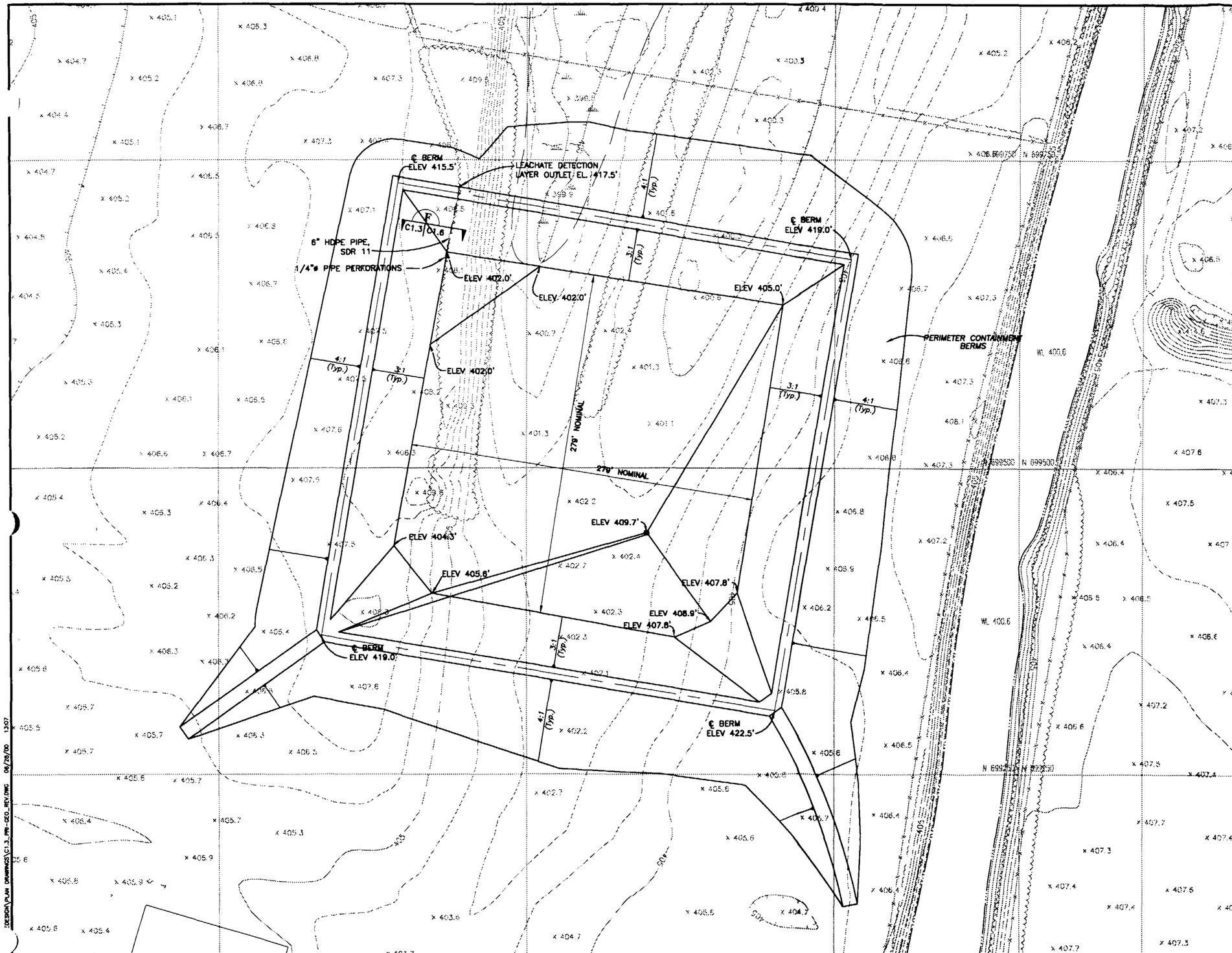
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

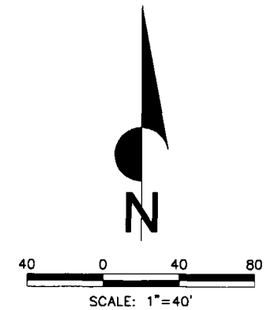
SECONDARY GEOMEMBRANE LAYOUT

PROJECT NUMBER
C1000003699.00

SHEET
C1.2

S:\C10000\3000\3699.00\LM DESIGN\PLAN DRAWINGS\C1.2_TOPCLAY_REV.DWG 06/28/00 13:05





REDUCED DRAWING – VERIFY SCALE

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: M. BRUNGARD
DRAWN BY: G. BRADFORD
CHECKED BY: G. WANTLAND
PROJECT MANAGER: G. WANTLAND
DATE: JUNE 28, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.286.1711 FAX: 813.287.8591

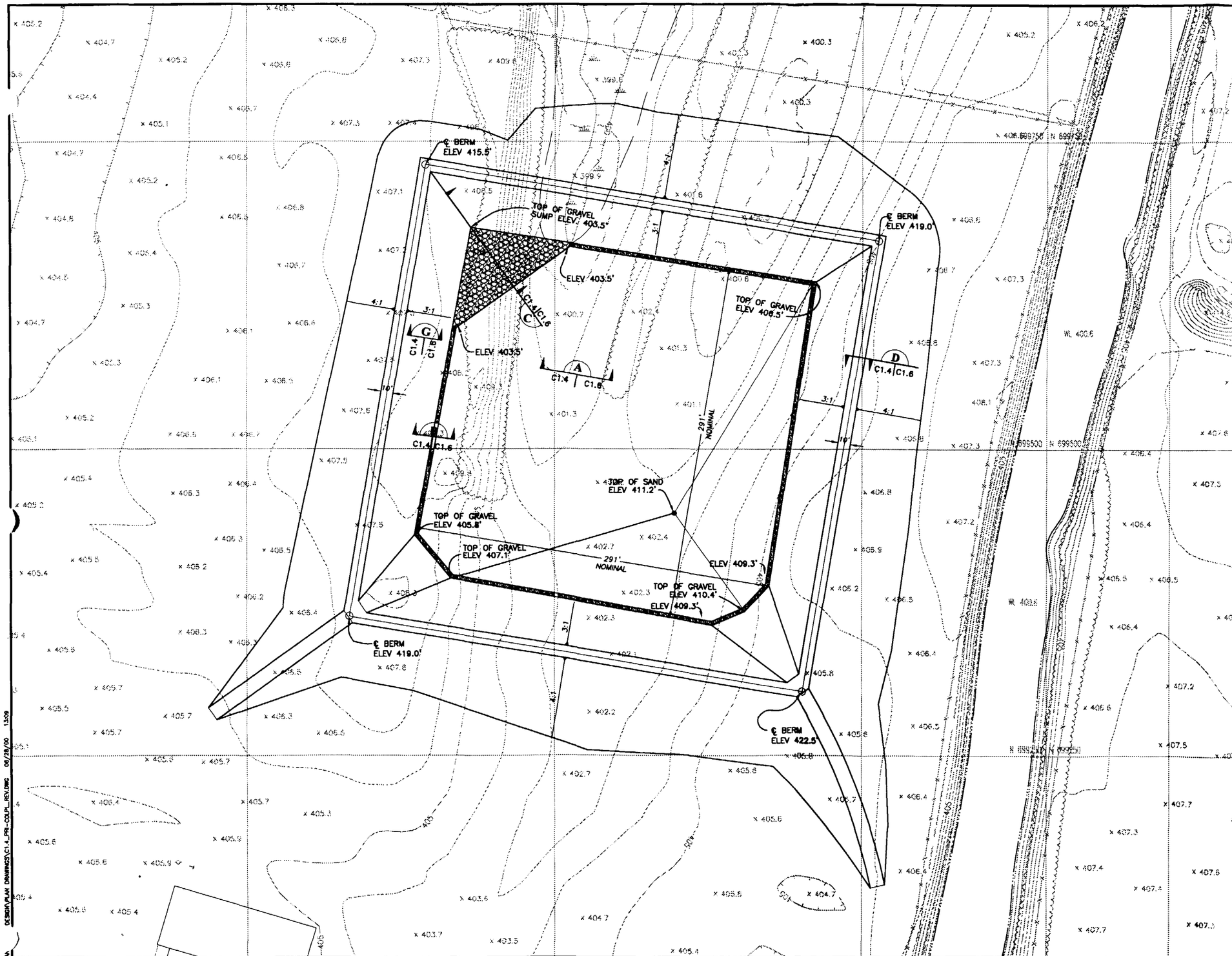
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

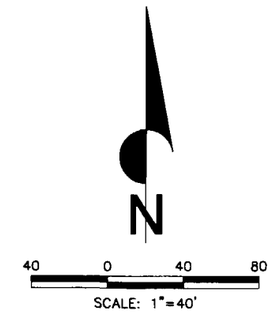
PRIMARY GEOMEMBRANE LAYOUT

PROJECT NUMBER
C100003899.00

SHEET
C1.3

S:\C10000\3000\3899.00\LA_DESIGN\PLAN DRAWINGS\C1.3_PRI-GEO_REV.DWG 06/28/00 13:07





Notes:

1. *Access Ramp shall be extended down the inside slope of the landfill to facilitate dried sediment placement.*
2. *Inside ramp slope shall be no steeper than 6'(H.) : 1'(V.).*
3. *Inside ramp not shown for clarity.*

REDUCED DRAWING – VERIFY SCALE

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: M. BRUNGARD
DRAWN BY: G. BRADFORD
CHECKED BY: G. WANTLAND
PROJECT MANAGER: G. WANTLAND
DATE: JUNE 28, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1482
TEL: 813.286.1711 FAX: 813.287.8591

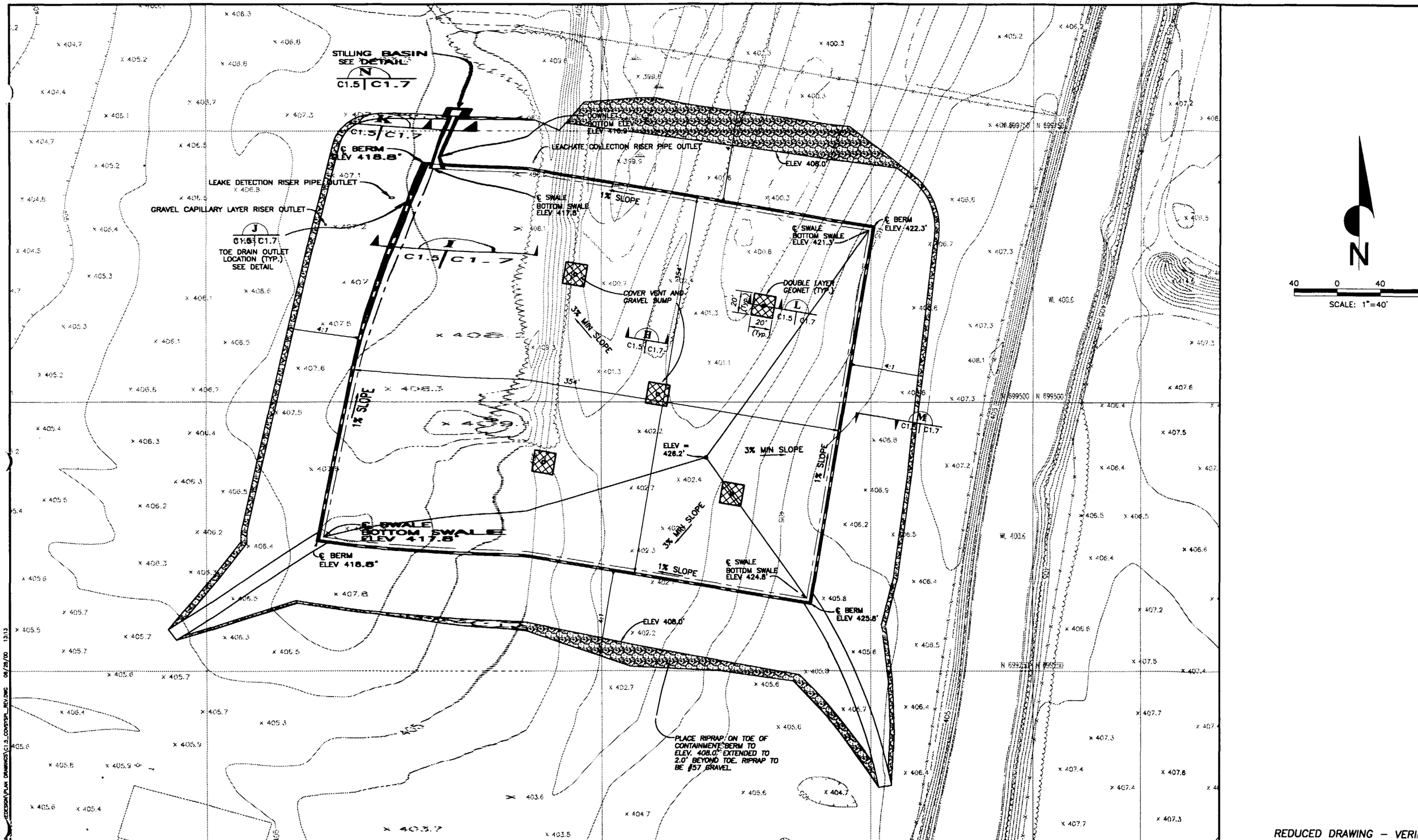
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

TOP OF PRIMARY COLLECTION SYSTEM PLAN

PROJECT NUMBER: C100003899.00

SHEET: C1.4

S:\C10000\3000\3899.00\LAN DESIGN\PLAN DRAWINGS\C1.4_PRI-COLPL_REV.DWG 06/29/00 13:09



REDUCED DRAWING – VERI

REV	DESCRIPTION OF REVISION	BY	DATE

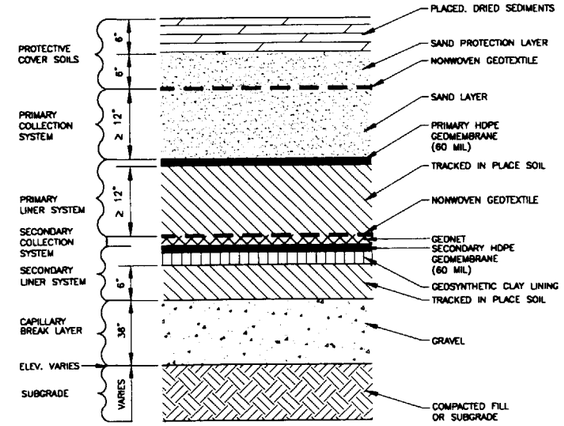
DESIGNED BY: M. BRUNGARD
DRAWN BY: G. BRADFORD
CHECKED BY: G. WANTLAND
PROJECT MANAGER: G. WANTLAND
DATE: JUNE 28, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.286.1711 FAX: 813.287.8591

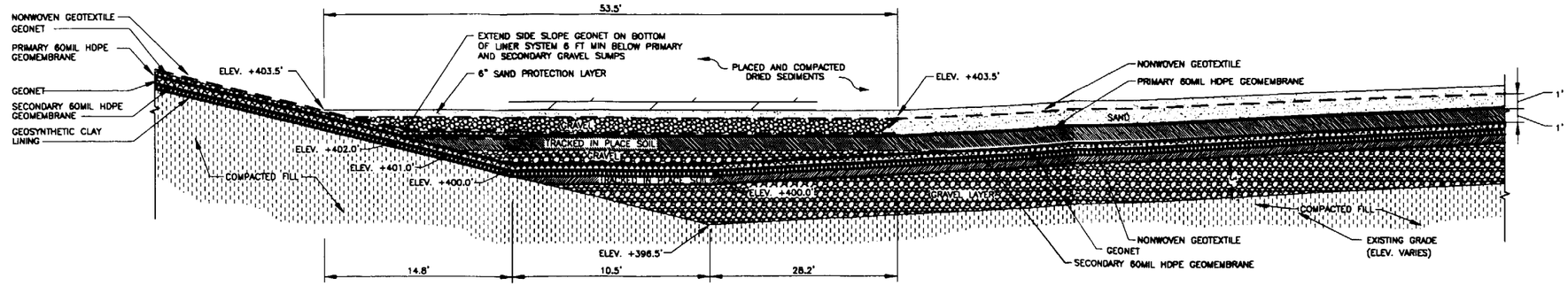
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

COVER SYSTEM PLAN

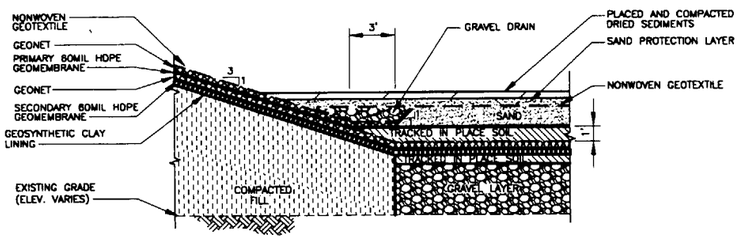
S:\C10000\3000\3899.00\LAN...EDESIGN\PLAN DRAWINGS\C1.5_COVSYSPL_REV.DWG 06/28/00 13:13



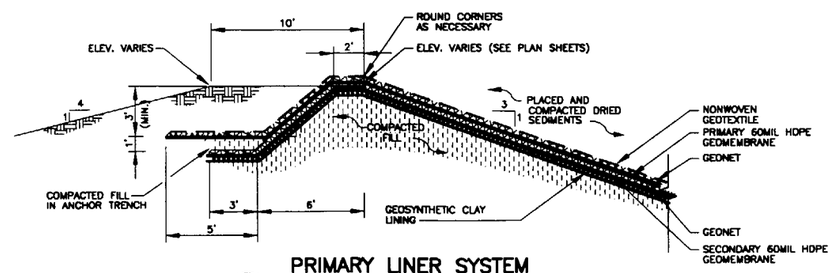
A BOTTOM LINER SYSTEM DETAIL
C1.4 C1.6 N.T.S.



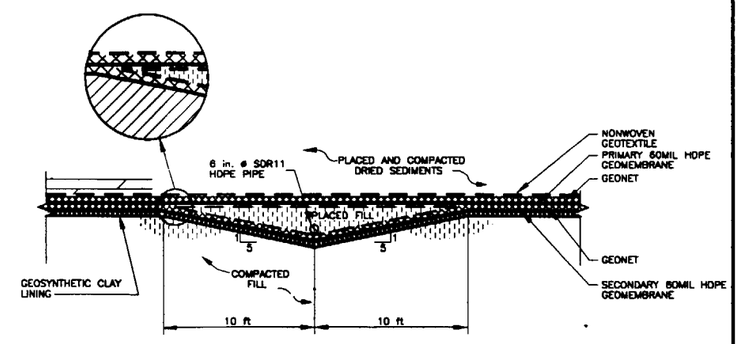
C COLLECTION SUMP DETAIL
C1.4 C1.6 NTS



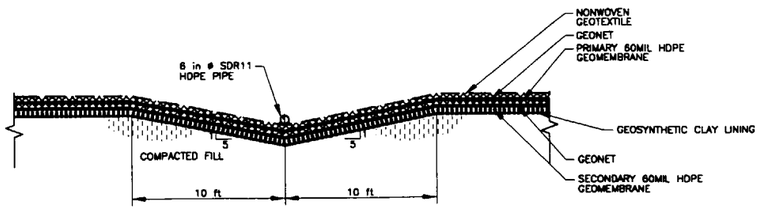
B GRAVEL DRAIN DETAIL
C1.4 C1.6 APPROX. SCALE: 1" = 5'



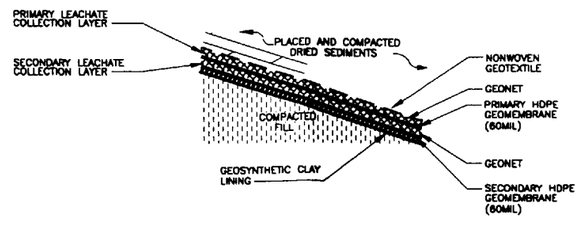
D PRIMARY LINER SYSTEM ANCHOR DETAIL
C1.4 C1.6 APPROX. SCALE: 1" = 5'



E SECONDARY LEACHATE COLLECTION SYSTEM RISER PIPE DETAIL
C1.2 C1.6 APPROX. SCALE: 1" = 5'



PRIMARY LEACHATE COLLECTION SYSTEM SIDE SLOPE RISER PIPE DETAIL
F
C1.3 C1.6 APPROX. SCALE: 1" = 5'



SIDE SLOPE LINER SYSTEM DETAIL
G
C1.4 C1.6 N.T.S

NOTE:
THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION BY SCALING. SOME ELEMENTS HAVE BEEN EXAGGERATED FOR CLARITY OF LOCATION.

WARNING
0 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: G. WANTLAND
DRAWN BY: G. BRADFORD
CHECKED BY: JJ/BLW
PROJECT MANAGER: G. WANTLAND
DATE: JUNE 28, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.286.1711 FAX: 813.287.8591

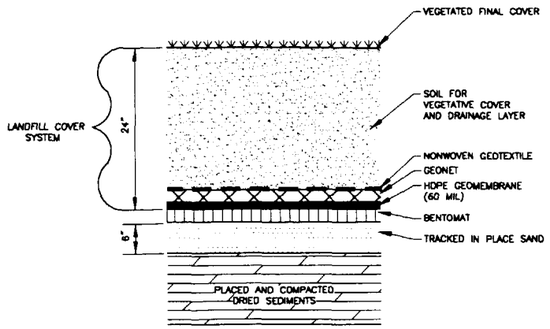
SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

LINER SYSTEM DETAILS

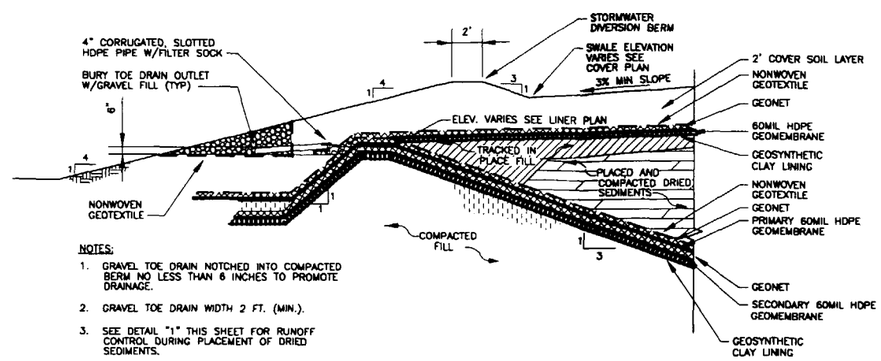
PROJECT NUMBER C100003899.00

SHEET C1.6

S:\C100001\30001\3899.001\LANDFILL REDESIGN\PLAN DRAWINGS\C1.6_LINRDETL_REV.DWG 06/28/00 13:18

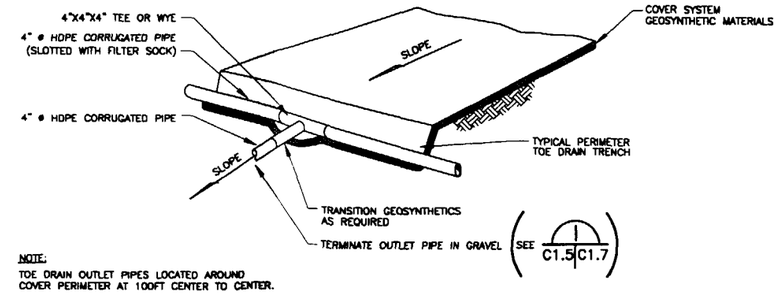


H C1.5 C1.7 COVER SYSTEM DETAIL
N.T.S.



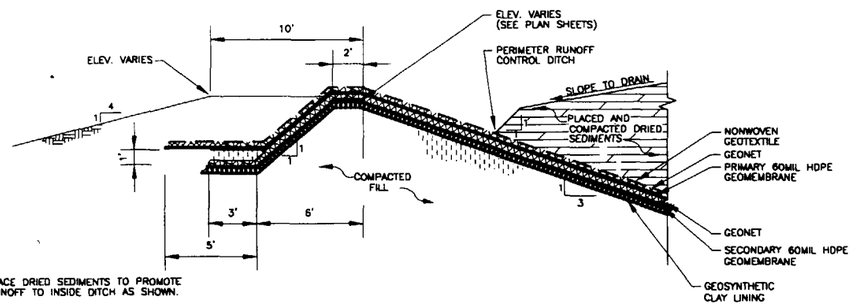
NOTES:
1. GRAVEL TOE DRAIN NOTCHED INTO COMPACTED BERM NO LESS THAN 6 INCHES TO PROMOTE DRAINAGE.
2. GRAVEL TOE DRAIN WIDTH 2 FT. (MIN.).
3. SEE DETAIL "1" THIS SHEET FOR RUNOFF CONTROL DURING PLACEMENT OF DRIED SEDIMENTS.

I C1.5 C1.7 COVER SYSTEM DETAIL
N.T.S.



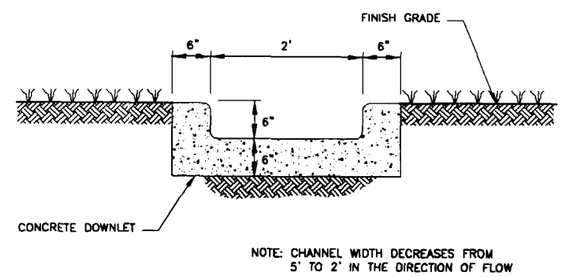
NOTE:
TOE DRAIN OUTLET PIPES LOCATED AROUND COVER PERIMETER AT 100FT CENTER TO CENTER.

TYPICAL
J C1.5 C1.7 TOE DRAIN OUTLET DETAIL
N.T.S.



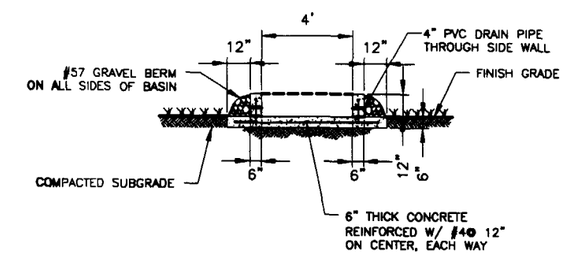
NOTES:
1. PLACE DRIED SEDIMENTS TO PROMOTE RUNOFF TO INSIDE DITCH AS SHOWN.

1 C1.7 C1.7 RUNOFF CONTROL BERM DETAIL
APPROX. SCALE: 1" = 5'

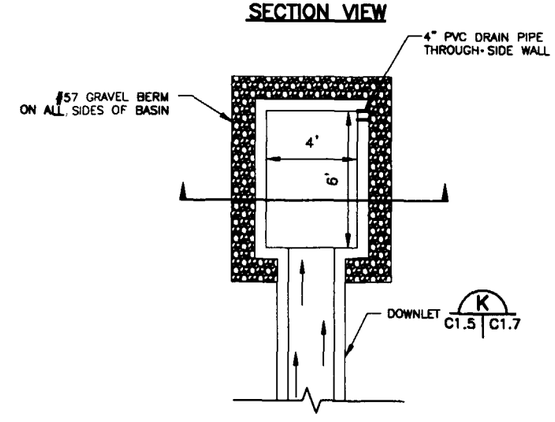


NOTE: CHANNEL WIDTH DECREASES FROM 5' TO 2' IN THE DIRECTION OF FLOW

K C1.5 C1.7 DOWNLET SECTION
N.T.S.

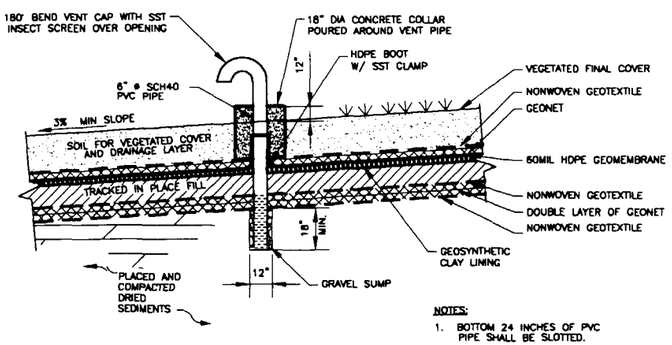


SECTION VIEW



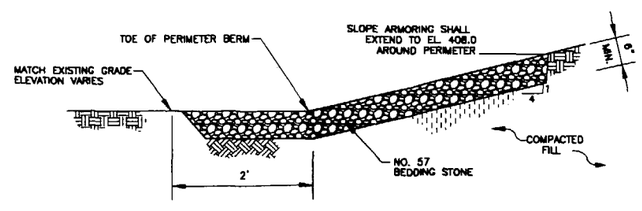
PLAN VIEW

N C1.5 C1.7 STILLING BASIN
N.T.S.



NOTES:
1. BOTTOM 24 INCHES OF PVC PIPE SHALL BE SLOTTED.
2. DOUBLE LAYER OF GEONET FOR VENT SHALL BE 20FT X 20FT IN PLAN.

L C1.5 C1.7 TYPICAL COVER VENT
N.T.S.



M C1.5 C1.7 SLOPE ARMORING DETAIL
N.T.S.

NOTE:
THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION BY SCALING. SOME ELEMENTS HAVE BEEN EXAGGERATED FOR CLARITY.

REV	DESCRIPTION OF REVISION	BY	DATE

DESIGNED BY: G. WANTLAND
DRAWN BY: G. BRADFORD
CHECKED BY: JJ/WJW
PROJECT MANAGER: G. WANTLAND
DATE: JUNE 28, 2000

URS Greiner Woodward Clyde
7650 WEST COURTNEY CAMPBELL CSWY.
TAMPA, FLORIDA 33607-1462
TEL: 813.286.1711 FAX: 813.287.8591

SOLUTIA INC.
SAUGET AREA 1
CAHOKIA, ILLINOIS

COVER SYSTEM DETAILS

PROJECT NUMBER
C100003899.00

SHEET
C1.7

S:\C10000\3000\3899.001\AWP2-TECDESIGN\PLAN DRAWINGS\C1.7_COSYDET_REV.DWG 06/28/00 13:16

Appendix A

URS Greiner Woodward Clyde
A Division of URS Corporation

2318 Millpark Drive
Maryland Heights, MO 63043
Tel: 314 429 0100
Fax: 314 429 0462
Offices Worldwide

December 2, 1999
23.99STL022.01

Mr. Bruce Yare
Manager, Remediation Technology
Solutia, Inc.
P.O. Box 66760
St. Louis, Missouri 63166

Subject: Report of Geotechnical Investigation For Proposed Landfill Cell Cahokia, Illinois

Dear Bruce:

This letter report transmits our geotechnical findings and recommendations for the subject site. The work was performed in accordance with our proposal dated October 28, 1999 and your authorization. The intent of this investigation was to obtain information to characterize the subsurface conditions and assess the foundation requirements for a landfill that would contain PCB-impacted materials (soil/sediment).

PROJECT DESCRIPTION

We understand that the landfill will be located on the Solutia property formerly known as the Moto property. It is planned that the northern boundary of the cell will be adjacent to the southern boundary of Site G (Figure 1) and the eastern boundary of the cell adjacent to the west bank of Dead Creek. We understand the planned cell area is on the order of about 1.4 acres. Based on Drawing C1.5 provided by, and conversations with the designer, the height of the perimeter berms will not likely exceed 20 ft above current existing grade, and the height at the center of the landfill, when capped, will be about 25 ft above the existing grade. The exterior slopes of the containment berms will be about 4:1 and the interior slopes about 3:1.

FIELD INVESTIGATION

A total of four borings were drilled and a piezometer installed on the property between November 8, 1999 through November 10, 1999. Two hand-augers borings were drilled on November 15,1999. The approximate locations of the borings and the piezometer installed for this study are shown in Figure 1 and also in Figure C1.5. The geotechnical borings are designated GB-1 through GB-3, the piezometer is PZ-1, and the hand-auger borings are HA-1 and HA-2. Two borings, GB-1 and GB-3, were drilled to depths of about 50 ft and GB-2 was drilled to a depth of about 75 ft. Boring GB-2 was drilled deeper to estimate the vertical extent of loose to medium dense alluvium to help assess settlement and liquefaction potential of the site. The piezometer boring was drilled to a depth of about 20 ft and a piezometer was installed to that depth. Currently the piezometer readings are made on a weekly basis. A URS Greiner Woodward Clyde (URSGWC) representative directed the field investigation, logged the borings and collected soil samples for laboratory testing. Potential borrow sources of fill material for berms have not yet been identified and evaluated.

The work was conducted in accordance with Solutia's site policies and procedures and with a site-specific health and safety plan approved by URSGWC and Solutia.

The borings were drilled with a CME-55 truck-mounted drilling rig owned and operated by Roberts Environmental Drilling, Inc. (REDI) of Illinois. Borings were advanced using 4-¼ inch I.D. hollow-stem augers. Once the water table was encountered, typically at a depth of between 9 to 14 ft below ground surface, borings were continued using a 3-7/8 inch diameter roller bit and a bentonite-based drilling mud.

Soil samples were obtained from the borings using either a 1-½ inch I.D. split-spoon sampler in accordance with the Standard Penetration Test (SPT) Method (ASTM D-1586) or a hydraulically pushed thin-walled sampler (Shelby tube) to obtain "undisturbed" samples.

Sampling was made at 2½-ft vertical intervals in the upper 10 ft and at 5-ft vertical intervals thereafter. Upon completion, the borings were tremmie-grounted with a cement-bentonite mixture. Drilling spoils and excess sample were placed in containers provided by Solutia along with drilling fluids displaced during grouting.

Field boring logs were prepared by a URSGWC representative based upon recovered soil samples, cuttings, drilling characteristics, and field conditions. The logs have been subsequently modified to reflect laboratory test results. Detailed logs of borings and piezometer installation are attached. Graphic boring logs depicting generalized subsurface conditions are shown in Figure 2.

LABORATORY TESTING

Laboratory tests were performed on selected soil samples to characterize the index and strength properties of the subsurface soils. The tests performed included visual classification, water contents, liquid and plastic limits, unconfined compression strength and a consolidation test. Results of the laboratory tests are summarized in Table 1 and are also included on the detailed boring logs. Unconfined compression tests and consolidation test figures are also attached.

SUBSURFACE CONDITIONS

The subsurface conditions at this property primarily consist of about 5 ft of low plasticity silty clayey soil in Borings GB-1 through GB-3 to about 20 ft of clayey silts in PZ-1. The upper 5 ft of clayey materials is underlain by alluvial non-plastic fine sandy silts to depths of about 20 ft in Borings GB-1 and GB-3. Alluvial sands underlie the sandy silts to the drilled depths. The consistency of the upper cohesive material is typically firm to stiff. The silts within the upper 20 ft are typically loose and the alluvial sands immediately below the sandy silts are loose to medium dense, and become medium dense to dense with depth. In Borings GB-1 and GB-2, the relative density indicates a loose to medium dense layer exists between elevation 370 and 360 (depth between 40 and 50 ft). Below elevation 360 the relative density varies between medium dense to very dense.

GROUNDWATER

The water surface was encountered between 9 and 15 ft in all borings at the time of drilling on November 8, 1999. Groundwater was observed at a depth of about 9.5 ft below grade in the piezometer boring. A piezometric reading of 9.77 ft was recorded on November 15, 1999 and 9.95 ft on November 22, 1995. A piezometer reading of 10.22 ft was recorded on 12/1/1999. Weekly readings of the piezometer are planned. There have been only small changes in the piezometer readings to date.

ENGINEERING ANALYSIS AND RECOMMENDATIONS

Based upon the results of our field investigation, laboratory test results, engineering analyses, and experience, the following conclusions and recommendations are provided.

The alluvium encountered within 5 to 10 ft below the water table is generally loose to medium dense. The liquefaction potential of the site was evaluated using the "simplified procedure" by Seed and Idriss, (1972) as updated in NCEER, 1997, and Idriss, 1998. The ground motion parameters were estimated using a peak ground acceleration (PGA) of 0.1g obtained from the USGS Hazard Maps for the area by Zip Code. An earthquake magnitude (Mw) 6.5 was selected based on our previous studies in this general area. Based on this analysis, liquefaction is not triggered at the site. Liquefaction induced settlement due to shaking of up to 3 inches was calculated for the site. The consequences of damage to the liner and the foundation are judged to be insignificant and tolerable.

Based on our understanding, the exterior slopes will be constructed with a slope of 4:1 and the interior will be 3:1, therefore the risk of slope instability is negligible. Assuming no water outside the slope and that the berm will be constructed of well compacted cohesive material with a cohesion of about 1000 psf and weighing about 120 pcf, and allowing for a surcharge of about 200 psf we estimated that the minimum factor of safety against slope stability to be about 3.75. The slopes are judged to be stable under seismic conditions. For the proposed geometry,

topographic conditions and subsurface conditions, risk of damage due to lateral spreading or landsliding during seismic activity is judged to be negligible.

The anticipated differential settlements of the liner between the center of the cell and the center of the berm due to the weight of the berm and landfilled materials using Schmertmann (1978) are less than 1/4 inch. These estimates pertain to settlement of the 5-ft thick proposed liner system. The total anticipated settlement is the sum of the static settlement provided above and the 3 inches obtained from the liquefaction analysis. Please note that in the case of liquefaction induced settlements the total can also be equal to the differential settlement. However the magnitude of the sum of these is judged to be tolerable for the landfill liner and foundation system assuming the landfill material in the cell are silts and sands placed under controlled conditions and compacted to minimize further settlement during a seismic event.

Based on the consolidation test results, most of the static foundation settlement will probably occur during construction. Therefore, long-term settlement of the foundation soils and the liner are judged to be insignificant to the integrity of the landfill and foundation soils.

We are pleased to provide you with these services and look forward to our continued involvement in this project.

Sincerely,

George M. S. Manyando, Ph.D., P.E.
Senior Geotechnical Engineer

William L Durbin, P.E.
Senior Principal

GMM/RBB/WLD:efb

Attachments

12/2/99

K:\GEO\Solutia Rpt Geo.doc

TABLE 1

SOLUTIA
LABORATORY TESTING DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS: WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	TOTAL UNIT WEIGHT (pcf)	STRENGTH: Type Test	PEAK DEVIATOR STRESS (tsf)	AXIAL STRAIN @ PEAK STRESS (%)	CONSOL. INITIAL CONDITIONS: VOID RATIO (-)	SATUR-ATION (%)	REMARKS
GB-1		1-2.5	13.5		np		SM								
GB-1		4.35-4.7	20.4				ML		106.3	UC	0.52	3.2			
GB-1		5.05-5.4	18.7				ML								
GB-1		5.4-5.75	18.3				ML								
GB-1		6-8							111.3						
GB-1		6.15	21.8												
GB-1		6.45	28.2				ML		115.0	UC	0.48	7.7			
GB-1		6.75	32.5												
GB-1		7.3	35.3												
GB-1		7.55	32.3		np		ML		113.9				1.000	89.0	
GB-1		9-10.5	32.6				CL-ML								
GB-1		14-15.5	36.6				SM	43.2							
GB-1		19-20.5	32.3				SP-SM	6.2							
GB-2		1-3							112.0						
GB-2		1.1	22.3												
GB-2		1.35	22.6				ML		116.0	UC	0.95	4.0			
GB-2		1.65	19.4												
GB-2		5.3-5.65	28.1	34	24	10	ML								
GB-2		6-7.5	29.5				CL-ML								
GB-2		9-10.5	25.5				SP-SM	9.1							
GB-2		29-30.5	22.1				SP	3.7							
GB-2		34-35.5	17.9				SP	3.6							
GB-2		49-50.5	21.2				SP	2.1							

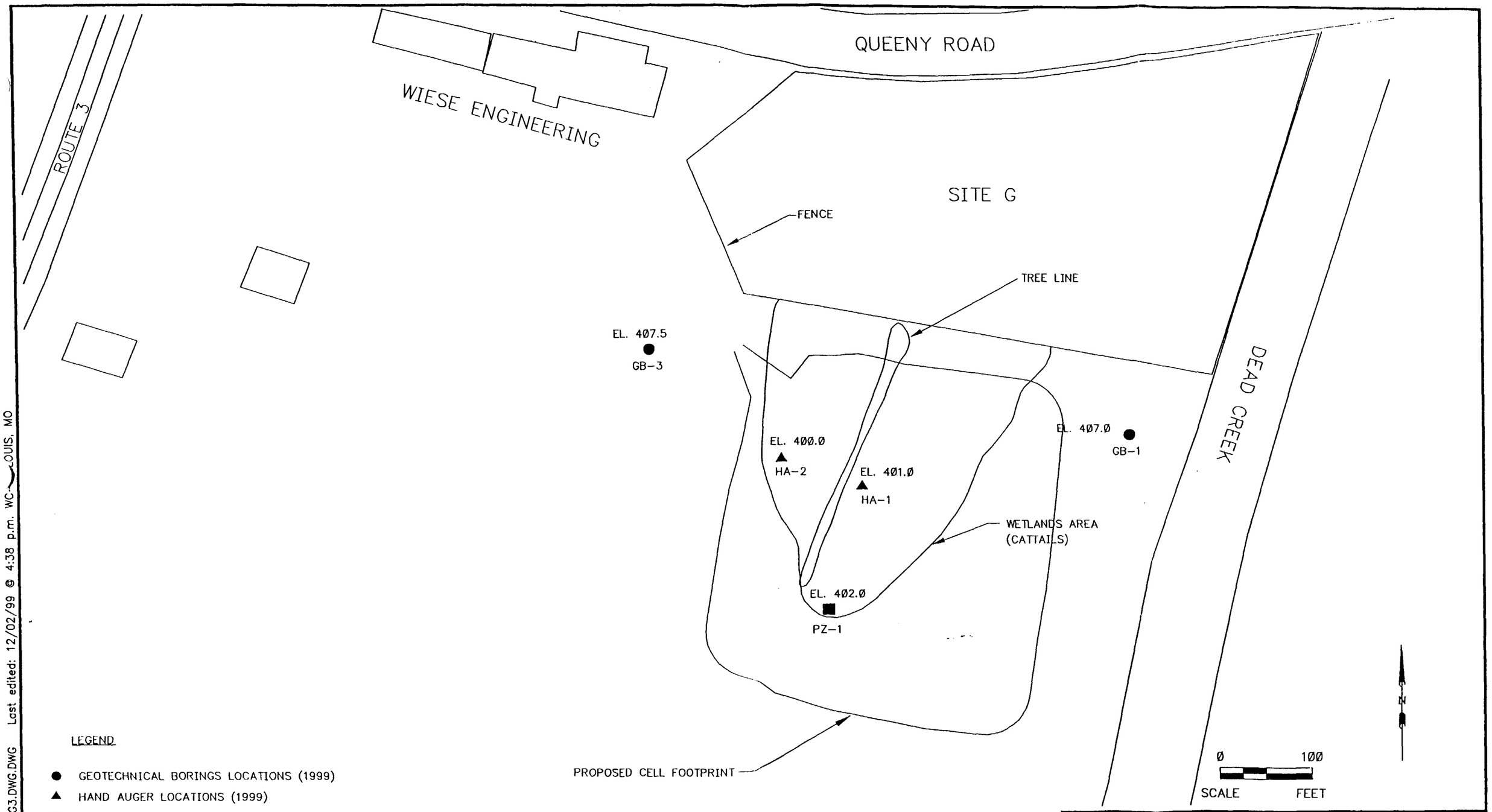
Prepared by: CMJ Reviewed by: 97 Date: 11/30/1999

SOLUTIA
LABORATORY TESTING DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS: WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLAS. IND.	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	TOTAL UNIT WEIGHT (pcf)	STRENGTH: Type Test	PEAK DEVIATOR STRESS (tsf)	AXIAL STRAIN @ PEAK STRESS (%)	CONSOL. INITIAL CONDITIONS: VOID RATIO (-)	SATUR-ATION (%)	REMARKS
GB-3		1-3							91.7						
GB-3		1.15	13.5												
GB-3		1.7	6.4												
GB-3		2.25	8.9												
GB-3		7.1-7.45	7.1				SM	18.1							
GB-3		7.45-7.8	6.2				SP								
GB-3		7.8-8.15	21.2				SP								
GB-3		8.15-8.5	8.1				SP		88.9						
GB-3		9-10.5	34.5				SM	48.6							
GB-3		11.5-13	35.5	32	25	7	ML								
GB-3		14-15.5	32.8				CL-ML								
GB-3		19-20.5	26.9				SP	4.8							
GB-3		44-45.5	18.8				SP	2.1							
P2-1		1-2.5	31.2				CL								
P2-1		4-5.5	36.0	60	20	40	CH								
P2-1		6-7.5	36.4				CL-ML								

Note: (1) USCS symbol based on visual observation unless Sieve and Atterberg limits reported.

Prepared by: CMJ Reviewed by: RJ Date: 11/30/1999



TSCA CELL INVESTIGATION
SOLUTIA PROPERTY
CAHOKIA, ILLINOIS

PROJECT NO. 2399STL022.00

URS Greiner Woodward Clyde
A Division of URS Corporation

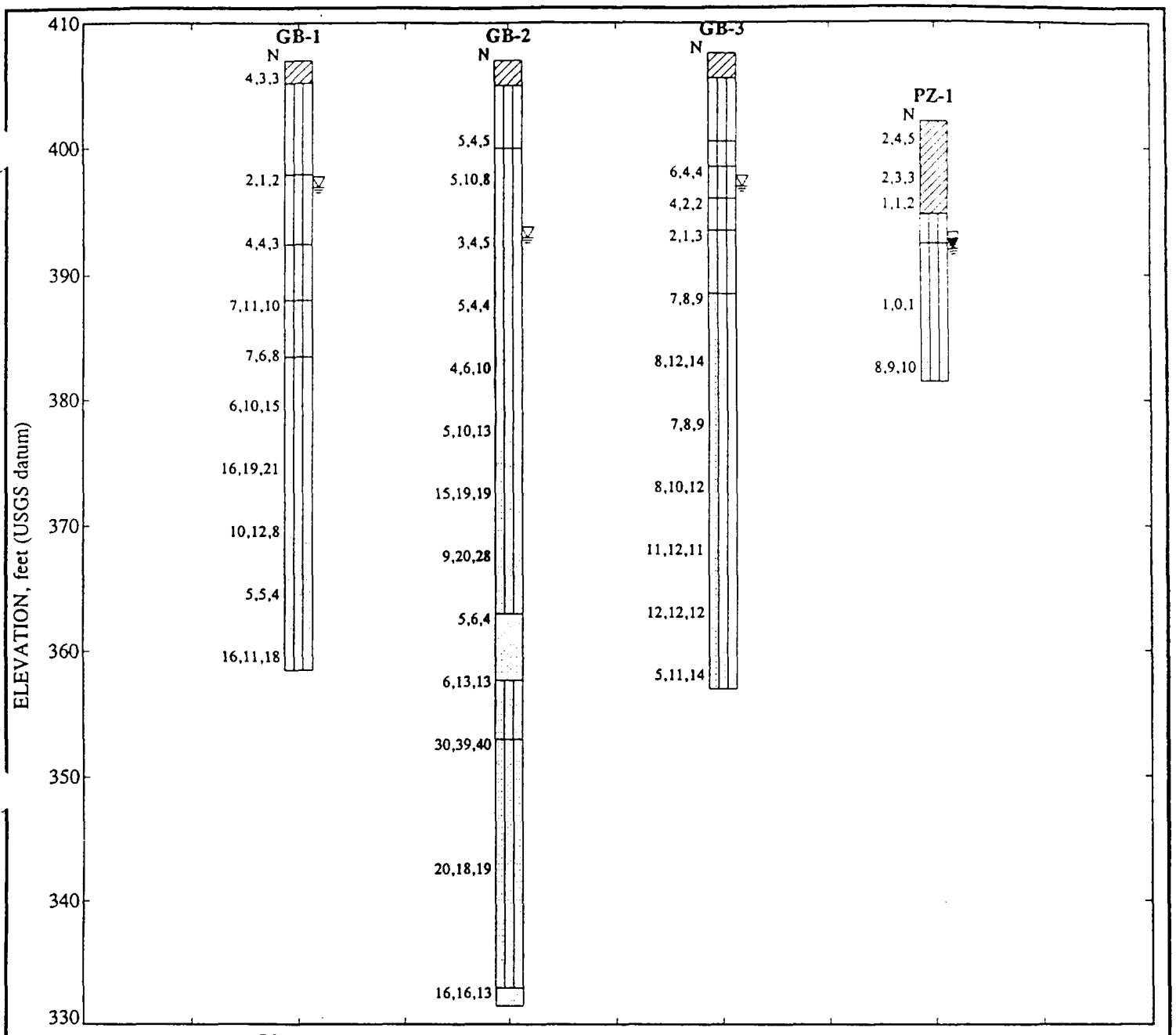
DRN. BY: djd 11/11/99
DSGN. BY: th
CHKD. BY:

Boring Plan Location

FIG. NO. 1

File: F:\S_022\FIG3.DWG.DWG Last edited: 12/02/99 @ 4:38 p.m. WC-LOUIS, MO

Boring Logs



Water level entry at time of drilling

Water level after drilling

P: Hydraulically pushed sample

RQD: Rock Quality Designation

7,10,15: Blows/6" penetration of sampler unless indicated otherwise

N-values equal sum of blows for last 12 inches

NOTE: These graphic logs depict generalized soil conditions. Refer to individual logs for details.

Legend:

- Low plastic CLAY
- Low plastic SILT
- Silty SAND
- SAND

Drawn by: djd	Checked by: gmm	Date: 11/17/99

Solutia, Sauget, Illinois

Project No. 2399STL022

Woodward-Clyde Consultants

Graphic Boring Logs Figure 2.

Template: N-TMP07S; Proj ID: TL022; Printed: 11/19/99

LOG of BORING No. GB-1

DATE 11/8/99 SURFACE ELEVATION, FT 407.0 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
0				Firm, dark brown, moist, low plasticity Silty CLAY (CL)									Boring advanced with 4 1/4in. I.D HSA and Mud rotary
		4 3 3	100		405.2								
				Loose tan, dry, fine Sandy SILT (ML)	1.8				14				
			83										
5								0.5	20				
									19				
			83						18				
								0.5	22				
				Becoming moist					28				
									33				
									35				
					398.0				32				
		2 1 2	100	Very loose, tan, wet, SILT (ML); with trace of clay and some fine sand ▽	9.0								
10									33				
				Becoming loose									
		4			392.5								
15		4 3		Loose, wet, tan, fine Silty SAND (SM)	14.5								Switch to Mud Rotary
									37				
					388.0								
20		7 11 10	83	Medium dense, tan, wet fine Sandy SILT, to Silty SAND (SM/ML)	19.0								
									32				
		7 6 8	72		383.5								
				Medium dense, tan, wet, medium to fine Silty SAND (SM)	23.5								

Completion Depth: 48.5 Ft. Water Depth: 10 ft., After ATD hrs.

Project No.: 2399STL022 ____ ft., After ____ hrs.

Project Name: Solutia ____ ft., After ____ hrs.

Drilling Contractor: Redi Logged by: Tim Hicks

12/2/99 WCCXS TL022

URS Greiner Woodward Clyde

LOG of BORING No. GB-1

DATE 11/8/99 SURFACE ELEVATION, FT 407.0 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
25													
		6 10 15	83	Becoming gray, medium dense, medium to fine gravel									
30				Medium dense, gray Silty SAND (SM); with trace of medium to fine gravel									
		16 19 21	83	Becoming dense and less silty									
35													
		10 12 8	67	Becoming medium dense									
40													
		5 5 4	67	Becoming loose									
45				Loose, wet, gray Silty SAND (SM)									
		16 11 18		Becoming medium dense	358.5								
				Bottom of boring at 48.5ft.	48.5								

Completion Depth: 48.5 Ft. Water Depth: 10 ft., After ATD hrs.

Project No.: 2399STL022 ____ ft., After ____ hrs.

Project Name: Solutia ____ ft., After ____ hrs.

Drilling Contractor: Redi Logged by: Tim Hicks

URS Greiner Woodward Clyde

LOG of BORING No. GB-2

DATE 11/9/99 SURFACE ELEVATION, FT 407.0 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
0			33	Brown, soft, moist, low plasticity Silty CLAY (CL)	405.0			1.0	22				Boring advanced with 4 1/4in. I.D HSA and Mud Rotary
				Loose. tan, dry, fine Sandy SILT (ML)	2.0				23 19				
5		5 4 5	58 49	Becoming Medium dense, gray with iron staining	400.0				28	34	10		
				Loose, moist, gray, fine Silty SAND (SM)	7.0				30				
10		5 10 8	89	Becoming medium dense, light brown and gray					26				
15		3 4 5	67	Becoming loose and saturated									Switched to Mud Rotary
20		5 4 4	78	Trace of fine gravel, becoming coarse to fine sand									
		4	67	Becoming medium dense with a trace of medium to fine gravel									

Completion Depth: 75.5 Ft. Water Depth: 14 ft., After ATD hrs.

Project No.: 2399STL022 ft., After hrs.

Project Name: Solutia ft., After hrs.

Drilling Contractor: Redi Logged by: Tim Hicks

LOG of BORING No. GB-2

DATE 11/9/99 SURFACE ELEVATION, FT 407.0 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
25		6 10		Medium dense, gray, wet Silty SAND (SM); with a trace medium to fine gravel									
30		5 10 13		Medium dense, gray, wet Silty SAND (SM)					22				
35		15 19 19	67	Becoming dense					18				
40		9 20 28	78	With fine gravel, decrease in silt content									
					363.0 44.0								
45		5 6 4	78	Loose, medium dense, moist, gray coarse to fine SAND (SP); with some fine gravel									
		6	78		357.7 49.3								

Completion Depth: 75.5 Ft.

Water Depth: 14 ft., After ATD hrs.

Project No.: 2399STL022 ____ ft., After ____ hrs.

Project Name: Solutia ____ ft., After ____ hrs.

Drilling Contractor: Redi

Logged by: Tim Hicks

LOG of BORING No. GB-2

DATE 11/9/99 SURFACE ELEVATION, FT 407.0 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
50		13 13		Medium dense, gray, moist, medium to fine SAND (SM/SP); with trace of silt					21				
					353.0								
55		30 39 40	100	Very dense, gray, moist, fine Silty SAND (SM)	54.0								
60				Very dense, gray, moist fine Silty SAND (SM)									
65		20 18 19	83	Becoming dense with some silt, coarse to fine sand, trace of fine gravel									
70													
					333.0								
		16	83		74.0								

Completion Depth: 75.5 Ft.

Water Depth: 14 ft., After ATD hrs

Project No.: 2399STL022 ft., After hrs.

Project Name: Solutia ft., After hrs.

Drilling Contractor: Redi

Logged by: Tim Hicks

URS Greiner Woodward Clyde

LOG of BORING No. GB-2

DATE 11/9/99 SURFACE ELEVATION, FT 407.0 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
75		16		Becoming medium dense, gray, wet,	331.5								
		13		coarse to fine gravel with medium to fine SAND (SP)	75.5								
				Bottom of boring at 75.5ft.									
80													
85													
90													
95													

Completion Depth: 75.5 Ft. Water Depth: 14 ft., After ATD hrs.

Project No.: 2399STL022 ____ ft., After ____ hrs.

Project Name: Solutia ____ ft., After ____ hrs.

Drilling Contractor: Redi Logged by: Tim Hicks

12/2/99 WCCXS TL022

URS Greiner Woodward Clyde

LOG of BORING No. GB-3

DATE 11/10/99 SURFACE ELEVATION, FT 407.5 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
0			83	Medium stiff, dark brown, moist, low plasticity Silty CLAY (CL)	405.5				14				Boring advanced with 4 1/4in. I.D HSA and Mud Rotary
			63	Loose, tan, dry SILT (ML); with some sand and trace of clay	2.0				6 9				
5			83		400.5								
				Loose, tan, dry fine SAND (SM); with some silt	7.0 398.5				7 6 21				
10		6 4 4	94	Loose, brown, moist, fine Sandy SILT (ML/SM) Becoming saturated ▽	9.0 396.0				8 35				
		4 2 2	83	Loose, gray, wet SILT (ML); with some sand	11.5 393.5				36	32	7		Switched to Mud Rotary
15		2 1 3	83	Loose, brown, tan, wet Sandy SILT (ML)	14.0 388.5				33				
20		7 8 9	83	Medium dense, tan, gray, fine Silty SAND (SM)	19.0				27				
		8	83										

Completion Depth: 50.5 Ft. Water Depth: 10.5 ft., After ATD hrs.

Project No.: 2399STL022 ____ ft., After ____ hrs.

Project Name: Solutia ____ ft., After ____ hrs.

Drilling Contractor: Redi Logged by: Tim Hicks

LOG of BORING No. GB-3

DATE 11/10/99 SURFACE ELEVATION, FT 407.5 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
25		12 14		Medium dense, tan, gray fine SAND (SM)									
30		7 8 9	67										
35		8 10 12	83	Decrease in silt content, becoming trace of silt, and trace ofr medium to fine gravel									
40		11 12 11	72	Decrease in silt content, trace of silt and trace of medium to fine gravel									
45		12 12 12	67	Medium dense, tan, gray, fine SAND (SM)					19				
		5	72										

Completion Depth: 50.5 Ft. Water Depth: 10.5 ft., After ATD hrs.

Project No.: 2399STL022 ____ ft., After ____ hrs.

Project Name: Solutia ____ ft., After ____ hrs.

Drilling Contractor: Redi Logged by: Tim Hicks

LOG of BORING No. GB-3

DATE 11/10/99 SURFACE ELEVATION, FT 407.5 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
50		11			357.0								
		14		Bottom of boring at 50.5ft.	50.5								
55													
60													
65													
70													

Completion Depth: 50.5 Ft. Water Depth: 10.5 ft., After ATD hrs.

Project No.: 2399STL022 _____ ft., After _____ hrs.

Project Name: Solutia _____ ft., After _____ hrs.

Drilling Contractor: Redi Logged by: Tim Hicks

LOG of BORING No. PZ-1

DATE 11/8/99 SURFACE ELEVATION, FT 402.0 DATUM USGS LOCATION See Figure 1

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
0				Soft, moist, brown,low plasticity Silty CLAY									Boring advanced with 4 1/4in. I.D HSA
		2 4 5	100	Becoming stiff					31				
5		2 3 3	100	Becoming firm, medium plasticity mottled brown, gray			1.5		36	60	40		
		1 1 2	100		394.8								
				Very loose, wet, gray, Sandy SILT (ML); with medium to fine sand	7.2				36				
					392.5								
10				Loose, wet, gray, medium to fine SAND (SM); with some silt	9.5								
15		1 0 1	78	Very loose, wet, tan, fine SAND (SM); with a trace of silt									
20		8 9 10	88	Becoming medium dense	381.5								
				Bottom of boring at 20.5ft.	20.5								

Completion Depth: 20.5 Ft.

Water Depth: 9.5 ft., After ATD hrs.

Project No.: 2399STL022

10 ft., After 18 hrs.

Project Name: Solutia

ft., After hrs.

Drilling Contractor: Redi

Logged by: Tim Hicks

12/2/99 WCCXS TL022

URS Greiner Woodward Clyde

MONITORING WELL INSTALLATION REPORT

Well No. PZ-1

Project Solutia

Location See Figure 1.

Project No 2399STL022 Installed By Redi Date 11/8/99 Time 1100

Method of Installation 4 1/4in. H.S.A. Done 1150

LOG OF BORING AND WELL

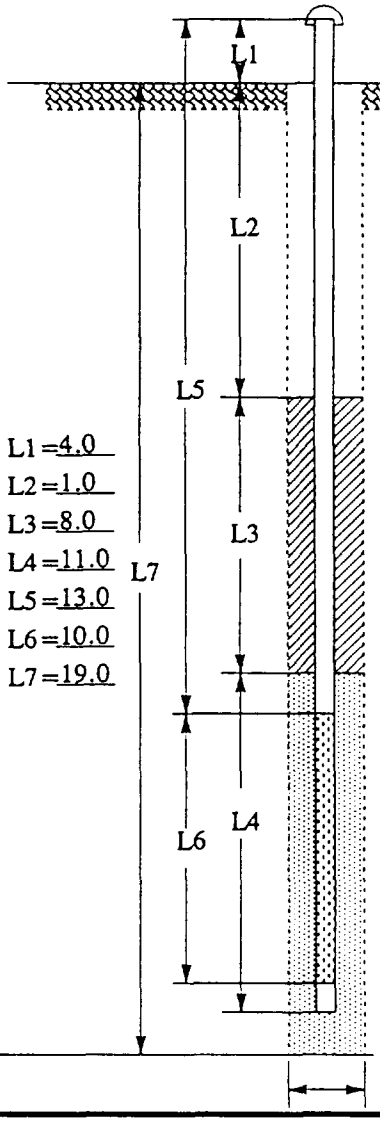
BORING

Depth in Ft.	Description	Symbol
0.00	Soft, moist, brown,low plasticity Silty CLAY Becoming stiff Becoming firm, medium plasticity mottled brown, gray	
7.20	Very loose, wet, gray, Sandy SILT (ML); with medium to fine sand	
9.50	Loose, wet, gray, medium to fine SAND (SM); with some silt Very loose, wet, tan, fine SAND (SM); with a trace of silt Becoming medium dense	
	Bottom of boring at 20.5ft.	

WELL

Type of Well

Ground Elev. Top of Riser Elev.



L1 = 4.0
L2 = 1.0
L3 = 8.0
L4 = 11.0
L5 = 13.0
L6 = 10.0
L7 = 19.0

Riser Pipe I.D., in. 1in.

Type of Pipe PVC

Backfill Type Around Riser
Portland cement

Top of Seal Elevation

Type of Seal Material
See below

Top of Filter Elevation 8.0

Type of Filter Material
Quartz

Size of Opening, in. 0.01

Diameter of Well Tip, in. 1.0

Bottom of Screen Elevation 19.0

Bottom of Riser Elevation 19.0

Bttm of Boring Elev. 19.0

Diameter of Boring, in. 4.2

Remarks

Inspected By Tim Hicks

WOODWARD-CLYDE CONSULTANTS

LOG of BORING No. HA-1

DATE 11/15/99 SURFACE ELEVATION, FT 401.0 DATUM USGS LOCATION See Figure 1.

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
0				Firm, dark brown, low to medium Silty CLAY (CL)	399.5								
				Loose, tan, fine Sandy SILT (~~SM~~ ML); with trace of clay	1.5 399.0								
				Bottom of Hand Auger at 2ft.	2.0								
5													

Completion Depth: 2.0 Ft.

Water Depth: _____ ft., After _____ hrs.

Project No.: 2399STL022

_____ ft., After _____ hrs.

Project Name: Solutia

_____ ft., After _____ hrs.

Drilling Contractor: Redi

Logged by: Tim Hicks

11/19/99 WCCXS TL022

URS Greiner Woodward Clyde

LOG of BORING No. HA-2

DATE 11/15/99 SURFACE ELEVATION, FT 400.0 DATUM USGS LOCATION See Figure 1.

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	RECOVERY, %	DESCRIPTION	STRATUM EL / DEPTH	SYMBOL	PP, TSF	FIELD Qu,KSF	NMC, %	LL	PI	Qu, KSF	NOTES
0				Firm, dark brown, low to medium plasticity Silty CLAY (CL)	398.5								
				Loose, tan, fine Sandy SILT (SM); with trace of clay	1.5 398.0								
				Bottom of Hand Auger at 2ft.	2.0								
5													

Completion Depth: 2.0 Ft.

Water Depth: _____ ft., After _____ hrs.

Project No.: 2399STL022

_____ ft., After _____ hrs.

Project Name: Solutia

_____ ft., After _____ hrs.

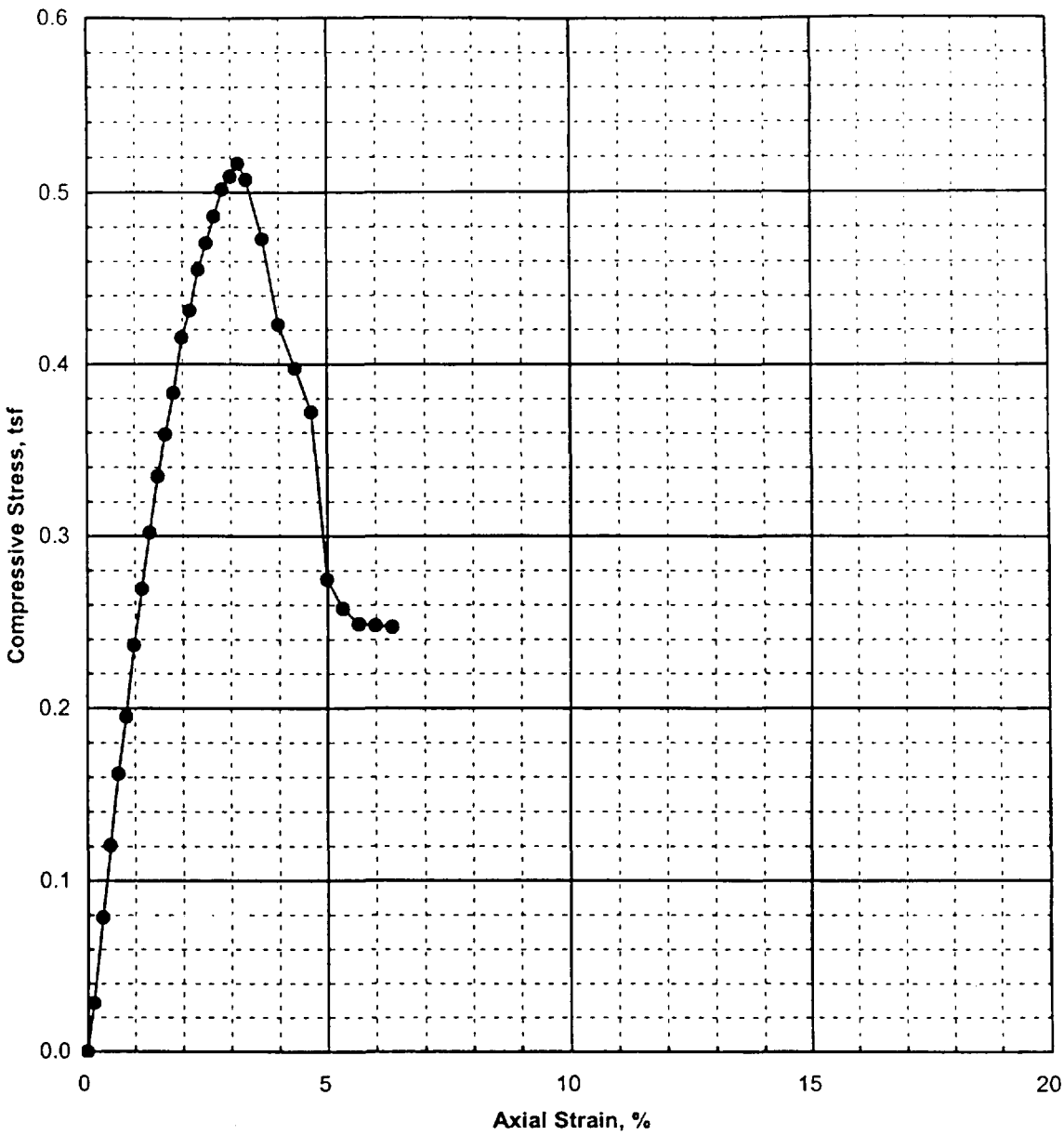
Drilling Contractor: Redi

Logged by: Tim Hicks

11/19/99 WCCXS TL022

URS Greiner Woodward Clyde

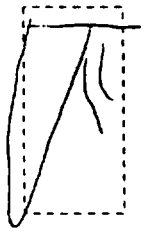
Subsurface Soil Laboratory Test Data



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	LL	PI	Length (in)	Diameter (in)
20.4	106.3	88.4			2.959	1.886

Description and/or Classification: ML, brown slightly to nonplastic SILT, trace f. sand



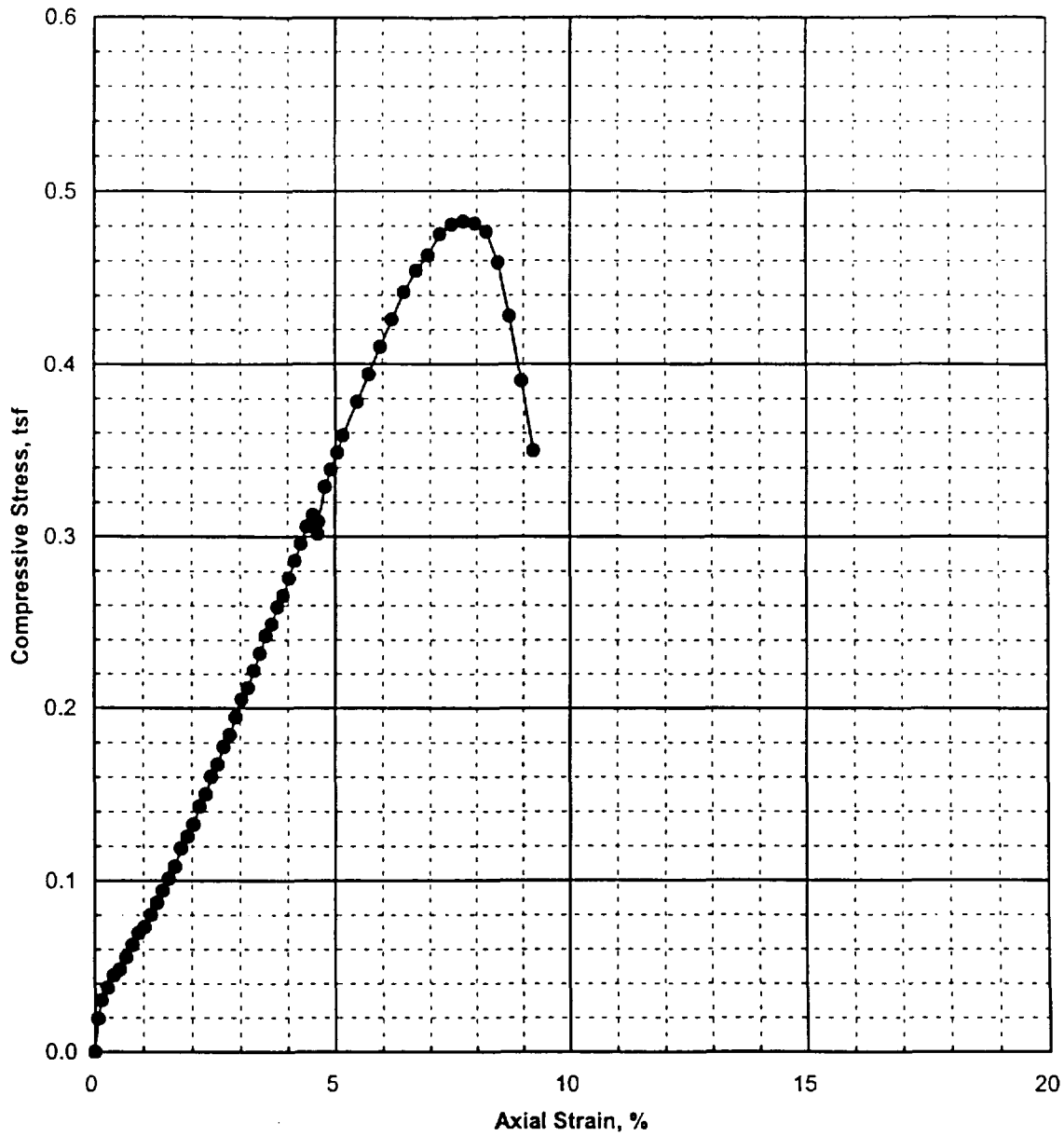
FAILURE SKETCH

Test Summary

q_u (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.52	3.16	1.00

Tested by: BB
Test Date: Nov-18-99
Reviewed by: MT

Project No. 23-99STL0022.01	SOLUTIA	UNCONFINED COMPRESSION TEST Boring: GB-1	
URS Greiner Woodward Clyde		Sample: A Depth:4.35-4.7	November 1999



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	LL	PI	Length (in)	Diameter (in)
28.2	115.0	89.7			5.862	2.874

Description and/or Classification: ML, brown slightly to nonplastic SILT, trace f. sand

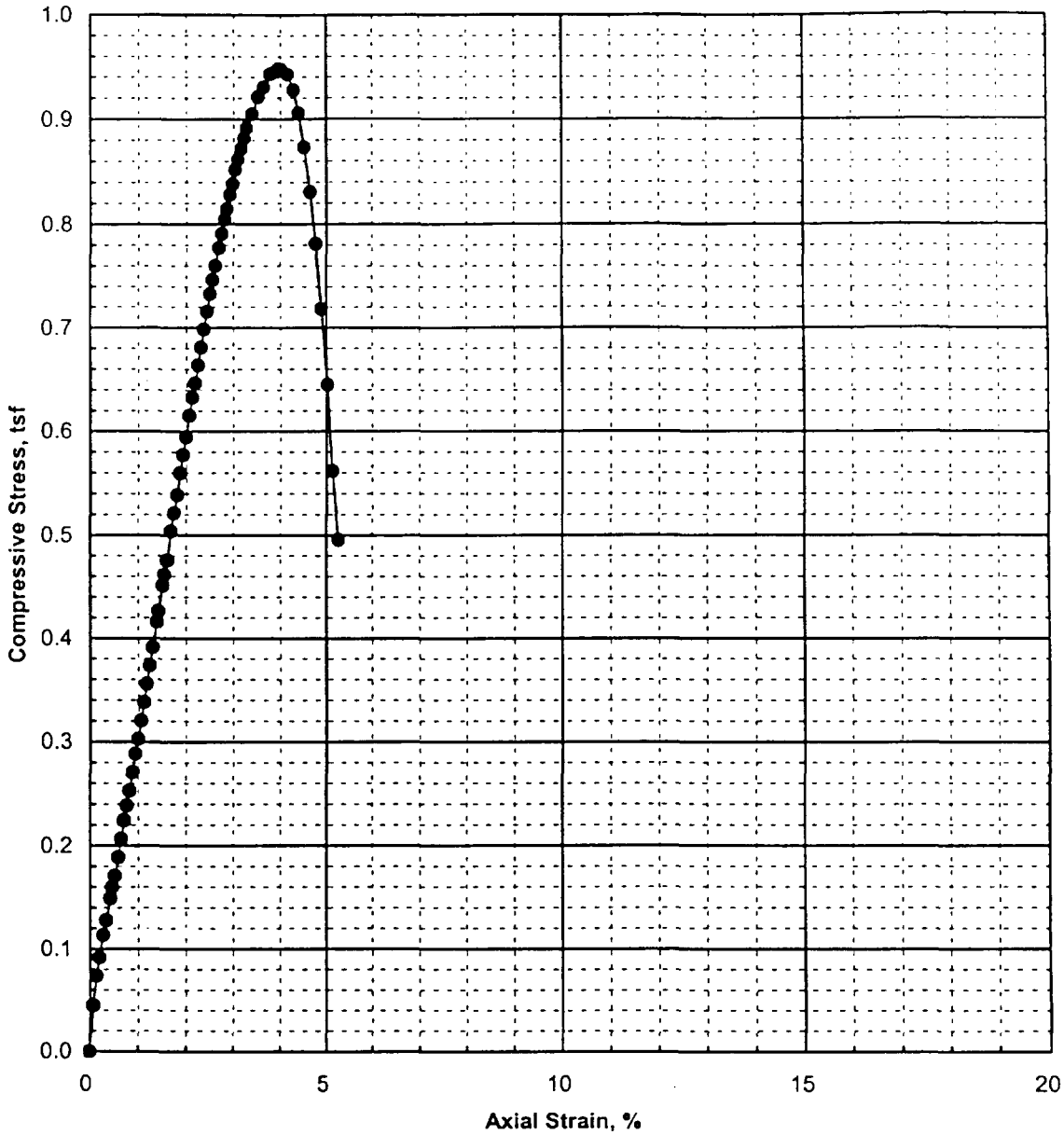
Test Summary

q_u (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.48	7.70	0.74

Tested by: BB
Test Date: Nov-17-99
Reviewed by: 97

FAILURE SKETCH

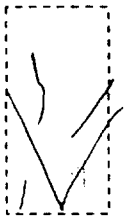
Project No. 23-99STL0022.01	SOLUTIA	UNCONFINED COMPRESSION TEST Boring: GB-1	
URS Greiner Woodward Clyde		Sample: A Depth:6.45	November 1999



Specimen Information

Water Content (%)	Wet Unit Weight (pcf)	Dry Unit Weight (pcf)	LL	PI	Length (in)	Diameter (in)
22.6	116.0	94.7			6.006	2.873

Description and/or Classification: ML, light brown s-np SILT, trace clay; top 1" CL, dark brown silty CLAY.



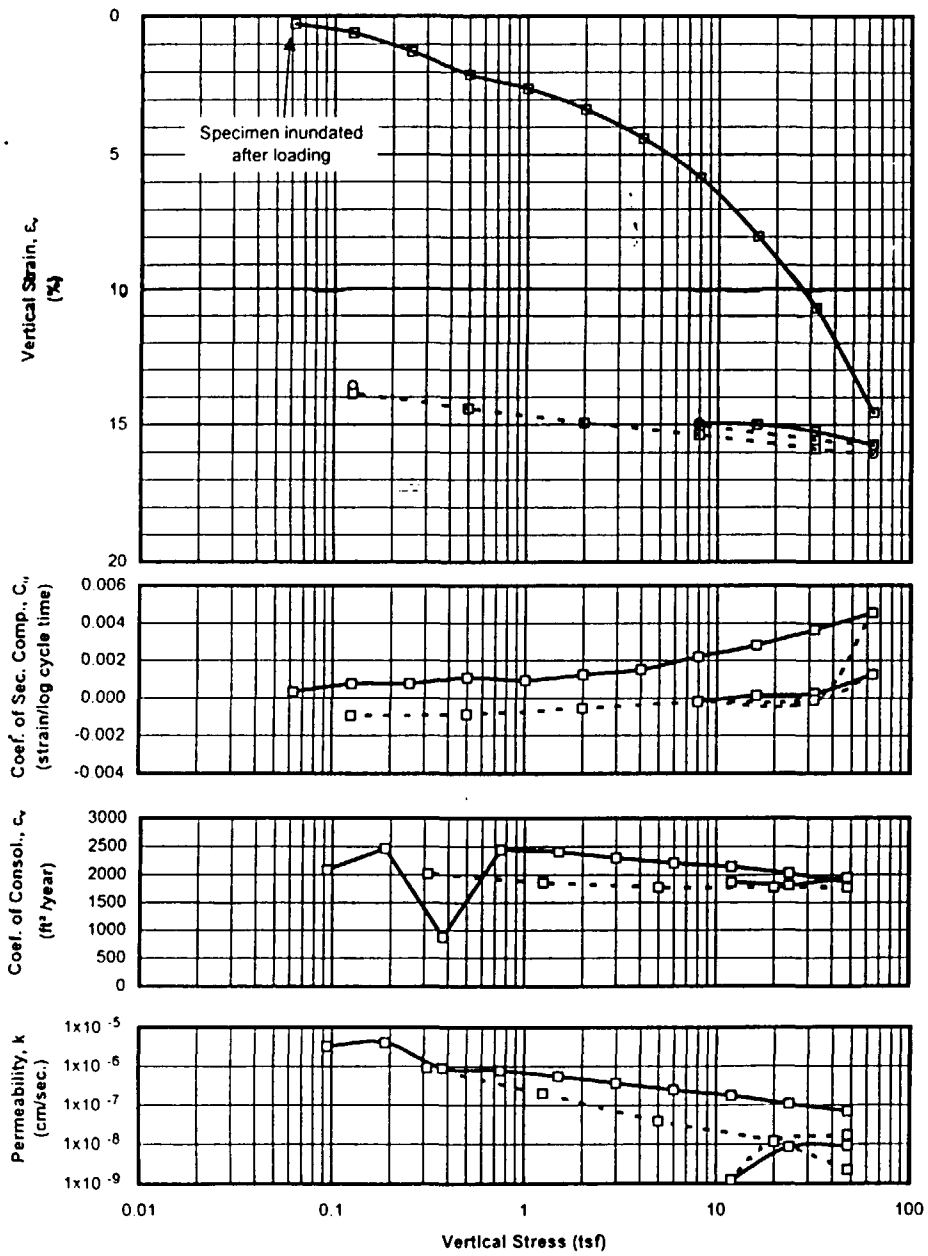
FAILURE SKETCH

Test Summary

q_u (tsf)	Strain to Peak (%)	Strain Rate (%/min)
0.95	3.96	0.73

Tested by: BB
Test Date: Nov-29-99
Reviewed by: 91

Project No. 23-99STL0022.01	SOLUTIA	UNCONFINED COMPRESSION TEST Boring: GB-2	
URS Greiner Woodward Clyde		Sample: A Depth:1.35	November 1999



SAMPLE INFORMATION

Boring:	GB-1
Sample:	Spec C
Depth:	7.55 feet
Elevation:	
Type:	3-inch thin wall tube
	ML, brown nonplastic SILT, trace f. sand

SPECIMEN INFORMATION

(NOTE: Initial and final states refer to beginning and end of test)

Initial height:	0.61	inch
Diameter:	2.50	inch

Initial water content:	32.3	%
Initial total unit weight:	113.9	pcf
Initial dry unit weight:	86.1	pcf
Initial void ratio:	1.000	
Initial degree of saturation:	89	%
Final water content:	29.6	%
Final total unit weight:	122.9	pcf
Final dry unit weight:	94.8	pcf
Final void ratio:	0.818	
Final degree of saturation:	100	% (assumed specific gravity = 2.76)

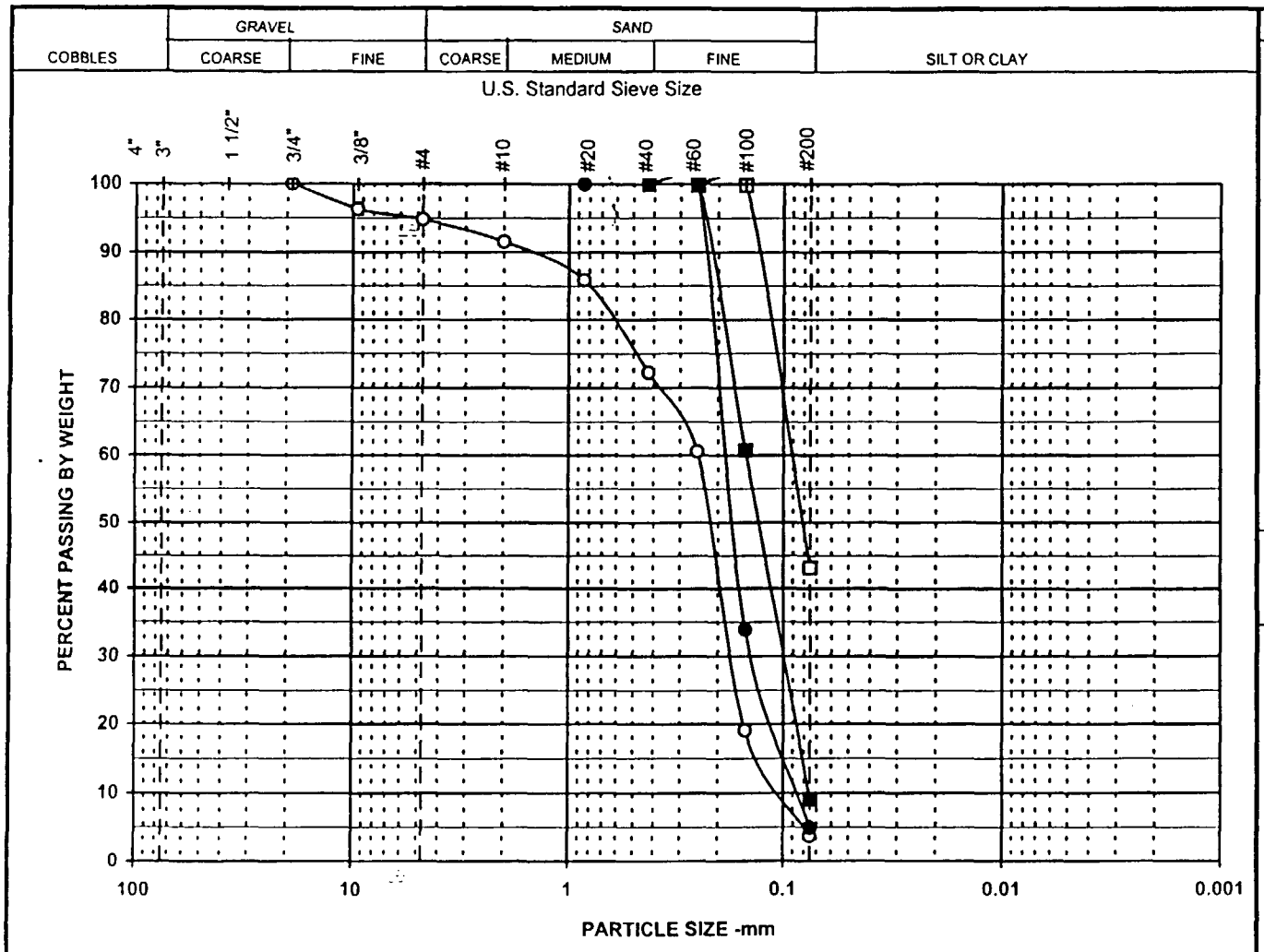
TEST SUMMARY

Construction Method:	Casagrande (Log)
Estimated preconsolidation stress (tsf):	12.8 (Range: 10.9 to 15.3)
Estimated in situ effective overburden stress (tsf):	
Compression Ratio (strain per log cycle stress):	0.128
Compression Index (void ratio per log cycle stress):	0.256
Swell Ratio (strain per log cycle stress):	0.008
Swell Index (void ratio per log cycle stress):	0.016
Recompression Ratio (strain per log cycle stress):	0.012
Recompression Index (void ratio per log cycle stress):	0.024
Remarks:	

LEGEND: □ End of primary ○ End of Stage ——— Loading - - - - - - - Unloading

Test Date: 11/17/99 Tested By: GET Checked By: SJ

	Solutia	ONE DIMENSIONAL CONSOLIDATION TEST Boring GB-1 Depth 7.55 feet
URS Greiner Woodward Clyde	Project No. 23-99STL0022	November 1999 Fig.



SYMBOL	DESCRIPTION AND REMARKS
□	dark brown silty f. SAND.
■	brown f. SAND, trace silt.
○	dark brown m-f SAND, trace gravel, c. sand, silt.
●	brown f. SAND, trace silt.

Symbol	□	■	○	●
Boring	GB-1	GB-2	GB-2	GB-3
Sample				
Spec				
Depth	14-15.5	9-10.5	29-30.5	19-20.5
% +3"				
% Gravel			5.2	
% SAND	56.8	90.9	91.1	95.2
% FINES	43.2	9.1	3.7	4.8
% -2μ				
Cc		1.0	1.2	1.2
Cu		2.0	2.3	2.1
LL				
PL				
PI				
USCS	SM	SP-SM	SP	SP
w (%)	36.6	25.5	22.1	26.9

Particle Size	PERCENT FINER			
(Sieve #)	□	■	○	●
4"				
3"				
1 1/2"				
3/4"			100.0	
3/8"			96.3	
4			94.8	
10			91.5	
20			85.9	100.0
40	100.0	100.0	72 2	99.9
60	99.9	99.8	60.6	99.7
100	99.8	60.7	19.1	33.9
200	43.2	9.1	3.7	4.8

PARTICLE SIZE DISTRIBUTION

Solutia

Project No.		Figure
23-99STL022	November 1999	

URS Greiner Woodward Clyde

Siev1.xls 11/30/1999

PROJECT:	Solutia				
PROJECT NO.:	23-99STL0022	Initial height:	0.613 inch	Final height:	0.554 inch
BORING:	GB-1	Initial water content:	32.3 %	Final water content:	29.6 %
SAMPLE:	Spec C	Initial dry density:	86.1 pcf	Final dry density:	94.8 pcf
TEST:	C99216	Initial total density:	113.9 pcf	Final total density:	122.9 pcf
DEPTH, feet:	7.55	Initial saturation:	89 %	Final saturation:	100 %
BY:	GET	Initial void ratio:	1.000	Final void ratio:	0.818
TEST DATE:	11/17/1999			Final strain:	9.8 %

EQUIPMENT:

Load Frame No.: 5

Ring Diameter: 2.5 inch

SPECIMEN DESCRIPTION: ML, brown nonplastic SILT, trace f. sand

G	LL	PL	PI
2.76		np	

Load No.	Load (tsf)	d_{100} (inch)	t_{100} Strain (%)	t_{100} Void Ratio (-)	Final Strain (%)	Final Void Ratio (-)	c_v (ft²/year)	C_α (strain/logt)	Constrained Modulus (tsf)	Permeability (cm/sec)
1	0.063	0.0017	0.277	0.995	0.345	0.994	89.22	0.0003	22.56	1.19E-07
2	0.125	0.0037	0.602	0.988	0.857	0.983	2086.38	0.0007	19.26	3.27E-06
3	0.250	0.0078	1.273	0.975	1.511	0.970	2467.32	0.0008	18.63	4.00E-06
4	0.500	0.0128	2.093	0.959	2.371	0.953	871.77	0.0011	30.47	8.63E-07
5	1.00	0.0160	2.610	0.948	2.905	0.942	2440.00	0.0009	96.78	7.61E-07
6	2.00	0.0206	3.359	0.933	3.832	0.924	2407.63	0.0012	133.40	5.44E-07
7	4.00	0.0271	4.410	0.912	4.911	0.902	2301.41	0.0015	190.31	3.65E-07
8	8.00	0.0360	5.862	0.883	6.533	0.870	2207.57	0.0022	275.50	2.42E-07
9	16.0	0.0490	7.994	0.841	9.213	0.816	2144.66	0.0028	375.26	1.72E-07
10	32.0	0.0657	10.708	0.786	11.603	0.768	2031.05	0.0036	589.49	1.04E-07
11	64.0	0.0893	14.564	0.709	15.759	0.685	1871.59	0.0046	829.93	6.80E-08
12	32.0	0.0955	15.562	0.689	15.531	0.690	1796.95	-0.0001	3208	1.69E-08
13	8.00	0.0922	15.023	0.700	14.940	0.702	1771.15	-0.0002	4455	1.20E-08
14	16.0	0.0920	15.005	0.700	15.050	0.699	1868.95	0.0001	45734	1.23E-09
15	32.0	0.0936	15.254	0.695	15.314	0.694	1809.76	0.0002	6429	8.49E-09
16	64.0	0.0966	15.751	0.685	16.073	0.679	1950.94	0.0013	6443	9.14E-09
17	32.0	0.0974	15.884	0.683	15.856	0.683	1778.30	-0.0001	24135	2.22E-09
18	8.00	0.0943	15.367	0.693	15.306	0.694	1775.23	-0.0002	4647	1.15E-08
19	2.00	0.0916	14.938	0.702	14.766	0.705	1778.33	-0.0006	1400	3.83E-08
20	0.500	0.0884	14.412	0.712	14.070	0.719	1855.80	-0.0009	285.14	1.96E-07
21	0.125	0.0850	13.863	0.723	13.580	0.729	2015.63	-0.0009	68.20	8.92E-07

APPENDIX B

FOUNDATION EVALUATION

Containment Cell Capacity

URS Greiner Woodward Clyde

Job Solutia - Sauget
Description Approximate Volume of Containment Cell

Project No. C10003899
Computed by Bill Weber
Checked by GRW

Page 1 of 3
Sheet ___ of ___
Date 6/27/2000
Date 27 June 00
Reference

Problem: Calculate the approximate volume of containment cell.

Given: Plan drawings

Volume of Prismatoid = $\frac{1}{6}h(B_1 + 4M + B_2)$

Volume of Pyramid = $\frac{1}{3}bh$

Assumptions: As stated in calculations

Conclusion: THE APPROXIMATE VOLUME OF THE CONTAINMENT CELL = ~~514,000~~ 51,400 yd^3

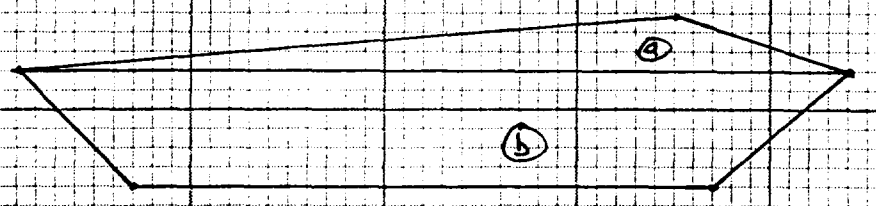
URS Greiner Woodward Clyde

Job Solutia - Sauget
Description Approximate Volume of Containment Cell

Project No. C10000 3899.00
Computed by Bill Weber
Checked by GMW

Page 2 of 3
Sheet ___ of ___
Date 6/27/2000
Date 27 June 00
Reference

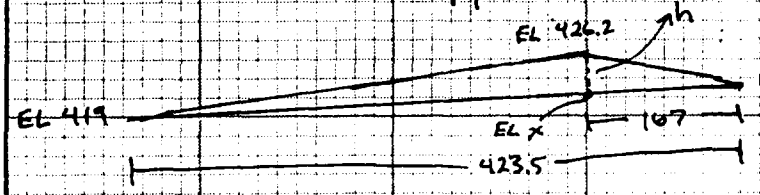
Calculations:



Assume Volume of (a) is estimated by a pyramid, and Volume of (b) is estimated by a prismatoid.

(a) From AutoCAD the base area of the pyramid is 131697 ft^2

Find h of pyramid



Slope of base = $\frac{6.8}{500}$ = 1.3%

167 (1.3%) = 2.3

∴ EL x = 425.8 − 2.3
= 423.5

h = 426.2 − 423.5 = 2.7 ft

$V = \frac{1}{3}bh = \frac{1}{3}(131697\,ft^2)(2.7\,ft)$
$= \boxed{118527.3\,ft^3}$

URS Greiner Woodward Clyde

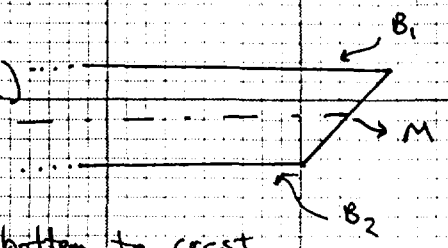
Job Solutia Sauget | Project No. C10000 3899.00 | Sheet ___ of ___

Description Approximate Volume of Containment Cell | Computed by Bill Weber | Date 6/27/2000

Checked by GMW | Date 27 Jun 00

Reference

(b) $\forall$ of prismatoid $= \frac{1}{6} h (B_1 + 4M + B_2)$



From AutoCAD.

$B_1 = \underline{131697\ ft^2}$ ✓

h from bottom to crest $= \underline{12\ ft}$

$M = \underline{105418.9\ ft^2}$ ✓

$B_2 = \underline{81797.2\ ft^2}$ ✓

$\forall = \frac{1}{6} 12\ ft (131697\ ft^2 + 4(105418.9\ ft^2) + 81797.2\ ft^2)$

$= \boxed{1270339.6\ ft^3}$ ✓

Total Volume $= \forall_{(a)} + \forall_{(b)}$

$= 118527.3 + 1270339.6 = 1388866.9\ ft^3$ ✓

$= 51439\ yd^3$

$= \boxed{51400\ yd^3}$ ✓

Bearing Capacity

URS Greiner Woodward Clyde

Job: Solutia Sauget
Description: Bearing Capacity
Project No. CI0000 3899.00
Computed by: M. Brungard
Checked by: Bill Weber
Page ___ of ___
Sheet 1 of 1
Date: 5/3/00
Date: 5/25/2000
Reference

Purpose: Estimate the allowable and ultimate bearing capacity of the subgrade soils at the landfill site.

Equation: $q_{ult} = cN_c + \gamma D_f N_q + \frac{1}{2}\gamma B N_\gamma$

where: c = undrained shear strength
N_c, N_q, N_γ = Bearing Capacity Factors
γ = soil unit weight
D_f = Depth of overburden or footing
B = Width of footing.

Assumptions: Undrained Shear strengths from Lab testing were 480 to 950 psf

Use $\phi = 0°$ for analysis and use $D_f = 0'$

Calculations: $q_{ult} = cN_c + \cancel{\gamma D_f N_q}^{\,0} + \cancel{\frac{1}{2}\gamma B N_\gamma}^{\,0}$

for $\phi = 0°$, $\rightarrow N_c = 5.14$

$q_{ult} = 480\text{ psf}(5.14) = \boxed{2467\text{ psf}}$ Limiting Conditions

$q_{allowable} = \frac{q_{ult}}{2.5} = \frac{822}{1000}\text{ psf}$

*The factor of Safety may be reduced since adequate strength info was available

Check underlying sand Bearing Capacity:

Based on Blow counts, a ϕ of 30° is the minimum expected strength in the sands

$D_f = 10' \pm$ = clay & silt layer thickness, $c = 0$ psf

Assume $\gamma_{(clay\&silt)} \approx 100$ pcf, $\gamma_{(sand)} \approx 120$ pcf (saturated)

$N_c = 30.13$ $N_q = 18.4$ $N_\gamma = 15.7$ for $\phi = 30°$

$q_{ult} = \cancel{cN_c}^{\,0} + \gamma_{clay\&silt} D_f N_q + \frac{1}{2}\gamma_s B N_\gamma$ Assume $B = 2'$

$= 100\text{pcf}(10')18.4 + \frac{1}{2}(120-62\text{pcf})2'(15.7)$

$= 18{,}400\text{ psf} + 910\text{ psf} = 19{,}310\text{ psf} \gg \boxed{2467\text{ psf}}$

*Surficial silt & clay is the limiting horizon.

Settlement Potential

URS Greiner Woodward Clyde

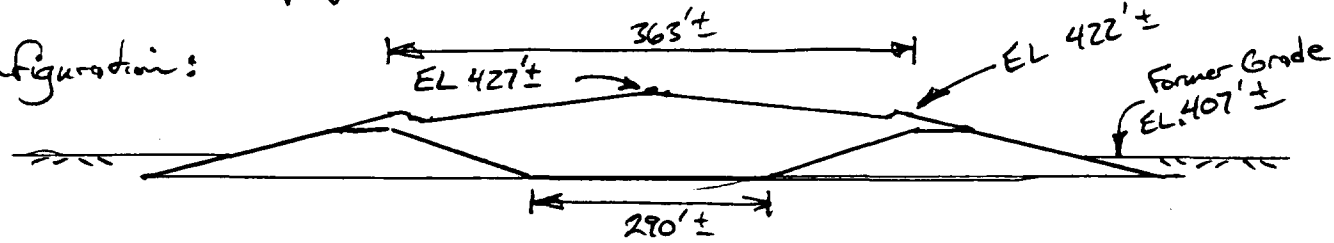
Job: Solutia Sauget
Description: Settlement Potential

Project No. C10003899.00
Computed by: M. Brungard
Checked by: Bill Weber

Page ___ of ___
Sheet 1 of 4
Date 5/4/00
Date 5/25/2000
Reference

Purpose: Document conditions used to predict the settlement potential of the proposed containment cell due to self weight.

Configuration:

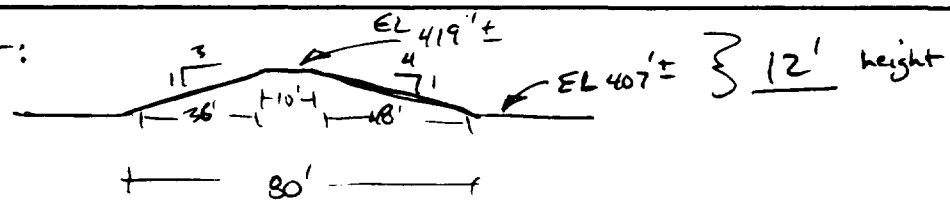


Assumptions:
$\gamma_{soil} = \gamma_{waste} = 115$ pcf (moist)
Average Fill Elevation $= \frac{422+427}{2} = 424.5'$
Original Ground Elevation $= 407'$
Average Fill Height $= 424.5' - 407' = 17.5'$
Depth to bedrock $= 120'$ below EL. 407'
3 borings used to estimate the avg. SPT blow counts
Effective footprint of cell is about 400' x 400'
G.W. table at EL 397' (10' depth)

Entire Cell:
Calculations: Applied Surface pressure $= 17.5' \times 115$ pcf $= 2012$ psf

Total Settlement $\approx$ 26" ± by computerized Schmertmann analysis

Berm Settlement:



Berm Calculations:
Assume effective width of berm is 52
Applied Surface Pressure $= 12' \times 115$ pcf $= 1380$ psf say 1400

Total Settlement = 2.5" ± by computerized Schmertmann analysis

URS Greiner Woodward Clyde

Job Solutia Sauget
Description Settlement Potential

Project No. C100003899.00
Computed by M. Bringard
Checked by Bill Weber

Page ___ of ___
Sheet 2 of 4
Date 5/4/00
Date 5/25/2000
Reference

Lining System Settlement:

The settlement calculated for the entire cell is at the center of the cell. The settlement for an edge of a square is 2/3 the settlement at the center. This is taken from Shape factors for loads on an elastic half-space. These conditions should be applicable to the foundation conditions at the site.

Center Settlement : 2.6" ±
Edge Settlement : 2/3 (2.6") = 1.7" ±

Differential Settlement = 2.6" − 1.7" = 0.9"
in Bottom Lining

say 1"

Settlement due to entire cell footprint

DATE: 5/11/2000
TIME: 17:22: 7

MB

FILE NAME: boringc.txt
DESCRIPTION: Solutia Sauget Boring Corrected Average

FOOTING PROPERTIES		GENERAL INFORMATION	
Width	400.00 FT	Groundwater Depth	10.00 FT
Length	400.00 FT	Qc/N Ratio	4.00
Depth	0.00 FT		
Total Pressure	2000.00 PSF		

SUBSURFACE INFORMATION AND LAYER SETTLEMENTS BY SCHMERTMANN'S METHOD

LAYER BOTTOM DEPTH (FT)	DUTCH CONE Qc (TSF)	USCS	UNDRAIN STRNGTH Su (PSF)	UNIT WEIGHT (PCF)	COMP. SLOPE C	RECOMP. SLOPE Cr	CONS. RATIO OCR	SETTLE-MENT (IN)
5.00	44			119.50				0.08
10.00	36			118.50				0.10
15.00	32			55.60				0.13
20.00	52			58.23				0.09
25.00	76			61.98				0.06
30.00	76			61.98				0.07
35.00	104			64.10				0.05
40.00	48			57.60				0.12
45.00	40			56.60				0.16
50.00	80			62.60				0.08
55.00	224			70.40				0.03
65.00	96			63.60				0.16
75.00	72			61.35				0.23
120.00	72			61.35				1.26

Total Settlement 2.61

Berm Settlement

DATE: 5/12/2000
TIME: 13: 2:51

MB

FILE NAME: boringc.txt
DESCRIPTION: Solutia Sauget Boring Corrected Average

FOOTING PROPERTIES		GENERAL INFORMATION	
Width	52.00 FT	Groundwater Depth	10.00 FT
Length	300.00 FT	Qc/N Ratio	4.00
Depth	0.00 FT		
Total Pressure	1400.00 PSF		

SUBSURFACE INFORMATION AND LAYER SETTLEMENTS BY SCHMERTMANN'S METHOD

LAYER BOTTOM DEPTH (FT)	DUTCH CONE Qc (TSF)	USCS	UNDRAIN STRNGTH Su (PSF)	UNIT WEIGHT (PCF)	COMP. SLOPE C	RECOMP. SLOPE Cr	CONS. RATIO OCR	SETTLE-MENT (IN)
5.00	44			119.50				0.08
10.00	36			118.50				0.12
15.00	32			55.60				0.16
20.00	52			58.23				0.12
25.00	76			61.98				0.09
30.00	76			61.98				0.11
35.00	104			64.10				0.09
40.00	48			57.60				0.21
45.00	40			56.60				0.26
50.00	80			62.60				0.12
55.00	224			70.40				0.04
65.00	96			63.60				0.18
75.00	72			61.35				0.22
120.00	72			61.35				0.68

Total Settlement 2.49

Slope Stability

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	05-04-00
Time of Run:	2:09pm
Run By:	Martin Brungard
Input Data Filename:	C:SAUGET.IN
Output Filename:	C:SAUGET.OUT
Plotted Output Filename:	C:SAUGET.PLT

PROBLEM DESCRIPTION Solutia Sauget Landfill
-Exterior Slope Seismic Condition

BOUNDARY COORDINATES

3 Top Boundaries
5 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	40.00	30.00	40.00	3
2	30.00	40.00	110.00	60.00	1
3	110.00	60.00	150.00	60.00	1
4	30.00	40.00	150.00	40.00	3
5	0.00	30.00	150.00	30.00	2

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	1000.0	0.0	0.00	0.0	0
2	120.0	120.0	0.0	30.0	0.00	0.0	1
3	120.0	120.0	480.0	0.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	30.00
2	150.00	30.00

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (lb/sqft)	Deflection (deg)
1	110.00	150.00	200.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

A Horizontal Earthquake Loading Coefficient
Of0.100 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of0.000 Has Been Assigned

Cavitation Pressure = 0.0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

800 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 40 Points Equally Spaced Along The Ground Surface Between X = 20.00 ft.
and X = 30.00 ft.

Each Surface Terminates Between X = 120.00 ft.
and X = 150.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	29.23	40.00
2	33.73	37.82
3	38.35	35.90
4	43.07	34.25
5	47.88	32.88
6	52.75	31.78
7	57.69	30.96
8	62.66	30.42
9	67.65	30.17
10	72.65	30.20
11	77.64	30.53
12	82.60	31.13
13	87.52	32.02
14	92.39	33.19
15	97.17	34.63
16	101.87	36.35
17	106.46	38.33
18	110.93	40.57
19	115.26	43.07
20	119.45	45.80
21	123.47	48.77
22	127.31	51.97
23	130.97	55.38
24	134.42	59.00
25	135.27	60.00

Circle Center At X = 69.5 ; Y = 117.5 and Radius, 87.4

*** 1.354 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.10	40.00
2	28.73	38.11
3	33.43	36.41
4	38.21	34.91
5	43.04	33.63
6	47.92	32.54
7	52.84	31.67
8	57.80	31.00
9	62.78	30.55
10	67.77	30.31
11	72.77	30.29
12	77.77	30.47
13	82.75	30.87
14	87.71	31.48
15	92.65	32.30
16	97.54	33.33
17	102.38	34.57
18	107.17	36.01
19	111.89	37.66
20	116.54	39.50
21	121.10	41.55
22	125.58	43.78
23	129.95	46.20
24	134.22	48.81
25	138.37	51.59
26	142.40	54.55
27	146.30	57.68
28	148.95	60.00

Circle Center At X = 70.9 ; Y = 147.7 and Radius, 117.4

*** 1.356 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.85	40.00
2	28.48	38.12
3	33.19	36.43
4	37.96	34.95
5	42.79	33.66

6	47.67	32.58
7	52.60	31.70
8	57.55	31.03
9	62.53	30.57
10	67.52	30.32
11	72.52	30.28
12	77.52	30.44
13	82.51	30.81
14	87.47	31.40
15	92.41	32.19
16	97.31	33.18
17	102.16	34.38
18	106.96	35.79
19	111.70	37.39
20	116.37	39.19
21	120.95	41.18
22	125.45	43.36
23	129.85	45.73
24	134.15	48.28
25	138.34	51.01
26	142.41	53.91
27	146.36	56.98
28	149.93	60.00

Circle Center At X = 71.1 ; Y = 149.7 and Radius, 119.4

*** 1.357 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	27.95	40.00
2	32.52	37.97
3	37.18	36.17
4	41.93	34.61
5	46.76	33.29
6	51.64	32.22
7	56.57	31.39
8	61.54	30.82
9	66.53	30.50
10	71.53	30.43
11	76.52	30.61
12	81.51	31.04
13	86.46	31.73
14	91.37	32.67
15	96.23	33.85
16	101.02	35.27
17	105.74	36.94
18	110.36	38.84
19	114.88	40.98
20	119.29	43.33
21	123.57	45.91

22	127.72	48.71
23	131.72	51.70
24	135.57	54.90
25	139.25	58.29
26	140.93	60.00

Circle Center At X = 70.4 ; Y = 129.4 and Radius, 98.9

*** 1.358 ***

Failure Surface Specified By 29 Coordinate Points

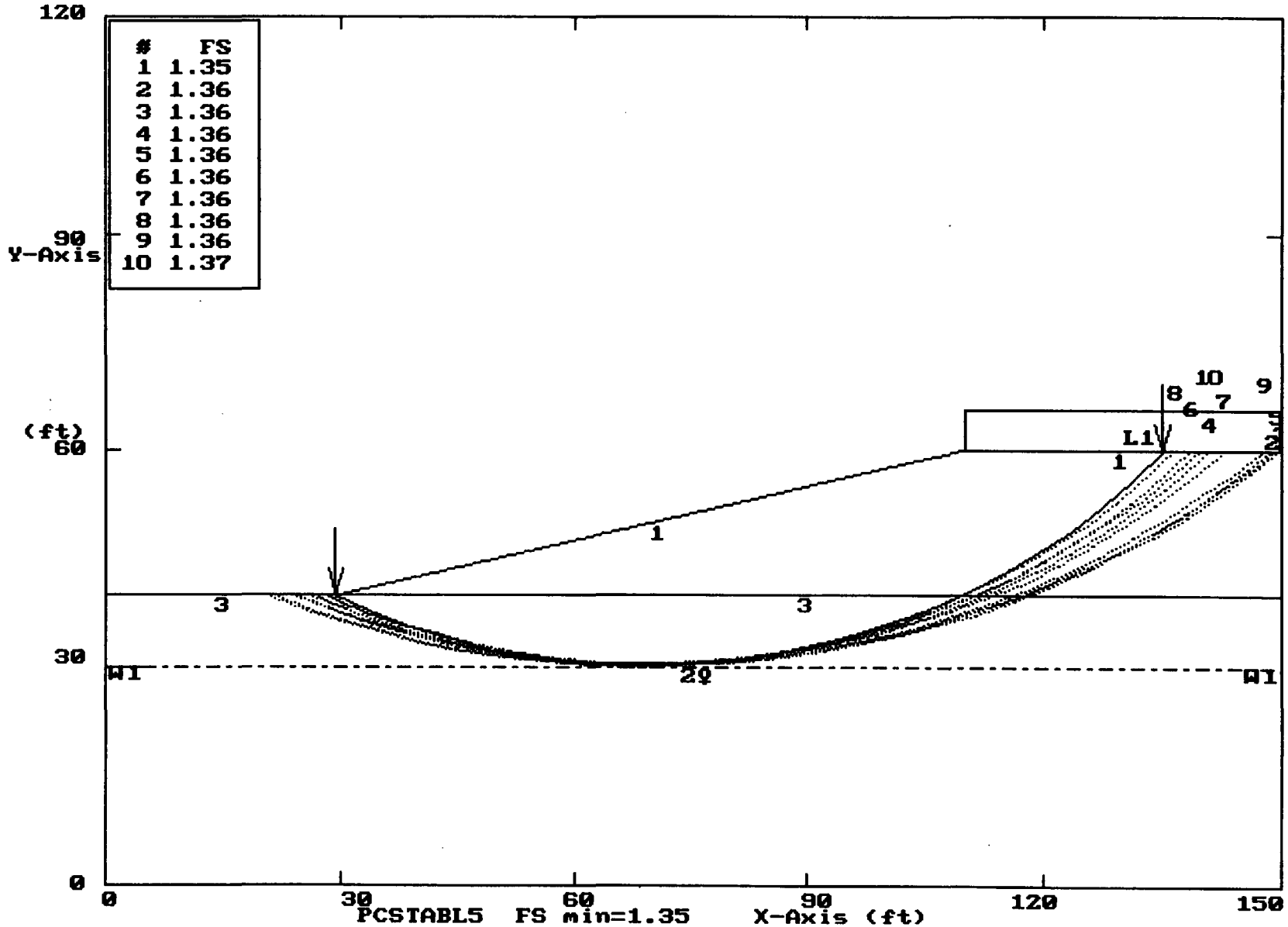
Point No.	X-Surf (ft)	Y-Surf (ft)
1	20.51	40.00
2	25.15	38.12
3	29.85	36.43
4	34.62	34.93
5	39.45	33.63
6	44.33	32.53
7	49.25	31.62
8	54.20	30.92
9	59.17	30.42
10	64.16	30.12
11	69.16	30.02
12	74.16	30.13
13	79.15	30.44
14	84.12	30.95
15	89.07	31.67
16	93.99	32.58
17	98.86	33.70
18	103.69	35.01
19	108.45	36.52
20	113.16	38.21
21	117.79	40.10
22	122.33	42.18
23	126.80	44.44
24	131.16	46.88
25	135.42	49.49
26	139.57	52.28
27	143.61	55.23
28	147.52	58.34
29	149.44	60.00

Circle Center At X = 69.0 ; Y = 153.0 and Radius, 122.9

*** 1.359 ***

Failure Surface Specified By 26 Coordinate Points

Solutia Sauget Landfill Exterior Slope Seismic Condition
Ten Most Critical. C:SAUGET.PLT By: Martin Brungard 5-04-00 :09pm



PCSTABL5 FS min=1.35

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	05-04-00
Time of Run:	2:06pm
Run By:	Martin Brungard
Input Data Filename:	C:SAUGET5.IN
Output Filename:	C:SAUGET5.OUT
Plotted Output Filename:	C:SAUGET5.PLT

PROBLEM DESCRIPTION Solutia Sauget Landfill
-Exterior Slope Static Condition

BOUNDARY COORDINATES

3 Top Boundaries
5 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	40.00	30.00	40.00	3
2	30.00	40.00	110.00	60.00	1
3	110.00	60.00	150.00	60.00	1
4	30.00	40.00	150.00	40.00	3
5	0.00	30.00	150.00	30.00	2

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	1000.0	0.0	0.00	0.0	0
2	120.0	120.0	0.0	30.0	0.00	0.0	1
3	120.0	120.0	480.0	0.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	30.00
2	150.00	30.00

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (lb/sqft)	Deflection (deg)
1	110.00	150.00	200.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

800 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 40 Points Equally Spaced Along The Ground Surface Between X = 20.00 ft.
and X = 30.00 ft.

Each Surface Terminates Between X = 120.00 ft.
and X = 150.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	29.23	40.00
2	33.73	37.82
3	38.35	35.90
4	43.07	34.25
5	47.88	32.88
6	52.75	31.78
7	57.69	30.96
8	62.66	30.42
9	67.65	30.17
10	72.65	30.20
11	77.64	30.53
12	82.60	31.13
13	87.52	32.02
14	92.39	33.19
15	97.17	34.63
16	101.87	36.35
17	106.46	38.33
18	110.93	40.57
19	115.26	43.07
20	119.45	45.80
21	123.47	48.77
22	127.31	51.97
23	130.97	55.38
24	134.42	59.00
25	135.27	60.00

Circle Center At X = 69.5 ; Y = 117.5 and Radius, 87.4

*** 1.943 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	26.67	40.00
2	31.20	37.88
3	35.83	36.01
4	40.56	34.38
5	45.37	33.02
6	50.25	31.91
7	55.18	31.07
8	60.14	30.50
9	65.13	30.19
10	70.13	30.16
11	75.13	30.39
12	80.10	30.89
13	85.04	31.65
14	89.94	32.68
15	94.77	33.97
16	99.52	35.52
17	104.18	37.33
18	108.74	39.38
19	113.19	41.67
20	117.50	44.20
21	121.67	46.96
22	125.69	49.94
23	129.54	53.13
24	133.21	56.52
25	136.60	60.00

Circle Center At X = 68.3 ; Y = 123.1 and Radius, 93.0

*** 1.956 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.21	40.00
2	32.75	37.92
3	37.41	36.09
4	42.15	34.50
5	46.97	33.17
6	51.85	32.09
7	56.78	31.27
8	61.75	30.71
9	66.74	30.41
10	71.74	30.37
11	76.73	30.60
12	81.71	31.09
13	86.65	31.85
14	91.55	32.86
15	96.39	34.12
16	101.15	35.64
17	105.83	37.41
18	110.40	39.42

19	114.87	41.68
20	119.21	44.16
21	123.41	46.87
22	127.47	49.79
23	131.36	52.92
24	135.09	56.26
25	138.63	59.79
26	138.83	60.00

Circle Center At X = 69.9 ; Y = 125.3 and Radius, 95.0

*** 1.966 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	27.95	40.00
2	32.52	37.97
3	37.18	36.17
4	41.93	34.61
5	46.76	33.29
6	51.64	32.22
7	56.57	31.39
8	61.54	30.82
9	66.53	30.50
10	71.53	30.43
11	76.52	30.61
12	81.51	31.04
13	86.46	31.73
14	91.37	32.67
15	96.23	33.85
16	101.02	35.27
17	105.74	36.94
18	110.36	38.84
19	114.88	40.98
20	119.29	43.33
21	123.57	45.91
22	127.72	48.71
23	131.72	51.70
24	135.57	54.90
25	139.25	58.29
26	140.93	60.00

Circle Center At X = 70.4 ; Y = 129.4 and Radius, 98.9

*** 1.976 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.36	40.00
2	28.94	37.98
3	33.60	36.19
4	38.35	34.63
5	43.18	33.31
6	48.06	32.22
7	52.98	31.37
8	57.95	30.76
9	62.93	30.40
10	67.93	30.28
11	72.93	30.40
12	77.92	30.77
13	82.88	31.38
14	87.81	32.23
15	92.68	33.32
16	97.51	34.65
17	102.26	36.21
18	106.92	38.00
19	111.50	40.02
20	115.97	42.26
21	120.33	44.71
22	124.56	47.37
23	128.65	50.24
24	132.60	53.30
25	136.40	56.56
26	140.04	59.99
27	140.04	60.00

Circle Center At X = 67.9 ; Y = 132.7 and Radius, 102.4

*** 1.987 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	25.90	40.00
2	30.49	38.01
3	35.16	36.25
4	39.92	34.71
5	44.75	33.40
6	49.63	32.32
7	54.56	31.47
8	59.52	30.86
9	64.50	30.48
10	69.50	30.35
11	74.50	30.45
12	79.49	30.79

13	84.46	31.37
14	89.39	32.18
15	94.28	33.23
16	99.11	34.51
17	103.88	36.01
18	108.57	37.75
19	113.17	39.70
20	117.68	41.87
21	122.07	44.26
22	126.35	46.85
23	130.50	49.64
24	134.51	52.62
25	138.37	55.80
26	142.08	59.15
27	142.94	60.00

Circle Center At X = 69.9 ; Y = 135.3 and Radius, 104.9

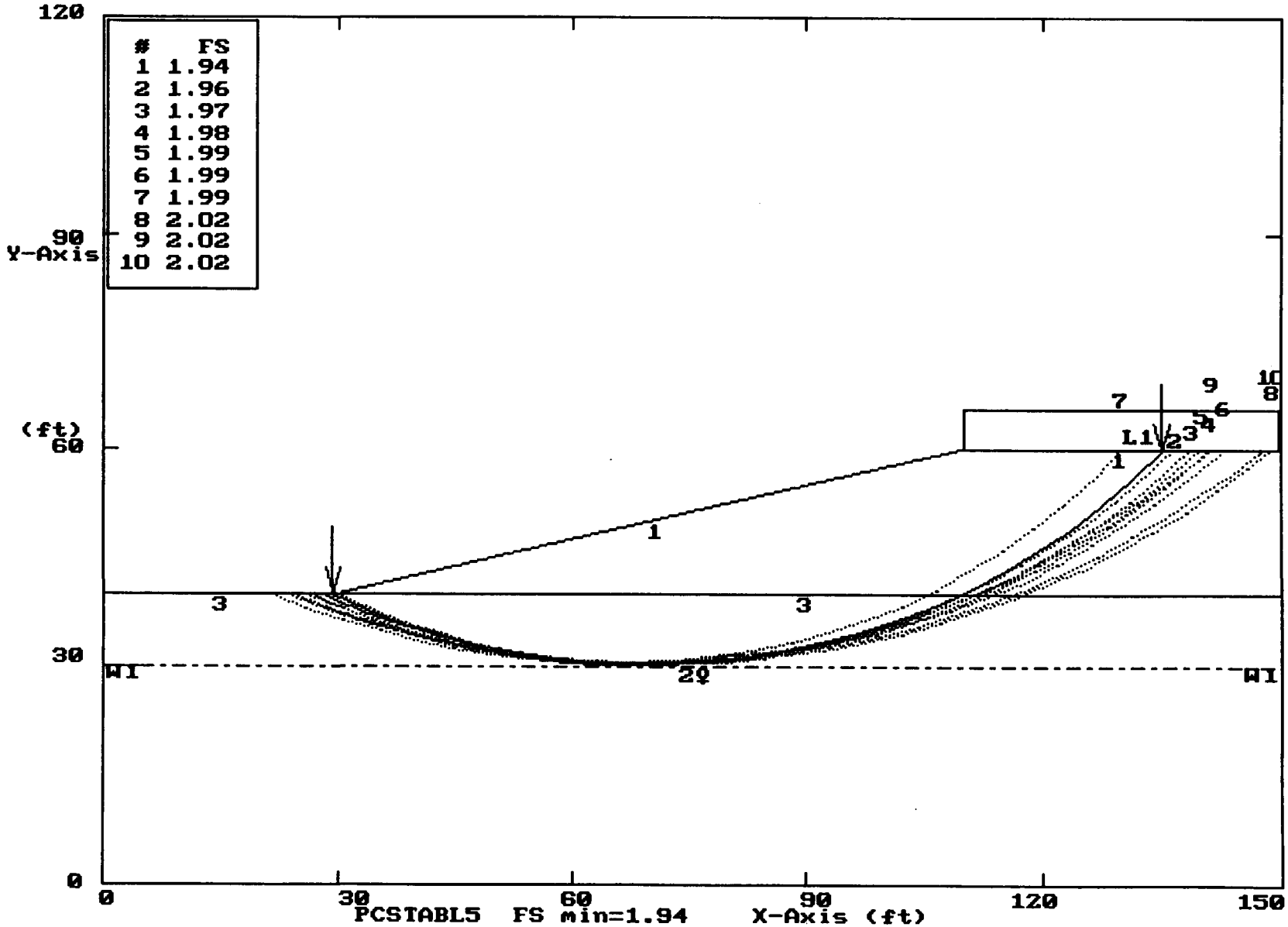
*** 1.988 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	30.00	40.00
2	34.49	37.79
3	39.10	35.87
4	43.83	34.24
5	48.65	32.90
6	53.54	31.87
7	58.49	31.14
8	63.47	30.73
9	68.47	30.62
10	73.46	30.83
11	78.44	31.34
12	83.37	32.17
13	88.24	33.30
14	93.03	34.73
15	97.72	36.46
16	102.29	38.48
17	106.73	40.78
18	111.02	43.35
19	115.14	46.18
20	119.08	49.26
21	122.82	52.59
22	126.34	56.14
23	129.63	59.90
24	129.71	60.00

Circle Center At X = 67.7 ; Y = 110.8 and Radius, 80.2

Solutia Sauget Landfill Exterior Slope Static Condition
Ten Most Critical. C:SAUGET5.PLT By: Martin Brungard 5-04-00 :06pm



--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	05-05-00
Time of Run:	3:28pm
Run By:	Martin Brungard
Input Data Filename:	C:SAUGET4.IN
Output Filename:	C:SAUGET4.OUT
Plotted Output Filename:	C:SAUGET4.PLT

PROBLEM DESCRIPTION Solutia Sauget
-2' cover thickness, 12% slope, seismic

BOUNDARY COORDINATES

1 Top Boundaries
3 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	35.00	180.00	56.60	1
2	10.00	34.20	180.00	54.60	2
3	10.00	34.00	180.00	54.40	1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	120.0	300.0	0.0	0.00	0.0	0
2	110.0	120.0	0.0	11.0	0.00	0.0	0

A Horizontal Earthquake Loading Coefficient
Of0.100 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of0.000 Has Been Assigned

Cavitation Pressure = 0.0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

25 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 1.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	4.00	33.40	12.00	34.34	0.20
2	170.00	53.30	178.00	54.30	0.20

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.22	35.15
2	1.50	34.95
3	2.48	34.74
4	3.21	34.06
5	4.05	33.50
6	176.68	54.18
7	177.25	55.00
8	177.93	55.73
9	178.17	56.38

*** 1.194 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.44	36.01
2	9.26	35.86
3	10.21	35.54
4	11.11	35.11
5	11.83	34.42
6	176.58	54.18
7	177.29	54.89
8	177.80	55.75
9	178.39	56.41

*** 1.203 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.52	35.66
2	5.90	35.32
3	6.79	34.88
4	7.77	34.65
5	8.65	34.18
6	9.63	34.00
7	172.21	53.53
8	172.69	54.40
9	173.40	55.11
10	173.97	55.88

*** 1.213 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.61	35.67
2	6.29	35.13
3	7.18	34.67
4	8.16	34.44
5	9.02	33.94

6	170.22	53.35
7	170.89	54.10
8	171.46	54.92
9	172.07	55.65

*** 1.218 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.84	35.58
2	4.92	35.55
3	5.90	35.36
4	6.61	34.65
5	7.57	34.38
6	8.44	33.89
7	173.61	53.66
8	174.30	54.38
9	174.98	55.11
10	175.54	55.94
11	175.59	56.07

*** 1.236 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.46	36.02
2	8.56	35.97
3	9.39	35.42
4	10.26	34.92
5	11.03	34.28
6	176.04	54.07
7	176.32	55.03
8	176.73	55.95
9	176.89	56.23

*** 1.242 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	7.29	35.87
2	7.38	35.80
3	8.38	35.78
4	9.14	35.13
5	10.09	34.82
6	10.86	34.18
7	172.95	53.62
8	173.27	54.57
9	173.71	55.47
10	173.88	55.87

*** 1.251 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.88	35.71
2	6.59	35.34
3	7.42	34.79
4	8.14	34.10
5	9.14	34.02
6	170.57	53.42
7	170.98	54.34
8	171.33	55.28
9	171.62	55.59

*** 1.276 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.54	35.43
2	4.13	34.85
3	4.85	34.14
4	5.62	33.51
5	176.57	54.08
6	177.27	54.79
7	177.95	55.52
8	178.64	56.25
9	178.78	56.45

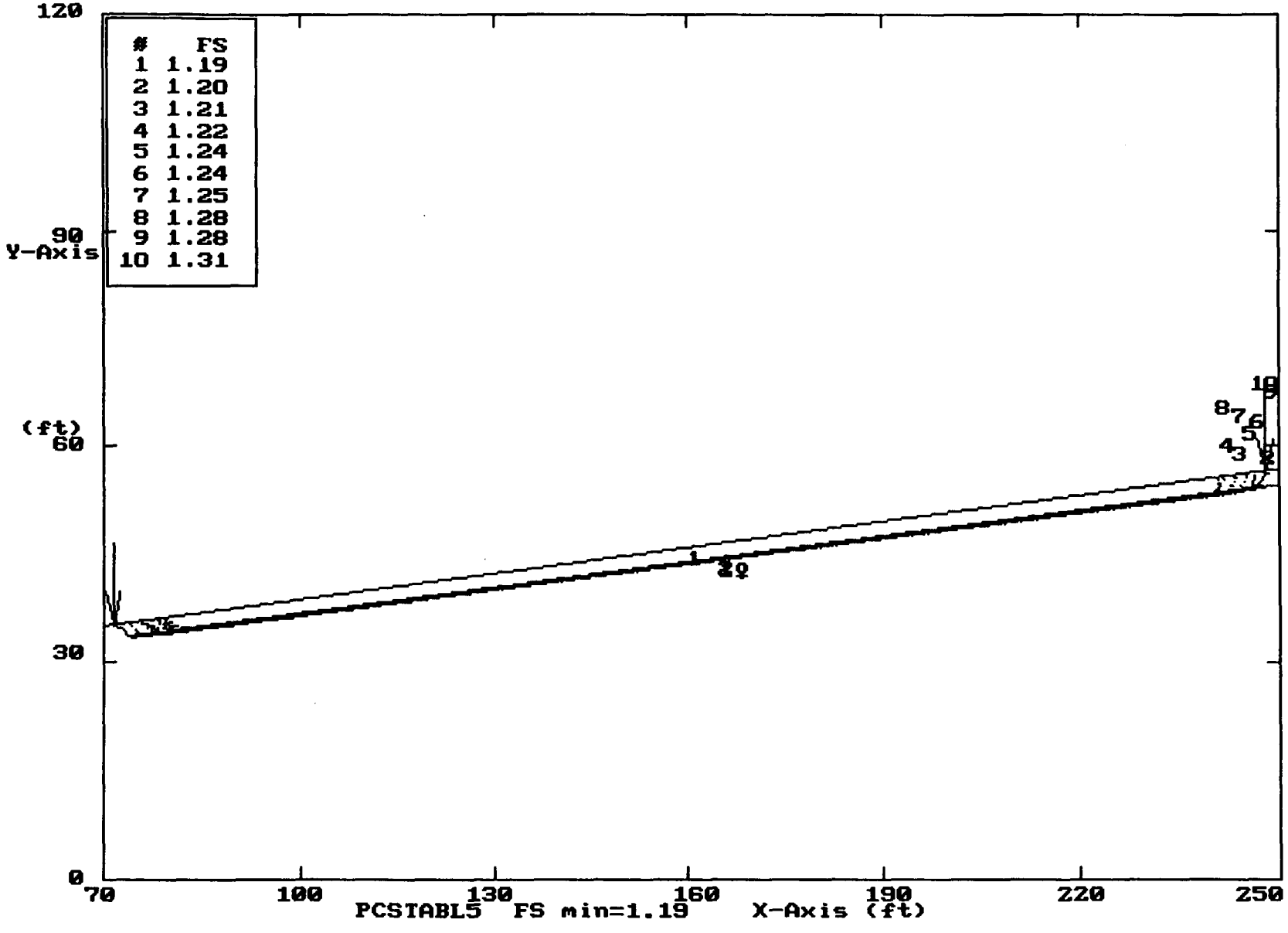
*** 1.278 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	7.66	35.92
2	8.35	35.24
3	9.23	34.76
4	10.22	34.62
5	11.16	34.28
6	176.03	54.00
7	176.34	54.95
8	176.56	55.93
9	176.75	56.21

*** 1.308 ***

Solutia Sauget 2' cover thickness, 12% slope, seismic
Ten Most Critical. C:SAUGET4.PLT By: Martin Brungard 5-05-00 :28pm



--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	05-04-00
Time of Run:	2:47pm
Run By:	Martin Brungard
Input Data Filename:	C:SAUGET3.IN
Output Filename:	C:SAUGET3.OUT
Plotted Output Filename:	C:SAUGET3.PLT

PROBLEM DESCRIPTION Solutia Sauget
-2' cover thickness, 12% slope, static

BOUNDARY COORDINATES

1 Top Boundaries
3 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	35.00	180.00	56.60	1
2	10.00	34.20	180.00	54.60	2
3	10.00	34.00	180.00	54.40	1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	120.0	300.0	0.0	0.00	0.0	0
2	110.0	120.0	0.0	11.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

25 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 1.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	4.00	33.40	12.00	34.34	0.20
2	170.00	53.30	178.00	54.30	0.20

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.22	35.15
2	1.50	34.95
3	2.48	34.74
4	3.21	34.06
5	4.05	33.50
6	176.68	54.18
7	177.25	55.00
8	177.93	55.73
9	178.17	56.38

*** 2.203 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.44	36.01

2	9.26	35.86
3	10.21	35.54
4	11.11	35.11
5	11.83	34.42
6	176.58	54.18
7	177.29	54.89
8	177.80	55.75
9	178.39	56.41

*** 2.220 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.52	35.66
2	5.90	35.32
3	6.79	34.88
4	7.77	34.65
5	8.65	34.18
6	9.63	34.00
7	172.21	53.53
8	172.69	54.40
9	173.40	55.11
10	173.97	55.88

*** 2.238 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.61	35.67
2	6.29	35.13
3	7.18	34.67
4	8.16	34.44
5	9.02	33.94
6	170.22	53.35
7	170.89	54.10
8	171.46	54.92
9	172.07	55.65

*** 2.246 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.84	35.58
2	4.92	35.55
3	5.90	35.36
4	6.61	34.65
5	7.57	34.38
6	8.44	33.89
7	173.61	53.66
8	174.30	54.38
9	174.98	55.11
10	175.54	55.94
11	175.59	56.07

*** 2.280 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.46	36.02
2	8.56	35.97
3	9.39	35.42
4	10.26	34.92
5	11.03	34.28
6	176.04	54.07
7	176.32	55.03
8	176.73	55.95
9	176.89	56.23

*** 2.291 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	7.29	35.87
2	7.38	35.80
3	8.38	35.78
4	9.14	35.13
5	10.09	34.82
6	10.86	34.18

7	172.95	53.62
8	173.27	54.57
9	173.71	55.47
10	173.88	55.87

*** 2.307 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.88	35.71
2	6.59	35.34
3	7.42	34.79
4	8.14	34.10
5	9.14	34.02
6	170.57	53.42
7	170.98	54.34
8	171.33	55.28
9	171.62	55.59

*** 2.352 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.54	35.43
2	4.13	34.85
3	4.85	34.14
4	5.62	33.51
5	176.57	54.08
6	177.27	54.79
7	177.95	55.52
8	178.64	56.25
9	178.78	56.45

*** 2.355 ***

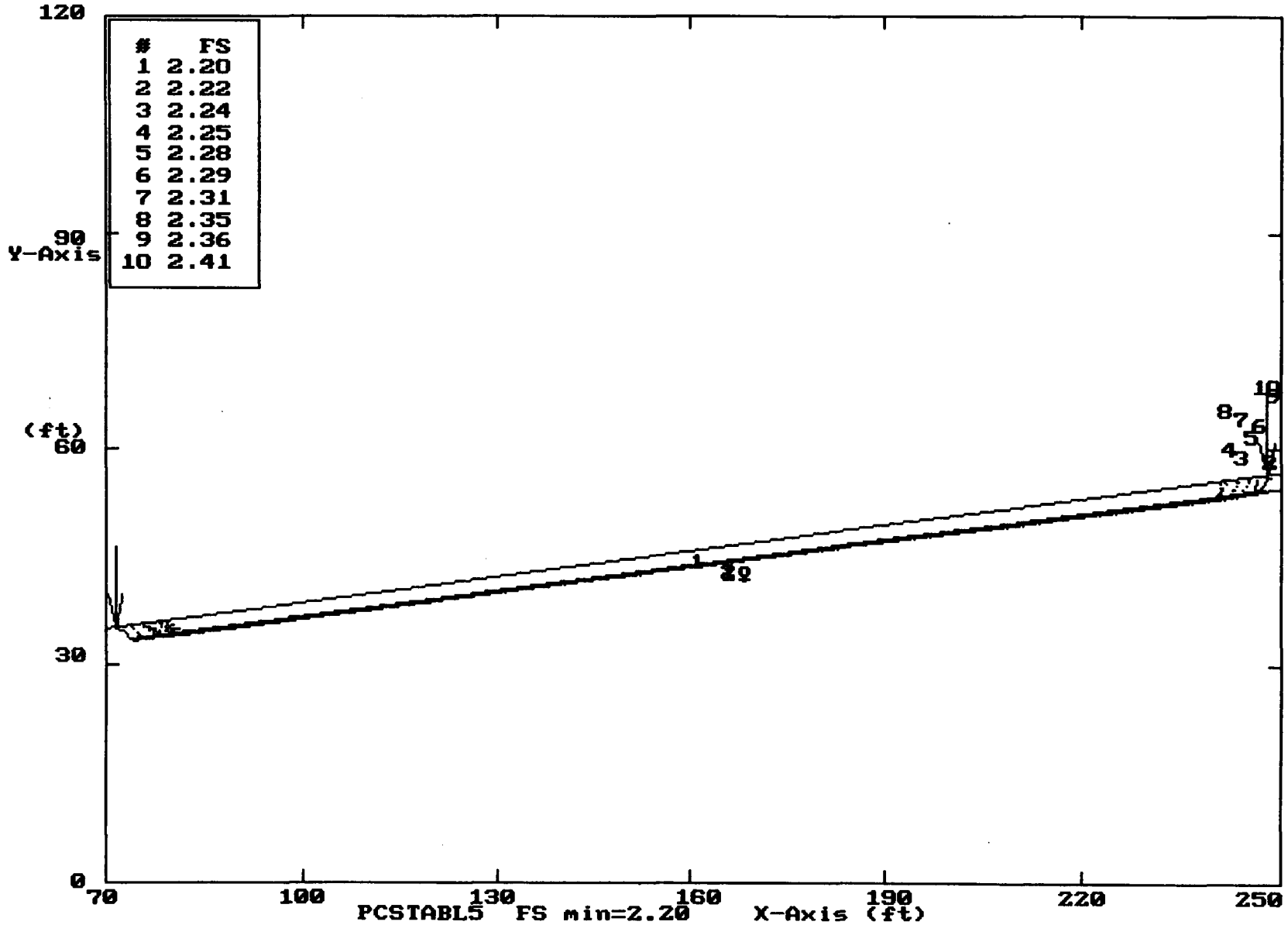
Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	7.66	35.92
2	8.35	35.24
3	9.23	34.76
4	10.22	34.62
5	11.16	34.28
6	176.03	54.00
7	176.34	54.95
8	176.56	55.93
9	176.75	56.21

*** 2.411 ***

Solutia Sauget 2' cover thickness, 12% slope, static
Ten Most Critical. C:SAUGET3.PLT By: Martin Brungard 5-04-00 :47pm



--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	05-04-00
Time of Run:	2:14pm
Run By:	Martin Brungard
Input Data Filename:	C:SAUGET6.IN
Output Filename:	C:SAUGET6.OUT
Plotted Output Filename:	C:SAUGET6.PLT

PROBLEM DESCRIPTION Solutia Sauget Landfill
-Interior Slope Seismic Condition

BOUNDARY COORDINATES

4 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	20.00	20.00	20.00	3
2	20.00	20.00	63.50	34.50	1
3	63.50	34.50	73.50	34.50	1
4	73.50	34.50	131.00	20.00	1
5	20.00	20.00	131.00	20.00	3
6	0.00	16.00	131.00	16.00	2

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	1000.0	0.0	0.00	0.0	0
2	120.0	120.0	0.0	30.0	0.00	0.0	1

3	120.0	120.0	480.0	0.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	16.00
2	131.00	16.00

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (lb/sqft)	Deflection (deg)
1	63.50	73.50	200.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

A Horizontal Earthquake Loading Coefficient
Of0.100 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of0.000 Has Been Assigned

Cavitation Pressure = 0.0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

800 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 40 Points Equally Spaced Along The Ground Surface Between X = 0.00 ft.

and X = 10.00 ft.

Each Surface Terminates Between X = 75.00 ft.
and X = 85.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.28	20.00
2	5.47	17.26
3	9.89	14.93
4	14.51	13.02
5	19.29	11.56
6	24.19	10.54
7	29.16	9.99
8	34.16	9.91
9	39.14	10.30
10	44.07	11.15
11	48.89	12.45
12	53.58	14.21
13	58.07	16.39
14	62.35	18.99
15	66.36	21.97
16	70.07	25.32
17	73.46	29.00
18	76.48	32.98
19	76.90	33.64

Circle Center At X = 32.5 ; Y = 63.2 and Radius, 53.4

*** 2.091 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.00	20.00
2	4.01	17.01
3	8.28	14.41
4	12.79	12.24
5	17.48	10.52
6	22.31	9.25
7	27.25	8.45
8	32.24	8.14
9	37.24	8.30
10	42.20	8.95
11	47.07	10.06
12	51.81	11.64
13	56.38	13.68
14	60.73	16.14
15	64.83	19.00
16	68.63	22.25
17	72.10	25.85
18	75.21	29.77
19	77.60	33.47

Circle Center At X = 33.0 ; Y = 60.0 and Radius, 51.9

*** 2.096 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.10	20.00
2	8.24	17.19
3	12.64	14.81
4	17.25	12.89
5	22.04	11.43
6	26.94	10.46
7	31.92	9.99
8	36.92	10.02
9	41.89	10.55
10	46.78	11.57
11	51.55	13.08
12	56.14	15.06
13	60.51	17.49
14	64.62	20.35
15	68.41	23.60
16	71.87	27.22
17	74.94	31.16
18	76.55	33.73

Circle Center At X = 34.1 ; Y = 59.8 and Radius, 49.8

*** 2.097 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.28	20.00
2	5.45	17.24
3	9.87	14.90
4	14.50	13.00
5	19.28	11.56
6	24.19	10.58
7	29.16	10.08
8	34.16	10.07
9	39.14	10.54
10	44.05	11.49
11	48.84	12.91
12	53.48	14.78
13	57.91	17.10
14	62.10	19.83
15	66.00	22.95
16	69.58	26.44
17	72.81	30.26
18	75.41	34.02

Circle Center At X = 31.8 ; Y = 61.7 and Radius, 51.6

*** 2.097 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.03	20.00
2	5.11	17.11
3	9.44	14.62
4	13.99	12.54
5	18.71	10.89
6	23.56	9.69
7	28.51	8.94
8	33.50	8.66
9	38.49	8.84
10	43.45	9.48
11	48.33	10.59
12	53.08	12.14

13	57.67	14.13
14	62.05	16.54
15	66.19	19.34
16	70.05	22.52
17	73.60	26.04
18	76.81	29.88
19	79.03	33.10

Circle Center At X = 34.0 ; Y = 62.4 and Radius, 53.7

*** 2.099 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.05	20.00
2	6.11	17.08
3	10.43	14.56
4	14.97	12.46
5	19.69	10.82
6	24.54	9.63
7	29.49	8.91
8	34.49	8.68
9	39.48	8.92
10	44.43	9.64
11	49.28	10.84
12	54.00	12.50
13	58.54	14.60
14	62.85	17.12
15	66.91	20.05
16	70.66	23.36
17	74.07	27.01
18	77.12	30.97
19	78.54	33.23

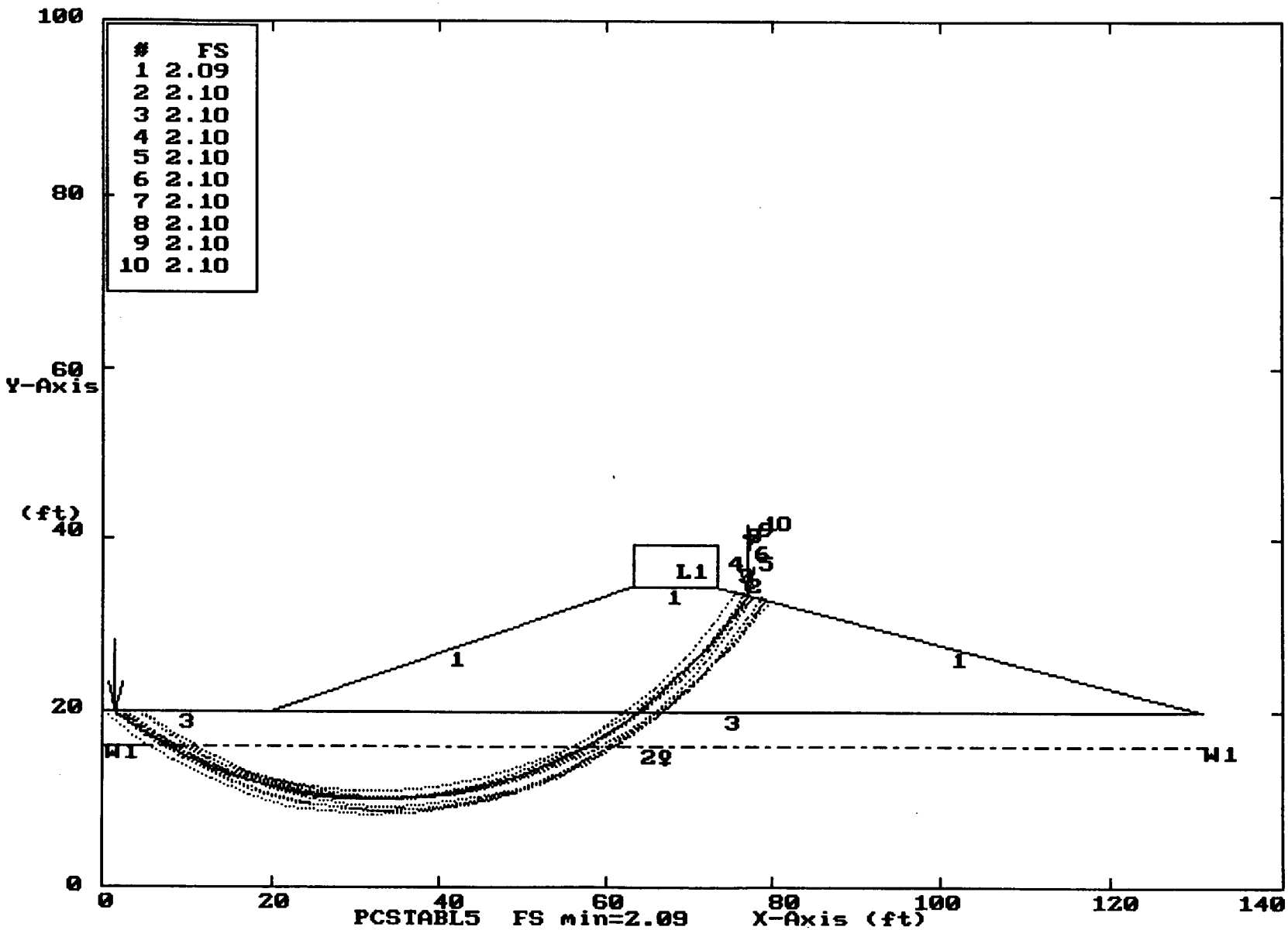
Circle Center At X = 34.4 ; Y = 60.7 and Radius, 52.0

*** 2.099 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.62	20.00
2	8.78	17.23
3	13.20	14.89

Solutia Sauget Landfill Interior Slope Seismic Condition
Ten Most Critical. C:SAUGET6.PLT By: Martin Brungard 5-04-00 :14pm



--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 05-04-00
Time of Run: 2:17pm
Run By: Martin Brungard
Input Data Filename: C:SAUGET7.IN
Output Filename: C:SAUGET7.OUT
Plotted Output Filename: C:SAUGET7.PLT

PROBLEM DESCRIPTION Solutia Sauget Landfill
-Interior Slope Static Condition

BOUNDARY COORDINATES

4 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	20.00	20.00	20.00	3
2	20.00	20.00	63.50	34.50	1
3	63.50	34.50	73.50	34.50	1
4	73.50	34.50	131.00	20.00	1
5	20.00	20.00	131.00	20.00	3
6	0.00	16.00	131.00	16.00	2

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	1000.0	0.0	0.00	0.0	0
2	120.0	120.0	0.0	30.0	0.00	0.0	1

3	120.0	120.0	480.0	0.0	0.00	0.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	16.00
2	131.00	16.00

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (lb/sqft)	Deflection (deg)
1	63.50	73.50	200.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

800 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 40 Points Equally Spaced
Along The Ground Surface Between X = 0.00 ft.
and X = 15.00 ft.

Each Surface Terminates Between X = 65.00 ft.
and X = 80.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.39	20.00
2	14.55	17.24
3	19.02	14.99
4	23.71	13.27
5	28.58	12.11
6	33.54	11.52
7	38.54	11.52
8	43.51	12.10
9	48.37	13.26
10	53.07	14.98
11	57.53	17.23
12	61.70	19.99
13	65.52	23.22
14	68.94	26.87
15	71.91	30.89
16	73.91	34.40

Circle Center At X = 36.0 ; Y = 54.2 and Radius, 42.8

*** 2.837 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.08	20.00
2	12.13	17.07
3	16.49	14.63
4	21.11	12.70
5	25.91	11.30
6	30.84	10.46
7	35.83	10.19
8	40.82	10.48

9	45.74	11.35
10	50.54	12.76
11	55.14	14.72
12	59.49	17.18
13	63.53	20.12
14	67.22	23.51
15	70.49	27.29
16	73.31	31.42
17	74.76	34.18

Circle Center At X = 35.7 ; Y = 54.1 and Radius, 43.9

*** 2.838 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.00	20.00
2	9.10	17.14
3	13.49	14.74
4	18.11	12.83
5	22.91	11.43
6	27.83	10.56
7	32.82	10.23
8	37.82	10.44
9	42.76	11.19
10	47.60	12.48
11	52.26	14.27
12	56.70	16.57
13	60.87	19.33
14	64.72	22.52
15	68.20	26.11
16	71.27	30.06
17	73.89	34.32
18	73.92	34.39

Circle Center At X = 33.4 ; Y = 56.3 and Radius, 46.1

*** 2.839 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.00	20.00
2	9.10	17.13

3	13.47	14.72
4	18.09	12.79
5	22.88	11.37
6	27.80	10.47
7	32.79	10.11
8	37.78	10.28
9	42.73	10.99
10	47.58	12.23
11	52.26	13.98
12	56.73	16.22
13	60.93	18.93
14	64.82	22.08
15	68.34	25.62
16	71.47	29.53
17	74.15	33.75
18	74.41	34.27

Circle Center At X = 33.7 ; Y = 56.6 and Radius, 46.5

*** 2.839 ***

Failure Surface Specified By 17 Coordinate Points

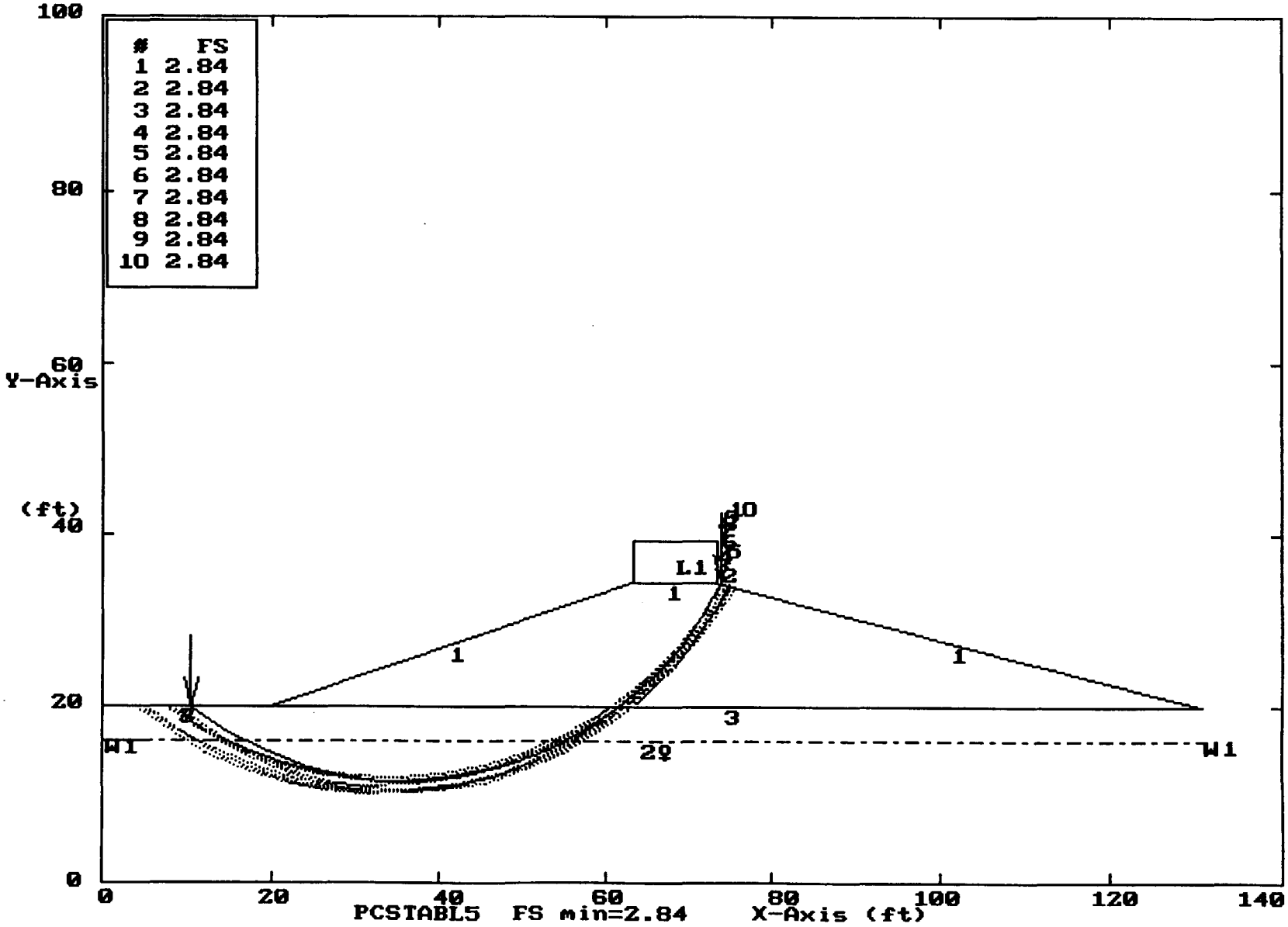
Point No.	X-Surf (ft)	Y-Surf (ft)
1	7.31	20.00
2	11.57	17.38
3	16.08	15.22
4	20.79	13.54
5	25.64	12.36
6	30.60	11.69
7	35.60	11.54
8	40.58	11.92
9	45.50	12.81
10	50.30	14.21
11	54.93	16.10
12	59.34	18.46
13	63.48	21.27
14	67.30	24.49
15	70.76	28.10
16	73.83	32.05
17	75.11	34.09

Circle Center At X = 34.5 ; Y = 59.5 and Radius, 47.9

*** 2.840 ***

Failure Surface Specified By 17 Coordinate Points

Solutia Sauget Landfill Interior Slope Static Condition
Ten Most Critical. C:SAUGET7.PLT By: Martin Brungard 5-04-00 :17pm



--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date: 05-05-00
Time of Run: 3:31pm
Run By: Martin Brungard
Input Data Filename: C:SOUGET2.IN
Output Filename: C:SOUGET2.OUT
Plotted Output Filename: C:SOUGET2.PLT

PROBLEM DESCRIPTION Solutia Sauget
-2' cover thickness, 3% slope seismic

BOUNDARY COORDINATES

1 Top Boundaries
3 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	35.00	180.00	40.40	1
2	10.00	33.30	180.00	38.40	2
3	10.00	33.10	180.00	38.20	1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	120.0	300.0	0.0	0.00	0.0	0
2	110.0	120.0	0.0	11.0	0.00	0.0	0

A Horizontal Earthquake Loading Coefficient
Of0.100 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of0.000 Has Been Assigned

Cavitation Pressure = 0.0 psf

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

25 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 1.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	4.00	33.20	12.00	33.40	0.20
2	170.00	38.00	178.00	38.20	0.20

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.42	35.16
2	5.51	35.08
3	6.29	34.46
4	7.18	34.01
5	8.16	33.77
6	9.02	33.27
7	170.22	38.03
8	170.79	38.85
9	171.43	39.62
10	171.97	40.16

*** 2.031 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	7.28	35.22
2	7.44	35.10
3	8.42	34.90
4	9.15	34.21
5	9.98	33.66
6	10.90	33.27
7	177.96	38.27
8	178.53	39.09
9	179.21	39.82
10	179.42	40.38

*** 2.047 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.27	35.16
2	5.90	34.60
3	6.79	34.16
4	7.77	33.93
5	8.65	33.46
6	9.63	33.27
7	172.21	38.01
8	172.69	38.88
9	173.40	39.59
10	173.86	40.22

*** 2.080 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.68	35.14
2	5.52	34.88
3	6.24	34.18

4	7.22	33.98
5	7.94	33.29
6	176.15	38.21
7	176.36	39.19
8	176.98	39.98
9	177.25	40.32

*** 2.187 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.62	35.20
2	7.23	34.66
3	8.03	34.06
4	9.02	33.94
5	9.79	33.30
6	171.48	38.11
7	172.10	38.89
8	172.61	39.75
9	172.64	40.18

*** 2.392 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.04	35.06
2	2.44	34.83
3	3.34	34.38
4	4.17	33.83
5	4.90	33.14
6	170.05	37.94
7	170.76	38.65
8	171.08	39.60
9	171.12	40.13

*** 2.672 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.64	35.08
2	2.89	34.83
3	3.63	34.16
4	4.61	33.95
5	5.61	33.88
6	6.37	33.23
7	176.27	38.10
8	176.88	38.89
9	177.36	39.76
10	177.73	40.33

*** 3.588 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.50	35.04
2	1.60	35.01
3	2.51	34.61
4	3.42	34.18
5	4.36	33.85
6	5.16	33.25
7	6.16	33.23
8	176.17	38.11
9	176.87	38.83
10	177.56	39.55
11	178.25	40.27
12	178.33	40.35

*** 3.706 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.73	35.05
2	1.82	34.96
3	2.69	34.47
4	3.66	34.26
5	4.40	33.58
6	5.34	33.23
7	175.03	38.16

8	175.06	39.16
9	175.74	39.89
10	176.05	40.28

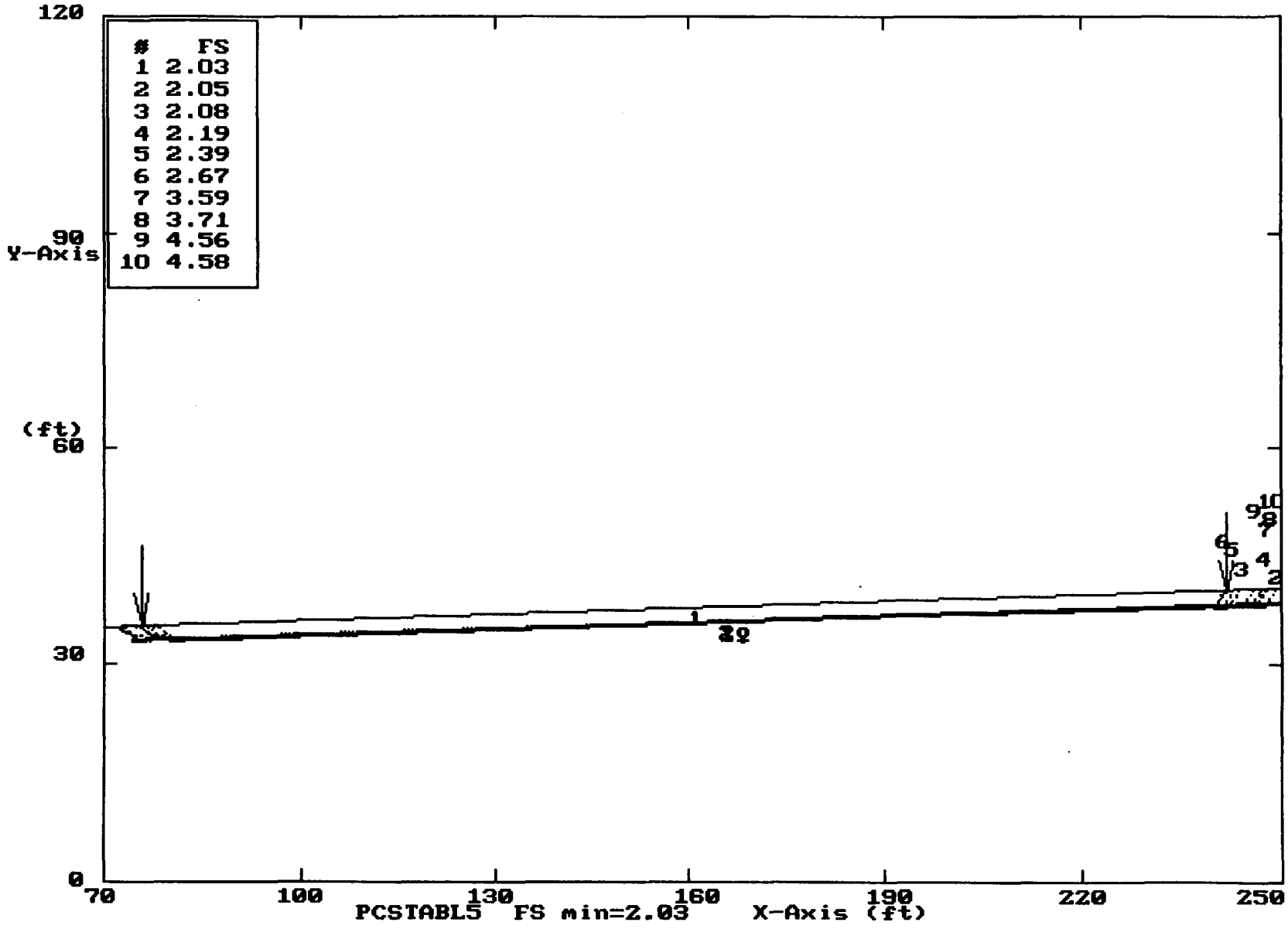
*** 4.556 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.31	35.07
2	2.94	34.82
3	3.72	34.19
4	4.63	33.77
5	5.47	33.24
6	175.98	38.10
7	176.19	39.08
8	176.89	39.79
9	177.33	40.32

*** 4.576 ***

Solutia Sauget 2' cover thickness, 3% slope seismic
Ten Most Critical. C:SOUGET2.PLT By: Martin Brungard 5-05-00 :31pm



--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	05-04-00
Time of Run:	2:45pm
Run By:	Martin Brungard
Input Data Filename:	C:SOUGET2A.IN
Output Filename:	C:SOUGET2A.OUT
Plotted Output Filename:	C:SOUGET2A.PLT

PROBLEM DESCRIPTION Solutia Sauget
-2' cover thickness, 3% slope static

BOUNDARY COORDINATES

1 Top Boundaries
3 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	35.00	180.00	40.40	1
2	10.00	33.30	180.00	38.40	2
3	10.00	33.10	180.00	38.20	1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	120.0	300.0	0.0	0.00	0.0	0
2	110.0	120.0	0.0	11.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Sliding Block Surfaces, Has Been Specified.

25 Trial Surfaces Have Been Generated.

2 Boxes Specified For Generation Of Central Block Base

Length Of Line Segments For Active And Passive Portions Of Sliding Block Is 1.0

Box No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Height (ft)
1	4.00	33.20	12.00	33.40	0.20
2	170.00	38.00	178.00	38.20	0.20

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.42	35.16
2	5.51	35.08
3	6.29	34.46
4	7.18	34.01
5	8.16	33.77
6	9.02	33.27
7	170.22	38.03
8	170.79	38.85
9	171.43	39.62
10	171.97	40.16

*** 8.817 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	7.28	35.22
2	7.44	35.10
3	8.42	34.90
4	9.15	34.21
5	9.98	33.66
6	10.90	33.27
7	177.96	38.27
8	178.53	39.09
9	179.21	39.82
10	179.42	40.38

*** 8.884 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.27	35.16
2	5.90	34.60
3	6.79	34.16
4	7.77	33.93
5	8.65	33.46
6	9.63	33.27
7	172.21	38.01
8	172.69	38.88
9	173.40	39.59
10	173.86	40.22

*** 9.027 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.68	35.14
2	5.52	34.88
3	6.24	34.18
4	7.22	33.98
5	7.94	33.29
6	176.15	38.21
7	176.36	39.19
8	176.98	39.98
9	177.25	40.32

*** 9.492 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.62	35.20
2	7.23	34.66
3	8.03	34.06
4	9.02	33.94
5	9.79	33.30
6	171.48	38.11
7	172.10	38.89
8	172.61	39.75
9	172.64	40.18

*** 10.376 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.04	35.06
2	2.44	34.83
3	3.34	34.38
4	4.17	33.83
5	4.90	33.14
6	170.05	37.94
7	170.76	38.65
8	171.08	39.60
9	171.12	40.13

*** 11.588 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.64	35.08
2	2.89	34.83
3	3.63	34.16
4	4.61	33.95
5	5.61	33.88
6	6.37	33.23

7	176.27	38.10
8	176.88	38.89
9	177.36	39.76
10	177.73	40.33

*** 15.553 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.50	35.04
2	1.60	35.01
3	2.51	34.61
4	3.42	34.18
5	4.36	33.85
6	5.16	33.25
7	6.16	33.23
8	176.17	38.11
9	176.87	38.83
10	177.56	39.55
11	178.25	40.27
12	178.33	40.35

*** 16.064 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.31	35.07
2	2.94	34.82
3	3.72	34.19
4	4.63	33.77
5	5.47	33.24
6	175.98	38.10
7	176.19	39.08
8	176.89	39.79
9	177.33	40.32

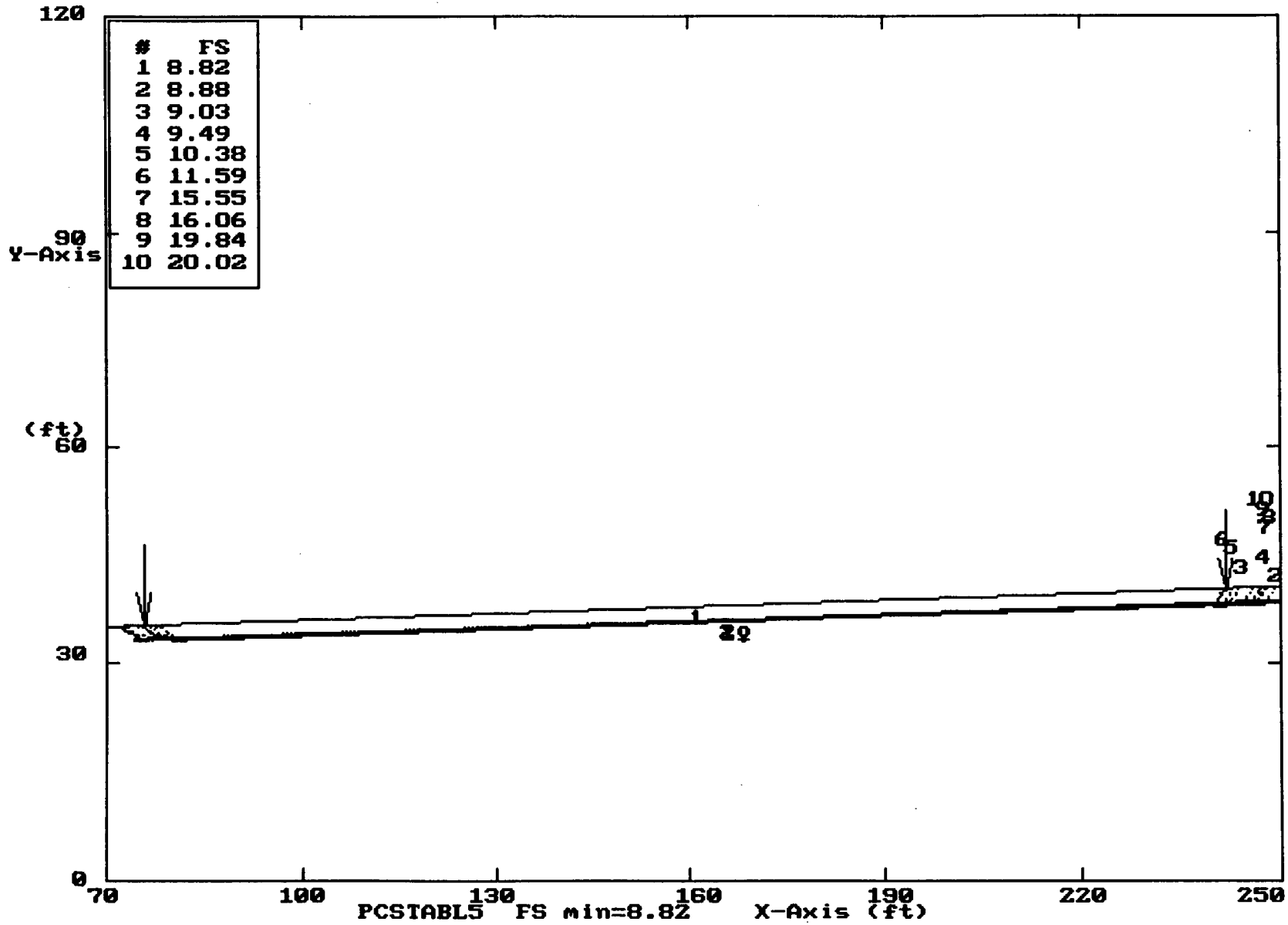
*** 19.836 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.73	35.05
2	1.82	34.96
3	2.69	34.47
4	3.66	34.26
5	4.40	33.58
6	5.34	33.23
7	175.03	38.16
8	175.06	39.16
9	175.74	39.89
10	176.05	40.28

*** 20.023 ***

Solutia Sauget 2' cover thickness, 3% slope static
Ten Most Critical. C:SOUGETZA.PLT By: Martin Brungard 5-04-00 :45pm



APPENDIX C

LINER SYSTEM COMPONENT DESIGN

Gravel Drain Sizing

URS Greiner Woodward Clyde

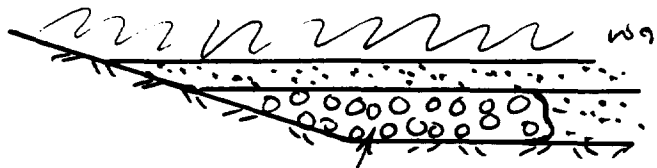
Job: Solutia Sauget
Description: Gravel Drain Sizing

Project No. C10000 3899.00
Computed by: M. Brungard
Checked by: Bill Weber

Page ___ of ___
Sheet 1 of 2
Date: 5/11/00
Date: 5/25/2000
Reference

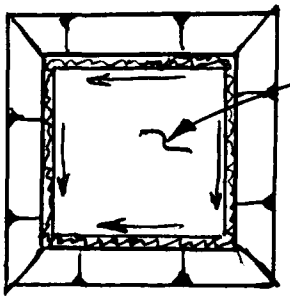
Purpose: Estimate cross-section for the gravel drainage blanket around the perimeter of the leachate collection layer.

Configuration:



wastes
6" Sand Protective Layer
12" Sand Collection Layer
12" Thick × (?) wide Gravel Layer.

Assumptions:



Bottom Dimensions ≈ 290' × 290'

Gravel Layer Length = 4 × 290'
= 1160'
or 580' per ~~side~~ leg

Sand Permeability = 1×10^{-2} cm/sec

3/8" Gravel Permeability = 10 cm/sec
estimated as follows:

Hazen Eqn. → $K = 100\, D_{10}^2$ (cm/sec) (D_{10} in cm)

for 3/8" Gravel, the D_{10} is estimated as 4 mm or (0.4 cm)

$K = 100(0.4)^2 = 16$ cm/sec, use $\boxed{10 \text{ cm/sec}}$

Calculations:

When leachate level is over the top of gravel, the intake area into the gravel is $(1' + w)$ where w is the gravel layer width.

Use a relatively high gradient into gravel ($i = 0.5$).

Flow into gravel

$$Q = K i A$$
$$= 1 \times 10^{-2} \text{ cm/sec } (0.5)(580' \times (1' + w))$$
$$= 3.28 \times 10^{-4} \text{ ft/sec } (0.5)(580 \times (1 + w))$$

Use the bottom slope of 0.1 along the gravel path for gradient.

Flow through gravel

$$Q = K i A$$
$$= 10 \text{ cm/sec } (0.1)(1' \times (w))$$
$$= 0.328 \text{ ft/sec } (0.1)(w)$$
$$= 0.0328(w)$$

URS Greiner Woodward Clyde

Job: Solutia Sanget
Description: Gravel Drain Sizing
Project No. C10000 3899.00
Computed by: M. Brunyard
Checked by: Bill Weber
Page ___ of ___
Sheet 2 of 2
Date: 5/11/00
Date: 5/25/2000
Reference

Set flow into gravel = flow through gravel

$$0.0328(w) = 3.28\times10^{-4}(0.5)(580'\times(1+w))$$
$$0.0328(w) = 0.09512 + 0.09512(w)$$

$$\boxed{w = -1.5'}$$

gravel flow can't keep up w/ flow into gravel when W.L. is over gravel. ✓

Use W.L. = 12" in collection layers

Flow into gravel $Q = 1\times10^{-2}\,\text{cm/sec}\,(0.5)(580'\times1')$
$= 0.09512\ \text{ft}^3/\text{sec}$ ✓

Flow through gravel $Q = 10\,\text{cm/sec}\,(0.1)(1'\times w)$
$= 0.0328\,w$ ✓

Set flows equal $0.0328\,w = 0.09512$
$w = 2.9'$ say 3'

$Q = 0.0328(3) = 0.098\ \text{ft}^3/\text{sec}$
$= 44$ gpm per leg ✓
$= 88$ gpm for both legs ✓

Conclusion: 88 gpm is probably greater than the pumping capacity for suction hoses able to fit into the HDPE piping 6" SDR 11 → I.D. = 6"

Therefore, 3' wide gravel layer is OK for the cell's leachate collection layer.

Pipe Loading

hillips Driscopipe
929 N. Central Expwy, #300
ichardson,TX 75080
-800-527-0662
ww.driscopipe.com

Pipe Loading

al Calculation
---

alculated by : M. Brungard
Company : URS
Address : 3676 Hartsfield Rd
State : Tallahassee
Phone :
Fax :
E-mail :

alculated For : Solutia Sauget
Company :
Project :

---

nput Variables were as follows:

Using Driscopipe 1000

SDR = 11
Burial Depth to Crown of Pipe = 1 (ft)
Soil Density = 120 (pcf)
Water Table (feet above crown of pipe) = 0 (ft)
Other Loads = 3600 (psf)
Soil Modulous = 1000 (psi)
onservative Long Term Pipe Modulous @ 23 Deg C = 35000

---

lowable Ring Deflection @ 1.0% strain = 2.75
S(A) (Stress in Pipe Wall) = 129.17
P(T) (Pressure at Crown of Pipe = 25.83
P(CB) (Critical Buckling Pressure = 197.6
Calculated Ring Deflection (%) = 2.58
Crushing Design Safety Factor = 11.6 to 1
Wall Buckling Design Safety Factor = 7.6 to 1
Ring Deflection = acceptable

OK
MK
5/8/00

omments : A wheel loading of 50 psi at ground surface was assumed (=7,200 psf). The stress influence diagram for a 1-ft wide tire shows that the stress at 1-ft depth (top of pipe) was about (0.3 x surface loading). A loading of (0.5 x surface loading) was used as a conservative estimate. (0.5 x 7,200 psf = 3600 psf)

---

e Calculations in this program are, to the best of our knowledge correct and
or t various calculations as shown in the Driscopipe Design Manual.
t accept responsibility for the use and/or application of these programs.
project has its own set of variables and conditions. Interpretation of these
iables is important. The user must apply proper engineering when selecting values
input into these programs.

Checked Bill Weber
5/25/2000

Geotextile Clogging Potential

URS Greiner Woodward Clyde

Job: Solutia Sauget
Description: Geotextile Clogging Potential
Project No. C100008899.00
Computed by: M. Brungard
Checked by: Bill Weber
Page ___ of ___
Sheet 1 of 1
Date: 5/11/00
Date: 5/25/2000
Reference

Purpose: Determine Clogging Potential for geotextiles used in the containment cell when in contact w/ wastes or native soils.

Assumptions: Based on a 4 to 8 oz/sy non woven geotextile, the A.O.S. is about 70 to 100 (sieve size)
AOS = Apparent Opening Size

#70 sieve = 0.21 mm
#100 sieve = 0.149 mm

— The waste materials are expected to be primarily silts with some fine sand. Sieve analyses are not available now for these materials. Assume that the D_{85} for the wastes is about 0.07 mm
— The natural soil D_{85} is about 0.1 mm

Criteria: $AOS < (2 \text{ to } 3)(D_{85})$ from: Designing w/ Geosynthetics, Koerner, Prentice Hall, 1990. pg 122.

For the waste cell, use $3(D_{85})$ since the flow is very limited
For the cover soil, use $2(D_{85})$ since the flow is long-term.

Waste Cell: AOS(required) = 3(0.07mm) = 0.21 mm
AOS(available) = 0.21 mm to 0.149 mm } OK ✓

Cover Soil: AOS(required) = 2(0.1) = 0.2 mm
AOS(available) = 0.21 mm to 0.149 mm } OK ✓

Conclusion: Fabric w/ AOS of 70 to 100 is OK for use at this site.

GCL Loading Calculations

URS Greiner Woodward Clyde

Job: Solutia Sauget
Description: GCL Loading Calculations

Project No. CI0000 3899.00
Computed by: M. Brungard
Checked by: Jill Weber

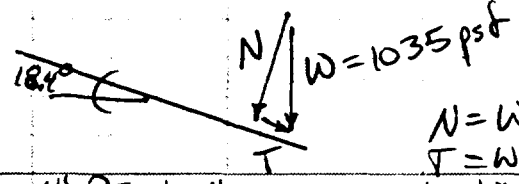
Page ___ of ___
Sheet 1 of 1
Date: 5/5/00
Date: 5/25/2000
Reference

Purpose: Estimate the shear loading placed on the GCL when located on the containment cell side slopes.

Assumptions: GCL will rest on compacted clayey soils. The GCL will be placed directly beneath a HDPE lining. The side slope angle is no greater than 3:1.

The average overburden stress is 1035 psf as calculated in the "Lining Tensile Stress" calculations by M. Brungard dated 5/4/00

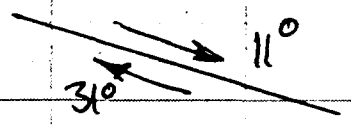
Calculations:



$N = W \cos 18.4° = 982$ psf
$T = W \sin 18.4° = 326$ psf

Friction Transfer: HDPE to Non woven geotextile = 11° (1)
GCL to clay soil = 31° (2)

Source: (1) Interface Friction Analysis, Schlegel Lining Technology, July 20, 1987
(2) Cetco Product Manual, Direct Shear Test Data



By Inspection, the entire down force (T) must be carried by the internal shear strength of the GCL. No tension produced in GCL.

Internal Shear Strength of GCL must be greater than 326 psf. = (T)

A GCL with 500 psf internal shear strength is suitable for the side slopes.

This analysis conservatively assumes the HDPE lining does not take or reduce the load (T) = 326 psf and all of the load is transferred to the GCL.

Lining Tensile Stress

URS Greiner Woodward Clyde

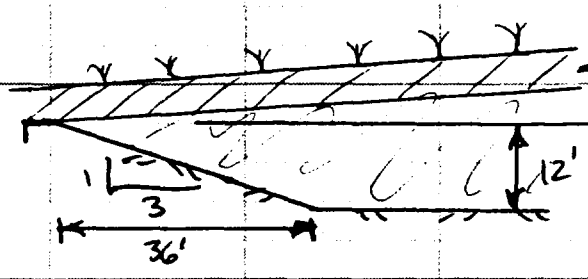
Job: Solutia Sauget
Description: Lining Tensile Stress

Project No. C10000 3899.00
Computed by: M. Brungard
Checked by: Bill Weber

Page ___ of ___
Sheet 1 of 2
Date 5/4/00
Date 5/25/2000
Reference

Purpose: Estimate the tensile stress placed on the HDPE linings in the containment cell.

Configuration:

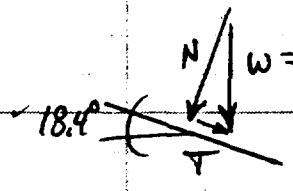


Assume Waste = γ = 115 pcf

Calculations:

Min cover thickness at top of slope = 2'
Max thickness over toe of slope = 2' + (36' × 5%) + 12' = 15.8'
Avg thickness over slope = $\frac{15.8' + 2}{2}$ = 8.9' say 9'

Avg overburden stress = 9' × 115 pcf = 1035 psf



$N = W\cos 18.4° = 982$ psf
$T = W\sin 18.4° = 326$ psf

Friction Transfer: HDPE to HDPE = 11° (1)
HDPE to geotextile = 11° (2)

Sources: (1) Designing w/ Geosynthetics, Koerner, 1990, pg. 382
(2) Interface Friction Analysis, Schlegel Lining Technologies, July 20, 1991

HDPE to HDPE downdrag (liner to geonet)

(HDPE to Geotextile) liner to GCL resisting force

$\tau_{down} = \sigma_N \tan\phi$

$\tau_{resist} = \sigma_N \tan\phi$

where: $\sigma_N = N$ = normal stress = 982 psf
$\phi = 11°$

Since the friction above & below the lining is equal, the lining is not in tension

URS Greiner Woodward Clyde

Page ___ of ___

Job Solutia Sauget | Project No. C10000 3899.00 | Sheet 2 of 2

Description Lining Tensile Stress | Computed by M. Brungard | Date 5/4/00

Checked by Bill Weber | Date 5/25/2000

Reference

if the geotextile to HDPE friction was 9°, then the lining will be in Tension. The amount of tension is calculated below.

$\tau_{down} = 982 \tan 11° = 190$ psf

$\tau_{resist} = 982 \tan 9° = 155$ psf

slope length $= \sqrt{12^2 + 36^2} = 37.95'$

Tension $= (190\text{psf} - 155\text{psf}) \times 37.95' = 1328$ pounds/ft

or 1845 psi for 60-mil lining

HDPE yield stress is about 2800 psi, the ultimate stress is about 3000 psi

Conclusions:

The analyses show that the HDPE yield stress will not be reached in the 60-mil linings. The GCL and HDPE lining interface example is the worst case example. Placing the HDPE lining over most soils would provide a better condition and less lining stress.

The analysis shows that tension in the lining may not occur at all. The worst case analysis was added to evaluate other potential conditions.

The analyses above assume that the waste mass is free to move down the slope. Because the waste will be placed from the bottom of cell to the top, the underlying wastes will significantly limit the down slope movement possible. Therefore, this analysis is very conservative.

To prevent overstressing the lining system, soil or waste should not be dumped down the slope without incorporating protective reinforcements and barriers over the linings and geonets.

Sump Sizing

URS Greiner Woodward Clyde

Job: Solutia Sauget
Description: Sump Sizing

Project No. C10000 3899.00
Computed by: M. Brungard
Checked by: Bill Weber

Page ___ of ___
Sheet 1 of 1
Date: 5/15/00
Date: 5/22/2000
Reference

Purpose: Estimate the minimum volume and size of gravel-filled sumps for the primary and secondary collection systems.

Method: Use the HELP model results for the containment cell performed during construction.

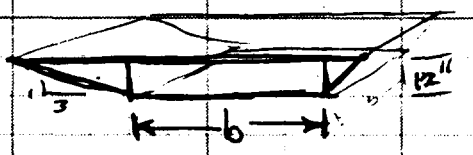
Use Avg Annual Flow rates and assume daily pump outs during construction.

From HELP model 5/8/00 { Primary : 58,350 ft³/yr = 1195 gpd ✓
Secondary : 8,512 ft³/yr = 175 gpd ✓

Analysis: Use gravel porosity of 0.35 for calculations. The maximum allowable head is 12 inches. Assume flat bottom in sump and include the gravel area on the side slopes.

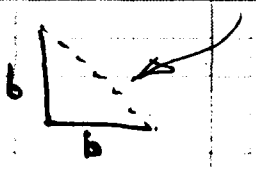
— Primary: Gravel Sump Volume = $\frac{1195 \text{ gal}}{0.35}$ = 3414 gal = 456 ft³

$V = 1.5 \cdot b^2 \cdot 1.5$



$V = b^2 + 2(1.5)b$
$= b^2 + 3b$

Since the plan of the sump will be as shown below double the volume to determine the correct side length



$(456 \text{ ft}^3)2 = b^2 + 3b$

$0 = b^2 + 3b - 912$

$b = 29'$

— Secondary: Gravel Sump Volume = $\frac{175 \text{ gal}}{0.35}$ = 500 gal = 66.8 ft³

Double volume → 66.8 (2) = 134 ft³

$134 \text{ ft}^3 = b^2 + 3b$

$0 = b^2 + 3b - 134$

$b = 10.2'$

Conclusion: ~~The cell configuration requires that the (b) dimension of the primary~~ (MB)

(OK) Use the sump sizes calculated.

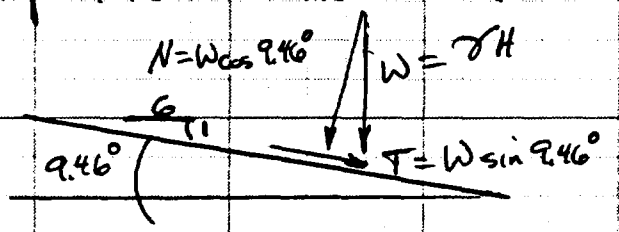
Access Ramp Stability

URS Greiner Woodward Clyde

Job: Solutia Sauget
Description: Access Ramp Stability
Project No. C100003899.00
Computed by: M. Brungard
Checked by: Bill Weber
Page ___ of ___
Sheet 1 of 3
Date 5/19/00
Date 6/2/2000
Reference

Purpose: Design a system of slope reinforcement to allow equipment and soil to enter the containment cell without over stressing the lining system.

Configuration: The proposed containment cell will incorporate 6:1 ramps into the lined cell.



where: H = soil layer thickness, use 2'
γ = soil unit wt. = 120 pcf

Analysis: Assume the interface friction angle between the HDPE geomembrane and HDPE fly sheet is at least 6°. The value is more likely to be about 8°, but use the minimum value of 6°. Source: Designing w/ Geosynthetics, Koerner, Prentiss Hall, 1990.

Use a reinforcement to carry the down slope loading. The reinforcement loading is the difference between driving & resisting forces.

Driving Force: $T = W \sin 9.46°$
$= 2'(120\text{pcf}) \sin 9.46°$
$= \underline{39.5 \text{ psf}}$ ✓

Resisting Force: $F = W \cos 9.46° (\tan 6°)$
$= 2'(120\text{pcf}) \cos 9.46 (\tan 6°)$
$= \underline{24.9 \text{ psf}}$ ✓

Ramp Slope Length = $6 \times 12'$ (height) = $\underline{72 \text{ feet}}$ ✓

Reinforcement Tension Force = $(39.5\text{psf} - 24.9\text{psf}) \times 72'$
$= \underline{1051 \text{ lbs/ft}}$ ✓

Note: This is just the soil veneer loading. Equipment will additionally load the reinforcement.

Equipment Loading: A small dump truck or dozer may weigh as little as 35,000 lbs. Larger equipment may weight upwards of 100,000 lbs. Use 50,000 & 100,000 lbs for analysis.

URS Greiner Woodward Clyde

Job: Solutia Sauget
Description: Access Ramp Stability
Project No. C100003899.00
Computed by: M. Brungard
Checked by: Bill Weber
Page ___ of ___
Sheet 2 of 3
Date 5/19/00
Date 6/2/2000
Reference

Equipment Weight (W_e) = 50,000 lbs or 100,000 lbs

Additional driving force = $W_e \sin 9.46°$

or (50,000 lbs) sin 9.46° = 8,217 lbs ✓
(100,000 lbs) sin 9.46° = 16,435 lbs ✓

If the equipment width is assumed as 10', then the driving force may be derived as:

8217 lbs / 10' = 821.7 lbs/ft ✓
16,435 lbs / 10' = 1,643.5 lbs/ft ✓

Total Reinforcement Loading = Soil Veneer Tension + Equipment Tension

= 1,051 lbs/ft + 822 lbs/ft = 1,873 lbs/ft ✓

or = 1,051 lbs/ft + 1644 lbs/ft = 2,695 lbs/ft ✓

Use a factor of safety of 2 on reinforcement loads

Load range = 3,750 to 5,400 lbs/ft ✓

The ultimate capacity of Tensar Uniaxial Geogrids is reported to be up to 2 times the dynamic strength reported by Tensar. This information was provided by Randy Frilloux of Contech Construction Products.

Use a UX1600SB with a tensile strength of 3,585 lbs/ft. The factors of safety incorporated by Tensar are to accounts for long-term stress & creep limits. These are not required in the short-term use for these ramps.

Reinforcement Anchorage: Use a design anchorage strength of 5,400 lbs/ft to avoid having a sudden failure by over-stressing the geogrid to its ultimate strength.

Assume a soil backfill strength of 30° and a burial depth of 2'.

URS Greiner Woodward Clyde

Job: Solutia Sauget
Description: Access Ramp Stability

Project No. CI0000 3899.00
Computed by: M. Brungard
Checked by: Bill Weber

Page ___ of ___
Sheet 3 of 3
Date 5/19/00
Date 6/2/2000
Reference

For 3-dimensional reinforcements like UX1600SB, the efficiency is reported to be about 70% by: Designing w/ Geosynthetics, Koerner, Prentiss Hall, 1990.

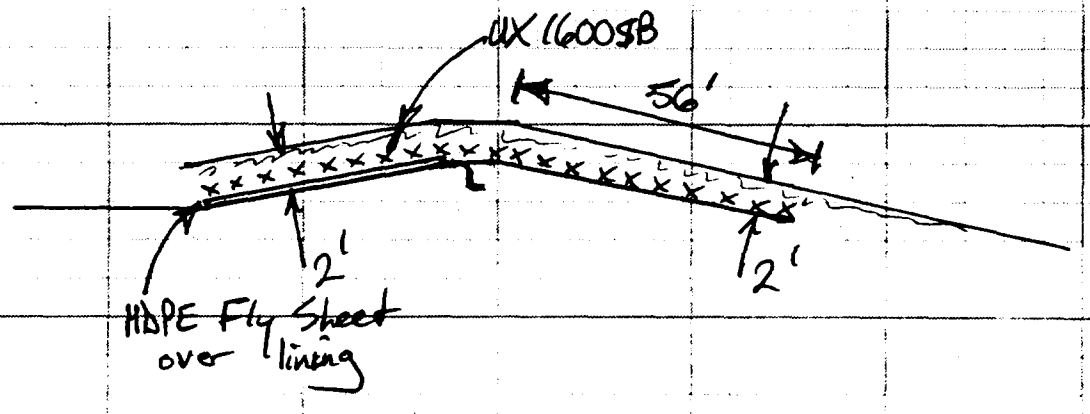
Anchorage Capacity = $E(\sigma \tan\phi) L_e$ where $E = 70\%$
$\sigma = 120\,pcf \times 2'$
$\phi = 30°$
L_e = embedment length

$$5400\ lbs/ft = 0.70(240\,psf \tan 30°)\ L_e$$

$$\underline{L_e = 56\ feet}$$

Conclusion: Use Tensar UX1600 SB for reinforcement. Use 2' soil cover over ramp slope to protect against mechanical damage to lining. Use a HDPE fly sheet between lining and geogrid to reduce friction transfer to lining.

Bury anchorage with about 2 feet of soil cover. use a granular fill to bed the geogrid anchorage. Anchorage length = 56 feet.



HELP Evaluation

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP3\SAUGETP.D4
TEMPERATURE DATA FILE:        C:\HELP3\SAUGETT.D7
SOLAR RADIATION DATA FILE:    C:\HELP3\SAUGETR.D13
EVAPOTRANSPIRATION DATA:      C:\HELP3\SAUGETE.D11
SOIL AND DESIGN DATA FILE:    C:\HELP3\SAUGETS.D10
OUTPUT DATA FILE:             C:\HELP3\SAUGET.OUT


TIME:  16:21     DATE:   5/ 5/2000


******************************************************************************

     TITLE:  SOLUTIA SAUGET LANDFILL

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   8
          THICKNESS                    =     24.00   INCHES
          POROSITY                     =      0.4630 VOL/VOL
          FIELD CAPACITY               =      0.2320 VOL/VOL
          WILTING POINT                =      0.1160 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2856 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.369999994000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1193	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	3.00	PERCENT
DRAINAGE LENGTH	=	340.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	3.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC

LAYER 6

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 8

THICKNESS	=	168.00	INCHES
POROSITY	=	0.4630	VOL/VOL
FIELD CAPACITY	=	0.2320	VOL/VOL
WILTING POINT	=	0.1160	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.369999994000E-03	CM/SEC

LAYER 7

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0450	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	275.0	FEET

LAYER 8

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	3.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 9

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 8

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4630	VOL/VOL
FIELD CAPACITY	=	0.2320	VOL/VOL
WILTING POINT	=	0.1160	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.369999994000E-03	CM/SEC

LAYER 10

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0100	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	275.0	FEET

LAYER 11

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	3.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 12

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 13

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 8

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4630	VOL/VOL
FIELD CAPACITY	=	0.2320	VOL/VOL
WILTING POINT	=	0.1160	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.369999994000E-03	CM/SEC

LAYER 14

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	36.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	275.0	FEET

LAYER 15

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 8

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4630	VOL/VOL
FIELD CAPACITY	=	0.2320	VOL/VOL
WILTING POINT	=	0.1160	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4630	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.369999994000E-03	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 8 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 341. FEET.

SCS RUNOFF CURVE NUMBER	=	79.30	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	2.910	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	5.572	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.260	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.320	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	58.201	INCHES
TOTAL INITIAL WATER	=	58.201	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ST. LOUIS MISSOURI

STATION LATITUDE	=	38.45	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	98	
END OF GROWING SEASON (JULIAN DATE)	=	300	
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.40	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	74.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.72	2.14	3.28	3.55	3.54	3.73
3.63	2.55	2.70	2.32	2.53	2.22

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.60	33.80	43.20	56.10	65.60	74.80
78.90	77.00	69.70	57.90	44.60	34.20

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI
AND STATION LATITUDE = 38.45 DEGREES

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.65	323765.125	100.00
RUNOFF	0.024	251.910	0.08
EVAPOTRANSPIRATION	27.545	290968.156	89.87
DRAINAGE COLLECTED FROM LAYER 2	3.0806	32540.881	10.05
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.011	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0017		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000001	0.011	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.004	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.007	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.007	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	0.000	4.110	0.00
SOIL WATER AT START OF YEAR	60.985	644200.000	
SOIL WATER AT END OF YEAR	60.985	644204.125	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.036	0.00

****

****

ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	39.59	418201.062	100.00
RUNOFF	3.480	36760.812	8.79
EVAPOTRANSPIRATION	27.592	291460.625	69.69
DRAINAGE COLLECTED FROM LAYER 2	9.8713	104273.672	24.93
PERC./LEAKAGE THROUGH LAYER 4	0.000005	0.050	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0191		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.006	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000004	0.044	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.029	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.016	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.016	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	-1.353	-14294.126	-3.42
SOIL WATER AT START OF YEAR	60.985	644204.125	
SOIL WATER AT END OF YEAR	59.632	629910.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.030	0.00

****

****

ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.44	374363.437	100.00
RUNOFF	0.344	3628.731	0.97
EVAPOTRANSPIRATION	27.070	285946.219	76.38
DRAINAGE COLLECTED FROM LAYER 2	6.7548	71352.523	19.06
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.015	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0039		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000001	0.015	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.007	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.008	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.008	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	1.272	13435.970	3.59
SOIL WATER AT START OF YEAR	59.632	629910.000	
SOIL WATER AT END OF YEAR	60.645	640606.375	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.259	2739.613	0.73
ANNUAL WATER BUDGET BALANCE	0.0000	-0.032	0.00

****

****

ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.22	361476.062	100.00
RUNOFF	0.442	4664.964	1.29
EVAPOTRANSPIRATION	28.668	302832.719	83.78
DRAINAGE COLLECTED FROM LAYER 2	4.3833	46302.277	12.81
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.017	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0051		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.001	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000001	0.016	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.007	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.009	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.009	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	0.727	7676.210	2.12
SOIL WATER AT START OF YEAR	60.645	640606.375	
SOIL WATER AT END OF YEAR	61.219	646672.625	
SNOW WATER AT START OF YEAR	0.259	2739.613	0.76
SNOW WATER AT END OF YEAR	0.412	4349.573	1.20
ANNUAL WATER BUDGET BALANCE	0.0000	-0.136	0.00

****

****

ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	33.60	354926.844	100.00
RUNOFF	0.238	2519.239	0.71
EVAPOTRANSPIRATION	30.228	319310.469	89.97
DRAINAGE COLLECTED FROM LAYER 2	4.6845	49484.230	13.94
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.020	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0051		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.001	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.019	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.010	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.010	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.010	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	-1.551	-16387.256	-4.62
SOIL WATER AT START OF YEAR	61.219	646672.625	
SOIL WATER AT END OF YEAR	60.079	634634.937	
SNOW WATER AT START OF YEAR	0.412	4349.573	1.23
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.129	0.00

****

****

ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.69	377004.250	100.00
RUNOFF	0.389	4107.287	1.09
EVAPOTRANSPIRATION	28.841	304651.875	80.81
DRAINAGE COLLECTED FROM LAYER 2	6.8004	71834.617	19.05
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.025	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0098		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.002	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.023	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.012	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.011	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.011	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	-0.340	-3589.630	-0.95
SOIL WATER AT START OF YEAR	60.079	634634.937	
SOIL WATER AT END OF YEAR	59.739	631045.312	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.064	0.00

****

****

ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.47	300737.156	100.00
RUNOFF	1.550	16368.519	5.44
EVAPOTRANSPIRATION	22.055	232976.469	77.47
DRAINAGE COLLECTED FROM LAYER 2	4.0334	42605.801	14.17
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.015	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0044		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.001	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000001	0.014	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.007	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.007	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.007	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	0.832	8786.417	2.92
SOIL WATER AT START OF YEAR	59.739	631045.312	
SOIL WATER AT END OF YEAR	60.571	639831.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.070	0.00

****

****

ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.71	398342.094	100.00
RUNOFF	0.534	5639.037	1.42
EVAPOTRANSPIRATION	30.167	318665.687	80.00
DRAINAGE COLLECTED FROM LAYER 2	7.3622	77769.023	19.52
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.019	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0050		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.001	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.018	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.006	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.012	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.012	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	-0.353	-3731.713	-0.94
SOIL WATER AT START OF YEAR	60.571	639831.687	
SOIL WATER AT END OF YEAR	60.218	636100.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.023	0.00

****

****

ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.95	369187.344	100.00
RUNOFF	3.241	34231.441	9.27
EVAPOTRANSPIRATION	24.835	262335.969	71.06
DRAINAGE COLLECTED FROM LAYER 2	5.8833	62146.891	16.83
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.026	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0104		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.003	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.023	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.014	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.009	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.009	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	0.991	10473.118	2.84
SOIL WATER AT START OF YEAR	60.218	636100.000	
SOIL WATER AT END OF YEAR	60.726	641470.937	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.483	5102.172	1.38
ANNUAL WATER BUDGET BALANCE	0.0000	-0.111	0.00

****

****

ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.23	340455.219	100.00
RUNOFF	1.051	11100.992	3.26
EVAPOTRANSPIRATION	25.951	274127.687	80.52
DRAINAGE COLLECTED FROM LAYER 2	5.2335	55283.199	16.24
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.022	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0082		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.002	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.020	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.011	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.010	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.010	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	-0.005	-56.613	-0.02
SOIL WATER AT START OF YEAR	60.726	641470.937	
SOIL WATER AT END OF YEAR	60.860	642877.375	
SNOW WATER AT START OF YEAR	0.483	5102.172	1.50
SNOW WATER AT END OF YEAR	0.345	3639.115	1.07
ANNUAL WATER BUDGET BALANCE	0.0000	-0.100	0.00

****

****

ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.54	343729.750	100.00
RUNOFF	1.345	14207.578	4.13
EVAPOTRANSPIRATION	25.917	273768.187	79.65
DRAINAGE COLLECTED FROM LAYER 2	4.6166	48766.336	14.19
PERC./LEAKAGE THROUGH LAYER 4	0.000004	0.039	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0170		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.006	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000003	0.033	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.026	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.007	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.007	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	0.662	6987.647	2.03
SOIL WATER AT START OF YEAR	60.860	642877.375	
SOIL WATER AT END OF YEAR	60.669	640864.187	
SNOW WATER AT START OF YEAR	0.345	3639.115	1.06
SNOW WATER AT END OF YEAR	1.197	12639.980	3.68
ANNUAL WATER BUDGET BALANCE	0.0000	-0.025	0.00

****

****

ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.65	292075.344	100.00
RUNOFF	0.803	8482.851	2.90
EVAPOTRANSPIRATION	26.174	276484.312	94.66
DRAINAGE COLLECTED FROM LAYER 2	3.3134	34999.957	11.98
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.019	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0063		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.001	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.018	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.011	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.007	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.007	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	-2.640	-27891.752	-9.55
SOIL WATER AT START OF YEAR	60.669	640864.187	
SOIL WATER AT END OF YEAR	59.210	625454.750	
SNOW WATER AT START OF YEAR	1.197	12639.980	4.33
SNOW WATER AT END OF YEAR	0.015	157.661	0.05
ANNUAL WATER BUDGET BALANCE	0.0000	-0.067	0.00

****

****

ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.42	289645.687	100.00
RUNOFF	0.020	215.640	0.07
EVAPOTRANSPIRATION	26.420	279086.687	96.35
DRAINAGE COLLECTED FROM LAYER 2	0.2858	3018.781	1.04
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.005	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0002		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000000	0.005	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.002	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000000	0.002	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000000	0.002	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	0.693	7324.417	2.53
SOIL WATER AT START OF YEAR	59.210	625454.750	
SOIL WATER AT END OF YEAR	59.898	632723.750	
SNOW WATER AT START OF YEAR	0.015	157.661	0.05
SNOW WATER AT END OF YEAR	0.020	213.040	0.07
ANNUAL WATER BUDGET BALANCE	0.0000	0.165	0.00

****

****

ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.75	293131.625	100.00
RUNOFF	0.399	4214.822	1.44
EVAPOTRANSPIRATION	22.685	239623.437	81.75
DRAINAGE COLLECTED FROM LAYER 2	3.8460	40626.520	13.86
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.009	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0021		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000001	0.009	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.003	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.006	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.006	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	0.820	8666.734	2.96
SOIL WATER AT START OF YEAR	59.898	632723.750	
SOIL WATER AT END OF YEAR	60.704	641234.625	
SNOW WATER AT START OF YEAR	0.020	213.040	0.07
SNOW WATER AT END OF YEAR	0.035	368.901	0.13
ANNUAL WATER BUDGET BALANCE	0.0000	0.095	0.00

****

****

ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.54	333166.594	100.00
RUNOFF	1.570	16580.018	4.98
EVAPOTRANSPIRATION	25.083	264957.844	79.53
DRAINAGE COLLECTED FROM LAYER 2	6.0841	64268.660	19.29
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.023	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0089		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.002	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.021	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.012	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.008	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.008	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	-1.197	-12639.977	-3.79
SOIL WATER AT START OF YEAR	60.704	641234.625	
SOIL WATER AT END OF YEAR	59.542	628963.562	
SNOW WATER AT START OF YEAR	0.035	368.901	0.11
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.023	0.00

****

****

ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.11	360314.187	100.00
RUNOFF	2.413	25487.684	7.07
EVAPOTRANSPIRATION	27.522	290723.000	80.69
DRAINAGE COLLECTED FROM LAYER 2	4.3051	45476.145	12.62
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.018	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0059		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.001	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.017	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.009	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.008	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.008	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	-0.130	-1372.596	-0.38
SOIL WATER AT START OF YEAR	59.542	628963.562	
SOIL WATER AT END OF YEAR	59.412	627591.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.073	0.00

****

****

ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.61	238836.250	100.00
RUNOFF	2.097	22146.135	9.27
EVAPOTRANSPIRATION	18.154	191765.969	80.29
DRAINAGE COLLECTED FROM LAYER 2	2.1828	23057.705	9.65
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.013	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0047		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.001	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000001	0.012	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.007	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000000	0.004	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000000	0.004	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	0.177	1866.417	0.78
SOIL WATER AT START OF YEAR	59.412	627591.000	
SOIL WATER AT END OF YEAR	59.122	624527.187	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.467	4930.187	2.06
ANNUAL WATER BUDGET BALANCE	0.0000	0.011	0.00

****

****

ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	41.85	442074.156	100.00
RUNOFF	2.541	26839.400	6.07
EVAPOTRANSPIRATION	31.232	329914.156	74.63
DRAINAGE COLLECTED FROM LAYER 2	7.0407	74373.445	16.82
PERC./LEAKAGE THROUGH LAYER 4	0.000002	0.022	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0090		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.001	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000001	0.016	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.008	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.007	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.007	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	1.036	10946.960	2.48
SOIL WATER AT START OF YEAR	59.122	624527.187	
SOIL WATER AT END OF YEAR	60.625	640404.375	
SNOW WATER AT START OF YEAR	0.467	4930.187	1.12
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.171	0.00

****

****

ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	33.48	353659.250	100.00
RUNOFF	0.897	9474.285	2.68
EVAPOTRANSPIRATION	27.777	293418.875	82.97
DRAINAGE COLLECTED FROM LAYER 2	5.0123	52946.508	14.97
PERC./LEAKAGE THROUGH LAYER 4	0.000001	0.014	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0027		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.001	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000002	0.018	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.008	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.010	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.010	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	-0.206	-2180.405	-0.62
SOIL WATER AT START OF YEAR	60.625	640404.375	
SOIL WATER AT END OF YEAR	60.419	638223.937	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.028	0.00

****

****

ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.65	397708.281	100.00
RUNOFF	0.692	7312.188	1.84
EVAPOTRANSPIRATION	27.836	294039.187	73.93
DRAINAGE COLLECTED FROM LAYER 2	9.2266	97463.133	24.51
PERC./LEAKAGE THROUGH LAYER 4	0.000003	0.031	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0122		
DRAINAGE COLLECTED FROM LAYER 7	0.0000	0.002	0.00
PERC./LEAKAGE THROUGH LAYER 8	0.000003	0.029	0.00
AVG. HEAD ON TOP OF LAYER 8	0.0000		
DRAINAGE COLLECTED FROM LAYER 10	0.0000	0.017	0.00
PERC./LEAKAGE THROUGH LAYER 12	0.000001	0.012	0.00
AVG. HEAD ON TOP OF LAYER 11	0.0000		
DRAINAGE COLLECTED FROM LAYER 14	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 15	0.000001	0.012	0.00
AVG. HEAD ON TOP OF LAYER 15	0.0000		
CHANGE IN WATER STORAGE	-0.105	-1106.402	-0.28
SOIL WATER AT START OF YEAR	60.419	638223.937	
SOIL WATER AT END OF YEAR	60.314	637117.562	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.118	0.00

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.49	2.05	2.93	3.43	3.20	4.51
	3.26	2.50	2.86	2.21	2.17	2.34
STD. DEVIATIONS	0.79	1.05	0.90	1.42	1.74	2.24
	2.07	1.27	1.44	1.28	1.58	1.10
RUNOFF						
TOTALS	0.210	0.405	0.382	0.007	0.019	0.093
	0.038	0.000	0.006	0.005	0.019	0.017
STD. DEVIATIONS	0.312	0.453	0.749	0.021	0.048	0.208
	0.102	0.000	0.022	0.023	0.043	0.031
EVAPOTRANSPIRATION						
TOTALS	0.488	0.698	2.271	3.384	3.518	4.759
	3.446	2.509	2.144	1.503	1.100	0.768
STD. DEVIATIONS	0.254	0.439	0.509	0.858	1.060	1.463
	1.597	1.156	1.029	0.309	0.367	0.204
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.3745	0.7412	1.5196	0.6086	0.3566	0.2508
	0.0648	0.0229	0.0108	0.1243	0.3407	0.7852
STD. DEVIATIONS	0.4922	1.0051	0.8313	0.5815	0.6077	0.5925
	0.1480	0.1002	0.0417	0.4369	0.7828	1.0015
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 7						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 8						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 10

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 12

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 14

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 15

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0024	0.0202	0.0366	0.0046	0.0029	0.0022
	0.0004	0.0001	0.0001	0.0021	0.0050	0.0082
STD. DEVIATIONS	0.0032	0.0307	0.0447	0.0058	0.0063	0.0060
	0.0010	0.0006	0.0003	0.0086	0.0137	0.0195

DAILY AVERAGE HEAD ON TOP OF LAYER 8

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 11

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 15

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	32.96	(4.646)	348140.0	100.00
RUNOFF	1.203	(1.0512)	12711.68	3.651
EVAPOTRANSPIRATION	26.588	(3.0465)	280852.87	80.672
LATERAL DRAINAGE COLLECTED FROM LAYER 2	5.20003	(2.28190)	54929.516	15.77800
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000	(0.00000)	0.021	0.00001
AVERAGE HEAD ON TOP OF LAYER 3	0.007	(0.005)		
LATERAL DRAINAGE COLLECTED FROM LAYER 7	0.00000	(0.00000)	0.002	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.00000	(0.00000)	0.019	0.00001
AVERAGE HEAD ON TOP OF LAYER 8	0.000	(0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 10	0.00000	(0.00000)	0.011	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.00000	(0.00000)	0.008	0.00000
AVERAGE HEAD ON TOP OF LAYER 11	0.000	(0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 14	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 15	0.00000	(0.00000)	0.008	0.00000
AVERAGE HEAD ON TOP OF LAYER 15	0.000	(0.000)		
CHANGE IN WATER STORAGE	-0.034	(1.0117)	-354.12	-0.102

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	3.44	36337.754
RUNOFF	1.265	13359.7051
DRAINAGE COLLECTED FROM LAYER 2	0.98498	10404.58690
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000002	0.01724
AVERAGE HEAD ON TOP OF LAYER 3	2.886	
MAXIMUM HEAD ON TOP OF LAYER 3	4.136	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	30.6 FEET	
DRAINAGE COLLECTED FROM LAYER 7	0.00000	0.00031
PERCOLATION/LEAKAGE THROUGH LAYER 8	0.000000	0.00113
AVERAGE HEAD ON TOP OF LAYER 8	0.000	
MAXIMUM HEAD ON TOP OF LAYER 8	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 7 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 10	0.00000	0.00103
PERCOLATION/LEAKAGE THROUGH LAYER 12	0.000000	0.00007
AVERAGE HEAD ON TOP OF LAYER 11	0.000	
MAXIMUM HEAD ON TOP OF LAYER 11	0.012	
LOCATION OF MAXIMUM HEAD IN LAYER 10 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 14	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 15	0.000000	0.00009
AVERAGE HEAD ON TOP OF LAYER 15	0.000	
MAXIMUM HEAD ON TOP OF LAYER 15	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 14 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	2.22	23399.3594

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3865
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1160

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

****

****

FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	6.2002	0.2583
2	0.0125	0.0501
3	0.0000	0.0000
4	0.1875	0.7500
5	0.2700	0.0450
6	38.9760	0.2320
7	0.8100	0.0450
8	0.0000	0.0000
9	2.7840	0.2320
10	0.0025	0.0100
11	0.0000	0.0000
12	0.1875	0.7500
13	1.3920	0.2320
14	1.1520	0.0320
15	5.5560	0.4630
SNOW WATER	0.000	

****
****

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP3\SAUGETP.D4
TEMPERATURE DATA FILE:       C:\HELP3\SAUGETT.D7
SOLAR RADIATION DATA FILE:   C:\HELP3\SAUGETR.D13
EVAPOTRANSPIRATION DATA:     C:\HELP3\SAUGETE.D11
SOIL AND DESIGN DATA FILE:   C:\HELP3\SAUGETC.D10
OUTPUT DATA FILE:            C:\HELP3\SAUGETC.OUT


TIME:  10:44     DATE:   5/ 8/2000


******************************************************************************

     TITLE:  SOLUTIA SAUGET LANDFILL During Construction

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   8
          THICKNESS                    =     80.00   INCHES
          POROSITY                     =      0.4630 VOL/VOL
          FIELD CAPACITY               =      0.2320 VOL/VOL
          WILTING POINT                =      0.1160 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.2511 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.369999994000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.00
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.
```

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	18.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0585	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999978000E-02	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	275.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	3.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 8

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4630	VOL/VOL
FIELD CAPACITY	=	0.2320	VOL/VOL
WILTING POINT	=	0.1160	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.369999994000E-03	CM/SEC

LAYER 5

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.25	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0105	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	275.0	FEET

LAYER 6

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	2.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	3.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 7

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 17

THICKNESS	=	0.25	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7500	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000003000E-08	CM/SEC

LAYER 8

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 8

THICKNESS	=	6.00	INCHES
POROSITY	=	0.4630	VOL/VOL
FIELD CAPACITY	=	0.2320	VOL/VOL
WILTING POINT	=	0.1160	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.369999994000E-03	CM/SEC

LAYER 9

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 21

THICKNESS	=	36.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	275.0	FEET

LAYER 10

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 8

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4630	VOL/VOL
FIELD CAPACITY	=	0.2320	VOL/VOL
WILTING POINT	=	0.1160	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4630	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.369999994000E-03	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 8 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 1.% AND A SLOPE LENGTH OF 300. FEET.

SCS RUNOFF CURVE NUMBER	=	90.20	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	3.020	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	5.507	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.260	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.320	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	32.219	INCHES
TOTAL INITIAL WATER	=	32.219	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM ST. LOUIS MISSOURI

STATION LATITUDE	=	38.45	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	98	
END OF GROWING SEASON (JULIAN DATE)	=	300	
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.40	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	73.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	67.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	74.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
1.72	2.14	3.28	3.55	3.54	3.73
3.63	2.55	2.70	2.32	2.53	2.22

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.60	33.80	43.20	56.10	65.60	74.80
78.90	77.00	69.70	57.90	44.60	34.20

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ST. LOUIS MISSOURI
AND STATION LATITUDE = 38.45 DEGREES

****

ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	30.65	336003.656	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	27.519	301680.531	89.78
DRAINAGE COLLECTED FROM LAYER 2	2.4984	27389.021	8.15
PERC./LEAKAGE THROUGH LAYER 3	0.432531	4741.667	1.41
AVG. HEAD ON TOP OF LAYER 3	1.6536		
DRAINAGE COLLECTED FROM LAYER 5	0.4325	4741.171	1.41
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0003		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	0.200	2192.863	0.65
SOIL WATER AT START OF YEAR	35.003	383728.312	
SOIL WATER AT END OF YEAR	35.203	385921.156	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.048	0.00

****

****

ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	39.59	434009.344	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	27.596	302520.594	69.70
DRAINAGE COLLECTED FROM LAYER 2	10.0134	109773.078	25.29
PERC./LEAKAGE THROUGH LAYER 3	1.299532	14246.251	3.28
AVG. HEAD ON TOP OF LAYER 3	6.6265		
DRAINAGE COLLECTED FROM LAYER 5	1.2373	13563.729	3.13
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0008		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	0.744	8151.987	1.88
SOIL WATER AT START OF YEAR	35.203	385921.156	
SOIL WATER AT END OF YEAR	35.947	394073.156	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.078	0.00

****

****

ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.44	388514.625	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	27.194	298114.000	76.73
DRAINAGE COLLECTED FROM LAYER 2	7.3918	81032.945	20.86
PERC./LEAKAGE THROUGH LAYER 3	1.030263	11294.364	2.91
AVG. HEAD ON TOP OF LAYER 3	4.9091		
DRAINAGE COLLECTED FROM LAYER 5	1.0925	11976.186	3.08
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0007		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	-0.238	-2608.687	-0.67
SOIL WATER AT START OF YEAR	35.947	394073.156	
SOIL WATER AT END OF YEAR	35.450	388621.281	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.259	2843.172	0.73
ANNUAL WATER BUDGET BALANCE	0.0000	0.139	0.00

****

****

ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.22	375140.094	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	28.659	314174.406	83.75
DRAINAGE COLLECTED FROM LAYER 2	4.5695	50093.402	13.35
PERC./LEAKAGE THROUGH LAYER 3	0.700499	7679.288	2.05
AVG. HEAD ON TOP OF LAYER 3	3.0242		
DRAINAGE COLLECTED FROM LAYER 5	0.7005	7679.345	2.05
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0005		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	0.291	3193.113	0.85
SOIL WATER AT START OF YEAR	35.450	388621.281	
SOIL WATER AT END OF YEAR	35.589	390143.594	
SNOW WATER AT START OF YEAR	0.259	2843.172	0.76
SNOW WATER AT END OF YEAR	0.412	4513.990	1.20
ANNUAL WATER BUDGET BALANCE	0.0000	-0.184	0.00

****

****

ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	33.60	368343.312	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	30.240	331508.094	90.00
DRAINAGE COLLECTED FROM LAYER 2	3.1095	34088.547	9.25
PERC./LEAKAGE THROUGH LAYER 3	0.519427	5694.271	1.55
AVG. HEAD ON TOP OF LAYER 3	2.0590		
DRAINAGE COLLECTED FROM LAYER 5	0.5194	5693.663	1.55
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0003		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	-0.269	-2947.032	-0.80
SOIL WATER AT START OF YEAR	35.589	390143.594	
SOIL WATER AT END OF YEAR	35.732	391710.531	
SNOW WATER AT START OF YEAR	0.412	4513.990	1.23
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.005	0.00

****

****

ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	35.69	391255.250	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	28.901	316829.906	80.98
DRAINAGE COLLECTED FROM LAYER 2	4.3306	47474.695	12.13
PERC./LEAKAGE THROUGH LAYER 3	0.674017	7388.982	1.89
AVG. HEAD ON TOP OF LAYER 3	2.8726		
DRAINAGE COLLECTED FROM LAYER 5	0.6738	7386.157	1.89
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0004		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	1.785	19564.518	5.00
SOIL WATER AT START OF YEAR	35.732	391710.531	
SOIL WATER AT END OF YEAR	37.516	411275.062	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.019	0.00

****

****

ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	28.47	312105.219	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	22.013	241324.687	77.32
DRAINAGE COLLECTED FROM LAYER 2	7.6924	84328.852	27.02
PERC./LEAKAGE THROUGH LAYER 3	1.070648	11737.088	3.76
AVG. HEAD ON TOP OF LAYER 3	5.1141		
DRAINAGE COLLECTED FROM LAYER 5	1.0709	11739.515	3.76
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0007		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	-2.307	-25287.867	-8.10
SOIL WATER AT START OF YEAR	37.516	411275.062	
SOIL WATER AT END OF YEAR	35.209	385987.187	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.007	0.00

****

****

ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.71	413399.687	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	30.203	331105.531	80.09
DRAINAGE COLLECTED FROM LAYER 2	6.5000	71257.336	17.24
PERC./LEAKAGE THROUGH LAYER 3	0.929714	10192.078	2.47
AVG. HEAD ON TOP OF LAYER 3	4.3012		
DRAINAGE COLLECTED FROM LAYER 5	0.9027	9895.495	2.39
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0006		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	0.104	1141.241	0.28
SOIL WATER AT START OF YEAR	35.209	385987.187	
SOIL WATER AT END OF YEAR	35.314	387128.437	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.050	0.00

****

****

ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.95	383142.875	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	24.892	272886.375	71.22
DRAINAGE COLLECTED FROM LAYER 2	6.6010	72363.578	18.89
PERC./LEAKAGE THROUGH LAYER 3	0.942917	10336.821	2.70
AVG. HEAD ON TOP OF LAYER 3	4.3779		
DRAINAGE COLLECTED FROM LAYER 5	0.9661	10590.480	2.76
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0006		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	2.490	27302.203	7.13
SOIL WATER AT START OF YEAR	35.314	387128.437	
SOIL WATER AT END OF YEAR	37.321	409135.594	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.483	5295.038	1.38
ANNUAL WATER BUDGET BALANCE	0.0000	0.211	0.00

****

****

ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.23	353324.625	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	25.987	284886.437	80.63
DRAINAGE COLLECTED FROM LAYER 2	6.3791	69931.312	19.79
PERC./LEAKAGE THROUGH LAYER 3	0.917932	10062.918	2.85
AVG. HEAD ON TOP OF LAYER 3	4.2396		
DRAINAGE COLLECTED FROM LAYER 5	0.9219	10106.423	2.86
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0006		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	-1.058	-11599.585	-3.28
SOIL WATER AT START OF YEAR	37.321	409135.594	
SOIL WATER AT END OF YEAR	36.401	399054.375	
SNOW WATER AT START OF YEAR	0.483	5295.038	1.50
SNOW WATER AT END OF YEAR	0.345	3776.676	1.07
ANNUAL WATER BUDGET BALANCE	0.0000	0.012	0.00

****

****

ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.54	356722.969	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.051	285587.250	80.06
DRAINAGE COLLECTED FROM LAYER 2	5.1065	55980.879	15.69
PERC./LEAKAGE THROUGH LAYER 3	0.762566	8359.708	2.34
AVG. HEAD ON TOP OF LAYER 3	3.3839		
DRAINAGE COLLECTED FROM LAYER 5	0.7626	8359.811	2.34
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0005		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	0.620	6794.955	1.90
SOIL WATER AT START OF YEAR	36.401	399054.375	
SOIL WATER AT END OF YEAR	36.169	396508.219	
SNOW WATER AT START OF YEAR	0.345	3776.676	1.06
SNOW WATER AT END OF YEAR	1.197	13117.780	3.68
ANNUAL WATER BUDGET BALANCE	0.0000	0.058	0.00

****

****

ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.65	303115.969	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.159	286768.969	94.61
DRAINAGE COLLECTED FROM LAYER 2	4.3541	47732.344	15.75
PERC./LEAKAGE THROUGH LAYER 3	0.677457	7426.690	2.45
AVG. HEAD ON TOP OF LAYER 3	2.8835		
DRAINAGE COLLECTED FROM LAYER 5	0.6774	7426.236	2.45
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0004		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	-3.540	-38811.602	-12.80
SOIL WATER AT START OF YEAR	36.169	396508.219	
SOIL WATER AT END OF YEAR	33.810	370650.781	
SNOW WATER AT START OF YEAR	1.197	13117.780	4.33
SNOW WATER AT END OF YEAR	0.015	163.621	0.05
ANNUAL WATER BUDGET BALANCE	0.0000	-0.001	0.00

****

****

ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.42	300594.500	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	26.409	289511.937	96.31
DRAINAGE COLLECTED FROM LAYER 2	1.0127	11102.008	3.69
PERC./LEAKAGE THROUGH LAYER 3	0.213900	2344.896	0.78
AVG. HEAD ON TOP OF LAYER 3	0.6751		
DRAINAGE COLLECTED FROM LAYER 5	0.2141	2346.887	0.78
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.027	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0001		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.027	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	-0.216	-2366.399	-0.79
SOIL WATER AT START OF YEAR	33.810	370650.781	
SOIL WATER AT END OF YEAR	33.589	368226.906	
SNOW WATER AT START OF YEAR	0.015	163.621	0.05
SNOW WATER AT END OF YEAR	0.020	221.093	0.07
ANNUAL WATER BUDGET BALANCE	0.0000	0.034	0.00

****

****

ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	27.75	304212.187	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	22.752	249418.250	81.99
DRAINAGE COLLECTED FROM LAYER 2	2.4830	27220.068	8.95
PERC./LEAKAGE THROUGH LAYER 3	0.422091	4627.217	1.52
AVG. HEAD ON TOP OF LAYER 3	1.6420		
DRAINAGE COLLECTED FROM LAYER 5	0.4220	4626.412	1.52
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0003		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	2.093	22947.379	7.54
SOIL WATER AT START OF YEAR	33.589	368226.906	
SOIL WATER AT END OF YEAR	35.668	391012.531	
SNOW WATER AT START OF YEAR	0.020	221.093	0.07
SNOW WATER AT END OF YEAR	0.035	382.845	0.13
ANNUAL WATER BUDGET BALANCE	0.0000	0.065	0.00

****

****

ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT
PRECIPITATION	31.54	345760.500	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	25.016	274240.156	79.32
DRAINAGE COLLECTED FROM LAYER 2	6.8506	75099.859	21.72
PERC./LEAKAGE THROUGH LAYER 3	0.958552	10508.224	3.04
AVG. HEAD ON TOP OF LAYER 3	4.5294		
DRAINAGE COLLECTED FROM LAYER 5	0.9079	9952.692	2.88
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0006		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	-1.234	-13532.370	-3.91
SOIL WATER AT START OF YEAR	35.668	391012.531	
SOIL WATER AT END OF YEAR	34.468	377863.031	
SNOW WATER AT START OF YEAR	0.035	382.845	0.11
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.126	0.00

****

****

ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
PRECIPITATION	34.11	373934.281	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	27.953	306436.187	81.95
DRAINAGE COLLECTED FROM LAYER 2	6.0213	66009.109	17.65
PERC./LEAKAGE THROUGH LAYER 3	0.877935	9624.451	2.57
AVG. HEAD ON TOP OF LAYER 3	3.9881		
DRAINAGE COLLECTED FROM LAYER 5	0.9285	10178.478	2.72
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0006		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	-0.793	-8689.486	-2.32
SOIL WATER AT START OF YEAR	34.468	377863.031	
SOIL WATER AT END OF YEAR	33.676	369173.531	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.028	0.00

****

****

ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.61	247864.406	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	18.141	198871.562	80.23
DRAINAGE COLLECTED FROM LAYER 2	4.0331	44213.223	17.84
PERC./LEAKAGE THROUGH LAYER 3	0.633356	6943.232	2.80
AVG. HEAD ON TOP OF LAYER 3	2.6741		
DRAINAGE COLLECTED FROM LAYER 5	0.6335	6944.625	2.80
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0004		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	-0.197	-2164.890	-0.87
SOIL WATER AT START OF YEAR	33.676	369173.531	
SOIL WATER AT END OF YEAR	33.012	361892.094	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.467	5116.551	2.06
ANNUAL WATER BUDGET BALANCE	0.0000	-0.123	0.00

****

****

ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	41.85	458784.844	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	31.116	341116.094	74.35
DRAINAGE COLLECTED FROM LAYER 2	3.7668	41294.395	9.00
PERC./LEAKAGE THROUGH LAYER 3	0.596008	6533.797	1.42
AVG. HEAD ON TOP OF LAYER 3	2.4939		
DRAINAGE COLLECTED FROM LAYER 5	0.5958	6531.999	1.42
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0004		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	6.371	69842.250	15.22
SOIL WATER AT START OF YEAR	33.012	361892.094	
SOIL WATER AT END OF YEAR	39.849	436850.906	
SNOW WATER AT START OF YEAR	0.467	5116.551	1.12
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.085	0.00

****

****

ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	33.48	367027.812	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	28.008	307038.656	83.66
DRAINAGE COLLECTED FROM LAYER 2	9.2008	100864.828	27.48
PERC./LEAKAGE THROUGH LAYER 3	1.235383	13543.005	3.69
AVG. HEAD ON TOP OF LAYER 3	6.1277		
DRAINAGE COLLECTED FROM LAYER 5	1.2354	13543.631	3.69
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0008		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	-4.964	-54419.234	-14.83
SOIL WATER AT START OF YEAR	39.849	436850.906	
SOIL WATER AT END OF YEAR	34.885	382431.656	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.106	0.00

****

****

ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.65	412741.906	100.00
RUNOFF	0.000	0.000	0.00
EVAPOTRANSPIRATION	27.839	305185.219	73.94
DRAINAGE COLLECTED FROM LAYER 2	4.5386	49755.090	12.05
PERC./LEAKAGE THROUGH LAYER 3	0.698795	7660.614	1.86
AVG. HEAD ON TOP OF LAYER 3	3.0007		
DRAINAGE COLLECTED FROM LAYER 5	0.6345	6956.166	1.69
PERC./LEAKAGE THROUGH LAYER 7	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0004		
DRAINAGE COLLECTED FROM LAYER 9	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000003	0.028	0.00
AVG. HEAD ON TOP OF LAYER 10	0.0000		
CHANGE IN WATER STORAGE	4.638	50845.465	12.32
SOIL WATER AT START OF YEAR	34.885	382431.656	
SOIL WATER AT END OF YEAR	39.523	433277.125	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.058	0.00

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	1.49	2.05	2.93	3.43	3.20	4.51
	3.26	2.50	2.86	2.21	2.17	2.34
STD. DEVIATIONS	0.79	1.05	0.90	1.42	1.74	2.24
	2.07	1.27	1.44	1.28	1.58	1.10
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.488	0.699	2.273	3.391	3.510	4.749
	3.474	2.516	2.150	1.508	1.105	0.770
STD. DEVIATIONS	0.256	0.439	0.507	0.861	1.054	1.469
	1.611	1.160	1.034	0.312	0.369	0.206
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.2332	0.2120	0.3458	0.5753	0.6901	0.6622
	0.6386	0.5494	0.4461	0.3833	0.3081	0.2785
STD. DEVIATIONS	0.1698	0.2064	0.3017	0.3340	0.3240	0.3009
	0.2957	0.2613	0.2042	0.1667	0.1283	0.1443
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0393	0.0349	0.0522	0.0802	0.0945	0.0909
	0.0888	0.0786	0.0661	0.0591	0.0494	0.0458
STD. DEVIATIONS	0.0219	0.0260	0.0370	0.0395	0.0371	0.0345
	0.0339	0.0305	0.0246	0.0210	0.0169	0.0186
LATERAL DRAINAGE COLLECTED FROM LAYER 5						
TOTALS	0.0392	0.0311	0.0374	0.0497	0.0717	0.0840
	0.0936	0.0936	0.0845	0.0766	0.0625	0.0525
STD. DEVIATIONS	0.0222	0.0170	0.0213	0.0226	0.0308	0.0334
	0.0354	0.0349	0.0323	0.0317	0.0288	0.0260
PERCOLATION/LEAKAGE THROUGH LAYER 7						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 9

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 10

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	1.8251	1.8255	2.7068	4.6532	5.4013	5.3558
	4.9984	4.2999	3.6077	3.0000	2.4922	2.1797
STD. DEVIATIONS	1.3287	1.7914	2.3617	2.7011	2.5359	2.4340
	2.3148	2.0453	1.6512	1.3051	1.0373	1.1296

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0003	0.0003	0.0003	0.0004	0.0006	0.0007
	0.0007	0.0007	0.0007	0.0006	0.0005	0.0004
STD. DEVIATIONS	0.0002	0.0001	0.0002	0.0002	0.0002	0.0003
	0.0003	0.0003	0.0003	0.0002	0.0002	0.0002

DAILY AVERAGE HEAD ON TOP OF LAYER 10

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	INCHES		CU. FEET	PERCENT
PRECIPITATION	32.96	(4.646)	361299.9	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	26.632	(3.0557)	291960.25	80.808
LATERAL DRAINAGE COLLECTED FROM LAYER 2	5.32266	(2.30157)	58350.234	16.15008
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.77968	(0.27733)	8547.279	2.36570
AVERAGE HEAD ON TOP OF LAYER 3	3.529	(1.528)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	0.77645	(0.27614)	8511.955	2.35593
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000	(0.00000)	0.028	0.00001
AVERAGE HEAD ON TOP OF LAYER 6	0.001	(0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 9	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00000	(0.00000)	0.028	0.00001
AVERAGE HEAD ON TOP OF LAYER 10	0.000	(0.000)		
CHANGE IN WATER STORAGE	0.226	(2.5330)	2477.44	0.686

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	3.44	37711.344
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.04787	524.80231
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.005826	63.87018
AVERAGE HEAD ON TOP OF LAYER 3	11.615	
MAXIMUM HEAD ON TOP OF LAYER 3	16.082	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	84.5 FEET	
DRAINAGE COLLECTED FROM LAYER 5	0.00577	63.22698
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.00008
AVERAGE HEAD ON TOP OF LAYER 6	0.001	
MAXIMUM HEAD ON TOP OF LAYER 6	0.003	
LOCATION OF MAXIMUM HEAD IN LAYER 5 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 9	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00010
AVERAGE HEAD ON TOP OF LAYER 10	0.000	
MAXIMUM HEAD ON TOP OF LAYER 10	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 9 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	2.22	24283.8711

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4630

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1160

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

****

****

FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	22.3903	0.2799
2	3.2104	0.1784
3	0.0000	0.0000
4	2.8482	0.2373
5	0.0028	0.0114
6	0.0000	0.0000
7	0.1875	0.7500
8	1.3920	0.2320
9	1.1520	0.0320
10	5.5560	0.4630
SNOW WATER	0.000	

****
****

APPENDIX D

COVER SYSTEM COMPONENT DESIGN

Cover System Stormwater Control

URS Greiner Woodward Clyde

Job: Solutia Sauget
Description: Cover System Stormwater Control

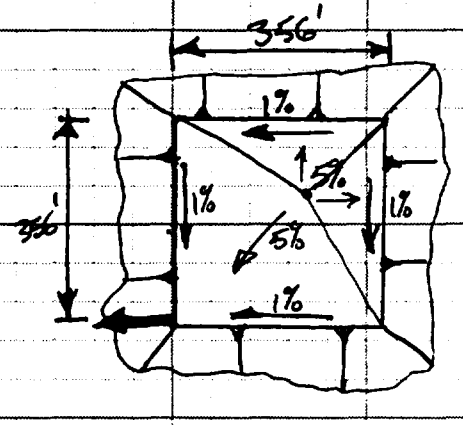
Project No. C10000 3899.00
Computed by: M. Brungard
Checked by: Bill Weber

Page ___ of ___
Sheet 1 of 5
Date: 5/12/00
Date: 5/25/2000
Reference

Purpose: Estimate flow, velocity, & depth of flow for various portions of the cover system drainage.

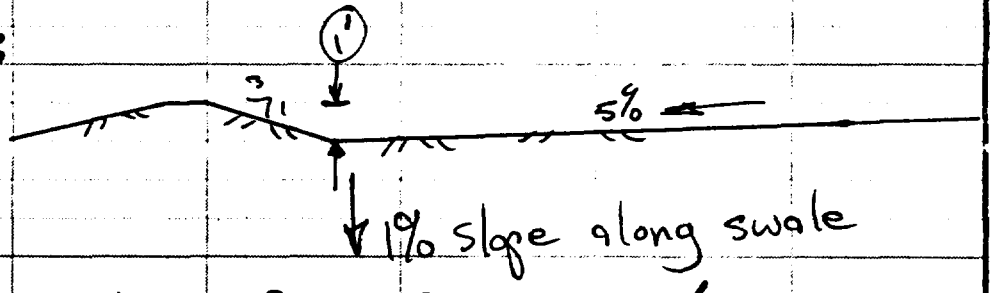
Assumptions: The cover area is about 356' × 356' or 2.91 ac. The 100 yr, 24-hr storm is 8.21 inches, taken from: "Frequency Distributions & Hydroclimatic Characteristics of Heavy Rainstorms in Illinois" by Huff & Angel. The 2 yr, 24 hr storm is 3.28 inches.

Configuration:



Analysis: Use TR-55 methodology for Graphical Peak Flow.
Time of Concentration = 0.36 hr, output attached QTR-55
Peak Flow = 16 cfs, QTR-55 output attached

Perimeter Swale:



Flow Depth for 8 cfs is 0.58'
Flow Velocity for 8 cfs is 2.03 ft/sec

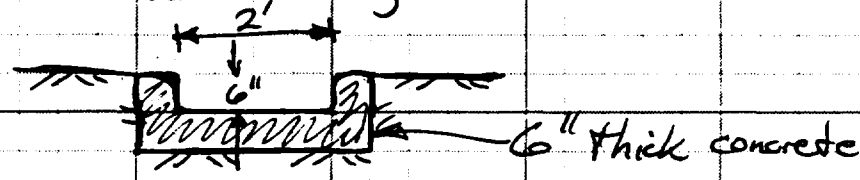
see attached Flow Master calculation sheets

For 8 cfs, the 1-foot swale depth is OK.
The flow velocity is OK for grassed protection.

URS Greiner Woodward Clyde

Job: Solutia Saget
Description: Cover System Stormwater Control
Project No. C10000389200
Computed by: M. Brungard
Checked by: Bill Weber
Page ___ of ___
Sheet 2 of 5
Date 5/12/00
Date 5/25/2000
Reference

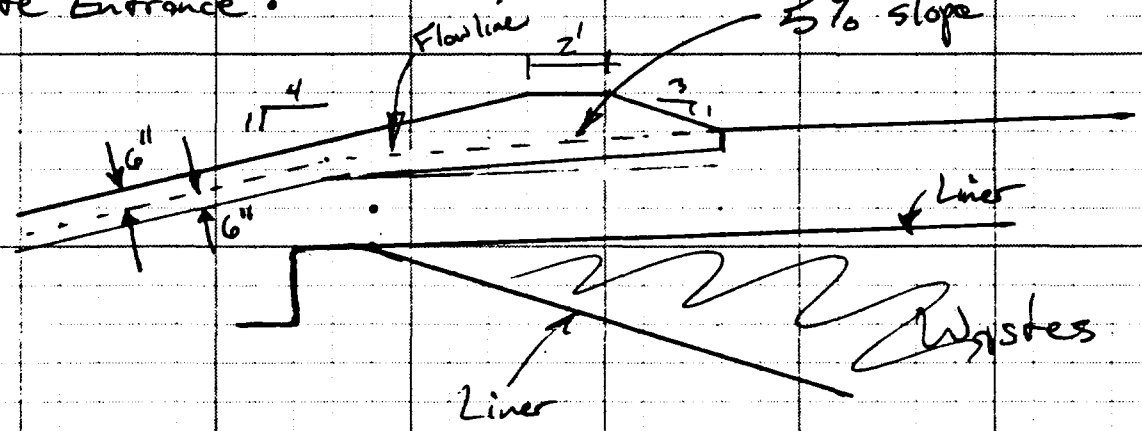
Downchute: Bring flow directly down the 4:1 side slope. Use rectangular section. 2' wide x 6" deep



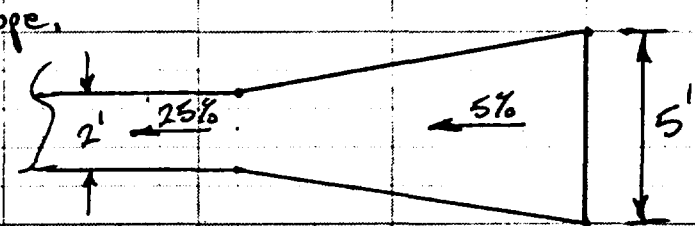
Depth of Flow = 0.38' = 4.5" < 6" OK

see attached Flow Master sheet

Downchute Entrance:



The attached FlowMaster sheet shows that a 3' rectangular channel width keeps the depth of flow to about 6 inches for the 5% channel slope.



Make the entrance width transition from 5' down to 2' for the 5% slope channel section

URS Greiner Woodward Clyde

Job: Solutia Sauget
Description: Cover System Stormwater Control

Project No. C100003899.00
Computed by: M. Brungard
Checked by: Bill Weber

Page ___ of ___
Sheet 3 of 5
Date 5/12/00
Date 5/25/2000
Reference

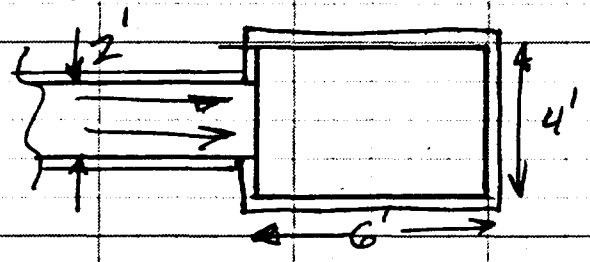
Stilling Basin: Since the Froude Number of the flow in the Downchute is fairly high (6), a rip rap apron is not suitable for this use.

Arbitrarily select a 1-foot sill height for the stilling basin. Use Figure 18.10 (attached) from the Hydraulic Design Handbook, Mays, McGraw-Hill, 1999 to determine hydraulic jump length. Use horizontal apron case.

$L/D = 6$, D is the sill height $= 1'$, so $\underline{L = 6'}$

Because the stilling basin will have an end sill, the hydraulic jump length is going to be shorter than 6'. Use $\underline{6'}$ for the stilling basin length any how.

Since the downchute channel is 2' wide, arbitrarily use a stilling basin width of $\underline{4'}$



Use an overflow sill length of $6' + 6' + 4' = \underline{16'}$

Estimate depth of flow over sill using broadcrested weir equation.

$$q = 0.55\left(\frac{2}{3}\right)\sqrt{2g}\,(d_3)^{1.5}$$

$$q = Q/L = 16\text{ cfs}/16' = \underline{1\ \tfrac{\text{cfs}}{\text{ft}}}$$

$$1 = 0.55(2/3)\sqrt{2(32.2)}\,(d_3)^{1.5}$$

$$1 = 2.94\,d_3^{1.5}$$

$$0.3398 = d_3^{1.5}$$

$$\underline{d_3 = 0.49'}$$

URS Greiner Woodward Clyde

Job Solutia Sauget | Project No. C100003899.00 | Page ___ of ___
Sheet 4 of 5
Description Cover System Stormwater Control | Computed by M. Brunogard | Date 5/12/00
Checked by B. Weber | Date 5/25/2000
Reference

Overflow Velocity = q/d_c at sill. For Broad-crested weirs, the d_c is roughly 2/3 the d_3 depth.

$d_c = 2/3(0.49') = \underline{0.33'}$

$q = 1\ cfs/ft$ ← 16 cfs / 16 ft

velocity = 1 cfs/ft / 0.33' = 3 ft/sec

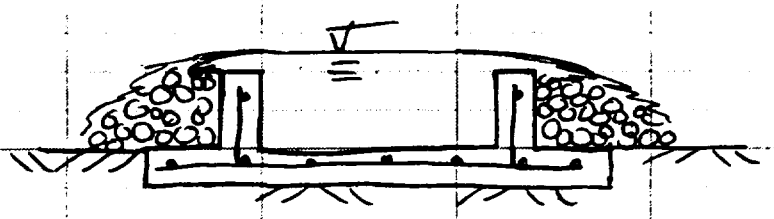
check Froude Number: $F = \frac{V}{\sqrt{g d_c}}$

$= \frac{3}{\sqrt{32.2(0.33)}}$

$= 0.92$

Flow over sill is subcritical, basin size is OK

Conclusion: 6' by 4' x 1' stilling basin will dissipate the energy from the downchute. Use a wide lip at the sill base to reduce erosion potential. Use a berm of gravel around the basin to further reduce erosion potential. Based on 3 ft/sec velocity, the average size of gravel should be at least 2 inches (diameter). Install a pipe sleeve through sill wall to allow basin to drain between events.



Structural Considerations: No significant loading to basin, use temp & shrinkage steel. To meet min cover requirements, the concrete thickness is 6". Gross Area/ft = 0.5 ft²/ft
Steel Area = 0.002 (Gross Area) = .001 ft² = .144 in²/ft.
Use #4 bars @ 12" OC.

Source: Hydraulic Design Handbook, Mays, McGraw Hill, 1999 (5/5)

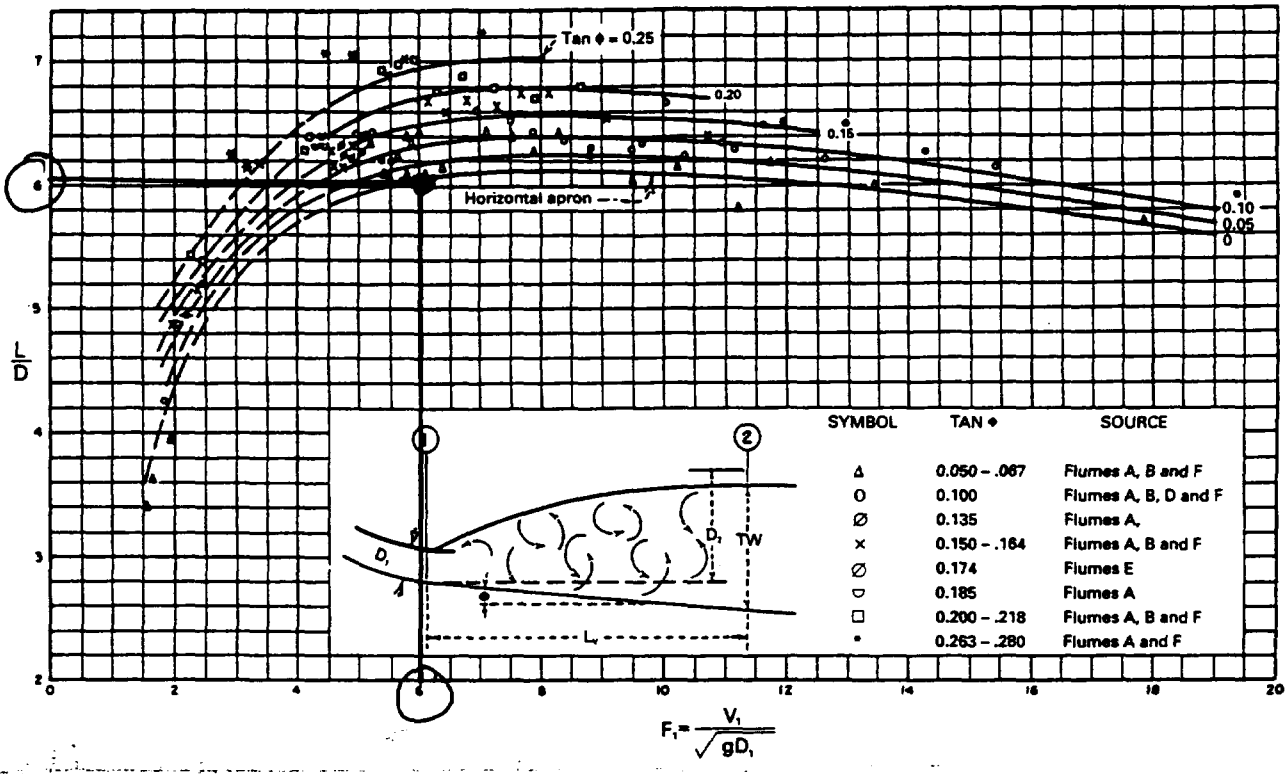


FIGURE 18.10 Jump length in terms of conjugate depth, D_2 for stilling basins with sloping aprons.(From Peterka, 1964)

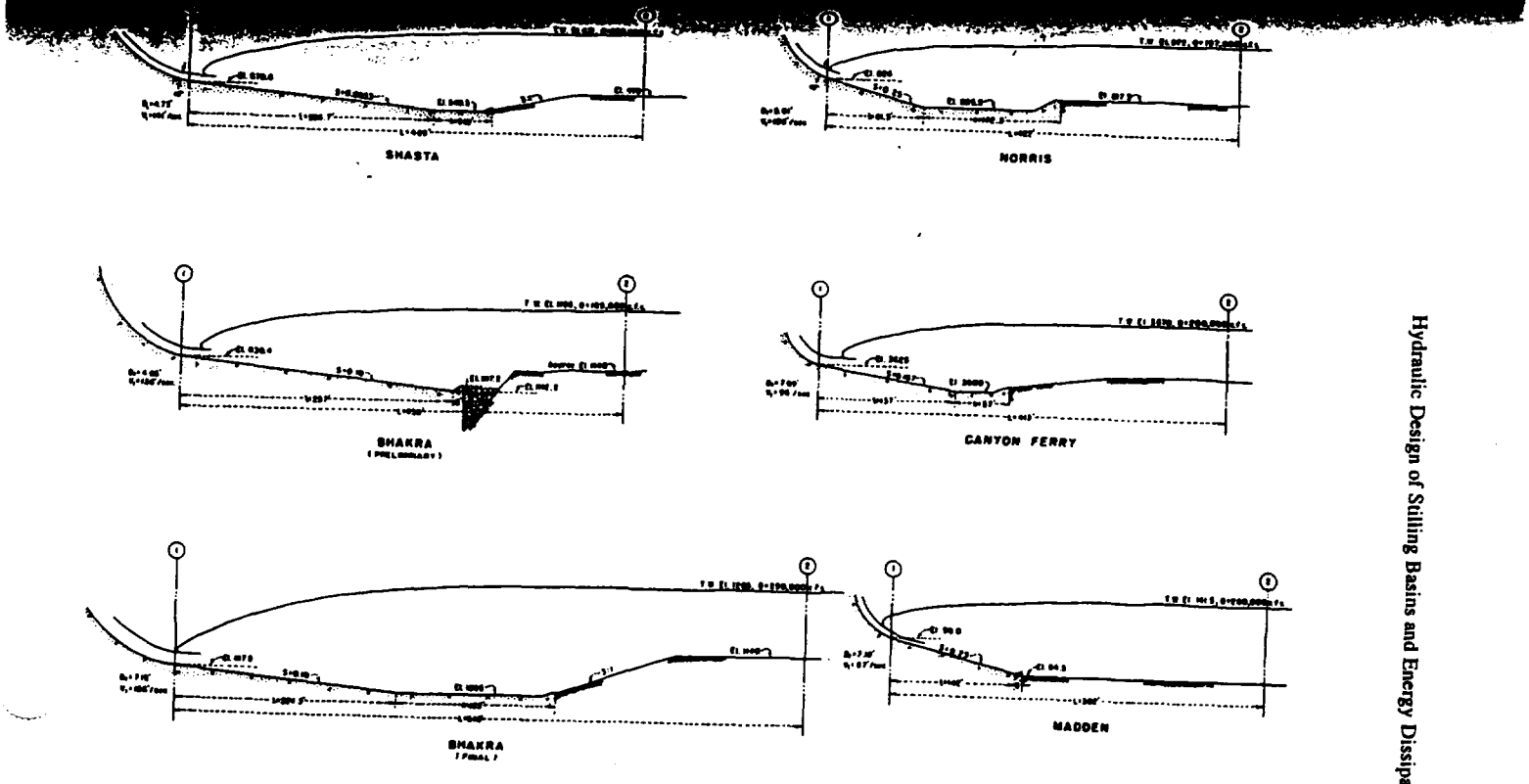


FIGURE 18.11(a) Existing stilling basins with sloping aprons.(From Peterka, 1964)

Quick TR-55 Ver.5.47 S/N:
Executed: 15:27:16 05-12-2000 s:\1999\00026\SAUGET2.TCT

Solutia Sauget Containment Cell
Cover System Run Off

Tc COMPUTATIONS FOR: Grassed

SHEET FLOW (Applicable to Tc only)

Segment ID			
Surface description		Grassed	
Manning's roughness coeff., n		0.1500	
Flow length, L (total < or = 300)	ft	300.0	
Two-yr 24-hr rainfall, P2	in	3.280	
Land slope, s	ft/ft	0.0500	

$$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$$ hrs 0.27 = 0.27

SHALLOW CONCENTRATED FLOW

Segment ID			
Surface (paved or unpaved)?			
Flow length, L	ft	0.0	
Watercourse slope, s	ft/ft	0.0000	

$$Avg.V = Csf * (s)^{0.5}$$ ft/s 0.0000

where: Unpaved Csf = 16.1345
Paved Csf = 20.3282

T = L / (3600*V) hrs 0.00 = 0.00

CHANNEL FLOW

Segment ID			
Cross Sectional Flow Area, a	sq.ft	3.93	
Wetted perimeter, Pw	ft	13.60	
Hydraulic radius, r = a/Pw	ft	0.289	
Channel slope, s	ft/ft	0.0100	
Manning's roughness coeff., n		0.0320	

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$$ ft/s 2.0352

Flow length, L ft 700

T = L / (3600*V) hrs 0.10 = 0.10

::

TOTAL TIME (hrs) 0.36

Quick TR-55 Version: 5.47 S/N:

>>>>> GRAPHICAL PEAK DISCHARGE METHOD <<<<<

Solutia Sauget Containment Cell
Cover System Run Off

CALCULATED
DISK FILE: s:\1999\00026\SAUGET2 .GPD

Drainage Area	(acres)	2.91	--->	0.0045 sq.mi.
Runoff Curve Number	(CN)	80		
Time of Concentration,Tc	(hrs)	.36		
Rainfall Distribution	(Type)	II		
Pond and Swamp Areas	(%)	0	--->	0.0 acres

	Storm #1	Storm #2	Storm #3
Frequency (years)	25	50	100
Rainfall, P, 24-hr (in)	6.02	7.07	8.21
Initial Abstraction, Ia (in)	0.500	0.500	0.500
Ia/p Ratio	0.083	0.071	0.061
Unit Discharge, * qu (csm/in)	622	622	622
Runoff, Q (in)	3.80	4.76	5.82
Pond & Swamp Adjustment Factor	1.00	1.00	1.00
PEAK DISCHARGE, qp (cfs)	11	13	16

Summary of Computations for qu

Ia/p	#1	0.100	0.100	0.100
C0	#1	2.553	2.553	2.553
C1	#1	-0.615	-0.615	-0.615
C2	#1	-0.164	-0.164	-0.164
qu (csm)	#1	622.107	622.107	622.107
Ia/p	#2	0.100	0.100	0.100
C0	#2	2.553	2.553	2.553
C1	#2	-0.615	-0.615	-0.615
C2	#2	-0.164	-0.164	-0.164
qu (csm)	#2	622.107	622.107	622.107
* qu (csm)		622	622	622

* Interpolated for computed Ia/p ratio (between Ia/p #1 & Ia/p #2)
If computed Ia/p exceeds Ia/p limits, bounding limit for Ia/p is used.

$$\log(qu) = C0 + (C1 * \log(Tc)) + (C2 * (\log(Tc))^2)$$

qp (cfs) = qu(csm) * Area(sq.mi.) * Q(in.) * (Pond & Swamp Adj.)

Downchute
Worksheet for Rectangular Channel

Project Description	
Project File	c:\haestad\fmw\sauget.fm2
Worksheet	Solutia Sauget Containment RectChute
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Channel Slope

Input Data		
Mannings Coefficient	0.015	
Depth	0.38	ft
Bottom Width	2.00	ft
Discharge	16.00	cfs

Results		
Channel Slope	0.252115	ft/ft
Flow Area	0.76	ft^2
Wetted Perimeter	2.76	ft
Top Width	2.00	ft
Critical Depth	1.26	ft
Critical Slope	0.008996	ft/ft
Velocity	21.05	ft/s
Velocity Head	6.89	ft
Specific Energy	7.27	ft
Froude Number	6.02	
Flow is supercritical.		

Downchute entrance
Worksheet for Rectangular Channel

Project Description	
Project File	c:\haestad\fmw\sauget.fm2
Worksheet	Solutia Sauget DnChute Entrance
Flow Element	Rectangular Channel
Method	Manning's Formula
Solve For	Channel Slope

Input Data		
Mannings Coefficient	0.015	
Depth	0.52	ft
Bottom Width	3.00	ft
Discharge	16.00	cfs

Results		
Channel Slope	0.038123	ft/ft
Flow Area	1.56	ft^2
Wetted Perimeter	4.04	ft
Top Width	3.00	ft
Critical Depth	0.96	ft
Critical Slope	0.006428	ft/ft
Velocity	10.26	ft/s
Velocity Head	1.63	ft
Specific Energy	2.15	ft
Froude Number	2.51	
Flow is supercritical.		

Swale w/ 3:1 side and 5% side
Worksheet for Triangular Channel

Project Description	
Project File	c:\haestad\fmw\sauget.fm2
Worksheet	Solutia Sauget Containment Cell Swales
Flow Element	Triangular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.032	
Channel Slope	0.010000	ft/ft
Left Side Slope	3.000000	H : V
Right Side Slope	20.000000	H : V
Discharge	8.00	cfs

Results		
Depth	0.58	ft
Flow Area	3.93	ft^2
Wetted Perimeter	13.56	ft
Top Width	13.45	ft
Critical Depth	0.50	ft
Critical Slope	0.024004	ft/ft
Velocity	2.03	ft/s
Velocity Head	0.06	ft
Specific Energy	0.65	ft
Froude Number	0.66	
Flow is subcritical.		

Run-off Velocity/Sheet Flow

URS Greiner Woodward Clyde

Job: Solutia Sauget | Project No. C100005899.00 | Page ___ of ___ | Sheet 1 of 1

Description: Runoff Velocity Sheet Flow | Computed by: M. Brungard | Date: 5/10/00

Checked by: Bill Weber | Date: 5/25/2000

Reference

Purpose: Estimate runoff velocity on cover system under sheet flow conditions.

Method: Use a Time of Travel (T_T) equation to estimate velocity.

Use Flow Length = 300' = (L)
slope = 3% to 12% = (S)
Manning Sheet Flow (n) = 0.15 - for short grass
2 yr - 24 hr Rain fall = 3.28 in from Huff & Angel, 1989 (P)

$$T_T = \frac{0.007(nL)^{0.8}}{(P)^{0.5}\, S^{0.4}}$$

Solution: (3%) $T_T = \frac{0.007(0.15(300'))^{0.8}}{\sqrt{3.28} \times 0.03^{0.4}} = .33 \text{ hr} = 1189 \text{ sec}$ ✓

(12%) $T_T = \frac{0.007(0.15(300'))^{0.8}}{\sqrt{3.28} \times 0.12^{0.4}} = .19 \text{ hr} = 683 \text{ sec}$ ✓

(3%) Velocity $= \frac{300'}{1189 \text{ sec}} =$ 0.25 ft/sec ✓

(12%) Velocity $= \frac{300'}{683 \text{ sec}} =$ 0.44 ft/sec ✓

Suitability of Grassed Surfaces for Erosion Control.

Based on the maximum allowable velocities for grassed channel linings on easily erodible soils, the max. velocity is about 3 ft/sec, from Table 10-15, Municipal Stormwater Management, Debo & Reese, Lewis Publishers, 1995.

* Therefore, grassed surfaces are permissible for the cover.
3 ft/sec >> 0.44 ft/sec

Quick TR-55 Ver.5.47 S/N:
Executed: 16:27:44 05-08-2000 s:\1999\00026\SAUGET1.TCT

Solutia Sauget Waste Area Peak Flow

MB

Tc COMPUTATIONS FOR: waste

SHEET FLOW (Applicable to Tc only)

Segment ID				
Surface description		graded waste		
Manning's roughness coeff., n		0.0110		
Flow length, L (total < or = 300)	ft	300.0		
Two-yr 24-hr rainfall, P2	in	3.280		
Land slope, s	ft/ft	0.0200		
$T = \frac{.007 * (n*L)^{0.8}}{P2^{0.5} * s^{0.4}}$	hrs	0.05	=	0.05

SHALLOW CONCENTRATED FLOW

Segment ID				
Surface (paved or unpaved)?				
Flow length, L	ft	0.0		
Watercourse slope, s	ft/ft	0.0000		
$Avg.V = Csf * (s)^{0.5}$	ft/s	0.0000		
where: Unpaved Csf = 16.1345; Paved Csf = 20.3282				
$T = L / (3600*V)$	hrs	0.00	=	0.00

CHANNEL FLOW

Segment ID				
Cross Sectional Flow Area, a	sq.ft	0.00		
Wetted perimeter, Pw	ft	0.00		
Hydraulic radius, r = a/Pw	ft	0.000		
Channel slope, s	ft/ft	0.0000		
Manning's roughness coeff., n		0.0000		
$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$	ft/s	0.0000		
Flow length, L	ft	0		
$T = L / (3600*V)$	hrs	0.00	=	0.00

::

TOTAL TIME (hrs) 0.05

Quick TR-55 Version: 5.47 S/N:

>>>>> GRAPHICAL PEAK DISCHARGE METHOD <<<<<

Solutia Sauget Waste Area Peak Flow

MB

CALCULATED
DISK FILE: s:\1999\00026\SAUGET1 .GPD

Drainage Area	(acres)	3	--->	0.0047 sq.mi.
Runoff Curve Number	(CN)	90		
Time of Concentration,Tc	(hrs)	.05		
Rainfall Distribution	(Type)	II		
Pond and Swamp Areas	(%)	0	--->	0.0 acres

	Storm #1	Storm #2	Storm #3
Frequency (years)	25		
Rainfall, P, 24-hr (in)	6.02		
Initial Abstraction, Ia (in)	0.222	0.222	0.222
Ia/p Ratio	0.037	0.000	0.000
Unit Discharge, * qu (csm/in)	1191	0	0
Runoff, Q (in)	4.87	0.00	0.00
Pond & Swamp Adjustment Factor	1.00	1.00	1.00
PEAK DISCHARGE, qp (cfs)	27	0	0

Summary of Computations for qu

Ia/p	#1	0.100	0.000	0.000
C0	#1	2.553	0.000	0.000
C1	#1	-0.615	0.000	0.000
C2	#1	-0.164	0.000	0.000
qu (csm)	#1	1190.884	0.000	0.000
Ia/p	#2	0.100	0.000	0.000
C0	#2	2.553	0.000	0.000
C1	#2	-0.615	0.000	0.000
C2	#2	-0.164	0.000	0.000
qu (csm)	#2	1190.884	0.000	0.000
* qu (csm)		1191	0	0

* Interpolated for computed Ia/p ratio (between Ia/p #1 & Ia/p #2)
If computed Ia/p exceeds Ia/p limits, bounding limit for Ia/p is used.

$$\log(qu) = C0 + (C1 * \log(Tc)) + (C2 * (\log(Tc))^2)$$

qp (cfs) = qu(csm) * Area(sq.mi.) * Q(in.) * (Pond & Swamp Adj.)

Waste Consolidation

URS Greiner Woodward Clyde

Job: Solutia Sauget
Description: Waste Consolidation

Project No. C10000 3899.00
Computed by: M. Brungard
Checked by: Bill Weber

Page ___ of ___
Sheet 1 of 2
Date 5/12/00
Date 5/25/00
Reference

Purpose: Estimate Cover settlement due to waste consolidation

Configuration: Max. Waste thickness = 16'
Cover Soil thickness = 2'

Assumptions: Waste material is a sandy silt soil
Liquid Limit is less than 40
Material will be dried to meet paint filter requirements
Material will be compacted to some degree in place

Calculations: Since actual consolidation parameters for waste are unavailable, use correlations to estimate parameters

For remolded clays: $C_c = 0.007(LL-7)$
$= 0.007(40-7)$
$= \underline{0.23}$

Since wastes will be compacted, using the C_c for normally consolidated soil above is not appropriate. Use C_r.

C_r is reportedly about 5 to 10% of C_c, source: An Introduction to Geotechnical Engineering, Holtz & Kovacs, Prentiss Hall, 1981, pg 341.

Use $C_r = 0.023$ in calculations

Void Ratio is unknown, but using 0.6 as the void ratio should produce conservative settlement results.

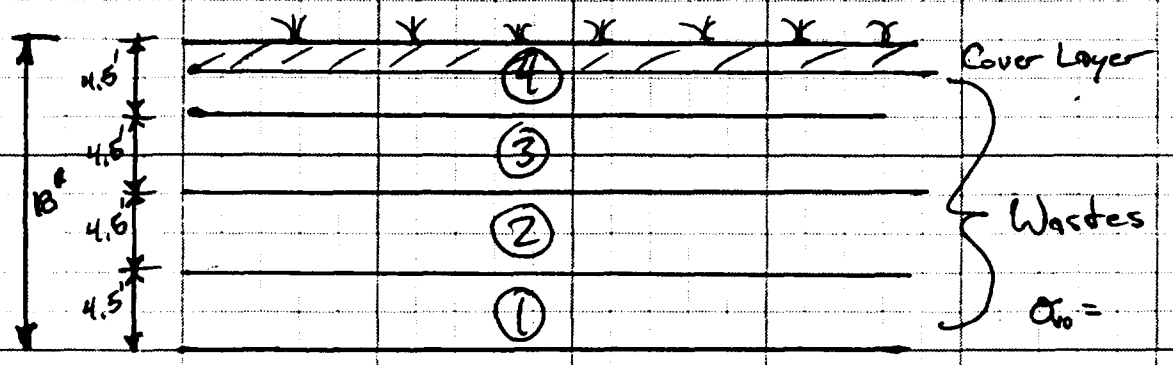
Use $e_o = 0.6$

URS Greiner Woodward Clyde

Job: Solutia Sauget
Description: Waste Consolidation

Project No. C10000 3899.00
Computed by: M. Brungard
Checked by: Bill Weber

Page ___ of ___
Sheet 2 of 2
Date 5/12/00
Date 5/25/2000
Reference



Use $\gamma = 115$ pcf for wastes & cover

$$\text{settlement} = C_r \frac{H}{1+e_o} \log \frac{\sigma'_{vo} + \Delta\sigma_v}{\sigma'_{vo}}$$

use $\sigma'_{vo} = 2.25' \times 115\text{pcf} = 260$ psf at middle of each layer

Layer ①; $\Delta\sigma_v = (3 \times 4.5') \times 115\text{pcf} = 1552$ psf

① settlement $= 0.023 \frac{4.5'}{1+0.6} \log \frac{260+1552}{260} = 0.05' = \underline{0.6''}$

Layer ②; $\Delta\sigma_v = (2 \times 4.5') \times 115\text{pcf} = 1035$ psf

② settlement $= 0.023 \frac{4.5}{1+0.6} \log \frac{260+1035}{260} = 0.045' = \underline{0.5''}$

Layer ③; $\Delta\sigma_v = 4.5' \times 115\text{pcf} = 520$ psf

③ settlement $= 0.023 \frac{4.5'}{1+0.6} \log \frac{260+520}{260} = 0.03' = \underline{0.4''}$

Layer ④ $\Delta\sigma_v = 2' \times 115$ pcf $= 230$ psf

④ settlement $= 0.023 \frac{2.5}{1+0.6} \log \frac{260+230}{260} = 0.01' = \underline{0.1''}$

Total Settlement at Cover Surface $\approx \underline{1.6''}$

Conclusion: The total settlement above is overstated since a portion of the settlement should occur during waste placement, reducing the actual settlement of the completed cover system.

The actual cover system settlement is estimated @ 1"

Appendix E

TECHNICAL SPECIFICATIONS
SAUGET AREA 1 TSCA LANDFILL

Prepared for:

Solutia Inc.
575 Maryville Centre Drive
St. Louis, MO 63141

Prepared by:

URS Greiner Woodward Clyde

7650 West Courtney Campbell Causeway
Tampa, Florida 33607-1462
C100003899.00

June 30, 2000

TABLE OF CONTENTS

SECTION	TITLE	REVISION
01010	SUMMARY OF WORK	0
01050	CONSTRUCTION SURVEY	0
02100	EROSION CONTROL	0
02150	STORMWATER CONTROL DURING CONSTRUCTION	0
02175	CLEARING AND GRUBBING	0
02190	BORROW AREAS AND TEMPORARY HAUL ROADS	0
02200	EARTHWORK	0
02225	SEDIMENT MATERIAL HANDLING	0
02227	GEOGRID REINFORCEMENT	0
02242	GEOTEXTILE	0
02244	GEOMEMBRANE	0
02245	GEOSYNTHETIC CLAY LINER	0
02246	GEONET	0
02619	CORRUGATED POLYETHYLENE PIPE	0
02715	LEACHATE COLLECTION SYSTEM RISER PIPES	0
02932	SEEDING	0

SECTION 01010

SUMMARY OF WORK

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.0 SECTION INCLUDES

A. Background Information

B. General Requirements

C. Summary of Work

1.1 BACKGROUND INFORMATION

A. Solutia plans to construct a 500-foot (ft) by 500-ft TSCA landfill located in Cahokia, Illinois. This landfill will have a design capacity of 50,000 cubic yards. This landfill will contain non-native sediments and soils from in and adjacent to Dead Creek.

B. A containment cell will be constructed under this contract to contain non-native sediments and soils from in and adjacent to Dead Creek. The cell will consist of a double liner system and a cover system. The cover system consists of, from top to bottom, the following layers: vegetative cover, cover soil, geotextile, geonet, geomembrane, geosynthetic clay liners and tracked in-place fill. The double liner system will consists of, from top to bottom, the following layers: geotextile, sand drainage layer, primary geomembrane, tracked in-place soil, geotextile, geonet, secondary geomembrane, geosynthetic clay liner, capillary break ground layer, tracked in-place soil and subgrade.

1.2 GENERAL REQUIREMENTS

A. Authority of Construction Manager

1. The work will be reviewed, observed and inspected by the on-site Construction Manager in accordance with the contract, Plans, Specifications, the Construction Quality Assurance Manual for Installation of Geosynthetic Components and the Construction Quality Assurance Manual for Installation of Soil Components of the Lining and Final Cover

Systems. The Construction Manager will decide all questions which may arise as to the quality or acceptability of materials furnished and work performed; the manner of performance and rate of progress of the work; the interpretations of the Drawings and Specifications and the acceptable fulfillment of the contract on the part of the Contractor. Construction Manager's decisions will be final and binding.

B. Conformity with Drawings and Specifications

1. All work performed and all materials furnished shall be in conformity with the lines, grades, cross sections, dimensions, details, gradations, physical, and chemical characteristics of materials in accordance with tolerances shown on the Drawings required by the Specifications. Construction tolerances and accuracy limits will be as defined in the respective items of the contract or if not defined, as determined by the Construction Manager.

2. It is the responsibility of the Contractor to verify all quantities of materials shown on the Drawings before ordering same, as payment is provided for acceptable materials complete in place. The Contractor will not be paid for material rejected due to improper fabrication, excess quantity or for any other reasons within his control.

3. In the event the Construction Manager finds that the work performed or the materials used are not within conformity with the Drawings and Specifications, the affected material or product shall be removed and replaced or otherwise satisfactorily corrected by and at the expense of the Contractor.

4. Any deviations from the Plans, Specifications and approved Shop Drawings will be made only with the approval of the Construction Manager and with the concurrence of the Designer. All requests for variance or modification shall be by written communication from the Contractor to the Construction Manager.

5. The Specifications accompanying the Drawings are essential parts of the contract and a requirement occurring in one is as binding as though occurring in all. They are intended to be cooperative and to describe and provide for a complete work. In cases of disagreement, dimensions provided on figures shall govern over scaled dimensions, Drawings shall govern over Specifications, and addenda shall govern over both Specifications and Drawings.

C. Cooperation of Contractor

1. The Contractor shall designate, to the Construction Manager in writing, the name of a Superintendent, employed by the firm, regardless of how much of the work may be sublet. The Superintendent shall be cooperative, responsible and competent, English speaking, authorized to receive orders and to act for the Contractor. The Superintendent will be on-site and available at all times during construction of the perimeter containment levee, lining and final cover systems, and all appurtenant work. In the event a competent superintendent is not available, the Construction Manager may suspend work at no additional cost to the Owner until one is available.

D. Removal of Defective and Unauthorized Work

1. All work which has been rejected as being in nonconformance with the Drawings and Specifications shall be remedied or removed and replaced in an acceptable manner by the Contractor at his expense. Work done beyond the lines and grades given or as shown on the plans, or any extra work done without written authority will be considered as unauthorized and done at the expense of the Contractor and will not be paid for. Work so done may be ordered removed at the Contractor's expense. Upon failure on the part of the Contractor to comply with any order of the Construction Manager made under the provisions of this paragraph, the Construction Manager will have authority to cause defective work to be remedied or removed and replaced and unauthorized work to be removed and the cost thereof may be deducted from any moneys due or to become due to the contractor.

E. Protection of Adjoining Property

1. The Contractor shall take proper measures to protect the adjacent or adjoining property which might be injured by any process of construction, and, in case of any injury or damage resulting from any act or omission on the part of or on behalf of the Contractor, he shall restore at his own expense the damaged property to a condition similar or equal to that existing before such injury or damage was done, or he shall make good such injury or damage in an acceptable manner.

F. Contractor's Responsibility for Work

1. Until final written acceptance of the project by the Construction Manager, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the

elements or from any other cause, whether arising from the execution or from the nonexecution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof which are a portion of the work, not damaged by the Contractor or his operations, except for damage to the work due to Acts of God (force majeure) such as earthquake, tidal wave, tornado, hurricane, or other cataclysmic phenomena of nature or acts of governmental authorities. In case of suspension of work for any cause, the Contractor shall be responsible for the preservation of all materials. He shall provide suitable drainage and shall erect temporary structures where required.

G. Work Near Electrical Power Lines

1. Any operations by the Contractor which are located near any electrical power lines shall be accomplished using established industry and utility safety practices. The Contractor shall consult with the appropriate utility company prior to beginning any such work. All associated costs will be the responsibility of the Contractor.

H. Workers and Equipment

1. The Contractor shall furnish such suitable machinery, equipment, and construction forces as may be necessary, in the opinion of the Construction Manager, for the proper prosecution of the work. Construction Manager may require the Contractor to provide additional resources to maintain the project schedule. Construction Manager may suspend the work until his requests are complied with.

2. All workers employed by the Contractor shall have such skill and experience as will enable them to properly perform the duties assigned. Any person employed by the Contractor or a subcontractor who, in the opinion of the Construction Manager, does not perform his work in a proper and skillful manner, or who is disrespectful, intemperate, disorderly or otherwise objectionable, shall at a written request of the Construction Manager be forthwith discharged and shall not be employed again on any of the work without written consent of the Construction Manager.

3. Contractor and all employees, subcontractors, supporting firms and incidental labor shall meet the minimum safety requirements for Solutia's Pensacola Plant.

I. Final Clean Up

1. Upon completion of the work and before acceptance and final payment is made, the Contractor shall clean, remove rubbish and temporary structures from the site, restore in an acceptable manner all property which has been damaged during the prosecution of the work and leave the site of the work in a neat and presentable condition throughout.

J. Final Inspection

1. Whenever the work provided for in, and contemplated under, the contract has been satisfactorily completed (with the exception of any performance periods) and the final clean up performed, the Contractor shall notify in writing to the Construction Manager to make the "Final Inspection". Such inspection will be made as soon as possible, but not longer than (10) days after such notification. After such final inspection, if the work is found to be satisfactory (with the exception of any performance periods), the Contractor will be notified in writing of the acceptance of same. The "Final Acceptance" will not release the Contractor from responsibility for all items, materials, or equipment requiring performance test periods or final measurements unless otherwise shown in the contract.

1.3 SUMMARY OF WORK

A. General

1. The Contractor shall work closely and communicate regularly with the Owner in order to minimize conflicts and expedite the completion of the work. The Construction Manager serves as the Owner's representative.

2. All equipment and materials on-site during the work will be the responsibility of the Contractor. The Owner shall not be responsible for theft, vandalism or damage to any of the equipment or materials.

3. Contractor shall be required to prepare and adhere to a Quality Control Plan for field installation, as approved by the Construction Manager.

4. Contractor shall select and pay for an independent laboratory(ies) as required for testing soil and geosynthetic materials.

5. Contractor shall adhere to all health and safety requirements as identified in the Site Health and Safety Plan and as required by Plant and Solutia corporate safety requirements.

6. Contractor shall prepare and submit for approval by the Construction Manager all Work Plans, Safety Plans, and Construction Plans as required by these Specifications.

B. Work Covered by Contract Documents

1. Work of this Contract comprises the construction of a composite synthetic double lined disposal cell and final cover system designed in accordance with the requirements of the U.S. Environmental Protection Agency and the Illinois Environmental Protection Agency for Solutia Inc.

2. Principal Work Items to be performed by Contractor:

- Mobilization to site
- Site preparation to include clear and grub, borrow area development, erosion control, haul road development and stormwater management measures.
- Perimeter berm construction
- Construct capillary break ground layer and sump
- Construct tracked in-place soil layer
- Install geosynthetic clay liner
- Secondary geomembrane installation
- Secondary leachate collection system installation including sumps and riser pipes
- Install primary geomembrane layer
- Construct primary leachate collection system drainage layer, sumps and riser pipes
- Install geotextile or primary collection system
- Place sand protective layer
- Place non-native sediments and selected soils adjacent to Dead Creek into cell (by others)
- Install cover system geosynthetics
- Construct perimeter toe drain
- Place cover and drainage layer soils
- Place gravel drains

- Install vegetated cover on cover system and slopes
- Grade berms to accommodate drainage
- Construct downlet structures

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION 01010

SECTION 01050

CONSTRUCTION SURVEY

SECTION 01050

CONSTRUCTION SURVEY

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Surveying Services

B. Surveys for Contractor Quality Control Program

C. Surveys for Measurements and Payment

D. Site Reference Points as Shown in the Plans

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work

1.3 DEFINITIONS

A. Land Surveyor: Surveyor shall be a registered land surveyor in the State of Illinois and acceptable to the Construction Manager.

B. Record Documents: All information collected by Surveyor.

1.4 SUBMITTALS

A. Contractor shall submit name, address, and telephone number of Surveyor to the Construction Manager before starting survey work.

B. On request of the Construction Manager, Contractor shall submit documentation verifying accuracy of survey work.

C. Contractor shall submit certificate signed by Surveyor certifying that elevations and locations of site constructed features are in conformance, or non-conformance, with Contract Documents.

1.5 PROJECT RECORD DOCUMENTS

A. Contractor shall maintain on site a complete, accurate log of control and survey work as it progresses.

B. Upon completion of the work or as requested by the Construction Manager, Contractor shall submit Record Documents to the Construction Manager.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 INSPECTION

A. Contractor shall verify locations of site reference and survey control points prior to starting work. Contractor shall promptly notify the Construction Manager of any discrepancies discovered.

3.2 SURVEY REFERENCE POINTS

A. Contractor shall protect survey control points prior to starting sitework and preserve permanent reference points during construction. Contractor shall not relocate site reference points without prior written approval by the Construction Manager.

B. Contractor shall promptly report to the Construction Manager the loss, damage, or destruction of any reference point or relocation required because of changes in grades or other reasons. Contractor shall replace dislocated survey control points based on original survey control at no cost to the Owner.

C. Contractor shall install and maintain temporary benchmarks located near the work site in a location free of potential vehicular traffic. Contractor shall determine horizontal coordinates of the benchmark to an accuracy of ±0.25 ft relative to the site coordinate system and the elevation to an accuracy of ±0.1 ft NGVD (National Geodetic Vertical Datum, 1929).

3.3 SURVEY REQUIREMENTS

A. Contractor shall reference survey and site reference points to permanent benchmarks and record locations of survey control points, with horizontal and vertical data, on Project Record Documents.

B. Contractor shall establish lines and levels, locate and lay out by instrumentation and similar appropriate means:

1. Site features to be constructed including necessary stakes for cut, fill, placement, and grading operations and stakes for slopes.

2. Grid along perimeter of cell work area to facilitate Contractor quality control activities.

C. Contractor shall verify layouts periodically during construction by same means.

3.4 SURVEYS FOR CONTRACTOR QUALITY CONTROL

A. Contractor shall perform surveys to determine as-built elevations of all cell components as required by the Specifications and the Contractor's Quality Control Plan and shall notify the Construction Manager prior to starting the work.

B. Contractor's field superintendent shall sign Surveyor's field notes or shall keep duplicate field notes and shall provide copies of same to the Construction Manager.

3.5 SURVEYS FOR MEASUREMENTS AND PAYMENT

A. Contractor shall perform surveys to determine percent of completed work including surveys to establish measurement reference lines. Contractor shall notify the Construction Manager prior to starting the survey.

B. Surveys shall be conducted after establishing a grid system sufficiently close between grid lines to determine the measured quantity. Grid spacings shall not be greater than 50 ft for determination of volume calculations, unless otherwise approved by the Construction Manager.

C. Contractor's field superintendent shall sign Surveyor's field notes and shall keep duplicate copy of field notes and shall calculate and certify quantities for progress payment purposes.

END OF SECTION 01050

SECTION 02100

EROSION CONTROL

SECTION 02100

EROSION CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnish labor, equipment and materials as specified herein to erect, maintain and remove a temporary sediment barrier or equivalent attached to supporting posts and entrenched.

B. Contractor shall be responsible for prevention of runoff from site causing erosion products to be deposited at locations outside the limits of the work.

C. Contractor shall collect eroded materials from their off-site locations and return these to the site.

D. Contractor shall be responsible for repairing and restoring erosion which occurred during construction to original conditions.

1.2 SUBMITTALS

A. Contractor shall prepare an Erosion and Sediment Control Plan that is in accordance with the standards and requirements of the Environmental Protection Agency Region V and Illinois Environmental Protection Agency.

B. Contractor shall submit this Erosion and Sediment Control Plan for approval by the Construction Manager.

1.3 LOCATIONS FOR USE

A. Below disturbed areas where sheet and/or fill erosion may occur.

B. At locations hydraulically downgradient of site construction activities and at locations indicated on the Plans.

C. At locations selected by the Construction Manager to prevent sediment migration.

PART 2 PRODUCTS

2.1 MATERIALS

A. Geotextile (filter) shall be a pervious sheet of propylene, nylon, polyester or ethylene yarn.

B. Geotextile (filter) shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable exposed life at a temperature range of 0° to 120° F.

C. Stakes for silt fences shall be 1" x 2" wood (preferred) or equivalent metal with a minimum length equal to the height of silt fence plus 12 inches.

D. Contractor may identify alternate materials for erosion control. Alternate materials shall be submitted to the Construction Manager for evaluation of equivalency prior to installation.

PART 3 EXECUTION

3.1 REQUIREMENTS

A. Erosion control devices shall be installed as depicted on the Drawings.

B. Best Management Practices shall be utilized in the installation of the devices to prevent and/or correct problems related to the transport of material or soil by runoff water particularly from construction and other land disturbing activities.

C. All devices shall be installed in accordance with the standards and requirements of the Environmental Protection Agency Region V, the Illinois Environmental Protection Agency or as required by the Drawings or Specifications.

D. Requests for deviations from the approved Erosion and Sediment Control plan must be submitted in writing to the Construction Manager.

3.2 INSTALLATION

A. The geotextile shall be delivered to the jobsite in a continuous roll and cut to the length of the barrier to avoid the use of joints. When joints are necessary, it shall be spliced together only at a support post, with a minimum 6-inch overlay, and securely sealed.

B. Posts shall be spaced a maximum of 6 feet apart at the barrier location and driven securely into the ground a minimum of 12 inches.

C. A trench shall be excavated upslope from the barrier approximately 4" x 4" deep along the line of posts.

D. Geotextile shall be stapled or wired to the fence, and 8 inches of the fabric shall be extended in to the trench. The fabric shall not extend more than 36 inches above the original ground surface.

E. The trench shall be backfilled over the filter fabric.

F. Silt fences shall be removed when they have served their useful purpose, but not before the upslope area construction is completed.

3.3 MAINTENANCE DURING CONSTRUCTION

A. The Contractor shall inspect erosion prevention measures immediately after each rainfall and at least daily during prolonged rainfall. Required repairs shall be made immediately.

B. If the geotextile on a silt fence decomposes or become ineffective prior to the end of the desired use, the Contractor shall replace the fabric promptly.

C. Sediment and other erosion products deposited against the barrier shall be checked after each storm event. They must be removed when deposits reach approximately ½ the height of the barrier, or if deformation of the barrier has occurred.

D. Any sediment deposits remaining in place after the silt fence or barrier is no longer required shall be dressed to conform with the existing grade, prepared and seeded.

END OF SECTION 02100

SECTION 02150

STORMWATER CONTROL DURING CONSTRUCTION

SECTION 02150

STORMWATER CONTROL DURING CONTRUCTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Maintain adequate site drainage.

B. Collection and routing of stormwater.

1.2 SUBMITTALS

A. Contractor shall develop a Stormwater Control Plan in accordance with the standards and requirements of the Illinois Environmental Protection Agency.

B. Contractor shall submit the Stormwater Control Plan for Construction Manager approval.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 SURFACE WATER CONTROL

A. Contractor shall furnish, install, maintain and operate all equipment and materials needed to prevent, control and remove surface water within or adjacent to the area of work.

B. Contractor shall provide and maintain berms, curbs, surface drainage swales or runs as necessary, to prevent surface water from entering fill placement areas.

C. Contractor shall immediately remove impounded water that affects any area of the Work.

D. Stormwater pumped from within the landfill berms shall be discharged in accordance with the approved Stormwater Management Plan. Contractor may propose above ground temporary water holding areas in the Stormwater Management Plan.

3.2 GROUND WATER CONTROL

A. Contractor shall furnish, install, maintain, and operate all equipment and materials to prevent ground water from flowing into excavations or onto work areas or areas designated to receive fill.

B. Collected ground water must be treated and discharged by the Contractor using procedures required by the Specifications and consistent with the measures used for surface water control.

3.3 MAINTENANCE DURING CONSTRUCTION

A. The Contractor shall maintain adequate drainage of construction work areas of the site during progress of the work such that ponding of rainwater does not occur.

B. Stormwater drainage shall be diverted away from the construction and work areas of the site.

C. Stormwater control measures shall fully comply with the approved Stormwater Control Plan.

END OF SECTION 02150

SECTION 02175

CLEARING AND GRUBBING

SECTION 02175

CLEARING AND GRUBBING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnish labor, equipment and materials as required to clear and grub existing vegetation from areas designated as Borrow Areas and Temporary Haul Road(s).

B. Removal and disposal of vegetation generated by the Clearing and Grubbing activities.

1.2 RELATED SECTIONS

A. Section 02190 - Borrow Areas and Temporary Haul Road(s).

B. Section 01050 - Construction Survey

C. Section 02100 - Erosion Control

D. Section 02200 - Earthwork

1.3 SUBMITTALS

A. Contractor shall submit a Clearing and Grubbing Plan that is consistent with the selected locations for the Borrow Areas and Temporary Haul Road(s).

B. Contractor shall secure any and all required permits to remove, transfer and dispose of materials generated during Clearing and Grubbing activities. This includes any materials deemed salvageable or suitable for reuse outside of the Owner's property.

C. Contractor shall include Clearing and Grubbing in the Erosion Control Plan as required by Section 02100.

D. Contractor shall include Clearing and Grubbing in the Stormwater Control Plan as required by Section 02150.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

A. Contractor shall protect bench marks/monuments, reference points, designated monitoring wells and all utilities shown on the drawings. Reference Section 02200-1.6 Earthwork, Protection.

B. Contractor shall insure that all roads remain uninterrupted during the work. Any encroachment or potential impact to facilities must be coordinated for approval through the Construction Manager.

3.2 IMPLEMENTATION

A. Clearing: Clearing shall consist of the removal and disposition of standing trees and snags, stumps, boulders, brush, down timber, logs and other growth, and objects on and above the ground surface. Cleared materials shall be disposed of in areas designated on the drawings or at locations mutually selected by the Contractor and approved by the Construction Manager.

B. Grubbing: Grubbing shall consist of the removal of stumps, roots, buried logs, boulders, and other deleterious materials below the ground surface within the limits of the designated Borrow Areas and Haul Road locations. Stumps, roots over 1.0 inch in diameter, buried logs, and boulders shall be removed completely. The grubbed area shall be managed in a manner as to prevent any of the above listed vegetation or objects to be transported to the Landfill construction placement area.

C. Disposal: Cleared and grubbed materials shall be placed in designated locations shown on the drawings. All materials generated during the Clearing and Grubbing process shall be disposed of outside of the designated limits of the Borrow Areas and Haul Road(s). Material stockpile locations may be agreed to during the work, by Contractor and Construction Manager, if the selected locations provide mutual benefit and do not impact future use of the selected areas. Onsite burning is not permitted.

D. Limbs, brush, and branches shall be chipped by mechanical chipping machine and stockpiled outside of the limits of the borrow area. Tree trunks and logs shall be piled or stacked outside of the perimeter of the borrow area.

3.2 MAINTENANCE DURING CONSTRUCTION

A. Contractor shall promptly remove cleared and grubbed materials from any active borrow work area.

B. Surface areas disturbed during the work shall be graded to establish smooth contours, provide stable slopes, and promote controlled drainage.

C. Clearing and Grubbing activities shall be conducted in such manner as to promote the efficient and expedient utilization of the Borrow Areas and Temporary Haul Road(s).

END OF SECTION 02175

SECTION 02190

BORROW AREAS AND TEMPORARY HAUL ROADS

SECTION 02190

BORROW AREAS AND TEMPORARY HAUL ROADS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnish labor, equipment and materials as specified herein to develop, utilize and maintain the soil borrow areas and temporary transfer haul roads.

B. Contractor shall be responsible for survey layout, site preparation, excavation, material transfer and maintenance of the borrow area and the haul road(s).

C. Contractor shall manage the borrow area to provide construction soils as required by the Construction Drawings and Specifications.

1.2 RELATED SECTIONS

A. Section 01050 - Construction Survey

B. Section 02100 - Erosion Control

C. Section 02150 - Stormwater Control During Construction

D. Section 02175 – Clearing and Grubbing

E. Section 02200 - Earthwork

1.3 SUBMITTALS

A. Contractor shall include the Borrow Area and Temporary Haul Roads in the Sediment and Erosion Control Plan and the Stormwater Control Plan as required by Section 02100 and Section 02150.

B. Contractor shall prepare layout drawings of the proposed limits for the Borrow Area and the location(s) of the proposed Temporary Haul Road(s) that conform to the requirements of the Drawings.

C. Contractor shall include the Borrow Areas and Temporary Haul Road(s) in the Construction Plan as required by Section 02200 - Earthwork. In addition to the listed requirements, Contractor shall include the location(s) and estimated quantities of roadway drainage culverts, roadway fill and cut sections, and all other appurtenances and materials deemed necessary by the Contractor for the development of the facilities.

D. Contractor shall include re-vegetation (seeding & mulching) in the Construction Plan that specifically addresses the Borrow Area restoration.

E. The Contractor shall submit this information to the Construction Manager for approval prior to implementation.

1.4 TESTING

A. Testing shall be in accordance with the provisions of Section 02200 - Earthwork.

PART 2 EXECUTION

2.1 PREPARATION

A. Contractor shall prepare the area by Clearing and Grubbing in accordance with Section 02175.

B. Contractor shall selectively excavate and transfer onsite borrow soils identified in Section 02200 - Earthwork. These soils shall be identified in the Borrow Area as described in the above Section 1.4 - Testing.

C. The Construction Manager shall approve the Contractors Construction Plan prior to commencement of the work.

2.2 EXCAVATION

A. All excavations shall comply with the requirements of OSHA 29 CFR Part 1926.

B. Temporary cut slopes shall not be steeper than 1 horizontal to 1 vertical. Finished slopes, left for final grading and long- term maintenance, shall not be steeper than 3:1 horizontal to vertical distance. Final Borrow Area grading will be a part of the Contractor's work and shall be coordinated with the Construction Manager for acceptance and approval. Acceptance criteria shall be in accordance with Section 02100 - Erosion Control and Section 02200 - Earthwork.

C. Contractor may stockpile borrow soils as deemed necessary for access and efficiency. The Construction Manager shall approve the location and size of the soil stockpiles. Stockpiles shall be leveled and graded at the completion of the work.

D. All excavation shall be conducted in a manner that provides efficient access for the hauling equipment and promotes uninterrupted construction traffic flow.

E. Site restoration will not include removal of the Temporary Haul Roads. Temporary Haul Roads shall be left graded to properly drain and all culverts and appurtenances that have become an integral part of the road shall become the property of the Owner.

F. Contractor shall seed and mulch all disturbed areas following final grading as outlined in Section 2.2, B, of this specification. There are no provisions for hydro-seeding the Landfill Cover, however, hydro-seeding is considered to be an acceptable option for re-vegetating the borrow areas.

2.3 MAINTANENCE and PROTECTION DURING CONSTRUCTION

A. Contractor shall maintain the Borrow Area work area and the Temporary Haul Roads in accordance with the provisions of Section 02100 - Erosion Control and Section 02150 - Stormwater Control.

B. Contractor shall provide all Traffic and Safety controls as required by Section 02200 - Earthwork.

C. Effective Dust Control Measures must be employed at all times, in all areas of the work. Contractor shall include any and all dust suppression measures that are necessary for workers health and safety and for the health and safety of persons on or adjacent to the Owner's property. Dust Control Measures may include, but are not limited to: watering spray trucks, approved chemical dust suppressants, road grading, or surface treatments, such as gravel. The Construction Manager shall approve all proposed dust control methods and may request additional control measures if site conditions begin to effect visibility, traffic safety or workers breathing areas.

PART 3 QUALITY CONTROL

3.1 REQUIREMENTS

A. Contractor shall manage the Borrow Area in a manner that supplies the specified soils relative to the soil placement requirements of the Landfill Design.

B. Contractor shall identify the soils at the Borrow Area prior to transfer to the designated placement area.

C. Contractor shall control excavation, loading and hauling to insure that only designated borrow soils are incorporated into the designated Landfill construction placement areas.

END OF SECTION 02190

SECTION 02200

EARTHWORK

SECTION 02200

EARTHWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section describes general earthwork requirements for site preparation, perimeter berms, insitu soil compaction, soil protection, sand drainage layer, gravel fill, vegetative cover soil, and related activities. This section does not include sediment handling and placement.

1.2 REFERENCES

A. ASTM D75 - Practice for Sampling Aggregates.

B. ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.

C. ASTM D422 - Method for Particle-Size Analysis of Soils.

D. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).

E. ASTM D1556 - Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

F. ASTM D2167 - Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

G. ASTM D2216 - Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.

H. ASTM D2434 - Test Method for Permeability of Granular Soils.

I. ASTM D2487 - Classification of Soils for Engineering Purposes.

J. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

K. ASTM D2937 - Test Method for Density of Soil in Place by the Drive Cylinder Method.

L. ASTM D3017 - Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

M. ASTM D4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

N. ASTM D1140 - Test Method for Amount of Material in Soils Finer than the No. 200 Sieve.

O. ASTM D5084 - Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Perimeter.

1.3 DEFINITIONS

A. Well-Graded: A mixture of particle sizes that has no specific concentration, or lack thereof, of one or more sizes. A material type that, when compacted, produces a strong and relatively incompressible soil mass.

B. Coverage: One coverage is defined as the requirement of successive trips of a piece of compaction equipment, which by means of sufficient overlap, will ensure that all areas of the layer being compacted have been subjected to one pass of the compaction equipment.

C. Optimum Moisture Content: The maximum moisture content that will result when plotted against the dry unit weight of a soil when subjected to the ASTM D698 compaction test.

D. Percent Compaction: The percent compaction in-place shall be calculated as the ratio (in percent) of the in-place dry density to the estimated maximum dry density, in accordance with ASTM D698, of the representative fill material at the location of the in-place density test.

E. Proof Rolling: Rolling a surface with a minimum of 3 passes with approved compaction equipment for the purpose of detecting soft or loose areas.

F. On-Site Soils: On-site soils are defined as the insitu material located within the footprint of the liner system and the perimeter berms.

G. Borrow Soils: borrow soils are defined as material transferred to the footprint area from a remote location.

H. Unsuitable Materials: All soil materials that contain waste, debris, roots, organic matter, frozen matter, stone or rock with any dimension greater than 1-inch, or any other material that are determined by the Construction Manager to be unsuitable for stable, compacted backfill purposes. Approved on-site borrow soils are suitable fill.

I. Borrow Areas: Borrow areas are those locations approved by the Construction Manager for procurement, excavation and use of materials for Construction of the Perimeter Containment Levee, Final Cover or landfill soil components. Borrow areas do not include "on-site soils" as defined herein.

J. Fine-Grained Soils: Fined grained soils are defined as those materials which pass a 200 sieve in accordance with the guidelines established in ASTM C136.

1.4 TESTING

A. The Contractor will retain the services of a QC testing laboratory that has been approved by Construction Manager to perform tests as specified herein. At a minimum, the Contractor shall be responsible for providing QC for the following:

1. Compliance testing for materials provided from onsite and offsite sources.

2. QC testing and inspection during construction.

B. The Contractor shall inspect and verify all earthwork operations are in conformance with this specification and the contract documents. Moisture/density relationships for the various fill materials will be established as part of the QC program. Field density tests, sample selection, and construction observations will be performed in sufficient numbers and in such locations to verify that the specified density is being achieved.

C. The Contractor shall inform the Construction Manager prior to conducting all field tests to allow oversight. No additional fill placement shall be permitted in areas that have not met the specified fill placement criteria.

1.5 SUBMITTALS

A. Construction Plan

The Contractor shall submit a construction plan identifying the procedures and methods to be used. The plan shall be approved by the Construction Manager prior to any earthwork activities. The construction plan shall, at a minimum, include the following:

1. Proposed material source(s) and proposed method(s) of sampling.

2. Proposed soil processing, placement, compaction, and moisture control equipment, including equipment catalog with weight, dimensions, and operating data for all equipment.
3. Proposed locations of soil processing and moisture control.

4. Proposed methods for soil processing and moisture control.

5. Proposed work schedule.

6. Proposed method of protecting Work, to include temporary drainage measures.

7. Proposed QC Personnel. All QC personnel shall demonstrate specific experience of at least 2 years in the areas in which they will be performing QC inspections.

8. Proposed professional engineer registered in Illinois with no less than 5 years experience in the performance and evaluation of geotechnical laboratory tests on constructed materials.

9. Proposed land surveyor licensed in the State of Illinois.

10. Proposed excavation, stockpiling, regrading and staging plan describing handling and transport of borrow materials.

11. Proposed proof rolling method and equipment for each subgrade condition.

B. Contractor shall submit results of prequalification test data on each material source to the Construction Manager for approval prior to procurement, excavation, transport, stockpiling or use.

C. Contractor shall submit results of all field and laboratory prequalification and quality control data to the Construction Manager within 1 work day of receipt.

D. Contractor shall submit the results of all observations and documentation generated by its quality control personnel the next work day.

E. Contractor shall submit results of all field surveys and documentation to the Construction Manager. Copies of surveyor field data, books and notes shall be submitted within 1 work day of generation. Copies of survey information signed and sealed by a Florida licensed surveyor shall be submitted within 1 work day of receipt.

1.6 PROTECTION

A. All streets, roads, grading, structures, utilities and other improvements not specifically designated to be cleared, removed, stripped or altered as a part of the work shall be protected from damage throughout the construction period. Any damage caused by the Contractor, his employees, agents, or any lower tiered subcontractors shall be immediately repaired to the original condition and to the satisfaction of the Construction Manager at no additional cost to the Owner.

B. Traffic Control

1. Keep all roads, sidewalks, and parking areas that are not part of this project usable at all times.

2. The Contractor shall provide all necessary barricades, lights, signs, signals, etc., for the protection of the workers and the public, as established by the Occupational Safety and Health Administration (OSHA) Construction Safety and Health Regulation 29 CFR, Part 1926, Subpart G, Signs, Signals and Barricades, and in Subpart P- Excavations, trenching and shoring, and IDOT Standard Specifications for Highway Construction, latest edition.

C. Existing Utilities

1. The Contractor is solely responsible for identification of all utilities, both known and unknown.

2. Known existing utilities are indicated on the Plans. The Contractor shall hand excavate areas within 6 feet (ft) of existing utilities. Any requested variance from the hand excavation requirement shall be submitted in writing to the Construction Manager.

3. Actual locations of all existing utilities within the work area shall be located by the Contractor by hand excavation and indicated on the As-Built drawings.

4. After the actual locations and routing of the existing utilities have been found to be accurately determined through this hand excavation, and after approval from the Construction Manager, the Contractor may begin excavation using machinery in a manner acceptable to the Construction Manager.

5. After excavation by machinery has begun, the Contractor shall be fully responsible for all utilities that were found through hand excavation and/or which were indicated on the Drawings.

6. Any existing utility indicated on the Drawings that is damaged by the Contractor shall be immediately repaired to its previous undamaged condition at no additional cost to the Owner.

7. Notify the Construction Manager immediately of any encountered utilities not shown on the Drawings.

8. Obtain approval from the Construction Manager before backfilling in areas of known utilities. Utility warning tape (provided by the Contractor) shall be placed 12 inches above existing or newly installed utilities.

D. Monitoring Wells

1. Contractor shall be solely responsible for identification of all groundwater monitoring wells.

2. Known groundwater monitoring wells are indicated on the Plans. Contractor shall not operate machinery, excavate, mound soil or otherwise disturb the ground surface around a monitoring well without the concurrence of the Construction Manager.

3. Contractor shall be solely responsible for the protection and usability of the monitoring wells during the work.

4. If the Contractor damages a monitoring well during the performance of the work, the Contractor shall immediately notify the Construction Manager of the damage.

5. If the Owner subsequently determines that the damaged monitoring well no longer performs satisfactorily, the Owner will have the well repaired, replaced or abandoned by a qualified well installer and will recover any resulting cost from the Contractor.

6. Repair , replacement or abandonment procedures shall be those required by the Northwest Water Management District. Repair, replacement and/or abandonment procedures shall include all fees and documentation required by the Water Management District.

1.7 REGULATORY REQUIREMENTS

A. Permits

Obtain and comply with all appropriate local, state, and federal permits and licenses required for performing the work.

PART 2 PRODUCTS

2.1 ON-SITE SOILS

A. Soils in the vicinity of the Landfill contain a limited amount of organic and inorganic constituents. Excavation and removal of onsite or surrounding soils is not permitted unless approved by the Construction Manager.

B. Pockets, lenses or layers of material differing in texture, gradation, moisture or density from the surrounding material shall be identified and removed with the concurrence of the Construction Manger. Removed materials shall be replaced with

Compacted Fill in accordance with the requirements of the Specifications. Removed materials shall be disposed in the manner and location designated by the Construction Manager.

2.2 BORROW SOURCES

A. Borrow sources do not exist within the property boundary of the proposed landfill for use on this project.

B. Borrow sources may not be available within the Plant boundaries for the Drainage Material or the Vegetated Cover Fill.

C. Offsite Sources

1. Contractor shall be responsible for locating sources of borrow material from offsite sources sufficient to complete the work. The Contractor shall obtain representative samples of the proposed source for laboratory testing. Results of the testing along with representative samples of the proposed material shall be submitted to the Construction Manager for approval prior to procurement, excavation, transport stockpiling or use.

2. Contractor use of other borrow sources shall only be with the written approval of the Construction Manager. Unless otherwise directed by the Construction Manager all material shall conform to the requirements of the Specifications.

2.3 FILL MATERIAL

A. Compacted Fill

1. Compacted Fill shall consist of random granular or cohesive materials obtained from approved on-site or off-site borrow areas. Compacted Fill will contain a minimum of 5 percent by dry weight of material passing the U.S. No. 200 Sieve and be free of lenses, pockets or layers of material differing in texture, gradation, and moisture from surrounding material. Compacted Fill shall consist of soil types meeting the following classifications of ASTM D2487:

Silty to Clayey Sands	SC, SP, SP-SM, SC-SM
Silty Sands	SM, SP
Clayey Silts to Silty Clays	SC-SM, SM-SC, CL
Silty Sandy Clays	CL
Combinations of the above	

2. The maximum clod size for Compacted Fill shall be 4 inches in any dimension. Oversize material shall be removed or reworked to conform to these

requirements. Non-uniform material shall be removed or reworked to conform to these requirements.

B. Tracked In-place Fill

1. Tracked In-place Fill shall consist of poorly graded granular or cohesive fill obtained from approved borrow areas. Tracked In-place Fill shall be free from lenses, pockets or layers of material differing in texture, gradation, and moisture from surrounding material.

2. Tracked In-place Fill shall consist of soils types meeting the following classifications of ASTM D2487:

Silty to Clayey Sands	SC, SP, SP-SM, SC-SM
Silty Sands	SM, SP
Clayey Silts to Silty Clays	SC-SM, SM-SC, CL
Silty Sandy Clays	CL
Combinations of the above	

3. The maximum clod size for Tracked In-place Fill shall be 2 inches in any dimension. Oversize material shall be removed or reworked to conform to these requirements. Non-uniform material shall be removed or reworked to conform to these requirements.

C. Drainage Material

1. Drainage material shall consist of siliceous, non-carbonate, non-angular sound sand or gravel obtained from approved borrow sources. Drainage material will contain a maximum of 10 percent by dry weight of material passing the U.S. No. 100 Sieve and be free of lenses, pockets or layers of material differing in texture, gradation and moisture from the surrounding material.

2. Sand drainage material shall consist of soil types meeting the following classifications of ASTM D2487:

Slightly Silty Sands	SM, SP-SM, SW-SM
Well Graded to Poorly Graded Sands	SP, SW

Sand drainage material shall conform to the following ASTM C33 requirements for fine aggregates:

Sieve Size	Percent Passing by Weight
3/8 inch	100
No. 4	95 – 100
No. 8	80 – 100
No. 16	50 – 85
No. 30	25 – 60
No. 50	10 – 30
No. 100	0 – 10

Sand drainage material shall have a laboratory measured permeability of $\geq 1 \times 10^{-3}$ cm/sec.

3. Gravel drainage material shall consist of soil types meeting the following classifications of ASTM D2487.

Sandy Gravel to Sandy Silty Gravel	GW-GM, GP-GM
Well Graded to Poorly Graded Gravel	GW, GP

Gravel drainage material shall conform to the following ASTM C33 requirements for coarse aggregates:

Sieve Size	Percent Passing by Weight
1.5 inch	100
1 inch	95 – 100
½ inch	25 – 60
No. 4	0 – 10
No. 8	0 – 5

Gravel drainage material shall have a laboratory measured permeability of ≥ 1 cm/sec.

D. Protective Fill

1. Protective Fill shall consist of granular or fine-grained cohesive materials obtained from approved borrow areas, or other sources as approved by the Construction Manager. Protective Fill will be used to construct the protective soil layer placed directly on the Primary Collection System. Protective Fill shall consist of soil types meeting the following classifications:

Silty to Clayey Sands	SC, SP, SP-SM, SC-SM
Poor to Well Graded Sands	SP, SW
Sandy to Silty Clays	CL, SM-SC
Sludges	

2. Protective Fill shall be free of rocks, sticks, roots deleterious or unsuitable materials. Maximum clod size for protective fill shall be 4 inches in any dimension. Oversize material shall be removed or reworked to conform to these requirements. Non-uniform material shall be removed or reworked to conform to these requirements.

E. Vegetated Cover Fill

1. Vegetated Cover Fill shall consist of granular material obtained from approved borrow areas. Vegetated Cover Fill will contain a maximum of 15 percent by dry weight of material passing the U.S. No. 200 Sieve and be free from lenses, pockets or layers of material differing in texture, gradation, and moisture from surrounding material. The Vegetated Cover Fill shall have a laboratory measured permeability $\geq 1 \times 10^{-3}$ cm/sec. Vegetated Cover Fill shall consist of soil types meeting the following classifications of ASTM D2487:

Silty Sands	SM
Clayey Sands	SC, CL-SC
Silty to Clayey Sand	SP-SM, SP-SC, SC-SM
Topsoil	
Combinations of the above	

2. The maximum clod size for vegetated cover shall be 2 inches in any dimension. Oversize material shall be removed or reworked to conform to these requirements. Non-uniform material shall be removed or reworked to conform to these requirements.

3. Vegetated Cover Fill shall conform to the following gradation requirements:

Sieve Size	Percent Passing by Weight
No. 16	100
No. 30	90 – 100
No. 50	60 – 100
No. 100	25 – 80
No. 200	5 – 40

2.4 EQUIPMENT

1. All equipment and tools used in the performance of this work are subject to the approval of the Construction Manager before work is started.

2. Contractor shall provide compaction equipment appropriate for the material types to obtain the densities specified. At a minimum "footed" rollers are expected for compaction of fine-grained soils or cohesive fills. Smooth drum rollers or hand compaction methods may be appropriate for granular drainage material sands and gravels.

3. Contractor shall provide hand-operated compaction equipment in areas closer than 2 ft from pipes or other appurtenant structures to obtain the densities specified.
4. Contractor shall operate and maintain compaction equipment in accordance with the manufacturer's instructions and recommendations. If inadequate densities are obtained, provide larger and/or different type equipment at no cost to the Owner.

5. Contractor shall provide equipment for applying water of a type and quality adequate for the Work, free of leaks and equipped with a distributor bar or other approved device to ensure uniform application.

6. Contractor shall provide equipment for mixing and drying out material, such as blades, discs, or other approved equipment.

7. Contractor shall sufficiently weigh the compaction equipment such that the feet fully penetrate the loose lift during initial compaction.

8. Contractors mixing and blending equipment shall fully penetrate loose lifts during mixing to achieve a uniform material.

PART 3 EXECUTION

3.1 WATER CONTROL

A. Contractor shall furnish, install, maintain and operate all equipment and materials needed to prevent, control and remove surface water within or adjacent to the area of work in accordance with the approved Stormwater Control Plan identified in Section 02150 of these Specifications.

B. Contractor shall furnish, install, maintain, and operate all equipment and materials to prevent ground water from flowing into excavations or onto work areas or areas designated to receive fill as necessary or as required by the Construction Manager.

3.2 CLEARING AND GRUBBING - LANDFILL FOOPRINT AREA

A. Contractor shall remove vegetation including snags, brush, and rubbish occurring in the areas of the work.

B. Roots, brush, rotten wood, and other refuse collected by the Contractor from the clearing and grubbing operations shall be disposed by the Contractor at the designated location shown on the Drawings.

3.3 SUBGRADE PREPARATION

A. General

1. Contractor shall proof roll footprint areas as shown on the Plans to identify soft or spongy areas.

2. Contractor shall remove soft or spongy areas and replace with Compacted Fill. Low spots and depressions shall be backfilled to achieve a uniform grade.

3. Contractor shall spread out excavated subgrade soils for drying and blending with onsite soils within the footprint of the landfill unless Contractor's written request for options are approved.

B. Perimeter Berms and Liner System Footprint

1. Contractor shall disc, harrow and breakup subgrade soils to a depth of 8 inches within the perimeter berm and liner system footprint.

2. Contractor shall prepare subgrade soils to meet the requirements of Compacted Fill.

3. Soils not meeting the requirements of Compacted Fill shall be removed and replaced by the Contractor.

4. Contractor shall adjust in-place soils moisture content to be no less than 2 percent below optimum and no more than 3 percent above optimum as determined by ASTM D698.

5. Contractor shall compact insitu soils to not less than 95 percent of the laboratory maximum Standard Proctor dry density (ASTM D698). Any single in-place density test falling below 90 percent compaction level shall be classified as a failing test and the area of materials represented by the failing test shall be re-processed by the Contractor until 95 percent or greater compaction is achieved. Areas represented by in-place density test results falling between 90 and 95

percent maximum Standard Proctor dry density may be accepted if both of the following conditions are met:

(a) The test result is not more than 1 in 5 successive tests in the range of 90 to 95 percent maximum density.

(b) Total number of in-place density tests falling in the range of 90 to 95 percent maximum dry density is less than 10 percent of the total number of in-place density tests completed at that time.

Areas represented by unacceptable tests with compactions between 90 and 95 percent shall be reprocessed by the Contractor until 95 percent or greater maximum dry density is achieved.

3.4 SURFACE PREPARATION

A. The compacted surface of any layer of fill which is too wet or too dry for bonding to the next layer of material shall be dried or moistened by the Contractor and compacted before the next layer is placed.

B. Contractor shall scarify the foundation so that the surface materials will bond and compact with the first layer of fill.

C. Contractor shall place all fill to conform to the grades and cross-sections shown on the Plans.

3.5 EXCAVATION

A. All excavation shall comply with the requirements of OSHA 29 CFR Part 1926.

B. Limits

1. Contractor shall excavate to lines, grades, and dimensions, as shown on the Plans.

2. Contractor shall minimize excavation beyond limits shown unless otherwise approved in writing by the Construction Manager.

3. Contractor shall design and use sloping, sheeting, shoring and bracing as necessary to protect existing structures from damage.

4. Contractor shall grade the surface of overexcavated areas by creating a smooth transition to adjoining areas, and slope to drain.

5. Overexcavated areas shall be backfilled and compacted by the Contractor in accordance with these specifications at no expense to the Owner unless additional excavation was previously approved by the Construction Manager.

C. At the conclusion of each days work, Contractor shall backfill, barricade or adequately fence and protect all trenches and/or excavations in accordance with the Owner's EH&S Requirements.

3.6 PLACEMENT

A. General

1. Contractor shall construct the soil components of the lining and final cover system using suitable fill materials as specified.

2. Contractor shall construct soil components to the lines and grades shown on the Plans.

3. Contractor shall construct each layer of each zone in a continuous and nearly horizontal layer for the full width at the elevation of the layer unless otherwise required by the Specifications or Plans.

4. Contractor shall place and compact all materials to prevent constructed discontinuities in the fill or segregated areas of the work. Differences in elevation for material placed and compacted shall not exceed four (4) ft unless otherwise approved in writing by the Construction Manager.

5. Special care shall be taken by the Contractor to ensure bonding of new fill to constructed segments previously placed by benching in 2 ft horizontally into the existing fill for each 1-ft vertical placement. This requirement shall not apply to construction interfaces between side slopes and bottom materials.

6. Contractor shall moisten or aerate, scarify, and work with harrows, discs, or other suitable equipment in such a manner to reduce the clod size of material being placed to the requirements given. Blend all material to be free from lenses, pockets, or layers of material differing in texture, gradation, and moisture from surrounding materials and to depths that provide a bonding surface with the new material.

7. Soils with excess moisture shall be sufficiently dried to meet the specified compaction requirements.

8. Contractor may at his option add moisture to the borrow area.

B. Compacted Fill

1. Prior to placing any new fill, the Contractor shall scarify the foundation upon which new fill is to be placed. Where the proposed fills overlie unsuitable materials, such materials shall be removed by the Contractor.

2. Contractor shall ensure the uniform moisture distribution of the Compacted Fill.

3. Materials too dry for compaction may be pre-wetted in the borrow areas by the Contractor. Supplemental water, if required, may be added by the Contractor to the material after placement and prior to compaction by uniform sprinkling and shall be mixed uniformly using discs.

4. Contractor shall conduct borrow and placing operations to assure product uniformity.

5. The material shall be placed by the Contractor in maximum 12-inch thick (loose) lifts.

6. The placement moisture content for Compacted Fill zone materials shall be between 2 percent below and 3 percent above optimum moisture content (ASTM D698).

7. Compacted Fill shall be compacted by the Contractor to not less than 95 percent of the laboratory maximum Standard Proctor dry density (ASTM D698). Any single in-place density test falling below 90 percent compaction level shall be classified as a failing test and the area of materials represented by the failing test shall be be-processed by the Contractor until 95 percent compaction is achieved. Areas represented by in-place density test results falling between 90 and 95 percent maximum Standard Proctor dry density may be accepted if both of the following conditions are met:

   (a) The test result is not more than 1 in 5 successive tests in the range of 90 to 95 percent maximum density.

   (b) The total number of in-place density tests falling between 90 to 95 percent maximum dry density is less than 10 percent of the total number of in-place density tests completed at that time.

   Areas represented by unacceptable tests with compactions between 90 and 95 percent shall be reprocessed by the Contractor until 95 percent or greater maximum dry density is achieved.

8. The Contractor shall route all construction equipment in a manner that ensures uniform compaction of each lift.

9. Lift thickness shall be controlled by the Contractor through the use of temporary grade stakes.

10. If the compacted surface of any completed lift of fill is too wet or too dry for placement of the subsequent lift, it shall be dried back or moistened, and then scarified before the next lift of fill is placed. Contractor shall remove grade stakes from the fill prior to compacting that lift.

11. Contractor shall protect and maintain a smooth finished surface on the embankment prior to seeding with vegetative cover.

12. Erosion gullies, rills or other surface discontinuity developing on the exterior face of the embankment shall be repaired by the Contractor immediately.

13. Erosion features which average 2 inches deep or less shall be repaired by the Contractor by reblading and compacting the surface.

14. Erosion features which average greater than 6 inches deep shall be removed by the Contractor and replaced using procedures acceptable to the Construction Manager.

C. Tracked In-place Fill

1. Tracked In-place Fill shall be placed by the Contractor to the lines and grades shown in the Plans.

2. Soil material shall conform to the material requirements of these Specifications for Tracked In-place Fill.

3. The Contractor shall place the first lift of Tracked In-place Fill over the geosynthetic material (i.e., geomembrane liner) in a uniform loose lift no less than 12 inches thick by track-mounted earthmoving equipment. All fill shall be "rolled" into place such that fill placement shall not "gouge" or displace the lower materials.

4. The first lift of the Tracked In-place Fill will be inspected and tested. If the in-place density and moisture content meet the requirements of the Specifications, either all or a portion of the first lift will be accepted.

5. Prior to placement of subsequent lifts, the Contractor shall sufficiently roughen the area to a depth of approximately 2 inches. Fill moisture content shall be modified as necessary to provide a suitable bond with the next lift.

6. Contractor shall spread subsequent fill in uniform lifts not exceeding 9 inches in loose thickness before compaction.

7. Contractor shall adjust moisture content as required to maintain the range specified. Moisture content adjustment shall be accomplished by aerating and discing when too wet or by adding water and mixing by discing or blading when too dry. The addition of water to the clay fill shall utilize thorough mixing to achieve a uniform moisture content distribution within the Low Permeability Fill.

8. Contractor shall compact Tracked In-place Fill to no less than 90 percent of the laboratory maximum Standard Proctor dry density as per ASTM D698.

9. The placement moisture content shall be between optimum and 3 percent above optimum moisture content as determined by ASTM D698.

10. Contractor shall not permit equipment to travel directly on geosynthetic material.

D. Drainage Material

1. Contractor shall place Drainage Materials to the lines and grades shown in the Plans.

2. Drainage Material shall conform to the material requirements for Sand Drainage or Gravel Drainage Material or Capillary Break Layer in these Specifications.

3. Contractor shall prevent soils from adjacent zones being tracked or mixed with Drainage Material Fill.

4. Contractor shall loosely dump and "roll" Sand Drainage Material into place without sliding or gouging underlying material.

5. Contractor shall place Sand Drainage Material in uniform horizontal lifts no less than 12 inches thick prior to compaction.

6. Contractor shall compact Sand Drainage layer to 50 percent relative density.

7. Contractor shall place Gravel Drainage Fill in uniform lifts. Contractor shall not dump gravel on geosynthetic materials.

8. Contractor shall not permit equipment to travel directly on geosynthetic material.

E. Protective Fill

1. Contractor shall place Protective Fill to the lines and grades shown in the Plans.

2. Protective Fill shall conform to the requirements of these Specifications.

3. Contractor shall place Protective Fill in uniform loose lifts no less than 18 inches thick. Contractor shall "roll" Protective Fill into place without gouging underlying materials.

4. Protective Fill shall be walked into place using track-mounted equipment.

5. Contractor shall not permit equipment to travel directly on geosynthetic material.

F. Vegetated Cover Fill

1. Contractor shall place Vegetated Cover to the lines and grades shown on the Plans.

2. Contractor shall place first lift of Vegetated Cover in uniform horizontal lifts of 12 inches.

3. Contractor shall "roll" Vegetated Cover Fill into place without gouging underlying layers using tracked equipment with ground pressures less than 5 psi.

4. Each lift of Vegetated Cover Fill shall be compacted by the Contractor with no less than 3 coverages using tracked equipment.

5. Contractor shall not permit equipment to directly travel across geosynthetic material.

3.7 MAINTENANCE

A. During work interruption(s) Contractor shall be solely responsible for preventing moisture loss from compacted materials.

B. Contractor shall remove and replace or recondition materials that have dried below the specified moisture range for that fill classification.

C. Contractor shall replace dried soils using material and procedures in accordance with these Specifications.

D. Temporary covers may be used to prevent moisture loss.

E. Desiccation Cracks

1. Desiccation cracks within the compacted material shall be repaired immediately by the Contractor.

2. Contractor shall repair shall desiccation cracks (less than 2 inches in depth) by discing or rotary tilling the fill to produce clods that are no greater than 2 inches.

Moisture content of the fill shall be properly adjusted to within the range specified. Fill shall be thoroughly mixed to achieve a uniform moisture content distribution and compacted to the specified value.

3. Contractor shall repair deep desiccation cracks (greater than 2 inches in depth) by removing the fill from the compacted layer to a depth of 1.5 times the average depth of desiccation crack. Contractor shall replace and recompact fill into the excavated area meeting the requirements of the Specifications.

3.8 CONSTRUCTION TOLERANCE

A. Survey Precision

1. Contractor shall provide survey control for all earthwork placement, compaction, excavation and grading and as otherwise directed by the Construction Manager.

2. Contractor shall perform surveys of the work to ± 0.1 ft vertically and ± 0.25 ft horizontally.

B. Surface Tolerance

1. Contractor shall construct finished subgrades, compacted surfaces and drainage material layers from -0.0 to +0.1 ft.

2. Contractor shall provide constructed work with variations in final grade ≤ 0.25 ft above minimum thickness vertically between any two points located within 100 ft in any direction with the exception of designated changes in grade.

3.9 SURVEY CONTROL DATA

A. Survey data shall be collected as specified below or as otherwise directed by the Construction Manager.

B. Subgrade

1. Contractor shall collect survey data at points a maximum of 50 ft apart beneath the lining system footprint.
2. Contractor shall collect survey data at points 100 ft apart on the centerline of the perimeter berm.

3. Contractor shall collect survey data for the outside toe of the perimeter berm at the same frequency as the measurements of the centerline.

C. Perimeter Berm

1. Contractor shall collect survey data at points 100 ft apart. Survey data points shall at a minimum be on the centerline of the perimeter berm, the outside toe and the inside toe of the lift.

2. Contractor shall collect survey data on every third lift of the perimeter berm starting with the finished surface of the first lift.

D. Tracked In-place Fill

1. Contractor shall collect survey data at points 50 ft apart and no less than 6 points per grade.

2. Contractor shall collect survey data of the following surfaces:

   - the finished layer to receive Tracked In-place Fill
   - the compacted surface of the first lift of Tracked In-place Fill
   - the final constructed surface of Tracked In-place Fill

E. Drainage Material

1. Contractor shall collect survey data at the following locations:
   - the finished layer to receive the drainage material
   - locations, widths, grades and elevations of gravel drains and sumps
   - the top and bottom of each drainage layer

2. Contractor shall collect survey data at points no further than 25 ft apart and no less than 6 points per grade.

F. Protective Cover Layer

1. Contractor shall collect survey data at points 100 ft apart and no less than 6 points per grade.

2. Contractor shall collect survey data on the finished surface to receive Protective Cover and on the top of the Protective Cover Layer.

G. Vegetated Cover

1. Contractor shall collect survey data at points 100 ft apart and no less than 6 points per grade.

2. Contractor shall collect survey data on the finished surface to receive the Vegetated Cover and on the top of the Vegetated Cover Layer.

3.10 QUALITY CONTROL

A. General

1. Tests and analysis of fill materials will be performed by the Contractor's approved QC personnel and Testing Laboratory.

2. Field inspection and testing will be performed by the Contractor.

3. The test frequency option which results in the greatest number of tests shall be used by the Contractor.

4. If the Construction Manager suspects the accuracy of the Nuclear Density gauge based on the review of QA test comparisons, the Contractor shall be responsible for proposing corrective actions to be taken to resolve discrepancies. The Construction Manager must approve the proposed corrective action before any further testing with the Nuclear Density gauge is accepted.

5. If the Contractor's in-place density test fails due to moisture content, re-test in the same area. If the second test fails, remove or rework area defined by surrounding tests meeting the Specifications.

6. All perforations due to density test probe, sample tubes, or test pit excavation shall be backfilled by the Contractor. All perforations shall be backfilled with material similar to that of the layer. Backfill shall be recompacted using methods and procedures specified. Contractor may use a powdered bentonite backfill as an option.

7. One point compaction tests shall be performed by the Contractor whenever a change in material is observed or suspected, as directed by the Construction Manager and no less than once per day per material type.

8. Contractor may use one point compaction data for calculation of maximum Standard Proctor dry density until a laboratory generated moisture density curve is developed. Contractor may continue placement at his own risk.

9. If placed and compacted material does not meet the requirements of these Specifications based on the laboratory generated moisture density curve, the Contractor shall remove or rework all such material to meet these requirements at no additional cost to the Owner.

10. Contractor shall submit all preconstruction and construction quality control data with a cover letter signed and sealed by a Florida registered professional engineer indicating the requirements of the Specifications have been achieved and the data as presented is representative of the material tested.

B. Preconstruction Material Quality Evaluation

1. The Contractor shall perform material quality evaluations on all proposed borrow sources for approval by the Construction Manager prior to procurement, excavating, transport, stockpiling or use.

2. Compacted Fill testing requirements:

• ASTM D2216	1 per source
• ASTM D4318	1 per source
• ASTM D1140	1 per source
• ASTM D698	1 per source
• ASTM D5084	1 per source

3. Tracked In-place Fill testing requirements:

• ASTM D2216	1 per source
• ASTM D4318	1 per source
• ASTM D1140	1 per source
• ASTM D698	1 per source

4. Drainage Material testing requirements for each sand and gravel source:

• ASTM D2216	1 per source per type
• ASTM D422	1 per source per type
• ASTM D2434	1 per source per type

5. Protective Fill testing requirements:

• ASTM D2216	1 per source
• ASTM D1140 or D422	1 per source
• ASTM D698	1 per source

6. Vegetated Cover Fill testing requirements:

• ASTM D2216	1 per source
• ASTM D4318	1 per source

- ASTM D1140 — 1 per source
- ASTM D5084 — 1 per source

C. Construction Material Quality Evaluation

1. Laboratory testing shall be performed by the Contractor's QC personnel on each source throughout the performance of construction.

2. Compacted Fill testing requirements for each borrow source used:

   - ASTM D2216 — 1 per 20,000 yds^3
   - ASTM D4318 — 1 per 20,000 yds^3
   - ASTM D1140 — 1 per 20,000 yds^3
   - ASTM D698 — 1 per 20,000 yds^3
   - ASTM D5084 — 1 per 50,000 yds^3

3. Tracked In-place Fill testing requirements for each borrow source used:

   - ASTM D2216 — 1 per 10,000 yds^3
   - ASTM D4318 — 1 per 10,000 yds^3
   - ASTM D1140 — 1 per 10,000 yds^3
   - ASTM D698 — 1 per 20,000 yds^3

4. Drainage Material testing requirements for each sand and gravel source:

   - ASTM D2216 — 1 per 10,000 yds^3
   - ASTM D422 — 1 per 10,000 yds^3
   - ASTM D2434 — 1 per 10,000 yds^3

5. Protective Fill testing requirements for each material source:

   - ASTM D2216 — 1 per 50,000 yds^3
   - ASTM D1140 or D422 — 1 per 50,000 yds^3
   - ASTM D698 — 1 per 50,000 yds^3

6. Vegetated Cover testing requirements for each material source:

   - ASTM D2216 — 1 per 20,000 yds^3
   - ASTM D4318 — 1 per 10,000 yds^3
   - ASTM D1140 or D422 — 1 per 10,000 yds^3
   - ASTM D5084 — 1 per 20,000 yds^3

D. Constructed Material Quality Control

1. Compacted Fill

In-place density ASTM D2922 ASTM D3017	1 per 2,000 yd^3 placed and compacted
In-place density verification ASTM D2937 ASTM D2216	1 per 15,000 yd^3 placed and compacted

2. Tracked In-place Fill

In-place density ASTM D2922 ASTM D3017	1 per 15,000 ft^2 placed and compacted with a minimum of 6 per lift
In-place density verification ASTM D2937 ASTM D2216	1 per 2,000 yd^3 placed and compacted with a minimum of 1 per lift

END OF SECTION 02200

SECTION 02225

SEDIMENT MATERIAL HANDLING

SECTION 02225

SEDIMENT MATERIAL HANDLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Excavation, temporary storage and transport of sediments, soils and subsurface soil materials.

B. Placement and compaction of excavated sediments, soils and subsurface soil materials in the Landfill.

C. All collection, control, temporary storage, testing and discharge of contaminated water associated with waste excavation, treatment, temporary storage, placement and compaction in the waste disposal cell.

D. Procurement, transportation, storage, handling, installation and operation of all equipment and materials necessary for conduct of the work.

E. Health and safety requirements of the project Health and Safety Plan, as well as Solutia's Pensacola Facility plant specific safety requirements.

1.2 DEFINITIONS

A. Sediments: Fine grained solids located within the limits of the Dead Creek remaining after the creek is unwatered and the residual material dewatered and dried.

B. Subsurface Soils: Existing soil material located directly beneath the sediments within the creek that require removal.

C. Contaminated Water: All stormwater falling directly on exposed sediments, stormwater run on contacting sediments or groundwater seepage contacting sediments material during excavation, temporary storage, handling, transport, placement or compaction.

D. Compactive Effort: Energy applied to the sediments or soils after placement in the Landfill by tracked or wheeled equipment.

1.3 SUBMITTALS

A. Excavation and Material Handling

1. Contractor shall submit an Excavation and Material Handling Plan for approval by the Construction Manager.

2. Contractor's Excavation and Material Handling Plan shall address excavation, stockpiling, temporary storage, handling, transport and placement into the Landfill for sediments and soils.

3. The Contractor's plan shall address management of contaminated water and shall be compatible with the water treatment system for this project.

PART 2 PRODUCTS

2.1 EQUIPMENT

A. All equipment and tools used in the performance of this work are subject to the approval of the Construction Manager before work is started.

B. Provide compaction equipment appropriate for the material types to obtain the densities specified.

C. Provide hand-operated compaction equipment in areas closer than 2 feet (ft) from liners or structures to obtain the densities specified.

D. Operate and maintain compaction equipment in accordance with the manufacturer's instructions and recommendations. If inadequate densities are obtained, provide larger and/or different type equipment at no cost to the Owner.

E. Provide equipment for mixing and drying out material, such as blades, discs, or other approved equipment.

F. Contractor shall provide and operate dewatering equipment to remove and maintain control of stormwater runoff and keep the work area in an unwatered condition throughout the construction period in a manner approved by the Construction Manager.

PART 3 EXECUTION

3.1 GENERAL

A. All excavations, trenching, and shoring shall comply with the rules and regulations as established by OSHA Construction Safety and Health Regulations 29 CFR, Part 1926.

B. Contractor shall place all processed and temporarily stored sediments in such a manner as to prevent dispersal by wind, water erosion and to minimize the generation of leachate from rainfall.

C. Contaminated water within the confines of the active portion of the TSCA waste disposal cell, waste handling areas, and creek areas shall be controlled, collected, and discharged in accordance with the direction of the Construction Manager.

D. Mixtures of sediments with soils or subsurface soils shall be handled as if the mixture is 100 percent sediment for the purpose of placement and compaction.

3.2 SEDIMENT AND SOIL HANDLING

A. Dewatering/Drying

1. Sediments within the creek shall be dewatered and dried.

2. Contractor shall install dewatering sumps at the locations and in the manner selected by the Construction Manager.

3. Contractor shall maintain the dewatering sumps to promote removal of rainfall runoff and stormwater.

4. The Contractor may use mechanical methods such as discing, harrowing, or stockpiling to hasten the drying process as approved or as directed by the Construction Manager. The sediments shall not be placed into the landfill until dewatered sufficiently to pass the EPA paint filter criteria.

B. Sediment and Soil Excavation

1. Sediment and soils approved for placement in the Landfill shall be excavated, transported, placed and compacted by the Contractor in the manner approved by the Construction Manager.

2. Contractor shall excavate sediments in a coordinated fashion that minimizes the amount of handling and minimizes the potential to spill or generate contaminated water.

3. Subsurface soil materials located beneath the sediments shall be excavated by the Contractor as directed by the Construction Manager.

4. Excavated soils and subsurface soils shall be transported, placed and compacted in the disposal cell by the Contractor.

5. Contractor's Excavation and Material Handling Plan shall include methods and procedures to control and prevent stormwater run on and run off from areas with exposed sediments to adjacent areas.

3.3 PLACING AND SPREADING SEDIMENTS

A. Do not place sediments until the area to receive fill is completed and accepted by the Construction Manager.

B. Place sediment materials to the lines and grades shown on Plans with specified suitable materials.

C. Grade sediments in a manner that will promote positive site drainage and that will direct drainage away from the work and prevent ponding.

D. Uniformly grade areas to provide a finished surface that is smooth, compacted and free of irregularities. Comply with compaction requirements and grade to cross sections, lines and elevations indicated.

E. Place and compact the sediments in the landfill with sufficient compactive effort to provide a minimum undrained shear strength of 500 psf. Sediment shear strength will be measured by the Contractor and observed by the Construction CQA Consultant using either pocket penetrometer or field penetrometer instruments. The Construction Manager reserves the right to require a higher minimum shear strength if field conditions indicate that construction or operation problems will occur.

F. Place sediment adjacent to the side wall lining with a clearance between the construction equipment and lining of between 2 and 4 ft. The minimum undrained shear strength requirement shall not apply to sediments placed in this zone.

G. Compact each lift of fill thoroughly, using appropriate compaction equipment.

H. If tests indicate Work does not meet specified requirements, rework, remove or replace and retest at no cost to Owner.

I. Contractor shall minimize the surface area of placed sediments within the Landfill.

J. Exposed face of placed and compacted sludge shall vary in accordance with the thickness of the exposed fill.

K. Contractor shall place and compact sediment in accordance with the following:

Maximum Elevation Difference in Compacted Sediment Thickness (ft)	Maximum Exposed Sediment Face Slope Angle
5	3.0 (H) to 1 (V)
10	3.5 (H) to 1 (V)
15	4.0 (H) to 1 (V)

L. Contractor shall not place and compact sediment in layers that creates differences in surface elevations of greater than 10 ft.

3.4 PLACING AND SPREADING SOILS

A. Place soil materials to the lines and grades shown on Plans with specified suitable materials.

B. Grade soils in a manner that will promote positive site drainage and that will direct drainage away from the work and prevent ponding.

C. Uniformly grade areas to provide a finished surface that is smooth, compacted and free of irregularities. Comply with compaction requirements and grade to cross sections, lines and elevations indicated.

D. Place and compact the soils in the landfill with sufficient compactive effort to provide a minimum undrained shear strength of 500 psf. Shear strength will be measured by the Contractor and observed by the Construction CQA Consultant using either pocket penetrometer or field penetrometer instruments. The Construction Manager reserves the right to require a higher minimum shear strength if field conditions indicate that construction or operation problems will occur.

E. Place soils adjacent to the side wall lining with a clearance between the construction equipment and lining of between 2 and 4 ft. The minimum undrained shear strength requirement shall not apply to soils placed in this zone.

F. Compact each lift of fill thoroughly, using appropriate compaction equipment.

G. If tests indicate Work does not meet specified requirements, rework, remove or replace and retest at no cost to Owner.

H. Contractor shall minimize the surface area of placed soils within the Landfill.

I. Exposed face of placed and compacted soils shall vary in accordance with the thickness of the exposed fill.

J. Contractor shall place and compact soils in accordance with the following:

Maximum Elevation Difference in Compacted Soil Material Thickness (ft)	Maximum Exposed Soil Face Slope Angle
5	2.5 (H) to 1 (V)
10	3.0 (H) to 1 (V)
15	3.5 (H) to 1 (V)

K. Contractor shall not place and compact soil in layers that creates differences in surface elevations of greater than 10 ft.

END OF SECTION 02225

SECTION 02227

GEOGRID REINFORCEMENT

SECTION 02227

GEOGRID REINFORCEMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Geogrid reinforced ramp construction for landfill cell access.

B. Geogrid reinforced landfill cover.

1.2 REFERENCES

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A.	ASTM C136	Method for Sieve Analysis of Fine and Coarse Aggregates.
B.	ASTM D422	Method for Particle-Size Analysis of Soils.
C.	ASTM D698	Moisture Density Relations of Soils and Soil-Aggregate Mixtures Using a 5.5 Pound (2.49 kg) hammer and a 12-inch (304.8 mm) drop.
D.	ASTM D2487	Classification of Soils for Engineering Purposes.
E.	ASTM D2922	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
F.	ASTM D3017	Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
G.	ASTM D4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
H.	ASTM D4595	Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.

I. ASTM D5321 Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.

1.3 SUBMITTALS

A. General

1. Contractor shall submit qualification information on the Manufacturer, Installer and Geosynthetic Testing Laboratory.

2. Contractor shall submit prequalification data on each geosynthetic material to the Construction Manager for approval prior to procurement, transport, stockpiling or use.

3. Contractor shall submit results of all quality control data and information to the Construction Manager within 1 work day of receipt.

4. Contractor shall submit all observations and documentation generated by its quality control personnel daily for the current day's activities.

5. Contractor shall submit results of all field surveys and documentation within 1 day of generation including copies of data, field books and notes. Copies of survey information signed and sealed by a Illinois licensed surveyor shall be submitted within 1 day of receipt.

6. Contractor shall submit signed documentation that the geogrid was installed in accordance with the Plans and Specifications.

B. Manufacturer

The Manufacturer shall submit the following prior to installing geosynthetics:

1. A list of material properties including certified test results attached to samples of the proposed geosynthetic material.

2. The origin and identification of the resin used to manufacture the product.

3. Submit all quality control documentation required by these Specifications prior to installation.

C. Installer

The Installer shall submit the following prior to installation:

1. Resume of superintendent to be assigned to the project including dates/duration of employment. The superintendent shall have demonstrated experience of two similar projects.

2. A list of personnel to be performing field seaming operations with pertinent experience information.

3. All geosynthetic quality control certificates.

1.4 TESTING

A. Contractor shall retain the services of an independent testing laboratory. At a minimum, Contractor shall be responsible for providing the following quality control information:

1. Compliance testing for installed geosynthetics.

2. Quality control testing during construction.

B. The Contractor shall inspect and ensure all work is in conformance with these Specifications.

C. Contractor shall inform the Construction Manager prior to conducting all quality control testing to allow oversight.

D. Contractor shall submit all quality control data (both pre-construction and construction) with a cover letter signed and sealed by a Illinois registered professional engineer indicating the requirements of the Specifications were achieved and the data is representative of the material tested.

1.5 QUALITY ASSURANCE

A. Geogrid shall be free of defects, rips, holes, or flaws.

B. It shall be manufactured in widths and lengths that will permit installation with as few laps as possible.

C. Geogrid shall be marked with the Manufacturer's name, product identification, lot number, roll number, and roll dimensions.

D. Contractor shall provide a storage area such that geogrid is protected from mud, dirt, dust, debris, and exposure to ultraviolet (UV) light and heat.

E. Contractor shall submit all material and workmanship warranties for the geogrid installation.

1.6 DELIVERY, STORAGE AND HANDLING

A. Contractor shall check the geogrid upon delivery to assure that the proper material has been received.

B. Contractor shall maintain the integrity of the geogrids in a state equal to that which existed at the time of testing and certification for both onsite and offsite storage. This includes but is not limited to ultraviolet protection, protection against rodents, contaminant chemical abrasion, and any other harmful elements.

C. Geogrid shall be stored at temperatures above 35°F and be shaded from prolonged periods of direct exposure to sunlight.

D. Contractor shall prevent excessive mud, wet cement, epoxy, and like materials, which may affix themselves to the grid, from coming in contact with the geogrid material.

E. Rolled geogrid material shall be laid flat or placed on end for storage.

F. Only approved geogrids shall be used in construction. Geogrids delivered to the site shall be clearly marked to show the brand name, type of grid, ultimate tensile strength, location and date of manufacture, and its length (direction of reinforcement) and width.

G. Geogrids delivered to the project site shall remain in factory packaging capable of protecting it from sunlight (ultraviolet), moisture, or any other harmful elements until it is ready to be installed.

PART 2 PRODUCTS

2.1 DEFINITIONS

A. Fill: Selected soil materials to be used in construction of the geogrid reinforced ramp or cover soil layers as specified in Section 02200.

B. Geogrid: An oriented high density polyethylene (HDPE) or polyester grid structure specifically manufactured for use as soil reinforcement.

C. Uniaxial Grid: A geogrid which has been manufactured with high tensile strength in one direction only.

D. Direction of Reinforcement: Refers to the orientation that the geogrid is used in for a particular project; along the roll for uniaxial geogrid.

E. MD: Machine direction.

F. CMD: Cross machine direction.

2.2 ACCEPTABLE MANUFACTURERS

A. The Tensar Corporation

B. A manufacturer of equivalent products, preapproved by the Construction Manager.

2.3 GEOGRID

A. The geogrid reinforcement shall be composed of either oriented high density polyethylene (HDPE); or high-tenacity polyester fibers coated with a protective coating of PVC, bitumen, or latex.

B. Contractor shall obtain from the manufacturer and shall furnish to the Construction Manager test reports certifying that the geogrid meets the requirements of this Specification prior to installation.

C. The geogrid reinforcement shall:

1. Be uniaxially oriented polymer grid structure.

2. Be composed of polypropylene, polyester, or high density polyethylene.

D. The manufacturer shall submit test reports certifying that the product meets the requirements of this Specification.

E. The geogrids shall have the following minimum requirements:

Location	Long-Term Allowable Strength (lb/ft)	Minimum Ultimate Tensile Strength (lb/ft)
Cover	1,200	N/A
Ramp	N/A	10,000

F. Acceptable geogrid products are:

Location	Product Number	Manufacturer
Cover	UX1100HS	Tensar
Cover	UX1400SB	Tensar
Ramp	UX1700HS	Tensar

PART 3 EXECUTION

3.1 GEOGRID INSTALLATION

A. For landfill cell access ramps

1. After completion of the lining system installation, place a 60-mil HDPE fly sheet directly over the clean lining surface covering the entire slope length from crest to toe. The minimum width of the HDPE fly sheet shall be 20 feet (ft).

2. Place a protective geotextile over the HDPE fly sheet

3. Place the geogrid over the geotextile and HDPE layers, fully covering the slope length and extending outside the landfill cell the required distance. The minimum width of the geogrid ramp shall be 12 ft.

4. Bury the geogrid anchorage outside the landfill cell to the required depth.

5. Compact the geogrid anchorage backfill in 6 inch lifts to at least 95 percent of the maximum dry density determined by ASTM D698.

6. After all anchorage fill has been placed, place ramp fill on the landfill cell slope by dumping or pushing the fill down the prepared ramp area. Place at least 8 inches of fill before allowing equipment access.

7. The maximum gross vehicle weight for equipment constructing or using the ramp shall be 100,000 pounds.

B. For landfill cover slope reinforcement

1. Place geogrid directly over the completed 60-mil HDPE geomembrane and geogrid drainage composite landfill cover.

2. Place the cover soil fill over the geogrid and landfill cover in a 12-inch minimum lift thickness. Place at least 2 ft of cover soil fill over the top of the landfill cover to fully anchor the reinforcement prior to placing fill on the cover slopes. Push or dump fill from the top of the cover downward.

3. Compact the cover soil fill to at least 95 percent of the cover soil's maximum dry density as determined by ASTM D698.

C. All geogrid shall be placed at the proper location as shown on the Plans and at an orientation with its strongest axis within 5 degrees of being perpendicular to the slope direction. Correctness of the orientation (roll direction) of the geogrid shall be verified by the Contractor.

D. Adjacent geogrid panels shall be butted together and nylon cable ties shall be placed every 5 ft.

E. Geogrids shall be pulled taut in the reinforcement direction and secured in-place with sand bags, or backfill as required by fill properties, fill placement procedures or weather conditions, or as directed by the Contractor.

F. Geogrid may be connected to an identical geogrid panel using a Bodkin-type connection with components recommended by the geogrid manufacturer. The connection may not be located within 25 ft (in either direction) of the top of slope or slope break.

G. Backfill material shall be placed in lifts and compacted as directed under Section 02200 - Earthwork.

H. Backfill shall be placed, spread, and compacted in such a manner that minimizes the development of wrinkles in and/or movement of the geogrid.

I. Select fill material shall be placed, spread, and compacted in a manner that minimizes the development of wrinkles in and/or movement of the geogrid. Do not exceed 12 inches in loose lift thickness of select fill material.

J. Construction equipment shall not be operated directly on the geogrid. A minimum soil thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the soil and damaging the geogrid.

K. Rubber tired equipment may pass over geogrid reinforcement which has been covered with 6 inches of soil. Sudden braking and sharp turning shall be avoided.

L. Contractor shall take all necessary precautions to avoid damaging the geogrid during installation and soil placement. Geogrid damaged by the Contractor shall be repaired or replaced as directed by the Engineer at the Contractor's expense.

END OF SECTION 02227

SECTION 02242

GEOTEXTILE

SECTION 02242

GEOTEXTILE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Storage, handling, and installation of geotextile.

1.2 REFERENCES

A. ASTM D1117 - Methods of Testing Nonwoven Fabrics.

B. ASTM D5199 - Method for Measuring Thickness of Textile Materials.

C. ASTM D5261 - Test Method for Mass Per Unit Area (Weight) of Nonwoven Fabric.

D. ASTM D3786 - Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics: Diaphragm Bursting Strength Tester Method.

E. ASTM D4439 - Terminology for Geosynthetics.

F. ASTM D4491 - Test Methods for Water Permeability of Geotextiles by Permittivity.

G. ASTM D4533 - Test Method for Trapezoid Tearing Strength of Geotextiles.

H. ASTM D4632 - Test Methods for Breaking Load and Elongation of Geotextiles (Grab Method).

I. ASTM D4751 - Test Method for Determining Apparent Opening Size of a Geotextile.

J. ASTM D4833 - Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.

K. ASTM D4873 - Standard Guide for Identification, Storage and Handling of Geotextiles.

1.3 SUBMITTALS

A. General

1. Contractor shall submit qualification information on the Manufacturer, Installer and Geosynthetic Testing Laboratory.

2. Contractor shall submit prequalification data on each geosynthetic material to the Construction Manager for approval prior to procurement, transport, stockpiling or use.

3. Contractor shall submit results of all quality control data and information to the Construction Manager within 1 work day of receipt.

4. Contractor shall submit all observations and documentation generated by its quality control personnel daily for the current day's activities.

5. Contractor shall submit results of all field surveys and documentation within 1 day of generation including copies of data, field books and notes. Copies of survey information signed and sealed by an Illinois licensed surveyor shall be submitted within 1 day of receipt.

B. Manufacturer

The Manufacturer shall submit the following prior to installing geosynthetics:

1. A list of material properties including certified test results attached to samples of the proposed geosynthetic material.

2. The origin and identification of the resin used to manufacture the product.

3. Submit all quality control documentation required by these Specifications prior to installation.

C. Installer

The Installer shall submit the following prior to installation:

1. Resume of superintendent to be assigned to the project including dates/duration of employment.

2. A list of personnel to be performing field seaming operations with pertinent experience information.

3. All geosynthetic quality control certificates.

D. Contractor shall submit all material and workmanship warranties for the geotextile installation.

1.4 TESTING

A. Contractor shall retain the services of an independent testing laboratory. At a minimum, Contractor shall be responsible for providing the following quality control information:

1. Compliance testing for installed geosynthetics.

2. Quality control testing during construction.

B. The Contractor shall inspect and ensure all work is in conformance with these Specifications.

C. Contractor shall inform the Construction Manager prior to conducting all quality control testing to allow oversight.

D. Contractor shall submit all quality control data (both pre-construction and construction) with a cover letter signed and sealed by a Illinois registered professional engineer indicating the requirements of the Specifications were achieved and the data is representative of the material tested.

PART 2 PRODUCTS

2.1 GENERAL

A. Contractor shall furnish materials whose "Minimum Average Roll Values" (MARV), as defined by the Federal Highway Administration (FHWA), meet or exceed the criteria listed below.

B. Products shall be comprised of polymeric yarns of fibers oriented into a stable network which retains its relative structure during handling, placement and long-term service.

2.2 GEOTEXTILE

A. For filtration, cushion, and protection purposes, the geotextile shall consist of staple fiber needle-punched, nonwoven, polypropylene fabric where shown on the Drawings. The following minimum fabric properties are required:

GEOTEXTILE PROPERTIES			
Property	**Standard**	**MARV**	**Units**
Mass per Area	ASTM D 5261	16	oz/yd^2
Grab Strength	ASTM D 4632	380	lbs
Elongation	ASTM D 4632	60	%
AOS	ASTM D 4751	100	U.S. Sieve
Permittivity	ASTM D 4491	0.7	sec^{-1}
Trapezoidal Tear Strength	ASTM D 4533	145	lbs
Burst Strength	ASTM D 3786	750	psi
Puncture Strength	ASTM D 4833	240	lbs

2.3 MANUFACTURERS

A. Synthetic Industries

B. Approved Equal

PART 3 EXECUTION

3.1 INSTALLATION

A. Geotextile storage, handling and installation shall be the responsibility of the Contractor. Any damaged or unacceptable material shall be replaced at no additional cost to the Owner. During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. To that effect, geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings.

B. Geotextile rolls shall be handled in such a way that they are not damaged.

C. Geotextile shall be securely anchored and then rolled in such a manner as to continually keep the geotextile sheet in tension.

D. Geotextile shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

E. If white colored geotextile is used, precautions shall be taken against "snow blindness" of personnel.

F. Contractor shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

G. Geotextile shall not be exposed to precipitation prior to being installed. Wrappings protecting geotextile rolls shall be removed less than one hour prior to unrolling the geotextile. After the wrapping has been removed, the geotextile shall not be exposed to direct sunlight for more than 15 days (unless otherwise approved by the Construction Manager).

H. Contractor shall seam geotextile rolls by either overlapping, sewing or other methods approved by the Construction Manager.

I. At a minimum, the Contractor shall use the following seaming techniques at the specified locations:

Location	Method of Seaming
• Side Slopes of Lining System	Sewn
• Over Primary Collection System	Sewn
• Fabric Wrapped Around Sumps and Gravel Drain	Overlapped or sewn
• Beneath Soil Protection Layer	Sewn
• Beneath Cover System Geomembrane	Overlapped or sewn
• Above Cover System Geomembrane	Sewn
• Slopes Steeper Than 10 Percent	Sewn
• Slopes Flatter Than 10 Percent	Overlapped or sewn

J. The geotextile seams not sewn shall be overlapped a minimum of 6 inches.

K. Geotextile seams designated as requiring to be sewn shall be continuously sewn with polymeric thread.

1. The thread shall be capable of supplying a seam strength efficiency of 80 percent of the required tensile strength utilizing a Type 401 two-thread chain stitch with a "J" seam.

2. The seam shall have 8 stitches per inch and the stitches shall be a minimum of 2 inches from the fabric edge.

L. Contractor shall pay particular attention at seams such that no soil material is inadvertently inserted beneath the geotextile.

M. Material placement shall be in the direction of the overlap.

N. Soil materials over the geotextile shall be placed in a manner such that the geotextile is not damaged, minimal slippage of the geotextile or underlying layers occurs, and no excess tensile stresses are present in the geotextile.

O. No construction equipment with ground pressure greater than 5 psi shall operate on slopes.

3.2 REPAIRS

A. Holes or tears in the fabric shall be repaired as follows: A fabric patch made from the same geotextile shall be placed over the hole or tear and sewn to the underlying geotextile. Provide a minimum overlap of 24 inches in all directions. Should any tear exceed 10 percent of the width of the roll, that section of the roll shall be removed and replaced.

3.3 QUALITY CONTROL

A. Visual inspections of shipment and storage activities shall be made by the Construction Manager to assure that the fabric has been protected from ultraviolet light exposure, precipitation or other inundation, and dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

B. Contractor shall designate each roll with a roll number (identification code) which is consistent with the layout plan. The rolls shall be positioned on the site as shown on the approved layout drawings. Instructions on boxes or wrapping containing the geotextile materials shall be followed to assure that rolls are unrolled in the proper direction.

3.4 MATERIAL QUALITY EVALUATION

A. Contractor shall submit an affidavit and/or quality control certificate signed by the manufacturer certifying that the geosynthetic rolls meet or exceed specified requirements to the Construction Manager for approval prior to deployment.

B. Preinstallation material quality evaluation testing shall be performed as follows:

• ASTM D5261	4 per roll
• ASTM D4632	1 per 50,000 ft^2
• ASTM D4751	1 per 50,000 ft^2
• ASTM D4491	1 per 50,000 ft^2
• ASTM D4533	1 per 50,000 ft^2
• ASTM D3786	1 per 100,000 ft^2
• ASTM D4833	1 per 100,000 ft^2

C. Conformance Testing

1. Samples shall be obtained at a frequency of one sample per 50,000 square feet.

2. The Contractor shall obtain samples and forward them to a laboratory designated by the Construction Manager.

3. Tests shall be performed to determine mass per Area (ASTM D5261), Permittivity (ASTM D4491), and Tensile Strength (ASTM D4632).

4. The sample shall be across the entire width of the roll excluding the first three (3) feet (ft), and shall be cut three (3) ft long by width roll.

5. Samples shall be 3 ft long by roll width. Machine direction shall be marked on sample with an arrow.

3.5 PLACEMENT OF EARTHEN MATERIALS OVER GEOTEXTILE

A. The Contractor shall place all earthen materials located on top of geotextile in such a manner as to ensure:

1. No damage of geotextile.

2. Minimal slippage of geotextile on underlying layers.

3. No excess tensile stresses in geotextile.

B. Place materials over geotextile by pushing material out over geotextile ahead of equipment in 12-inch thick minimum lifts.

C. On sideslopes, earthen material placement shall begin at toe of slope and proceed upslope to top of slope.

D. Equipment used to place earthen material over the geotextile shall have a maximum contact pressure of 5 lbs/sq inch on earthen material.

E. Thickness of earthen material over geotextile shall be 12 inches or more before equipment used to place earthen material shall be permitted to cross areas where geotextile has been installed.

F. Thickness of cover material over the top geotextile shall be 2 ft before vehicles with contact pressure greater than 8 lbs/sq inch shall be permitted to cross areas where geotextile has been installed.

END OF SECTION 02242

SECTION 02244

GEOMEMBRANE

SECTION 02244

GEOMEMBRANE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. The Contractor shall furnish all material, labor and equipment for the installation of the geomembrane as specified herein and as shown on the Drawings, and shall install the geomembrane and other geosynthetic components of the cover system in close coordination with the Construction Manager.

1.2 REFERENCES

A.	ASTM D638 -	Test Method for Tensile Properties of Plastics.
B.	ASTM D792 -	Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
C.	ASTM D1004 -	Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
D.	ASTM D1204 -	Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
E.	ASTM D1238, Condition E -	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
F.	ASTM D1505 -	Test Method for Density of Plastics by the Density – Gradient Technique.
G.	ASTM D1603 -	Test Method for Carbon Black in Olefin Plastics.
H.	ASTM D1693 -	Test Method for Environmental Stress-Cracking of Ethylene Plastics.
I.	ASTM D4339 -	Terminology for Geosynthetics.
J.	ASTM D4437 -	Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.

K.	ASTM D4833 -	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
L.	ASTM D4885 -	Test Method for Determining Performance Strength of Geomembranes by Wide Strip Tensile Method
M.	ASTM D5199 -	Test Method for Measuring Thickness of Plastics.
N.	GRI GM6 -	Standard Practice for Pressurized Air Channel Test for Dual Seamed Geomembranes.

1.3 DEFINITIONS

A. Batch: A quantity of resin, usually the capacity of one railcar, used in the fabrication of High Density Polyethylene (HDPE) geomembrane rolls. The finished rolls are identified by a roll number corresponding to the resin batch used.

B. Bridging: Condition existing when the geomembrane is not in contact with the underlying material.

C. Contractor: The party responsible for manufacturing, shipping, field handling, transporting, storing, deploying, seaming, temporary restraining (against wind), and installing the geomembrane. This responsibility includes the work performed by the Manufacturer and the Installer.

D. Manufacturer: The party responsible for production of any of the various geosynthetic components.

E. Installer: The part responsible for installation of the geosynthetics.

F. Extrudate: HDPE material produced in the form of a rod used by the Contractor to extrusion weld panels of geomembrane together.

G. Geomembrane: Very-low permeability synthetic flexible membrane liner (FML) barrier used to minimize fluid migration.

H. Geomembrane Subsurface: Material surface upon which geomembrane will be placed.

I. Quality Assurance Laboratory (Third Party Laboratory): Party, independent from the Owner, Manufacturer, and Contractor, responsible for conducting laboratory tests on samples of geomembrane obtained at the site.

J. Panel: The unit area of geomembrane, a roll or a portion of a roll, that will be seamed in the field.

K. Panel Layout Drawings: Drawings submitted by the Contractor indicating panel numbers, field seams, and details.

L. Subgrade: Soil material directly below the geomembrane.

1.4 TESTING

A. Contractor shall retain the services of an independent testing laboratory. At a minimum, Contractor shall be responsible for providing the following quality control information:

1. Compliance testing for installed geosynthetics.

2. Quality control testing during construction.

B. The Contractor shall inspect and ensure all work is in conformance with these Specifications.

C. Contractor shall inform the Construction Manager prior to conducting all quality control testing to allow oversight.

D. Contractor shall submit all quality control data (both pre-construction and construction) with a cover letter signed and sealed by a Illinois registered professional engineer indicating the requirements of the Specifications were achieved and the data is representative of the material tested.

1.5 SUBMITTALS

A. General

1. Contractor shall submit qualification information on the Manufacturer, Installer and Geosynthetic Testing Laboratory.

2. Contractor shall submit prequalification data on each geosynthetic material to the Construction Manager for approval prior to procurement transport, stockpiling or use.

3. Contractor shall submit results of all quality control data and information to the Construction Manager within 1 work day of receipt.

4. Contractor shall submit all observations and documentation generated by its quality control personnel daily for the current day's activities.

5. Contractor shall submit results of all field surveys and documentation within 1 day of generation including copies of data, field books and notes. Copies of survey information signed and sealed by a Illinois licensed surveyor shall be submitted written 1 day of receipt.

B. Manufacturer

The Manufacturer shall submit the following prior to installing geosynthetics:

1. A list of material properties including certified test results attached to samples of the proposed geosynthetic material.

2. The origin and identification of the resin used to manufacture the products.

3. Submit all quality control documentation required by these Specifications prior to installation.

C. Installer

The Installer shall submit the following prior to installation:

1. Resume of Superintendent to be assigned to the project including dates/duration of employment.

2. Resume of Master Seamer including dates/duration of employment.

3. A list of personnel to be performing field seaming operations with pertinent experience information.

4. All geosynthetic quality control certificates .

5. Certification that the extrudate is comprised of the same resin as the geomembrane to be used.

6. Description of seaming techniques and apparatus to be used.

7. Properties of extrudate to be used.

D. Raw Materials

1. Copy of quality control certificates issued by resin suppliers.

2. Production date(s) of resin.

3. Reports on tests conducted to confirm quality of resin used to manufacture geomembrane rolls assigned to considered facility. Report shall indicate compliance with requirements in Part 2 – Products of this Specification.

4. Statement that no reclaimed polymer is added to resin during manufacture of actual geomembrane to be used in this project.

E. Geomembrane Roll Production: Copy of quality control certificates indicating compliance with requirements of Part 2 of this Specification.

F. Installation Panel Layout Drawing identifying placement patterns and seams, both fabricated (if applicable) and field seams, as well as any variance or additional details which deviate from the Drawings. Layout shall be drawn to scale and shall be adequate for use as the construction plan, and shall include information such as dimensions, panel numbering, and installation details. The Engineer shall review all Panel Layout Drawings prior to installation.

G. Installation Schedule.

H. During installation the Contractor shall submit:

1. Quality control documentation recorded during installation.

3. Daily subgrade acceptance for each area to be covered signed by the Installer.

I. Warranties:

1. Submit a material warranty signed by the geomembrane manufacturer. The material warranty shall be against manufacturing defects and workmanship, and against deterioration due to ozone, ultraviolet, and other exposure to the elements, for a period of one year from final acceptance. The material warranty shall be limited to replacement of material, and shall not cover installation of replacement geomembrane.

2. Submit workmanship warranty signed by the geomembrane installer. The installer shall warrant the geomembrane system to be installed to be free of defects in workmanship for a period of 2 years following the date of final acceptance of the work under this Contract. The workmanship warranty shall cover installation of replacement geomembrane.

J. Submittals Required for Project Closeout

1. Record Drawing: Submit reproducible drawings of record showing changes from the approved installation drawings. The record drawings shall include the

identification and location of each repair, cap strip, penetration, boot, and sample taken from the installed geomembrane.

2. Quality Control Record: Submit copies of all material and seam test results. Each test shall be identified by date of sample, date of test, sample location, name of individual who performed the test, and standard test method used.

3. Weld Test Summary Report: Submit copies of report showing normal distribution of all test results, and individual test results identifying the high, low, and average of the five coupon samples in each test.

1.6 QUALIFICATIONS

A. Manufacturer

1. Manufacturer shall have at least 5 years continuous experience in the manufacturing of HDPE geomembrane rolls and experience totaling 2 million sq ft of manufactured HDPE for at least 10 completed facilities.

2. The Manufacturer shall have an internal quality control program that meets standard industry requirements.

B. Installer

1. The Installer shall have at least 5 years continuous experience in the installation of HDPE geomembrane and experience totaling 2 million sq ft of installed HDPE geomembrane for at least 10 completed facilities.

2. The Installer's Superintendent shall have previously managed at least two installation projects which entail at least 100,000 ft^2 of HDPE geomembrane.

3. Personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. At least one "Master Seamer" shall have experience seaming a minimum of 1 million sq. ft. of HDPE geomembrane using same type of seaming apparatus in use on-site. The "Master Seamer" shall have experience seaming textured and non-textured material and shall provide direct supervision, as required, over less experienced seamers.

C. Quality Assurance Program

Manufacturer/Contractor shall agree to participate in and conform with all items and requirements of these Specifications and the Construction Quality Assurance Manual for the Installation of Geosynthetic Components.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver and store geomembrane in strict accordance with the manufacturer's recommendations.

B. Geomembrane delivered to the site shall be inspected for damage, unloaded, and stored with a minimum of handling. The storage area shall be such that materials are protected from mud, soil, dirt, and debris. Geomembrane may be stored directly on prepared level surface, but no more than three rolls in height.

C. The Contractor shall be responsible for coordination and payment of shipping, unloading, storing, handling and installing geomembrane.

D. Use appropriate handling equipment to load, move or deploy geomembrane rolls. Appropriate handling equipment includes slings, spreader bars or an equipment bucket which has been properly protected.

E. Damaged or unacceptable materials shall be replaced at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. GSE Lining Technology, Inc. (Gundle/SLT), Houston, Texas.

B. Approved Equal

2.2 GEOMEMBRANE

A. The geomembrane shall consist of new, first-quality products designed and manufactured specifically for the purpose of this work, as satisfactorily demonstrated by prior use.

B. The geomembrane shall be high-density polyethylene (HDPE) with a UV-stabilized surface and contain no plasticizers, fillers, chemical additives, reclaimed polymers, or extenders.

C. Approximately 2 percent carbon black shall be added to the resin for ultraviolet resistance.

D. The only other compound elements shall be anti-oxidants and heat stabilizers, of which up to 1.5 percent total, as required for manufacturing, may be added.

E. The geomembrane shall be supplied as a single-ply continuous sheet with no factory seams. Rolls shall have a minimum width of 22 feet.

F. The roll length shall be maximized to provide the largest manageable sheet for the fewest field seams.

G. All rolls shall be identified with a unique roll number printed on a label affixed to the inside and outside of the roll.

H. Each roll shall have a continuous identification printed on the membrane showing manufacturer, thickness, material, and date of manufacture.

I. HDPE geomembrane shall meet the following Minimum Average Roll Values (MARV) requirements except when designated minimum, maximum, or range of values).\

J. Geomembrane shall not have striations, roughness, pinholes or bubbles on the surface.

HDPE REQUIREMENTS

Properties	Test Method	MARV Requirements
Liner Thickness, mils (nominal)	ASTM D5199	60
Density (g/cc)	ASTM D1505-A	0.94
Melt Flow Index (g/10 min)	ASTM D1238-E	1.0 (max)
Tensile Properties (Typical) 1. Tensile Strength @ Break (ppi) 2. Elongation @ Break (%)	ASTM D638 Type IV Dumb-bell @ 2 ipm (2.0" Gauge Length) (NSF 54, Mod.)	 240 560
Tear Resistance Initiation (lbs)	ASTM D1004 Die C	45
Low Temperature Brittleness °F	ASTM D746-B	-107 (max)
Dimensional Stability % Change Each direction	ASTM D1204 212 °F 1 hr.	± 2
Environmental Stress Crack Resistance (hrs)	ASTM D1693 Method B (modified NSF 54)	1500
Puncture Resistance (lbs)	FTMS 101 Method 2065	80
Carbon Black Content (%) Carbon Black Dispersion	ASTM D1603 ASTM D3015	2 A1, A2 and B1

2.3 EXTRUDATE

A. Extrudate shall be made from the same resin as the geomembrane.

B. Additives shall be thoroughly dispersed in the extrudate.

C. Additives shall be free of contamination by moisture or foreign matter.

2.4 FIELD SEAMS

A. Approved processes for seaming are extrusion welding and fusion double seam welding.

B. Only apparatus which has been specifically approved by make and model shall be used.

C. Proposed alternate processes shall be documented and submitted by the Contractor for approval by the Construction Manager.

D. Resin used for extrusion welding shall be produced from same resin type as geomembrane.

E. Physical properties of the welding resin shall be the same as those of the resin used in the geomembrane.

F. Geomembrane seams shall meet following requirements:

HDPE GEOMEMBRANE
SEAM PROPERTIES

Property	Qualifier	Unit	Specified Value	Test Method
Shear Strength (at yield point)	minimum	lb/in width	220 and FTB[1]	ASTM D4437
Peel Adhesion Fusion	minimum	lb/in width	150 and FTB[1]	ASTM D4437
Peel Adhesion Extrusion	minimum	lb/in width	130 and FTB[1]	ASTM D4437

Note:

[1] = Film Tear Bond (FTB) is defined as failure of one of the sheets by tearing, instead of separating from the other sheet at the weld interface area (i.e., sheet fails before the weld fails).

2.5 EQUIPMENT

A. Welding Equipment:

1. The Contractor shall provide welding equipment equipped with gauges showing temperatures at the nozzle (extrusion welder) or at the wedge (wedge welder), or have the equipment capable of measuring the temperature of the nozzle (hot air).

2. Equipment shall be maintained in adequate number to avoid delaying work, and shall be supplied by a power source capable of providing constant voltage under a combined-line load.

3. Electric generator shall not be placed on the membrane, unless otherwise approved by the Construction Manager.

B. Field Tensiometer:

1. The Contractor shall provide a tensiometer for onsite shear and peel testing of geomembrane seams.

2. The tensiometer shall be motor driven and have jaws capable of traveling at a measured rate of two (2) inches per minute.

3. The tensiometer shall be in good working order, built to ASTM specifications, and accompanied by evidence of recent calibration.

4. It shall be equipped with a gauge that measures the force in unit pounds exerted between the jaws and have a digital readout.

C. Punch Press:

1. The Contractor shall provide a punch press for the onsite preparation of specimens for testing.

2. The press shall be capable of cutting specimens in accordance with ASTM D4437.

D. Vacuum Box:

1. The Contractor shall provide a vacuum box for onsite testing of geomembrane seams.

2. The vacuum box shall have a transparent viewing window on top and a soft, closed-cell neoprene gasket attached to the bottom.

3. The housing shall be rigid and equipped with a bleed valve and vacuum gauge.

4. A separate vacuum source shall be connected to the vacuum box.

5. The equipment shall be capable of inducing and holding a vacuum of 5 psi.

E. Air Pressure Testing (for double seam with an enclosed space):

1. The equipment shall consist of a manual or motor driven air pump equipped with a pressure gauge.

2. The equipped shall be capable of generating and sustaining pressure over 25 psi.

3. Equipment shall be mounted on a cushion to protect the geomembrane.

4. It shall be equipped with a rubber hose with fittings and connections along with a sharp hollow needle.

5. Other pressure feed devices with a gauge and an accuracy of one (1) psi may be used, as approved by the Construction Manager.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Contractor shall remove all gravel and other protrusions from geomembrane subgrade. Grade stakes or hubs shall also be removed from subgrade prior to geomembrane placement.

B. Special care must be taken to maintain prepared soil surface. Soil surface shall be observed daily to evaluate desiccation cracking. Damage to subgrade shall be repaired to the satisfaction of the Construction Manager.

C. Do not place geomembrane in area which has become softened by precipitation.

D. Contractor shall certify to the Construction Manager in writing daily that the surface on which the geomembrane will be placed is acceptable.

3.2 PREPARATIONS

A. Damage to geomembrane subsurface during geomembrane deployment or other activities shall be repaired prior to installation.

B. Subgrade shall be smooth and consist of clean fine graded material free of rocks, protrusions, sharp objects and deleterious material of any kind.

C. Edges of excavations and grade changes should be rounded to a minimum six (6) inch radius.

D. Geomembrane material may be placed when air temperature is greater than 35°F, and increasing or less than 100°F, unless other limits are approved, in writing, by the Construction Manager.

E. Do not place during precipitation in presence of excessive moisture (e.g., fog, dew), in area of ponded water, or during excessive winds.

3.3 ANCHOR TRENCH

A. The anchor trench shall be excavated by the Contractor to the lines and grades shown on the Plans prior to geomembrane deployment.

B. Contractor shall remove all loose soil from the anchor trench prior to geomembrane deployment No loose soil shall be allowed to underlie the geomembrane.

C. Excavated surface of the anchor trench shall be protected by the Contractor from desiccation or excessive moisture.

D. Contractor shall not damage geomembrane during backfill placement in anchor trench.

3.4 DEPLOYMENT

A. Each panel deployed shall be assigned a simple and logical identifying code consistent with the submitted panel layout drawings.

B. No more panels shall be deployed in one day that can be welded during that same day.

C. Tack welding may be acceptable as a temporary measure; however, tack welded panels shall not be left overnight.

D. Panels shall be shingled on all slopes such that the upper panel of a cross-seam is overlapped above the lower panel.

E. Panels shall be oriented perpendicular to the line of the slope crest (i.e., down and not across slope).

F. Ballast, that will not damage the geomembrane, shall be used to prevent uplift due to wind. Methods used shall minimize wrinkles.

G. Contractor shall securely anchor the geomembrane on a daily basis to prevent "pull-out" from the anchor trench with materials and methods approved by the

Construction Manager. Special attention should be given to geomembrane shrinkage overnight.

H. Folds shall be immediately removed on all installations.

I. Personnel walking on the geomembrane shall not engage in activities or wear types of shoes, that could damage the geomembrane.

J. Smoking shall not be permitted while working on the geomembrane.

K. Vehicular traffic directly on the geomembrane shall not be permitted.

L. Equipment shall not damage the geomembrane by handling, trafficking, leakage of hydrocarbons, or any other means.

M. The geomembrane surface shall not be used as a work area, for preparing patches, storing tools and supplies, or other uses. If needed, a protective cover may be spread out as a work surface.

N. Material shall be placed in a manner to allow for geomembrane shrinkage, contraction and to avoid bridging.

3.5 SEAMING

A. Seam Layout

1. In general, orient end seams (traverse) parallel to line of maximum slope, i.e., oriented along, not across, slope. In corners and odd-shaped geometric locations, minimize numbers of field seams.

2. Seam coding system shall be compatible with panel coding system.

3. During welding operations, at least one Master Seamer shall be present and shall provide supervision over other welders.

4. The surface of the geomembrane shall be clean of grease, moisture, dust, dirt, debris, or other foreign material.

5. Solvents or adhesives shall not be used unless the product is approved in writing by the Construction Manager.

6. Panels shall overlap by a minimum of four (4) inches for all welds.

7. Seams shall be welded to the outside edge of panels placed under anchor berms or in anchor trenches.

8. Fishmouths or wrinkles at seam overlaps shall be cut to achieve a flat overlap.

9. The cut fishmouths or wrinkles shall be extrusion welded or patched where the overlap is more than three (3) inches.

10. When there is less than three (3) inches overlap, an oval or round patch extending a minimum of six (6) inches beyond the cut in each direction shall be used.

11. Seams shall be welded only when ambient temperature is between 35°F and 100°F as measured 6 inches above the geomembrane surface unless other limits are approved in writing by the Engineer.

B. Extrusion Seaming

1. Adjacent panels shall be tack bonded together using procedures that do not damage the geomembrane, allow required tests to be performed, and are not detrimental to final seaming.

2. Welding apparatus shall be free of heat-degraded extrudate before welding.

3. The geomembrane surface shall be abraded a maximum of 1/4 inch beyond the weld bead area, using a disc grinder, or equivalent, not more than one hour before extruding seam.

4. The ends of all seams, which are more than five (5) minutes old, shall be ground when restarting the weld.

5. Grinding depth shall not exceed ten (10) percent of the liner thickness.

6. Use apparatus equipped with gauges giving temperature in apparatus and at nozzle.

7. Provide documentation of extrudate to the Construction Manager and certify that extrudate is compatible with specifications and is comprised of same resins as geomembrane.

8. Maintain one spare operable seaming apparatus on-site. Equipment used for seaming shall not damage geomembrane. Protect geomembrane from damage in heavily trafficked areas.

9. Purge extruder prior to beginning seam until all heat-degraded extrudate has been removed from barrel.

10. Place electric generator on smooth base. Place smooth insulating plate or fabric beneath hot welding apparatus after use.

C. Fusion Seaming

1. Welding apparatus shall be automated, vehicular-mounted, and equipped with gauges indicating applicable temperatures and pressures.

2. Edges of cross seams shall be ground smooth including top and bottom prior to welding.

3. Maintain one spare operable seaming apparatus on-site. Equipment used for seaming shall not damage geomembrane. Protect geomembrane from damage in heavily trafficked areas.

D. Trial Welds

1. Trial welds shall be performed on geomembrane samples to verify welding equipment operations and performance of seaming methods and conditions.

2. Minimum of two (2) trial welds per day or shift per welding apparatus shall be made, one made prior to the start of work and one completed at mid shift.

3. Welds shall be made under the same surface and environmental conditions as the production welds (i.e., in contact with geomembrane subsurface and similar ambient temperature).

E. Trial Weld Testing

1. Sample shall be at least three (3) feet long and two (2) feet wide with the seam centered lengthwise.

2. Three (3), 1-inch wide test strips shall be cut from the trial weld.

3. Each of the specimens shall be tested in the field by the Contractor for peel and shear using a digital tensiometer.

4. Remaining sample shall be retained for future testing.

5. A trial weld specimen shall pass when the results are achieved for both peel and shear tests as shown herein. For double-wedge welding, both welds shall be individually tested and both shall be required to pass in peel.

6. Seaming apparatus or seamer shall not be accepted and shall not be used for seaming until deficiencies are corrected and two consecutive successful full trial seams are achieved

3.6 MATERIAL QUALTY EVALUATION

A. Contractor shall submit an affidavit and/or quality control certificate signed by the geomembrane manufacturer certifying that the geomembrane blankets and/or rolls meet or exceed specified requirements to the Construction Manager for approval prior to geomembrane deployment.

B. Preinstallation material quality evaluation testing shall be performed as follows:

1. Raw material for geomembrane and extrudate rod or bead:

• ASTM D792	1 per batch
• ASTM D1238, Condition E	1 per batch
• ASTM D746	1 per batch

2. Geomembrane Roll:

• ASTM D5199	Continuous or 25 per sheet
• ASTM D638	1 per 50,000 ft^2
• ASTM D1505-A	1 per 50,000 ft^2
• ASTM D1004, Die C	1 per 50,000 ft^2
• ASTM D4833	1 per 50,000 ft^2
• ASTM D1603	1 per 100,000 ft^2

C. Conformance Testing

1. Samples shall be obtained at a frequency of one sample per 50,000 square feet.

2. The Contractor shall obtain samples and forward them to a laboratory designated by the Construction Manager.

3. Tests shall be performed to determine geomembrane Density (ASTM D1505), Thickness (ASTM D5199) and Tensile Strength (ASTM D 638).

4. The sample shall be across the entire width of the roll excluding the first three (3) feet, and shall be cut three (3) feet long by width of roll.

3.7 CONSTRUCTION QUALTY EVALUATION

A. Contractor shall non-destructively test all field seams over their full length using a vacuum test unit, air pressure (for double fusion seams only), or other approved methods. Non-destructive testing shall be carried out daily as the seaming progresses and not at completion of all seaming or at the completion of the day.

B. Vacuum testing shall conform to the following requirements:

1. The equipment shall consist of 2 vacuum box assemblies consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a port hole or valve assembly, a vacuum gauge, a vacuum pump assembly equipped with a pressure control, a rubber pressure/vacuum hose with fittings and connections, a soapy solution and an applicator.

2. Testing shall conform to the following procedure: Brush soapy solution on geomembrane (approximately 12" x 36"). Place vacuum box over the wetted seam area. Close bleed valve and open vacuum valve, and ensure that a leak-tight seal is created. Apply a vacuum of approximately five (5) psi. Examine the geomembrane through the viewing window for the presence of soap bubbles for not less than fifteen (15) seconds. All areas where soap bubbles appear shall be marked and repaired as described in this Section. If no bubble(s) appear after 15 seconds, close vacuum valve and open bleed valve, move box over next adjoining area with minimum three (3) inches overlap, and repeat process.

C. Air Pressure Testing (for double seam with an enclosed space):

1. The equipment shall consist of an air pump (manual or motor driven) equipped with a pressure gauge capable of generating and sustaining pressure over twenty-five (25) psi and mounted on a cushion to protect the geomembrane, a rubber hose with fittings and connections, a sharp hollow needle, or other approved pressure feed device, and a gauge with an accuracy of one (1) psi.

2. Testing shall conform to the following procedure: Seal both ends of the seam to be tested. Insert needle or other approved pressure-feed device into the channel created by the double-wedge weld. Energize the air pump to a minimum pressure of twenty-five (25) psi, close the valve, and sustain the pressure for at least five (5) minutes. If pressure loss exceeds two (2) psi or does not stabilize, locate faulty area and repair as described in this Section. Puncture opposite end of the seam to release air. If blockage is present, locate and test seam on both sides of blockage. Remove needle or other approved pressure-feed device and seal penetration holes by extrusion welding.

D. Spark Testing: For those extrusion welded seams which are unable to be tested by a vacuum box, the spark test method shall be used with a 24-gauge copper wire placed 1/8" under the top sheet overlap and a Holiday detector operating at 20,000 volts.

E. Field seam locations that cannot be non-destructively tested by the Contractor as determined by the Construction Manager shall be cap-stripped using the same materials as the underlying geomembrane.

3.8 DESTRUCTIVE TESTING

A. Sample Location

1. Collect destructive test samples at a minimum frequency of one test per 500 feet of seam length. Test locations shall be determined during seaming. Locations may be prompted by appearance of excess heating, contamination, offset welds, or suspected defect. The Construction Manager shall be responsible for choosing the locations. The Construction Manager shall not notify the Contractor in advance of selecting locations where seam samples will be taken.

2. The Contractor shall cut samples at locations designated by the Construction Manager as the seaming progresses to obtain-laboratory test results before the geomembrane is covered. The Construction Manager shall number each sample and mark the sample number and location on the panel layout drawing.

3. The Contractor shall immediately repair all holes in the geomembrane resulting from destructive sampling. The continuity of the repair shall be vacuum tested in accordance with this Section.

4. The destructive sample shall be eighteen (18) inches wide by forty-two (42) inches long with the seam centered lengthwise. The sample shall be cut into three (3) equal parts for distribution to the Contractor, the Laboratory and the Owner for archiving.

B. Laboratory Testing

1. Samples shall be tested in peel and shear (ASTM D4437).

2. All tests shall exhibit a Film Tearing Bond type of separation in which the geomembrane material tears before the weld.

3. At least five (5) coupons shall be tested by each test method.

4. Four (4) of the five (5) coupons shall meet the minimum requirements stated herein.

5. Test results shall be provided verbally within 24 hours after receiving samples, and within three (3) days in written form.

C. Destructive Test Failure

1. One of two options shall be followed:

   a. Option 1: Reconstruct the seam between any two (2) passed test locations.

b. Option 2: Trace the weld to an intermediate location at least ten (10) feet minimum or to where the seam ends, in both directions from the location of the failed test to collect a destructive test sample at both locations. Check the next seam welded using the same welding device if required to obtain an additional sample (i.e., if one side of the seam is less than ten (10) feet long). Bounding laboratory samples shall be taken, and destructive testing shall be performed per this Section. If the bounding samples pass, then the seam shall be reconstructed between the test sample locations. If any additional samples fail, then the process shall be repeated to establish the zone in which the seam shall be reconstructed.

2. Reconstruction methods shall include extrusion welding of previously wedge welded seams, cap stripping of seam, or replacing seam with a new one (1) foot wide panel and welding in place.

D. Acceptable seams shall be bounded by two locations from which samples have passed destructive tests. For reconstructed seams exceeding fifty (50) feet, a sample taken from within the reconstructed seam shall also pass destructive testing. Whenever a sample fails, additional testing may be required for seams that were welded by the same welder and welding apparatus or were welded during the same shift.

3.9 DEFECTS AND REPAIRS

A. The geomembrane shall be examined for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.

B. The geomembrane surface shall be clean at the time of the examination.

C. Each suspect location shall be repaired and non-destructively tested.

D. Geomembrane shall not be covered at locations which have been repaired until test results with passing values are available.

E. Damaged geomembrane shall be removed and replaced with acceptable geomembrane if damage cannot be satisfactorily repaired.

F. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or non-destructive test shall be repaired.

G. The Contractor shall be responsible for repair of damaged or defective areas. One of the procedures listed below shall be recommended by the Contractor and approved by the Engineer:

1. Patching: Used to repair large and small holes, tears, undispersed raw materials, and contamination by foreign matter.

2. Abrading and Re-welding: Used to repair small seam sections (less than twelve (12) inches long).

3. Spot Welding: Spot welding is not allowed.

4. Capping: Used to repair large lengths of failed seams.

5. Removing unsatisfactory material and replacing with new material.

H. Geomembrane surfaces to be repaired shall be abraded (extrusion welds only) no more than 1/2 hour prior to the repair.

1. Patches or caps shall extend at least six (6) inches beyond the edge of the defect, and all corners of material to be patched and the patches shall be rounded to a radius of at least four (4) inches.

2. The geomembrane below large caps shall be cut to avoid water or gas collection between the two sheets.

I. Repairs shall be verified using the following procedure:

1. Each patch repair shall be non-destructively tested using methods specified in this Section.

2. Destructive testing may be required at the discretion of the Construction Manager.

3.10 GEOMEMBRANE ACCEPTANCE

A. Contractor shall retain all ownership and responsibility for the geomembrane until final acceptance by the Construction Manager.

B. Construction Manager will accept the geomembrane installation when the installation is finished and all required documentation from the Contractor has been received and approved, and verification of the adequacy of all field seams and repairs, including associated testing, is complete.

3.11 MATERIALS IN CONTACT WITH GEOMEMBRANE

A. General

1. Carefully install materials in contact with geomembrane surfaces to minimize damage potential.

2. Clamps, clips, bolts, nuts, or other fasteners used to secure geomembrane to each appurtenance shall have lifespan equal to or exceeding geomembrane's.

B. Pipes and Other Appurtenances

1. Install geomembrane around appurtenances, such as pipes, protruding through geomembrane as shown in Plans. Unless otherwise specified, initially install geomembrane sleeve or apron around each appurtenance prior to geomembrane installation.

2. After material is placed and seamed, complete final field seam connection between appurtenance sleeve or apron and geomembrane. Maintain sufficient initial overlap of appurtenance sleeve so shifts in location of geomembrane can be accommodated.

3. Extreme care shall be taken while seaming around appurtenances because both nondestructive and destructive seam testing might not be feasible. Do not damage geomembrane while making connections to appurtenances.

END OF SECTION 02244

SECTION 02245

GEOSYNTHETIC CLAY LINER

SECTION 02245

GEOSYNTHETIC CLAY LINER (GCL)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section includes the requirements for procurement, transportation, storage, handling, installation, and protection of geosynthetic clay liner (GCL).

1.2 REFERENCES

A. American Society for Testing Materials (ASTM)

1. ASTM E496 - Test Method for Plate Water Absorption of Cohesive Soils.

2. ASTM D4643 - Test Method for Determination of Water Content of Soil (modified)

3. ASTM D5084 - Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (modified).

4. ASTM D5321 - Test Method for Determining the Coefficient of Soil an Geosynthetic or Geosynthetic Friction by the Direct Shear Method.

5. ASTM D3776 - Test Method for Mass Per Unit Area of Textiles.

6. ASTM D4632 - Test Method for Grab Breaking Load and Elongation of Geotextiles.

7. ASTM D3786 - Test Method for the Mullen Burst Strength of Textiles.

B. U.S. Pharmacopoeia - National Formulary XVII, page 1210

1. USP-NF-XVII - Test Method for the Free Swell of Bentonite Clay.

C. Geosynthetics Research Institute, Drexel University

1. GRI-GCL-1 - Test Method for the Confined Swell of Geosynthetic Clay Liners.

1.3 SUBMITTALS

A. Pre-installation: Submit the following to the Engineer for approval prior to GCL deployment.

1. Manufacturer's specification for GCL which includes properties contained in Tables 1 and 2.

2. Written certification that the GCL meets the properties listed in Tables 1 and 2.

3. Written certification that GCL manufacturer has continuously inspected GCL for the presence of needles and found GCL to be needle-free.

4. Written certification from the GCL manufacturer that the bentonite will not shift during transportation or installation thereby causing thin spots in the body of the GCL.

5. Quality control certificates signed by a responsible entity of the GCL manufacturer. Each quality control certificate shall include roll identification numbers, and results of quality control tests. At a minimum, results shall be given for tests and corresponding methods specified in Tables 1 and 2.

6. Written certification that sealing material is made of same natural sodium bentonite as the GCL.

B. Installation: Submit the following as installation proceeds: Subgrade surface acceptance, signed by the Contractor for each area that will be covered directly by GCL.

1.4 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping

1. GCL shall be supplied in rolls wrapped individually in relatively impermeable and opaque protective covers.

2. GCL rolls shall be marked or tagged with the following information:

a. Manufacturer's name

b. Product identification

c. Roll number

d. Roll dimensions

e. Roll weight

B. Storage and Protection:

1. The Contractor shall provide on-site storage area for GCL rolls from time of delivery until installation.

2. After Contractor mobilization, store and protect GCL from dirt, water, ultraviolet light exposure, and other sources of damage.

3. Preserve integrity and readability of GCL roll labels.

PART 2 PRODUCTS

2.1 MATERIALS

A. The active ingredient of the GCL shall be natural sodium bentonite. The bentonite shall be encapsulated between two polypropylene textiles.

B. For side slopes steeper than 7H:1V the GCL shall be lock-stitched with high strength polypropylene thread to provide internal shear strength reinforcing. The internal shear reinforcing mechanism shall resist failure due to thread pull-out over long-term creep situations.

C. The textiles shall be sufficiently porous to allow bentonite flow-through such that the permeability of the overlap seams is equal to or less than the permeability of the body of the GCL sheet without the addition of granular or paste bentonite.

D. The bentonite and textiles used to manufacture the GCL shall have the following minimum properties:

TABLE 1

Property	Test Method	Value	Units
BENTONITE			
Free Swell	USP-NF-XVII	28	ml
Plate Water Absorption	ASTM E946	800	%
pH	ASTM D4972	8 to 11	
TEXTILE BACKINGS			
Weight	ASTM D3776	3.0	oz/sy
Grab Tensile	ASTM D4632	90	lb
Mullen Burst	ASTM D3786	150	psi

E. The final GCL product shall have the following minimum properties:

TABLE 2

Property	Test Method	Value	Units	Min. Test Freq.
Bentonite Content @ 20% Moisture Content	Weigh 12" x Roll Width	1.0	lbs./sq. ft.	1/20,000 sf
Confined Swell	GRI-GCL-1	150	%	1/300,000 sf
Permeability under 5 psi effective confining pressure	ASTM D5084	5×10^{-9}	cm/sec	1/1,000,000 sf
Overlap Seam Permeability under psi effective confining pressure	ASTM D5084	5×10^{-9}	cm/sec	1/1,000,000 sf
Hydrated Internal Residual Shear Resistance*	ASTM D5321	10	degrees	Periodic
Hydrated Internal Residual Shear Resistance**	ASTM D532	700 6	psf cohesion degrees friction angle	Periodic

* For side slopes less than or equal to 7H:1V.

** For side slopes steeper than 7H:1V. Residual shear strength measured at 3" of displacement.

F. The bentonite shall be continuously adhered to both geotextiles to ensure that the bentonite will not be displaced during handling, transportation, storage and installation, including cutting, patching and fitting around penetrations.

G. The bentonite sealing compound or bentonite granules used to seal penetrations and make repairs shall be made of the same natural sodium bentonite as the GCL and shall be as recommended by the GCL manufacturer.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. The Construction Manager shall obtain certification from the Installer that the surface on which the GCL will be placed is acceptable. The Certificate of Acceptance shall be provided prior to GCL installation.

B. After the surface has been accepted by the Installer, it is the Installer's responsibility to indicate to the Construction Manager any change in surface condition that may require repair. If the Construction Manager concurs with the Installer, then the Earthwork Subcontractor shall be notified and the Construction Manager shall confirm that the surface is repaired.

C. The subgrade shall be maintained at the specified moisture content until covered by the GCL. Upon placement of panel(s), the Installer is responsible for maintaining/repairing the surface covered by the GCL unless otherwise agreed.

3.2 EXAMINATION

A. The Engineer will collect samples of GCL to be installed for conformance testing.

3.3 INSTALLATION

A. GCL Deployment: Handle GCL in a manner to ensure it is not damaged. At a minimum, comply with the following:

1. On slopes, anchor the GCL securely and deploy it down the slope in a controlled manner.

2. Weight the GCL with sandbags or equivalent in the presence of wind.

3. Cut GCL with a geotextile cutter (hook blade), scissors, or other approved device. Protect adjacent materials from potential damage due to cutting of GCL.

4. Prevent damage to underlying layers during placement of GCL.

5. During GCL deployment, do not entrap in or beneath GCL, stones, trash, or moisture that could damage GCL.

6. Visually examine entire GCL surface. Ensure no potentially harmful foreign objects such as needles are present.

7. Do not place GCL in the rain or at time of impending rain.

8. Do not place GCL in areas of ponded water.

9. Replace GCL that is hydrated before placement of overlying geomembrane.

10. In general, only deploy GCL that can be covered during that day by geomembrane or a minimum of twelve (12) inches of approved cover soil.

11. Orient the preferred GCL surface in relation to prepared soil or other geosynthetics as directed by the Representative.

12. On side slopes, run GCL to the bottom of the slope as indicated.

13. Seam areas or runs shall also be flat and clear of any large rocks, debris or ruts.

14. Contacting surfaces shall be clean and clear of dirt or native soil with all edges pulled tight to maximize contact and to smooth out any wrinkles or creases.

15. Overlaps shall be a minimum of six (6) inches.

16. A proper seam shall cover the six (6) inch lap line and leave the nine (9) inch match line exposed.

17. The Contractor shall only work on an area that can be completed in one working day.

18. Completion shall be defined as the full installation and anchoring of the liner and placement of the overlying specified geomembrane liner.

B. Overlaps:

1. On slopes, overlap GCL to the manufacturer's match line.

2. In general, no horizontal seams are allowed on side slopes.

3. Apply granular bentonite to overlapped area at a rate of 1/4 pound per linear foot.

4. At sumps, overlap GCLs at least one (1) foot.

5. At bottom of collection sumps, unroll an extra layer of GCL on top of previously installed GCL. Avoid placing seams on top of underlying seams.

6. Seams shall be augmented with granular bentonite to ensure seam integrity.

7. Granular bentonite shall be dispersed evenly from the panel edge to the lap line at a minimum rate of ¼ pound per linear foot continuously along all seams or overlap areas.

8. Accessory bentonite shall be of the same type as the material within the composite liner itself. Adhesives may be used on seams to keep panels in contact during backfill operations, if necessary.

C. Defects and Repairs:

1. Repair all flawed or damaged areas by placing a patch of the same material extending at least one (1) foot beyond the flaw or damaged area.

2. Treat seams of repaired areas as per stated in Overlaps above.

3. The edges of the patch shall be fastened to the repaired liner with construction adhesive, in addition to the bentonite-enhanced seam.

D. Interface with Other Products: Ensure the following when deploying overlying material.

1. GCL and underlying materials are not damaged.

2. Minimal slippage of GCL on underlying layers occurs.

3. No excess tensile stresses occur in GCL.

3.4 ANCHOR TRENCH SYSTEMS

A. Anchor trenches shall be excavated to the lines and grades shown on the Drawings prior to placement of the GCL.

B. To minimize desiccation of the clay, no more than the amount of trench required for the GCL to be anchored in one day shall be excavated.

C. The corners of the anchor trench where the GCL enters the trench shall be rounded to a smooth radius prior to the installation of the GCL.

D. No loose soil shall be allowed to underlie the GCL in the anchor trench.

E. The GCL shall be temporarily anchored with sand bags or other approved means until the overlying geosynthetics are placed and secured.

3.5 EQUIPMENT

A. Storage

1. Wooden pallets for above ground storage of GCL.

2. Heavy, waterproof tarpaulin for protecting unused GCL.

B. Installation

1. Equipment used for GCL deployment shall utilize a spreader bar to prevent slings from damaging edges.

2. Steel pipe shall be inserted into roll core for lifting.

3. Sand bags for securing tarpaulin.

4. 3-inch wide grips for moving GCL panels into place for each installation technician.

5. Bentonite Sealing Compound and/or Granular Bentonite for securing around penetrations and structures.

6. Equipment used for the placement of all liners above the GCL shall not exceed a ground pressure of four (4) psi.

END OF SECTION 02245

SECTION 02246

GEONET

SECTION 02246

GEONET

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section includes the requirements for geonet procurement, transportation, storage, handling and installation.

1.2 REFERENCES

A. ASTM D413 - Standard Test Methods for Rubber Property – Adhesion to Flexible Substrate.

B. ASTM D792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.

C. ASTM D1238 - Condition E Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.

D. ASTM D1505 - Test Method for Density of Plastics by the Density – Gradient Technique.

E. ASTM D1603 - Test Method for Carbon Black in Olefin Plastics.

F. ASTM D4439 - Terminology for Geosynthetics.

G. ASTM D4716 - Standard Test Method for Constant Head Hydraulic Transmissivity (In-plane Flow) of Geotextiles and Geotextile Related Products.

1.3 SUBMITTALS

A. General

1. Contractor shall submit qualification information on the Manufacturer, Installer and Geosynthetic Testing Laboratory.

2. Contractor shall submit prequalification data on each geosynthetic material to the Construction Manager for approval prior to procurement, transport, stockpiling or use.

3. Contractor shall submit results of all quality control data and information to the Construction Manager within 1 work day of receipt.

4. Contractor shall submit all observations and documentation generated by its quality control personnel daily for the current day's activities.

5. Contractor shall submit results of all field surveys and documentation within 1 day of generation including copies of data, field books and notes. Copies of survey information signed and sealed by a Illinois licensed surveyor shall be submitted within 1 day of receipt.

6. Contractor shall submit signed documentation that the geonet was installed in accordance with the Plans and Specifications.

B. Manufacturer

The Manufacturer shall submit the following prior to installing geosynthetics:

1. A list of material properties including certified test results attached to samples of the proposed geosynthetic material.

2. The origin and identification of the resin used to manufacture the product.

3. Submit all quality control documentation required by these Specifications prior to installation.

C. Installer

The Installer shall submit the following prior to installation:

1. Resume of superintendent to be assigned to the project including dates/duration of employment. The superintendent shall have demonstrated experience of two similar projects.

2. A list of personnel to be performing field seaming operations with pertinent experience information.

3. All geosynthetic quality control certificates.

1.4 TESTING

A. Contractor shall retain the services of an independent testing laboratory. At a minimum, Contractor shall be responsible for providing the following quality control information:

1. Compliance testing for installed geosynthetics.

2. Quality control testing during construction.

B. The Contractor shall inspect and ensure all work is in conformance with these Specifications.

C. Contractor shall inform the Construction Manager prior to conducting all quality control testing to allow oversight.

D. Contractor shall submit all quality control data (both pre-construction and construction) with a cover letter signed and sealed by a Illinois registered professional engineer indicating the requirements of the Specifications were achieved and the data is representative of the material tested.

1.5 QUALITY ASSURANCE

A. Geonet shall be free of defects, rips, holes, or flaws.

B. It shall be manufactured in widths and lengths that will permit installation of geonet with as few laps as possible.

C. Geonet shall be marked with the Manufacturer's name, product identification, lot number, roll number, and roll dimensions.

D. Contractor shall provide a storage area such that geonet is protected from mud, dirt, dust, debris, and exposure to ultraviolet (UV) light and heat.

E. Contractor shall submit all material and workmanship warranties for the geonet installation.

1.6 GEONET TRANSPORTATION, HANDLING, AND STORAGE

A. Transportation of geonet is responsibility of Contractor, who shall be liable for all damages to geonet prior to and during transportation to Site.

B. Handling, storage, and care of geonet on-site is responsibility of Contractor prior to, during and after geonet installation.

C. Contractor shall retain ownership of geonet until installation is accepted by the Construction Manager. Contractor shall be liable for all damages to geonet incurred prior to final acceptance of installation by Construction Manager.

PART 2 PRODUCTS

2.1 GEONET

A. Provide products for the geonet comprised of high-density polyethylene (HDPE). The geonet shall be manufactured by extruding two sets of strands to form a three dimensional structure to provide plane flow and shall meet the following minimum average roll values except as noted.

GEONET PROPERTIES			
Property	**Test**	**Value**	**Units**
Density	ASTM D792 or D1505	0.90 min.	g/cu cm
Thickness	ASTM D5199	200 min.	mils
Melt Flow Index	ASTM D1238	1.0 max.	g/10 min.
Carbon Black Content	ASTM D1603	2-3 range	%
Tensile Strength at Break:			
• Machine Direction	ASTM D751	25 min.	PPI
• Cross Direction	ASTM D751	15 min.	PPI

PART 3 EXECUTION

3.1 GEONET PLACEMENT AND HANDLING

A. Handle all geonet in such a manner as to ensure it is not damaged in any way.

B. Geonet shall be anchored and installed by rolling it down the slope so as to continually keep the material in tension.

C. In the presence of wind, geonets shall be weighted with sandbags or equivalent. Such sandbags shall be installed during placement and shall remain until replaced with earthen cover material.

D. Geonets shall be cut using an approved cutter only. If in place, special care must be taken to protect geomembrane from damage which could be caused by cutting of geonets.

E. During placement, care shall be taken not to entrap in geonet stones, excessive dust, or moisture that could hamper subsequent seaming. If geonet is not free of debris and soil prior to installation, Contractor shall clean geonet prior to installation.

F. The Contractor shall examine the geonet over the entire surface, after installation, to ensure that no potentially harmful foreign objects are present. Any foreign objects so encountered shall be removed by Contractor, or geonet shall be replaced.

G. Geonet shall not be welded or tack welded to the underlying geomembrane.

3.2 QUALITY CONTROL

A. Visual inspections of shipment and storage activities shall be made by the Construction Manager to assure that the geonet has been protected from ultraviolet light exposure, precipitation or other inundation, and dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

B. Contractor shall designate each roll with a roll number (identification code) which is consistent with the layout plan. The rolls shall be positioned on the site as shown on the approved layout drawings. Instructions on boxes or wrapping containing the geotextile materials shall be followed to assure that rolls are unrolled in the proper direction.

3.3 MATERIAL QUALITY EVALUATION

A. Contractor shall submit an affidavit and/or quality control certificate signed by the manufacturer certifying that the geosynthetic rolls meet or exceed specified requirements to the Construction Manager for approval prior to deployment.

B. Preinstallation material quality evaluation testing shall be performed as follows:

• ASTM D5199	4 per roll
• ASTM D792	1 per 50,000 ft^2
• ASTM D751	1 per 50,000 ft^2
• ASTM D1238	1 per 100,000 ft^2
• ASTM D1603	1 per 100,000 ft^2

C. Conformance Testing

1. Samples shall be obtained at a frequency of one sample per 50,000 square feet.

2. The Contractor shall obtain samples and forward them to a laboratory designated by the Construction Manager.

3. Tests shall be performed to determine Density (ASTM D792), Thickness (ASTM D5199), and Tensile Strength (ASTM D751).

4. The sample shall be across the entire width of the roll excluding the first three (3) feet, and shall be cut three (3) feet long by width roll.

5. Samples shall be 3 feet long by roll width. Machine direction shall be marked on sample with an arrow.

3.4 GEONET SEAMS AND OVERLAPS

A. The geonet shall be overlapped at least 4 inches on downslope seams and joined by colored plastic ties every 5 feet.

B. On transverse (horizontal) seams the geonet shall be overlapped 12 inches and joined by colored plastic ties every 12 inches. No horizontal seams will be allowed on slopes greater than 6:1.

C. Metallic devices are not allowed.

D. Seams shall be tied continuously through the anchor trenches and toe drains every 12 inches.

E. Unless prior approval is obtained, no horizontal seams shall be allowed on side slopes.

F. In the event horizontal seams on side slopes can not be avoided, adjacent rolls shall be tied every 6 inches.

3.5 GEONET REPAIR

A. Any holes or tears in geonet shall be repaired as follows: A patch made from same geonet material shall overlap the undamaged geonet a minimum of 12 inches on all sides and tied every 6 inches.

END OF SECTION 02246

SECTION 02619

CORRUGATED POLYETHYLENE PIPE

SECTION 02619

CORRUGATED POLYETHYLENE PIPE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section includes the requirements for procurement, transportation, storage, handling and installation of corrugated polyethylene pipe and filter fabric as a drainage conduit for the cover system.

1.2 REFERENCES

A. ASTM D618 - Practice for Conditioning Plastics and Electrical Insulating Materials for Testing.

B. ASTM D1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

C. ASTM D2122 - Determining Dimensions of Thermoplastic Pipe and Fittings.

D. ASTM F405 - Standard Specification for Corrugated Polyethylene (PE) Tubing and Fittings.

1.3 SUBMITTALS

A. General

1. Contractor shall submit qualification information on the Manufacturer, Installer and Geosynthetic Testing Laboratory.

2. Contractor shall submit prequalification data on each geosynthetic material to the Construction Manager for approval prior to procurement, transport, stockpiling or use.

3. Contractor shall submit results of all quality control data and information to the Construction Manager within 1 work day of receipt.

4. Contractor shall submit all observations and documentation generated by its quality control personnel daily for the current day's activities.

5. Contractor shall submit results of all field surveys and documentation within 1 day of generation including copies of data, field books and notes. Copies of survey information signed and sealed by a Illinois licensed surveyor shall be submitted within 1 day of receipt.

6. Submit list of minimum property values for the pipe, fittings and filter fabric including certified test results to the Construction Manager. Material properties shall be in conformance with those defined herein.

B. Manufacturer

The Manufacturer shall submit the following prior to installing geosynthetics:

1. A list of material properties including certified test results attached to samples of the proposed geosynthetic material.

2. The origin and identification of the resin used to manufacture the product.

3. Submit all quality control documentation required by these Specifications prior to installation.

C. Installer

The Installer shall submit the following prior to installation:

1. Resume of superintendent to be assigned to the project including dates/duration of employment.

2. A list of personnel to be performing field seaming operations with pertinent experience information.

3. All geosynthetic quality control certificates.

1.4 QUALITY ASSURANCE

A. Filter fabric shall be free of defects, rips, holes, or flaws.

B. During shipment and storage, the pipe shall be wrapped in relatively impermeable and opaque protective covers.

C. Pipe shall be marked with the manufacturer's name, product identification, lot number, roll number, and roll dimensions.

D. Storage area shall be such that filter fabric is protected from mud, dirt, dust, debris, moisture, and exposure to ultraviolet (UV) light and heat.

E. The Contractor shall inspect and ensure all work is in conformance with these Specifications.

F. Contractor shall inform the Construction Manager prior to conducting all quality control testing to allow oversight.

G. Contractor shall submit all quality control data (both pre-construction and construction) with a cover letter signed and sealed by a Illinois registered professional engineer indicating the requirements of the Specifications were achieved and the data is representative of the material tested.

H. Contractor shall submit all material and workmanship warranties for installation of the pipe.

1.5 TRANSPORTATION, HANDLING AND STORAGE

A. Transportation is the responsibility of the Contractor, who shall be liable for all damages prior to and during transportation to site.

B. Handling, storage, and care on-site is responsibility of the Contractor prior to, during and after installation. The Owner will designate adequate storage space on-site. Contractor shall be liable for all damages incurred prior to final acceptance, except for those due to negligent actions on part of the Owner.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Hancor, Inc. - Hancor Heavy Duty Tubing with Highway Sleeve

B. Advanced Drainage Systems, Inc. - ADS Single Wall with ADS Sock

C. Approved Equal

2.2 PIPE

A. The drainage piping (pipe and fittings) shall be four (4) inch perforated, corrugated, high density polyethylene (HDPE) piping (i.e., tubing) meeting or exceeding the criteria below.

Inside Diameter (in.)	4.0
Outside Diameter (in.)	4.6 nominal
Pitch (in.)	0.7
Corrugations	Annular
Perforations	Slotted (6 per circumference)
Inlet Area (sq in./ft) • Minimum • Maximum	 2.4 3.8

B. The drain outlets shall meet the above requirements, except perforations (i.e., slots) are not allowed.

2.3 FILTER FABRIC

A. The filter fabric shall meet the following minimum values:

Size (in.)	4
Fiber	Knitted Polyester
Specific Gravity	1.3
Yarn Denier	150-200
Weight (oz/yd^2 relaxed)	5.4
Weight (oz/yd^2 applied)	3.5
Cross Stretch (in.)	14.5
Melt Point ((°F)	450-500
Thickness (in.)	0.04
Mullen Burst (psi)	100-135
Water Permeability (K) @ 3 gpm	0.12
EOS, U.S. Sieve	40

B. The filter fabric shall be applied to the pipe by the manufacturer prior to shipment.

PART 3 EXECUTION

3.1 PLACEMENT AND HANDLING

A. Handle all materials in such a manner as to ensure it is not damaged in any way.

B. Materials shall not be dragged.

C. During placement, care shall be taken not to entrap stones, excessive dust, or moisture that could hamper subsequent performance. If pipe is not free of debris and soil prior to installation, Contractor shall clean material prior to installation.

D. The Construction Manager will examine the drainage piping over the entire surface to ensure that no potentially harmful foreign objects are present. Any foreign objects so encountered shall be removed by the Contractor, or material shall be replaced.

3.2 INSTALLATION

A. Installation shall be in accordance with manufacture's instructions.

B. Pipe shall be joined with internal or external couplers, or coupling bands and fittings supplied by the pipe manufacturer covering at least two (2) full corrugations on each of the pipe ends.

C. The filter fabric shall be completely continuous along the perforated pipe.

D. Filter fabric joints must have a minimum overlap of six (6) inches.

E. The filter fabric shall be secured to the pipe in such a manner that sand bedding shall not infiltrate through any overlaps.

F. Seal filter fabric at all outlet drain locations such that no water will enter perforations unless passing through the filter fabric.

G. Contractor shall ensure that the outlet drains have been inspected and approved by the Construction Manager prior to backfill.

H. Contractor shall protect the ends of the drain pipes from being damaged or from allowing foreign objects(e.g., debris, sand, filter fabric) from entering the pipes.

I. Each pipe shall be inspected by the Contractor prior to making connections to ensure pipe is free of foreign objects. Any foreign objects shall be removed by the Contractor.

J. Contractor shall exercise care to thoroughly compact the sand under the haunches of the pipe and to ensure that the material is in intimate contact with the pipe. The

backfill shall be brought up evenly in layers on both sides of the pipe until the trench is fill to the required elevation.

K. Contractor shall replace or repair any damaged pipe or filter fabric as directed by the Construction Manager, at no additional cost the Owner.

L. The Contractor is responsible for all excavation and backfill required for complete installation of toe drain outlets.

M. The drain outlets shall be installed on 150 foot centers, as shown on the Plans.

END OF SECTION 02619

SECTION 02715

LEACHATE COLLECTION SYSTEM RISER PIPES

SECTION 02715

LEACHATE COLLECTION SYSTEM RISER PIPES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Primary and secondary leachate collection system riser pipes.

1.2 REFERENCES

A. ASTM D1505 - Density of Plastics

B. ASTM D751 - Standard Test Method for Coated Fabrics

C. ASTM D638 - Standard Test Method for Tensile Properties of Plastics

1.3 SUBMITTALS

A. General

1. Contractor shall submit qualification information on the Manufacturer and Installer.

2. Contractor shall submit prequalification data on each geosynthetic material to the Construction Manager for approval prior to procurement, transport, stockpiling or use.

3. Contractor shall submit results of all quality control data and information to the Construction Manager within 1 work day of receipt.

4. Contractor shall submit all observations and documentation generated by its quality control personnel daily for the current day's activities.

5. Contractor shall submit results of all field surveys and documentation within 1 day of generation including copies of data, field books and notes. Copies of survey information signed and sealed by a Illinois licensed surveyor shall be submitted within 1 day of receipt.

6. Contractor shall submit HDPE pipe pressure test procedures in writing for Construction Manager approval.

B. Manufacturer

1. The Manufacturer shall submit the following prior to installing leachate collection system riser pipes:

- A list of material properties including certified test results attached to samples of the proposed HDPE riser pipes.
- The origin and identification of the resin used to manufacture the product.
- Submit all quality control documentation required by these Specifications prior to installation.

C. Installer

1. The Installer shall submit the following prior to installation:

- Resume of superintendent to be assigned to the project including dates/duration of employment.
- A list of personnel to be performing installation operations with pertinent experience information.
- All HDPE pipe quality control certificates.

1.4 TESTING

A. The Contractor shall inspect and ensure all work is in conformance with these Specifications.

B. Contractor shall inform the Construction Manager prior to conducting all quality control testing to allow oversight.

C. Contractor shall submit all quality control data (both pre-construction and construction) with a cover letter signed and sealed by a Illinois registered professional engineer indicating the requirements of the Specifications were achieved and the data is representative of the material tested.

PART 2 PRODUCTS

2.1 GEOPIPE

A. Leachate collection system pipe shall conform to the following minimum material specifications for HDPE Pipe:

Property	ASTM Reference	Nominal Value	Unit
Density (pipe)	D1505	0.955	g/cm^3
Density (natural base resin)	D1505	0.945	g/cm^3
Melt Index, condition E	D1238	0.1-0.2	g/10 min.
Melting Point (Vicat Softening Temperature)	D1525	255	°F
Brittleness Temperature	D746	<-180	°F
Thermal Expansion	D696	$9X10^{-5}$	in/in/°F
Thermal Conductivity	C177	2.7	$Btu\text{-}in/ft^2/hr/°F$
Tensile Strength, yield (2.0 in/min.)	D638	>3200	psi
Tensile Strength, ultimate (2.0 in/min.)	D638	≥5000	psi
Elongation (2.0 in/min.)	D638	≥800	percent
Modulus of Elasticity	D638	110,000	psi
Flexural Modulus	D3350	125,000	psi
Long Term Hydrostatic Strength (LTHS)	D2837	1600	psi
Hydrostatic Design Basis (HDB)	D2837	1600	psi
Hardness - Shore D	D2240	66	--
Environmental Stress Crack Resistance (ESCR), condition C	D1693	>5000	hrs.

B. HDPE Pipe shall meet the following minimum requirements:

Specified Size (in.)	Min ID (in.)	Max SDR[1]
6	5.5	11
8	7.5	26
12	11.1	26

[1] SDR = Standard Dimension Ratio = Pipe OD/Pipe Thickness.

C. Slotted PE pipe shall have 1/16-inch wide slots on 1/4-inch centers or approved alternate.

D. Contractor shall perforate one end of the HDPE pipe for a length of 3 feet. Adjacent rows of the perforations shall be offset by one-half the distance between perforations in any row.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify all lines and grades of field conditions are as shown on the Plans.

B. Verify that all surfaces have been properly prepared prior to installation of the leachate collection or detection systems.

3.2 INSTALLING LEACHATE COLLECTION AND DETECTION SYSTEM RISER PIPES

A. General

1. The leachate collection system riser shall be installed and constructed in accordance with the lines, grades, dimensions, and cross sections shown on the Plans and as required by these Specifications.

B. Excavating Riser Pipe Trench

1. The riser pipe trench shall be excavated along the slope of the excavation to the grades, dimensions, cross-sections, and details shown on the Plans or as directed by the Construction Manger.

2. Excavate utilizing suitable equipment in a manner approved by the Construction Manager.

3. Contractor shall not damage installed geosynthetics during excavation.

C. Installing Riser Pipe

1. The HDPE riser pipe (casing) shall be installed to the design lengths indicated on the Plans in a work area to be designated by the Construction Manager.

2. HDPE pipe shall be welded to construct the length specified on the Plans prior to placement on the slope. Contractor shall join pipe segments using butt fusion welding techniques.

3. Positive anchorage of the riser pipe to prevent pipe movement during backfilling is required.

4. The HDPE riser pipe shall be slotted in accordance with the dimensions required by these specifications and in accordance with manufacturer recommendations. Slotted portion of pipe shall be installed into and shall not exceed thickness of the collection sump. Remainder of pipe length shall not be slotted.

5. The HDPE riser pipe shall be placed against the prepared surface of the slope excavation by the Contractor using suitable equipment in a manner approved by the Construction Manager and in accordance with the manufacturer recommendations. The HDPE riser pipe shall be anchored at the top with ballast approved by the Construction Manager.

6. Synthetic membranes shall be constructed around the riser pipe as shown in the Plans and in accordance with the requirements of these Specifications.

D. Placing Riser Pipe Backfill

1. Bedding material may be utilized on the prepared surface beneath the HDPE riser pipe to facilitate pipe placement as well as the placement and compaction of the backfill materials.

2. Soil designated "Compacted Fill" shall be used as backfill around the pipe. Contractor shall roll fill into place without damaging the underlying geosynthetics.

3. Backfill soil shall be compacted by the Contractor using tracked equipment having ground pressure ≤ 5 psi. Backfill soil shall have no less than 2 coverages with the equipment.

4. Contractor shall use proper care not to damage underlying geosynthetics during soil placement or compaction. Equipment shall not make quick starts, stops or turns which may damage geosynthetic materials.

5. Backfill placement shall begin at the toe of slope and proceed upslope.

6. Backfill placed and compacted to thicknesses or grades in excess of the grades on either side of the riser pipe trench shall be trimmed by approved measures to conform to the surrounding grades.

3.3 MATERIAL QUALITY EVALUATION

A. Contractor shall submit an affidavit and/or quality control certificate signed by the manufacturer certifying that the HDPE pipe will meet or exceed specified requirements to the Construction Manager for approval prior to deployment.

B. Preinstallation material quality evaluation testing shall be performed as follows:

• ASTM D1505	1 per batch
• ASTM D638	1 per 1,000 ft of pipe
• ASTM D2837	1 per 1,000 ft of pipe
• ASTM D2240	1 per 1,000 ft of pipe

3.4 FIELD QUALITY CONTROL

A. HDPE Pipe

1. Visually inspect all HDPE pipe couplings and welds.

2. Pressure test sump discharge conduit to 30 psi.

END OF SECTION 02715

SECTION 02932

SEEDING

SECTION 02932

SEEDING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provide all labor, material, equipment and incidentals required to seed, fertilize, mulch and maintain the vegetated cover.

1.2 REFERENCES

A. FS 0-F-241 - Fertilizers, Mixed Commercial

1.3 DEFINITIONS

A. Weeds: Includes Dandelion, Jimsonweek, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweek, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, And Brome Grass.

1.4 REGULATORY REQUIREMENTS

A. Contractor shall comply with regulatory agency requirements for fertilizer and herbicide composition.

B. Contractor shall provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

C. Contractors shall submit maintenance requirements for continuing maintenance of established vegetated cover.

D. Contractor shall include maintenance instructions, cutting method and maximum grass height; types application frequency, and recommended coverage of fertilizer, and watering schedule to be performed by Solutia.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Products shall be delivered to site to support progress of work.

B. Products shall be stored and protected from deleterious conditions.

C. Grass seed mixture shall be delivered in sealed containers. Seed in damaged packaging is not acceptable.

D. Fertilizer shall be delivered in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.6 MAINTENANCE PERIOD

A. Notwithstanding the Contractor's warranty, the Owner will pay the Contractor a lump sum price to maintain the Work in its accepted condition for one (1) year. The Maintenance Period shall start from the date of the Construction Manager's Final Acceptance. The Contractor's Maintenance Period Work shall include:

1. Supply and placement of fill materials to re-establish final grades and the landfill cover thickness in accordance with the design drawings and specifications.

2. Supply and install E&S controls to minimize erosion of the landfill cover.

3. Establish and maintain successful revegetation of the cover in accordance with this specification.

4. Contractor is responsible for repairing any settlement areas that occur in the 12-month maintenance period.

B. The Contractor's Manager will inspect the grass growth at the end of the Maintenance Period. During the Maintenance Period, the Contractor shall sample the topsoil to develop fertilizer requirement, apply fertilizer, kill grubs and weeds, reseed, and cut the grass.

1.7 SUBMITTALS

A. Contractor shall submit certification that seed mixture conforms to this section and the requirements of the State of Illinois.

B. Contractor shall submit all material and workmanship warranties related to seeding.

PART 2 PRODUCTS

2.1 SEED MIXTURE

A. Seed mixture shall conform to the following:

1. Bahia Seed: 80% by weight

2. Bermuda Grass Seed: 20% by weight

B. Pensacola Bahia seed shall have a minimum pure seed content of 95 percent with a minimum active germination of 40 percent and a total germination of 80 percent including firm seed.

C. Bermuda grass seed shall be of a common variety with a minimum pure seed content of 95 percent with a minimum germination of 85 percent.

2.2 ACCESSORIES

A. Mulching material shall be dry mulch consisting of straw or hay of one or more of the following types: oat, rye, wheat straw, or of pangola, peanut, coastal bermuda or bahia grass hay. Only undeteriorated mulch can be readily cut into the soil and shall be used.

B. Fertilizer: Type 12-8-8 or equivalent.

PART 3 EXECUTION

3.1 INSPECTION

A. Contractor shall verify that prepared soil base is ready to receive the work of this section.

B. Contractor shall certify in writing that the condition of the soil base is ready to receive seeding. Beginning of installation means acceptance of existing site conditions.

3.2 FERTILIZING

A. Contractor shall apply fertilizer at a rate of 800 to 1,000 lbs/acre.

B. Contractor shall apply fertilizer after smooth raking of topsoil.

C. Contractor shall apply fertilizer at the same time or with same machine as will be used to apply seed.

D. Fertilizer shall be mixed thoroughly into upper 2 inches of topsoil.

E. Contractor shall lightly water fertilized areas to aid the dissipation of fertilizer.

3.3 SEEDING

A. Contractor shall apply seed at a rate of 40-60 lbs/acre and rake in lightly. Contractor shall not seed any areas in excess of that which can be mulched on the same day.

B. Contractor shall not sow immediately following rain, when ground is too dry, or during windy periods. Seed operation shall stop when wind speeds exceed 15 mph.

C. Contractor shall select an appropriate roller to facilitate grass growth.

D. Seeding machinery can be mounted on rubber tires or tracks but must maintain a ground pressure not exceeding 8 lbs/sq in.

E. Immediately following seeding and compacting, mulch shall be applied to a thickness of 1/8 inches.

F. Water shall be applied to irrigate the newly seeded ground cover for period of 60 days. The irrigation procedures shall be designed such as the topsoil will be saturated to a depth of at least 4 inches when the system is in use.

3.4 WARRANTY PERIOD

A. The warranty period shall extend for a period of 1 year after acceptance of conditions by the Construction Manager.

B. Contractor shall immediately reseed areas which show bare spots at no additional cost to the Construction Manager.

3.5 SCHEDULE

A. Seeding and fertilizers shall be applied to all areas disturbed during construction.

3.6 SUCCESSFUL REVEGETATION

A. Contractor shall reestablish a diversified, self-sustaining stand of grass that is adapted to the region. The Construction Manager will determine acceptability of the grass growth in accordance with the following:

1. Landfill shall have at least 85% groundcover of permanent grass species.

2. No area or patch greater than 36-inch x 36-inch shall be barren.

3. No trees, wood shrubs or deep-rooted plants shall be allowed to grow on the revegetated areas.

END OF SECTION 02932

Appendix F

CONSTRUCTION QUALITY ASSURANCE MANUAL FOR INSTALLATION OF GEOSYNTHETIC COMPONENTS FOR THE SAUGET AREA 1 TSCA LANDFILL

Prepared for:

Solutia Inc.
575 Maryville Centre Drive
St. Louis, MO 63141

Prepared by:

URS Greiner Woodward Clyde

7650 West Courtney Campbell Causeway
Tampa, Florida 33607-1462
C100003899.00

June 30, 2000

TABLE OF CONTENTS

1.0 GENERAL 1-1
1.1 SCOPE 1-1
1.2 PROJECT ORGANIZATION 1-1
1.2.1 Solutia Leadership Team 1-1
1.2.2 Construction Manager 1-2
1.2.3 Designer 1-2
1.2.4 Geosynthetic Construction Quality Assurance Consultant 1-2
1.2.5 Geosynthetic Quality Assurance Laboratory 1-2
1.2.6 Construction Contractor(s) 1-2
1.3 PROJECT TEAM RESPONSIBILITIES AND QUALIFICATIONS 1-2
1.3.1 Construction Manager 1-3
1.3.1.1 Responsibilities 1-3
1.3.1.2 Qualifications 1-3
1.3.2 Designer 1-4
1.3.2.1 Responsibilities 1-4
1.3.2.2 Qualifications 1-4
1.3.2.3 Submittals 1-4
1.3.3 Manufacturer 1-4
1.3.3.1 Definitions 1-4
1.3.3.2 Responsibilities 1-4
1.3.3.3 Qualifications 1-4
1.3.3.4 Submittals 1-5
1.3.4 Installer 1-5
1.3.4.1 Definitions 1-5
1.3.4.2 Responsibilities 1-5
1.3.4.3 Qualifications 1-5
1.3.4.4 Submittals 1-6
1.3.5 Geosynthetic Construction Quality Assurance Consultant 1-7
1.3.5.1 Responsibilities 1-7
1.3.5.2 Qualifications 1-8
1.3.5.3 Submittals 1-8
1.3.6 Geosynthetic Quality Assurance Laboratory 1-8
1.3.6.1 Responsibilities 1-8
1.3.6.2 Qualifications 1-8
1.3.6.3 Submittals 1-9
1.4 COMMUNICATION 1-9
1.4.1 Resolution Meeting 1-9
1.4.2 Pre-construction Meeting 1-9
1.4.3 Progress Meetings 1-10

2.0 GEOMEMBRANES 2-1
2.1 QUALITY CONTROL DOCUMENTATION 2-1
2.2 CONFORMANCE TESTING 2-1
2.2.1 Sampling Procedures 2-1
2.2.2 Test Results 2-3

TABLE OF CONTENTS

2.3 SUBGRADE PREPARATION 2-3
2.3.1 Surface Preparation 2-3
2.3.2 Anchor Trench 2-4
2.4 GEOMEMBRANE DEPLOYMENT 2-5
2.4.1 Panel Nomenclature 2-5
2.4.2 Panel Deployment Procedure 2-5
2.4.3 Deployment Weather Conditions 2-5
2.4.4 Method of Deployment 2-6
2.4.5 Damage and Effects 2-6
2.4.6 Writing on the Liner 2-7
2.5 FIELD SEAMING 2-7
2.5.1 Seam Layout 2-7
2.5.2 Accepted Seaming Methods 2-7
2.5.2.1 Extrusion Process 2-8
2.5.2.2 Fusion Process 2-8
2.5.3 Seam Preparation 2-9
2.5.4 Trial Seams 2-9
2.5.5 General Seaming Procedures 2-10
2.5.6 Seaming Weather Conditions 2-11
2.5.6.1 Normal Weather Conditions 2-11
2.5.6.2 Cold Weather Conditions 2-11
2.5.6.3 Warm Weather Conditions 2-12
2.6 NONDESTRUCTIVE SEAM TESTING 2-12
2.6.1 Concept 2-12
2.6.2 Vacuum Testing 2-12
2.6.3 Air Pressure Testing 2-13
2.6.4 Test Failure Procedure 2-14
2.7 DESTRUCTIVE SEAM TESTING 2-14
2.7.1 Concept 2-14
2.7.2 Location and Frequency 2-14
2.7.3 Sampling Procedures 2-15
2.7.4 Sample Dimensions 2-15
2.7.5 Field Testing 2-16
2.7.6 Laboratory Testing 2-16
2.7.7 Destructive Test Failure Procedures 2-16
2.8 DEFECTS AND REPAIRS 2-17
2.8.1 Identification 2-17
2.8.2 Evaluation 2-17
2.8.3 Repair Procedures 2-17
2.8.4 Repair Verification 2-18
2.8.5 Large Wrinkles 2-18
2.9 GEOMEMBRANE PROTECTION 2-18
2.9.1 Soils 2-19

TABLE OF CONTENTS

3.0 GEOTEXTILES 3-1
- 3.1 QUALITY CONTROL DOCUMENTATION 3-1
- 3.2 CONFORMANCE TESTING 3-2
  - 3.2.1 Sampling Procedures 3-2
  - 3.2.2 Test Results 3-3
- 3.3 GEOTEXTILE DEPLOYMENT 3-3
- 3.4 SEAMING PROCEDURES 3-4
- 3.5 DEFECTS AND REPAIRS 3-5
- 3.6 GEOTEXTILE PROTECTION 3-5

4.0 GEONETS 4-1
- 4.1 QUALITY CONTROL DOCUMENTATION 4-1
- 4.2 CONFORMANCE TESTING 4-2
  - 4.2.1 Sampling Procedures 4-2
  - 4.2.2 Test Results 4-2
- 4.3 GEONET DEPLOYMENT 4-3
- 4.4 SEAMS AND OVERLAPS 4-4
- 4.5 DEFECTS AND REPAIRS 4-5
- 4.6 GEONET PROTECTION 4-5

5.0 GEOGRIDS 5-1
- 5.1 QUALITY CONTROL DOCUMENTATION 5-1
- 5.2 CONFORMANCE TESTING 5-2
  - 5.2.1 Sampling Procedures 5-2
  - 5.2.2 Test Results 5-3
- 5.3 GEOGRID DEPLOYMENT 5-3
- 5.4 SEAMS AND OVERLAPS 5-4
- 5.5 REPAIRS 5-4
- 5.6 SOIL MATERIALS PLACEMENT 5-4

6.0 LINING SYSTEM ACCEPTANCE 6-1

7.0 DOCUMENTATION 7-1
- 7.1 DAILY REPORT'S 7-1
- 7.2 DESTRUCTIVE TESTING REPORTS 7-1
- 7.3 PROGRESS REPORTS 7-1
- 7.4 AS-BUILT DRAWINGS 7-2
- 7.5 FINAL CERTIFICATION REPORT 7-2

Appendices

Appendix A	Examples of Geosynthetic Quality Assurance Documentation

Exhibits

Exhibit 1-1	Resolution Meeting Agenda
Exhibit 1-2	Pre-Construction Meeting Agenda
Exhibit 2-1	Final Construction Quality Assurance Certification Report – General Outline

1.1 SCOPE

This Construction Quality Assurance (CQA) Manual addresses the quality assurance of the installation of geosynthetic materials used by Solutia Inc. (Solutia) for the construction of the Sauget Area 1 TSCA Landfill located in Cahokia, Illinois.

This manual addresses quality assurance, not quality control. In the context of this manual, quality assurance refers to means and actions employed to assure conformity of the geosynthetic system production and installation with the project-specific, Plans, Specifications, contractual and regulatory requirements. Quality assurance is provided by a party independent from production and installation. Quality control refers only to those actions taken to ensure that materials and workmanship meet the requirements of the Plans and Specifications. Quality control is provided by the manufacturers and installers of the various components of the geosynthetic system.

The scope of this CQA Manual applies to manufacturing, shipment, handling, and installation of geosynthetics. This CQA Manual does not address design guidelines, installation specifications, or selection of geosynthetic materials. It also does not address the quality assurance of soils, except in cases where soil placement may have an influence on the geosynthetics. The quality assurance of soil components of landfill lining and final cover systems is addressed in Solutia's "Quality Assurance Manual for the Installation of Soil Components of the Lining and Final Cover Systems".

1.2 PROJECT ORGANIZATION

Solutia has the overall responsibility for ensuring that all construction activities fulfill the objectives of the project. Solutia will retain an independent construction management firm to coordinate all construction activities of the Feed Pond closure and construction of the TSCA Landfill. Solutia will also retain an independent inspection firm to provide Construction Quality Assurance services during construction activities.

Key personnel, their authority and responsibilities with respect to the CQA process are as follows:

1.2.1 Solutia Leadership Team

The Solutia Leadership Team will act as a contact with all regulatory agencies for all matters concerning the project and has overall responsibility for the conduct of project activities. The Solutia Leadership Team will ensure that corporate standards are applied during the project and will have the overall responsibility to ensure the project meets all established QA/QC goals. The Solutia Leadership Team is responsible for the coordination between the design firm and Construction Manager and serves as Solutia's representative during construction. They are also the primary point of contact between Solutia and all supporting team members. The Solutia Leadership Team will perform its duties under the direction of Bruce Yare and Mike Light.

1.2.2 Construction Manager

Acting under the authority delegated to him by Solutia, the Construction Manager is the on-site representative and will implement the overall project plans through day-to-day direction of field activities. Solutia will retain a construction management firm to provide these services.

1.2.3 Designer

The Designer is the individual and/or firm responsible for the preparation of the design, including plans and project-specific specifications for the geosynthetic components of the lining and final cover system. The Designer for the TSCA Landfill is URS Greiner Woodward Clyde.

1.2.4 Geosynthetic Construction Quality Assurance Consultant

The Geosynthetic Construction Quality Assurance (CQA) Consultant is a firm independent from the Construction Manager, Manufacturer(s), and Installer that shall be responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic system on behalf of Solutia.

1.2.5 Geosynthetic Quality Assurance Laboratory

The Geosynthetic Quality Assurance Laboratory (QAL) is a firm, independent from the Construction Manager, Manufacturer(s), and Installer, responsible for conducting tests on samples of geosynthetics taken from the site. Solutia will retain an independent laboratory to perform geosynthetic testing for the project.

1.2.6 Construction Contractor(s)

Selected Contractors will be responsible for performing the work outlined in the Plans and Specifications. This work shall include:

- Site mobilization and demobilization
- Site preparation
- Construction of the TSCA Landfill Liner System
- Construction of the TSCA Landfill Cover System

1.3 PROJECT TEAM RESPONSIBILITIES AND QUALIFICATIONS

The parties discussed in this section are associated with the ownership, design, manufacture, transportation, installation, and quality assurance of the geosynthetic system. The qualifications and responsibilities of these parties are outlined in the following subsections.

1.3.1 Construction Manager

1.3.1.1 Responsibilities

The Construction Manager is responsible for all construction quality. The Construction Manager is responsible for the organization and implementation of the quality assurance activities for the project.

The Construction Manager shall serve as communications coordinator for the project, initiating all construction meetings. As communications coordinator, the Construction Manager shall serve as a liaison between all parties involved in the project to insure that communications are maintained.

The principal responsibilities of the Construction Manager are:

- Establish effective communications with the Solutia Leadership Team and Contractor field representatives, and other project team personnel through correspondence, meetings, and discussions, as required, to maintain close working relationships.
- Execute the project work plans and implement procedures through overall planning and day-to-day direction of field activities.
- Ensure that QA and QC procedures are implemented throughout execution of the work.
- Review Contractor progress reports and payments.
- Issue weekly field activity reports.
- Maintain on-site documentation consisting of procedures, rules and regulations, drawings, survey information, correspondence, meetings, etc.
- Manage and assist other field personnel in overseeing Contractors.

The Construction Manger shall also be responsible for proper resolution of all quality assurance issues that arise during construction.

1.3.1.2 Qualifications

The selection of the Construction Manager is the direct responsibility of Solutia. Qualifications for this position include familiarity with the following:

1. Applicable construction methods and procedures.
2. General geosynthetic lining techniques.
3. All applicable regulatory requirements.
4. Company policies and procedures for project management.
5. Quality assurance requirements.

1.3.2 Designer

1.3.2.1 Responsibilities

The Designer is responsible for performing the engineering design and preparing the associated Plans and Specifications for the geosynthetic components of the lining and final cover system. The Designer is responsible for approving all design and specification changes and making design clarifications necessitated during construction of the geosynthetic components of the lining and final cover system.

1.3.2.2 Qualifications

The Designer shall be a qualified engineer, certified or licensed as required by regulation. The Designer shall be familiar with geosynthetics (including detailed geosynthetic design methods and procedures) and applicable regulatory requirements.

1.3.2.3 Submittals

The Designer shall submit the project Plans and Specifications to the Solutia Leadership Team and the Construction Manager.

1.3.3 Manufacturer

1.3.3.1 Definitions

The Manufacturer is a firm responsible for production of any of the various geosynthetic liner system components outlined in the Specifications.

1.3.3.2 Responsibilities

Each Manufacturer is responsible for the production of its geosynthetic product. In addition, each Manufacturer is responsible for the condition of the geosynthetic until the material is accepted by the Construction Manager after delivery. Each Manufacturer shall produce a consistent product meeting the Specifications. Each Manufacturer shall provide quality control documentation for its product as specified in the Specifications.

1.3.3.3 Qualifications

Each Manufacturer shall be pre-qualified by Solutia. Each Manufacturer shall provide sufficient production capacity and qualified personnel to meet the demands of the project. Each Manufacturer shall have an internal quality control program for its product that meets standard industry requirements.

1.3.3.4 Submittals

Pre-qualification: A Manufacturer shall meet the following requirements and submit the following information:

1. A list of material properties including certified test results, to which are attached geosynthetic samples.
2. The origin (supplier's name and production plant) and identification (brand name and number) of resin used to manufacture the product.

Pre-installation: Prior to the installation of any geosynthetic material, a Manufacturer must submit to the Construction Manager all quality control documentation required by the Specifications. This documentation shall be reviewed by the Construction Manager before installation can begin.

1.3.4 Installer

1.3.4.1 Definitions

The Installer is the firm responsible for installation of the geosynthetics. The Installer may be affiliated with the Manufacturer.

The Superintendent is responsible for the Installer's field crew. The Superintendent shall represent the Installer at all site meetings and shall be responsible for acting as the Installer's spokesman on the project.

The Master Seamer shall be the most experienced seamer of the Installer's field crew. The Master Seamer shall provide direct supervision over less experienced seamers.

1.3.4.2 Responsibilities

The Installer shall be responsible for field handling, storing, deploying, seaming, temporary restraining and all other aspects of the geosynthetics installation. The Installer may also be responsible for transportation of these materials from on-site storage to the area of the work.

1.3.4.3 Qualifications

The Installer shall be pre-qualified and approved by Solutia. The Installer shall be able to provide qualified personnel to meet the demands of the project. At a minimum, the Installer shall provide a Superintendent and a Master Seamer as described below.

The Superintendent and Master Seamer must be qualified based on previously demonstrated experience, management ability, and authority.

For geomembrane installation all personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests using the equipment and seaming techniques proposed for this project.

1.3.4.4 Submittals

Pre-qualification: To be considered for pre-qualification, the Installer shall submit the pre-qualification information required by the Specifications.

Pre-installation: Prior to commencement of the installation, the Installer must submit to the Construction Manager:

1. Resume of the Superintendent to be assigned to this project, including dates and duration of employment.
2. Resume of the Master Seamer to be assigned to this project, including dates and duration of employment.
3. A panel layout drawing showing the installation layout identifying field seams as well as any variance or additional details which deviate from the engineering drawings. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.
4. Installation schedule.
5. A list of personnel performing field seaming operations along with pertinent experience information.
6. All geosynthetic quality control certificates as required by this QAM (unless submitted directly to the Construction Manager by the Manufacturer).
7. Certification that extrudate to be used is comprised of the same resin as the geomembrane to be used.

This documentation shall be reviewed by the Construction Manager before installation of the geosynthetic can begin.

Installation: During the installation, the Installer shall be responsible for the submission of:

1. Quality control documentation recorded during installation.
2. Subgrade surface acceptance certificates for each area to be covered by the lining system, signed by the Installer.

Completion: Upon completion of the installation, the Installer shall submit:

1. The warranty obtained from the Manufacturer.
2. The installation warranty.

1.3.5 Geosynthetic Construction Quality Assurance Consultant

1.3.5.1 Responsibilities

The Geosynthetic Construction Quality Assurance (CQA) Consultant is responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic system. The Geosynthetic CQA Consultant is responsible for implementation of the project CQA Manual and management of the Geosynthetic Quality Assurance Laboratory. The Geosynthetic CQA Consultant is also responsible for issuing a final certification report sealed by a registered professional engineer.

The specific duties of the Geosynthetic CQA Consultant personnel are as follows:

1. Reviews other site-specific documentation, including proposed layouts, and manufacturer's and installer's literature.
2. Reviews all changes to design drawings and specifications as issued by the Designer.
3. Attends all quality assurance related meetings.
4. Reviews all Manufacturer and Installer certifications and documentation and makes appropriate recommendations.
5. Reviews the Installer's personnel qualifications for conformance with the qualifications for work on site.
6. Reviews the calibration certification of the on-site tensiometer, if applicable.
7. Notes any on site activities that could result in damage to the geosynthetics.
8. Reports to the Construction Manager, and logs in the daily report.
9. Prepares a daily summary of the quantities of geosynthetics installed that day.
10. Prepares the weekly summary of geosynthetic quality assurance activities.
11. Oversees the marking, packaging and shipping of all laboratory test samples.
12. Reviews the results of laboratory testing and makes appropriate recommendations.
13. Reports any unapproved deviations from the CQA Manual to the Construction Manager.
14. Prepares the final certification report.

1.3.5.2 Qualifications

The Geosynthetic CQA Consultant shall be pre-qualified by Solutia. The Geosynthetic CQA Consultant shall be experienced in quality assurance of geosynthetics. The Geosynthetic CQA Consultant shall be experienced in the preparation of quality assurance documentation including: quality assurance forms, reports, certifications, and manuals.

1.3.5.3 Submittals

Pre-qualification: To be considered for pre-qualification, the Geosynthetic CQA Consultant must provide the following information:

1. Corporate background and information.
2. Quality assurance capabilities:
   a. A summary of the firm's experience with geosynthetics.
   b. A summary of the firm's experience in quality assurance, including installation quality assurance of geosynthetics.
   c. A summary of quality assurance documentation and methods used by the firm, including sample quality assurance forms, reports, certifications, and manuals prepared by the firm.
   d. Resumes of key personnel.

Pre-installation: Prior to beginning work on a project, the Geosynthetic CQA Consultant must provide the Construction Manager with the following information:

1. Resumes of personnel to be involved in the project.
2. Proof of the required quality assurance experience of all of the quality assurance personnel.

1.3.6 Geosynthetic Quality Assurance Laboratory

1.3.6.1 Responsibilities

The Geosynthetic QAL shall be responsible for conducting the appropriate laboratory tests as directed by the Geosynthetic CQA Consultant or the Construction Manager. The test procedures shall be done in accordance with the test methods outlined in the Plans and Specifications. The Geosynthetic QAL shall be responsible for providing test results.

1.3.6.2 Qualifications

The Geosynthetic QAL shall have experience in testing geosynthetics and be familiar with American Society for Testing and Materials (ASTM), and other applicable test standards. The Geosynthetic QAL shall be capable of providing verbal results of destructive seam tests within 24 hours of receipt of test samples and shall maintain that standard throughout the installation. The Geosynthetic QAL shall be approved by Solutia.

On-site laboratory facilities may be used by the Geosynthetic QAL provided they are appropriately equipped and approved by the Geosynthetic QAC and the Construction Manager.

1.3.6.3 Submittals

Geomembrane destructive test results shall typically be provided verbally to the Construction Manager within 24 hours of receipt of test samples. The Geosynthetic QAL shall submit all destructive seam test results to the Construction Manager in written form within 48 hours of receipt of test samples unless otherwise specified by the Construction Manager. Written test results shall be in an easily readable format and include references to the standard test methods used.

1.4 COMMUNICATION

To guarantee a high degree of quality during installation and assure a final product that meets all project specifications, clear, open channels of communication are essential. This section issues appropriate lines of communication and describes all necessary meetings.

1.4.1 Resolution Meeting

Following the completion of the construction drawings and specifications for the project, a resolution meeting may be held. If a resolution meeting is required, it is recommended that the meeting be held prior to bidding the construction work and include all parties then involved, typically including the Construction Manager, Designer, Geosynthetic CQA Consultant, and a Solutia Leadership Team representative. If necessary, this meeting can be held in conjunction with the pre-construction meeting.

The purpose of this meeting is to establish lines of communication, review construction drawings and specifications for completeness and clarity, begin planning for coordination of tasks, and anticipate any problems which might cause difficulties and delays in construction. All aspects of the design shall be reviewed during this meeting so that clarification and/or design changes may be made before the construction work is bid. In addition, the guidelines regarding quality assurance testing and problem resolution must be known and accepted by all.

A recommended agenda for the resolution meeting is presented in Exhibit 1-1. The meeting shall be documented by the Construction Manager and minutes shall be transmitted to all parties.

1.4.2 Pre-construction Meeting

A pre-construction meeting shall be held at the site prior to beginning geosynthetic deployment. Typically, the meeting shall be attended at a minimum by the Construction Manager, Designer, Installer, and Geosynthetic CQA Consultant.

Specific topics considered for this meeting include review of the project CQA Manual for any problems or additions. In addition, the responsibilities of each party should be reviewed and understood clearly. A recommended agenda with specific topics for the pre-construction meeting is presented in Exhibit 1-2. The meeting shall be documented by the Construction Manager and minutes shall be transmitted to all parties.

1.4.3 Progress Meetings

A progress meeting shall be held at least weekly between the Geosynthetic CQA Consultant, Installer's Superintendent, Construction Manager, and any other concerned parties. This meeting shall discuss current progress, planned activities for the next week, issues requiring resolution, and any new business or revisions to the work. The Geosynthetic CQA Consultant shall log any problems, decisions, or questions arising at this meeting in his weekly report. If any matter remains unresolved at the end of this meeting, the Construction Manager shall be responsible for the resolution of the matter and the communication of the decision to the appropriate parties.

2.1 QUALITY CONTROL DOCUMENTATION

Prior to the installation of any geomembrane material, the Manufacturer or Installer shall provide the Construction Manager with the following information:

1. The origin (resin suppliers name and resin production plant), identification (brand name and number), and production date of the resin.
2. Copies of the quality control certificates issued by the resin supplier.
3. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geomembrane meets the Specifications.
4. Reports on quality control tests conducted by the Manufacturer to verify that the geomembrane manufactured for the project meets the project specifications.
5. A statement indicating that no reclaimed polymer was added to the resin during manufacturing.
6. A list of the materials with which comprise the geomembrane, expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.
7. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.
8. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, sampling procedures, and results of quality control tests. At a minimum, results shall be for:

    a. Density
    b. Carbon black content
    c. Carbon black dispersion
    d. Thickness
    e. Tensile properties
    f. Tear resistance

These quality control tests shall be performed in accordance with the frequency and test methods in the Specifications.

The Manufacturer shall identify all rolls of geomembranes with the following:

1. Manufacturer's name
2. Product identification
3. Thickness
4. Roll number

5. Roll dimensions

The Geosynthetic CQA Consultant shall review these documents and shall report any discrepancies with the above requirements to the Construction Manager. The Geosynthetic CQA Consultant shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed performance criteria. Measurements of properties by the Manufacturer are properly documented and that test methods used are acceptable.
2. Quality control certificates have been provided at the specified frequency for all rolls and that each certificate identifies the rolls related to it.
3. Rolls are appropriately labeled.
4. Certified minimum properties meet the requirement of the Specifications.

2.2 CONFORMANCE TESTING

Upon delivery of the rolls of geomembrane, the Geosynthetic CQA Consultant shall ensure conformance test samples are obtained for the geomembrane. These samples shall be that forwarded to the Geosynthetic QAL for testing to ensure conformance to the Specifications. If the Construction Manager desires, the Geosynthetic CQA Consultant can direct the conformance sampling be completed at the manufacturing plant.

The following conformance tests shall be conducted:

1. Density
2. Carbon black content
3. Carbon black dispersion
4. Thickness
5. Tensile characteristics

These conformance tests shall be performed in accordance with the test frequency and methods in the Specifications.

2.2.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetic CQA Consultant. Samples shall be taken across the entire width of the roll and shall not include the first 3 ft (1 m). Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The Geosynthetic CQA Consultant shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetic CQA Consultant based on a review of all roll information including quality control documentation manufacturing records.

2.2.2 Test Results

All conformance test results shall be reviewed and by the Geosynthetic CQA Consultant prior to the deployment of the geomembrane. The Geosynthetic CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the Construction Manager. The Geosynthetic CQA Consultant shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications. Based upon the recommendation of the Geosynthetic CQA Consultant, the Construction Manager shall accept or reject the geomembrane.

If the Manufacturer has reason to believe that failing tests may be the result of Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that sample in question be retested by the Geosynthetic QAL with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different Solutia approved Geosynthetic QALs at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to approval of the Construction Manager.

If a test result is in nonconformance, all material from the lot represented by the failed test should be considered out of specification and rejected. Alternatively, at the option of the Construction Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specifications (note that this procedure is valid only when rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

2.3 SUBGRADE PREPARATION

2.3.1 Surface Preparation

The Earthwork Contractor shall be responsible for preparing the supporting soil for geomembrane placement. The Construction Manager shall coordinate the work of the Earthwork Contractor and the Installer so that the requirements of the Specifications and the project CQA Manual are met.

Before the geomembrane installation begins, the Geosynthetic CQA Consultant shall verify that:

1. A qualified land surveyor has verified all lines and grades.
2. A qualified geotechnical engineer has verified that the supporting soil meets the density specified in the project specifications.

3. The surface to be lined has been rolled, compacted, or handworked so as to be free irregularities, protrusions, loose soil and abrupt changes in grade.
4. The surface of the supporting soil does not contain stones which may be damaging the geomembrane.
5. There is no area excessively softened by high water content.
6. There is no area where the surface of the soil contains desiccation cracks with dimensions exceeding those allowed by the Specifications.

The Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. A certificate of acceptance shall be given by the Installer to the Geosynthetic CQA Consultant and Construction Manager prior to commencement of geomembrane deployment in the area under consideration.

After the supporting soil has been accepted by the Installer, it is the Installer's responsibility to indicate to the Construction Manager any change in the supporting soil condition that may require repair work. The Construction Manager may consult with the Geosynthetic CQA Consultant regarding the need for repairs. The Construction Manager shall ensure that the supporting soil is repaired.

At any time before or during the geomembrane installation, the Geosynthetic CQA Consultant shall indicate to the Construction Manager any locations which may not be adequately prepared for the geomembrane.

2.3.2 Anchor Trench

The Geosynthetic CQA Consultant shall verify that the anchor trench has been constructed according to the design Plans and Specifications.

If the anchor trench is excavated in a clay material susceptible to desiccation, the amount of trench open at any time should be minimized. The Geosynthetic CQA Consultant shall inform the Construction Manager of any signs of significant desiccation associated with the anchor trench construction.

Slightly rounded corners shall be provided in the trench so as to avoid sharp bends in the geomembrane. Excessive amounts of loose soil shall not be allowed to underlie geomembrane in the anchor trench.

The anchor trench shall be adequately drained to prevent ponding or softening of adjacent sods while the trench is open. The anchor trench shall be backfilled and compacted as outlined in the project specifications.

Care shall be taken when backfilling the trenches to prevent any damage to geosynthetics. The Geosynthetic CQA Consultant shall observe the backfilling operation and advise the Construction Manager of any problems. Any problems shall be documented by the Geosynthetic CQA Consultant in his daily report.

2.4 GEOMEMBRANE DEPLOYMENT

2.4.1 Panel Nomenclature

A field panel is defined as a unit of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of roll cut in the field.

It shall be the responsibility of the Geosynthetic CQA Consultant to ensure that each field panel be given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be agreed upon by the Construction Manager, Installer and Geosynthetic CQA Consultant. This field panel identification code shall be as simple and logical as possible. In general, it is not appropriate to identify panels using roll numbers since numbers established in the manufacturing plant are usually cumbersome and are related to location in the field. The Geosynthetic CQA Consultant shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code shall be used for all quality assurance records.

The Geosynthetic CQA Consultant shall verify that field panels are installed at the locations indicated on the Installer's layout plan, as approved by the Construction Manager.

2.4.2 Panel Deployment Procedure

The Geosynthetic CQA Consultant shall review the panel deployment progress of the Installer (keeping in mind issues relating to wind, rain, clay liner desiccation, and other site-specific conditions) and advise the Construction Manager on its compliance with the approved panel layout drawing and its suitability to the actual field conditions. Once approved, only the Construction Manager can authorize changes to the panel deployment procedure. Geosynthetic CQA Consultant shall verify that the condition of the supporting soil does not change detrimentally during installation.

The Geosynthetic CQA Consultant shall record the identification code, location, and date of installation of each field panel.

2.4.3 Deployment Weather Conditions

Geomembrane deployment shall not proceed at an ambient temperature below 32° F (0° C) or above 104° F (40° C) unless otherwise authorized, in writing, by the Construction Manager. Geomembrane placement shall not be performed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds. Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment.

The Geosynthetic CQA Consultant shall verify that the above conditions are fulfilled. Ambient temperature shall be measured by the Geosynthetic CQA Consultant in the area in which the panels are to be deployed. The Geosynthetic CQA Consultant shall inform the Construction

Manager of any weather related problems which may not allow geomembrane placement to proceed.

2.4.4 Method of Deployment

Before the geomembrane is handled on site, the Geosynthetic CQA Consultant shall verify that handling equipment to be used on the site is adequate and does not pose risk of damage to the geomembrane. During handling, the Geosynthetic CQA Consultant shall observe and verify that the Installer's personnel handle the geomembrane with care.

The Geosynthetic CQA Consultant shall verify the following:

1. Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means.
2. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement.
3. Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris.
4. All personnel do not smoke or wear damaging shoes while working on the geomembrane, or engage in other activities which could damage the geomembrane.
5. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting soil.
6. The method used to place the panels minimized wrinkles (especially differential wrinkles between adjacent panels).
7. Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind. In case of winds, continuous loading, e.g., by sand bags, is recommended along edges of panel to minimize risk of wind flow under the panels.
8. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

The Geosynthetic CQA Consultant shall inform the Construction Manager if the above conditions are not fulfilled.

2.4.5 Damage and Effects

Upon delivery to the site, the Geosynthetic CQA Consultant shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. The Geosynthetic CQA Consultant shall advise the Construction Manager, in writing, of any rolls or portions of rolls which should be rejected and removed from the site because they have severe flaws, and/or minor repairable flaws.

The Geosynthetic CQA Consultant shall inspect each panel, after placement and prior to seaming, for damage and/or defects. The Geosynthetic CQA Consultant shall advise the Construction Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels, or portions of damaged panels, which have been rejected shall be marked and their removal from the work area recorded by the Geosynthetic CQA Consultant. Repairs shall be made using procedures described in the Specifications.

2.4.6 Writing on the Liner

To avoid confusion, the Installer and the Geosynthetic CQA Consultant shall each use different colored markers that are readily visible for writing on the geomembrane. The markers used must be semi-permanent and compatible with the geomembrane. The installer shall use a yellow marker to write on the geomembrane. The Geosynthetic CQA Consultant shall use a red marker.

2.5 FIELD SEAMING

2.5.1 Seam Layout

Before installation begins, the Installer must provide the Construction Manager and the Geosynthetic CQA Consultant with a panel layout drawing, i.e., a drawing of the facility to be lined showing all expected seams. The Geosynthetic CQA Consultant shall review the panel layout drawing and verify that it is consistent with accepted state-of-practice. No panels may be seamed without written approval of the panel layout drawing by the Construction Manager. In addition, panels not specifically shown on the panel layout drawing may not be used without the Construction Manager's prior approval.

In general, seams should be oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 ft (1.5 m) from the toe of the slope, or areas of potential stress concentrations, unless otherwise authorized by the Construction Manager.

A seam numbering system compatible with the panel numbering system shall be used by the Geosynthetic CQA Consultant.

2.5.2 Accepted Seaming Methods

Approved processes for field seaming are extrusion welding and fusion welding. Proposed alternate processes shall be documented and submitted by the Installer to the Construction Manager for approval. Only apparatus which have been specifically approved by make and model shall be used. The Construction Manager shall submit all documentation regarding seaming methods to be used to the Geosynthetic CQA Consultant for review.

2.5.2.1 Extrusion Process

The Geosynthetic CQA Consultant shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances to the construction manager.

The Geosynthetic CQA Consultant shall verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus decided upon at the pre-construction meeting.
2. Equipment used for seaming is not likely to damage the geomembrane.
3. Prior to beginning a seam, the extruder is purged until all heat-degraded extrudate has been removed from the barrel.
4. Clean and dry welding rods or extrudate pellets are used.
5. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.
6. Grinding shall be completed no more than 1 hour prior to seaming.
7. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.
8. The geomembrane is protected from damage in heavily trafficked areas.
9. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instance shall exposed grinding marks extend more than ¼-inch from the seamed area.
10. In general, the geomembrane panels are aligned to have a nominal overlap of 3 inches (75 mm) for extrusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.
11. No solvent or adhesive is used unless the product is approved in writing by the construction manager prior to use (samples shall be submitted to the construction manager for testing and evaluation).
12. The procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any temporary welding apparatus is controlled such that the geomembrane is not damaged or degraded.

2.5.2.2 Fusion Process

The Geosynthetic CQA Consultant shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances to the construction manager.

The Geosynthetic CQA Consultant shall also verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus decided upon at the pre-construction meeting.
2. Equipment used for seaming is not likely to damage the geomembrane.
3. For cross seams, the edge of the cross seam is ground to an incline prior to welding.
4. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.
5. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.
6. The geomembrane is protected from damage in heavily trafficked areas.
7. A movable protective layer is used as required by the installer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets and prevent debris from collecting around the pressure rollers.
8. In general, the geomembrane panels are aligned to have a nominal overlap of 5 inches (125 mm) for fusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.
9. No solvent or adhesive is used unless the product is approved in writing by the Construction Manager prior to use (samples shall be submitted to the Construction Manager for testing and evaluation).

2.5.3 Seam Preparation

The Geosynthetic CQA Consultant shall verify that prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind. If seam overlap grinding is required, the Geosynthetic CQA Consultant must ensure that the process is completed according to the manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane. The Geosynthetic CQA Consultant shall also verify that seams are aligned with the fewest possible number of wrinkles and "fishmouths".

2.5.4 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once each five hours, for each production seaming apparatus used that day. Each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least 5 ft (1.0 m) long by 1 ft (0.3 m) wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in Section 4.6.2.

Two specimens shall be cut from the sample with a 1-inch (25 mm) wide die. The specimens shall be cut by the installer at locations selected randomly along the trial seam sample by the Geosynthetic CQA Consultant. The specimens shall be tested in peel using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of two inches per

minute. They should not fail in the seam. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial welds are achieved. The Geosynthetic CQA Consultant shall observe all trial seam procedures.

The remainder of the successful trial seam sample shall be cut into three pieces, one to be retained in the construction manager's archives, one to be given to the installer, and one to be retained by the Geosynthetic CQA Consultant for possible laboratory testing. Each portion of the sample shall be assigned a number and marked accordingly by the Geosynthetic CQA Consultant, who shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.

If agreed upon between the Construction Manager and the Geosynthetic CQA Consultant, and documented by the Geosynthetic CQA Consultant in his/her daily report, the remaining portion of the trial seam sample can be subjected to destructive testing. If a trial seam sample fails a test conducted by the Geosynthetic QAL, then a destructive seam test sample shall be taken from each of the seams completed by the seamer during the shift related to the considered trial seam. These samples shall be forwarded to the Geosynthetic QAL and, if they fail the tests, the seam shall be subjected to the "Destructive Test Failure Procedures" identified in this CQA Manual. The conditions of this paragraph shall be considered satisfied for a given seam if a destructive seam test sample has already been taken.

2.5.5 General Seaming Procedures

During general seaming, the Geosynthetic CQA Consultant shall be cognizant of the following:

1. For fusion welding, it may be necessary to place a movable protective layer of plastic directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture buildup between the sheets to be welded and prevent debris from collecting around the pressure rollers.
2. If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.
3. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches (150 mm) beyond the cut in all directions.
4. If seaming operations are carried out at night, adequate illumination shall be provided.
5. Seaming shall extend to the outside edge of panels placed in the anchor trench.
6. All cross seam tees should be extrusion welded to a minimum distance of 4 inches on each side of the tee.
7. No field seaming shall take place without the master seamer being present.

The Geosynthetic CQA Consultant shall verify that the approved seaming procedures are followed, and shall inform the Construction Manager of any nonconformance.

2.5.6 Seaming Weather Conditions

2.5.6.1 Normal Weather Conditions

The normal required weather conditions for seaming are as follows:

1. Ambient temperature between 32° F (0° C) and 104° F (40° C).
2. Dry conditions (i.e., no precipitation or other excessive moisture, such as fog or dew).
3. No excessive winds.

The Geosynthetic CQA Consultant shall verify that these weather conditions are fulfilled and notify the Construction Manager in writing if they are not. Ambient temperature shall be measured by the Geosynthetic CQA Consultant in the area in which the panels are to be placed. The Construction Manager will then decide if the installation is to be stopped or special procedures used.

2.5.6.2 Cold Weather Conditions

To ensure a quality installation, if seaming is conducted when the ambient temperature is below 32° F (0° C), the following conditions must be met:

1. Geomembrane surface temperatures shall be determined by the Geosynthetic CQA Consultant at intervals of at least once per 100 foot of seam length to determine if preheating is required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32° F (0° C).
2. Preheating may be waived by the construction manager based on a recommendation from the Geosynthetic CQA Consultant, if the installer demonstrates to the Geosynthetic CQA Consultant's satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.
3. If preheating is required, the Geosynthetic CQA Consultant shall inspect all areas of geomembrane that have been preheated by a hot air device prior to seaming, to ensure that they have not been overheated.
4. Care shall be taken to confirm that the surface temperatures are not lowered below the minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for the seam area.
5. All preheating devices shall be approved prior to use by the construction manager.
6. Additional destructive tests shall be taken at an interval between 500 and 250 feet of seam length, at the discretion of the Geosynthetic CQA Consultant.
7. Sheet grinding may be performed before preheating, if applicable.

8. Trial seaming shall be conducted under the same ambient temperature and preheating conditions as the actual seams. Under cold weather conditions, new trial seams shall be conducted if the ambient temperature drops by more than 5° F from the initial trial seam test conditions.

2.5.6.3 Warm Weather Conditions

At ambient temperatures above 104° F, no seaming of the geomembrane shall be permitted unless the installer can demonstrate to the satisfaction of the construction manager that geomembrane seam quality is not compromised.

Trial seaming shall be conducted under the same ambient temperature conditions as the actual seams.

At the option of the Geosynthetic CQA Consultant, additional destructive tests may be required for any suspect areas.

2.6 NONDESTRUCTIVE SEAM TESTING

2.6.1 Concept

The Installer shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantitative information on seam strength. Nondestructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

For all seams, the Geosynthetic CQA Consultant shall:

1. Observe nondestructive testing procedures.
2. Record location, data, test unit number, name of tester, and outcome of all testing.
3. Inform the Installer and Construction Manager of any required repairs.

Any seam that cannot be nondestructively tested shall be cap-stripped with the same geomembrane. The cap-stripping operations shall be observed by the Geosynthetic CQA Consultant and Installer for uniformity and completeness.

2.6.2 Vacuum Testing

The following procedures are applicable to vacuum testing.

1. The equipment shall consist of the following:

a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.

b. A pump assembly equipped with a pressure controller and pipe connections.

c. A rubber pressure/vacuum hose with fittings and connections.

d. A soapy solution.

e. A bucket and wide paint brush, or other means of applying the soapy solution.

2. The following procedures shall be followed:

a. Energize the vacuum pump and reduce the tank pressure to approximately 5 psi (10 in. of Hg) (35 kPa) gauge.

b. Wet a strip of geomembrane approximately 12 inches x 48 inches (0.3 m x 1.2 m) with the soapy solution.

c. Place the box over the wetted area.

d. Close the bleed valve and open the vacuum valve.

e. Ensure that a leak-tight seal is created.

f. For a period of not less than 10 seconds, apply vacuum and examine the geomembrane through the viewing window for the presence of soap bubbles.

g. If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches (75 mm) overlap, and repeat the process.

h. All areas where soap bubbles appear shall be marked and repaired.

2.6.3 Air Pressure Testing

The following procedures are applicable to double fusion welding which produces a double seam with an enclosed space.

1. The equipment shall consist of the following:

a. An air pump (manual or motor driven), equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa) and mounted on a cushion to protect the geomembrane.

b. A rubber hose with fittings and connections.

c. A sharp hollow needle, or other approved pressure feed device.

2. The following procedures shall be followed:

a. Seal both ends of the seam to be tested.

b. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.

c. Insert a protective cushion between the air pump and the geomembrane.

d. Energize the air pump to a pressure between 25 and 30 psi (160 and 200 kPa), close valve, allow 2 minutes for pressure to stabilize, and sustain pressure for at least 5 minutes.

e. If loss of pressure exceeds 4 psi (30 kPa) or does not stabilize, locate faulty area and repair in accordance with Section 4.9.3.

f. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Seal the cut end of the air channel.

g. Remove needle or other approved pressure feed device and seal.

2.6.4 Test Failure Procedure

The Installer shall complete any required repairs in accordance with the requirements of the Specifications. For repairs, the Geosynthetic CQA Consultant shall:

1. Observe the repair and testing of the repair.
2. Mark on the geomembrane that the repair has been made.
3. Document the repair procedures and test results.

2.7 DESTRUCTIVE SEAM TESTING

2.7.1 Concept

Destructive seam tests shall be performed at selected locations in accordance with the requirements of the Specifications. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

2.7.2 Location and Frequency

The Geosynthetic CQA Consultant shall select locations where seam samples will be cut out for laboratory testing. Those locations shall be established as follows:

1. A minimum frequency of one test location per 500 ft (150 m) of seam length performed by each welder. This minimum frequency is to be determined as an average taken throughout the entire facility.
2. Test locations shall be determined during seaming at the Geosynthetic CQA Consultant's discretion. Selection of such locations may be prompted by suspicion of overheating, contamination, offset welds, or any other potential cause of imperfect welding.

3. One additional CQA destructive seam test will be performed for every 10 destructive tests required by the specifications with a minimum of two CQA destructive tests per geomembrane layer.

The Installer shall not be informed in advance of the locations where the seam samples will be taken.

2.7.3 Sampling Procedures

Samples shall be cut by the Installer at locations chosen by the Geosynthetic CQA Consultant as the seaming progresses so that laboratory test results are available before the geomembrane is covered by another material. The Geosynthetic CQA Consultant shall:

1. Observe sample cutting.
2. Assign a number to each sample, and mark it accordingly.
3. Record sample location on layout drawing.
4. Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in the Specification. The continuity of the new seams in the repaired area shall be tested.

2.7.4 Sample Dimensions

At a given sampling location, two types of samples shall be taken by the Installer. First, two samples for field testing should be taken. Each of these samples shall be cut with a 1-inch (25 mm) wide die, with the seam centered parallel to the width. The distance between these two samples shall be 42 inches (1.1 m). If both samples pass the field test described in Section 4.8.5, a sample for laboratory testing shall be taken.

The sample for laboratory testing shall be located between the samples for field testing. The sample for laboratory testing shall be 12 inches (0.3 m) wide by 42 inches (1.1 m) long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

1. One portion to the Installer for optional laboratory testing, 12 inches x 12 inches (0.3 m x 0.3 m)
2. One portion for Geosynthetic QAL testing, 12 inches x 18 inches (0.3 m x 0.5 m) and
3. One portion to the Construction Manager for archive storage, 12 inches x 12 inches (0.3 m x 0.3 m).

Final determination of the sample sizes shall be made at the pre-construction meeting.

2.7.5 Field Testing

The two 1-inch (25 mm) wide strips shall be tested in the field using a tensiometer for peel and shall not fail according to the criteria in the Specifications. The tensiometer shall be capable of maintaining a constant jaw separation rate of 2 in. per minute. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If it fails, the seam should be repaired. Final judgement regarding seam acceptability, based on the failure criteria shall be made by the Construction Manager.

The Geosynthetic CQA Consultant shall witness all field tests and mark all samples and portions with their number. The Geosynthetic CQA Consultant shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

2.7.6 Laboratory Testing

Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the Geosynthetic CQA Consultant in a manner which will not damage the test sample. The Construction Manager will be responsible for storing the archive samples. Test samples shall be tested by the Geosynthetic QAL.

Testing shall include "seam strength" and "peel adhesion". These terms are defined in the specifications. The minimum acceptable values to be obtained in these tests are indicated in the Specifications. At least 5 specimens shall be tested in each shear and peel. Specimens shall be selected alternately by test from the samples (i.e., peel, shear, peel, shear...). A passing test shall meet the minimum acceptable values in at least 4 of the 5 specimens tested for each method.

The Geosynthetic QAL shall provide verbal test results no more than 24 hours after they receive the samples. The Geosynthetic CQA Consultant shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Construction Manager.

2.7.7 Destructive Test Failure Procedures

The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetic QAL, or by field tensiometer. The Installer has two options:

1. The Installer can repair the seam between any two passing test locations.
2. The Installer can trace the welding path to an intermediate location (at 10 ft (3 m) minimum from the point of the failed test in each direction) and take a sample with a 1 in. (25 mm) wide die for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is repaired between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be repaired.

All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests of trial seam samples taken as indicated in Section 4.6.4 may be used as a boundary for the failing seam. In cases exceeding 150 ft (50 m) of repaired seam, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Specifications.

The Geosynthetic CQA Consultant shall document all actions taken in conjunction with destructive test failures.

2.8 DEFECTS AND REPAIRS

2.8.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the Geosynthetic CQA Consultant for identification of defects, holes, busters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be cleaned by the installer if the amount of dust or mud inhibits examination.

2.8.2 Evaluation

Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in the Specifications as appropriate. Each location which fails the nondestructive testing shall be marked by the Geosynthetic CQA Consultant and repaired by the installer. Work shall not proceed with any materials which will cover locations which have been repaired until appropriate nondestructive and laboratory test results with passing values are available.

2.8.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Construction Manager, Installer, and Geosynthetic CQA Consultant.

1. The repair procedures available include:

    a. Patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.

    b. Spot welding or seaming, used to repair small tears, pinholes, or other minor, localized flaws.

    c. Capping, used to repair large lengths of failed seams.

d. Extrusion welding the flap, used to repair areas of inadequate fusion seams, which have an exposed edge. Repairs of this type shall be approved by the Geosynthetic CQA Consultant, and shall not exceed 50 ft (15 m) in length.

e. Removing bad seam and replacing with a strip of new material welded into place.

2. For any repair method, the following provisions shall be satisfied:

a. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be abraded no more than one hour prior to the repair.

b. All surfaces shall be clean and dry at the time of the repair.

c. All seaming equipment used in repairing procedures shall meet the requirements of the project CQA Manual.

d. Patches or caps shall extend at least 6 inches (150 mm) beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately 3 inches (75 mm).

2.8.4 Repair Verification

Each repair shall be numbered and logged. Each repair shall be nondestructively tested using the methods described in the Specifications as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150 ft long may be of sufficient extent to require destructive test sampling, at the discretion of the Geosynthetic CQA Consultant. Failed tests indicate that the repair shall be redone and retested until a passing test results. The Geosynthetic CQA Consultant shall observe all nondestructive testing of repairs and shall record the number of each repair, date, and test outcome.

2.8.5 Large Wrinkles

When seaming of the geomembrane is completed, and prior to placing overlying materials, the Geosynthetic CQA Consultant shall indicate to the Construction Manager which wrinkles should be cut and reseamed by the Installer. The number of wrinkles to be repaired should be, kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation process, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over on to itself. This is generally the case for a wrinkle that extends 12 inches from the subgrade. Seams produced while repairing wrinkles shall be tested as outlined above.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the Geosynthetic CQA Consultant to ensure that wrinkle formation is minimized.

2.9 GEOMEMBRANE PROTECTION

The quality assurance procedures indicated in this section are intended only to assure that the installation of adjacent materials does not damage the geomembrane. The quality assurance of the adjacent materials themselves should be covered in separate sections of the project CQA Manual as necessary.

2.9.1 Soils

A copy of the specifications prepared by the designer for placement of soils shall be given to the Geosynthetic CQA Consultant by the Construction Manager. The Geosynthetic CQA Consultant shall verify that these specifications are consistent with the state-of-practice such as:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32° F (0° C) nor above 104° F (40° C) unless otherwise specified.
2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.
3. A geotextile or other cushion approved by the designer is generally required between aggregate and the geomembrane.
4. Equipment used for placing soil shall not be driven directly on the geomembrane.
5. A minimum thickness of 1 ft (0.3 m) of soil is specified between a light dozer (ground pressure of 5 psi (35 kPa) or lighter) and the geomembrane.
6. In any areas traversed by any vehicles other than low ground pressure vehicles approved by the Construction Manager, the soil layer shall have a minimum thickness of 3 ft (0.9 m). This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.

The Geosynthetic CQA Consultant shall measure soil thickness and verify that the required thicknesses are present. The Geosynthetic CQA Consultant must also verify that final thicknesses are consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage is unlikely. The Geosynthetic CQA Consultant shall inform the Construction Manager if the above conditions are not fulfilled.

3.1 QUALITY CONTROL DOCUMENTATION

Prior to the installation of any geotextile, the Manufacturer or Installer shall provide the Construction Manager with the following information:

1. The origin (resin supplier's name and resin production plant) and identification (brand name and number) of the resin used to manufacture the geotextile.
2. Copies of the quality control certificates issued by the resin supplier.
3. Reports on quality control tests conducted by the Manufacturer to verify that the geotextile manufactured for the project meets the project specifications.
4. A specification for the geotextile which includes all properties contained in the project specifications measured using the appropriate test methods.
5. Written certification that minimum average roll values given in the specification are guaranteed by the Manufacturer.
6. For non-woven geotextiles, written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle free.
7. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures and results of quality control tests. At a minimum, results shall be given for:

    a. Mass per unit area
    b. Grab strength
    c. Trapezoidal tear strength
    d. Burst strength
    e. Puncture strength
    f. Thickness

    Quality control tests shall be performed in accordance with the frequency and test methods identified in the project Specifications.

The Manufacturer shall identify all rolls of geotextiles with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

The Geosynthetic CQA Consultant shall review these documents and shall report any discrepancies with the above requirements to the Construction Manager. The Geosynthetic CQA Consultant shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum average roll properties meet the project specifications.

3.2 CONFORMANCE TESTING

Upon delivery of the rolls of geotextiles, the Geosynthetic CQA Consultant shall ensure that conformance test samples are obtained for the geotextile. These samples shall then be forwarded to the Geosynthetic QAL for testing to ensure conformance to ensure conformance to the project specifications.

At a minimum, the following conformance tests shall generally be performed on geotextiles:

1. Mass per unit area
2. Grab strength
3. Trapezoidal tear strength
4. Burst strength
5. Puncture strength
6. Thickness

These conformance tests shall be performed in accordance with the test methods specified in the project specifications. Other conformance tests may be required by the project specifications.

3.2.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetic CQA Consultant. Samples shall be taken across the entire width of the roll and shall not include the first complete revolution of fabric on the roll. Samples shall not be taken from any portion of a roll which has been subjected to excess pressure or stretching. Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The Geosynthetic CQA Consultant shall mark the machine direction on the samples with an arrow. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetic CQA Consultant based on a review of all roll information including quality control documentation and manufacturing records.

3.2.2 Test Results

All conformance test results shall be reviewed by the Geosynthetic CQA Consultant prior to the deployment of the geotextile. The Geosynthetic CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the Construction Manager. The Geosynthetic CQA Consultant shall be responsible for checking that all test results meet or exceed the property values listed in the project Specifications. Based upon the recommendations of the Geosynthetic CQA Consultant, the Construction Manager shall accept or reject the geotextile.

If the Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different Solutia approved Geosynthetic QALs at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Construction Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out of specification and rejected. Alternatively, at the option of the Construction Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

3.3 GEOTEXTILE DEPLOYMENT

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

The Geosynthetic CQA Consultant shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Construction Manager.

The Installer shall handle all geotextiles in such a manner as to ensure they are not damaged in any way, and the following shall be complied with:

1. On slopes, the geotextiles shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.
2. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.
3. Geotextiles shall be cut using a geotextile cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.
4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.
5. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.
6. A visual examination of the geotextile shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.

The Geosynthetic CQA Consultant shall note any noncompliance and report it to the Construction Manager.

3.4 SEAMING PROCEDURES

On slopes steeper than 10 (horizontal):1 (vertical), all geotextiles shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped a minimum of 3 inches (75 mm) prior to seaming. In general, no horizontal seam shall be allowed on side slopes (i.e., seams shall be along, not across, the slope), except as part of a patch.

On bottoms and slopes shallower than 10 (horizontal):1 (vertical), geotextiles shall be seamed as indicated above (preferred), or thermally bonded with the written approval of the Construction Manager.

The Installer shall pay particular attention at seams to ensure that no earth cover material could be inadvertently inserted beneath the geotextile.

Any sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Sewing shall be done using machinery and stitch types specified in the project specifications or as approved in writing by the Construction Manager and the Geosynthetic CQA Consultant.

3.5 DEFECTS AND REPAIRS

Any holes or tears in the geotextile shall be repaired as follows:

1. On slopes, a patch made from the same geotextile shall be sewn into place in accordance with the project specifications. Should any tear exceed 10% of the width of the roll, that roll shall be removed from the slope and replaced.

2. Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.

3. The Geosynthetic CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the Construction Manager.

3.6 GEOTEXTILE PROTECTION

All soil materials located on top of a geotextile shall be deployed in such a manner as to ensure:

1. The geotextile and underlying lining materials are not damaged.
2. Minimal slippage of the geotextile on underlying layers occurs.
3. No excess tensile stresses occur in the geotextile.

Any noncompliance shall be noted by the Geosynthetic CQA Consultant and reported to the Construction Manager. If portions of the geotextile are exposed, the Geosynthetic CQA Consultant may periodically place two (or more, at his discretion) marks on the geotextile 10 ft (3 m) apart along the slope and measure the elongation of the geotextile during the placement of soil. This data shall be reported to the Construction Manager.

4.1 QUALITY CONTROL DOCUMENTATION

Prior to the installation of any geonet, the Manufacturer or Installer shall provide the Construction Manager with the following information:

1. The origin (resin supplier's name and resin production plant), identification (brand name and number), and production date of the resin.
2. Copies of the quality control certificates issued by the resin supplier.
3. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geonet meets the Specifications.
4. Reports on quality control tests conducted by the Manufacturer to verify that the geonet manufactured for the project meets the project specifications.
5. A list of the materials which comprise the geonet expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.
6. A specification for the geonet which includes all properties contained in the Specifications measured using the appropriate test methods.
7. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.
8. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures and results of quality control tests. At a minimum, results shall be given for:

   a. Density
   b. Mass per unit area
   c. Thickness
   d. Carbon black content
   e. Transmissivity

   Quality control tests shall be performed in accordance with the frequency and test methods identified in the Specifications.

The Manufacturer shall identify all rolls of geonets with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

The Geosynthetic CQA Consultant shall review these documents and shall report any discrepancies with the above requirements to the Construction Manager. The Geosynthetic CQA Consultant shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum properties meet the Specifications.

4.2 CONFORMANCE TESTING

Upon delivery of the rolls of geonet, the Geosynthetic CQA Consultant shall ensure that conformance test samples are obtained for the geonet. These samples shall then be forwarded to the Geosynthetic QAL for testing to ensure conformance to the Specifications.

At a minimum, the following tests shall be performed:

1. Density
2. Mass per unit area
3. Thickness

These conformance tests shall be performed in accordance with the test methods specified in the Solutia specifications. Other conformance tests required by the project specifications shall be performed.

4.2.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetic CQA Consultant. Samples shall be taken across the entire width of the roll and shall not include the first 3 ft (1 m). Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The Geosynthetic CQA Consultant shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetic CQA Consultant based on a review of all roll information including quality control documentation and manufacturing records.

4.2.2 Test Results

All conformance test results shall be reviewed and by the Geosynthetic CQA Consultant prior to the deployment of the geonet. The Geosynthetic CQA Consultant shall examine all results from

laboratory conformance testing and shall report any nonconformance to the Construction Manager. The Geosynthetic CQA Consultant shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications. Based upon the recommendations of the Geosynthetic CQA Consultant the Construction Manger will accept or reject the geonet.

If the Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the Geosynthetic QAL with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different Solutia approved Geosynthetic QALs at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Construction Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out of specification and rejected. Alternatively, at the option of the Construction Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

4.3 GEONET DEPLOYMENT

The Geosynthetic CQA Consultant shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Construction Manager.

Geonet cleanliness is essential to its performance. Therefore, the geonet rolls should be protected against dust and dirt during shipment and storage.

The Geosynthetic CQA Consultant shall verify that the geonet is free of dirt and dust prior to installation. The Geosynthetic CQA Consultant shall report the outcome of this verification to the Construction Manager, and if the geonet is judged dirty or dusty, it shall be washed by the Installer prior to installation. Washing operations shall be observed by the Geosynthetic CQA Consultant and improper washing operations shall be reported to the Construction Manager.

The Installer shall handle all geonet in such a manner as to ensure that it is not damaged in any way, and the following shall be complied with:

1. On slopes, the geonet shall be secured and rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet shall be positioned by hand after being unrolled to minimize wrinkles.
2. In the presence of wind, all geonet shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.
3. Unless otherwise specified, geonet shall not be welded to geomembrane.
4. Geonet shall only be cut using scissors or other cutting tools approved by the Construction Manager that will not damage the underlying geosynthetics. Care shall be taken not to leave tools in the geonet.
5. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geonet.
6. During placement of geonet, care shall be taken not to entrap in the geonet dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. If dirt or excessive dust is entrapped in the geonet, it should be hosed clean prior to placement of the next material on top of it. In this regard, care shall be taken with the handling of sandbags, to prevent rupture or damage of the sandbag.

The Geosynthetic CQA Consultant shall note any noncompliance and report it to the Construction Manager.

4.4 SEAMS AND OVERLAPS

Adjacent geonet shall be joined according to construction drawings and specifications. At a minimum, the following requirements shall be met:

1. Adjacent rolls shall be overlapped by at least 4 inches (100 mm).
2. Overlaps shall be secured by tying.
3. Tying can be achieved by plastic fasteners or polymer braid. Tying devices shall be white or yellow for easy inspection. Metallic devices are not allowed.
4. Tying shall be every 5 ft (1.5 m) along the slope, every 6 inches (0.15 m) in the anchor trench, and every 6 inches (0.15 m) along end-to-end scams on the base of the landfill.
5. In general, no horizontal seams shall be allowed on side slopes.
6. In the corners of the side slopes of rectangular landfills, where overlaps between perpendicular geonet strips are required, an extra layer of geonet shall be unrolled along the slope, on top of the previously installed geonet, from top to bottom of the slope.
7. When more than one layer of geonet is installed, joints shall be staggered.

The Geosynthetic CQA Consultant shall note any noncompliance and report it to the Construction Manager.

When several layers of geonet are stacked, care shall be taken to prevent strands of one layer from penetrating the channels of the next layer, thereby significantly reducing the transmissivity. This cannot happen if stacked geonet are placed in the same direction.

4.5 DEFECTS AND REPAIRS

Any holes or tears in the geonet shall be repaired by placing a patch extending 1 ft (0.3 m) beyond the edges of the hole or tear. The patch shall be secured to the original geonet by tying every 6 inches (0.15 m). Tying devices shall be as indicated in the Specifications. If the hole or tear width across the roll is more than 50% of the width of the roll, the damaged area shall be repaired as follows:

1. On the base of the landfill, the damaged area shall be cut out and the two portions of the geonet shall be joined as indicated in the Specifications.
2. On sideslopes, the damaged geonet shall be removed and replaced.

The Geosynthetic CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the Construction Manager.

4.6 GEONET PROTECTION

Soil should never be placed in direct contact with geonet. Soil materials near the geonet shall be placed in such a manner as to ensure:

1. The geonet and underlying lining materials are not damaged.
2. Minimal slippage of the geonet on underlying layers occurs.
3. No excess tensile stresses occur in the geonet.

Any noncompliance shall be noted by the Geosynthetic CQA Consultant and reported to the Construction Manager.

5.1 QUALITY CONTROL DOCUMENTATION

Prior to the installation of any geogrid, the Manufacturer or Installer shall provide the Construction Manager with the following information:

1. The origin (resin supplier's name and resin production plant), identification (brand name and number), and production date of the resin.
2. Copies of the quality control certificates issued by the resin supplier.
3. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geogrid meets the Specifications.
4. Reports on quality control tests conducted by the Manufacturer to verify that the geogrid manufactured for the project meets the project specifications.
5. A list of the materials which comprise the geogrid, expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.
6. A specification for the geogrid which includes all properties contained in the project specifications measured using the appropriate test methods.
7. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.
8. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificate shall include roll identification numbers, sampling procedures, and results of quality control tests. At a minimum, results shall be given for:

    a. Mass per unit area
    b. Measurement of spacing between strands
    c. Wide strip tensile strength
    d. Node strength

Quality control tests shall be performed in accordance with the frequency and test methods specified in the Specifications.

The Manufacturer shall identify all rolls of geogrids with the following:

a. Manufacturer's name
b. Product identification
c. Roll number
d. Roll dimensions

The Geosynthetic CQA Consultant shall review these documents and shall report any discrepancies with the above requirements to the Construction Manager. The Geosynthetic CQA Consultant shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.
2. Measurement of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum properties meet the Specifications.

5.2 CONFORMANCE TESTING

Upon delivery of the rolls of geogrid, the Geosynthetic CQA Consultant shall ensure that conformance test samples are obtained for the geogrid. These samples shall then be forwarded to the Geosynthetic QAL for testing to ensure conformance to the project specifications.

At a minimum, the following conformance tests shall be performed on geogrid:

1. Mass per unit area
2. Measurement of spacing between strands
3. Wide strip tensile strength
4. Node strength

These conformance tests shall be performed in accordance with the test methods specified in the project specifications. Other conformance tests may be required by the project specifications.

5.2.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetic CQA Consultant. Samples shall be taken across the entire width of the roll and shall not include the first 3 ft (1 m). Unless otherwise specified, samples shall be 3 ft (1 m) long by the roll width. The Geosynthetic CQA Consultant shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetic CQA Consultant based on a review of all roll information including quality control documentation and manufacturing records.

5.2.2 Test Results

All conformance test results must be reviewed and accepted or rejected by the Geosynthetic CQA Consultant prior to the deployment of the geogrid.

The Geosynthetic CQA Consultant shall examine all results from laboratory conformance testing and shall report any nonconformance to the Construction Manager. The Geosynthetic CQA Consultant shall be responsible for checking that all test results meet or exceed the minimum property values listed in project specifications.

If the Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the Geosynthetic QAL with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different Solutia approved Geosynthetic QALs at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL's test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Construction Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test shall be considered out of specification and rejected. Alternatively, at the option of the Construction Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

5.3 GEOGRID DEPLOYMENT

The Installer shall handle all geogrid in such a manner as to ensure it is not damaged in any way, and the following shall be complied with:

1. On slopes, the geogrid shall be secured and rolled down the slope in such a manner as to continually keep the geogrid in tension.
2. In the presence of wind, all geogrids shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.

3. Geogrid shall be cut using scissors only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geogrid.
4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geogrid.

The Geosynthetic CQA Consultant shall note any noncompliance and report it to the Construction Manager.

5.4 SEAMS AND OVERLAPS

The geogrid, where used, shall be placed in continuous pieces downslope. No lateral joining is required. Edge to edge placement shall be sufficient.

Where geogrid is joined end to end, a splice approved by the manufacturer shall be used. The splice shall not have any metallic components.

5.5 REPAIRS

Any damaged roll of geogrid shall be discarded. No repairs shall be allowed.

5.6 SOIL MATERIALS PLACEMENT

All soil materials located on top of a geogrid shall be deployed in such a manner as to ensure:

1. The geogrid and underlying materials are not damaged.
2. Minimal slippage of the geogrid on underlying layers occurs.

Any noncompliance shall be noted by the Geosynthetic CQA Consultant and reported to the Construction Manager.

SECTION SIX LINING SYSTEM ACCEPTANCE

Upon written recommendation by the Geosynthetic CQA Consultant, the Construction Manager shall consider accepting the geosynthetic lining system. The conditions of acceptance are described below. The Installer and Manufacturer(s) will retain all ownership and responsibility for the geosynthetics in the lining and final cover system until acceptance by Solutia. At Solutia's discretion, the geosynthetic-lining system may be accepted in sections at points of substantial completion or upon completion of all work.

The geosynthetic lining system will be accepted by Solutia when:

1. The installation of the lining and cover system or section thereof, is finished.
2. Verification of the adequacy of all seams and repairs, including associated testing, is completed.
3. All documentation of installation is completed.
4. The Geosynthetic CQA Consultant is able to recommend acceptance.

The Geosynthetic CQA Consultant shall certify that installation has proceeded in accordance with the requirement of the Plans and Specifications except as noted to the Construction Manager. This certification shall be provided in the final certification report.

An effective CQA Manual depends largely on identification of all construction activities that shall be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The Geosynthetic CQA Consultant shall document that all requirements in the geosynthetic portions of the project have been addressed and satisfied.

The Geosynthetic CQA Consultant shall provide the Construction Manager with signed descriptive remarks, data sheets, and checklists to verify that all monitoring activities have been carried out. The Geosynthetic CQA Consultant shall also maintain at the job site a complete file of all documents which comprise the CQA Manual, including Plans and Specifications, checklists, test procedures, daily logs, and other pertinent documents.

7.1 DAILY REPORTS

Each on-site representative of the Geosynthetic CQA Consultant shall complete a daily report and/or logs on prescribed forms, outlining all monitoring activities for that day. The precise areas, panel numbers, seams completed and approved, and measures taken to protect unfinished areas overnight shall be identified. Failed seams or other panel areas requiring remedial action shall be identified with regard to nature of action, required repair, and precise location. Repairs completed must also be identified. Any problems or concerns with regard to operations on site should also be noted. Any matters requiring action by the Construction Manager shall be identified. The report shall include a summary of the quantities of all geosynthetics installed that day.

This report must be completed daily, and submitted to the Construction Manager at the beginning of the work day following the report date.

7.2 DESTRUCTIVE TESTING REPORTS

The destructive test reports from all sources shall be collated by the Geosynthetic CQA Consultant. This includes field tests, Installers laboratory tests (if performed), and Geosynthetic QAL tests. A summary list of test sample pass/fail results shall be prepared by the Geosynthetic CQA Consultant on an ongoing basis, and submitted with the weekly progress reports.

7.3 PROGRESS REPORTS

Progress reports shall be prepared by the Geosynthetic CQA Consultant and submitted to the Construction Manager. These reports shall be submitted every week, starting the first Friday of geosynthetics deployment on site. This report shall include: an overview of progress to date; an outline of any changes made to the Plans or Specifications, any problems or deficiencies in installation at the site, and an outline of any action taken to remedy the situation(s); a summary of weather conditions; and a brief description of activities anticipated for the next reporting period.

All geosynthetics CQA Consultant daily reports for the period should be appended to each progress report.

7.4 AS-BUILT DRAWINGS

As-built drawings shall be prepared by the Geosynthetic CQA Consultant. The as-built drawings shall include, at a minimum, the following information for geomembranes:

1. Dimensions of all geomembrane field panels.
2. Location, as accurate as possible, of each panel relative to the site survey grid (furnished by the Construction Manager).
3. Identification of all seams and panels with appropriate numbers or identification codes (see Section 4.5.1).
4. Location of all patches and repairs.
5. Location of all destructive testing samples.

Information collected during installation of the geosynthetic materials shall be compiled in the field while construction is in progress. Upon completion of a layer or component of the landfill (e.g. primary geomembrane liner) a draft copy of the compiled as built drawing and construction data shall be submitted to the Construction Manager.

The as-built drawings shall illustrate each layer of geomembrane, and, if necessary, another drawing shall identify problems or unusual conditions of the geotextile or geonet layers. In addition, applicable cross-sections shall show layouts of geonets, geotextiles or geogrids in sump areas or any other areas which are unusual or differ from the design Plans.

7.5 FINAL CERTIFICATION REPORT

A final certification report shall be submitted upon completion of the work. This report shall summarize the activities of the project, and document all aspects of the quality assurance program performed.

The final certification report shall include, at a minimum, the following information:

1. Parties and personnel involved with the project
2. Scope of work
3. Outline of project
4. Quality assurance methods
5. Test results (conformance, destructive and non-destructive, including laboratory tests)
6. Certification, sealed and signed by a registered Professional Engineer
7. As-built drawings, sealed and signed by a registered professional engineer

The Geosynthetic CQA Consultant shall certify in the report that the installation has proceeded in accordance with the project Plans and Specifications except as noted to the Construction Manager. A recommended outline for the final certification report is given in Exhibit 2-1. At

the direction of the Construction Manager this final certification report may be combined with the certification report for the soil components of the lining and final cover system.

APPENDIX A

EXAMPLES OF GEOSYNTHETIC QUALITY ASSURANCE DOCUMENTATION

PANEL PLACEMENT FORM

PROJECT:	QUALITY ASSURANCE MONITOR:	MATERIAL DESCRIPTION:

DATE/ TIME	PANEL NUMBER	ROLL NUMBER	PANEL LENGTH	PANEL WIDTH	PANEL LOCATION	PANEL CONDITION- VISUAL INSPECTION	COMMENTS

TRIAL WELD INFORMATION

PROJECT:	QUALITY ASSURANCE MONITOR:	MATERIAL DESCRIPTION:

					EXTRUSION WELDS		FUSION WELDS					
Date/ Time	Weather/ Winds	Ambient Temp.	Seamer Initials	Machine Number	Barrel Temp. Set/PYRO	Preheat Temp. Set/PYRO	Wedge Temp. Set/PYRO	Measured Speed (ft/min)	Wheel Tension Setting	Peel Values (lbs/inch)	Pass/Fail	Comments

PANEL SEAMING CHECKLIST

PROJECT:	QUALITY ASSURANCE MONITOR:	MATERIAL DESCRIPTION:

DATE/ TIME	WEATHER/ WINDS	AMBIENT TEMP.	SEAMER INITIALS	MACHINE NUMBER	SEAM TYPE	SEAM NUMBER	PANEL NUMBERS	SEAM LENGTH	TEMP. SETTING	MACHINE SPEED	COMMENTS

NON-DESTRUCTIVE SEAM TEST LOG

PROJECT:	QUALITY ASSURANCE MONITOR:	MATERIAL DESCRIPTION:

DATE/ TIME	SEAM NUMBER	TESTER INITIALS	AIR TESTING					PASS/ FAIL	VACCUM BOX PASS/FAIL	COMMENTS
			PRESSURE (PSI)			TIME				
			START	END	DROP	START	END			

DESTRUCTIVE SEAM TEST LOG

PROJECT:	QUALITY ASSURANCE MONITOR:	MATERIAL DESCRIPTION:

DATE/ TIME	SAMPLE I.D.	SEAM NUMBER	TENS NUMBER	OPERATOR INTIALS	FIELD TENSIOMETER PEEL VALUES (LBS/INCH)			PASS/ FAIL	DATE TO LAB PKG. SLIP NO.	LAB PASS/ FAIL	COMMENTS

CERTIFICATE OF COMPLETION

TYPE: PARTIAL ____ SUBSTANTIAL ____ FINAL____

PROJECT NAME: _____
SITE NAME: _____
DATE: _____

DESCRIPTION OF WORK CERTIFIED:

_____

_____

I HEREBY CERTIFY THAT THE ABOVE IDENTIFIED WORK HAS BEEN INSPECTED AND THAT IT HAS BEEN PROPERLY INSTALLED. I FURTHER CERTIFY THAT ALL REQUIRED TESTING HAS BEEN COMPLETED AND THE RESULTS HAVE BEEN DEEMED ACCEPTABLE BY THE GEOSYNTHETIC QAE. THE WORK IS SUITABLE FOR ITS INTENDED USE.

GEOSYNTHETIC QAE

SIGNATURE: _____ DATE: _____

NAME (PRINT): _____

TITLE: _____

REPRESENTING: _____

INSTALLER'S REPRESENTATIVE

SIGNATURE: _____ DATE: _____

NAME (PRINT): _____

TITLE: _____

REPRESENTING: _____

SOLUTIA REPRESENTATIVE

SIGNATURE: _____ DATE: _____

NAME (PRINT): _____

TITLE: _____

REPRESENTING: _____

CERTIFICATE OF COMPLETION

OF SOIL SUBGRADE SURFACE

DATE: _____

PROJECT NAME: _____

SITE NAME: _____

LOCATION OF SUBGRADE SURFACE TO BE LINED: _____

_____

_____

I HEREBY CERTIFY THAT THE ABOVE AREA IS SUITABLE FOR THE INSTALLATION OF GEOSYNTHETICS, AND THAT I SHALL BE RESPONSIBLE FOR ITS INTEGRITY AND SUITABILITY IN ACCORDANCE WITH THE SPECIFICATIONS FROM THIS DATE TO COMPLETION OF THE INSTALLATION.

INSTALLER'S REPRESENTATIVE

NAME (PRINT): _____ DATE: _____

TITLE: _____

REPRESENTING: _____

SIGNATURE: _____

ACKNOWLEDGED BY:

GEOSYNTHETIC QUALITY ASSURANCE CONSULTANT

NAME (PRINT): _____ DATE: _____

TITLE: _____

REPRESENTING: _____

SIGNATURE: _____

EXHIBITS

EXHIBIT 1-1

RESOLUTION MEETING AGENDA
SOLUTIA INC.

1. Introductions

   A. Assign Minute Taker

   B. Identify Parties

      1. Construction Manager
      2. Designer
      3. Geosynthetic Quality Assurance Consultant
      4. Solutia representative
      5. Others

2. Distribution of Documents

   A. Design and Construction Drawings
   B. Specifications
   C. Construction Quality Assurance (CQA) Manuals
   D. Permit Documents

3. Review Construction Plans and Specifications

4. Review Geosynthetic CQA Manual

5. Tour Project Site

6. Contract Administration and Construction Issues

7. Define Lines of Communication

8. Project Deliverables

9. Schedule

EXHIBIT 1-2

PRE-CONSTRUCTION MEETING AGENDA
SOLUTIA INC.

1. Introductions
   - A. Assign Minute Taker
   - B. Identify Parties
     1. Construction Manager
     2. Construction Contractor
     3. Geosynthetic Construction Quality Assurance Consultant
     4. Installer
     5. Designer
     6. Solutia Representative
2. Distribution of Documents
   - A. Construction Plans and Specifications
   - B. Geosynthetic Panel Layout
   - C. Geosynthetic Construction Quality Assurance Manual
3. Lines of Communication
   - A. Reporting Methods
   - B. Progress Meetings
   - C. Procedures for Approving Design Clarifications and Changes During Construction
4. Tour Project Site
5. Site Requirements
   - A. Safety Rules
   - B. Site Rules
   - C. Work Schedule
   - D. Storage of Materials
   - E. Available Facilities

EXHIBIT 1-2

PRE-CONSTRUCTION MEETING AGENDA
SOLUTIA INC.
(Continued)

6. Construction Issues
   A. Scope of Work
   B. Review Plans and Specifications
      1. Design and Construction Requirements
      2. Geosynthetic Panel Layout
   C. Review Construction Procedures
      1. Proposed Construction Sequencing
      2. Equipment
   D. Review Construction Schedule
   E. Review Procedures for Preparing and Approving Change Orders
7. Discuss Construction Quality Assurance Plan
   A. Soils
   B. Geosynthetics
   C. Structural Systems (e.g., risers, piping, etc.)
8. Project Deliverables
   A. Responsibilities
      1. Construction Manager
      2. Designer
      3. Installer
      4. Geosynthetic Construction Quality Assurance Consultant
   B. Distribution of Deliverables
   C. Approval Procedures

EXHIBIT 2-1

FINAL CONSTRUCTION QUALITY ASSURANCE CERTIFICATION REPORT
GENERAL OUTLINE
SOLUTIA INC.

1. Introduction
   - Purpose
   - Scope
   - Unit Description
2. Project Specifications
   - Scope
   - Design Changes
3. Quality Assurance Plan
   - Scope
   - Project-Specific Addenda
4. Quality Assurance Work Performed
   - Weather Constraints
   - Conformance Testing
   - Visual Monitoring
   - Nondestructive Testing
   - Destructive Testing
   - Repairs
5. Summary and Conclusions
6. Project Certification
7. Appendices
   - Geosynthetic and/or Soils QAC Personnel
   - Contractor Personnel
   - Quality Assurance Plan (QAP) and Specification Modifications
   - Design Change Forms
   - Earthwork Testing Records (if required)

EXHIBIT 2-1

FINAL CONSTRUCTION QUALITY ASSURANCE CERTIFICATION REPORT
GENERAL OUTLINE
SOLUTIA INC.
(Continued)

- Conformance Testing Records
- Manufacturer Quality Control Records
- Quality Assurance Reports
- Subgrade Acceptance Certificates Panel Placement Records
- Destructive Seam Testing Records Destructive Seam Testing Records Repairs
- As-Built Drawings

Appendix G

CONSTRUCTION QUALITY ASSURANCE MANUAL FOR INSTALLATION OF SOIL COMPONENTS OF THE LINING AND FINAL COVER SYSTEMS FOR THE SAUGET AREA 1 LANDFILL

Prepared for:

Solutia Inc.
575 Maryville Centre Drive
St. Louis, MO 63141

Prepared by:

URS Greiner Woodward Clyde

7650 West Courtney Campbell Causeway
Tampa, Florida 33607-1462
C100003899.00

June 30, 2000

Revision 0

TABLES OF CONTENTS

1.0 INTRODUCTION 1-1

2.0 DEFINITION OF OPERATIONS AND RESPONSIBILITIES 2-1

2.1 DEFINITIONS 2-1

2.2 PROJECT ORGANIZATION 2-1
- 2.2.1 Solutia Leadership Team 2-1
- 2.2.2 Construction Manager 2-2
- 2.2.3 Designer 2-2
- 2.2.4 Construction Quality Assurance Consultant 2-2
- 2.2.5 Construction Quality Assurance Laboratory 2-2
- 2.2.6 Earthwork Contractor(s) 2-2

2.3 PROJECT TEAM RESPONSIBILITIES AND QUALIFICATIONS 2-3
- 2.3.1 Construction Manager 2-3
  - 2.3.1.1 Responsibilities 2-3
  - 2.3.1.2 Qualifications 2-3
- 2.3.2 Designer 2-4
  - 2.3.2.1 Responsibilities 2-4
  - 2.3.2.2 Qualifications 2-4
  - 2.3.2.3 Submittals 2-4
- 2.3.3 Earthwork Contractor 2-4
  - 2.3.3.1 Responsibilities 2-4
  - 2.3.3.2 Qualifications 2-4
- 2.3.4 Construction Quality Assurance Consultant 2-5
  - 2.3.4.1 Responsibilities 2-5
  - 2.3.4.2 Qualifications 2-5
- 2.3.5 Construction Quality Assurance Laboratory 2-6
  - 2.3.5.1 Responsibilities 2-6
  - 2.3.5.2 Qualifications 2-6

3.0 MEETINGS 3-1

3.1 PRE-CONSTRUCTION MEETING 3-1

3.2 PROGRESS MEETINGS 3-1

3.3 PROBLEM OR WORK DEFICIENCY MEETING 3-2

4.0 EARTH MATERIALS QUALITY ASSURANCE 4-1

4.1 GENERAL 4-1

4.2 MATERIAL EVALUATION 4-1
- 4.2.1 General 4-1
- 4.2.2 Laboratory Soils Tests 4-1
- 4.2.3 Soils Selection Criteria 4-2
  - 4.2.3.1 Compacted Fill 4-2
  - 4.2.3.2 Tracked-in Place Fill 4-3
  - 4.2.3.3 Drainage Material 4-3

4.2.3.4 Protective Fill 4-4
4.2.3.5 Vegetated Cover Fill 4-4
4.2.4 Earth Fill Material Management 4-5

4.3 CONSTRUCTION QUALITY EVALUATION 4-5
4.3.1 Subgrade Evaluation 4-5
4.3.2 Fill Placement 4-6
4.3.3 Evaluation of Low Permeability Fill 4-6
4.3.4 Evaluation of Layer Bonding 4-7
4.3.5 Construction Quality Control Testing 4-7
4.3.6 Perforations 4-8

4.4 DEFICIENCIES 4-9
4.4.1 Examination of the Deficiency 4-9
4.4.2 Notification 4-9
4.4.3 Repairs and Retesting 4-9

4.5 ACCEPTANCE 4-9

5.0 DOCUMENTATION 5-1

5.1 DAILY RECORDKEEPING 5-1
5.1.1 Memorandum of Discussion With Earthwork Contractor or Subcontractors 5-1
5.1.2 Observation and Testing Data Sheets 5-1

5.2 CONSTRUCTION PROBLEM AND RESOLUTION DATA SHEETS 5-2

5.3 PHOTOGRAPHIC REPORTING DATA SHEETS 5-3

5.4 DESIGN AND/OR SPECIFICATIONS CHANGES 5-3

5.5 PROGRESS REPORTS 5-3

5.6 CERTIFICATION AND SUMMARY REPORT 5-3

5.7 STORAGE OF RECORDS 5-4

Tables

Table 1	Pre-Construction Testing Frequency for Materials Evaluation of Soil Components of Lining and Final Cover Systems
Table 2	Construction Testing Frequency for Materials Evaluation of Soil Components of Lining and Final Cover Systems
Table 3	Testing Frequency for Construction Quality Evaluation of Soil Components of Lining and Final Cover Systems

Appendices

Appendix A	Construction Quality Assurance Checklist

SECTION ONE TABLE OF CONTENTS

1.0 INTRODUCTION..... 1-1

This manual describes Construction Quality Assurance (CQA) procedures for the installation of the soil components of lining and final cover systems during construction of the Sauget Area 1 TSCA Landfill located in Cahokia, Illinois. This manual addresses only the soil components of the liner and cover systems. CQA guidelines for geosynthetic materials are covered in Solutia's Construction Quality Assurance Manual for Installation of Geosynthetic Components.

All parties listed in Section 2.1, as they become involved in this project, will be issued a copy of this Construction Quality Assurance Manual (CQA Manual) from the Owner or Construction Manager. They will also be given other quality assurance documents specifically prepared for the project, as appropriate.

This manual is to be the basis of the overall CQA program for soil components of lining and final cover systems. Site-specific addenda will be prepared as appropriate by the Construction Manager or his designee.

The overall goals of this CQA program are to ensure that proper construction techniques and procedures are used and to verify that the materials and installation techniques used meet project specifications. The main emphasis of the CQA Manual is careful documentation during the entire quality assurance process, from the selection of materials through the installation of final cover. In addition, the program will 1) identify and define problems that may occur during construction, and 2) ensure that these problems are corrected before the construction is complete. At completion of the work, the program will culminate in a certification report which documents that the earthwork has been constructed in accordance with the project plans and specifications. This certification is the responsibility of the Construction Quality Assurance Consultant (CQA Consultant).

2.0 DEFINITION OF OPERATIONS AND RESPONSIBILITIES 2-1

2.1 DEFINITIONS 2-1

2.2 PROJECT ORGANIZATION 2-1
2.2.1 Solutia Leadership Team 2-1
2.2.2 Construction Manager 2-2
2.2.3 Designer 2-2
2.2.4 Construction Quality Assurance Consultant 2-2
2.2.5 Construction Quality Assurance Laboratory 2-2
2.2.6 Earthwork Contractor(s) 2-2

2.3 PROJECT TEAM RESPONSIBILITIES AND QUALIFICATIONS 2-3
2.3.1 Construction Manager 2-3
2.3.1.1 Responsibilities 2-3
2.3.1.2 Qualifications 2-3
2.3.2 Designer 2-4
2.3.2.1 Responsibilities 2-4
2.3.2.2 Qualifications 2-4
2.3.2.3 Submittals 2-4
2.3.3 Earthwork Contractor 2-4
2.3.3.1 Responsibilities 2-4
2.3.3.2 Qualifications 2-4
2.3.4 Construction Quality Assurance Consultant 2-5
2.3.4.1 Responsibilities 2-5
2.3.4.2 Qualifications 2-5
2.3.5 Construction Quality Assurance Laboratory 2-6
2.3.5.1 Responsibilities 2-6
2.3.5.2 Qualifications 2-6

SECTION TWO DEFINITION OF OPERATIONS AND RESPONSIBILITIES

2.1 DEFINITIONS

This manual has been developed for the application of construction quality assurance and quality control procedures to the soil components of liner and final cover systems. CQA and quality control are defined as follows:

Construction Quality Assurance (CQA) - a planned and systematic application of all means and actions designed to provide adequate confidence that items or services meet design and specifications requirements and will perform satisfactorily in service. In the context of this project, CQA refers to means and actions employed by the Construction Manager and the CQA Consultant to ensure conformity of the soil components of the lining and final cover systems in accordance with the requirements of the Plans, Specifications and the guidelines set forth in this CQA Manual.

Quality Control - those actions which provide a means to measure and regulate the characteristics of an item or service to design and specifications requirements. In the context of this project, quality control refers to those actions taken by the Earthwork Contractor to ensure that the product and the workmanship meet the requirements of the Plans and Specifications.

Project Plans and Specifications - includes all Specifications and engineering drawings developed for this project and any modifications thereto.

Site Specific Addenda - those documents and/or modifications to the CQA manual(s) that are developed to address specific design requirements for a given project.

2.2 PROJECT ORGANIZATION

Solutia has the overall responsibility for ensuring that all construction activities fulfill the objectives of the project. Solutia will retain an independent construction manager to coordinate all activities for construction of the TSCA Landfill. Solutia will also retain an independent firm to provide CQA services for this project.

Key personnel and their authority and responsibilities with respect to the quality assurance functions for this project are as follows:

2.2.1 Solutia Leadership Team

The Solutia Leadership Team will represent Solutia (the Owner) and has overall responsibility for the conduct of project activities. The team will ensure that corporate standards are applied during the project and will have the overall responsibility to ensure the project meets all established QA/QC goals. The Leadership Team will provide the lead for contact with all regulatory agencies. They are also the primary point of contact between Solutia and all supporting team members. The team is responsible for coordination of project activities between the Designer and the Construction Manager. The Solutia Leadership Team will perform its duties under the direction of Bruce Yare and Mike Light.

2.2.2 Construction Manager

Acting under the authority delegated to him by Solutia, the Construction Manager is the on-site representative and will implement the overall project plans through day-to-day direction of field activities. A construction management firm will be selected to perform these services.

2.2.3 Designer

The Designer is the individual and/or firm responsible for the preparation of the design, including Plans and project-specific Specifications for the soil components of the lining and final cover systems. The Designer for the TSCA Landfill is URS Greiner Woodward Clyde.

2.2.4 Construction Quality Assurance Consultant

The CQA Consultant is a firm independent from the Construction Manager and Earthwork Contractor that shall be responsible for observing and documenting activities related to the quality assurance of the production and installation of the soil lining components on behalf of Solutia.

2.2.5 Construction Quality Assurance Laboratory

The Construction Quality Assurance Laboratory (CQA Laboratory) is a firm, independent from the Construction Manager and Earthwork Contractor, responsible for conducting tests on samples of soil components taken from the site. A laboratory will be selected to perform geotechnical and soil testing for the project.

2.2.6 Earthwork Contractor(s)

Selected Contractors will be responsible for performing the work outlined in the Construction Plans and Specifications. This work shall include:

- Site mobilization and demobilization
- Site Preparation
- Construction of the soil components of the TSCA Landfill Liner System
- Construction of the soil components of the TSCA Landfill Final Cover System

2.3 PROJECT TEAM RESPONSIBILITIES AND QUALIFICATIONS

The parties discussed in this section are associated with the ownership, design, construction, installation, and quality assurance of the soil components of the lining and final cover systems. The qualifications and responsibilities of these parties are outlined in the following subsections.

2.3.1 Construction Manager

2.3.1.1 Responsibilities

The Construction Manager is responsible for all construction quality. The Construction Manager is responsible for the organization and implementation of the quality assurance activities for the project. The Construction Manager shall serve as communications coordinator for the project, initiating all construction meetings. As communications coordinator, the Construction Manager shall serve as a liaison between all parties involved in the project to insure that communications are maintained.

The principal responsibilities of the Construction Manager are:

- Establish effective communications with the Solutia Leadership Team, Contractor field representatives, and other project team personnel through correspondence, meetings, and discussions, as required, to maintain close working relationships.
- Execute the project work plans and implement procedures through overall planning and day-to-day direction of field activities.
- Ensure that QA/QC procedures are implemented throughout execution of the work.
- Review Contractor progress reports and payments.
- Issue weekly field activity reports.
- Maintain on-site documentation consisting of procedures, rules and regulations, drawings, survey information, correspondence, meetings, etc.
- Manage and assist other field personnel in overseeing Contractors.

The Construction Manger shall also be responsible for proper resolution of all quality assurance issues that arise during construction.

2.3.1.2 Qualifications

The selection of the Construction Manager is the direct responsibility of Solutia. Qualifications for this position include but are not limited to familiarity with the following:

1. Applicable construction methods and procedures.
2. General soil components of the lining and final cover system.
3. All applicable regulatory requirements.

4. Company policies and procedures for project management.
5. Quality assurance requirements.

2.3.2 Designer

2.3.2.1 Responsibilities

The Designer is responsible for performing the engineering design and preparing the associated Plans and Specifications for the soil components of the lining and final cover systems. The Designer is responsible for approving all design and specification changes and making design clarifications necessitated during construction of the soil components of the lining and final cover systems.

2.3.2.2 Qualifications

The Designer shall be a qualified engineer, certified or licensed as required by regulation. The Designer shall be familiar with soil and earth materials, geotechnical design procedures and applicable regulatory requirements.

2.3.2.3 Submittals

The Designer shall submit the project design Plans and Specifications to the Solutia Leadership Team and Construction Manager.

2.3.3 Earthwork Contractor

2.3.3.1 Responsibilities

The Earthwork Contractor is responsible for execution of the requirements of the Plans and Specifications for construction of the lining and final cover systems for the TSCA Landfill.

2.3.3.2 Qualifications

The Earthwork Contractor shall provide the following information to the Construction Manager:

- A demonstration of bonding capability and a list of outstanding contracts.
- A list of comparable projects for which the following information shall be provided for each project:
  - Name of the facility, its location, and date of installation.
  - Name of project manager or contact person for the installation.
  - Description and purpose of installation and definition of contractor's scope of work.

- A list of readily available equipment required to perform the work, at a minimum generally consisting of scrapers, graders, scarifiers, compactors, disking equipment, water trucks, and admixing equipment as appropriate.

2.3.4 Construction Quality Assurance Consultant

2.3.4.1 Responsibilities

The CQA Consultant is responsible for observing and documenting activities related to the quality assurance of the production and installation of the soil components of the lining system. The CQA Consultant is responsible for implementation of the project Quality Assurance Manual and management of the CQA Laboratory. The CQA Consultant is also responsible for issuing a final certification report sealed by a registered professional engineer.

The specific duties of the CQA Consultant are as follows:

a. Review all design drawings and specifications.

b. Review other site-specific documentation, including proposed layouts, and manufacturer's and installer's literature.

c. Review all changes to design drawings and specifications as issued by the Designer.

d. Attends all quality assurance related meetings, e.g., pre-construction, daily, weekly.

e. Manages the preparation of the as-built drawing(s).

f. Reports to the Construction Manager, and logs in the daily report, any relevant observations.

g. Prepares the weekly summary of soil quality assurance activities.

h. Oversees the marking, packaging and shipping of all laboratory test samples.

i. Reviews the results of laboratory testing and makes appropriate recommendations.

j. Reports any unapproved deviations from the Plans and Specifications to the Construction Manager.

k. Prepares the final certification report.

2.3.4.2 Qualifications

The CQA Consultant shall be experienced in quality assurance of soil components of the lining and final cover system. The CQA Consultant shall be experienced in the preparation of quality assurance documentation including: quality assurance forms, reports, certifications, and manuals.

2.3.5 Construction Quality Assurance Laboratory

2.3.5.1 Responsibilities

The CQA Laboratory shall be responsible for conducting the appropriate laboratory tests as directed by the Construction Manager or his designee. The test procedures shall be done in accordance with the test methods outlined in this CQA Manual and/or the project specifications. The CQA Laboratory shall be responsible for providing test results. The selected laboratory will also have responsibility for all bench level QA/QC, data reduction, reporting, and performance monitoring.

2.3.5.2 Qualifications

The CQA Laboratory shall have experience in testing soils in accordance with American Society for Testing and Materials (ASTM) or other applicable test standards.

3.0 MEETINGS 3-1

3.1 PRE-CONSTRUCTION MEETING 3-1

3.2 PROGRESS MEETINGS 3-1

3.3 PROBLEM OR WORK DEFICIENCY MEETING 3-2

3.1 PRE-CONSTRUCTION MEETING

A pre-construction meeting shall be held at the site. At a minimum, the meeting shall be attended by the Earthwork Contractor, the Designer, the CQA Consultant, the Solutia Leadership Team and the Construction Manager. The purpose of the pre-construction meeting is to:

- Provide all parties with any relevant documents.
- Review the Plans and Specifications provided by the Designer.
- Review the responsibilities of each party.
- Review lines of authority and communication.
- Review procedures for documentation and reporting of information.
- Discuss any appropriate modification of the CQA Plan (i.e., ensure that site-specific considerations are added, and review any special permit conditions or state/federal requirements that may need to be included).
- Review distribution and storage of documents and reports.
- Review of the Earthwork Contractor's quality control procedures.
- Establish protocol for testing.
- Establish protocol for handling construction deficiencies, and repairs and retesting.
- Conduct a site walk-around to discuss work plans and inspect material handling, borrow, and stockpiling locations, as well as areas that may be required for temporary storage or use.
- Review a time schedule for all operations.
- Review work area security and safety protocol.
- Discuss and establish procedures for material processing (moisture condition, soil blending, etc.).
- Discuss and establish procedures for care and control of water, protection from wind, drying, dust control, and general liner protection and housekeeping.
- Review health and safety requirements applicable to all parties.
- Develop site-specific addenda to the CQA Manual for the proposed project.

The meeting shall be documented by the Construction Manager or a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties prior to the start of construction.

3.2 PROGRESS MEETINGS

A progress meeting shall be held at least weekly at the work area. Progress meetings shall be conducted at other times during the project as appropriate or necessary as determined by the

Construction Manager. At a minimum, the meeting shall be attended by the Earthwork Contractor, the CQA Consultant and the Construction Manager. The purpose of the meeting is to:

- Review the previous week's activities and accomplishments.
- Review the work activity and location for the week.
- Discuss the earthwork contractor's personnel and equipment assignments.
- Review the work schedule.
- Discuss possible problems.
- Review any new test data.

The meeting shall be documented by the Construction Manager.

3.3 PROBLEM OR WORK DEFICIENCY MEETING

A special meeting shall be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting shall be attended by the Earthwork Contractor, the Construction Manager, and the CQA Consultant. If the problem requires a design modification, the Designer should also be present. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- Define and discuss the problem or deficiency.
- Review alternative solutions.
- Implement an action plan to resolve the problem or deficiency.

The meeting shall be documented by the Construction Manager.

4.1 GENERAL

Construction of the soil components for the lining and final cover system as well as other specified earthwork must be in strict accordance with the project Plans and Specifications. Compliance is confirmed by checking that: 1) the earthen backfill materials will exhibit the required characteristics, and 2) the placement techniques used by the Earthwork Contractor will be adequate,

CQA related activities for construction of the soil components of the lining and final cover system will include observation, independent testing and documentation of the following:

- Pre-construction Testing
- Construction Testing
- Post-construction Testing

Independent evaluation and/or CQA testing within these categories shall consist of the following as appropriate:

- Material Evaluation
- Construction Quality Evaluation
- Hydraulic Conductivity Evaluation

4.2 MATERIAL EVALUATION

4.2.1 General

The types of soils used in lining systems include compacted fill, tracked-in-place fill, drainage material, protective fill and vegetative cover soil. Prior to construction, sources for each of these materials shall be identified, and samples of each material from each source shall be tested to determine whether they meet project specifications.

This manual focuses on material tests conducted during the construction phase. These tests must be performed to confirm that the procured material meets project specifications before it is accepted for construction. Further material testing is necessary if alternative borrow material is required during construction or if soils are processed on site (i.e., when drainage materials are washed to increase their permeability). All material evaluation tests are to be performed by the CQA Laboratory or in a geotechnical laboratory approved for use by the Construction Manager.

4.2.2 Laboratory Soils Tests

Tests to confirm the adequacy of procured materials shall be performed as part of the Earthwork Contractors QC activities on each material from each source area. All tests shall be documented, and the material shall be accepted or rejected according to the results of these tests. Testing of samples shall be performed in accordance with the requirements of the Plans and Specifications.

The CQA Consultant shall confirm the minimum number if required tests were performed and that the test results appear valid. If the results appear questionable he shall direct the Earthwork Contractor to perform additional testing. Independent testing will be performed as deemed appropriate by the CQA Consultant or as otherwise directed by the Construction Manager.

4.2.3 Soils Selection Criteria

All soil material used during construction shall meet the minimum criteria in the project specifications, unless otherwise directed by the Construction Manager. Table 1 includes the testing frequencies required by the Specifications.

4.2.3.1 Compacted Fill

Compacted Fill shall consist of random granular or cohesive material obtained from approved borrow areas. Compacted Fill may be used for construction of the following soil components:

- Subgrade
- Perimeter Berms

Compacted Fill may also be used to adjust or modify the slope of subgrade soils. Compacted Fill shall meet the minimum requirements given in the Plans and Specifications. Compacted Fill shall consist of the following soil types:

- Silty to Clayey Sands
- Silty Sands
- Clayey Silts to Silty Clays
- Silty Sandy Clays
- Combinations of the above

The Earthwork Contractor shall furnish representative samples of the Compacted Fill to the CQA Consultant and Construction Manager for each material source he may use. In addition the results of the following tests shall be provided to the CQA Consultant and Construction Manager for approval prior to procurement, importing or stockpiling the materials:

• Moisture Content	ASTM D 2216
• Atterburg Limits	ASTM D 4318
• Particle Size	ASTM D 1140
• Moisture Density Relationship	ASTM D 698
• Permeability	ASTM D 5084

4.2.3.2 Tracked-in Place Fill

Tracked-in Place Fill shall consist of poorly graded granular or cohesive fill obtained from approved borrow areas. Tracked-in Place Fill will be used for construction of the Protection Layer Soils over the secondary collection system. Tracked-in Place Fill shall meet the minimum requirements of the Plans and Specifications. Tracked-in Fill shall consist of the following soil types:

- Silty to Clayey Sands
- Clayey Silts or Silty Clays
- Sandy Clays
- Combinations of the above

The Earthwork Contractor shall furnish representative samples of the Tacked-in Fill to the CQA Consultant and Construction Manager for each material source he may use. In addition the results of the following tests shall be provided to the CQA Consultant and Construction Manager for approval prior to procurement, importing or stockpiling the materials:

• Moisture Content	ASTM D 2216
• Atterburg Limits	ASTM D 4318
• Particle Size	ASTM D 1140
• Moisture Density Relationship	ASTM D 698

4.2.3.3 Drainage Material

Drainage Material shall consist of granular soils obtained from approved on-site or off-site borrow areas. Drainage Material will be used for construction of the following soil components:

- Primary Drainage Sand Layer
- Primary and Secondary Collection Sump Gravel
- Gravel Drains for Primary Collection Layer
- Capillary Break Layer

Drainage Material shall meet the minimum requirements given in the Plans and Specifications. Drainage Material shall consist of the following soil types:

- Sandy Gravel to Sandy Silty Gravel
- Well Graded to Poorly Graded Gravels
- Silty Sands

- Well Graded to Poorly Graded Sands

The Earthwork Contractor shall furnish representative samples of the Drainage Material to the CQA Consultant and Construction Manager for each material source he may use. In addition the results of the following tests shall be provided to the CQA Consultant and Construction Manager for approval prior to procurement, importing or stockpiling the materials:

- Moisture Content ASTM D 2216
- Particle Size ASTM D 422
- Permeability ASTM D 2434

4.2.3.4 Protective Fill

Protective Fill shall consist of granular or fine-grained cohesive material obtained from approved borrow areas, or other sources as approved by the Construction Manager. Protective Fill will be used to construct the protective soil layer placed directly on the Primary Collection System. Protective Fill shall meet the minimum requirements of the Plans and Specifications. Protective Fill shall consist of the following soil types:

- Silty to Clayey Sands
- Poor to Well Graded Sands
- Sandy to Silty Clays
- Sludges
- Combinations of the above

Protective Fill shall be free of rocks, gravel, sticks, roots or unsuitable materials.

4.2.3.5 Vegetated Cover Fill

Vegetated Cover Fill shall consist of granular material obtained from approved on-site or off-site borrow areas. Vegetated Cover Fill will be used for construction of the final cover layer (i.e. Vegetated Cover and Drainage Layer). Vegetated Cover Fill shall meet the minimum requirements given in the Plans and Specifications. Vegetated Cover Fill shall consist of the following soil types:

- Silty Sands
- Clayey Sand
- Combinations of the above

The Earthwork Contractor shall provide the CQA Consultant and Construction Manager with representative samples of Vegetated Cover Fill for each material source he may use. In addition

the results of the following tests shall be provided to the CQA Consultant and Construction Manager for approval prior to procurement, importing or stockpiling the materials:

- Moisture Content ASTM D 2216
- Particle Size ASTM D 422
- Particle Size ASTM D 1140
- Permeability ASTM D 2434 or ASTM D 5084

4.2.4 Earth Fill Material Management

As the material is excavated from an approved borrow facility, the CQA Consultant shall confirm that the soils meet the requirements of the Specifications. The CQA Consultant will use his experience with visual/manual soil classification techniques to assess the segregation of soils. The CQA Consultant will note in his field records changes in odor, texture, apparent moisture, and the depths of which they occur. The CQA Consultant shall confirm that adequate processing, as described in the Specifications is performed for removal of roots, rocks, rubbish or unsuitable materials, and achieve the specified soil clod size.

Materials from the excavation will be stockpiled in areas approved by the Construction Manager and protected. If excavated soils exhibit distinct characteristic changes with depth, the CQA Consultant should verify that stockpiles be segregated by depth, and the depth range of the stockpiles be recorded and posted. Each stockpile shall be identified, and the CQA Consultant should prepare a field drawing of stockpile locations.

4.3 CONSTRUCTION QUALITY EVALUATION

Construction quality evaluation shall be performed on all components of the construction. Criteria to be used for determination of acceptability of the construction work shall be as identified in the Specifications. Tables 2 and 3 present the testing frequencies required in the Specifications.

4.3.1 Subgrade Evaluation

During construction, the subgrade soil shall be evaluated in accordance with the Specifications to confirm that its characteristics are equivalent to those utilized in the design of the lining systems. Subgrade damage due to excess moisture (causing softening) or insufficient moisture (causing desiccation and shrinkage), shall be identified and repaired.

At a minimum, the CQA Consultant shall determine the suitability of the subgrade for placement of the Remolded and Compacted Soils by continuous visual inspection during proof rolling.

Final subgrade elevations shall be measured and recorded by the Earthwork Contractor. The CQA Consultant shall confirm that all subgrade elevations are in accordance with the Plans and Specifications. The CQA Consultant shall notify the Construction Manager and Earthwork Contractor of deficiencies in subgrade elevation or characteristics.

4.3.2 Fill Placement

The Earthwork Contractor will be responsible for implementing a Construction Quality Control program (CQC) to ensure that all earthwork is performed in accordance with the Plans and Specifications. The CQA Consultant will oversee the Earthwork Contractor's CQC plan and will document and observe the construction activity. The responsibilities of the CQA Consultant include the following:

- Document that roots, rocks, rubbish or off-spec materials;
- Evaluation of soil materials to be used for clay liner and cover, sand and gravel drainage layers, and general fill;
- Observation of compaction performance of Earthwork Contractor's equipment and techniques;
- Documentation of excavation and segregation of soils suitable for use;
- Evaluation of stockpiling activities and stockpile fill suitable for use;
- Evaluation of subgrade slopes and bottom for proper grade and soil condition;
- Observation Inspection of drainage layer installation; and
- Evaluation of lift thickness and compaction.

4.3.3 Evaluation of Low Permeability Fill

The CQA Consultant shall observe compaction procedures and CQC efforts to confirm that low permeability fill is constructed in accordance with the Plans and Specifications. The CQA Consultant shall observe and make recommendations to the Construction Manager and Earthwork Contractor to correct deficiencies on the following:

- Removal of roots, rocks, rubbish, or off-spec material from the fill material;
- Identification of changes in soil characteristics necessitating a change in requirements of the Plans and Specifications;
- Adequate spreading of material to obtain complete coverage and the specified loose lift thickness;
- Adequate spreading and incorporation of water to obtain full penetration through clods and uniform distribution of the required water content;
- Procedures to be followed to adjust the soil moisture content in the event of a significant prolonged rain during construction;
- Prevention of significant water loss before and after compaction;
- Use of equipment type, configuration, and weight;
- Use of equipment speed and number of equipment passes for compaction;

- Uniformity of coverage by compaction equipment, especially at fill edges, in equipment turnaround areas, and at the tops and bottoms of slopes;
- Consistent achievement of the required soil density, water content, and compactive effort throughout each completed lift;
- Repair of penetrations or holes resulting from the collection of undisturbed soil samples, and the use of density or moisture probes.
- Methods to bond fill lifts;
- Placement of protective cover(s) to prevent desiccation of material between the installation of lifts or after completion of the clay liner (where necessary);
- Prevention of accidental damage of installed portions of the clay liner by equipment traffic; and
- Weather conditions which may affect construction quality.

The CQA Consultant shall note any deficiencies and report them to the Construction Manager. The CQA Consultant shall be responsible for confirming that corrections are made.

4.3.4 Evaluation of Layer Bonding

Evaluation of layer bonding may be determined by using test pits to make visual observations. All test pits shall be excavated in a manner acceptable to the CQA Monitor. Test pits shall be at least 1 foot in depth and approximately 1 square foot in plan. All pits shall be backfilled and compacted in accordance with the Specifications. The backfill shall be compacted using hand compaction equipment or other methods approved by the CQA Consultant.

The CQA Consultant shall confirm that layer bonding between compacted lifts is adequate and that discontinuities do not appear to exist. The CQA Consultant shall notify the Construction Manager of any layer bonding deemed to be deficient and shall confirm that repairs are performed by the Earthwork Contractor.

4.3.5 Construction Quality Control Testing

Laboratory and field tests shall be performed by the Earthwork Contractor in accordance with the requirement of the Plans and Specifications.

The CQA Consultant shall observe the CQC testing and review all test results from both laboratory and field-testing. He shall confirm that the minimum testing is performed in accordance with the Specifications. He shall confirm that the CQC testing results adequately indicates that earthwork construction meets or exceeds design requirements in accordance with the Plans and Specifications.

Questions concerning the accuracy of any single test shall be addressed by retesting in the same or adjoining locations. Periodic checks using the drive cylinder method shall be performed in accordance with the Specifications to confirm the nuclear density results.

Additional testing shall be used at the discretion of CQA Consultant and/or the Construction Manager when visual observations indicate a potential problem. Additional testing for suspect areas shall be considered when:

- Compactor slippage during rolling operation;
- Lift thickness is greater than specified;
- Earthfill is at improper and/or variable moisture content;
- Less than specified number of compactor (roller) coverages are made;
- Dirt-clogged rollers are used to compact the material;
- Rollers may not have used optimum ballast;
- Fill materials differ substantially from those specified; and
- The degree of compaction is doubtful.

During construction, the frequency of testing may also be increased in the following situations:

- Adverse weather conditions;
- Breakdown of equipment;
- At the start and finish of grading;
- Materials fail to meet specifications; and
- The work area is reduced.

4.3.6 Perforations

All perforations must be backfilled. These shall include, but not be limited to, the following:

- Density test locations
- Permeability sampling locations
- Test pit locations

Unless otherwise noted in the Specifications, or as directed by the Construction Manager, all perforations shall be backfilled with soil equivalent to the soil used for construction of the layer. The soil shall be broken into clod sizes smaller than the perforation diameter and compacted in-place with a tamping rod, Modified or Standard Proctor hammer, or hand tamper depending on the size of the perforation. Test pits shall be backfilled with the same material and using the same procedures as required for the material being tested or examined. The CQA Consultant shall confirm that all perforations are properly repaired.

4.4 DEFICIENCIES

4.4.1 Examination of the Deficiency

If a deficiency is discovered in the work, the CQA Consultant shall immediately determine the extent and nature of the deficiency. If the deficiency is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the deficient area by directing the Earthwork Contractor to perform additional tests, observations, a review of records, or other appropriate methods. If the deficiency is related to adverse site conditions, such as overly wet soils or surface desiccation, the CQA Consultant shall define the limits and nature of the deficiency.

4.4.2 Notification

After determining the extent and nature of a deficiency, the CQA Consultant shall notify the Construction Manager and Earthwork Contractor.

4.4.3 Repairs and Retesting

The Earthwork Contractor shall correct the deficiency to the satisfaction of the Construction Manager. If a requirement cannot be met, or unusual weather conditions hinder work, then the CQA Consultant, Construction Manager and Earthwork Contractor shall discuss alternate solutions and a schedule for correction of the deficiency.

All retests performed by the Earthwork Contractor, as directed by the CQA Consultant, must confirm that the deficiency has been corrected before any additional work is performed in the area of the deficiency. The CQA Consultant shall also confirm that all installation requirements are met and that all CQC submittals are provided.

4.5 ACCEPTANCE

The CQA Consultant shall recommend to the Construction Manager acceptance of the work performed by the Earthwork Contractor. Acceptance of the completed work shall be in accordance with the requirements of the Plans and Specifications. Acceptance of the soil components of the lining and final cover systems will be based on observation, measurements and laboratory test results.

The following methods shall be used by the CQA Consultant as the basis to judge the acceptability of the construction of the soil components of the lining and final cover systems.

1. Evaluate the following for a given lift or section:
    - Dry density;
    - Moisture content;
    - Lift thickness; and
    - Clod size.

2. Compare measured results to Specification requirements and determine the variation.
3. If dry density is too low, adjust moisture content as necessary and recompact lift.
4. If moisture content is too dry:
   - Adjust moisture content upward and recompact, or
   - Run laboratory permeability on field-compacted sample.
5. If lift is too thick:
   - Decrease thickness,
   - Check dry density and moisture at bottom of lift, or
   - Run laboratory permeability on field compacted sample.
6. If clod size is too large: inspect test pit(s) to determine integrity of lift and layer bonding.

If two or more items fail to comply, then the lift or section being assessed shall be deemed unacceptable and shall be suitably broken up, moisture content adjusted, recompacted and retested.

An effective CQA Plan depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA Consultant shall document that all quality assurance requirements have been addressed and satisfied.

The CQA Consultant shall provide the Construction Manager with signed descriptive remarks, data sheets, and checklists to verify that all monitoring activities have been carried out. The Construction Manager shall also maintain at the job site a complete file of plans and specifications, a CQA manual, checklists, test procedures, daily logs, and other pertinent documents.

5.1 DAILY RECORDKEEPING

Standard reporting procedures will include preparation of a daily log which, at a minimum, shall consist of: a) field notes; including memorandum of meetings and/or discussions with the earthwork contractor, b) observation and testing data sheets, and c) construction problem and solution data sheets. This information will be regularly submitted to and reviewed by the Construction Manager.

5.1.1 Memorandum of Discussion With Earthwork Contractor or Subcontractors

A memorandum will be prepared each day as necessary, summarizing discussions between the CQA Consultant and Earthwork Contractor. At a minimum, the memorandum will include the following information:

- Date, project name, location, and other identification
- Names of parties to discussion
- Relevant subject matter or issues
- Activities planned
- Constraints or suggestions
- Schedule
- Signature of the CQA Consultant

5.1.2 Observation and Testing Data Sheets

Observation and testing data sheets will be prepared daily. At a minimum, these data sheets will include the following information:

- An identifying sheet number for cross referencing and document control
- Date, project name, location, and other identification
- Data on weather conditions

- A reduced-scale site plan showing all proposed work areas and test locations
- Descriptions and locations of ongoing construction
- Equipment and personnel in each work area, including subcontractors
- Descriptions and specific locations of areas, or units, of work being tested and/or observed and documented (identified by lift and location)
- Locations where tests and samples were taken
- A summary of test results
- Calibrations or recalibrations of test equipment, and actions taken as result of recalibration
- Off-site materials received, including quality verification documentation
- Decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality
- The CQA Consultant signature

5.2 CONSTRUCTION PROBLEM AND RESOLUTION DATA SHEETS

Sheets describing special construction situations shall be cross-referenced with specific observation and testing data sheets, and must include the following information, where available:

- An identifying sheet number for cross-referencing and document control
- A detailed description of the situation or deficiency
- The location and probable cause of the situation or deficiency
- How and when the situation or deficiency was found or located
- Documentation of the response to the situation or deficiency
- Final results of any responses
- Any measures taken to prevent a similar situation from occurring in the future
- The signature of the CQA Consultant and signature indicating concurrence by the Construction Manager

The Construction Manager shall be made aware of any significant recurring non-conformance with the Specifications. The Construction Manager shall then determine their cause and recommend appropriate changes in procedures or Specifications. When this type of evaluation is made, the results must be documented, and any revision to procedures or Specifications shall be approved by the Designer.

A summary of all supporting data sheets, along with final testing results and the CQA Consultant's concurrence that the work is completed in accordance with the requirements of the

Plans and Specifications, shall be required upon completion of the repair, replacement or resolution of the issue.

5.3 PHOTOGRAPHIC REPORTING DATA SHEETS

Photographic reporting data sheets, where used, shall be cross-referenced with observation and testing data sheet(s) and/or construction problem and solution data sheet(s).

These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain color prints; negatives will also be stored in a separate file in chronological order. These records shall be presented to the Construction Manager upon completion of the project.

5.4 DESIGN AND/OR SPECIFICATIONS CHANGES

Design and/or specifications changes may be required during construction. In such cases, the CQA Consultant shall notify the Construction Manager and Designer.

Design and/or specifications changes shall be made only with written agreement of the Construction Manager and the Designer, and shall take the form of an addendum to the Specifications.

5.5 PROGRESS REPORTS

The Construction Manager shall prepare a summary progress report each week, or at time intervals established at the pre-construction meeting. As a minimum, this report shall include the following information:

- A unique identifying sheet number for cross-referencing and document control
- The date, project name, location, and other information
- A summary of work activities during progress reporting period
- A summary of construction situations, deficiencies, and/or defects occurring during progress reporting period
- A summary of test results, failures and retests
- The signature of the Construction Manager

5.6 CERTIFICATION AND SUMMARY REPORT

At the completion of the work, the CQA Consultant shall submit to the Construction Manager a final certification and summary report. This report shall certify that the work has been performed in compliance with the Plans and Specifications.

At a minimum, this report shall include: a) summaries of all construction activities, b) observation and testing data sheets including sample location plans, c) construction problems and

resolutions data sheets, d) changes in design and material specifications, e) as-built drawings, and f) certification statement sealed and signed by a registered Professional Engineer. The as-built drawings shall include scale drawings depicting the location of the construction and details pertaining to the extent of construction (depths, plan dimensions, elevations, soil component thicknesses, etc.). All surveying and base maps required for development of the as-built drawings shall be done by a qualified land surveyor.

5.7 STORAGE OF RECORDS

All handwritten data sheet originals, especially those containing signatures, should be stored by the Construction Manager in a safe repository on site. Other reports may be stored by any standard method which will allow for easy access.

An effective CQA Plan depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA Consultant shall document that all quality assurance requirements have been addressed and satisfied.

The CQA Consultant shall provide the Construction Manager with signed descriptive remarks, data sheets, and checklists to verify that all monitoring activities have been carried out. The Construction Manager shall also maintain at the job site a complete file of plans and specifications, a CQA manual, checklists, test procedures, daily logs, and other pertinent documents.

5.1 DAILY RECORDKEEPING

Standard reporting procedures will include preparation of a daily log which, at a minimum, shall consist of: a) field notes; including memorandum of meetings and/or discussions with the earthwork contractor, b) observation and testing data sheets, and c) construction problem and solution data sheets. This information will be regularly submitted to and reviewed by the Construction Manager.

5.1.1 Memorandum of Discussion With Earthwork Contractor or Subcontractors

A memorandum will be prepared each day as necessary, summarizing discussions between the CQA Consultant and Earthwork Contractor. At a minimum, the memorandum will include the following information:

- Date, project name, location, and other identification
- Names of parties to discussion
- Relevant subject matter or issues
- Activities planned
- Constraints or suggestions
- Schedule
- Signature of the CQA Consultant

5.1.2 Observation and Testing Data Sheets

Observation and testing data sheets will be prepared daily. At a minimum, these data sheets will include the following information:

- An identifying sheet number for cross referencing and document control
- Date, project name, location, and other identification
- Data on weather conditions

TABLES

TABLE 1

PRE-CONSTRUCTION TESTING FREQUENCY FOR MATERIALS EVALUATION OF SOIL COMPONENTS OF LINING AND FINAL COVER SYSTEMS

SAUGET AREA 1 TSCA LANDFILL
SOLUTIA INC.
CAHOKIA, ILLINOIS

Test Type and ASTM Description	Compacted Fill (cu yd)	Tracked-in Place Fill (cu yd)	Drainage Material Sand (cu yd)	Drainage Material Gravel (cu yd)	Protective Fill (cu yd)	Vegetative Cover (cu yd)
Moisture Content (D2216)	1 per source	1 per source	1 per source	1 per source	1 per source	1 per source
Atterberg Limits (D4318)	1 per source	1 per source	----------	----------	1 per source	1 per source
Particle Size (Clays – D1140) (Sands, Gravel – D422)	1 per source	1 per source	1 per source	1 per source	1 per source	1 per source
Moisture Density (D698)	1 per source	1 per source	----------	----------	1 per source	1 per source
Permeability (Clays – D5084) (Sands, Gravel – D2434)	1 per source	1 per source	1 per source	1 per source	1 per source	1 per source

TABLE 2

CONSTRUCTION TESTING FREQUENCY FOR MATERIALS EVALUATION OF SOIL COMPONENTS OF LINING AND FINAL COVER SYSTEMS

SAUGET AREA 1 TSCA LANDFILL
SOLUTIA INC.
CAHOKIA, ILLINOIS

Test Type and ASTM Description	Compacted Fill (cu yd)	Tracked-in Place Fill (cu yd)	Drainage Material Sand (cu yd)	Drainage Material Gravel (cu yd)	Protective Fill (cu yd)	Vegetative Cover (cu yd)
Moisture Content (D2216)	1 per 20,000	1 per 10,000	1 per 10,000	1 per 10,000	1 per 50,000	1 per 20,000
Atterberg Limits (D4318)	1 per 20,000	1 per 10,000	----------	----------	----------	1 per 10,000
Particle Size (Clays – D1140) (Sands, Gravel – D422)	1 per 20,000	1 per 10,000	1 per 10,000	1 per 10,000	1 per 50,000	1 per 10,000
Moisture Density (D698)	1 per 20,000	1 per 20,000	----------	----------	1 per 50,000	1 per 20,000
Permeability (Clays - D5084) (Sands, Gravel - D2434)	1 per 50,000	1 per 20,000	1 per 10,000	1 per 10,000	----------	1 per 20,000

TABLE 3

TESTING FREQUENCY FOR CONSTRUCTION QUALITY EVALUATION OF SOIL COMPONENTS OF LINING AND FINAL COVER SYSTEMS

SAUGET AREA 1 TSCA LANDFILL
SOLUTIA INC.
CAHOKIA, ILLINOIS

Test Type and ASTM Description	Compacted Fill	Tracked-in Place Fill	Drainage Material Sand	Drainage Material Gravel	Protective Fill	Vegetative Cover
Field Placed Moisture and Density (D2922/D3017)	1 per 2,000 yd^3	1 per 15,000ft^2 or 6 per lift (minimum)	----------	----------	----------	1 per 2,000 yd^3
Field Placed Density/Moisture Verification (D2937)	1 per 15,000 yd^3	1 per 2,000 yd^3 or 1 per lift (minimum)	----------	----------	----------	----------
Layer Bonding	----------	1 per layer	----------	----------	----------	----------
Survey of As Built Configuration	• Base of fill • Completed section • As directed	All appurtenant components 50 feet center to center or minimum 6 points per grade at least the following locations: • Base of excavation • Top of first clay lift for each layer • Top of all collection systems • Base and top of all sumps and drains • As directed by the owner or his representative				
Inplace Permeability	----------	----------	----------	----------	----------	----------

APPENDIX A

CONSTRUCTION QUALITY ASSURANCE CHECKLIST

I. SUBMITTAL OF QUALIFICATIONS (2.3)

A. Earthwork Contractor (2.3.1)

1. Demonstration of bonding capability and list of outstanding contracts. _____
2. A list of five comparable projects. _____
   a. Name of facility, location, and date of installation. _____
   b. Name of project manager or contact person for installation. _____
   c. Description and purpose of installation and definition of contractor's scope. _____
3. A list of readily available equipment. _____

B. CQA Consultant (2.3.2)

1. Corporate Information
   a. Corporate history _____
   b. Proof of insurance _____
      1) professional liability _____
      2) "umbrella" coverage _____
      3) other coverages required by state and local Statutes or proposed contractual agreements. _____
2. Inspection Capabilities
   a. Summary of firm's experience with observation and testing, especially soil components for waste facilities. _____
   b. Summary of firms experience in CQA/QC (emphasis on soil components). _____
3. Personnel
   a. Resumes of personnel to be involved in the project. _____
   b. Supervising engineer must have proof of engineering degree and/or professional engineering registration in project state. _____
   c. Specific experience with soil components of inspecting personnel. _____

II. MEETINGS (3)

A. Resolution Meeting (with Design Engineer, Owner, Project Manager, and CQA Monitor Present) (3.1)

1. Provide all parties with relevant documents. _____

2. Review plans and specifications. _____
3. Make modifications to CQA plan. _____
4. Review of the CQA plan and quality control procedures. _____
5. Review and assign responsibilities to parties. _____
6. Establish procedures for documentation and reporting information. _____
7. Establish methods for distribution and storage of documents and reports. _____
8. Prepare a time schedule for operations. _____
9. Establish work area security and safety protocol. _____
10. Discuss and select earthwork contractors to be asked to bid. _____
11. Review special permit conditions and/or state and federal requirements. _____
12. Select testing equipment as well as protocol for testing and placement of soil materials. _____
13. Meeting documented by CQA monitor or designate and minutes transmitted to all parties . _____

B. Pre-Construction Meeting (with Earthwork Contractor, CQA Monitor, and Project Manager present) (3.2) _____

1. Discuss modifications to CQA plan. _____
2. Review special permits and state and federal requirements. _____
3. Review responsibilities of each party. _____
4. Review lines of authority and communication. _____
5. Review procedures for documentation and reporting information. _____
6. Review distribution and storage of documents and reports. _____
7. Establish protocol for testing. _____
8. Establish protocol for handling construction deficiencies. _____
9. Establish protocol for repairs and retesting. _____
10. Conduct site-walk. _____
    a. Discuss work plans. _____
    b. Inspect material handling, borrow, and stockpile locations. _____
11. Review a time schedule for all operations. _____
12. Review work area security and safety protocol. _____

13. Discuss and establish procedures for material processing. _____
14. Establish procedures for control of water and general materials protection and housekeeping. _____
15. Review health and safety requirements. _____
16. Meeting documented by CQA Monitor or designate and minutes transmitted to all parties prior to start of construction _____

C. Progress Meetings with Earthwork Contractor and CQA Monitor (3-3)

1. Review work activity and location for the day. _____
2. Discuss personnel and equipment for the assignment of the day. _____
3. Review previous day's activities and accomplishments. _____
4. Review work schedule. _____
5. Discuss possible problems. _____
6. Review new test data. _____
7. Meeting documented by CQA Monitor. _____

D. Problem or Work Deficiency Meeting (with Earthwork Contractor, Owner, and CQA Monitor present) (3.4)

1. Define and discuss the problem or deficiency. _____
2. Review alternative solutions. _____
3. Implement action plan. _____
4. Meeting documented by CQA Monitor. _____

III. EARTH MATERIALS CONSTRUCTION QUALITY ASSURANCE (4)

A. Material Evaluation (4.2)

1. Laboratory soil tests (4.2.2)

a. Laboratory determination of water moisture content of sail, rock, and soil aggregate mixtures (ASTM D2216-80). _____

b. Particle-size analysis of soils; amount of material finer than No. 200 sieve (ASTM D422-63) and (ASTM D1140-54). _____

c. Laboratory determination of liquid limit and plasticity index of soil (ASTM D4318-83). _____

d. Shrinkage factors of the soils (ASTM D427-83). _____

e. Specific gravity of soils (ASTM D854-83). _____

2. Soils Selection Criteria (4.2.3)

   a. General earthfill shall consist of material taken from on-site or approved off-site excavations or stockpiles and shall meet the requirement of Section 4.2.3.1 _____

   b. Clay liner/cover material. (4.2.3.2)

      1) Natural soil (4.2.3.2.1)

         a) Shall consist of clean, select material free of organics, trash, excess silt, or other deleterious matter. _____

         b) Shall be classified as CL or CH. _____

         c) Shall not be organic soil. _____

         d) May be sand and silt sails (SC, ML, MH). _____

         e) Shall have recompacted coefficient of permeability equal to or less than 1×10^{-7} cm/sec. _____

      2) Admix Material (4.2.3.2.2)

         a) Admixing of soils to lower permeability to 1×10^{-7} performed with written approval of Project Manager. _____

         b) Manufacture of admix conducted in accordance with Section 4.2.3.2.2. _____

         c) Admix material shall meet with the approval of the Inspector/Engineer . _____

   c. Drainage Materials (4.2.3.3)

      1) Shall consist of clean sands and/or gravel or other permeable material (SW, SP, GW, or GP). _____

      2) Shall be free from contamination. _____

      3) Shall contain less than 5 percent (dry weight) material that passes the no. 200 sieve and with 100 percent by weight passing the 3-inch sieve. _____

      4) Gravel for pipe trenches shall be GW or GP. _____

      5) gravels for pipe trenches contain less than 5 percent fines and be of a gradation whereby 95 percent of the material is larger Than the perforations at the drainage pipe _____

      6) drainage layers shall have a permeability greater than or equal to 1×10^{-2} cm/sec _____

d. Protective Cover Over Membrane (2.4.3.5)

1) must be fine-grained earthfill with maximum particle size of ¼-inch _____

2) must be fine-grained earthfill with maximum particle size of ¼-inch _____

e. Vegetative cover material (4.2.3.5)

1) shall be topsoil material and/or soil capable of providing for establishment of surficial grasses _____

3. Test Fill (4.2.4)

a. Test fill shall be used to evaluate

1) material handling and placement requirements _____

2) compaction equipment and procedures _____

3) number of coverages needed to achieve required results _____

4) permeability samples _____

b. Test fill dimensions a minimum of 20 feet by 60 feet _____

c. Test fill shall be constructed using the same equipment to be used on the project _____

d. Test fill observed and tested by CQA monitors. _____

B. Construction Quality Evaluation (4.3)

1. Inspection of the Work (4.3.1)

a. Inspection of the water content and other physical properties _____

b. Inspection of thickness of lifts, loosely placed and compacted _____

c. Inspection of action of heavy equipment on the construction surface _____

d. Inspection of number of coverages for each lift _____

2. Evaluation of Layer Bonding (4.3.2)

a. Layer bonding can be evaluated by observing test pits _____

b. Test pits excavated in a manner acceptable to the CQA monitor _____

c. Each test pit shall be excavated to 1-foot in depth _____

d. Test pits shall be backfilled and compacted in accordance with the specifications using a hand compactor to the satisfaction of the CQA monitor (or owner or his representative) _____

3. Laboratory and Field Tests (4.3.3)

   a. Compaction test (5.5-pound hammer, 12-inch drop) (ASTM D698-78) _____

   b. Compaction test (10-pound hammer 18-inch drop) (ASTM D1557-78) _____

   c. Liquid limit plastic limit, and plasticity index (ASTM D4318-83) _____

   d. Sieve analysis (passing no. 200 sieve) (ASTM D422-63 and ASTM D1140-54) _____

   e. Strength test; packet penetration _____

   f. Strength test; Torvane shear _____

   g. Field moisture/density determination: drive cylinder (ASTM D2937-83) _____

   h. Field moisture/density determination: nuclear methods (ASTM D2922-8l and ASTM D3017-78) _____

   i. Field moisture/density determination: rubber balloon (ASTM D2167-66) _____

   j. Field moisture/density determination: sand-cone method (ASTM D1556-82) _____

      Note: minimum of 1 sand-core test per 20 nuclear tests (1 per day) _____

   k. Failing area shall be reworked _____

4. Subgrade (4.3.4)

   a. Subgrade soil tested to confirm proper soil characteristics achieved _____

   b. CQA monitor shall observe subgrade during proof-rolling _____

   c. CQA monitor shall perform pocket penetrometer or Torvane sheer test in suspect soil areas _____

   d. Optional tests

      1) Laboratory test: Compaction test _____

      2) Field test: Moisture/density _____

      3) Field test: Pocket penetrometer _____

C. Hydraulic Conductivity Evaluations (4.4)

   1. Laboratory tests shall be performed to assess hydraulic conductivity of materials during pre- construction (one of the following):

a. Permeability of granular soil (constant head test) (ASTM D2434-68) _____
b. Permeability (back pressure saturated) (See Appendix E) _____
c. Atterberg limits _____
d. Particle size analysis _____

D. Special Testing (4.5) (as deemed necessary by the Owner or his representative)

1. Compressive strength, unconfined cohesive soils (ASTM D2166-66) _____
2. One-dimensional consolidation properties of soils (ASTM D2435-80) _____
3. Direct shear (consolidated, drained) ASTM 3080-72) _____
4. Shear, triaxal compression _____
   a. Consolidated drained (CD) (see U.S. Army Corps of Engineers EM 1110-2-1906 or Lambe, 1951) _____
   b. Consolidated undrained (CU) (see U.S. Army Corps of Engineers EM 1110-2 1906 or Lambe, 1951) _____
   c. Unconsolidated undrained (UU) ASTM D2850-82 _____

E. Quality Control Testing Frequency (4.6) (See Tables 1, 2, and 3 of the manual)

F. Clay Liner Perforations (4.7)

1. Construction permeability samples taken such that the sample tube is inserted into the liner normal to the plane of the constructed surface _____
2. All perforations shall be backfilled with soil-bentonite mixture _____
3. Backfill mixture compacted in-place using appropriate method _____
4. Perforation requiring filling include; density probe, permeability sample locations, and test pits _____

G. Deficiencies (4-8)

1. CQA monitor shall determine the extent and nature of the defect immediately upon discovery _____
2. CQA monitor shall notify owner and contractor of defect, and schedule retests for corrected work _____
3. Corrections shall be verified by retest performed by CQA Monitor _____
4. CQA Monitor shall verify that all installation requirements are met and all submittals are provided _____

IV. DOCUMENTATION (5)

A. Daily Recordkeeping (completed by CQA Monitor) (5.1)

1. Daily memorandum of discussion with earthwork contractor (fill in appropriate form) _____
2. Observation and testing data sheets (fill in appropriate form) _____

B. Construction Problem and Solution Data Sheets (5.2) to Include:

1. A unique identifying sheet number _____
2. A detailed description of the situation or deficiency _____
3. Location and probable cause or situation or deficiency _____
4. How and when situation or deficiency was discovered _____
5. Documentation of the response to the situation or deficiency _____
6. Final result of the response _____
7. Measure undertaken to avoid or prevent similar future occurrences _____
8. Signature of the CQA monitor and project manager _____
9. Summary of all supporting data and test sheets required upon completion of construction _____

C. Photographic Reporting Data Sheet (5.3) _____

D. Design and/or Specification Changes (5.4)

1. CQA monitor shall inform the project manager and Design Engineer of any design and/or specification changes _____
2. Design and/or specification changes shall be made only with written agreement of the project manager and the design engineer. This change shall take the form of an amendment to the specification or Construction Quality Assurance Manual. _____

E. Progress Reports (5.5)

1. The CQA monitor shall prepare a summary progress report weekly, or at a frequency established at the pre-construction meeting _____
2. The progress report will include:
   a. A unique identifying sheet number _____
   b. The date, project name, location, and other information _____
   c. A summary of work activities during progress reporting periods _____

d. A summary of construction situations, deficiencies and/or defects occurring during progress reporting period _____

e. A summary of test results, failures, and retests _____

f. The signature of the CQA monitor _____

F. Certification and Summary Report (5.6)

1. The CQA consultant shall submit to the project manager a final certification and summary report that includes:

a. Summaries of construction activities _____

b. Observation and testing data sheets with test location plans _____

c. Construction problems and solutions data sheets _____

d. Changes from design and material specifications _____

e. As-built drawings, including:

1) scale drawings with locations and extent of construction _____

2) surveying and base maps required done by qualified land surveyor _____

3) as-built document prepared by the CQA Engineer and included in the CQA plan documentation _____

V. TESTING FREQUENCY

A. Pre-construction Testing Frequency for Material Evaluation

1. Subgrade

a. Compaction test (ASTM D1557 or ASTM D698) 1 per 20,000 cu yd _____

2. General Earthfill

a. Atterberg limits (ASTM D4318) 1 per 20.000 cu yd _____

b. Compaction test (ASTM D1557 or ASTM D698) 1 per 20,000 cu yd _____

3. Clay Liner/Cover Stockpile

a. Moisture content (ASTM D2216) 1 per 20,000 cu yd _____

b. Particle size - (clays ASTM D1140, other ASTM D422) 1 per 20,000 cu yd _____

c. Atterberg limits - (ASTM D4313) 1 per 20,000 cu yd _____

d. Compaction test - (ASTM 01557 or D698) 1 per 20,000 cu yd _____

e. Permeability - 1 per 20,000 cu yd per material _____

4. Sand Stockpile

a. Moisture content - ASTM D2216 1 per source _____

b. Particle size - (clays ASTM D1140, other ASTM D422) 1 per source _____

c. Permeability - 1 per source _____

5. Gravel Stockpile

a. Moisture content - (ASTM D2216) 1 per source _____

b. Particle size - (clays ASTM D1140, other ASTM D422) 1 per source _____

c. Permeability - 1 per source _____

(Note: See Table 1 of Construction Quality Assurance Manual)

B. Construction Testing Frequency for Material Evaluation

1. General Earthfill

a. Atterberg limits - (ASTM D4318) 1 per 10,000 cu yd _____

b. Compaction test - (ASTM D1557 or ASTM D698) as necessary _____

2. Clay Liner/Cover in Place

a. moisture content - (ASTM D2216) 1 per 1,000 cu yd _____

b. Particle size - (clays ASTM D1140, other ASTM D422) 1 per 1,000 cu yd _____

c. Atterberg limits - (ASTM D4318) 1 per 5,000 cu yd _____

d. compaction test - (ASTM D1557 or D698) 1 per 5,000 cu yd or changes _____

e. Laboratory permeability - 1 per 5,000 cu yd _____

3. Sand in Place

a. Moisture content - (ASTM D2216) 1 per 10,000 sq ft _____

b. Particle size - (clays ASTM D1140 ASTM D422) 1 per 10,000 sq ft _____

4. Gravel in Place

a. Moisture content - (ASTM D2216) 1 per 10,000 sq ft _____

b. Particle size - (clays ASTM D1140, other ASTM D422) 1 per 10,000 sq ft _____

5. Cover Over Geomembrane

   a. Particle size - (clays ASTM D1140, other ASTM D422) 1 per 5,000 cu yd _____

6. Vegetative Cover

   a. Particle size - (clays ASTM D1140, other ASTM D422) 1 per 5,000 cu yd _____

   (Note: See Table 2 of Construction Quality Assurance Manual

C. Construction Testing Frequency for Construction Quality Evaluation

1. Subgrade

   a. Field moisture/density - 1 per 10,000 sq ft _____

   b. Penetrometer or Torvane shear - weak or suspect areas _____

2. General Earthfill

   a. Field moisture/density - 1 per 10,000 sq ft _____

3. Clay Liner/Cover Material

   a. Field moisture/density - 1 per 10,000 sq ft _____

4. Protective Cover Over Geomembrane

   a. Field moisture/density - 1 per 10,000 sq ft _____

   (Note: See Table 3 of Construction Quality Assurance Manual)

I. SUBMITTAL OF QUALIFICATIONS (2.3)

A. Earthwork Contractor (2.3.1)

1. Demonstration of bonding capability and list of outstanding contracts. _____
2. A list of five comparable projects. _____
   a. Name of facility, location, and date of installation. _____
   b. Name of project manager or contact person for installation. _____
   c. Description and purpose of installation and definition of contractor's scope. _____
3. A list of readily available equipment. _____

B. CQA Consultant (2.3.2)

1. Corporate Information
   a. Corporate history _____
   b. Proof of insurance _____
      1) professional liability _____
      2) "umbrella" coverage _____
      3) other coverages required by state and local Statutes or proposed contractual agreements. _____
2. Inspection Capabilities
   a. Summary of firm's experience with observation and testing, especially soil components for waste facilities. _____
   b. Summary of firms experience in CQA/QC (emphasis on soil components). _____
3. Personnel
   a. Resumes of personnel to be involved in the project. _____
   b. Supervising engineer must have proof of engineering degree and/or professional engineering registration in project state. _____
   c. Specific experience with soil components of inspecting personnel. _____

II. MEETINGS (3)

A. Resolution Meeting (with Design Engineer, Owner, Project Manager, and CQA Monitor Present) (3.1)

1. Provide all parties with relevant documents. _____

2. Review plans and specifications. _____
3. Make modifications to CQA plan. _____
4. Review of the CQA plan and quality control procedures. _____
5. Review and assign responsibilities to parties. _____
6. Establish procedures for documentation and reporting information. _____
7. Establish methods for distribution and storage of documents and reports. _____
8. Prepare a time schedule for operations. _____
9. Establish work area security and safety protocol. _____
10. Discuss and select earthwork contractors to be asked to bid. _____
11. Review special permit conditions and/or state and federal requirements. _____
12. Select testing equipment as well as protocol for testing and placement of soil materials. _____
13. Meeting documented by CQA monitor or designate and minutes transmitted to all parties . _____

B. Pre-Construction Meeting (with Earthwork Contractor, CQA Monitor, and Project Manager present) (3.2) _____

1. Discuss modifications to CQA plan. _____
2. Review special permits and state and federal requirements. _____
3. Review responsibilities of each party. _____
4. Review lines of authority and communication. _____
5. Review procedures for documentation and reporting information. _____
6. Review distribution and storage of documents and reports. _____
7. Establish protocol for testing. _____
8. Establish protocol for handling construction deficiencies. _____
9. Establish protocol for repairs and retesting. _____
10. Conduct site-walk. _____
    a. Discuss work plans. _____
    b. Inspect material handling, borrow, and stockpile locations. _____
11. Review a time schedule for all operations. _____
12. Review work area security and safety protocol. _____

13. Discuss and establish procedures for material processing. _____
14. Establish procedures for control of water and general materials protection and housekeeping. _____
15. Review health and safety requirements. _____
16. Meeting documented by CQA Monitor or designate and minutes transmitted to all parties prior to start of construction _____

C. Progress Meetings with Earthwork Contractor and CQA Monitor (3-3)

1. Review work activity and location for the day. _____
2. Discuss personnel and equipment for the assignment of the day. _____
3. Review previous day's activities and accomplishments. _____
4. Review work schedule. _____
5. Discuss possible problems. _____
6. Review new test data. _____
7. Meeting documented by CQA Monitor. _____

D. Problem or Work Deficiency Meeting (with Earthwork Contractor, Owner, and CQA Monitor present) (3.4)

1. Define and discuss the problem or deficiency. _____
2. Review alternative solutions. _____
3. Implement action plan. _____
4. Meeting documented by CQA Monitor. _____

III. EARTH MATERIALS CONSTRUCTION QUALITY ASSURANCE (4)

A. Material Evaluation (4.2)

1. Laboratory soil tests (4.2.2)

a. Laboratory determination of water moisture content of sail, rock, and soil aggregate mixtures (ASTM D2216-80). _____

b. Particle-size analysis of soils; amount of material finer than No. 200 sieve (ASTM D422-63) and (ASTM D1140-54). _____

c. Laboratory determination of liquid limit and plasticity index of soil (ASTM D4318-83). _____

d. Shrinkage factors of the soils (ASTM D427-83). _____

e. Specific gravity of soils (ASTM D854-83). _____

2. Soils Selection Criteria (4.2.3)

   a. General earthfill shall consist of material taken from on-site or approved off-site excavations or stockpiles and shall meet the requirement of Section 4.2.3.1 _____

   b. Clay liner/cover material. (4.2.3.2)

      1) Natural soil (4.2.3.2.1)

         a) Shall consist of clean, select material free of organics, trash, excess silt, or other deleterious matter. _____

         b) Shall be classified as CL or CH. _____

         c) Shall not be organic soil. _____

         d) May be sand and silt sails (SC, ML, MH). _____

         e) Shall have recompacted coefficient of permeability equal to or less than 1×10^{-7} cm/sec. _____

      2) Admix Material (4.2.3.2.2)

         a) Admixing of soils to lower permeability to 1×10^{-7} performed with written approval of Project Manager. _____

         b) Manufacture of admix conducted in accordance with Section 4.2.3.2.2. _____

         c) Admix material shall meet with the approval of the Inspector/Engineer . _____

   c. Drainage Materials (4.2.3.3)

      1) Shall consist of clean sands and/or gravel or other permeable material (SW, SP, GW, or GP). _____

      2) Shall be free from contamination. _____

      3) Shall contain less than 5 percent (dry weight) material that passes the no. 200 sieve and with 100 percent by weight passing the 3-inch sieve. _____

      4) Gravel for pipe trenches shall be GW or GP. _____

      5) gravels for pipe trenches contain less than 5 percent fines and be of a gradation whereby 95 percent of the material is larger Than the perforations at the drainage pipe _____

      6) drainage layers shall have a permeability greater than or equal to 1×10^{-2} cm/sec _____

d. Protective Cover Over Membrane (2.4.3.5)

1) must be fine-grained earthfill with maximum particle size of ¼-inch _____

2) must be fine-grained earthfill with maximum particle size of ¼-inch _____

e. Vegetative cover material (4.2.3.5)

1) shall be topsoil material and/or soil capable of providing for establishment of surficial grasses _____

3. Test Fill (4.2.4)

a. Test fill shall be used to evaluate

1) material handling and placement requirements _____

2) compaction equipment and procedures _____

3) number of coverages needed to achieve required results _____

4) permeability samples _____

b. Test fill dimensions a minimum of 20 feet by 60 feet _____

c. Test fill shall be constructed using the same equipment to be used on the project _____

d. Test fill observed and tested by CQA monitors. _____

B. Construction Quality Evaluation (4.3)

1. Inspection of the Work (4.3.1)

a. Inspection of the water content and other physical properties _____

b. Inspection of thickness of lifts, loosely placed and compacted _____

c. Inspection of action of heavy equipment on the construction surface _____

d. Inspection of number of coverages for each lift _____

2. Evaluation of Layer Bonding (4.3.2)

a. Layer bonding can be evaluated by observing test pits _____

b. Test pits excavated in a manner acceptable to the CQA monitor _____

c. Each test pit shall be excavated to 1-foot in depth _____

d. Test pits shall be backfilled and compacted in accordance with the specifications using a hand compactor to the satisfaction of the CQA monitor (or owner or his representative) _____

3. Laboratory and Field Tests (4.3.3)

   a. Compaction test (5.5-pound hammer, 12-inch drop) (ASTM D698-78) _____

   b. Compaction test (10-pound hammer 18-inch drop) (ASTM D1557-78) _____

   c. Liquid limit plastic limit, and plasticity index (ASTM D4318-83) _____

   d. Sieve analysis (passing no. 200 sieve) (ASTM D422-63 and ASTM D1140-54) _____

   e. Strength test; packet penetration _____

   f. Strength test; Torvane shear _____

   g. Field moisture/density determination: drive cylinder (ASTM D2937-83) _____

   h. Field moisture/density determination: nuclear methods (ASTM D2922-8l and ASTM D3017-78) _____

   i. Field moisture/density determination: rubber balloon (ASTM D2167-66) _____

   j. Field moisture/density determination: sand-cone method (ASTM D1556-82) _____

      Note: minimum of 1 sand-core test per 20 nuclear tests (1 per day) _____

   k. Failing area shall be reworked _____

4. Subgrade (4.3.4)

   a. Subgrade soil tested to confirm proper soil characteristics achieved _____

   b. CQA monitor shall observe subgrade during proof-rolling _____

   c. CQA monitor shall perform pocket penetrometer or Torvane sheer test in suspect soil areas _____

   d. Optional tests

      1) Laboratory test: Compaction test _____

      2) Field test: Moisture/density _____

      3) Field test: Pocket penetrometer _____

C. Hydraulic Conductivity Evaluations (4.4)

1. Laboratory tests shall be performed to assess hydraulic conductivity of materials during pre- construction (one of the following):

a. Permeability of granular soil (constant head test) (ASTM D2434-68) _____
b. Permeability (back pressure saturated) (See Appendix E) _____
c. Atterberg limits _____
d. Particle size analysis _____

D. Special Testing (4.5) (as deemed necessary by the Owner or his representative)

1. Compressive strength, unconfined cohesive soils (ASTM D2166-66) _____
2. One-dimensional consolidation properties of soils (ASTM D2435-80) _____
3. Direct shear (consolidated, drained) ASTM 3080-72) _____
4. Shear, triaxal compression _____
   a. Consolidated drained (CD) (see U.S. Army Corps of Engineers EM 1110-2-1906 or Lambe, 1951) _____
   b. Consolidated undrained (CU) (see U.S. Army Corps of Engineers EM 1110-2 1906 or Lambe, 1951) _____
   c. Unconsolidated undrained (UU) ASTM D2850-82 _____

E. Quality Control Testing Frequency (4.6) (See Tables 1, 2, and 3 of the manual)

F. Clay Liner Perforations (4.7)

1. Construction permeability samples taken such that the sample tube is inserted into the liner normal to the plane of the constructed surface _____
2. All perforations shall be backfilled with soil-bentonite mixture _____
3. Backfill mixture compacted in-place using appropriate method _____
4. Perforation requiring filling include; density probe, permeability sample locations, and test pits _____

G. Deficiencies (4-8)

1. CQA monitor shall determine the extent and nature of the defect immediately upon discovery _____
2. CQA monitor shall notify owner and contractor of defect, and schedule retests for corrected work _____
3. Corrections shall be verified by retest performed by CQA Monitor _____
4. CQA Monitor shall verify that all installation requirements are met and all submittals are provided _____

IV. DOCUMENTATION (5)

A. Daily Recordkeeping (completed by CQA Monitor) (5.1)

1. Daily memorandum of discussion with earthwork contractor (fill in appropriate form) _____
2. Observation and testing data sheets (fill in appropriate form) _____

B. Construction Problem and Solution Data Sheets (5.2) to Include:

1. A unique identifying sheet number _____
2. A detailed description of the situation or deficiency _____
3. Location and probable cause or situation or deficiency _____
4. How and when situation or deficiency was discovered _____
5. Documentation of the response to the situation or deficiency _____
6. Final result of the response _____
7. Measure undertaken to avoid or prevent similar future occurrences _____
8. Signature of the CQA monitor and project manager _____
9. Summary of all supporting data and test sheets required upon completion of construction _____

C. Photographic Reporting Data Sheet (5.3) _____

D. Design and/or Specification Changes (5.4)

1. CQA monitor shall inform the project manager and Design Engineer of any design and/or specification changes _____
2. Design and/or specification changes shall be made only with written agreement of the project manager and the design engineer. This change shall take the form of an amendment to the specification or Construction Quality Assurance Manual. _____

E. Progress Reports (5.5)

1. The CQA monitor shall prepare a summary progress report weekly, or at a frequency established at the pre-construction meeting _____
2. The progress report will include:
   a. A unique identifying sheet number _____
   b. The date, project name, location, and other information _____
   c. A summary of work activities during progress reporting periods _____

d. A summary of construction situations, deficiencies and/or defects occurring during progress reporting period _____

e. A summary of test results, failures, and retests _____

f. The signature of the CQA monitor _____

F. Certification and Summary Report (5.6)

1. The CQA consultant shall submit to the project manager a final certification and summary report that includes:

a. Summaries of construction activities _____

b. Observation and testing data sheets with test location plans _____

c. Construction problems and solutions data sheets _____

d. Changes from design and material specifications _____

e. As-built drawings, including:

1) scale drawings with locations and extent of construction _____

2) surveying and base maps required done by qualified land surveyor _____

3) as-built document prepared by the CQA Engineer and included in the CQA plan documentation _____

V. TESTING FREQUENCY

A. Pre-construction Testing Frequency for Material Evaluation

1. Subgrade

a. Compaction test (ASTM D1557 or ASTM D698) 1 per 20,000 cu yd _____

2. General Earthfill

a. Atterberg limits (ASTM D4318) 1 per 20.000 cu yd _____

b. Compaction test (ASTM D1557 or ASTM D698) 1 per 20,000 cu yd _____

3. Clay Liner/Cover Stockpile

a. Moisture content (ASTM D2216) 1 per 20,000 cu yd _____

b. Particle size - (clays ASTM D1140, other ASTM D422) 1 per 20,000 cu yd _____

c. Atterberg limits - (ASTM D4313) 1 per 20,000 cu yd _____

d. Compaction test - (ASTM 01557 or D698) 1 per 20,000 cu yd _____

e. Permeability - 1 per 20,000 cu yd per material _____

4. Sand Stockpile

a. Moisture content - ASTM D2216 1 per source _____

b. Particle size - (clays ASTM D1140, other ASTM D422) 1 per source _____

c. Permeability - 1 per source _____

5. Gravel Stockpile

a. Moisture content - (ASTM D2216) 1 per source _____

b. Particle size - (clays ASTM D1140, other ASTM D422) 1 per source _____

c. Permeability - 1 per source _____

(Note: See Table 1 of Construction Quality Assurance Manual)

B. Construction Testing Frequency for Material Evaluation

1. General Earthfill

a. Atterberg limits - (ASTM D4318) 1 per 10,000 cu yd _____

b. Compaction test - (ASTM D1557 or ASTM D698) as necessary _____

2. Clay Liner/Cover in Place

a. moisture content - (ASTM D2216) 1 per 1,000 cu yd _____

b. Particle size - (clays ASTM D1140, other ASTM D422) 1 per 1,000 cu yd _____

c. Atterberg limits - (ASTM D4318) 1 per 5,000 cu yd _____

d. compaction test - (ASTM D1557 or D698) 1 per 5,000 cu yd or changes _____

e. Laboratory permeability - 1 per 5,000 cu yd _____

3. Sand in Place

a. Moisture content - (ASTM D2216) 1 per 10,000 sq ft _____

b. Particle size - (clays ASTM D1140 ASTM D422) 1 per 10,000 sq ft _____

4. Gravel in Place

a. Moisture content - (ASTM D2216) 1 per 10,000 sq ft _____

b. Particle size - (clays ASTM D1140, other ASTM D422) 1 per 10,000 sq ft _____

5. Cover Over Geomembrane

   a. Particle size - (clays ASTM D1140, other ASTM D422) 1 per 5,000 cu yd _____

6. Vegetative Cover

   a. Particle size - (clays ASTM D1140, other ASTM D422) 1 per 5,000 cu yd _____

   (Note: See Table 2 of Construction Quality Assurance Manual

C. Construction Testing Frequency for Construction Quality Evaluation

1. Subgrade

   a. Field moisture/density - 1 per 10,000 sq ft _____

   b. Penetrometer or Torvane shear - weak or suspect areas _____

2. General Earthfill

   a. Field moisture/density - 1 per 10,000 sq ft _____

3. Clay Liner/Cover Material

   a. Field moisture/density - 1 per 10,000 sq ft _____

4. Protective Cover Over Geomembrane

   a. Field moisture/density - 1 per 10,000 sq ft _____

   (Note: See Table 3 of Construction Quality Assurance Manual)