Appendix A

Surface Impoundment Retrofitting Exemption Application

Surface Impoundment Retrofitting Exemption Application

Allied Corporation

Metropolis Works
Metropolis, Illinois

November 7, 1986

SURFACE IMPOUNDMENT RETROFITTING

EXEMPTION APPLICATION

For

Allied Corporation
Metropolis Works
Metropolis, Illinois

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Submitted to

U.S. Environmental Protection Agency - Region V

November 7, 1986

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EXECUTIVE SUMMARY

Allied Corporation's Metropolis Works has worked with the Illinois Environmental Protection Agency and the U.S. Environmental Protection Agency over the history of their joint existences to protect the environment. Most specifically, with regard to wastewater discharges from the facility, Allied Corporation has cooperated fully with the regulatory agencies to minimize fluoride discharges to the Ohio River. The wastewater treatment process, which was approved by the regulatory agencies, involves the precipitation of fluoride as a calcium fluoride sludge in wastewater treatment settling ponds (surface impoundments) built specifically for that purpose at the Metropolis plant.

Allied has continued to work with the regulatory agencies through the passage and implementation of the Resource Conservation and Recovery Act and its amendments, the Hazardous and Solid Waste Amendments (HSWA) of 1984. Allied's efforts have included complying with the RCRA groundwater monitoring system requirements and other Interim Status requirements for continued operation of the plant including the submittal of a RCRA Part B Permit Application.

It is Allied's understanding that this Part B Permit may be one of the first two land activity permits issued in the State of Illinois. The Part B Permit Application incorporates a closure plan which centers on the ultimate recycling of the calcium fluoride sludges and the clean closure of the impoundments in approximately the year 2020.

Currently, the ultimate status of the surface impoundments depends upon the application of the Minimum Technology Requirements as defined in the HSWA. It is Allied's contention that the Metropolis surface impoundment design and operation conform to the performance standards described in Section 3004(o)(1)(A) of the HSWA.

Since U.S. EPA and Illinois EPA technical staff have questioned the Metropolis impoundments' conformance with Minimum Technology Requirements (even though HSWA does not address the specific design of the Metropolis impoundments) Allied has developed the enclosed complete application for a Section 3005 (j)(4) retrofitting variance. This variance requires the owner or operator of a qualifying Interim Status facility to demonstrate that there will be no migration of hazardous constituents to surface water or groundwater at any time in the future. Allied's intention to pursue this variance was discussed with Region V and Illinois EPA staff on 28 August 1986. This discussion is

centered on a work plan developed by Allied and WESTON to meet the requirements of the 3005 (j)(4) requirements as identified in the "Interim Status Surface Impoundments Retrofitting Variances Guidance Document" dated July 8, 1986. Subsequent to this meeting, Allied made modifications to the work plan based on suggestions from U.S. EPA and IEPA staff. The work plan was implemented during September and October, 1986 and has resulted in the preparation of this application.

In developing this variance request, Allied has analyzed and evaluated the engineering design and operation of the surface impoundments, conducted a waste characterization of the liquids and the solids, initiated an analysis of the compatibility of the waste with the liner and developed a detailed description of the geology and hydrogeology of the area beneath the impoundments.

The information and data resulting from these analyses were incorporated in a numerical simulation of the migration of impoundment fluids from a hypothetical leak in the flexible membrane liner. The numerical model selected for this analysis conformed both to the requirements described in the retrofitting variance guidance document and to suggestions offered by the U.S. EPA Region V staff.

The conclusions of this evaluation strongly support Allied's contention that there is no potential for migration of hazardous constituents to the groundwater or surface water based on the design, operation, and location characteristics of the impoundments at Metropolis, Illinois.

The primary controlling factors restricting the migration of fluids from the impoundments are the extremely low permeability of the natural clay formation beneath the impoundments and the effect of the waste to further reduce the permeability of the soils.

SECTION 4

SITE GEOLOGY AND HYDROGEOLOGY

To meet U.S. EPA requirements for the "no migration" exemption as defined in Section 4 of the Retrofitting Variance Guidance document (EPA/530-SW-86-017) , a geologic investigation was initiated at the Allied Metropolis Works site. The focus of the investigation was to characterize the unsaturated zone (vadose zone) below the settling ponds. Detailed soil stratigraphic columns were developed and numerous soil samples were obtained for geotechnical analysis to provide the necessary data to perform a detailed hydrogeologic analysis including the interaction between the ponds and the underlying soils.

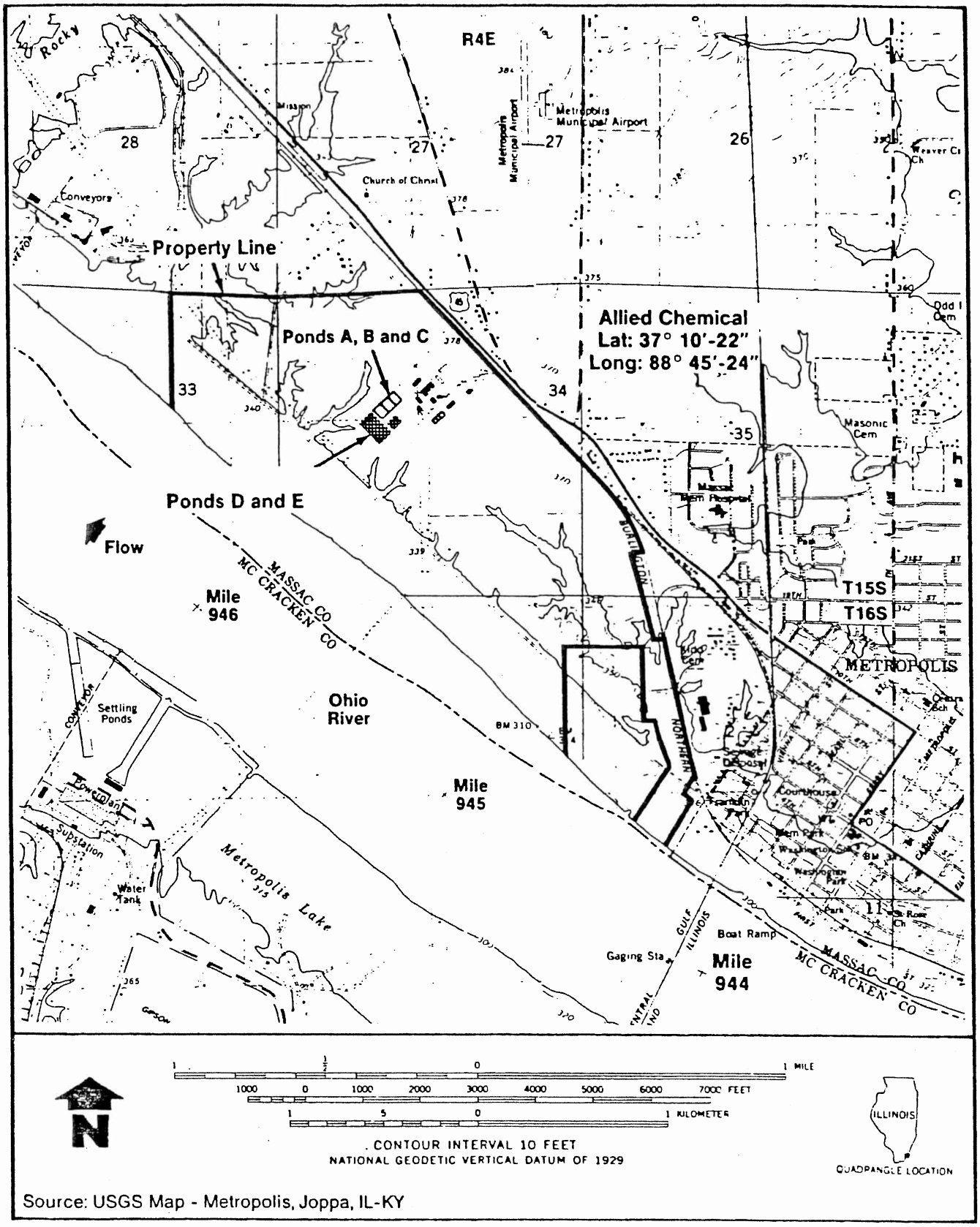
The following section on site geology and hydrogeology is structured so as to provide the permit writer with the following:

- Sufficient background information regarding regional and local geology (primarily obtained from the RCRA Part B Application, March 1985 -- Allied Metropolis Works);
- All geotechnical data necessary to characterize the unsaturated zone;
- Detailed analysis of potential flow characteristics within the unsaturated zone on which to base numerical flow modeling;
- Description of an idealized section of the unsaturated zone incorporating all data and interpretations presented in the preceding subsections.

4.1 SITE SETTING

4.1.1 Topography and Physiography

Allied Metropolis Works is located approximately 1.5 miles northwest of Metropolis, Illinois. According to the Metropolis-Joppa, IL-KY quadrangle map (published by USGS), the site is in the W 1/2, NE 1/4, and SE 1/4, NW 1/4 of Section 34, T.15S., R.4E., of Massac County. Refer to Figure 4-1 for the site location. The facility lies within the northern edge of the Coastal Plains physiographic province and beyond the southern extent of continental glaciation. The deposits are typical of pro-glacial and glacial margin environments showing the presence of outwash sands and gravels, lake deposits consisting of silts and clays and windblown loess. The unconsolidated sediments are underlain by rocks that are Mesozoic-aged and younger.



Source: USGS Map - Metropolis, Joppa, IL-KY

FIGURE 4-1 SITE LOCATION MAP

The site is approximately one-half mile northeast of the Ohio River at an elevation between 370 to 380 MSL (Mean Sea Level). The river pool elevation is 290 MSL due to the controls at Lock and Dam No. 53. The Allied Metropolis Works is located on a bluff which is dissected by several ravines that are approximately 30 to 40 feet deep, and are graded to a narrow bench or terrace that is located approximately 30 to 50 feet above the Ohio River.

4.1.2 Climatology and Surface Conditions

The Metropolis area has a continental climate typical of the southern Illinois region. Temperature maximums exceed 100°F during two of every three summers and temperature minimums drop below 0°F during one of every two winters. Local precipitation data was obtained from the Paducah, Kentucky Airport and from the Massac, Pope and Harden Tri-County Soil Survey. The data is presented in Appendix F.2.

Precipitation is evenly distributed throughout the year, each month generally having four to seven days during which precipitation exceeds 0.1 inch. The wettest months are January through June and the driest months are September and October. Major droughts are infrequent. Summer precipitation mostly occurs in short showers; however, a single thunderstorm often produces more than one inch of rain. Total annual precipitation averages approximately 46 inches. Using EPA publication 600/8-83-030, November 1983, a potential evapotranspiration for the Metropolis area is approximately 30 to 33 inches per year. Annual runoff is estimated to be 15 to 20 inches per year.

The surface soil at the Allied Metropolis Works site is the Weir silt loam which extends up to 2.5 feet below the surface. It is generally a low permeability soil (0.2-0.6 inches per hour) and has an available water capacity ranging from 0.20 to 0.25 inches per inch of soil. The slopes surrounding the site range from 1 to 3 percent which, combined with the low permeability, favor sheet runoff.

4.2 SITE STRATIGRAPHY

The soils present at the facility are Pleistocene-aged sediments and consist of the following stratigraphic units:

- Cahokia Alluvium - Recent river deposits which are derived from erosional processes up to the present time. Typically, it is comprised of a poorly-sorted sand, silt or clay and has localized sandy gravel deposits.

- Carmi Member of the Equality Formation - Predominantly quiet-water lake sediments consisting of well-bedded silts and clays.

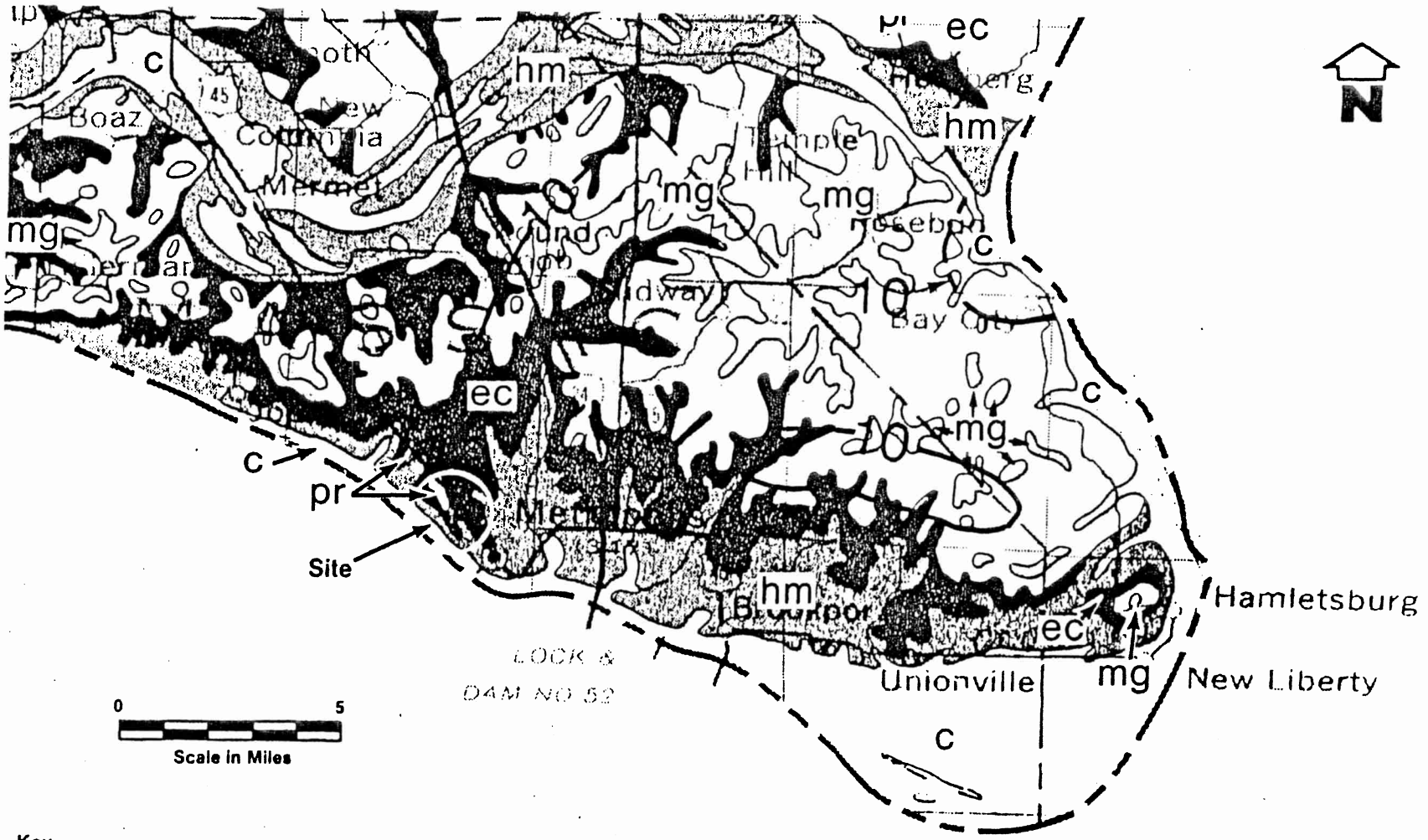
- Mackinaw Member of the Henry Formation - Glacial outwash from former valley trains. Generally a well-sorted sand or gravel with localized clay or silt deposits.

- Peoria Loess and Roxanna Silt - Windblown silt with local lenses of fine-grained sand.

The bluff on which the site is located is composed of the Carmi Member of the Equality Formation. Directly underlying this formation is the Mackinaw Member of the Henry Formation. This deposit is exposed along the face of the bluff down to the remnant terrace. The youngest deposits which overlie the face and top of the upper bluff are the windblown Peoria Loess and Roxanna Silt (Figure 4-2).

The bedrock underlying the alluvial Pleistocene sediments are the Cretaceous-aged McNairy Sandstone (Figure 4-3). The sandstone is poorly to moderately indurated and is typically white to light gray in color. The McNairy Sandstone is approximately 150 to 200 feet thick in the vicinity of the site. A black, lignitic shale or siltstone underlies the sandstone sediments and can be as much as 70 feet thick. Mississippian-aged St. Louis Limestone unconformably underlies the Cretaceous rocks. The Cretaceous formations are eroded and thin out approximately 10-20 miles inland from the site, exposing the Mississippian rocks (Geologic Map of Illinois, 1967; Handbook of Illinois Stratigraphy, Bulletin 95, 1975).

Several hydrogeologic and geotechnical investigations have been performed in the past seven years at the Allied Metropolis Works' plant. Wells and soil borings have been installed which provide sufficient information to map the soil stratigraphy below the site. According to these data, 80 to 90 feet of unconsolidated Pleistocene sediments overlie the McNairy Sandstone in the vicinity of the site. Cross-sections have been developed from past reports. Recently, two more sections have been prepared. Refer to Figure 4-4 through 4-6, for location of borings and detailed cross-sections. These sections include data obtained in September 1986 along with other borings made in the past seven years. The information obtained in the most recent investigation was focused on the soils of the Carmi Member of the Equality Formation, the uppermost unit, down to approximately 40 to 45 feet below the surface. The soils encountered were generally, bedded silty clays and clayey silts with occasional clayey to silty sand lenses. These sediments are derived from low energy or quiet-water lake environments. Field observations also note that iron staining was present in the bedded sediments which is due to weathering processes and is reflective of unsaturated soil conditions.



Key

c	Cahokia Alluvium - Poorly Sorted Sand, Silt and Clay Deposited on Floodplains and In Channels of Modern Rivers
hm	Mackinaw Member of Henry Formation - Sand and Gravel Outwash Along Former Valley Trains
ec	Carmi Member of Equality Formation - Quiet-Water Lake Sediment Dominated by Well-Bedded Silt
pr	Peoria Loess and Roxanna Silt - Windblown Silt More than 20 Feet Thick On Uplands
mg	Mounds Gravel (Pliocene) - Terrace Remmants On Uplands Characterized by High Chert Content
10	Thickness of Loess Deposits Where Less Than 20 Feet

White Areas On Map Indicate That Rocks Older Than Pliocene Are Exposed At the Surface

Source: Illinois State Geological Survey, 1979

FIGURE 4-2 SURFICIAL DEPOSITS MAP

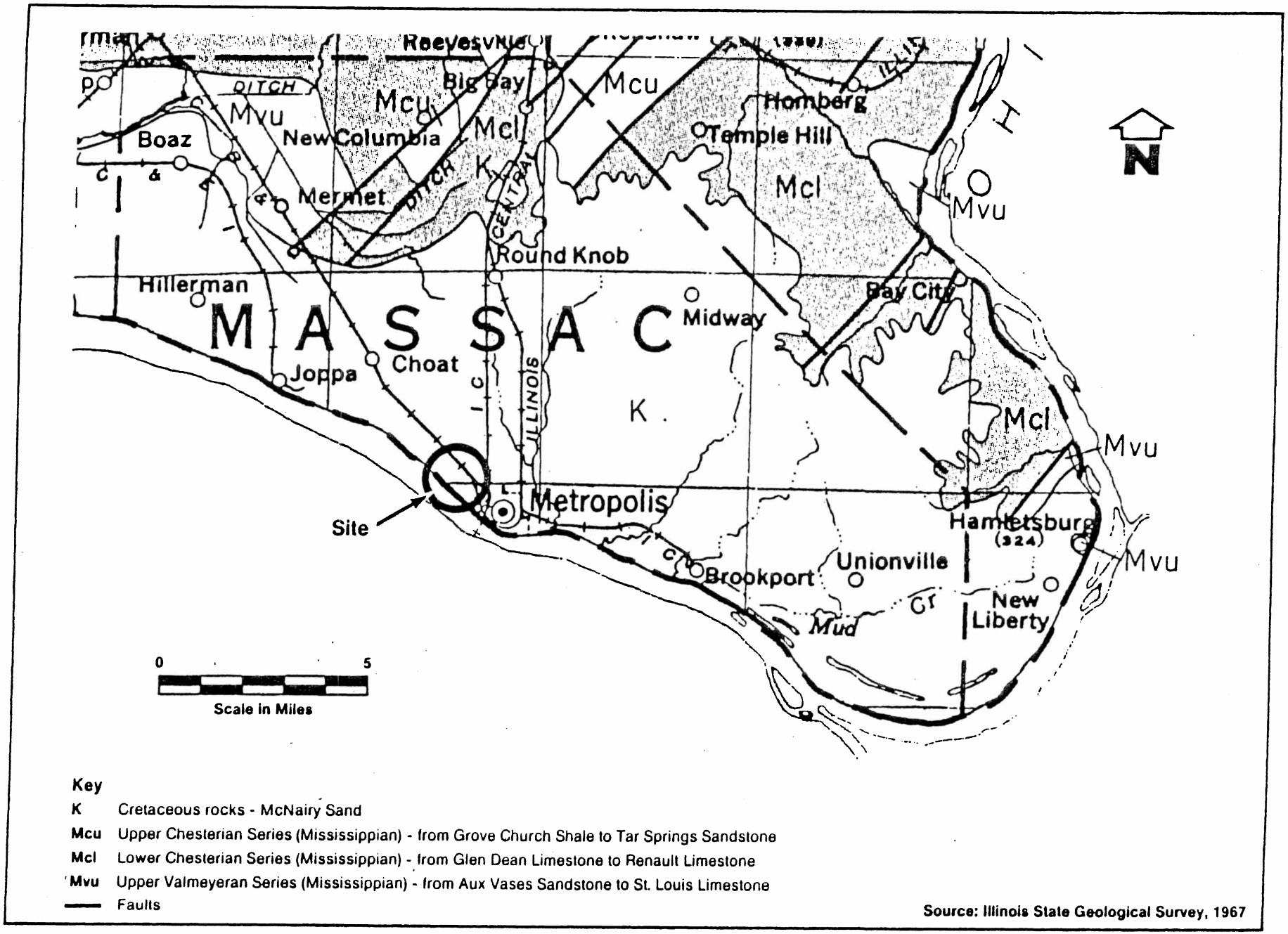
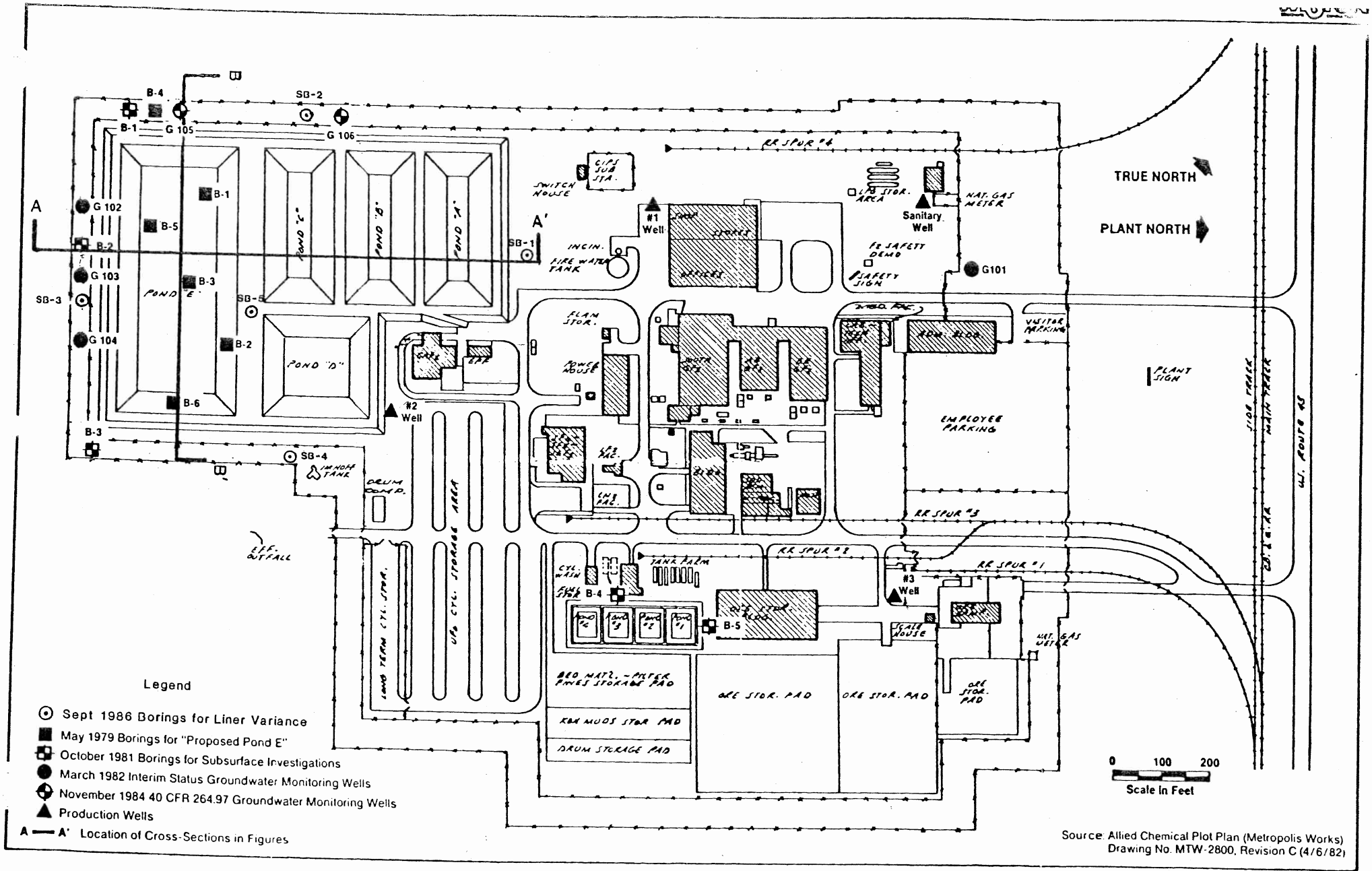
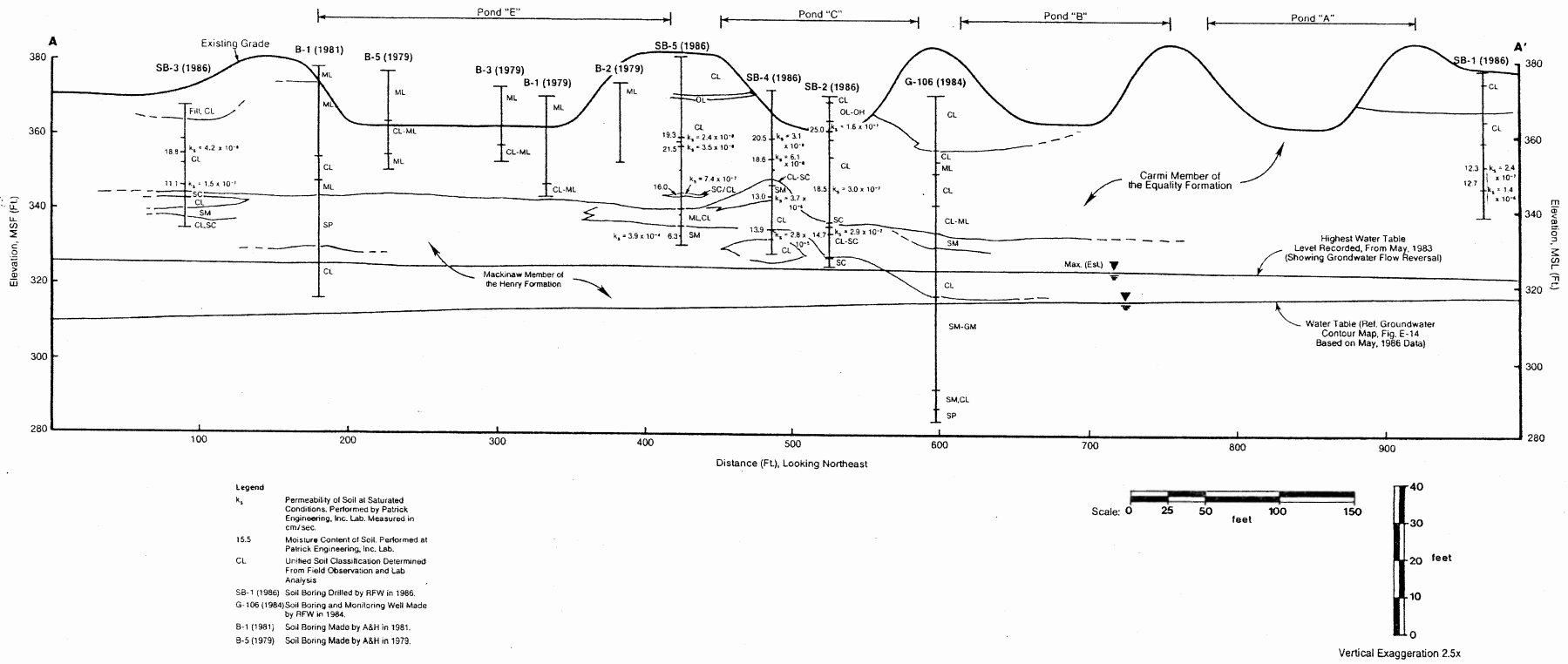


FIGURE 4-3 BEDROCK GEOLOGY MAP



Source: Allied Chemical Plot Plan (Metropolis Works) Drawing No. MTW-2800, Revision C (4/6/82)

FIGURE 4-4 LOCATIONS OF BORINGS



Legend

k_s	Permeability of Soil at Saturated Conditions. Performed by Patrick Engineering, Inc. Lab. Measured in cm/sec.
15.5	Moisture Content of Soil. Performed at Patrick Engineering, Inc. Lab.
CL	Unified Soil Classification Determined From Field Observation and Lab Analysis
SB-1 (1986)	Soil Boring Drilled by RFW in 1986.
G-106 (1984)	Soil Boring and Monitoring Well Made by RFW in 1984.
B-1 (1981)	Soil Boring Made by A&H in 1981.
B-5 (1979)	Soil Boring Made by A&H in 1979.

FIGURE 4-5 HYDROGEOLOGIC CROSS SECTION FOR A-A'

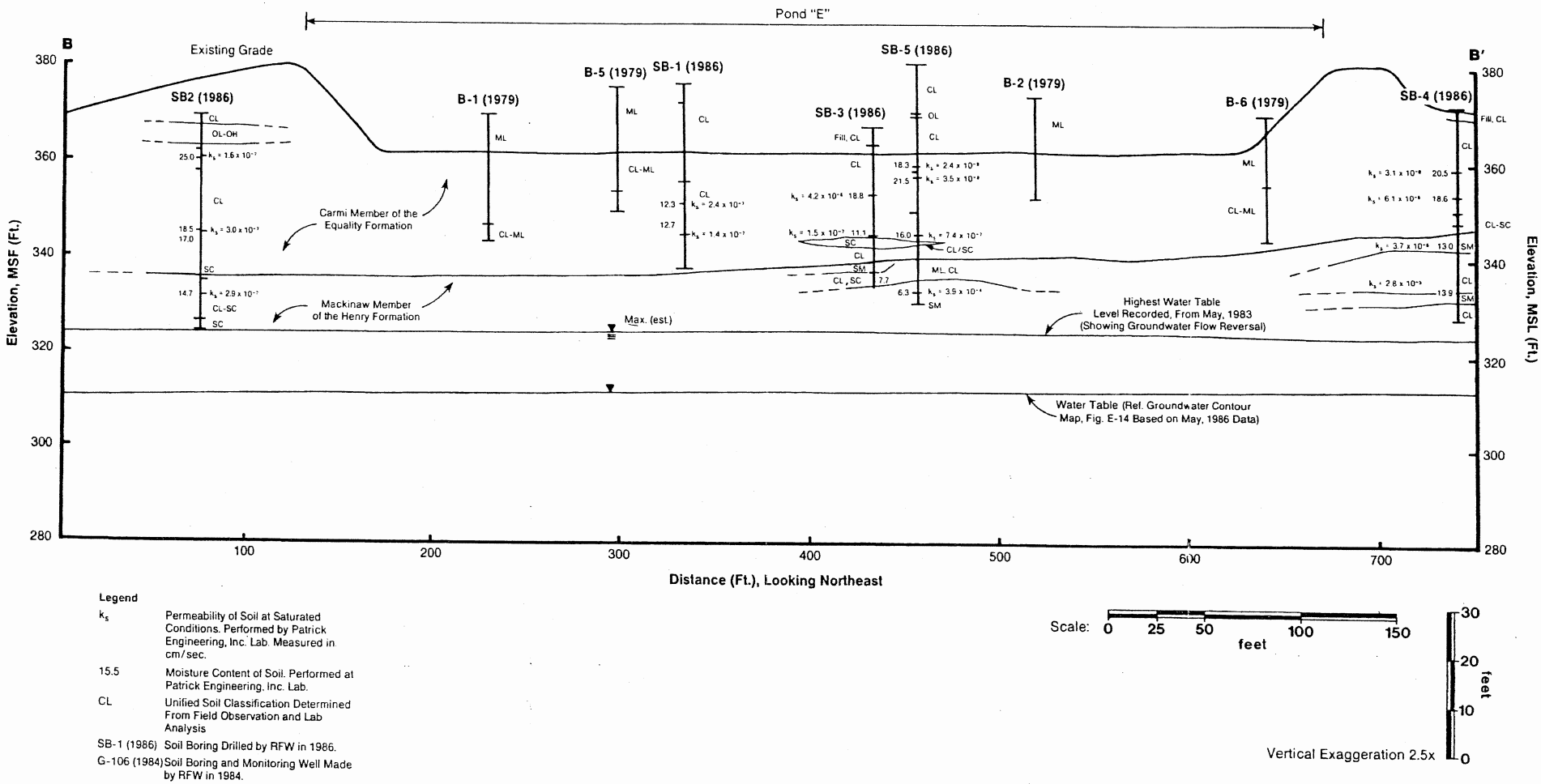


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FIGURE 4-6 HYDROGEOLOGIC CROSS SECTION FOR B-B'

According to previous borings, the Carmi Member is 20 to 55 feet thick (approximately between 375 feet and 344 feet above MSL). According to the detailed, stratigraphic cross-sections prepared from earlier studies, it appears that the bedded sediments tend to thin out towards the Ohio River. Included in the Carmi Member are windblown (eolian) Peoria and Roxanna silts. These sediments may be as much as 20 feet thick although the silt deposits were not encountered in the most recent borings. Generally, the windblown silt deposits thicken away from the bluffs, toward Highway 45.

Four borings penetrated the Mackinaw Member of the Henry Formation between 20 to 40 feet below grade. It is composed of well-sorted (poorly-graded) sand and silty sand with occasional gravel. There are occasional silty clay layers within the Mackinaw Member, that are both localized and extensive in the vicinity of the site. The outwash sands of the Mackinaw Member are also bedded, reflecting paleo drainage systems in the pro-glacial environments. This unit is typically 35 to 65 feet thick below the facility. The top of the Mackinaw Member is approximately 344 feet above MSL in the vicinity of the Allied Plant. The Mackinaw Member also tends to thin out towards the Ohio River due to ongoing erosion. Along the river, Recent Cahokia Alluvium is present and most likely overlies the Cretaceous-aged rocks.

The wells at the site indicate that sandstone bedrock is present below the Pleistocene sediments. The bedrock, which is the McNairy Sandstone, is flat-lying in the Metropolis area and occurs at depths of 80 to 90 feet below the surface (approximately 290 feet above MSL). As mentioned earlier, a lignitic shale unit, referred to as the Levings Member, is approximately 70 feet thick and underlies the upper sandstones. A lower sandstone unit occurs below the Levings Member, giving the Cretaceous rocks a total thickness of 130 to 160 feet. The Mississippian-aged St. Louis Limestone underlies the lower sandstone unit. Well data indicates the limestone is more than 80 feet thick in the Metropolis area.

4.3 GROUNDWATER OCCURRENCE AND FLOW

4.3.1 Water Table Conditions

A summary of depth to groundwater readings for on-site monitor wells is given in Table 4-1. Well construction data indicates the water level to be within the screened interval. Relating this information to the stratigraphy of the area as discussed in Section 4.2, it is apparent that the water table, or phreatic surface, occurs within the sandy deposits of the Mackinaw Member of the Henry Formation. This observation is also consistent with water level readings recorded in on-site borings performed in 1979, 1981, and 1982.

TABLE 4-1

GROUNDWATER ELEVATION DATA
INTERIM STATUS MONITORING WELLS

	Upgradient Well G101	Downgradient Wells G102	G103	G104
Well Construction Data				
Top of Casing	377.53	363.52	367.91	372.49
Top of Screen	319.38	320.64	323.95	327.99
Bottom of Screen	294.38	295.64	298.95	302.99
Groundwater Elevations				
June 1982	*318.2	310.5	310.9	310.5
September 1982	317.3	306.3	306.6	307.0
December 1982	316.2	303.9	304.3	<304.9
March 1983	317.8	310.5	310.8	311.0
May 1983#	321.3	325.2	325.1	324.9
August 1983	320.2	307.1	307.6	308.2
September 1983	317.4	306.3	306.6	307.0
November 1983	317.8	304.5	304.8	305.3
December 1983	318.2	311.3	311.6	311.6
February 1984	318.0	308.5	308.9	308.9
May 1984	321.2	320.4	320.3	320.1
August 1984	321.4	309.9	310.2	310.7
November 1984	318.4	306.5	306.7	306.6

* This elevation was determined on March 12, 1982 to satisfy the requirements for issuance of an operating permit by the Department of Land/Noise Pollution Control for the Calcium Fluoride Recovery ponds.

\# Temporary flow reversal in the uppermost aquifer. Flood levels in the Ohio River reached Elevation 332.5 feet (MSL).

Recharge to the water table aquifer generally occurs through percolation of rain water through the silty soils. Discharge is generally from the aquifer into the Ohio River, however in lower elevations, water actually flows downward in an intermediate flow system recharging the underlying upper McNairy Sandstone aquifer (refer to Appendix F.1).

4.3.2 Underlying Aquifers

Three deeper aquifers are noted below the Allied site. The first is the McNairy Sand of Cretaceous Age, the second is the lower McNairy Sand of Cretaceous Age and the third is the St. Louis Limestone of Mississippian Age.

Four deep wells exist on site which supply water to the plant. Water level recorded on well logs from these boreholes show the McNairy Sand to be an unconfined aquifer in direct hydraulic connection with the water table aquifer in the Mackinaw Member of the Henry Formation.

There are deep wells on the site which penetrate the Cretaceous sandstones and the Mississippian limestones. The well logs indicate that both the lower McNairy Sand and the St. Louis Limestone are confined and considered hydraulically independent of the shallower unconfined aquifers (see Appendix F.1). The lower McNairy Sandstone is effectively confined by the fairly impermeable Levings Member and the crevassed zones of the St. Louis Limestones are confined by dense cherty zones near the top of that formation.

4.3.3 Groundwater Flow Conditions

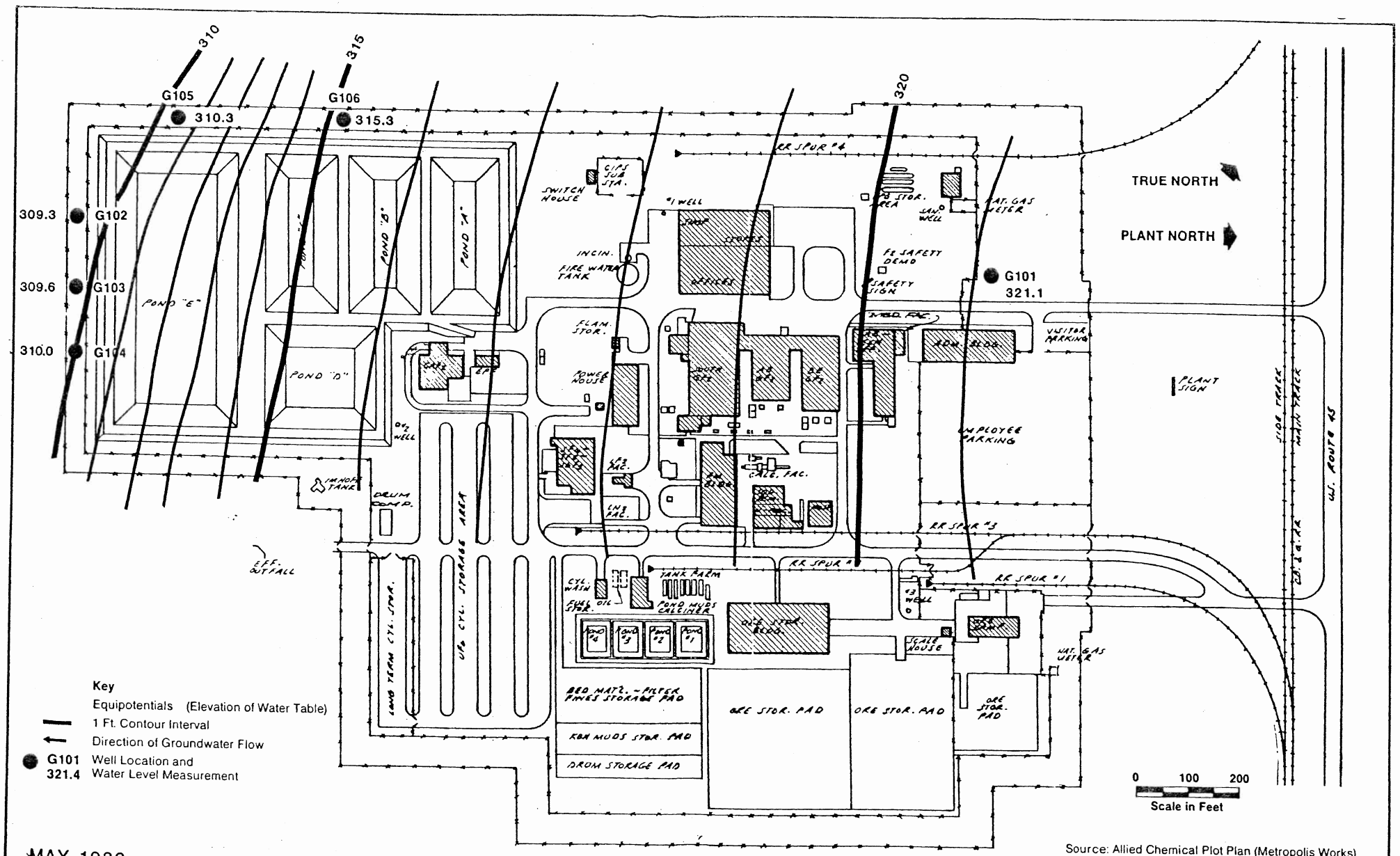
A water table contour map has been developed from water levels recorded at the various monitor well locations (Figure 4-7). The water table slopes from northeast to southwest with flow directions ranging from S50°W. To S55°W. The gradient ranges from .00049 to .0071 ft/ft.

To estimated groundwater flow velocities, Darcy's Law is applied using the following equation:

$$V=\frac{ki}{Ne}$$

Where, V = Average linear velocity
k = Hydraulic conductivity
i = Hydraulic gradient
Ne = Effective porosity.

The hydraulic conductivities for the Mackinaw Member of the Henry Formation range from 1×10^{-3} cm/sec (2.8 ft/day) to 2.2×10^{-2} cm/sec (56.7 ft/day) (see Appendix F.1). Typical porosity values for fine sand are estimated from the literature to range from 40 to 50 percent (Bouwer, 1978). Due to the dense and silty nature of the soil, a value of 40 percent is believed representative of site conditions.



Source: Allied Chemical Plot Plan (Metropolis Works) Drawing No. MTW-2800, Revision C (4/6/82)

FIGURE 4-7 WATER TABLE MAP AND GROUNDWATER FLOW

Using the above values, a range of horizontal groundwater flow velocities for the water table aquifer is estimated to be from 0.0034 ft/day to 1.0 ft/day. The variation in flow rate is therefore strongly related to the hydraulic gradient which is greatly affected by seasonal water table fluctuations. Using average water levels recorded for a two year period (1982 to 1984) from on-site monitor wells, an average annual gradient is approximated to be 0.0044 ft/ft. The resulting average annual flow rate therefore ranges from 0.031 ft/day to 0.62 ft/day.

The historical groundwater level data from the Metropolis plant monitor wells indicates that temporary flow reversals occur within the water table aquifer on a periodic basis. The flow reversal is associated with the occurrence of flood conditions in the Ohio River. The duration of reversal events generally ranges from 10 to 34 days however a series of multiple events may extend the flow reversal for up to 58 days (refer to Appendix F.1).

4.4 HYDRAULIC AND ENGINEERING PROPERTIES OF THE UNSATURATED ZONE

4.4.1 General

In September 1986, WESTON performed five soil borings using a five-foot split-barrel sampler. Samples were obtained on a continuous basis to obtain a detailed stratigraphy of the soils underlying the ponds at the Allied Metropolis site. The borings penetrated the Carmi Member of the Equality Formation with depths ranging from 32.5 to 50.0 feet below grade. Shelby tube samples were used to obtain undisturbed soil samples at predetermined depths, using the data on the boring logs. Each borehole was offset approximately five feet or less from the original borehole for the Shelby tube samples. Soil samples were sent to the Patrick Engineering, Inc. laboratory in Glen Ellyn, Illinois and the Earth Resources Technology Laboratory in Garden Grove, California for geotechnical analysis. The samples were analyzed for grain size distribution, moisture content, density, Atterberg Limits, triaxial permeability (horizontal and vertical), cation exchange capacity (CEC) and unsaturated flow characteristics.

4.4.2 Grain Size Distribution

To classify the soil types present below the settling ponds, grain-size distribution analyses were performed on Shelby tube samples. A total of 16 grain-size analyses were performed using ASTM D-422-63 procedures. A hydrometer was used in conjunction with the standard sieves to quantify the silt and clay fractions. Analytical results are summarized in Table 4-2 and presented in graph form in Appendix E.1.

TABLE 4-2
SUMMARY OF GEOTECHNICAL DATA
ALLIED METROPOLIS WORKS

Boring No.	Sample No.	Sample Depth (ft.)	USCS	% Gravel	% Sand	% Silt/ Clay	USDA	% Gravel	% Sand	% Silt	% Clay	W_c %	γ_d (pcf)	LL	PI	Total Organic Matter (%)	HYDRAULIC CONDUCTIVITY TESTING: Sample Size h (in.)	Sample Size ø (in.)	Consol. γ_d (pcf)	Coefficient of Saturated Hydraulic Conductivity k_v (cm/sec.)	Coefficient of Saturated Hydraulic Conductivity k_h (cm/sec.)	CEC (meq/100g)
SB-1	3	22.5-25.0	CL	0	5	95	Silt Loam	0	11	61	20	12.3	119.9	37	21	0.8	2.03	2.87	120.5	2.4×10^{-7}		10.8
SB-1	4	29.0-30.0	CL-ML/ SC	0	33	67	Sandy Clay Loam	0	42	33	25	12.7	109.3	29	16	4.4	2.04	2.87	109.9	1.4×10^{-6}		6.53
SB-1	5	30.0-30.7	CL-ML											25	6							
SB-2	1	8.0-9.4	CL	3	9	88	Clay	9	9	55	27	25.0 25.0	100.2 98.8	42	19	3.6	2.08 2.19	1.38 1.43	101.8 100.4	1.6×10^{-7}	7.8×10^{-8}	4.08
SB-2	5	24.0-25.8	CL	0	14	86	Silty Clay Loam	0	20	52	28	18.5	106.3	39	21	6.1	2.09	2.85	107.5	3.0×10^{-7}		9.65
SB-2	6	34.0-36.3	CL	0	48	52	Sandy Clay Loam	0	56	22	20	14.7	113.1	29	16	0.0	2.05	2.87	113.8	2.9×10^{-7}		7.92
SB-3	1	6.0-8.0	CL	0	2	98	Silty Clay Loam	1	6	65	28	20.4 20.8	98.1 100.0	35	16	0.0	1.91 2.04	1.47 1.46	99.1 100.9	1.6×10^{-7}	3.6×10^{-7}	8.92
SB-3	3	12.0-13.3	CL	0	6	94	Silty Clay Loam	0	12	58	30	18.8	104.2	45	26	3.3	1.95	2.86	106.0	4.2×10^{-8}		10.2
SB-3	4	20.0-21.4	CL	0	42	58	Loam	1	48	29	22	11.1	109.1	26	11	1.4	2.22	2.87	110.6	1.5×10^{-7}		7.64
SB-4	1	11.5-13.5	CL	0	4	96	Silty Clay Loam	0	8	62	30	20.0 20.8	105.6 101.8	42	24	3.3	2.11 2.01	1.46 1.47	106.8 103.0	3.1×10^{-8}	9.1×10^{-8}	9.76
SB-4	3	17.0-19.0	CL	1	7	93	Silt Loam	1	14	60	25	18.6	107.8	35	18	2.4	2.10	2.84	109.9	6.1×10^{-8}		9.78
SB-4	5	27.3-28.7	SM	0	75	25	Loamy Sand	0	80	1	19	13.0	107.1	N/A		3.6	2.14	2.87	107.9	3.7×10^{-6}		5.58
SB-4	6	37.0-39.0	SM	0	80	20	Loamy Sand	0	83	6	11	13.9	102.7	N/A		1.6	2.90	2.86	102.7	2.8×10^{-5}		12.0
SB-5	1	20.0-22.0	CL	0	6	94	Silty Clay Loam	0	15	54	31	19.4 19.2	108.0 106.9	38	20	2.9	2.17 2.03	1.45 1.46	109.8 107.9	1.4×10^{-6}	2.4×10^{-8}	9.25
SB-5	2	22.1-24.3	CL	0	6	94	Silty Clay Loam	0	12	59	29	20.9 21.9	102.1 102.1	48	29	3.3	2.07 1.96	1.42 1.42	103.6 105.7	3.5×10^{-8}	5.5×10^{-8}	12.9
SB-5	5	35.8-37.4	CL/SC	0	44	56	Sandy Clay Loam	0	48	27	25	16.0	108.0	24	8	1.3	1.99	2.89	103.8	7.4×10^{-7}		6.14
SB-5	6	47.0-48.2	SM	0	83	17	Loamy Sand	0	83	2	15	6.3	102.4	N/A		0.1	2.26	2.80	103.0	3.9×10^{-4}		8.61

2.0×10^{-7}
GEO, mean

Based on results of the geotechnical testing, the predominant soil types immediately underlying the ponds are silty clays and are designated as CL in the Unified Soil Classification System (silty clay loam, silt loam or sandy clay loam using the U.S. Department of Agriculture classification system). The grain size distribution data indicates that the silty clay soils from the Carmi Member have 0 to 3 percent gravel 2 to 48 percent sand and 52 to 98 percent silt/clay combinations. For the Shelby tubes which penetrated the Mackinaw Member, soils were classified as silty sand (SM) had 75 to 83 percent sand and 17 to 25 percent silty-clay combinations.

4.4.3 Moisture Content

Moisture content of the soils were obtained in order to determine the degree of soil saturation. Samples were taken from the Shelby tubes for representative moisture characteristics of the soils underlying the ponds. There were a total of 21 moisture content analyses performed on 15 separate soil samples using ASTM D-2216-80 procedures. Five duplicates were taken from various samples. The results of these duplicates demonstrate the consistency in moisture content values. The data is summarized in Table 4-2 and detailed in Appendix E.1.

The moisture content data indicate a range of moisture contents between 6.3 and 25 percent under field conditions. By calculating the saturated moisture contents for each sample, the degree of saturation can be measured. Table 4-3 summarizes moisture and density data and includes the calculated degree of saturation (all values below 100 percent are considered unsaturated). According to these values, the soils of the Carmi Member and the upper portion of the Mackinaw Member are unsaturated. The values typically decrease with depth within the Carmi Member and in zones of higher sand content. Sandy soils (SM) from the Mackinaw Member show a much lower moisture content than the clayey soils (CL) of the Carmi Member.

4.4.4 Atterberg Limits

The Atterberg Limits are used for determining the liquid limit and plasticity index of soils. These are used to classify soils in the Unified Soil Classification System. Tests were performed on selected Shelby tube samples using procedures in accordance with ASTM D-4318 guidelines. The results of analyses are summarized in Table 4-2.

A total of fourteen Atterberg Limit analyses were performed. The results of the Atterberg Limits confirm the field classifications based on field observations and grain size distribution results. As discussed earlier, most of the soils encountered in the Carmi Member are classified as silty

TABLE 4-3 SUMMARY OF DATA USED TO CALCULATE DEGREE OF SATURATION
ALLIED METROPOLIS WORKS

BORING NUMBER	SAMPLE NUMBER	DEPTH IN FEET	DRY BULK DENSITY PCF	DENSITY G/CC	SOLIDS DENSITY G/CC	SOLIDS %	POROSITY %	SAT MOISTURE %	FIELD MOISTURE %	SATURATIO %
SB-1	3	22.5-25.0	119.9	1.92	2.65	72.4	27.6	14.4	12.3	85.5
SB-1	4	29.0-30.0	109.3	1.75	2.65	66.0	34.0	19.4	12.7	65.3
SB-2	1	8.0-9.4	98.8	1.58	2.65	59.7	40.3	25.5	25.0	97.9
SB-2	5	24.0-25.8	106.3	1.70	2.65	64.2	35.8	21.1	18.5	87.8
SB-2	6	34.0-36.3	113.1	1.81	2.65	68.3	31.7	17.5	14.7	83.9
SB-3	3	12.0-13.3	104.2	1.67	2.65	62.9	37.1	22.2	18.8	84.5
SB-3	4	20.0-21.4	109.1	1.75	2.65	65.9	34.1	19.6	11.1	56.8
SB-4	1	11.5-13.5	105.6	1.69	2.65	63.8	36.2	21.4	20.0	93.2
SB-4	1	11.5-13.5	101.8	1.63	2.65	61.5	38.5	23.7	20.8	87.9
SB-4	3	17.0-19.0	107.8	1.72	2.65	65.1	34.9	20.2	18.6	91.9
SB-4	5	27.3-28.7	107.1	1.71	2.65	64.7	35.3	20.6	13.0	63.0
SB-4	6	37.0-39.0	102.7	1.64	2.65	62.0	38.0	23.1	13.9	60.1
SB-5	1	20.0-22.0	108.0	1.73	2.65	65.2	34.8	20.1	19.4	96.4
SB-5	1	20.0-22.0	106.9	1.71	2.65	64.5	35.5	20.7	19.2	92.6
SB-5	2	22.1-24.3	102.1	1.63	2.65	61.6	38.4	23.5	20.9	89.0
SB-5	2	22.1-24.3	102.1	1.63	2.65	61.6	38.4	23.5	21.9	93.3
SB-5	5	35.8-37.4	108.0	1.73	2.65	65.2	34.8	20.1	16.0	79.5
SB-5	6	47.0-48.2	102.4	1.64	2.65	61.8	38.2	23.3	6.3	27.0

Note: All analyses were performed on undisturbed Shelby tube samples.
A degree of saturation less than 100% indicates that the soil is not saturated.

clays (CL) with occasional silty sand (SM) or clayey sand (SC) deposits.

4.4.5 Total Organic Matter

Total organic matter (TOM) tests were performed on sixteen selected Shelby tube samples to determine the weight percentage of moisture, ash and organic matter in the soil. Total organic matter tests were performed in accordance with ASTM D-2974 procedures. Samples were placed in a muffle furnace for 24 hours to determine the organic content which is done by comparing samples on a before and after weight basis. Total organic matter results are summarized in Table 4-2.

Reviewing the data reveals the total organic contents to range from 0 to 6.1 percent.

4.4.6 Triaxial Permeability - Distilled Water Permeant

To characterize the permeability and hydraulic conductivity of the soils beneath the impoundments, triaxial permeability tests were performed on undisturbed Shelby tube samples from depths of 8 to 48 feet below grade. The testing was performed in accordance with U.S. Army Corps. of Engineers procedures defined in Manual EM-1110-2-1906. A total of 16 vertical permeabilities were measured. In addition, horizontal permeabilities were also measured for five samples corresponding to the elevation of the pond bottoms. Comparison of the vertical and horizontal permeabilities from the same sample were used to quantify the anisotropic ratio of the Carmi Member clays. To determine the horizontal permeability, a core was carefully trimmed to approximate the sample size used for vertical permeability. (Sample sizes were typically 2 to 3 inches in height and 1.4 to 2.9 inches in diameter, however horizontal cores were generally slightly smaller). The sample core was then stood on end and analyzed using the procedures described above. The permeability data is summarized in Table 4-2. All test and QA/QC procedures are detailed in Appendix E.2.

The majority of the permeability analyses were performed on samples obtained from the silty clays of the Carmi Member. Vertical permeabilities were found to range from 1.4×10^{-6} cm/sec (1.45 ft/yr) to 2.5×10^{-8} cm/sec (0.025 ft/yr). Vertical permeabilities on the sandier soils of the Mackinaw Member ranged from 3.9×10^{-4} cm/sec (393.6 ft/yr) to 3.7×10^{-6} cm/sec (3.83 ft/yr).

Horizontal permeabilities of the five samples tested were found to range from 5.6×10^{-7} cm/sec (0.58 ft/yr) to 5.5×10^{-8} cm/sec (0.057 ft/yr). Comparing horizontal to vertical permeabilities (Kh/Kv) it is evident that the horizontal flow vector is greater than the vertical flow component in all the tested samples except sample SB2-1. The ratio of Kh/Kv was

found to range from 1.57 to 23.3 suggesting that for every 1 cm water migrates vertically through the clays, it may migrate up to 23 cm horizontally along the thin silty fine sand seams.

The primary cause for anisotropy on a small scale is due to clay mineral orientation in unconsolidated sediments. Core samples of clays seldom show horizontal to vertical anisotropy greater than 10:1, and is usually less than 3:1 (Freeze-Cherry, 1979). On a larger scale, however, it can be shown that there is a relationship between layered heterogeneity and anisotropy (Maasland, 1957; Marcus and Evenson, 1961).

4.4.7 Triaxial Permeability -- Pond Water Permeant

To determine the effect of actual pond water on soil permeability and constituent transport, two samples (SB4-5 and SB2-6) were tested for hydraulic conductivity using Pond E water as a permeant. Pond E water was selected as the permeant as this water is believed to be representative of the five ponds.

The soil classification for SB4-5 is a silty sand (SM). The same sample showed a Kv of 3.7×10^{-6} cm/sec using the distilled water as a permeant. Approximately six pore volumes of pond water were passed through the sample during the course of the test. The first pore volume included distilled water before being completely replaced with the pond water. According to the data, the vertical permeability (Kv) was approximately 8.5×10^{-7} cm/sec at the start of the test (using distilled water). The permeability decreased slightly during the transition period (time when pond water replaced distilled water), then increased to 1.0×10^{-6} cm/sec. Throughout the remainder of the test, Kv values gradually decreased (after 5 pore volumes); The final Kv was 6.0×10^{-7} cm/sec, using a hydraulic gradient of 128. For the last pore volume, the gradient was increased such that the Kv value increased. Consequently, the Kv values beyond the fifth pore volume should be disregarded. Additional testing will be performed as to verify previous results.

The pH values were also recorded. Typically, pH decreased with time, suggesting a buffering effect by the kaolinitic soil of the Carmi Member. The pH after the first pore volume was reduced to 8.1. After 4 pore volumes, the pH was reduced to 6.1. The final pH recorded (7.3) was obtained after 5 pore volumes passed through the sample.

Using pond water as a permeant, a total of five pore volumes were passed through SB2-6. The hydraulic gradient used for this test was 543 which is higher than the gradient noted above. The gradient was increased because the amount of time required for pore volumes to pass through the sample was considerably higher. According to the data presented

previously, SB2-6 was classified as a silty clay (CL) and had a Kv of 2.9×10^{-7} cm/sec using distilled water as a permeant. The initial kv at the higher pressure was at 4.0×10^{-8} cm/sec. The final K_v value recorded has 5.5×10^{-9} cm/sec with a pH of 6.5.

Reviewing the results of vertical hydraulic conductivity for samples using distilled water and pond water as permeants, it is apparent that permeability is decreased when pond water interacts with the natural system. The initial decrease noted is a function of using higher confining pressures during testing with the pond water permeant. The increased pressure results in a decrease in void ratio thus decreasing permeability. The data, however, also show that with prolonged contact between the pond water permeant and the natural soils, under constant test conditions, permeability also decreases. This decrease is the result of the breakdown of individual crystal lattices within the kaolinitic clay structure resulting from interaction with the alkaline pond water chemistry. The breakdown of the crystalline structure results in the formation of an amorphous (noncrystalline) mineraloid. Such materials are inherently less permeable than crystalline materials as there are no defined planes of weakness or empty lattice sites which promote the migration of fluids. For a detailed discussion regarding pond water-soil interaction, refer to Section 5 of this report.

4.4.8 Unsaturated Flow Characteristics

To characterize the unsaturated flow properties of the vadose zone beneath the Metropolis impoundments, six samples were submitted to the Earth Technology Corporation's laboratory in Garden Grove, California for determination of the capillary-moisture relationship in accordance with ASTM D 3152 procedures (this relationship is also referred to as the soil- water characteristic). Seven duplicate subsamples were prepared from each of the six undisturbed Shelby tube samples. Each of the subsamples was allowed to equilibrate at tensions ranging from 0.25 to 13.7 bars (0.25, 0.5, 1.0, 2.0, 4.0, 8.0, and 13.7 bars), prior to determining the equilibrated moisture contents. The moisture contents were converted from a unit dry weight basis to a unit volume basis by multiplying the unit dry weight moisture content by the clay density of the sample and dividing by the unit weight of water. The results of these tests are summarized in tabular form on Table 4-4 and in graphical form in Appendix E.2.

The unsaturated hydraulic conductivity of these samples was calculated from the soil-water characteristic by the Campbell (1974) method. This calculation is performed by first plotting the soil-water characteristic on log-log plots. The slope of these plots are then used in the following formula:

$$K = K_{sat} \left(\frac{\theta_i}{\theta_s} \right)^{2b + 3}$$

TABLE 4-4
SUMMARY OF HYDRAULIC PROPERTIES OF SELECTED SAMPLES

BORING NO. and SAMPLE NO.	SAMPLE DEPTH (feet)	ASTM CLASS	AMBIENT MOISTURE CONTENT %	POROSITY %	SATURATED HYDRAULIC CONDUCTIVITY (cm/sec)	CAMPBELL 1 COEFFICIENT
SB-2, 2	10-12	CL	19.5	40.3	1.6×10^{-7}	78.42
SB-2, 4	22-24	CL	18.5	34.5	3.0×10^{-7}	50.04
SB-4, 2	13.5-15.4	CL	19.7	38.3	3.1×10^{-8}	71.46
SB-4, 4	25.0-27.2	SM	13.0	34.7	3.7×10^{-6}	70.16
SB-5, 3	26.0-28.1	SM	13.9	35.2	3.5×10^{-8}	102.84
SB-5, 4	34.0-35.9	CL/SC	16.0	34.7	7.4×10^{-7}	31.64

Geometric mean
1.8×10^{-7}

1 Campbell Coefficient equals 2b + 3, where b is the slope of the log-log plot of matric potential versus volumetric moisture content.

Where K_i = Relative hydraulic conductivity at a given moisture content;
K_{sat} = Saturated hydraulic conductivity;
θ_i = Moisture content; and
θ_s = Saturated Moisture content (assumed to be equal to porosity).
b = Negative one times the slope of the log-log plot of the soil-water characteristic.

The log-log plots of the soil water characteristic, showing the arithmetic relationship between the matrix potential (tension) and volumetric moisture content, are presented in Appendix E.2. The tabulated values of unsaturated hydraulic conductivity are also provided in Appendix E.2.

Over the range of tested pressures (tensions), the unsaturated hydraulic conductivity of the silty clay (CL), which generally predominates above an elevation of approximately 345 feet MSL, ranges between 6×10^{-8} and 1.4×10^{-13} centimeters per second. The unsaturated hydraulic conductivity of the silty and clayey sands (SC) which underlie the silty clay ranges from 1×10^{-8} to 4.5×10^{-15} centimeters per second over the tested range. The lower values associated with the coarser grain materials can be attributed to the lower moisture content values at comparable pressures. The arithmetic relationship between matrix potential, moisture content and unsaturated hydraulic conductivity, as determined for these soils, was used to estimate the unsaturated hydraulic conductivities at the prevailing ambient moisture contents. These values are presented on Table 4-5. It is readily apparent from these values that the magnitude of unsaturated hydraulic conductivity varies directly as a function of moisture content. As a result, the fine grained materials of the Carmi Formation exhibit greater unsaturated hydraulic conductivity values than the underlying silty and clayey sands.

4.5 SUMMARY - DESCRIPTION OF AN IDEALIZED SECTION

Based on the analysis and data presented above, an idealized stratigraphic section of the soils immediately below the ponds can be developed. For the purposes of this investigation, the stratigraphic section can be divided into three major units:

- Carmi Member
- Upper Mackinaw
- Lower Mackinaw

4.5.1 Carmi Member

The Carmi Member sediments overlie the Mackinaw Member and were the focus of this study. The bottom of the unit ranges 15 to 35 feet below the bottom of the ponds, at an elevation

TABLE 4-5
SUMMARY OF CAPILLARY - MOISTURE TEST DATA
ALLIED METROPOLIS WORKS

BORING NO.	SAMPLE NO.	DEPTH (FT)	CAPILLARY MOISTURE BY WEIGHT IN PERCENT @ 0.25 BAR 8.4 FT.	0.5 BAR 16.7 FT.	1 BAR 33.5 FT.	2 BAR 66.9 FT.	4 BAR 133.8 FT.	8 BAR 267.6 FT.	13.7 BA 458.3 F
SB-2	2	10-12	25.20	24.78	24.52	24.03	23.20	23.04	22.93
SB-2	4	22-24	18.61	18.44	18.43	17.91	16.91	16.49	16.10
SB-4	2	13.5-15.4	21.78	21.59	--	21.18	20.10	19.94	19.70
SB-4	4	25.0-27.2	18.91	18.74	--	18.28	17.52	17.38	16.87
SB-5	3	26.0-28.1	19.96	19.83	--	19.45	18.82	--	18.61
SB-5	4	34.0-35.9	14.33	13.83	12.80	12.09	11.81	11.20	11.02

between 345 and 325 feet above MSL. The sediments of the Carmi Member were deposited in a pro-glacial, low energy environment. The soils range from silty clays (CL) to clayey silts (ML), have a low plasticity, and are generally massive. Locally, however, varved zones are present consisting of thinly interbedded silty clays and silts. These varved horizons are nonconsistent throughout the site.

Saturated vertical permeabilities within the unit generally range from 3×10^{-7} cm/sec to 2.5×10^{-8} cm/sec (sandier horizons may show slightly higher permeability). Although the unit is fairly massive, horizontal permeabilities are generally greater than vertical permeabilities and were found to range from 5.6×10^{-7} cm/sec to 5.5×10^{-8} cm/sec. A comparison of vertical and horizontal permeabilities yields Kh/Kv ratio ranging up to 23.3.

Moisture contents within the Carmi Member range from 11.1 to 25 percent. Degree of saturation calculations confirm field observations showing the soils to be unsaturated. The unsaturated hydraulic conductivities ranged from 6×10^{-8} cm/sec to 1.4×10^{-13} cm/sec.

4.5.2 Upper Mackinaw Member

The upper portion of the Mackinaw Member is a transitional deposit between the low energy lacustrine deposits of the Carmi Member and the higher energy outwash deposits of the Mackinaw Member. The Upper Mackinaw is characterized by a complex sequence of clayey silts and sands, finer sands and and clays. The exact boundary between the Mackinaw and Carmi Members is difficult to distinguish; however, it is estimated that the contact occurs between an elevation of 345 and 325 feet MSL in the vicinity of the impoundments (the unit thickens to the west). This unit is unsaturated throughout with moisture contents ranging from 6.3 to 16 percent.

Saturated vertical permeabilities were found to range from 3.9×10^{-4} cm/sec to 3.7×10^{-6} cm/sec. Evaluation of unsaturated flow characteristics indicate that unsaturated hydraulic conductivities range from 1×10^{-8} to 4.5×10^{-15} cm/sec, which are lower than the saturate flow values noted above.

4.5.3 Lower Mackinaw Member

The lower Mackinaw Member consists of well-sorted outwash sand and gravel. The unit ranges up to 45 feet in thickness under the Allied site. The top of this unit generally marks the water table which is approximately 44 feet below the surface in the vicinity of the Allied ponds. This zone was not addressed in this study; however, from previous work, it

was reported that hydraulic conductivities range from 1 x 10^{-3} to 2.2 x 10^{-2} cm/sec. Groundwater flow within the unit is from northeast to southwest with flow directions ranging from S 50^{o} W to S 55^{o} W. The hydraulic gradients range from .00049 to .0071 ft/ft (refer to Appendix F.1 for details).

SECTION 7

CONCLUSIONS

The results of the various tests and analyses described herein indicate that there is no potential for migration of hazardous constituents from the Allied Metropolis impoundments to the local surface waters and groundwater. This conclusion is based on the favorable site location characteristics, state-of-the-art design and operating practices and the nature of the impoundment contents. To assure a conservative analysis of the maximum extent of potential contaminant migration, the following assumptions or inputs were utilized in the evaluations described herein:

1) The pond sludge was submitted for both TCLP and EP Toxicity analysis to more thoroughly define the potential leachable concentrations;

2) The reduction in hydraulic conductivity that results when the pond fluid reacts with the soil liner was not incorporated in the numerical simulation;

3) A leachate detection/collection trench spacing of 20 feet was assumed in the numerical simulation. In four of the five impoundments the actual trench spacing is less than 20 feet;

4) The unsaturated flow characteristic curves selected to represent the Carmi Member in the numerical simulation resulted in greater groundwater flow velocities than would the curves developed from the site soils.

5) The moisture content distribution provided as an initial condition to the transient flow simulation is greater than the distribution determined by the soil sampling and analysis program. As a result the predicted groundwater flow velocities are greater than would result from the use of the actual field values.

The specific rationale for the above-stated conclusion are summarized as follows:

Concentrations of Hazardous Constituents

The CaF_2 waste has a very low degree of hazard. It is hazardous only because of the characteristic of pH. Analysis of the free water phase (effluent) in the impoundments indicates that only fluoride is present in concentrations in excess of maximum contaminant levels (MCL). Arsenic and selenium may also occur in concentrations up to twice the

maximum contaminant levels but, because of uncertainties in the detection limits, this cannot be quantified. Leachable concentrations of cadium and lead in excess of maximum contaminant levels were reported from the TCLP analysis of the impoundment sludges. Arsenic and selenium may be present in the TCLP leachate in concentrations up to twice the MCL. However, given the prevailing pH levels of the impoundment sludges and waters it is unlikely that the TCLP conditions could ever be simulated naturally. In any event, metal content of pond liquids and sludge extracts are consistently well below EP Toxicity contaminant criteria.

Leak Detection and Location History

Leaks that have occurred in the flexible membrane liner have been detected by monitoring pH and fluoride levels in the leachate detection/collection sumps. These leaks have all been located at or near the air-water interface and have all been associated with mechanical ruptures. There is no evidence of deterioration of the flexible membrane liner or the lap-seams. Allied is confident that the results of the liner/leachate compatibility tests will confirm the long-term viability of the flexible membrane liner. Given that the bottoms of the impoundments are covered with 5 to 15 feet of sludge the greatest potential for a mechanical rupture is along the sidewalls of the impoundments. It is extremely unlikely that the leakage associated with such a rupture will migrate beyond the sideslope leachate collection/detection trenches and continue undetected for a prolonged period.

Finite Life of Impoundments

The storage ponds at the Metropolis plant are an integral component of a resource recovery process. It is anticipated that this resource, the CaF_2 inventory, will be completely recovered by approximately the year 2020, at which time a clean closure of the impoundments will be performed. The closure will include a grid-based soil sampling program and the removal of any soils and residues which are found to be contaminated.

Site Stratigraphy

The impoundments are directly underlain by approximately 12 to 16 feet of homogeneous, lacustrine clays and silty clay. The saturated conductivity of this material are on the order of 1×10^{-7} to 1×10^{-8} cm/sec. The silty clays grade into an underlying clayey silt and clayey sand unit that is approximately 25 to 30 feet of transition zone outwash comprised of clayey sands, silty sands, and clay stringers. The site saturated conductivity of this unit ranges between 1×10^{-5} and 1×10^{-7} cm/sec. However, the water table is encountered at an average depth of approximately 45 feet below the bottom of the impoundments, in the alluvial

deposits of the Mackinaw Member. No saturated horizons were detected above the water table. Clay deposits immediately under the impoundments are above the water table and, hence, unsaturated. Conductivities of unsaturated clays are significantly lower than permeabilities of saturated clays (see Section 4). In addition, saturated permeability tests conducted with the impoundment fluids indicate the unsaturated conductivity is reduced by approximately one order of magnitude after the passage of five pore volumes.

Predicted Groundwater Flow

The results of the numerical simulation of groundwater flow through the unsaturated zone indicates that the maximum groundwater seepage velocity through the materials that underlie the impoundments is approximately 0.05 feet per year. This translates to approximately a 2.3 foot depth of penetration over the maximum anticipated lifespan of the impoundments. Over the 44 year simulation period a total of 10 gallons of pond fluid leaked through a hypothetical 0.33 square foot opening in the flexible membrane liner. This is equivalent to an average leakage rate of approximately 0.004 gallons per year per square inch of liner opening. These rates were computed using the conservative assumptions and input data described at the front of this section.

Fate of Contaminants in Natural Soils

Should a leak develop in the flexible membrane liner the alkaline impoundment fluids will react with the soil liner to transform the kaolinitic clay minerals to amphorous mineraloids. During this transformation naturally occurring metallic and non-metallic ions will be released from the clay minerals as the aluminosilicates are dissolved. Concurrent with this transformation the hydraulic conductivity of the soil liner is reduced as the clay crystal lattices are broken down. The released ions will migrate along with the wetting front until the alkaline pH solution is neutralized. As this neutralization occurs the remobilized ions will be reincorporated into the clay as a mineralized zone, or halo, near the wetting front. This mineralized halo will essentially be a zone enriched in aluminum, sodium and potassium hydroxides and insoluble complex metal hydroxides. The rate and extent to which this remobilization and subsequent reprecipitation will occur is limited by the rate of alkaline fluid replenishment, which is controlled by the permeability of the soil liner. As the results of the modeling indicate, the maximum anticipated rate of pond fluid leakage is very low. Consequently the extent of contaminant migration is expected to be correspond to the extent of fluid migration.

Appendix E.1

Soils Data

The Earth Technology Corporation

3777 Long Beach Boulevard • P.O. Box 7765 • Long Beach, California 90807
Telephone: (213) 595-6611 / (714) 821-7062 • Telex: 656338

October 30, 1986

Mr. Marvin Laderman
Precision Laboratories
11824 Western Avenue
P. O. Box 915
Garden Grove, CA 92642-0915

Subject: Final Report "Capillary Moisture Test"

Dear Mr. Laderman:

Transmitted herewith are the results of capillary-moisture tests performed on your samples. The tests were performed in accordance with ASTM D 3152. For each pressure, the samples were allowed to drain for a minimum of 24-hour period prior to moisture content determination. Our computation indicated that a 24-hour draining period was adequate for these samples. Test data are summarized in Table 1 and moisture-retention curves are presented in Figures 1 through 6. As expected, the shapes of the moisture-retention curves are flat in case of clay and are broader in case of sandy clay.

If you have any questions regarding these test results or if we can be of further assistance, please contact us.

Very truly yours,

THE EARTH TECHNOLOGY CORPORATION (Western)

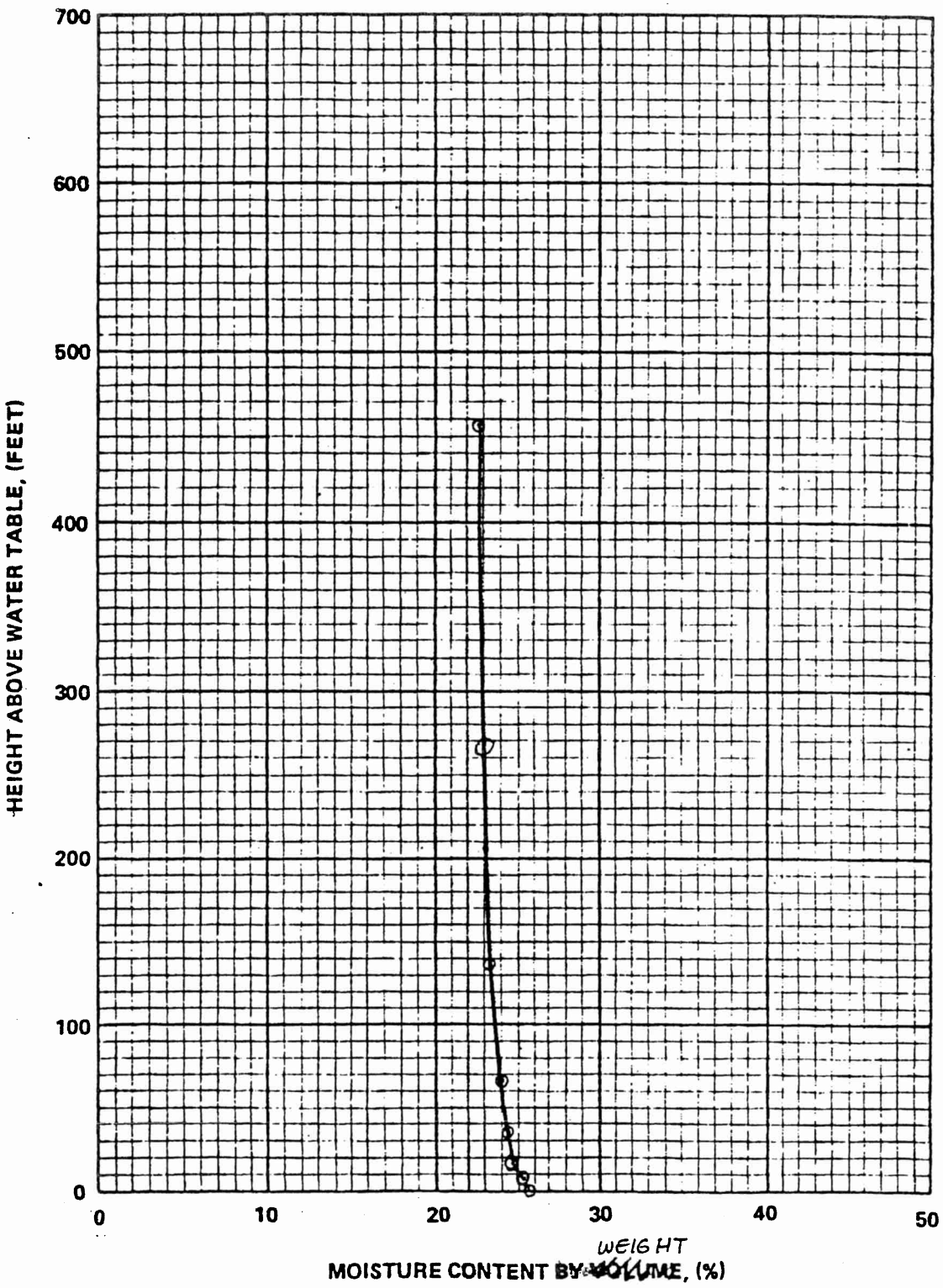
Apichart Phukunhaphan
Manager, Environmental Geomechanics
Laboratory
Senior Project Engineer

AP:sv
Attachments

TABLE 1 : SUMMARY OF CAPILLARY - MOISTURE TEST DATA
(Project No. 87-205-06)

BORING NO.	SAMPLE NO	DEPTH (FT)	CAPILLARY MOISTURE BY WEIGHT IN PERCENT @						
			0.25 BAR 8.4 FT.	0.5 BAR 16.7 FT.	1 BAR 33.5 FT.	2 BAR 66.9 FT.	4 BAR 133.8 FT.	8 BAR 267.6 FT.	13.7 BAR 458.3 FT.
SB-2	2	10-12	25.20	24.78	24.52	24.03	23.20	23.04	22.93
SB-2	4	22-24	18.61	18.44	18.43	17.91	16.91	16.49	16.10
SB-4	2	13.5-15.4	21.78	21.59	-	21.18	20.10	19.94	19.70
SB-4	4	25.0-27.2	18.91	18.74	-	18.28	17.52	17.38	16.87
SB-5	3	26.0-28.1	19.96	19.83	-	19.45	18.82	-	18.61
SB-5	4	34.0-35.9	14.33	13.83	12.80	12.09	11.81	11.20	11.02

Compiled by _____ Drawn by K.S. 9/30/86 Checked by AP 9/30/86 Approved by _____



BORING NO. / ~~TEST PIT~~ : SB-2

SAMPLE NO.: 2

DEPTH (FT) : 10.0-12.0

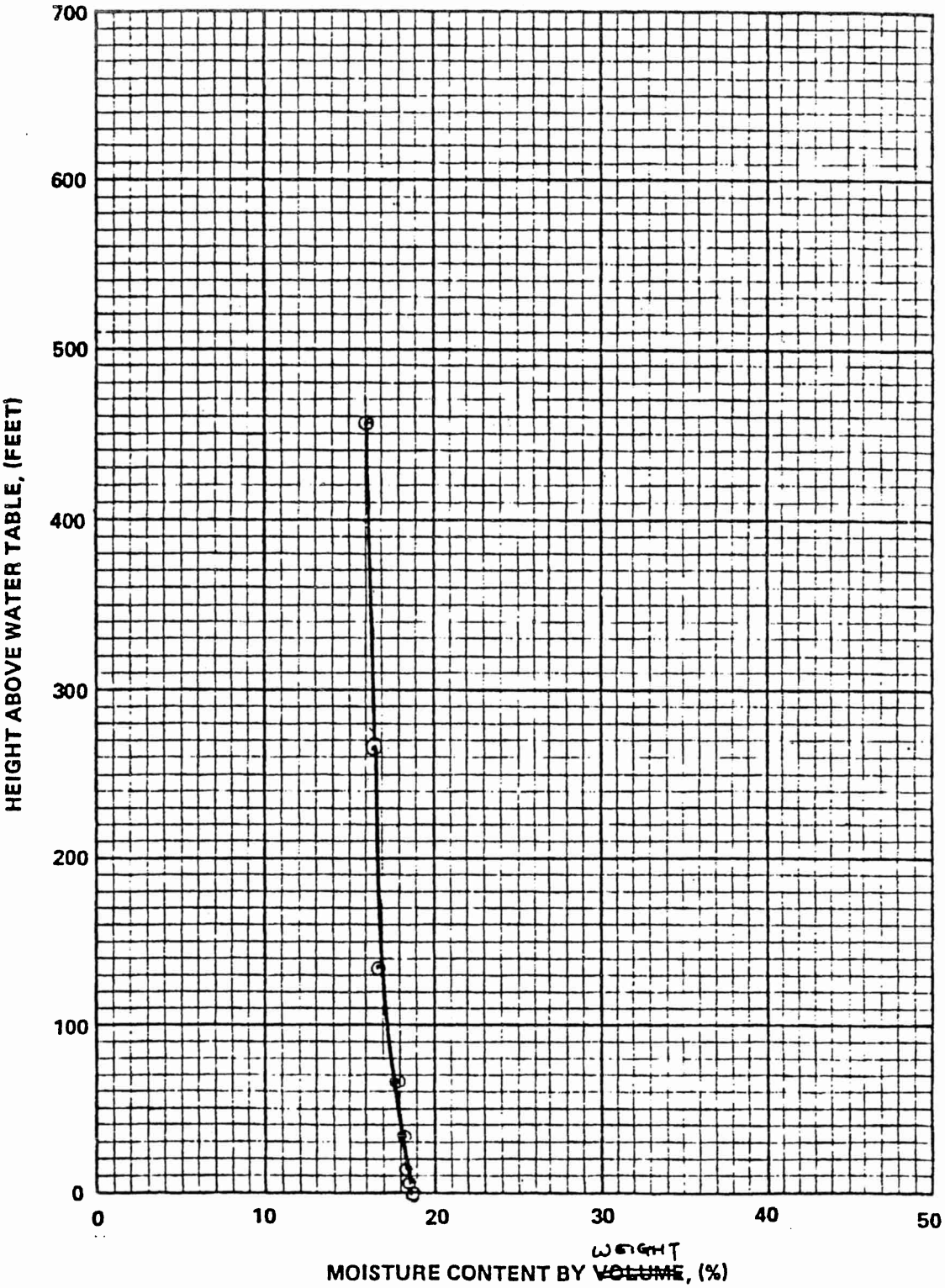
The Earth Technology Corporation

PROJECT NO.: 87-205-06 PRECISION LAB

CAPILLARY–MOISTURE RELATIONSHIPS
ASTM D 3152

FIGURE 1

Compiled _____ Drawn by K. C. 7/30/96 Checked by _____ 7/00/96 Approved by _____



BORING NO. ~~TEST PIT~~: SB-2

SAMPLE NO.: 4

DEPTH (FT): 22.0-24.0

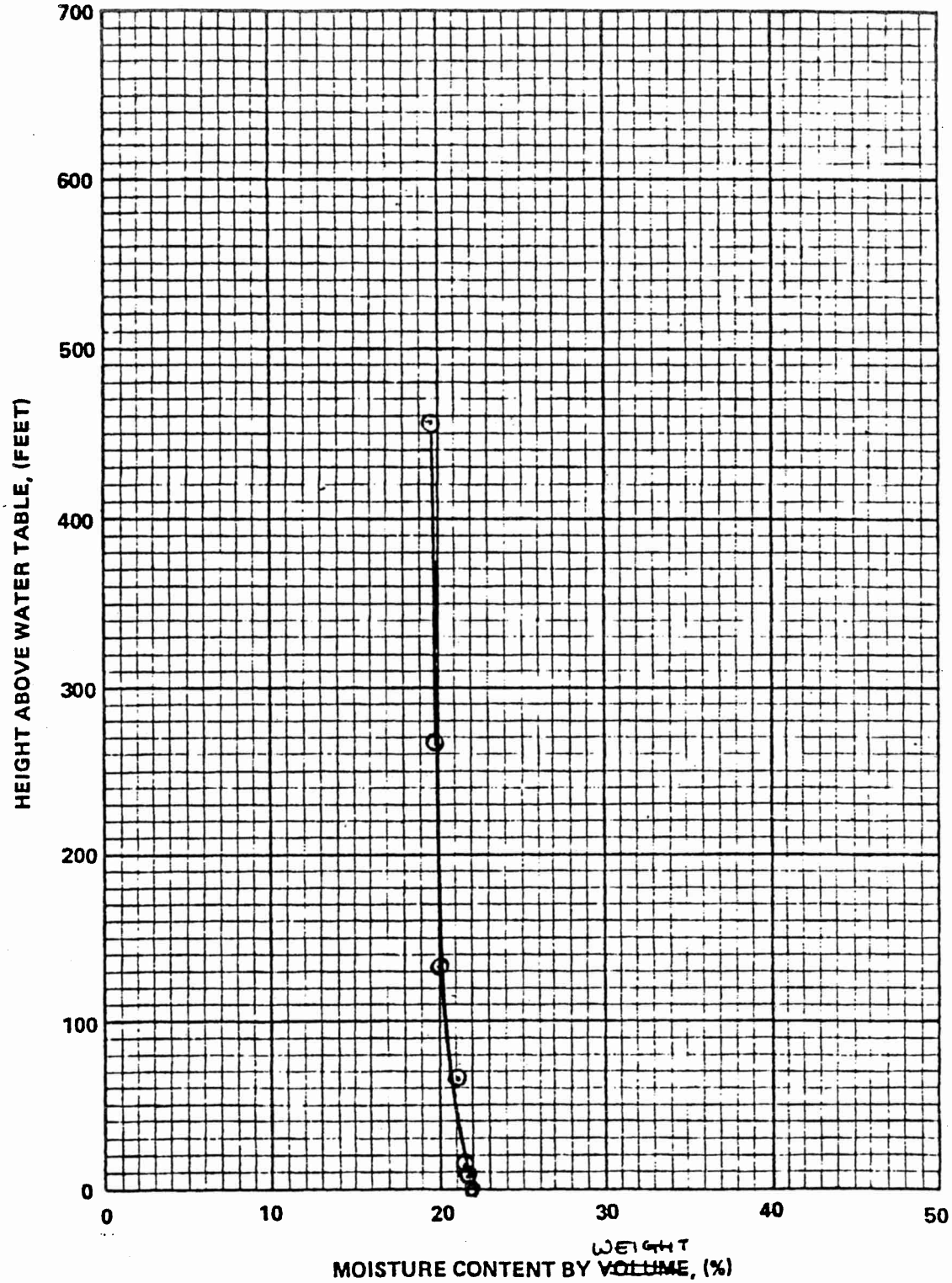
The Earth Technology Corporation

PROJECT NO.: 87-205-06 PRECISION LAB

CAPILLARY–MOISTURE RELATIONSHIPS
ASTM D 3152

FIGURE 2

Compiled by _____ Drawn by R. J. 9/30/86 Checked by MP 9/30/86 Approved by _____



BORING NO.
~~TEST PIT~~ : SB-4

SAMPLE NO.: 2

DEPTH (FT) : 13.5-15.4

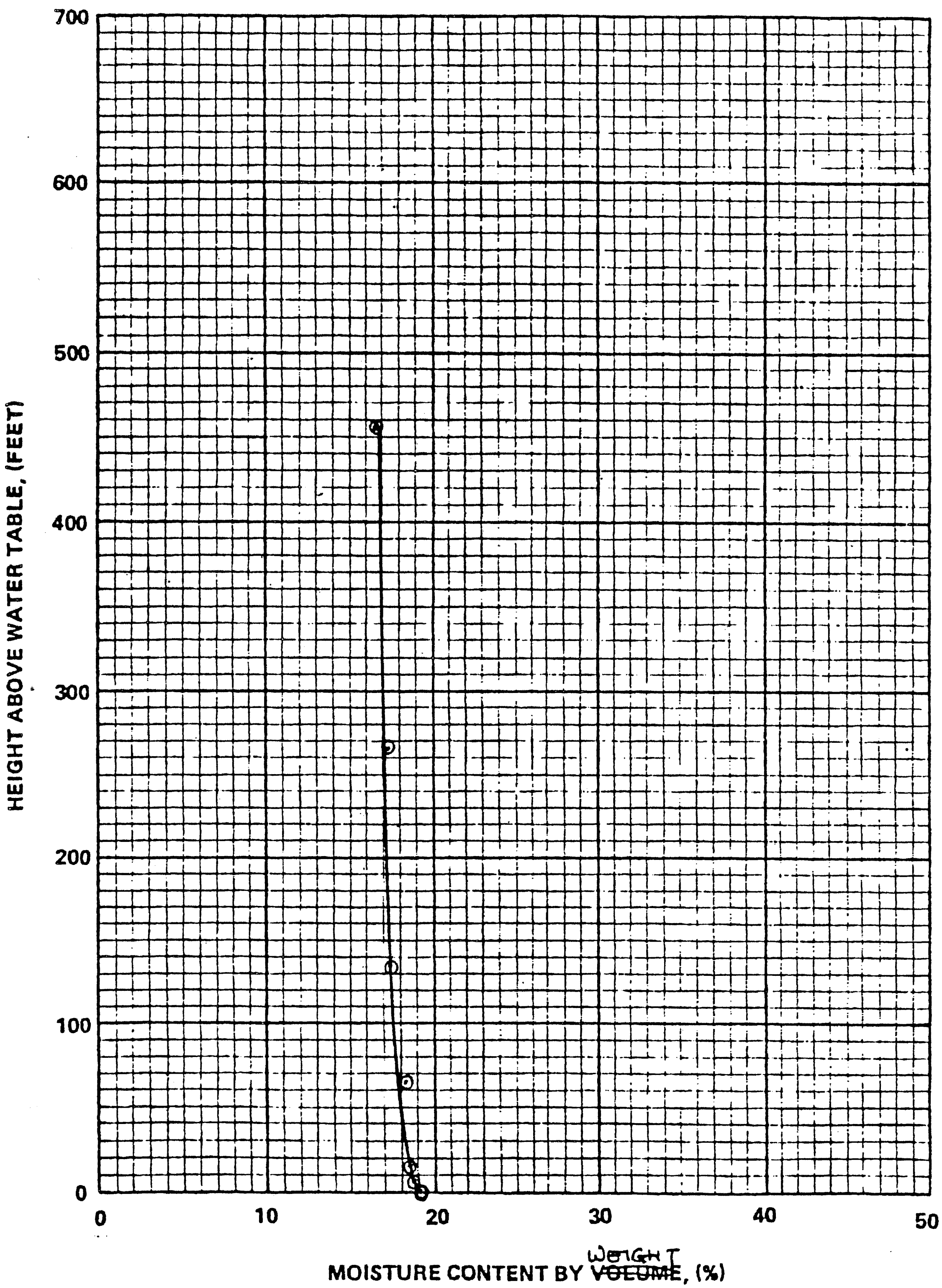
The Earth Technology Corporation

PROJECT NO.: 87-205-06

Precision Lab.

CAPILLARY–MOISTURE RELATIONSHIPS
ASTM D 3152

FIGURE 3



BORING NO.
~~TEST PIT~~ : SB-4

SAMPLE NO.: 4

DEPTH (FT) : 25.0-27.2

The Earth Technology Corporation

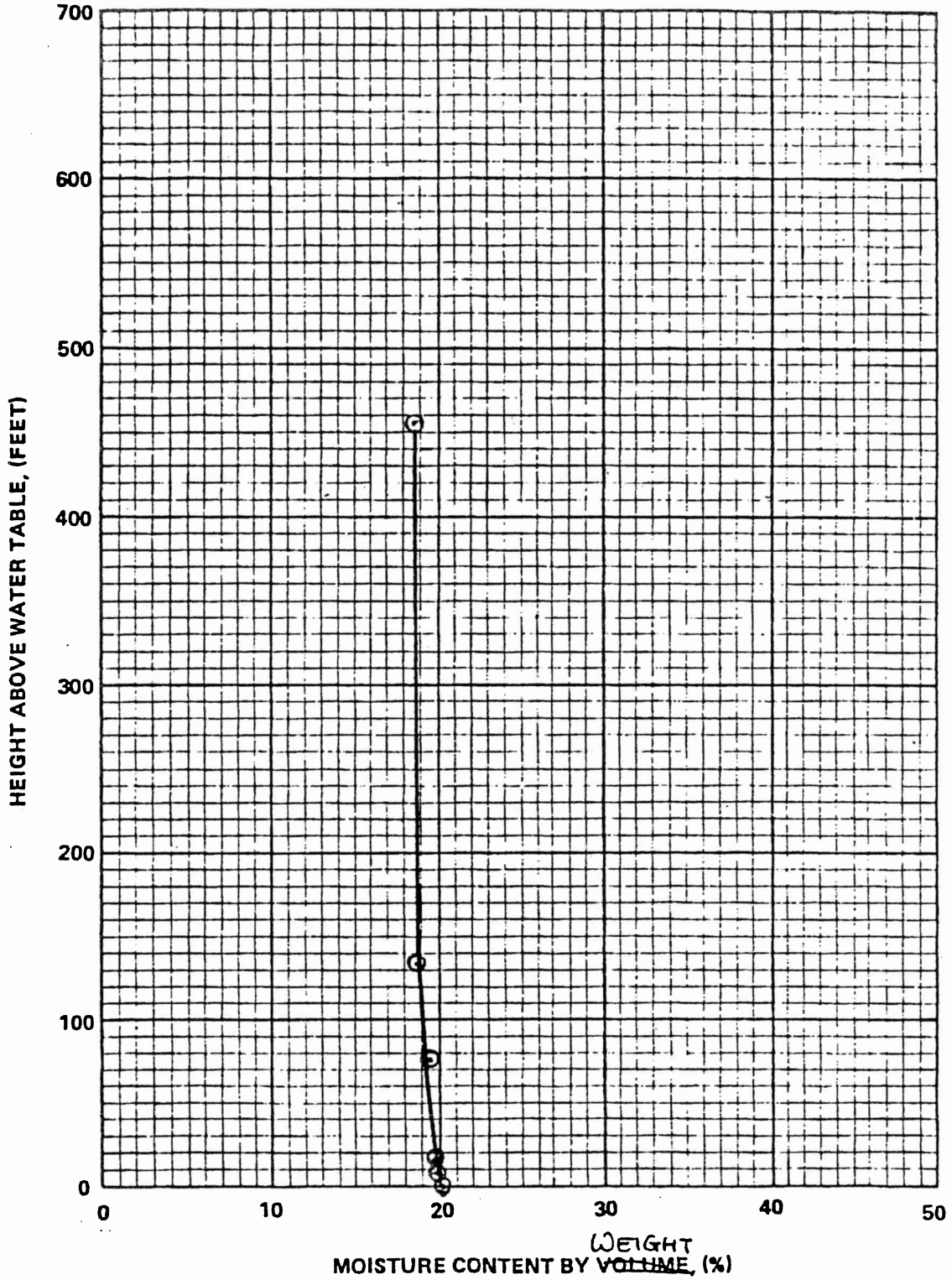
PROJECT NO.: 87-205-06
PRECISION LAB

CAPILLARY–MOISTURE RELATIONSHIPS
ASTM D 3152

FIGURE 4

Drawn by ______ Checked by ______ Approved by ______

Compiled by _____ Drawn by K. Y. 7/30/87 Checked by _____ Approved by _____ 11/20/87



BORING NO.
~~TEST PIT~~ : SB-5

SAMPLE NO.: 3

DEPTH (FT) : 26.0-28.1

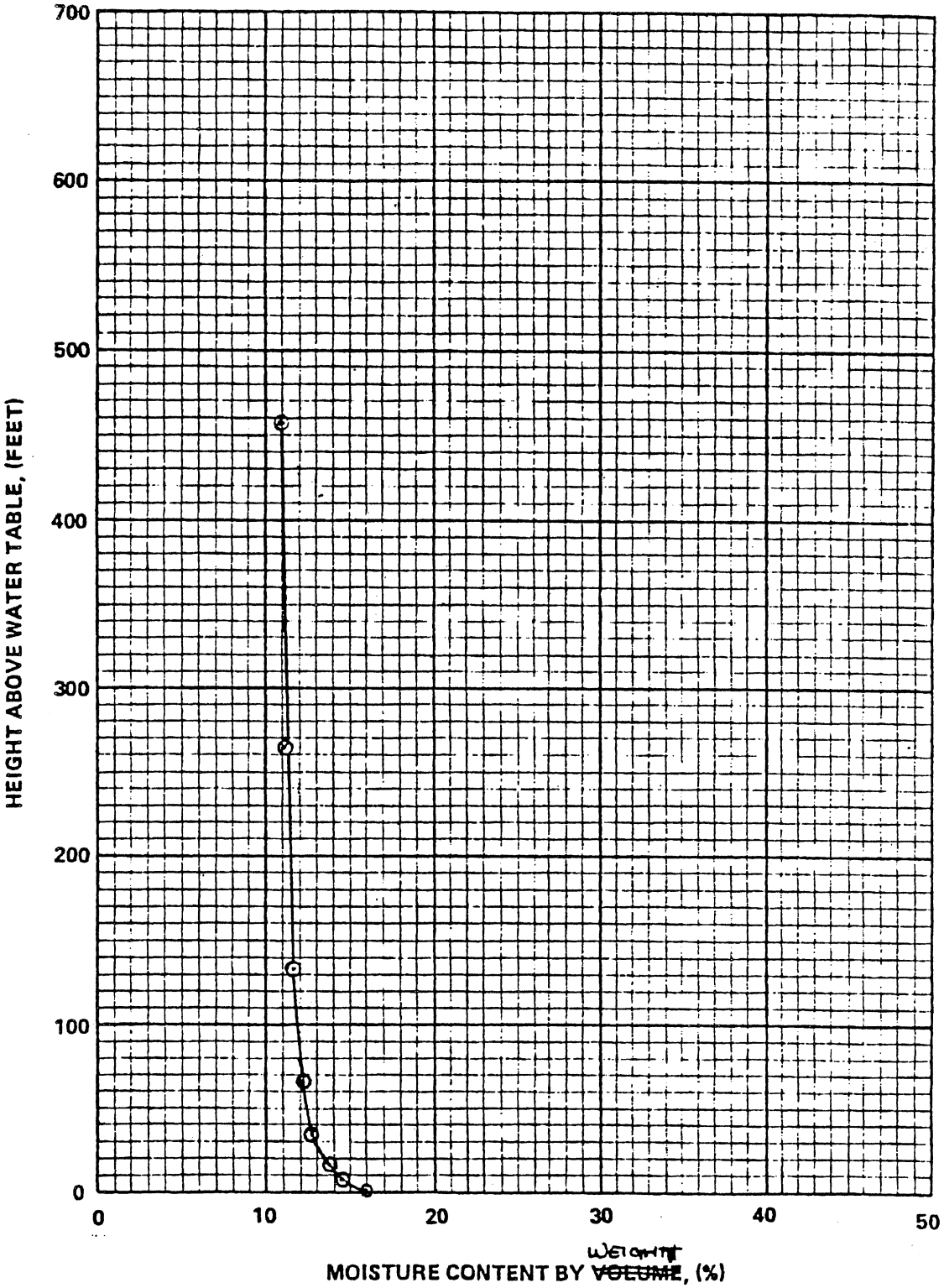
The Earth Technology Corporation

PROJECT NO.: 87-205-06

Precision Lab

CAPILLARY–MOISTURE RELATIONSHIPS
ASTM D 3152

FIGURE 5



BORING NO.

~~TEST PIT~~: SB-5

SAMPLE NO.: 4

DEPTH (FT): 34.0 – 35.9

The Earth Technology Corporation

PROJECT NO.: 87-205-06

Precision Lab.

CAPILLARY–MOISTURE RELATIONSHIPS
ASTM D 3152

FIGURE 6

Compiled by ____ Drawn by ____ Checked by ____ Approved by ____

PATRICK ENGINEERING INC.
Engineers • Geologists • Hydrologists
346 Taft Avenue
Glen Ellyn, Illinois 60137
(312) 858-7050

October 31, 1986

Weston, Inc.
100 Corporate North
Suite 101
Bunnockburn, Illinois 60015

Attention: Mr. Kerry Van Allen
Project Geologist

Subject: Allied Corporation - Metropolis Works
Contract Laboratory Testing
Quality Assurance

Reference: PEI Project No. L112

Gentlemen:

Patrick Engineering Inc. performs in-house quality assurance/quality control for all laboratory testing. Our laboratory has been inspected and approved by the U.S. Army Corps of Engineers, letter enclosed.

All laboratory test data and results for the subject project were checked by a qualified technician and random checks were made by a professional engineer. Several laboratory tests were duplicated to insure accurate and consistent results.

It has been a pleasure working with you on this project. Should you have any questions do not hesitate to contact me.

Very truly yours,

PATRICK ENGINEERING INC.

Jeffrey C. Schuh

Jeffrey C. Schuh, P. E.

JCS/kak

Enclosure: U.S. Army Corps of Engineers
Letter of Laboratory Approval

ref:146/1112

DEPARTMENT OF THE ARMY
U.S. Army Engineer Division, Ohio River
P.O. Box 27168, 5851 Mariemont Avenue
Cincinnati, Ohio 45227

ORDED-GL (105/84.705C) 17 September 1984

SUBJECT: Inspection of Commercial Testing Facilities Patrick Engineering Inc., Glen Ellyn, Illinois

Commander: Chicago District
Attn: G. E. Sanborn, NCCED-S

1. References:

a. ER 1110-1-8100, Laboratory Investigations

b. ER 1110-1-261, Control of Field Testing Procedures

c. Your DA Form 2544 Number NCC-1A-84-58 dated 13 July 1984, requesting an inspection of the subject laboratory

2. In response to your request, reference 1.c., subject as above, the results of the required inspection conducted on 29 August 1984, are inclosed.

3. A copy of the test cost sheet is inclosed for your information. Billing will be at the end of the month on SF1080.

FOR THE COMMANDER:

David P. Hammer

DAVID P. HAMMER, P.E.
Chief, Geotechnical Branch

Incl
as

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL	SUBJECT
ORDED-GL (105/84.705C)	Inspection of Commercial Testing Facilities Patrick Engineering Inc., 346 Taft Avenue Glen Ellyn, Illinois

TO Commander, Chicago District FROM ORDED-GL DATE 17 SEPT 84 CMT 1

Attn: G.E. Sanborn, NCCED-S

THRU: ORDED-G

1. General:

a. Date of Inspection: 29 August 1984 Inspector: Ronald L. Sprague

b. Contracts for which testing is being, or will be, performed:

Contract No.	Description	Amount	% Complete	Area Office

c. General Information:

Business Name: Patrick Engineering Inc.

Street Address: 346 Taft Avenue

City & State: Glen Ellyn, Illinois

How Long in Business: 5-6 years

Number Employed: Professional: 8 Technical: 2 Clerical: 3

Type of Service Offered: Soils-Foundations: X Drilling: X

Constr. Control: X Concrete: X Asphalt: X

Testing Area: Sq. Ft. 1200 Type of Building: Two Story

Auxiliary or Portable Labs:

Transmittal of Test Results: Telecon w/confirmation:

Written Reports Only: X Hand-Carried: Mailed:

Additional Information:

This laboratory was found to be neat, well arranged, and to have adequate bench and floor space to accommodate the required testing.

2. Personnel Contacted:

Name	Organization	Title
Dan Dietzler	Patrick Engineering Inc.	President
Tony Charlton	Patrick Engineering Inc.	Staff Engineer
Devin Moose	Patrick Engineering Inc.	Staff Engineer

3. Inspection of Equipment and Procedures:

a. Required reference material, of the proper issue, are on hand as indicated:

ASTM: 1983 AASHTO: _____ CRD: _____

Contract Spec: No Mil Std: No Fed Spec: EM

b. Equipment and procedures for conducting the following tests were inspected: (Attention was given only those procedures as indicated by an asterisk).

st Method		Description
CRD	ASTM	*** Concrete Tests ***
C5	C143	Slump of Portland Cement Concrete
C11	C31; C470	Making & Curing Compressive & Flexural Specimens in Field
C10; C29	C617; C39	Capping Cylindrical Concrete Specimens
C14	C39	Compressive Strength of Cylindrical Concrete Specimens
C16	C78	Flexural Strength of Concrete Beam Specimens
C41	C231	Air Content of Freshly Mixed Concrete by Pressure Method
C8	C173	Air Content of Freshly Mixed Concrete by Volumetric Method
C76	C427	Moisture Condition of Hardened Concrete, Relative Humidity
C7	C138	Unit Weight, Yield & Air Content of Concrete
C3	C192	Concrete Mixture Design
C10	C192	Making & Curing Compressive & Flexural Specimens in Lab
C75	C567	Unit Weight of Structural Lightweight Concrete
C500	E329	Inspection and Testing Agencies in Construction
C20	C666	Resistance of Concrete to Rapid Freezing & Thawing

Test Method			Description
CRD	ASTM		*** Aggregate Testing ***
C103	C136		Sieve Analysis of Fine and Coarse Aggregate
C105	C117		Material Finer than #200 Sieve by Washing
C106	C29		Unit Weight of Aggregate
C107	C127		Specific Gravity & Absorption of Coarse Aggregate
C108	C128		Specific Gravity & Absorption of Fine Aggregate
C113	C566		Total Moisture Content of Aggregate by Drying
C119	--		Flat & Elongated Particles in Coarse Aggregate
C121	C40		Organic Impurities in Sands for Concrete
C117	C131		Resistance to Abrasion of Small-Size Coarse Agg. (LAR)
C137	C88		Soundness of Aggregate, Sodium or Magnesium Sulfate
C142	C142		Clay Lumps & Friable Particles in Aggregates
C122	C123		Lightweight Pieces in Aggregates
C123	C227		Potential Alkali-Reactivity (Mortar Bar Method)
C127	C295		Petrographic Examination of Aggregates for Concrete
C128	2289		Potential Reactivity of Aggregates (Chemical Method)
C134	C330		Lightweight Aggregates for Structural Concrete
C140	C342		Potential Volume Change, Cement-Aggregate Combinations
C145	C535		Resistance to Abrasion of Large-Size Coarse Agg. (LAR)
C146	C586		Potential Alkali-React. of Carbonate Rocks (Rock Cyl Meth)
EM 1906	MIL STD 621A	ASTM	*** Soil Testing ***
APP I	105	D2216	Water Content, General
APP III	103	D423, 424	Liquid and Plastic Limits
APP V	--	D422	Grain Size Analysis
APP IV	--	D854	Specific Gravity of Solids
APP VI	100	D698 D1557	Moisture Density Relations of Soils
--	106	D1556	Density of Soil in Place by the Sand Cone Method
--	--	D2167	Density of Soil in Place by the Rubber Balloon Method
--	102	D2937	Density of Soil in Place by the Drive Cylinder Method
APP XII	--	D2049	Relative Density

ORDED-GL
SUBJECT: Inspection of Commercial Testing Facilities

Test Method	Description
	*** Soil Testing (Con't.) ***
ASTM D2922	Density of Soil in Place by the Nuclear Method
ASTM D3017	Moisture Content of Soil & Soil Agg., Nuclear Method
	*** Bituminous Testing ***
MIL STD 620A	Unit Weight, Marshall Stability and Flow
ASTM D2172	Extraction Test
MIL STD 620A	Asphalt Mixture Design

\ddition\al Laboratory Capabilities:

In addition to normal range of testing capability, the laboratory is fitted with :ne following equipment:

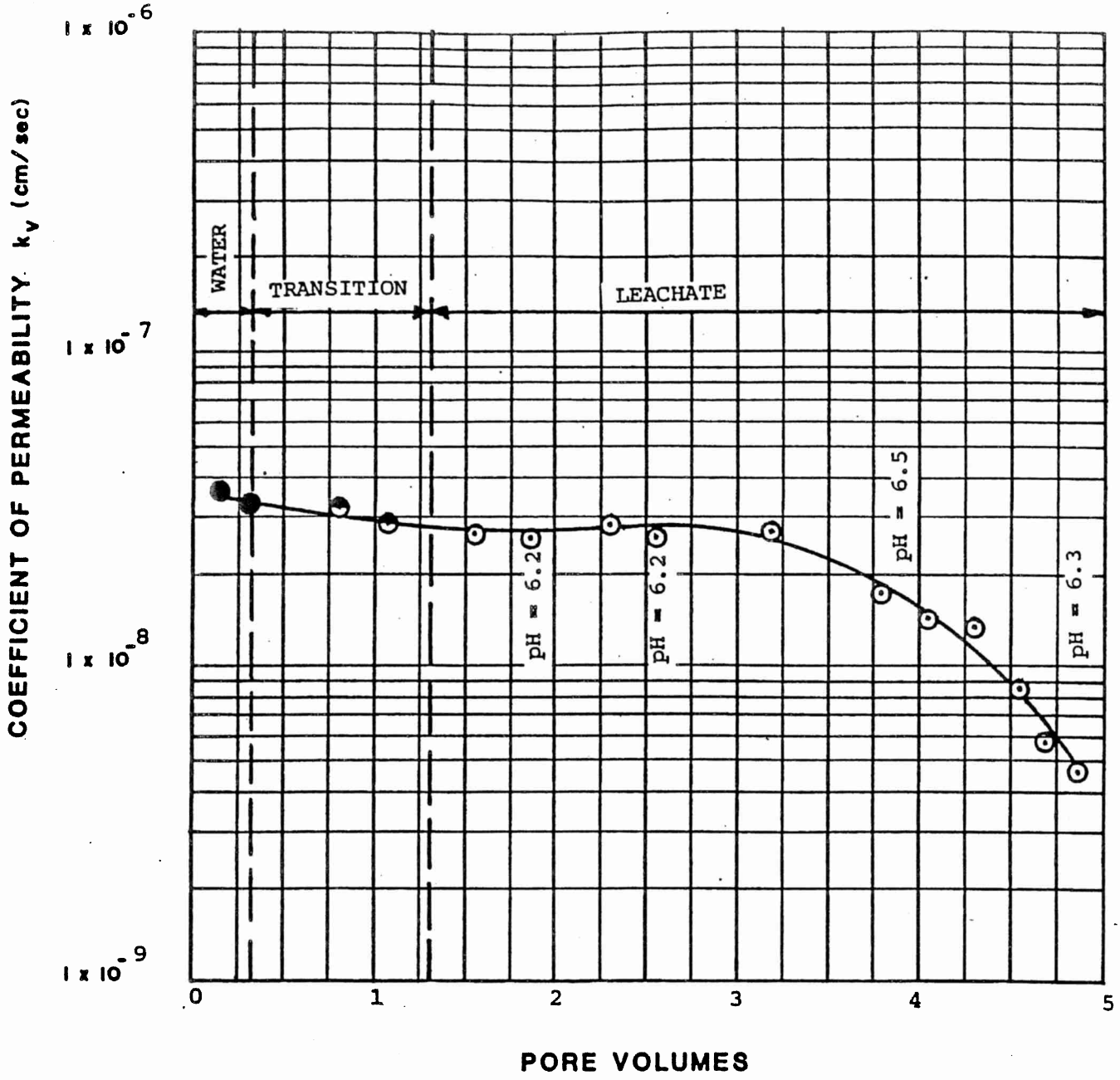
1. Consolidometer, 1 each, capable of accepting a 2.4 inch sample. EM 1110-2-1906 requires that the consolidation ring be not less than 2 3/4 inch and perferably not less than 4 inches inside diameter.

2. Triaxial Compression Chamber, 2 each, capable of accepting both 1.4 and 2.8 inch diameter samples. Triaxial apparatus is gear driven and can be used to perform Q, R, S, and $\bar{R}$ tests.

3. Unconfined Compression Test apparatus, 1 each.

4. Permeability Apparatus - apparatus available to perform Constant Head and Falling Head Premeabilities and Permeability tests with back pressure.

PERMEABILITY VS. PORE VOLUME



LEGEND

- • WATER PERMEANT
- o LEACHATE PERMEANT

AMPLE HEIGHT	= 2.01 in.
AMPLE DIAMETER	= 1.44 in.
AMPLE VOLUME	= 3.27 in.^{3}
ONSOLIDATED DRY UNIT WT	= 114.6 pcf
OID RATIO	= 0.47
ELL PRESSURE	= 100 psi
PRESSURE	= 50 psi
OTTOM PRESSURE	= 90 psi

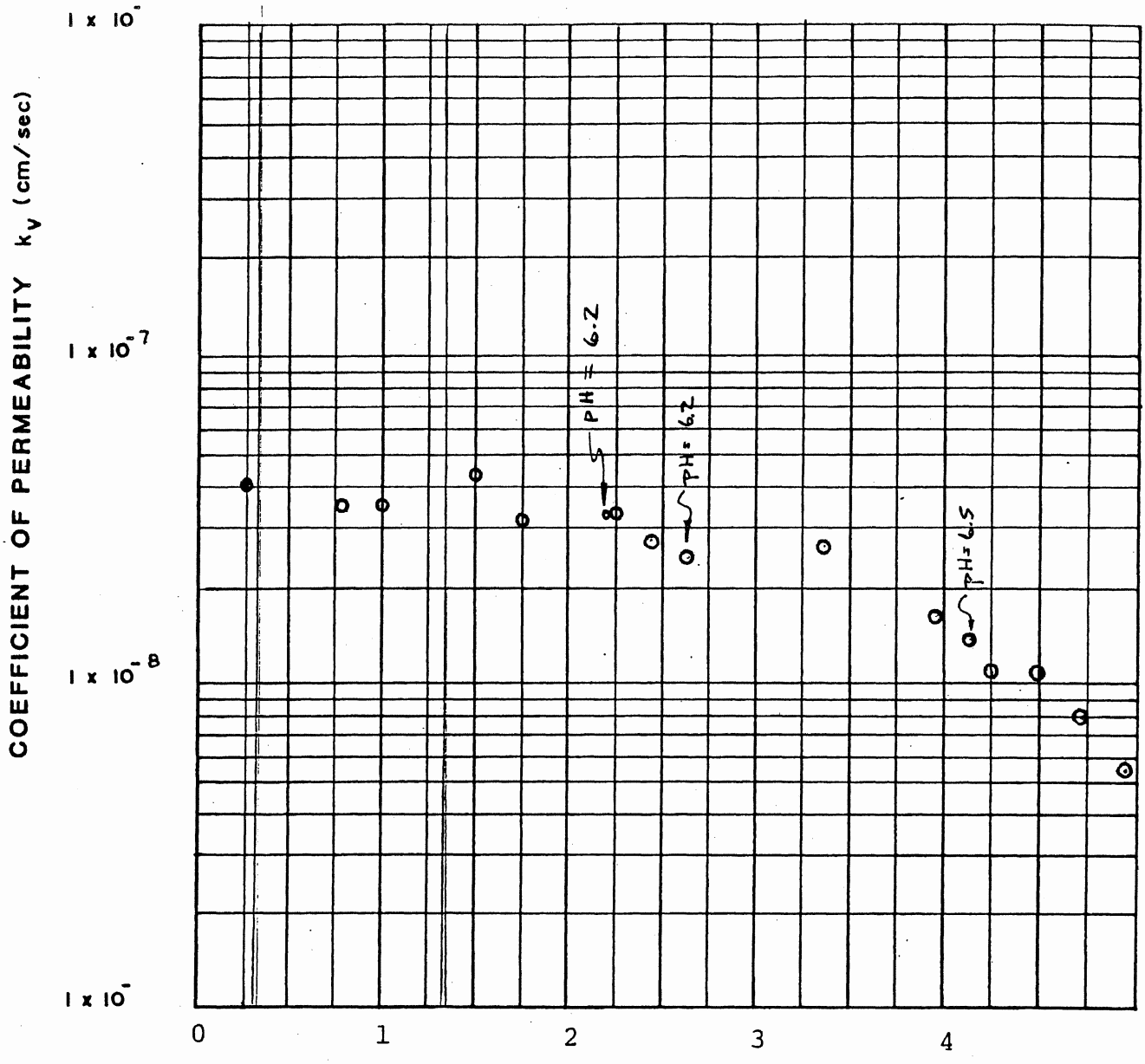
WESTON CONSULTANTS
ALLIED CORPORATION
METROPOLIS WORKS

DATE : OCTOBER, 1986 | PROJECT NO. L112

BORING NO. SB-2
SAMPLE NO. 6

PATRICK ENGINEERING INC.
Engineers • Geologists • Hydrologists
Glen Ellyn, Illinois

PERMEABILITY VS. PORE VOLUME



PRELIMINARY

Sample SB -2 #6

LEGEND

- • WATER PERMEANT
- o LEACHATE PERMEANT

SAMPLE HEIGHT	= 2.04 in.
SAMPLE DIAMETER	= 1.43 in.
SAMPLE VOLUME	= 3.28 in^3
CONSOLIDATED DRY UNIT WT	=
VOID RATIO	=
CELL PRESSURE	= 100 psi
TOP PRESSURE	= 50 psi
BOTTOM PRESSURE	= 90 psi

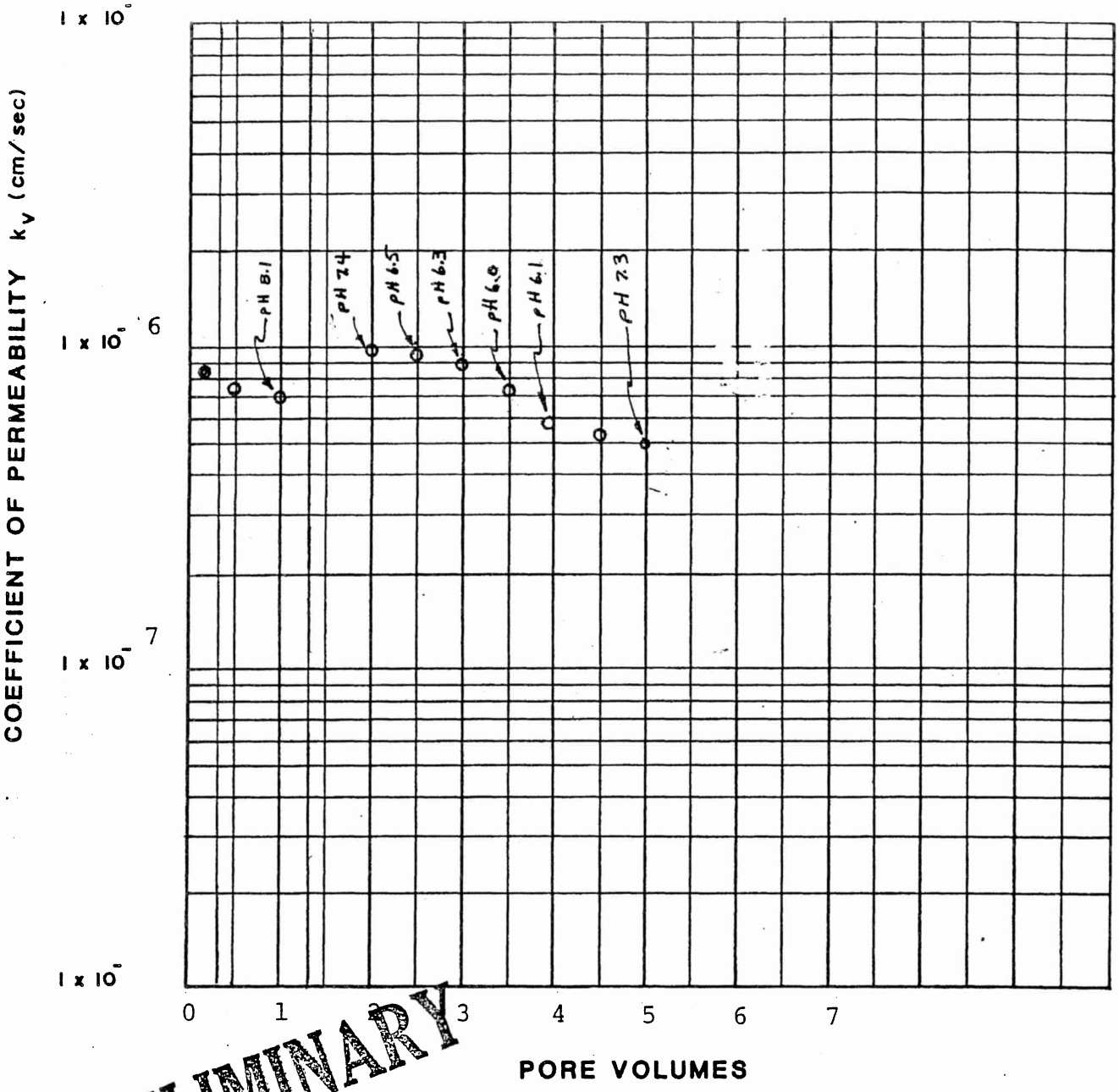
WESTON CONSULTANTS
ALLIED CORPORATION
METROPOLIS WORKS

DATE : OCTOBER, 1986 | PROJECT NO. L112

BORING NO.
SAMPLE NO.

PATRICK ENGINEERING INC.
Engineers • Geologists • Hydrologists
Glen Ellyn, Illinois

PERMEABILITY VS. PORE VOLUME



PRELIMINARY

sample #5

LEGEND

- • WATER PERMEANT
- o LEACHATE PERMEANT

SAMPLE HEIGHT	=	2.16 in.
SAMPLE DIAMETER	=	1.40 in.
SAMPLE VOLUME	=	3.32 in^3
CONSOLIDATED DRY UNIT WT	=	117.4 pcf
VOID RATIO	=	.436
CELL PRESSURE	=	100 psi
TOP PRESSURE	=	80 psi
BOTTOM PRESSURE	=	90 psi

WESTON CONSULTANTS
ALLIED CORPORATION
METROPOLIS WORKS

DATE : OCTOBER, 1986 | PROJECT NO. L112

BORING NO.
SAMPLE NO.

PATRICK ENGINEERING INC.
Engineers • Geologists • Hydrologists
Glen Ellyn, Illinois

WESTON CONSULTANTS

ALLIED CORPORATION - METROPOLIS WORKS

Boring No.	Sample No.	Sample Depth (ft.)	USCS	% Gravel	% Sand	% Silt/ Clay	W_c %	γ_d (pcf)	LL	PI	Total Organic Matter (%)	HYDRAULIC CONDUCTIVITY TESTING: Sample Size h (in.)	Sample Size ø (in.)	Consol. γ_d (pcf)	Coefficient of Saturated Hydraulic Conductivity: k_v cm/sec.	k_v ft./yr.	k_h cm/sec.	k_h ft./yr	CEC (meg/100g)
SB-1	3	22.5-25.0	CL	0	5	95	12.3	119.9	37	21	0.8	2.03	2.87	120.5	2.4×10^{-7}	2.5×10^{-1}			10.8
SB-1	4	29.0-30.0	CL-ML/ SC	0	33	67	12.7	109.3	29	16	4.4	2.04	2.87	109.9	1.4×10^{-6}	1.5			6.53
SB-1	5	30.0-30.7	CL-ML						25	6									
							25.0	100.2				2.08	1.38	101.8			7.8×10^{-8}	8.1×10^{-2}	
SB-2	1	8.0-9.4	CL	3	9	88	25.0	98.8	42	19	3.6	2.19	1.43	100.4	1.6×10^{-7}	1.7×10^{-1}			4.08
SB-2	5	24.0-25.8	CL	0	14	86	18.5	106.3	39	21	6.1	2.09	2.85	107.5	3.0×10^{-7}	3.1×10^{-1}			9.65
SB-2	6	34.0-36.3	CL	0	48	52	14.7	113.1	29	16	0.0	2.05	2.87	113.8	2.9×10^{-7}	3.0×10^{-1}			7.92
							20.4	98.1				1.91	1.47	99.1			3.6×10^{-7}	3.7×10^{-1}	
SB-3	1	6.0-8.0	CL	0	2	98	20.8	100.0	35	16	0.0	2.04	1.46	100.9	1.6×10^{-7}	1.7×10^{-1}			8.92
SB-3	3	12.0-13.3	CL	0	6	94	18.8	104.2	45	26	3.3	1.95	2.86	106.0	4.2×10^{-8}	4.3×10^{-2}			10.2
SB-3	4	20.0-21.4	CL	0	42	58	11.1	109.1	26	11	1.4	2.22	2.87	110.6	1.5×10^{-7}	1.6×10^{-1}			7.64
							20.0	105.6				2.11	1.46	106.8	3.1×10^{-8}	3.2×10^{-2}			
SB-4	1	11.5-13.5	CL	0	4	96	20.8	101.8	42	24	3.3	2.01	1.47	103.0			9.1×10^{-8}	9.4×10^{-2}	9.76
SB-4	3	17.0-19.0	CL	1	7	93	18.6	107.8	35	18	2.4	2.10	2.84	109.9	6.1×10^{-8}	6.3×10^{-2}			9.78
SB-4	5	27.3-28.7	SM	0	75	25	13.0	107.1	N/A		3.6	2.14	2.87	107.9	3.7×10^{-6}	3.8			5.58
SB-4	6	37.0-39.0	SM	0	80	20	13.9	102.7	N/A		1.6	2.90	2.86	102.7	2.8×10^{-5}	29.0			12.0
							19.4	108.0				2.17	1.45	109.8	1.4×10^{-8}	1.5×10^{-2}			
SB-5	1	20.0-22.0	CL	0	6	94	19.2	106.9	38	20	2.9	2.03	1.46	107.9			2.4×10^{-8}	2.5×10^{-2}	9.25
							20.9	102.1				2.07	1.42	103.6			5.5×10^{-8}	5.7×10^{-2}	
SB-5	2	22.1-24.3	CL	0	6	94	21.9	102.1	48	29	3.3	1.96	1.42	105.7	3.5×10^{-8}	3.6×10^{-2}			12.9
SB-5	5	35.8-37.4	CL/SC	0	44	56	16.0	108.0	24	8	1.3	1.99	2.89	103.8	7.4×10^{-7}	7.6×10^{-1}			6.14
SB-5	6	47.0-48.2	SM	0	83	17	6.3	102.4	N/A		0.1	2.26	2.80	103.0	3.9×10^{-4}	403.5			8.61

ref:dw/t3/L112-3

aqualab inc.

ANALYTICAL REPORT

Mr. Jeff Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

14 October 1986
Sample No. 33907

SAMPLE DESCRIPTION: SB-1 #3

Date Received: 09-26-86

Cation Exchange Capacity	10.8	meq/100g
Exchangeable Calcium	116.	mg/100 g
Exchangeable Magnesium	48.6	mg/100 g
Exchangeable Potassium	7.94	mg/100 g
Exchangeable Sodium	19.2	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

REC'D
OCT 17 1986
PATRICK ENGR. INC.
GLEN ELLYN, IL

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeff Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

14 October 1986
Sample No. 33909

SAMPLE DESCRIPTION: SB-2 #1

Date Received: 09-26-86

Cation Exchange Capacity	4.08	meq/100g
Exchangeable Calcium	27.8	mg/100 g
Exchangeable Magnesium	29.6	mg/100 g
Exchangeable Potassium	6.45	mg/100 g
Exchangeable Sodium	2.22	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeff Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

14 October 1986
Sample No. 33908

SAMPLE DESCRIPTION: SB-1 #4

Date Received: 09-26-86

Cation Exchange Capacity	6.53	meq/100g
Exchangeable Calcium	75.6	mg/100 g
Exchangeable Magnesium	26.5	mg/100 g
Exchangeable Potassium	3.35	mg/100 g
Exchangeable Sodium	11.2	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeff Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

14 October 1986
Sample No. 33911

SAMPLE DESCRIPTION: SB-2 #6

Date Received: 09-26-86

Cation Exchange Capacity	7.92	meq/100g
Exchangeable Calcium	93.4	mg/100 g
Exchangeable Magnesium	33.2	mg/100 g
Exchangeable Potassium	4.93	mg/100 g
Exchangeable Sodium	9.12	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeff Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

14 October 1986
Sample No. 33910

SAMPLE DESCRIPTION: SB-2 #5

Date Received: 09-26-86

Cation Exchange Capacity	9.65	meq/100g
Exchangeable Calcium	108.	mg/100 g
Exchangeable Magnesium	41.6	mg/100 g
Exchangeable Potassium	6.94	mg/100 g
Exchangeable Sodium	15.1	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeff Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

14 October 1986
Sample No. 33912

SAMPLE DESCRIPTION: SB-3 #3

Date Received: 09-26-86

Cation Exchange Capacity	10.2	meq/100g
Exchangeable Calcium	112.	mg/100 g
Exchangeable Magnesium	45.7	mg/100 g
Exchangeable Potassium	4.82	mg/100 g
Exchangeable Sodium	16.5	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeffrey Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

20 October 1986
Sample No. 34540

SAMPLE DESCRIPTION: PEI Project #L112; SB-3 #1

Date Received: 10-02-86

Cation Exchange Capacity	8.92	meq/100g
Exchangeable Calcium	98.4	mg/100 g
Exchangeable Magnesium	46.5	mg/100 g
Exchangeable Potassium	1.92	mg/100 g
Exchangeable Sodium	3.31	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

REC'D
OCT 22 1986
PATRICK ENGR. INC.
GLEN ELLYN, IL

William H. Mottashed

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeffrey Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

20 October 1986
Sample No. 34542

SAMPLE DESCRIPTION: PEI Project #L112; SB-4 #1

Date Received: 10-02-86

Cation Exchange Capacity	9.76	meq/100g
Exchangeable Calcium	117.	mg/100 g
Exchangeable Magnesium	44.6	mg/100 g
Exchangeable Potassium	5.00	mg/100 g
Exchangeable Sodium	2.71	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeffrey Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

20 October 1986
Sample No. 34541

SAMPLE DESCRIPTION: PEI Project #L112; SB-3 #4

Date Received: 10-02-86

Cation Exchange Capacity	7.64	meq/100g
Exchangeable Calcium	93.9	mg/100 g
Exchangeable Magnesium	33.5	mg/100 g
Exchangeable Potassium	2.51	mg/100 g
Exchangeable Sodium	2.96	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeff Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

14 October 1986
Sample No. 33914

SAMPLE DESCRIPTION: SB-4 #5

Date Received: 09-26-86

Cation Exchange Capacity	5.58	meq/100g
Exchangeable Calcium	64.4	mg/100 g
Exchangeable Magnesium	22.1	mg/100 g
Exchangeable Potassium	3.66	mg/100 g
Exchangeable Sodium	10.6	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeff Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

14 October 1986
Sample No. 33913

SAMPLE DESCRIPTION: SB-4 #3

Date Received: 09-26-86

Cation Exchange Capacity	9.78	meq/100g
Exchangeable Calcium	110.	mg/100 g
Exchangeable Magnesium	42.1	mg/100 g
Exchangeable Potassium	5.86	mg/100 g
Exchangeable Sodium	15.6	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeffrey Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

20 October 1986
Sample No. 34544

SAMPLE DESCRIPTION: PEI Project #L112; SB-5 #1

Date Received: 10-02-86

Cation Exchange Capacity	9.25	meq/100g
Exchangeable Calcium	112.	mg/100 g
Exchangeable Magnesium	41.4	mg/100 g
Exchangeable Potassium	4.09	mg/100 g
Exchangeable Sodium	3.39	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeffrey Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

20 October 1986
Sample No. 34543

SAMPLE DESCRIPTION: PEI Project #L112; SB-4 #6

Date Received: 10-02-86

Cation Exchange Capacity	12.0	meq/100g
Exchangeable Calcium	101.	mg/100 g
Exchangeable Magnesium	82.7	mg/100 g
Exchangeable Potassium	0.83	mg/100 g
Exchangeable Sodium	1.97	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeffrey Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

20 October 1986
Sample No. 34545

SAMPLE DESCRIPTION: PEI Project #L112; SB-5 #5

Date Received: 10-02-86

Cation Exchange Capacity	6.14	meq/100g
Exchangeable Calcium	78.1	mg/100 g
Exchangeable Magnesium	24.9	mg/100 g
Exchangeable Potassium	2.79	mg/100 g
Exchangeable Sodium	2.80	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed

William H. Mottashed
Bartlett Division

aqualab inc.

ANALYTICAL REPORT

Mr. Jeff Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

14 October 1986
Sample No. 33915

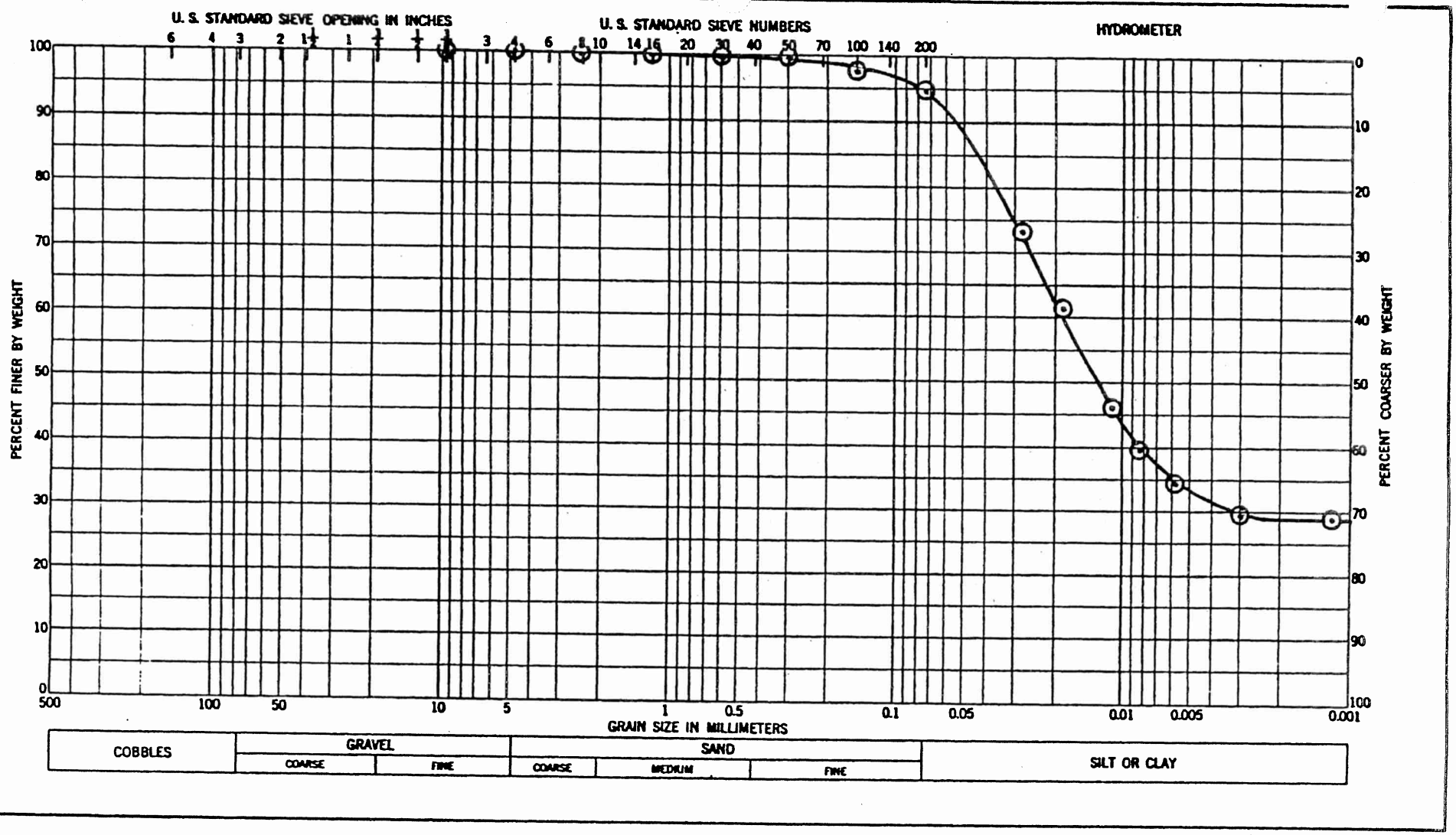
SAMPLE DESCRIPTION: SB-5 #2

Date Received: 09-26-86

Cation Exchange Capacity	12.9	meq/100g
Exchangeable Calcium	140.	mg/100 g
Exchangeable Magnesium	56.5	mg/100 g
Exchangeable Potassium	7.83	mg/100 g
Exchangeable Sodium	24.3	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed
Bartlett Division



Sample No.	Elev. or Depth	Classification	Nat w%	LL	PL	PI	Remarks
SB-1 #3	22.4'-25.0'	Silty Clay CL	12.3	37	16	21	

WESTON CONSULTANTS
BANNOCKBURN, ILLINOIS
ALLIED CORPORATION -
METROPOLIS WORKS
PROJECT NO. L112

PATRICK ENGINEERING INC.

PARTICLE SIZE DISTRIBUTION

aqualab inc.

ANALYTICAL REPORT

Mr. Jeffrey Schuh
PATRICK ENGINEERING, INC.
346 Taft
Glen Ellyn IL 60137

20 October 1986
Sample No. 34546

SAMPLE DESCRIPTION: PEI Project #L112; SB-5 #6

Date Received: 10-02-86

Cation Exchange Capacity	8.61	meq/100g
Exchangeable Calcium	24.9	mg/100 g
Exchangeable Magnesium	88.2	mg/100 g
Exchangeable Potassium	1.26	mg/100 g
Exchangeable Sodium	1.84	mg/100 g

Results on an air-dried basis using neutral, pH 7.0, 1.0N Ammonium Acetate method.

William H. Mottashed

William H. Mottashed
Bartlett Division

Appendix D

Boring Logs

Canonie

Boring Log

PROJECT No. CES 82-005
BORING No. G-102
PAGE 1 OF 1

PROJECT NAME MONITOR WELL INSTALLATION, ALLIED CHEMICAL COMPANY
BORING LOCATION METROPOLIS WORKS, METROPOLIS, ILLINOIS SURFACE ELEV. - -
DRILLER CANONIE DRILLING DATE: START 3-16-82 FINISH 3-16-82

DEPTH	SAMPLE No	SAMPLE TYPE	SAMPLE INTERVAL FROM	SAMPLE INTERVAL TO	BLOW COUNT 0-6	BLOW COUNT 6-12	BLOW COUNT 12-18	RECOVERY IN INCHES	U.S.C.S. SOIL TYPE	PERCENT MOISTURE	qu TSF	CONTACT DEPTH	SOIL DESCRIPTION AND REMARKS	PIEZO.
													NOTE: DESCRIPTIONS AND DEPTHS FROM OBSERVED AUGER CUTTINGS.	
10									CL			10.0	LIGHT BROWN TO YELLOW-BROWN, SILTY CLAY, LOW TO MEDIUM PLASTICITY.	
									ML-CL			14.0	GRAY, CLAYEY SILT, LOW PLASTICITY.	
20									CL			20.0	LIGHT BROWN, SILTY CLAY, MEDIUM PLASTICITY.	
									ML-CL, SC			28.0	BROWN, SANDY SILT, SOME CLAY AND FINE TO COARSE GRAVEL, GRADING WITH DEPTH TO CLAYEY SAND, MEDIUM PLASTICITY.	
30									SP, ML, SC			36.0	BROWN, FINE SAND AND SILT, SOME FINE GRAVEL, LITTLE CLAY. LAYERS OF GRAY, CLAYEY SILT AND REDDISH BROWN, CLAYEY FINE SAND.	
40									CL			44.0	LIGHT BROWN, SILTY CLAY, LOW TO MEDIUM PLASTICITY.	
									ML			46.0	BROWN, CLAYEY SILT, LOW TO MEDIUM PLASTICITY, SOME VERY FINE SAND, INCREASING MOISTURE CONTENT.	
50										▼		48.0		
60									SP-SM				LIGHT BROWN, SILTY, FINE SAND, LITTLE CLAY, SATURATED.	
70														
80													END BORING AT 76.0 FEET. WATER TABLE AT 48 FEET ON 3-16-82.	

WESTON

DRILLING LOG

WELL NUMBER: G-105
LOCATION: West edge of Plant
OWNER: Allied Chemical
ADDRESS: Metropolis, IL
TOTAL DEPTH: 86.5'
SURFACE ELEVATION:
WATER LEVEL:
DRILLING COMPANY: Cannonie
DRILLING METHOD: Hollow stem auger
DATE DRILLED: 11/30-12/1/84
DRILLER: Jerry
HELPER: John
LOG BY: M. Hutson

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					0-2' Reddish brown silty clay w/trace sand; moist, soft, medium plasticity. (CL)
		S1	SS		2-4' Gray to reddish brown, silty sand w/trace gravel; moist, firm, low-medium plasticity (SM)
		S2	SS		
		S3	SS		4-30' Gray to yellowish brown, mottled, silty clay w/trace sand and organic debris; most to dry, firm to hard, low to medium plasticity. (CL)
		S4	SS		
		S5	SS		
		S6	SS		
		S7	ST		
		S8	SS		
		S9	SS		
		S10	SS		
		S11	SS		
		S12	SS		
		S13	SS		
		S14	ST		

WESTON

DRILLING LOG

WELL NUMBER: G-105 (cont) OWNER: _____

LOCATION: _____ ADDRESS: _____

_____ _____

_____ TOTAL DEPTH _____

SURFACE ELEVATION: _____ WATER LEVEL: _____

DRILLING COMPANY: _____ DRILLING METHOD: _____ DATE DRILLED: _____

DRILLER: _____ HELPER: _____

LOG BY: _____

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
		S15	SS		
		S16	SS		30-34.5' Gray to yellowish brown, sandy silt
		S17	SS		w/some clay; hard, dry, low plasticity
					(ML)
		S18	SS		34.5-37.5' Yellowish brown, fine-medium grained
					sand w/trace silt, dry, soft, (SM)
		S19	SS		
		S20	SS		37.5-41' Yellowish brown, fine grained silty sand
					to clayey sand; dry, hard, low plasticity
		S21	SS		(SM-SC)
		S22	SS		41-65' Gray to yellowish brown silty sand to
		S23	SS		sandy clay; firm to hard, dry to moist,
		S24	SS		low to medium plasticity. (SM-SC)
		S25	SS		
		S26	SS		

WESTON

DRILLING LOG

WELL NUMBER: G-105 (cont)
OWNER:
LOCATION:
ADDRESS:
TOTAL DEPTH
SURFACE ELEVATION:
WATER LEVEL:
DRILLING COMPANY:
DRILLING METHOD:
DATE DRILLED:
DRILLER:
HELPER:
LOG BY:

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
		S27	SS		65-70.5' Gray, fine-medium grained clayey sand to
		S28	SS		sandy clay; wet, soft, non-cohesive, (SC)
					70.5-86.5'Dark yellowish brown, fine-medium
		S29	SS		grained, silty sand and gravel; wet,
		S30	SS		hard, non-cohesive. (SM-SP)
		S31	SS		
					Boring terminated 86.5' below the surface.

WESTERN

DRILLING LOG

WELL NUMBER: G-106
OWNER: Allied Chemical
LOCATION: West edge of plant
ADDRESS: Metropolis, IL
TOTAL DEPTH 86.5
SURFACE ELEVATION:
WATER LEVEL:
DRILLING COMPANY: Cannonie
DRILLING METHOD: Hollow stem auger
DATE DRILLED: 11/28/84
DRILLER: Jerry
HELPER: John
LOG BY: M. Hutson

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					0-2.5' Reddish brown to dark brown, silty clay: moist, soft, low plasticity. (CL)
		S1	SS		2,5-14'
		S2	SS		Gray to reddish brown, mottled, silty clays
		S3	SS		w/trace very fine grained sand, soft to
		S4	SS		firm, moist to dry, low to medium
		S5	SS		plasticity (CL)
		S6	SS		
		S7	SS		14-17' Gray to yellowish brown, mottled, silty
					clay w/trace very fine grained sand, dry,
					firm, low plasticity (CL)
		S8	ST		
		S9	SS		17-20' Light gray to yellowish brown, mottled
					clayey silt w/trace fine sand; firm, dry,
					low plasticity, (ML)

WESTON

DRILLING LOG

WELL NUMBER: G-106 (cont) OWNER: _____

LOCATION: _____ ADDRESS: _____

_____ _____

_____ TOTAL DEPTH _____

SURFACE ELEVATION: _____ WATER LEVEL: _____

DRILLING COMPANY: _____ DRILLING METHOD: _____ DATE DRILLED: _____

DRILLER: _____ HELPER: _____

LOG BY: _____

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
		S10	SS		
		S11	SS		20-29' Gray to yellowish brown, silty clay
		S12	SS		w/trace fine grained sand; hard, dry, low
		S13	SS		to medium plasticity. (CL)
		S14	SS		
		S15	SS		30-36' Gray to yellowish brown silty clay to
		S16	SS		clayey silt w/trace very fine grained
		S17	SS		sand; dry, hard, low plasticity, (CL-ML)
		S18	SS		36-40' Gray to yellowish brown silty sand w/some
					clay to silty clay w/some sand; dry, hard,
					low to medium plasticity (SM-CL)
		S19	SS		40-53' Gray to yellowish brown mottled silty clay
					w/trace very fine grained sand; moist, soft
		S20	DD		to firm, low to medium plasticity (CL)

WESTERN

DRILLING LOG

WELL NUMBER: G-106 (cont) OWNER:

LOCATION: ADDRESS:

TOTAL DEPTH

SURFACE ELEVATION: WATER LEVEL:

DRILLING COMPANY: DRILLING METHOD: DATE DRILLED:

DRILLER: HELPER:

LOG BY:

SKETCH MAP

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
		S21	SS		53-78'
		S22	SS		Gray to yellowish brown fine-medium grained
		S23	SS		sand w/some silt and gravel; wet below 59',
		S24	SS		soft, (SM-GM)
		S25	SS		
		S26	SS		78-83' Gray to yellowish brown, very fine grained
					silty sand and silty clay' wet, soft, low
					plasticity (SM-CL)
		S27	SS		83-86.5' White to gray, fine to medium grained
					sand; wet, soft, non-cohesive (SP)
					Boring terminated 86.5 below surface

DRILLING LOG

WELL NUMBER: GW107 OWNER: Allied
LOCATION Southwest corner of ponds ADDRESS: Metropolis, IL
TOTAL DEPTH 64'
SURFACE ELEVATION 364.74' WATER LEVEL:
DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/13/87
DRILLER: Al HELPER: John
LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
		1	SS	5 6 5	Medium stiff to stiff gray clay to silty clay, mottled brown, grades to hard silt with trace sand, oolitic-like texture (ml)
		2	SS	4 5 3	
		3	SS	4 6 9	
		4	SS	4 7 9	
		5	SS	9 14 18	
		6	SS	9 13 17	
		7	SS	13 20 28	
17.5'		8	SS	12 20 34	Dense to very dense white to gray silty fine sand to sandy silt, mottled brown (sm)

* ASTM D1586

DRILLING LOG

WELL NUMBER: GW107 OWNER: Allied
LOCATION: southwest corner of ponds ADDRESS: Metropolis, IL
TOTAL DEPTH: 64'
SURFACE ELEVATION: 364.74' WATER LEVEL:
DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/13/87
DRILLER: Al HELPER: John
LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Dense to very dense white to gray silty fine sand to sandy silt, mottled brown (sm)
		9	SS	27 30/2	
		10	SS	29 100/6	
					26.0'
		11	SS	36 47 50/5	White medium to coarse sand and brown fine gravel, (sw)
					27.3'
					Very dense gray clayey silt, mottled brown (ml)
		12	SS	15 46 60	
					33.0'
		13	SS	7 7 7	Stiff to very stiff gray silty clay to clayey silt, grading to sandy silt, mottled brown (ml-sm)
		14	SS	14 21 29	
		15	SS	7 9 7	

* ASTM D1586

WELL NUMBER 64107 OWNER: Allied
LOCATION Southwest corner of ponds ADDRESS Metropolis, IL
TOTAL DEPTH 64'
SURFACE ELEVATION 364.74' WATER LEVEL:
DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/13/87
DRILLER: Al HELPER: John
LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Same as above
		16	SS	7 7 7	
		17	SS	7 8 10	
					44.0' Medium dense, sandy silt and silty fine to medium sand (SM)
		18	SS	10 12 14	
		19	SS	5 6 7	
		20	SS	10 10 14	
					55.5' Very dense, white and brown medium to coarse-grained sand and fine gravel, some fine sand (SW).
		21	SS	18 50 41	

* ASTM D:586

WELL NUMBER 6W107 OWNER Allied

LOCATION Southwest corner of ponds ADDRESS Metropolis, IL

TOTAL DEPTH 64'

SURFACE ELEVATION 364.74' WATER LEVEL:

DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/13/87

DRILLER: Al HELPER: John

LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
		22	SS	30 42 40	Same as above
					64.0'
					E.O.B.

*ASTM D1586

WELL NUMBER GW108 OWNER: Allied

LOCATION Southeast corner of ponds ADDRESS: Metropolis, IL

TOTAL DEPTH 67'

SURFACE ELEVATION 366.92' WATER LEVEL:

DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/9-10/87

DRILLER: Al HELPER: John

LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Medium-dense light brown clayey, silty sand (SC)
		1	SS	10 11 14	
					25'
					Stiff to very stiff gray and brown clay to silty clay, plastic (CL)
		2	SS	3 4 5	
		3	SS	5 7 12	
		4	SS	5 10 10	
		5	SS	5 9 9	
		6	SS	5 6 6	
		7	SS	5 9 10	
		8	SS	4 7 9	

* ASTM D1586

DRILLING LOG

WELL NUMBER: GW108 OWNER: Allied
LOCATION: southeast corner of ponds ADDRESS: Metropolis, IL
TOTAL DEPTH: 67'
SURFACE ELEVATION: 366.92' WATER LEVEL:
DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/9-10/87
DRILLER: Al HELPER: John
LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Same as above
		9	SS	–	22.0'
					Medium dense to very dense white, gray, and brown fine to medium-grained sand, trace gravel, grading to sandy silt. (SP-SM)
		10	SS	26 40 40	
		11	SS	24 15 12	
		12	SS	19 30 17	
		13	SS	16 30 38	
		14	SS	–	
		15	SS	6 10 10	36.5'
					Stiff to very stiff gray silty clay to clayey silt, trace sand, mottled brown (CL-ML)
		16	SS	3 5 5	

* A.S.T.M. D1586

DRILLING LOG

WELL NUMBER: GW108 OWNER: Allied
LOCATION: Southeast corner of ponds ADDRESS: Metropolis, IL
TOTAL DEPTH: 67'
SURFACE ELEVATION: 366.92' WATER LEVEL:
DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/9-10/87
DRILLER: Al HELPER: John
LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Same as above
		17	SS	4 7 12	
		18	SS	7 6 7	
		19	SS	–	
					48.5'
		20	SS	28 28 25	Very dense, white, gray, and brown silty fine to medium sand (SM)
		21	SS	21 35 50	
		22	SS	28 46 57	
					56.0'
		23	SS	55 80 60	Very dense brown medium to coarse sand grading to medium gravel. (SW)
		24	SS	26 100 126	

* ASTM D:586

DRILLING LOG

WELL NUMBER: GW108 OWNER: Allied

LOCATION: Southeast corner of ponds ADDRESS: Metropolis, IL

TOTAL DEPTH: 67'

SURFACE ELEVATION: 366.92' WATER LEVEL:

DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/9-10/87

DRILLER: Al HELPER: John

LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Same as above
					67.0' E.O.B.

* ASTM D1586

SHEET 4 OF 4

DRILLING LOG

WELL NUMBER: GW109 — OWNER: Allied

LOCATION: northwest corner of ponds — ADDRESS: Metropolis, IL

TOTAL DEPTH: 78.5'

SURFACE ELEVATION: 377.86' — WATER LEVEL:

DRILLING COMPANY: Layne — DRILLING METHOD: HSA — DATE DRILLED: 7/14-15/87

DRILLER: Al — HELPER: John

LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Stiff to very stiff gray and brown silty clay, clayey silt and silt (ml-cl)
		1	SS	11 8 8	
		2	SS	3 4 6	
		3	SS	5 8 8	
		4	SS	5 5 6	
		5	SS	4 7 8	
		6	SS	4 6 9	
		7	SS	4 7 9	
		8	SS	3 6 7	

*ASTM D1586

WELL NUMBER: GW109 | OWNER: Allied
LOCATION: northwest corner of site | ADDRESS: Metropolis, IL
TOTAL DEPTH: 78.5'
SURFACE ELEVATION: 377.86' | WATER LEVEL:
DRILLING COMPANY: Layne | DRILLING METHOD: HSA | DATE DRILLED: 7/14-15/87
DRILLER: Al | HELPER: John
LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Same as above
9		SS		4 8 10	
10		SS		4 7 8	
11		SS		6 7 12	
					33.5'
12		SS		5 10 17	Medium to very dense brown, silty fine sand (SM)
13		SS		19 34 55	
14		SS		7 12 14	
15		SS		24 34 60	
16		SS		13 9 14	

*ASTM D1586

WELL NUMBER: 6W109 OWNER: Allied

LOCATION: northwest corner of ponds ADDRESS: Metropolis, IL

TOTAL DEPTH: 78.5'

SURFACE ELEVATION: 377.86' WATER LEVEL:

DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/14-15/87

DRILLER: Al HELPER: John

LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Same as above
					41.0'
		17	SS	15 22 40	Very dense white and brown fine to medium sand, trace coarse sand (sw)
		18	SS	12 29 36	
		19	SS	14 54 3/4	
					48.5'
		20	SS	5 6 6	Stiff brown and gray silty clay to clayey silt, trace fine sand (cl - ml)
		21	SS	4 6 6	
		22	SS	4 5 6	
		23	SS	4 8 10	
					57.0'
		24	SS	17 32 60	Very dense white and brown fine to coarse sand, trace gravel (sw)

* A S T M D1586

DRILLING LOG

WELL NUMBER: 6W109
LOCATION: northwest corner of ponds
SURFACE ELEVATION: 377.86'
DRILLING COMPANY: Layne
DRILLER: Al
LOG BY: L. Weyer

OWNER: Allied
ADDRESS: Metropolis, IL
TOTAL DEPTH: 78.5'
WATER LEVEL:
DRILLING METHOD: HSA
DATE DRILLED: 7/14-15/87
HELPER: John

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Same as above
		25	SS	12 25 40	
78.5'					E.O.B.

* A.S.T.M. D1586

WELL NUMBER: GW110 OWNER: Allied

LOCATION: adjacent to waste storage pad ADDRESS: Metropolis, IL

TOTAL DEPTH: 73'

SURFACE ELEVATION: 375.50' WATER LEVEL:

DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/16/87

DRILLER: Al HELPER: John

LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Disturbed soil - could not obtain samples - area was excavated to check for buried lines
					11.0'
		1	SS	5 8 12	Stiff, gray and brown silty clay to clayey silt, trace fine sand (cl-ml)
		2	SS	3 5 5	
		3	SS	4 7 8	
		4	SS	4 4 6	

* ASTM D1586

WELL NUMBER: GW110 OWNER: Allied
LOCATION: adjacent to waste storage pad ADDRESS: Metropolis, IL
TOTAL DEPTH: 73'
SURFACE ELEVATION: 375.50' WATER LEVEL:
DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/16/87
DRILLER: Al HELPER: John
LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Same as above
5		5	SS	5 7 9	
6		6	SS	5 4 6	
7		7	SS	7 20 40	26.5'
					medium to very dense gray and brown silty fine sand grading to medium sand (sm - sp)
8		8	SS	5 9 14	
9		9	SS	37 33 38	
10		10	SS	10 12 14	
11		11	SS	8 9 16	
					38.5'
12		12	SS	9 24 28	See next page

* ASTM D1586

DRILLING LOG

WELL NUMBER: GW110 OWNER: Allied
LOCATION: adjacent to waste storage pad ADDRESS: Metropolis, IL
TOTAL DEPTH: 73'
SURFACE ELEVATION: 325.50' WATER LEVEL:
DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/6/87
DRILLER: Al HELPER: John
LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
					Dense gray and brown medium to coarse sand (sp)
		13	SS	12 19 14	
					From 44 to 49 feet - layer of loose, white fine sand (sp)
		14	SS	5 9 11	50.5'
					Very stiff gray and brown silty clay to clayey silt (cl - ml)
					52.5'
		15	SS	30 62/3	Very dense red-brown fine to coarse sand grading to medium gravel (sw)

* ASTM D1586

DRILLING LOG

WELL NUMBER: GW110 OWNER: Allied

LOCATION: adjacent to waste storage pad ADDRESS: Metropolis, IL

TOTAL DEPTH: 73'

SURFACE ELEVATION: 375.50' WATER LEVEL:

DRILLING COMPANY: Layne DRILLING METHOD: HSA DATE DRILLED: 7/16/87

DRILLER: Al HELPER: John

LOG BY: L. Weyer

NOTES:

DEPTH (FEET)	GRAPHIC LOG	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE BLOWS*	DESCRIPTION / SOIL CLASSIFICATION (COLOR, TEXTURE, STRUCTURES)
		16	SS	10 25 35	Same as above
					73.0'
					E.O.B.

*ASTM D1586

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70° 's F, Partly Cloudy, Rain

Boring Information:
Boring No.: GB-03
Well No.: GB-03
Surf. Elev.: 375.02

Depth Information:
Total: 65.00
Auger: 64.82
Core:

Dates:
Start: 6/19/2003
Finish: 6/19/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0						0		Stick-up = 2.60 ft				375
	1					0		Concrete		Crushed Limestone Gravel (Road Base).		
						0				Yellowish Brown Clayey Silt; Moist; Stiff; Trace Sand.		
			GB0304	4.0'		0						
5	2					0						370
						0						
						0						
						0						
				5.0'		0						
10	3					0		Bentonite Grout		Very Moist 12.0-13.0'.		365
						0						
						0						
				5.0'		0						
15	4					0						360
						0						
						0						
				5.0'		0						
20	5					0						

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70° 's F, Partly Cloudy, Rain

Boring Information:
Boring No.: GB-03
Well No.: GB-03
Surf. Elev.: 375.02

Depth Information:
Total: 65.00
Auger: 64.82
Core:

Dates:
Start: 6/19/2003
Finish: 6/19/2003

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Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0				Yellowish Brown Clayey Silt; Moist; Stiff; Trace Sand.		355
						0				Light Grey.		
	5					0				Coarse.		
				5.0'		0						
25						0				Grey Silt; Moist; Firm; Little Clay.		350
	6					0				Yellowish Brown Clayey Silt; Moist; Firm; Some Sand.		
						0				Light Brown Silt; Moist to Dry; Hard; Very Compact.		
				5.0'		0				Yellowish Brown Clayey Silt; Moist; Firm; Some Fine Grained Sand.		
30						0		Bentonite Grout		Yellowish Brown Clayey Silt; Moist; Firm; Some Sand.		345
	7					0						
						0				Becoming More Silty and Sandy.		
				5.0'		0						
35						0				Light Greyish Brown Sandy Silt; Moist; Firm; Little Clay.		340
	8					0				Grey Fine to Medium Grained Silty Sand; Moist; Firm.		
						0				Yellowish Brown Fine to Medium Grained Sand; Moist; Loose.		
				4.1'		0						
40	9					0						

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
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Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70° 's F, Partly Cloudy, Rain

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Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 – 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ – Continuous Barrel ⊠ – Split Spoon ⧄ – Shelby Tube ▮ – Core ☐ – Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0						335
	9					0				Tan.		
						0						
				2.0'		0		Bentonite Grout				
45						0				Dark Yellowish Brown Clayey Silt; Grades to Light Grey Mottles; Moist; Firm; Some Sand.		330
	10					0						
						0						
				4.8'		0				Greyish Brown.		
50						0		Bentonite Plug				325
	11					0						
						0				More Sandy.		
				4.8'		0						
55								Filter Pack				320
	12									Light Tan Fine to Medium Grained Sand; Wet; Loose.		
				3.2'	6							
60	13	⊠			17							

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
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Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70° 's F, Partly Cloudy, Rain

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Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
												315
	13	⊠		2.0'	25 32 6			Filter Pack		Light Tan Fine to Medium Grained Sand; Wet; Loose.		
	14	⊠		2.0'	20 27 32							
	15	⊠		0.9'	12 36 27 10							
65												310
										End of Boring = 65.00'		
70												305
75												300
80												

NOTES:

Andrews Engineering, Inc.

3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70° 's F, Clear

Boring Information:
Boring No.: GB-04
Well No.: GB-04
Surf. Elev.: 375.36

Depth Information:
Total: 64.72
Auger: 64.72
Core:

Dates:
Start: 6/17/2003
Finish: 6/17/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 – 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ – Continuous Barrel ⊠ – Split Spoon ⧄ – Shelby Tube ◧ – Core ☐ – Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0	1					0		Stick-up = 2.68 ft; Concrete		Crushed Limestone Gravel (Road Base).		375
5	2		GB0404	3.5'		0						370
10	3			5.0'		0		Bentonite Grout		Dark Yellowish Brown Clayey Silt; Few Black Organic Streaks; Moist; Firm; Trace Sand.		365
15	4			4.6'		0						360
20	5			5.0'		0						

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70° 's F, Clear

Boring Information:
Boring No.: GB-04
Well No.: GB-04
Surf. Elev.: 375.36

Depth Information:
Total: 64.72
Auger: 64.72
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Dates:
Start: 6/17/2003
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Drilling Contractor:
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Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⊘ - Shelby Tube ▮ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0		Bentonite Grout		Dark Yellowish Brown Clayey Silt; Few Black Organic Streaks; Moist; Firm; Trace Sand.		355
	5			5.0'		0						
25						0				Sand Lens <0.1'.		350
	6			5.0'		0				Dark Yellowish Brown Sandy Clayey Silt; Moist; Firm.		345
30	7					0						
				5.0'		0				Light Grey Sandy Silt; Moist; Firm.		340
35	8					0						
	9			4.7'		0				Dark Yellowish Brown Fine to Medium Grained Sand; Moist; Loose. White Sand.		
40												

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70°'s F, Clear

Boring Information:
Boring No.: GB-04
Well No.: GB-04
Surf. Elev.: 375.36

Depth Information:
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Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0				White Sand.		335
						0				Dark Yellowish Brown Sand.		
	9					0				Tan Sand.		
				2.7'		0		Bentonite Grout				
45						0						330
	10					0				Dark Yellowish Brown Clayey Sandy Silt; Moist; Firm.		
				5.0'		0						
50						0		Bentonite Plug				325
	11					0						
				5.0'		0						
55						0						320
	12					0		Filter Pack		Dark Yellowish Brown Silty Sand; Moist.		
						0						
	13			3.8'								
60												

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70°'s F, Clear

Boring Information:
Boring No.: GB-04
Well No.: GB-04
Surf. Elev.: 375.36

Depth Information:
Total: 64.72
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Core:

Dates:
Start: 6/17/2003
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Sample Type: ▮ – Continuous Barrel ⊠ – Split Spoon ⧄ – Shelby Tube ▮ – Core □ – Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
	13	▮		0.4'	11			Filter Pack		Dark Yellowish Brown Silty Sand; Moist.		315
	14	⊠		1.0'	42 50/4							
	15	⊠		0.8'	3 35 31 14					Tan Fine to Medium Grained Sand and Gravel; Wet; Loose.		
65										*End of Boring = 64.72'*		310
70												305
75												300
80												

NOTES:

Andrews Engineering, Inc.

3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Low 70° 's F, Partly Cloudy Rain

Boring Information:
Boring No.: GB-05
Well No.: GB-05
Surf. Elev.: 377.12

Depth Information:
Total: 67.00
Auger: 64.88
Core:

Dates:
Start: 6/18/2003
Finish: 6/18/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: Continuous Barrel - Split Spoon - Shelby Tube - Core - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0						0		Stick-up = 2.49 ft		Crushed Limestone Gravel (Road Base).		
	1					0		Concrete				375
			GB0504	3.1'		0						
5	2					0						370
				5.0'		0						
10	3					0		Bentonite Grout		Yellowish Brown Clayey Silt; Moist; Firm; Trace Sand.		365
				5.0'		0						
15	4					0						360
	5			5.0'		0						
20						0						

NOTES:

Andrews Engineering, Inc.
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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
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Site No.: 1278540002
AEEI No.: 91-135/0011

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Coord. System:
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Easting:

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Boring Information:
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Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0				Yellowish Brown Clayey Silt; Moist; Firm; Trace Sand.		
	5					0						
						0						355
				5.0'		0						
25						0				Yellowish Brown Clayey Silt; Moist; Firm; Trace Sand.		
	6					0						
						0						350
						0						
				5.0'		0						
30						0		Bentonite Grout				
	7					0						
						0				Yellowish Brown Sandy Clayey Silt; Moist; Firm.		345
						0						
				5.0'		0						
35						0				Yellowish Brown to Tan Fine to Medium Grained Sand; Moist; Loose.		
	8					0				Tan Sand.		
						0				Dark Yellowish Brown Sand.		
						0				White to Grey Sand.		340
						0						
				4.4'		0				Dark Yellowish Brown Sand.		
	9					0						
40						0						

NOTES:

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Field Boring Log

Site Information:
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Site No.: 1278540002
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Low 70°'s F, Partly Cloudy Rain

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Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0		Bentonite Grout		White Sand.		
	9					0				Dark Yellowish Brown Sand.		335
						0				White Sand.		
				4.0'		0				Dark Yellowish Brown Sand and Gravel; Moist; Loose.		
45						0				White Fine to Medium Grained Sand; Moist; Loose to Compact.		
	10					0						
						0				Light Grey Clayey Silt; Few Dark Yellowish Brown Mottles; Moist; Firm; Some Sand.		330
				4.6'		0						
50						0				More Sandy.		
	11					0		Bentonite Plug				325
						0						
				5.0'		0						
55						0				Sandy Clayey Silt; Moist; Firm; Trace Gravel.		
	12					0		Filter Pack				
						0				Light Grey Fine to Medium Grained Sand; Moist; Loose.		320
						0						
				4.8'	8	0				Wet.		
60	13	⊠			16							

NOTES:

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Field Boring Log

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Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⊘ - Shelby Tube ▮ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
	13	⊠		2.0'	23 29			Filter Pack		Light Grey Fine to Medium Grained Sand; Wet; Loose.		
	14	⊠		1.1'	3 33 50					Some Gravel.		315
	15	⊠		0.8'	11 37 24 50							
65	16	⊠		1.0'	8 33 33 38			Formation Sand		Medium to Coarse Grained Sand and Gravel; Wet; Loose.		
										End of Boring = 67.00'		310
70												305
75												300
80												

NOTES:

Andrews Engineering, Inc.

3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Low 70° 's F, Clear

Boring Information:
Boring No.: GB-06
Well No.: GB-06
Surf. Elev.: 372.69

Depth Information:
Total: 72.00
Auger: 72.00
Core:

Dates:
Start: 6/23/2003
Finish: 6/23/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ▨ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0						0		Stick-up = 2.67 ft		Brown Clayey Silt Topsoil; Moist; Firm; Rootlets.		
	1		GB0604			0		Concrete				370
5				4.0'		0						
	2					0						365
10				5.0'		0				Light Yellowish Brown Clayey Silt; Moist; Firm; Trace Sand; Few Rootlets.		
	3					0		Bentonite Grout				360
15				5.0'		0						
	4					0						355
20				5.0'		0						

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Low 70° 's F, Clear

Boring Information:
Boring No.: GB-06
Well No.: GB-06
Surf. Elev.: 372.69

Depth Information:
Total: 72.00
Auger: 72.00
Core:

Dates:
Start: 6/23/2003
Finish: 6/23/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0		Bentonite Grout		Light Yellowish Brown Clayey Silt; Moist; Firm; Trace Sand; Few Rootlets.		
	5					0						350
						0						
						0						
25				5.0'		0						
	6					0				More Sandy.		345
						0						
30				5.0'		0						
	7					0				Yellowish Brown Sandy Silt; Moist; Firm; Some Clay.		340
						0				Dark Yellowish Brown Sand; Moist; Firm.		
35				4.0'		0				Yellowish Brown Clayey Silt; Moist; Firm; Some Sand.		
	8					0						335
						0				Yellowish Brown Silty Sand; Moist; Firm.		
40				5.0'		0						

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Low 70° 's F, Clear

Boring Information:
Boring No.: GB-06
Well No.: GB-06
Surf. Elev.: 372.69

Depth Information:
Total: 72.00
Auger: 72.00
Core:

Dates:
Start: 6/23/2003
Finish: 6/23/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0						
						0						
	9					0				Yellowish Brown Silty Sand; Moist; Firm.		330
						0						
45				5.0'		0				Yellowish Brown Clayey Sandy Silt; Moist; Firm.		
	10					0						325
						0				More Clayey.		
50				5.0'		0						
	11					0				More Sandy.		320
						0						
55				4.8'		0						
	12					0						315
						0						
60				5.0'		0						

Borehole Detail: Bentonite Grout; Bentonite Plug; Filter Pack

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Low 70° 's F, Clear

Boring Information:
Boring No.: GB-06
Well No.: GB-06
Surf. Elev.: 372.69

Depth Information:
Total: 72.00
Auger: 72.00
Core:

Dates:
Start: 6/23/2003
Finish: 6/23/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ▨ - Shelby Tube ▮ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0				Yellowish Brown Clayey Sandy Silt; Moist; Firm.		
	13					0						
						0				Light Grey Clay; Moist to Wet; Moderately Firm.		310
						0				Grey to Yellowish Brown Fine to Medium Grained Sand; Moist to Wet; Firm.		
65				5.0'		0				Light Grey Clayey Sand; Moist to Wet; Moderately Firm.		
	14					0						
						0				Grey Fine to Medium Grained Sand; Wet; Loose; Some Gravel.		
						0				Light Grey; Moist.		305
						0						
70				2.3'	HW	0						
	15				HW							
				2.0'	1							
					10							
										End of Boring = 72.00'		300
75												
												295
80												

Filter Pack

NOTES:

Andrews Engineering, Inc.

3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
High 70° 's F, Clear

Boring Information:
Boring No.: GB-07
Well No.: GB-07
Surf. Elev.: 373.06

Depth Information:
Total: 72.00
Auger: 72.00
Core:

Dates:
Start: 6/24/2003
Finish: 6/24/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 – 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: – Continuous Barrel – Split Spoon – Shelby Tube – Core – Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0	1		GB0704	3.3'		0		Stick-up = 2.52 ft Concrete		Brown Clayey Silt Topsoil; Moist; Firm; Trace Sand; Rootlets.		370
5	2			5.0'		0				Yellowish Brown Clayey Silt; Moist to Very Moist; Moderately Firm; Trace Sand.		365
10	3			5.0'		0		Bentonite Grout				360
15	4			5.0'		0						355
20						0						

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
High 70° 's F, Clear

Boring Information:
Boring No.: GB-07
Well No.: GB-07
Surf. Elev.: 373.06

Depth Information:
Total: 72.00
Auger: 72.00
Core:

Dates:
Start: 6/24/2003
Finish: 6/24/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ■ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ◧ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0		Bentonite Grout		Light Yellowish Brown to Light Grey Clayey Silt; Moist; Firm; Trace Sand.		350
25	5			5.0'		0						
	6					0				Dark Yellowish Brown Sandy Clayey Silt; Moist; Firm.		345
						0				Dark Yellowish Brown Silty Sand; Moist; Firm.		
30				5.0'		0				Light Yellowish Brown to Light Grey Clayey Silt; Moist; Firm; Trace Sand.		
	7					0				Light Grey Clayey Silt to Silt; Moist; Firm; Trace Sand.		340
						0				Dark Yellowish Brown to Light Grey Clayey Silt; Moist; Firm; Some Sand.		
35				5.0'		0				More Sandy.		
	8					0						335
						0				Dark Yellowish Brown Silty Sand to Sand; Moist; Firm to Moderately Firm to Loose.		
40				5.0'		0				Dark Yellowish Brown Sand; Moist; Loose.		

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
High 70° 's F, Clear

Boring Information:
Boring No.: GB-07
Well No.: GB-07
Surf. Elev.: 373.06

Depth Information:
Total: 72.00
Auger: 72.00
Core:

Dates:
Start: 6/24/2003
Finish: 6/24/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0				Dark Yellowish Brown Sand; Moist; Loose.		
						0				Dark Yellowish Brown Sandy Clayey Silt; Moist; Moderately Firm to Firm.		
	9					0						330
						0				Light Grey with Dark Yellowish Brown Mottles.		
45				5.0'		0						
						0						
						0						
	10					0						
						0		Bentonite Grout				325
						0				Dark Yellowish Brown Clayey Sand; Moist; Soft.		
50				5.0'		0						
						0						
						0						
	11					0				Light Yellowish Brown Clayey Silt; Few Dark Yellowish Brown and Grey Mottles; Moist; Firm; Some Sand.		320
						0						
						0						
55				4.3'		0				Dark Yellowish Brown Fine to Medium Grained Moist; Loose.		
						0						
						0				Light Grey Clayey Silt.		
	12					0				Dark Yellowish Brown Silty Sand; Moist to Wet; Loose.		315
						0		Bentonite Plug				
						0		Filter Pack				
60				3.5'		0				Less Silty.		

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
High 70° 's F, Clear

Boring Information:
Boring No.: GB-07
Well No.: GB-07
Surf. Elev.: 373.06

Depth Information:
Total: 72.00
Auger: 72.00
Core:

Dates:
Start: 6/24/2003
Finish: 6/24/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ▨ - Shelby Tube ▮ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0						
						0				Light Grey Sandy Silty Clay; Moist; Moderately Firm; Trace Gravel.		
	13					0						310
						0				Light Grey Clayey Sand; Wet; Moderately Firm.		
65				5.0'		0		Filter Pack				
	14									Dark Yellowish Brown.		305
										Dark Yellowish Brown Sand; Wet; Loose.		
70				3.6'	3					Tan Medium to Coarse Grained Sand and Gravel; Wet; Loose.		
	15				7							
				2.0'	13							
					30					*End of Boring = 72.00'*		
												300
75												
												295
80												

NOTES:

Andrews Engineering, Inc.

3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Low 80°'s F, Clear

Boring Information:
Boring No.: GB-08
Well No.: GB-08
Surf. Elev.: 372.33

Depth Information:
Total: 66.00
Auger: 65.00
Core:

Dates:
Start: 6/25/2003
Finish: 6/25/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0						0		Stick-up = 3.11 ft		Crushed Limestone Gravel (Road Base).		
						0		Concrete		Dark Yellowish Brown Silty Clay; Moist; Moderately Firm; Trace Sand; Some Rootlets.		
	1					0						370
			GB0804			0						
5				4.3'		0						
						0						
	2					0						365
						0						
						0						
10				5.0'		0				More Greyish.		
						0		Bentonite Grout				
	3					0						360
						0						
15				5.0'		0						
						0						
	4					0				Dark Yellowish Brown Clayey Silt; Moist; Firm; Trace Sand.		355
						0						
20				5.0'		0						

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Low 80° 's F, Clear

Boring Information:
Boring No.: GB-08
Well No.: GB-08
Surf. Elev.: 372.33

Depth Information:
Total: 66.00
Auger: 65.00
Core:

Dates:
Start: 6/25/2003
Finish: 6/25/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 – 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ■ – Continuous Barrel ⊠ – Split Spoon ⊘ – Shelby Tube ■ – Core □ – Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0		Bentonite Grout		Dark Yellowish Brown Clayey Silt; Moist; Firm; Trace Sand.		
						0				More Sandy.		
	5					0						350
						0						
25				5.0'		0				Dark Yellowish Brown Sandy Clayey Silt; Moist; Firm.		
	6					0						345
						0				Dark Yellowish Brown Fine to Medium Grained Sand; Moist to Very Moist; Loose.		
30				4.4'		0						
	7					0				Tan Sand.		340
						0						
35				3.8'		0				Light Greyish Brown Silty Sand; Moist; Loose.		
	8					0						335
						0				Yellowish Brown Fine to Medium Grained Sand; Moist; Loose.		
40				4.5'		0						

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Low 80°'s F, Clear

Boring Information:
Boring No.: GB-08
Well No.: GB-08
Surf. Elev.: 372.33

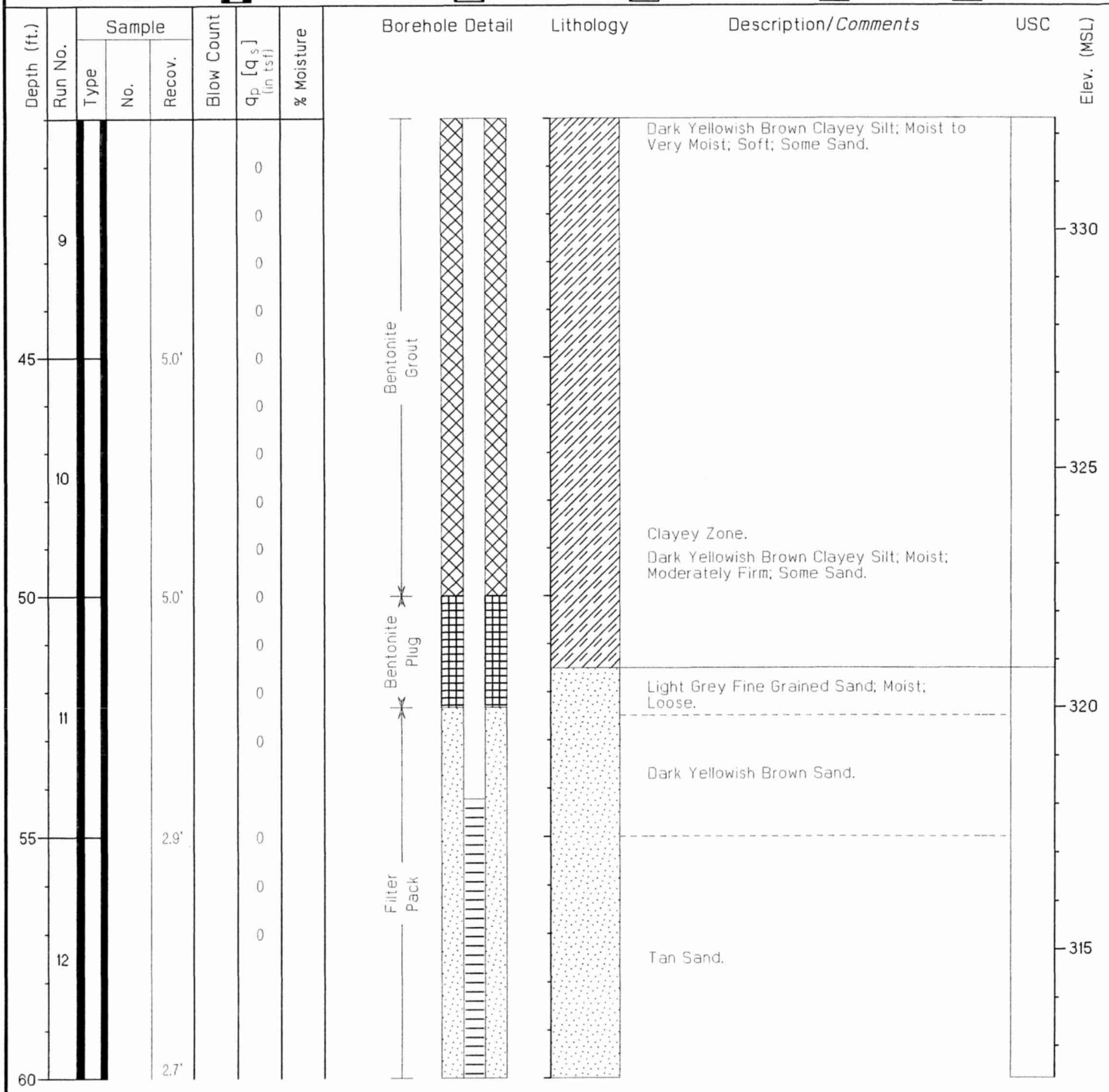
Depth Information:
Total: 66.00
Auger: 65.00
Core:

Dates:
Start: 6/25/2003
Finish: 6/25/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ■ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ◧ - Core □ - Blind Drill



NOTES:

Andrews Engineering, Inc.

3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Low 80° 's F, Clear

Boring Information:
Boring No.: GB-08
Well No.: GB-08
Surf. Elev.: 372.33

Depth Information:
Total: 66.00
Auger: 65.00
Core:

Dates:
Start: 6/25/2003
Finish: 6/25/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler and 2' Split Spoon.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
	13	⊠		1.0'	HW HW 3 12			Filter Pack		Tan Sand.		
	14	⊠		1.2'	1 38 41 >50					Grey Clayey Sand; Moist to Wet; Firm to Moderately Firm.		310
65	15	⊠		2.0'	31 50			Formation Sand		Tan Coarse Grained Sand and Gravel; Wet; Loose.		
										End of Boring = 66.00'		305
70												300
75												295
80												

NOTES:

Andrews Engineering, Inc.

3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70°'s F, Clear

Boring Information:
Boring No.: GB-10
Well No.: GB-10
Surf. Elev.: 375.00

Depth Information:
Total: 64.68
Auger: 64.68
Core:

Dates:
Start: 6/16/2003
Finish: 6/16/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 – 8¼" HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: Continuous Barrel – Split Spoon – Shelby Tube – Core – Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0						0		Stick-up = 2.85 ft		Crushed Limestone Gravel (Road Base).		375
	1					0		Concrete		Light Brown Clayey Silt; Some Dark Yellowish Brown Mottles; Moist; Firm; Trace Sand.		
				3.7'		0				Yellowish Brown Clayey Silt; Few Dark Yellowish Brown Mottles; Moist; Firm; Trace Sand.		
5	2					0						370
				5.0'		0						
10	3					0		Bentonite Grout				365
				4.3'		0				More Clayey; Less Firm.		
15	4					0						360
				5.0'		0				More Sandy.		
20	5					0						355

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70°'s F, Clear

Boring Information:
Boring No.: GB-10
Well No.: GB-10
Surf. Elev.: 375.00

Depth Information:
Total: 64.68
Auger: 64.68
Core:

Dates:
Start: 6/16/2003
Finish: 6/16/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
						0				Yellowish Brown Clayey Silt; Few Dark Yellowish Brown Mottles; Moist; Firm; Trace Sand.		355
	5					0						
						0				Dark Yellowish Brown Fine to Medium Grained Sand; Moist; Loose; Few Dark Organic Streaks.		
				4.0'		0						
25						0						350
	6					0						
						0				Dark Yellowish Brown Clayey Silty Sand; Few Light Grey Mottles; Moist; Firm.		
				5.0'		0						
30						0						345
	7					0						
						0				Dark Yellowish Brown Sand; Moist; Loose.		
				4.3'		0						
						0				Yellowish Brown Clayey Silty Sand; Moist; Firm.		
35						0						340
	8					0						
						0				Yellowish Brown Silty Sand; Moist; Moderately Loose; Little Clay.		
				3.5'		0						
	9					0						
40						0						335

Bentonite Grout

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70°'s F, Clear

Boring Information:
Boring No.: GB-10
Well No.: GB-10
Surf. Elev.: 375.00

Depth Information:
Total: 64.68
Auger: 64.68
Core:

Dates:
Start: 6/16/2003
Finish: 6/16/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
										Yellowish Brown Silty Sand; Moist; Moderately Loose; Little Clay.		335
	9					0						
				3.4'		0						
45	10					0		Bentonite Grout		Yellowish Brown Sandy Clayey Silt; Moist; Firm.		330
				5.0'		0						
50	11					0		Bentonite Plug				325
				5.0'		0				Yellowish Brown Clayey Silt; Moist to Very Moist; Firm; Trace to No Sand.		
55	12					0		Filter Pack				320
						0				Yellowish Brown Sandy Clayey Silt; Moist to Very Moist; Firm.		
				5.0'		0				Grading to Pink; More Sandy.		
	13									Light Greyish Pink Fine to Medium Grained Sand; Wet; Loose.		315
60												

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135/0011

Location:
Coord. System:
Northing:
Easting:

Weather:
Mid 70° 's F, Clear

Boring Information:
Boring No.: GB-10
Well No.: GB-10
Surf. Elev.: 375.00

Depth Information:
Total: 64.68
Auger: 64.68
Core:

Dates:
Start: 6/16/2003
Finish: 6/16/2003

Drilling Contractor:
Name: Terra Drill, Inc.
City: Valmeyer, IL
Equipment: CME 75 - 8¼" HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Marlo
Helper (s): D. Alger

Sample Type: - Continuous Barrel - Split Spoon - Shelby Tube - Core - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
												315
	13							Filter Pack		Light Greyish Pink Fine to Medium Grained Sand; Wet; Loose.		
				1.0'								
65										*End of Boring = 64.68'*		310
70												305
75												300
80												295

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 183967.3
Easting: 860515.3

Weather:
Mid 80°'s F, Clear

Boring Information:
Boring No.: GB-17
Well No.: GB-17
Surf. Elev.: 375.6

Depth Information:
Total: 95.54
Auger: 95.54
Core:

Dates:
Start: 9/20/2004
Finish: 9/21/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: CME 1050 - 8¼" OD HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Skinner
Helper (s): M. Martin
S. Bruce

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⁄ - Shelby Tube ▮ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0								Stick-up = 2.43 ft		Gravel (Fill).		375
	1							Concrete		(Run 1 - no recovery, descriptions from cuttings) Dark yellowish brown, Clayey SILT, moist.		
5				0.0						Moderately firm, few grey mottles.		370
	2											
10				3.9				Bentonite Grout		Grading to lighter grey with few dark yellowish brown mottles.		365
	3											
15				5.0								360
	4											
20				5.0								

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 183967.3
Easting: 860515.3

Weather:
Mid 80°'s F, Clear

Boring Information:
Boring No.: GB-17
Well No.: GB-17
Surf. Elev.: 375.6

Depth Information:
Total: 95.54
Auger: 95.54
Core:

Dates:
Start: 9/20/2004
Finish: 9/21/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: CME 1050 - 8¼" OD HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Skinner
Helper (s): M. Martin
S. Bruce

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
										(Continued) Light grey, Clayey SILT, moist, firm, few dark yellowish brown mottles.		355
	5											
25				5.0								350
	6											
30				5.0						Trace to little sand, some dark yellowish brown mottles.		345
	7											
35				5.0						Dark yellowish brown, Silty SAND, moist, moderately firm.		340
	8											
40				3.0						Dark yellowish brown, fine to medium grained SAND, moist, loose.		

Bentonite Grout

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 183967.3
Easting: 860515.3

Weather:
Mid 80°'s F, Clear

Boring Information:
Boring No.: GB-17
Well No.: GB-17
Surf. Elev.: 375.6

Depth Information:
Total: 95.54
Auger: 95.54
Core:

Dates:
Start: 9/20/2004
Finish: 9/21/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: CME 1050 - 8¼" OD HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Skinner
Helper (s): M. Martin
S. Bruce

Sample Type: - Continuous Barrel - Split Spoon - Shelby Tube - Core - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
										(Continued) Dark yellowish brown, fine to medium grained SAND, moist, loose.		335
										Fine gravel from 41.7'-42.0'.		
	9									Dark yellowish brown, Clayey SAND, moist, moderately firm, few light grey mottles.		
45				1.8								330
	10											
50				5.0				Bentonite Grout				
	11									Light brownish grey, Clayey SILT, moist, moderately firm, few dark yellowish brown mottles.		325
55				5.0						Gradational increase in grain size (silt to sand).		320
	12									Light grey, Clayey SAND, moist, loose, few dark yellowish brown mottles.		
60				3.6								

NOTES:

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3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 183967.3
Easting: 860515.3

Weather:
Mid 80°'s F, Clear

Boring Information:
Boring No.: GB-17
Well No.: GB-17
Surf. Elev.: 375.6

Depth Information:
Total: 95.54
Auger: 95.54
Core:

Dates:
Start: 9/20/2004
Finish: 9/21/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: CME 1050 - 8¼" OD HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Skinner
Helper (s): M. Martin
S. Bruce

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
										Light brown, medium to coarse grained SAND, wet, loose.		315
	13											
65				3.8								310
	14											
70				1.4						Light grey, very fine grained SAND, moist to dry, firm and compact.		305
	15											
75				3.2						Gradational contact- Light grey, Silty SAND, wet, moderately firm and compact. Varve layering from 76'-76.2'.		300
	16									Varve layering from 78'-79'. Dark yellowish brown.		
80				3.9								

Bentonite Grout

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 183967.3
Easting: 860515.3

Weather:
Mid 80° 's F, Clear

Boring Information:
Boring No.: GB-17
Well No.: GB-17
Surf. Elev.: 375.6

Depth Information:
Total: 95.54
Auger: 95.54
Core:

Dates:
Start: 9/20/2004
Finish: 9/21/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: CME 1050 - 8¼" OD HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Skinner
Helper (s): M. Martin
S. Bruce

Sample Type: ▮ - Continuous Barrel ☒ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
								Bentonite Grout; Bentonite Plug; Filter Pack		(Continued) Dark yellowish brown, Silty SAND.		295
	17									Dark yellowish brown, coarse grained SAND and chert/quartz GRAVEL, wet, loose.		
85				2.7								
	18									White, fine grained SAND, wet, loose, dark yellowish brown to black laminations.		290
90				3.0								
	19											285
95				2.6								
										End of Boring = 95.54'		280
100												

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 184278.3
Easting: 860554.9

Weather:
High 80° 's F, clear

Boring Information:
Boring No.: SB-01
Well No.:
Surf. Elev.: 375.7

Depth Information:
Total: 16.0
Auger:
Core:

Dates:
Start: 9/22/2004
Finish: 9/22/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: Direct Push (Power Probe 9600 SKID) w/ Dual Tube Sampling System

Personnel:
Geologist: M. Hewitt, P.G.
Driller: J. Camp
Helper (s):

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
										CA6 - Limestone gravel fill.		375
	1		SB0102		0					Dark yellowish brown, Clayey SILT, moist, firm.		
			SB0104	3.1	0.8							
5	2				1.1							370
			SB0108	4.0	0							
10	3				0							365
			SB0112	4.0	0					More clayey.		
	4				0							
15			SB0116	4.0	0			Bentonite				360
20										*End of Boring = 16.0'*		

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 184063.7
Easting: 860653.5

Weather:
High 80°'s F, clear

Boring Information:
Boring No.: SB-02
Well No.:
Surf. Elev.: 375.3

Depth Information:
Total: 16.0
Auger:
Core:

Dates:
Start: 9/22/2004
Finish: 9/22/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: Direct Push (Power Probe 9600 SKID) w/ Dual Tube Sampling System

Personnel:
Geologist: M. Hewitt, P.G.
Driller: J. Camp
Helper (s):

Sample Type: - Continuous Barrel - Split Spoon - Shelby Tube - Core - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
										CA6 - Limestone gravel fill.		375
	1		SB0202		0					Dark yellowish brown, Clayey SILT, moist, firm.		
			SB0204	2.1	0.7							
5	2				0.3							370
			SB0208	4.0	1.2			Bentonite				
10	3				0.2							365
			SB0212	4.0	0.4					More clayey.		
	4				0							
15												360
			SB0216	4.0	0					*End of Boring = 16.0'*		
20												

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 184096.2
Easting: 860780.5

Weather:
High 80° 's F, clear

Boring Information:
Boring No.: SB-03
Well No.:
Surf. Elev.: 375.5

Depth Information:
Total: 16.0
Auger:
Core:

Dates:
Start: 9/22/2004
Finish: 9/22/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: Direct Push (Power Probe 9600 SKID) w/ Dual Tube Sampling System

Personnel:
Geologist: M. Hewitt, P.G.
Driller: J. Camp
Helper (s):

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
										CA6 - Limestone gravel fill.		375
	1		SB0302		2.0					Dark yellowish brown, Clayey SILT, moist, firm.		
			SB0304	3.0	1.2							
5	2				1.7							370
			SB0308	4.0	3.4							
10	3				3.3							365
			SB0312	4.0	2.2					More clayey.		
	4				0.2							
15			SB0316	4.0	0.2			Bentonite				360
										End of Boring = 16.0'		
20												

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 183888.3
Easting: 860904.2

Weather:
High 80° 's F, clear

Boring Information:
Boring No.: SB-04
Well No.:
Surf. Elev.: 375.7

Depth Information:
Total: 16.0
Auger:
Core:

Dates:
Start: 9/22/2004
Finish: 9/22/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: Direct Push (Power Probe 9600 SKID) w/ Dual Tube Sampling System

Personnel:
Geologist: M. Hewitt, P.G.
Driller: J. Camp
Helper (s):

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0								Bentonite		CA6 - Limestone gravel fill.		375
	1		SB0402		0					Dark yellowish brown, Silty CLAY, moist, firm.		
			SB0404	2.3	0							
5	2				0.1							370
			SB0408	2.8	0							
10	3				0							365
			SB0412	4.0	0					More clayey.		
	4				0							
15			SB0416	4.0	0							360
										End of Boring = 16.0'		
20												

NOTES:

Andrews Engineering, Inc.
3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 184386.9
Easting: 860563.3

Weather:
High 80° 's F, clear

Boring Information:
Boring No.: SB-05
Well No.:
Surf. Elev.: 375.1

Depth Information:
Total: 16.0
Auger:
Core:

Dates:
Start: 9/22/2004
Finish: 9/22/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: Direct Push (Power Probe 9600 SKID) w/ Dual Tube Sampling System

Personnel:
Geologist: M. Hewitt, P.G.
Driller: J. Camp
Helper (s):

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
										CA6 - Limestone gravel fill.		375
										Dark yellowish brown, Clayey SILT, moist, firm.		
	1		SB0502		0.4							
			SB0504	2.5	0.3							
5	2				0.5							370
			SB0508	4.0	0.1							
10	3				0							365
			SB0512	4.0	0					More clayey.		
	4				0							
15			SB0516	4.0	0			Bentonite				360
										End of Boring = 16.0'		
20												

NOTES:

Andrews Engineering, Inc.

3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 183743.5
Easting: 860735.4

Weather:
High 80° 's F, clear

Boring Information:
Boring No.: SB-06
Well No.:
Surf. Elev.: 375.1

Depth Information:
Total: 16.0
Auger:
Core:

Dates:
Start: 9/22/2004
Finish: 9/22/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: Direct Push (Power Probe 9600 SKID) w/ Dual Tube Sampling System

Personnel:
Geologist: M. Hewitt, P.G.
Driller: J. Camp
Helper (s):

Sample Type: Continuous Barrel | Split Spoon | Shelby Tube | Core | Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0										CA6 - Limestone gravel fill.		375
	1		SB0602		0					Dark yellowish brown, Clayey SILT, moist, firm.		
			SB0604	4.0	0							
5	2				0							370
			SB0608	4.0	0							
10	3				0.8							365
			SB0612	4.0	0.2					More clayey.		
	4				0							
15			SB0616	3.8	0							360
								Bentonite		*End of Boring = 16.0'*		
20												

NOTES:

Andrews Engineering, Inc.

3300 Ginger Creek Drive, Springfield, IL 62711 (217) 787-2334

Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 184013.6
Easting: 860621.4

Weather:
Mid 80°'s F, clear

Boring Information:
Boring No.: SB-07
Well No.:
Surf. Elev.: 374.8

Depth Information:
Total: 60.0
Auger: 60.0
Core:

Dates:
Start: 9/21/2004
Finish: 9/21/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: CME 1050 - 8¼" OD HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Skinner
Helper (s): S. Bruce
M. Martin

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ▮ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0								Concrete Plug		CA6 - Limestone gravel fill.		
	1		SB0702		0					Dark yellowish brown, Clayey SILT, moist, firm, few light grey mottles.		
					0							
5			SB0705	3.7	0							370
					0							
	2		SB0708		0							
10				5.0	0			Bentonite		Light grey with dark yellowish brown mottles.		365
	3		SB0712		0							
					0							
15				5.0	0							360
			SB0716		0							
	4				0							
20				5.0	0							355

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 184013.6
Easting: 860621.4

Weather:
Mid 80° 's F, clear

Boring Information:
Boring No.: SB-07
Well No.:
Surf. Elev.: 374.8

Depth Information:
Total: 60.0
Auger: 60.0
Core:

Dates:
Start: 9/21/2004
Finish: 9/21/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: CME 1050 - 8¼" OD HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Skinner
Helper (s): S. Bruce
M. Martin

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ▨ - Shelby Tube ▮ - Core □ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
										(Continued) Light grey, Clayey SILT, moist, firm, some dark yellowish brown mottles.		
	5				0							
					0							
25				5.0	0							350
					0							
	6				0							
										Dark yellowish brown, Silty SAND, moist, moderately firm, few light grey mottles.		
30				5.0	0							345
	7				0							
					0							
35				5.0	0					Dark yellowish brown to light grey, medium to fine grained SAND, moist.		340
	8											
40				0.5	0			Bentonite				335

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 91-135

Location:
Coord. System: State Plane
Northing: 184013.6
Easting: 860621.4

Weather:
Mid 80° 's F, clear

Boring Information:
Boring No.: SB-07
Well No.:
Surf. Elev.: 374.8

Depth Information:
Total: 60.0
Auger: 60.0
Core:

Dates:
Start: 9/21/2004
Finish: 9/21/2004

Drilling Contractor:
Name: Reynolds Drilling Corp.
City: Springfield, IL
Equipment: CME 1050 - 8¼" OD HSA w/5' Continuous Barrel Sampler.

Personnel:
Geologist: M. Hewitt, P.G.
Driller: T. Skinner
Helper (s): S. Bruce
M. Martin

Sample Type: ▮ - Continuous Barrel ⊠ - Split Spoon ⧄ - Shelby Tube ◧ - Core ☐ - Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
	9				0			Bentonite		Dark yellowish brown to light grey, medium to fine grained SAND, moist.		
45				3.4								330
	10				0					Dark yellowish brown, Silty SAND, moist, moderately firm, some clay.		
					0							
50				5.0	0					Increased clay content, firm, few light grey mottles.		325
	11				0							
					0							
55				5.0						Dark yellowish brown, very fine grained SAND, moist, loose, few light grey mottles.		320
	12									Saturated.		
										Color change to light greyish brown.		
60				3.5						*End of Boring = 60.0'*		315

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 1991-135-8

Location:
Coord. System: State Plane
Northing: 184071.74
Easting: 860589.59

Weather:
Clear 60's windy

Boring Information:
Boring No.: SB-08
Well No.:
Surf. Elev.: 375.4

Depth Information:
Total: 4.0
Auger:
Core:

Dates:
Start: 11/3/2005
Finish: 11/3/2005

Drilling Contractor:
Name: Roberts Environmental Drilling, Inc.
City: Millstadt, IL
Equipment: Geoprobe

Personnel:
Geologist: M. Hewitt, P.G.
Driller: M. Cooper
Helper (s): E. Wetzel

Sample Type: Continuous Barrel | Split Spoon | Shelby Tube | Core | Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
								Bentonite plug		CA6 GRAVEL; dry to moist; loose		375
	1		08-2.1	3.4	0.0 0.0 0.0					Light orangish yellow, some dark brown mottles; Clayey SILT; moist; firm; few iron concretions		
										End of Boring = 4.0'		
5												370
10												365
15												360
20												

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 1991-135-8

Location:
Coord. System: State Plane
Northing: 184002.75
Easting: 860553.89

Weather:
Clear 60's windy

Boring Information:
Boring No.: SB-09
Well No.:
Surf. Elev.: 375.1

Depth Information:
Total: 4.0
Auger:
Core:

Dates:
Start: 11/3/2005
Finish: 11/3/2005

Drilling Contractor:
Name: Roberts Environmental Drilling, Inc.
City: Millstadt, IL
Equipment: Geoprobe

Personnel:
Geologist: M. Hewitt, P.G.
Driller: M. Cooper
Helper (s): E. Wetzel

Sample Type: Continuous Barrel | Split Spoon | Shelby Tube | Core | Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0												375
	1		09-1.2	3.7	0.0 0.0 0.0			Bentonite plug		CA6 GRAVEL; dry; loose Light yellowish brown, some dark yellowish brown mottles; Silty CLAY; moist; firm; few iron concretions		
										End of Boring = 4.0'		
5												370
10												365
15												360
20												

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 1991-135-8

Location:
Coord. System: State Plane
Northing: 184034.58
Easting: 860629.36

Weather:
Clear 60's windy

Boring Information:
Boring No.: SB-10
Well No.:
Surf. Elev.: 375.0

Depth Information:
Total: 4.0
Auger:
Core:

Dates:
Start: 11/3/2005
Finish: 11/3/2005

Drilling Contractor:
Name: Roberts Environmental Drilling, Inc.
City: Millstadt, IL
Equipment: Geoprobe

Personnel:
Geologist: M. Hewitt, P.G.
Driller: M. Cooper
Helper (s): E. Wetzel

Sample Type: Continuous Barrel | Split Spoon | Shelby Tube | Core | Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tst)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0												375
	1		10-2	3.0	0.0 0.0 0.0			Bentonite plug		CA6 GRAVEL; dry; loose Dark yellowish brown, some dark yellowish brown mottles; Silty CLAY; moist; firm; few iron concretions		
										End of Boring = 4.0'		
5												370
10												365
15												360
20												355

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 1991-135-8

Location:
Coord. System: State Plane
Northing: 183952.45
Easting: 860609.29

Weather:
Clear 60's windy

Boring Information:
Boring No.: SB-11
Well No.:
Surf. Elev.: 375.5

Depth Information:
Total: 4.0
Auger:
Core:

Dates:
Start: 11/3/2005
Finish: 11/3/2005

Drilling Contractor:
Name: Roberts Environmental Drilling, Inc.
City: Millstadt, IL
Equipment: Geoprobe

Personnel:
Geologist: M. Hewitt, P.G.
Driller: M. Cooper
Helper (s): E. Wetzel

Sample Type: Continuous Barrel | Split Spoon | Shelby Tube | Core | Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tsf)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0								Bentonite plug		CA6 GRAVEL; dry; loose		375
	1		1I-1.3		0.0					Light gray; Clayey SILT; moist; moderately firm		
					0.0					More Clayey from 2.5' - 3.5'		
				4.0	0.0					*End of Boring = 4.0'*		
5												370
10												365
15												360
20												

NOTES:

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Field Boring Log

Site Information:
Name: Honeywell International
Location: Metropolis, Illinois
County: Massac
Site No.: 1278540002
AEEI No.: 1991-135-8

Location:
Coord. System: State Plane
Northing: 184107.11
Easting: 860672.76

Weather:
Clear 60's windy

Boring Information:
Boring No.: SB-12
Well No.:
Surf. Elev.: 375.4

Depth Information:
Total: 12.0
Auger:
Core:

Dates:
Start: 11/3/2005
Finish: 11/3/2005

Drilling Contractor:
Name: Roberts Environmental Drilling, Inc.
City: Millstadt, IL
Equipment: Geoprobe

Personnel:
Geologist: M. Hewitt, P.G.
Driller: M. Cooper
Helper (s): E. Wetzel

Sample Type: Continuous Barrel | Split Spoon | Shelby Tube | Core | Blind Drill

Depth (ft.)	Run No.	Sample Type	Sample No.	Sample Recov.	Blow Count	q_p [q_s] (in tst)	% Moisture	Borehole Detail	Lithology	Description/*Comments*	USC	Elev. (MSL)
0										CA6 GRAVEL; dry; loose		375
	1		12-2		0.0					Dark yellowish orange, some dark orange mottles; Silty CLAY; moist; firm; few iron concretions; no odor; no visual contamination		
			12-4	2.0	0.0							
5	2		12-6		0.0							370
			12-8	4.0	0.0							
10	3		12-10		0.0							365
			12-12	4.0	0.0							
15												360
20												

Bentonite plug

End of Boring = 12.0'

NOTES: