REMEDIAL INVESTIGATION REPORT
REMEDIAL INVESTIGATION/FEASIBILTY STUDY

BOWERS LANDFILL, CIRCLEVILLE, OHIO 102598

DAMES & MOORE
JOB NO. 00850-032-17

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Dames & Moore

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1.0 INTRODUCTION

1.1 LOCATION

Bowers Landfill is situated in Pickaway County, approximately 25 miles south of Columbus, Ohio, and 2 miles north of the city limits of Circleville, Ohio (Drawing 1-1). The site is located near the northwest corner of the intersection of Island Road and Circleville-Florence Chapel Road, on the eastern edge of the Scioto River Valley, in Section 3, Township 4 North, Range 22 West (Drawing 1-2).

1.2 HISTORY OF OPERATION

The property on which the landfill is situated was purchased in June, 1957 by John M. Bowers, D.D.S., of Circleville. Based upon an inspection of a 1957 aerial photograph, the property in question comprised a cultivated field and woodlands. Much of the area now occupied by the landfill was wooded, and the size of riparian woodland along the Scioto River appears to have been somewhat greater than at present. A small stream flowed to the south along the eastern side of the property, along the base of a bluff. This stream entered the Scioto River just above the Circleville-Florence Chapel Road bridge (Burgess & Niple, 1981).

The aerial photo also indicates that clearing of the woodland along the Scioto River near the bridge was underway at that time. The photo shows no evidence of a sand and gravel operation, nor does it indicate that any landfilling had begun.

It is reported (Burgess & Niple, 1981) that sand and gravel operations were initiated by Dr. Bowers in the eastern portion of the site in 1958. The operation was located about 150 feet east of the present landfill location and about 2,000 feet north of Circleville-Florence Chapel Road. The original excavation was advanced into a hillside, at an elevation above that of the future landfill.

Shortly after opening the sand and gravel operation, Dr. Bowers commenced the landfill operation (1958 or 1959). According to a report from a person familiar with the operation (Burgess & Niple, 1981), the method of landfilling was an area-type fill; excavation did not occur, but rather, refuse was dumped directly on the ground and covered with soil from the sand and gravel operation. However, recent discussions with another individual claiming to be familiar with site operations (McFarland, 1986) suggest that some excavation of the existing ground may have occurred near the southern site boundary during early

operation prior to landfilling. The excavation was reported to have contained some water and to have been backfilled with construction debris.

Access to the site during the early years of landfill operation appears to have been from Island Road, past the sand and gravel pit, and across a wooden bridge over the drainage to the landfill. According to one observer, the filling operation began at the northwest end of the landfill near the Scioto River, and progressed southward toward Circleville-Florence Chapel Road. However, very little first-hand knowledge or recorded information is available to document the early years of landfill operation.

As the landfill extended to the south, access was gained from Circleville-Florence Chapel Road. Use of this access route apparently necessitated installation of a pipe to accommodate flow in the drainage ditch running between the landfill and the hill to the east. On the basis of aerial photos, it appears that the pipe may have been installed during 1967. Water from the ditch was carried beneath the landfill and into the Scioto River through this pipe.

According to information on file with the Ohio Environmental Protection Agency (OEPA), the majority of waste materials deposited on the site consisted of residential refuse collected by the City of Circleville as well as by several private haulers in the Circleville area. There are reports that wastes also came from at least three manufacturing plants and two grain elevators in the area. A list of wastes sent to the landfill from PPG Industries and E.I. duPont de Nemours Company, Inc. as reported in the Eckhardt survey is attached as Table 1-1.

There are no operating records for the landfill, and the owner (Dr. Bowers) is now deceased. Consequently, it has proven virtually impossible to determine the sources of refuse or what its composition may have been. In 1981, interviews were conducted with several persons who were familiar with the landfill operation. Information obtained during these interviews includes the following:

- Over a period of several years, refuse was burned at the facility. This resulted in at least four "cease burning" orders from the Ohio Department of Health.
- A 1967 report from the Ohio Department of Health states that about 150 open truck loads were received monthly, plus wastes hauled in by private autos and trucks. The report estimated that about 40 percent of the waste was generated by various industries operating in the area, including PPG and duPont, among others.
- It was reported that drums of unknown substances and bulk liquids were deposited on the landfill.

- Responses to the House Subcommittee on Oversight and Investigation by PPG and duPont in 1978 contained estimates of about 1,700 and 6,000 tons of material, respectively, sent to the landfill from 1965 to 1968 (see Table 1-1).

It is concluded that the landfill commenced operation in late 1958 or 1959, and ceased operation in 1969. During its operation, the site was known locally as the Island Road Landfill, the Metz Landfill, the Red Bridge Landfill, and the Bowers Landfill.

1.3 PREVIOUS INVESTIGATIONS

In July of 1980, U.S. EPA representatives collected five surface water samples near the landfill. Locations where samples were obtained are illustrated on Drawing 1-3 and are as follows (Burgess and Niple, 1981):

- At the pipe at the extreme southern edge of the landfill where it discharges into the Scioto River (Location A).
- From two water-filled depressions in the southwest part of the farm field, near the Scioto River levee (Locations B and C).
- From a water-filled depression on the west side of and adjacent to the landfill, about 300 feet north of the access road to the field (Location D).
- From a water-filled depression adjacent to the landfill at the point where the landfill makes a bend to the west toward the Scioto River (Location E).

Results of the laboratory analyses (Burgess & Niple, 1981) showed the presence of organic constituents in the water samples from the three locations in the vicinity of the landfill (see Table 1-2 and Drawing 1-3). Detected parameters involved benzene (Location D at a concentration of 0.012 mg/L), ethylbenzene (Locations D and E at concentrations of 0.12 and 2.40 mg/L, respectively), and toluene (Locations C, D, and E at concentrations of 0.04, 1.10, and 1.80 mg/L, respectively).

An investigation was commissioned in 1981 by Dr. Bowers and financed by PPG to determine whether an existing or potential hazard was created by the presence of the landfill. A preliminary report (Burgess & Niple, 1981) was prepared in November of that year. The scope of that investigation included:

- A review of aerial photos and published and unpublished literature relating to the site.
- The installation of three shallow monitoring wells (MW-1, MW-2 and MW-3, Drawing 1-3) to characterize geologic conditions in the vicinity of the landfill, and to collect ground water samples for chemical analyses.

- The collection of water samples for chemical analyses from these three monitoring wells as well as from two surface water locations (Locations A and F, Drawing 1-3) on three separate occasions.

- The collection of water samples for chemical analyses from ten private wells in the vicinity of the landfill.

Findings of the Burgess & Niple investigation are summarized and interpreted as follows:

- The site is underlain by a relatively impermeable silty clay which, in turn, is underlain by sand and gravel.

- The landfill is located in the floodplain of the Scioto River. Flood water typically reaches the toe of the landfill slope several times per year, and overtops the landfill, on the average, once every 2 years. (Flood stage data have since been updated by the U.S. Army Corps of Engineers, as discussed in Section 2.5 of this report. Data now indicate that the entire landfill would be overtopped, on the average, once every 5 to 10 years, and that portions of the landfill may be inundated approximately once every 2 years).

- During an initial GC/MS scan of a sample obtained from MW-2 (07/17/81), ten EPA Priority Pollutants were reported to be present in concentrations ranging from 0.01 to 2.48 mg/L (although methylene chloride, reported at 0.10 mg/L, was also detected in a laboratory blank). Apparently, a separate analysis of the same sample obtained from MW-2 was conducted. Reported results for two organic constituents conflicted with those generated from the GC/MS scan (ethylbenzene at 66.8 mg/L versus 2.48 mg/L, and toluene at 43.4 mg/L versus 2.53 mg/L). No reason was given in the report for this discrepancy. A concentration of mixed xylenes was also reported in the MW-2 sample at 27 mg/L.

- Subsequent analyses of samples obtained from MW-2 and MW-3 detected concentrations of ethylbenzene, mixed xylenes, and toluene at concentrations in the range of those reported for the initial MW-2 sample, although concentrations detected in the MW-3 samples were lower than in MW-2 (see Table 1-2).

- Phenols were reported in all samples collected during this study, including upgradient well MW-1 and offsite private wells. The validity of these results may therefore be questionable.

- Results of remaining analyses for organic, inorganic, and indicator parameters in ground water and surface water samples did not suggest presence of elevated levels.

Additional samples of leachate (May, 1982) and ponded water (May, 1983) were collected and analyzed by OEPA. Exact sampling locations are not currently available; however, the May, 1982 samples were reported to be collected approximately 100 feet upgradient of the Scioto River. Reported analyses of the samples indicated the following maximum levels of organic constituents (Bowers Consent Order, 1985):

	Leachate 5/82 (mg/L)	Ponded Water 5/83 (mg/L)
Toluene	47.7	7.1
Ethylbenzene	13.0	4.0
Xylene	12.1	-
Methyl isobutyl ketone	1.8	-
Phenol	1.1	-

1.4 PRESENT SITE CONDITIONS

The L-shaped landfill extends northerly from the Circleville-Florence Chapel Road, then turns to the west and continues toward the river for about 1,000 feet. It is approximately 4,000 feet long and averages about 125 feet across. Its average height is about 10 feet. The sides are sloped at about 2 to 1 (horizontal to vertical).

An unpaved (dirt) road runs along the top of the landfill for most of its length. Based on observations during the field investigation, vehicle traffic is limited to an occasional traverse of the northern portion of this road by farmers to gain access to the cultivated field between the landfill and the Scioto River. The extent of this traffic is believed to be several days during the growing season for field preparation, planting, pesticide/herbicide application and harvesting. Approximately the southern two-thirds of the road apparently does not experience vehicle traffic, due to the presence of a locked chain barrier at the southern entrance. On one occasion during the study, a group of individuals was observed operating recreational vehicles (ATVs) on the road. Several individuals were also observed walking along the southern portion of the road, to gain access to the Scioto River for fishing.

The landfill is vegetated with a relatively heavy growth of grasses, weeds, and shrubs, and contains a large number of trees, principally on the slopes of the berm, with some reaching heights of 20 feet or more.

The volume of material in the landfill was estimated by surveying the length of the landfill and by establishing four cross sections of the landfill at approximately 1,000-foot intervals (Burgess & Niple, 1981). It was found that the volume of material in the landfill, including clean fill that was used as cover, is about 130,000 cubic yards.

Miscellaneous debris is visible along portions of the landfill. It appears that some of the debris was never properly covered, while the remainder was probably dumped after the landfill operation was shut

down. Most of the exposed material is in the form of shredded and rolled plastic film. The remains of several drums are partially visible at a few locations. The drums are rusted and decomposed, and appear to have been present for an extended number of years. There is no noticeable odor associated with the landfill, nor has any effect (stress) on the vegetative cover been noted. A fair abundance of wildlife (deer, squirrels, and raccoon) has been noted.

There have been reports of leachate seeps from the sides of the landfill. It appears that the seeps have been most active during and immediately following periods of precipitation. The previously referenced report noted four areas where seeps were observed, and monitoring wells were installed near two of those areas (Drawing 1-3). During the 1986-1987 field investigation reported herein, very little evidence of seeps or leachate was noted. Evidence of a potential seep area was observed near the south end of the landfill, where an orange-red discoloration of water was noted. The water was ponded, and no flowing water was observed.

Runoff from the landfill is down either of the side-slopes to ditches running along the sides of the landfill. The ditch on the west side of the landfill is typically quite shallow and not well developed. Although the ditch drains southward, it is overgrown by vegetation in many places, and is subject to ponding as a result of high places along its course. A point of discharge of this ditch to the Scioto River is apparently not present, due to the occurrence of a levee (natural or artificial) along the river near the southern boundary. Instead, flow appears to pond in the southern portion of the property during wet periods, until infiltration and evapotranspiration slowly reduce the ponded volume. The majority of this ditch was observed to be dry during most of the field study, especially during periods of low precipitation.

The ditch to the east of the landfill also flows south, discharging into the Scioto River through a culvert pipe running beneath the landfill, as discussed previously. The outlet of this culvert appears to have been covered with sediment over the years, and appeared as a spring in the bank along the Scioto River during the investigation. The culvert pipe may be partially clogged, as drainage of the ditch appeared to be relatively slow, particularly during low flow stage in the ditch. This ditch was observed to contain water throughout most of the year, and may receive some inflow in the form of ground water discharge from the sand and gravel deposits to the east.

Three monitoring wells installed during the 1981 investigation were presumed to be still in existence at the time the field program reported herein commenced. The integrity of these wells was not known, due to the elapsed time since installation, and the lack of information regarding well completion. A

diligent search was made, resulting in two of the three wells being found (MW-1 and MW-2). These wells were found to have 2-inch PVC casing inserted in the borehole. Casing of MW-2 was not secure within the borehole, and the hole appeared to be open to the shallow aquifer. The wells were sealed during the course of the current investigation, as described in Section 3.0. Well MW-3 could not be located; the present condition of this well is not known.

When well MW-2 was opened in preparation for sealing, elevated readings were detected at the wellhead with two organic vapor survey instruments; a photoionization detection (PID) and a flame ionization detector (FID). The PID registered in excess of 20 parts per million (ppm), and the FID registered off-scale, when probes were placed inside of the well casing. These results may indicate either a relatively concentrated organic vapor source, or conversely, a low-level source that resulted from concentration of organic vapors over a long period of time. Thus, the apparent levels may not be representative of actual ground water conditions.

1.5 PURPOSE OF THE PRESENT INVESTIGATION

The investigation reported herein is part of a formalized program undertaken in accordance with the National Contingency Plan promulgated by the U. S. Environmental Protection Agency (U.S. EPA) in 40 CFR Part 300. That program is the Remedial Investigation/Feasibility Study (RI/FS) program. The work reported herein constitutes the first part of that program, the RI.

The purpose of the RI program is to characterize the physical, biological, and chemical environment at and near the site, and to assess the nature and extent of contamination at the landfill. On the basis of that information, the degree of risk represented by the landfill can be subsequently estimated through completion of an Endangerment Assessment. Following completion of the RI and associated Endangerment Assessment, a Feasibility Study (FS) is conducted to develop, screen, and select appropriate alternatives for site remediation.

1.6 SCOPE OF WORK

The basis for this program's scope of work was initially included in a Remedial Action Master Plan (RAMP) prepared for the site (U.S. EPA, 1983). The scope of work was further defined in the course of discussions between PPG, duPont, U.S. EPA, and OEPA, resulting in establishment of a Consent

Agreement between these parties. Dames & Moore was selected by PPG and duPont to conduct the RI/FS; documents were subsequently prepared and submitted to specify planned project activities, including a Work Plan, Quality Assurance/Sampling Plan, and Health and Safety Plan (Dames & Moore, 1986a, b, and c). Final plan approval was issued by U.S. EPA and OEPA in September, 1986.

The scope of work of this RI has been divided into several tasks, as summarized below:

- Hydrogeological study
- Ground water sampling and analyses
- Surface water and sediment sampling and analyses
- Soil sampling and analyses
- Biological study

TABLE 1-1

SUMMARY OF WASTE CATEGORIES REPORTED IN ECKHARDT SURVEY BY DUPONT AND PPG BOWERS LANDFILL - CIRCLEVILLE, OHIO

Generator	Composition of Waste
E.I. DuPont de Nemours & Company	Heavy metals and trace metals (bonded organically and inorganically) Arsenic, selenium, and antimony Iron, magnesium, and manganese Zinc, cadmium, copper, and chromium Organics Amides, amines, and imides Resins Elastomers Solvents, polar (except water) Halogenated aliphatics Acrylates and latex emulsions Solvents, halogenated aliphatic Oils and oil sludges Esters and ethers Alcohols Ketones and aldehydes Inorganics Salts Paints and pigments Asbestos
PPG Industries Incorporated	Organics Halogenated aliphatics Halogenated aromatics Acrylates and latex emulsions Amides, amines, and imides Plasticizers Resins Elastomers Solvents, polar (except water) Trichloroethylene Other solvents nonpolar Solvents, halogenated aliphatic Oils and soil sludges Esters and ethers Alcohols Inorganics Salts Mercaptans Wastes with flash point below 100°F

Source: Bowers Consent Order, 1985.

TABLE 1-2

SUMMARY OF PREVIOUSLY REPORTED SAMPLING AND ANALYSIS DATA
BOWERS LANDFILL - CIRCLEVILLE, OHIO
SOURCE: BURGESS & NIPLE, 1981
(Concentrations in mg/L unless otherwise noted.)

Parameter	U.S. EPA Surface Water Sampling Locations 7/9/80(1)					Burgess & Niple Sampling Locations(1)			
	A	B	C	D	E	A 7/17/81	A 8/20/81	A 9/15/81	F 7/17/87
1. Indicator Parameters									
Chloride	NA	NA	NA	NA	NA	31	NA	17	60
Chemical oxygen demand	NA	NA	NA	NA	NA	32	35	34	190
Conductivity (µhos)	NA	NA	NA	NA	NA	NA	440	570	NA
Hardness (as CaCO3)	NA	NA	NA	NA	NA	320	NA	NA	460
Nitrate (as N)	NA	NA	NA	NA	NA	0.13	NA	NA	0.15
pH (lab-S.U.)	NA	NA	NA	NA	NA	7.5	7.4	7.1	7.8
2. Inorganic Parameters									
Antimony	NA	NA	NA	NA	NA	NA	NA	NA	ND
Arsenic	NA	NA	NA	NA	NA	NA	NA	NA	ND
Barium	NA	NA	NA	NA	NA	NA	NA	NA	0.410
Beryllium	NA	NA	NA	NA	NA	NA	NA	NA	ND
Cadmium	NA	NA	NA	NA	NA	NA	ND	NA	0.009
Chromium	NA	NA	NA	NA	NA	NA	NA	NA	0.04
Copper	NA	NA	NA	NA	NA	NA	NA	NA	0.03
Cyanide	NA	NA	NA	NA	NA	NA	NA	NA	0.03
Iron	NA	NA	NA	NA	NA	1.4	0.18	6.20	1.5
Lead	NA	NA	NA	NA	NA	NA	NA	NA	0.015
Mercury	NA	NA	NA	NA	NA	NA	NA	NA	ND

NA = parameter not analyzed for.
ND = parameter analyzed for but not detected.
B - parameter detected in laboratory blank.
(1)Sampling locations on Drawing 1-3.

TABLE 1-2 (Continued)

Parameter	U.S. EPA Surface Water Sampling Locations 7/9/80(1) A	B	C	D	E	Burgess & Niple Sampling Locations(1) A 7/17/81	A 8/20/81	A 9/15/81	F 7/17/87
Nickel	NA	NA	NA	NA	NA	NA	ND	NA	0.01
Selenium	NA	NA	NA	NA	NA	NA	NA	NA	ND
Silver	NA	NA	NA	NA	NA	NA	NA	NA	ND
Thallium	NA	NA	NA	NA	NA	NA	ND	NA	0.003
Zinc	NA	NA	NA	NA	NA	NA	NA	NA	0.05
3. Organic Parameters									
Benzene(2)	ND	ND	ND	0.012	ND	ND	NA	NA	NA
Diethyl phthalate (2)	NA	NA	NA	NA	NA	ND	NA	NA	NA
Ethylbenzene(2)	ND	ND	ND	0.12	2.40	ND	NA	NA	NA
Ethylbenzene(3)	ND	NA	NA	NA	NA	NA	ND	ND	ND
Methylene chloride(2)	ND	NA	NA	NA	NA	ND(B)	NA	NA	NA
Mixed xylenes(2)	ND	NA	NA	NA	NA	NA	ND	ND	ND
Naphthalene(2)	NA	NA	NA	NA	NA	ND	NA	NA	NA
Phenols(2)	NA	NA	NA	NA	NA	ND	NA	NA	NA
Phenols(4)	NA	NA	NA	NA	NA	0.0011	NA	0.05	0.081
Toluene(2)	ND	ND	0.04	1.10	1.80	ND	NA	NA	NA
Toluene(3)	NA	NA	NA	NA	NA	NA	ND	ND	ND
Trichloroethylene(2)	NA	NA	NA	NA	NA	ND	NA	NA	NA
1,2,-Trans-dichloroethylene(2)	NA	NA	NA	NA	NA	ND	NA	NA	NA
2,4-Dimethylphenol(2)	NA	NA	NA	NA	NA	0.15	NA	NA	NA

NA = parameter not analyzed for.
ND = parameter analyzed for but not detected.
B - parameter detected in laboratory blank.
(1)Sampling locations on Drawing 1-3.
(2)Gas chromatography/mass spectrometry.
(3)Gas chromatography - liquid extraction.
(4)Spectrophotometry.

Table 1-2 (Continued)

Parameter	Burgess & Niple Sampling Locations (1)								
	MW-1 7/17/81	MW-1 8/20/81	MW-1 9/15/81	MW-2 7/17/81	MW-2 8/20/81	MW-2 9/15/81	MW-3 7/17/81	MW-3 8/20/81	MW-3 9/15/08
1. Indicator Parameters									
Chloride	25	NA	15	38	NA	26	64	NA	13
Chemical oxygen demand	56	88	159	440	670	410	470	320	120
Conductivity (µhos)	NA	500	670	NA	850	1000	NA	580	530
Hardness (as CaCO3)	400	NA	NA	500	NA	NA	580	NA	NA
Nitrate (as N)	0.02	NA	NA	0.36	NA	NA	0.11	NA	NA
pH (lab-S.U.)	7.2	7.3	7.1	6.5	6.6	6.2	6.9	6.9	6.9
2. Inorganic Parameters									
Antimony	ND	NA	NA	ND	NA	NA	NA	NA	NA
Arsenic	ND	NA	NA	ND	NA	NA	NA	NA	NA
Barium	0.13	NA	NA	0.41	NA	NA	NA	NA	NA
Beryllium	ND	NA	NA	ND	NA	NA	NA	NA	NA
Cadmium	0.017	ND	NA	0.01	0.006	NA	NA	ND	NA
Chromium	0.009	NA	NA	0.017	NA	NA	NA	NA	NA
Copper	0.014	NA	NA	0.015	NA	NA	NA	NA	NA
Cyanide	ND	NA	NA	ND	NA	NA	NA	NA	NA
Iron	1.5	0.06	0.85	40	0.90	100	0.43	0.26	3.90
Lead	0.02	NA	NA	0.01	NA	NA	NA	NA	NA
Mercury	ND	NA	NA	ND	NA	NA	NA	NA	NA

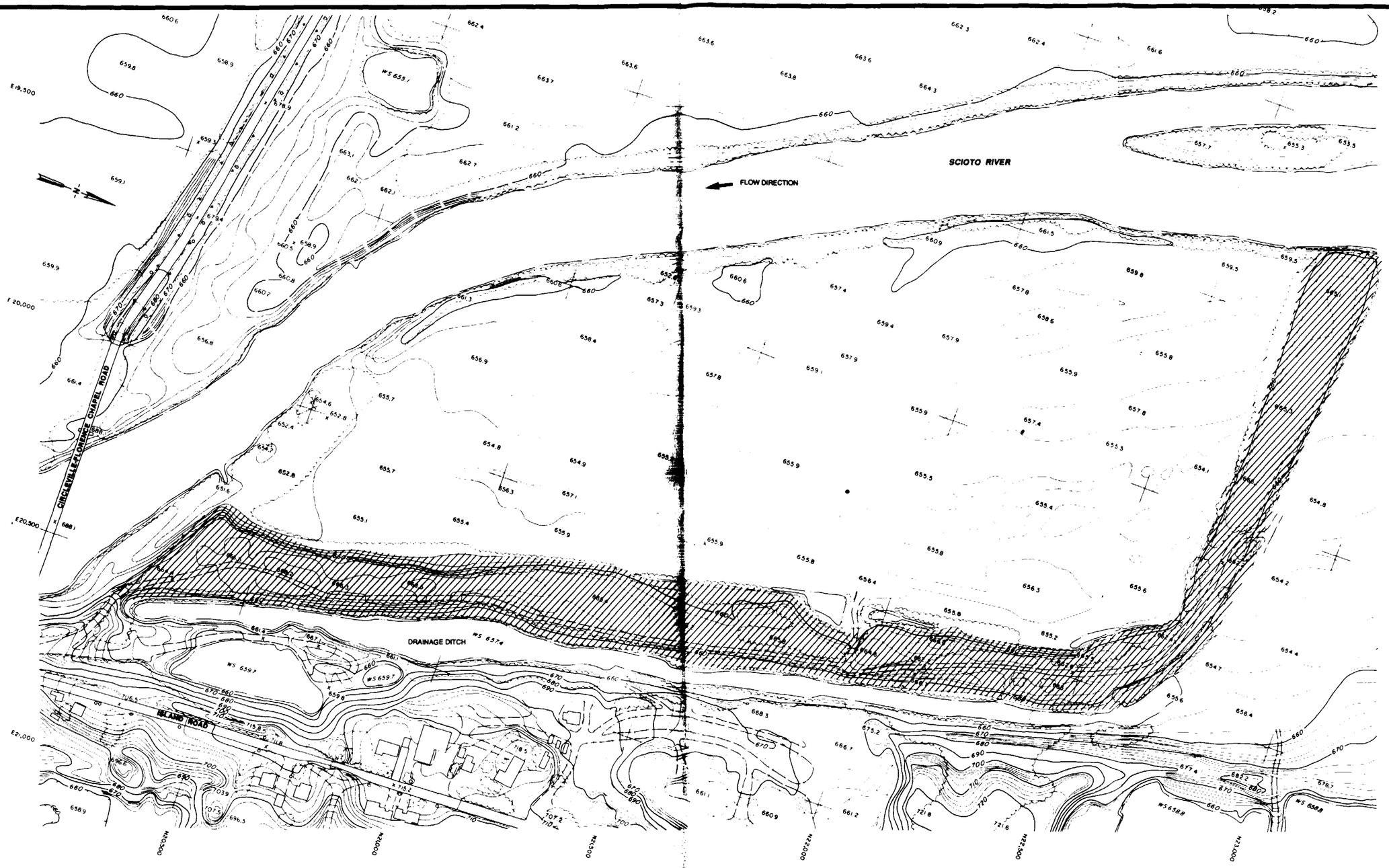
NA = parameter not analyzed for.
ND = parameter analyzed for but not detected.
B - parameter detected in laboratory blank.
(1)Sampling locations on Drawing 1-3.
(2)Gas chromatography/mass spectrometry.
(3)Gas chromatography - liquid extraction.
(4)Spectrophotometry.

TABLE 1-2 (Continued)

Parameter	Burgess & Niple Sampling Locations (1)								
	MW-1 7/17/81	MW-1 8/20/81	MW-1 9/15/81	MW-2 7/17/81	MW-2 8/20/81	MW-2 9/15/81	MW-3 7/17/81	MW-3 8/20/81	MW-3 9/15/08
Nickel	0.03	0.007	NA	0.15	ND	NA	NA	ND	NA
Selenium	ND	NA	NA	ND	NA	NA	NA	NA	NA
Silver	ND	NA	NA	ND	NA	NA	NA	NA	NA
Thallium	0.019	ND	NA	0.009	ND	NA	NA	ND	NA
Zinc	0.1	NA	NA	0.05	NA	NA	NA	NA	NA
3. Organic Parameters									
Benzene(2)	ND	NA	NA	0.03	NA	NA	NA	NA	NA
Diethyl phthalate (2)	ND	NA	NA	0.01	NA	NA	NA	NA	NA
Ethylbenzene(2)	ND	NA	NA	2.48	NA	NA	NA	NA	NA
Ethylbenzene(3)	ND	ND	ND	66.8	40.0	76.0	NA	10.0	11.0
Methylene chloride(2)	ND(B)	NA	NA	0.10(B)	NA	NA	NA	NA	NA
Mixed xylenes(2)	ND	ND	ND	27	86.0	74.0	NA	34.0	20.0
Naphthalene(2)	ND	NA	NA	0.19	NA	NA	NA	NA	NA
Phenols(2)	ND	NA	NA	0.06	NA	NA	NA	NA	NA
Phenols(4)	0.016	0.07	0.06	1.0	0.96	1.12	0.0021	0.37	0.08
Toluene(2)	ND	NA	NA	2.53	NA	NA	NA	NA	NA
Toluene(3)	ND	ND	ND	43.4	53.0	62.0	NA	18.0	11.0
Trichloroethylene(2)	ND	NA	NA	0.02	NA	NA	NA	NA	NA
1,2,-Trans-dichloroethylene(2)	ND	NA	NA	0.09	NA	NA	NA	NA	NA
2,4-Dimethylphenol(2)	ND	NA	NA	0.04	NA	NA	NA	NA	NA

NA = parameter not analyzed for.
ND = parameter analyzed for but not detected.
B - parameter detected in laboratory blank.
(1)Sampling locations on Drawing 1-3.
(2)Gas chromatography/mass spectrometry.
(3)Gas chromatography - liquid extraction.
(4)Spectrophotometry.

#D6



LEGEND:

EXISTING LANDFILL

0 300

SCALE IN FEET

CONTOUR INTERVAL: 2 FEET

DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984

REV	DATE	DESCRIPTION	DR BY	APP BY

PROJECT NO. 850-32-17

DES BY	
DR BY	
CHK BY	
APP BY	

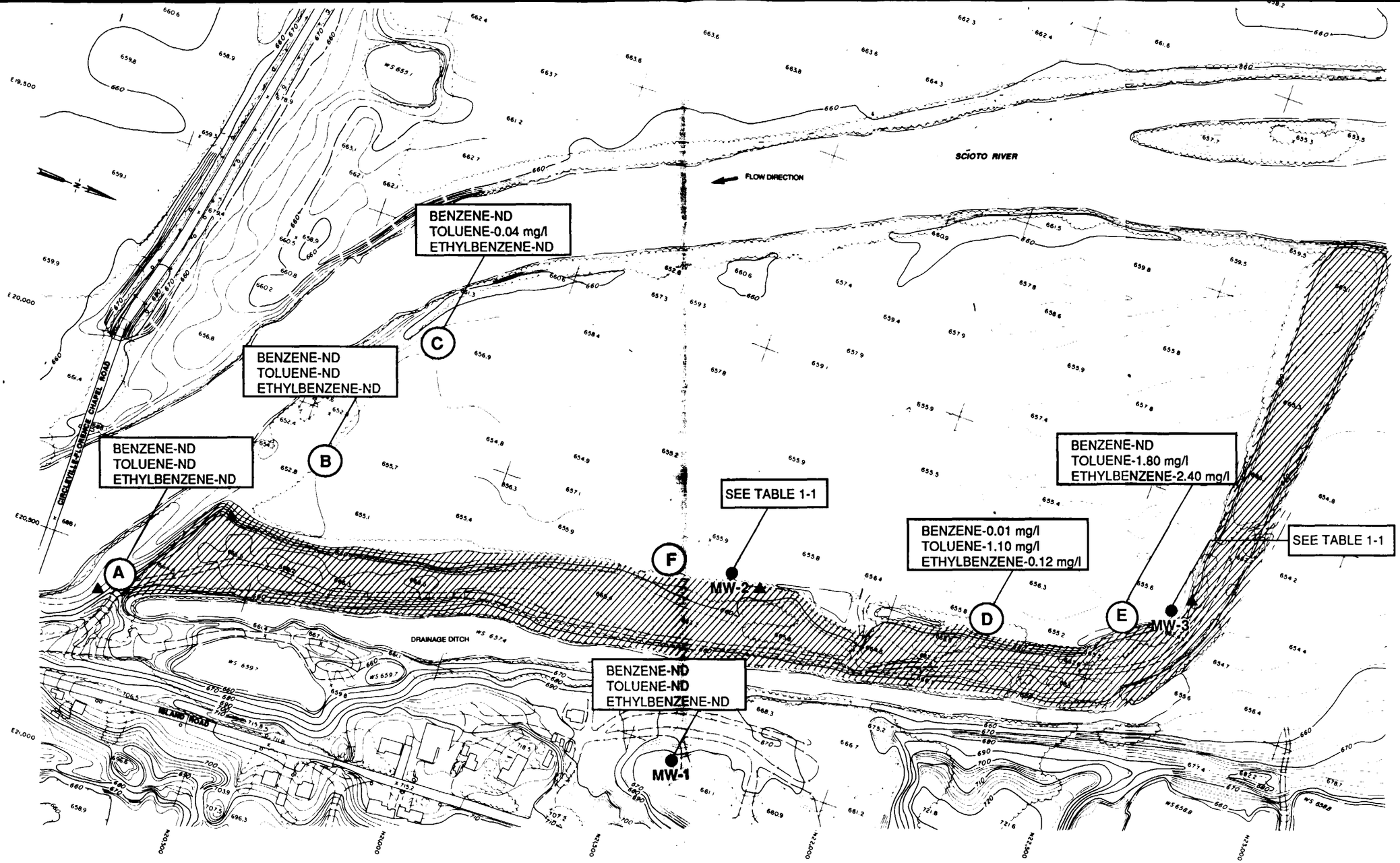
BOWERS LANDFILL
CIRCLEVILLE, OHIO

Dames & Moore

SHEET TITLE: **Site Layout**

SHEET ___ OF ___

DRAWING NO: **1-2**



LEGEND:

EXISTING LANDFILL

MW-1 ● APPROXIMATE LOCATION, IDENTIFICATION NUMBER AND SUMMARY OF ANALYTICAL RESULTS FOR BTE* CORRESPONDING TO MONITORING WELLS INSTALLED DURING PREVIOUS SITE INVESTIGATIONS (BURGESS & NIPLE, 1981)

▲ APPROXIMATE LOCATION OF SEEPAGE OBSERVED DURING PREVIOUS SITE INVESTIGATION (BURGESS & NIPLE, 1981)

(C) APPROXIMATE LOCATION, IDENTIFICATION NUMBER AND SUMMARY OF SAMPLE ANALYTICAL RESULTS FOR BTE* CORRESPONDING TO SURFACE WATER SAMPLES OBTAINED AND ANALYZED (BURGESS & NIPLE, 1981)

*BTE = BENZENE, TOLUENE AND ETHYLBENZENE CONCENTRATIONS (mg/l); ND INDICATES PARAMETER NOT DETECTED

0 300
SCALE IN FEET

CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984

REV	DATE	DESCRIPTION	DR BY	APP BY

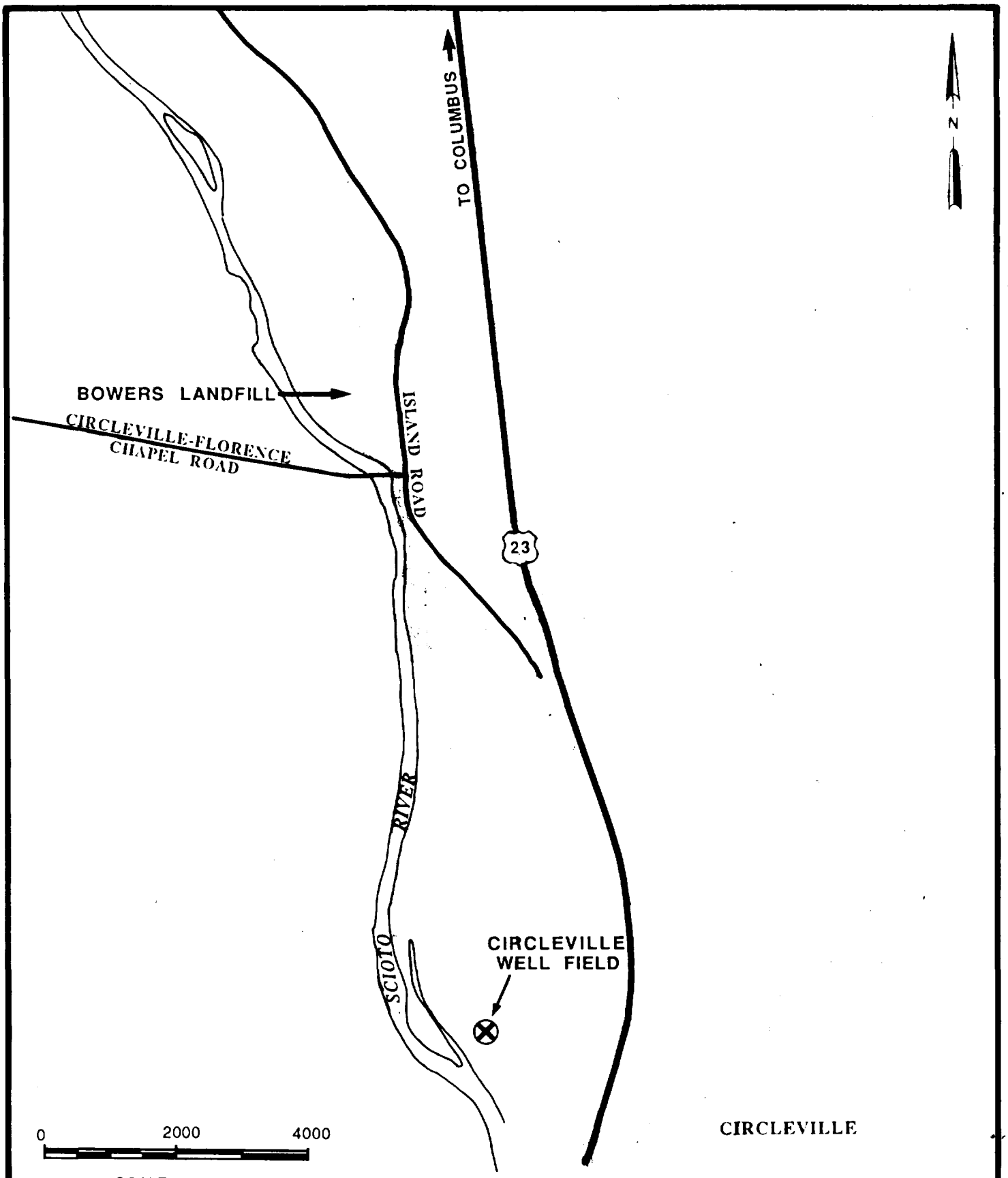
PROJECT NO. 850-32-17

DES BY	MJL	7/20/87	BOWERS LANDFILL CIRCLEVILLE, OHIO
DR BY	JB	7/21/87	
CHK BY			
APP BY			

SHEET TITLE: Summary of Previous Site Monitoring/Observations

SHEET ___ OF ___

DRAWING NO: 1-3



BASE MAP SOURCE: Compiled from the following USGS 7 1/2 minute topographic quadrangle maps: Ashville, Ohio, 1958, photorevised 1970; Circleville, Ohio, 1961, photorevised 1974.

Quadrangle Location

PROJECT NO. 850-32-17			
DES BY			BOWERS LANDFILL CIRCLEVILLE, OHIO Dames & Moore
DR BY			
CHK BY			
APP BY			
SHEET TITLE: Site Vicinity Map			SHEET ___ OF ___ DRAWING NO: 1-1

2.0 ENVIRONMENTAL SETTING

2.1 POPULATION/DEMOGRAPHY

Although the predominant land use in Pickaway County, Ohio, is agricultural, the county's proximity to Columbus has resulted in an increase in residential and commercial development over the last several years. The population of the county in 1975 was 43,567, a net increase of 9.4 percent since 1970 (U.S.D.A., 1980). The only city in the county is Circleville, which is located about 2 miles south of the site. The population of Circleville was 12,590 in 1980.

The site area is rural. The number of houses shown on the 1970 Ashville and 1978 Circleville Quadrangle sheets is 15 within a 0.5-mile radius of the landfill and 45 within a 1-mile radius. Distribution of the houses is:

	Number of houses within 0.5-mile radius	Number of houses from 0.5- to 1.0-mile radius
West of Scioto River	3	7
Along Red Bridge-East Reingold Road	12	15
Along North Court Street (extended)	0	23

The average number of people per household in 1975 in the county was 3.9. Using that factor, the population within 0.5 mile of the site would be 59 people, and the number of people residing within 1 mile would be 234.

2.2 LAND USE

Land use in the vicinity of the site falls into four principal categories; agricultural, quarrying, residential, and undeveloped. The largest of those in terms of land requirements is agricultural (cash grain and livestock farming). In 1969, about 96.7 percent of the total county land area was in farms. On the basis of 1984 aerial photographs (Chicago Aerial Survey, 1984), farming is estimated to account for about 90 percent of land used within 1 mile of the site. Several sand and gravel operations, both active and inactive, are located in the vicinity of the site. It is estimated that they account for about 2 percent of the land use within 1 mile of the site. Land requirements for residential purposes within 1 mile of the site are estimated to represent less than 1 percent of the land use. Undeveloped land consists primarily of woodlands along the Scioto River and in other places throughout the area. It is estimated to account for slightly less than 8 percent of the land within 1 mile of the site.

Based on observations during the current study, recreational activities in the area include occasional angling along the banks of the Scioto, and waterfowl hunting on the river and in the farm fields. As discussed previously, recreational vehicles were observed on or near the landfill on several occasions.

2.3 CLIMATE

Pickaway County is characterized by cold, windy winters and hot, humid summers. Winter precipitation, typically snow, accumulates enough moisture to minimize drought conditions during the summer growing season. The average daily minimum winter temperature is 24 degrees, while the average daily maximum summer temperature is about 85 degrees. (U.S.D.A., 1980)

Sixty percent of the total annual precipitation falls in the 6-month period from April through September. The average seasonal snowfall is 13 inches. The average monthly precipitation is as follows (U.S.D.A., 1980):

January	2.54 inches
February	2.42 inches
March	3.61 inches
April	3.88 inches
May	4.16 inches
June	3.54 inches
July	3.91 inches
August	3.24 inches
September	3.33 inches
October	2.05 inches
November	2.76 inches
December	2.59 inches

Wind conditions from the Columbus airport are shown on Drawing 2-1.

2.4 SOILS

The soil types found in the vicinity of the site are from the Eldean-Genesee-Warsaw Association. They are found in floodplains, outwash plains, and stream terraces. This association is characterized by nearly level to sloping, well-drained soils formed in moderately fine-textured to coarse-textured glacial outwash and alluvium.

Most of the farming field situated between the landfill and the Scioto River is formed on the Genesee soil. It is classified as a silt loam; the Unified Soil Classification System designation is CL or ML. Liquid limits are typically in the range of 26 to 40, and the Plasticity Index is normally between 3 to

15. The northeast corner of the farm field and much of the landfill area is classed as the Shoals Series, described as a silt loam. The Unified Soil Classification System symbol associated with this series is CL or CL-ML. The range of Liquid Limits is from 22 to 40, and the Plasticity Index is typically between 4 and 15.

2.5 SURFACE WATER HYDROLOGY

The dominant hydrologic feature in the vicinity of the site is the Scioto River. It is the largest river in Central Ohio, draining an area of 3,217 square miles upstream of the site (U.S.G.S., 1977). The Scioto flows south from an area northwest of Columbus, and empties into the Ohio River near Portsmouth, Ohio.

Based upon recent unpublished data (U. S. Army Corps of Engineers, 1986), the following approximate flood flows and associated stages may be expected in the vicinity of the site:

Flood Return Period (years)	Discharge near Circleville (cfs)	Water Stage near Circleville (Feet, MSL)	Water Stage near Site (Feet, MSL)*
1	30,200	660.9	662.3
2	40,200	662.5	663.9
5	57,000	664.5	665.9
10	74,800	665.9	667.3
20	94,000	667.4	668.8
50	128,600	669.6	671.0
100	157,900	671.4	672.8

* Site data obtained by addition of 1.43-foot correction to Circleville data to compensate for elevation change.

In an average year, the farm field between the landfill and the Scioto River is under water for about 29 days, usually in the spring and winter (Burgess & Niple, 1981). During the current study, two flood events occurred at the site (October and November, 1986). Crest stage elevations for these events were in the range of 662-663 feet, MSL, based on field observations and Corps of Engineers data.

Runoff from the landfill is down either of the side slopes into ditches on either side of the landfill. Water in the east ditch flows to the south and discharges into the Scioto River via a culvert constructed through the Scioto River levee. As stated in an earlier section, the ditch on the west side of the landfill is not well developed and ponding of water in that ditch is common. Ponding is most likely to occur during periods of precipitation.

2.6 GEOLOGIC CONDITIONS

Geologic conditions in the site area can be divided into two categories: unconsolidated glacial and alluvial (stream) deposits, and the underlying consolidated rock strata. Logs of water wells in the vicinity of the site indicate that bedrock is generally between 75 and 100 feet below ground surface. The uppermost bedrock formation underlying the glacial deposits is the Upper Devonian Ohio Shale. This formation is reported to be several hundred feet thick in the site area and is characterized as an impermeable, black, carbonaceous shale. It is underlain by the Olentangy Shale, also of Devonian Age, and is lithologically similar to the Ohio Shale.

Unconsolidated materials in the site area are part of a large buried valley system that predates glacial history. All major buried valleys have rather complex geologic histories, and this one is no exception. The oldest identifiable drainage system that existed in this area is the Teays River, which had its origin in West Virginia, and flowed across Ohio and Indiana into Illinois. The Teays River flowed northward at the site; its valley cut deeply into the Ohio Shale. The alluvial deposits of the Teays were largely clay, silt, and fine sand that are not important sources of ground water supplies because of their relatively impermeable nature (O.D.N.R., 1965)

Eventually a new drainage system was established. As a part of this drainage system, a major river, named the Newark River, was formed. This river had its source in northeastern Ohio, and flowed south at the site, occupying a portion of the Teays Valley. The advance of glaciation filled the Newark Valley with sand, gravel, and silt, materials deposited by the glaciers and their meltwaters. The present-day Scioto River meanders across the former Newark Valley.

The area near the site is characterized by another, somewhat unusual, geologic feature. Several long, linear ridges, called eskers, run parallel to the river. One of these eskers, referred to as the Circleville Esker, is one of the most prominent in Ohio. Eskers are composed of sand and gravel deposited by meltwater flowing through ice tunnels under or within the glacier. Many of the sand and gravel operations in the area have been in esker deposits. The topographically high area immediately east of the site is part of the Circleville Esker.

The floodplain is mantled by a layer of soil (as described earlier) that may be a few feet thick and consists of silt, clay, and sand laid down by Scioto River backwater during overflow. Water well logs show that the underlying sand and gravel deposits are interbedded with clay and till. The presence of these

materials are sufficiently widespread in some places to function hydraulically as a locally semi-confining bed separating the sand and gravel into an upper and a lower aquifer.

A detailed description of the onsite geologic conditions as observed during the investigation described herein may be found in Section 3.1.

2.7 HYDROGEOLOGIC CONDITIONS

Ground water in Central Ohio occurs in the pore spaces of unconsolidated materials and bedrock. The uppermost bedrock unit in the site area is the Ohio Shale, which, because of its low permeability, is not a producer of ground water. Additionally, the quality of water from that formation is presumed to be non-potable due to the presence of naturally occurring salts and sulfides. Deeper formations also contain non-potable water.

Ground water conditions in the unconsolidated glacial/alluvial materials include the vadose (unsaturated) zone and the phreatic (saturated) zone. Throughout the Scioto River Valley, the top of the saturated zone is typically in the range of 10 to 20 feet below surface.

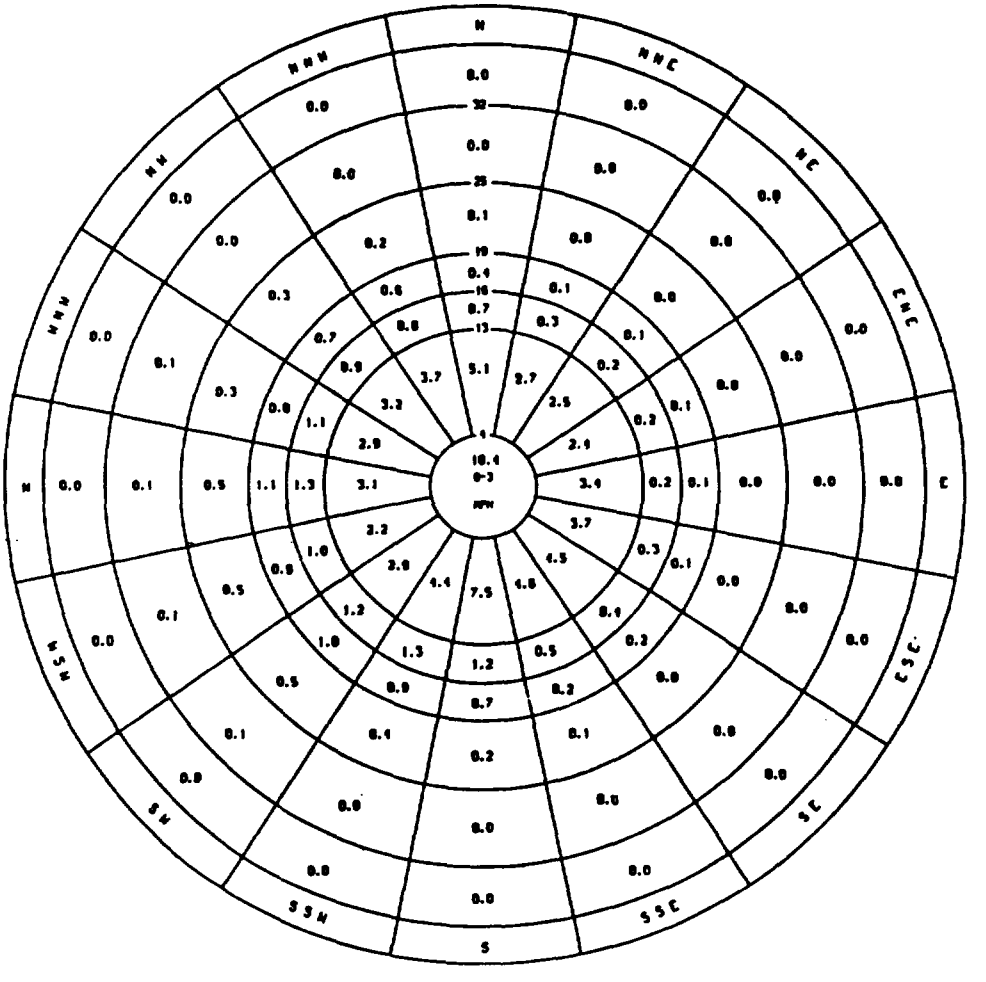
Regionally, natural recharge to aquifers in the Scioto Valley occurs through infiltration from precipitation, from infiltration of Scioto River water during high stage conditions, and from underflow through buried valley walls. The amount of recharge from any given source is primarily a function of existing geologic conditions. It appears that, on a regional scale, recharge from the Scioto River during flooding represents a minor contribution because of the relatively short duration of flooding and the existence of relatively impermeable surficial soils in the alluvial valley. The primary sources of recharge are from infiltration of precipitation falling on the land surface, and from underground movement of ground water from aquifers in the adjacent upland area.

In the vicinity of the study area, it would appear that recharge to ground water occurs primarily through infiltration of precipitation on locations to the east of the landfill. In these areas, surficial clay soils appear to be absent, and more permeable sand and gravel soils are present to allow fairly high infiltration rates. However, to the west and north of the landfill, clay soils are present to greatly reduce infiltration capacity; therefore recharge in these areas is considered to be limited.

Ground water levels in the area generally reflect topographic conditions. Ground water movement is toward the Scioto River unless locally reversed by pumping from large nearby well fields. The closest known well field is the Circleville municipal field, located approximately 1.5 miles to the south, and downstream of the site. The well field presently consists of three production wells completed in the alluvial aquifer and producing a combined yield of approximately 1.65 million gallons per day (City of Circleville, 1987). The distance between the site and this well field is regarded as being far in excess of that which may affect ground water movement in the vicinity of the site, given the relatively high permeability of the sand and gravel aquifer and its unconfined nature.

Pumping from sand and gravel pits near the site is reportedly for aggregate washing operations (Sturm and Dillard, 1987). The wash water is returned to the pit after use; therefore, ground water flow patterns in the area are probably not influenced by this activity.

Several small-capacity private water wells are known to exist in the area. Based on a review of available well logs, and discussions with local residents, all private wells are believed to be completed in the unconsolidated sand and gravel materials. There are no known water wells within a mile of the landfill in a downgradient direction, as all wells appear to be located across the Scioto River or on topographically higher (upgradient) areas. Because the river is assumed to act as a linear ground water discharge boundary during most of the year, there is no evidence of ground water flow across the river channel.



SOURCE: U.S. Department of Commerce
National Oceanic and Atmospheric Administration,
1986.

PROJECT NO. 850-32-17			
DES BY			BOWERS LANDFILL CIRCLEVILLE, OHIO
DR BY			
CHK BY			
APP BY			Dames & Moore
SHEET TITLE: WIND ROSE COLUMBUS, OHIO			SHEET OF DRAWING NO: 2-1

3.0 SITE INVESTIGATION

An investigation was conducted at the Bowers landfill site in order to characterize the physical setting and to provide information relative to the occurrence and distribution of contaminants, if present, in the various media. The investigation took place during the period from July 1986 through May 1987. Associated tasks included: a hydrogeologic study, including an electromagnetic (EM) survey and borehole drilling/monitoring well installation; two rounds of ground water sampling and analysis; two rounds of surface water/sediment sampling and analysis; one round of surficial soil sampling and analysis; and a biological study. The scope of work and methods employed in the conduct of each task are discussed in a work plan and associated documents prepared for the investigation (Dames & Moore, 1986a, b, and c).

This section of the report includes a discussion of each investigative task, including the task objective, approach, results, and interpretation. Detailed descriptions of methods and procedures associated with completion of the tasks are excluded from this section; rather, they are included in appendices for reference, as necessary.

3.1 HYDROGEOLOGIC INVESTIGATION

The initial phase of the site investigation included a hydrogeologic investigation. Objectives of this investigation, as discussed in the work plan, included an evaluation of subsurface geologic conditions at the site, definition of water-bearing formations, and estimation of the rate and direction of ground water flow. The purpose of gathering this information is to describe the hydrogeologic environment at the site and to provide data for the eventual selection and design of appropriate remedial measures.

The hydrogeologic investigation was subdivided into two tasks: an EM survey and borehole drilling/monitoring well installation. The EM survey is a surface geophysical technique designed to provide information relative to lithologic and hydrogeochemical conditions and/or variations across the site. Subsurface borings and associated monitoring wells further define geologic, hydrogeologic, and water quality conditions.

This section of the report includes discussions of the EM survey and drilling/monitoring well installation subtasks that constitute the hydrogeologic investigation. Under each category, a brief review of the technical approach is included; the reader is referred to the appropriate appendix for more detailed

description of procedure and methodology. Results of the two subtasks are presented and analyzed, followed by a section that combines these data with previously reported information to provide a comprehensive interpretation of hydrogeologic conditions at the site.

3.1.1 Electromagnetic (EM) Survey

3.1.1.1 Review of Method

The EM survey technique produces measurements of terrain conductivity, often referred to as apparent electrical conductivity, of soil/rock and associated pore fluids, averaged over hemispherical volumes of subsurface strata. The principle of operation involves the introduction of a low-frequency electromagnetic signal of known strength into the shallow subsurface using a transmitter coil contacting the ground. This primary signal, in turn, generates a secondary signal, which is read by a receiver coil located at a known distance from the transmitter. The strength of the signal received is directly related to the terrain conductivity, which is read and recorded by the operator in millimhos-per-meter (mmho/m).

Horizontal and vertical variations in terrain conductivity are generally indicative of changes in subsurface conditions. Factors that can influence conductivity readings include soil/rock type (texture, porosity, etc.), strata thickness, moisture content, and the presence of solutes in the ground water. For example, values of terrain conductivity would be higher in an area with clay strata than in one with sand and gravel, all other factors being equal. This is a result of the higher porosity (and associated moisture content) exhibited by clay. Similarly, regions where ground water contains relatively high concentrations of dissolved constituents may exhibit higher values of terrain conductivity than regions with lower concentrations of these constituents. In such cases, the ability of the solute to enhance the transmission of electrical current is the determining factor.

3.1.1.2 Objective

The purpose of conducting an EM survey at the site was to provide an initial characterization of hydrogeologic conditions, and particularly, to define variations in conductivity readings across the site. Those readings may, in turn, be used to:

- Identify anomalous areas.
- Locate (or relocate) test borings to investigate anomalous areas, if appropriate.
- Interpolate subsurface conditions between borings.
- Aid in an assessment of the lateral extent of a surficial clay layer reported to be present at several onsite locations.

3.1.1.3 Summary of Task

An EM survey was conducted at the site during the period of July 8-14, 1986. Approximately 200 measurement stations were established along 13 profile lines across the site (Drawing 3-1). Measurements of terrain conductivity were obtained at three approximate sounding depths of 7.5, 15, and 30 meters, using a Geonics EM34-3XL survey instrument. Conductivity values, in mmho/m were read and recorded for subsequent evaluation. A more detailed discussion of methods employed during this study phase, taken from an earlier technical memorandum prepared to summarize the hydrogeologic investigation (Dames & Moore, 1987a) is included in Appendix A.

3.1.1.4 EM Survey Results

Terrain conductivity values obtained at the locations shown in Drawing 3-1 for the three sounding depths, are listed on Table 3-1. Data from each sounding depth have been plotted and contoured to allow an interpretation of conductivity values, and variations thereof, across the site. Drawings 3-2 through 3-4 correspond to values obtained at the 10-, 20-, and 40-meter coil spacings (7.5-, 15-, and 30-meter depths), respectively. Each illustration was prepared by plotting conductivity values at the midpoint of the respective coil spacing, followed by contouring of the data points. The 10-meter coil spacing data were adjusted by subtraction of 1 mmho/m from each value prior to tabulation (Table 3-1) and plotting (Drawing 3-2). This adjustment was conducted to reflect results of a pre-survey calibration, as discussed in Appendix A. Profiles showing variations in conductivity along each of the 13 survey lines are included as Appendix B.

A review of the EM survey data yields the following observations:

- Overall, terrain conductivity values vary fairly uniformly across the site, allowing continuity in the contouring of data.

- Areas of apparently elevated conductivity (i.e., on the order of 10 mmho/m or more above nearby readings) coinciding with locations on the landfill are present.
- An overall trend of decreasing conductivity from northeast to southwest is noted, with values (mmho/m) ranging from the upper twenties to the low thirties near the landfill to the low twenties-upper teens near the river.
- The area directly east of the landfill exhibits low terrain conductivity, with values (mmho/m) in the low teens to single digits.

Potential sources of elevated readings on the landfill include: metallic materials (e.g., steel drums, pipe, construction debris, automobiles, etc.); fine-grained soil within or covering the landfill; compacted soil and/or waste; soil pore fluids with elevated dissolved solids concentrations. Data interpretation techniques are not available to identify one or more specific sources. However, since virtually all EM readings obtained on the landfill appear to be at least slightly elevated, it is assumed that overall characteristics of the landfill soil, waste, or pore fluids are involved.

The more significant anomalies observed during the study may be associated with the presence of metallic materials. Such an assumption does not necessarily imply that metallic materials might be buried only at those locations. Rather, it is likely that certain readings were obtained much closer to a metallic object than were other readings. Such anomalies include the following areas (see Drawings 3-2 through 3-4): east of well location 5; north of well location 5; east of well location 6; north of well location 6 near the "elbow" of the landfill; north of well location 10 near the northern end of the landfill road. It is noted that an abandoned segment of a natural gas pipeline is reported to be buried within the fill near the latter two locations (Columbia Gas, 1986). This pipeline may be associated with the anomalously high (and low) readings in that area.

Apparently, there is no direct correlation between observed remnants of steel drums on the landfill surface and significant anomalies listed above. For example, an area containing remnants of several drums is present to the northeast of well location 7. However, no EM anomalies were observed in that area. Any such attempts to correlate EM anomalies with locations of potential drums are hindered by the following factors:

- Verification of a given anomaly as being due to metallic material would prove difficult at best. Potential geophysical methods for accomplishing this, such as a magnetometer survey, would most likely encounter strong interferences due to the probable random scattering of metal within the landfill.
- If verified as metallic (i.e., ferromagnetic), methods for distinguishing between drums and other metallic materials are not known to be available.

- The magnitude of an EM anomaly is not only a function of the mass of a metallic object (i.e., number of drums), but also of depth, distance, and orientation of the object(s).

Further discussion of the EM survey results is included in Section 3.1.3, where information is combined with that obtained from the drilling/monitoring well installation phase to allow a more comprehensive assessment of hydrogeologic conditions existing at the site.

3.1.2 Drilling/Monitoring Well Installation

3.1.2.1 Objectives

Objectives of subsurface drilling activities, as discussed in the work plan, include the following:

- Observation and recording of geologic and hydrogeologic conditions, as well as indications of potential subsurface contamination
- Collection of subsurface soil samples for physical and chemical analysis
- Installation of monitoring wells for subsequent water level measurements and ground water sample collection

3.1.2.2 Summary of Task

Drilling/monitoring well installation activities were carried out during the period from September 26, 1986 to January 20, 1987. During this period, a total of 18 borings were successfully drilled at 10 locations in the site vicinity (Drawing 3-5). Soil samples were obtained at various intervals in each borehole and evaluated in the field to provide a description of physical characteristics present in the subsurface. Twenty samples were submitted for physical testing by a geotechnical laboratory. The boreholes were completed as monitoring wells, to allow for the subsequent measurement of water levels and the collection of ground water samples for chemical analysis. Two of the three monitoring wells previously installed at the site, and considered to be in disrepair, were sealed during this period. Horizontal and vertical coordinates of each boring/monitoring well were obtained during a location and elevation survey (February 25-27, 1987), and water levels were measured on three occasions (February 9-13, March 12, and April 27, 1987). Staff gages were installed at four locations (Drawing 3-5) during this study phase, to allow comparison between ground water and surface water elevations.

A more detailed discussion of this study phase, including methods and materials used, field procedures, and other important aspects, is included as Appendix C. The following discussion of drilling/monitoring well installation results is drawn from an earlier Technical Memorandum summarizing the hydrogeologic investigation (Dames & Moore, 1987a).

3.1.2.3 Drilling/Monitoring Well Installation Results

Boring/monitoring well logs have been prepared to describe subsurface geologic conditions encountered in each boring, and to include information regarding monitoring well construction. The logs are included as Appendix D.

Horizontal and vertical coordinates obtained for monitoring wells and surface water staff gages are listed on Table 3-2. Surveyed locations of these monitoring points are illustrated on Drawing 3-5.

Water surface elevations obtained from monitoring wells and staff gages on February 9-13, March 12 and April 27, 1987, are listed on Table 3-3; water level data for the shallow (water table) wells obtained March 12 have been contoured on Drawing 3-6 (elevations measured during the period February 9-13 were obtained over an extended time period, and were not contoured; elevations measured on April 27, while slightly higher, exhibit essentially the same areal distribution, and were not illustrated). Drawing 3-7 illustrates the apparent piezometric surface in the deep (near-bedrock) piezometers, as observed on March 12, 1987.

Results of physical testing performed on selected split-spoon (and Shelby tube) soil samples (grain-size classification, Atterberg Limits, and permeability) are summarized on Table 3-4, and detailed in Appendix E. Overall, results agree reasonably well with field classification of samples, although some minor discrepancies exist.

A discussion of observations and interpretations pertaining to data collected during the drilling/monitoring well installation subtask (and associated water level measurements) is included in the following report section (Section 3.1.3), where data from the hydrogeologic investigation are combined into a comprehensive summary of site conditions.

3.1.3 Overall Results - Hydrogeologic Investigation

Five hydrogeologic cross-sections have been prepared based upon information collected during the hydrogeologic investigation. Cross-section locations are illustrated on Drawing 3-8; cross-sections A-A' through E-E' are provided as Drawings 3-9 through 3-13.

A review of information collected during the drilling/monitoring well installation phase, as illustrated on these cross-sections, suggests the following relative to geologic conditions:

- Surficial geology in the site vicinity is characterized by the presence of silty clay and clay, averaging approximately 10 feet in thickness. This material is most likely related to floodplain deposition of fine sediment by the Scioto River, and appears to be continuous over much of the site and the field to the west.

- Underlying the surficial clay is a zone of brown sand and gravel, exhibiting somewhat variable thickness and degree of sorting. The average thickness of this unit is approximately 25 to 30 feet. The presence of this material is most likely related to late-glacial and post-glacial (Recent) fluvial action.

- This sand and gravel deposit is, in most locations, underlain by a relatively thick (10 to 20 feet) gray silt-clay zone which, due to the observed poor degree of sorting and presence of angular pebbles/gravel, appears to be glacial till. This material may be a remnant of earlier glacial ground moraine deposition that occurred as an ice sheet advanced or receded over previously deposited fluvial sediments and/or bedrock.

- A gray sand, with lesser amounts of gravel, is present beneath the till at most locations. This material appears to be more well sorted and uniform than the shallower fluvial sediments previously described. This unit may be associated with the presence of a pre-glacial or interglacial stream channel. Some apparent "erratic" shale fragments were observed in association with this zone, generally near the upper surface of the sand.

- Shale bedrock was observed below this sand zone at several drilling locations, ranging in depth below ground surface from 40 to 100 feet. The apparent bedrock surface trend, as identified during this drilling program, agrees closely with previous subsurface data obtained in the general region, in that bedrock topography dips to the south and west from an apparent inter-valley bedrock high located just north of the site (ODNR, 1965). The shale is characterized as gray, greenish-gray, and black, weathered at the top, and becoming dense, dry, and hard at short distances below bedrock surface. Pyrite nodules were observed in most of the samples considered to be "in-situ" bedrock.

- It is noted that an apparent difference in depth to shale bedrock was observed between two borings advanced at location 5 (P-5B and one attempted replacement boring). The discrepancy was on the order of 15 feet between borings (63 feet for P-5B versus 48 feet for the replacement boring). Due to the close spacing of the borings (approximately 20 feet), the shallower occurrence of shale is interpreted as "float", or a shale boulder within the unconsolidated material.

Further review of these cross-sections, and of water surface elevation data, yields the following observations relative to hydrogeologic conditions (i.e., ground water flow system):

- The upper sand and gravel unit (discussed previously) appears to be the uppermost aquifer (or saturated zone) capable of transmitting substantial quantities of ground water.

- The lower sand and gravel unit present beneath the till layer constitutes a second aquifer occurring in the site vicinity.

- The apparent separation of these zones by lower permeability till, and the observed vertical variation in piezometric head, suggests that the two units are hydraulically separate, and act as distinct water-bearing units in the vicinity of the site.

- Ground water flow direction in the uppermost aquifer appears to be west-southwest, from the landfill to the Scioto River (Drawing 3-6). The observed piezometric gradient in this zone is on the order of 10^{-3} to 10^{-2} feet per foot. The hydraulic conductivity of the sand and gravel is estimated to be on the order of 400 feet per day (ODNR, 1965). Therefore, an approximate ground water flow rate of 0.4 to 4 feet per day may be assumed.

- The direction of ground water movement in the lower aquifer, based upon March 12, 1987 readings, is apparently to the east, but generally in the downstream direction as shown on Drawing 3-7 (this interpretation is based upon only three data points, which may not provide a complete picture of the piezometric surface). One possible explanation for the apparent eastward flow direction is that, on a larger scale, flow in the lower aquifer is axisymmetric about the center of the alluvial valley. Recharge from upland areas to the east and west moves toward the center of the valley, and continues downstream. At the site, the Scioto River is situated near the western edge of the valley (see Figure 1), but does not influence flow in the deep aquifer sufficiently to alter the axisymmetric behavior. Comparison of piezometric surfaces of the two aquifers (see Drawings 3-6 and 3-7) is further evidence that they are hydraulically separate in the study area. The observed hydraulic gradient in the lower aquifer is on the order of 10^{-3} feet per foot. A similar value of hydraulic conductivity as that used previously may be assumed, resulting in an approximate ground water flow rate of 0.4 feet per day.

- Measured vertical piezometric head gradients suggest that, under low to moderate streamflow and moisture conditions, the Scioto River acts as a ground water discharge boundary (i.e., ground water flow is discharging to the river). Short-term, temporary reversals to this trend are expected to occur during periods of high river stage.

- Observed water level data suggest that recharge to the upper aquifer zone occurs, at least in part, from areas to the east of the site. This observation agrees with information obtained during the investigation indicating that low-permeability surficial clay is present to the west of the landfill, thereby limiting infiltration of water. However, this clay appears to be absent to the east, thus promoting higher ground water recharge capacity.

- Recharge to the lower aquifer appears to originate from the north, and may be associated with an area where this zone is in direct contact with upper water-bearing zone, or possibly in communication with the Scioto River.

Observations relative to a comparison of observed hydrogeologic conditions at drilling locations and measured terrain conductivity, as illustrated on the hydrogeologic cross-sections, include the following:

- An apparent direct relationship exists between terrain conductivity and depth to (shale) bedrock. Specifically, it appears that, as the shale becomes shallower (to the north and east), its greater ability to conduct current (relative to sand and gravel) results in a higher terrain conductivity value. The relationship may be distorted somewhat, however, due to anomalous readings obtained near the landfill.

- It is difficult to identify a relationship between occurrence of the shallow clay layer and terrain conductivity values, since observed thicknesses of the clay appear relatively consistent across the site, whereas terrain conductivity values at the shallow sounding depth exhibit some variability.

- The observed decrease in shallow-depth terrain conductivity from east to west may be related to depth to ground water table, as data presented in subsequent sections indicate an increase in depth to water at two well locations near the Scioto River (locations 7 and 8), from that observed at locations near the landfill (locations 5, 6, 10 and 11). This is the expected relationship between terrain conductivity and depth to water table, other factors remaining equal.

3.2 GROUND WATER SAMPLING AND ANALYSIS

Following installation and development of monitoring wells at the site, a program of ground water sample collection and analysis was initiated. The program involved two rounds of sample collection from the 18 monitoring wells at locations 4 through 13 (Drawing 3-5). In addition, four offsite residential wells (locations 14 through 17, Drawing 3-5) were sampled concurrent with the first round of onsite ground water sample collection. All samples underwent laboratory analysis for organic compounds, inorganic elements, cyanide, and dioxin.

This report section includes a summary of the field sampling events, including the sampling schedule, methods employed, and other pertinent information (see Appendix F for a more detailed discussion of the field program). This section also discusses laboratory procedures followed by a presentation and discussion of associated analytical results. Results of an assessment conducted to evaluate the validity of laboratory data are incorporated into Section 4.0, which deals with project Quality Assurance/Quality Control (QA/QC).

3.2.1 Objective

Specific objectives of the ground water sampling and analysis program include the following:

- An evaluation of the background chemistry of ground water in the site vicinity
- Detection of contamination zones, if present, in the ground water system near the landfill

3.2.2 Sampling Schedule

Sampling activities at the site were subdivided into two events or rounds of sampling. Primary purposes of scheduling two rounds of sample collection included the following:

- The gathering of data during both low and moderate streamflow conditions, to assess whether changes in ground water chemistry occur during different hydrologic conditions
- Allowance for review of results of the initial set of analyses, so that adjustments to the field program could be made, if necessary

The first round of ground water sample collection occurred during the period from February 9 to 15, 1987; the second round occurred during the period from April 27 to May 1, 1987. As illustrated by a comparison of ground water and surface water elevation data (Table 3-3), the first round was carried out during a period of relatively low recharge/moisture conditions, and the second round took place during or after a period of relatively high recharge/moisture. While surface water levels in the Scioto River do not appear to have been higher during the second period of sample collection than those observed during Round One (Table 3-3), water elevations in the ditch and ponded areas, as well as those in the monitoring wells (Table 3-3), were observed to be significantly higher than those measured during round one sampling. The apparent disparity in the relationship of Scioto River levels between sampling rounds (compared to other surface water and ground water levels) is most likely a reflection of the dynamic character of this system.

3.2.3 Summary of Task

Sampling procedures for the onsite monitoring wells commenced with initial purging of at least three times the volume of water standing in the well, followed by actual sample collection. Equipment used for purging and sampling included precleaned, dedicated stainless-steel bailers and cable.

Residential well samples were collected from existing piping systems at a point as close as possible to the well. These wells were purged by allowing the pump to run for a minimum of 10 minutes, or until it became apparent that all standing water was removed. Residential well sample treatment was identical to that employed for onsite ground water samples, except that sample portions obtained for analysis of inorganic elements were not filtered in the field, while onsite ground water sample portions were filtered to remove suspended solids often present in monitoring well samples.

All samples (monitoring wells and residential wells) collected for analysis of cyanide were preserved in the field using sodium hydroxide. Samples were placed in cooled shuttles with chain-of-custody forms, sealed, and shipped by overnight courier service to the laboratory for analysis.

A more detailed discussion of methods employed during the collection of ground water samples during the investigation is included as Appendix F. This discussion is taken from Technical Memoranda previously prepared to summarize the two sampling and analysis events (Dames & Moore, 1987b and c). Details of the ground water sample collection are combined in this appendix with those for surface water and sediment sampling, since all were carried out during the same time periods and utilized similar procedures and equipment.

3.2.4 Laboratory Analysis

Ground water samples collected during the two sampling events were submitted to CompuChem Laboratories for analysis of organic compounds on the U.S. EPA Hazardous Substance List (HSL), inorganic elements, cyanide, and dioxin. Laboratory analytical methods, QA/QC procedures, and data reporting were carried out in accordance with U.S. EPA Contract Laboratory Program (CLP) requirements (U.S. EPA, 1984, 1985a and 1985b).

3.2.5 Analytical Results

Results of field analyses of the ground water samples are listed in Table 3-5. Laboratory analyses, including the residential wells, are reported in Tables 3-6 through 3-10. A brief review of analytical data, categorized by parameter group, is presented below.

3.2.5.1 Volatile Organic Compounds

Results of volatile organic analyses for ground water samples collected during both sampling rounds are listed in Table 3-6. Two volatile compounds, methylene chloride and acetone, were reported in a portion of the samples, including the field blank, background, and residential well samples. These compounds were also detected in laboratory method blanks associated with several samples, indicating possible/probable laboratory contamination. The majority of reported concentrations of these two compounds were below CLP Contract Required Detection Limits (CRDL). CompuChem Laboratories

reports that these compounds are commonly introduced into samples from airborne vapors and/or solvent extraction procedures in the laboratory.

The remaining volatile compounds reported in the first round of ground water samples (designated "01" under the appropriate site I.D. in the tables) were low levels (below CRDL limits) of benzene (sample P-6B) and tetrachloroethene (sample W-12). Tetrachloroethene was also present in samples obtained from well W-12 during the second sampling round ("02" designation), at or below CRDL limits (note that a field duplicate was obtained at W-12 during this sample collection; a third laboratory (matrix spike) analysis was conducted on sample volume obtained from this location, resulting in an additional independent data set).

3.2.5.2 Semivolatile Organic Compounds

Semivolatile organic analysis results are shown on Table 3-7. Phthalate compounds, primarily bis(2-ethylhexyl) phthalate, were reported in 10 of the 22 Round One samples (9 of 10 below CRDL limits), and three of the 18 Round Two samples (all below CRDL limits). The two remaining semivolatile compounds reported in the ground water samples were 2-methylnaphthalene and N-nitrosodiphenylamine, both reported in Round One samples at concentrations below CRDL limits.

3.2.5.3 Pesticide/PCB Compounds

Results of the ground water sample analyses for pesticide and PCB compounds are listed on Table 3-8. As shown, pesticide/PCB compounds were not detected in any of the ground water samples.

3.2.5.4 Dioxin

Results of the ground water sample analyses for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) are listed on Table 3-9. As shown, TCDD was not detected in any of the samples.

3.2.5.5 Inorganic Elements/Cyanide

Table 3-10 lists concentrations of the 23 inorganic elements and cyanide reported for the ground water samples. Cyanide was detected in one of the 18 Round One samples (background location W-4) at a concentration level of 20 µg/L . Cyanide was not detected in any of the Round Two samples.

Arsenic was reported in three of the four residential well samples collected during the first sampling event (concentrations between 11 and 16 µg/L). Special analytical techniques were employed by the laboratory in the analysis of arsenic (and three other trace metals) in residential well samples. The purpose of utilizing these techniques in the analysis of residential well samples was to achieve detection of parameters at levels well below Maximum Contaminant Levels (MCLs). The MCL for arsenic is 50 µg/L.

Nitrate (as N) was also analyzed for in Round One residential well samples, and reported to be present in three of the four samples at concentrations between 1,300 and 1,600 µg/L. The MCL for nitrate is 10,000 µg/L.

Barium was reported in sample P-5B at 2,020 µg/L (both sampling rounds); the MCL for barium is 1,000 µg/L. As discussed in Section 5.0, higher concentrations of several dissolved inorganic species appear to be present in all of the deeper aquifer samples (P-5B, P-6B, and P-8B). This apparent difference in water quality between the upper and lower aquifers may be due to a variation in the character of parent material forming granular deposits (e.g., higher percentage of shale in the deeper aquifer), and is further supported by observed concentrations of other inorganic parameters (e.g., sodium).

A variety of major-ion inorganic species, such as calcium, iron, magnesium, and sodium, were reported in the majority of samples. These ions generally occur naturally as dissolved constituents in ground water. A statistical analysis of the inorganic results is included in Section 5.0.

3.3 SURFACE WATER/SEDIMENT SAMPLING AND ANALYSIS

Sampling of surface water and sediment from various surface water bodies across the site was conducted concurrently with the collection of ground water samples. The objective of this sampling activity, as discussed in the work plan, involves an assessment of the presence or absence of contamination in water and sediment of the Scioto River and other surface water bodies near the site. The program involved two rounds of surface water and sediment sample collection from 12 locations (18 through 29,

Drawing 3-13), including five from the Scioto River, five along the drainage ditch east of the landfill, one from a water-filled pit east of the landfill and one from a shallow depression west of the landfill. All water and sediment samples underwent laboratory analysis for organic compounds, inorganic elements, cyanide, and dioxin.

This report section includes a summary of field sampling activities, including sampling schedule, methods employed, and other pertinent information (see Appendix F for a more detailed discussion of the field program). This section also includes an outlining of laboratory procedures, followed by a presentation and discussion of associated analytical results. Results of an assessment conducted to evaluate the validity of laboratory data are incorporated in Section 4.0, which deals with project QA/QC.

3.3.1 Objective

Specific objectives of the surface water/sediment sampling and analysis program include the following:

- An evaluation of the background chemistry of surface water and sediment present in the site vicinity
- Detection of contamination zones, if present, near the landfill

3.3.2 Sampling Schedule

Sampling activities at the site were subdivided into two events or rounds of sampling, conducted concurrent with ground water sampling. Primary purposes of scheduling two rounds of sample collection, as discussed previously for the ground water sampling, were as follows:

- The gathering of data during both low and moderate streamflow conditions, to assess whether changes in surface water or sediment chemistry occur during varied hydrologic conditions
- Allowance for review of results of the initial set of analyses, so that adjustments to the field program can be made, if necessary

The first round of surface water and sediment sample collection occurred during the period from February 14 to 15, 1987; the second round occurred during the period from April 28 to May 1, 1987. As discussed in Section 3.2.2, the first round of surface water and sediment sample collection appears to have occurred during a period of relatively dry hydrologic conditions, and the second round occurred during relatively wet hydrologic conditions (although streamflow in the Scioto River was actually slightly higher during the first round).

3.3.3 Summary of Task

Procedures for surface water sampling involved the collection of a sample volume at each location from a point approximately 5 feet offshore and midway in depth along the water profile. Sediment samples were collected at the edge of the water line existing at the time of sample collection, from an area approximately 1 foot square and 3 to 5 inches in depth. Equipment used for water sampling included precleaned stainless-steel beakers attached to an extension handle. Sediment samples were obtained using precleaned stainless-steel scoops.

Surface water sample volumes collected for analysis of inorganic elements were not filtered in the field prior to analysis, but were immediately preserved with nitric acid. All water samples collected for analysis of cyanide were preserved in the field using sodium hydroxide. Surface water and sediment samples were placed in cooled shuttles with chain-of-custody forms, sealed, and shipped to CompuChem Laboratories for analysis using an overnight courier service.

A more detailed discussion of methods employed during the collection of surface water and sediment samples is included as Appendix F. This discussion is taken from Technical Memoranda previously prepared to summarize the two sampling and analysis events (Dames & Moore, 1987b and c). Details of the surface water/sediment sample collection are combined with those for ground water, since the activities were carried out during the same time periods and utilized similar procedures and equipment.

3.3.4 Laboratory Analysis

Surface water and sediment samples collected during the two sampling events were submitted to CompuChem Laboratories for analysis of organic compounds on the U.S. EPA Hazardous Substance List (HSL), inorganic elements, cyanide, and dioxin. Laboratory analytical methods, QA/QC procedures, and data reporting were carried out in accordance with U.S. EPA Contract Laboratory Program (CLP) requirements (U.S. EPA, 1984, 1985a and 1985b).

3.3.5 Analytical Results - Surface Water Samples

Results of field analyses associated with the surface water samples are listed on Table 3-11. Results of chemical analyses performed on the surface water samples are shown on Tables 3-12 through 3-16. A brief review of analytical data, categorized by parameter group, is presented below.

3.3.5.1 Volatile Organic Compounds

Volatile organic analyses for the surface water samples are tabulated on Table 3-12. As with the ground water analyses, two volatile compounds, methylene chloride and acetone, were reported present in a portion of the samples, including a field blank, trip blanks, and an upgradient river sample. These compounds were also detected in nine of the 14 laboratory method blanks associated with the samples, indicating probable laboratory contamination. Eleven of the 14 reported values of these two compounds were below CRDL limits.

Remaining volatile compounds reported in the 12 Round One surface water samples were low levels (below CRDL limits) of 1,2-dichloroethane, present in two surface water samples (SW-22 and SW-23) and tetrachloroethene, present in three samples (SW-18 [upgradient river sample], SW-20, and SW-22). No additional volatile compounds were reported in the 12 Round Two surface water samples.

3.3.5.2 Semivolatile Organic Compounds

Semivolatile organic analysis results are shown on Table 3-13. One semivolatile compound, diethylphthalate, was reported in the first round sample collect at SW-22, at a level below CRDL limits. Round Two semivolatile compounds involved bis(2-ethylhexyl) phthalate reported in four samples at levels below CRDL limits. One of the four samples was upstream location SW-18. Bis(2-ethylhexyl) phthalate was also detected in the laboratory blank associated with these samples, indicating the potential for laboratory contamination.

3.3.5.3 Pesticide/PCB Compounds

Results of the surface water sample analyses for pesticide/PCB compounds are listed on Table 3-14. During Round One sampling, one compound, Aroclor 1260, was reported at a concentration of 1.2

µg/L in upstream (background) river location SW-18, and 2.6 µg/L in sample SW-21 DUP (duplicate sample). The compound was not reported present in sample SW-21, however. No pesticide/PCB compounds were reported in the surface water samples collected during the second round of sampling.

3.3.5.4 2,3,7,8-TCDD (Dioxin)

Results of the surface water sample analyses for 2,3,7,8-TCDD are summarized on Table 3-15. As indicated, TCDD was not detected in any of the surface water samples.

3.3.5.5 Inorganic Elements/Cyanide

Table 3-16 lists concentrations of the 23 inorganic elements and cyanide reported for the surface water samples. Cyanide was not detected in any of the Round One samples, but was reported in four of the Round Two samples (Locations 19, 20, 22, and 23) at concentrations from 10 to 16 µg/L.

Lead was reported in one of the two field blanks prepared during Round One, at a concentration of 20 µg/L. Lead was reported in seven of the 12 Round Two samples (Locations 18 through 23 and 28), but was also detected in two of the three field blanks (it is noted that one additional field blank, SW-BLNK-EPA, was prepared for inorganic analyses, because a shortage of preservatives necessitated borrowing a quantity from EPA representatives). Four of the seven samples reported as containing lead had concentrations below the Control Required Detection Limit (CRDL). One sample, SW-22, was reported to have a lead concentration of 77 µg/L, although the laboratory spike sample recovery was reported to be outside of control limits for this sample. The MCL for lead is 50 µg/L.

Mercury was detected in Round One sample SW-22 at the level of 0.23 µg/L, although the associated spike sample recovery was reported to be outside of control limits. Mercury was also detected in Round Two sample SW-26 at 0.27 µg/L. The MCL for mercury is 2 µg/L.

Silver was reported in Round Two sample SW-26 at 21 µg/L, although one of the associated field blanks reportedly contained silver at 15 µg/L, the associated sample spike recovery was listed as outside control limits. The MCL for silver is 50 µg/L.

Major ions such as calcium, magnesium, and sodium, were found to be present in all of the samples; these elements typically occur in water. A statistical analysis of the inorganic results is included in Section 5.0.

3.3.6 Analytical Results - Sediment Samples

Results of chemical analyses performed on sediment samples are contained on Tables 3-17 through 3-21. A summary discussion of these analytical results is provided below, grouped according to analysis category.

3.3.6.1 Volatile Organic Compounds

Volatile organic analyses for sediment samples are tabulated on Table 3-17. Two volatile compounds, methylene chloride and acetone, were reported in every sample, including the field blanks and background samples. These compounds were also detected in laboratory method blanks associated with each sample, indicating probable laboratory contamination.

Low levels (below CRDL limits) of one additional volatile compound, chloroform, were reported in a sediment sample and associated duplicate obtained at location 28 during Round One (sample numbers SE-28 and SE-28DUP). Chloroform was reported in two samples (SE-18 and SE-26) during Round Two. Concentrations were below CRDL. Toluene was reported in two sediment samples, at concentrations below CRDL limits (including the field blank), and in one sediment sample (SE-22) at a concentration of 61 µg/kg.

3.3.6.2 Semivolatile Organic Compounds

Semivolatile organic analysis results are shown on Table 3-18. The majority of detected semivolatile compounds belong to a group of compounds known as polynuclear aromatic hydrocarbons (PAHs). PAH compounds were detected in varying numbers, in every sediment sample collected, including background locations. Most PAH concentrations were below CRDL limits; the maximum reported value was 3,600 µg/kg of benzo(a)anthracene in SE-19 (Round One), and 1,000 µg/kg of benzo (b/k) fluoranthene in SE-25 (Round Two).

Remaining semivolatile compounds detected in the sediment samples included four phthalate compounds, primarily bis(2-ethylhexyl) phthalate, which was present in almost all samples at levels ranging from below CRDL detection limits to 2,000 µg/kg in SE-22 (Round Two). However, this compound was also reported in approximately half of the laboratory blanks associated with the samples, suggesting the possibility of laboratory contamination.

Several additional semivolatile compounds were reported present in the sediment. For Round One, 4-methylphenol was reported in SE-25 at 660 µg/kg. This compound was also reported in eight Round Two samples, ranging from below CRDL limits (three samples) to levels in the 6,800-8,600 µg/kg range (SE-21, SE-21DUP and SE-22). Remaining semivolatile compounds reported in Round Two samples included phenol and benzoic acid, present in five and four samples, respectively, at concentrations below CRDL limits, and acenaphthylene was found in one sample.

3.3.6.3 Pesticide/PCB Compounds

Table 3-19 lists pesticide/PCB analytical results for the sediment samples. Aroclor-1248, a polychlorinated biphenyl (PCB), was reported in three of the 12 Round One sediment samples and one associated field duplicate (SE-27, SE-28, SE-28DUP, and SE-29), at concentrations ranging between 420 and 2,300 µg/kg. PCBs are a family of chlorobiphenyl mixtures that were manufactured in the United States for approximately 50 years (1929 to 1977).

PCBs were not reported in any of the Round Two samples.

Chlordane, a pesticide compound, was reported in four Round One samples adjacent to the Scioto River, on the fringe of the agricultural area to the west of the landfill. Sample numbers 20, 21 and 21-DUP, and 22, contained chlordane concentrations of 200, 120, 140, and 170 µg/kg, respectively. Location 21 is also situated at the outlet of the pipe which drains the ditch east of the landfill. Chlordane is an insecticide that is relatively insoluble in water. A second pesticide, 4,4'-DDT, was reported to be present in one sediment sample (SE-29) during Round Two collection and analysis, at a concentration of 28.0 µg/kg. However, the compound was not detected in a field duplicate collected at the same location (SE-29DUP).

3.3.6.4 2,3,7,8-TCDD (Dioxin)

Results of sediment sample analyses for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) are listed on Table 3-20. As indicated, TCDD was not detected in any of the samples.

3.3.6.5 Inorganic Elements/Cyanide

Table 3-21 lists concentrations of the 23 inorganic elements and cyanide reported for the sediment samples. Cyanide was not detected in any of the samples. A majority of the inorganic elements were found to be present in the samples, as these elements occur naturally in soils. With five exceptions (calcium, lead, magnesium, mercury and zinc) the average values of inorganic species found are below the average values listed for Ohio soils (Table 3-32). No specific trends have been observed during the current review of these data. A statistical analysis of the inorganic results is discussed in Section 5.0.

3.4 SURFICIAL SOIL SAMPLING AND ANALYSIS

Sampling of surficial soil at the site was conducted immediately prior to the initiation of drilling/monitoring well installation activities. The purpose of this sampling activity, as discussed in the work plan, was to assess the presence or absence of contamination in surficial soil in the vicinity of the site.

The program involved collection and analysis of surficial grab soil samples from 15 locations at the site (30 through 44, Drawing 3-15), five Shelby tube samples near selected onsite drilling locations (5, 6, 7, 10, and 11, Drawing 3-15), and two Shelby tube samples from offsite background locations (45 and 46, Drawing 3-15). Surficial soil samples underwent laboratory analysis for organic compounds, inorganic elements, cyanide, and dioxin.

This report section includes a summary of field sampling activities, including sampling schedule, methods employed, and other pertinent information. The reader is referred to Appendix G for a more detailed discussion of the field program. Laboratory procedures are outlined in that appendix, followed by a presentation and discussion of associated analytical results. Results of an assessment conducted to evaluate the validity of laboratory data are incorporated into Section 4.0, which deals with project QA/QC.

3.4.1 Objective

Specific objectives of the surficial soil sampling and analysis program include the following:

- Assess whether contamination is present in the soil
- If present, provide data relative to the depth, areal extent, and concentration of hazardous constituents

3.4.2 Sampling Schedule

Sampling activities at the site were carried out during the period of September 23 through 25, 1986. All surficial soil grab samples were obtained on September 23rd; Shelby tube soil samples were collected on September 24th and 25th.

3.4.3 Summary of Task

Surficial soil grab soil samples were collected at each location from an area approximately 1 foot square and 3 to 5 inches deep. Equipment used for grab sampling included precleaned stainless-steel scoops, spoons, and compositing pans. Shelby tube soil samples were obtained using precleaned, thin-walled, 3-inch-diameter steel (Shelby) tubes, pushed from the ground surface to a depth of approximately 30 inches.

Grab soil samples were placed in containers supplied by the laboratory; Shelby tube soil samples were sealed inside the metal tubes. All soil samples were placed in cooled shuttles with chain-of-custody forms, sealed, and shipped by overnight courier service to CompuChem Laboratories for analysis.

A more detailed description of methods employed during the collection of soil samples is included as Appendix G. This discussion is taken from a technical memorandum previously prepared to summarize the task (Dames & Moore, 1987d).

3.4.4 Laboratory Analysis

Surficial soil samples collected during the two sampling events were submitted to CompuChem Laboratories for analysis of organic compounds on the U.S. EPA Hazardous Substance List (HSL), inorganic elements, cyanide, and dioxin. Laboratory analytical methods, QA/QC procedures, and data

reporting were carried out in accordance with U.S. EPA Contract Laboratory Program (CLP) requirements (U.S. EPA, 1984, 1985a and 1985b).

3.4.5 Analytical Results

Results of chemical analyses performed on soil samples are summarized on Tables 3-22 through 3-31. Tables 3-22 through 3-26 present data obtained for the grab soil samples and the field blank; Tables 3-27 through 3-31 correspond to the Shelby tube samples, including background locations 45 and 46. Drawings 3-16 through 3-21 illustrate areal distributions of selected inorganic and organic parameters. Following is a brief review of analytical data, categorized by parameter group.

3.4.5.1 Volatile Organic Compounds

Volatile organic analyses for grab and Shelby tube samples are summarized on Tables 3-22 and 3-27, respectively. Two volatile compounds, methylene chloride and acetone, were reported in most samples, including the field blank and background samples. These compounds were also detected in laboratory method blanks associated with each sample, indicating probable laboratory contamination.

The only additional volatile compounds reported in any of the soil samples were low levels (below CRDL limits) of bromomethane (sample number 34) and chloroform (sample number 31).

3.4.5.2 Semivolatile Organic Compounds

Semivolatile organic analysis results are shown on Tables 3-23 and 3-28.

The most prevalent semivolatiles detected belong to a group of compounds known as polynuclear aromatic hydrocarbons (PAHs). HSL compounds belonging to this group include fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene. PAHs are a diverse group of compounds formed as a result of incomplete combustion or pyrolysis of organic hydrocarbons. PAHs commonly occur in the environment, originating from both natural and manmade sources (U.S. EPA, 1980).

Reported PAHs ranged in occurrence from 1 to 22 samples, and in concentration from 41 to 11,000 µg/kg. Most concentrations reported were below CRDL detection limits; a small number of reported values were above CRDL detection limits, primarily in sample number 39. Most of the PAHs were also detected in background samples, suggesting that low-level occurrences may be related to natural or external sources.

Drawing 3-16 was prepared to show concentrations and distribution of pyrene in soil samples collected throughout the site. This compound was selected as representative for the PAHs as a group, since relative values of all PAHs detected appear to follow a similar pattern.

Eight other semi-volatile compounds were detected at levels below CRDL. They include benzoic acid, dibenzofuran, acenaphthylene, acenaphthene, and four phthalates as shown on Tables 3-23 and 3-28.

3.4.5.3 Pesticide/PCB Compounds

Tables 3-24 and 3-29 summarize pesticide/PCB analytical results for the grab and Shelby tube samples, respectively. Aroclor-1248, a polychlorinated biphenyl (PCB), was reported in seven of the 22 soil samples. Concentrations and distribution of this compound at the site are illustrated on Drawing 3-17. Aroclor-1254 was also reported to be present in two of the samples. Locations where PCB compounds were detected in soil are, for the most part, situated on or near the landfill. The exception to this is location 42, away from the landfill and adjacent to the Scioto River, where Aroclor-1254 was detected.

Additional compounds in the pesticide/PCB group that were reported in the soil samples include three pesticide compounds: beta-BHC, dieldrin, and chlordane, reported in sample number 11 at concentrations of 22, 27, and 110 µg/kg, respectively. Dieldrin was also reported in sample number 07 at a concentration of 20 µg/kg. BHC isomers, including beta-BHC, are described as herbicide components that are practically insoluble in water. Domestic production and sale of these compounds has been discontinued. Dieldrin and chlordane are insecticides that are also relatively insoluble in water. Domestic production and use of dieldrin have also been discontinued (Farm Chemicals Handbook, 1981). The presence of pesticides in soil at the site is most likely related to past and present agricultural activities.

3.4.5.4 Dioxin

Results of soil sample analyses for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) are summarized on Tables 3-25 and 3-30. As indicated, TCDD was not detected in any of the samples.

3.4.5.5 Inorganic Elements/Cyanide

Tables 3-26 and 3-31 list concentrations of the 23 inorganic elements and cyanide reported for the soil samples. Cyanide was not detected in any of the samples. A majority of the inorganic elements were found to be present in the samples; these elements occur naturally in soils. Relative concentrations and distributions of arsenic, lead, mercury, and zinc at site sampling locations are illustrated on Drawings 3-18, 3-19, 3-20, and 3-21, respectively. These elements were selected for illustration because they are trace metals that exhibit variations in concentration across the site.

In addition to information obtained from analyses of sample numbers 45 and 46 for background data, Table 3-32 illustrates concentrations of various inorganic elements reported in the literature for locations in Pickaway County (Logan and Miller, 1983) and other central Ohio areas (Shacklette and Boerngen, 1984). These data are supplied for general comparison to data obtained from the site. However, caution must be exercised in making such comparisons, due to the high degree of variability in the concentrations of various elements occurring in different soil types/geographic locations.

3.5 BIOLOGICAL STUDY

As part of the site investigation, a biological study program was conducted to collect information on biota present, and evaluate observed or potential impacts on various plant and wildlife species due to site conditions.

The program involved an initial review of available information regarding the types and characteristics of plant and wildlife species present in the area. Special attention was given to evaluating whether rare or endangered species were present, as well as to which species, if any, may be especially sensitive to potential contaminants or provide pathways for contaminant migration/accumulation. This initial analysis was followed by a site reconnaissance to identify and classify biota and habitat in the area, and to look for evidence of potential stresses related to the presence of the landfill.

This report section includes a summary of the site area vegetation and wildlife, documents the presence or absence of endangered or threatened species, describes physical and chemical effects of past disturbances at the site, and concludes with a discussion of the potential pathways and associated receptors.

3.5.1 Objectives

Specific objectives of this task, as outlined in the work plan, include the following:

- Identification of critical receptors in the area
- Evaluation of what, if any, current stresses those receptors are experiencing
- Definition of potential pathways for contaminant bioaccumulation
- Development of information for assessing environmental impacts of alternative remedial actions

3.5.2 Vegetation Characterization

3.5.2.1 Riparian Area

The riparian area (Drawing 3-22) consists of a narrow band of tree-canopied vegetation. In this area, topographic relief is moderate to steep, with elevations varying in some places from 10 to 14 feet. Toward the middle and extreme north end of the site, the bank is more gradual. Based on the observed diameter classes of the dominant tree species, this area has been undisturbed for an extended period of time. The dominant tree species are silver maple, box elder, and sycamore. Subdominants include hackberry, honey locust, several cottonwoods, and American elm. Where the tree canopy shades the ground, there is little understory vegetation, and the ground cover is sparse. In other locations, where the overstory closure is not complete, there is a more well-developed understory vegetation dominated by silver maple and box elder. In addition, there are examples of yellow buckeye, ailanthus, redbud, honey locust, red mulberry, pawpaw, elm, oak, hackberry, and osage orange in the riparian area. Table 3-33 lists the observed species from each of the three strata--overstory, understory, and ground cover.

3.5.2.2 Field Border Area

Vegetation of the field border area (Drawing 3-22) has a mixed character, representing a transition between the riparian area and the cropland. There is no significant overstory tree canopy and, as a result, the understory and the ground cover vegetation are denser than that in the riparian area. Understory dominants include boxelder, silver maple, ailanthus, hackberry, redbud, sycamore, cottonwood, and sandbar willow. Ground cover vegetation includes yarrow, pigweed, broomsedge, ground nut, bidens, beggar's ticks, lambsquarter, field bindweed, tall morning glory, and others (see Table 3-33).

3.5.2.3 Cropland Area

Vegetation in the cropland area (Drawing 3-22) was the sparsest of the areas surveyed. Although planted in soybeans, little supplemental cultivation or herbicide spraying had been done in the recent past, as evidenced by the wide variety of weed species observed throughout the field and the height of the weeds--well above the planted crop. Common weed species observed were pigweed, giant ragweed, milkweed, New England aster, cheatgrass, shepherd's purse, field daisy, dodder, hedge bindweed, morning glory, orchardgrass, jimsonweed, Queen Anne's lace, Johnsongrass, cheeseweed, peppergrass, sheep sorrel, piemarker, giant foxtail, and sowthistle, among others (see Table 3-33).

3.5.2.4 Berm Area

Similar to the riparian area, the berm area (Drawing 3-22) has overstory, understory, and ground cover strata present. Some areas are predominantly wooded, while others are in oldfield succession in the absence of an overstory or understory canopy. The species in this survey area are diverse, as is the age structure of the vegetation. Dominant overstory species include box elder, silver and red maple, hackberry, sycamore, cottonwood, and American elm. Understory vegetation of this location includes red maple, silver maple, yellow buckeye, ailanthus, hackberry, redbud, honey locust, bush honeysuckle, osage orange, wild apple, red mulberry, sycamore, cottonwood, red oak, smooth sumac, sandbar willow, and American and red elm. In the open areas, the ground cover includes thickets of giant ragweed, broomsedge, three-awn grass, common milkweed, false nettle, spotted knapweed, field daisy, chicory, bull thistle, field bindweed, nutgrass, teasel, barnyardgrass, Joe-pye-weed, St. John's wort, honeysuckle, cheeseweed, black medic, field mint, evening primrose, and fall panicum (Table 3-33).

3.5.3 Wildlife Characterization

3.5.3.1 Riparian Area

The riparian area showed more evidence of wildlife use than the other three area types surveyed. There were tracks of deer, muskrat, raccoon, and opossum, and burrows of woodchuck, muskrat, and possibly fox. The burrows were so numerous that they were observed to occur at intervals of roughly 50 feet. Deer use of this area is primarily as a travel route and watering area. Other species observed during the investigation included Canadian geese, mallards, barred owls, red-tailed hawks, deer and fox. Raccoons use the shallow areas of the Scioto River to forage for freshwater mussels, and many opened shells were found in several locations. Eastern toads and leopard frogs were observed along the riverbank, as was the sign of rabbits and squirrels. A listing of the species either observed in the riparian area or likely to occur based on habitat appropriateness and species' ranges is provided on Table 3-34. Other species with ranges in Central Ohio are listed in Tables 3-35, 3-36, and 3-37.

Observations were also made of the Scioto River during the survey. Many insect larvae were emerging from the near-shore shallow waters at this time, including midges, mayflies, and other Ephemeroptera. Actively foraging for these insects were many fish, primarily carp, that were observed open-mouthed, "vacuuming" the insects in the shallowest of near-shore waters. In fact, the fish were swimming in such shallow water that in many cases, a large portion of the dorsal body was exposed above the water, making species identification much more certain. In addition to carp, many small minnows were observed in quiet pools near the shore. Tackle found lying on the bank indicates some past fishing activity in the area.

3.5.3.2 Field Border

Although burrows of ground-dwelling wildlife were observed in the field border, they were much less common than in the riparian area, and overall, wildlife use of the border is less evident. However, the vegetation in the field border provides forage resources for a variety of species, including raccoon, opossum, squirrel, and deer. In addition, it provides excellent concealment opportunities for fox, observed to occur on the site, and the brush areas make up excellent habitat for rabbits, several of which were roused from the thickets during the survey. The field border is probably used most in the evening and nighttime hours by nocturnal species. Because of the lack of bare ground in this habitat type, there was no opportunity to

observe track of the resident wildlife. The species observed and likely to occur in this area are listed on Table 3-34.

3.5.3.3 Cropland Area

Wildlife foraging was not greatly evident in the cropland, except along its periphery. The rank growth of weeds there probably provides good wildlife concealment for forays into the open area to retrieve soybeans, a resource suitable for small and intermediate-sized mammals. Some use of the cropland area by deer and raccoon is likely, based upon field observations. The cropland is a habitat area that is probably heavily surveyed by raptorial birds because of its openness. Table 3-34 lists the observed and likely species for this area.

3.5.3.4 Berm Area

Wildlife use of the berm area is similar to that reported for the riparian habitat, though not so heavy, as evidenced by the lesser number of burrows. Because the berm area is larger and more diverse in its vegetative composition, there are more sites used by birds for nesting and foraging. Only a few places in the berm area showed evidence of deer use, but squirrel and raccoon use appears to be heavy. The long, narrow drainage ditch immediately to the east of the berm area (Drawing 3-22) provides some habitat potential for migratory waterfowl, especially in the late fall/early winter. Some fish and minnows were observed in the water, and tracks of raccoon and opossum were observed in the soft soil forming the shoreline of the ponded area. In the afternoon of the survey, a common rat snake was observed coiled in a small shrub at the edge of the bermed area. These species, and others likely to occur in this area, are listed on Table 3-34.

3.5.4 Endangered and Threatened Species

During the literature review portion of the study, both federal and state listings of endangered and threatened species were examined. On the federal listing published by the U.S. Fish and Wildlife Service, the following species are listed as potentially occurring in the vicinity:

• Plants:	Northern wild monkshood	Not observed on site
• Birds:	Bald eagle Peregrine falcon	Not observed; no suitable habitat on site Not observed; no suitable habitat on site
• Bats:	Gray bat, Indiana bat, Virginia big-eared bat	Not observed; no suitable habitat for these species on site
• Fishes:	Scioto madtom	Not observed, but habitat for this species includes this reach of the Scioto River.
• Clams:	Pearly mussel, Cumberland bean pearly mussel, orange-footed pearly mussel, white cat's paw, fat pocketbook	Not observed, but habitat for these species includes this reach of the Scioto River.

The state of Ohio's listing program for endangered, threatened, or special concern species is administered by the Ohio Department of Natural Resources (ODNR) Division of Natural Areas and Preserves. Their records identify species of concern and show locations where they have been observed (Moseley, 1986). A species of concern is essentially one that exhibits certain characteristics, making it especially sensitive to specific environmental pressures. The 7.5-minute topographic maps including and closest to the site are the Ashville and Circleville quadrangles. Portions of these quadrangles are provided as Drawings 3-23 and 3-24, and show by number the locations of ODNR-recorded sightings of the following species of concern:

Ashville Quadrangle:

1. Tall larkspur *(Delphinium exaltatum)*

2. Northern riffle shell *(Epioblasma torulosa rangiana)*
   Long solid (mollusk) *(Fusdonaia maculata)*
   Cob shell *(Quadrula cylindrica)*

3. Glade mallow *(Napaea dioica)*

4. Stages Pond State Nature Preserve

5. Bur-head *(Echinodorus rostratus)*
   Bristly scorpion-grass *(Myosotis macroperma)*

Circleville Quadrangle:

1. Streamline chub *(Hybopsis dissimilis)*

2. Rock elm *(Ulmus thomasii)*

3. Rigid pocketbook *(Lampsilis ovata)*
   Northern riffle shell *(Epioblasma torulosa rangiana)*
   Common washboard *(Megalonaias nervosa)*
   Club shell *(Pleuroblema clava)*
   Cob shell *(Quadrula cylindrica)*
   Common elephant ear *(Elliptio crassidens)*
   Bluebreast darter *(Etheostoma camurum)*

4. River redhorse *(Moxostoma carinatum)*
   False map turtle *(Graptemys pseudogeographica)*
   Silver chub *(Hybopsis storeriana)*
   Goldeneye *(Hiodon alosoides)*
   Streamline chub *(Hybopsis dissimilis)*

5. Rigid pocketbook *(Lampsilis ovata)*
   Northern riffle shell *(Epioblasma torulosa rangiana)*

6. Bluebreast darter *(Etheostoma camurum)*

7. Tansy-mustard *(Descurainia pinnata)*

8. Tansy-mustard *(Descurainia pinnata)*

9. Coolwort *(Pilea fontana)*

10. Bur-head *(Echinodorus rostratus)*
    Sessile yellow-cress *(Rorippa sessiliflora)*
    Tansy-mustard *(Descurainia pinnata)*

11. Big floater (mollusk) *(Anodonta grandis corpulenta)*

12. Large cranberry *(Vaccinium macrocarpon)*

13. Short's chervil *(Chaerophyllum procumbens* var. *shortii)*

14. Engelmann's umbrella-sedge *(Cyperus engelmanii)*

15. Prickly hornwort *(Ceratophyllum echinatum)*

16. Wild rice *(Zizania aquatica)*

17. Lake chubsucker *(Erimyzon sucetta)*

18. Ohio goldenrod *(Solidago ohioensis)*

19. Red-eared slider *(Chrysemys scripta)*
    False map turtle *(Graptemys pseudogeographica)*
    Paddlefish *(Polyodon spathula)*

20. Roundleaf spurge *(Euphorbia serpens)*

As shown on Drawing 3-23, no recorded sighting of any of these species has been made at the site (the site is located in the southwest corner of Drawing 3-23). The nearest recorded documented sightings are from a location about 3,000 feet south of the site.

3.5.5 Physical and Chemical Effects of Past Site Disturbance

The most extensive ongoing disturbance to the site noted during the field investigation is the agricultural activity in the cropland area near the center of the site. Cultivation no doubt contributes to the sedimentation and erosion of the cropland's surficial soils. In addition, spraying of fertilizers and herbicides would add chemical constituents to the surface soil and runoff from the area.

On the eastern portion of the site in the bermed landfill vicinity, there is evidence of past surface disturbance including mounded soil, construction rubble, and plastic sheeting. In and around the ditch paralleling the landfill to the east, tires and other debris are commonly observed. To the north of the site is an active sand and gravel quarry. Although the quarry is not within site boundaries, it is considered part of the overall profile of physical disturbance in the area.

Attention was directed during the field program toward identifying any current stresses observable in biota of the habitat areas. Specifically, vegetation was examined for damage that could be attributable to past waste disposal activities. Contaminants have the potential to induce such effects as stunted growth, foliar loss, etiolation, necrosis, marginal scorching, leaf blotching, chlorosis, mottling, discoloration, uneven veination, cupping or curling, early abscission, and premature leaf shedding. No indications of these kinds of effects were visible. However, there were many examples of pathogenic injury to the vegetation resulting from a variety of natural causes, including insect, bacterial, and fungal sources. Observed plant pathogenic injuries included hackberry leaf spot *(Cercospora spegazzini)*, box elder leaf disease *(Phyllosticta minima)*, box elder stem canker *(Eutypella parasitica)*, silver maple powdery mildew *(Phyllactinia guttata)*, maple rot *(Fomes applanatus* and *F. connatus)*, yellow buckeye leaf blotch *(Guignardia aesculi)*, sycamore anthracnose *(Gnomonia platani)*, and sycamore canker-stain disease *(Ceratocystis fimbriata)* (after Hepting, 1971). It is probable that these pathogens are commonly occurring in the region as a whole and are not related to the presence of the landfill (observations of similar plant pathogens from two offsite locations -- near the gaging station and across the river -- were noted).

3.5.6 Potential Contaminant Receptors and Pathways

The three potential receptor groups for contamination from the site are vegetation, wildlife, and humans. The following paragraphs discuss the pathways to these receptors and briefly evaluate the potential for contaminant exposure.

Pathways to vegetation include:

1. Systemic uptake of near-surface materials passing into the plant through the root system via soil water migration
2. Solubilizing, by precipitation, of contaminants spread on the ground surface in the vicinity of the receptor plants, thus making the contaminant available for uptake into the plant through the vascular system
3. Direct deposition of contaminant dust on the foliar surfaces, where it can be directly absorbed by the leaf into the fluid transport system of the plant

Wildlife receptors include fish, mussels, large and intermediate-sized mammals, small mammals, and game birds. The primary contaminant pathway is from the primary producers through the trophic chain to the primary and secondary consumers. The most likely potential contaminant pathways at the site are the following:

1. Freshwater mussels (potential direct absorption from water) to raccoon to fox
2. Rabbit (digestion of vegetation with potentially contaminated dust) to fox
3. Squirrel (digestion of vegetation with potentially contaminated dust) to fox
4. Small rodents (digestion of vegetation with potentially contaminated dust) to fox
5. Small rodents (digestion of vegetation with potentially contaminated dust) to hawks, owls, and other raptors
6. Assorted carrion to turkey vultures (primary or secondary consumption of potentially contaminated food)
7. Direct uptake of potentially contaminated water by primary or secondary consumers

Human receptors could be exposed to contamination through the following pathways:

1. Fish (accumulation in tissue from potential contaminants in surface water) to man
2. Deer (accumulation in tissue from uptake of potentially contaminated forage) to man

3. Aquatic macrophytes to waterfowl to man
4. Rabbit (accumulation in tissue from uptake of potentially contaminated forage) to man
5. Squirrel (accumulation in tissue from uptake of potentially contaminated forage) to man
6. Direct ingestion of vegetation from the site by man.
7. Direct ingestion of potentially contaminated water by man.

While the pathways do exist for contaminant migration through the food chain, no observations were made during the site survey that would indicate such migration is occurring.

Other pathways were evaluated and, because of site conditions and the nature of the pathway, are considered to be of minor importance compared to the seven listed above. They include air deposition (inhalation), surface water contact (dermal, ingestion), and ground water (dermal, ingestion).

TABLE 3-1

EM SURVEY DATA IN MMHOS/M FOR VARIOUS
COIL SPACING IN METERS

TRAVERSE LINE STATIONING	DISTANCE (FEET)	10	20	40
STATION A	100	10	9	10
	200	8	10	12
	300	12	12	*
	400	13	12	17
	500	21	22	20
	600	21	24	26
	700	23	25	28
	800	17	19	23
	950	22	22	14
	1080	18	6	14
	1200	21	8	17
	1500	8	10	14
	1600	5	8	14
	1700	6	10	14
	1800	7	12	15
	1900	8	12	16
	2000	6	12	*
	2300	4	8	17
	2600	7	10	11
	2700	7	11	18
A'	2900	19	21	24
STATION B	300	31	28	28
	400	24	24	28
	500	22	22	25
	600	22	21	25
	700	25	22	24
	800	28	26	27
	900	31	26	29
	1000	31	28	30
	1100	31	29	31
	1200	28	27	30
	1300	31	27	30
	1400	29	28	30
	1500	28	27	30
	1600	27	26	31
	1700	27	25	30

TABLE 3-1 (Continued)

TRAVERSE LINE STATIONING	DISTANCE (FEET)	10	20	40
B CONT.				
	1800	27	26	32
	1900	28	26	32
	2000	37	32	32
	2080	37	34	31
	2200	24	19	24
	2300	28	24	26
B'	2400	29	28	33
STATION C	0	28	26	32
	40	27	28	34
	140	27	26	32
	240	25	26	30
	340	21	22	29
	440	21	24	30
	540	24	25	32
	640	24	25	29
	740	23	25	29
	840	23	25	28
	940	22	23	28
	1040	21	22	27
	1140	20	21	26
	1240	22	21	26
	1340	20	21	25
	1440	18	19	23
	1540	16	18	22
	1640	19	18	20
	1740	15	15	20
	1840	14	14	17
	1940	16	16	18
C'	2040	16	16	18
STATION D	0	16	16	20
	100	15	14	20
	200	17	16	20
	300	16	16	20
	400	15	15	19
	500	12	16	19
	600	14	15	22
	700	18	19	24
	800	23	23	25
	1425	49	39	34
	1500	59	48	42
	1600	29	27	22
	1720	21	18	19
D'	1800	17	17	19

TABLE 3-1 (Continued)

TRAVERSE LINE STATIONING	DISTANCE (FEET)	10	20	40
STATION E	0	39	31	34
	100	35	73	21
	200	29	30	34
	300	27	28	34
	400	31	29	33
	500	29	28	32
	600	26	26	32
	700	23	25	31
	800	23	24	29
	900	24	26	30
	1000	23	25	29
E'	1070	18	22	28
STATION F	0	23	24	*
	100	27	26	30
	200	31	28	26
	300	23	24	32
	400	25	25	30
	495	25	25	30
	600	27	26	32
	700	25	26	34
	800	29	28	32
	900	28	28	34
	1000	27	27	34
F'	1100	24	23	30
STATION G	100	37	28	*
	200	21	20	25
	300	36	25	24
	400	35	22	20
	900	5	6	10
G'	1100	10	14	18
STATION H	0	31	22	28
	115	25	25	28
	215	24	23	28
	315	28	25	27
	515	27	23	23
H'	615	25	21	22

TABLE 3-1 (Continued)

TRAVERSE LINE STATIONING	DISTANCE (FEET)	10	20	40
STATION I	0	31	24	25
	100	33	24	26
	200	25	24	26
	300	29	25	28
	400	23	21	24
	500	19	20	24
	600	17	19	24
	700	19	18	23
	800	16	16	21
	900	17	16	20
	1000	20	18	20
I'	1100	21	19	20
STATION J	0	14	14	17
	100	14	15	16
	200	19	18	21
	300	22	21	22
	400	17	19	23
	500	22	22	24
	600	23	22	26
	700	24	23	28
	809	29	28	30
J'	1021	39	44	*
STATION K	0	20	19	22
	100	21	21	23
	200	23	22	27
	300	26	25	27
	400	24	24	28
	500	23	23	27
	600	29	27	29
	700	28	27	30
	800	27	27	30
	1059	31	26	30
	1159	28	26	30
	1259	21	19	25
K'	1355	16	18	15
STATION L	0	20	21	25
	100	21	22	28
	200	24	24	28
	300	25	25	29
	400	23	24	28

TABLE 3-1 (Continued)

TRAVERSE LINE STATIONING	DISTANCE (FEET)	10	20	40
	500	21	23	29
	600	26	25	32
	700	29	27	28
	800	35	28	33
	910	23	27	8
	1000	33	29	36
	1100	28	26	32
L'	1200	29	27	30
STATION M	0	22	23	28
	100	23	24	30
	200	25	26	30
	300	21	23	29
	400	24	26	30
	500	25	25	30
	600	25	25	32
	700	27	26	32
M'	760	27	26	33

• DENOTES MISSING DATA POINTS

TABLE 3-2

MONITORING WELL AND STAFF GAGE LOCATION
AND ELEVATION DATA
BOWERS LANDFILL, CIRCLEVILLE, OHIO

Well Number	Northing	Easting	Ground Elevation	Measurement Point Elevation/1
W-4	21,428	20,924	673.73	677.07
P-4A	21,417	20,925	673.75	676.22
W-5	20,457	20,288	652.83	657.28
P-5A	20,447	20,300	653.12	657.26
P-5B	20,440	20,298	653.00	656.27
W-6	22,019	19,965	656.21	659.22
P-6A	21,992	19,970	656.24	658.98
P-6B	22,004	19,968	656.25	657.90
W-7	22,667	18,961	659.10	662.50
P-7A	22,665	18,946	659.19	662.43
W-8	21,380	19,340	660.38	663.39
P-8A	21,391	19,336	660.49	662.18
P-8B	21,402	19,330	660.42	662.07
W-9	23,111	19,361	656.00	658.39
W-10	22,309	19,501	656.40	660.41
W-11	21,238	19,901	654.43	657.61
W-12	21,884	20,284	666.67	669.67
W-13	20,492	20,591	658.91	662.36

Staff Gage Number	Northing	Easting	Elevation of Datum/2
SG-23	19,882	20,704	648.57
SG-24	20,392	20,583	655.74
SG-25	20,407	20,645	654.39
SG-28	21,966	20,016	652.29

/1 Monitoring well measurement point is top of riser pipe.
/2 Staff gage datum is zero point on gage.

TABLE 3-3

GROUND WATER AND SURFACE WATER ELEVATON DATA
BOWERS LANDFILL, CIRCLEVILLE, OHIO

Well Number	Measurement Point Elevation(1)	Depth to Water 2/87(3)	Water Surface Elevation 2/87(3)	Depth to Water 3/12/87	Water Surface Elevation 3/12/87	Depth to Water 4/27/87	Water Surface Elevation 4/27/87
W-4	677.07	19.69	657.38	19.56	657.51	18.75	658.32
P-4A	676.22	18.56	657.66	18.48	657.74	17.58	658.64
W-5	657.28	8.57	648.71	8.46	648.82	8.03	649.25
P-5A	657.26	8.45	648.81	8.46	648.80	7.99	649.27
P-5B	656.27	6.61	649.66	6.75	649.52	5.98	650.29
W-6	659.22	7.75	651.47	7.89	651.33	6.74	652.48
P-6A	658.98	7.38	651.60	7.63	651.35	6.47	652.51
P-6B	657.90	7.02	650.88	7.21	650.69	6.11	651.79
W-7	662.50	13.25	649.25	13.29	649.21	12.63	649.87
P-7A	662.43	12.22	650.21	12.33	650.10	11.47	650.96
W-8	663.39	14.21	649.18	14.46	648.93	13.95	649.44
P-8A	662.18	12.55	649.63	12.78	649.40	12.19	649.99
P-8B	662.07	9.59	652.48	9.79	652.28	9.39	652.68
W-9	658.39	7.45	650.94	7.72	650.67	6.19	652.20
W-10	660.41	9.47	650.94	9.73	650.68	8.44	651.97
W-11	657.61	7.42	650.19	7.52	650.09	6.60	651.01
W-12	669.67	13.75	655.92	13.93	655.74	12.63	657.04
W-13	662.36	8.54	653.82	9.00	653.36	7.03	655.33

TABLE 3-4

RESULTS OF PHYSICAL TESTING SPLIT-SPOON AND SHELBY TUBE SOIL SAMPLES BOWERS LANDFILL - CIRCLEVILLE, OHIO

Boring Number	Sample Number	Permeability (cm/sec)	Liquid Limit	Plastic Limit	USCS Classification**
W-4	2	NA	27	17	CL
W-4	9	NA	NA	NA	SM
W-5	1	NA	53	32	MH
W-5	2	NA	29	22	ML-CL
W-5	3	NA	31	22	SM-SC
P-5A	1	NA	53	31	MH
P-5A	6	NA	23	16	SM-SC
P-5B	11	NA	20	15	SM-SC
W-6	1	NA	37	24	CL
W-6	3	NA	35	29	ML
P-6A	2	NA	NA	NA	B-LINE
P-6B	9	NA	NA	NA	B-LINE
P-6B	13	NA	NA	NA	B-LINE
P-7A	1	NA	50	29	CL
P-7A	5	NA	24	19	SM-SC
P-7A	9	NA	NA	NA	NO DATA
W-8	1	NA	NA	NA	B-LINE
W-8	2	NA	NA	NA	B-LINE
P-8A	14	NA	21	15	SM-SC
P-8B	1	NA	22	15	SM-SC
SO-8*	-	$3.1\text{-}10^{-8}$	34	23	CL
SO-9*	-	4.57×10^{-8}	60	32	MH-CH

* Shelby tube sample. Note that SO-4 provided insufficient sample volume to allow physical testing.

** Classifications as follows:

CL - Inorganic clay, low to medium plasticity
CH - Inorganic clay, high plasticity
ML - Inorganic silts, clayey silts and fine sands, slightly plastic
MH - Inorganic silts, micaceous or diatomaceous fine sand
SM - Silty sands, sand-silt mixtures
SC - Clayey sands, sand-clay mixtures
B-LINE - No clear classification available

TABLE 3-3 (Continued)

Staff Gage Number	Elevation of Datum(2)	Gage Height 2/87(3)	Water Surface Elevation 2/87(3)	Gage Height 3/12/87	Water Surface Elevation 3/12/87	Gage Height 4/27/87	Water Surface Elevation 4/27/87
SG-23	648.57	-0.85	647.72	-0.8	647.77	-1.50	647.07
SG-24	655.74	0.13	655.87	-0.2	655.54	0.44	656.18
SG-25	654.39	0.45	654.84	0.0	654.39	1.80	656.19
SG-28	652.29	0.45	652.74	0.2	652.49	1.96	654.25

(1) Monitoring well measurement point is top of riser pipe.
(2) Staff gage datum is zero point on gage.
(3) Measurements obtained over the period February 9-13, 1987 (concurrent with sampling activities).

TABLE 3-5

GROUND WATER SAMPLING - FIELD ANALYSIS DATA

Well Identification	Date of Analysis	Temperature (°C)	pH (s.u.)	Specific Conductance (µs/cm)*
BL-W-04	02/09/87	10.8	7.4	295
	05/01/87	12.8	6.7	674
P-04A	02/09/87	11.5	7.1	775
	05/01/87	12.4	7.1	694
W-05	02/13/87	12.2	7.2	595
	04/30/87	12.9	6.6	545
P-5A	02/13/87	12.2	7.2	613
	04/30/87	13.4	6.7	533
P-5B	02/13/87	12.9	7.4	1483
	04/30/87	13.3	6.6	1302
W-06	02/12/87	8.4	6.7	807
	4/29/87	12.1	6.0	677
P-6A	02/12/87	12.1	6.9	669
	04/29/87	13.6	5.5	579
P-06B	02/12/87	10.1	7.3	533
	04/29/87	13.4	5.7	472
W-07	02/10/87	12.8	6.8	717
	04/29/87	12.8	6.7	660
P-07A	02/10/87	12.4	6.7	678
	04/29/87	12.8	6.4	626
W-08	02/12/87	11.5	6.6	651
	04/27/87	14.1	6.9	194
P-08A	02/11/87	11.5	6.7	666
	04/27/87	15.2	6.9	184
P-08B	02/11/87	11.5	6.8	732
	04/27/87	13.6	6.8	219
W-09	02/10/87	6.8	6.5	716
	04/27/87	14.4	7.0	584

TABLE 3-5 (Continued)

Well Identification	Date of Analysis	Temperature (°C)	pH (s.u.)	Specific Conductance (µs/cm)*
W-10	02/11/87	9.3	6.5	952
	04/27/87	11.6	6.4	609
W-11	02/12/87	12.2	6.8	651
	04/27/87	17.6	6.7	233
W-12	02/10/87	11.5	6.5	801
	04/29/87	13.7	5.7	727
W-13	02/09/87	12.1	6.9	544
	04/30/87	11.0	5.7	535

*microsiemans/centimeter

TABLE 3-6
GROUND WATER SAMPLE RESULTS - VOLATILE ORGANICS
(All concentrations reported in µg/L)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

	Trip Blank (VOA)			Field Blank				W-04		P-04A		W-05			P-05A		
Volatile Compound	01	02-No.1	02-No.2	01-No.1	01-No.2	02-No.1	02-No.2	01	02	01	02	01	02	02DUP	01	01DUP	02
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	BDL	BDL (B)	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	BDL	ND	BDL	ND
Acetone	ND	ND	ND	ND	29 (B)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl acetate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates that parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-6 (Continued)

Volatile Compound	P-05B		W-06			P-06A		P-06B			W-07		P-07A		W-08	
	01	02	01	01DUP	02	01	02	01	02	02DUP	01	02	01	02	01	02
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND
Acetone	BDL	ND	BDL	ND	ND	ND	ND	11 (B)	14	12	ND	ND	ND	ND	ND	ND
Carbon disulfide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl acetate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates that parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-6 (Continued)

Volatile Compound	P-08A		P-08B		W-09		W-10			W-11		W-12			
	01	02	01	02	01	02	01	01DUP	02	01	02	01	02	02DUP	02MSPIKE
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.1	7.4	ND
Acetone	ND	ND	ND	ND	ND	ND	BDL (B)	ND	ND	ND	ND	ND	14	ND	ND
Carbon disulfide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl acetate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	5.3	5.3	BDL
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates that parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accu
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-6 (Continued)

Volatile Compound	W-13 01	W-13 02	W-13 02DUP	RW-14	RW-15	RW-16	RW-16-DUP	RW-17
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	BDL	ND	BDL	ND	ND
Acetone	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl acetate	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND
Total xylenes	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates that parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-7
GROUND WATER SAMPLE RESULTS - SEMIVOLATILE ORGANICS
(All concentrations reported in µg/L)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

	Field Blank				W-04		P-04A		W-05			P-05A			P-05B	
Semivolatile Compound	01-No.1	01-No.2	02-No.1	02-No.2	01	02	01	02	01	02	02DUP	01	01DUP	02	01	02
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates that parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-7 (Continued)

Semivolatile Compound	Field Blank				W-04		P-04A		W-05			P-05A			P-05B	
	01-No.1	01-No.2	02-No.1	02-No.2	01	02	01	02	01	02	02DUP	01	01DUP	02	01	02
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl) phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND	BDL	ND	ND	BDL	ND
Di-n-octyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

TABLE 3-7 (Continued)

Semivolatile Compound	W-06			P-06A		P-06B			W-07		P-07A		W-08		P-08A	
	01	01DUP	02	01	02	01	02	02DUP	01	02	01	02	01	02	01	02
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

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B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-7 (Continued)

Semivolatile Compound	W-06			P-06A		P-06B			W-07		P-07A		W-08		P-08A	
	01	01DUP	02	01	02	01	02	02DUP	01	02	01	02	01	02	01	02
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl) phthalate	ND	ND	ND	ND	BDL	ND	ND	ND	BDL	ND	21	ND	BDL	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

TABLE 3-7 (Continued)

Semivolatile Compound	P-08B		W-09		W-10			W-11		W-12				W-13		
	01	02	01	02	01	01DUP	02	01	02	01	02	02DUP	02MSPIKE	01	02	02DUP
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates that parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-7 (Continued)

Semivolatile Compound	P-08B		W-09		W-10			W-11		W-12				W-13		
	01	02	01	02	01	01DUP	02	01	02	01	02	02DUP	02MSPIKE	01	02	02DUP
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND
4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl) phthalate	ND	ND	BDL	ND	BDL	ND	ND	BDL	ND	BDL	ND	ND	BDL	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

TABLE 3-7 (Continued)

Semivolatile Compound	RW-14	RW-15	RW-16	RW-16-DUP	RW-17
Phenol	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND
4-Methylphenol	ND	ND	ND	ND	ND
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	ND	ND
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates that parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-7 (Continued)

Semivolatile Compound	RW-14	RW-15	RW-16	RW-16-DUP	RW-17
4-Nitrophenol	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND
N-nitrosodiphenylamine	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND
Butyl benzyl phthalate	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND
bis(2-ethylhexyl) phthalate	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND
Di-n-octyl phthalate	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

TABLE 3-8
GROUND WATER SAMPLE RESULTS - PESTICIDE/PCB
(All concentrations reported in µg/L)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

Pesticide/PCB Compound	Field Blank				W-04		P-04A		W-05			P-05A		
	01-No.1	01-No.2	02-No.1	02-No.2	01	02	01	02	01	02	02DUP	01	01DUP	02
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1254	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

TABLE 3-8 (Continued)

Pesticide/PCB Compound	P-05B		W-06			P-06A		P-06B			W-07		P-07A	
	01	02	01	01DUP	02	01	02	01	02	02DUP	01	02	01	02
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1254	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

TABLE 3-8 (Continued)

Pesticide/PCB Compound	W-08		P-08A		P-08B		W-09		W-10			W-11	
	01	02	01	02	01	02	01	02	01	01DUP	02	01	02
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1254	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

TABLE 3-8 (Continued)

Pesticide/PCB Compound	W-12 01	W-12 02	W-12 02DUP	W-12 02MSPIKE	W-13 01	W-13 02	W-13 02DUP	RW-14	RW-15	RW-16	RW-16-DUP	RW-17
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1254	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

TABLE 3-9
GROUND WATER SAMPLE RESULTS - DIOXIN
(All concentrations reported in µg/L)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

	Field Blank				W-04		P-04A		W-05		P-05A			P-05B		
Compound	01-No.1	01-No.2	02-No.1	02-No.2	01	02	01	02	01	02DUP	01	01DUP	02	01	02	02 DUP
2,3,7,8-tetrachlorodi-benzo-p-dioxin (TCDD)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

	W-06			P-06A			P-06B		W-07		P-07A		W-08		P-08A	
Compound	01	01DUP	02	01	02	01	02	02DUP	01	02	01	02	01	02	01	02
2,3,7,8-tetrachlorodi-benzo-p-dioxin (TCDD)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

	P-08B		W-09		W-10			W-11		W-12				W-13		
Compound	01	02	01	02	01	01DUP	02	01	02	01	02	02DUP	02MSPIKE	01	02	02DUP
2,3,7,8-tetrachlorodi-benzo-p-dioxin (TCDD)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Compound	RW-14	RW-15	RW-16	RW-16-DUP	RW-17
2,3,7,8-tetrachlorodi-benzo-p-dioxin (TCDD)	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

TABLE 3-10
GROUND WATER SAMPLE RESULTS - INORGANIC ELEMENTS, CYANIDE AND NITRATE
(All concentrations reported in µg/L)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

	Field Blank				W-04		P-04A		W-05			P-05A		
Inorganic Parameter	01-No.1	01-No.2	02-No.1	02-No.2	01	02	01	02	01	02	02DUP	01	01DUP	02
Aluminum	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND	BDL	ND	ND	ND
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	BDL	BDL	ND (N)	ND	BDL	BDL (N)	BDL	BDL (N)	BDL (N)	BDL (N)	ND (N)	BDL (N)	BDL	BDL (N)
Barium	ND (E)	ND (E)	ND	ND	BDL (E)	BDL	BDL (E)	BDL	217	213	204	202	203 (E)	BDL
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	BDL	BDL	BDL	BDL	113000	103000	107000	100000	80300	82600	79300	80500	83400	79200
Chromium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	BDL	BDL	ND	ND	BDL	BDL	BDL	BDL	ND	ND	ND	ND	BDL	ND
Iron	ND	BDL	BDL	BDL (E)	BDL	BDL	1250	376	1100	796	728	BDL	149	BDL
Lead	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium	ND	BDL	ND	ND	38100	35100	36700	34800	25600	26300	25200	26000	26800	25400
Manganese	ND (E)	ND (E)	BDL (E)	ND	395 (E)	239 (E)	53 (E)	42 (E)	92 (E)	68 (E)	67 (E)	203 (E)	205 (E)	132 (E)
Mercury	ND	ND	ND (N)	ND	ND	0.76 (N)	ND	0.22 (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND	ND (N)
Nickel	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (E,N)	ND (E,N)	ND (E,N)	ND	BDL (N)	ND (N)	ND	ND (N)	ND (N)
Silver	ND	ND	ND	ND (N)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	ND (E)	8050 (E)	ND	ND	7700 (E)	7190	14600 (E)	13700	11100 (E)	5920	5640	11600 (E)	17200 (E)	7280
Thallium	ND	ND	ND	ND (N)	ND	ND	ND	ND	ND (N)	ND	ND	ND (N)	ND	ND
Vanadium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	BDL	BDL	BDL	BDL (E)	BDL	BDL	24	BDL	BDL (E)	BDL	BDL	BDL (E)	BDL	BDL
Cyanide	ND	ND	ND	ND	20	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate as N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
E - Indicates a value estimated or not reported due to the presence of interference.
N - Indicates spike sample recovery is not within control limits.
S - Indicates value determined by Method of Standard Additions.
NA - Parameter not analyzed for.

TABLE 3-10 (Continued)

Inorganic Parameter	P-05B 01	P-05B 02	W-06 01	W-06 01DUP	W-06 02	P-06A 01	P-06A 02	P-06B 01	P-06B 02	P-06B 02DUP	W-07 01	W-07 02
Aluminum	BDL	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	BDL (N)	11 (N)	BDL	BDL	ND (N)	BDL	BDL (N)	BDL	BDL	ND	ND	20 (N)
Barium	2020	2020	226 (E)	223 (E)	234	BDL (E)	BDL	488 (E)	531	522	335 (E)	383
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	71600	67300	107000	106000	107000	89200	89100	58600	59000	57800	97900	93500
Chromium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	BDL	ND	BDL	BDL	ND	ND	ND	ND	ND	ND	BDL	ND
Copper	ND	ND	BDL	BDL	ND	BDL	ND	BDL	ND	ND	BDL	ND
Iron	615	BDL	367	272	BDL	154	ND	107	273 (E)	263 (E)	864	3700
Lead	ND	ND	ND	ND	ND	ND	ND	ND	8.5 (S,N)	10 (N)	ND	ND
Magnesium	36900	35600	38000	38000	38200	34500	33600	23500	24400	23800	33500	39900
Manganese	159 (E)	134 (E)	1350 (E)	1360 (E)	1330 (E)	332 (E)	333 (E)	192 (E)	183 (E)	178 (E)	347 (E)	126 (E)
Mercury	ND (N)	ND (N)	ND	ND	ND (N)	ND	ND (N)	ND	ND	ND	ND	ND (N)
Nickel	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	7060	5120	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	183000 (E)	173000	21000 (E)	19600 (E)	10300	7880 (E)	BDL	29700 (E)	20600	20300	10000 (E)	7490
Thallium	ND (N)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND
Zinc	BDL (E)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	21	BDL
Cyanide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate as N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
E - Indicates a value estimated or not reported due to the presence of interference.
S - Indicates value determined by Method of Standard Additions.
N - Indicates spike sample recovery is not within control limits.
NA - Parameter not analyzed for.

Table 3-10 (Continued)

Inorganic Parameter	P-07A 01	P-07A 02	W-08 01	W-08 02	P-08A 01	P-08A 02	P-08B 01	P-08B 02	W-09 01	W-09 02	W-10 01	W-10 01DUP	W-10 02
Aluminum	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	BDL	ND	BDL	BDL	BDL	BDL	BDL	ND	ND	ND	BDL	BDL	ND
Barium	309 (E)	306	287 (E)	308	322 (E)	308	596 (E)	684	BDL (E)	BDL	BDL (E)	BDL (E)	BDL
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	92700	101000	93900	98000	99800	98800	95900	95400	119000	101000	133000	132000	129000
Chromium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	BDL	ND
Copper	BDL	ND	BDL	ND	BDL	ND	BDL	ND	BDL	ND	BDL	BDL	ND
Iron	1100	BDL (E)	498	521 (E)	846	1380 (E)	994	948 (E)	BDL	BDL (E)	165	294	BDL (E)
Lead	ND	ND (N)	ND	BDL (N)	ND	BDL (N)	ND	BDL (N)	ND	BDL (N)	ND	ND	BDL (N)
Magnesium	39300	35800	31800	34000	34500	34600	36000	36900	33400	28800	50600	50400	49800
Manganese	314 (E)	324 (E)	141 (E)	121 (E)	198 (E)	177 (E)	230 (E)	234 (E)	26 (E)	19 (E)	1890 (E)	1880 (E)	657 (E)
Mercury	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND	ND (N)
Nickel	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	ND	5270	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (E,N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	12900 (E)	9420	6300 (E)	BDL	5160 (E)	BDL	17900 (E)	15400	6550 (E)	ND	23900 (E)	22900 (E)	20300
Thallium	ND	ND (E)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	BDL	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	BDL	BDL	22	BDL	BDL	BDL	BDL	BDL	BDL	BDL	22	BDL	20
Cyanide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate as N	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
E - Indicates a value estimated or not reported due to the presence of interference.
N - Indicates spike sample recovery is not within control limits.
NA - Parameter not analyzed for.

Table 3-10 (Continued)

Inorganic Parameter	W-11 01	W-11 02	W-12 01	W-12 02	W-12 02DUP	W-12 02MSPIKE	W-13 01	W-13 02	W-13 02DUP	RW-14	RW-15	RW-16	RW-16-DUP	RW-17
Aluminum	BDL	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	BDL	BDL	ND	ND (N)	ND (N)	ND (N)	BDL	17 (N)	11 (N)	16 (LD)	14 (LD)	11 (LD)	11 (LD)	ND (LD)
Barium	348 (E)	351	BDL (E)	BDL	BDL	BDL	264 (E)	300	305	BDL	BDL	BDL	BDL	BDL
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND (LD)	ND (LD)	ND (LD)	ND (LD)	ND (LD)
Calcium	117000	130000	123000	117000	113000	110000	76000	77300	78000	97100	101000	89700	88400	94100
Chromium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND (LD)	ND (LD)	ND (LD)	ND (LD)	ND (LD)
Cobalt	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	BDL	ND	BDL	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND	32
Iron	8760	5930 (E)	BDL	106	ND	ND	7110	6000	5980	2510	30000	2370	2250	4670
Lead	ND	9.2 (N)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Magnesium	35100	36600	35100	33800	32700	32700	22600	23700	23800	33500	34200	31300	30900	31200
Manganese	264 (E)	347 (E)	BDL (E)	BDL (E)	BDL (E)	BDL (E)	300 (E)	305 (E)	309 (E)	39 (E)	51 (E)	42 (E)	42 (E)	16 (E)
Mercury	ND	ND (N)	ND	ND (N)	ND (N)	ND (N)	ND	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)
Nickel	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (LD)	ND (LD)	ND (LD)	ND (LD)	3.5 (LD)
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	17200 (E)	15000	5300 (E)	BDL	ND	BDL	8410 (E)	6460	7920	8360 (E)	19800 (E)	10400 (E)	9980 (E)	9710 (E)
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)
Vanadium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	BDL	BDL	21	BDL	BDL	BDL	BDL	BDL	BDL	BDL (E)	20 (E)	20 (E)	22 (E)	174 (E)
Cyanide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrate as N	NA	NA	NA	NA	NA	NA	NA	NA	NA	1600	1400	1300	1300	BDL

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
E - Indicates a value estimated or not reported due to the presence of interference.
N - Indicates spike sample recovery is not within control limits.
S - Indicates value determined by Method of Standard Additions.
NA - Parameter not analyzed for.
LD - Special analytical techniques used to attain detection limits lower than standard CRDL values.

TABLE 3-11

SURFACE WATER SAMPLING - FIELD ANALYSIS

Surface Water Location	Date of Analysis	Temperature (°C)	pH (s.u.)	Specific Conductance (µs/cm)*
18	02/14/87	5.3	7.7	690
	04/28/87	17.7	7.3	529
19	02/14/87	5.2	7.5	658
	04/28/87	18.4	7.1	608
20	02/14/87	5.5	8.0	266
	04/28/87	18.2	6.5	201
21	02/14/87	4.8	7.1	184
	04/28/87	14.1	8.2	433
22	02/14/87	4.9	7.8	255
	04/28/87	14.9	7.3	599
23	02/14/87	5.7	7.3	663
	04/28/87	14.5	5.9	611
24	02/15/87	3.6	7.6	551
	04/30/87	18.4	6.5	428
25	02/15/87	5.1	7.9	564
	04/28/87	19.0	7.5	369
26	02/15/87	7.4	7.3	537
	05/01/87	17.2	6.8	423
27	02/15/87	2.3	7.4	536
	04/29/87	20.2	6.2	488
28	02/15/87	2.9	7.2	834
	04/29/87	22.9	6.3	816
29	02/15/87	2.5	7.2	248
	04/30/87	17.4	6.6	515

*microsiemans/centimeter

TABLE 3-12
SURFACE WATER SAMPLE RESULTS - VOLATILE ORGANICS
(All concentrations reported in µg/L)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

	SW Blank				SW Trip Blank		SW-18		SW-19		SW-20	
Volatile Compound	01	01 DUP	02	02 DUP	01	02	01	02	01	02	01	02
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	BDL (B)	ND	ND	ND	BDL (B)	BDL (B)	BDL	ND	BDL (B)	ND	BDL	ND
Acetone	10 (B)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl acetate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	BDL	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-12 (Continued)

Volatile Compound	SW-21				SW-22		SW-23		SW-24		SW-25	
	01	01-DUP	02	02-DUP	01	02	01	02	01	02	01	02
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	ND	ND	ND	BDL (B)	5.2	BDL (B)	5.7	ND	ND	BDL	ND	ND
Acetone	ND	ND	ND	ND	ND	ND	BDL (B)	ND	ND	ND	ND	ND
Carbon disulfide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	BDL	ND	BDL	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl acetate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-12 (Continued)

Volatile Compound	SW-26		SW-27		SW-28			SW-29		
	01	02	01	02	01	01-DUP	02	01	02	02DUP
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	BDL, B	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon disulfide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl acetate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-13
SURFACE WATER SAMPLE RESULTS - SEMIVOLATILE ORGANICS
(All concentrations reported in µg/L)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

	SW Blank				SW-18		SW-19		SW-20		SW-21			
Semivolatile Compound	01	01 DUP	02	02 DUP	01	02	01	02	01	02	01	01-DUP	02	02-DUP
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-13 (Continued)

Semivolatile Compound	SW Blank				SW-18		SW-19		SW-20		SW-21			
	01	01 DUP	02	02 DUP	01	02	01	02	01	02	01	01-DUP	02	02-DUP
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl) phthalate	ND	ND	ND	ND	ND	BDL (B)	ND	BDL (B)	ND	ND	ND	ND	BDL (B)	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-13 (Continued)

Semivolatile Compound	SW-22		SW-23		SW-24		SW-25		SW-26		SW-27	
	01	02	01	02	01	02	01	02	01	02	01	02
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-13 (Continued)

Semivolatile Compound	SW-22		SW-23		SW-24		SW-25		SW-26		SW-27	
	01	02	01	02	01	02	01	02	01	02	01	02
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl) phthalate	ND	BDL (B)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-octyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-13 (Continued)

Semivolatile Compound	SW-28 01	SW-28 01-DUP	SW-28 02	SW-29 01	SW-29 02	SW-29 02DUP
Phenol	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	ND
4-Methylphenol	ND	ND	ND	ND	ND	ND
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	ND	ND	ND
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-13 (Continued)

Semivolatile Compound	SW-28 01	SW-28 01-DUP	SW-28 02	SW-29 01	SW-29 02	SW-29 02DUP
4-Nitrophenol	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND
N-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND
Butyl benzyl phthalate	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND
bis(2-ethylhexyl) phthalate	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND
Di-n-octyl phthalate	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-14
SURFACE WATER SAMPLE RESULTS - PESTICIDE/PCBs
(All concentrations reported in µg/L)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

Pesticide/PCB	SW Blank				SW-18		SW-19		SW-20		SW-21				SW-22	
Compound	01	01 DUP	02	02 DUP	01	02	01	02	01	02	01	01-DUP	02	02-DUP	01	02
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1254	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1260	ND	ND	ND	ND	1.2	ND	ND	ND	ND	ND	ND	2.6	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

TABLE 3-14 (Continued)

Pesticide/PCB	SW-23		SW-24		SW-25		SW-26		SW-27		SW-28			SW-29		
Compound	01	02	01	02	01	02	01	02	01	02	01	01-DUP	02	01	02	02DUP
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1254	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

TABLE 3-15
SURFACE WATER SAMPLE RESULTS - DIOXIN
(All concentrations reported in µg/L)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

Compound	SW Blank 1		SW Blank 2		SW Trip Blank		SW-18		SW-19		SW-20		SW-21			
	01	02	01	02	01	02	01	02	01	02	01	02	01	01-DUP	02	02-DUP
2,3,7,8-tetrachlorodi-benzo-p-dioxin (TCDD)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Compound	SW-22		SW-23		SW-24		SW-25		SW-26		SW-27		SW-28			
	01	02	01	02	01	02	01	02	01	02	01	02	01	01-DUP	02	02DUP
2,3,7,8-tetrachlorodi-benzo-p-dioxin (TCDD)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Compound	SW-29	
	01	02
2,3,7,8-tetrachlorodi-benzo-p-dioxin (TCDD)	ND	ND

TABLE 3-16
SURFACE WATER SAMPLE RESULTS - INORGANIC ELEMENTS AND CYANIDE
(All concentrations reported in µg/L)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

Inorganic	SW Blank				SW-Blank	SW-18		SW-19		SW-20		SW-21				SW-22	
Parameter	01	01 DUP	02	02 DUP	EPA	01	02	01	02	01	02	01	01-DUP	02	02-DUP	01	02
Aluminum	BDL	ND	ND	ND	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	120	BDL
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND (N)	BDL	BDL	ND (N)	ND
Barium	BDL	ND	BDL	ND	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	BDL	BDL	BDL	BDL	BDL	75400	76800	73300	75800	77100	75300	74900	75000	64900	66300	76900	76400
Chromium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron	BDL	BDL	BDL (E)	BDL	BDL (E)	294	406 (E)	358	438 (E)	234	413 (E)	811	640	2540 (E)	2450 (E)	243	383 (E)
Lead	20	ND	BDL (N)	ND	6.1 (N)	ND	6.6 (N)	ND	BDL (S,N)	ND	8.0 N	ND	ND	BDL (N)	9.4 (N)	ND	77 (N)
Magnesium	ND	ND	ND	ND	ND	25400	26300	24600	25800	25900	25700	22600	22600	21100	21700	25700	26100
Manganese	BDL	BDL (E)	ND (E)	ND (E)	ND (E)	34 (E)	55 (E)	34 (E)	55 (E)	34 (E)	55 (E)	115 (E)	111 (E)	189 (E)	195 (E)	37 (E)	56 (E)
Mercury	ND	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	0.23 (N)	ND
Nickel	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND	ND	ND (N)	BDL (N)	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND	ND (N)	ND (N)	ND	ND (N)
Silver	ND	ND	ND	ND	15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	BDL	5020 (E)	ND	ND	ND	37800 (E)	26600	37500 (E)	26100	36400 (E)	27000	9240 (E)	8650 (E)	BDL	BDL	39400 (E)	29000
Thallium	ND	ND (N)	ND	ND	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND (N)	ND	ND	ND (N)	ND
Vanadium	ND	ND (E)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	26	BDL	BDL	BDL	BDL	34 (E)	27	25 (E)	33	27 (E)	30	BDL (E)	BDL (E)	23	BDL	29 (E)	28
Cyanide	ND	ND	ND	ND	NA	ND	ND	ND	10	ND	12	ND	ND	ND	ND	ND	10

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.
E - Indicates a value estimated or not reported due to the presence of interference.
N - Indicates spike sample recovery is not within control limits.
S - Indicates value determined by Method of Standard Additions.
NA - Parameter not analyzed for.

TABLE 3-16 (Continued)

Inorganic	SW-23		SW-24		SW-25		SW-26		SW-27		SW-28			SW-29		
Parameter	01	02	01	02	01	02	01	02	01	02	01	01-DUP	02	01	02	02DUP
Aluminum	117	BDL	BDL	BDL	810	263	BDL	BDL	BDL	213	BDL	BDL	ND	BDL	1140	1080
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND (N)	ND	ND (N)	ND (N)	ND	ND	BDL (N)	BDL	ND (N)	BDL (N)	ND (N)	ND	ND	ND	BDL (N)	BDL (N)
Barium	50	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	76600	75500	76600	58500	71300	46700	74800	65300	77000	70000	121000	118000	121000	73000	74500	73800
Chromium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	BDL	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND	ND	BDL	ND	BDL	ND	ND	ND	ND	BDL	BDL
Iron	252	450 (E)	465	517	2060	636 (E)	289	426 (E)	127	944	980	1040	214 (E)	362	2420	2460
Lead	ND	BDL (N)	ND	ND	ND	ND (S,N)	ND	ND	ND	ND	ND	ND	BDL (N)	ND	ND	ND
Magnesium	25700	25900	23200	19000	25900	23200	23400	20800	27200	24300	47400	46300	45700	26600	27100	26800
Manganese	35 (E)	55 (E)	154 (E)	83 (E)	98	28 (E)	143 (E)	110	33 (E)	122 (E)	787 (E)	817	28 (E)	41	162 (E)	163 (E)
Mercury	ND (N)	ND	ND (N)	ND (N)	ND	ND (N)	ND (N)	0.27	ND (N)	ND (N)	ND (N)	ND	ND (N)	ND	ND (N)	ND (N)
Nickel	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND (N)	ND	ND	ND (N)	ND	ND (N)	ND (N)
Silver	ND	ND	ND	ND	ND	ND	ND	21 (N)	ND	ND	ND	BDL	ND	ND	ND	ND
Sodium	39700 (E)	27300	10700 (E)	BDL	13500	BDL	10900 (E)	9620	5310 (E)	BDL	19700 (E)	18800	9910	BDL	BDL	BDL
Thallium	ND (N)	ND	ND (N)	ND	ND	ND	ND (N)	ND	ND (N)	ND	BDL (N)	ND	ND	ND	ND	ND
Vanadium	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	BDL	ND	ND	ND	ND	ND
Zinc	33 (E)	37	18 (E)	BDL	BDL	BDL	11 (E)	25 (E)	BDL (E)	BDL	48 (E)	43	BDL	BDL	BDL	BDL
Cyanide	ND	16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.
E - Indicates a value estimated or not reported due to the presence of interference.
N - Indicates spike sample recovery is not within control limits.
S - Indicates value determined by Method of Standard Additions.
NA - Parameter not analyzed for.

TABLE 3-17
SEDIMENT SAMPLE RESULTS - VOLATILE ORGANICS
(All concentrations reported in µg/kg)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

	SE Blank		SE-18		SE-19		SE-20		SE-21				SE-22	
Volatile Compound	01	02	01	02	01	02	01	02	01	01-DUP	02	02-DUP	01	02
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	7.6 (B)	7.7 (B)	22 (B)	30 (B)	14 (B)	19 (B)	19 (B)	24 (B)	31 (B)	15 (B)	50 (B)	53 (B)	13 (B)	54 (B)
Acetone	170 (B)	95 (B)	19 (B)	27 (B)	16 (B)	20 (B)	BDL (B)	15 (B)	BDL (B)	BDL (B)	27 (B)	32 (B)	36 (B)	140 (B)
Carbon disulfide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl acetate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	61
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

Table 3-17 (Continued)

Volatile Compound	SE-23		SE-24		SE-25		SE-26		SE-27		SE-28			SE-29		
	01	02	01	02	01	02	01	02	01	02	01	01-DUP	02	01	02	02DUP
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	23 (B)	15 (B)	9.4 (B)	66 (B)	17 (B)	150 (B)	18 (B)	61 (B)	36 (B)	23 (B)	20 (B)	22 (B)	32	25 (B)	60 (B)	120 (B)
Acetone	24 (B)	BDL (B)	BDL (B)	15 (B)	BDL (B)	21 (B)	BDL (B)	38 (B)	19 (B)	19 (B)	20 (B)	BDL (B)	BDL	BDL (B)	17 (B)	15 (B)
Carbon disulfide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	BDL	BDL	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl acetate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl vinyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-18
SEDIMENT SAMPLE RESULTS - SEMIVOLATILE ORGANICS
(All concentrations reported in µg/kg)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

	SE Blank		SE-18		SE-19		SE-20		SE-21			
Semivolatile Compound	01	02	01	02	01	02	01	02	01	01-DUP	02	02-DUP
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	BDL
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8100	6800
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	BDL
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

II - Indicates indistinguishable isomers.

TABLE 3-18 (Continued)

Semivolatile Compound	SE Blank		SE-18		SE-19		SE-20		SE-21			
	01	02	01	02	01	02	01	02	01	01-DUP	02	02-DUP
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Anthracene	ND	ND	BDL	BDL	BDL	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND
Fluoranthene	ND	ND	700	900	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Pyrene	ND	ND	700	810	BDL	BDL	590	BDL	BDL	BDL	BDL	BDL
Butyl benzyl phthalate	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	BDL	BDL	3600	BDL	BDL	BDL	BDL	BDL	BDL	BDL
bis(2-ethylhexyl) phthalate	ND	ND	520 (B)	660 (B)	840	950 (B)	1100	900 (B)	BDL	BDL	1600 (B)	1500 (B)
Chrysene	ND	ND	550	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Di-n-octyl phthalate	ND	ND	BDL	BDL	BDL	BDL	BDL	BDL	ND	ND	BDL	ND
Benzo(b)fluoranthene	ND	ND	910 (II)	890 (II)	750 (II)	550 (II)	BDL (II)	BDL (II)	BDL (II)	BDL (II)	BDL (II)	BDL (II)
Benzo(k)fluoranthene	ND	ND	910 (II)	890 (II)	750 (II)	550 (II)	BDL (II)	BDL (II)	BDL (II)	BDL (II)	BDL (II)	BDL (II)
Benzo(a)pyrene	ND	ND	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Indeno(1,2,3-cd)pyrene	ND	ND	BDL	BDL	BDL	ND	BDL	BDL	BDL	BDL	BDL	BDL
Dibenz(a,h)anthracene	ND	ND	BDL	BDL	BDL	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	BDL	BDL	BDL	ND	BDL	ND	BDL	BDL	BDL	BDL

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

II - Indicates indistinguishable isomers.

TABLE 3-18 (Continued)

Semivolatile Compound	SE-22		SE-23		SE-24		SE-25		SE-26		SE-27	
	01	02	01	02	01	02	01	02	01	02	01	02
Phenol	ND	ND	ND	BDL	ND	ND	ND	BDL	ND	BDL	ND	ND
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ND	8600	ND	670	ND	BDL	660	1200	ND	BDL	ND	BDL
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

II - Indicates indistinguishable isomers.

TABLE 3-18 (Continued)

Semivolatile Compound	SE-22		SE-23		SE-24		SE-25		SE-26		SE-27	
	01	02	01	02	01	02	01	02	01	02	01	02
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	BDL	BDL	BDL	BDL	ND	ND	ND	BDL	BDL	BDL	BDL	ND
Anthracene	ND	BDL	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	BDL	BDL	BDL	BDL	BDL	ND	BDL	950	BDL	BDL	BDL	ND
Pyrene	BDL	BDL	BDL	BDL	BDL	ND	BDL	800	BDL	BDL	BDL	ND
Butyl benzyl phthalate	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	BDL	BDL	ND	BDL	ND	ND	ND	BDL	BDL	ND	BDL	ND
bis(2-ethylhexyl) phthalate	BDL	2000 (B)	BDL	1100 (B)	BDL	BDL (B)	BDL	BDL (B)	BDL	BDL (B)	BDL	BDL
Chrysene	BDL	BDL	BDL	BDL	ND	ND	ND	710	BDL	BDL	BDL	ND
Di-n-octyl phthalate	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	BDL (II)	BDL (II)	BDL (II)	BDL (II)	BDL (II)	ND	BDL (II)	1000 (II)	BDL (II)	ND	BDL (II)	ND
Benzo(k)fluoranthene	BDL (II)	BDL (II)	BDL (II)	BDL (II)	BDL (II)	ND	BDL (II)	1000 (II)	BDL (II)	ND	BDL (II)	ND
Benzo(a)pyrene	BDL	BDL	BDL	BDL	ND	ND	ND	BDL	BDL	ND	BDL	ND
Indeno(1,2,3-cd)pyrene	BDL	BDL	ND	ND	ND	ND	ND	BDL	ND	ND	BDL	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND
Benzo(g,h,i)perylene	BDL	BDL	ND	ND	ND	ND	ND	BDL	ND	ND	BDL	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

II - Indicates indistinguishable isomers.

TABLE 3-18 (Continued)

Semivolatile Compound	SE-28 01	SE-28 01-DUP	SE-28 02	SE-29 01	SE-29 02	SE-29 02DUP
Phenol	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND
Benzyl alcohol	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	ND
4-Methylphenol	ND	ND	ND	ND	ND	ND
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	BDL	ND	ND	ND
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND
Dimethyl phthalate	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

II - Indicates indistinguishable isomers.

TABLE 3-18 (Continued)

Semivolatile Compound	SE-28 01	SE-28 01-DUP	SE-28 02	SE-29 01	SE-29 02	SE-29 02DUP
4-Nitrophenol	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND
N-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	BDL	BDL	BDL	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	ND	ND
Fluoranthene	BDL	BDL	BDL	BDL	ND	ND
Pyrene	BDL	BDL	BDL	BDL	ND	ND
Butyl benzyl phthalate	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	BDL	BDL	BDL	BDL	ND	ND
bis(2-ethylhexyl) phthalate	BDL	BDL	BDL (B)	BDL	BDL	BDL (B)
Chrysene	BDL	BDL	BDL	BDL	ND	ND
Di-n-octyl phthalate	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	BDL (II)	BDL (II)	760 (II)	BDL (II)	ND	ND
Benzo(k)fluoranthene	BDL (II)	BDL (II)	760 (II)	BDL (II)	ND	ND
Benzo(a)pyrene	BDL	BDL	BDL	BDL	ND	ND
Indeno(1,2,3-cd)pyrene	ND	BDL	ND	BDL	ND	ND
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	BDL	ND	BDL	ND	ND

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

II - Indicates indistinguishable isomers.

TABLE 3-19
SEDIMENT SAMPLE RESULTS - PESTICIDE/PCBs
(All concentrations reported in µg/kg)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

Pesticide/PCB	SE Blank		SE-18		SE-19		SE-20		SE-21				SE-22	
Compound	01	02	01	02	01	02	01	02	01	01-DUP	02	02-DUP	01	02
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	200	ND	120	140	ND	ND	170	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1254	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

TABLE 3-19 (Continued)

Pesticide/PCB	SE-23		SE-24		SE-25		SE-26		SE-27		SE-28			SE-29		
Compound	01	02	01	02	01	02	01	02	01	02	01	01-DUP	02	01	02	02DUP
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	28	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND	ND	ND	ND	ND	2300	ND	420	520	ND	1600	ND	ND
Aroclor-1254	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor-1260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.

TABLE 3-20
SEDIMENT SAMPLE RESULTS - DIOXIN
(All concentrations reported in µg/kg)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

Compound	SE Blank		SE Trip blank		SE-18		SE-19		SE-20		SE-21				SE-22	
	01	02	01	02	01	02	01	02	01	02	01	01-DUP	02	02-DUP	01	02
2,3,7,8-tetrachlorodi-benzo-p-dioxin (TCDD)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Compound	SE-23		SE-24		SE-25		SE-26		SE-27		SE-28				SE-29	
	01	02	01	02	01	02	01	02	01	02	01	01-DUP	02	02DUP	01	02
2,3,7,8-tetrachlorodi-benzo-p-dioxin (TCDD)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 3-21
SEDIMENT SAMPLE RESULTS - INORGANIC ELEMENTS AND CYANIDE
(All concentrations reported in mg/kg)
BOWERS LANDFILL - CIRCLEVILLE, OHIO

	SE Blank		SE-18		SE-19		SE-20		SE-21			
Inorganic Parameter	01	02	01	02	01	02	01	02	01	01-DUP	02	02-DUP
Aluminum	43*	BDL* (E)	7320*	5720* (E)	4460*	4280* (E)	6550*	5460* (E)	8410*	9750*	8320* (E)	7800* (E)
Antimony	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)
Arsenic	ND (N,*)	ND (N)	12 (N,*)	7.2 (N)	BDL (S,N,*)	BDL (N)	7.8 (N,*)	7.1 (N)	7.9 (M,N,*)	7.0 (N,S,*)	12 (N)	11 (N)
Barium	BDL	BDL (E)	118	108 (E)	72	71 (E)	92	99 (E)	149	157	168 (E)	BDL (E)
Beryllium	ND	ND	BDL	ND	ND	ND	ND	ND	BDL	BDL	ND	ND
Cadmium	ND	ND	ND	2.1	ND	ND	1.7	ND	ND	ND	BDL	ND
Calcium	BDL	BDL (E)	21800	28800 (E)	23800	32000 (E)	25300	24900 (E)	27200	27700	35300 (E)	32800 (E)
Chromium	ND	ND	12	16	13	15	19	14	25	26	20	17
Cobalt	BDL (E)	ND	BDL (E)	BDL	BDL (E)	BDL	BDL (E)	BDL	BDL (E)	BDL (E)	ND	ND
Copper	BDL (E)	ND (E)	22 (E)	21 (E)	19 (E)	16 (E)	26 (E)	20 (E)	38 (E)	38 (E)	24 (E)	23 (E)
Iron	76	64* (E)	21200	15000* (E)	12100	13700* (E)	17300	16100* (E)	24400	26100	24100* (E)	23400* (E)
Lead	ND	ND	26	38	28	28	39	35	101	98	48	49
Magnesium	BDL	ND (E)	9790	11000 (E)	8680	11200 (E)	9840	9130 (E)	11300	11700	12400 (E)	11600 (E)
Manganese	BDL	BDL* (E)	554	336* (E)	194	282* (E)	266	276* (E)	531	580	487* (E)	458* (E)
Mercury	ND (N)	ND	0.17 (N)	0.40	0.14 (N)	0.46	0.31 (N)	0.37	0.12 (N)	0.19 (N)	1.1	0.45
Nickel	ND	ND	31	24	14	18	25	30	31	35	36	37
Potassium	BDL	ND	BDL	ND	BDL	ND	BDL	ND	BDL	BDL	ND	ND
Selenium	ND (N)	ND (N)	ND (E,N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (E,N)	ND (N)	ND (N)	ND (N)
Silver	ND	BDL	ND	4.2	BDL	ND	BDL	BDL	BDL	ND	8.0	ND
Sodium	BDL	ND	ND	ND	ND	ND	BDL	ND	BDL	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	ND (E)	ND	20 (E)	BDL	BDL (E)	BDL	19 (E)	BDL	22 (E)	25 (E)	BDL	BDL
Zinc	BDL	BDL* (E)	95	177* (E)	113	139* (E)	174	189* (E)	215	224	219* (E)	204* (E)
Cyanide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
E - Indicates a value estimated or not reported due to the presence of interference.
N - Indicates spike sample recovery is not within control limits.
S - Indicates value determined by Method of Standard Addition.
M - Indicates duplicate injection results exceed control limits.
* - Indicates duplicate analysis results exceed control limits.

TABLE 3-21 (Continued)

Inorganic Parameter	SE-22		SE-23		SE-24		SE-25		SE-26		SE-27	
	01	02	01	02	01	02	01	02	01	02	01	02
Aluminum	4910*	3160* (E)	6710*	5600* (E)	4240*	4460*	2820*	4260* (E)	6310*	5300*	8840*	2820*
Antimony	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)
Arsenic	21 (N,*)	5.7 (N)	5.1 (S,N,*)	6.0 (N)	5.9 (N,*)	3.6 (N)	6.9 (N,*)	7.4 (N)	7.4 (N,*)	6.2 (N)	7.2 (N,*)	4.0 (N)
Barium	100	BDL (E)	133	115 (E)	72	88	BDL	63 (E)	104	141	136	73
Beryllium	ND	ND	ND	ND	ND	BDL	ND	ND	ND	BDL	BDL	BDL
Cadmium	ND	ND	ND	ND	ND	4.2	ND	1.9	ND	2.9	ND	2.9
Calcium	22900	25500	39500	47200 (E)	91000	77100	93000	110000	48100	26500	33700	82500
Chromium	14	12	19	15	5.4	6.5	4.2	5.2	9.9	9.2	13	BDL
Cobalt	BDL (E)	ND	BDL (E)	BDL	BDL (E)	BDL	BDL (E)	BDL	BDL (E)	BDL	BDL (E)	BDL
Copper	24 (E)	12 (E)	27 (E)	20 (E)	18 (E)	14 (E)	12 (E)	18 (E)	22 (E)	18 (E)	36 (E)	14 (E)
Iron	19600	10800* (E)	18600	18400* (E)	15600	15300*	12200	17300* (E)	20800	12700*	26600	11500*
Lead	31	41*	37	37	9.0	17*	9.5	20	38	79	104	34
Magnesium	8150	8320 (E)	15500	19500	30400	21400	22400	35300	13900	11000	13800	27300
Manganese	342	266* (E)	425	403* (E)	367	665*	247	416* (E)	265	244*	552	476*
Mercury	0.31 (N)	0.52	0.20 (N)	0.59	ND (N)	0.76	ND (N)	ND	ND (N)	1.4	ND (N)	ND
Nickel	21	19	ND	27	19	18	13	26	28	15	30	15
Potassium	BDL	ND	BDL	ND	ND	ND	ND	ND	ND	ND	BDL	ND
Selenium	ND (E,N)	ND (N)	ND (E,N)	ND (N)	ND (E,N)	ND (E,N)	ND (E,N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)
Silver	BDL	ND	BDL	ND	BDL	ND	ND	ND	ND	ND	ND	ND
Sodium	ND	ND	BDL	ND	ND	ND	BDL	ND	ND	ND	BDL	ND
Thallium	ND	ND	ND	ND	ND	ND	ND (E)	BDL	ND	ND	ND	BDL
Vanadium	BDL (E)	BDL	17 (E)	BDL	14 (E)	BDL	BDL	BDL	16 (E)	BDL	25 (E)	BDL
Zinc	142	132* (E)	177	158* (E)	67	69*	58	81* (E)	119	159*	163	65*
Cyanide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
E - Indicates a value estimated or not reported due to the presence of interference.
N - Indicates spike sample recovery is not within control limits.
S - Indicates value determined by Method of Standard Addition.
M - Indicates duplicate injection results exceed control limits.
* - Indicates duplicate analysis results exceed control limits.

TABLE 3-21 (Continued)

Inorganic Parameter	SE-28 01	SE-28 01-DUP	SE-28 02	SE-29 01	SE-29 02	SE-29 02DUP
Aluminum	10500*	12100*	7320*	10700*	6740*	7890*
Antimony	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)	ND (N)
Arsenic	8.3 (S,N,*)	13 (N,*)	6.3 (N)	16 (N,*)	4.5 (N)	7.4 (N)
Barium	151	171	179	205	179	204
Beryllium	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium	ND	1.8	BDL	ND	ND	3.5
Calcium	10100	11200	13900	9620	8990	10500
Chromium	16	18	11	15	11	12
Cobalt	BDL (E)	BDL (E)	BDL	14 (E)	BDL	BDL
Copper	45 (E)	49 (E)	22 (E)	31 (E)	20 (E)	20 (E)
Iron	25400	30200	17200*	29300	16000*	19700*
Lead	42	48	45*	25	23*	26*
Magnesium	5310	6230	6640	5470	4480	4990
Manganese	291	392	365*	854	658*	846*
Mercury	0.26 (N)	0.21 (N)	ND	ND (N)	1.0	ND
Nickel	43	48	28	37	23	25
Potassium	BDL	BDL	ND	BDL	ND	ND
Selenium	ND (N)	ND (E,N)	ND (N)	ND (N,E)	ND (N)	ND (N)
Silver	ND	ND	ND	ND	ND	ND
Sodium	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	BDL	ND	BDL	ND
Vanadium	26 (E)	30 (E)	BDL	28 (E)	BDL	BDL
Zinc	415	483	191*	125	91*	107*
Cyanide	ND	ND	ND	ND	ND	ND

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates parameter was detected at a concentration below the U.S.EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
E - Indicates a value estimated or not reported due to the presence of interference.
N - Indicates spike sample recovery is not within control limits.
S - Indicates value determined by Method of Standard Addition.
M - Indicates duplicate injection results exceed control limits.
* - Indicates duplicate analysis results exceed control limits.

TABLE 3-22

SURFICIAL SOIL GRAB SAMPLE RESULTS - VOLATILE ORGANIC COMPOUNDS
(All concentrations reported in µg/kg)

Volatile Compound	BL-SO-BLNK	BL-SO-30	BL-SO-31	BL-SO-32	BL-SO-33	BL-SO-34	BL-SO-35	BL-SO-36	BL-SO-37	BL-SO-38	BL-SO-39	BL-SO-40	BL-SO-41	BL-SO-42	BL-SO-43	BL-SO-44
Chloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	8.5(B)	42(B)	14(B)	12(B)	BDL(B)	7.4(B)	20(B)	12(B)	10(B)	18(B)	BDL(B)	8.8(B)	12(B)	12(B)	38(B)	16(B)
Acetone	150(B)	82(B)	14(B)	31(B)	BDL(B)	BDL(B)	ND	BDL(B)	29(B)	13(B)	BDL(B)	31(B)	BDL(B)	BDL(B)	56(B)	BDL(B)
Carbon Disulfide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vinyl Acetate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl Vinyl Ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

DATA REPORTING QUALIFIERS

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates that parameter was detected at a concentration below the U.S. EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

NOTE: Data from background samples SO-45 and SO-46 are provided in Table 3-27.

TABLE 3-23

SURFICIAL SOIL GRAB SAMPLE RESULTS - SEMIVOLATILE ORGANIC COMPOUNDS
(All concentrations reported in µg/kg)

Semivolatile Compound	BL-SO-BLNK	BL-SO-30	BL-SO-31	BL-SO-32	BL-SO-33	BL-SO-34	BL-SO-35	BL-SO-36	BL-SO-37	BL-SO-38	BL-SO-39	BL-SO-40	BL-SO-41	BL-SO-42	BL-SO-43	BL-SO-44
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzyl Alcohol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic Acid	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	BDL
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethyl Phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl Phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

(continued)

TABLE 3-23 (Continued)

Semivolatile Compound	BL-SO-BLNK	BL-SO-30	BL-SO-31	BL-SO-32	BL-SO-33	BL-SO-34	BL-SO-35	BL-SO-36	BL-SO-37	BL-SO-38	BL-SO-39	BL-SO-40	BL-SO-41	BL-SO-42	BL-SO-43	BL-SO-44
N-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Bromophenyl Phenyl ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	BDL	BDL	BDL	BDL	ND	BDL	BDL	BDL	BDL	6800	BDL	BDL	BDL	BDL	BDL
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	BDL
Di-n-butylphthalate	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND	BDL	BDL	ND	ND	ND
Fluoranthene	ND	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	9100	BDL	BDL	BDL	BDL	660
Pyrene	ND	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	11000	BDL	BDL	BDL	BDL	560
Butyl Benzyl Phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4300	BDL	BDL	BDL	BDL	BDL
bis(2-ethylhexyl) phthalate	BDL	ND	ND	ND	BDL	BDL	BDL	BDL	BDL	BDL	ND	BDL	BDL	BDL	BDL	BDL
Chrysene	ND	ND	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5200	BDL	BDL	BDL	BDL	BDL
Di-n-octyl Phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	BDL
Benzo(b)fluoranthene	ND	ND	BDL(II)	BDL(II)	BDL(II)	BDL(II)	ND	BDL(II)	BDL(II)	BDL(II)	8600(II)	BDL (II)	BDL(II)	470(II)	510(II)	960(II)
Benzo(k)fluoranthene	ND	ND	BDL(II)	BDL(II)	BDL(II)	BDL(II)	ND	BDL(II)	BDL(II)	BDL(II)	8600(II)	BDL(II)	BDL(II)	470(II)	510(II)	960(II)
Benzo(a)pyrene	ND	ND	BDL	BDL	BDL	BDL	ND	BDL	BDL	BDL	4300	BDL	BDL	BDL	BDL	BDL
Indeno(1,2,3-cd)pyrene	ND	ND	BDL	BDL	BDL	ND	ND	BDL	BDL	BDL	2600	BDL	BDL	BDL	BDL	BDL
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	BDL	BDL	BDL	ND	ND	BDL	BDL	BDL	3100	BDL	BDL	BDL	BDL	BDL

DATA REPORTING QUALIFIERS

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates that parameter was detected at a concentration below the U.S. EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.

II - Indicates isomers coeluded and were indistinguishable.

NOTE: Data from background samples SO-45 and SO-46 are provided in Table 3-28.

TABLE 3-24

SURFICIAL SOIL GRAB SAMPLE RESULTS - PESTICIDE/PCB COMPOUNDS
(All concentrations reported in µg/kg)

Pesticide/PCB Compound	BL-SO-BLNK	BL-SO-30	BL-SO-31	BL-SO-32	BL-SO-33	BL-SO-34	BL-SO-35	BL-SO-36	BL-SO-37	BL-S-38	BL-SO-39	BL-SO-40	BL-SO-41	BL-SO-42	BL-SO-43	BL-SO-44
alpha-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Linden	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endosulfan Sulfate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin Ketone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1016	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1221	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1232	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1242	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1248	ND	ND	1200	ND	ND	3600	350	380	350	ND	ND	700	1100	ND	ND	ND
AROCLOR-1254	ND	ND	ND	ND	300	ND	ND	ND	ND	ND	ND	ND	ND	240	ND	ND
AROCLOR-1260	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

DATA REPORTING QUALIFIERS

ND - Indicates compound was analyzed for but not detected.

NOTE: Data from background samples SO-45 and SO-46 are provided in Table 3-29.

TABLE 3-25

SURFICIAL SOIL GRAB SAMPLE RESULTS - DIOXIN
(All concentrations reported in µg/kg)

Compound	BL-SO-BLNK	BL-SO-30	BL-SO-31	BL-SO-32	BL-SO-33	BL-SO-34	BL-SO-35	BL-SO-36	BL-SO-37	BL-S-38	BL-SO-39	BL-SO-40	BL-SO-41	BL-SO-42	BL-SO-43	BL-SO-44
2,3,7,8-tetrachlorodi-benzo-p-dioxin (TCDD)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

DATA REPORTING QUALIFIERS

ND - Indicates compound was analyzed for but not detected.

NOTE: Data from background samples SO-45 and SO-46 are provided in Table 3-30.

TABLE 3-26

SURFICIAL SOIL GRAB SAMPLE RESULTS - INORGANIC ELEMENTS/CYANIDE
(All concentrations reported in mg/kg)

Inorganic Parameter	BL-SO-BLNK	BL-SO-30	BL-SO-31	BL-SO-32	BL-SO-33	BL-SO-34	BL-SO-35	BL-SO-36	BL-SO-37	BL-SO-38	BL-SO-39	BL-SO-40	BL-SO-41	BL-SO-42	BL-SO-43	BL-SO-44
Aluminum	15800	21100	20200	14500	19800	2400	20700	21700	18500	16000	9570	18200	25400	12800	11200	14400
Antimony	46(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)
Arsenic	5.6(N)	78(S,N)	86(S,N)	10(N)	8.1(N)	144(S,N)	ND(N)	153(S,N)	94(S,N)	19(N)	20(N)	103(S,N)	121(S,N)	13(N)	15(N)	102(S,N)
Barium	28	173	217	158	171	279	238	219	162	176	71	287	229	134	139	180
Beryllium	BDL	BDL	BDL	BDL	BDL	1.2	1.1	BDL	BDL	BDL	BDL	1.1	1.2	BDL	BDL	BDL
Cadmium	ND	1.7	1.7	1.3	1.9	2.4	2.3	2.5	2.1	BDL	ND	1.6	1.0	2.0	2.1	1.7
Calcium	BDL	15100	10300	21100	15000	7930	24000	11300	13300	9580	96300	15800	10600	24800	25200	27100
Chromium	5.8	25	26	18	26	25	25	28	24	20	9.9	22	28	25	21	27
Cobalt	BDL	BDL	15	12	15	34	14	18	16	15	7.9	15	16	BDL	12	12
Copper	7.1	36	37	32	38	46	52	45	42	37	22	55	35	33	37	39
Iron	4930	30100	33200	25800	31600	32900	35500	47800	36500	31900	17500	35400	38400	22400	24400	26600
Lead	38	92	35	77	101	104	179	120	106	85	80	147	100	85	92	155
Magnesium	BDL	8260	7070	7250	8940	5900	14000	7810	7680	6260	22900	7440	6720	10700	11300	11800
Manganese	89(N)	610(N)	368(N)	552(N)	560(N)	1290(N)	472(N)	540(N)	531(N)	486(N)	374(N)	745(N)	568(N)	436(N)	519(N)	567(N)
Mercury	ND	0.21	0.22	0.23	0.25	0.23	0.41	0.31	0.36	0.29	0.15	0.43	0.14	0.40	0.58	0.32
Nickel	5.3(E)	38(E)	41(E)	33(E)	41(E)	94(E)	43(E)	45(E)	40(E)	40(E)	20(E)	40(E)	39(E)	30(E)	30(E)	33(E)
Potassium	800	3460	2680	2120	2990	3270	3020	3060	2330	2330	1780	2710	4190	2230	1550	2090
Selenium	ND(N)	ND(N)	ND(N)	ND(N)	BDL(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	BDL(N)	ND(N)	ND(N)
Silver	ND(N)	ND(N)	ND(N)	ND(N)	0.47(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)
Sodium	BDL	ND	BDL	ND	BDL	BDL	BDL	BDL	ND	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Thallium	ND	0.49	ND	BDL	BDL	ND	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	8.8	57	55	39	51	64	54	55	43	42	25	52	71	35	28	35
Zinc	15(E)	154(E)	165(E)	132(E)	185(E)	265(E)	540(E)	219(E)	245(E)	149(E)	87(E)	234(E)	159(E)	153(E)	189(E)	211(E)
Cyanide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

DATA REPORTING QUALIFIERS

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates that parameter was detected at a concentration below the U.S. EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantification below this value is not considered accurate.
E - Indicates value estimated or not reported due to presence of interference.
N - Indicates spike sample recovery not within control limits.
S - Indicates value determined by Method of Standard Additions.

NOTE: Data from background samples SO-45 and SO-46 are provided in Table 3-31.

TABLE 3-27

SURFICIAL SHELBY TUBE SOIL SAMPLE RESULTS - VOLATILE ORGANIC COMPOUNDS
(All concentrations reported in µg/kg)

Volatile Compound	BL-SO-05T6	BL-SO-06T6	BL-SO-07T6	BL-SO-10T6	BL-SO-11T6	BL-SO-45T6 (background)	BL-SO-46T6 (background)
Chloromethane	ND	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	34(B)	49(B)	11(B)	150(B)	120(B)	BDL(B)	9.6(B)
Acetone	ND	17(B)	BDL(B)	18(B)	ND	BDL(B)	24(B)
Carbon Disulfide	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND
2-Butanone	ND	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	ND
Vinyl Acetate	ND	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	ND	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND
2-Chloroethyl Vinyl Ether	ND	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND	ND
2-Hexanone	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND
Ethyl Benzene	ND	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND	ND
Total Xylenes	ND	ND	ND	ND	ND	ND	ND

DATA REPORTING QUALIFIERS

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates that parameter was detected at a concentration below the U.S. EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantifications below this value is not considered accurate.
(on a dry weight basis) will be higher than those listed above.

B - Indicates compound was also detected in associated laboratory blank(s). Laboratory contamination is possible/probable.

TABLE 3-28

SHELBY TUBE SOIL SAMPLE RESULTS - SEMIVOLATILE ORGANIC COMPOUNDS
(All concentrations reported in µg/kg)

Semivolatile Compound	BL-SO-5T6	BL-SO-06T6	BL-SO-07T6	BL-SO-10T6	BL-SO-11T6	BL-SO-45T6 (background)	BL-SO-46T6 (background)
Phenol	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	ND	ND	ND	ND	ND	ND	ND
2-Chlorophenol	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
Benzyl Alcohol	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND
2-Methylphenol	ND	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	ND	ND
4-Methylphenol	ND	ND	ND	ND	ND	ND	ND
N-Nitroso-Dipropylamine	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND
2-Nitrophenol	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND
Benzoic Acid	ND	ND	ND	ND	ND	ND	ND
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND
4-Chloroaniline	ND	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	ND	ND	ND	ND	ND	ND	ND
2-Nitroaniline	ND	ND	ND	ND	ND	ND	ND
Dimethyl Phthalate	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND
3-Nitroaniline	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	ND	ND	ND	ND	ND	ND	ND
4-Nitrophenol	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND
4-Chlorophenyl Phenyl ether	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND
4-Nitroaniline	ND	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	ND	ND	ND	ND	ND	ND	ND

(continued)

TABLE 3-28 (Continued)

Semivolatile Compound	BL-SO-5T6	BL-SO-06T6	BL-SO-07T6	BL-SO-10T6	BL-SO-11T6	BL-SO-45T6 (background)	BL-SO-46T6 (background)
N-nitrosodiphenylamine	ND	ND	ND	ND	ND	ND	ND
4-Bromophenyl Phenyl ether	ND	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND
Pentachlorophenol	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	BDL	ND	ND	BDL	BDL	BDL	BDL
Anthracene	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	ND	ND	ND	ND	BDL	ND	ND
Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Butyl Benzyl Phthalate	ND	ND	ND	ND	ND	ND	ND
3,3'-Dichlorobenzidine	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	BDL	ND	BDL	BDL	BDL	BDL	BDL
bis(2-ethylhexyl) phthalate	BDL	BDL	ND	BDL	BDL	BDL	BDL
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Di-n-octyl Phthalate	ND	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	BDL	BDL(II)	BDL(II)	BDL(II)	460(II)	BDL(II)	BDL(II)
Benzo(k)fluoranthene	BDL	BDL(II)	BDL(II)	BDL(II)	460(II)	BDL(II)	BDL(II)
Benzo(a)pyrene	BDL	ND	ND	BDL	BDL	BDL	BDL
Indeno(1,2,3-cd)pyrene	ND	ND	ND	BDL	BDL	ND	BDL
Dibenz(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	BDL	BDL	ND	BDL

DATA REPORTING QUALIFIERS

ND - Indicates compound was analyzed for but not detected.

BDL - Indicates that parameter was detected at a concentration below the U.S. EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantifications below this value is not considered accurate.
(on a dry weight basis) will be higher than those listed above.

II - Indicates isomers coeluded and were indistinguishable.

TABLE 3-29

SURFICIAL SOIL SHELBY TUBE SAMPLE RESULTS - PESTICIDE/PCB COMPOUNDS
(All concentrations reported in µg/kg)

Pesticide/PCB Compound	BL-SO-05T6	BL-SO-06T6	BL-SO-07T6	BL-SO-10T6	BL-SO-11T6	BL-SO-45T6 (background)	BL-SO-46T6 (background)
alpha-BHC	ND	ND	ND	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND	22	ND	ND
delta-BHC	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindar	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND
Heptachlor Epoxide	ND	ND	ND	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	20	ND	27	ND	ND
4,4'-DDE	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND	ND	ND	ND
Endosulfan Sulfate	ND	ND	ND	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND	ND	ND
Endrin Ketone	ND	ND	ND	ND	ND	ND	ND
Chlordane	ND	ND	ND	ND	110	ND	ND
Toxaphene	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1016	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1221	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1232	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1242	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1248	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1254	ND	ND	ND	ND	ND	ND	ND
AROCLOR-1260	ND	ND	ND	ND	ND	ND	ND

DATA REPORTING QUALIFIERS

ND - Indicates compound was analyzed for but not detected.

TABLE 3-30

SURFICIAL SOIL SHELBY TUBE SAMPLE RESULTS - DIOXIN
(All concentrations reported in µg/kg)

Compound	BL-SO-05T6	BL-SO-06T6	BL-SO-07T6	BL-SO-10T6	BL-SO-11T6	BL-SO-45T6 (background)	BL-SO-46T6 (background)
2,3,7,8-tetrachlorodi-benzo-p-dioxin (TCDD)	ND	ND	ND	ND	ND	ND	ND

DATA REPORTING QUALIFIERS

ND - Indicates compound was analyzed for but not detected.

TABLE 3-31

SURFICIAL SOIL SHELBY TUBE SAMPLE RESULTS - INORGANIC ELEMENTS/CYANIDE
(All concentrations reported in mg/kg)

Inorganic Parameter	BL-SO-05T6	BL-SO-06T6	BL-SO-07T6	BL-SO-10T6	BL-SO-11T6	BL-SO-45T6 (background)	BL-SO-46T6 (background)
Aluminum	13800	13700	8690	13800	14100	9600	10400
Antimony	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)
Arsenic	12	20(S)	10	20(S)	169(S)	11	10
Barium	157	198	127	192	27	149	156
Beryllium	BDL	BDL	0.72	BDL	BDL	BDL	BDL
Cadmium	1.7	1.6	1.0	1.6	1.9	2.1	1.1
Calcium	18200	11400	16700	10600	22500	22000	15200
Chromium	22	17	13	19	28	22	17
Cobalt	14(E)	16(E)	11(E)	16(E)	14(E)	BDL(E)	13(E)
Copper	41(E)	37(E)	27(E)	37(E)	42(E)	34(E)	33(E)
Iron	30200	32500	22300	30900	29200	23100	25300
Lead	95(E)	84(E)	58(E)	79(E)	102(E)	74(E)	67(E)
Magnesium	8780	6600	8400	5980	10200	8340	5840
Manganese	375	767	521	749	589	552	716
Mercury	0.24(N)	0.13(N)	0.10(N)	0.14(N)	0.18(N)	0.31(N)	0.32(N)
Nickel	39(E)	40(E)	29(E)	41(E)	40(E)	34(E)	34(E)
Potassium	1620	1610	942	1450	1790	BDL	1300
Selenium	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(E,N)	ND(N)
Silver	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)	ND(N)
Sodium	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Thallium	ND	BDL	BDL	BDL	BDL	ND	BDL
Vanadium	32	34	21	35	34	22	23
Zinc	212(E)	206(E)	179(E)	256(E)	397(E)	220(E)	210(E)
Cyanide	ND	ND	ND	ND	ND	ND	ND

DATA REPORTING QUALIFIERS

ND - Indicates compound was analyzed for but not detected.
BDL - Indicates that parameter was detected at a concentration below the U.S. EPA Contract Laboratory Program, Contract Required Detection Limit (CRDL); quantifications below this value is not considered accurate.
(on a dry weight basis) will be higher than those listed above.
E - Indicates value estimated or not reported due to presence of interference.
N - Indicates spike sample recovery not within control limits.
S - Indicates value determined by Method of Standard Additions.

TABLE 3-32

CONCENTRATIONS OF VARIOUS INORGANIC ELEMENTS REPORTED IN OHIO SOILS
(All concentrations reported in mg/kg)

Inorganic Parameter	Average value - Pickaway Co. (OARDC)*	Average value - Central Ohio (USGS)**
Aluminum	NR	66000
Antimony	NR	NR
Arsenic	NR	14
Barium	NR	580
Beryllium	NR	1.4
Cadmium	0.2	NR
Calcium	NR	3900
Chromium	11	77
Cobalt	NR	20
Copper	20	25
Iron	NR	32500
Lead	17	31
Magnesium	NR	3300
Manganese	NR	933
Mercury	NR	0.18
Nickel	17	40
Potassium	NR	18000
Selenium	NR	0.51
Silver	NR	NR
Sodium	NR	7000
Thallium	NR	NR
Vanadium	NR	76
Zinc	74	81

NR - Indicates that element was not analyzed for during study.

NOTES:

* From "Background Levels of Heavy Metals in Ohio Farm Soils," Research Circular 275, Ohio State University, Ohio Agricultural Research and Development Center, 1983. Values represent average of data obtained for Pickaway County.

** From "Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States," by H. T. Shacklette and J. G. Boerngen, 1984. U.S.G.S. Professional Paper 1270, 1984. Values represent approximate average of five data points surrounding the Circleville area.

TABLE 3-33. BOWERS SITE VEGETATION SURVEY

Scientific Name	Common Name	Riparian	Field Border	Cropland	Berm Area
Abutilon theophrasti	Piemarker		G	G	G
Acer negundo	Boxelder	O,U	U		O,U
Acer rubrum	Red maple		U		O,U
Acer saccharinum	Silver maple	O,U,G	U	U	O,U,G
Achillea millefolium	Common yarrow	G	G		G
Aesculus octandra	Yellow buckeye	U			U
Ailanthus altissima	Ailanthus	U	U		U
Amaranthus retroflexus	Pigweed	G	G	G	
Ambrosia trifida	Giant ragweed	G	G	G	G
Andropogon virginicus	Broomsedge	G	G		G
Apios americana	Ground nut	G			
Arctium minus	Burdock	G	G	G	
Aristida longaspica	Three-awn grass	G			G
Aristida spp.	Wiregrass	G			G
Asclepias syriaca	Common milkweed	G	G	G	G
Asimina triloba	Pawpaw	U			U
Aster novae-angliae	New England aster	G	G	G	G
Bidens aristosa	Bidens	G	G		G
Bidens bipinnata	Beggars ticks	G	G	G	G
Boehmeria cylindrica	False nettle	G			G
Bromus secalinus	Cheatgrass	G		G	
Campsis radicans	Trumpet creeper	G			G
Capsella bursa-pastoris	Shepherd's purse	G	G		G
Celtis occidentalis	Hackberry	O,U	U		O,U
Centaurea maculosa	Spotted knapweed	G			G
Cercis canadensis	Redbud	U	U		U
Chenopodium album	Lambsquarter	G	G	G	G
Chrysanthemum leucanthe	Field daisy	G		G	G
Cichorium intybus	Chicory			G	G
Cirsium vulgare	Bull thistle				G
Convolvulus arvensis	Field bindweed	G	G	G	G
Convolvulus purpurea	Tall morning glory		G	G	

TABLE 3-33. BOWERS SITE VEGETATION SURVEY

Scientific Name	Common Name	Riparian	Field Border	Cropland	Berm Area
Convolvulus sepium	Hedge bindweed	G	G	G	
Coreopsis tinctoria	Coreopsis		G		
Cuscuta campestris	Field dodder		G	G	
Cyperus esculentus	Nutgrass	G			G
Cyperus rotundus	Northern nutsedge	G			G
Cyperus rotundus	Purple nutsedge	G			G
Dactylis glomerata	Orchardgrass	G	G	G	
Datura stramonium	Jimson weed	G	G	G	
Daucus carota	Queen Anne's lace	G		G	
Digitaria ischaemum	Crabgrass	G	G	G	
Dipsacus sylvestris	Teasel		G	G	G
Echinocloa crusgalli	Barnyardgrass	G			G
Echinocystis lobata	Wild cucumber	G	G	G	G
Eleusine indica	Goosegrass		G	G	
Erigeron annuus	Daisy fleabane	G	G	G	
Eupatorium dubitum	Joe-pye-weed	G	G		G
Eupatorium rugosum	White snakeroot	G			G
Euphorbia lathyris	Spurge	G	G	G	G
Festuca elatior	Meadow fescue	G	G	G	G
Fragaria virginiana	Wild strawberry	G			G
Gleditsia triacanthos	Honey locust	O,U	U		U
Helianthus annuus	Sunflower		G	G	
Hordeum vulgare	Wild barley	G			G
Hypericum perforatum	St John's wort	G	G		G
Kochia scoparia	Kochia	G			
Lactuca pulchella	Blue lettuce	G			G
Lactuca scariola	Wild lettuce	G	G		
Lamium amplexicaule	Henbit	G			G
Lepidium virginicum	Peppergrass	G	G	G	G
Ligustrum vulgare	Common privet	U			U
Lonicera japonica	Honeysuckle	G	G	G	G
Lonicera xylosteum	Bush honeysuckle	U			U

TABLE 3-33. BOWERS SITE VEGETATION SURVEY

Scientific Name	Common Name	Riparian	Field Border	Cropland	Berm Area
Maclura pomifera	Osage orange	U			U
Malus spp.	Wild apple				U
Malva neglecta	Cheeseweed	G	G	G	G
Medicago lupulina	Black medic				G
Menthat arvensis	Field mint	G	G		G
Morus rubra	Red mulberry	U	U		U
Oenothera biennis	Evening primrose				G
Panicum dichotomiflorum	Fall panicum	G	G	G	G
Parthenocissus quinquefol	Virginia creeper	G	G		G
Phlox divaricata	Wild sweet william				G
Phytolacca americana	Pokeweed	G			G
Pilea pumila	Clearweed	G	G		G
Plantago lanceolata	Buckhorn plantain	G			G
Plantago major	Broadleaf plantain	G			G
Platanus occidentalis	Sycamore	O,U	U		O,U
Poa annua	Annual bluegrass	G	G		G
Poa pratensis	Bluegrass	G	G	G	G
Poa pratensis	Kentucky bluegrass	G			G
Polygonum pensylvanicum	Smartweed	G	G	G	G
Populus deltoides	Cottonwood	O,U	U		O,U
Potentilla recta	Sulfur cinquefoil	G			G
Quercus rubra	Red oak				U
Rhus glabra	Smooth sumac				U
Rhus radicans	Poison ivy	G	G	G	G
Rosa carolina	Pasture rose	G			G
Rosa multiflora	Wild rose	G	G		G
Rudbeckia hirta	Black-eyed susan	G			
Rumex acetosella	Sheep sorrel	G	G	G	G
Rumex crispus	Curly dock	G			G
Salix interior	Sandbar willow	U	U	U	U
Setaria faberi	Giant foxtail	G	G	G	G
Setaria glauca	Small foxtail	G		G	

TABLE 3-33. BOWERS SITE VEGETATION SURVEY

Scientific Name	Common Name	Riparian	Field Border	Cropland	Berm Area
Setaria viridis	Green foxtail	G	G		G
Sida spinosa	Sida	G	G	G	
Solanum dulcamara	Bitter nightshade		G	G	
Solanum nigrum	Black nightshade	G	G	G	
Solidago canadensis	Showy goldenrod	G	G		G
Solidago canadensis	Goldenrod	G	G		G
Solidago gigantea	Tall goldenrod	G			G
Sonchus asper	Sow thistle	G		G	
Sonchus oleraceus	Sow thistle	G			G
Sorghum halepense	Johnsongrass	G	G	G	
Staphylea trifolia	Bladdernut	U			
Stellaria media	Chickweed		G	G	
Taraxacum officinale	Dandelion	G	G		G
Thlaspi arvense	Pennycress		G	G	
Tradescantia lanceolata	Spiderwort	G			G
Tragopogon pratensis	Goatsbeard	G	G		G
Ulmus americana	American elm	O,U	U		O,U
Ulmus rubra	Red elm	U			U
Urtica dioica	Stinging nettle	G			G
Verbena stricta	Hoary vervain	G	G		G
Vernonia altissima	Ironweed	G	G		G
Viola palmata	Woods violet	G			G
Vitis aestivalis	Summer grape	G	G		G
Vitis labrusca	Fox grape	G	G		G
Xanthium spinosum	Cocklebur	G	G	G	G
Xanthium strumarium	Cocklebur	G	G	G	G

NOTE:
O = Overstory stratum
U = Understory stratum
G = Ground cover stratum

TABLE 3-34. MAMMALS OBSERVED AT OR WITH RANGES INCLUDING, THE BOWERS LANDFILL SITE

Scientific Name	Common Name	Riparian	Field Border	Cropland	Berm Area
Didelphis marsupialis virginicus	Opossum	X	X	-	X
Marmota monax monax	Woodchuck	X	-	-	X
Mephitis mephitis	Skunk	X	-	-	-
Microtus pennsylvanicus	Meadow vole	-	X	X	X
Mus musculus	House mouse	X	-	-	X
Odocoileus virginiana macroura	White-tailed deer	X	-	-	-
Ondatra zibethicus	Muskrat	X	X	-	-
Paromyscus leucopus noveboracensis	White-footed mouse	-	X	X	X
Procyon lotor lotor	Raccoon	X	X	X	X
Scalopus aquaticus machrinoides	Eastern mole	X	-	-	X
Sciurus carolinensis carolinensis	Grey squirrel	X	X	-	X
Sciurus niger rufiventer	Fox squirrel	X	-	-	X
Sylvilagus floridanus mearnsii	Eastern cottontail rabbit	X	X	X	X
Tamias striatus fisheri	Chipmunk	X	-	-	X
Vulpes vulpes fluva	Red fox	X	X	-	X

Note: Species nomenclature follows Jones, Carter, and Genoways, 1973.
Observations include tracks, scat, sign, nests, dens, or burrows.

TABLE 3-35

TERRESTRIAL AMPHIBIAN FAUNA KNOWN TO EXIST IN THE SCIOTO RIVER BASIN

American toad	northern leopard frog
Blanchard's cricket frog	northern red salamander
bullfrog	northern two-lined salamander
cave salamander	Ohio spring salamander
four-toed salamander	pickerel frog
Foweler's toad	ravine salamander
gray treefrog	red-back salamander
green frog	red-spotted newt
Jefferson salamander	slimy salamander
Kentucky spring salamander	small-mouthed salamander
long-tailed salamander	spotted salamander
marbled salamander	spring peeper
midland mud salamander	tiger salamander
mountain chorus frog	western chorus frog
northern dusky salamander	wood frog

TABLE 3-36

LIST OF BIRDS (81 TAXONS) KNOWN TO NEST THROUGHOUT THE CENTRAL OHIO REGION WHICH INCLUDES THE BOWERS SITE
(listed alphabetically by common name)

alder flycatcher[1]
American goldfinch[1]
American woodcock
Baltimore oriole[1]
barn owl[1,3]
barn swallow
barred owl
belted kingfisher
black-billed cuckoo
blue-gray gnatcatcher[3]
blue jay
blue-winged warbler[1,3]
bobwhite (quail)
brown-headed cowbird
brown thrasher
cardinal
Carolina chickadee[3]
Carolina wren
catbird
cedar waxwing
cerulean warbler[1,3]
chimney swift
chipping sparrow[3]
common crow
common grackle
common nighthawk
Cooper's hawk[1,3]
downy woodpecker
eastern bluebird[1]
eastern kingbird
eastern meadowlark
eastern phoebe
eastern wood pewee
field sparrow
grasshopper sparrow[1]
great crested flycatcher
great horned owl
green heron
hairy woodpecker
Henslow's sparrow[2]
horned lark
house sparrow
house wren[2]
indigo bunting
killdeer
Louisiana waterthrust[1,3]
mockingbird[1]
mourning dove
orchard oriole[1]
ovenbird[3]
purple martin
red-bellied woodpecker[1,3]
red-eyed vireo
red-headed woodpecker
red-shouldered hawk[2]
red-tailed hawk
red-winged blackbird
robin
rock dove
rough-winged swallow[1]
ruby-throated hummingbird[3]
rufous-sided towhee
scarlet tanager[1,3]
screech owl
song sparrow
sparrow hawk (kestrel)
spotted sandpiper
starling
tree swallow[1,2]
tufted titmouse
turkey vulture[3]
vesper sparrow
warbling vireo[1,3]
white-breasted nuthatch
wood duck
yellow-billed cuckoo
yellow-breasted chat[3]
yellow-shafted flicker
yellowthroat
yellow-throated vireo[2]
yellow warbler

1 local where appropriate habitat exists
2 more numerous in northern third of Central Ohio region
3 more numerous in southern third of Central Ohio region

Sources: Chapman, 1937; Hicks, 1935; Smith et al., 1973, Trautman and Trautman, 1968.

TABLE 3-37
AQUATIC SPECIES KNOWN TO OCCUR IN CENTRAL OHIO

Petromyzontidae
- northern brook lamprey††
- Ohio brook lamprey
- Ohio lamprey††
- silver lamprey††

Polyodontidae
- paddlefish††

Acipenseridea
- lake sturgeon††

Lepisosteidae
- longnose gar
- shortnose gar††

Amiidae
- bowfin

Hiodontidae
- goldeye
- mooneye††

Clupeidae
- eastern gizzardshad
- skipjack herring

Umbridae
- central mudminnow

Escidae
- central redfin pickerel
- Ohio muskellunge

Catostomidae
- bigmouth buffalofish
- black buffalofish
- black redhorse
- blue sucker††
- central quillback carpsucker
- common white sucker
- golden redhorse
- highfin carpsucker
- hog sucker
- nothern river carpsucker
- Ohio redhorse
- river redhorse††
- silver redhorse
- smallmouth buffalofish
- spotted sucker
- western creek chubsucker
- western lake chubsucker††

Cyprinidae
- bigeye shiner††
- blacknose shiner††
- bluntnose minnow
- carp
- central common shiner
- channel mimic shiner
- common emerald shiner
- eastern gravel chub
- ghost shiner††
- goldenshiner
- goldfish
- hornyhead chub
- northeastern sand shiner
- northern bigeye chub
- northern bullhead minnow
- northern common shiner
- northern creek chub
- northern fathead minnow
- northern mimic shiner
- northern redfin shiner
- Ohio rosefin shiner
- Ohio speckled chub
- Ohio spotted chub
- Ohio stoneroller minnow
- pugnose minnow††
- redside dace
- river chub
- river shiner
- rosyface shiner
- rosyside (=rosy) dace††
- silver chub††
- silver shiner
- silverjaw minnow
- southern redbelly dace
- spotfin shiner
- steelcolor shiner
- suckermouth minnow
- western blacknose dace

Ictaluridae
- black bullhead
- brindled madtom
- brown bullhead
- channel catfish
- flathead catfish
- mountain madtom††
- northern madtom††
- Scioto madtom†,††
- stonecat madtom
- tadpole madtom
- yellow bullhead

Anguillidae
- American eel

TABLE 3-37 (Continued)

Cyprinodontidae
- blackstripe topminnow

Percopsidae
- troutperch

Atherinidae
- brook silversides

Serranidae
- white base

Centrarchidae
- black crappie
- central longear sunfish
- green sunfish
- northern bluegill sunfish
- northern largemouth blackbass
- northern rockbass
- northern smallmouth blackbass
- northern spotted blackbass
- orangespotted sunfish
- pumpkin sunfish
- redear sunfish
- warmouth sunfish
- white crappie

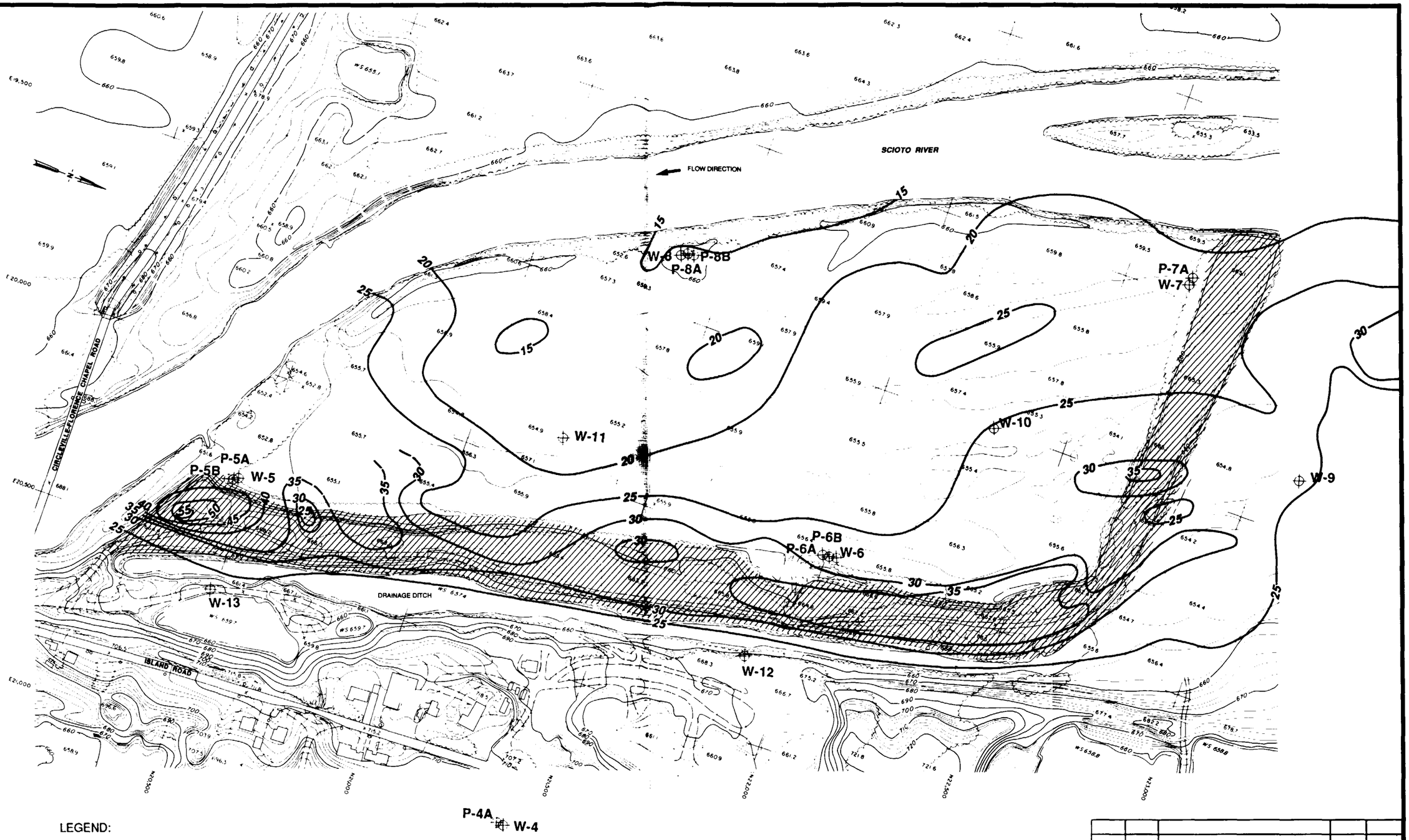
Percidae
- barred fantail darter
- blackside darter
- bluebreast darter
- central johnny darter
- eastern banded darter
- eastern sand darter††
- greenside darter
- least darter
- northern dusky darter
- northern orangethroat darter
- Ohio logperch darter
- rainbow darter
- river darter††
- sauger
- slenderhead darter††
- spotter darter††
- Tippecanoe darter††
- variegated darter
- yellow perch
- yellow walleye

Sciaenidae
- freshwater drum

Cottidae
- central redfin scuplin

† species officially declared an endangered species by the Fish and Wildlife Service, United States Department of the Interior (U.S. Dept. Interior, 1973 and 1975).

†† species officially declared an endangered species in Ohio by the Ohio Division of Wildlife (Ohio Division of Wildlife, 1976).



LEGEND:

EXISTING LANDFILL

W-11 SUBSURFACE BORING/MONITORING WELL LOCATION AND CORRESPONDING IDENTIFICATION NUMBER

—20— ISO-CONDUCTIVITY LINE (MMHO/M)

0 300
SCALE IN FEET

CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984

REV	DATE	DESCRIPTION	DR BY	APP BY
1	7/13/87	Reduce Scale		ML

PROJECT NO. 850-32-17

DES BY
DR BY
CHK BY
APP BY

BOWERS LANDFILL
CIRCLEVILLE, OHIO

Dames & Moore

SHEET TITLE:
EM Survey Results 10 Meter Coil Spacing

SHEET ___ OF ___

DRAWING NO:
3-2

SCIOTO RIVER

FLOW DIRECTION

CIRCLEVILLE-FLORENCE CHAPEL ROAD

DRAINAGE DITCH

ISLAND ROAD

C' D J W-8 P-8B P-8A K L M E P-7A W-7 F C I' H' W-11 W-10 M' W-9 P-5A P-5B W-5 G B D' A H I P-6B P-6A W-6 B' L' W-13 J' E' A' F' K' G' W-12 P-4A W-4

LEGEND:

EXISTING LANDFILL

W-11 SUBSURFACE BORING/MONITORING WELL LOCATION AND CORRESPONDING IDENTIFICATION NUMBER

D D' EM SURVEY TRAVERSE LINES, AS REFERRED TO IN PROFILE DRAWINGS AND DATA TABLES. DASHED WHERE DATA ARE MISSING.

0 300
SCALE IN FEET

CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984

REV	DATE	DESCRIPTION	DR BY	APP BY

PROJECT NO. 850-32-17

DES BY
DR BY
CHK BY
APP BY

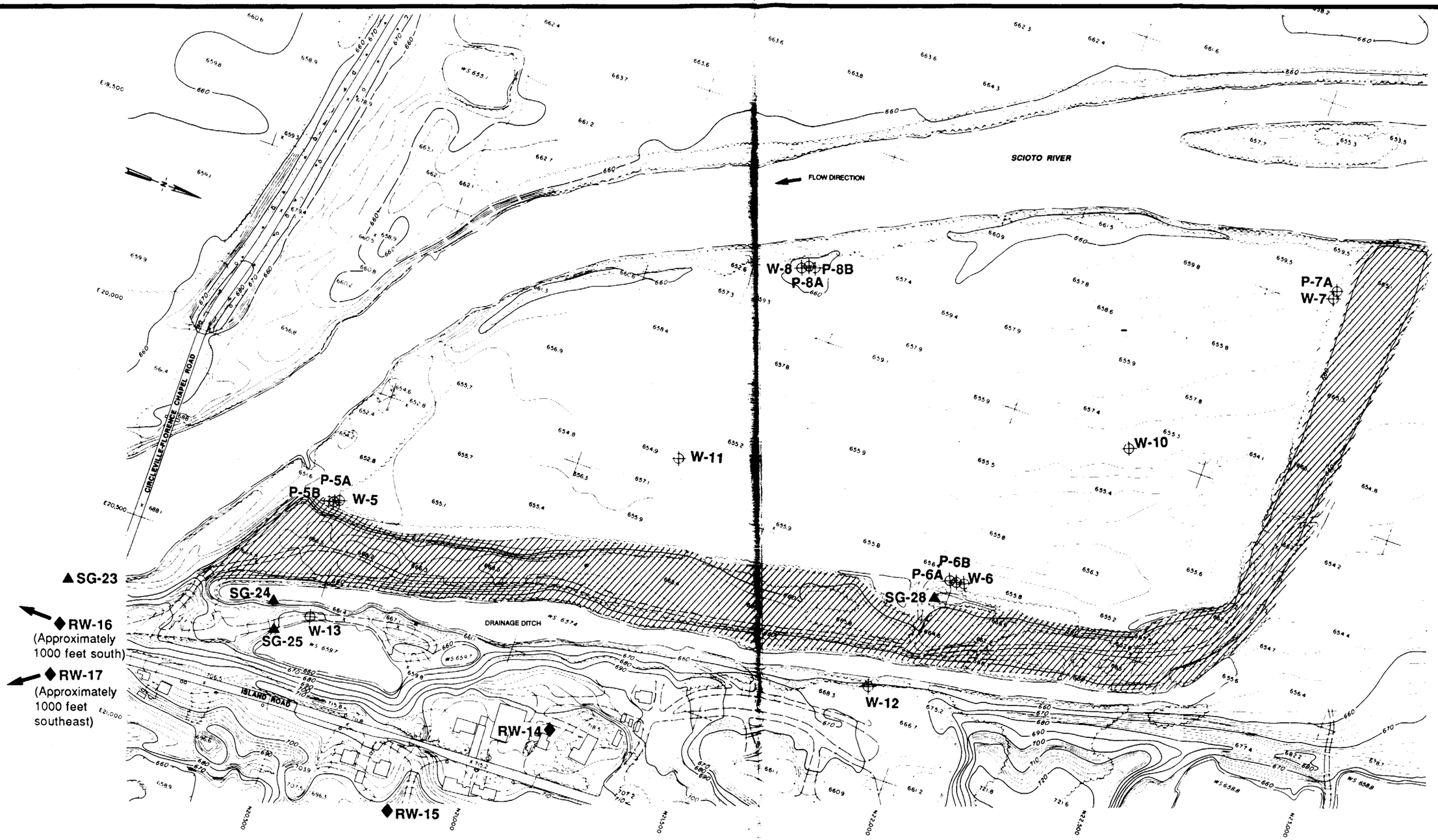
BOWERS LANDFILL
CIRCLEVILLE, OHIO

Dames & Moore

SHEET TITLE:
EM Survey Profile Line Locations

SHEET ___ OF ___

DRAWING NO:
3-1



LEGEND:

▨	EXISTING LANDFILL
⊕ W-11	SUBSURFACE BORING/MONITORING WELL LOCATION AND CORRESPONDING IDENTIFICATION NUMBER
◆ RW-14	RESIDENTIAL WELL SAMPLE LOCATION AND CORRESPONDING IDENTIFICATION NUMBER
▲ SG-28	SURFACE WATER STAFF GAGE LOCATION AND CORRESPONDING IDENTIFICATION NUMBER

0 300
SCALE IN FEET

CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984

REV	DATE	DESCRIPTION	DR BY	APP BY

SCALE: 1" = 250'

PROJECT NO. 850-32-17

DES BY	ML	4-2-87
DR BY	JB	4-26-87
CHK BY	ML	5-11-87
APP BY		

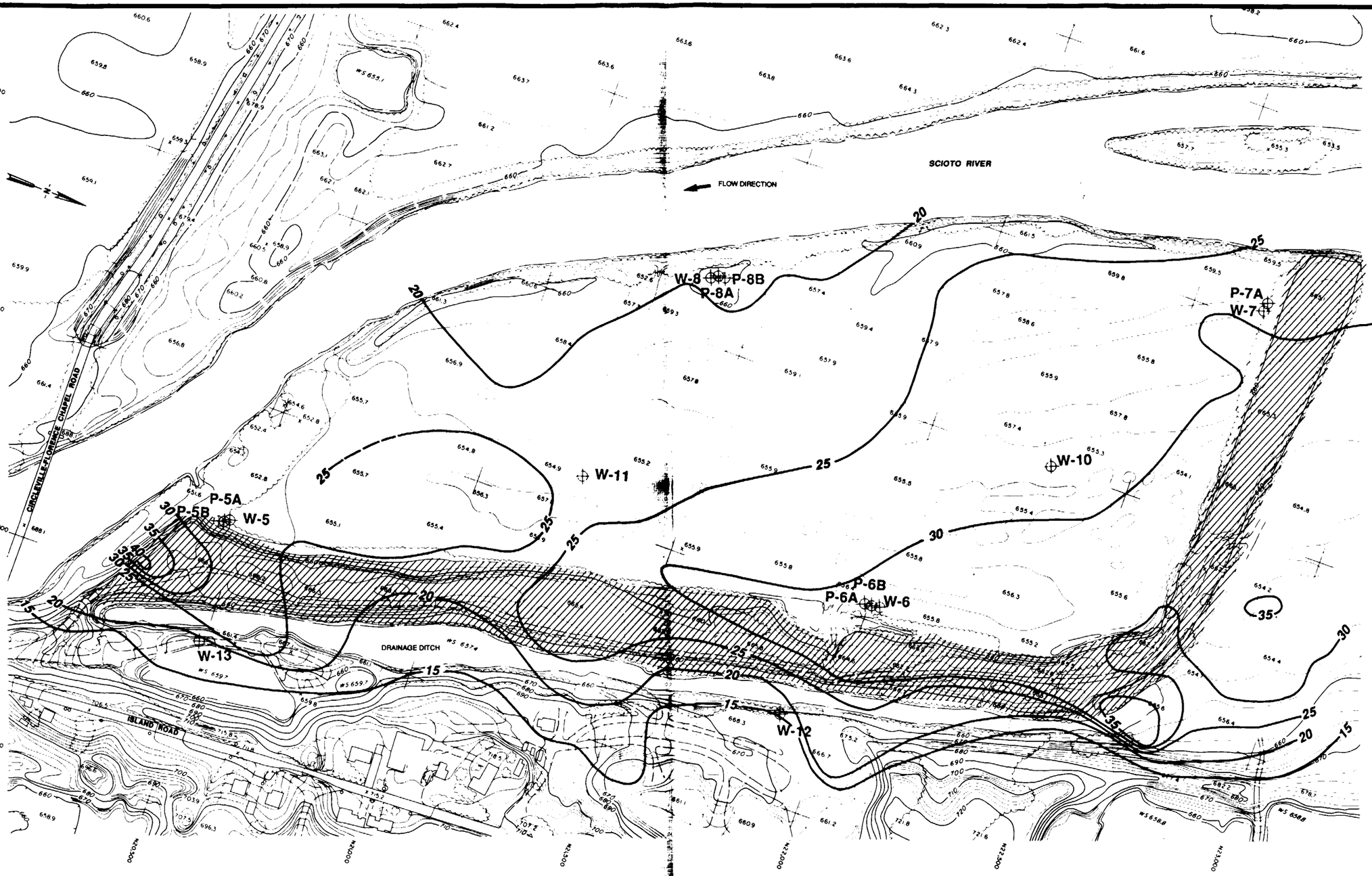
BOWERS LANDFILL
CIRCLEVILLE, OHIO

Dames & Moore

SHEET TITLE:
Monitoring Well and Staff Gage Locations

SHEET ___ OF ___

DRAWING NO:
3-5



LEGEND:

EXISTING LANDFILL

W-11 SUBSURFACE BORING/MONITORING WELL LOCATION AND CORRESPONDING IDENTIFICATION NUMBER

—20— ISO-CONDUCTIVITY LINE (MMHO/M)

0 300
SCALE IN FEET

CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984

REV	DATE	DESCRIPTION	DR BY	APP BY
1	7/13/87	Reduce Scale		ML

PROJECT NO. 850-32-17

DES BY
DR BY
CHK BY
APP BY

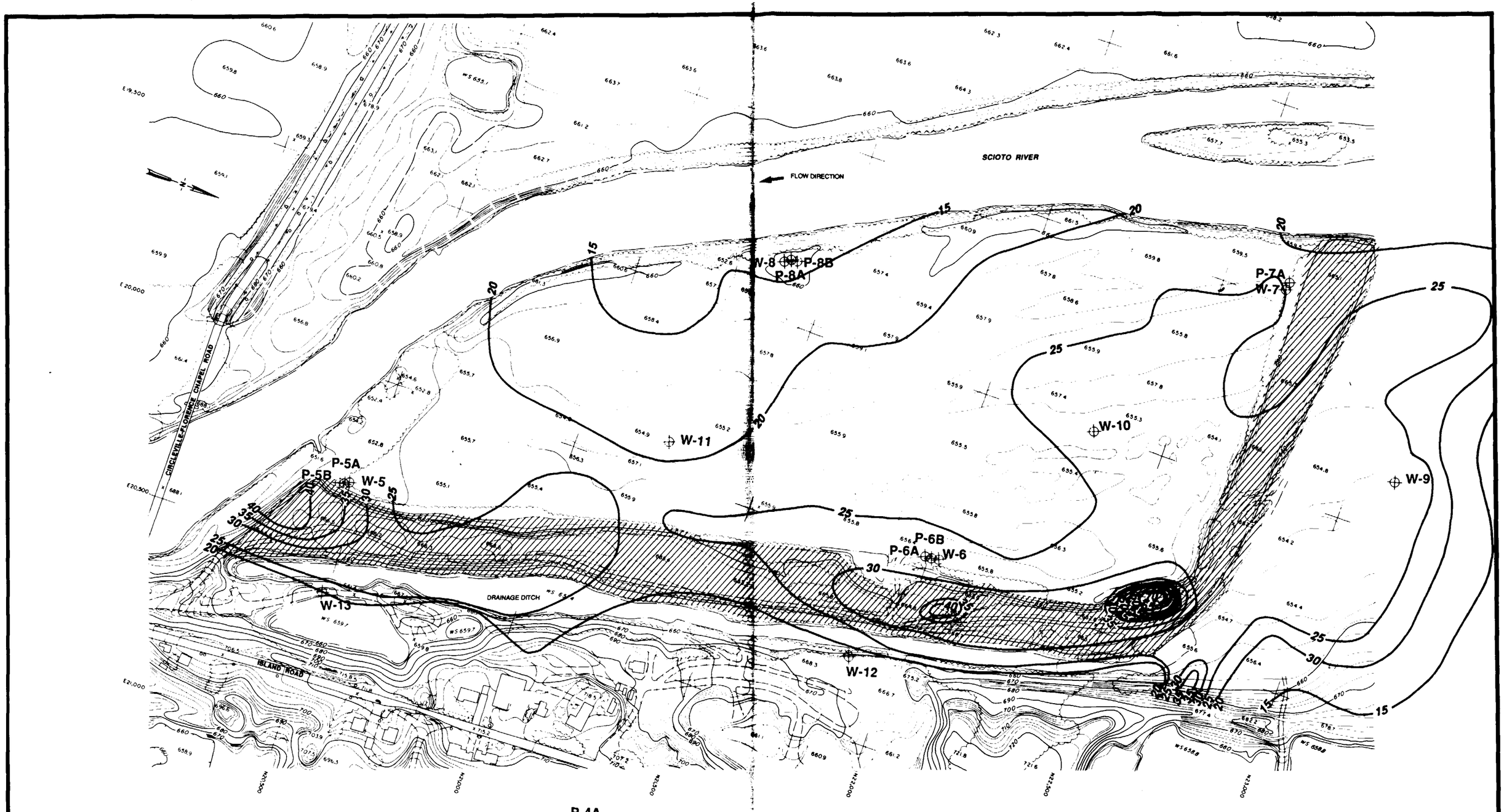
BOWERS LANDFILL
CIRCLEVILLE, OHIO

Dames & Moore

SHEET TITLE:
EM Survey Results 40 Meter Coil Spacing

SHEET ___ OF ___

DRAWING NO:
3-4



LEGEND:

EXISTING LANDFILL

W-11 SUBSURFACE BORING/MONITORING WELL LOCATION AND CORRESPONDING IDENTIFICATION NUMBER

—20— ISO-CONDUCTIVITY LINE (MMHO/M)

0 300
SCALE IN FEET

CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984

REV	DATE	DESCRIPTION	DR BY	APP BY
1	7/13/87	Reduce Scale		ML

PROJECT NO. 850-32-17

DES BY
DR BY
CHK BY
APP BY

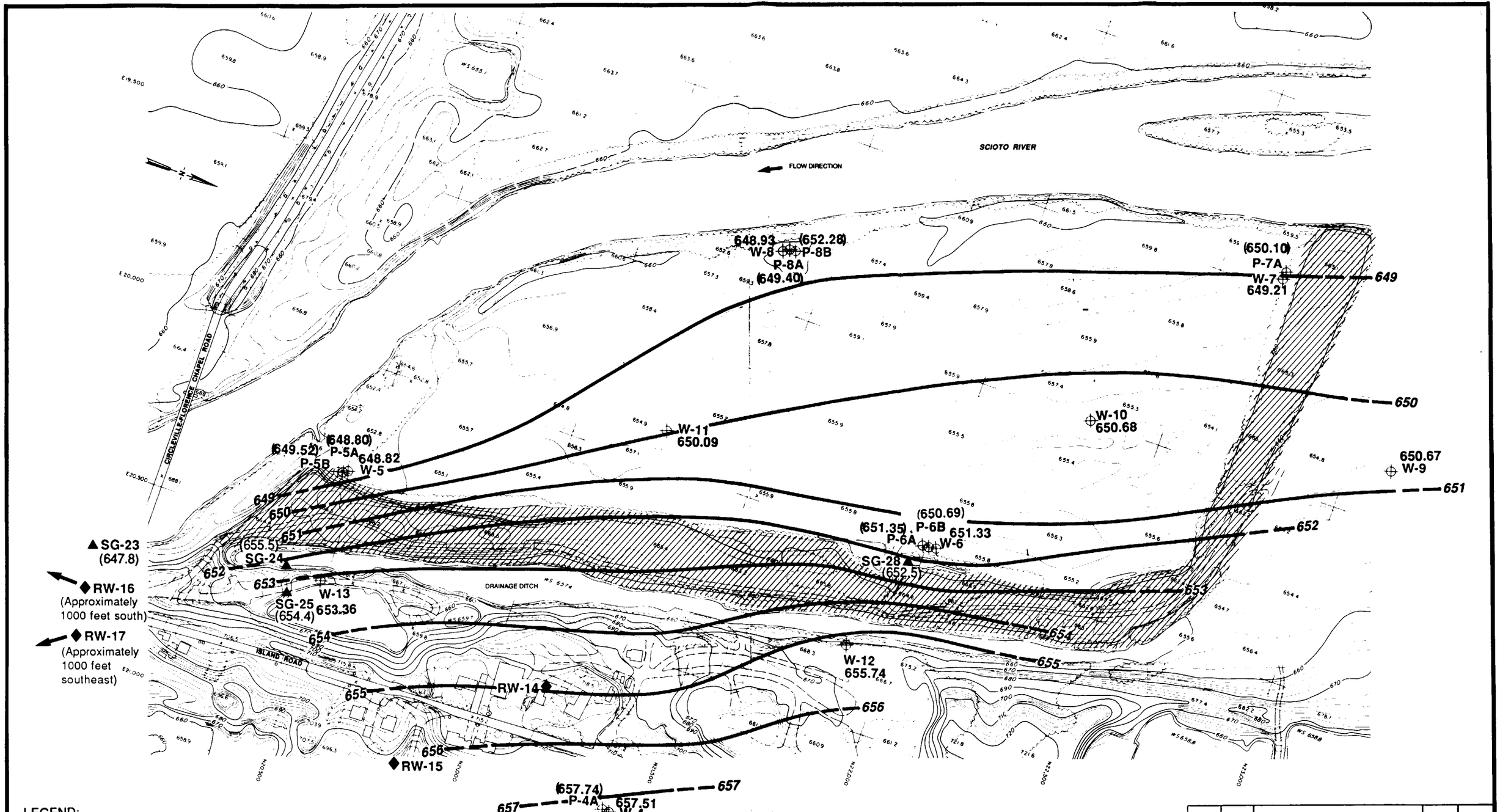
BOWERS LANDFILL
CIRCLEVILLE, OHIO

Dames & Moore

SHEET TITLE:
EM Survey Results 20 Meter Coil Spacing

SHEET ___ OF ___

DRAWING NO:
3-3



LEGEND:

▨	EXISTING LANDFILL
⊕ W-11	SUBSURFACE BORING/MONITORING WELL LOCATION AND CORRESPONDING IDENTIFICATION NUMBER
◆ RW-14	RESIDENTIAL WELL SAMPLE LOCATION AND CORRESPONDING IDENTIFICATION NUMBER
▲ SG-28	SURFACE WATER STAFF GAGE LOCATION AND CORRESPONDING IDENTIFICATION NUMBER
650.54 (657.41)	GROUND WATER OR SURFACE WATER ELEVATION (MEAN SEA LEVEL) MEASURED 3/12/87. BRACKETED VALUES NOT USED IN GENERATION OF PIEZOMETRIC SURFACE
654	SHALLOW GROUND WATER ZONE PIEZOMETRIC SURFACE CONTOUR

CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984

REV	DATE	DESCRIPTION	DR BY	APP BY

SCALE: 1" = 250'		PROJECT NO. 850-32-17
DES BY	ML	4-17-87
DR BY	JB	4-11-87
CHK BY	RP	5-11-87
APP BY	ML	5-12-87

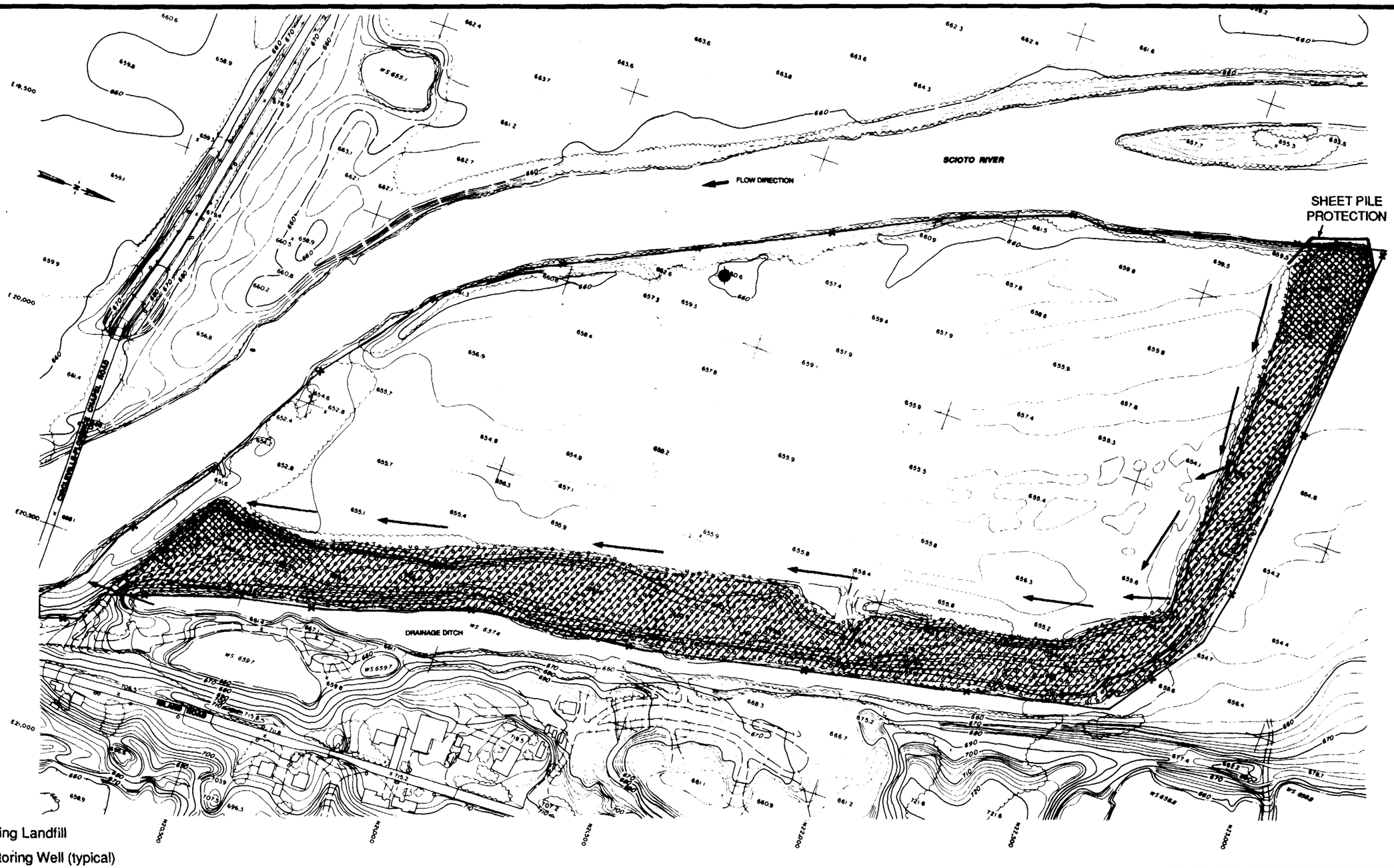
BOWERS LANDFILL
CIRCLEVILLE, OHIO

Dames & Moore

SHEET TITLE:
Ground Water and Surface Water Elevation Information 3/12/87

SHEET ___ OF ___

DRAWING NO: 3-6



LEGEND:

- Existing Landfill
- Monitoring Well (typical)
- Perimeter Fence
- Rip-Rap
- Synthetic Membrane Cap Over Landfill with Gas Venting System and Leachate Collection System
- Drainage Improvement

SITE ALTERNATIVE 7:

- Ground Water Monitoring
- Deed and Site Restrictions
- Management of Surface Debris
- Erosion Control and Drainage Improvements
- Install Gas Venting System
- Install Leachate Collection System
- Construct Synthetic Membrane Cap Over Landfill

0 300
SCALE IN FEET

CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984

REV	DATE	DESCRIPTION	DR BY	APP BY

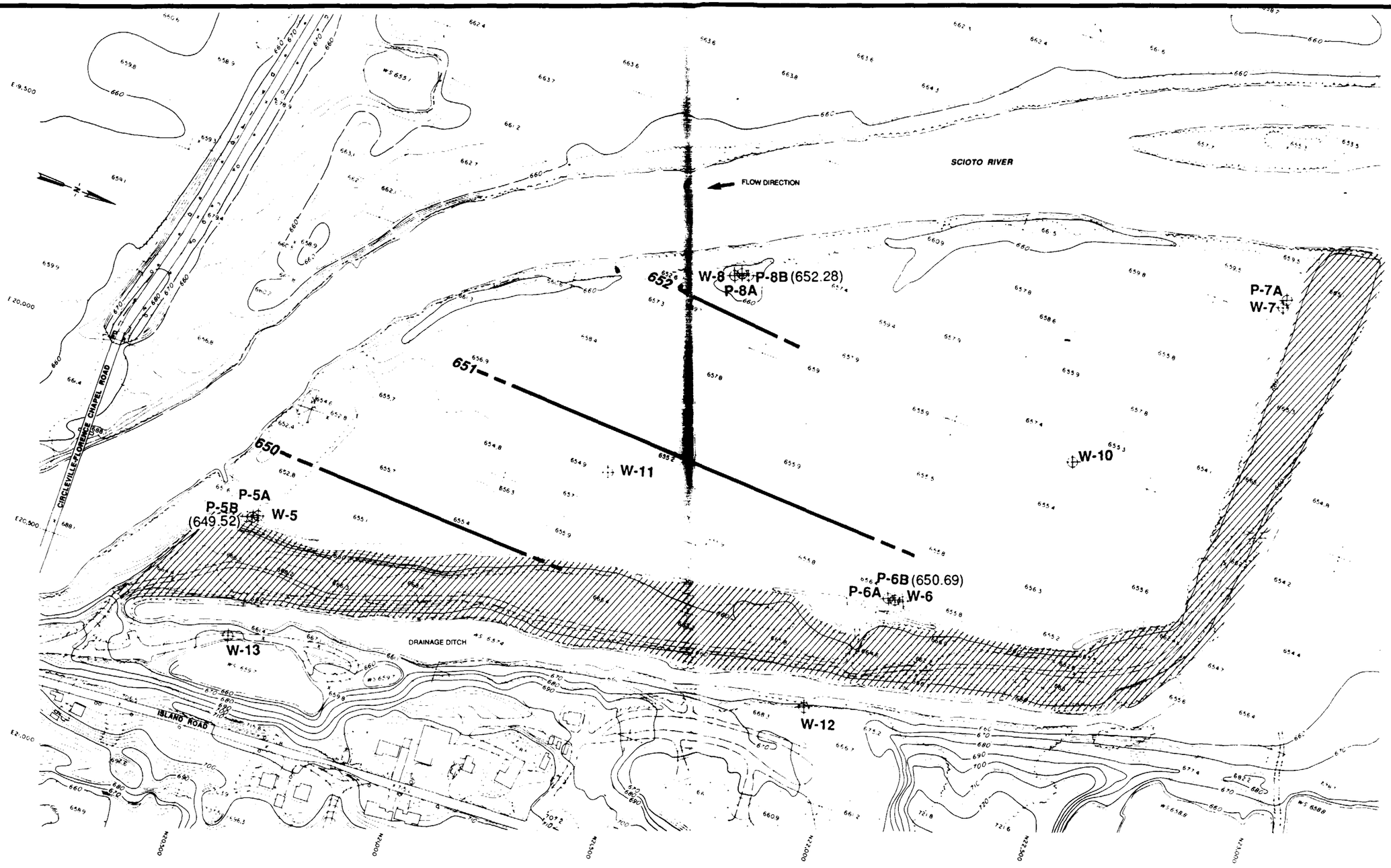
PROJECT NO. 850-32-17

DES BY		
DR BY		
CHK BY		
APP BY		

BOWERS LANDFILL
CIRCLEVILLE, OHIO
Dames & Moore

SHEET TITLE: SITE ALTERNATIVE 8

SHEET OF
DRAWING NO: 14



LEGEND:

▨	EXISTING LANDFILL
⊕ W-11	SUBSURFACE BORING/MONITORING WELL LOCATION AND CORRESPONDING IDENTIFICATION NUMBER
(649.52)	PIEZOMETRIC SURFACE ELEVATION (MEAN SEA LEVEL) MEASURED 3/12/87.
—650—	PIEZOMETRIC SURFACE CONTOUR

0 300
SCALE IN FEET

CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984

REV	DATE	DESCRIPTION	DR BY	APP BY

PROJECT NO. 850-32-17

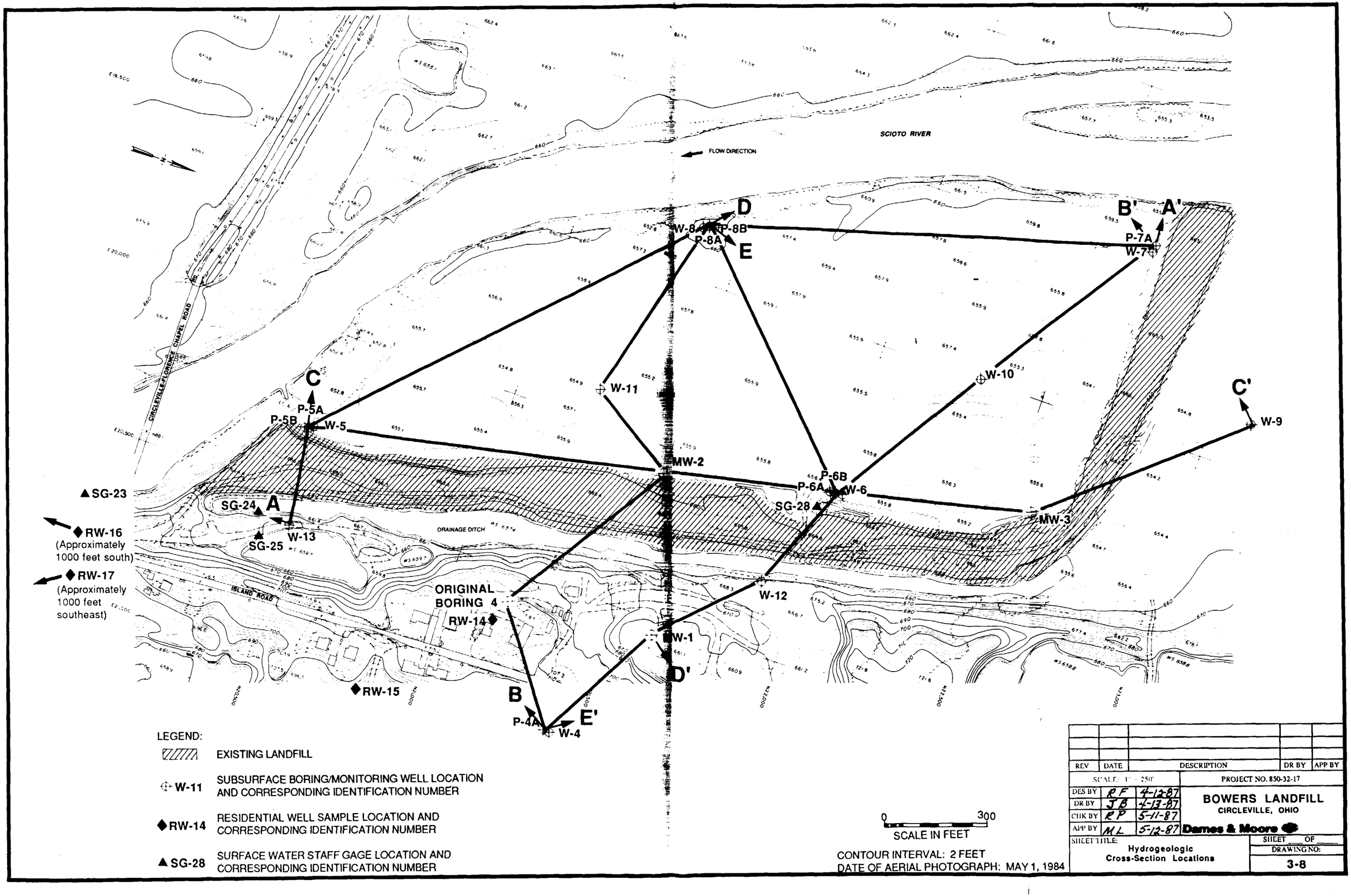
DES BY
DR BY
CHK BY
APP BY

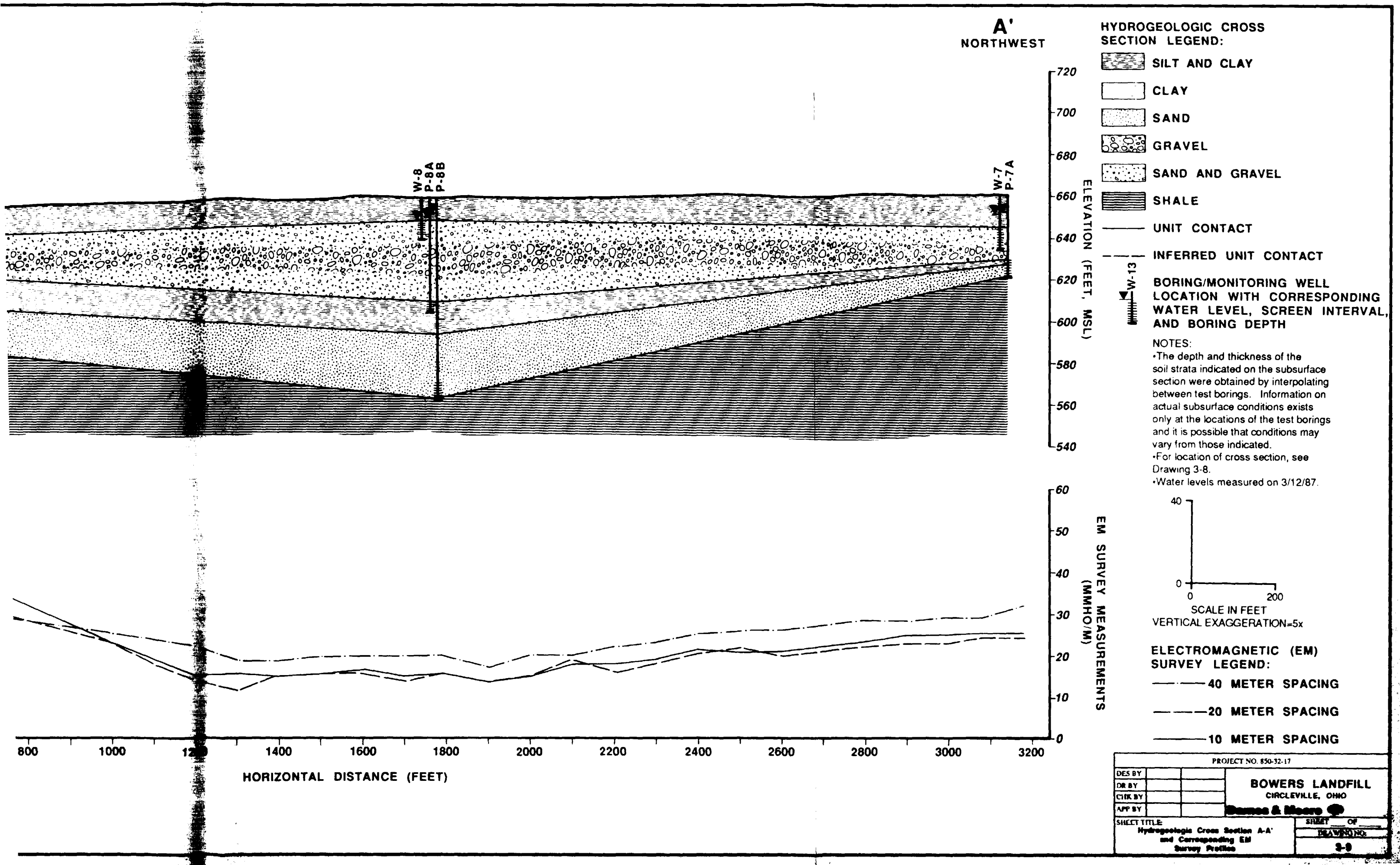
BOWERS LANDFILL
CIRCLEVILLE, OHIO

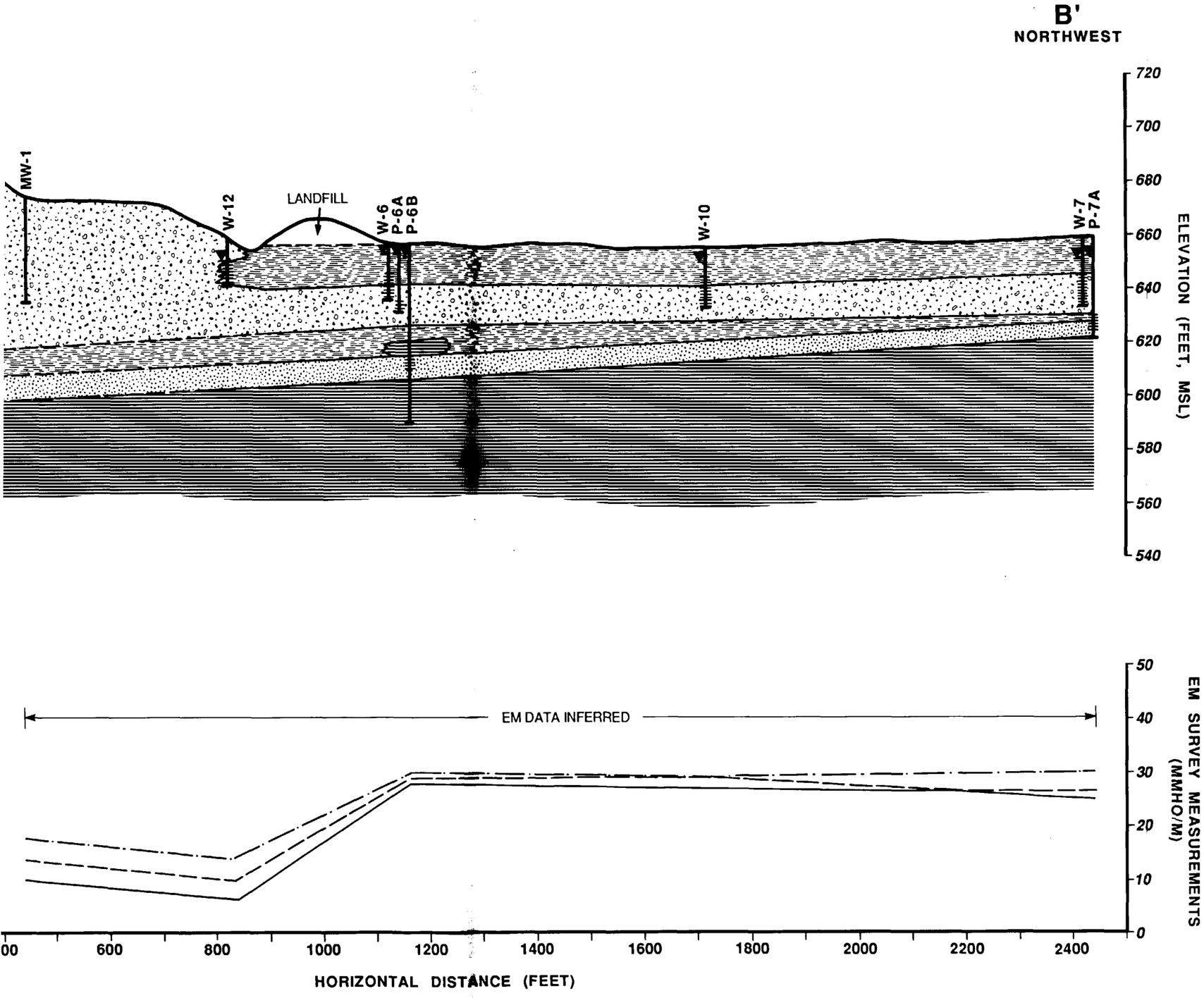
Dames & Moore

SHEET TITLE:
Lower Aquifer Piezometric Surface 3/12/87

SHEET ___ OF ___
DRAWING NO:
3-7


SCIOTO RIVER
FLOW DIRECTION
CIRCLEVILLE-FLORENCE CHAPEL ROAD
ISLAND ROAD
DRAINAGE DITCH
A
A'
B
B'
C
C'
D
D'
E
E'
W-8
P-8B
P-8A
P-7A
W-7
W-11
W-10
W-9
P-5A
P-5B
W-5
MW-2
P-6B
P-6A
W-6
SG-28
MW-3
SG-23
SG-24
SG-25
W-13
RW-16
(Approximately 1000 feet south)
RW-17
(Approximately 1000 feet southeast)
ORIGINAL BORING 4
RW-14
W-12
MW-1
RW-15
P-4A
W-4
LEGEND:
EXISTING LANDFILL
W-11 SUBSURFACE BORING/MONITORING WELL LOCATION AND CORRESPONDING IDENTIFICATION NUMBER
RW-14 RESIDENTIAL WELL SAMPLE LOCATION AND CORRESPONDING IDENTIFICATION NUMBER
SG-28 SURFACE WATER STAFF GAGE LOCATION AND CORRESPONDING IDENTIFICATION NUMBER
0 300
SCALE IN FEET
CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984
REV DATE DESCRIPTION DR BY APP BY
SCALE: 1" = 250'
PROJECT NO. 850-32-17
DES BY RF 4-12-87
DR BY JB 4-13-87
CHK BY RP 5-11-87
APP BY ML 5-12-87
BOWERS LANDFILL
CIRCLEVILLE, OHIO
Dames & Moore
SHEET TITLE:
Hydrogeologic Cross-Section Locations
SHEET OF
DRAWING NO:
3-8


A'
NORTHWEST
W-8
P-8A
P-8B
W-7
P-7A
720
700
680
660
640
620
600
580
560
540
ELEVATION (FEET, MSL)
60
50
40
30
20
10
0
EM SURVEY MEASUREMENTS (MMHO/M)
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
HORIZONTAL DISTANCE (FEET)
HYDROGEOLOGIC CROSS SECTION LEGEND:
SILT AND CLAY
CLAY
SAND
GRAVEL
SAND AND GRAVEL
SHALE
UNIT CONTACT
INFERRED UNIT CONTACT
W-13
BORING/MONITORING WELL LOCATION WITH CORRESPONDING WATER LEVEL, SCREEN INTERVAL, AND BORING DEPTH
NOTES:
•The depth and thickness of the soil strata indicated on the subsurface section were obtained by interpolating between test borings. Information on actual subsurface conditions exists only at the locations of the test borings and it is possible that conditions may vary from those indicated.
•For location of cross section, see Drawing 3-8.
•Water levels measured on 3/12/87.
40
0
0
200
SCALE IN FEET
VERTICAL EXAGGERATION=5x
ELECTROMAGNETIC (EM) SURVEY LEGEND:
40 METER SPACING
20 METER SPACING
10 METER SPACING
PROJECT NO. 850-32-17
DES BY
DR BY
CHK BY
APP BY
BOWERS LANDFILL
CIRCLEVILLE, OHIO
Dames & Moore
SHEET TITLE:
Hydrogeologic Cross Section A-A' and Corresponding EM Survey Profiles
SHEET ___ OF ___
DRAWING NO.
3-9



HYDROGEOLOGIC CROSS SECTION LEGEND:

- SILT AND CLAY
- CLAY
- SAND
- SAND AND GRAVEL
- SHALE
- UNIT CONTACT
- INFERRED UNIT CONTACT
- W-10 BORING/MONITORING WELL LOCATION WITH CORRESPONDING WATER LEVEL, SCREEN INTERVAL, AND BORING DEPTH

NOTES:

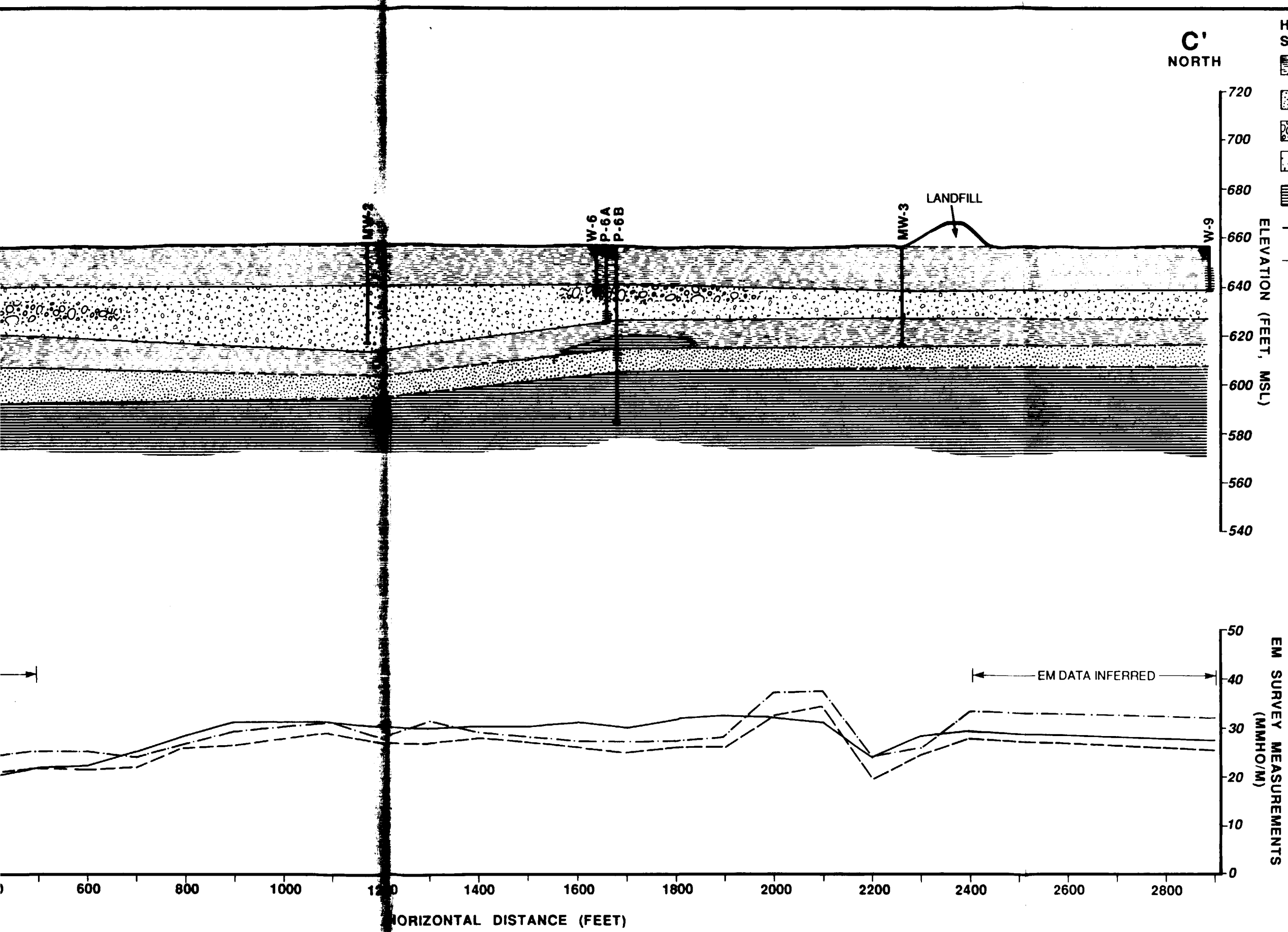
- The depth and thickness of the soil strata indicated on the subsurface section were obtained by interpolating between test borings. Information on actual subsurface conditions exists only at the locations of the test borings and it is possible that conditions may vary from those indicated.
- For location of cross section, see Drawing 3-8.
- Water levels measured on 3/12/87.

40
0
0 200
SCALE IN FEET
VERTICAL EXAGGERATION=5x

ELECTROMAGNETIC (EM) SURVEY LEGEND:

- 40 METER SPACING
- 20 METER SPACING
- 10 METER SPACING

PROJECT NO. 850-32-17		
DES BY		BOWERS LANDFILL CIRCLEVILLE, OHIO Dames & Moore
DR BY		
CHK BY		
APP BY		
SHEET TITLE: Hydrogeologic Cross Section B-B' and Corresponding EM Survey Profiles		SHEET ___ OF ___ DRAWING NO: 3-10



HYDROGEOLOGIC CROSS SECTION LEGEND:

- SILT AND CLAY
- SAND
- GRAVEL
- SAND AND GRAVEL
- SHALE
- UNIT CONTACT
- INFERRED UNIT CONTACT
- 6-W — BORING/MONITORING WELL LOCATION WITH CORRESPONDING WATER LEVEL, SCREEN INTERVAL, AND BORING DEPTH

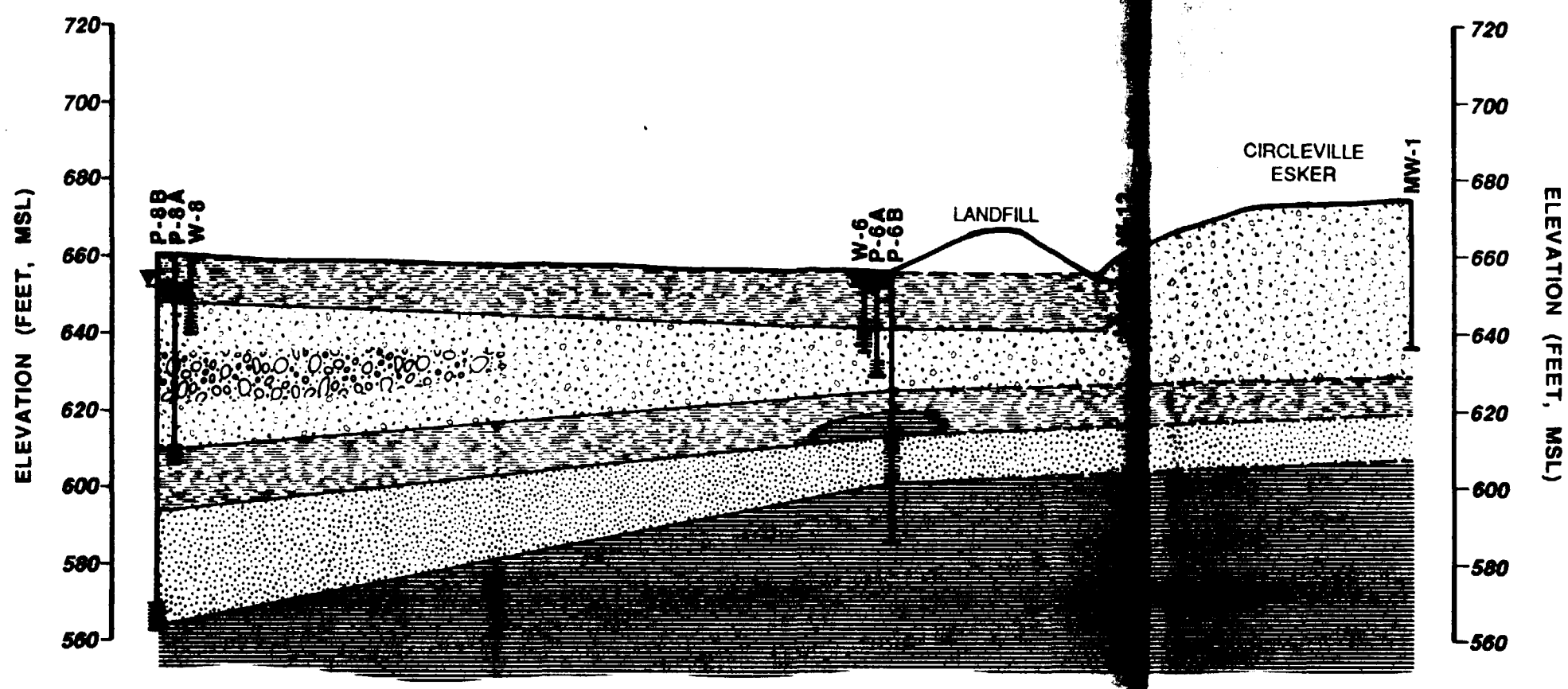
NOTES:
- The depth and thickness of the soil strata indicated on the subsurface section were obtained by interpolating between test borings. Information on actual subsurface conditions exists only at the locations of the test borings and it is possible that conditions may vary from those indicated.
- For location of cross section, see Drawing 3-8.
- Water levels measured on 3/12/87.

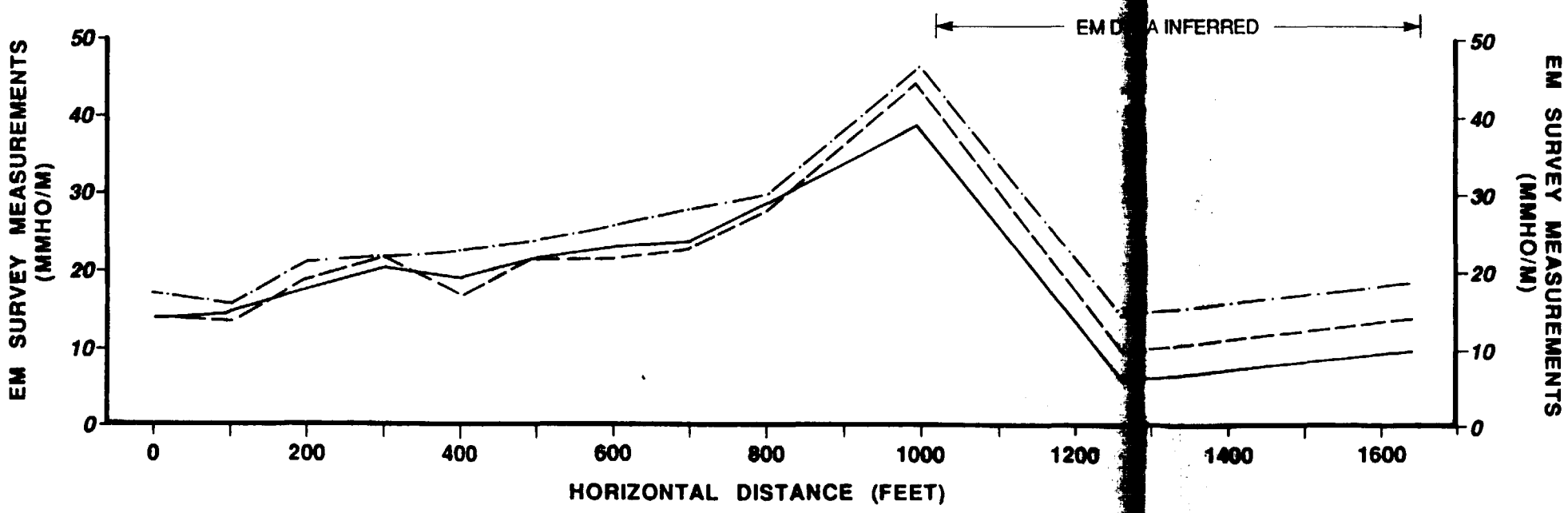
40
0
0 200
SCALE IN FEET
VERTICAL EXAGGERATION=5x

ELECTROMAGNETIC (EM) SURVEY LEGEND:

- 40 METER SPACING
- 20 METER SPACING
- 10 METER SPACING

PROJECT NO. 850-32-17			
DES BY			BOWERS LANDFILL CIRCLEVILLE, OHIO Dames & Moore
DR BY			
CHK BY			
APP BY			
SHEET TITLE: Hydrogeologic Cross Section C-C' and Corresponding EM Survey Profiles			SHEET ___ OF ___ DRAWING NO: 3-11



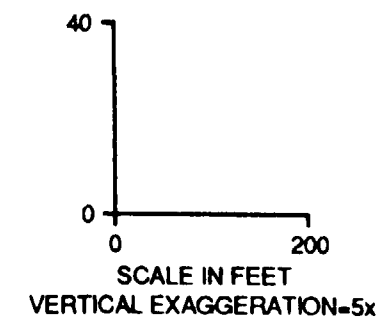


HYDROGEOLOGIC CROSS SECTION LEGEND:

- SILT AND CLAY
- SAND
- GRAVEL
- SAND AND GRAVEL
- SHALE
- UNIT CONTACT
- INFERRED UNIT CONTACT
- W-6 — BORING/MONITORING WELL LOCATION WITH CORRESPONDING WATER LEVEL, SCREEN INTERVAL, AND BORING DEPTH

NOTES:

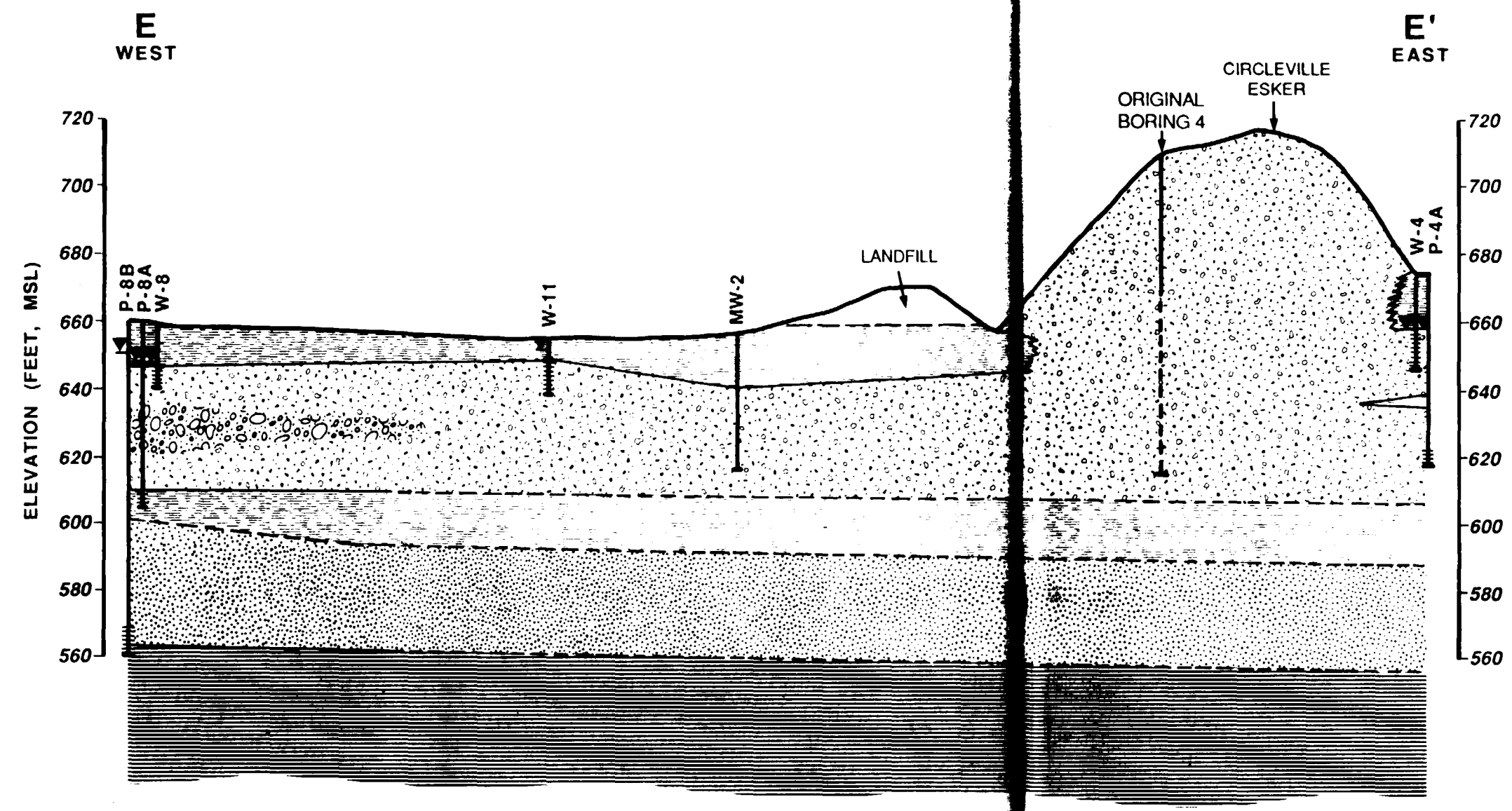
- The depth and thickness of the soil strata indicated on the subsurface section were obtained by interpolating between test borings. Information on actual subsurface conditions exists only at the locations of the test borings and it is possible that conditions may vary from those indicated.
- For location of cross section, see Drawing 3-8.
- Water levels measured on 3/12/87.

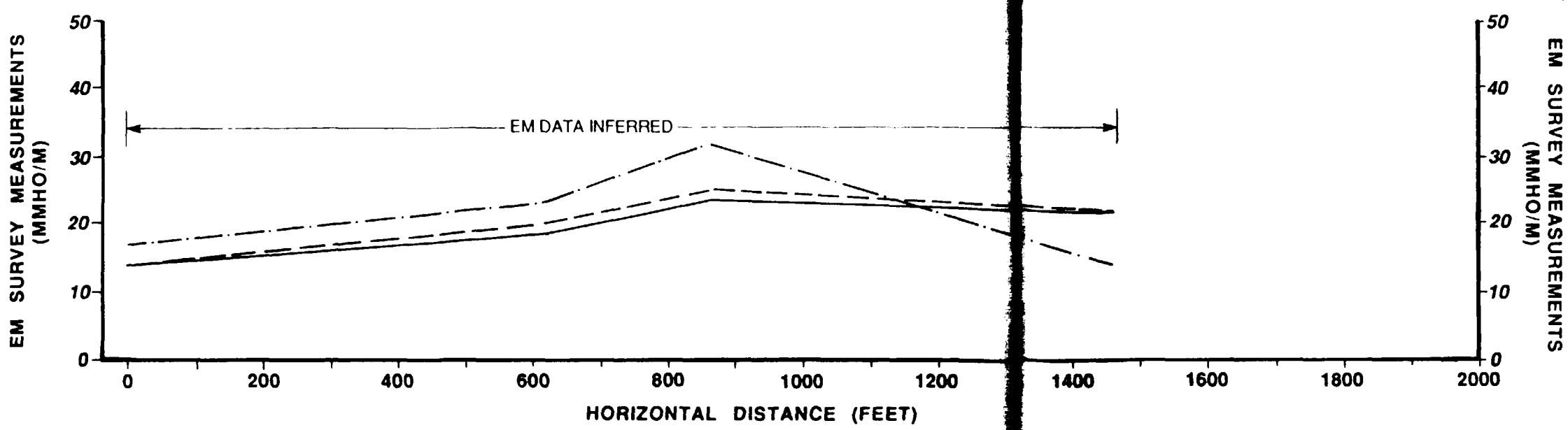


ELECTROMAGNETIC (EM) SURVEY LEGEND:

- 40 METER SPACING
- 20 METER SPACING
- 10 METER SPACING

PROJECT NO. 850-32-17			
DES BY			BOWERS LANDFILL CIRCLEVILLE, OHIO Dames & Moore
DR BY			
CHK BY			
APP BY			
SHEET TITLE: Hydrogeologic Cross Section D-D' and Corresponding EM Survey Profiles			SHEET OF DRAWING NO: 3-12





HYDROGEOLOGIC CROSS SECTION LEGEND:

- SILT AND CLAY
- CLAY
- SAND
- GRAVEL
- SAND AND GRAVEL
- SHALE
- UNIT CONTACT
- INFERRED UNIT CONTACT
- W-11 BORING/MONITORING WELL LOCATION WITH CORRESPONDING WATER LEVEL, SCREEN INTERVAL, AND BORING DEPTH

NOTES:

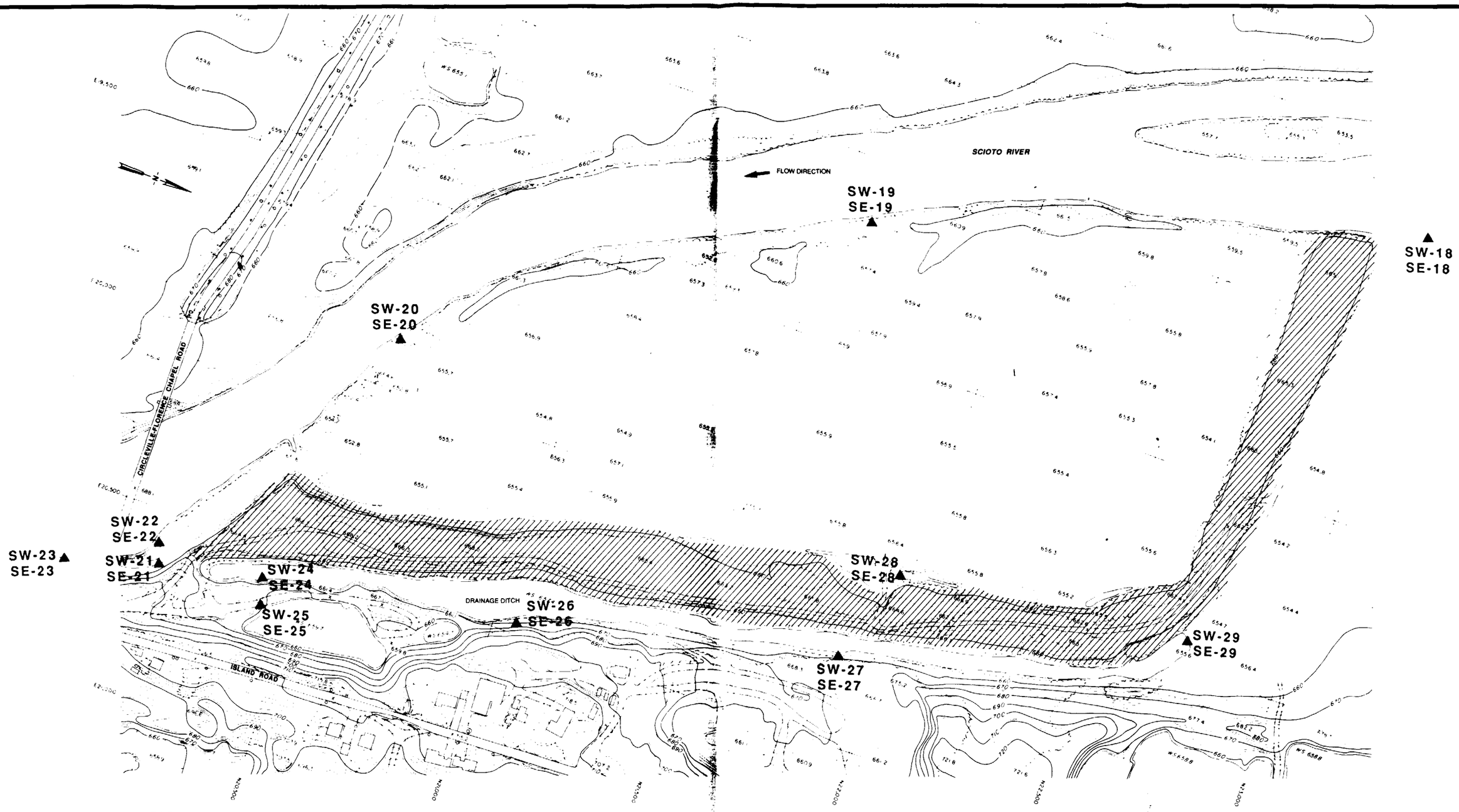
- The depth and thickness of the soil strata indicated on the subsurface section were obtained by interpolating between test borings. Information on actual subsurface conditions exists only at the locations of the test borings and it is possible that conditions may vary from those indicated.
- For location of cross section, see Drawing 3-8.
- Water levels measured on 3/12/87.

40
0
0
200
SCALE IN FEET
VERTICAL EXAGGERATION=5x

ELECTROMAGNETIC (EM) SURVEY LEGEND:

- 40 METER SPACING
- 20 METER SPACING
- 10 METER SPACING

PROJECT NO. 850-32-17		
DES BY		BOWERS LANDFILL CIRCLEVILLE, OHIO Dames & Moore
DR BY		
CHK BY		
APP BY		
SHEET TITLE: Hydrogeologic Cross Section E-E' and Corresponding EM Survey Profiles		SHEET OF DRAWING NO: 3-13



LEGEND:

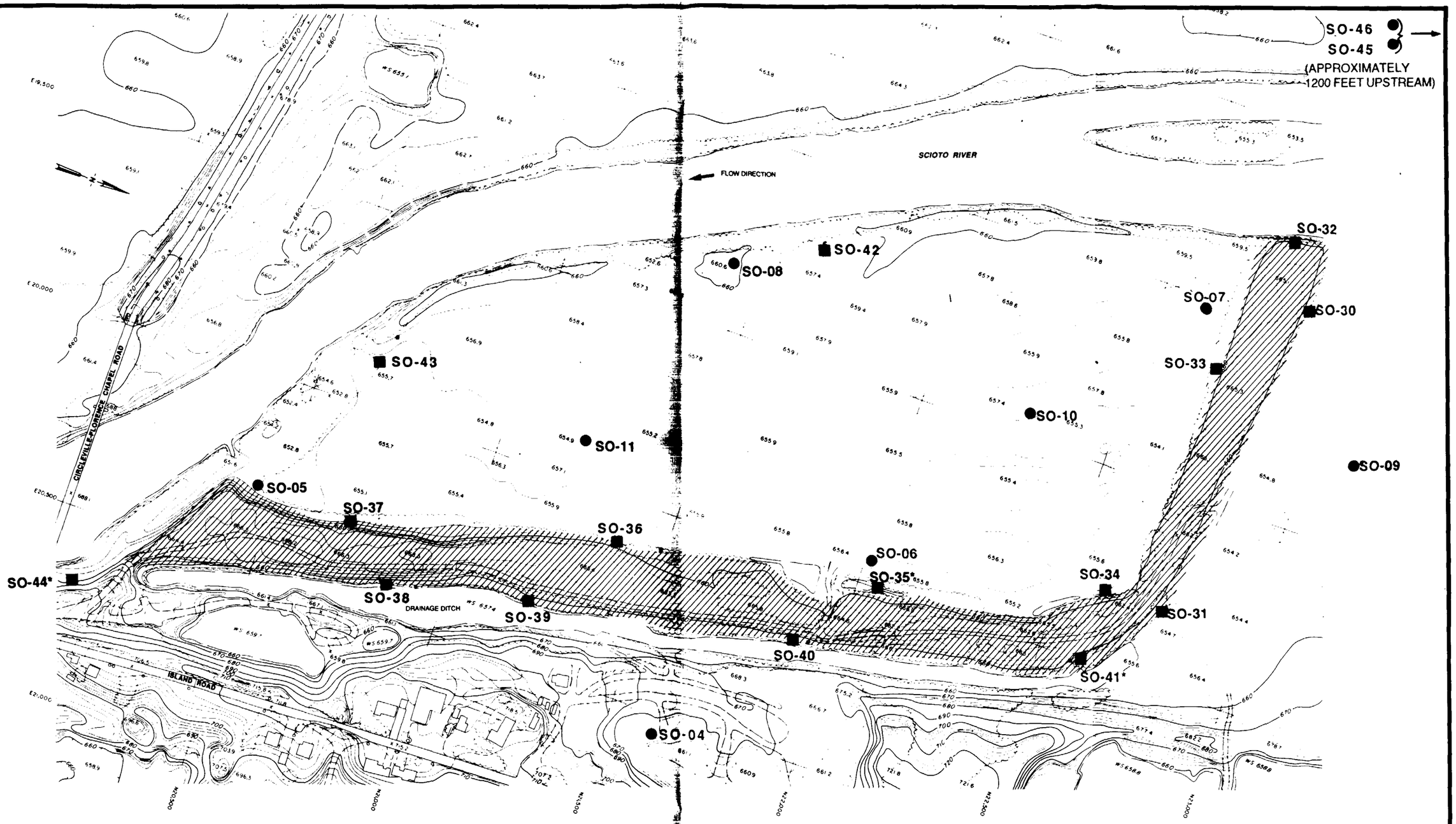
▨	EXISTING LANDFILL
▲ SW-25 SE-25	SURFACE WATER/SEDIMENT SAMPLE LOCATION AND CORRESPONDING IDENTIFICATION NUMBER.

0 300
SCALE IN FEET

CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1,1984

REV	DATE	DESCRIPTION	DR BY	APP BY

SCALE: AS SHOWN			PROJECT NO. 850-32-17
DES BY	MJL	4-12-87	BOWERS LANDFILL CIRCLEVILLE, OHIO
DR BY	JMG	5-1-87	
CHK BY	MJL	5-1-87	
APP BY	MJL	5-12-87	Dames & Moore
SHEET TITLE: SURFACE WATER/SEDIMENT SAMPLING LOCATIONS			SHEET ___ OF ___ DRAWING NO: 3-14



LEGEND:

EXISTING LANDFILL

■ SO-41* SURFICIAL SOIL GRAB SAMPLE LOCATION AND CORRESPONDING IDENTIFICATION NUMBER. ASTERISK INDICATES LOCATIONS WHERE SAMPLE SPLITS WERE OBTAINED.

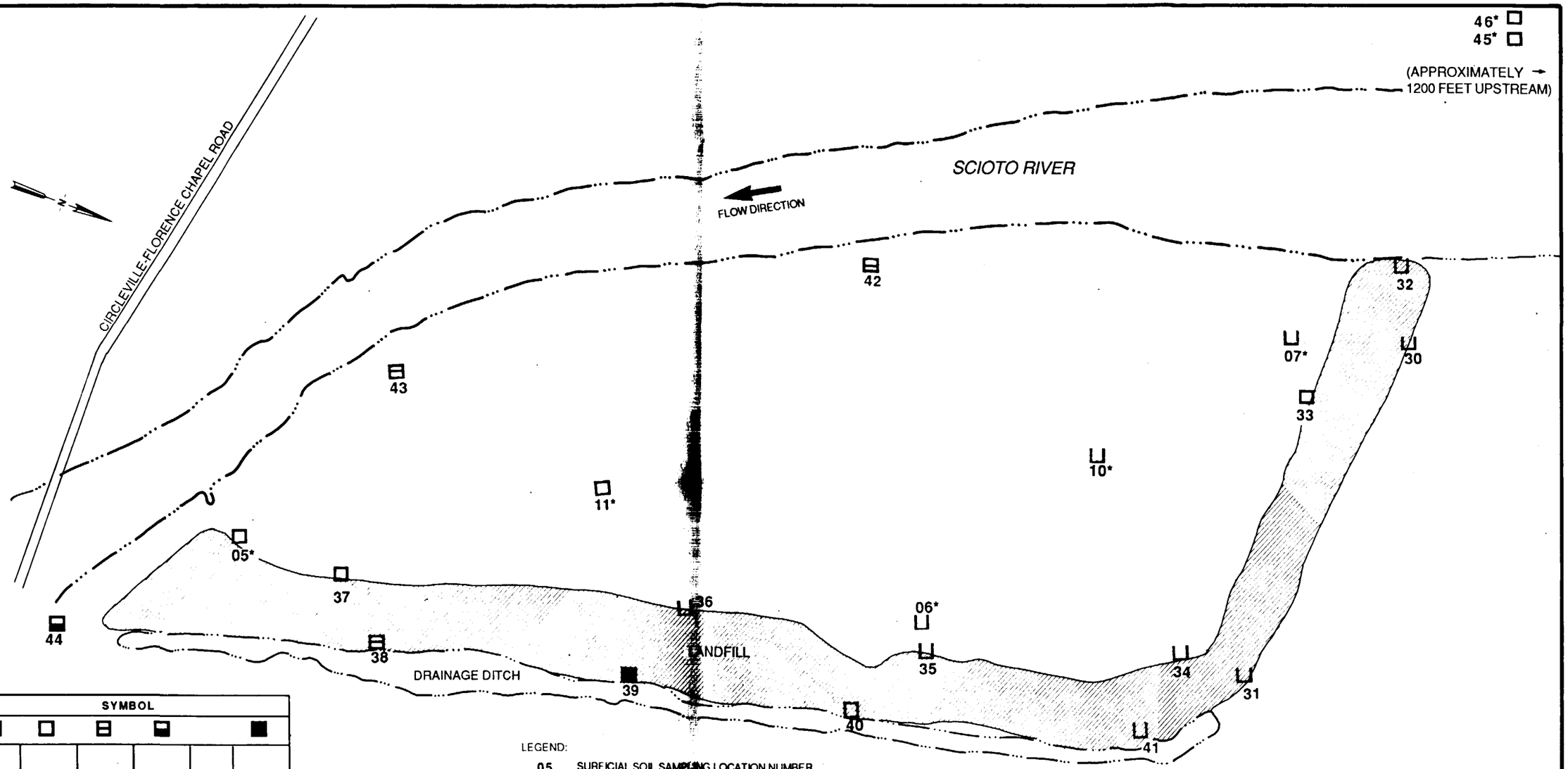
● SO-05 SURFICIAL SOIL SHELBY TUBE SAMPLE LOCATION AND CORRESPONDING IDENTIFICATION NUMBER

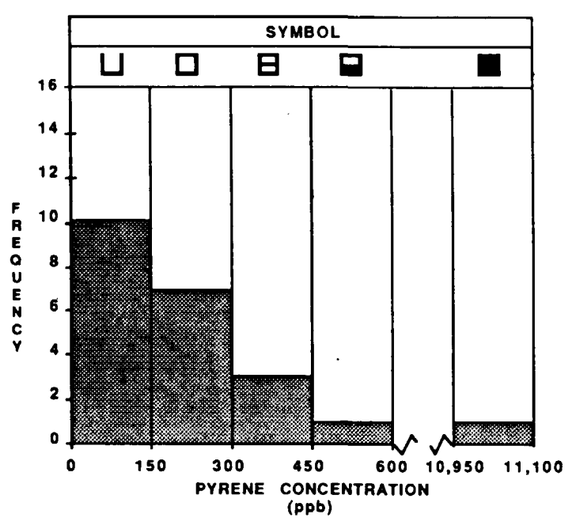
0 300
SCALE IN FEET

CONTOUR INTERVAL: 2 FEET
DATE OF AERIAL PHOTOGRAPH: MAY 1, 1984

REV	DATE	DESCRIPTION	DR BY	APP BY

SCALE: 1" = 250'	PROJECT NO. 850-32-17
DES BY MJL	BOWERS LANDFILL
DR BY JMG	CIRCLEVILLE, OHIO
CHK BY MJL	
APP BY	Dames & Moore
SHEET TITLE: SOIL SAMPLING LOCATIONS	SHEET 1 OF 1
	DRAWING NO: 3-15





Population = 22 Mean = 681 Standard Deviation = 2308

LEGEND:

05 SURFICIAL SOIL SAMPLING LOCATION NUMBER

PARAMETER CONCENTRATION RANGE AS INDICATED IN HISTOGRAM

* SHELBY TUBE SAMPLE, REMAINDER ARE GRAB SAMPLES

NOTE:
THE CONTRACT REQUIRED DETECTION LIMIT (CRDL) FOR THIS PARAMETER IS 330 ppb, AND MAY BE HIGHER DEPENDING ON THE DRY WEIGHT OF THE INDIVIDUAL SAMPLE. CONCENTRATIONS REPORTED BELOW THE CRDL ARE CONSIDERED ESTIMATES AS ACCURATE QUANTIFICATION IS NOT ALWAYS POSSIBLE.

0 300
SCALE IN FEET

REV	DATE	DESCRIPTION	DR BY	APP BY

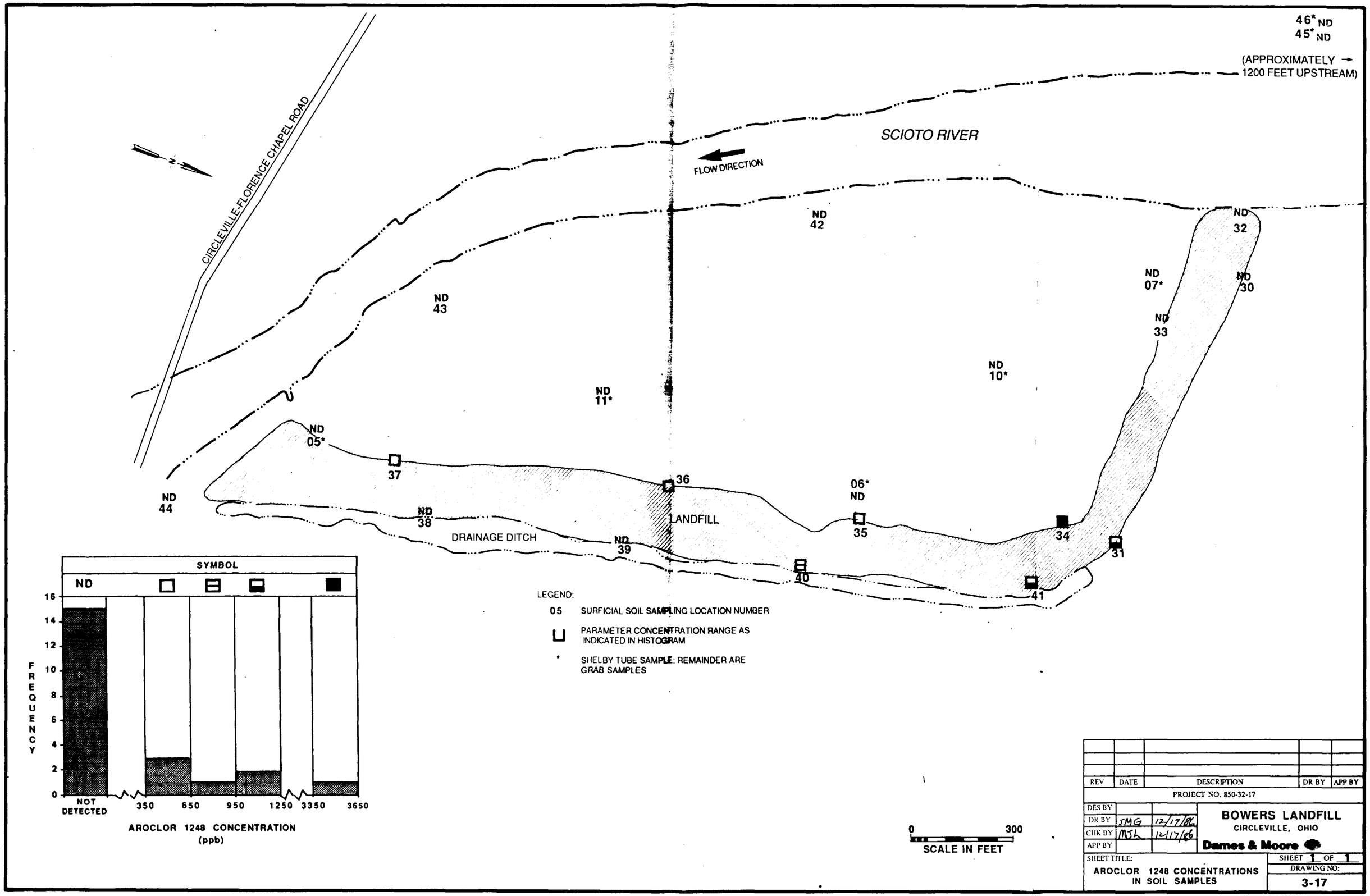
PROJECT NO. 850-32-17

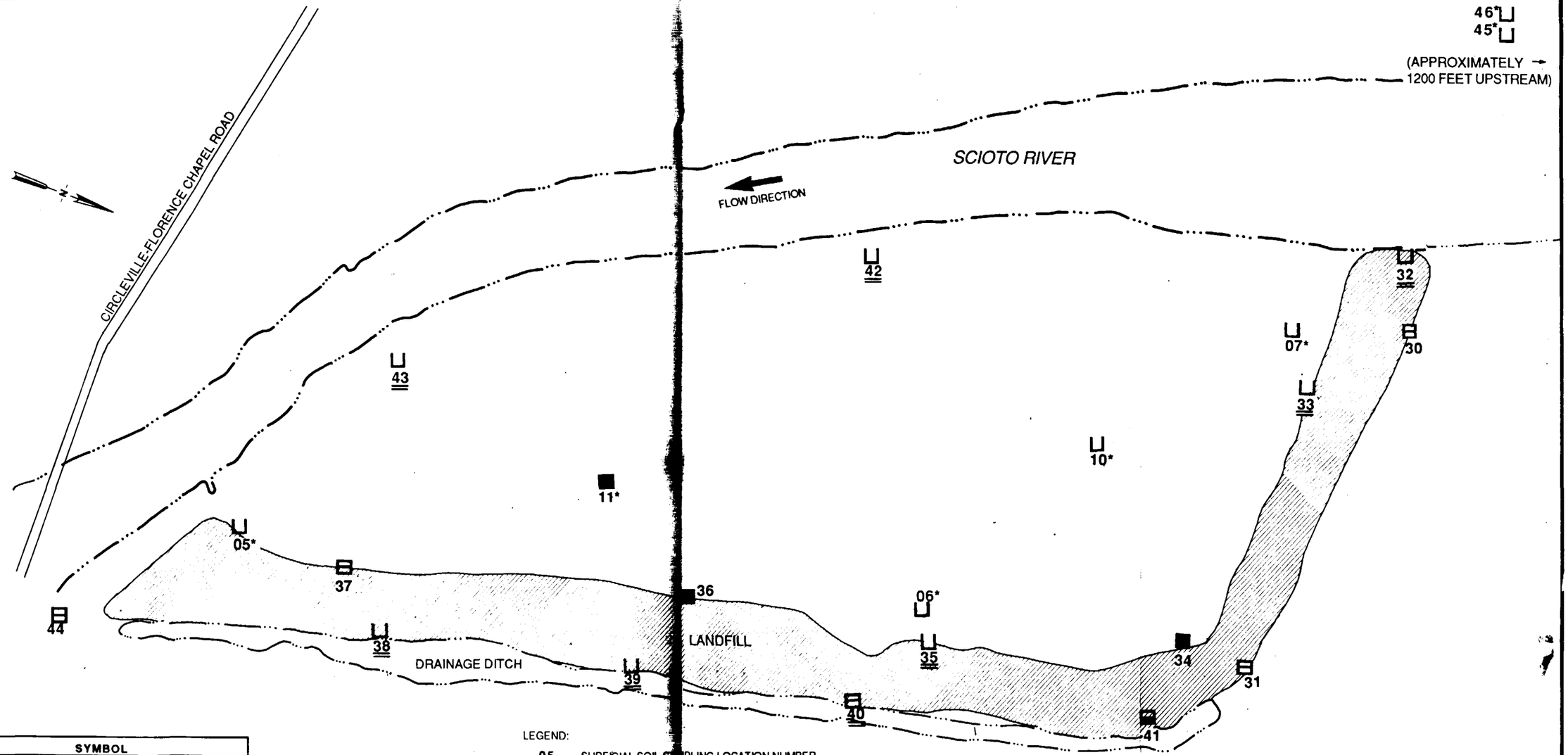
DES BY			BOWERS LANDFILL CIRCLEVILLE, OHIO
DR BY	JMG	12/17/86	
CHK BY	MJL	12/17/86	
APP BY			Dames & Moore

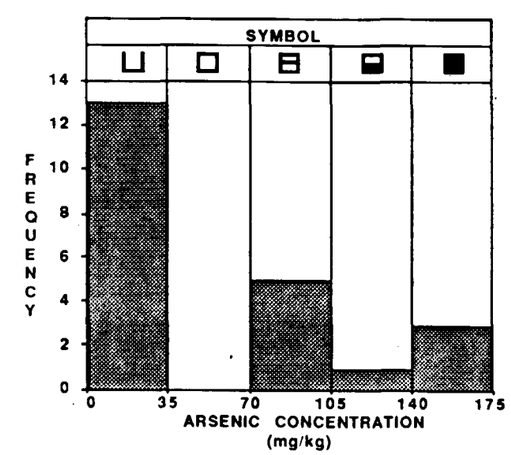
SHEET TITLE:
PYRENE CONCENTRATIONS IN SOIL SAMPLES

SHEET 1 OF 1

DRAWING NO: 3-16


46* ND
45* ND
(APPROXIMATELY → 1200 FEET UPSTREAM)
SCIOTO RIVER
FLOW DIRECTION
CIRCLEVILLE-FLORENCE CHAPEL ROAD
ND 42
ND 32
ND 07*
ND 30
ND 33
ND 43
ND 10*
ND 11*
ND 05*
37
36
06* ND
ND 44
ND 38
LANDFILL
35
34
DRAINAGE DITCH
ND 39
31
40
41
LEGEND:
05 SURFICIAL SOIL SAMPLING LOCATION NUMBER
PARAMETER CONCENTRATION RANGE AS INDICATED IN HISTOGRAM
SHELBY TUBE SAMPLE; REMAINDER ARE GRAB SAMPLES
SYMBOL
ND
FREQUENCY
16
14
12
10
8
6
4
2
0
NOT DETECTED
350
650
950
1250
3350
3650
AROCLOR 1248 CONCENTRATION (ppb)
0
300
SCALE IN FEET
REV
DATE
DESCRIPTION
DR BY
APP BY
PROJECT NO. 850-32-17
DES BY
DR BY SMG 12/17/86
CHK BY MSL 12/17/86
APP BY
BOWERS LANDFILL
CIRCLEVILLE, OHIO
Dames & Moore
SHEET TITLE:
AROCLOR 1248 CONCENTRATIONS IN SOIL SAMPLES
SHEET 1 OF 1
DRAWING NO:
3-17





Population = 22 Mean = 55.4 Standard Deviation = 56.0

LEGEND:

05 SURFICIAL SOIL SAMPLING LOCATION NUMBER

PARAMETER CONCENTRATION RANGE AS INDICATED IN HISTOGRAM

• SHELBY TUBE SAMPLE; REMAINDER ARE GRAB SAMPLES

SPIKE SAMPLE RECOVERY NOT WITHIN CONTROL LIMITS

0 300
SCALE IN FEET

REV	DATE	DESCRIPTION	DR	APP BY

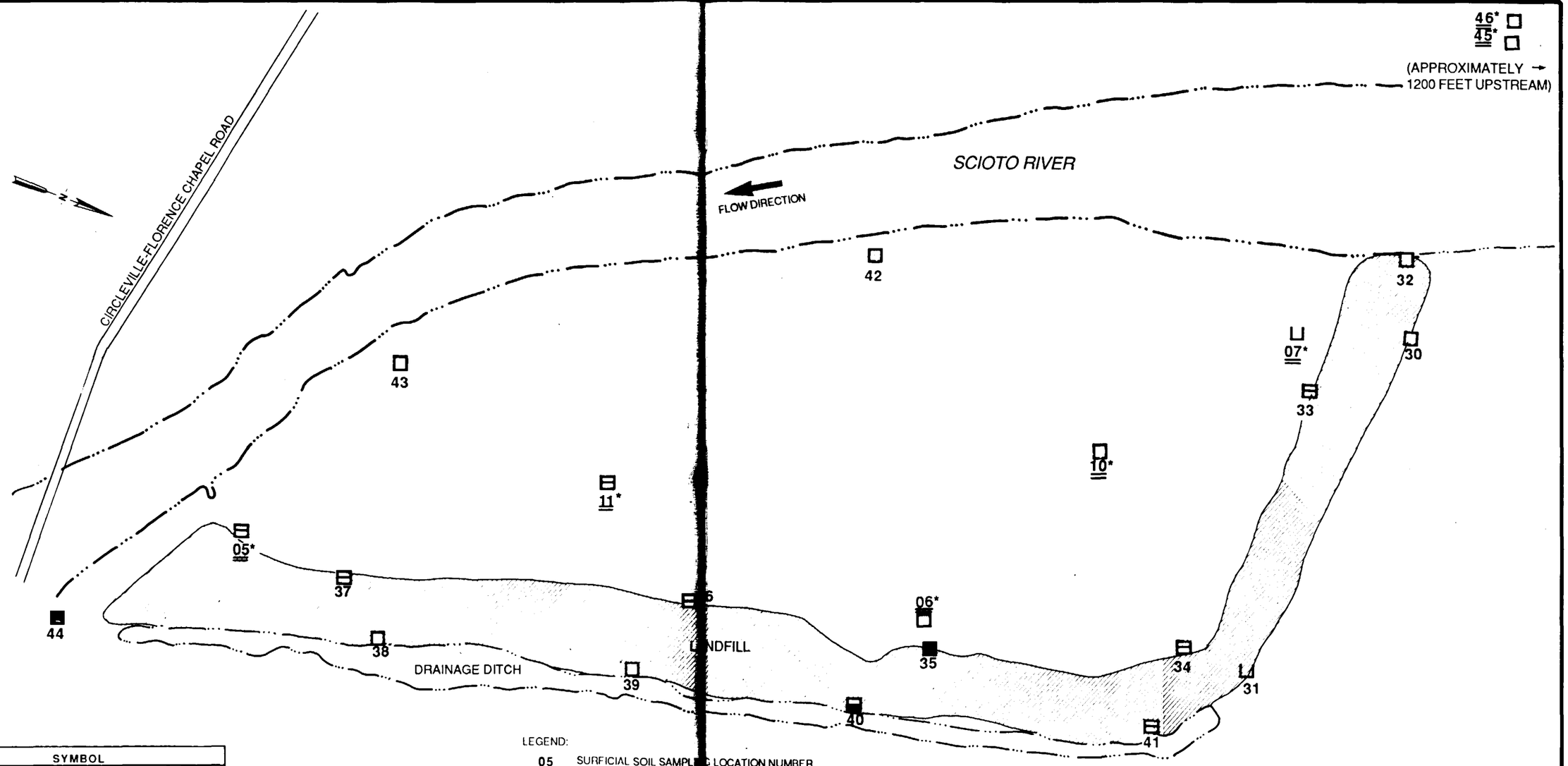
PROJECT NO. 850-32-17

DES BY		
DR BY	JMG	12/17/86
CHK BY	MSN	12/17/86
APP BY		

BOWERS LANDFILL
CIRCLEVILLE, OHIO
Dames & Moore

SHEET TITLE:
ARSENIC CONCENTRATIONS IN SOIL SAMPLES

SHEET 1 OF 1
DRAWING NO: 3-18



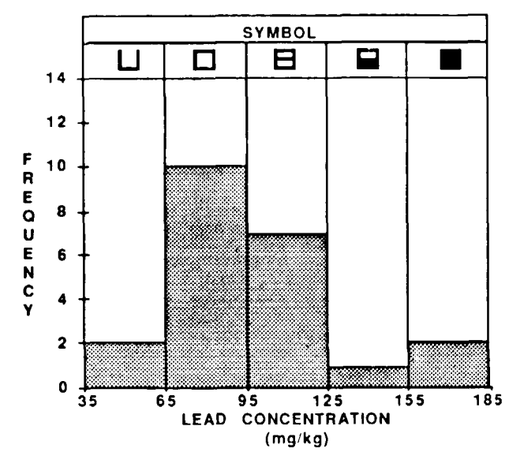
LEGEND:

05 SURFICIAL SOIL SAMPLING LOCATION NUMBER

PARAMETER CONCENTRATION RANGE AS INDICATED IN HISTOGRAM

* SHELBY TUBE SAMPLE; REMAINDER ARE GRAB SAMPLES

= VALUE ESTIMATED DUE TO PRESENCE OF INTERFERENCE



Population = 22 Mean = 96. Standard Deviation = 32.

0 300
SCALE IN FEET

REV	DATE	DESCRIPTION	DR BY	APP BY

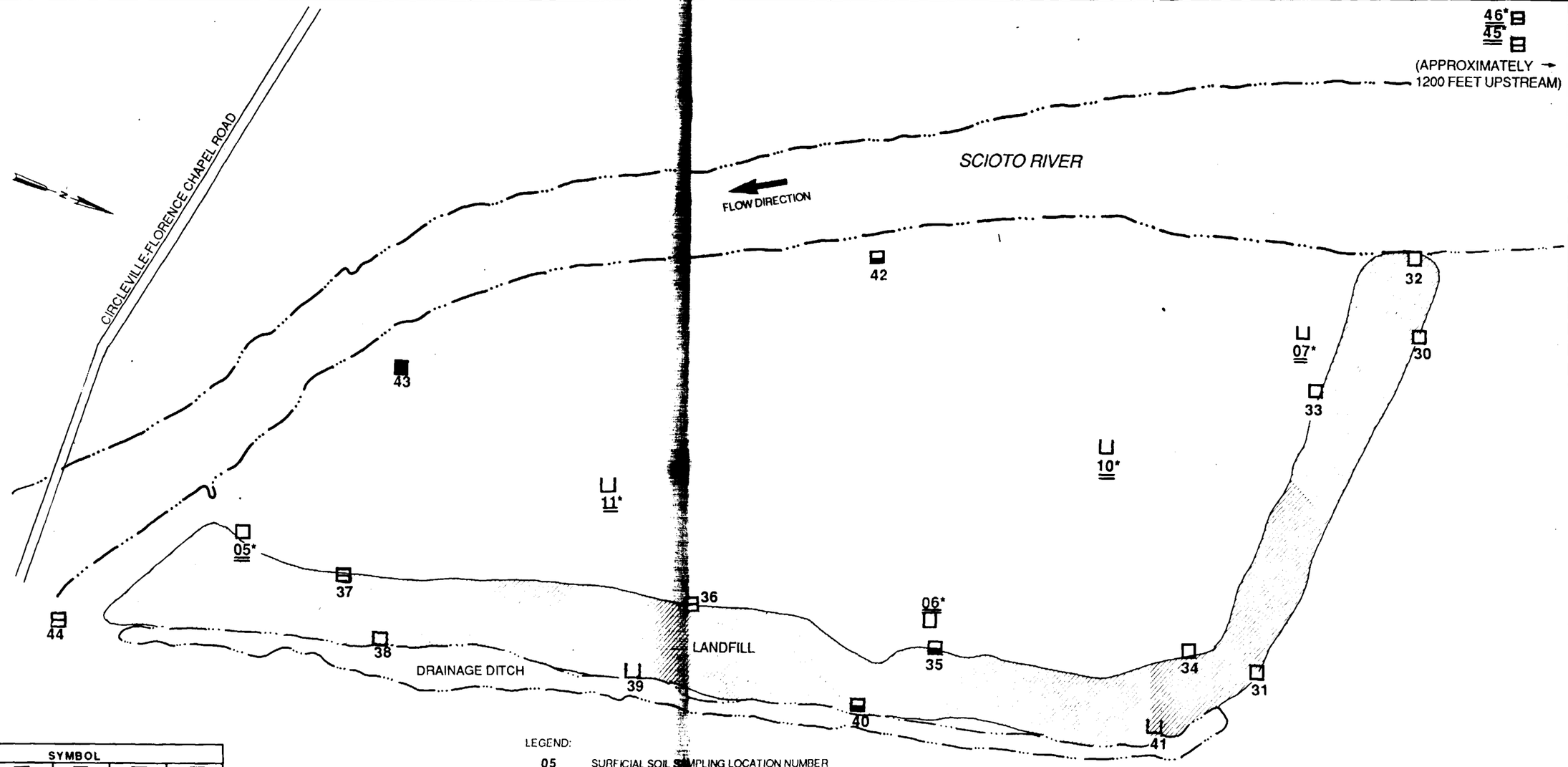
PROJECT NO. 850-32-17

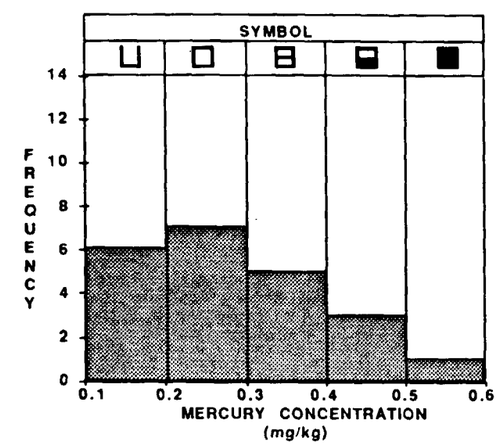
DES BY		
DR BY	JMG	12/16/86
CHK BY	MJL	12/17/86
APP BY		

BOWERS LANDFILL
CIRCLEVILLE, OHIO
Dames & Moore

SHEET TITLE:
LEAD CONCENTRATIONS IN SOIL SAMPLES

SHEET 1 OF 1
DRAWING NO:
3-19





Population = 22 Mean = 0.27 Standard Deviation = 0.12

LEGEND:

05 SURFICIAL SOIL SAMPLING LOCATION NUMBER

PARAMETER CONCENTRATION RANGE AS INDICATED IN HISTOGRAM

• SHELBY TUBE SAMPLE; REMAINDER ARE GRAB SAMPLES

SPIKE SAMPLE RECOVERY NOT WITHIN CONTROL LIMITS

0 300
SCALE IN FEET

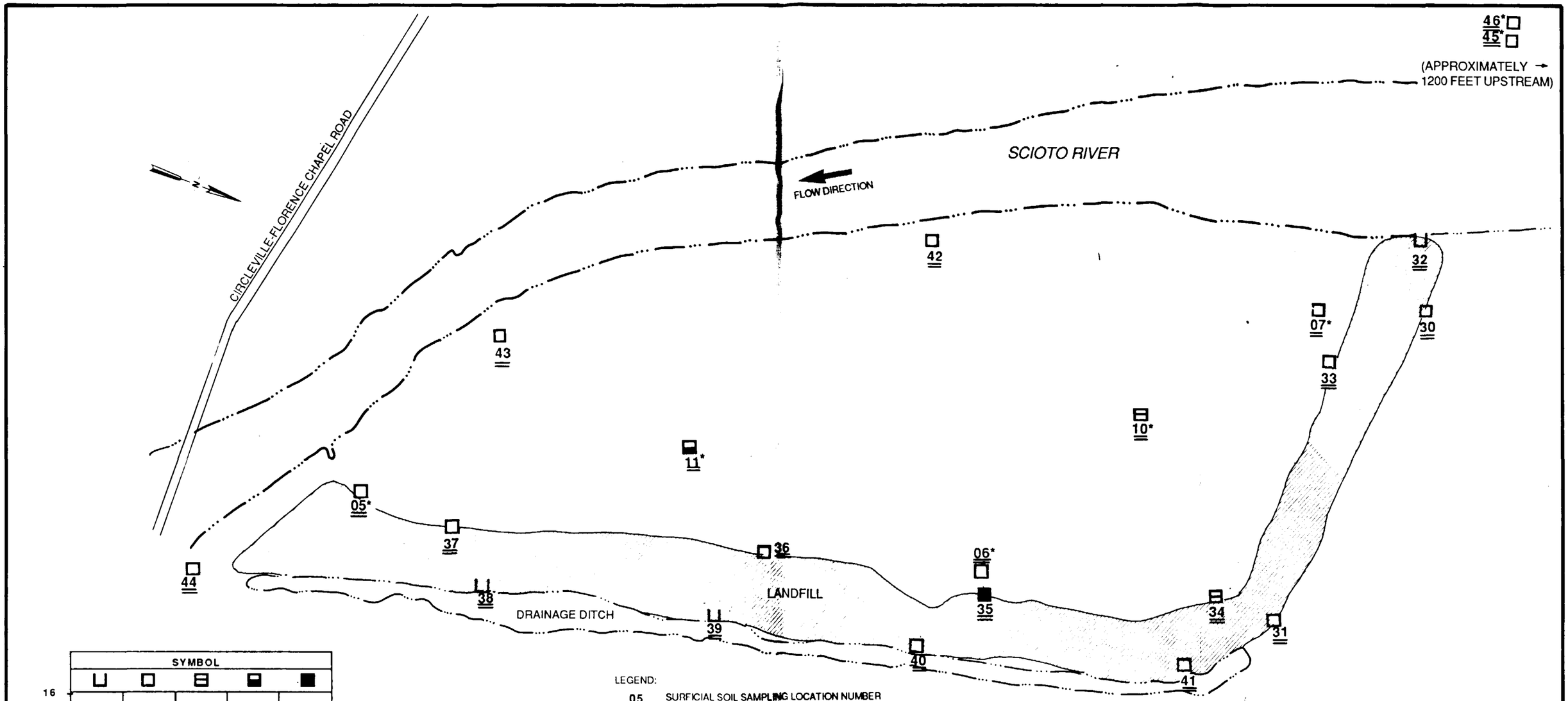
REV	DATE	DESCRIPTION	DR BY	APP BY

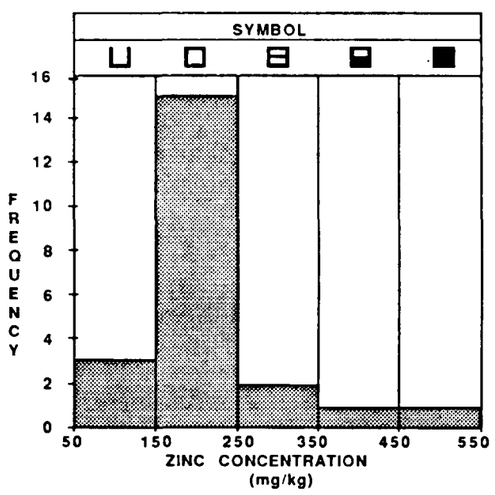
PROJECT NO. 850-32-17

DES BY			BOWERS LANDFILL CIRCLEVILLE, OHIO
DR BY	JMG	12/17/86	
CHK BY	MJL	12/17/86	
APP BY			Dames & Moore

SHEET TITLE:
MERCURY CONCENTRATIONS IN SOIL SAMPLES

SHEET 1 OF 1
DRAWING NO: 3-20





Population = 22 Mean = 217. Standard Deviation = 95.

LEGEND:

05 SURFICIAL SOIL SAMPLING LOCATION NUMBER

PARAMETER CONCENTRATION RANGE AS INDICATED IN HISTOGRAM

SHELBY TUBE SAMPLE; REMAINDER ARE GRAB SAMPLES

VALUE ESTIMATED DUE TO PRESENCE OF INTERFERENCE

0 300
SCALE IN FEET

REV	DATE	DESCRIPTION	DR BY	APP BY

PROJECT NO. 850-32-17

DES BY		
DR BY	JMG	12/16/86
CHK BY	MJL	12/17/86
APP BY		

BOWERS LANDFILL
CIRCLEVILLE, OHIO
Dames & Moore

SHEET TITLE:
ZINC CONCENTRATIONS IN SOIL SAMPLES

SHEET 1 OF 1
DRAWING NO:
3-21

LEGEND

2 Site categorization based on vegetation type as follows

NUMBER	AREA
1	Riparian
2	Field Border
3	Cropland
4	Berm

0 500 1000

SCALE IN FEET

REV	DATE	DESCRIPTION	DR BY	APP BY

PROJECT NO 8562

DESIGN BY	MJL	2/2/87
DR BY	JG	2/2/87
CHK BY	MJL	2/2/87
APP BY		

BOWERS LANDFILL
CIRCLEVILLE, OHIO

Dames & Moore

SHEET TITLE
Site Categorization
Based on Vegetation Type

SHEET OF

DRAWING NO
3-22

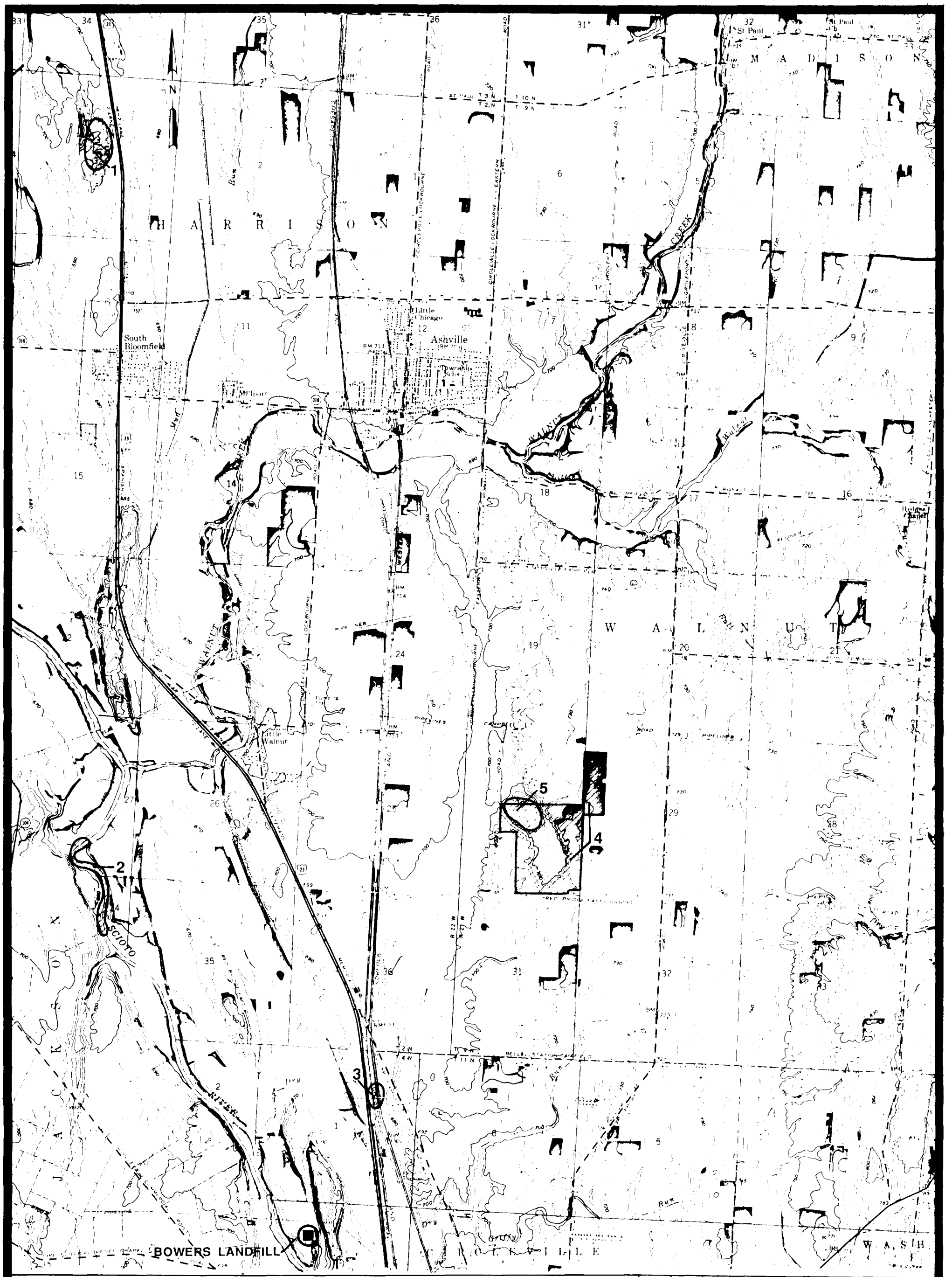
ion of Ohio Department of
al Resources (ODNR) recorded
ng of species of concern
associated text for listing of
es by number)

Ohio

0 7500

SCALE IN FEET

MJL	1/28/87	BOWERS LA
JMG	1/30/87	CIRCLEVILLE,
MJL	2/3/87	Dames & Moore



LEGEND:

5 Location of Ohio Department of Natural Resources (ODNR) recorded sighting of species of concern (See associated text for listing of species by number)

Ohio Quadrangle Location

0 2000 4000
SCALE IN FEET

BASE MAP SOURCE: USGS 7 1/2 minute topographic quadrangle map Ashville, Ohio, 1958, photorevised 1970.

REV	DATE	DESCRIPTION	DR BY	APP BY

PROJECT NO. 850-32-17

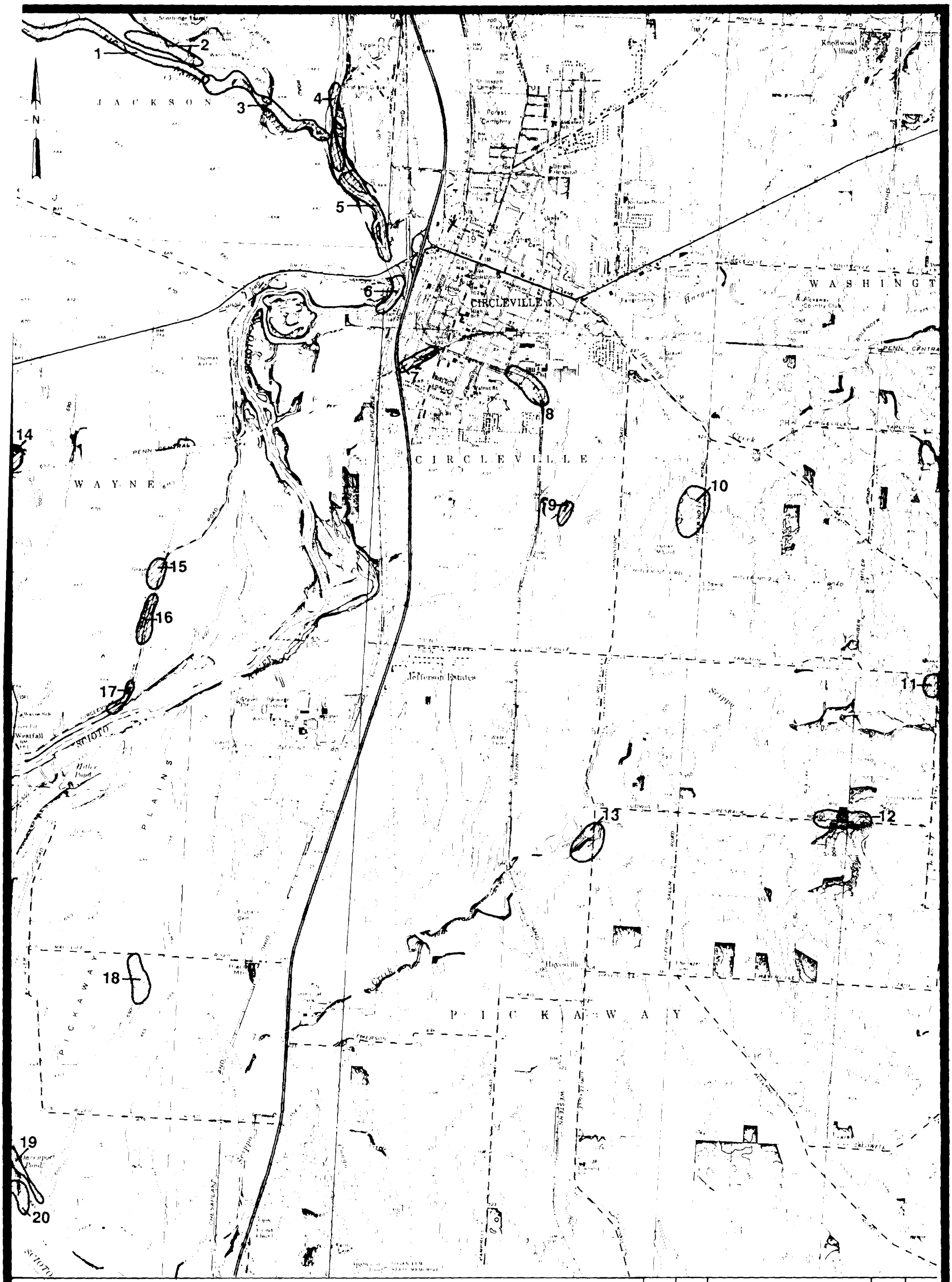
DES BY	MJL	1/28/87
DR BY	JMG	1/30/87
CHK BY	MJL	2/3/87
APP BY		

BOWERS LANDFILL
CIRCLEVILLE, OHIO
Dames & Moore

SHEET TITLE: Recorded Sightings of Species of Concern- Ashville, Quadrangle

SHEET ___ OF ___

DRAWING NO: 3-23



LEGEND:

7 Location of Ohio Department of Natural Resources (ODNR) recorded sighting of species of concern (See associated text for listing of species by number)

Ohio Quadrangle Location

0 2000 4000

SCALE IN FEET

BASE MAP SOURCE: USGS 7 1/2 minute topographic quadrangle map Circleville, Ohio, 1961, photorevised 1974.

REV	DATE	DESCRIPTION	DR BY	APP BY

PROJECT NO. 850-32-17

DES BY	MSL	1/28/87
DR BY	JMG	1/30/87
CHK BY	MSL	2/3/87
APP BY		

BOWERS LANDFILL
CIRCLEVILLE, OHIO

Dames & Moore

SHEET TITLE: Recorded Sightings of Species of Concern-Circleville Quadrangle

SHEET ___ OF ___

DRAWING NO: 3-24

- All monitoring wells were developed by mechanical surging and/or pumping, rather than by air injection (which could potentially alter ground water chemistry).
- Drilling/monitoring well installation activities were supervised and logged by personnel familiar with such procedures.

4.1.1.3 Site Surveying

- All surveying activities conducted to obtain horizontal and vertical coordinates of monitoring wells (and other sampling points) were conducted by a Licensed Professional Surveyor in the State of Ohio.

4.1.1.4 Ground Water Level Measurements

- Measurements of ground water levels were obtained using a meter that was previously checked for accuracy, and that was dedicated for use at the site.
- The meter cable and probe were rinsed between wells to minimize cross-contamination.
- Measurements were taken to the nearest 0.01 foot; all water level data included in this report were obtained within a period of several hours, to minimize effects of temporal variation.

4.1.2 Environmental Sample Collection

- Samples obtained at the site for chemical analyses (surficial soil, sediment, surface water, and ground water) were collected by personnel experienced in such procedures.
- All sampling equipment was dedicated to a specific sampling point.
- Essentially all sampling equipment was fabricated of stainless steel (soil/sediment scoops and compositing trays, surface water beakers, and ground water bailers/bailing line).
- All sampling equipment was new, was thoroughly cleaned in the laboratory prior to use, and was transported to the sampling location wrapped in food-grade plastic and/or aluminum foil.
- Sampling personnel had minimal contact with samples, and wore dedicated surgical gloves during collection/processing.
- Field instrumentation (i.e., temperature, pH, and specific conductance meters) were calibrated before use, and periodically during sampling events (see Appendix F).
- Field blanks, duplicates, and trip blanks were obtained during sampling of the various media, to check for field/laboratory-induced contamination and reproducibility of results (see Section 3.0).
- Samples were handled under strict chain-of-custody, as discussed in the QAPP.
- Samples were delivered to the laboratory using an overnight courier, to minimize time before analysis.

4.0 PROJECT QUALITY ASSURANCE/QUALITY CONTROL

This section summarizes the methods and procedures utilized during the Bowers remedial investigation to ensure a satisfactory level of quality assurance/quality control (QA/QC). The discussion is subdivided into three areas: field program, laboratory analysis, and data management. The intent of this section is to provide a brief synopsis of salient project activities related to QA/QC, and not to provide detailed discussions of the activities. Such discussions are found elsewhere in this report (Section 3.0 and appropriate appendices), in the Quality Assurance Project Plan (QAPP) prepared for this investigation (Dames & Moore, 1986b), and in other documents referenced below.

4.1 FIELD PROGRAM

The methods and procedures listed below were implemented during the field investigation (data collection) phase of this project, and are considered to have a direct (or indirect) bearing on the quality of data collected. The discussion is categorized by major activity.

4.1.1 Hydrogeologic Investigation

4.1.1.1 EM Survey

- The EM survey was conducted by personnel with previous experience in the execution and interpretation of this geophysical technique.
- Instrumentation was obtained directly from the manufacturer (Geonics), having been pre-calibrated and checked.
- Periodic checks and calibration of various instrument functions were performed, as recommended by Geonics, including: power supply, null balance, and coil orientation/alignment (see Appendix A).

4.1.1.2 Drilling/Monitoring Well Installation

- Drilling contractor personnel (Mathes) had previous experience in drilling/monitoring well installation for environmental studies.
- All drilling equipment and tools were steam-cleaned before initiation of each boring, to minimize cross-contamination.
- Stainless-steel well screen and riser pipe were utilized, and were steam-cleaned immediately prior to installation.
- Monitoring wells utilized threaded caps to prevent influx of Scioto River flood water.

4.2 LABORATORY ANALYSIS

The following items were considered pertinent to project QA/QC, relative to laboratory analysis of environmental samples (soil, sediment, surface water, and ground water) collected at the site:

- All samples collected during this program for chemical analysis were analyzed by an active Contract Laboratory Program (CLP) laboratory (CompuChem), following CLP Statements of Work for organic, inorganic, and dioxin analyses (U.S. EPA, 1984, 1985a, 1985b). Laboratories within the CLP program undergo periodic audits to ensure that the required level of QA/QC is maintained.

- QA/QC procedures required under the CLP program were followed in the analyses of these samples. Requirements include: sample holding times; instrument calibration, tuning and performance criteria; laboratory method blank analyses; matrix spike/matrix spike duplicate analyses; surrogate recovery criteria; compound identification requirements.

- A multi-level internal review of all data is conducted by CompuChem prior to their release, to verify results and ensure that QA/QC requirements have been met.

- Data reporting packages, as required by CLP, include all pertinent information to allow subsequent verification of results and QA/QC.

4.3 DATA MANAGEMENT

In the reduction analysis and reporting of data collected during this study, the following items are considered to be important from a QA/QC standpoint.

All laboratory analytical data received from CompuChem, as discussed in Section 4.2, were reviewed by an independent analytical chemist to assess the validity of the reported results. Procedures utilized in this assessment were based on a review of the CLP Statements of Work previously discussed, as well as published and unpublished guidance documents listed in Appendix H. A summary of this assessment is included as Appendix H. In the opinion of the reviewer, all data reported by the laboratory are considered to be valid.

- Overall data reduction and interpretation techniques are applied by personnel familiar with such procedures, and follow standard professional practices of the engineering/environmental science disciplines.

- Data transcribed onto summary tables or other forms of reporting are checked to minimize error.

- Field notes, logs, laboratory reports, and other raw data are maintained in the project files, to allow subsequent review or verification.

5.0 FINDINGS AND CONCLUSIONS

5.1 INTRODUCTION

The collection of field data and the laboratory analyses of environmental samples have been conducted in accordance with provisions described in the Work Plan (Dames & Moore, 1986a). A substantial amount of information on the site's physical, chemical, and biological environment has been collected and analyzed. On the basis of this information, conclusions about the environmental effects of the Bowers Landfill can be developed.

This section of the report is designed to integrate the findings described in Sections 2 and 3. The information presented in this Section focuses on findings and factors that may affect the occurrence and/or migration of contaminants, if present, at the site.

5.2 PHYSICAL CONDITIONS

5.2.1 Physiography

Physiographic conditions that are the result of past geologic processes described in Section 2.6 have a direct bearing on the hydrogeologic environment at the landfill site. Four major and distinct physiographic divisions exist in the immediate vicinity of the site. These are:

- Present-day topographic valley of the Scioto River
- Alluvial valley formed by pre-glacial, glacial and post-glacial river erosion/deposition. This alluvial valley includes the present-day Scioto River Valley, as well as glacial outwash deposits (Drawing 5-1)
- Glaciated areas on either side of the alluvial valley, consisting of glacial ground moraine and other glacial deposits underlain by Devonian-age shale bedrock
- The Circleville Esker, consisting of irregularly stratified granular materials

Approximate boundaries of these features are shown on Drawing 5-1, Regional Physiography. As can be observed from the drawing, the Circleville Esker is in close proximity to the landfill, and because of this nearby location, appears to have a direct influence on hydrogeologic conditions at the site.

5.2.2 Geologic Conditions

The unconsolidated (Pleistocene and Holocene) geologic materials in the site area can also be described in terms of the four categories defined above.

Geologic deposits underlying the valley floor typically consist of interbedded granular and non-granular formations. As described in Section 3.1, the granular materials (sand and gravel) are principally alluvial and/or glaciofluvial deposits. The non-granular deposits are derived principally from lacustrine environments (clay) and/or ice-contact deposits (glacial till). Both lithologies are characterized by facies changes (abrupt or gradual) and lateral discontinuities. By virtue of their depositional environments, the non-granular formations tend to be of wider geographic extent than the granular formations. The geologic profile at the site is characterized by a continuous layer of Holocene silty clay, underlain by sand and gravel, silty clay, another bed of sand and gravel and shale bedrock.

Glacial deposits in the upland areas (outside of the alluvial valley associated with the study area) are characterized by typical assemblages of glacial drift and till (Ohio Department of Natural Resources, 1975). These deposits are sufficiently permeable that infiltration from precipitation is transmitted through these materials and recharges aquifers within the glacial deposits. These upland deposits are not in direct contact with alluvial deposits at the site; however, they are in contact with the edge of the alluvial valley. Underflow from these materials has a direct effect on the hydrogeologic environment at the site by means of recharging the valley aquifers.

The Circleville Esker is represented by a series of several elongated features trending in a north-south direction in the center of the Scioto Valley (Ohio Department of Natural Resources, 1961). The esker is composed almost entirely of granular (sand and gravel) materials, which accounts for the extensive quarrying operations in the area. As a result of the extremely high-energy environment under which these materials were deposited, abrupt lithologic changes are common. Excavations in these deposits continue for some distance beneath the land surface, suggesting that the esker pre-dates at least the more recent portion of the alluvial deposits. It is believed that the topographic breaks between the eskers have been created by the meandering Scioto River.

As a part of the field investigation, a boring was drilled into the esker during the attempted installation of Location-4 wells. The boring, located approximately 400 feet southwest of existing Location 4 (Drawing 3-5) indicated the presence of well-sorted sand and gravel to at least 60 feet below

surface. Saturation was noted at approximately 60 feet below surface. Adverse drilling conditions prohibited logging of subsurface conditions below 60 feet, as well as installation of a monitoring well.

Bedrock underlying the unconsolidated materials consists of the Upper Devonian Ohio Shale. The depth of the shale ranges from approximately 40 to 100 feet in the vicinity of the landfill. Bedrock topography appears to slope towards the southwest at the site although regional bedrock dip is to the southeast. Some variability in bedrock depth over a short distance appears to have been observed while attempting to relocate boring/monitoring well P-5B (see Appendix C), in that the original boring and a boring approximately 25 feet from the original boring indicated shale at depths of 45 and 60 feet, respectively.

5.2.3 Hydrogeologic Conditions

On the basis of information and data presented in Section 3.1 and summarized above, certain conclusions can be developed as to the behavior of ground water in the geologic environment beneath the landfill and in the downgradient direction.

The potentiometric surface for the upper water-bearing zone slopes from the landfill to the west (see Drawing 3-6), indicating that ground water recharge to the aquifer system is from the east and that discharge is to the west or southwest. Ground water in the lower aquifer appears to flow in a more east-southeast direction, in the general downstream direction of the Scioto River (although based on limited data points). This may be due to an axisymmetric flow in the lower aquifer about the center of the alluvial valley, so that, while the Scioto River is near the western edge of the valley, it is hydraulically separate from the lower aquifer and does not exert control over flow behavior. Potentiometric levels in the lower aquifer are generally slightly higher than those in the upper aquifer in the vicinity of the Scioto River. Conversely, levels in the upper aquifer appear higher than those in the lower aquifer at locations away from the Scioto River (based on data obtained at Location 6). The observed differential in hydraulic head between the two zones (regardless of the relative vertical relationship), combined with the apparent difference in flow direction in the two zones, supports the interpretation that they act as independent aquifers in the site vicinity. This relationship may not exist regionally, however, if the till layer separating the zones is not continuous.

It was postulated in Section 2.6 that the principal source of recharge to the upper aquifer at the site is due to underflow from topographically higher areas to the east (and west), specifically from the esker (including the quarried areas) and the glacial deposits further east. The secondary source of recharge would

be infiltration from precipitation falling on the site, and the tertiary source would be periodic recharge from the Scioto River during periods of high stage.

For purposes of further discussion, a generalized cross section is presented as Drawing 5-2. The cross section represents the general hydrogeologic situation as it is believed to currently exist. One source of recharge to the upper aquifer at the site, as depicted on the drawing, appears to be from ground water moving through the esker. The esker is assumed to be hydraulically connected to the shallow aquifer at a location just east of the landfill.

The fact that the potentiometric surface in the lower aquifer is at a different elevation than that in the upper aquifer indicates that the esker may not be in direct hydraulic connection with the lower aquifer. It is therefore assumed that the base of the esker is at an elevation of about 640 feet. It is likely that recharge to the lower aquifer is principally from underflow from glacial drift at higher topographic elevations (to the east and west). This hydrogeologic condition is supported by the following:

- An extensive program by the Ohio Department of Natural Resources in the 1960s investigated the water-supply potential of major buried valleys in the state and found that the principal source of recharge to valley aquifers is from underflow (assuming that pumpage has not induced stream recharge)(ODNR, 1972).
- Water levels in the lower aquifers are higher than those in the upper aquifer.

Comparison of the potentiometric surface in the upper aquifer with Scioto River water elevations indicates that the aquifer discharges into the river. The rate of discharge is difficult to quantify because it is a function of river stage and the type of stream bottom conditions that exist along its course. It is unlikely that large quantities of ground water from the lower aquifer discharge directly to the river, due to the apparent low-permeability clay separating the lower and upper aquifers. However, the potential for ground water movement between the different aquifers is upward, and it is probable that some upward leakage occurs from the deeper zones through the intervening zones and into the shallower zone.

The landfill appears to be placed on a layer of silty clay that is interpreted as being continuous across much of the site based upon data obtained from the drilling program. The exception to this continuity may involve the esker to the east of the landfill. Based on available data for MW-1 (Burgess & Niple, 1981) the upper clay may not be continuous beneath the esker (see cross-section B-B'-Drawing 3-10). There is no evidence to suggest that the integrity of this layer was affected by excavation at the landfill. Other than a small pit dug at the south end of the landfill, records indicate that the disposal practice was to place refuse on the land surface, and not to fill excavations. No information has been obtained to suggest

that the small excavation was not reported to penetrate the silty clay (assuming it is continuous beneath the landfill).

On the basis of the foregoing, conclusions can be developed about the fate of leachate, if any, that may be generated by the landfill. No active seeps were observed during the course of this investigation, although a stagnant pool of discolored water observed near the location of Boring No. 5 may have been the result of a seep. In order for leachate to enter the ground water system at the site, it would be necessary for the leachate to permeate through the silty clay. Assuming that the hydraulic conductivity of the clay is on the order of 10^{-6} cm/sec, the rate of percolation would be on the order of 1 foot per year (under a hydraulic gradient of unity).

It is possible that leachate could enter directly into the aquifer system by entering the esker deposits on the east side of the landfill, or by permeating through the silty clay. In either case, the plume would follow the course of water movement in the upper aquifer to the west. Assuming an average ground water flow rate in the upper aquifer of 2 feet per day (Section 3.0), the contaminants would remain in-transit in the ground water system for a period of time ranging from 0 to 600 days (depending on location along the landfill), prior to discharging to the Scioto River (assuming that contaminants would move at the same rate as ground water).

5.3 ENVIRONMENTAL SAMPLES

5.3.1 Introduction

Samples from the following media have been collected and analyzed:

- soil (22 samples, 1 sampling event)
- ground water (18 onsite locations, 2 sampling events; 4 offsite residential well locations, 1 sampling event)
- surface water (12 locations, 2 sampling events)
- sediment (12 locations, 2 sampling events)

Each sample was analyzed for the presence of:

- volatile organic compounds (35 analytes)
- semi-volatile organic compounds (65 analytes)
- pesticides/PCB compounds (26 analytes)
- dioxin
- inorganic elements/cyanide (24 analytes)

As a result of the sampling and analytical program, 110 samples were analyzed for the presence of 151 parameters (16,650 discrete analytical tests). The results of that program are reported in Section 3.0.

A number of analytes were tested for and not found at detectable levels in any of the samples. In total, 151 analytes were tested; the following summary table shows the number of analytes that were found to occur above detectable (CRDL*) limits:

- Volatile Organic Compounds: Of 35 compounds, 31 were not detected at or above CRDL.
- Semi-volatile Compounds: Of 65 compounds, 53 were not detected at or above CRDL.
- Pesticides/PCBs: Of 26 analytes, 20 were not detected at or above CRDL.
- Dioxin was not detected.
- Inorganic Elements/Cyanide: Of 24 analytes, 2 were not detected at or above CRDL.

*U.S. EPA Contract Required Detection Limits.

The resultant data have been analyzed to identify patterns or occurrences that lead to the development of conclusions about the magnitude and extent of chemical contaminants found in the samples. For purposes of presentation, the remainder of this chapter is organized by chemical type. The approach generally used in the following subsections is to eliminate analytes from consideration that either were not detected or were not detected at elevated levels (in the case of naturally-occurring inorganic parameters), and to focus on the remaining analytes.

5.3.2 Volatile Organic Compounds

In the following discussion regarding the occurrence of volatile organic compounds (VOCs) in various site media, two compounds, methylene chloride and acetone, are excluded from consideration on the basis that the presence of these compounds in a given sample is due to laboratory contamination. Data supporting this position include:

- Flagging of portions of associated data by the laboratory to indicate presence of the compounds in laboratory blanks
- Statements by laboratory personnel describing the compounds as common "artifacts," or laboratory contaminants
- Provisions in CLP procedures allowing concentrations of the compounds in laboratory blanks at up to five times the CRDL before the results are considered unacceptable

5.3.2.1 Soil

Of the 22 surficial soil samples collected and analyzed for 35 VOC analytes, only two VOCs were reported. These detections involved concentrations below CRDL detection limits (see Table 3-22). They are:

Sample I.D.	Compound	Concentration (µg/kg)
SO-31	Chloroform	BDL
SO-34	Bromomethane	BDL

Soil sampling locations 31 and 34 are situated near the bend of the landfill (Drawing 3-14), in shallow drainageways along either edge. However, the extremely low concentrations of these compounds and the isolated occurrences suggest an absence of a significant VOC contamination problem in soil at the site.

5.3.2.2 Ground Water

Analyses for VOCs were conducted on two sets of samples from the 18 onsite monitoring wells and one set of samples from four offsite residential wells (see Table 3-6). The following VOCs were detected in ground water (near or below detection limits):

Sample I.D.	Compound	Concentration (µg/L)
P-6B-01	Benzene	BDL
W-12-01	Tetrachloroethene	BDL
W-12-02	Tetrachloroethene	5.3
W-12-02DUP	Tetrachloroethene	5.3
W-12-02MSPIKE	Tetrachloroethene	BDL

The following discussion relates to the detection of benzene in well P-6B:

- Benzene was not detected in the second sample collected from well P-6B. A faint hydrocarbon odor was noted by sampling personnel in water removed from this well during both sampling events.

- A slight oily film and fine black suspended solids were noted in water initially removed from P-6B (prior to well development). At that time, elevated flame-ionization detector (FID) readings ranging from several ppm to several tens of ppm above background were observed adjacent to the surface of water removed from the well (when agitated); however, photo-ionization detector (PID) readings were observed to be at background. While both the FID and PID measure various organic vapors, the FID is generally capable of detecting methane, while the PID is not.

- A weathered black shale (erratic) was encountered immediately above the completion zone (sand) during the drilling of well P-6B. The upper portion of the well screen and/or sand filter pack appears to be in contact with this shale (see boring log and monitor well completion details in Appendix D).

- Benzene was one of several VOCs reported to be present in ground water samples collected from monitoring wells during a previous site investigation (Section 1.0). However, benzene was not detected in any other well installed/sampled during this program, including shallow wells (P-6A and W-6) adjacent to P-6B.

From the previous discussion, the following are provided as possible explanations for the source of benzene in well P-6B: (1) The compound is associated with carbonaceous or hydrocarbon-containing shale encountered during drilling, which is also producing methane (and possibly other organic hydrocarbons not on the Hazardous Substance List [HSL], or (2) The compound is associated with contamination from the landfill. However, the source location would probably not be in the immediate vicinity of P-6B, since shallow wells at the same location do not show contamination.

The following discussion relates to the detection of tetrachloroethene in well W-12:

- While concentrations of tetrachloroethene in both samples obtained from well W-12 are very low (at or below detection limit), detection of the compound during both sampling events supports actual presence in the ground water at this location.

- W-12 is situated approximately 75 feet east of the landfill and is separated from the landfill by a drainage ditch. Piezometric surface elevations measured in shallow wells across the site (Drawing 3-6) suggest that W-12 is hydraulically upgradient of the landfill. However, local variations in ground water flow direction may occur, due to downward vertical gradients resulting from recharge from the ditch, or possibly due to preferential flow through more permeable esker deposits to the east of the landfill.

- Several drums can be observed in the bottom and along the eastern end of the drainage ditch near W-12; these may be associated with the low-level detection of tetrachloroethane in this well.

- While tetrachloroethene was detected at low levels in several surface water samples, the locations were Scioto River sampling points; none were points along the drainage ditch. Tetrachloroethene was not detected in other ground water samples collected during this program, nor was it reported in samples collected during previous site investigations.

Based on the previous discussion, it is concluded that tetrachloroethene is present in low levels in shallow ground water near W-12. The occurrence appears to be isolated, and may be associated with the presence of drums in and along the eastern edge of the drainage ditch (separate from the landfill).

Overall conclusions relative to the presence of VOCs in ground water at the site are as follows:

- Except for the apparently isolated occurrence of low levels of tetrachloroethene near W-12 (and possibly benzene near P-6B), current data indicate that VOCs are not present in ground water at the site.

- VOC contamination previously reported in two wells installed during an earlier study (Section 1.3) is apparently isolated in areal extent, or, to some degree, may be of lesser magnitude than earlier data suggested, possibly due to problems associated with well construction or laboratory analytical procedures during the earlier program (note that a significant discrepancy in reported concentrations of two VOCs, based on two analyses of the same sample, existed in the earlier study report, as discussed in Section 1.3).

5.3.2.3 Surface Water

Twenty-eight surface water samples (including duplicates) were collected at 12 locations during two sampling events and analyzed for VOCs (Table 3-12). No VOCs were detected at levels above CRDL. The following were detected below CRDL:

Sample I.D.	Compound	Concentration (µg/kg)
SW-18-01	Tetrachloroethene	BDL
SW-20-01	Tetrachloroethene	BDL
SW-22-01	1,2-dichloroethane	BDL
	Tetrachloroethene	BDL
SW-23-01	1,2-dichloroethane	BDL

The VOCs listed above were detected at very low concentrations (below detection limits), in Scioto River samples only, and occurred only during the first round of sampling (low-recharge conditions). While one possible explanation for the occurrence of these VOCs might be discharge of (contaminated) ground water to the Scioto River during baseflow conditions (low dilution potential), ground water quality data obtained from monitoring wells near the river concurrent with collection of these samples (locations 5, 7, and 8) do not support such a position. A more plausible explanation for the presence of these VOCs, especially in light of detection at upstream location 18, is the existence of an upstream (external) source contributing low levels of VOCs that were detectable at the site during this period.

5.3.2.4 Sediment

Of the 28 sediment samples collected during two site sampling events, VOCs were reported above CRDL at one location and below CRDL at four locations (Table 3-17). Results are summarized as follows:

Sample I.D.	Compound	Concentration (µg/kg)
SE-28-01	Chloroform	BDL
SE-28-01DUP	Chloroform	BDL
SE-18-02	Chloroform	BDL
SE-26-02	Chloroform	BDL
SE-22-02	Toluene	61*
SE-25-02	Toluene	BDL*

As discussed previously for soil sample results, the detected values of chloroform are very low (below detection limit). Detection at locations 26 and 28 (Drawing 3-13) tend to agree with detections at soil sampling locations 31 and 34 (Drawing 3-14) in that all are in low-lying drainageways adjacent to the landfill. However, detection of chloroform in sediment at background location 18 suggests a possible external (or natural) source of this compound at very low levels.

A specific source of toluene detected at locations 22 and 25 would be difficult to establish. The fact that toluene was detected in the field blank further compounds the problem.

Several areas containing oily sheens were observed in the sediment along the Scioto River bank near location 22, during both sampling events. On each occasion, an attempt was made to sample such areas, to maximize detection of potential contaminants. No VOCs were detected in sediment from location 22 during the first round; the toluene (61 µg/kg) detected during the second round may be associated with the observed oily sheens.

Several potential explanations exist relative to the presence of oily sheens and toluene in the vicinity of location 22, including:

- Surface migration of leachate to the south from the landfill.
- Discharge of (contaminated) ground water to the river from beneath the landfill.
- Transport and deposition of contaminants by the Scioto River from an upstream (external) source.

* Toluene was also detected in the field blank associated with the sediment samples, at a concentration below the CRDL.

While toluene was included as one of several VOCs detected in portions of the ground water and surface water samples collected during earlier site studies (Section 1.0), it was not detected in any other samples of the various media obtained during this investigation.

5.3.2.5 Summary

Occurrences of VOCs in the various media associated with this investigation are summarized below:

Medium	Compound	Concentration	Location(s)
Soil	Chloroform	BDL	31
	Bromomethane	BDL	34
Ground Water (Round 1)	Benzene	BDL	P-6B
	Tetrachloroethene	BDL	W-12
Ground Water (Round 2)	Tetrachloroethene	BDL-5.3 µg/L	W-12
Surface Water (Round 1)	Tetrachloroethene	BDL	18, 20, 22
	1,2-dichloroethane	BDL	22, 23
Surface Water (Round 2)		NOT DETECTED	
Sediment (Round 1)	Chloroform	BDL	28
Sediment (Round 2)	Chloroform	BDL	18, 26
	Toluene	BDL	25
	Toluene	61 mg/kg	22

In all, 35 VOCs were analyzed for in a total of 127 samples (including duplicates) resulting in a total of over 4,000 discrete parameter tests. Of that total, 10 samples were reported to contain a VOC at levels below CRDL limits, and three at levels slightly above CRDL limits (from two locations: W-12 and SE-22).

These results demonstrate that, with the possible exception of a few relatively isolated areas at the site (primarily ground water near W-12 and sediment near SE-22, and possibly areas near previously installed wells MW-1 and MW-2), volatile organic compounds were not found at detectable levels in the media as a result of landfilling activities.

5.3.3 Semi-Volatile Organic Compounds

In the following discussions relative to the occurrence of semi-volatile organic compounds in various onsite media, one compound, bis (2-ethylhexyl) phthalate is excluded from consideration. The following reasons support this exclusion:

- A number of the reported values of this compound were listed with qualifiers to indicate a similar presence in associated laboratory blanks.
- Laboratory personnel report that this compound is a frequent artifact, or laboratory contaminant, resulting from the use of various equipment manufactured with plastic (e.g., tubing, container lids, etc.).
- Several of the various field blanks and background samples contained the compound.
- The majority of occurrences of the compound were below CRDL limits.

5.3.3.1 Soil

Results of analyses of 22 surficial soil samples for 65 semi-volatile compounds are summarized below (see Tables 3-23 and 3-28). Compounds belonging to a group known as polynuclear aromatic hydrocarbons, or PAHs (fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3- cd)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene), have been grouped together in cases where concentrations were below CRDL limits, as similar concentrations were detected in background samples 45 and 46. In cases where concentrations(s) exceeded CRDL limits, the compound and corresponding concentration is itemized.

Sample I.D.	Compound	Concentration (µg/kg)
All (including background locations 45 and 46)	PAHs (one or more)	BDL
SO-11	Benzo(b,k)fluoranthene*	460
SO-34	Di-n-butylphthalate	BDL
SO-39	Phenanthrene	6,800
	Fluoranthene	9,100
	Pyrene	11,000
	Benzo(a)anthracene	4,300
	Chrysene	5,200
	Benzo(b,k)fluoranthene*	8,600
	Benzo(a)pyrene	4,300
	Indeno(1,2,3-cd)pyrene	2,600
	Benzo (g,h,i)perylene	3,100
	Butyl benzyl phthalate	BDL
	Di-n-octyl phthalate	BDL
	Acenaphthylene	BDL
	Acenaphthene	BDL
	Dibenzofuran	BDL
SO-40	Di-n-butylphthalate	BDL
SO-41	Benzoic acid	BDL
	Di-n-butylphthalate	BDL
SO-42	Benzo(b,k)fluoranthene*	470
SO-43	Benzo(b,k)fluoranthene*	510
	Di-n-octyl phthalate	BDL
SO-44	Fluoranthene	660
	Pyrene	560
	Benzo(b,k)fluoranthene*	960
	Benzoic acid	BDL

* -- Benzo(b)fluoranthene and benzo(k)fluoranthene are combined because the laboratory was unable to distinguish between isomers.

As discussed previously (Section 3.4.5.2), the widespread presence of low levels of PAH compounds (below or near CRDL limits) in the soil, both onsite and offsite (background) suggest either natural occurrence or another (external) source apart from the landfill.

Two occurrences of di-n-octyl phthalate (locations 34 and 43) and one occurrence of benzoic acid (location 44), all at levels below CRDL limits, do not appear to follow any pattern, or present evidence of contamination from the landfill.

A single soil sampling point, location 39 (east of the landfill), appears to exhibit concentrations of virtually all PAH compounds at levels above background. Several other semi-volatile compounds, including two phthalates and one other, were also detected at location 39, all below CRDL limits. Potential sources for the elevated levels of semi-volatiles at location 39 include:

- Shreads of plastic sheeting and other plastic debris mixed in with the soil matrix, primarily in relation to phthalate compounds.
- Presence of creosote or related substances in the area (e.g., railroad ties), primarily in relation to PAHs.
- Past occurrence of burning refuse, including plastic sheeting and other organic substances, particularly low-temperature combustion or smoldering (pyrolysis), as this tends to produce PAH compounds. Previous reports on the landfill (Burgess & Niple, 1981) indicate that burning of trash was a common occurrence during the years of operation (either intentional or unintentional).

5.3.3.2 Ground Water

As shown in Table 3-7, semi-volatile compounds above CRDL were not detected in any of the 49 samples. Three occurrences at levels below CRDL are:

Sample I.D.	Compound	Concentration (µg/L)
P-6B-01	2-Methylnaphthalene	BDL
W-7-01	Di-n-butylphthalate	BDL
W-13-01	N-nitrosodiphenylamine	BDL

The 2-methylnaphthalene reported in well P-6B during Round One (but not Round Two) is most likely associated with the low-level detection of benzene (also in Round One only). As discussed previously, it is not clear whether the source of the low-level organic compounds is natural or man-induced.

The remaining two semi-volatiles listed above as detected in ground water do not appear to indicate the presence of contamination, due to the low-level concentrations and lack of an areal pattern. The phthalate compound may be a laboratory contaminant, similar to bis (2-ethylhexyl) phthalate.

5.3.3.3 Surface Water

Of the two sets of surface water sampled and analyzed from 12 locations, only one semi-volatile compound, diethylphthalate, was detected (SW-22-01), and that was below CRDL limits (see Table 3-13). This phthalate may be a laboratory contaminant, or may be associated with the landfill (or other, external sources). However, the overall conclusion is that contamination of surface water by semi-volatile compounds is not present at the site.

5.3.3.4 Sediment

Results of the two rounds of sediment sample collection/analyses for the 12 sampling locations are summarized below (PAH compounds at concentrations below CRDL limits are grouped together due to the widespread occurrence of these compounds in sediment at low levels). A phthalate compound, Di-n-octyl phthalate, is excluded from the summary because, while found in eight samples below CRDL limits, it was also found in the background (location 18) samples.

Sample I.D.	Compound	Concentration (µg/kg)
All (including background location 18)	PAHs (one or more)	BDL
SE-18-01/02	Fluoranthene	700/900
	Pyrene	700/810
	Chrysene	550/BDL
	Benzo(b,k)fluoranthene*	910/890
SE-19-01/02	Benzo(a)anthracene	3,600/BDL
	Benzo(b,k)fluoranthene*	750/550
SE-20-01/02	Pyrene	590/BDL
SE-21-02/02DUP	Phenol	BDL/BDL
	4-Methylphenol	8,100/6,800
	Benzoic acid	BDL/BDL
SE-22-02	4-Methylphenol	8,600
	Benzoic acid	BDL
	Benzo(b,k)fluoranthene*	730
SE-23-02	Phenol	BDL
	4-Methylphenol	670
SE-24-02	4-Methylphenol	BDL
SE-25-01	4-Methylphenol	660
SE-25-02	Phenol	BDL
	4-Methylphenol	1,200
	Acenaphthene	BDL
	Fluoranthene	950
	Pyrene	800
	Chrysene	710
	Benzo(b,k)fluoranthene*	1,000
SE-26-02	Phenol	BDL
	4-Methylphenol	BDL
SE-27-02	4-Methylphenol	BDL
SE-28-02	Benzoic acid	BDL
	Benzo(b,k)fluoranthene*	760

* -- Benzo(b)fluoranthene and benzo(k)fluoranthene are combined because the laboratory was unable to distinguish between isomers.

A review of the above results indicates that, while some PAH concentrations are above CRDL limits, most are near those limits and none appear to be elevated above background.

Two phenolic compounds, phenol and 4-methylphenol, appear in four and eight sediment samples, respectively, all collected during Round Two, at concentrations ranging from below CRDL limits to 8,600 µg/kg of 4-methylphenol in sample SE-22-02. The source of these compounds is not readily apparent, although they were not found in background samples obtained from Location 18. This may suggest a possible relationship of the compounds to the landfill, although no clear indication is provided.

5.3.3.5 Summary

Occurrences of 65 semi-volatile compounds in 127 samples of the various media (over 8,000 discrete tests) are summarized below:

Medium	Compound	Concentration(µg/kg)	Locations
Soil	PAHs	BDL	all
	PAHs	above CRDL	11, 39, 42, 43, 44
	Phthalates	BDL	34, 39, 40, 41, 43
	Benzoic acid	BDL	41, 44
	Acenaphthylene, Acenaphthene, Dibenzofuran	BDL	39
Ground Water (Round 1)	2-Methylnaphthalene	BDL	P-6B
	Di-n-butylphthalate	BDL	W-7
	N-nitrosodiphenylamine	BDL	W-13
Ground Water (Round 2)		NOT DETECTED	
Surface Water (Round 1)	Diethylphthalate	BDL	22
Surface Water (Round 2)		NOT DETECTED	
Sediment (Round 1)	PAHs	Below or near CRDLs	all
	4-Methylphenol	660	25
Sediment (Round 2)	PAHs	Below or near CRDLs	all
	Phenol	BDL	21, 23, 25, 26
	4-Methylphenol	BDL-8,600	21, 22, 23, 24, 25 26, 27
	Benzoic acid	BDL	21, 22, 28

The following conclusions can be made relative to the presence of semi-volatile compounds in media at the site:

- Other than four low-level (below CRDL), apparently isolated occurrences, semi-volatile compounds are not present in ground water and surface water.
- Low levels of PAH compounds are present in soil and sediment, most likely resulting from background or external sources (see Section 3.4.5.2).

- Elevated levels of PAHs and several other semi-volatiles are present in soil at location 39 (on the eastern portion of the landfill).
- Two phenolic compounds appear to have been present in sediment at several locations throughout the site during the second round of sampling (high stage/high recharge) but were essentially absent (except for a single occurrence) during the first round of sampling (low stage/low recharge).

5.3.4 Pesticide/PCB Compounds

5.3.4.1 Soil

Of the 22 soil samples analyzed for 19 pesticide compounds, two samples were found to contain pesticides (see Tables 3-24 and 3-29). The findings are:

Location No. 11:	beta-BHC	22 µg/kg
	chlordane	110 µg/kg
	dieldrin	27 µg/kg
Location No. 7:	dieldrin	20 µg/kg

BHC (benzene hexachloride) is an insecticide formerly used in agricultural applications. It is no longer produced in the United States. It is practically insoluble in water, and vaporizes readily. Chlordane and dieldrin are also insecticides, and are presently used primarily for the subterranean control of termites. Both are insoluble in water (Farm Chemicals Handbook, 1981).

Locations No. 7 and No. 11 are in the cultivated field about 100 feet and 250 feet, respectively, from the toe of the landfill. Both samples were Shelby tube samples, and the soil analyzed was from approximately 0 to 12 inches in depth. Another Shelby tube sample (No. 10), taken at a location generally between locations 11 and 7, contained no pesticides. Also, surficial grab samples (0 to 3 inches in depth) taken from ditches adjacent to the landfill, contained no pesticides. It therefore appears that the occurrences are the result of agricultural application. Because pesticides were not found in any of the 13 soil samples collected in ditches adjacent to the landfill, it is difficult to establish the landfill as the probable source of these pesticides.

The 22 soil samples also were analyzed for the presence of seven PCB compounds. Nine of the samples tested positive (see Tables 3-24 and 3-29) and are:

Location 31	1,200 µg/kg	Aroclor 1248
Location 33	300 µg/kg	Aroclor 1254
Location 34	3,600 µg/kg	Aroclor 1248
Location 35	350 µg/kg	Aroclor 1248
Location 36	380 µg/kg	Aroclor 1248
Location 37	350 µg/kg	Aroclor 1248
Location 40	700 µg/kg	Aroclor 1248
Location 41	1,100 µg/kg	Aroclor 1248
Location 42	240 µg/kg	Aroclor 1254

Eight of the nine occurrences are from soil samples collected from ditches adjacent to the landfill; the exception is from location No. 42, which is about 100 feet from the Scioto River.

PCBs are essentially insoluble in water, and have a high chemical affinity for clay and organic compounds in soil. Accordingly, they are relatively immobile in the geologic environment.

The pattern of occurrence indicates that the landfill is the primary source of PCBs occurring at the site. The three highest levels were reported near the bend in the landfill, suggesting that a source may exist in that area. Other occurrences, except for location No. 42, are in ditches downgradient from the three samples referred to above. It is likely that silt or other materials containing PCBs may have been transported downgradient.

5.3.4.2 Ground Water

Forty-nine ground water samples from the 18 onsite wells and four offsite wells were analyzed for pesticide/PCB compounds. Neither pesticides nor PCBs were found in either set of samples. Because of the low water solubilities of most pesticides and all PCBs , it is unusual to find these compounds in water.

On the basis of the above, it can be concluded that pesticides and PCBs are not present in ground water at the site.

5.3.4.3 Surface Water

Pesticides were not found in either round of surface water samples (Table 3-14). PCBs (Arochlor 1260) were reported at very low levels at sample location 18 (1.2 µg/L), upstream of the site, and in the duplicate sample at location 21 (2.6 µg/L). PCBs were not found in the original sample obtained from location 21. No PCBs were found in the second round of samples.

On the basis of the available data, there is no indication that PCBs (that may occur on or in the landfill) are entering the surface water system.

5.3.4.4 Sediment

Two rounds of sediment samples collected at 12 locations (28 samples total, including duplicates) were analyzed for 19 pesticide compounds. The only pesticide reported was chlordane, which was detected at three locations in the first round of samples (Table 3-19). Results are as follows:

Location 20	200 µg/kg
Location 21	120 µg/kg
Location 21 DUP	140 µg/kg
Location 22	170 µg/kg

These pesticides were not found in the second round. However, DDT was detected (28 µg/kg) at location 29 (on the outside of the bend in the landfill). Its presence was not confirmed in the duplicate analysis.

As discussed previously for the soil analytical results, pesticides detected in the sediment were associated with locations away from the landfill (and near the agricultural fields), and not with locations near the landfill (such as the ditch or ponded areas). This further supports the position that pesticide compounds detected at the site may be associated with agricultural activities and not with the landfill.

Of the analyses for PCBs, one compound (Aroclor 1248) was detected at three sediment sampling locations near the landfill. These locations are in the same area as soil samples previously reported as containing PCBs (near the bend in the landfill and extending to the south). PCBs were detected in the first round of samples at those locations, but not in the second round. It appears that the occurrence of PCBs at these locations is related to the landfill, and possibly a result of short-distance transport of soil particles from the landfill surface, as discussed in Section 5.3.4.1.

5.3.4.5 Summary

Occurrence of pesticides and PCBs found at the Bowers landfill are listed below:

Medium	Pesticides	PCBs
Soil	Locations 7, 11	Locations 31, 33, 34, 35, 36, 37, 40, 41, 42
Ground Water (Round 1)	NOT DETECTED	
Ground Water (Round 2)	NOT DETECTED	
Surface Water (Round 1)	Not detected	Location 18, 21
Surface Water (Round 2)	NOT DETECTED	
Sediment (Round 1)	Locations 20, 21, 22	Locations 27, 28, 29
Sediment (Round 2)	NOT DETECTED	

The highest level of any contaminant reported was 3,600 µg/kg (ppb) of PCB in soil at location 34.

In all, 26 compounds were analyzed for in a total of 127 samples, resulting in over 3,000 discrete parameter tests. Of that total, 21 tests reported the presence of pesticides or PCBs at low (up to 3,600 µg/kg) levels. One of the 21 was an upstream (background) sample, and another was a duplicate.

Other than the occurrence of PCBs in soil and sediment near the landfill, there is no apparent geographic pattern of distribution.

Based on the results of this study, the following conclusions are made regarding the presence of pesticide/PCB compounds:

- Pesticides in soil at the site most likely are associated with onsite agricultural activities, and are not linked to the landfill.
- Pesticides in Scioto River sediment are also assumed to be the result of onsite agricultural activities, or of river silt deposition from offsite (agricultural) sources and are not linked to the landfill.
- PCBs in soil and in sediment are found near the landfill and appear to originate from the landfill.
- PCBs in surface water in the Scioto River are due to external sources, and are not linked to the landfill.

5.3.5 Dioxin

In all, 127 samples of the various media at the site were analyzed for the presence of dioxin. Dioxin was not detected in any samples of soil, ground water, surface water or sediment. Based upon recent information, both PPG and duPont have no reason to suspect that they generated dioxin or sent it to the landfill. Consequently, it is concluded that dioxin is not a contaminant of concern at this site.

5.3.6 Inorganic Elements/Cyanide

Due to the natural occurrence of inorganic elements in the environment, a method is needed to assist in an evaluation of whether levels detected are within normal ranges, or are considered to be elevated. Conventionally, background samples collected from similar environments, but away from potential source areas, are used to establish a norm. That approach has been used in this investigation; surface soil sampling locations 45 and 46 are offsite soil locations, surface water/sediment sampling location 18 is upstream on the Scioto River, and ground water sampling locations W-4, P-4A, W-9, W-12, W-13, RW-14, RW-15, RW-16, and RW-17 are upgradient of the landfill. Additionally, published data (Shacklette and Boerngen, 1984; Logan and Miller, 1983) give representative values for inorganic parameters for soil in central Ohio.

In addition to comparing data to those baselines, a statistical analysis was conducted. The method used was selected on the premise that, given a fairly extensive data population as has been collected during this study, the majority of values may be expected to be grouped together in a range of concentrations about some mean value. In geochemical studies, where log-normal distributions are common, the degree of variation (or "scatter") about the mean has been found to be fairly closely approximated by applying a statistical technique that utilizes the geometric mean (M) and geometric deviation (D). A previous study found that the scatter may be estimated by computing the product and quotient of M and D, respectively . Specifically, 68 percent of the individual values in a population should fall within the limits defined by M/D and M*D (or, in this situation, 16 percent would exceed, on average, the M*D threshold), and 95 percent should fall within the limits M/D^2 and $M*D^2$ (or 2.5 percent would exceed, on average, the $M*D^2$ threshold)(Shacklette and Boerngen, 1984).

This statistical analysis is applied to selected inorganic parameters for all of the various sample media obtained during this study. The selection of inorganic parameters was essentially based on whether or not a sufficient number of detections of a particular parameter were reported to allow a reasonable sample

population for statistical analysis. Certain major ion species, such as calcium and magnesium, were excluded, since they are generally not considered to be indicators of potential contamination.

In calculations associated with this statistical analysis, values below detection (ND) were assigned a value of one-half the reported detection limit. Values below CRDL limits were set equal to estimated concentrations provided by the laboratory (although the accuracy of these estimates remains questionable).

Results of the statistical analysis are summarized on Table 5-1, and discussed below, according to medium. In the following discussion, the selected statistical thresholds M*D and $M*D^2$ are referred to as the lower and upper thresholds, respectively. The thresholds may potentially be biased upward somewhat, due to the lumping of onsite data with background data (assuming that some elevated concentrations occur onsite).

It is emphasized that this analysis is applied as only one tool in the overall assessment of data obtained during the investigation. The fact that the concentration of a given inorganic parameter is above (or below) the selected threshold(s) is not conclusive evidence as to the presence (or absence) of contamination. The overall goal is to attempt identification of site locations where a parameter appears to be significantly elevated (or several parameters exhibit similar trends).

5.3.6.1 Soil

The 22 surficial soil samples collected during the study were analyzed for 23 inorganic elements and cyanide. Antimony and selenium were not detected in any of the samples. Because inorganic elements may be found naturally in soils, the presence of an element is not necessarily an indication of contamination.

The first conclusion drawn from an inspection of the analytical results listed in Tables 3-26 and 3-31 (prior to a statistical analysis) is that concentrations of inorganic elements are generally lower in the Shelby tube samples than in the surficial grab samples. Using a value of 2 times the maximum background level (locations 45 and 46) as a standard, 1 percent of the Shelby tube analyses (1 out of 115) exceeded that level, while 11 percent (31 out of 345) of the grab samples are above that level. One explanation is that a higher percentage of contaminants from offsite sources, such as windblown particles, and/or flood-deposited particles may be present in the shallower grab samples.

The following observations were made relative to the occurrence of inorganics in soil near the site based on general observations, comparison to background data and regional averages (Table 3-32), and specific statistical analyses (see Table 5-1) of arsenic, barium, cadmium, chromium, iron, lead, mercury, nickel, and zinc:

Aluminum	No sample exceeded the central Ohio average; also, aluminum is typically not an indication of soil contamination.
Antimony	Parameter was not detected in any samples.
Arsenic	Highest level found at location No. 11 in cultivated field; other occurrences above the lower statistical threshold used herein were detected at locations 34, 36, 40, 41 and 44, near the landfill.
Barium	No sample exceeded central Ohio average. Two samples (locations 34 and 40) were above the lower level (16 percent exceedance expected) threshold.
Beryllium	Although not detected in background samples, the occurrences found do not exceed central Ohio averages.
Cadmium	Occurrences are in line with background levels; maximum occurrence of 2.4 mg/kg compares with background sample of 2.1 mg/kg. When analyzed statistically by sample type (grab versus Shelby tube), only background sample No. 45 exceeded a threshold value.
Calcium	Although several values were above expected levels, only one was more than 24 percent above the higher background sample; also, calcium is not a typical indicator of contamination.
Chromium	No sample was more than 28 percent above the higher background sample. Sample No. 11 was above the lower statistical threshold.
Cobalt	The highest reading was nearly twice the level of the second highest which was about 38 percent above the higher background sample. The high level was at location No. 34.
Copper	No sample exceeded the higher background sample by more than 36 percent.
Cyanide	Not detected in any samples.
Iron	Iron in excess of 25 percent over the higher background sample occurred at 10 locations. Generally, those locations were proximal to the landfill. Location 36 was above the lower statistical threshold.
Lead	Statistically high occurrences of lead were found at locations 5, 11, 35 and 44. One is in the field (11), and the other three are near the landfill.
Magnesium	Levels in excess of 125 percent of the higher background level were found at five locations. Two were near the landfill and three were near the river. Magnesium is not considered an indicator of contamination.
Manganese	One sample was more than 4 percent above the higher background sample. Two samples (34 and 40) were above the lower threshold; one (34) was above the upper threshold.

Mercury	Statistically high levels were found in the two background samples (45 and 46), and at locations 40 and 43. The highest level was at location 43, in the agricultural field.
Nickel	Levels reported were within average range for central Ohio soils. Locations 10 and 34 were above the lower statistical threshold; location 34 was above the upper threshold.
Potassium	Only one of the 22 samples is below the higher background sample. Potassium is commonly used in agricultural applications, and none of the levels reported was above average for central Ohio soils.
Selenium	Not detected in any samples.
Silver	Silver (0.47 mg/kg) was found in only one sample, location No. 33.
Sodium	Not detected in any samples.
Thallium	Thallium (0.49 mg/kg) was found in only one sample, location No. 30.
Vanadium	Levels exceed 125 percent of background in all but three samples. There is no pattern to the distribution. No levels exceed averages for soil in central Ohio.
Zinc	Statistically high levels were found in two samples, one in the field (No. 11) and one near the landfill (No. 35).

Locations with three or more statistical outliers include two that are proximate to the landfill (34 and 40), and one in the cultivated field (11). Arsenic is the analyte most commonly found as a statistical outlier (six locations), and is the only element to occur in all three locations mentioned above. Arsenic was commonly used as an ingredient in agricultural pesticides, and its occurrence in soil at these levels may be related to such an application.

5.3.6.2 Ground Water

Ground water samples were collected from the 18 monitoring wells on two occasions and four residential wells on one occasion (Table 3-10). The following elements were not detected in any of the samples (above CRDL limits):

Aluminum	Antimony
Beryllium	Cadmium
Chromium	Cobalt
Copper	Nickel
Selenium	Silver
Thallium	Vanadium

The following elements were found in at least one sample of ground water above CRDL limits:

Element	Highest Level Found
Arsenic (50 µg/L)	20 µg/L
Barium (1,000 µg/L)*	2,020 µg/L
Calcium	133,000 µg/L
Iron [300 µg/L]**	8,760 µg/L
Lead (50 µg/L)*	10 µg/L
Magnesium	50,600 µg/L
Manganese [50 µg/L]**	1,890 µg/L
Mercury (2 µg/L)*	0.76 µg/L
Potassium	7,060 µg/L
Sodium	183,000 µg/L
Zinc [5,000 µg/L]**	24 µg/L
Cyanide	20 µg/L

* ( ) Primary Drinking Water Standard
** [ ] Secondary Drinking Water Standard

Notable by their absence were elements typically found in contaminated ground water, such as cadmium, chromium, and copper.

Not surprisingly, the most commonly detected elements in the ground water samples were calcium, iron, magnesium, manganese, and sodium. All are found in naturally-occurring ground water. Maximum values for these five elements are within the range of values generally found in ground water for Ohio. A statistical analysis of iron, manganese, and sodium resulted in eight, six, and three samples (many from the same well location) above the selected lower threshold (Table 5-1), respectively. One sample exceeded the upper threshold for sodium.

Arsenic was above the lower statistical threshold in eight samples from six locations (including background location W-4), and above the upper selected threshold in one sample, W-07-02 (see Table 5-1).

Barium was found in 12 locations. The highest level was at location P-5B, where concentrations during both sampling rounds were above drinking water standards (samples obtained from well P-5B also exhibited the highest values of field specific conductance). All three of the wells completed in the deeper aquifer contained concentrations of barium higher than those reported in upper aquifer wells, and above one or both of the selected statistical thresholds (Table 5-1). This may indicate a general difference in geochemistry between the two aquifer systems, and is not attributed to effects of the landfill.

Cyanide was found at only one location, W-04-01, which is hydraulically upgradient from the landfill. It was not found at that location in the second sampling event. While this one occurrence is an indication that cyanide may exist in ground water in the area, the cyanide reported cannot be attributed to the landfill.

Lead was found at two locations (No. 6 and No. 11) during the second round of sampling. Location No. 6 is adjacent to the landfill, while No. 11 is in the field. Both reported values were below 10 µg/L. The low levels and the absence of positive results in the first round of samples, suggests that ground water at the site is not contaminated with lead.

Mercury was found at one location (No. 4) in both aquifer levels during the second sampling event. None was detected in the first round sample. The well is hydraulically upgradient of the landfill. Accordingly, it is concluded that there is no evidence of mercury contamination from the landfill.

Potassium was noted at two locations, No. 5B and No. 7A. The presence of potassium was noted in both sampling rounds at No. 5B, but only in the second round at No. 7A. The locations are at the opposite ends of the landfill. Potassium is a commonly occurring element and generally not an indicator of contamination.

Zinc was detected in all ground water samples obtained during the RI, but nine of the reported concentrations were below CRDL detection limits. Six of the locations where concentrations were above CRDL are upgradient, or outside of the area of influence, of the landfill. The three remaining locations are W-7, W-8, and W-12. All concentrations above CRDL were reported in association with the first round of samples, except at Location No. 10, where zinc was detected in the duplicate sample obtained during round two, but not in the original sample. A statistical analysis indicates that RW-17 contains zinc above the selected thresholds (Table 5-1). The presence of zinc in the residential wells (particularly RW-17) may be related to the use of galvanized steel pipe in well casing and/or plumbing systems.

Overall, inorganic concentrations found in ground water are at expected concentrations. Observed statistical outliers (based on the selected thresholds) demonstrate no pattern of occurrence. The majority of inorganic parameters are in line with background levels. In several instances, water from the deeper aquifer exhibited higher concentrations of an analyte than did water from the shallow aquifer. Because of these reasons, the landfill does not appear to be contributing inorganics to ground water.

5.3.6.3 Surface Water

The following analytes were not detected at levels above CRDL limits in any of the 28 surface water samples (see Table 3-16):

Antimony	Arsenic
Beryllium	Cadmium
Chromium	Cobalt
Copper	Nickel
Potassium	Selenium
Thallium	Vanadium

Barium (50 µg/L) was detected in the first sampling event at location No. 23, downstream of the site in the Scioto River. Mercury was noted in two locations, No. 27 and No. 26, one each in the first and second, respectively. Silver was found at low levels in one blank sample, and in the second sample obtained at location No. 26. The low concentration of these metals coupled with their random geographic distribution and non-reproducibility (over time) of results is not indicative of a source of surface water contamination at the landfill.

Aluminum was found at relatively low levels at five surface water locations (No. 22, No. 23, No. 25, No. 27, and No. 29). The highest location was at location No. 29 (1,140 µg/L). With the exception of location No. 25, all occurrences were noted in a sample from either the first or second round, but not from both. Although the landfill may represent a source of inorganic compounds, the low levels, wide geographic distribution, and non-reproducibility of results makes it difficult to attribute inorganic levels in surface water to the landfill.

Statistical analysis of iron, manganese, sodium, and zinc in surface water resulted in one location (28) with manganese above the upper threshold (Table 5-1). Sodium appears to have been present at concentrations ranging between 36,000 and 40,000 µg/L in the Scioto River during the first round of sampling (including upstream location 18). Iron was present at concentrations between 2,000 and 2,500 µg/L in several samples collected along the drainage ditch east of the landfill. Manganese appears to be present at statistically high levels in the ponded water at location 28, just west of the landfill (Round One location north of the access road).

Cyanide was detected at four locations (No. 19, No. 20, No. 22, and No. 23). All are located in the Scioto River, and all were found in the second round of samples, but not the first round. Concentrations ranged from 10 to 16 µg/L. The source of this cyanide does not appear to be connected with

the landfill, especially since cyanide was not detected in surface water samples closer to the landfill and ground water samples (near potential discharge areas) in the vicinity of the four locations listed above.

5.3.6.4 Sediment

Sediment samples were collected at 12 locations on two different occasions (Table 3-21). Seven analytes -- antimony, beryllium, potassium, selenium, sodium, thallium, and cyanide -- were not found at detectable levels in any of the samples.

One sample, SE-22-01, was above the selected upper statistical threshold for arsenic (Table 5-1). Locations where reported values of arsenic, barium, chromium, iron, lead, manganese, mercury, or nickel were above the selected statistical lower threshold are summarized below (see Table 5-1):

Sample Location	
18	Arsenic
22	Arsenic, chromium, iron, lead, mercury, nickel
24	Arsenic, chromium, iron, lead, mercury, nickel
27	Arsenic, chromium, iron, lead, mercury, nickel
28	Arsenic, barium, iron, nickel, zinc
29	Arsenic, barium, manganese, mercury, nickel, zinc

Locations 28 and 29 are proximate to the landfill, locations 24 and 27 are along the drainage ditch adjacent to the landfill, location 21 is at the drainage ditch outfall near the Scioto River, and location 22 is along the Scioto River. The most commonly occurring elements above the selected lower statistical threshold were nickel (six samples from three locations), arsenic (five samples from five locations), and barium (five samples from two locations).

Interestingly, with two exceptions (iron and mercury), the concentrations of all analytes found in sediment are lower than those detected in soil, based on a comparison of statistical threshold values (see Table 5-1 and Section 5.3.6.1). It would seem that sediment in pools adjacent to or associated with the landfill would collect and accumulate inorganics that may originate from the landfill, with the result that concentrations of inorganics in sediment would exceed that of soil. However, data indicate the reverse to be true. It is not readily apparent why the observed relationship exists.

5.3.7 Conclusions

5.3.7.1 Volatile Organic Compounds

The low levels (below CRDL limits) of two VOCs found in soil near the landfill are not indicative of soil contamination. There is no evidence to suggest that measurable levels of VOCs from the landfill have contaminated soil in the cultivated field or to the east of the landfill.

The 1981 investigation found evidence of VOC contamination at two locations in shallow ground water adjacent to the landfill. The only VOC species (above detection limits) found in ground water during this study was from W-12, a location hydraulically upgradient from the landfill. It is postulated that this occurrence is caused by a source east of the landfill, or from drums observed between the landfill and the gravel pit. The results of this investigation bring into question the results of the 1981 study. Results of this current investigation demonstrate that if VOC contamination is present in portions of the landfill, it is apparently not migrating into the ground water system.

Previous site studies reported only limited evidence of surface water contamination in the Scioto River or in water bodies adjacent to the landfill (see Table 1-1 and Drawing 3-1). Results of this investigation do not suggest the presence of surface water contamination related to the landfill. The 1981 study reported the presence of leachate seeps from the landfill. None were noted during this investigation.

The only report of a VOC compound in sediment involved the detection of toluene in Sample SE-22-02. Sample location 22 is at the outfall of the drainage ditch to the east of the landfill; therefore, the landfill may be considered a potential source of this detected compound. However, the location is also on the active floodplain of the Scioto River, and toluene was detected in the field blank associated with the second round of sediment samples (below CRDL). Because of these additional factors, a clear identification of the toluene source is not possible.

Although VOCs are reported to be present in the landfill and were found during the 1981 study, the investigation reported herein did not find evidence of environmental contamination by VOCs from the landfill.

5.3.7.2 Semi-Volatile Organic Compounds

Semi-volatile compounds (primarily PAHs) were found in soil at elevated levels at one location (location 39 on top of the landfill) and at lower levels at several other locations. PAHs were reported to be present at levels near or below detection at all (including background) locations. Non-elevated levels of semi-volatiles are not attributed to the presence of the landfill. Elevated levels near location 39 appear to be related to the landfill and are probably the result of past landfilling activities (burning).

There is no evidence that semi-volatiles from the landfill have contaminated ground water.

There is no evidence that surface water has been contaminated by semi-volatiles from the landfill.

The low levels of semi-volatile concentrations in sediment (primarily PAHs) are not indicative of contamination, but rather are most likely due to background or external sources (as discussed for surficial soil).

In summary, some semi-volatile compounds, primarily PAHs, were found at all locations. Because PAHs are found widely in the environment, the source(s) cannot be identified with certainty. The overall low levels encountered in surficial soil and sediment at the site, and the lack of detection in any of the ground water or surface water samples, demonstrate that transport of any elevated levels of semi-volatiles (i.e., location 39) from the landfill has not occurred.

5.3.7.3 Pesticides

Pesticides were found in soil and sediment at low levels and not in ground water or surface water. The landfill may be considered a potential source of these compounds. A more probable source, however, is considered to be from applications and treatment of the cultivated field in association with agricultural practices.

5.3.7.4 PCBs

PCBs were found in soil, sediment, and surface water. The surface water occurrences were in the Scioto River (including an upstream location), and appear to be due to an external source, rather than the landfill. However, the pattern of distribution of PCBs in soil and sediment indicates that those occurrences

probably originate from the landfill. PCBs were not found in ground water or surface water samples collected adjacent to the landfill, indicating that transport of PCBs in water is not occurring.

5.3.7.5 Dioxin

Dioxin was not found in any sample collected from surficial soil, sediment, surface water, or ground water media at the site, and is not believed to have been disposed of in the landfill. It is concluded that no dioxin-related contamination is occurring.

5.3.7.6 Inorganic Compounds

Several inorganic elements (primarily arsenic, lead, and mercury) were detected in surficial soil samples at levels which, based on the chosen statistical analysis, appear to be above the ranges of values expected at the site. No clear pattern of occurrence of these values is evident at the site, however. Variations may be due, in part, to natural changes in soil mineralogy or, in the case of arsenic, due to pesticide residues. Concentrations of most remaining inorganic elements were similar to reported regional values, or did not exhibit statistically significant variation across the site. Overall, the evidence does not support the presence of inorganic contamination in the soil due to the landfill.

Concentrations of inorganic parameters in sediment samples, while exhibiting some statistical variation, were essentially much lower than maximum values detected in soil samples.

Concentrations of inorganic parameters in surface water samples were all very low; most were not detected in a sufficient number of samples to allow a statistical analysis.

The majority of inorganic parameters detected in ground water samples were at levels comparable to observed background values and/or commonly occurring regional values (e.g., iron). Concentrations of arsenic, while exhibiting some statistical variation, were all well below the primary drinking water standard, and in the same range as background values. The source of apparently elevated levels of manganese in two shallow wells is not apparent; however, the occurrences appear to be isolated. Elevated concentrations of barium and sodium in lower aquifer well samples appear to be due to natural geochemical variations, especially since levels in shallow wells were much lower.

Overall, the presence of inorganic parameters within the various media at the site are within the range of expected values. Concentrations of several elements, primarily in surficial soil and ground water,

exhibit some statistical variation, possibly due to natural mineralogical/geochemical variations. Low concentrations of inorganics in surface water, and for the most part, in ground water, indicate that transport of these constituents offsite is not occurring.

TABLE 5-1

SUMMARY OF STATISTICAL ANALYSIS, SELECTED INORGANIC PARAMETERS
BOWERS LANDFILL - CIRCLEVILLE, OHIO
(Concentrations as shown)

Data Group	Population (n)	Parameter	Geometric Mean (M)	Geometric Deviation (D)	M*D	Values Above M*D (Location/ Concentration)	$M*D^2$	Values Above $M*(D)^2$ (Location/ Concentration)
1. Surficial grab soil (concentrations in mg/kg)	15	Arsenic	30.7	3.2	98	SO-34/144 SO-36/153 SO-40/103 SO-41/121 SO-44/102	314	None
		Barium	180	1.4	252	SO-34/279 SO-40/287	353	None
		Cadmium	1.5	1.7	2.6	None	4.3	None
		Chromium	23	1.3	30	None	39	None
		Iron	30,492	1.3	39,640	SO-36/47,800	51,532	None
		Lead	97.8	1.5	147	SO-35/179 SO-44/155	220	None
		Manganese	547.7	1.3	712	SO-34/1,290 SO-40/745	926	SO-34/1,290
		Mercury	0.28	1.5	0.42	SO-40/0.43 SO-43/0.58	0.63	None
		Nickel	38.3	1.4	54	SO-34/94	75	SO-34/94
		Zinc	189	1.5	284	SO-35/540	425	SO-35/540

TABLE 5-1 (Continued)

Data Group	Population (n)	Parameter	Geometric Mean (M)	Geometric Deviation (D)	M*D	Values Above M*D (Location/ Concentration)	$M*D^2$	Values Above $M*(D)^2$ (Location/ Concentration)
2. Surficial Shelby tube soil (concentrations in mg/kg)	7	Arsenic	19	2.7	51.3	SO-11/169	139	SO-11/169
		Barium	125	2.0	250	None	500	None
		Cadmium	1.5	1.3	1.95	SO-45/2.1 (Background)	2.5	None
		Chromium	19.2	1.3	25	SO-11/28	33	None
		Iron	27,382	1.2	32,858	None	39,430	None
		Lead	78.6	1.2	94	SO-5/95 SO-11/102	113	None
		Manganese	594	1.3	772	None	1,003	None
		Mercury	0.19	1.6	0.29	SO-45/0.31 (Background) SO-46/0.32 (Background)	0.46	None
		Nickel	36.5	1.1	40	SO-10/41	44.2	None
		Zinc	232.5	1.3	302	SO-11/397	393	SO-11/397

TABLE 5-1 (Continued)

Data Group	Population (n)	Parameter	Geometric Mean (M)	Geometric Deviation (D)	M*D	Values Above M*D (Location/ Concentration)	$M*D^2$	Values Above $M*(D)^2$ (Location/ Concentration)
3. Surface water (µg/L)	28	Iron	568.4	2.3	1,307	SW-21-02/2,540 SW-21-02DUP/2,450 SW-25-01/2,060 SW-29-02/2,420 SW-29-02DUP/2,460	3,007	None
		Manganese	82.9	2.5	207	SW-28-01/787 SW-28-01DUP/817	518	SW-28-01/787 SW-28-01DUP/817
		Sodium	11,833	2.5	29,600	SW-18-01/37,800 (Background) SW-19-01/37,500 SW-20-01/36,400 SW-22-01/39,400 SW-23-01/39,700	74,000	None
		Zinc	20.9	1.6	33.4	SW-18-01/34 SW-23-02/37 SW-28-01/48 SW-28-01DUP/43	53.5	None

TABLE 5-1 (Continued)

Data Group	Population (n)	Parameter	Geometric Mean (M)	Geometric Deviation (D)	M*D	Values Above M*D (Location/ Concentration)	$M*D^2$	Values Above $M*(D)^2$ (Location/ Concentration)
4. Ground water (µg/L)	49	Arsenic	3.7	2.2	8	W-04-02/8.4 (Background) P-5B-01/8.7 P-5B-02/11 W-07-02/20 P-7A-01/11 W-11-01/8.6 W-13-02/17 W-13-02DUP/11	18	W-07-02/20
		Barium	234.8	2.0	470	P-5B-01/2,020 P-5B-02/2,020 P-6B-01/488 P-6B-02/531 P-6B-02DUP/522 P-8B-01/596 P-8B-02/684	939	P-5B-01/2,020 P-5B-02/2,020
		Iron	291.7	10.9	3,180	W-07-02/3,700 W-11-01/8,760 W-11-02/5,930 W-13-01/7,110 W-13-02/6,000 W-13-02DUP/5,980 RW-15/30,000 RW-17/4,670	34,660	None
		Manganese	129.4	4.9	634	W-06-01/1,350 W-06-01DUP/1,360 W-06-02/1,330 W-10-01/1,890 W-10-01DUP/1,880 W-10-02/657	3,100	None

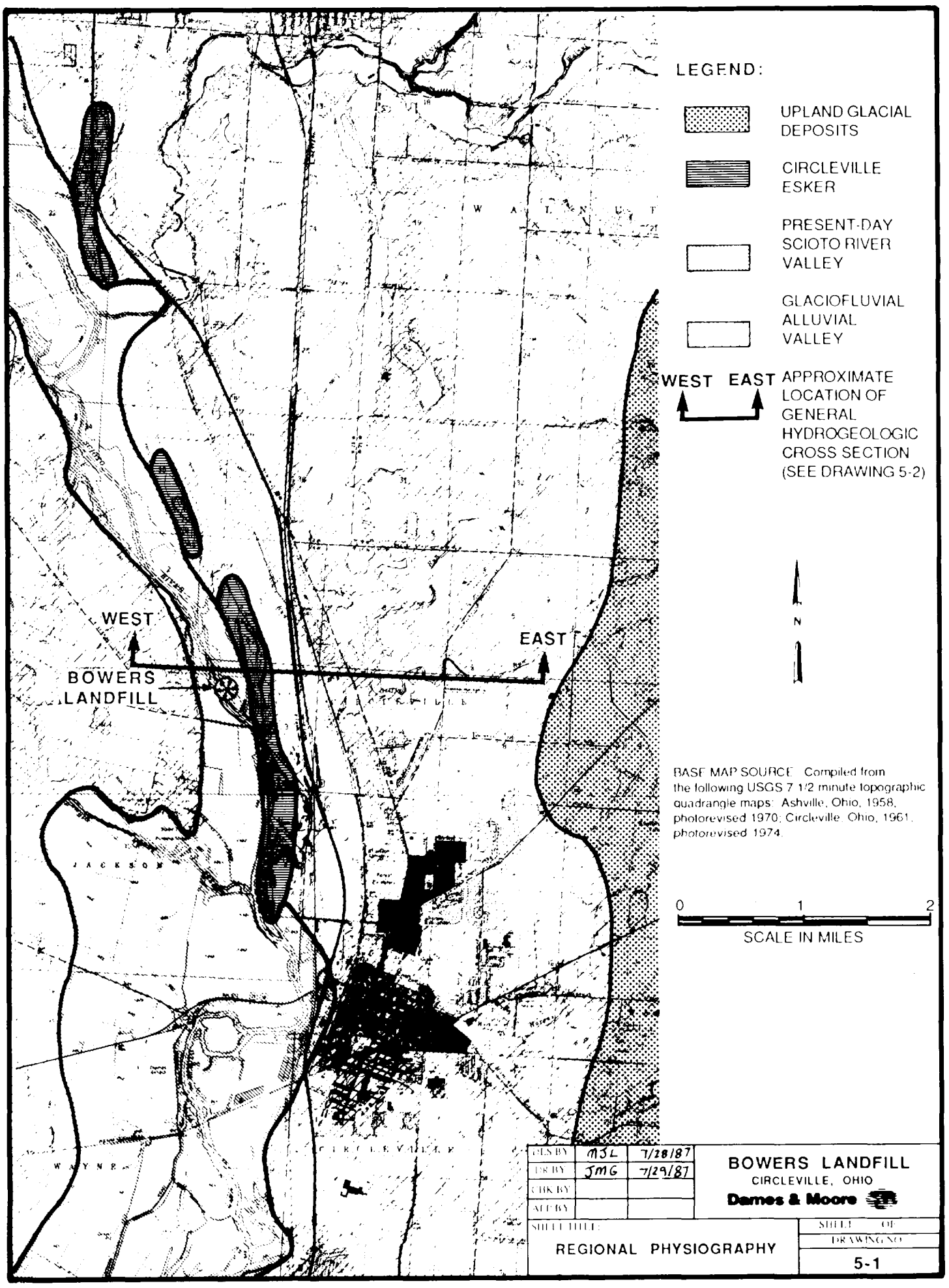
TABLE 5-1 (Continued)

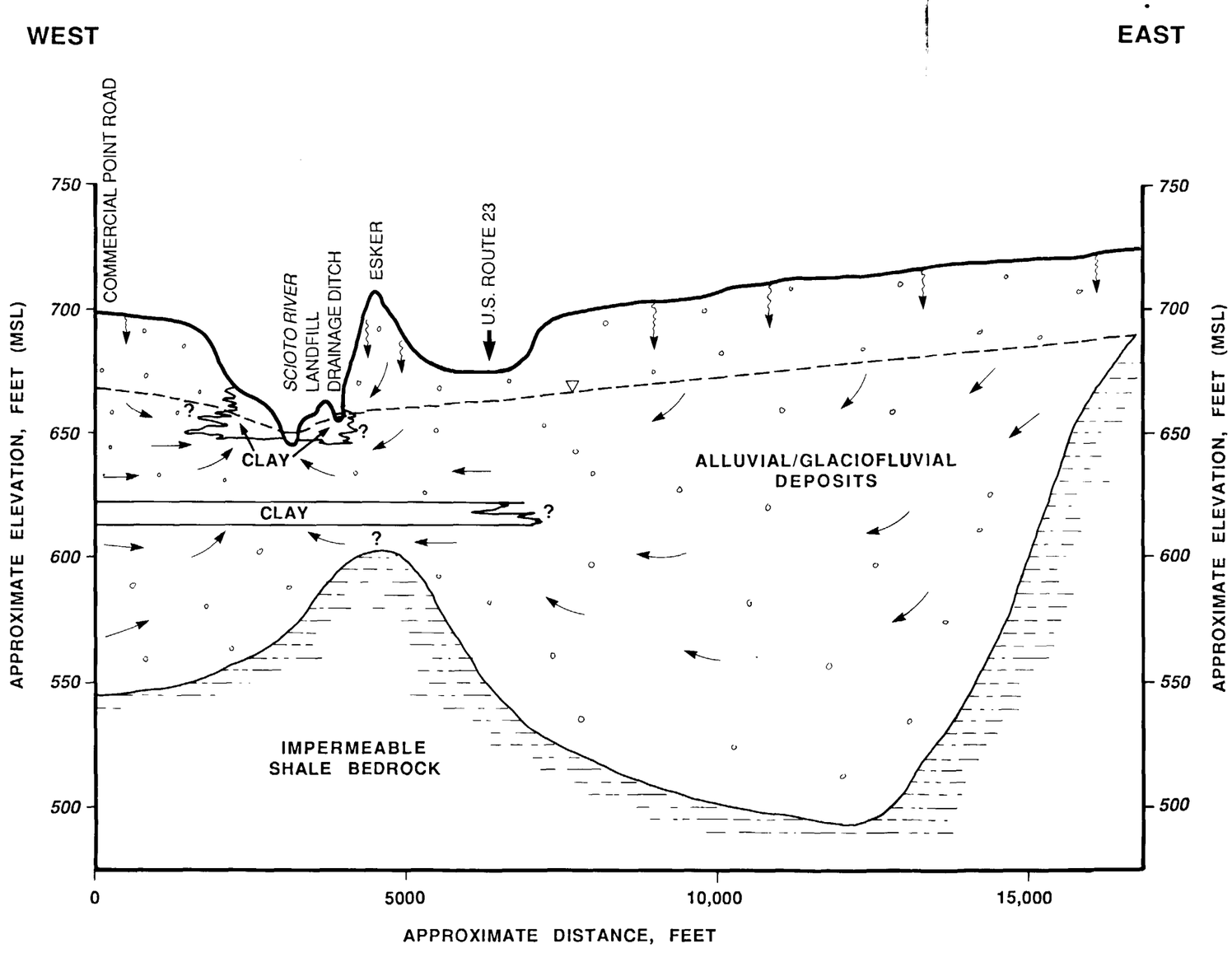
Data Group	Population (n)	Parameter	Geometric Mean (M)	Geometric Deviation (D)	M*D	Values Above M*D (Location/ Concentration)	$M*D^2$	Values Above $M*(D)^2$ (Location/ Concentration)
4. Ground water (continued)		Sodium	9,845	2.7	26,580	P-5B-01/183,000 P-5B-02/173,000 P-6B-01/29,700	71,800	P-5B-01/183,000 P-5B-02/173,000
		Zinc	12.5	2.0	25	RW-17/174	50	RW-17/174
5. Sediment (concentrations in mg/kg)	28	Arsenic	7.0	1.6	11.2	SE-18-01/12 SE-21-02/12 SE-22-01/21 SE-28-01DUP/13 SE-29-01/16	17.9	SE-22-01/21
		Barium	112.7	1.5	169	SE-28-01DUP/171 SE-28-02/179 SE-29-01/205 SE-29-02/179 SE-29-02DUP/204	254	None
		Chromium	11.9	1.7	20	SE-21-01/25 SE-21-01DUP/26	34	None
		Iron	18,193	1.4	25,037	SE-21-01DUP/26,100 SE-27-01/26,600 SE-28-01/25,400 SE-28-01DUP/30,200	34,648	None
		Lead	35	1.8	63	SE-21-01/101 SE-21-01DUP/98 SE-26-02/79 SE-27-01/104	113	None

TABLE 5-1 (Continued)

Data Group	Population (n)	Parameter	Geometric Mean (M)	Geometric Deviation (D)	M*D	Values Above M*D (Location/ Concentration)	$M*D^2$	Values Above $M*(D)^2$ (Location/ Concentration)
5. Sediment (continued)		Manganese	399	1.5	599	SE-24-02/665 SE-29-01/854 SE-29-02/658 SE-29-02DUP/846	898	None
		Mercury	0.21	2.8	0.59	SE-21-02/1.1 SE-24-02/0.76 SE-26-02/1.4 SE-29-02/1.0	1.65	
		Nickel	24.5	1.4	34.3	SE-21-01/DUP/35 SE-21-02/36 SE-21-02DUP/37 SE-28-01/43 SE-28-01DUP/48 SE-29-01/37	48	None
		Zinc	142	1.7	241	SE-28-01/415 SE-28-01DUP/483	697	None

#D12


LEGEND:
UPLAND GLACIAL DEPOSITS
CIRCLEVILLE ESKER
PRESENT-DAY SCIOTO RIVER VALLEY
GLACIOFLUVIAL ALLUVIAL VALLEY
WEST EAST
APPROXIMATE LOCATION OF GENERAL HYDROGEOLOGIC CROSS SECTION (SEE DRAWING 5-2)
N
WEST
EAST
BOWERS LANDFILL
BASE MAP SOURCE: Compiled from the following USGS 7 1/2 minute topographic quadrangle maps: Ashville, Ohio, 1958, photorevised 1970; Circleville, Ohio, 1961, photorevised 1974.
0 1 2
SCALE IN MILES
JACKSON
WAYNE
CIRCLEVILLE
DES BY MJL 7/28/87
DR BY JMG 7/29/87
CHK BY
APP BY
BOWERS LANDFILL
CIRCLEVILLE, OHIO
Dames & Moore
SHEET TITLE:
REGIONAL PHYSIOGRAPHY
SHEET OF
DRAWING NO.
5-1



LEGEND:

- INFILTRATION OF PRECIPITATION AND SURFACE WATER
- ASSUMED GROUND WATER FLOW DIRECTION
- APPROXIMATE GROUND WATER PIEZOMETRIC SURFACE

NOTES:
- Vertical scale is 40:1 exaggeration of horizontal.
- Approximate cross section location shown on Drawing 5-1.
- Interpretation based on information obtained during site investigation and previous published/ unpublished reports. Drawing is considered to be representative of hydrogeologic conditions on a regional basis.

DES BY	MJL	7/17/87	BOWERS LANDFILL CIRCLEVILLE, OHIO Dames & Moore
DR BY	JMG	7/23/87	
CHK BY			
APP BY			
SHEET TITLE: Generalized Hydrogeologic Cross Section in Site Vicinity			SHEET ___ OF ___ DRAWING NO: 5-2

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APPENDIX A

DISCUSSION OF METHODS
ELECTROMAGNETIC (EM) SURVEY

APPENDIX A

DISCUSSION OF METHODS
ELECTROMAGNETIC (EM) SURVEY

Preparatory Activities

In preparation for the EM survey at the site, an EM34-3XL terrain conductivity instrument was obtained from Geonics, Ltd., Ontario, Canada. The instrument is designed for horizontal profiling and/or vertical sounding by a two-person crew. Three effective sounding depths are available in each of the dipole configurations (horizontal or vertical). For this study, the horizontal dipole mode was selected because it is less sensitive to coil misalignment and more sensitive to near-surface materials.

The instrument was received precalibrated from the manufacturer. Additional instrument checks were completed prior to initiation of the survey, including checking of the power source, electronic nulling, and receiver compensation/gain functions.

Measurement Station Establishment

Initial onsite activities involved the establishment of measurement stations, or control points, at which terrain conductivity values would subsequently be obtained. This phase of the EM survey was carried out during the period July 8-11, 1986.

The measurement station grid established for the survey was based on 12 planned profile lines included in the work plan: seven parallel to and one perpendicular to the assumed ground water flow direction; two parallel to the east-west landfill leg, and two parallel to the north-south landfill leg. Lines were designed to coincide with planned drilling/monitoring well locations, to aid in the comparison of data.

A baseline was established parallel to, and directly west of, the north-south landfill leg. Additional profile lines were then established by measurement of distances and angles at various points along the baseline. Measurement stations were located along each profile line at approximately 100-foot intervals. Stations were marked with wooden stakes and labeled for future reference. Distances were measured through a combination of taping and pacing. Angles were established using a surveying transit. Approximately 200 measurement stations were established during this phase.

EM Survey Measurements

Following establishment of the measurement stations, the actual EM survey was conducted. This activity occurred during the period July 12-14, 1986.

The project work plan called for measurement of terrain conductivity at three innercoil spacings -- of 10, 20, and 40 meters. Using the horizontal dipole configuration, resulting effective depths of sounding of 7.5, 15, and 30 meters are obtained.

In order to obtain instrument readings at all three innercoil spacings using the 40-meter connector cable (to expedite the activity), a presurvey "calibration" was performed as recommended by Geonics (Bosnar, 1986). Measurements were obtained at a point for the 10- and 20-meter spacings using both the 40-meter cable and the 10- and 20-meter cable. Differences between the "correct" value (obtained using cable length corresponding to selected spacing) and that obtained with the 40-meter cable were noted, and used as correction factors in subsequent data analysis. Only the 10-meter spacing was found to require a correction (subtraction of 1 mmho/m), which has been applied to the data listed in this report. This approach is reported to provide results without a compromise in the resulting degree of accuracy (Bonsar, 1986).

Terrain conductivity values were then measured at each station. Approximately nine stations were excluded, however, due to poor access conditions. At each station, one of the two crew members remained

stationary at the marker. The other member proceeded along the survey line to each of the approximate coil spacings, as indicated on the instrument. Conductivity values, in millimohs per meter (mmho/m) were recorded in the field notes.

The following measures were employed during the survey to assist in the collection of accurate data:

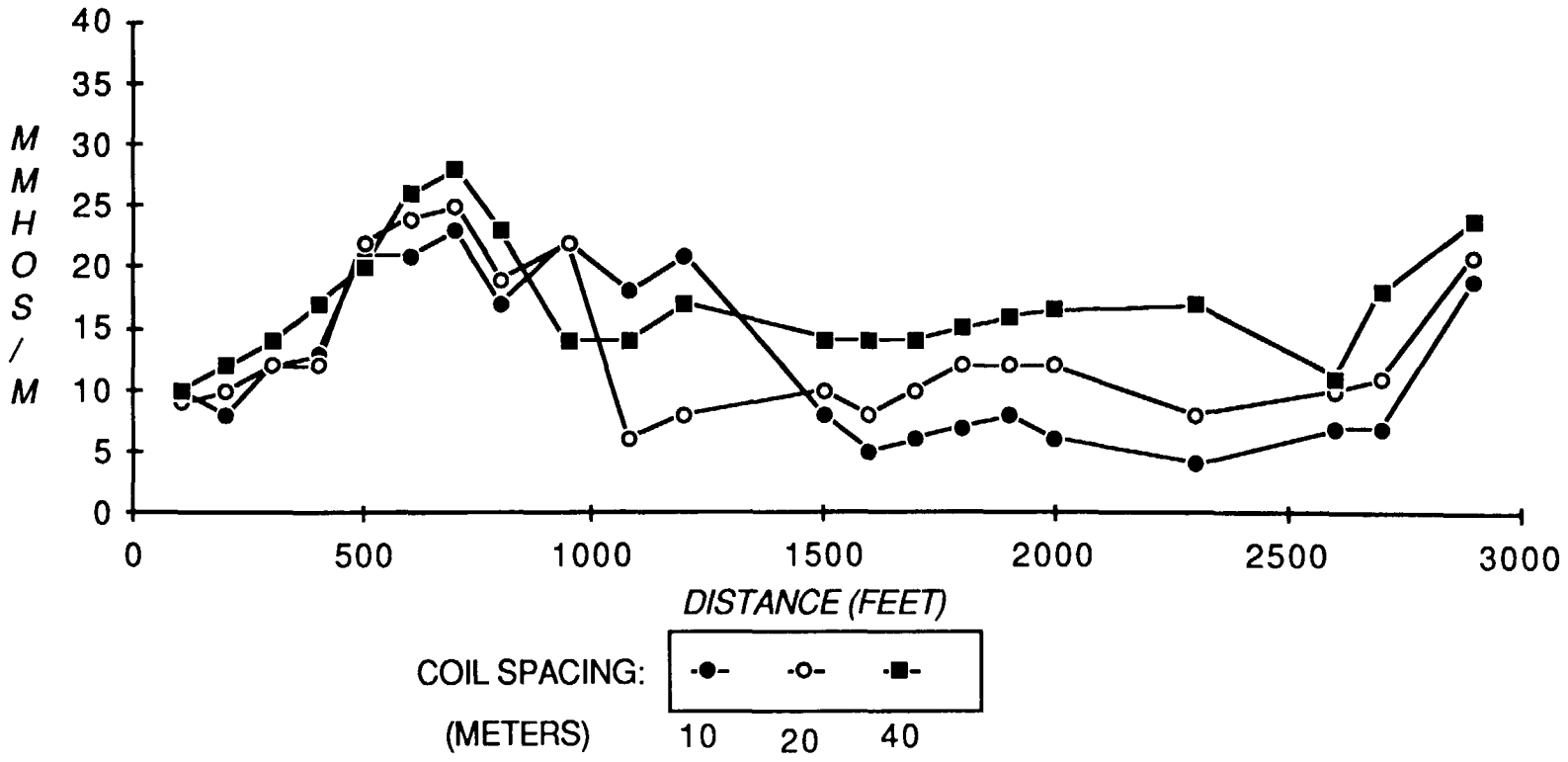
- The instrument power supply was checked periodically to verify adequate levels.
- Instrument null balance was checked and adjusted frequently, to minimize instrument "drift."
- Transmitter and receiver coil orientations were maintained in the same direction, and approximately in the same vertical plane.
- Cultural interferences (e.g., metallic objects, power lines, etc.) were avoided where possible, or their presence noted.

Source: Technical Memorandum, Hydrogeologic Investigation, Bowers Landfill RI/FS, Circleville, Ohio, Dames & Moore, May 22, 1987.

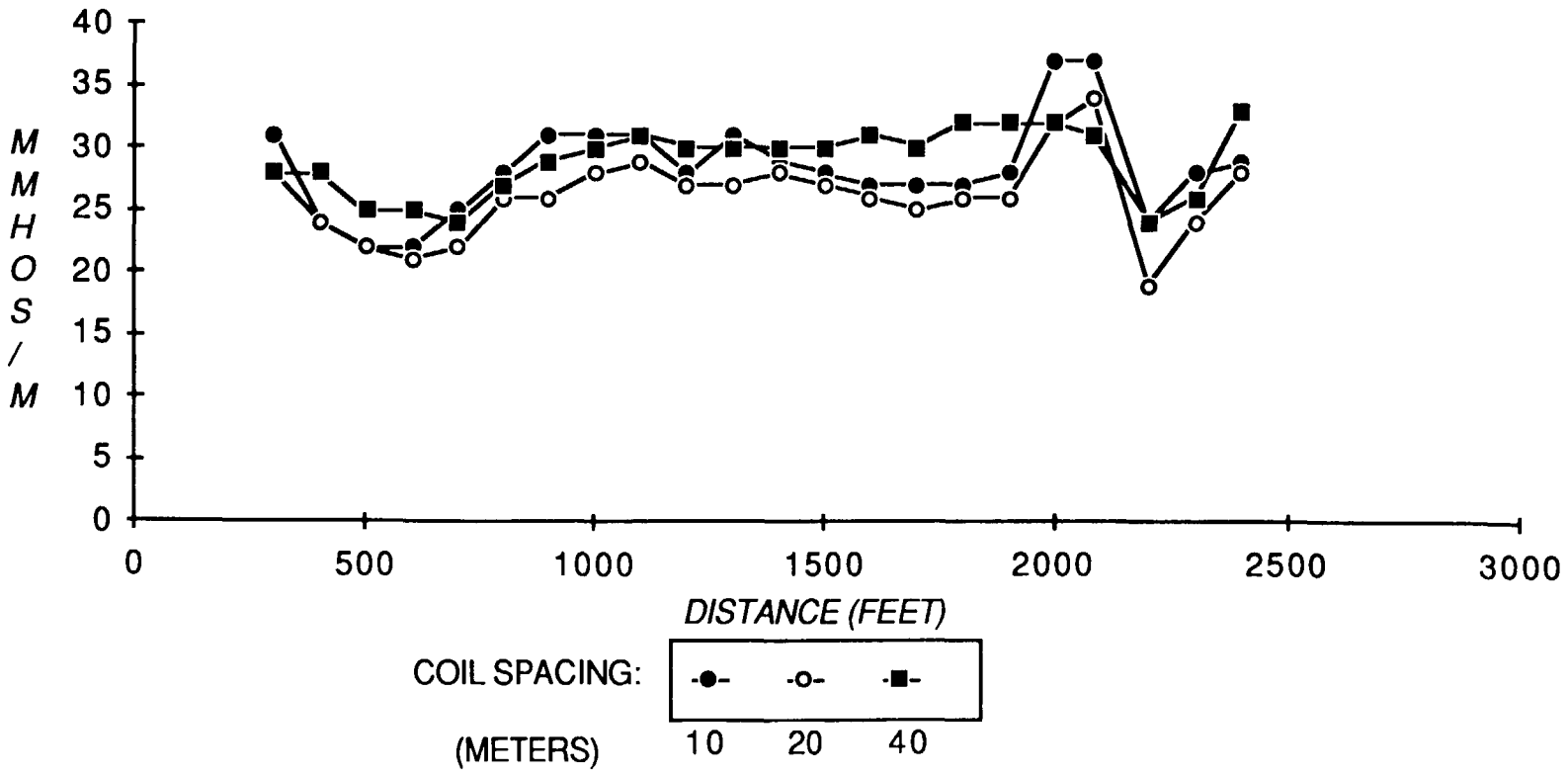
APPENDIX B

EM SURVEY PROFILE LINES

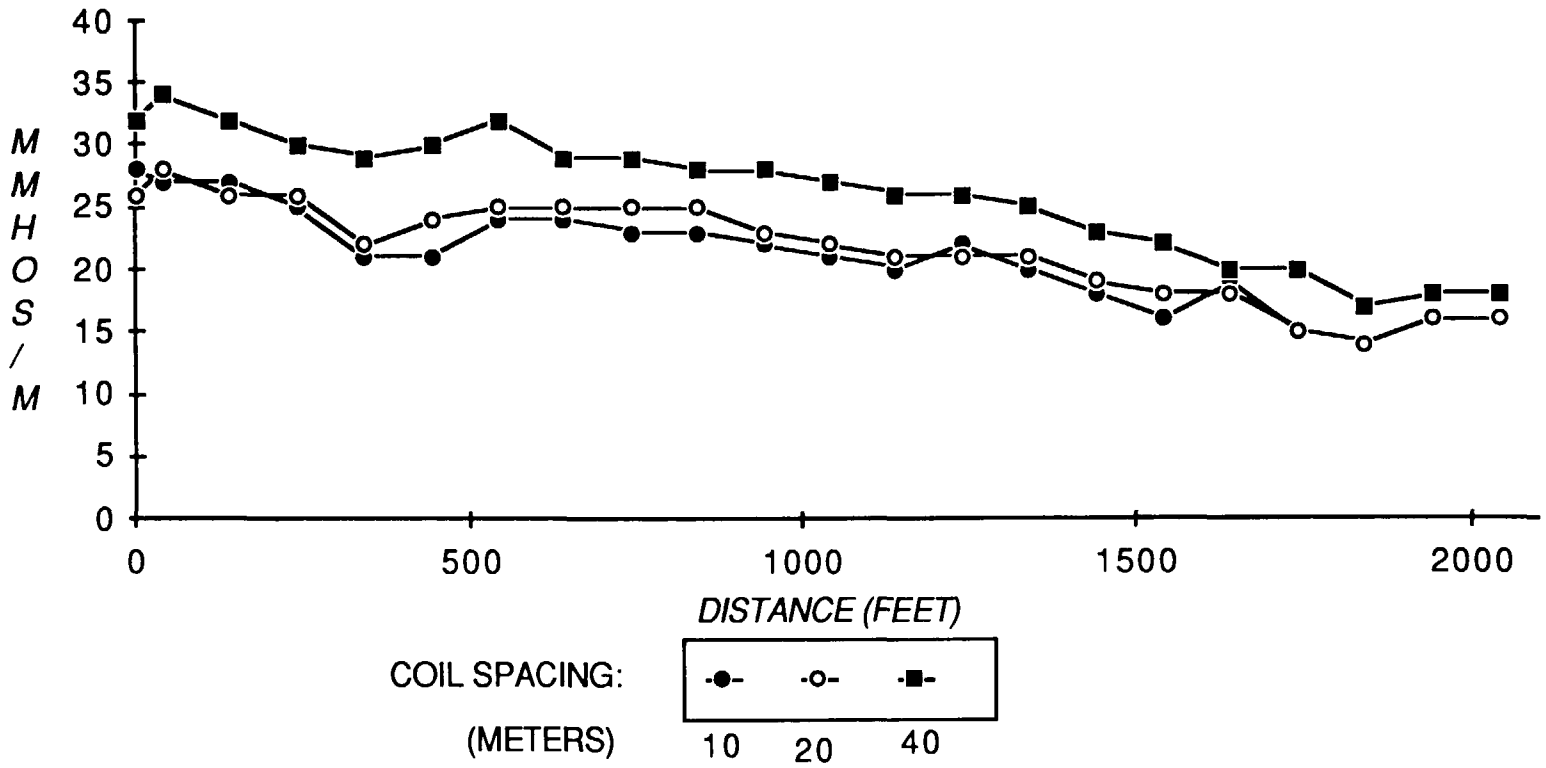
EM SURVEY LINE A-A'



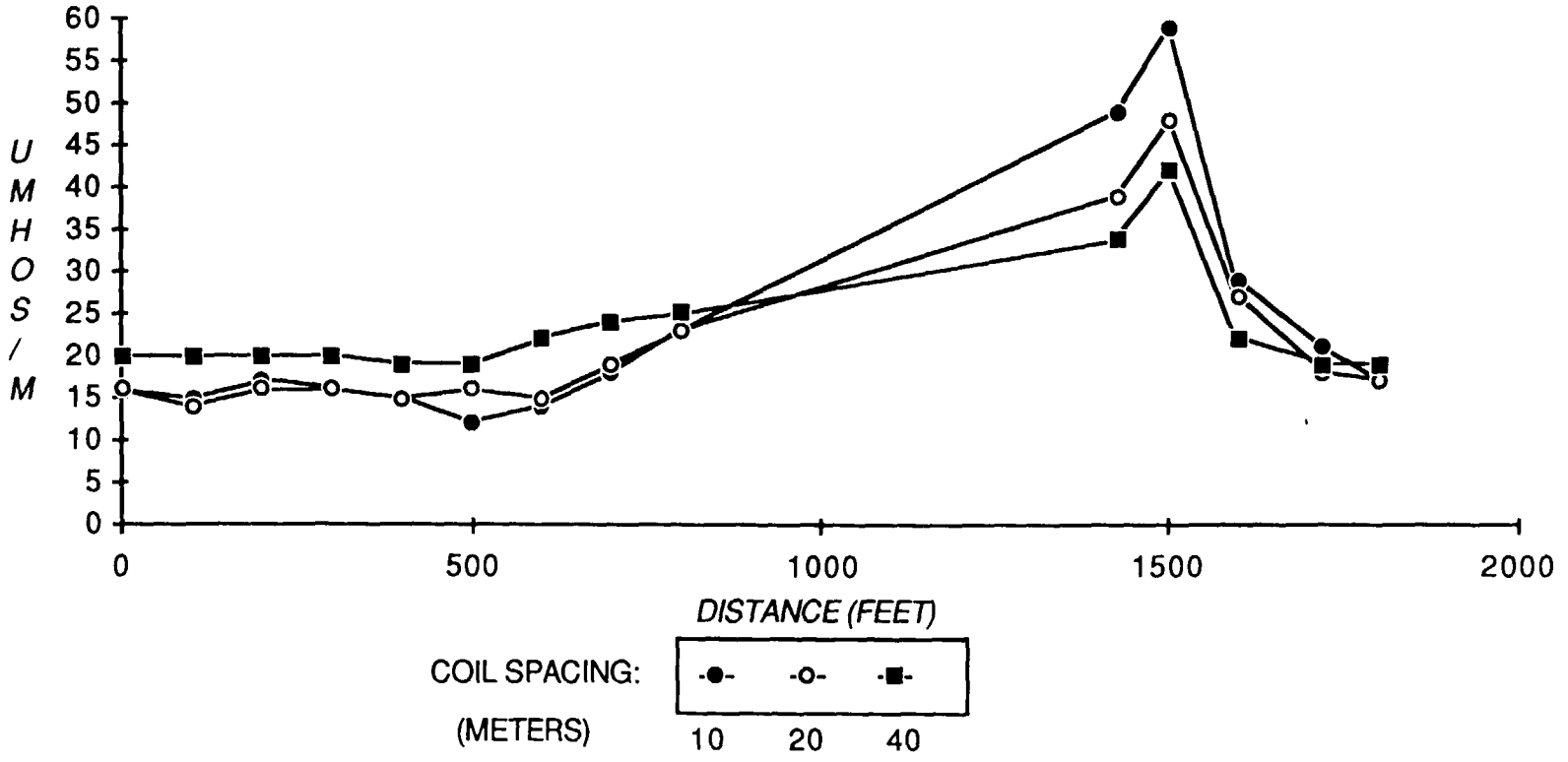
EM SURVEY LINE B-B'



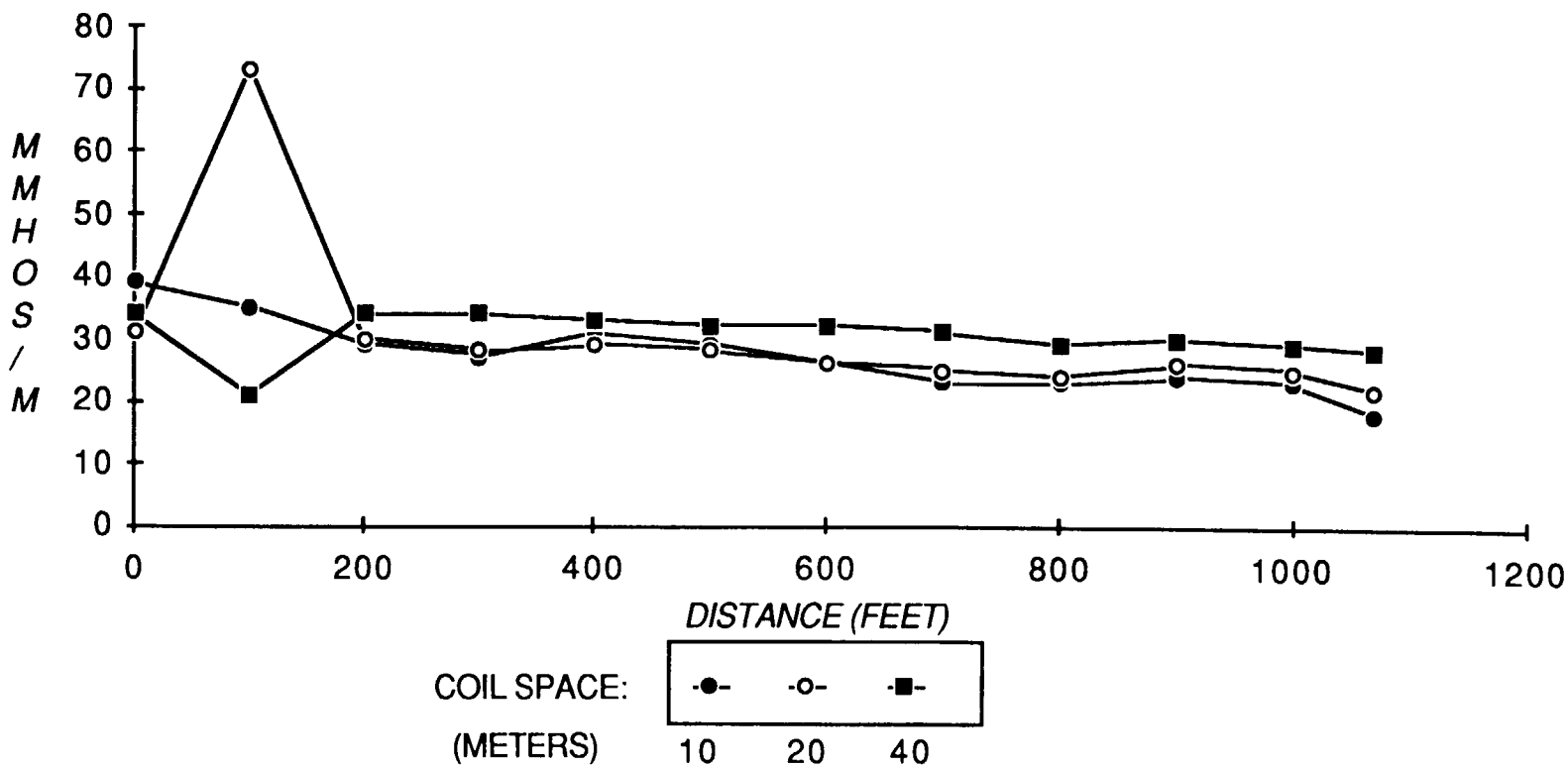
EM SURVEY LINE C-C'



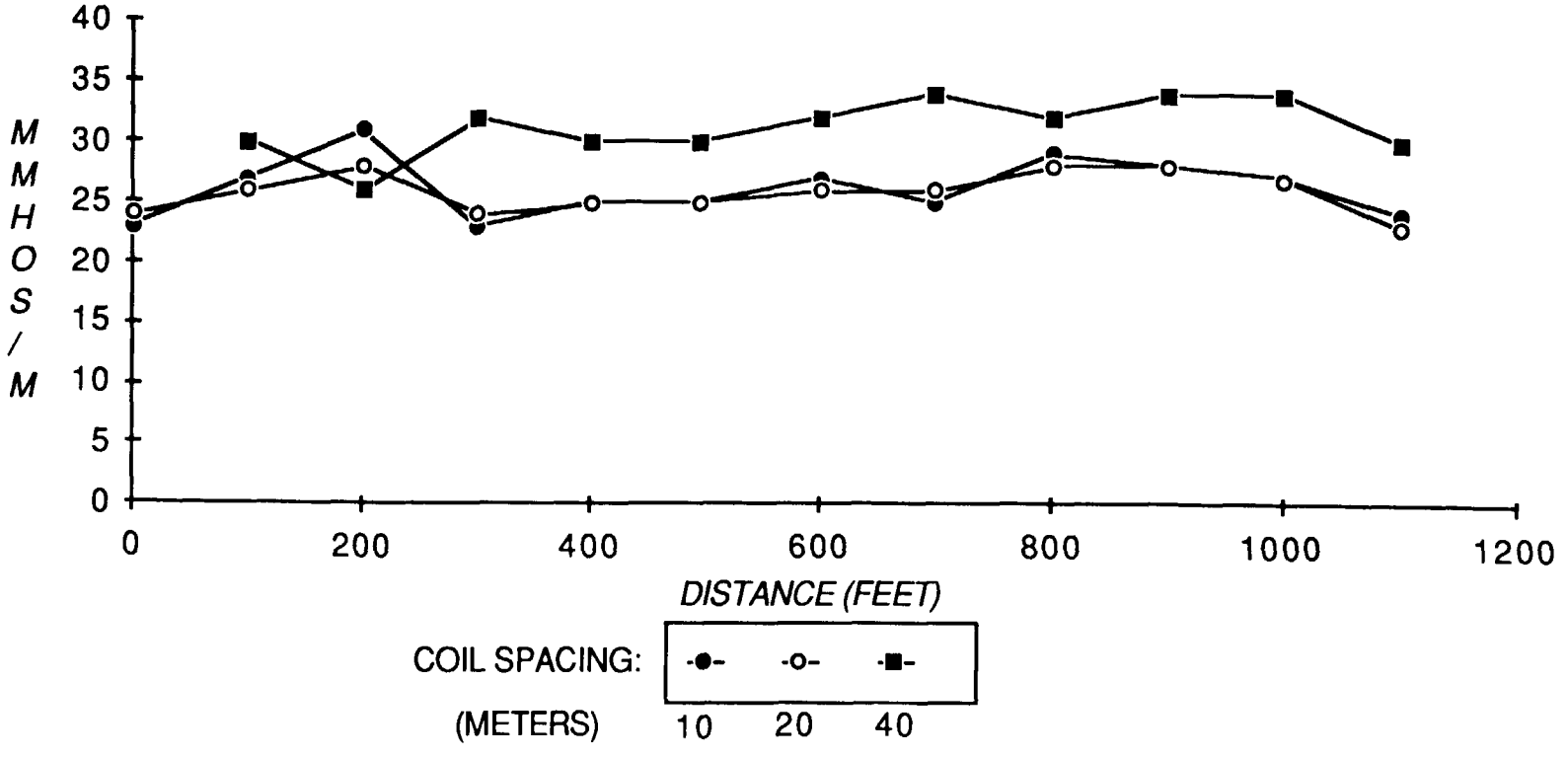
EM SURVEY LINE D-D'



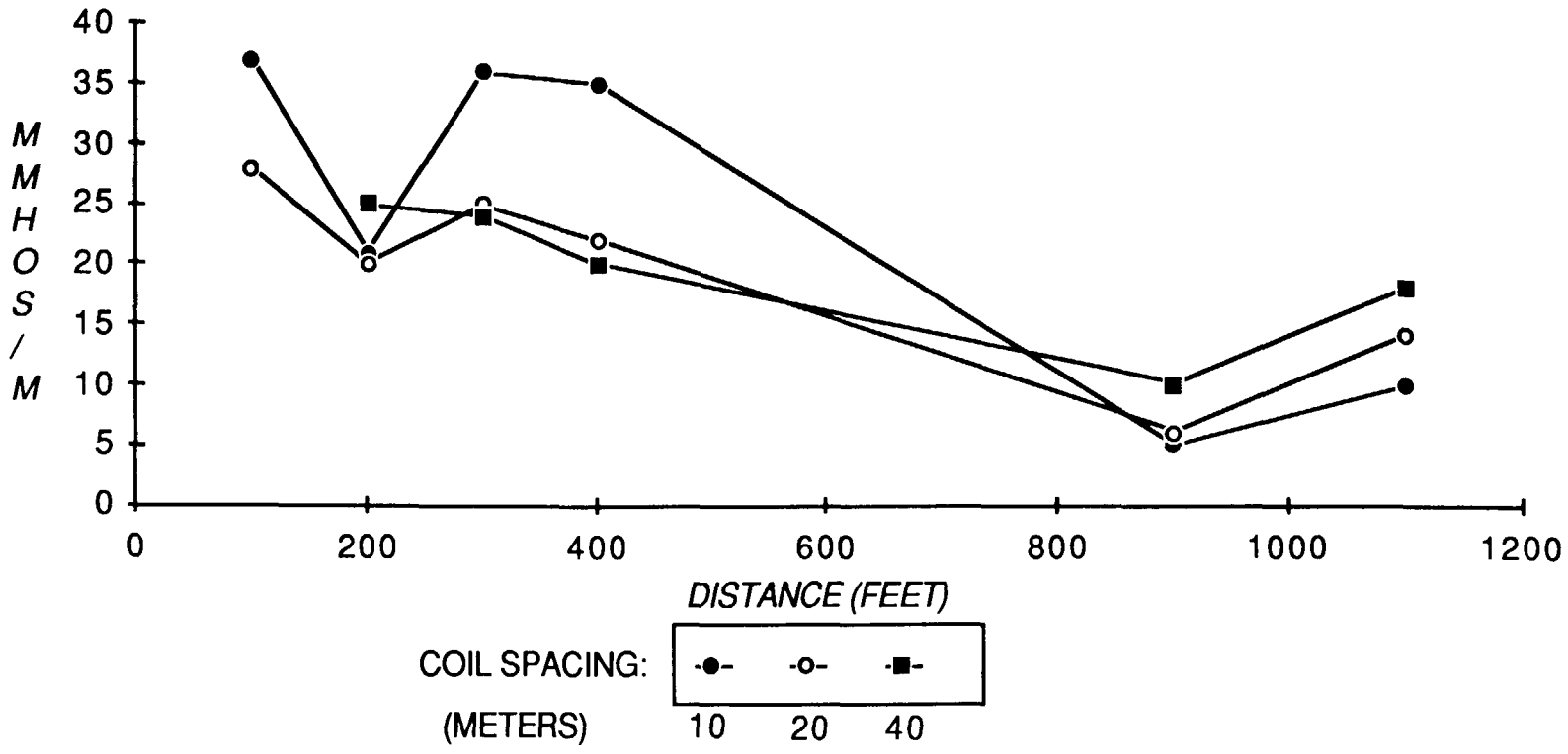
EM SURVEY LINE E-E'



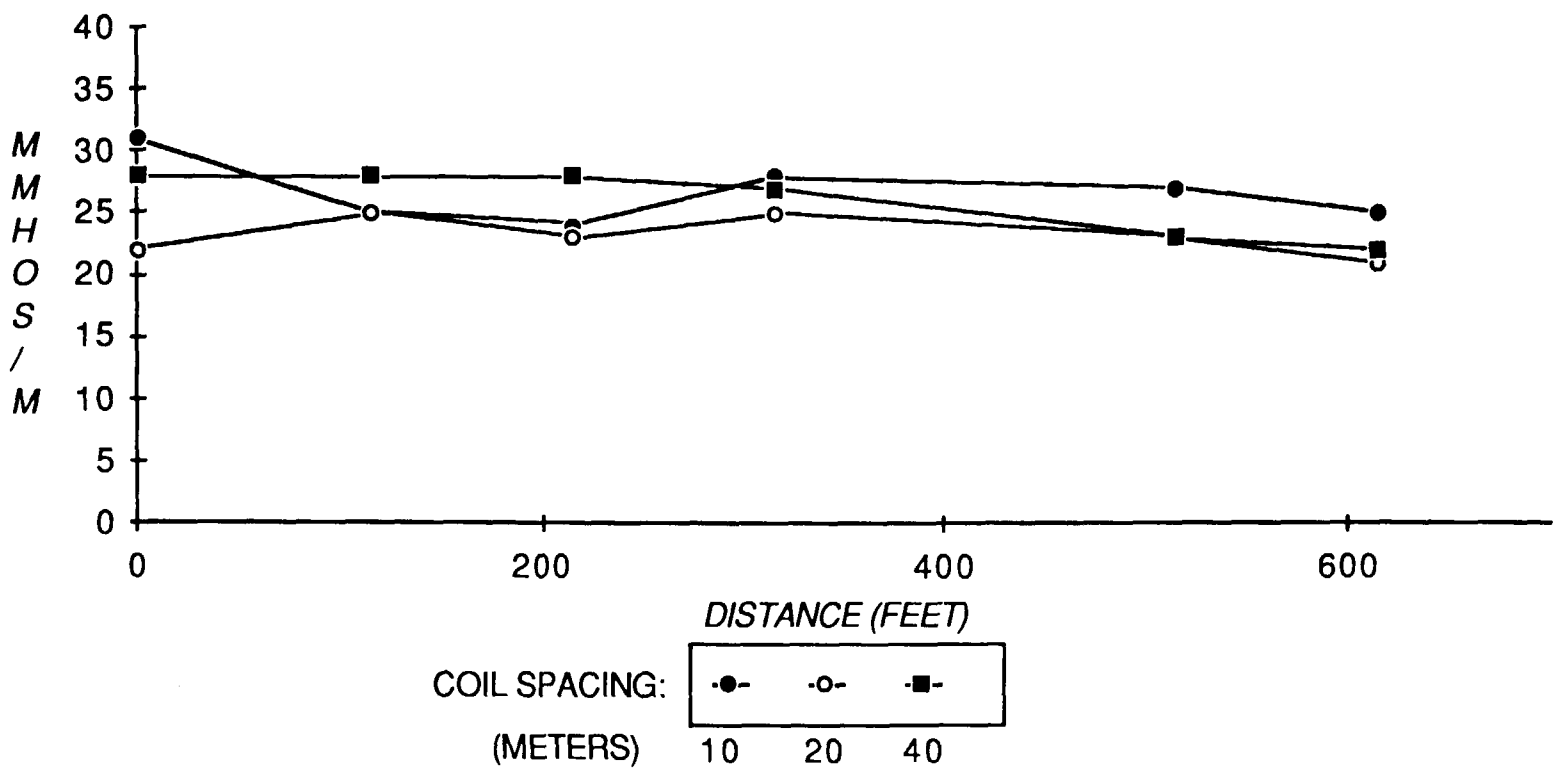
EM SURVEY LINE F-F'



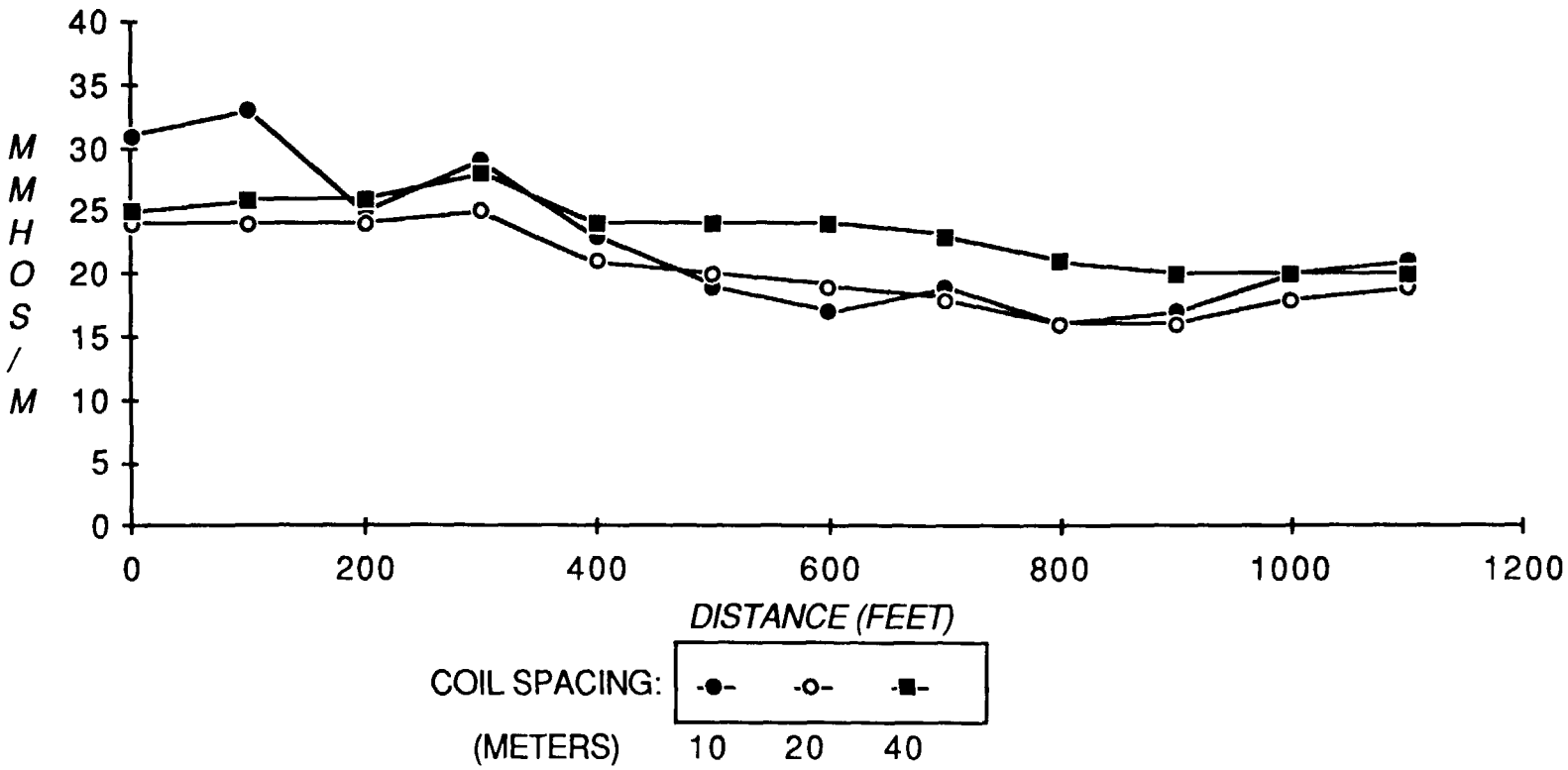
EM SURVEY LINE G-G'

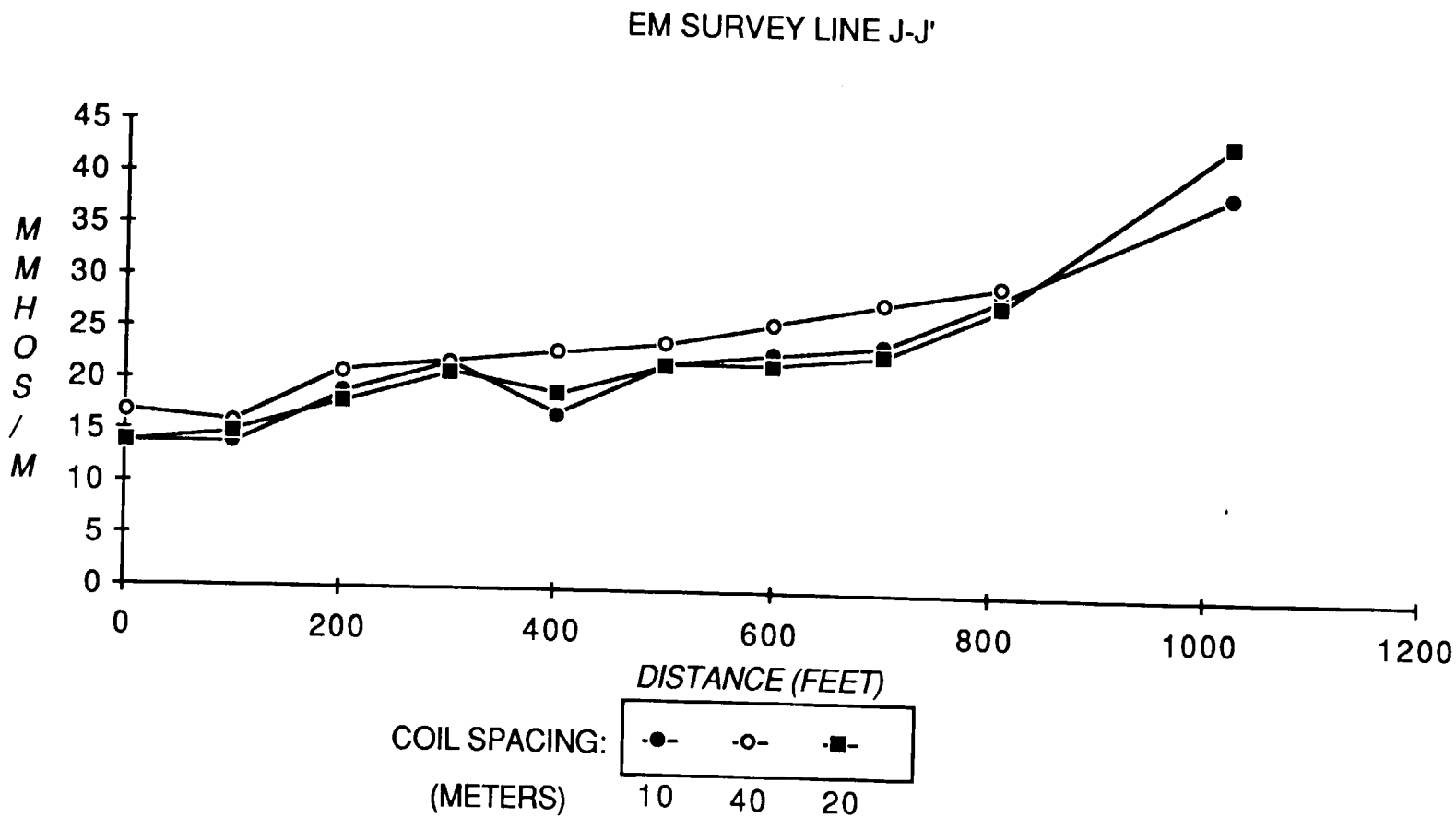


EM SURVEY LINE H-H'

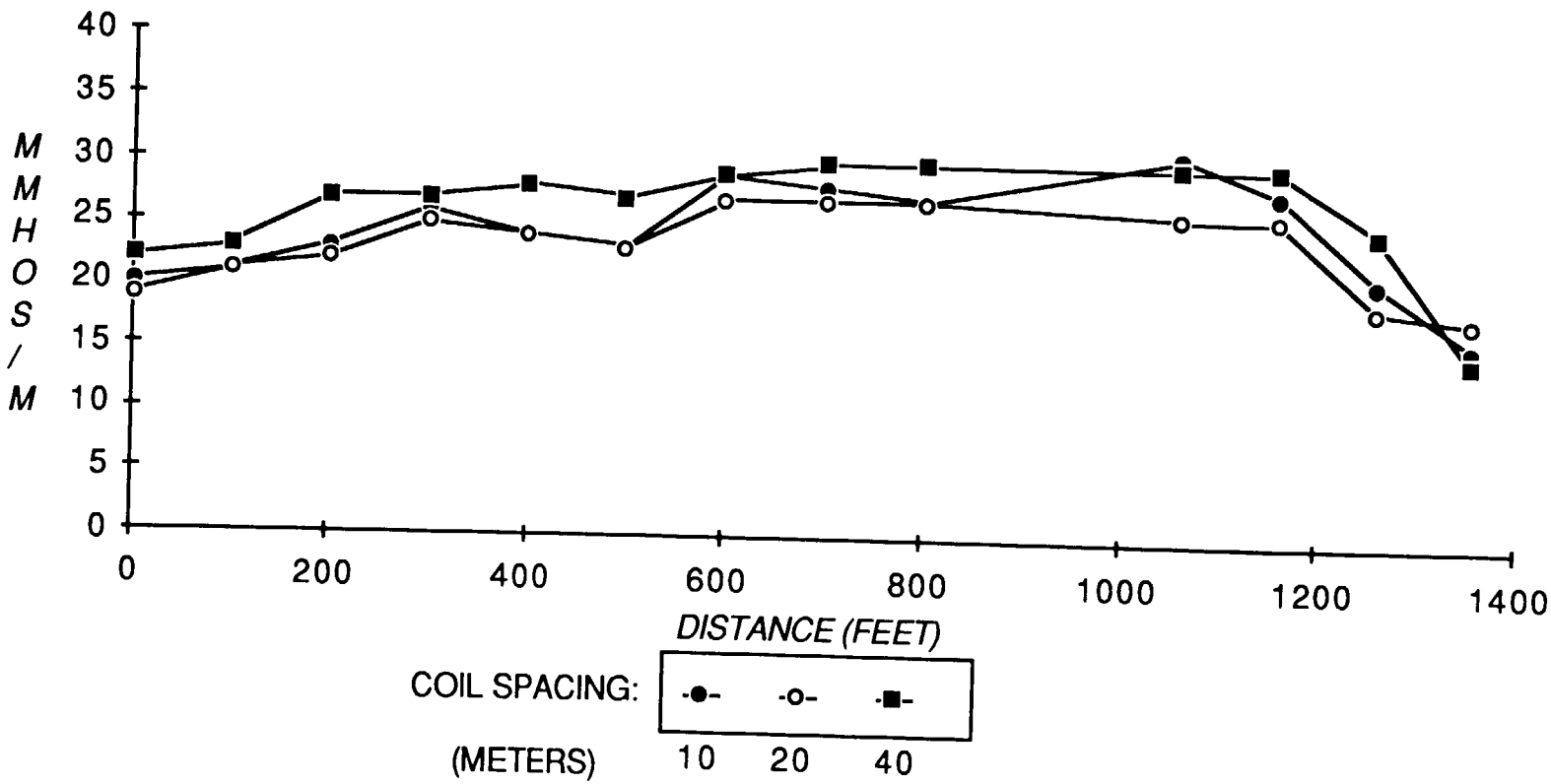


EM SURVEY LINE I-I'

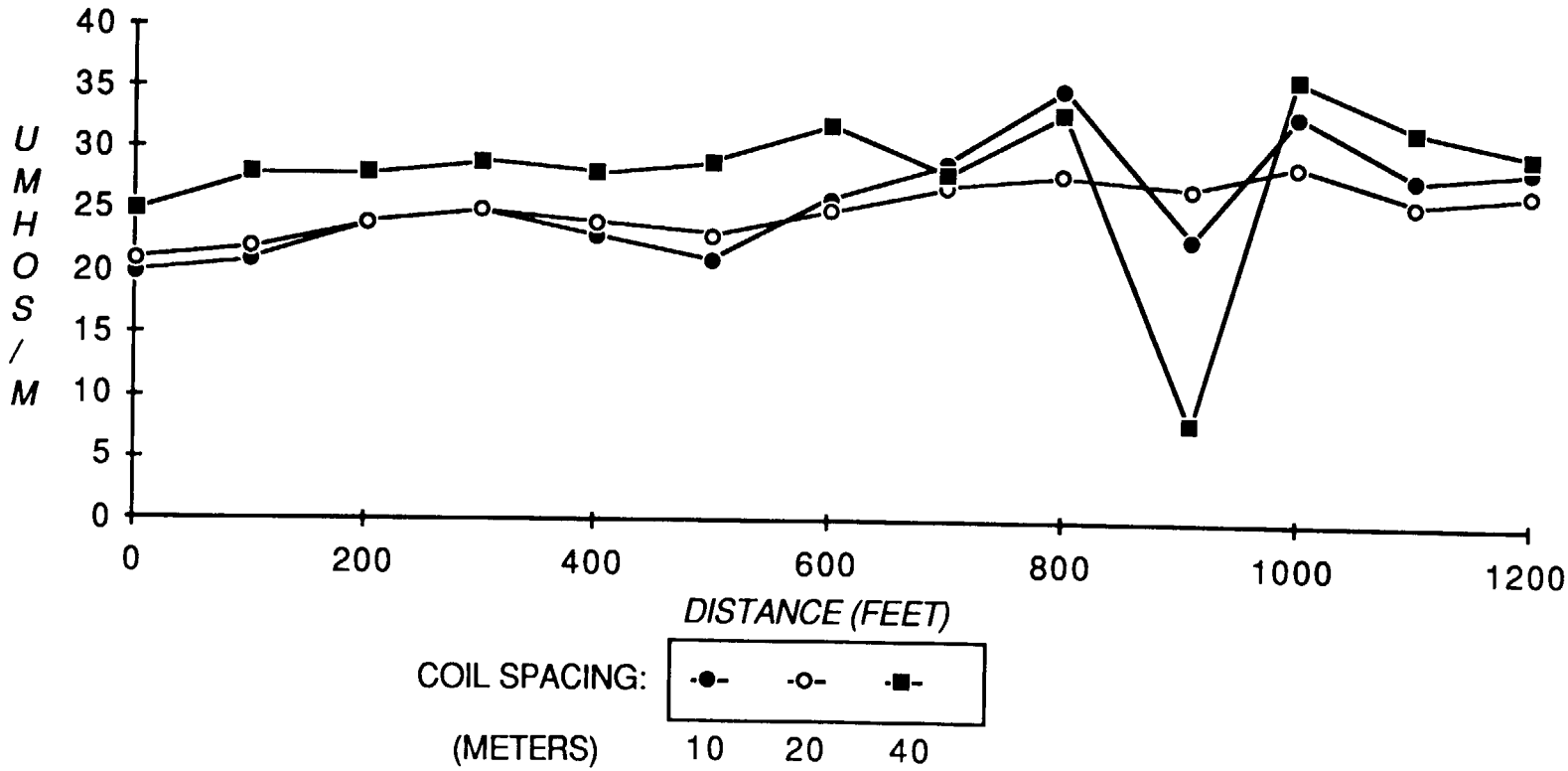



EM SURVEY LINE J-J'
MMHOS/M
45
40
35
30
25
20
15
10
5
0
0
200
400
600
800
1000
1200
DISTANCE (FEET)
COIL SPACING:
(METERS)
10
40
20

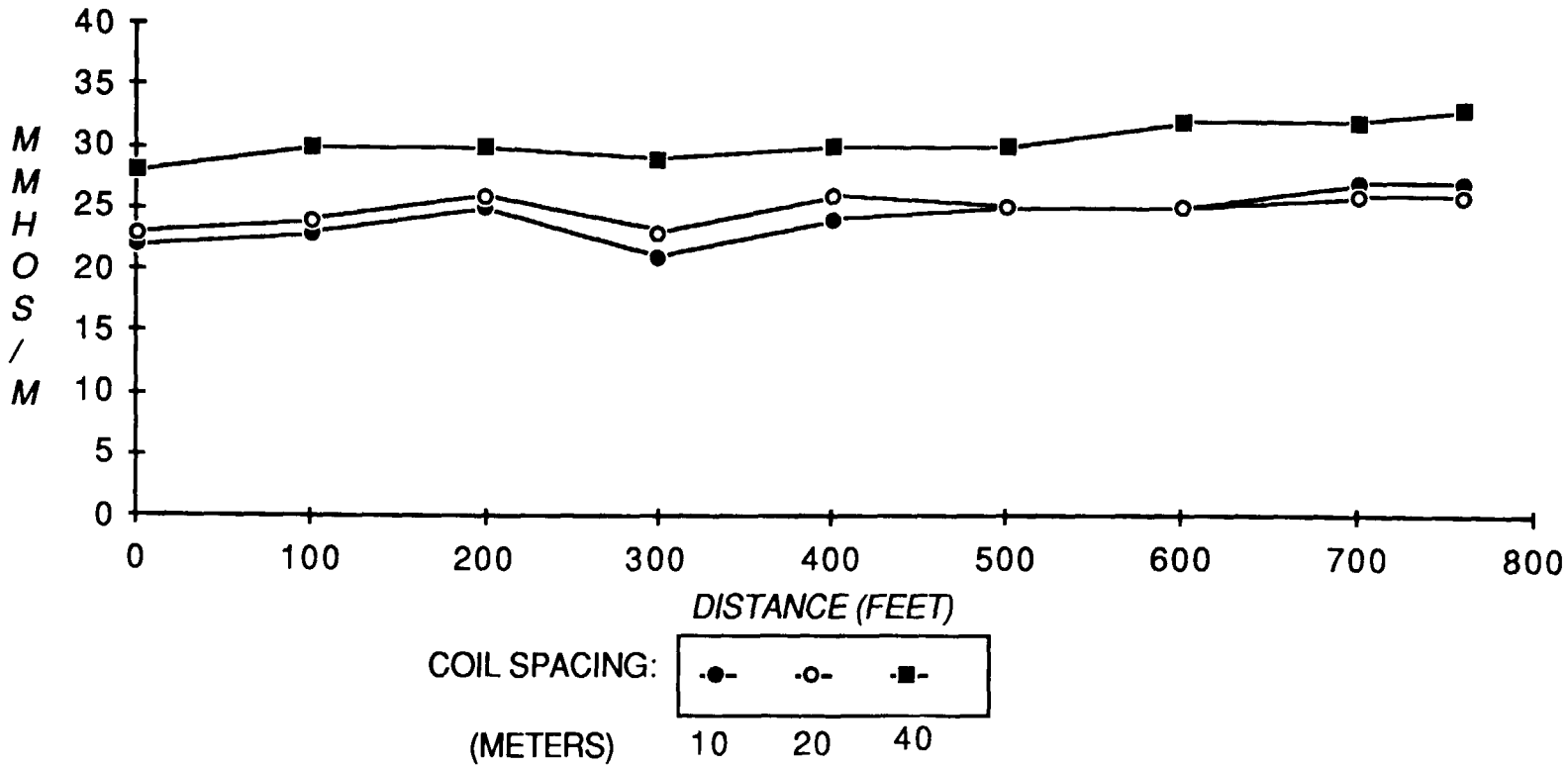
EM SURVEY LINE K-K'



EM SURVEY LINE L-L'



EM SURVEY LINE M-M'



APPENDIX C

DISCUSSION OF METHODS
DRILLING/MONTORING WELL INSTALLATION
AND ASSOCIATED ACTIVITIES

APPENDIX C

DISCUSSION OF METHODS DRILLING/MONITORING WELL INSTALLATIONS AND ASSOCIATED ACTIVITIES

Preparatory Activities

Initial activities associated with the drilling/monitoring well installation phase of the study included mobilization of a drilling subcontractor, procurement of supplies/equipment, and a reconnaissance of the site to verify proposed drilling locations.

The drilling subcontractor utilized for this sub-task was John Mathes & Associates, Columbia, Illinois. A Central Mining Equipment (CME) Model 45 auger rig was transported to the site. The rig and associated drilling tools were steam-cleaned at the initiation of site activities, to minimize potential contamination from external sources.

Supplies and equipment to be utilized during the study phase were delivered to the site and placed in a storage area. A water supply source, necessary for auger drilling operations, was established at the Circleville municipal well field, approximately 1-1/2 miles south of the site.

An initial reconnaissance of the site was conducted by Dames & Moore, representatives of U.S. EPA, and Ohio EPA, to discuss/verify planned drilling locations. Drilling location 5 presented potential access problems, as it is in a heavily-wooded, low-lying area frequently inundated by the Scioto River. The planned location was maintained, however, for consistency with the work plan. Location 4, originally planned for the vicinity of an inactive sand and gravel operation east of the landfill, was identified as requiring an adjustment due to the disclosure of plans to reactivate the operation. An acceptable location approximately 500 feet south of the original point was identified.

Subsurface Drilling Procedures

Drilling activities commenced at the site on September 26, 1986. Eighteen borings/monitoring wells were completed at 10 locations during this phase of the investigation. At each of the 10 locations (4 through 13), a shallow boring penetrated the upper portion of the saturated alluvial aquifer. Intermediate borings were advanced to various depths between the water table and bedrock at five locations (4 through 8). Deep borings were advanced to bedrock at three locations (5, 6, and 8), according to the planned work scope. Shale bedrock was also encountered in the intermediate boring at location 7.

Borings were advanced with the CME-45 drill rig, using 4-1/4-inch inside diameter (ID), continuous flight, hollow stem augers. The borehole diameter resulting from this size of auger is approximately 8 inches. Drill augers and associated tools that contacted the borehole were steam-cleaned between borings, to minimize the potential for cross-contamination.

Subsurface Sample Collection

Soil samples were obtained from the borings utilizing a 2-inch split-barrel sampler. Sampling was conducted through the inside of the hollow stem augers. The sampler was driven approximately 18 inches into the base of the borehole at selected depths, following standard penetration test procedures (ASTM Method D-1586). The sample barrel was then removed from the borehole and opened, allowing inspection and removal of the soil sample. Soil samples were generally collected from the deepest borehole at each of the 10 drilling locations, with approximately the following frequency:

Depth (feet)	Sampling Interval (feet)
0-20	2.5
20-50	5
>50	10

Sampling intervals were adjusted as necessary to accommodate site-specific conditions. Additional soil samples were collected from shallow borings at locations where multiple borings were advanced. The purpose of the additional sampling was to verify potentially important information obtained from the associated deeper boring. Such information included: definition of potential confining layers (e.g., clay), location of water-bearing zones, identification of the upper limit of saturation, and detection of potential zones of contamination.

Soil samples obtained from each boring were visually inspected and classified in the field by the onsite hydrogeologist. Physical properties such as color, texture, consistency, degree of uniformity, degree of saturation, and other important characteristics were noted and recorded on the field log.

Samples were additionally evaluated for signs of potential contamination, using properties such as odor and appearance, as well as results of scanning the sample with a photoionization and/or flame ionization detector (PID/FID). The PID/FID instruments are designed to detect organic compounds, particularly volatiles, if present in the soil and/or ground water. The intent of this initial evaluation was to assist in the identification of potentially contaminated subsurface zones, to allow adjustment of monitoring well completion intervals, if necessary.

All soil samples were placed in clean glass jars, sealed, labeled, and retained for additional inspection/testing, as needed. Samples considered representative of major subsurface lithologic units were forwarded to Tech Engineering, Lexington, Kentucky, for particle size analysis (ASTM Method D-422) and Atterberg limits (ASTM Methods D-423 and D-424), as appropriate.

Monitoring Well Installation

Following completion of each of the boreholes to the planned depths, monitoring wells were installed to facilitate water level measurement and ground water sampling. Monitoring well construction materials included 2-inch ID, flush-joint threaded stainless steel screen and stainless steel riser pipe. The screen type was continuous wire-wound monitoring screen (Johnson Division, UOP, Inc.) with 0.010 inch slot openings. A stainless steel plug was welded to the bottom of each screen. Eight-foot screen lengths were utilized for the shallow water table wells ("W" designation); 4-foot lengths were installed in the deeper piezometers ("P" designation). Riser pipe was Schedule 10, welded to Schedule 40 threaded couplings.

Well screen and riser pipe were transported to the site clean and wrapped in plastic; however, these materials were steam-cleaned immediately prior to installation in the borehole.

All well construction was carried out through the inside of the hollow stem augers. Well screen and riser pipe sections were coupled and lowered through the augers to the desired total depth (lower portions of boreholes were initially backfilled with sand and/or bentonite pellets, as appropriate, if the chosen screen interval was shallower than total borehole depth).

A filter pack was then installed in the annular space surrounding the screen, extending approximately 5 feet above the top of the screen. The filter pack utilized was a coarse flint sand (WB-30 and WB-40 specifications) supplied by Winter Brothers Quarry, St. Louis, Missouri. The slightly coarser WB-40 sand was generally used in the screen zone. Several feet of the finer WB-30 sand was usually placed in the upper portion of the filter pack (above the screen) to minimize grout migration into the completion zone. WB-30 sand was also utilized in the screen interval where soil samples indicated the presence of significant amounts of fine-grained material. Placement of the filter pack involved pouring through the augers, while periodically raising the augers several inches, allowing the sand to fill the annular space between the screen and borehole wall.

Following placement of the filter pack, a bentonite slurry seal was placed in the well annular space, from the top of the filter pack to just below ground surface. The slurry consisted of pure bentonite powder and water, mixed with a recirculating mud pump, using an orifice to increase fluid viscosity. Once mixed to the desired consistency, the slurry was pumped through the augers and into the annular space using a tremie pipe. The augers were raised periodically, allowing the slurry to completely fill the annular space. Pumping was maintained continuously at the base of the annular space until the slurry discharged at ground surface. The tremie pipe was removed, and additional slurry added periodically as settlement occurred.

Bentonite pellets were utilized in several of the more shallow monitoring wells to seal the annular space. Pellets were used primarily when it was not possible to install a significant thickness of filter pack sand above the screen to minimize bentonite slurry migration. In such instances, the bentonite pellets were poured through the augers to a minimum thickness of approximately 3 feet.

Following placement and stabilization of the bentonite seal, a concrete cap and pad were installed at the surface, to further minimize infiltration of surface water through the annular space. A locking outer steel casing was placed on the concrete to protect the monitoring well from damage and/or tampering. Steel protective posts were installed in concrete several feet away from, and surrounding each monitoring well. Threaded stainless steel caps were placed on the top of well riser pipes to provide a seal during periods of high water. Metal tags, stamped with identification numbers, were securely fastened to each well.

Monitoring Well Development

Monitoring wells were developed following installation, to remove fine-grained material from the completion zone in the vicinity of the well screen. This process is designed to minimize the influx of silt and clay to the monitoring well during ground water sample collection.

Two methods of well development were employed during this phase: mechanical surging and pumping. The mechanical surging technique utilizes a surge block, which is a weighted gasket device designed to create a tight seal when lowered into the well riser pipe. The surge block is lowered into the well on a steel cable attached to the drill rig power winch. Cyclic up and down action of the surge block within the water column alternatively forces water (and fine-grained material) into and out of the screen. Periodic removal of the water column and associated fines (with surge block or pump) aids in this development process. Mechanical surging was employed in the deeper "piezometer" wells, which contained a sufficient water column above the screen to facilitate surging.

Shallow, water table wells could not be effectively surged, however. These well were developed using a centrifugal pump. Pumping techniques employed in various combinations, depending on specific conditions, included: Overpumping (yield greater than that available at steady state), pump surging (suddenly breaking suction during pumping, allowing the water column to rush back into the well), and steady pumping at a sustainable rate.

All wells were surged and/or pumped for approximately 2 to 3 hours, and continued, if necessary, until steady pumping yielded what appeared to be low-turbidity water (based on visual observation).

Sealing of Previously Installed Monitoring Wells

During the course of drilling/monitoring well installation activities, previously installed monitoring wells MW-1 and MW-2 were sealed because they appeared to be in disrepair, and possibly were providing a source for direct surface water inflow to the shallow alluvial aquifer. Well MW-3, also planned for sealing, could not be located. Wells were sealed by pumping a cement-bentonite slurry into the bottom of the well, using a tremie pipe and mud pump from the drilling rig. The slurry was added until the well casing was filled. The tremie pipe was then withdrawn, and additional grout added as settlement occurred. Grout was also placed around the base of each well to seal voids in the annular space near the ground surface.

Salient Features Associated with Drilling/Monitoring Well Installation

A brief summary of pertinent aspects related to the drilling/monitoring well installation subtask is given in the following paragraphs.

Earlier it was stated that planned drilling location 4 was moved approximately 500 feet to the south. Attempts to drill and install monitoring wells at this location were unsuccessful, however, due to adverse drilling conditions (heaving sands entering the hollow stem augers). This location was subsequently moved approximately 400 feet east of the original location. Drilling/well installation efforts were successful at this third location.

As mentioned earlier, drilling activities commenced on September 26, 1986. The completion date for all drilling, well installation, and well development at the site was January 20, 1987. The extended time duration for this project phase was primarily a result of several relatively lengthy delays caused by flooding of low-lying portions of the site by the Scioto River. Specifically, portions of the agricultural field to the west of the landfill were inundated and/or inaccessible during the approximate periods October 1 to 20, 1986, and November 1, 1986 to January 9, 1987.

The flooding event that occurred at the site during October, 1986, inundated (or potentially inundated) four newly installed monitoring wells (W-9, W-13, P6B, and P-8A). It was also observed that the two-piece threaded plastic caps installed on these wells may not always be water-tight; thus, the potential for influx of surface water to these wells was present. Although the wells had yet to be developed, and field observations indicated that at least two of the wells (W-9 and W-13) showed no signs of having been affected, precautionary steps were taken. A minimum of two casing volumes was purged from each well upon reinitiation of site activities. All well caps were changed to a one-piece, threaded stainless steel variety. During this flooding event, borehole P-8A was in the process of being drilled. The potential for surface water to enter this borehole was also of concern; however, upon return to the site, evidence was observed to support the fact that surface water had not entered the well. Specifically, high water marks were observed approximately 1 foot above ground at the location, while the augers extended approximately 2 feet above ground. It was also observed that soil around the outside of the augers appeared to be forming a relatively tight seal against infiltration of water.

Extremely limited site access was experienced at location 5 due to the presence of standing water and/or mud (on one occasion, an all-terrain vehicle drilling rig became stuck while attempting to reach the location). As a result, borings/monitoring wells were located immediately adjacent to the landfill at that location. While drilling borehole P-5B, various quantities of apparent waste, in the form of glass, plastic, and other debris, were encountered within the silty clay soil material, in the interval 0-10 feet. It was not readily apparent whether this was "in-situ" waste or material that had washed off the landfill over a period of years. At a depth of approximately 10 feet, a blackish liquid was observed in soil samples and drilling tools. The borehole was advanced and completed as a monitoring well in an apparent deeper sand zone isolated from the shallow aquifer. Subsequently, concern was raised over the potential for cross-contamination; specifically, it was felt that analytical results of water samples obtained from this well may inaccurately indicate the presence of contamination. Several attempts were made to replace this well; however, drilling difficulties, combined with the inability to locate the sand zone a short distance from the original location, resulted in maintenance of the original well for sampling. An extended period of development was employed as a precaution. Results of ground water samples obtained from this well do not indicate the presence of contamination, however.

In the course of scanning borehole soil samples with the FID/PID instruments, readings above background were observed with the FID at various depths and boring locations. Scanning of the same samples with the PID did not indicate readings above background, although the instrument was repeatedly checked for proper response. Many of the elevated FID readings were obtained while scanning soil samples collected at relatively deep intervals, particularly in association with zones containing weathered shale material or apparent carbonaceous shale. Often, shallow soil samples collected from the same boring did not exhibit elevated FID readings. It had been reported that the FID is sensitive to methane, while the PID is not.

Monitoring well P-6B, completed in an apparent deeper glacial sand zone isolated from the shallow recent alluvium, produces water with a faint organic odor, and exhibits elevated FID readings (but not elevated PID readings). A weathered black carbonaceous shale zone was noted in this boring immediately above the completion zone. Carbonaceous shales often contain a substantial percentage of organic matter.

Monitoring well P-6B was also observed to be "loose" within the borehole several weeks following installation. Observations indicated that the upper section of riser pipe had become partially unthreaded due to difficulty encountered while loosening/tightening the threaded well cap. Efforts to tighten the casing were successful, and cement subsequently placed between the well protector and riser pipe appear to be preventing further problems. It is believed that the integrity of this well was not, nor is currently, in question.

Prior to the abandonment of previously installed monitoring well MW-2, elevated well headspace readings were obtained with the PID and FID instruments. Specifically, downhole readings with the PID were in the range of 40 ppm; downhole readings with the FID were off-scale (>10,000 ppm). It is noted that the FID is sensitive to methane gas, (in addition to other organic vapors), while the PID does not detect methane. The well had been sealed with an airtight cap for an extended period of time, possibly allowing the build-up of gases in the well headspace.

Location and Elevation Survey

A location and elevation survey was conducted at the site during the period February 25-27, 1987. Horizontal and vertical coordinates were established for recently installed monitoring wells, as well as surface water staff gages. Horizontal coordinates were also obtained for surface water/sediment and surficial soil sampling locations at that time.

Horizontal coordinates were obtained using a transit and electronic distance meter (EDM). Coordinates were tied to a baseline established along the Circleville-Florence Chapel Road bridge, and referenced to the existing base map grid. Several traverse "loops" were completed, each being tied back to the baseline to check accuracy.

Vertical coordinates (elevations) were obtained using an automatic level instrument and survey rod. Closed-loop traverses were also completed for the levelling; each loop being tied into the reference benchmark. The benchmark utilized for this survey was U.S. Army Corps of Engineers (ACOE) survey marker number 39/17, located on the northeast abutment of the previously mentioned bridge. The elevation of the benchmark was reported as 685.91 feet, mean sea level (MSL), as established by the U.S. Coastal and Geodetic Survey of 1927 (ACOE, 1987). Elevations were obtained for the top of the well riser pipe (water level measurement point) and ground surface at each monitoring well. Elevations of each staff gage datum point (0.0 foot mark) were also obtained.

All site surveying activities were conducted by a licensed professional surveyor in the State of Ohio.

Ground Water Level Measurements

Water level measurements have been obtained from each of the recently installed monitoring wells on three separate occasions: February 9-13, March 12, and April 27, 1987. Measurements obtained in February and April were concurrent with ground water sampling activities. Data obtained during the February sampling extended over a period of 5 days. Measurements were obtained primarily to compute well purge volumes; because these data may be influenced by temporal fluctuations, they are not presented here. Data corresponding to March and April measurements were obtained over a period of several hours, and are therefore considered more representative of the ground water flow system. Ground water levels were

measured using an electrical sounding device. Measurements were referenced to the top of the well riser pipe (inside the protective outer casing), and recorded to the nearest 0.01 foot. The sounding device was rinsed with distilled water between measurements, to minimize potential cross-contamination.

Source: Technical Memorandum, Hydrogeologic Investigation, Bowers Landfill RI/FS, Circleville, Ohio, Dames & Moore, May 22, 1987.

APPENDIX D

BORING/MONITORING WELL DETAILS

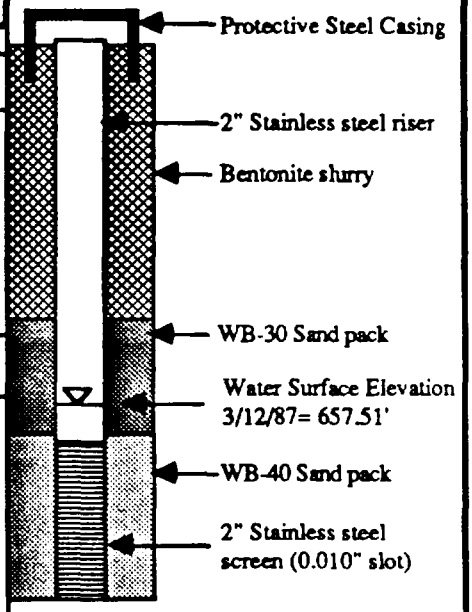
Monitoring Well # W-4

GROUND SURFACE ELEVATION = 673.73'
TOP OF CASING ELEVATION = 677.07'

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0				OL	Dark brown clayey SILT loam, moist, slightly plastic
	1	18/12	19	ML	Tan SILT, crumbly, dry, trace clay
	2	18/22	21		
	3	18/16	16		Some angular fragments in matrix
10	4	18/18	12		
	5	18/18	14		Becoming moist, clayey, slightly gray
	6	18/18	40	CL	Grayish silty CLAY, some rounded pebbles in matrix, moist
	7	18/8	4		Harder drilling noted at 16'
20	8	18/1	3		Saturation noted at 17.5'
				SW	Brown medium to coarse grained SAND, some pebbles and gravel
		18/0	17		
30	9	18/8	22		

Boring terminated on 10/28/86
Total Depth Drilled = 28.5 feet

Monitoring Well Construction Details



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Job No. 850-032-17

Boring and Monitoring Well Construction Details For Monitoring Well # W-4

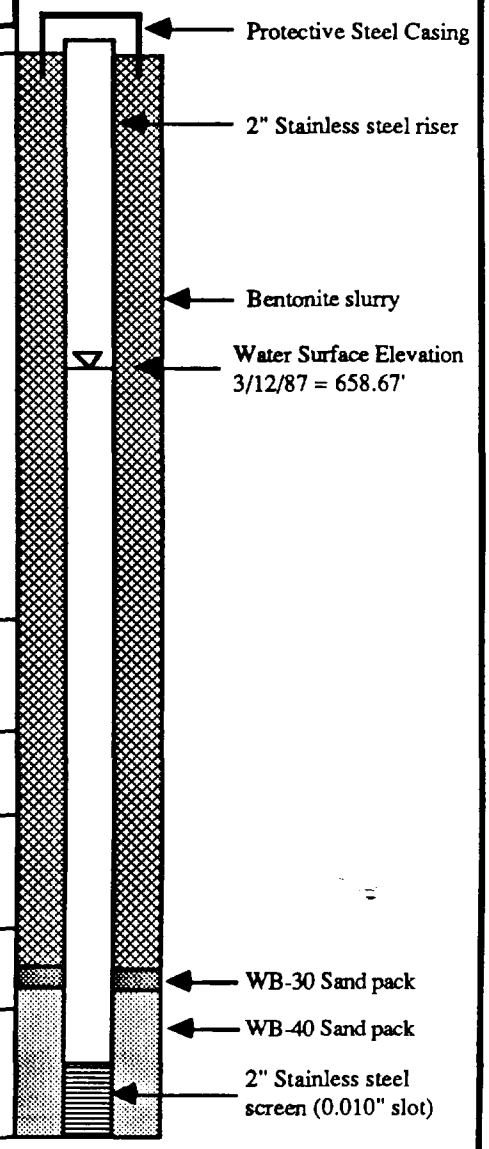
BOWERS LANDFILL CIRCLEVILLE, OHIO

Monitoring Well # P-4A

GROUND SURFACE ELEVATION = 673.73'
TOP OF CASING ELEVATION = 676.22

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0					See W-4 log for details of 0-30'
30				SW	Gray-brown coarse grained SAND, some pebbles and gravel, saturated, fairly graded
	1	18/18	25	ML	Gray sandy SILT with rounded and subangular gravel, slightly clayey, saturated
40	2	18/8	28	GC	GRAVEL and pebbles in gray silty clay matrix, gravel and pebbles are subrounded to angular limestone, shale, and granite, saturated
	3	18/16	17	GW	Driller noted less gravel at 42.5' GRAVEL and pebbles in brown medium to coarse grained sand, well graded, no silt or clay, saturated
50	4	18/18	49	SW	Gray coarse to medium grained SAND, some pebbles and gravel, well graded, no silt or clay, saturated
	5	18/20	51		Driller noted "hard, gravelly zone" from 52.5' - 54'
60					Boring terminated on 10/28/86 Total depth drilled = 57 feet

Monitoring Well Construction Details



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Boring and Monitoring Well Construction Details For Monitoring Well # P-4A

BOWERS LANDFILL CIRCLEVILLE, OHIO

Monitoring Well # W-5

GROUND SURFACE ELEVATION = 652.83

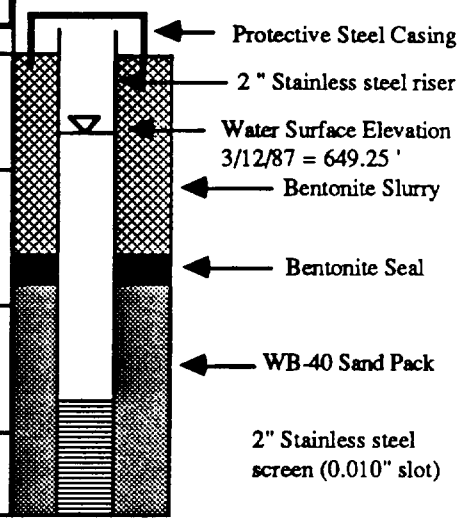
TOP OF CASING ELEVATION = 657.28'

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0				CL	See boring P-5B for more detailed sampling information
	1	18/18	6		Brown silty CLAY, medium plasticity, moist
				CH	Dark gray CLAY, high plasticity,moist, trace silt
10	2	18/18	2	CL	Dark gray silty CLAY with fine sand zones, moist, becoming saturated at 10.5'
	3	24/17	11	SP	Brown SAND and gravel, some silt and clay, well graded, saturated
20	4	18/14	84	GM	GRAVEL and pebbles in sand silt matrix, well graded, saturated

Well terminated on 1/13/87

Total depth drilled = 24.0'

Monitoring Well Construction Details



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Boring and Monitoring Well Construction Details For Monitoring Well # W-5

BOWERS LANDFILL CIRCLEVILLE, OHIO

Monitoring Well # P-5A

GROUND SURFACE ELEVATION = 653.12'

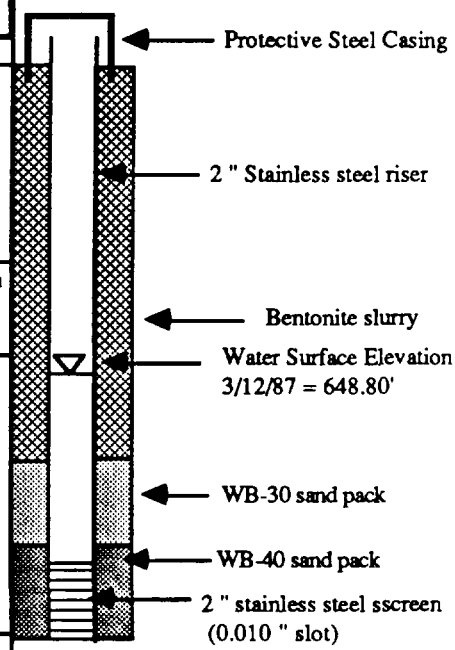
TOP OF CASING ELEVATION = 657.26 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0					See Boring P-5B for more detailed sampling information
	1	18/18	3	CH	Dark gray silty CLAY, high plasticity, moist, black charcoal chunks Few glass fragments in cuttings Rods dry
10	2	18/16	2		
	3	18/14	3	SC	Dark gray CLAY with silt and fine sand, moist, medium plasticity Water flowing into hole 10.5 '
	4	18/12	19	GM	Pebbles and GRAVEL in sand-silt matrix, well graded, saturated
20					
	5	18/11	83		
30	6	24/24	51	SC	Gray silty CLAY with pebbles (glacial till), stiff, dense, moist

Well terminated on 1/13/87

Total depth drilled= 30.0'

Monitoring Well Construction Details



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Boring and Monitoring Well Construction Details For Monitoring Well # P-5A

BOWERS LANDFILL CIRCLEVILLE, OHIO

Monitoring Well # P-5B

GROUND SURFACE ELEVATION = 653.00

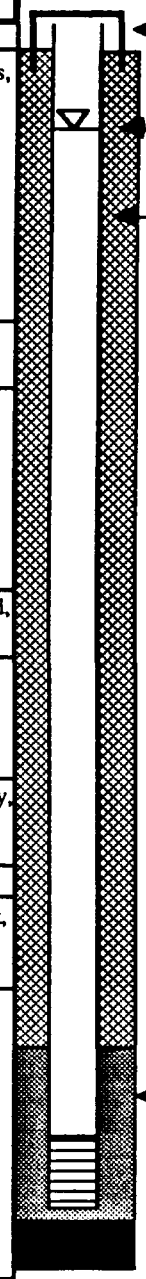
TOP OF CASING ELEVATION = 656.27 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0					
	1	18/8	6	CL	Olive-brown silty CLAY, medium plasticity, tan streaks, organic debris, saturation noted at 3 '
	2	18/10	6		clay becomes dark gray, medium plasticity, stiff, saturated
	3	18/6	10		Glass,plastic and assorted waste observed
10	4	18/4	2		Black dense liquid observed Silt and fine sand zones
	5	18/12	3		Driller notes sand in augers at 14.0 '
	6	18/5	4	SW	Coarse SAND and pebbles with gray clayey silt zones, saturated
	7	18/8	14	GW	Pebbles and GRAVEL in brown clay-silt matrix, saturated
20	8	18/7	11		
	10	18/14	26		Harder drilling noted at 22.5 '
30	11	18/14	62	GM	Gray GRAVEL,fine sand,silt and clay, very well graded, limestone cobbles,shell fragments
				CL	Harder drilling at 30.0 '
	12	18/18	63		Gray silty CLAY (glacial till), dense, stiff, pebbles in matrix, dry
40	13	18/14	106		Gray, black and green SHALE, variably weathered, dry, stiff, laminations visible Very stiff drilling
	14	18/15	78		GRAVEL and pebbles with some sand
				SM	Gray clayey SAND with silt,, fairly high clay content, moist Sand in augers at 46 '
50	15	18/16	42	SP	Gray medium-fine SAND, well sorted, trace silt and clay, saturated Drilling fairly uniform with several thin gravel zones 48- 57 '
	16	18/16	125		
60					Harder drilling 62-62.5 ' Eased up 62.5 - 63' Hard drilling again
	17	3/3	150/3		Green SHALE,hard,dense,dry, laminated

Well terminated on 1/12/87

Total depth drilled = 64.5 '

Monitoring Well Construction Details



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Boring and Monitoring Well Construction Details For Monitoring Well # P-5B

BOWERS LANDFILL CIRCLEVILLE, OHIO

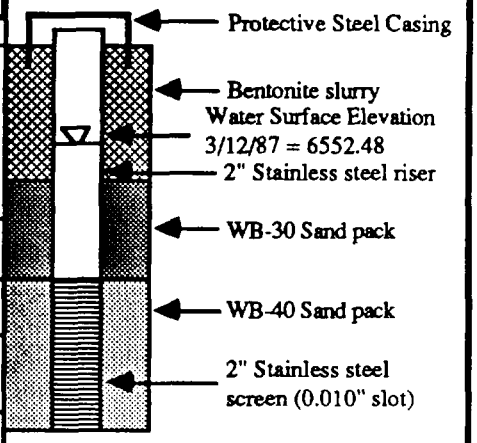
Monitoring Well # W-6

GROUND SURFACE ELEVATION = 656.21'
TOP OF CASING ELEVATION = 659.22'

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0					See P-6B log for details of 0-9'
10	1	18/12	3	CL	Olive-brown CLAY, medium plasticity, moist
	2	24/24	2		
	3	24/24	6	ML	Dark gray silty CLAY, variable silt content, medium plasiticity. Gravel at 14.5'
	4	24/24	21	SM / SW	Gray fine SAND, alternating silt and fine sand seams, some gravel and cobbles, very moist. Silt absent at 15'
20	5	18/10	18		Grayish-tan SAND and GRAVEL, poor sorting. Less gray coloration, trace clay at 19'

Boring terminated on 10/25/86
Total depth drilled = 20 feet

Monitoring Well Construction Details



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Boring and Monitoring Well Construction Details For Monitoring Well # W-6

BOWERS LANDFILL CIRCLEVILLE, OHIO

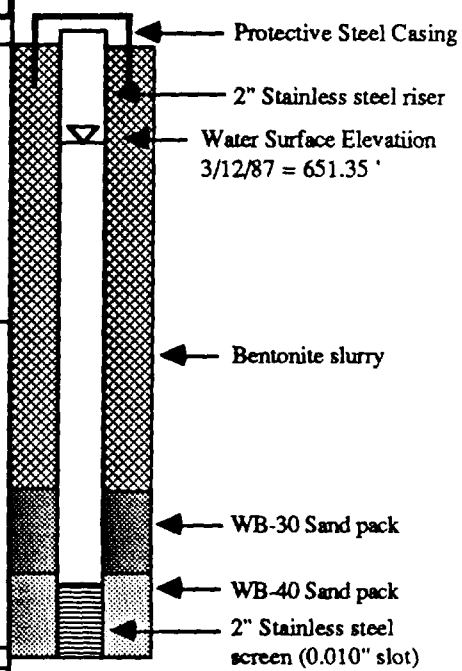
Monitoring Well # P-6A

GROUND SURFACE ELEVATION = 656.24'
TOP OF CASING ELEVATION = 658.98 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0					
					See P-6B log for more detailed sampling information
10	1	18/14	3	CH	Gray-brown CLAY, high plasticity, trace interbedded silt, dark gray and orange streaks, moist
	2	24/24	22	SW	Blackish-gray fine SAND grading to a medium grained gray sand, with angular to rounded pebbles and gravel
20					Becoming orange-brown at 15.5'
30	3	18/11	30		Clayey fine sand at 30' Cobbles noted at 31'
	4	18/18	61		Brown fine SAND, well sorted, black specks
					Gray clayey SILT, dense, medium plasticity, slightly moist, green and black subangular shale chunks

Boring terminated on 10/25/86
Total depth drilled = 32 feet

Monitoring Well Construction Details



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Boring and Monitoring Well Construction Details For Monitoring Well # P-6A

BOWERS LANDFILL CIRCLEVILLE, OHIO

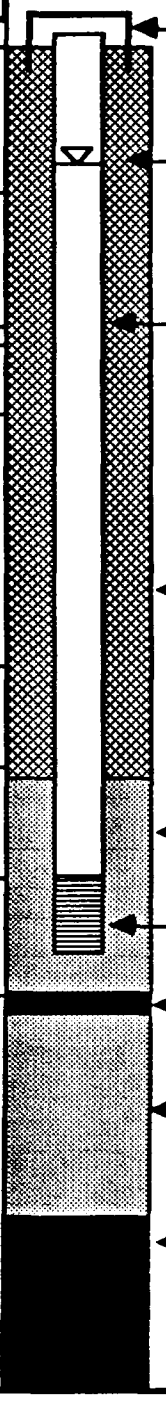
Monitoring Well # P-6B

GROUND SURFACE ELEVATION = 656.25'

TOP OF CASING ELEVATION = 657.90'

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0	1	18/9	14	ML	Dark brown SILT with some clay, crumbly, low plasticity, slightly moist
	2	18/11	17		Becoming more plastic with light brown streaks
	3	18/5	6	CH	Olive-brown CLAY, high plasticity, moist, saturated
10	4	18/18	3		Trace silt, very moist
	5	18/18	1		Interbedded dark gray fine sand zones, saturated
	6	18/16	14		Dark gray fine SAND, traces of clay
	7	18/9	22	GW	GRAVEL with pebbles and dark gray fine sand, saturated
20	8	18/18	19	SW	Brown coarse SAND with pebbles and gravel, trace silt and clay
	9	18/10	21		
30	10	18/10	27		Stiffer drilling noted @ 32.5'
	11	18/18	60	ML	Dark gray clayey SILT, loose and sandy at top, becoming more clayey and stiff with depth
					Drilling change noted @ 36 - 36.5 '
40	12	18/18	84		Black weathered SHALE, crumbly, dry, stiff, dense, becoming more brittle and laminated with depth, some greenish-gray streaks
					Drilling very stiff
	13	18/14	104	SP	Gray coarse SAND, fairly well sorted, some gravel
					Drilling softer at 43.5'
					Drilling stiffer at 47.5'
50	14	18/13	56		Black and gray SHALE, some green clay near 51', dry, laminated
					Drilling very stiff and slow
					Hard and brittle
60		3/2	00/3"		Drilling extremely slow
					Auger refusal at 61' 3"
					Switch to tri-cone bit (no auger stems) to penetrate and sample in shale
70					Chip samples show black shale, hard, brittle, laminated

Monitoring Well Construction Details



Boring terminated on 9/30/86
Total depth drilled = 71 feet

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Boring and Monitoring Well Construction Details For Monitoring Well # P-6B

BOWERS LANDFILL CIRCLEVILLE, OHIO

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0					See P-7A log for sampling details of 0-13'
10	1	18/18	4	SP	Green-orange-gray interbedded fine SAND and silty clay Gray medium coarse grained SAND, well sorted
20	2	18/18	26	SW	Coarse SAND with pebbles and gravel, fair sorting, saturated
	3	18/18	22		Black fine SAND, well sorted, same interbedded brown clay

Monitoring Well # W-7

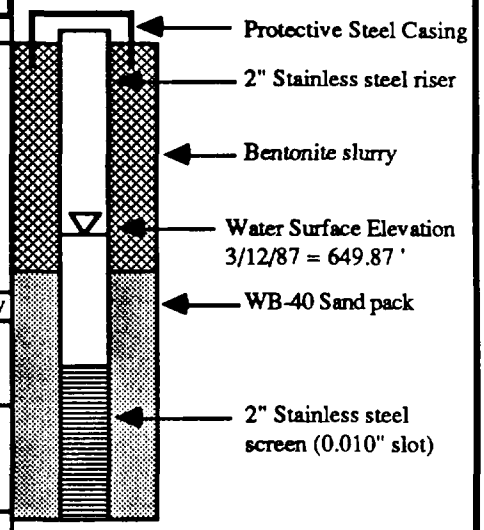
GROUND SURFACE ELEVATION = 659.10

TOP OF CASING ELEVATION = 662.50 '

Boring completed on 10/24/86

Total depth drilled = 25 feet

Monitoring Well Construction Details



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Boring and Monitoring Well Construction Details For Monitoring Well # W-7

BOWERS LANDFILL CIRCLEVILLE, OHIO

Monitoring Well # P-7A

GROUND SURFACE ELEVATION = 659.19

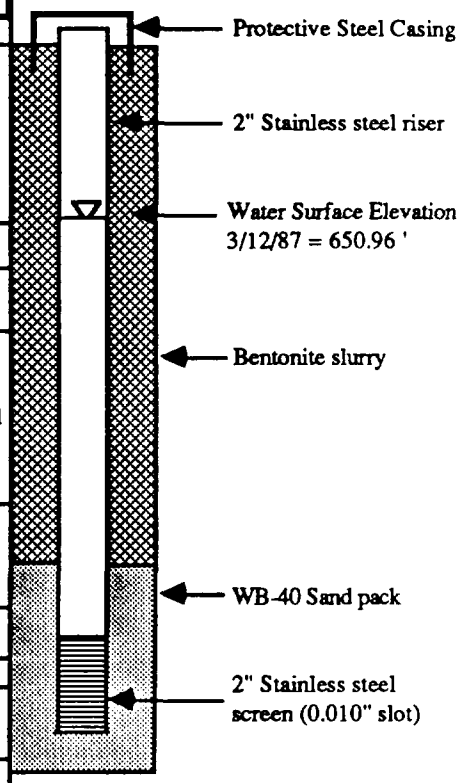
TOP OF CASING ELEVATION = 662.43 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0	1	18/6	30	OL	Dark brown silty CLAY, organic matter (topsoil), moist, medium plasticity
	2	18/12	22		Slightly higher plasticity
	3	18/18	10		Slightly siltier and lighter brown
10	4	18/18	4	CH	Orange-brown CLAY, trace silt, high plasticity, moist, orange mottling
	5	18/18	2	CL	Gray CLAY with interbedded silt and fine sand
	6	18/18	4		Becoming dark gray at 15'
	7	18/14	14	SP	Dark gray medium coarse grained SAND, sorted
20	8	18/12	23		Orange-brown clay layer at 17'
					Black zones appear to be composed of rounded carbonaceous material
					Brown clay parting, large gravel at 20'
	9	18/5	25	GP	GRAVEL and pebbles with some sand, fairly well sorted
30	10	18/18	6	SW	Fine to medium grained gray SAND, well sorted, black speckles
					Gray CLAY, high plasticity
	11	18/16	86		Gray medium to coarse grained SAND with pebbles
					Stiffer drilling noted at 37'
40	12	18/24	107		Gray-black SHALE, weathered at top, becoming less weathered with depth, laminated, shaves like soap, pyrite nodules at 39.5'

Boring terminated on 10/24/86

Total depth drilled = 38.5'

Monitoring Well Construction Details



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Boring and Monitoring Well Construction Details For Monitoring Well # P-7A

BOWERS LANDFILL CIRCLEVILLE, OHIO

Monitoring Well # W-8

GROUND SURFACE ELEVATION = 660.38

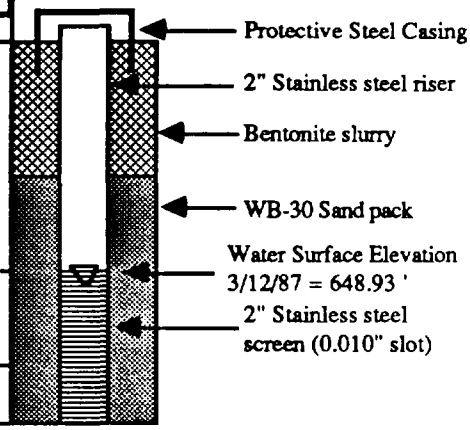
TOP OF CASING ELEVATION = 663.39 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0					
					See P-8B for sampling details of 0-12'
10					
	1	18/12	11	GW	Brown SAND and gravel, sand is medium to fine grained, pebbles and gravel with some broken cobbles, saturated
	2	18/12	9	SC	Dark gray clayey SAND with trace silt and pebbles/ gravel, well graded, some black carbonaceous material
20					

Boring terminated on 10/21/86

Total depth drilled = 20 feet

Monitoring Well Construction Details



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Job No. 850-032-17

Boring and Monitoring Well Construction Details For Monitoring Well # W-8

BOWERS LANDFILL CIRCLEVILLE, OHIO

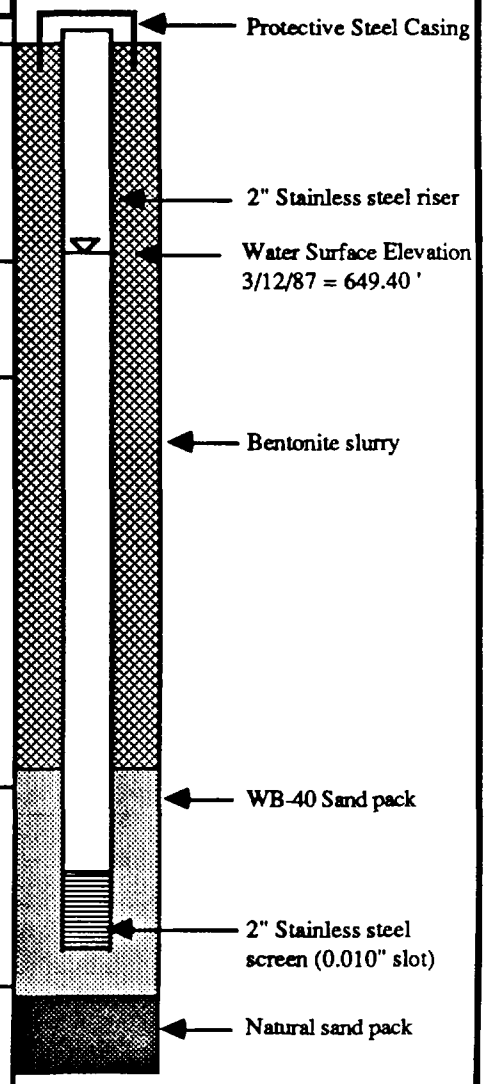
Monitoring Well # P-8A

GROUND SURFACE ELEVATION = 660.49'

TOP OF CASING ELEVATION = 662.18 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0	1	18/13	9	CL	Brown silty CLAY, moist Some fine sand zones Some coarser sand zones Saturation noted at 9' Distinct sand zones with shell fragments at 9.5'
	2	18/12	4		
	3	18/15	5		
10	4	18/14	3		
	5	18/5	13	SP	Coarse SAND with some gravel and fine sand, saturated Becomes gray at 15'
	6	18/13	7		
	7	18/5	10		
20	8	18/5	11	GW	GRAVEL with fine sand and pebbles, well graded sand and silt matrix
	9	18/12	13	GW	Brown coarse SAND seam, well sorted 24' -24.5' Drilling stiffer at 28'
30	10	18/15	42		
	11	18/10	19		More sand present at 34'
40	12	18/12	46	SP	Dark gray coarse SAND, well sorted, quartz, shale and limestone derived, subangular to rounded clasts
	13	18/14	52		
50	14	18/18	107	CL	Gray silty CLAY, dense, stiff, with some sandy zones and pebbles in matrix, wood fragments, low moisture content
	15	18/24	78		

Monitoring Well Construction Details



Dames & Moore

Job No. 850-032-17

Boring and Monitoring Well Construction Details For Monitoring Well # P-8A

BOWERS LANDFILL CIRCLEVILLE, OHIO

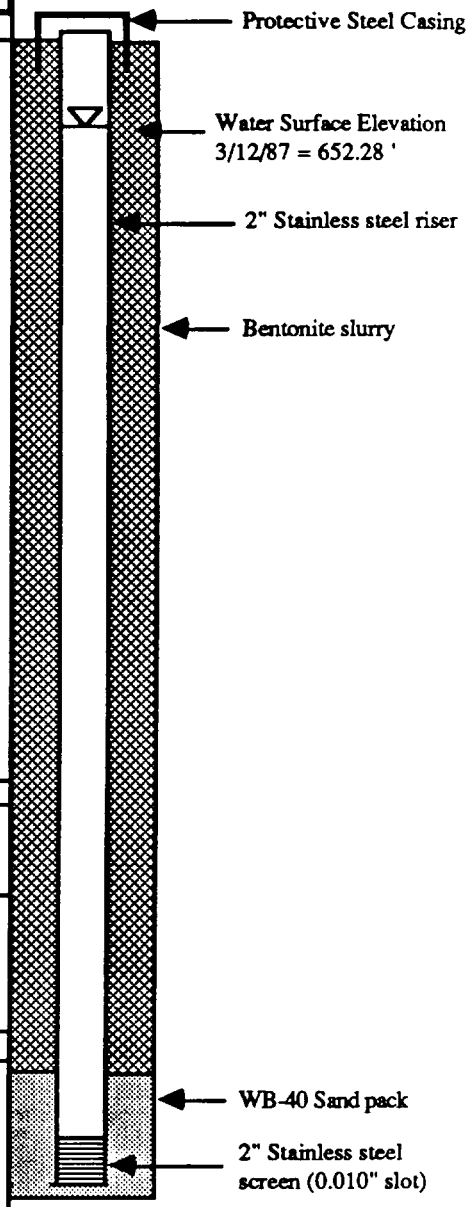
Monitoring Well # P-8B

GROUND SURFACE ELEVATION = 660.42'

TOP OF CASING ELEVATION = 662.07 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0					See P-8A log for details of 0 - 62'
10					
20					Driller notes cobbles/gravel at 26'
30					Sand flowing inside augers at 35' and 45'-53'
40					Stiffer drilling noted at 49'
50					
60	1	18/24	110	CL	Brown medium grained SAND, well sorted Gray silty CLAY with some pebbles, stiff, dense
70	2	18/24	120	SP	Easier drilling noted at 71.5' Gray medium to coarse grained SAND, well sorted, saturated
80	3	11/24	150		Gravel and pebbles present Black weathered SHALE, hard, brittle, laminated Drilling fairly easy
90	4	18/30	131	SP	Driller notes approximately 2' of sand in augers Gray medium grained SAND, uniform, well sorted, saturated, some pebbles and shale fragments
	5	18/18	291		Stiffer drilling noted Sand in augers at 97.2'
100					Black SHALE, weathered and fractured at top, becoming more competent with depth, hard, dense, laminated, dry, some gray and green shale zones, distinct pyrite crystals at 98.5' - bright silver-gold, unweathered
110					

Monitoring Well Construction Details



Boring terminated on 10/23/86
Total depth drilled = 97 feet

Dames & Moore

Job No. 850-032-17

Boring and Monitoring Well Construction Details For Monitoring Well # P-8B

BOWERS LANDFILL CIRCLEVILLE, OHIO

Monitoring Well # W-9

GROUND SURFACE ELEVATION = 656.00'

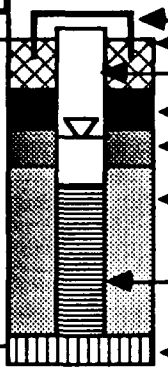
TOP OF CASING ELEVATION = 658.39 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0	1	18/14	14	ML	Dark brown clayey SILT with fine sand, very soft, slightly moist
	2	18/8	4		Saturated at 5.5'
	3	18/0	2		
10	4	18/19	1		Trace fine sand
	5	18/18	3		Clay lenses approximately 0.5' thick
	6	18/16	3		Gray-brown coarse sand seam with gravel and rounded pebbles
20					

Boring terminated on 9/26/86

Total depth drilled = 17 feet

Monitoring Well Construction Details



Water Surface Elevation 3/12/87 = 650.57 '

Dames & Moore

Job No. 850-032-17

Boring and Monitoring Well Construction Details For Monitoring Well # W-9

BOWERS LANDFILL CIRCLEVILLE, OHIO

Monitoring Well # W-10

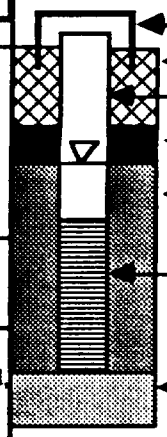
GROUND SURFACE ELEVATION = 656.40

TOP OF CASING ELEVATION = 660.41 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0	1	18/14	14	CL	Dark brown-olive, silty CLAY, moist, cohesive, medium plasticity
	2	18/18	10		Orange-brown coloration, slightly higher silt content
	3	18/24	3		Light olive coloration, very moist fine sand seam at 8.5'
10	4	18/18	2	ML	Light gray CLAYEY SILT with increasing fine sand content
	5	18/18	1		Resembles till
	6	18/14	17	SP	Brown medium to coarse grained SAND with pebbles and gravel, well sorted sand at 14.5' - rest is well graded, saturated
	7	18/12	18		
20	8	18/18	15		Well rounded pebbels at 18' Grayish brown coloration at 20'

Boring terminated on 10/26/86
Total depth drilled = 19.5'

Monitoring Well Construction Details



Water Surface Elevation
3/12/87 = 950.68 '

Dames & Moore

Job No. 850-032-17

Boring and Monitoring Well Construction Details For Monitoring Well # W-10

BOWERS LANDFILL CIRCLEVILLE, OHIO

Monitoring Well # W-11

GROUND SURFACE ELEVATION = 654.43'

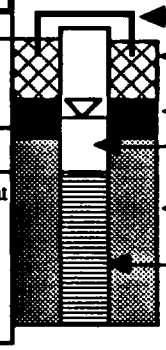
TOP OF CASING ELEVATION = 657.61 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0	1	18/15	6	CL	Brown silty CLAY, moist, cohesive, trace fine sand, clean sand and pebbles at 3.5'
	2	18/18	1	ML	Orange-brown clayey SILT - fine sand Coarse sand at 6'
	3	18/12	9	SW	Dark brown medium grained SAND becoming coarser at 7.5', with pebbles
10	4	18/12	18		Saturated
	5	18/14	16		Black fine sand at 12.5', saturated
	6	18/16	18		Gray to 15', becoming brownish
20					

Boring terminated on 10/26/86

Total depth drilled = 15'

Monitoring Well Construction Details



Water Surface Elevatio 3/12/87 = 650.09 '

Dames & Moore

Job No. 850-032-17

Boring and Monitoring Well Construction Details For Monitoring Well # W-11

BOWERS LANDFILL CIRCLEVILLE, OHIO

Monitoring Well # W-12

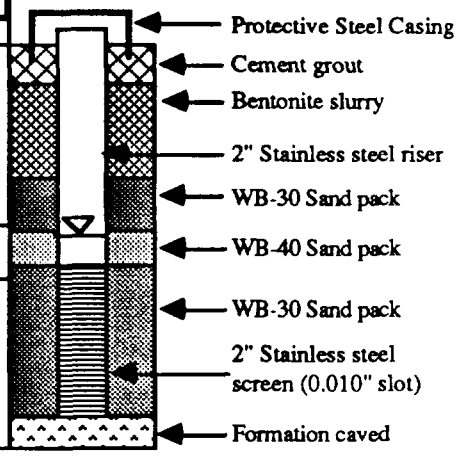
GROUND SURFACE ELEVATION = 666.67'

TOP OF CASING ELEVATION = 669.67 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0					
	1	18/15	10	GW	Dark brown coarse gravel, sand, clayey silt, slightly moist, appears to be fill material
	2	18/9	17		Dry
	3	18/12	25		
10	4	18/12	15	CL	Medium brown silty CLAY with trace sand and rounded pebbles, moist, stiff, medium plasticity
	5	18/ 10.5	15	GM	Light brown clayey SILT with coarse gravel
	6	18/12	6		
	7	18/11	13		
20	8	18/18	23		

Boring terminated on 9/26/86
Total depth drilled = 21'

Monitoring Well Construction Details



Water Surface Elevation
3/12/87 = 655.74 '

Dames & Moore

Job No. 850-032-17

Boring and Monitoring Well Construction Details For Monitoring Well # 12

BOWERS LANDFILL CIRCLEVILLE, OHIO

Monitoring Well # W-13

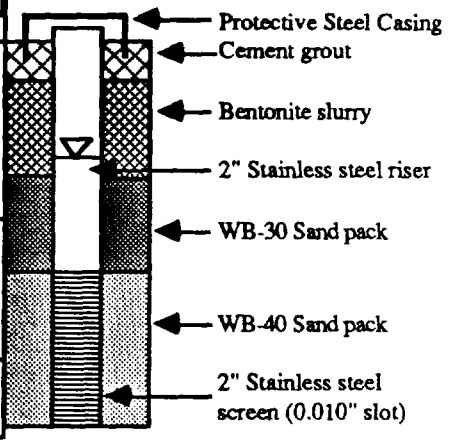
GROUND SURFACE ELEVATION = 658.91'

TOP OF CASING ELEVATION = 662.36 '

Depth (Feet)	Sample Location/ Number	Inches Driven/ Inches Recovered	SPT Blow Count/ft.	USCS Symbol	Description of Subsurface Material:
0	1	18/18	11	CL	Dark brown silty CLAY with sand and pebbles/gravel Appears to be fill
	2	18/9	8		
	3	18/0.5	15		Saturation noted
10	4	18/12	16	GC	Gravel, some carbonaceous shale, clay and silt, saturated
	5	18/14	19		
	6	18/14	28		
	7	18/14	35	GP	Gravel, better sorting, pebbles and coarse sand, trace silt and clay, distinct light brown-olive color, saturated
20	8	18/18			

Boring terminated on 9/28/86
Total depth drilled = 20'

Monitoring Well Construction Details



Water Surface Elevation
3/12/87 = 653.36 '

Dames & Moore

Job No. 850-032-17

Boring and Monitoring Well Construction Details For Monitoring Well # W-13

BOWERS LANDFILL CIRCLEVILLE, OHIO

APPENDIX E

RESULTS OF PHYSICAL TESTING
SPLIT-SPOON AND SHELBY TUBE SAMPLES

Job NO. DM330

GEOTECHNICAL LABORATORY REPORT

CLASSIFICATION

Prepared for:

Dames and Moore, Inc.

Prepared by:

TECH ENGINEERING INC.

373 Waller Avenue
Lexington, KY 40504
(606) 231 5167

June 18, 1987

Tommy C. Hopkins
President

TECH ENGINEERING INC.
373 Waller Avenue
Lexington, KY 40504
(606) 231 5167

David L. Allen
Vice President

June 18, 1987

Mr. Mike Lyden
Dames and Moore, Inc.
644 Linn St., Suite 501
Cincinnati, OH 45203

Dear Mr. Lyden:

Results obtained from classification tests are submitted herein. The tests were performed on samples you submitted and authorized for testing in May, 1987. The samples were identified as being from an inactive landfill -- PO. No. CIN 1509)

The all classification tests were performed according to ASTM Standards. The classification test results are shown in Table 1 through Table 20. The grain-size curves are shown in Appendix A.

We appreciate the opportunity to be of service to you on this project and hope that the information contained in the report conforms to your needs. If you have any questions, or if we may be of additional assistance concerning the report, please do not hesitate to call our office. The sample will be retained in our laboratory until further instructions from you concerning the status of the project. If no instructions are received, the samples will be discarded after six months.

Sincerely,

Tech Engineering, Inc.

Tommy C. Hopkins

Tommy C. Hopkins, P.E.

TABLE 6. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 W-4-2	27.0	17.0	10.0	2.75	A-4	(2)	CL

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	0.00	100.00
3/8 IN	3.82	98.71
NO. 4	1.90	98.07
NO. 10	5.60	96.18

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	4.06	89.55
NO. 40	5.84	80.01
NO. 60	4.74	72.26
NO. 200	11.79	52.99

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	68.00	36.00	52.79120	0.04235
2.00	68.00	34.00	49.58832	0.03042
5.00	68.00	31.00	44.78398	0.01968
15.00	69.00	27.00	38.57204	0.01162
30.00	69.50	25.00	35.36914	0.00833
60.00	70.00	22.50	31.55936	0.00595
240.00	73.00	19.00	26.63354	0.00298
1440.00	75.00	15.00	20.77939	0.00123

TABLE 12. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 W-4-9	0.0	0.0	0.0	2.75	A-1-B	(0)	SM

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	0.00	100.00
3/8 IN	10.41	96.72
NO. 4	24.70	88.95
NO. 10	51.67	72.68

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	32.35	49.04
NO. 40	28.00	28.58
NO. 60	9.43	21.69
NO. 200	6.99	16.58

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	72.00	26.00	16.80023	0.04441
2.00	72.00	24.00	15.36792	0.03183
5.00	73.00	22.00	14.05893	0.02027
15.00	73.00	19.00	11.91044	0.01193
30.00	74.00	16.00	9.88531	0.00854
60.00	75.00	13.00	7.86016	0.00611
240.00	78.00	11.00	6.79785	0.00303
1440.00	75.00	9.00	4.99551	0.00128

TABLE 4. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 W-5-1	53.0	32.0	19.0	2.70	A-7-5	(24)	MH

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	0.00	100.00
3/8 IN	0.00	100.00
NO. 4	0.00	100.00
NO. 10	0.00	100.00

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	0.05	99.92
NO. 40	0.05	99.83
NO. 60	0.08	99.70
NO. 200	0.42	99.00

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	67.00	60.00	94.15288	0.03394
2.00	67.00	58.00	90.84015	0.02461
5.00	67.00	54.00	84.21475	0.01632
15.00	68.00	48.00	74.47717	0.00997
30.00	69.00	46.50	72.19312	0.00711
60.00	70.00	39.50	60.79921	0.00532
240.00	72.00	30.00	45.48120	0.00283
1440.00	72.00	23.00	33.88678	0.00121

TABLE 17. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 W-5-2	29.0	22.0	7.0	2.68	A-4	(2)	ML-CL

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	0.00	100.00
3/8 IN	0.00	100.00
NO. 4	0.00	100.00
NO. 10	0.00	100.00

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	0.02	99.97
NO. 40	0.54	99.05
NO. 60	6.80	87.46
NO. 200	15.73	60.64

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	72.00	38.00	60.07487	0.04140
2.00	72.00	35.00	54.99222	0.02999
5.00	73.00	32.50	51.04843	0.01921
15.00	73.00	28.00	43.42444	0.01146
30.00	74.00	25.00	38.63358	0.00822
60.00	75.00	22.00	33.84271	0.00589
240.00	78.00	18.00	27.94112	0.00297
1440.00	74.00	14.00	19.99716	0.00127

TABLE 5. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 W-5-3	31.0	22.0	9.0	2.68	A-2-4	(0)	SM-SC

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	3.68	98.34
3/8 IN	5.74	95.75
NO. 4	19.76	86.83
NO. 10	31.96	72.41

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	5.87	65.20
NO. 40	6.75	56.91
NO. 60	12.40	41.67
NO. 200	6.76	33.37

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	69.00	32.00	35.52080	0.04428
2.00	69.00	31.00	34.29955	0.03155
5.00	70.00	29.00	32.00488	0.02011
15.00	70.00	27.00	29.56241	0.01178
30.00	70.50	24.00	25.89865	0.00850
60.00	71.00	21.00	22.33229	0.00609
240.00	73.50	17.00	17.86795	0.00308
1440.00	76.00	12.00	12.39271	0.00127

TABLE 20. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 P-5A-1	53.0	31.0	22.0	2.71	A-7-5	(26)	MH

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	0.00	100.00
3/8 IN	0.00	100.00
NO. 4	0.00	100.00
NO. 10	0.00	100.00

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	0.15	99.74
NO. 40	0.36	99.12
NO. 60	0.38	98.47
NO. 200	1.16	96.48

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	71.00	57.00	92.06152	0.03420
2.00	71.00	56.00	90.36562	0.02447
5.00	71.00	51.00	81.88640	0.01636
15.00	72.00	44.00	70.30757	0.01005
30.00	73.00	37.50	59.57663	0.00747
60.00	75.00	35.00	55.92113	0.00532
240.00	78.00	25.00	39.83882	0.00281
1440.00	75.00	19.00	28.78760	0.00122

TABLE 10. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 P-5A-6	23.0	16.0	7.0	2.60	A-4	(0)	SM-SC

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	21.67	91.33
1/2 IN	17.82	84.20
3/8 IN	2.67	83.14
NO. 4	6.90	80.38
NO. 10	24.25	70.68

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	4.73	65.05
NO. 40	5.33	58.72
NO. 60	5.03	52.74
NO. 200	7.70	43.58

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	69.00	40.00	44.53018	0.04255
2.00	69.00	38.00	42.12874	0.03060
5.00	69.00	35.00	38.52654	0.01983
15.00	69.50	30.00	32.52283	0.01189
30.00	70.00	28.00	30.26671	0.00847
60.00	71.00	25.00	26.76021	0.00608
240.00	73.00	20.00	21.17009	0.00310
1440.00	76.00	15.00	15.78682	0.00128

TABLE 15. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 P-5B-11	20.0	15.0	5.0	2.72	A-4	(0)	SM-SC

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	9.43	97.97
1/2 IN	7.09	96.44
3/8 IN	16.37	92.91
NO. 4	29.45	86.55
NO. 10	55.39	74.61

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	5.52	67.70
NO. 40	4.65	61.88
NO. 60	4.04	56.82
NO. 200	8.19	46.58

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	72.00	33.00	37.58157	0.04257
2.00	72.00	30.00	33.88002	0.03079
5.00	73.00	28.00	31.62480	0.01962
15.00	73.00	23.00	25.45552	0.01173
30.00	74.00	21.00	23.20032	0.00835
60.00	76.00	18.00	19.92375	0.00594
240.00	78.00	15.00	16.64719	0.00299
1440.00	74.00	13.00	13.32952	0.00127

TABLE 18. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 W-6-1	37.0	24.0	13.0	2.73	A-6	(5)	CL

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	0.00	100.00
3/8 IN	0.00	100.00
NO. 4	0.00	100.00
NO. 10	0.00	100.00

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	3.91	93.30
NO. 40	5.11	84.55
NO. 60	5.89	74.46
NO. 200	11.10	55.44

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	71.00	51.00	81.40117	0.03638
2.00	71.00	48.50	77.18671	0.02639
5.00	72.00	44.50	70.73383	0.01723
15.00	72.50	37.50	58.93327	0.01058
30.00	73.00	34.00	53.32332	0.00764
72.00	76.00	30.00	47.45108	0.00499
257.00	78.00	25.00	39.60278	0.00270
1440.00	75.00	20.00	30.30283	0.00120

TABLE 7. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 W-6-3	35.0	29.0	6.0	2.61	A-4	(2)	ML

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	14.13	93.40
1/2 IN	0.00	93.40
3/8 IN	2.81	92.08
NO. 4	2.25	91.03
NO. 10	3.52	89.39

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	0.81	88.16
NO. 40	0.67	87.14
NO. 60	2.70	83.04
NO. 200	16.21	58.44

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	69.00	35.00	49.09203	0.04420
2.00	69.00	33.00	46.03198	0.03174
5.00	69.00	29.00	39.91190	0.02068
15.00	69.00	25.00	33.79178	0.01228
30.00	69.50	22.00	29.20169	0.00886
60.00	70.00	19.00	24.79681	0.00634
240.00	73.00	16.00	20.85571	0.00317
1440.00	76.00	12.00	15.52612	0.00130

TABLE 14. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 P-6A-2	0.0	0.0	0.0	2.73	A-1-A	(0)	B-LINE

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	44.93	92.27
1/2 IN	89.52	76.87
3/8 IN	45.03	69.12
NO. 4	96.12	52.58
NO. 10	79.19	38.95

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	6.36	34.78
NO. 40	9.96	28.24
NO. 60	13.22	19.56
NO. 200	11.42	12.06

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	73.00	20.00	11.39015	0.04617
2.00	73.00	19.00	10.74413	0.03286
5.00	73.00	17.00	9.45207	0.02104
15.00	74.00	15.00	8.27126	0.01222
30.00	75.00	14.00	7.73649	0.00863
60.00	76.00	12.00	6.55568	0.00614
240.00	78.00	10.00	5.48614	0.00307
1440.00	74.00	9.00	4.39507	0.00129

TABLE 11. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO GI	USC
DM330 P-6B-9	0.0	0.0	0.0	2.73	A-1-A (0)	B-LINE

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	42.36	87.36
1/2 IN	36.93	76.34
3/8 IN	23.55	69.31
NO. 4	49.98	54.39
NO. 10	34.36	44.14

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	23.51	33.72
NO. 40	33.00	19.10
NO. 60	19.08	10.64
NO. 200	11.66	5.48

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	69.00	17.00	6.14174	0.04832
2.00	69.00	16.00	5.70571	0.03437
5.00	69.00	15.00	5.26969	0.02187
15.00	70.00	14.00	4.88644	0.01262
30.00	70.00	12.50	4.23240	0.00900
60.00	71.00	11.00	3.61312	0.00638
240.00	73.00	10.00	3.32728	0.00316
1440.00	76.00	8.00	2.68051	0.00128

TABLE 2. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 P-6B-13	0.0	0.0	0.0	2.73	A-1-B	(0)	B-LINE

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	36.01	93.96
3/8 IN	27.55	89.33
NO. 4	62.96	78.77
NO. 10	104.50	61.23

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	37.10	38.40
NO. 40	29.22	20.43
NO. 60	7.32	15.92
NO. 200	7.37	11.39

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	67.00	23.00	12.01284	0.04714
2.00	67.00	22.00	11.40746	0.03355
5.00	67.00	20.00	10.19672	0.02150
15.00	68.00	18.00	9.05925	0.01248
30.00	69.00	17.00	8.52715	0.00882
60.00	71.00	15.00	7.43794	0.00623
240.00	72.00	13.00	6.33144	0.00313
1440.00	72.00	10.00	4.51532	0.00130

TABLE 19. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 P-7A-1	50.0	29.0	21.0	2.68	A-7-6	(22)	CL

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	0.00	100.00
3/8 IN	0.00	100.00
NO. 4	0.00	100.00
NO. 10	0.00	100.00

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	0.05	99.91
NO. 40	0.05	99.83
NO. 60	0.25	99.40
NO. 200	5.69	89.65

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	71.00	59.00	95.91760	0.03366
2.00	71.00	57.00	92.50937	0.02440
5.00	72.00	43.00	68.94554	0.01773
15.00	73.00	38.00	60.71851	0.01062
30.00	73.00	35.00	55.60625	0.00769
60.00	75.00	31.00	49.37679	0.00554
240.00	78.00	24.00	38.32857	0.00285
1440.00	74.00	20.00	30.33829	0.00123

TABLE 16. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 P-7A-5	24.0	19.0	5.0	2.72	A-4	(0)	SM-SC

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	0.00	100.00
3/8 IN	0.00	100.00
NO. 4	0.00	100.00
NO. 10	0.00	100.00

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	0.16	99.73
NO. 40	2.22	95.97
NO. 60	7.92	82.57
NO. 200	19.37	49.81

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	72.00	31.00	47.47128	0.04322
2.00	72.00	29.00	44.13512	0.03101
5.00	72.00	24.00	35.79475	0.02031
15.00	73.00	21.00	31.07777	0.01188
30.00	74.00	19.00	28.02890	0.00845
60.00	75.00	17.00	24.98006	0.00601
240.00	78.00	15.00	22.50574	0.00299
1440.00	74.00	13.00	18.02048	0.00127

TABLE 1. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 P-7A-9	0.0	0.0	0.0	0.00	INSUFFICIENT DATA		

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	14.60	91.18
1/2 IN	12.38	83.71
3/8 IN	5.88	80.16
NO. 4	47.32	51.58
NO. 10	31.20	32.74
NO. 20	13.87	24.36
NO. 40	13.46	16.23
NO. 60	7.13	11.93
NO. 200	10.45	5.62

TABLE 3. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO GI	USC
DM330 W-8-1	0.0	0.0	0.0	2.71	A-1-B (0)	B-LINE

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	17.58	96.31
1/2 IN	49.22	85.96
3/8 IN	74.12	70.39
NO. 4	50.11	59.86
NO. 10	37.11	52.07

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	11.23	46.19
NO. 40	38.82	25.90
NO. 60	27.25	11.66
NO. 200	9.01	6.95

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	67.00	18.00	7.66633	0.04896
2.00	67.00	15.00	6.11691	0.03526
5.00	67.50	14.00	5.60044	0.02243
15.00	68.00	12.00	4.63001	0.01302
30.00	68.50	11.50	4.37178	0.00923
60.00	70.00	10.50	3.98033	0.00648
240.00	72.00	8.00	2.81927	0.00324
1440.00	72.00	8.00	2.81927	0.00132

TABLE 13. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 W-8-2	0.0	0.0	0.0	2.70	A-1-B	(0)	B-LINE

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	13.75	93.54
1/2 IN	25.67	81.48
3/8 IN	12.98	75.38
NO. 4	23.64	64.28
NO. 10	22.32	53.79

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	14.09	44.23
NO. 40	20.96	30.02
NO. 60	17.20	18.35
NO. 200	12.25	10.04

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	73.00	19.00	11.16836	0.04688
2.00	73.00	17.00	9.82528	0.03356
5.00	73.00	16.00	9.15374	0.02136
15.00	74.00	13.00	7.25478	0.01247
30.00	75.00	12.50	7.03466	0.00879
60.00	76.00	11.00	6.14300	0.00623
240.00	78.00	9.50	5.36699	0.00310
1440.00	75.00	9.00	4.68426	0.00129

TABLE 8. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 P-8A-14	21.0	15.0	6.0	2.62	A-4	(0)	SM-SC

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	0.00	100.00
3/8 IN	0.00	100.00
NO. 4	5.01	96.47
NO. 10	10.26	89.25

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	3.91	83.38
NO. 40	5.11	75.71
NO. 60	5.89	66.86
NO. 200	11.10	50.19

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	69.00	36.00	49.98608	0.04372
2.00	69.00	34.00	46.96448	0.03140
5.00	69.00	31.50	43.18750	0.02024
15.00	70.00	27.00	36.57173	0.01199
30.00	70.00	24.00	32.03934	0.00866
60.00	71.00	21.50	28.38274	0.00618
240.00	73.00	18.00	23.61531	0.00312
1440.00	76.00	13.00	16.84186	0.00129

TABLE 9. LABORATORY RECORD OF SOIL TEST DATA

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
DM330 P-8B-1	22.0	15.0	7.0	2.65	A-4	(0)	SM-SC

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
1 IN	0.00	100.00
3/4 IN	0.00	100.00
1/2 IN	0.00	100.00
3/8 IN	5.86	97.11
NO. 4	9.59	92.39
NO. 10	9.32	87.80

HYDROMETER SIEVE ANALYSIS

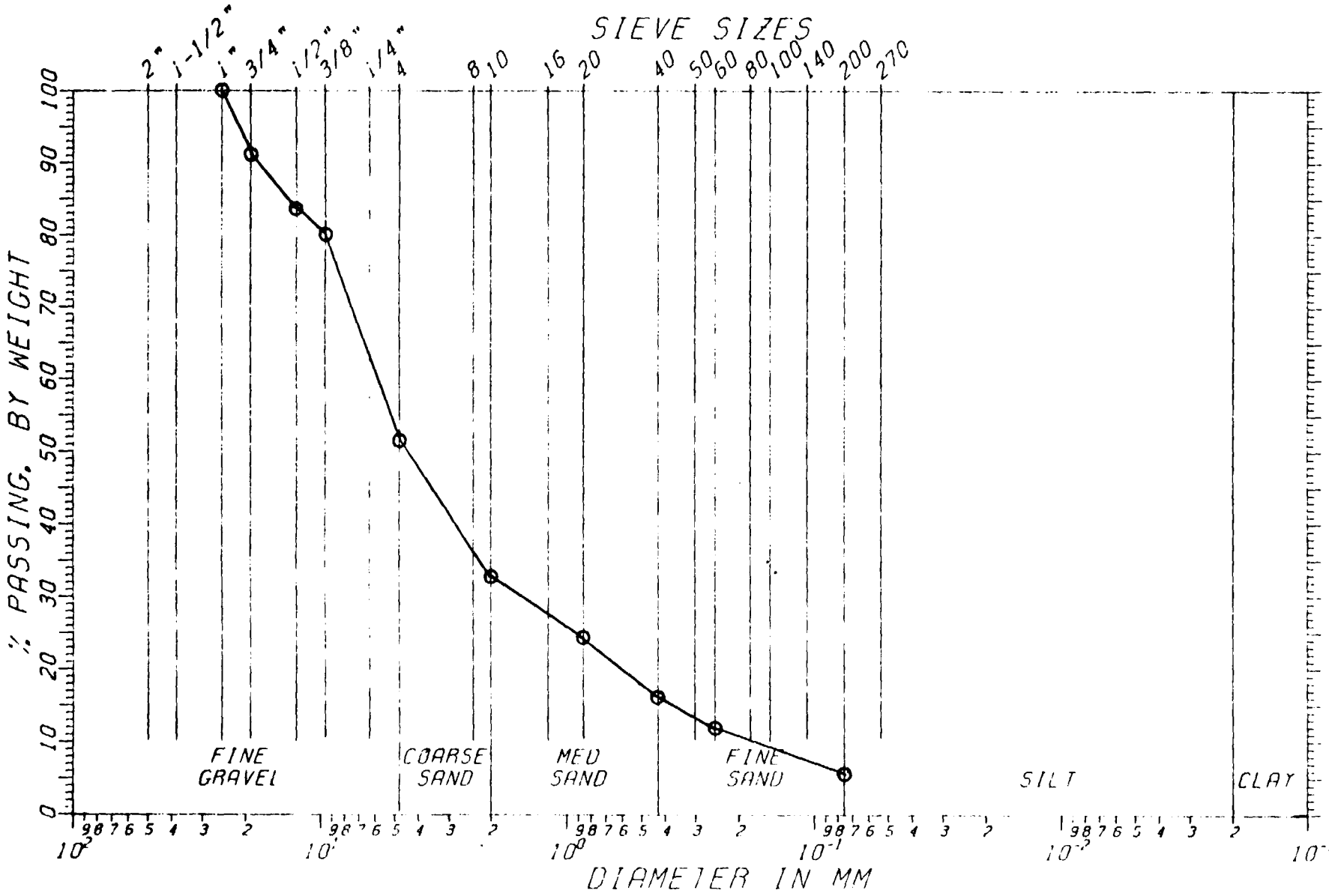
SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	4.76	80.77
NO. 40	7.40	69.84
NO. 60	7.92	58.15
NO. 200	10.72	42.33

HYDROMETER ANALYSIS

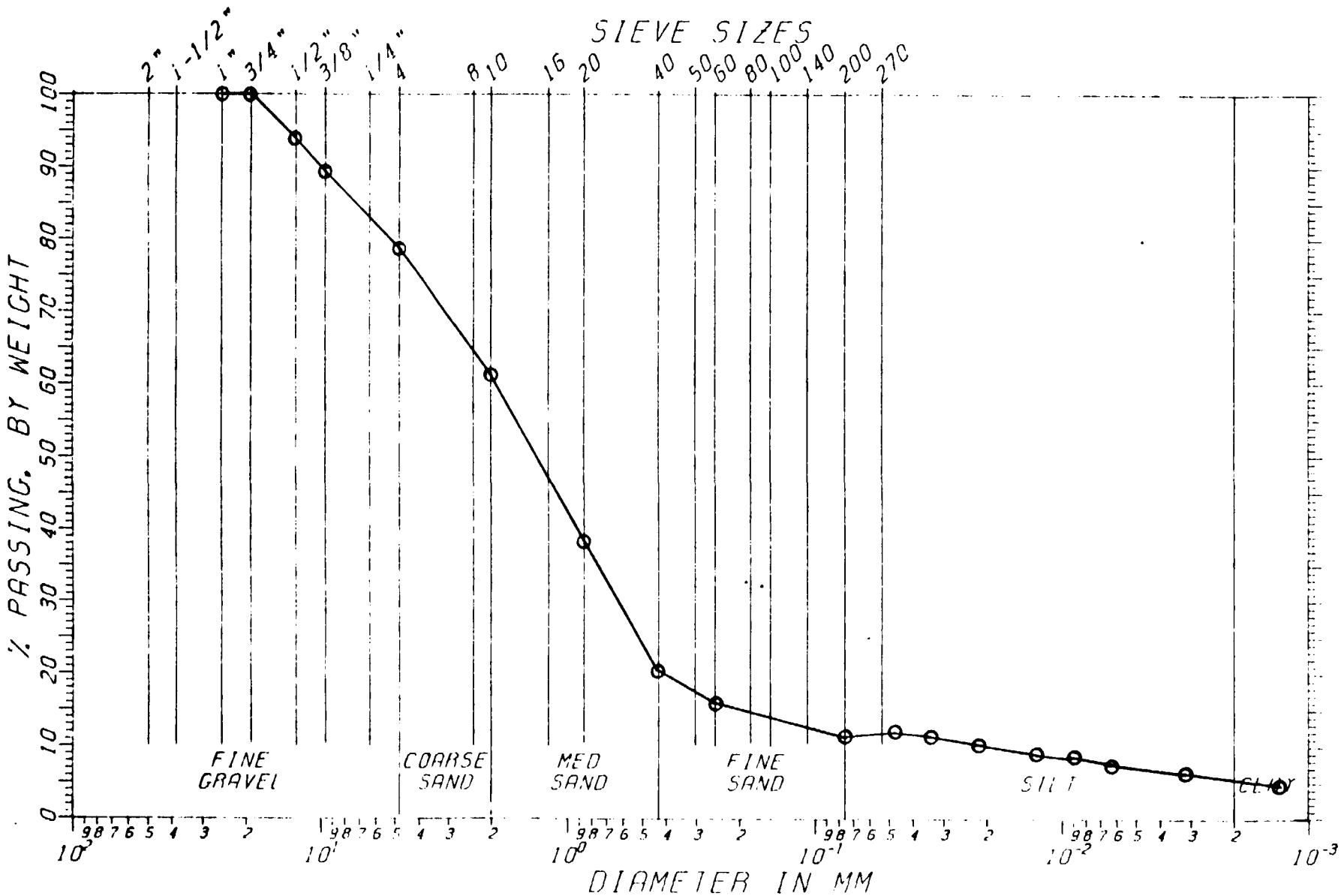
TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	69.50	32.00	42.93953	0.04468
2.00	69.50	29.50	39.24878	0.03219
5.00	70.00	26.00	34.26039	0.02073
15.00	70.00	23.00	29.83147	0.01221
30.00	70.50	20.50	26.14069	0.00878
60.00	71.00	18.50	23.30577	0.00624
240.00	73.00	16.00	20.12350	0.00313
1440.00	76.00	12.50	15.71917	0.00128

APPENDIX A

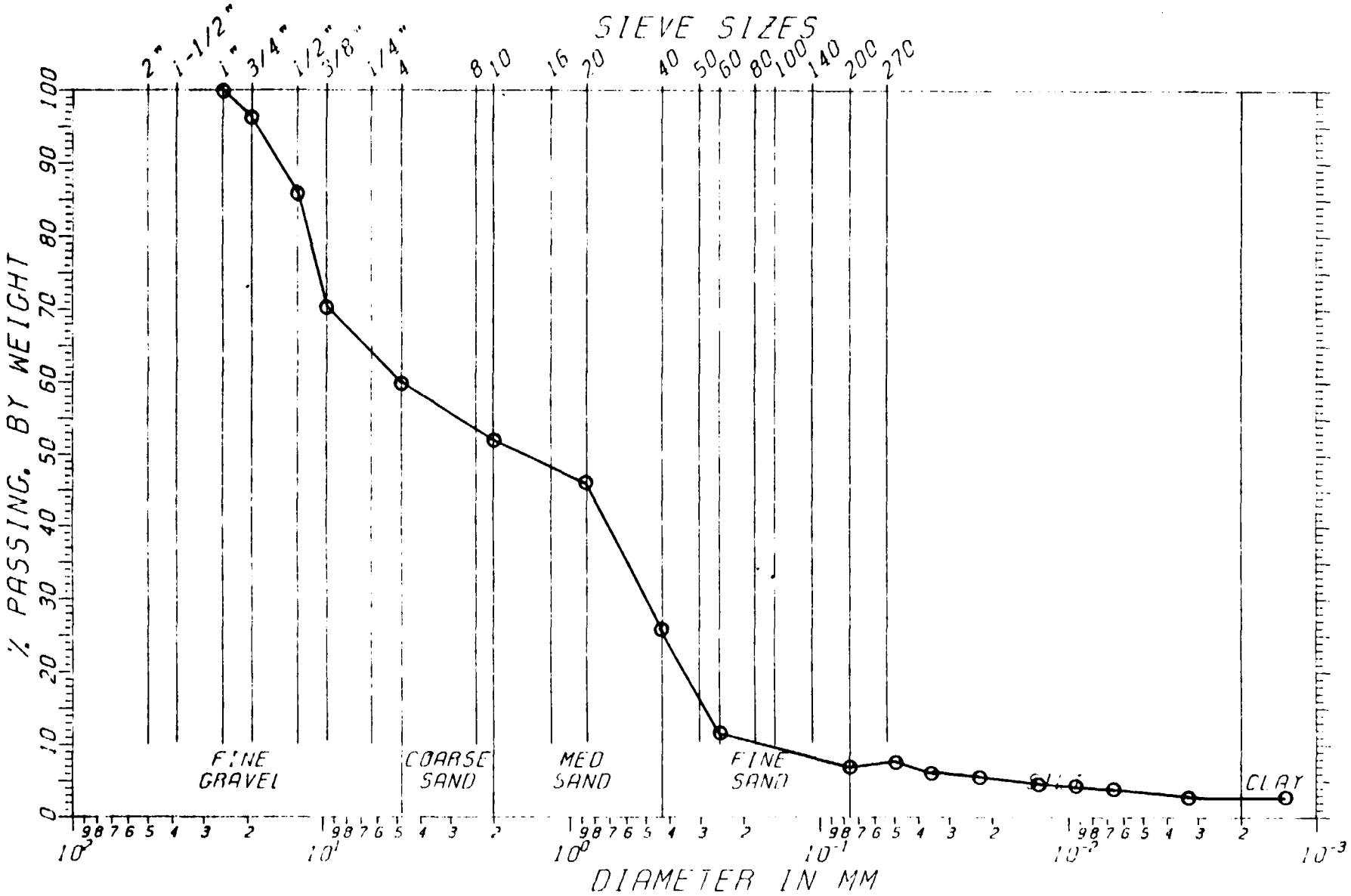
GRAIN-SIZE CURVES


SIEVE SIZES
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
DIAMETER IN MM

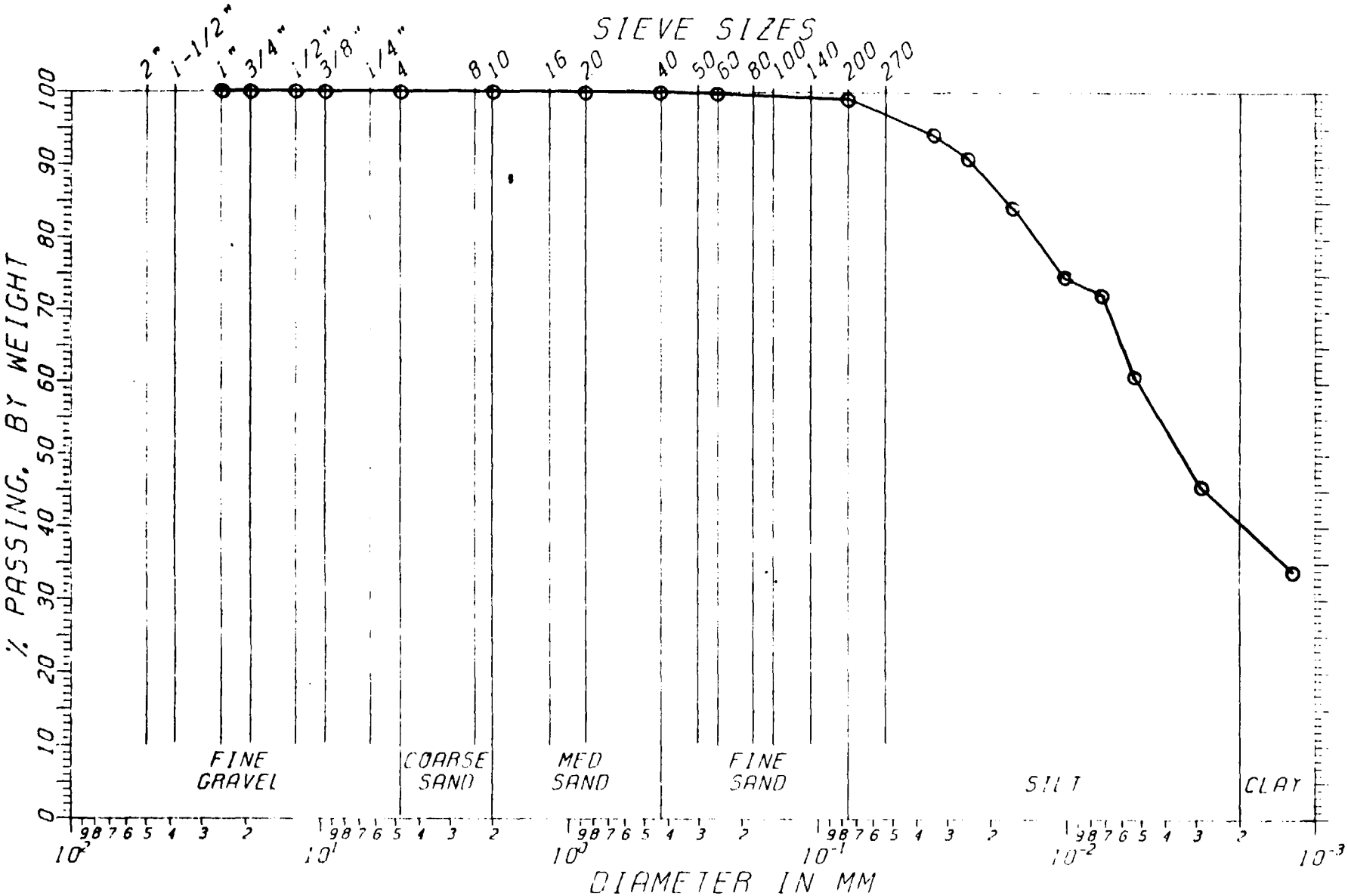
DM330 P-7A-9


SIEVE SIZES
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

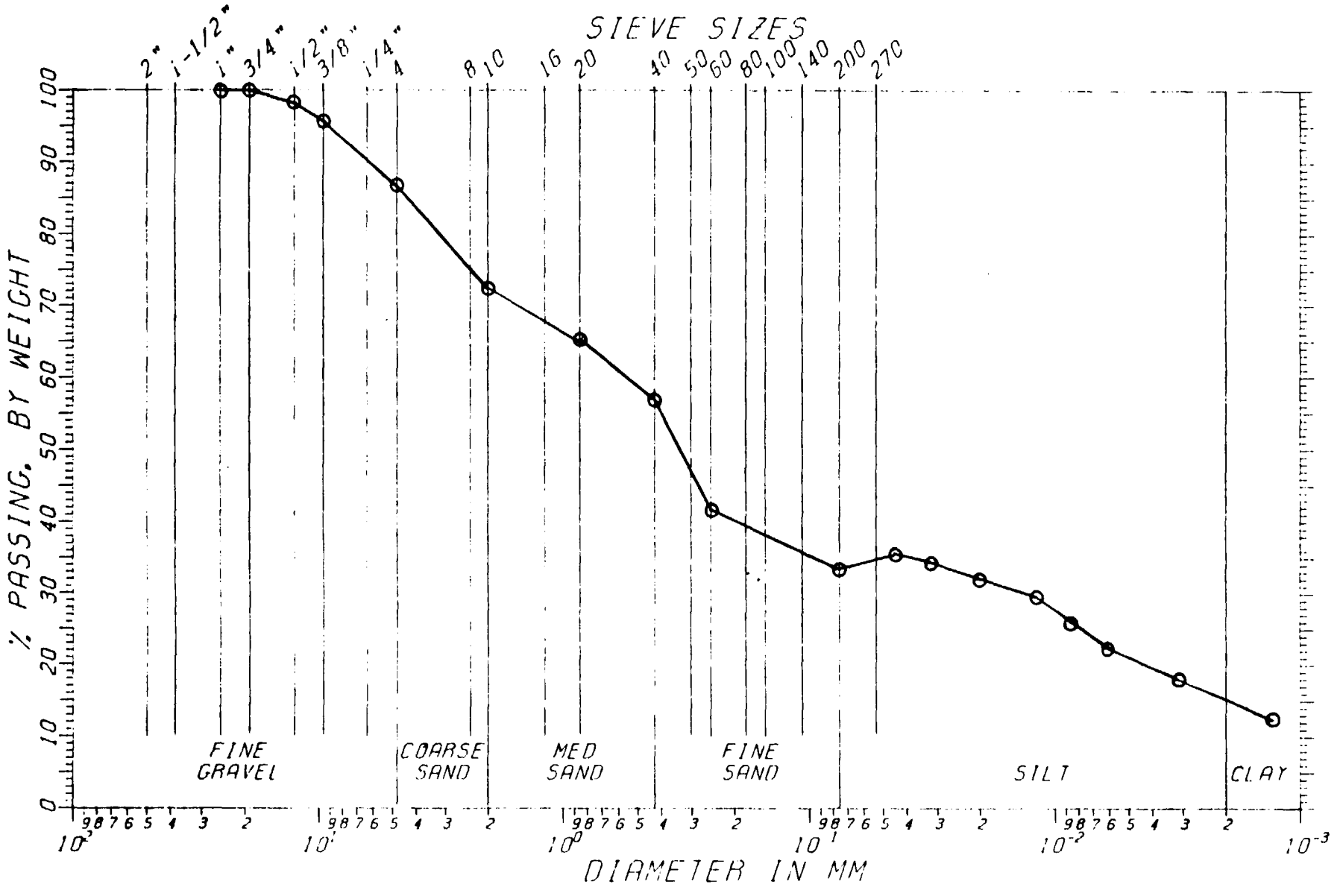
DM330 P-GB-13


SIEVE SIZES
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

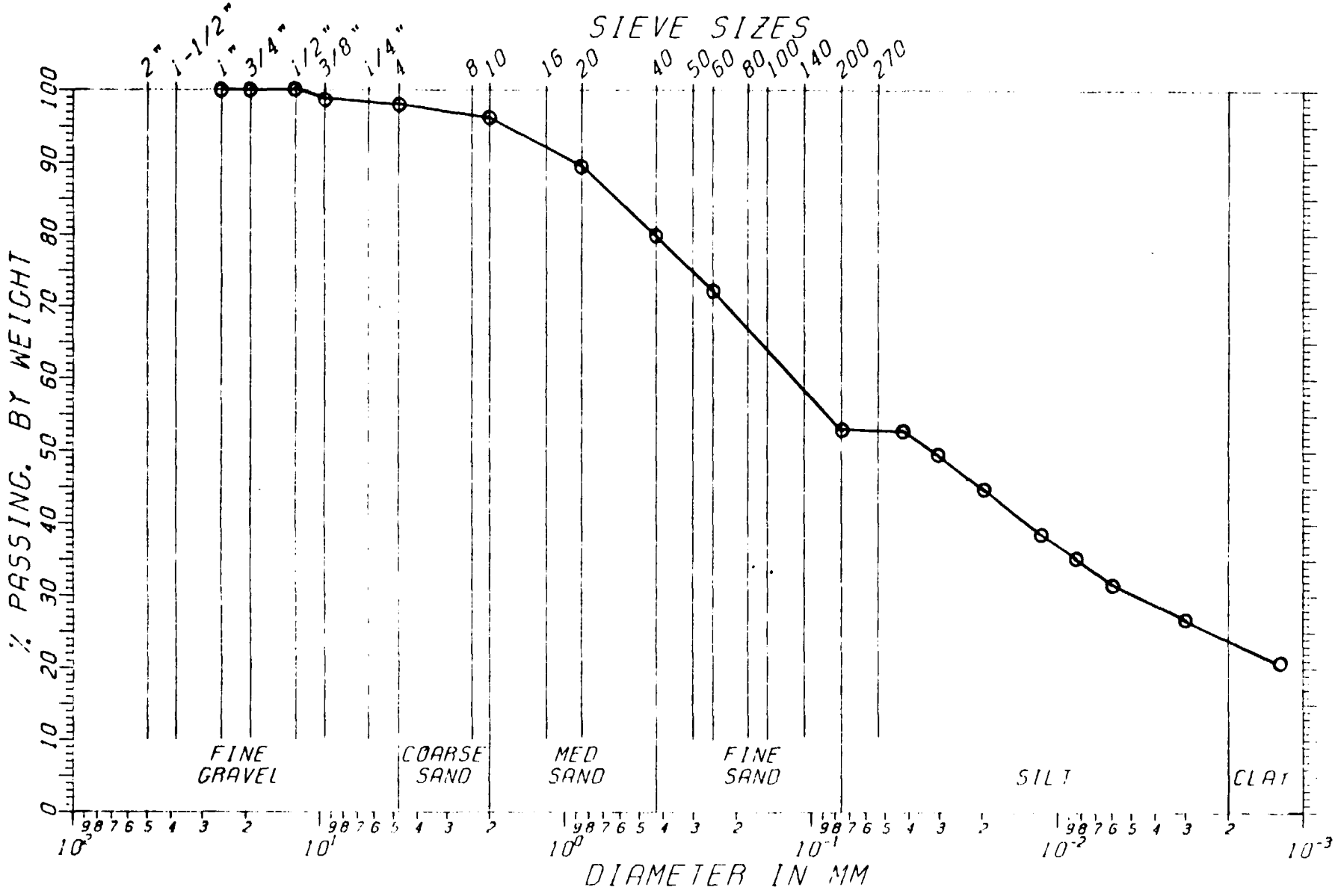
DM330 W-8-1


SIEVE SIZES
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

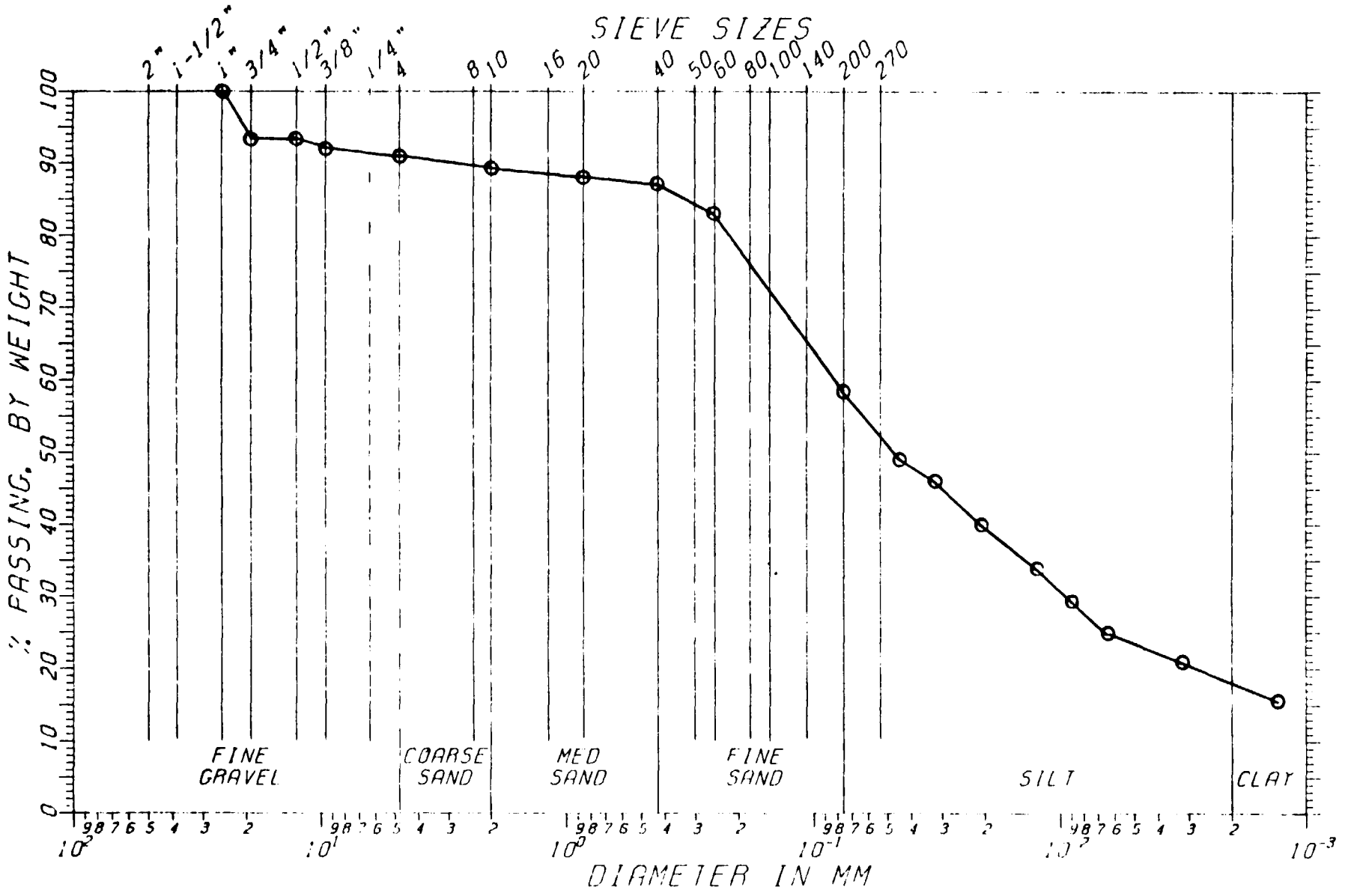
DM330 W-5-1


SIEVE SIZES
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^3 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

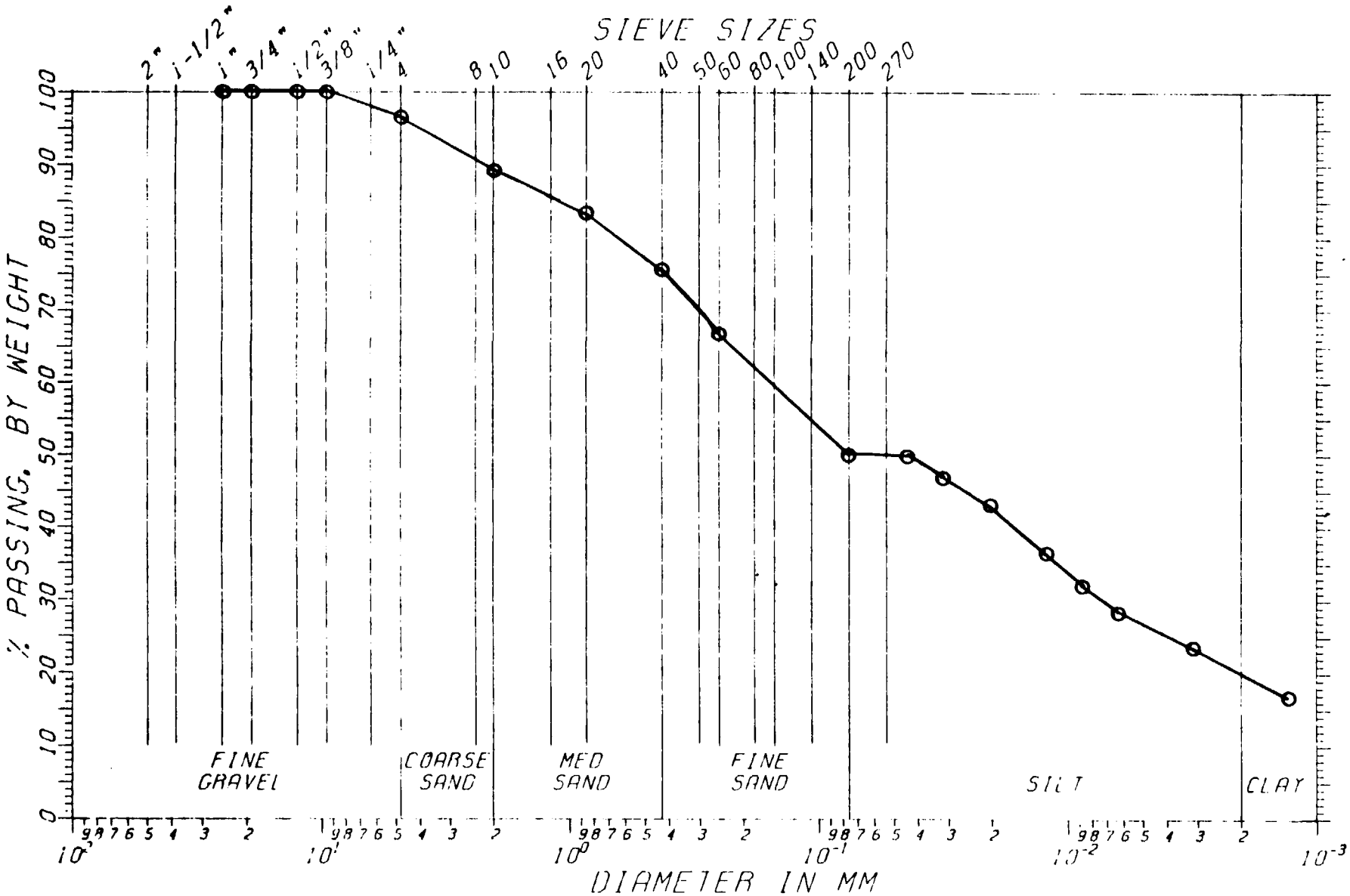
DM330 W-5-3


SIEVE SIZES
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^3 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

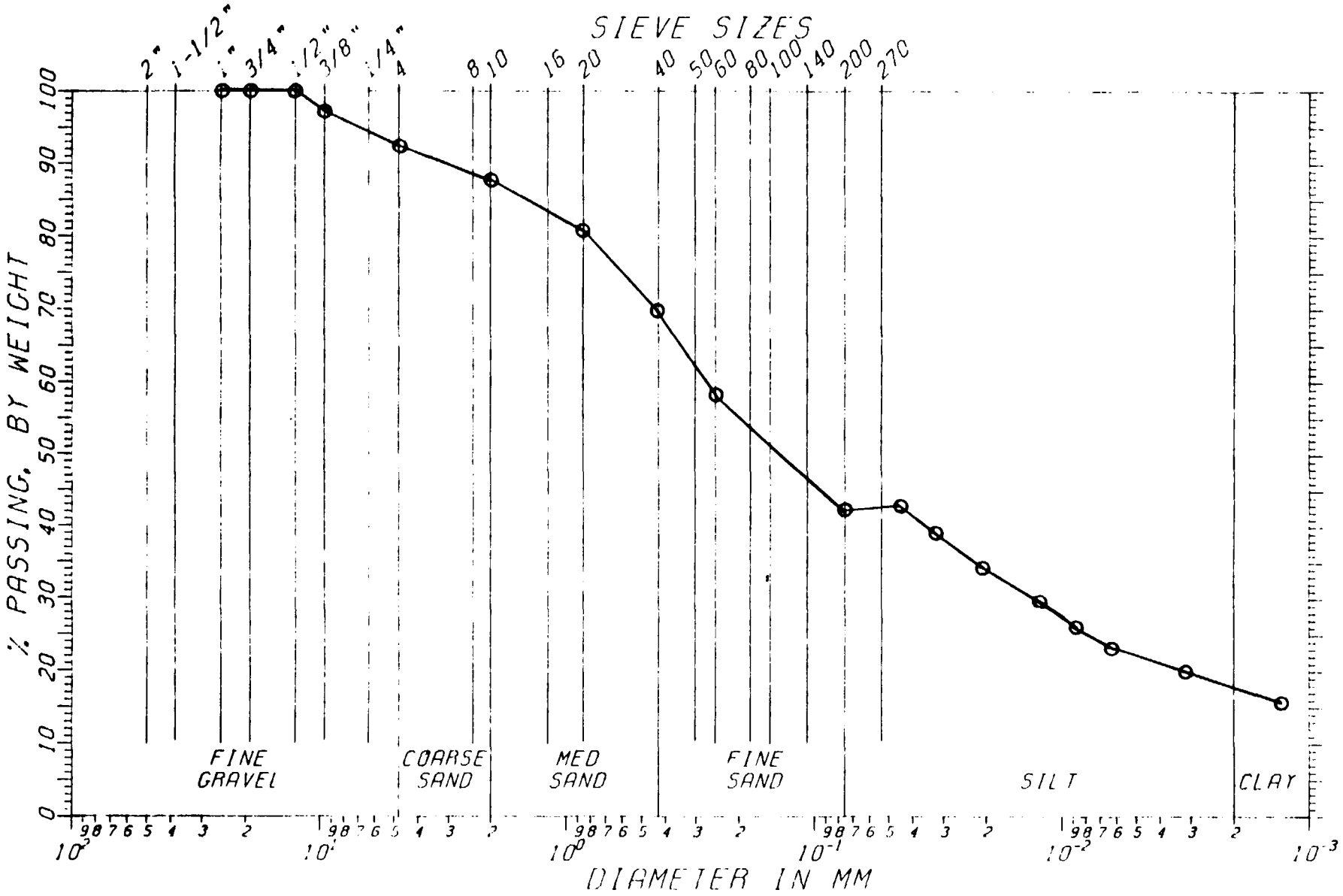
DM330 W-4-2


SIEVE SIZES
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

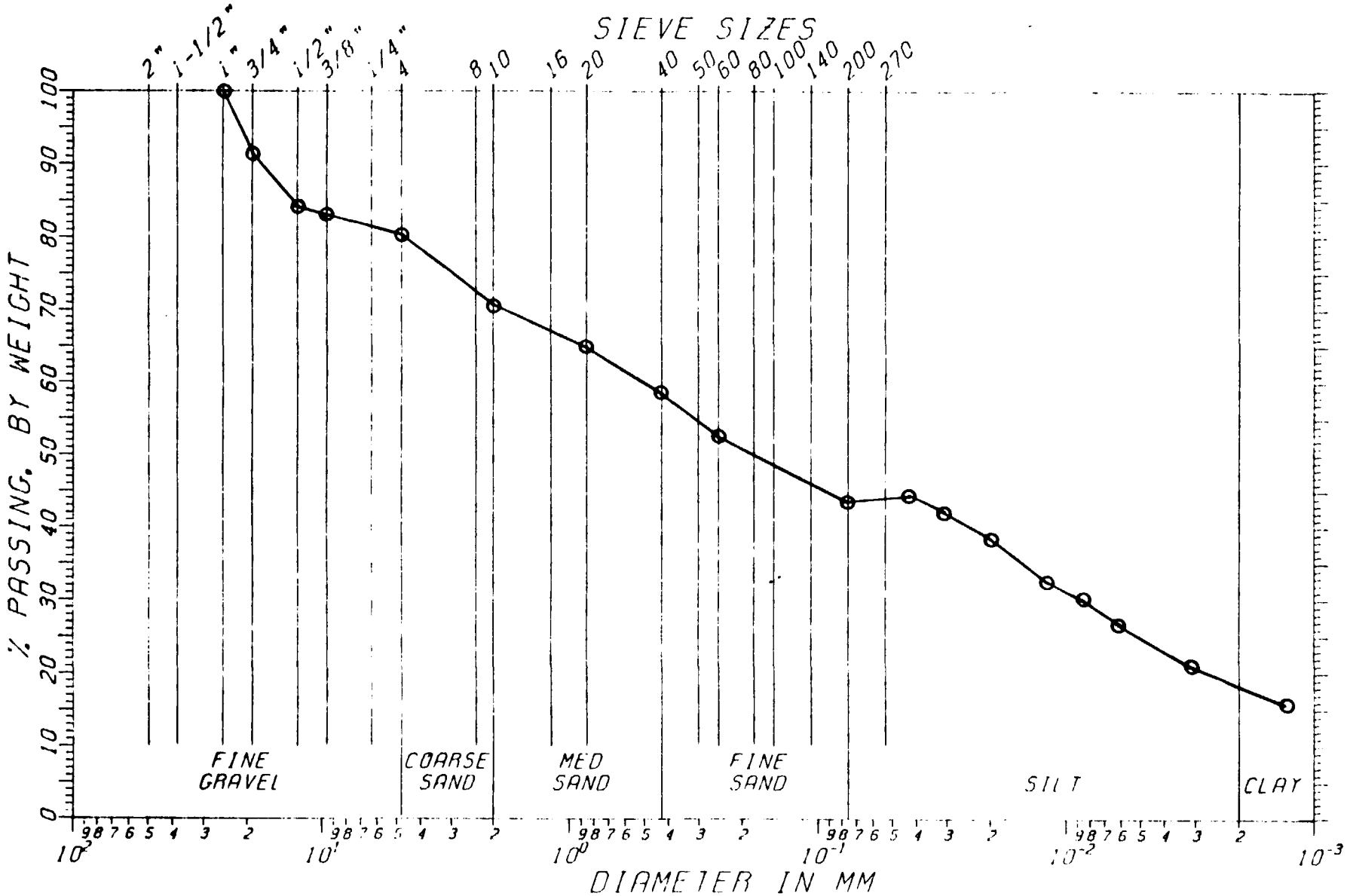
DM330 W-6-3


SIEVE SIZES
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

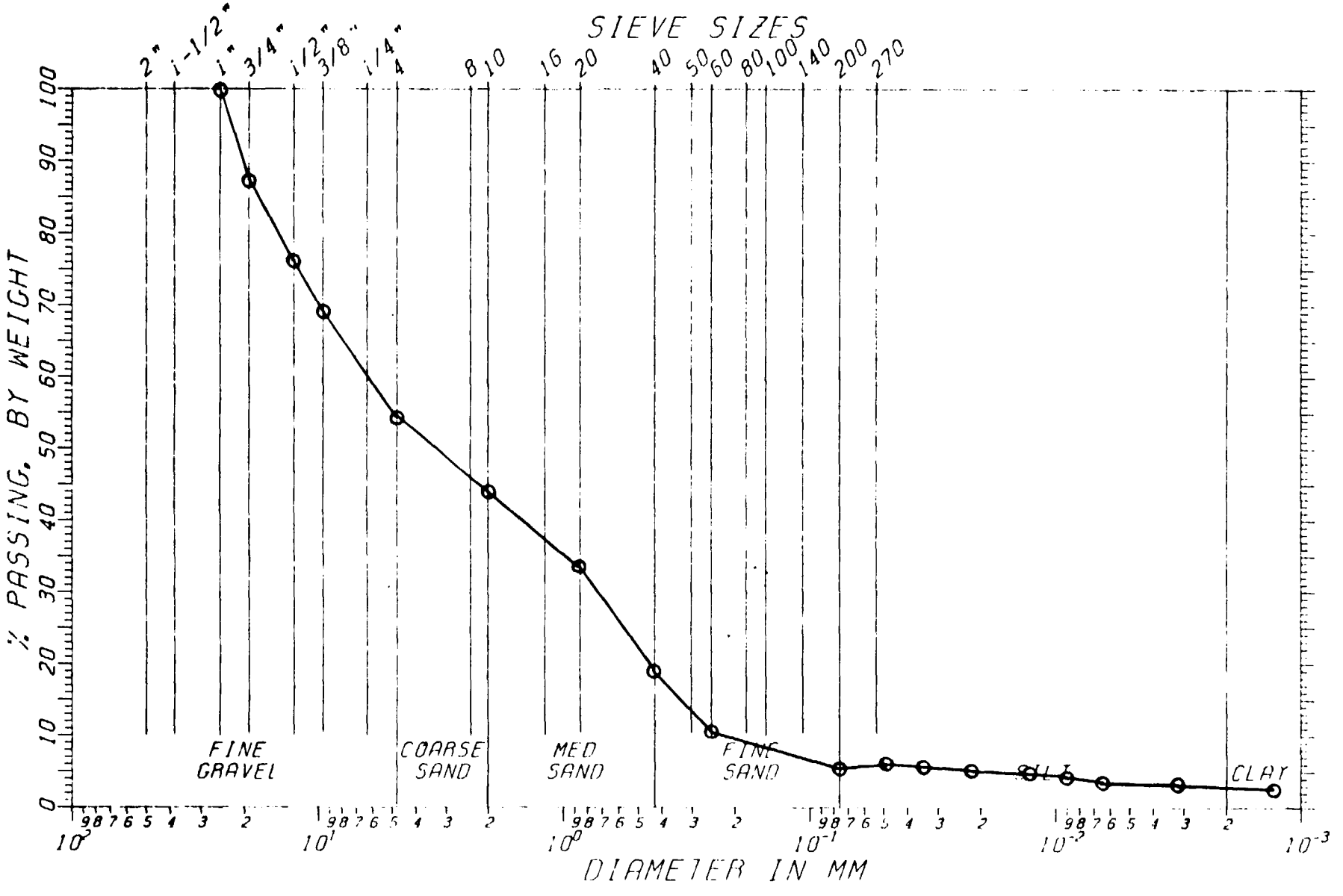
GM330 P-8A-14


SIEVE SIZES
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

DM330 P 8B-1


SIEVE SIZES
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

DM330 P-5A-6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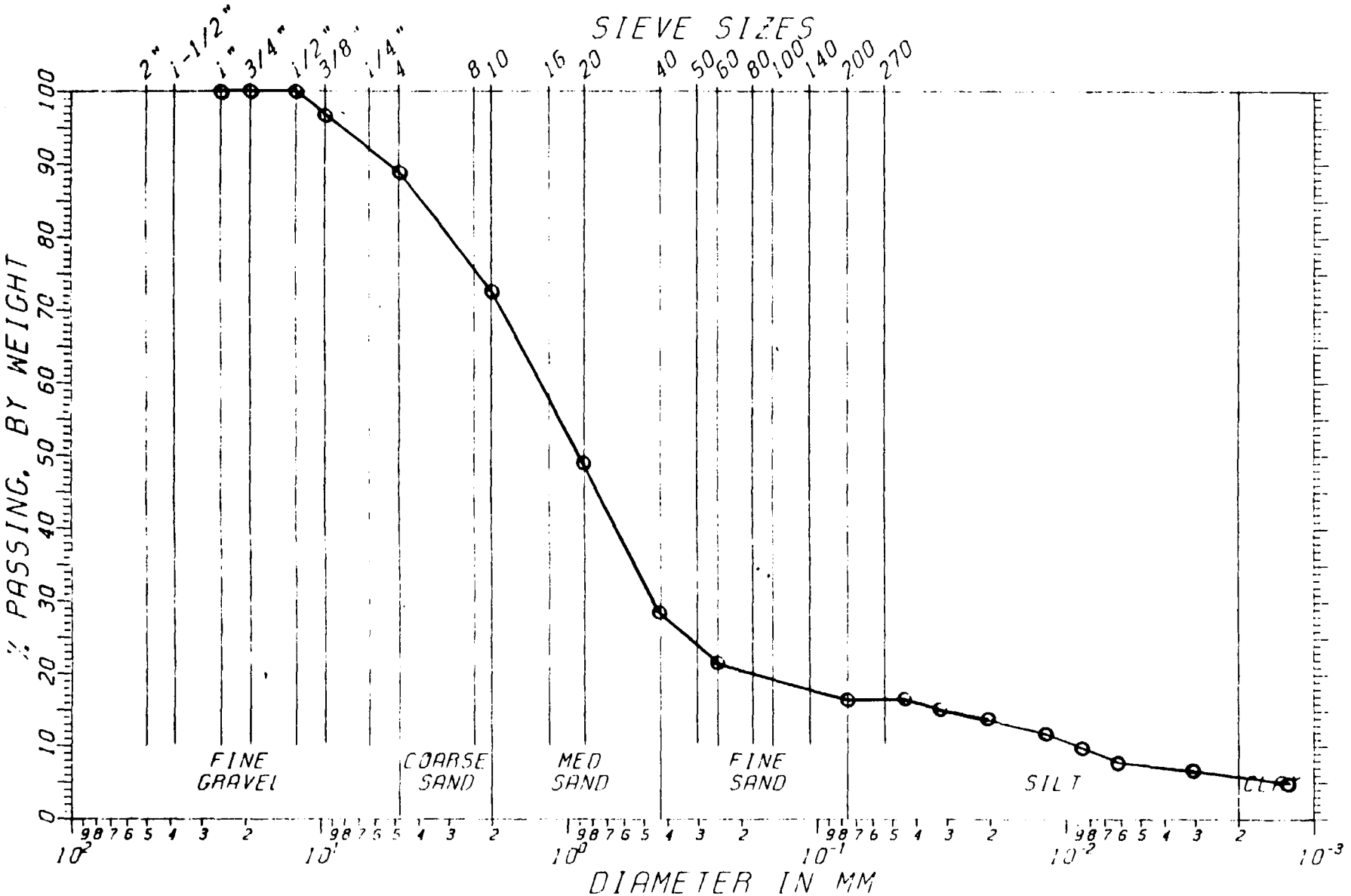
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

DM330 P -6B -9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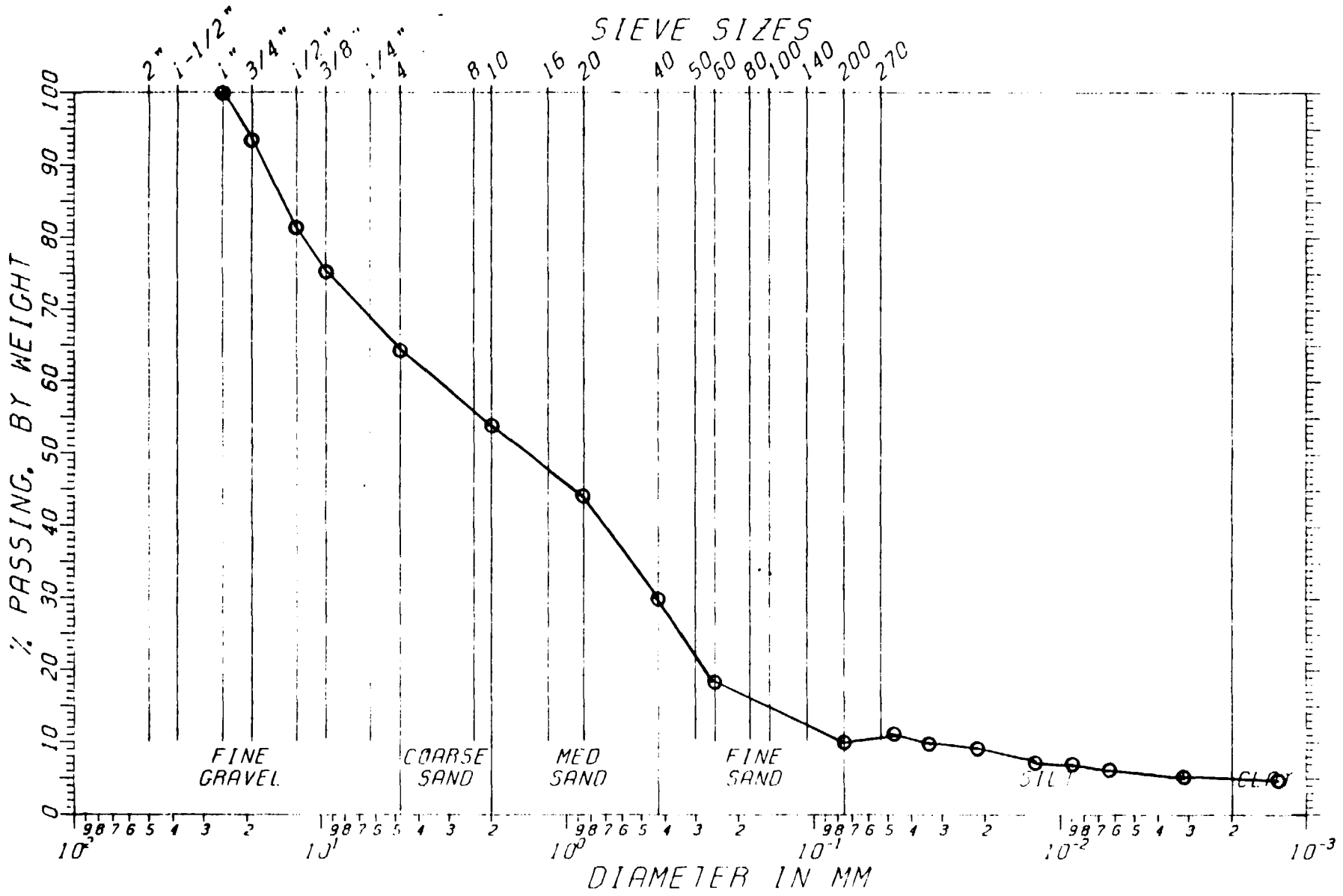
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

DM330 W-4-9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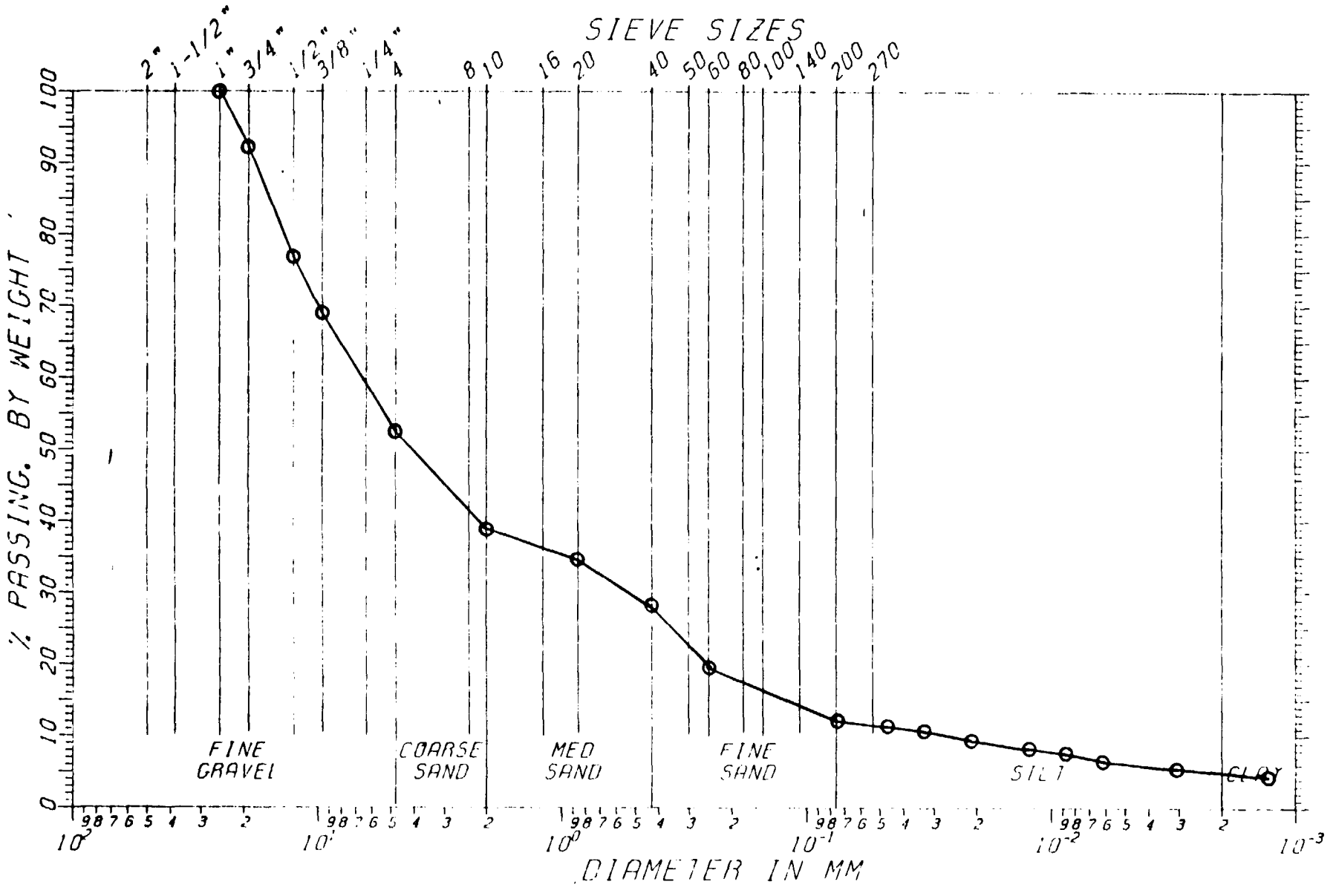
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

DM330 W-8-2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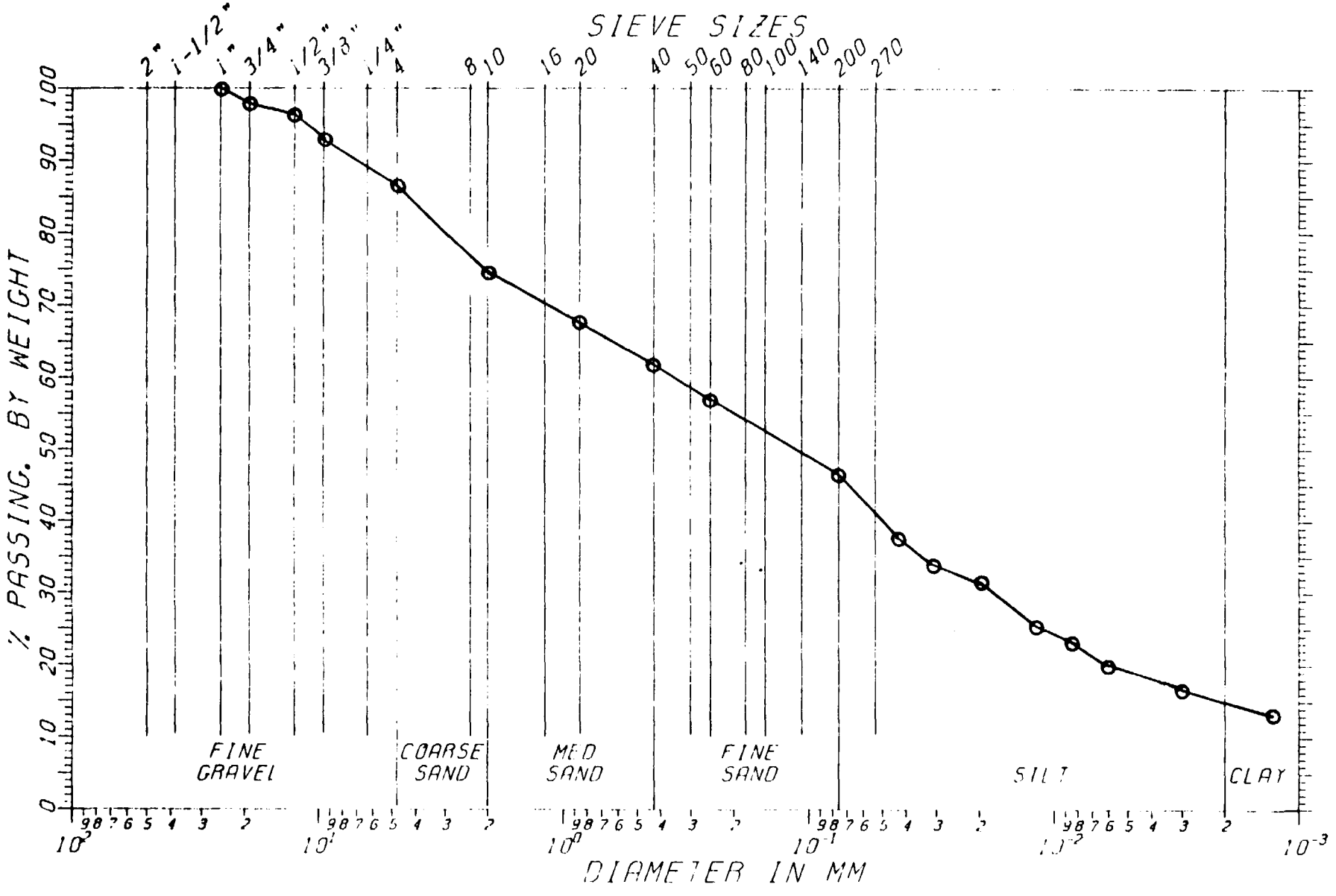
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

DM330 P 6A-2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% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

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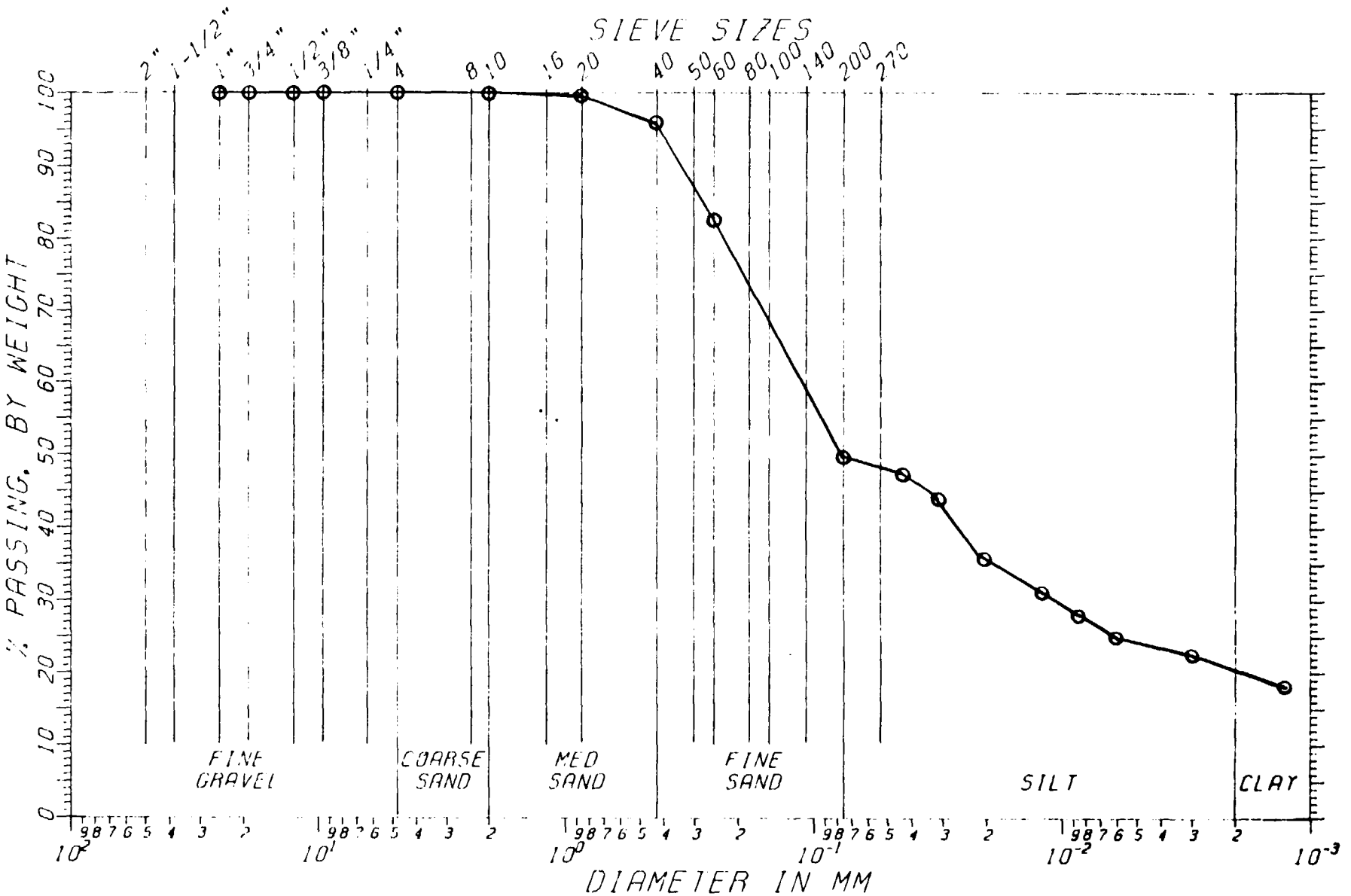
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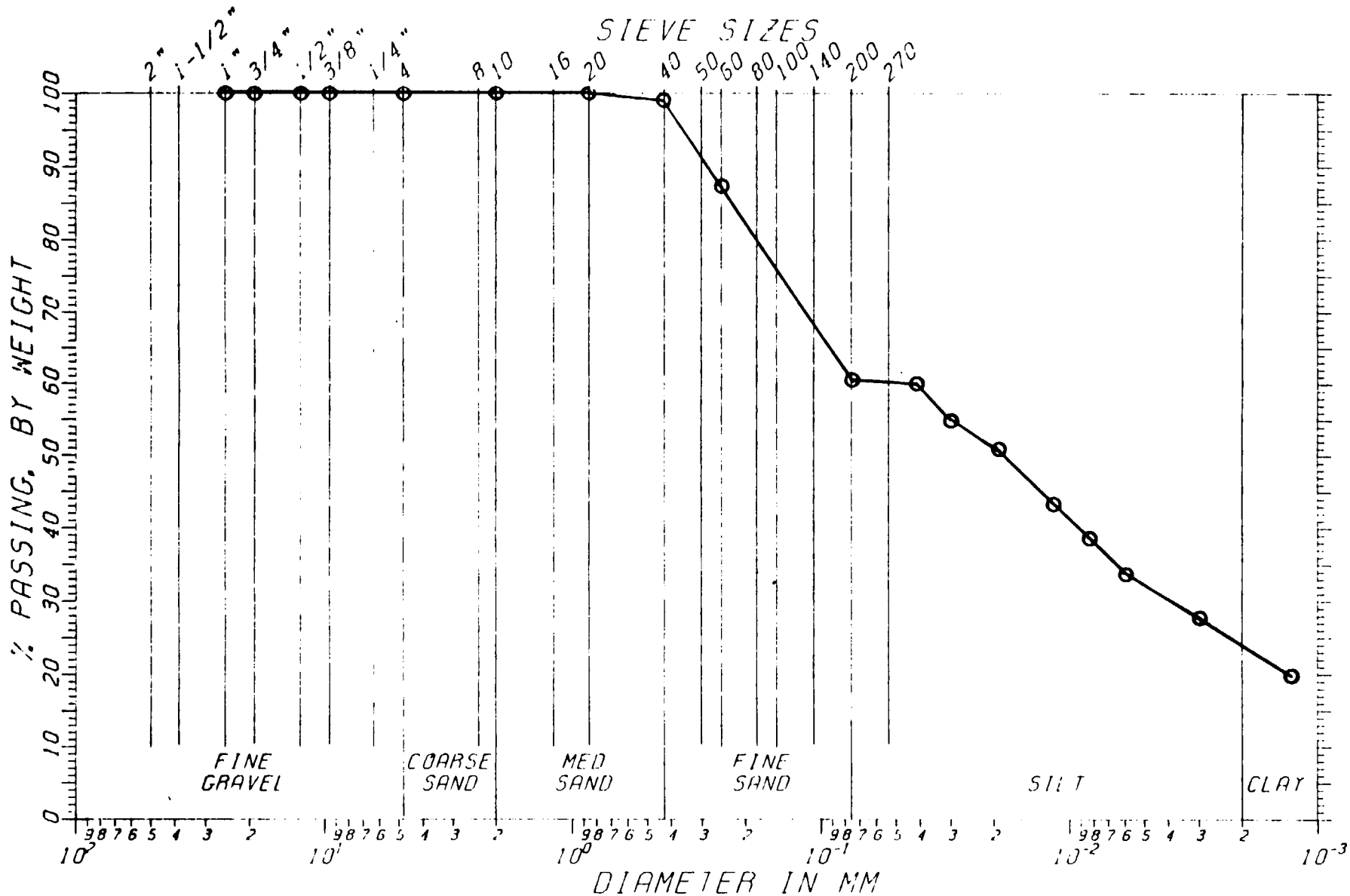
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

DM330 P-7A-5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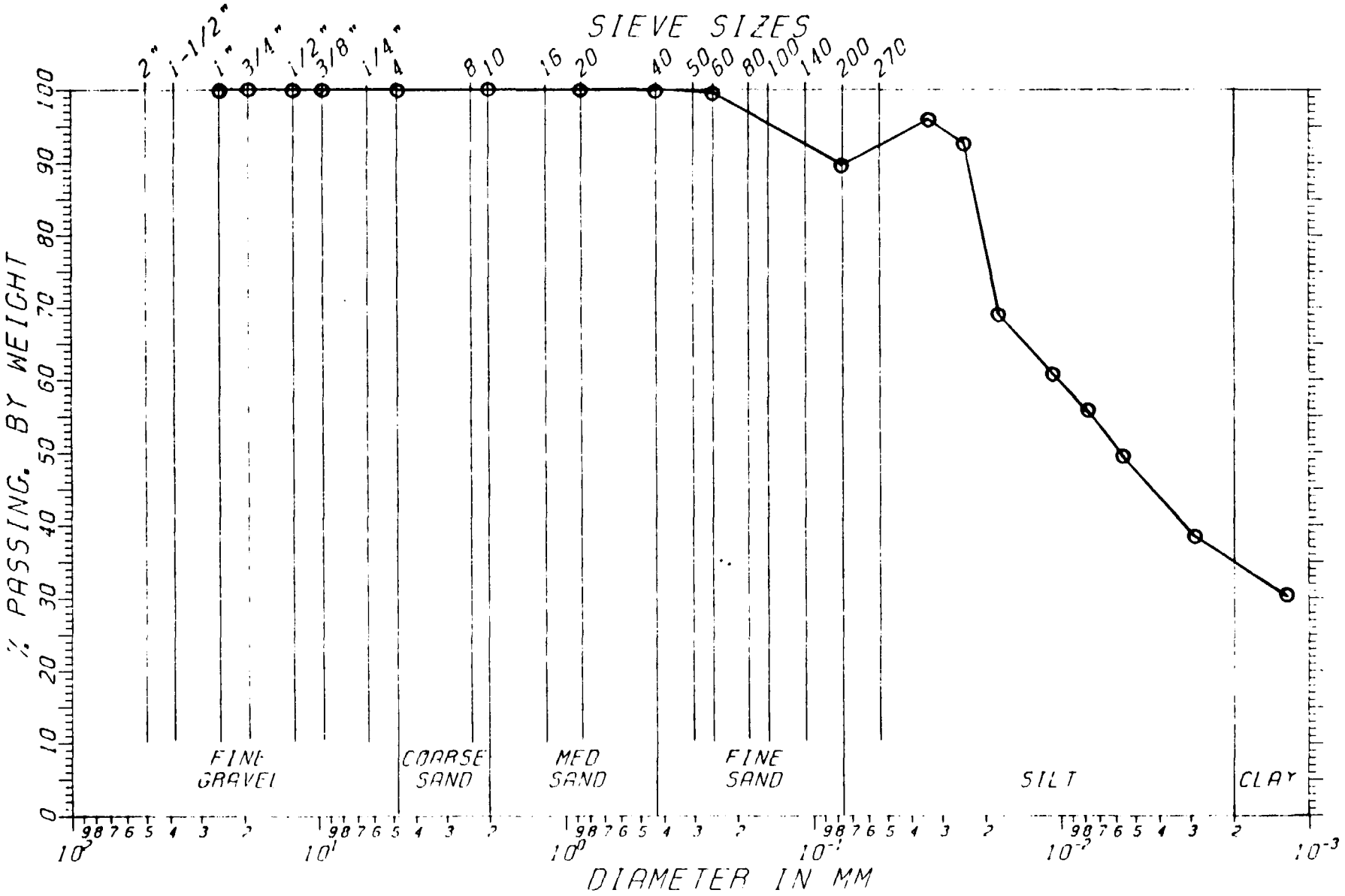
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

DM330 W-5-2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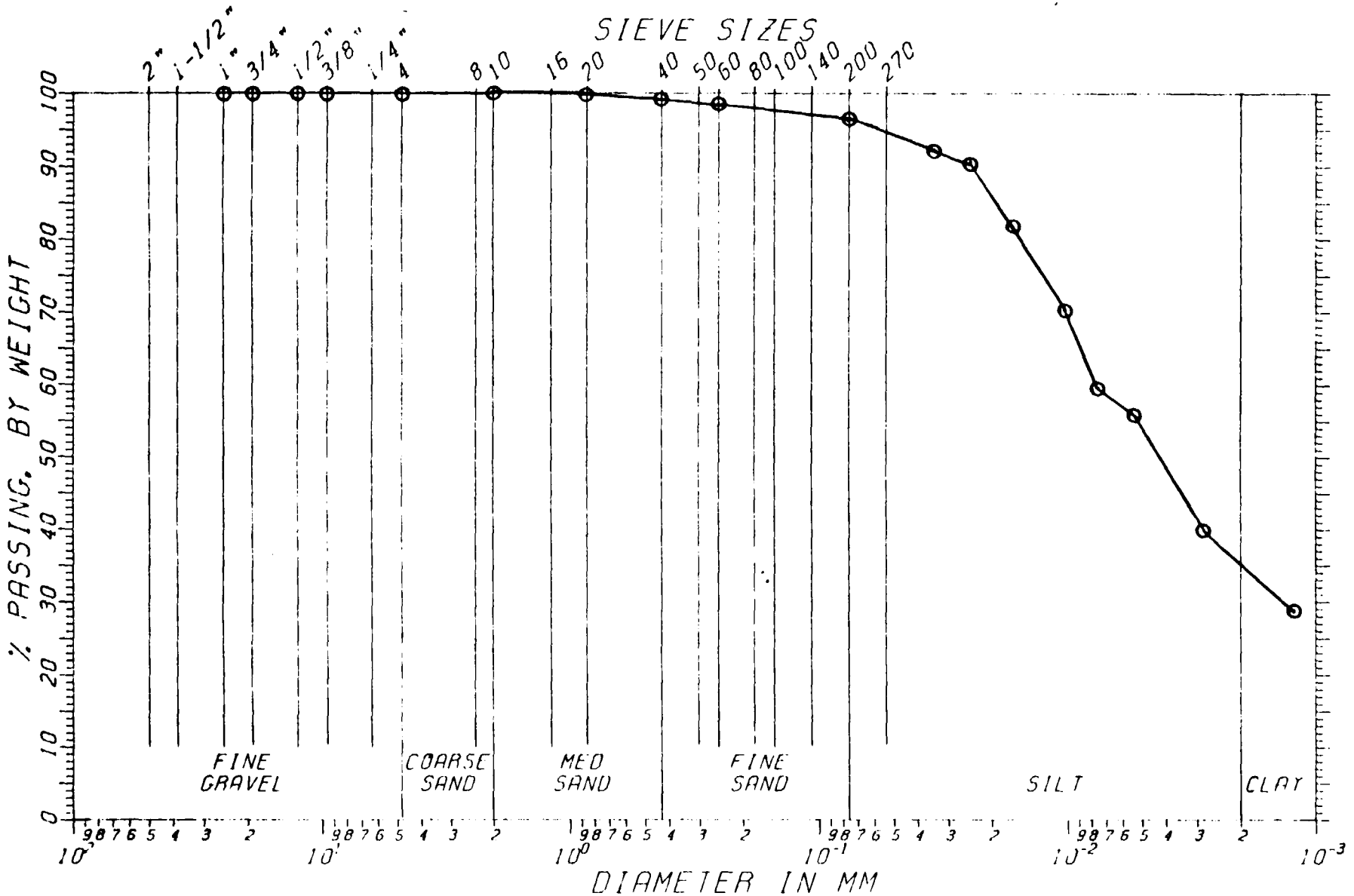
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

DM330 P-7A-1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% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^{2} 10^{1} 10^{0} 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

DM330 P-5A-1

Job NO. DM302

GEOTECHNICAL LABORATORY REPORT

PERMEABILITY

Prepared for:

Dames and Moore, Inc.

Prepared by:

TECH ENGINEERING, INC.

373 Waller Ave.

Lexington, Kentucky 40504

(606)-231-5167

December 3, 1986

TECH ENGINEERING, INC.

December 3, 1986

Tommy C. Hopkins
President
(606) 231-5167

373 Waller Ave.
Lexington, KY
40504

Mr. Mike Lyden
Dames and Moore, Inc.
644 Linn St., Suite 501
Cincinnati, OH 45203

Dear Mr. Lyden:

Results obtained from two permeability tests are submitted herein. The tests were performed on shelby tube samples you submitted and authorized for testing in October, 1986. The samples were identified as from the Bowers Landfill, Samples BL-SO-8 and BL-SO-9. The permeability tests were performed using a constant-head technique contained in the U.S. Army Engineer Waterways Experiment Station's (WES) engineering manual, Em 1110-2-1906, Appendix VII, page VII-7 ("Permeability Tests with Back Pressure"). Details of the testing procedure have also been described elsewhere (2) by Hopkins and Allen. The test was performed in a triaxial chamber. The specimens measured about 2.8 inches in diameter. The height of the specimens was from about 5.60 inches. A rubber membrane was fitted around each specimen. By using a rubber membrane jacket and cell pressure (confining pressure) larger than the back pressures acting at each end of the specimen, leakage of water between the walls of the specimen and membrane is prevented. Back pressures of 60 PSI were used to saturate each specimen. The back pressures were applied at the top and bottom of each specimen. The saturation period was approximately one day for each specimen. Water was used as the permeant. A differential pressure of 5 PSI was used to "drive" water through the specimens. Flow of water through each specimen was continued until a steady state condition was achieved. A detailed description of the permeability testing procedure is shown in a paper (2) entitled "Laboratory Determination of the Coefficient Hydraulic Conductivity of Mine Related Materials" by Tom Hopkins and David Allen. This paper was published in the 1982 Symposium on Surface Mining Hydrology, Sedimentology and Reclamation.

Permeability test results are presented in Table 1. Volume of flow of water through the specimens as a function of time are shown in Appendix A. Linear regression analysis was used to fit the values of flow volume and time. Calculations of the coefficients of permeability are shown in each figure. Values shown were corrected for temperature.

As a follow up to the permeabilities you requested that we do classification test on the two samples. The test results are presented in Tables 2 and 3. Grain-size curves are shown in Appendix B.

We appreciate the opportunity to be of service to you on this project and hope that the information contained in the report conforms to your needs. If you have any questions, or if we may be of additional assistance concerning the report, please do not hesitate to call our office. The sample will be retained in our laboratory until further instructions from you concerning the status of the project. If no instructions are received, the samples will be discarded after six months.

Sincerely,

Tech Engineering, Inc.

Tommy C. Hopkins

Tommy C. Hopkins, P.E.

Table 1. Results Obtained from Permeability Test from Bowers Landfill

SAMPLE NUMBER	INITIAL DENSITY		COEFFICIENT* OF PERMEABILITY K
	Water Content	Dry Density	
	(%)	(PCF)	(cm/sec.)
BL-SO-8	17.9	116.4	3.08×10^{-8}
BL-SO-9	27.9	98.6	4.57×10^{-8}

* K corrected to a temperature of 68 F.

TABLE 2. LABORATORY RECORD OF SOIL TEST DATA FOR BL-SO-8

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
BL-SO-8	34.0	23.0	11.0	2.72	A-6	(8)	CL

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
3/8 IN	0.00	100.00
NO. 4	0.00	100.00
NO. 10	0.00	100.00

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	0.08	99.86
NO. 40	0.17	99.57
NO. 60	0.21	99.22
NO. 200	10.96	80.52

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	68.00	44.00	68.91515	0.03988
2.00	68.00	42.00	65.55054	0.02871
5.00	68.00	38.00	58.82132	0.01879
15.00	69.00	33.00	50.61339	0.01121
30.00	70.00	30.00	45.77011	0.00806
60.00	71.00	27.00	40.85730	0.00578
240.00	75.00	22.00	33.60469	0.00291
1440.00	76.00	18.00	27.16518	0.00121

TABLE 3. LABORATORY RECORD OF SOIL TEST DATA FOR BL-SO-9

SAMPLE NUMBER	LL	PL	PI	SPGR	AASHTO	GI	USC
BL-SO-9	60.0	32.0	28.0	2.74	A-7-5	(32)	MH-CH

MECHANICAL SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
3/8 IN	0.00	100.00
NO. 4	0.00	100.00
NO. 10	0.00	100.00

HYDROMETER SIEVE ANALYSIS

SIEVE SIZE	WEIGHT RETAINED	TOTAL PERCENT PASSING
NO. 20	0.00	100.00
NO. 40	0.05	99.91
NO. 60	0.18	99.58
NO. 200	2.26	95.44

HYDROMETER ANALYSIS

TIME (MIN)	TEMP	HYD READING	PERCENT FINER	PARTICLE DIAMETER-M/M
1.00	67.00	56.00	94.98889	0.03525
2.00	67.00	54.00	91.39378	0.02550
5.00	68.00	52.00	88.01628	0.01638
15.00	68.00	47.00	79.02855	0.00995
30.00	68.00	43.00	71.83839	0.00731
60.00	69.00	38.00	63.06819	0.00536
240.00	75.00	31.00	52.08459	0.00272
1440.00	76.00	24.00	39.81131	0.00116

APPENDIX A

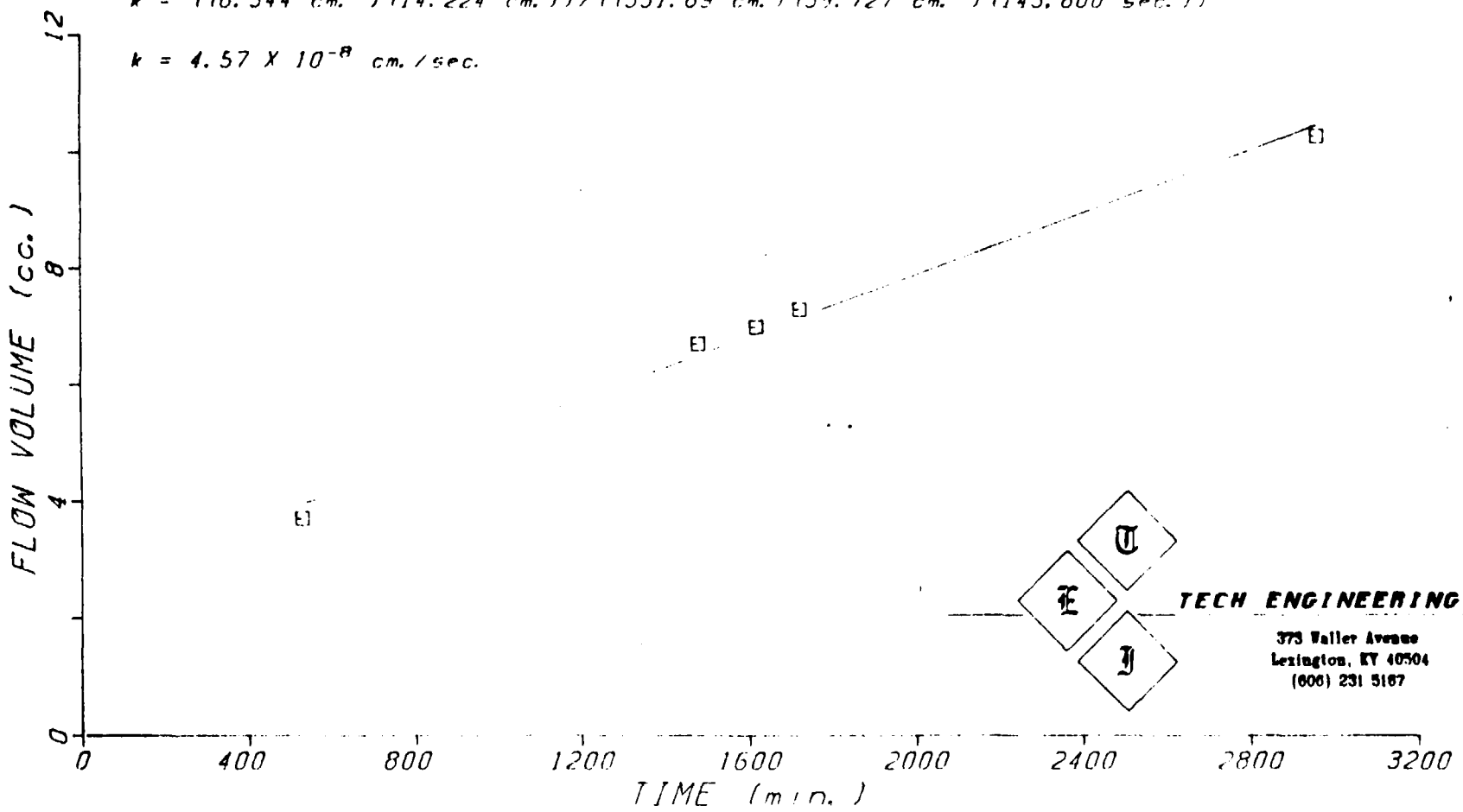
PERMEABILTIY TEST

VOLUME OF FLOW AS A FUNCTION OF TIME

LENGTH = 14.224 cm.
AREA = 39.727 cm.^{2}

ΔP = DIFFERENTIAL PRESSURE = 5 psi
h = HEAD LOSS = 351.6923 cm.
k = QL/hAt
k = ((6.544 cm.^{3})(14.224 cm.))/((351.69 cm.)(39.727 cm.^{2})(145.800 sec.))

k = 4.57 X 10^{-8} cm./sec.



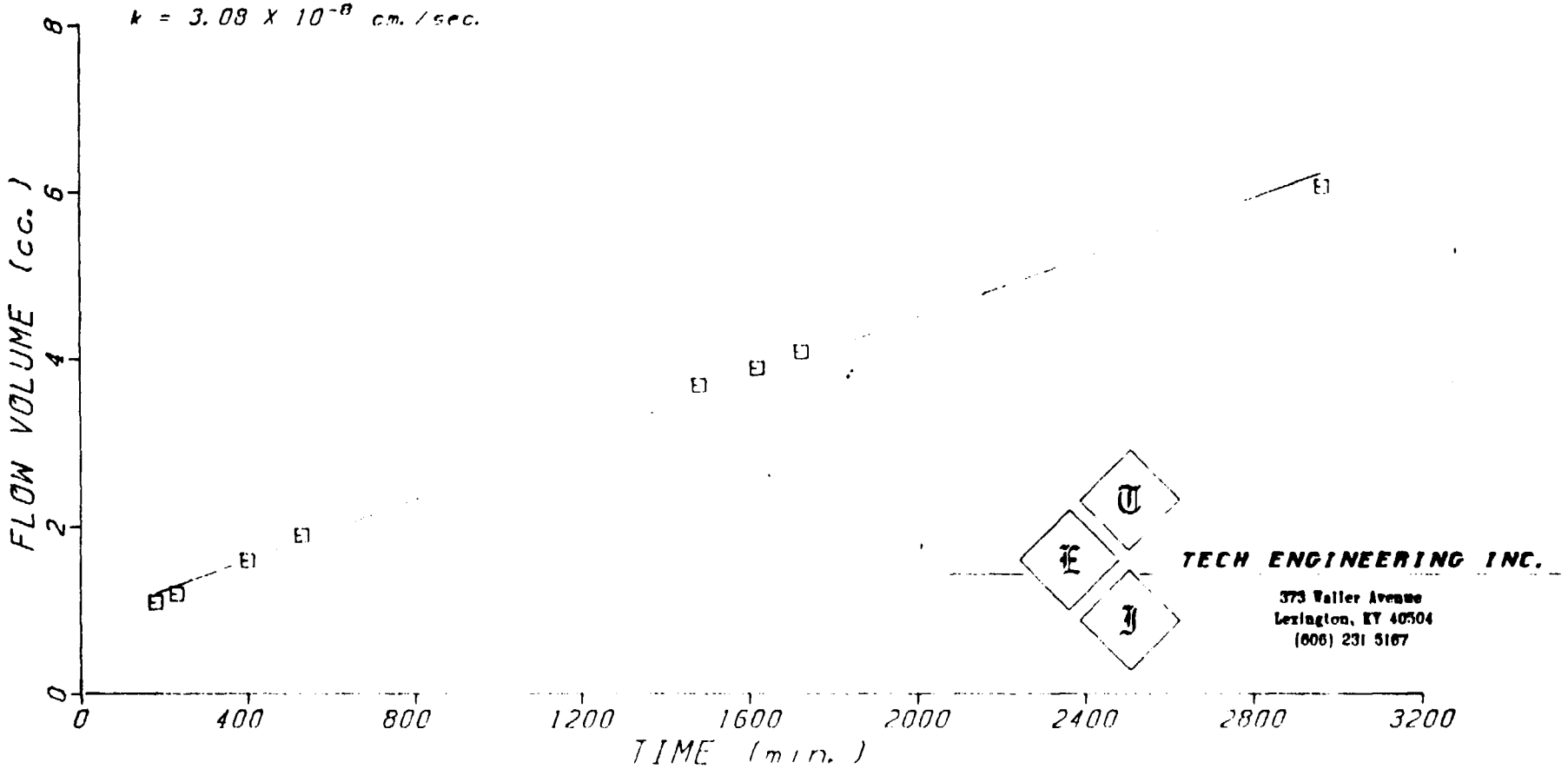
TECH ENGINEERING INC.
373 Waller Avenue
Lexington, KY 40504
(606) 231 5167

BL 50-9

LENGTH = 14.224 cm.
AREA = 39.727 cm.^{2}

ΔP = DIFFERENTIAL PRESSURE = 5 psi
h = HEAD LOSS = 351.6923 cm.
k = QL/hAt
k = ((15.054 cm.^{3})(14.224 cm.))/((351.69 cm.)(39.727 cm.^{2})(166.800 sec.))

k = 3.08 X 10^{-8} cm./sec.



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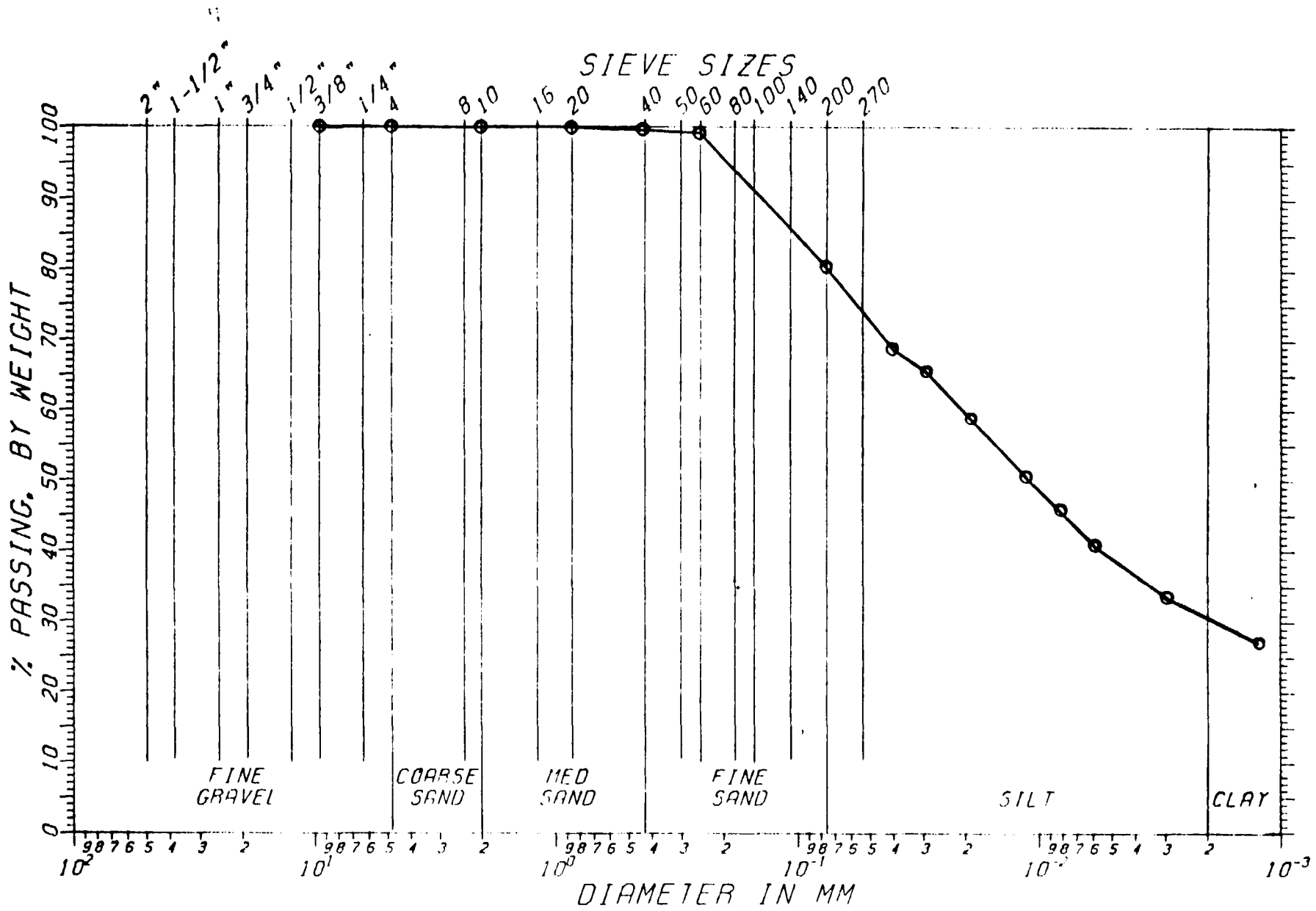
BL SO-8

APPENDIX B

GRAIN-SIZE CURVES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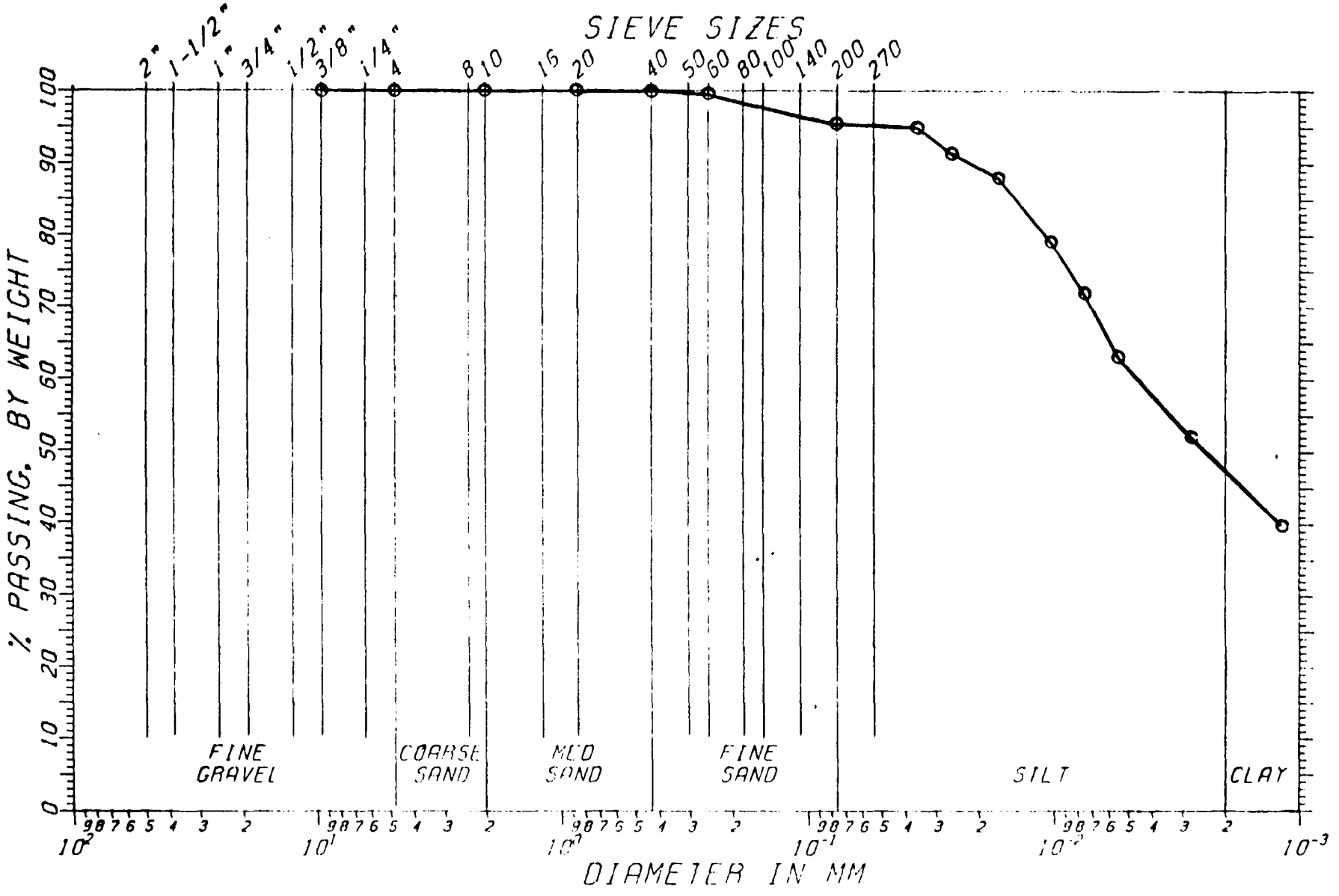
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

BL-S0-8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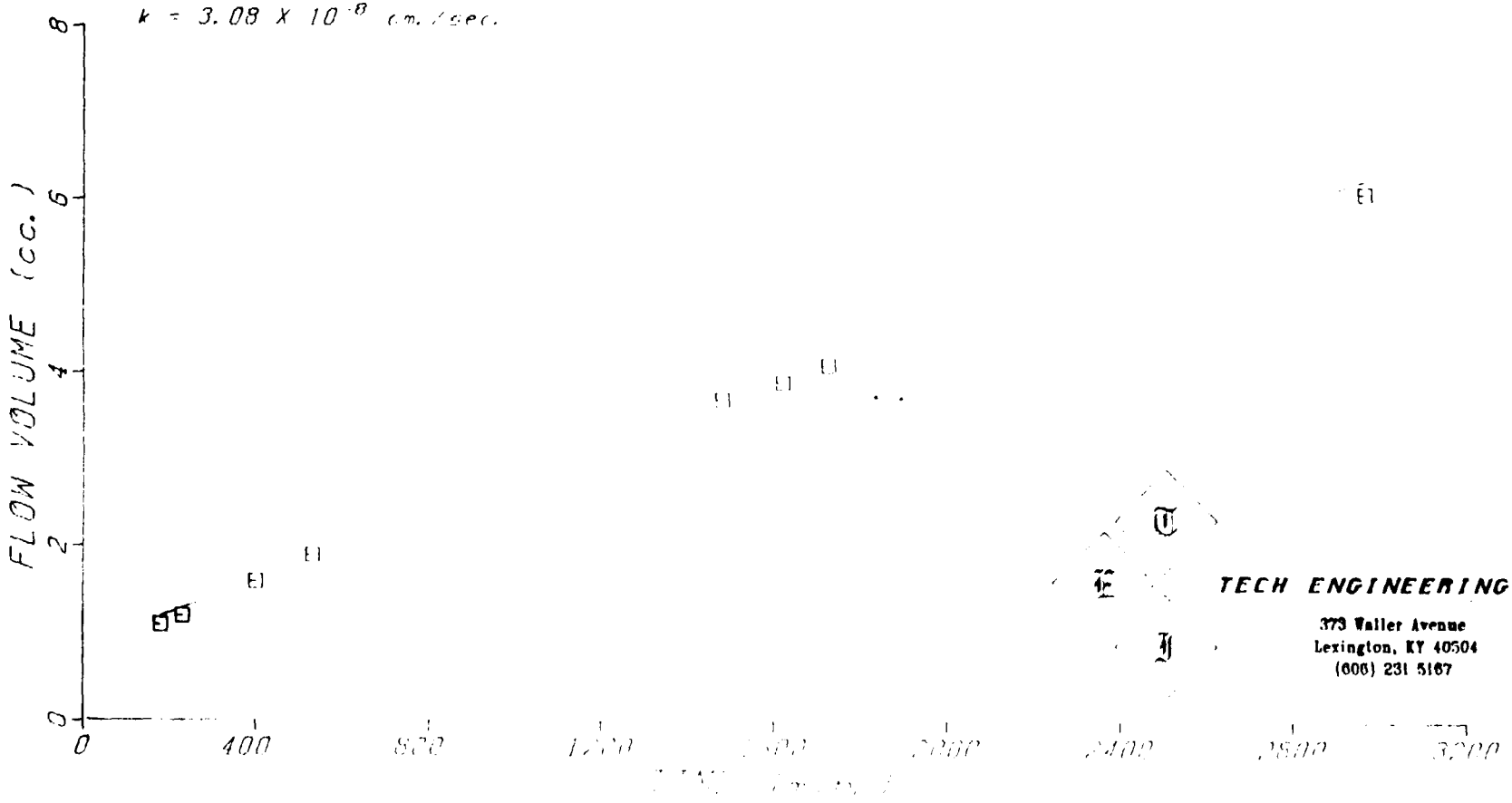
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
10^2 10^1 10^0 10^{-1} 10^{-2} 10^{-3}
DIAMETER IN MM

BL-50-9

LENGTH = 14.224 cm.
AREA = 39.727 cm.^{2}

ΔP = DIFFERENTIAL PRESSURE = 5 psi
h = HEAD LOSS = 351.6923 cm.
k = QL/hAt
k = (15.054 cm.^{3})(14.224 cm.)/(351.69 cm.)(39.727 cm.^{2})(168.800 sec.))

k = 3.08 X 10^{-8} cm./sec.



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BL 58-8

LENGTH = 14.224 cm.
AREA = 39.727 cm.^{2}

ΔP = DIFFERENTIAL PRESSURE = 5 psi
h = HEAD LOSS = 351.6923 cm.
k = QL/hAt
k = (16.544 cm.^{3})(14.224 cm.)/(351.69 cm.)(39.727 cm.^{2})(145.800 sec.)

k = 4.57 X 10^{-8} cm./sec.

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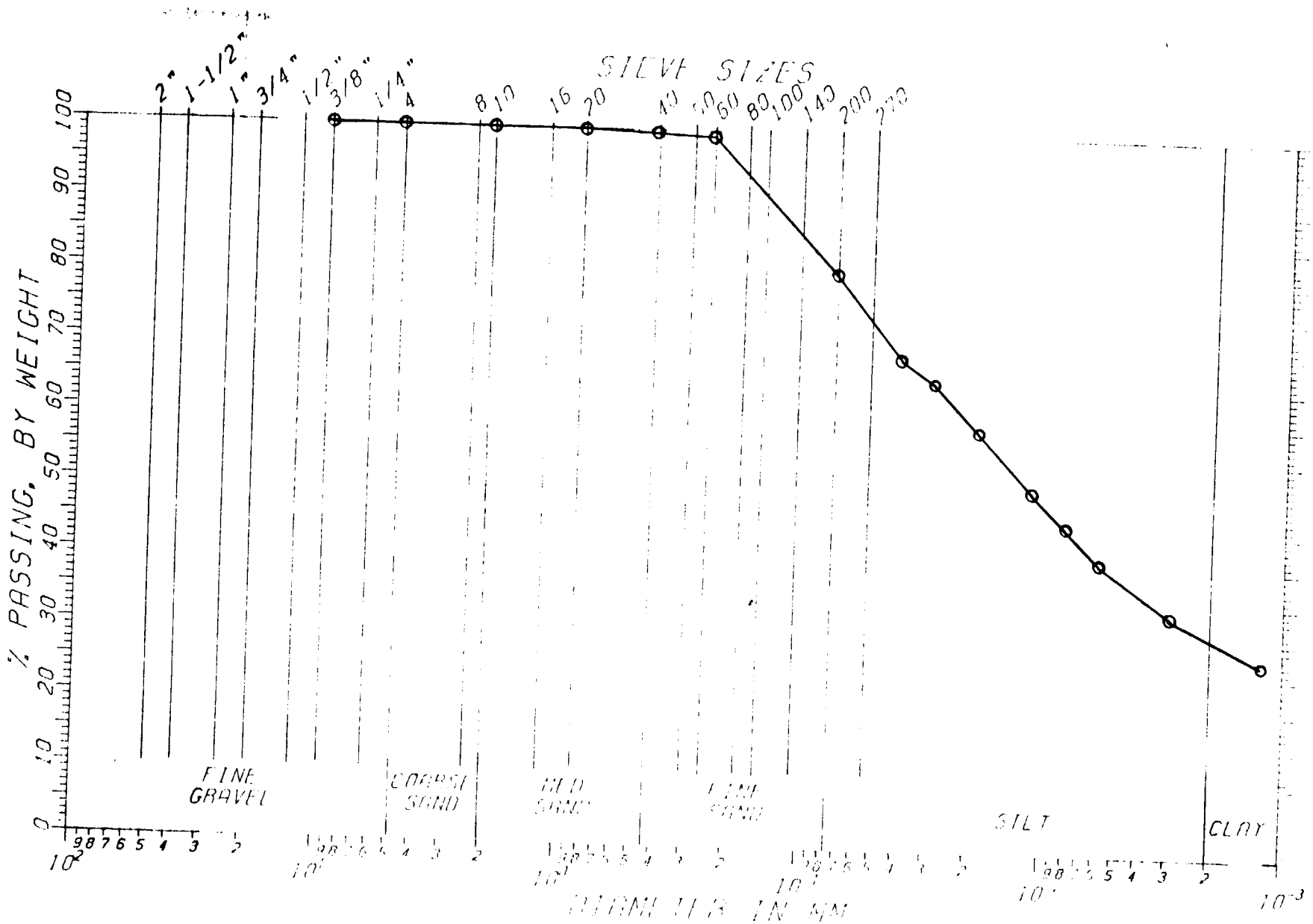
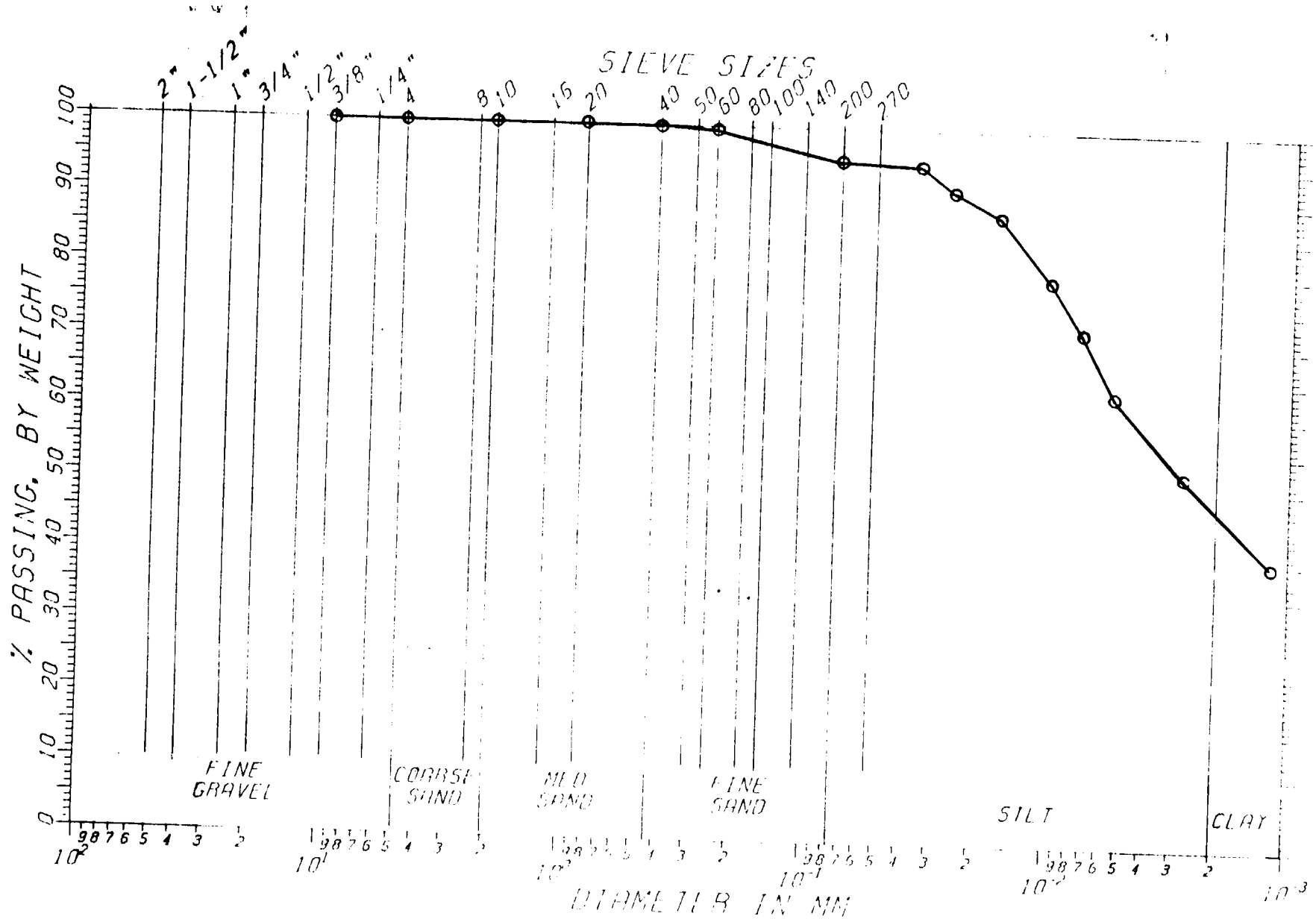
APPENDIX B

GRAIN-SIZE CURVES


SIEVE SIZES
2"
1-1/2"
1"
3/4"
1/2"
3/8"
1/4"
4
8
10
16
20
40
60
80
100
140
200
270
% PASSING, BY WEIGHT
100
90
80
70
60
50
40
30
20
10
0
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
DIAMETER IN MM

BL-SO-8


SIEVE SIZES
2" 1-1/2" 1" 3/4" 1/2" 3/8" 1/4" 4 8 10 16 20 40 50 60 80 100 140 200 270
% PASSING, BY WEIGHT
0 10 20 30 40 50 60 70 80 90 100
FINE GRAVEL
COARSE SAND
MED SAND
FINE SAND
SILT
CLAY
DIAMETER IN MM

BL-SO-9

APPENDIX F

DISCUSSION OF METHODS
GROUND WATER, SURFACE WATER; AND SEDIMENT
SAMPLING AND ANALYSIS

APPENDIX F

DISCUSSION OF METHODS GROUND WATER, SURFACE WATER, AND SEDIMENT SAMPLING AND ANALYSIS

Preparation

In preparation for site activities, ground water, surface water, and sediment sampling equipment was procured, field instruments were cleaned and calibrated, and arrangements for sample shuttle delivery and storage were made. Sample containers and shuttles were provided by the analytical laboratory and shipped to a storage facility in Circleville prior to the initiation of sampling.

Dedicated stainless-steel bottom-loading bailers, used for ground water sampling, were attached to 1/8-inch-diameter stainless-steel cables with copper clamps. Cables were measured and cut according to the corresponding depth of the well. Each bailer/cable assembly was permanently identified by stamping the designated well number on the copper clamp. Surface water sampling equipment consisted of an extension wand with an attached stainless-steel clamp designed to hold dedicated stainless-steel beakers. Dedicated stainless-steel utensils, including scoops, spoons, and mixing pans, were used for the collection/splitting of sediment samples.

All equipment that was to come in contact with ground water, surface water, or sediment being sampled (bailers and cable, stainless-steel beakers, utensils and mixing pans) was first cleaned with a 2.5 percent (by weight) trisodium phosphate-distilled water solution, followed by a wash with a 10 percent (by volume) acetone-distilled water solution, and finally triple-rinsed with distilled water. Bailers, cable, and other stainless-steel utensils were allowed to air-dry prior to being wrapped in food-grade aluminum foil for transport to the site.

Field instruments were also cleaned and calibrated. The electronic water level indicator used to measure ground water levels was dedicated to the site and thoroughly cleaned. The Hydrolab Digital 4041 instrument, used to obtain field measurements of water pH, temperature, and specific conductance was cleaned with a cloth and mild soap solution and calibrated according to manufacturer's directions. The instrument was calibrated for specific conductance using a 1-molar standard solution of potassium chloride of known specific conductance. The pH function was calibrated using using three standard buffer solutions of pH 4, 7, and 10.

Initial Site Activities

Before starting onsite activities, all sample shuttles were inspected to ensure that the shuttles were delivered in a sealed condition and remained sealed until sampling was initiated. A complete inventory of the sample shuttles, sample containers, field blank materials, and preservatives was also undertaken. Each sample shuttle consisted of a styrofoam box and its cover, enclosed and sealed in a cardboard box. Within each shuttle styrofoam box were the sample containers, blue ice, packing material for safe sample storage and preservation, and chain-of-custody forms.

Sample Containers

Each water sample required two sample shuttles: one consisting of four 1-liter glass jars for extractable and pesticide/PCB fraction organic analysis, two 500-ml polyethylene bottles for inorganic analysis, and two 40-ml glass vials with polytetrafluoroethylene (PTFE) septums for volatile organic analyses (VOA); the other shuttle contained three 1-liter glass jars for pesticides/dioxin analyses and one 1-liter glass jar for the analysis of cyanide.

The sample shuttles used for sediment sampling consisted of a sufficient number of sample containers for three sediment locations, each sample requiring two 40-ml VOA glass vials, one 1-liter glass jar for the remaining organic fractions and dioxin, and one 500-ml plastic bottle for inorganic parameters.

Sample Collection

Ground Water Sampling Procedures

Eighteen ground water monitoring wells were sampled. In addition to these samples, four field duplicates, two field banks, two trip blanks (VOA analysis), two additional sample volumes (organic analysis matrix spike/matrix spike duplicate) were obtained, to assess field and laboratory precision, accuracy, and quality control. Four offsite residential wells were also sampled concurrent with the first round of ground water sampling.

Prior to purging and sampling each well, the water-tight cap was removed and an organic vapor measurement obtained with a photoionization detector (PID) at the wellhead. The PID measurement was recorded on the field log. Water levels were measured and recorded to the nearest 0.01 foot, and were used to calculate the volume of standing water in each well. This volume, as well as the minimum volume of water to be purged prior to sample collection, was calculated for each well according to the following formula:

Well Volume (in gallons) (V_W) = $[\pi D^2/4]$ * [well depth (feet) - depth to water (feet)] * [7.48 (gal/cu ft)]

where D is well diameter (feet)

Minimum Purge Volume = (3) * (V_W)

The water level indicator probe and cable were thoroughly rinsed with distilled water between use in each well.

The dedicated bailer was lowered into the well using a portable hoist bracket, which consisted of a metal frame extending approximately 3 feet above the top of the well casing. A pulley was affixed to the top of the bracket, which was in turn attached to the well protector casing. The dedicated stainless-steel cable traveled on the pulley, which was aligned directly above the well opening to prevent the cable from dragging on the well casing. As the bailer was retrieved from the well, the cable was manually coiled and kept off the ground to prevent contamination. Purged water was collected and measured using a 5-gallon bucket, and periodically emptied on the ground, at least 10 feet from the well. Purging involved the bailing of water from the top of the water column, to ensure removal of all standing water from the well.

As the volume of water purged from the well approached the computed minimum purge volume, periodic measurements of pH, temperature, and specific conductance were obtained. After removal of the minimum volume, and when two successive readings of pH, temperature, and specific conductance were in what was considered by onsite representatives to be close agreement, sample collection was initiated. This procedure was designed to allow collection of representative samples from the aquifer, and not standing water that may exhibit altered chemistry.

The same stainless-steel bailer and cable were used for purging and sample collection. Care was taken to lower the bailer gently into the water column during purging and sampling to minimize disturbance. Ground water samples were collected by pouring directly from the bailer into the appropriate sample container.

With the exception of the volatile organics samples, all the sample containers were filled leaving an approximate 10 percent air space to allow for expansion during shipment, in case of freezing. The 40-ml VOA vials were filled to the top, and sealed so that no air space was present. VOA sample containers were filled from the same bailer load whenever possible, and checked for air bubbles before being accepted.

After organic fraction and cyanide sample bottles were filled, a dedicated 1-liter glass transfer container (provided by the laboratory) was filled to allow filtering of the sample for dissolved metals. With dedicated plastic tubing and a peristaltic pump, a sample was drawn from the transfer container, filtered through a disposable 0.45-micron cartridge filter, and pumped directly to the sample container.

Preservatives supplied by the laboratory were added to the cyanide and dissolved inorganic samples using disposable plastic pipettes. Inorganics samples were preserved with nitric acid until a pH of less than 2 was obtained. The cyanide samples were preserved using sodium hydroxide solution until a pH of greater than 12 was obtained. Sample pH was verified using wide range, color comparison pH paper.

Sample splits were obtained by the U.S. EPA for independent analyses. Sample split containers were filled as follows: volatile organic samples for both Dames & Moore and EPA were obtained from the same bailer load whenever possible. All other sample fractions were obtained by pouring from the bailer, alternating between Dames & Moore and EPA sample bottles.

Additional ground water samples for duplicate analyses were collected at four locations. The selection of duplicate ground water sample locations was based upon an evaluation of PID readings obtained at the well, odor, physical appearance, proximity of the well to the landfill or analysis results for the first set of samples, in the case of the second sampling round.

Ground water field blanks were obtained to provide an analytical check on field procedures, using the appropriate types of purified field blank water provided by the laboratory for the various analyses. Field blank water volumes were brought onsite in sealed containers and collected by pouring the water from each freshly opened container into a dedicated sample bailer. The water was then transferred back into the original container.

Filtering and preservation procedures for the ground water split, duplicate, and blank water volumes were identical to those utilized for the 18 monitoring well samples.

An additional volume of ground water was also obtained to permit laboratory analysis of a matrix spike/matrix spike duplicate (MS/MSD) for laboratory quality assurance/quality control (QA/QC) analyses.

Residential Well Sampling Procedures

One set of samples from private water supply wells was collected at locations 14 through 17. Locations were consistent with those discussed in the work plan, with the exception of location RW-16, which was shifted to a house to the south of the site, after it was learned that only two wells supplied all residences in the vicinity of planned locations 14 through 16. Information concerning location and ownership of these wells obtained during the sampling is included below.

Sample ID	Owner/Resident	Location
RW-14	Estate of Dr. John N. Bowers	20324 Island Rd.
RW-15	Estate of Dr. John N. Bowers	20351 Island Rd.
RW-16 & 16-DUP	Kenneth Hunt	1741 Island Rd.
RW-17	Mary Short	1680 Island Rd.

The well owners were contacted by phone in advance of sample collection time to obtain permission and establish a collection schedule. The work plan called for residential wells to be sampled at the closest possible point in the discharge line to the well. All samples were collected at the wellhead, with the exception of location RW-17, where difficulties in maintaining flow at the wellhead resulted in the collection of a sample from the tap. The water did not pass through a treatment system, but did pass through a pressure tank (approximately 25-gallon capacity); therefore, a sufficient volume of water was allowed to discharge before sample collection.

Residential well samples were handled in the same manner as ground water samples collected from onsite wells, except that the inorganic sample portion was not filtered. A trip blank for volatile organic analysis was included with the residential well samples. The trip blank consisted of a 40-ml VOA vial filled with ultrapure water and sealed at the laboratory. The blank travelled with sample containers from the laboratory to the site, and back to the laboratory for analysis, always remaining sealed. The objective of using a trip blank is to evaluate the potential for ambient or external conditions to introduce contamination into the samples.

Surface Water Sampling Procedures

Collection of surface water and sediment samples began with the collection of the Scioto River samples, and proceeded from the farthest downstream location (location 23) to the farthest upstream (background) location (location 18). Sampling of the ditch and pond areas occurred after the river sampling was completed. At every location, surface water samples were collected prior to sediment samples. Staff gages at several locations (Drawing 3-5) were read concurrent with sample collection, and values were recorded for subsequent evaluation of hydrologic conditions.

All surface water samples were collected approximately 5 feet from the edge of the water line; sediment sample locations were at the edge of the water, adjacent to the existing water surface.

Surface water samples were collected by dipping the inverted stainless-steel beaker, clamped to the extension rod, beneath the water to a depth approximately midway along the water cross-section, and turning the beaker upright to fill. At location 28, shallow water necessitated skimming water from the surface. Sample bottles were filled by pouring the water directly from the collection beaker. Dedicated beakers were used during the sampling program.

Sample splits were obtained by the U.S. EPA for independent analyses. At each sample split location, containers were filled as follows: volatile organic samples for both Dames & Moore and EPA were obtained from the same beaker load. All other sample fractions were obtained by pouring from the beaker, alternating between Dames & Moore and EPA sample bottles.

Additional surface water samples for duplicate analyses were collected at two locations. The selection of duplicate surface water sample locations was based upon an evaluation of the potential for contamination to be present in a given sample and Round One results, in the case of Round Two sampling.

Two field blanks were collected concurrent with the surface water sampling. The surface water field blanks were obtained to provide an analytical check on field procedures, using the appropriate types of blank water provided by the laboratory for the various analyses. Field blanks were collected by pouring the water from the blank water container into a sample beaker and then transferring the water back into the original sample container. Identical preservation procedures were used for all the surface water splits, duplicates, and field blank samples. One VOA trip blank was included for analysis with the surface water samples, as discussed previously for the ground water samples.

An additional volume of surface water was obtained to permit laboratory analysis of a matrix spike/matrix spike duplicate for QA/QC.

Surface water samples were not filtered for inorganic analysis. A container was filled to allow field measurement of temperature, specific conductance, and pH. Samples taken for inorganics were preserved using the same procedures discussed previously for ground water samples.

Sediment Sampling Procedures

Once surface water sampling was completed at a particular location, the sediment sample planned for that location was collected. At each sample location, an area onshore along the edge of the water surface was marked off. Each location was prepared by removing vegetation and surface debris, taking care not to disturb the sediment. Small portions of the sediment were immediately placed in the VOA vials and sealed. The sample area was then mixed in place to a depth of approximately 3 to 4 inches, and sediment was placed in the remaining sample containers. All sample containers were wiped clean and placed in a cooled sample shuttle.

At locations where EPA sample splits were collected, or where duplicate, blank, or laboratory matrix spike sample volumes were collected, stainless steel compositing pans were used to thoroughly mix the sample (except for the volatile organic sample fraction, which was obtained prior to sample mixing). Sediment samples were placed in a stainless-steel pan and mixed with a stainless-steel scoop prior to being portioned off into the remaining sample containers. Sample bottles were filled by alternating between Dames & Moore and EPA sample bottles.

Field Quality Control, Field Analyses, Documentation, and Sample Shipment

In addition to these various sample procedures described above, appropriate field quality control measures were maintained throughout the sampling program. To avoid cross-contamination, sampling personnel wore clean, disposable latex gloves and avoided contact with water and sediment samples. The Hydrolab instrument used to measure pH of water samples was calibrated on a daily basis prior to usage, using three laboratory standard buffer solutions of pH 4, 7, and 10, and checked before each sample analysis with a standard buffer solution of pH 7. The probe of the Hydrolab instrument was thoroughly rinsed between readings with distilled water.

A field log was maintained to record the sampling activities, and field data sheets were completed at each sample location. All sample containers were labeled to indicate sample identification, sampling date, and appropriate analysis code, using a permanent ink pen. Clear plastic tape was used as necessary to preserve the integrity of the label. Cooled ice containers were included in each shuttle, to maintain a temperature of approximately 4°C.

Prior to sealing a shuttle box, sample containers were checked to ensure proper seals and labeling. A chain-of-custody form was completed, signed, and included in each shuttle box. Each shuttle was sealed with plastic tape and a signed custody seal, to prevent tampering. Samples were transferred to a courier service at the site entrance, for overnight shipment to CompuChem Laboratories.

Source: Technical Memorandum - Round One and Two Ground Water, Surface Water and Sediment Sampling and Analysis, Bowers Landfill RI/FS, Circleville, Ohio, Dames & Moore, May 22 and July 24, 1987.

APPENDIX G

DISCUSSION OF METHODS
SURFICIAL SOIL SAMPLING AND ANALYSIS

APPENDIX G

DISCUSSION OF METHODS
SURFICIAL SOIL SAMPLING AND ANALYSIS

Preparation

In preparation for site activities, soil sampling equipment was procured and cleaned. Soil sampling equipment included stainless steel utensils such as scoops, spoons, spatulas, and mixing pans (grab sampling), as well as 3-inch-diameter, 30-inch-length, galvinized steel tubes (Shelby tube sampling). All equipment that was to come into contact with soil samples was first cleaned with a 2.5-percent (by weight) trisodium phosphate distilled water solution, followed by a 10-percent (by volume) acetone distilled water solution, and finally rinsed with distilled water. Shelby tubes also required an initial cleaning with nitric acid-distilled water to remove machine oil. All equipment was allowed to air-dry, and was then wrapped in aluminum foil for transport to the site.

Sample containers and shuttles were provided by CompuChem Laboratories and transported to the site. Each set of containers for grab sample collection consisted of two 40-ml glass vials with PTFE septums for volatile organic analyses (VOA), one 1-liter glass jar for remaining organic fractions, and one 500-ml plastic bottle for inorganic parameters.

Initial Site Activities

Site activities commenced on September 22, 1986, with a meeting at the site among representatives of Dames & Moore, Ohio EPA, and U.S. EPA contractors (PRC and Versar). The anticipated scope of work was reviewed, and topics such as health and safety procedures, sampling locations, and schedule were discussed. A preliminary site traverse was made to confirm sampling locations, where necessary.

Planned Shelby tube sampling/drilling location 5 was identified as posing potential problems for sample collection (and subsequent drilling/monitoring well installation). Of primary concern was the observation that the proposed location was situated in a poorly drained, low-lying area, subject to frequent inundation by the Scioto River. Numerous trees and understory vegetation at this location also presented difficulties for equipment access. Dames & Moore personnel suggested that proposed location 5 be moved approximately 100 feet north to the edge of the cultivated field, to allow drill rig access. EPA representatives requested that the proposed location be maintained, however. Excavating equipment (a small dozer) was subsequently brought onsite to clear a path for equipment to access this location.

A reconnaissance of the area to the west of the Scioto River was conducted to select background sampling locations 45 and 46. After obtaining landowner permission, and following a review of the Soil Survey (U.S.D.A., 1980), background locations across the river and approximately 1,200 feet upstream of the site were selected. The locations are on the fringe of a cultivated cornfield, and appear to lie on the southern boundary of a mapped occurrence of the Genessee soil series that predominates on the site.

Sample Collection - Grab Samples

Collection of surficial soil grab samples at the site took place on September 23, 1986. Dames & Moore personnel, accompanied by Ohio EPA/U.S. EPA representatives, obtained soil volumes from each of the 15 planned grab sample locations at the site (locations 30 through 44). Minor adjustments in most of the locations were made to achieve the objective stated in the work plan that field locations "will be selected to sample potentially contaminated soils, such as in areas of exposed waste, leachate seeps, or drainageways." Noteworthy adjustments include moving planned location 31 approximately 100 feet to the east, and location 42 approximately 100 feet to the south, so that samples would be obtained from drainageways.

At each sample location, the selected spot was prepared by clearing vegetation and surface debris, taking care not to disturb the soil. Using a precleaned stainless steel utensil, an area approximately one

square foot in area was marked off. Small portions of soil were then removed from the sample area, immediately placed in the VOA vials, and sealed. The sample area was then thoroughly mixed in-place to a depth of approximately 3 inches, and portions placed in the remaining sample containers. All containers were then labeled and placed in cooled samples shuttles. A field log was filled out at each sample location. When a sample shuttle was filled, chain-of-custody and laboratory instruction sheets were filled out and included with the shuttle; the shuttle was then sealed for transport to the laboratory. Each sample location was marked with a metal post for future identification.

At location 35, an additional sample volume was obtained to permit laboratory analysis of a matrix spike/matrix spike duplicate for quality assurance/quality control (QA/QC). An additional QA/QC activity involved the preparation of a field blank to assess the potential for the introduction of contamination during sample collection. The blank was prepared concurrent with sample collection at location 38, using material supplied by the laboratory. The blank was handled using precleaned sampling utensils and a compositing pan, in a manner similar to actual sample collection.

At locations 35, 41, and 44, sample splits were obtained by U.S. EPA for independent analyses. At each sample split location, sampling methods employed were similar to those described above, with the following exceptions:

- VOA vials were filled by alternating between Dames & Moore and EPA containers.
- Remaining sample fractions were obtained by depositing soil from the sample area in a precleaned stainless steel compositing pan, thoroughly mixing, dividing into quarters, and filling each set of containers from one of the quarters.

Sample Collection - Shelby Tube Samples

Shelby tube soil sample collection at the site took place on September 24 and 25, 1986. Dames & Moore personnel and a drilling rig/crew from John Mathes & Associates (drilling subcontractor), accompanied by Ohio EPA/U.S. EPA representatives, obtained Shelby tube soil samples from each of the eight onsite and two offsite sampling locations (locations 04 through 11, 45, and 46). Each onsite sampling location corresponded to planned drilling/monitoring well installation sites. Shelby tube samples were collected as a group prior to drilling to allow batch processing in the laboratory.

At each sample location, the selected spot was prepared by clearing vegetation and surface debris, taking care not to disturb the soil. A precleaned galvanized steel Shelby tube was attached to the drill stem and pushed from ground surface to a depth of approximately 30 inches. The tube was then twisted sharply to break the sample column from underlying soil, and removed. Data collected during the sampling activity indicate that most samples may have been compacted to various degrees by the pushing operation.

All Shelby tubes were then labeled to indicate sample number and the end corresponding to ground surface. Void space within each tube was filled with aluminum foil, and the tube ends sealed with foil, followed by plastic caps and duct tape. Each tube was placed in a cooled sample shuttle to await shipment. A field log was completed at each sample location.

At location 05, a second Shelby tube sample was extracted adjacent to the first. This additional volume was collected to permit laboratory analysis of a matrix spike/matrix spike duplicate for QA/QC.

Each Shelby tube sample and the hole left after removal of the tube were scanned with an organic vapor analyzer (OVA) and photoionization detector (HNu) to evaluate the possible presence of organic contaminants. This evaluation was intended to aid in the selection of five of the eight onsite samples for chemical analysis. As indicated on the field logs, none of the samples or sample holes produced above-background readings with either instrument; therefore, the five Shelby tube samples collected from points nearest to the landfill (05, 06, 07, 10, and 11) were selected for chemical analysis. Offsite background samples 45 and 46 were similarly selected for chemical analysis. The laboratory was instructed to extract each soil sample from the associated Shelby tube and analyze the top 6-inch increment, storing additional increments for possible future analysis. The remaining two tubes collected onsite (locations 08 and 09)

were forwarded to a geotechnical laboratory for physical testing. Sample number 04 was discarded, due to insufficient sample recovery.

The holes remaining after Shelby tube sample removal were sealed with bentonite to prevent direct movement of surface water into the subsurface.

Sample Shipment

All soil samples collected at the site for chemical analysis were sealed in cooled sample shuttles and hand-delivered for shipment via overnight courier to CompuChem Laboratories. Grab soil samples were shipped September 23, 1986 and received September 24, 1986; Shelby tube soil samples were shipped September 25, 1986 and received September 26, 1986.

Remaining Shelby tubes (locations 08 and 09) were shipped to Tech Engineering on October 2, 1986 and received October 4, 1986.

Source: Technical Memorandum - Preliminary Results Subtask 1.3.4 Soil Sampling and Analysis, Bowers Landfill RI/FS, Circleville, Ohio, Dames & Moore, January 26, 1987.

APPENDIX H

RESULTS OF LABORATORY DATA VALIDATION

MEMORANDUM

DATE: May 22, 1987

FROM: Clarence Lowery, Lowery & Lowery, Inc.
MEMO TO: Michael J. Lyden, Dames & Moore

SUBJECT: Laboratory Data Validation, Bowers Landfill Site

The validation was performed from May 12 through May 22, 1987. For the purpose of this report the comments are divided into two groups: (1) soil samples (SO) and (2) ground water samples (GW), surface water (SW), and sediment samples (SE). The following documents were used during the evaluation:

- Functional Guidelines for Evaluating Organic Analyses, U.S. EPA Technical Directive No. HQ-8410-01 Contract No. 68-01-6699, May 28, 1985.

- Functional Guidelines for Evaluating Pesticides/PCBs Analyses, U.S. EPA Technical Directive No. HQ-8410-01 Contract No. 68-01-6699, May 28, 1985.

- U.S. EPA Contract Laboratory Program, Statement of Work for Organic Analysis, 7/85 revision; Statement of Work No. 785, Inorganic Analysis, July, 1985;. Statement of Work, Dioxin Analysis, September 15, 1983.

- Functional Guidelines for Evaluating Inorganic Analysis, U.S. EPA, October 25, 1985.

(1) SOIL SAMPLES

The soil sample analyses were dated October, 1986 and involved two types: shelby tube and surficial grab samples. The samples were analyzed for organics, inorganics and dioxin. Comments relating to the organics are as follows:

The data are well presented. All support data are attached and the overall assessment in the laboratory complied with the guidelines associated with the CLP program. There were some outliers; however, in my opinion they did not affect the validity of the data. The outliers are as follows:

For the volatile fractions, the original analyses of all samples were performed within the specified holding time; however, seven of the samples were reanalyzed outside of holding time.

In some cases the Response Factor (RF) for initial calibration was not met for 2-Butanone.

Surrogate Recovery Acceptance Criteria were met for all fractions of all samples with the exception of BL-SO-06T6 which contained one acid surrogate that fell below the QC limit and three volatile surrogates that exceeded the QC limit. The failure of the volatile surrogates was attributed to a matrix problem; a pertinent Laboratory Notice was attached. Sample BL-SO-39-01 had a matrix interference that made quantitation of the surrogate in

the pesticide fraction unavailable. A pertinent Quality Assurance notice was attached. The Percent Recovery and the Relative Percent Recovery values were all within the QC limits with the following exceptions: one base/neutral compound whose percent recovery exceeded the QC limit in both the MS and MSD; one acid compound whose percent recovery exceeded the QC limit in the MS and one acid compound whose relative percent difference value exceeded the QC limit.

For the semivolatile fractions, the original extractions of all samples were performed within the specific holding time; however, two samples and the matrix spike/matrix spike duplicate were reextracted due to a laboratory accident; these reextractions fell outside of the specified holding time.

For the inorganics, the data are well presented. However, some sections of the data report forms were not completed. Review of the corresponding data package indicated that the required information was available. Again there are some outliers (as is normal in most laboratory analyses). In my opinion the outliers do not affect the validity of the data. The outliers are as follows:

Sample numbers 103048 and 10254 were sample spikes of 103047 (BL-SO-45T6) and 102581 (BL-SO-39-01). Antimony, mercury, selenium, and silver were flagged with an "N" indicating a problem with the sample matrix.

A serial dilution was performed on sample 102586 (BL-SO-34-01). Nickel and zinc were flagged with an "E" indicating that a chemical and/or physical interference was suspected.

The dioxin reports are excellent, all data are available and the forms are filled out properly.

SURFACE WATER, GROUND WATER, AND SEDIMENT SAMPLES

The water and sediment samples were validated in the same manner as the soil samples. All samples were dated early 1987 and consisted of six sets of data (60 samples).

In assessing the organics data, all information was available and the correct forms were filled out. Several outliers were identified during the validation process, but are not considered to have an impact on data validity. The outliers are as follows:

Of the volatile fractions, all sample fractions were analyzed within holding times; the initial analyses for the duplicate spikes were done within holding times; however, as the spike compounds failed originally, the spikes required reanalyses, which were not performed within holding times.

In the initial and continuing calibration the RF and RF(average) for one compound did not meet the required criteria.

The semivolatile extractions for 14 samples were within contract specified holding times for quality control samples. The MS/MDS associated with the samples were reextracted outside of holding

times because there was no comparison between the original sample and the sample spike prepared from it. However the initial extractions of the MS/MSD were within holding times.

For one sample batch, the initial extracts for the duplicate spikes and the base neutral compounds did not meet criteria. All QC criteria were met by the repeat extracts, but the reextractions could not be performed within holding times.

One sample had recoveries which were below the QC window for the acid surrogates (2-fluorophenol and d5-phenol), in both the initial and repeat extractions. The consistency between these duplicate analysis indicate that the failed acid surrogate recoveries were due to the particular nature of the sample matrix rather than any deficiencies in the analytical system.

In one of the initial calibrations the RF was outside of control limits.

The pesticide/PCB data was in order and well presented.

In assessing the inorganic data packages, it was noted that three data reporting forms were not always completed thoroughly (Forms IV, VI, and VIII). As an example, if arsenic or selenium was below the detection limit, Form VIII was not completed. The incompleteness of the forms does not invalidate the work. Upon further inspection, all required data were available and met criteria.

Specific problems found with the data included: selenium spike recoveries were outside the control limit for three samples. Also, of a lesser extent, mercury, arsenic and antimony wereoutside control limits in one sample. Three samples had at least one element outside of control limits for ICP dilution, and three samples did not meet the standard addition test.

Overall the data were available and well presented, meeting CLP criteria.

In assessing the dioxin analyses, again I judge the work to be excellent. All forms are properly completed and the data are available.

MEMORANDUM

Date: July 7, 1987

From: Clarence Lowery, Lowery & Lowery, Inc.
To: Mike Lyden, Dames & Moore

Subject: Laboratory Data Validation
Bowers Landfill RI/FS, Water and Sediment Samples

Testing Laboratory: CompuChem

The validation was performed from June 17 through July 6, 1987. Data were reviewed for completeness and compliance with guidelines established by EPA for the Contract Laboratory Program (CLP). The following documents were used:

- Functional Guidelines for Evaluating Organic Analyses, U.S. EPA Technical Directive No. HQ-8410-01 Contract No. 68-01-6699, May 28, 1985.

- Functional Guidelines for Evaluating Pesticides/PCBs Analyses, U.S. EPA Technical Directive No. HQ-8410-01 Contract No. 68-01-6699, May 28, 1985.

- U.S. EPA Contract Laboratory Program, Statement of Work for Organic Analysis, 7/85 revision; Statement of Work No. 785, Inorganic Analysis, July, 1985; Statement of Work, Dioxin Analysis, September 15, 1983.

- Functional Guidelines for Evaluating Inorganic Analysis, U.S. EPA, October 25, 1985.

The data included analyses for organics, inorganics, and dioxin. Results of the review are summarized below, grouped according to analysis type.

Organics

I. The data contained in the report of June 6, 1987 involved 15 sediment samples. In the volatile fractions, the MS/MSD were analyzed outside the holding time in order to confirm a matrix interference affecting recovery of the spike compounds, according to CompuChem narrative. The other minor problems were in the initial and continuing calibration where the RF for one compound was less than 0.05. Also in the continuing calibration for the %D, three of the compounds was >25%.

The semivolatile fraction included two samples extracted outside the holding time period, samples BL-SE-BLNK1-O2 and BL-SE-27-02. According to CompuChem there was an accident with the blank, and sample BL-SE-27-02 was re-extracted to confirm a matrix interference affecting the recovery of the surrogates and internal standards. Three samples did not meet the surrogate recovery criteria: BL-SE-26-02, BL-SE-29-02 and BL-SE-BLNK1-02. Four samples could not be identified on the tuning pages with the time of analysis. The acid extraction of the matrix spike had one standard slightly low, 16% versus 17% minimum.

word utils/(m)

The pesticide fractions were in order; however, the CompuChem narrative discussed a surrogate recovery problem of a semivolatile analysis in the pesticide section.

II. The dated contained in the report dated June 10, 1987 involved 24 water samples.

The volatile fraction data had only minor problems in the initial and continuing calibration. In the initial calibration, one standard had one compound with an RF <0.05. In the continuing calibration, all standards had one compound with an RF <0.05 and four of the six standards had 1-5 compounds with a %D > 25%. Again there was a problem in finding three sample times in the tuning data.

In the semivolatile fraction, two samples did not meet the holding times, BL-SW-BLNK1 and BL-W07-02. According to CompuChem, sample BL-W07-02 required re-extraction due to high surrogate recoveries. The re-extraction met criteria.

The B/N extraction of the matrix spike did not met the RPD criteria.

The initial calibration had one standard with one compound with an RSD > 30%.

In the continuing calibration, all standards had some compounds with a %D > 25%.

There was also a question of sample identification for six samples in the tuning data.

In the pesticide fraction, sample BL-W07-02 did not meet the holding times, as mentioned in the semivolatile extraction.

III. Samples reported in the data packet dated April 30, 1987 involved 12 water samples.

The volatile fraction was missing a chain-of-custody form for sample CC-TPB1NK and two samples could not be identified in the tuning information. The only other minor problems were with initial and continuing calibration. In the initial calibration, both standards had one compound with an RF of <0.05. Continuing calibration also had one compound with an RF <0.05 and one standard had six compounds with a %D > 25%.

In the semivolatile fraction, two samples could not be found in the tuning data. In the continuing calibration all standards had four to six compounds with a %D > 25%.

There were no problems found with the pesticide fractions.

IV. Samples reported in the data packet dated May 27, 1987 contained eight water samples.

The volatile fraction had two samples that could not be identified in the tuning data. The only other was a minor problem with continuing calibration. Both standards had one compound with RF <0.05 and six to seven compounds with %D > 25%.

The semivolatile fraction had one sample that could not be identified in the tuning information. Both standards had 10 to 11 compounds with %D > 25%.

There were no problems found with the pesticide fractions.

From an overall point, I thought the problems noted in the organics were not of significant magnitude to affect the validity of the data packet.

Inorganics

I. The samples reported in data packet dated June 10, 1987 were for six sediment samples. It was difficult to evaluate the packet, forms V, VI, and VII were not included.

II. The samples reported in data packet dated June 11, 1987 were for two water samples.

On evaluating the ICP check sample, the wrong page was included in the packet. The analysis was performed June 8th and the data for June 1st was included.

The percent recovery for sample spikes had three elements outside the range, Se, Ag, and Th.

There was a question on why Form VIII was not filled out; arsenic was detected, but between the CRDL and the IDL.

III. The samples reported in data packet dated June 4, 1987 contained nine sediment samples.

The associated quality control sample duplicate, BL-SE-25-02 had Fe, Al, Pb, Mn, and Zn outside the control limits.

The ICP dilution test on sample BL-SE-21-02 had Al, Ba, Ca, Cu, Fe, Mg, Mn, and Zn not within the 10% specified value.

IV. The samples reported in data packet dated June 8, 1987 were for 20 water samples.

Samples BL-SW-27-02 and _____ were analyzed but not reported on Form I, holding times.

As, Hg, and Se did not meet the control limits for spikes.

The ICP dilution test on sample BL-W07-02 had Mn outside the 10% specific value.

V. The samples reported in data packet dated June 1, 1987 were for 20 water samples.

Samples BL-SW-25-02 was used for spikes and Pb, Hg, Se, and CN were outside the control limits.

The ICP dilution test on sample BL-SW-25-02 had Mn outside the 10% specified value.

Overall the data submitted were good. There were some problems as noted, the missing data need to be submitted and reviewed and the samples submitted on report dated June 4, 1987 should be regarded as marginal, five elements were outside the control limits for duplicates and eight elements were outside the limits for ICP dilution.

Dioxins

Five data packets were submitted for review: June 8, 1987 (Reports I and II), May 28, 1987 (Reports I and II), and May 15, 1987.

I thought the data presentation was very good and met all criteria. The only problem found was chain-of-custody forms were missing.

C. Lowery, Consultant
Lowery & Lowery, Inc.
July 7, 1987