BETHLEHEM STEEL

FINAL RCRA FACILITY INVESTIGATION REPORT

Former Bethlehem Steel Corporation Facility
Lackawanna, New York

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APPENDIX G

INVESTIGATION OF DREDGE SOILS DUMPING AT BETHLEHEM STEEL CORPORATION'S LACKAWANNA, NEW YORK FACILITY

INVESTIGATION OF DREDGE SPOILS DUMPING

AT

BETHLEHEM STEEL CORPORATION'S

LACKAWANNA, NEW YORK FACILITY

PREPARED BY:

URS CORPORATION

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1.0 INTRODUCTION

In the fall of 2000, Bethlehem Steel Corporation (BSC) installed a series of groundwater monitors along the Lake Erie shoreline of its Lackawanna, NY property. These monitors were installed in order to assess the hydrogeology and soils at this portion of the facility in support of an ongoing RCRA Facility Investigation. The groundwater monitors, which included the installation of nested piezometers, were installed at locations and following procedures specified in the approved shoreline sampling work plan (URS, 2000). Prior to the start of the drilling program, a document review revealed the existence of two dredge spoil dumping grounds that, in the past, were historically located immediately offshore of the facility. These spoil areas were later covered during a westward extension of the shoreline facilitated by BSC's dumping of slag into Lake Erie. This dumping of slag into the lake was conducted with the approval of the U. S. Army Corps of Engineers (COE) and New York State through BSC's purchases of Riparian Rights.

During the installation of the groundwater monitors, contamination was observed in the borings at the approximate depths where the dredge spoils were assumed to have been placed. As a result, BSC undertook an investigation to learn the history, location, nature, and potential impacts resulting from the existence of dredge spoils that lie beneath the western portion of the facility in the area of the slag fill.

1.1 Objective

The primary objective of this investigation was to determine the physical and chemical characteristics of dredge spoils placed in the former dumping grounds and to assess the potential environmental impacts from dredge spoils that now lie beneath the western portion of BSC's Lackawanna, New York facility.

1.2 Scope of Services

The scope of work conducted for this evaluation consisted of the following tasks:

1.2.1 Historic Dredge Spoil Dumping Activities Review:

BSC retained URS Corporation (URS) to search for historic information relating to the dumping of dredge spoils into Lake Erie adjacent to BSC's facility. This search has been conducted primarily through Freedom of Information Act (FOIA) requests and literature searches. BSC also received information from Phillips, Lytle, Hitchcock, Blaine & Huber, attorneys for BSC.

1.2.2 Piezometer Drilling Program:

Soil cores from the drilling and construction of eight piezometer nests along BSC's Lackawanna shoreline were examined to assess whether the soils were representative of native materials, BSC's slag filling operations, or dredge spoils that may have resulted from historic dumping operations.

1.2.3 Soil Sampling and Analysis:

Soil samples were collected from discrete zones in the piezometer borings and sent to a New York certified laboratory for analysis for organic and inorganic compounds.

1.2.4 Report Preparation:

The information collected for the previous three tasks was evaluated and summarized in this report.

2.0 SHORELINE INVESTIGATION

2.1 Historical Dredge Spoil Dumping Activities Review

BSC has undertaken a search of documents relating to the location and nature of former dredge spoil dumping areas adjacent to the facility through :1) a review of dredge records from the U.S. Army Corps of Engineers and case files on area hazardous site available from the NYSDEC; 2) examination of documents obtained by BSC's legal counsel and; 3) a review of available literature that documents the chemistry of dredge spoils removed from the Buffalo Harbor, the Buffalo River and from contaminated sites that would have contributed pollutants in the past to the dredge spoils that now underlie the site.

2.1.1 Review of Agency Documents

Documents prepared by the U.S. Army Corps of Engineers (USACE) concerning the location, history, quality and nature of dredge spoils dumping in the vicinity of the Lackawanna facility were obtained and include:

- Design drawings for the Buffalo Harbor containment site. These drawings provided information on the bathymetry and the sequence of sediments offshore of the northwestern portion of the Lackawanna facility. Borings extended to bedrock (70 to 80 feet below lake level), encountered at lake bottom a gray to black silt and sand unit with gravel and evidence of wood similar to that described in the BSC shoreline borings.
- A Supplemental Information Report (SIR) dated 1983 and prepared by the district USACE which contained information on the dredging and disposal of spoils from the Buffalo Harbor. The report summarizes open lake dumping activities prior to 1967 and discusses subsequent efforts to contain the polluted dredged sediments from the Federal navigation channels within diked disposal facilities. The location of Federal navigation channels in the Buffalo area include: the Buffalo River, the Buffalo Harbor and the Black Rock Channel. The report also identifies areas dredged, dredging periods and quantities, and describes the physical and chemical characteristics of the dredge sediments. The practice of open lake disposal is further described as unacceptable due to the uncontrolled release of pollutants and resultant adverse environment impacts.
- A sediment sampling and analysis report prepared by EEI consultants for the USACE in 1996 provided additional information the quality of area dredge spoils. Included in this report is an analysis of the physical and chemical characteristics of sediments in the Buffalo Harbor, Buffalo River and Ship Canal. Bottom sediments were described as consisting of gray to black/brown silts with varying

amounts of clay and sand, and occasional rock fragments. Secondary features included petroleum odors, sheens and the presence of wood and leaf matter.

In addition to the USACE records, case files were obtained from Region 9 of the NYSDEC (Department of Environmental Conservation), in Buffalo, NY. These files contained information on local inactive hazardous waste sites and likely contaminants that would have been contributed to the federal navigation channels in the past. The location of hazardous waste sites are identified on Figure 3 of this report along with the location of the dredge spoil disposal areas. The current status of investigations, contaminants identified and areas affected by area hazardous waste sites were reviewed in annual progress reports (NYSDEC 2000).

2.1.2 <u>Examination of Other Documents</u>

Several documents secured by BSC attorneys provide information on the locations of former dredge spoils dumping areas (see Appendix B). These consist of a memo and several maps and drawings that demonstrate that there were at least two dumping grounds located immediately west of the former BSC facility shoreline. These documents include:

- A map dated April 1937 showing the existence of two dumping grounds (listed as "Old Dump Ground" and "Dump Ground") immediately west of the western most shoreline of BSC's Lackawanna facility as it existed in 1937. This map has the designations "War Department" and "Corps of Engineers, U.S. Army" along its top border. The locations of these former dumping grounds have been transferred to an up-to-date Lackawanna facility site map (see Figure 1). This figure clearly shows that the two reported former dump areas would presently lie beneath much of the western portion of the site.

- A memo dated February 2, 1949 by a W. E. Durell (affiliation not known) that provides a chart (Coast Chart No. 31) that shows the existence of a dumping ground adjacent and west of BSC's Lackawanna facility. This chart also appears to establish the dumping took place between the original Riparian Grant Line (believed to have been granted to predecessors of BSC on June 19, 1900 and periodically renewed until 1949) and the "proposed new Riparian Grant line" shown on the chart. In other words, this chart appears to establish that dredge spoils were dumped on the floor of Lake Erie before it was filled with slag by BSC. Further attached to the memo are three cross sections that measure the extent of dumping that took place between December 1936 and June 1948, at three locations in Lake Erie. These cross sections are reproduced as Figure 2, the line of section for these cross section is shown on Figure 1. The memo also states that "approximately 614,000 cu. yards of dredge spoils had been placed in the area since the site had been designated as a Federal dumping ground".

2.1.3 Literature Review

The "Preliminary Evaluation of Chemical Migration to Groundwater and the Niagara River from Selected Waste Disposal Sites" (USGS 1983) provides an evaluation of 138 known toxic waste sites along the United States side of the Niagara River in the Buffalo area. Included in this document is an extensive discussion on the chemistry of wastes disposed of by area industries, and of sediment placed into containment sites as a result of dredging operations. The latter provides important information on the chemical makeup of material that may have been placed in former dumping grounds that presently underlie the western portion of the Lackawanna site. Results of this assessment of area wide contamination and other documents researched, with respect to the analytical results of this investigation, are discussed in Section 2.4.

2.2 Piezometer Drilling Program

From September 28 to October 23, 2000, BSC conducted an investigation of the hydrogeology and sediments along the Lake Erie shoreline. BSC planned to use this information as part of the ongoing RCRA Facility Investigation of the Lackawanna facility.

The investigation consisted of drilling borings on the beach along the Lake Erie shoreline. Borings were drilled from September 28, 2000 through October 23, 2000 using a track mounted drilling rig that turned 4¼-inch hollow stem augers. Borings were drilled approximately 50 feet back from the shoreline at locations shown on Figure 1. During drilling, continuous split-spoon soil samples were collected, logged and screened with a photoionization detector (PID).

Upon completing each of the borings, three clustered piezometers screening shallow (8 to 12 feet bgs), medium (17 to 22 feet bgs) and deep (25 to 31 feet bgs) depths were installed in each of the boreholes.

Soil samples collected during drilling operations were carefully examined and logged by an experienced geologist. Geologic logs and piezometer construction diagrams are provided in Appendix A. Soil samples for laboratory analysis were collected from borings where evidence of contamination, either visual or were elevated PID readings occurred. Soil samples were placed in laboratory supplied containers and sent to STL laboratories in Pittsburgh, Pennsylvania for analysis.

Requested analytes consisted of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals and several inorganic parameters that are considered site specific compounds of potential interest (COPIs). A list of these parameters is provided on Table 1. Several additional parameters were requested for soil sample analysis. The additional parameters included several SVOCs that were identified as potentially being found in dredge spoils placed in a number of dumping grounds in the Buffalo area (Kaszalka et. al. 1983), and a search of tentatively identified compounds (TICs). Methods of analysis and results of the data validation are provided in Appendix D. All sampling data for this study was gathered in compliance with required RFI QA/QC protocols (Ecology and Environment, June 1989).

2.3 Boring Sediment Sequence

As mentioned in Section 2.1, dredge spoils from the Buffalo Harbor and Buffalo River were disposed offshore of shoreline areas that existed on BSC property prior to 1937 (see Figure 1). Consequently, it would be expected that drilling along the present shoreline would intercept dredge spoils directly below the slag fill placed by BSC since 1937.

The sequence of sediments identified during the shoreline investigation was typified by the presence of three main material units as described in logs for borings P-26 to P-32 included in Appendix A. In the order of sequence from the surface downward these units included:

Sediment Unit #1: Slag Fill (15 to 24 feet thick)

Sediment Unit #2: Mixed Silts and Sands (6 to 13 feet thick)

Sediment Unit #3: Silty Clay (Native till/ Lacustrine sediments) (17+ feet thick)

The dredge spoils placed offshore of BSC between 1936 and 1948 would be expected to consist of silty and sandy sediments similar to those described at other nearby dredge spoil containment areas (EEI 1996 and Koszalka et. al. 1983). Therefore, the presence of dredge spoils should correlate with Unit #2 which was found directly below the slag fill in the shoreline borings.

To confirm the presence of dredge spoils in the shoreline borings, a detailed examination was performed of soil core samples obtained at boring locations P-31 and P-32. Historical information on the placement of dredge spoils in the vicinity of these borings indicated that the thickness of the dredge spoil sediments should be between 5 and 15 feet thick and should occur at a depth of around 18 feet beneath the current shoreline surface (see Figure 2). The boring logs for P-31 and P-32 show that the silt and sand unit was intercepted at a depth of approximately 20 feet (allowing for load consolidation of the dredge spoils) in conformance with the historical data. Furthermore, the thickness of the silt and sand unit at these locations varied between 10 and 14 feet thick within the reported range measured by the 1936 and later 1948 soundings of the dredge spoil surface.

Detailed examination of the core samples in the internal of suspect dredge spoil (i.e., 20.0 to 34.0' in boring P-31 and 20.0' to 30.0' in boring P-32), confirmed the presence of disturbed sediments within this interval (see photographs of sediment cores in Appendix C). Indications of sediment disturbance included variable sediment texture, a mottled matrix and, contorted to massively bedded structure. Other indicators of sediment reworking included the presence of wood fibers and fragments, leaf matter, angular rock fragments and, the occasional occurrence of coal and glass fragments within the sediment matrix.

2.4 Soil Analytical Data

2.4.1 Data Quality Assurance

Soil samples from the Lakeshore sampling program were sent to the Severn Trent Laboratories in Pittsburgh, PA to be analyzed by United States Environmental Protection Agency

(USEPA) Methods 8260B (site-specific volatiles), 8270C (site-specific semi-volatiles and tentatively identified compounds), 6010B/ 7471A (site-specific metals) and general chemistry parameters. The samples were also scanned for several select aniline compounds in the 8270C analysis. Chain-of-custody records were maintained and accompanied the samples to the laboratory.

All analyses were validated independently for usability and completeness under the supervision of a URS quality assurance/ quality control (QA/QC) manager. The data were reviewed for compliance with specified analytical methods in accordance with USEPA Region II Standard Operating Procedures for the Validation of Organic Data acquired using SW-846 SOP numbers HW-24 (June 1999), HW-22 (April 1995) and HW-2 (January 1992).

The data assessment summaries and validation summary tables are provided in Appendix D, which also contains data flagged with validation qualifiers and references to data usability.

2.4.2 Summary of Analytical Results

Soil samples were obtained from the silt and sand unit from borings P-25 (20-22'), P-28 (25-28'), P-29 (18-20'), P-30 (28-30'), P-31 (28-30') and P-32 (23-24' and 24-28'). Samples were analyzed for BSC parameter list compounds Table 1, select compounds detected at other dredge soil areas, and for the 30 most prominent tentatively identified compounds (TICs). Results of the chemical analysis identified the presence of 23 organic compounds, 13 metals and 34 TICs. The organic compounds includes the fuel related BTEX (benzene, toluene, ethylbenzene, and xylene) compounds, volatile semi-volatiles and heavier molecular weight PAH's, chlorinated benzenes and phenolic compounds. Heavy metals and cyanide were detected in the inorganic fraction. Table 2 summarizes the chemical constituents detected in the respective shoreline sediment samples.

It should be noted that many of the compounds detected in the samples analyzed for this investigation were also detected in dredge spoil samples taken from the other containment areas that similarly received sediments from the Buffalo River, Buffalo Harbor, and the Black Rock Channel (Table 2). The source of these compounds has been associated with BSC and other documented contaminated industrial sites in the area that have contributed similar compounds to the local dredge spoils (see Figure 3). Chemical compounds not associated with BSC operations, but identified in sediments from the Buffalo River and Buffalo Harbor, were also detected in the shoreline sediments (Table 2- list of TIC compounds).

Of particular note are the aromatic amine compounds (Michlers Base and other undefined amines) that have been found in Buffalo River sediments and are associated with the manufacture of dyestuffs at the Buffalo Color Plant (Nelson and Nites 1980). Chemicals associated with dye stuffs including Michlers Base and aniline, have been continuously produced at this facility for more than 110 years. Prior to 1971, process water containing these chemicals were discharged to the Buffalo River where the sediments were periodically dredged and disposed of offshore in Lake Erie. Dyestuff chemicals have also been identified in sediments found at local dredge spoil containment sites (Table 2).

3.0 SUMMARY AND CONCLUSIONS

In the fall of 2000, BSC conducted an investigation of the shoreline area of its Lackawanna, New York facility. As part of this investigation eight boring locations were drilled to characterize the underlying sediments and to assess the presence of dredge spoils. Historical information indicated that dredge spoils taken from the Buffalo Harbor and Buffalo River by the Federal government, had been placed in two dumping grounds offshore of the BSC facility. The spoil materials were subsequently covered during the westward extension of the shoreline as a result of BSC's advancement of the slag fill area into Lake Erie.

During the investigation, samples of the sediment beneath the slag fill, within the zone of suspected dredge spoil placement, were obtained for chemical analysis. Results of this analysis indicated the presence of chemicals associated with BSC, as well as other contaminated industrial sites documented in the area. Observation of drill cores taken in the vicinity of historical soundings of the dredge spoils between 1936 and 1948, found that the thickness and depth of the mixed silts and sands, which were encountered beneath the slag, correlated with the historical placement information. Detailed examination of sediment cores from this interval confirmed the presence of dredge spoils which contained evidence of prior disturbance.

In conclusion, the results of this investigation have confirmed the occurrence of dredge spoils beneath the slag fill near the current Lake Erie shoreline. The dredge spoil sediments from the Buffalo Harbor area have been characterized as grossly polluted and, consequently have been deemed to be unacceptable for release into the open waters of Lake Erie (USACE 1983). The presence of chemicals in dredge sediments analyzed for this study, which are similar to chemicals detected in the Buffalo River and Buffalo Harbor, as well as in dredge sediments from other area disposal sites, further indicates that dredge sediments contaminated by numerous industrial sources were imported and placed along the BSC shoreline and are now buried beneath the slag fill. As a result, the potential impact of BSC's slag disposal operations on groundwater quality of the sand unit in this portion of the Lackawanna facility, can not be ascertained with certainty. Furthermore, the presence the of dredge spoils, which contain regulated compounds, contributes to environmental concerns at the site.

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Malcolm Pirnie, Inc., 1989, Remedial Investigation Report- Buffalo Color, Prepared for: Buffalo Color, (Sites 120-122) Corporation, April.

Engineering Science, Inc., 1989, Phase II Investigation at the MacNaughton Brooks site, (Site 138) Prepared for: NYSDEC Division of Hazardous Water Remediation, August.

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EA Science and Technology, 1988, Phase II Investigation of the Trifft Farm Site, (Site 206) Prepared for NYSDEC Division of Hazardous Waste Remediation, April.

RECRA Environmental, Inc., 1990, Phase II Investigation at the Donner-Hanna Coke Company, City of Buffalo, (Site 217) Prepared for: New York State Department of Environmental Conservation, July.

Podica Environmental Inc., 1997, Chemical Analysis at Buffalo Harbor Confined Disposal Facility #4, (Site 254) Prepared for: USACE, December.

TABLE 1

SITE-SPECIFIC HAZARDOUS CONSTITUENTS AND INDICATOR PARAMETERS
BETHLEHEM STEEL CORPORATION LACKAWANNA, NY FACILITY

PARAMETER		
Volatile Organic Compounds	**Semivolatile Organic Compounds**	**Metals**
Acrylonitrile	Acenaphthylene	Antimony
Benzene*	Anthracene	Arsenic
Bromochloromethane	Benzo(a)Anthracene	Barium
Bromodichloromethane	Benzo(a)Pyrene	Cadmium
Bromoform	Butyl benzyl phthalate	Calcium
Bromomethane	4-Chloro-3-Methylphenol	Chromium*
Carbon tetrachloride	bis (2-Chloroethyl)ether	Lead*
Chlorobenzene	2-Chloronaphthalene	Magnesium
Chloroethane	Chrysene	Mercury
2-Chloroethyl vinyl ether	1,2-Dichlorobenzene	Nickel
Chloroform	1,3-Dichlorobenzene	Potassium
Chloromethane	1,4-Dichlorobenzene	Selenium
Dibromochloromethane	Di-n-butyl phthalate	Silver
Dichlorodifluoromethane	Di-n-octyl phthalate	Sodium
1,1-Dichloroethane	2,4-Dichlorophenol	Thallium
1,2-Dichloroethane	Diethyl phthalate	
1,1-Dichloroethene	Dimethyl phthalate	
trans-1,2-Dichloroethene	2,4-Dimethylphenol	**Indicator Parameters**
1,2-Dichloropropane	4,6-Dinitro-2-Methylphenol	Alkalinity (CaCO3 to pH 4.5)
cis-1,3-Dichloropropene	2,4-Dinitrotoluene	Alkalinity Total
trans-1,3-Dichloropropene	2,6-Dinitrotoluene	Chloride
Ethylbenzene	bis(2-Ethylhexyl)Phthalate	Cyanide
Methylene chloride	Fluoranthene	Sulfate
1,1,1,2-Tetrachloroethane	Fluorene	Total Organic Carbon
1,1,2,2-Tetrachloroethane	Hexachlorobenzene	Total Dissolved Solids
Tetrachloroethene	Hexachlorobutadiene	Total Organic Halogens
Toluene	Hexachlorocyclopentadiene	Total Recoverable Phenolics
1,1,1-Trichloroethane	Hexachloroethane	
1,1,2-Trichloroethane	Isophorone	
Trichloroethene	3-Methylphenol & 4-Methylphenol	
Trichlorofluoromethane	2-Methylphenol	
Vinyl chloride	Naphthalene*	
Xylenes, Total	Pentachlorophenol	
	Phenanthrene	
	Phenol	
	Pyrene	
	Pyridine	
	2,3,4,6-Tetrachlorophenol	
	1,2,4-Trichlorobenzene	
	2,4,5-Trichlorophenol	
	2,4,6-Trichlorophenol	

Notes:

* Benzene, chromium, lead, naphthalene, and phenolic compounds represent hazardous metals and organic compounds that are generally prevalent in iron and steel industry wastes and which have been found at varying levels during previous groundwater monitoring studies at the Lackawanna site. These pollutants were also selected by EPA for regulation under 40 CFR 420 (EPA's effluent limitations specific for the iron and steel manufacturing point source category) and cover each major family of hazardous constituents—chromium and lead for metals; benzenes for volatile organics; naphthalene for base/neutral semi-volatile organics; and phenolics for acid extractable semi-volatile organics.

TABLE 2
SUMMARY OF DETECTED COMPOUNDS IN SHORELINE SOIL SAMPLES
BETHLEHEM STEEL CORPORATION, LACKAWANA, NEW YORK

LOCATION ID			P-25	P-28	P-29	P-30	P-31	P-32	P-32	Area Sites Reporting Similar Compounds (Refer to Figure 3)	
MATRIX			SO	SO	SO	SO	SO	SO	SO	Site Source Number [c]	Dredge Sediment [b] and Spoil Disposal Site [c]
DEPTH INTERVAL (ft.)			20.0-22.0	25.0-28.0	18.0-20.0	28.0-30.0	28.0-30.0	23.0-24.0	24.0-28.0		
DATE SAMPLED			10/6/00	10/10/00	10/11/00	10/12/00	10/23/00	10/23/00	10/23/00		
PARAMETER	CAS NO.	UNITS									
*BSC Volatile Organic Compounds											
Benzene	71-43-2	UG/KG	6.1 U	370 U	3.5 J	310 U	NA	NA	300 J	1, 2, 3, 4, 120-122, 135, 138, 196, 203, 206, 217, 249	241, 253, 254
Chlorobenzene	108-90-7	UG/KG	6.1 U	370 U	5.8 U	310 U	NA	NA	990	2, 3, 4, 120-122, 254, 196,	241, 253, 254
Ethylbenzene	100-41-4	UG/KG	6.1 U	370 U	5.8 U	310 U	NA	NA	410 J	1, 2, 3, 4, 120-122, 135, 138, 141, 148, 217	241, 253
Toluene	108-88-3	UG/KG	6.1 U	370 U	3.1 J	310 U	NA	NA	390 J	1, 2, 3, 4, 120, 122, 135, 138, 141, 196, 217, 249	241, 253, 254
m-Xylene & p-Xylene	95-47-6	UG/KG	5.3 J	140 J	1.8 J	310 U	NA	NA	1500	1, 2, 3, 4, 120-122, 135, 138, 217	
o-Xylene	136777-61-2	UG/KG	2.8 J	190 U	1.4 J	150 U	NA	NA	740	1, 2, 3, 4, 120-122, 135, 138, 217, 249	241, 253, 254
*BSC Semivolatile Organic Compounds											
Acenaphthylene	208-96-8	UG/KG	2200 J	13000 J	920	750 J	130 J	29 J	2000 J	1, 2, 3, 4, 120-122, 135, 138, 141, 203, 217, 249	254
Anthracene	120-12-7	UG/KG	3300 J	16000 J	1700	5500	800 J	88 J	14000	1, 2, 3, 4, 120-122, 135, 141, 217, 249	241
Benzo(a)anthracene	56-55-3	UG/KG	3200 J	13000 J	3100 J	4000 J	600 J	160 J	7900 J	1, 2, 3, 4, 120-122, 135, 138, 141, 203, 206, 217, 249	241, b
Benzo(a)pyrene	50-32-8	UG/KG	2500 J	11000 J	3200	2600 J	410 J	130 J	5600 J	1, 2, 3, 4, 120-122, 135, 138, 141, 203, 206, 217, 249	241
bis(2-Ethylhexyl) phthalate	117-81-7	UG/KG	4900 U	20000 U	870 U	4300 U	R	55 J	8600 U	1, 138, 203, 249	241, 254
Chrysene	218-01-9	UG/KG	3800 J	12000 J	3100 J	3600 J	710 J	150 J	7500 J	1, 2, 3, 4, 120-122, 135, 138, 141, 196, 203, 206, 217, 249	241, b
1,2-Dichlorobenzene	95-50-1	UG/KG	4900 U	20000 U	870 U	4300 U	440 J	R	1900 J	3, 4, 120-122, 196, 217	241, 254
1,4-Dichlorobenzene	106-46-7	UG/KG	4900 U	20000 U	870 U	4300 U	150 J	R	8600 U	3, 4, 120-122, 196	241, 254
2,4-Dimethylphenol	105-67-9	UG/KG	4900 U	20000 U	870 U	4300 U	28 J	R	8600 U	2, 120-122, 135, 217, 249	241
Fluoranthene	206-44-0	UG/KG	9100	33000	7400	10000	2000 J	300 J	26000	1, 2, 3, 4, 120-122, 135, 138, 141, 203, 206, 217, 249	241, 254
Fluorene	86-73-7	UG/KG	2900 J	24000	1300	4600	700 J	40 J	11000	1, 2, 3, 4, 120-122, 135, 138, 141, 203, 217, 249	
2-Methylphenol	95-48-7	UG/KG	4900 U	20000 U	62 J	4300 U	R	R	8600 U	2, 217, 249	
Naphthalene	91-20-3	UG/KG	19000	140000	3300	750 J	2000 J	130 J	48000	1, 2, 3, 4, 120-122, 126, 135, 138, 141, 196, 203, 217, 249	241, 254
Phenanthrene	85-01-8	UG/KG	12000	62000	5200	15000	2200 J	250 J	38000	1, 2, 3, 4, 120-122, 135, 138, 141, 203, 206, 217, 249	241, 254
Phenol	108-95-2	UG/KG	450 J	20000 U	74 J	4300 U	120 J	R	8600 U	2, 4, 135, 138, 148, 217, 249	
Pyrene	129-00-0	UG/KG	6400	25000	3500 J	6300	1000 J	230 J	13000	1, 2, 3, 4, 120-122, 135, 138, 141, 203, 206, 217, 249	241, b
1,2,4-Trichlorobenzene	120-82-1	UG/KG	4900 U	20000 U	870 U	4300 U	78 J	R	8600 U	120-122, 135	
*BSC Metals											
Antimony	7740-36-0	MG/KG	8.2 J	5.4 J	4.3 J	1.5 J	NA	NA	5.4 BJ	1, 3, 4, 120-122, 138, 196, 206, 217	241, 253
Arsenic	7740-38-2	MG/KG	28.8	31.6	23.8	10.6	NA	NA	28.1	1, 3, 4, 120-122, 135, 138, 148, 196, 206, 217, 220	241, 253, 254, b
Barium	7740-39-3	MG/KG	88.5	108	89.1	69	NA	NA	109	1, 3, 4, 135, 138, 148, 206, 217	241, 253, 254, b
Cadmium	7740-43-9	MG/KG	8.3 J	2.7	2.5	1.5	NA	NA	4.1	1, 3, 4, 120-122, 135, 138, 148, 190, 196, 206, 217, 220	241, 253, 254
Calcium	7740-70-2	MG/KG	43200	59000	47300	17600	NA	NA	30400	1, 135, 138, 206, 217, 254	
Chromium	7740-47-3	MG/KG	213	158	137	72.3	NA	NA	71.4	1, 3, 4, 120-122, 126, 135, 138, 147, 148, 190, 196, 203, 206, 217, 220, 249	241, 253, 254, b
Lead	7439-92-1	MG/KG	418	159	141	134	NA	NA	235	1, 3, 4, 120-122, 135, 138, 141, 147, 148, 190, 196, 206, 217, 220	241, 253, 254, b
Magnesium	7439-95-4	MG/KG	7900	11500 J	10500 J	7490 J	NA	NA	4650 J	1, 135, 138, 206, 217	254
Mercury	7439-97-6	MG/KG	0.19	0.47	0.44	1.6	NA	NA	2.4	3, 4, 120-122, 135, 138, 206, 217	241, 253, b
Nickel	7440-02-0	MG/KG	109 J	50.4	42.4	27.9	NA	NA	17.8	1, 3, 4, 120-122, 135, 138, 190, 196, 206, 217, 220	241, 253, b
Potassium	7440-09-7	MG/KG	1040	1010	873	605 B	NA	NA	561 B	1, 135, 138, 206, 217	
Silver	7440-22-4	MG/KG	1.4	1.4	0.95	0.44 B	NA	NA	1.8	1, 3, 4, 120-122, 135, 138, 206, 217	
Sodium	7440-23-5	MG/KG	305 B	288 B	266 B	88.7 B	NA	NA	147 B	1, 135, 138, 206, 217	254
*BSC General Chemistry Parameters											
Cyanide	57-12-5	MG/KG	1.6	1.6	2.2	0.94	NA	NA	2.1	1, 2, 3, 4, 135, 206, 217	
Total Recoverable Phenolics	--	MG/KG	0.59	0.23	0.073	0.084	NA	NA	0.065	3, 4, 206	
Chloride	--	MG/L	9.9	13.6	33.1	6.2	NA	NA	184		
Sulfate	--	MG/L	5.0 U	5.0 U	7.6	5.0 U	NA	NA	5.0 U	126, 217	
Total Organic Carbon	--	MG/KG	10900	21300	10800	20400	NA	NA	30700	2	

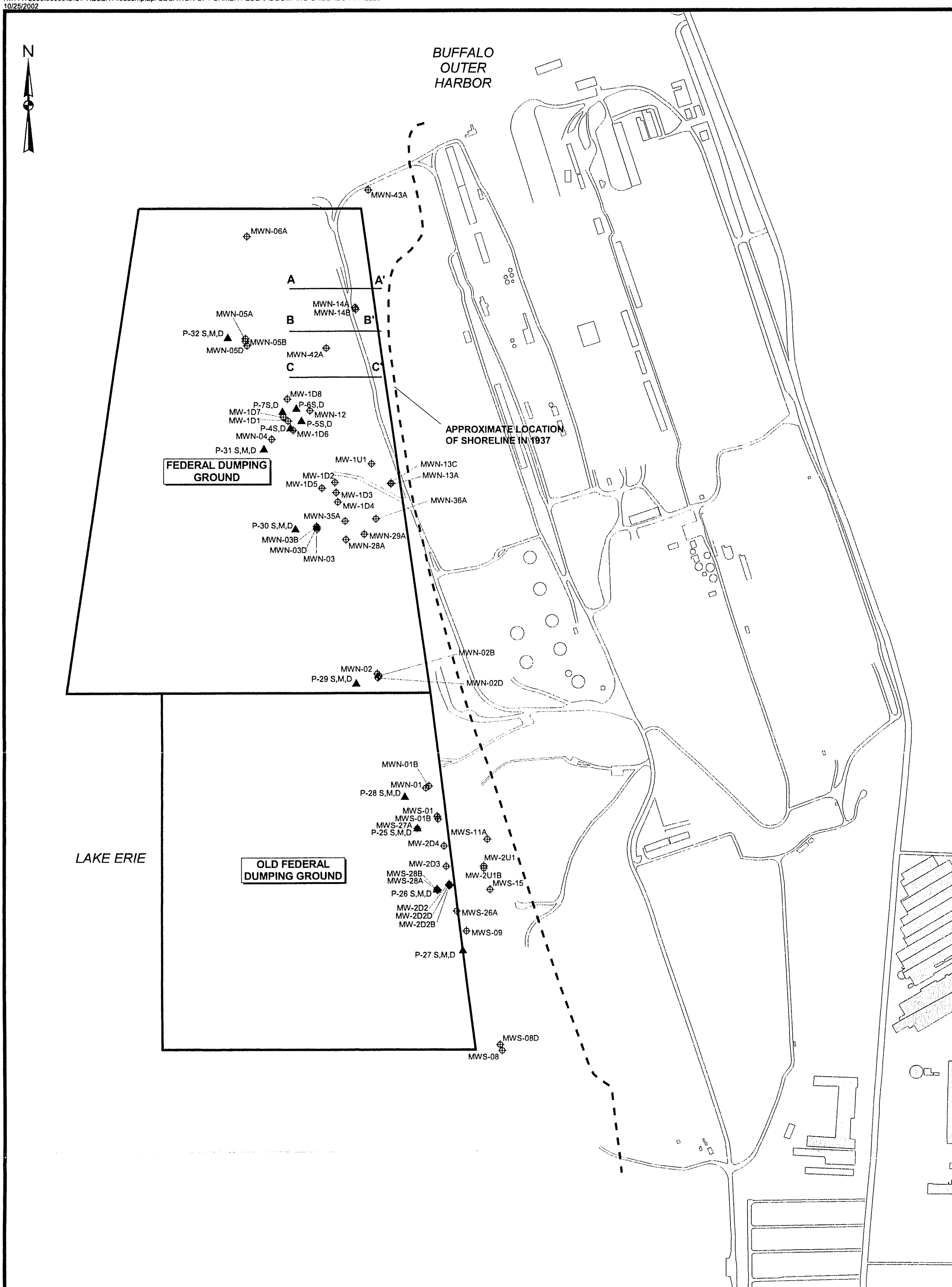
TABLE 2
SUMMARY OF DETECTED COMPOUNDS IN SHORELINE SOIL SAMPLES
BETHLEHEM STEEL CORPORATION, LACKAWANA, NEW YORK

LOCATION ID			P-25	P-28	P-29	P-30	P-31	P-32	P-32	Area Sites Reporting Similar Compounds (Refer to Figure 3)	
MATRIX			SO	SO	SO	SO	SO	SO	SO	Site Source Number [c]	Dredge Sediment [b] and Spoil Disposal Site [c]
DEPTH INTERVAL (ft.)			20.0-22.0	25.0-28.0	18.0-20.0	28.0-30.0	28.0-30.0	23.0-24.0	24.0-28.0		
DATE SAMPLED			10/6/00	10/10/00	10/11/00	10/12/00	10/23/00	10/23/00	10/23/00		
PARAMETER	CAS NO.	UNITS									
Tentatively Identified Compounds - Semivolatiles											
Dibenz(a,h)Anthracene	53-70-3	UG/KG	NI	NI	700 NJ	820 NJ	55 J	NI	NI	2, 120-122, 135, 138, 203, 217, 249	
n-Hexadecanoic acid	57-10-3	UG/KG	3900 R	NI	NI	NI	NI	NI	NI	217	
Aniline	62-53-3	UG/KG	NI	NI	NI	NI	160 J	NI	NI	120-122	241
Acenaphthene	83-32-9	UG/KG	NI	14000 JN	810 NJ	4000 NJ	470 J	28 J	6800 NJ	2, 3, 4, 120-122, 135, 138, 203, 217, 249	
N-Nitrosodiphenylamine	86-30-6	UG/KG	NI	NI	NI	NI	170 J	NI	NI	120-122, 206, 249	253
Carbazole	86-74-8	UG/KG	620 NJ	8200 NJ	2100 NJ	1400 NJ	230 J	NI	NI	135, 249	
Naphthalene, 1-methyl-	90-12-0	UG/KG	1200 NJ	2000 NJ	390 NJ	2200 NJ	NI	NI	2100 NJ		
Naphthalene, 2-methyl-	91-57-6	UG/KG	2200 NJ	4400 NJ	480 NJ	3900 NJ	680 J	NI	2400 NJ	2, 3, 4, 120-122, 135, 138, 141, 203, 217, 249	
Biphenyl	92-52-4	UG/KG	NI	5300 NJ	NI	NI	NI	NI	NI		
Ethylbenzylaniline (Benzenemethanamine, N-ethyl-N-phenyl-)	92-59-1	UG/KG	NI	NI	NI	5300 NJ	NI	NI	8700 NJ		
4,4'-Methylenebis(N,N-dimethylbenzenamine), common name - Michler's Base	101-61-1	UG/KG	NI	NI	NI	1300 NJ	NI	NI	NI	a	241
Dibenzofuran	132-64-9	UG/KG	1200 NJ	15000 NJ	710 NJ	2500 NJ	320 J	NI	NI	1, 2, 3, 4, 135, 138, 203, 217, 249	b
Benzo(ghi)perylene	191-24-2	UG/KG	2400 NJ	8400 NJ	950 NJ	1300 NJ	110 J	60 J	NI	2, 3, 4, 120-122, 135, 138, 141, 206, 217, 249	b
Indeno(1,2,3-cd)pyrene	193-39-5	UG/KG	1100 NJ	8700 NJ	1700 NJ	1400 NJ	130 J	62 J	NI	1, 2, 3, 4, 120-122, 135, 138, 203, 217, 249	b
Benzo(b)Fluoranthene	205-99-2	UG/KG	1200 NJ	9200 NJ	5300 NJ	2000 NJ	NI	97 J	NI	2, 3, 4, 120-122, 135, 138, 141, 203, 206, 217, 249	241, b
Benzo(k)Fluoranthene	207-08-9	UG/KG	NI	10000 NJ	7400 NJ	2300 NJ	650 J	130 J	3800 NJ	2, 3, 4, 120-122, 135, 138, 141, 203, 206, 217, 249	241, b
11H-Benzo[b]fluorene	243-17-4	UG/KG	NI	NI	220 NJ	NI	NI	NI	NI		
Naphthalene, 1,5-dimethyl-	571-91-9	UG/KG	NI	NI	NI	2300 NJ	NI	NI	NI		
Naphthalene, 2,6-dimethyl-	581-42-0	UG/KG	NI	NI	NI	2000 NJ	NI	NI	NI		
Benzenamine, 4,4',4"-methylidynetris[N,N-dimethyl	603-48-5	UG/KG	NI	NI	NI	NI	NI	NI	6700 NJ		
Hexadecane, 2,6,10,14-tetramethyl-	638-36-8	UG/KG	8700 NJ	NI	NI	NI	NI	NI	NI		
Naphthalene, 1-ethyl-	1127-76-0	UG/KG	NI	NI	NI	2400 NJ	NI	NI	NI		
Benzene, 1,1'-(1-butenylidene)bis-	1726-14-3	UG/KG	4200 NJ	NI	NI	NI	NI	NI	NI		
Pentadecane, 2,6,10,14-tetramethyl-	1921-70-6	UG/KG	NI	NI	1200 NJ	NI	NI	NI	NI		
Cyclic octaatomic sulfur	10544-50-0	UG/KG	3700 NJ	NI	NI	NI	NI	180 NJ	NI		
Benzene, 2,4-dimethyl-1-(phenylmethyl)-	28122-28-3	UG/KG	23000 NJ	NI	NI	NI	NI	NI	NI		
Unknown	--	UG/KG	6500 J	7600 J	2900 J	4000 J	1900 J	NI	12000 J		
Unknown Alkane	--	UG/KG	NI	17000 J	5700 J	NI	1200 J	NI	20000 J		
Unknown Branched Alkane	--	UG/KG	NI	NI	1500 J	6000 J	1800 J	NI	31000 J		
Unknown Cycloalkane	--	UG/KG	4400 J	5300 J	NI	2000 J	NI	NI	2300 J		
Unknown Organic Acid	--	UG/KG	NI	NI	160 J	NI	NI	140 J	NI		
Unknown PAH	--	UG/KG	4100 J	7000 J	3300 J	2900 J	330 J	NI	NI		
Unknown Straight Chain Alkane	--	UG/KG	7600 J	NI	2300 J	3800 J	NI	NI	NI		
Unknown Substituted Benzene	--	UG/KG	6500 J	7900 J	NI	NI	1200 J	NI	NI		
Unknown Substituted Naphthalene	--	UG/KG	29000 J	15000 J	NI	4900 J	640 J	NI	NI		

Notes: * BSC - These compounds are part of the site specific list of hazardous constituents and indicator parameters for the Bethlehem Steel Corporation's Lackawanna facility and are routinely analyzed for at this facility.
a - Aromatic Amines in and Near the Buffalo River, ACS Volume 14, Number 9, September 1980, Charles R. Nelson and Ronald A. Hites
b - Analytical Test Locations in the Buffalo River and Harbor (EEI Report, 1996)
c - Site Number as identified in *Preliminary Evaluation of Chemical Migration to Groundwater and the Niagara River from Selected Waste-Disposal Sites* USGS, 1983, E.J. Koszalka, J.E. Paschal, Jr., T.S. Miller, and P.B. Duran.

Data Qualifiers: B - The concentration is below the contract required detection limit but greater than the instrument detection limit.
J - The associated numerical value is an estimation.
NA - Not analyzed
NI - Not identified as a tentatively identified compound in the sample.
NJ - The analyte has been tentatively identified. The associated numerical value is an estimation.
R - Results were rejected. The presence or absence of the analyte cannot be verified.
U - The analyte was not detected.

N:\11172630.0000...\PRESENT\feddump.apr LOCATION OF FORMER FEDERAL DUMPING GROUNDS W/WELLS
10/25/2002



Legend

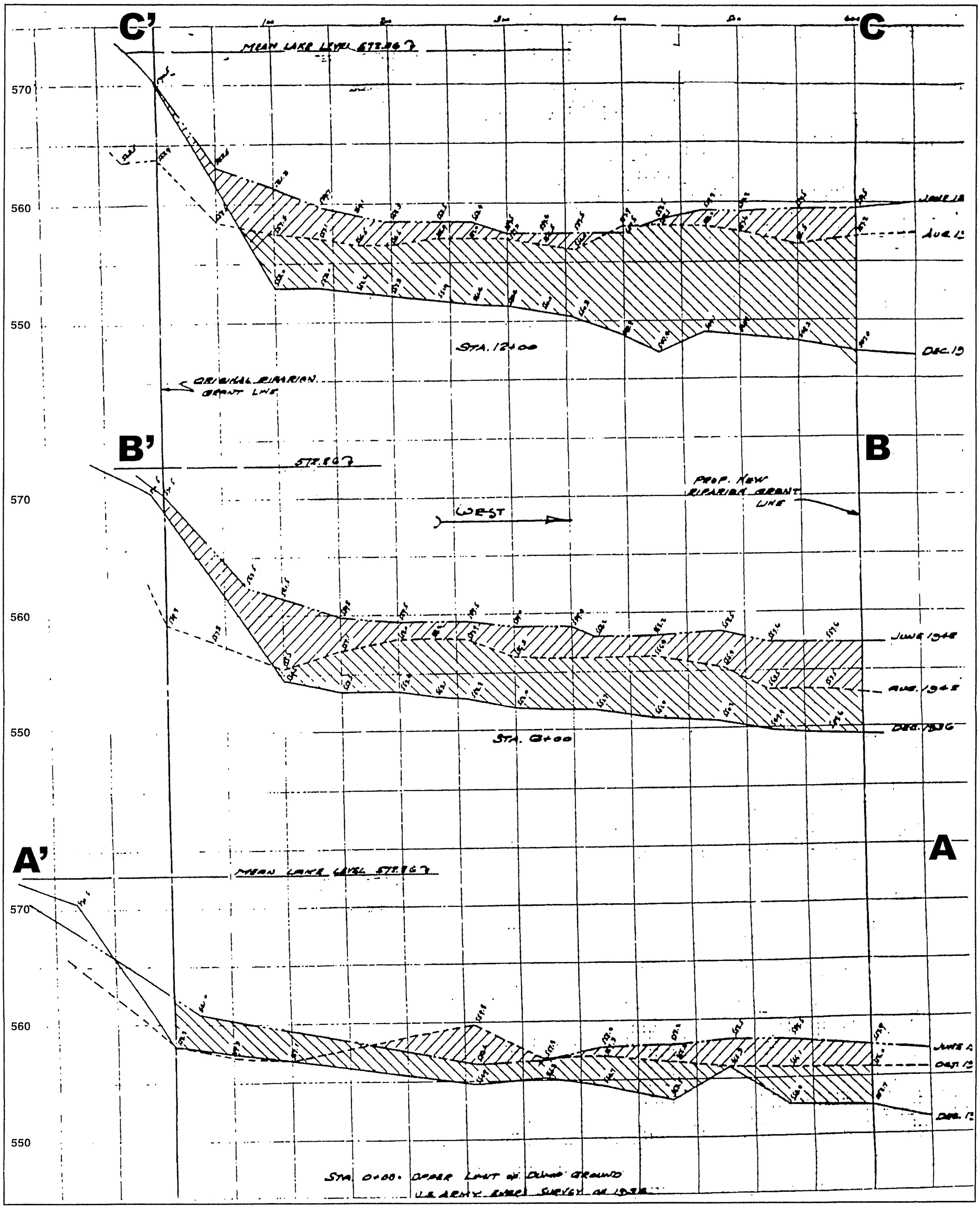
- ⊕ Shoreline Area Monitoring Well
- ▲ Shoreline Investigation Piezometer
- A___A' Dump Ground Cross Section (See Figure 2 for Cross Sectional View)

SOURCE FEDERAL DUMPING GROUNDS:
Buffalo Harbor Dumping Ground Drawing,
U.S. Army Corps of Engineers, April 24, 1937

1000 0 1000 Feet

URS	BETHLEHEM STEEL CORPORATION - LACKAWANNA, NEW YORK LOCATION OF FORMER FEDERAL DUMPING GROUNDS AND OTHER SITE FEATURES	FIGURE 1

ORIGINAL IN COLOR



Source: *February 2nd, 1949 Memorandum - Riparian Grant, W.E. Durell*

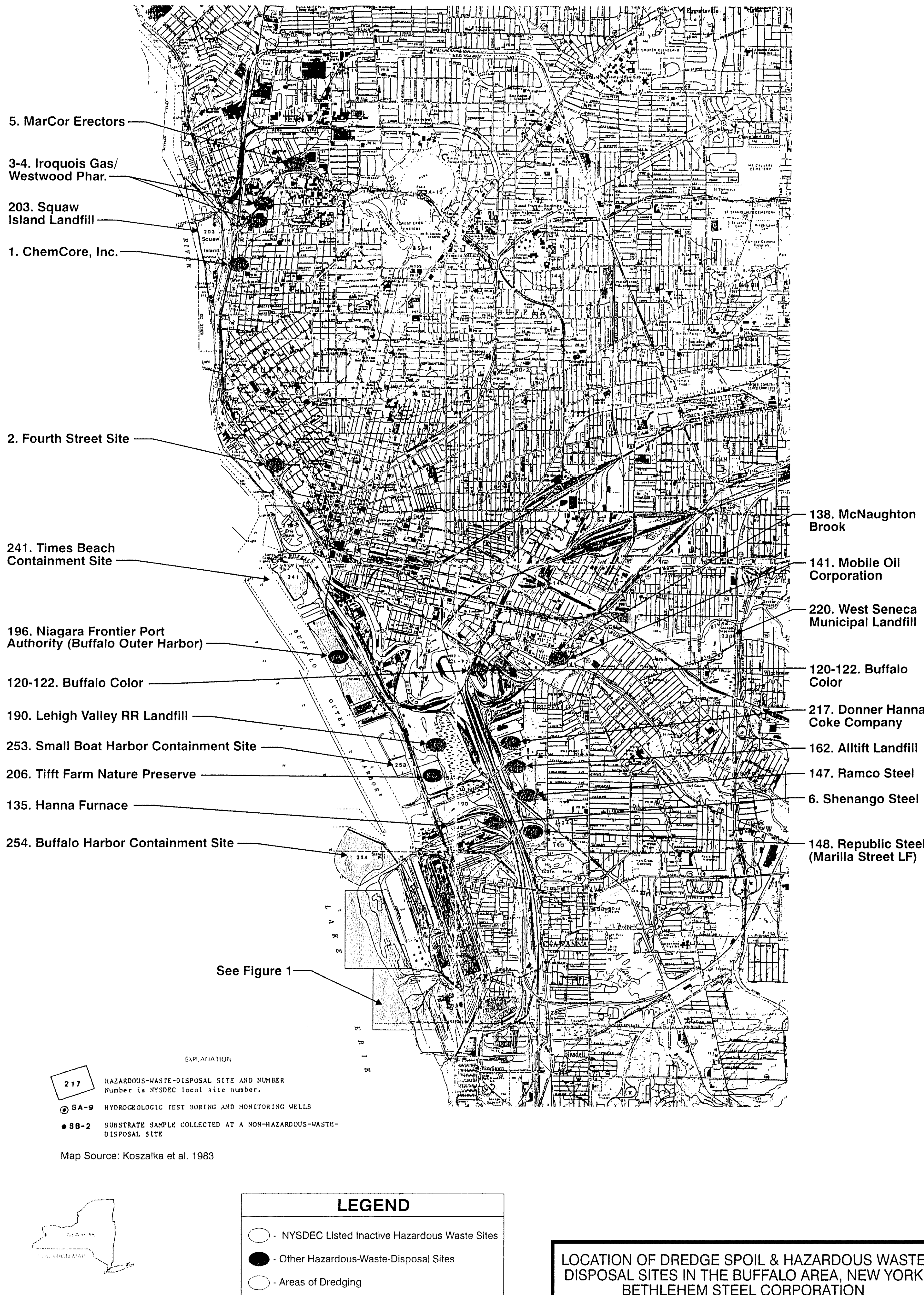
Dredge Spoil Disposal December 1936 to August 1943

Dredge Spoil Disposal August 1943 to June 1948

URS

BETHLEHEM STEEL CORPORATION, LACKAWANNA, NEW YORK
CROSS SECTION THROUGH
DREDGE SPOIL AREA

FIGURE 2



LOCATION OF DREDGE SPOIL & HAZARDOUS WASTE DISPOSAL SITES IN THE BUFFALO AREA, NEW YORK
BETHLEHEM STEEL CORPORATION
LACKAWANNA, NEW YORK

URS

FIGURE 3

ORIGINAL IN COLOR

APPENDIX A

BORING LOGS AND
PIEZOMETER CONSTRUCTION DIAGRAMS

URS Corporation	TEST BORING LOG
	BORING NO: P-25 S/M/D
PROJECT: Shoreline Drilling	SHEET: 1 of 1
CLIENT: Bethlehem Steel Corp.	JOB NO.: 4200008BSC.15
BORING CONTRACTOR: SJB Services Inc	BORING LOCATION: 200' S of Smokes Creek

GROUNDWATER:					CAS.	SAMPLER	CORE	TUBE	GROUND ELEVATION:	576.65
DATE	TIME	LEVEL	TYPE	TYPE		Split spoon			DATE STARTED:	09/28/00
10/2/00	16:38	4.35	Static	DIA.		2"			DATE FINISHED:	09/29/00
				WT.		140#			DRILLER:	A. Koske
				FALL		30"			GEOLOGIST:	J. Christy/ J. Doerr
	.			* POCKET PENETROMETER READING					REVIEWED BY:	J. Boyd

DEPTH FEET	STRATA	SAMPLE NO.	TYPE	BLOWS PER 6"		REC% ROD%	COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	PID	Moist
		1	SS	1	19	65%	Dark Gray	Dense	0.0-15.2: FILL; Slag, Fine to coarse sand and fine to coarse gravel, consisting of reworked, rounded to well rounded grains of slag, some silt, trace wood, plastic, metal.	SW	0.0	Moist
				23	34							
		2	SS	21	22	80%					0.0	
				16	29							
5		3	SS	14	32	50%		Very Dense			0.0	
				22	23							
		4	SS	50/3		35%	Gray				0.0	Wet @ 7.75'
		5	SS	50/2		10%					0.0	
10												
		6	SS	9	25	70%	Mottled Black / Gray		Slight odor, particles becoming more angular, less rounded		0.0	
				28	33							
		7	SS	24	50	100%					0.0	
				25	50							
15		8	SS	12	24	100%	Dark Gray to Black-Green	Dense			0.6	
				25	50/4				15.2-22.6 :SILTY FINE SAND; uniform, grain size, poorly sorted, compact, friable. Slight odor.	SM		
		9	SS	11	12	65%		Medium Dense			0.8	
				12	6							
		10	SS	3	4	70%		Loose			0.7	
20				4	4							
		11	SS	WoH	WoH	75%		Very Loose			50.0	
				1/12								
		12	SS	3	4	100%					0.0	
				2	2		Dusky Red/ Dark Gray		22.6-32.5: Interbedded CLAYEY SILTS to SILTY CLAYS with SILTY fine SAND to fine to medium SAND. Beds 3"-6" thick, uniform grain size within beds (beds poorly sorted) strong odor, sheen , NAPL in coarser beds.	ML/SM		
25		13	SS	WoH	1	10%		Very Soft			1.6	
				1	2							
		14	SS	1	2	100%		Soft			0.0	
				2	10							
		15	SS	1/12		80%		Very Soft			0.0	
30				1/12								
		16	SS	WoH	WoH	75%					0.0	
				WoH	4							
		17	SS	13	14	50%	Medium Gray	Hard	32.5-36.0: TILL; Silty Clay, some sand, and fine to coarse angular to subrounded gravel, slight purple cast	ML	0.0	
				21	21							
35		18	SS	8	10	10%					0.0	
				50/3					End of Boring @ 36' BGS			

Comments: Boring advanced with a fully tracked Nodwell ATV mounted CME 75 using 8-1/4 inch HSAs. Sampling accomplished with a 2-inch or 3-inch split barrel sampler. WoH = Weight of Hammer. Sample collected 20'-22' BGS.	PROJECT NO. 4200008BSC.15
	BORING NO. P-25 S/M/D

URS Corporation

TEST BORING LOG

BORING NO:	P-26 S/M/D
SHEET:	1 of 1
JOB NO.:	4200008BSC.15
BORING LOCATION:	400' S of Smokes Creek
GROUND ELEVATION:	577.75
DATE STARTED:	10/02/00
DATE FINISHED:	10/02/00
DRILLER:	A. Koske
GEOLOGIST:	J. Christy/ J. Doerr
REVIEWED BY:	J. Boyd

PROJECT: Shoreline Drilling
CLIENT: Bethlehem Steel Corp.
BORING CONTRACTOR: SJB Services Inc

GROUNDWATER:					CAS.	SAMPLER	CORE	TUBE
DATE	TIME	LEVEL	TYPE	TYPE		Split spoon		
				DIA.		2"		
				WT.		140#		
				FALL		30"		

* POCKET PENETROMETER READING

DEPTH FEET	STRATA	NO.	TYPE	BLOWS PER 6"		REC% ROD%	COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	PID	Moist
		1	SS	2	3	45%	Black-Brown	Medium Dense	0.0-19.5: FILL; Slag, Fine to coarse sand and fine to coarse gravel, consisting of reworked, rounded to well rounded grains of slag, some silt, trace glass, plastic, metal.	SW	0.0	Moist
				17	18							
		2	SS	28	12	100%		Dense			0.0	
				24	13							
5		3	SS	8	50/5	25%		Very Dense			0.0	
		4	SS	21	22	75%	Gray Brown	Dense			0.0	Wet @ 6'
				18	20							
		5	SS	25	43	85%	Black-Brown	Very Dense			0.0	
10				38	40							
		6	SS	8	11	85%		Medium Dense			0.0	
				12	19							
		7	SS	24	24	100%		Dense			0.0	
				25	22		Red					
15		8	SS	9	18	100%	Black-Brown				0.4	
				15	14							
		9	SS	8	8	100%	Green to Dark Gray				0.0	
				30	50/5							
		10	SS	19	21	100%					0.0	Dry
20				22	24		Dark Gray		19.5-27.5: SILT and SAND; graded beds, 4"-12" thick of medium to coarse sand, fine to medium sand, fine silty sand, and silt. Strong odor, sheen Trace clay, trace angular gravel.	SM/ML		
		11	SS	4	5	80%		Loose			0.0	Wet
				1	2							
		12	SS	2	2	100%					0.0	
				3	10							
25		13	SS	WoH	1	80%		Very Loose			0.0	
				2	1							
		14	SS	2	7	50%		Medium Dense			0.0	
				8	2		Gray	Soft	27.5-31.5: TILL; Silty Clay, some sand, and fine to coarse angular to subrounded, gravel. Till is satrurated	ML		
		15	SS	1/12		25%					0.0	
30				2	2							
		16	SS	1	1	50%			Clay, some calcareous shale		0.0	
				2	50/5				fragments. Typical Wanakah Shale			Dry
		17	SS	50/1		25%		Spoon Refusal	End boring at 32' BGS at top of rock.			
35												

Comments: Boring advanced with a fully tracked Nodwell ATV mounted CME 75 using 8-1/4 inch HSAs. Sampling accomplished with a 2-inch or 3-inch split barrel sampler. WoH = Weight of Hammer.

PROJECT NO.	4200008BSC.15
BORING NO.	P-26 S/M/D

URS Corporation

TEST BORING LOG

BORING NO:	P-27 S/M/D
SHEET:	1 of 1
JOB NO.:	4200008BSC.15
BORING LOCATION:	Approx 1600' S of Smokes Ck.
GROUND ELEVATION:	577.80
DATE STARTED:	10/02/00
DATE FINISHED:	10/02/00
DRILLER:	A. Koske
GEOLOGIST:	J. Christy
REVIEWED BY:	J. Boyd

PROJECT: Shoreline Drilling
CLIENT: Bethlehem Steel Corp.
BORING CONTRACTOR: SJB Services Inc

GROUNDWATER:

DATE	TIME	LEVEL	TYPE
11-00		5.5	Static

TYPE	CAS.	SAMPLER	CORE	TUBE
TYPE		Split spoon		
DIA.		2"		
WT.		140#		
FALL		30"		

* POCKET PENETROMETER READING

DEPTH FEET	SAMPLE NO.	TYPE	BLOWS PER 6"	REC% ROD%	COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	PID	Moist
	1	SS	2, 7, 21, 20	50%	Dark Brown	Medium Dense	0.0-21: FILL; Slag, Fine to coarse sand and fine to coarse gravel, consisting of reworked, rounded to well rounded grains of slag, some silt, trace glass, plastic, metal.	SW	0.0	Dry
	2	SS	25, 45, 37, 35	75%	Light Brown	Very Dense			0.0	
5	3	SS	10, 25, 15, 16	75%					0.0	
	4	SS	33, 20, 21, 24	75%	Olive Gray	Dense			0.0	Wet @ 8'
10	5	SS	8, 13, 16, 12	75%					1.9	
	6	SS	8, 8, 33, 34	50%					3.9	
	7	SS	33, 37, 40, 50/4	100%	Gray Green	Very Dense			3.0	
15	8	SS	1, 50/4	25%					4.8	
	9	SS	13, 22, 46, 50/2	100%					4.4	Moist
20	10	SS	15, 50/5	50%					2.8	Wet
	11	SS	7, 36, 25, 26	100%					NA	
	12	SS	18, 25, 28, 25	25%	Olive Gray		21.0-28.0: SILT and SAND; graded beds, 4"-12" thick of medium to coarse sand, fine to medium sand, fine silty sand, and silt.	SM/ML	3.3	
25	13	SS	3, 18, 26, 11	75%		Dense			2.1	
	14	SS	3, 3, 2, 11	75%		Loose			2.0	
30	15	SS	WoH, 3, 10, 14	25%	Brown	Stiff to Hard	28.0-32.0: TILL; Silty Clay, some sand, and fine to coarse angular to subrounded, gravel. Till is saturated Clay, some calcareous shale	ML	0.0	
	16	SS	2, 12, 50/4	50%					0.0	Dry
35							Terminated boring 32' BGS			

Comments: Boring advanced with a fully tracked Nodwell ATV mounted CME 75 using 4-1/4 inch HSA. Sampling accomplished with a 2-inch split barrel sampler.

PROJECT NO. 4200008BSC.15
BORING NO. P-27 S/M/D

URS Corporation

TEST BORING LOG

BORING NO.:	P-28 S/M/D
SHEET:	1 of 2
JOB NO.:	4200008BSC.15
BORING LOCATION:	Approx 75'N of Smokes Ck
GROUND ELEVATION:	576.78
DATE STARTED:	10/09/00
DATE FINISHED:	10/10/00
DRILLER:	A. Koske
GEOLOGIST:	J. Christy
REVIEWED BY:	J. Boyd

PROJECT: Shoreline Drilling
CLIENT: Bethlehem Steel Corp.
BORING CONTRACTOR: SJB Services Inc

GROUNDWATER:

DATE	TIME	LEVEL	TYPE
11-00		4.41	static

	CAS.	SAMPLER	CORE	TUBE
TYPE		Split spoon		
DIA.		2"		
WT.		140#		
FALL		30"		

* POCKET PENETROMETER READING

DEPTH FEET	STRATA	NO.	TYPE	BLOWS PER 6"	REC% ROD%	COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	PID	Moist
		1	SS	2 6 / 5 8	10%	Brown	Medium Dense	0.0-20: FILL; Slag, Fine to coarse sand and fine to coarse gravel, consisting of reworked, angular to rounded slag fragments, some silt, trace clay.	SW	--	Moist
		2	SS	12 12 / 24 28	75%	Brown	Dense			0.2	
5		3	SS	6 52 / 50/2 --	75%	Red	Very Dense			1.0	Dry
		4	SS	50/4 -- / -- --	25%	Olive Gray				1.0	Wet @ 6'
10		5	SS	6 50/3 / -- --	25%	Gray				0.2	
		6	SS	21 50/2 / -- --	25%					--	
		7	SS	15 55 / 50/3 --	50%	Dark Gray				0.8	
15		8	SS	16 22 / 37 50/4	100%	Black				--	
		9	SS	4 5 / 17 18	75%		Medium Dense			2.0	
20		10	SS	8 5 / 3 9	75%		Loose	*Note log detailed beyond this point.*		2.0	
21		11	SS	2 4 / 3 5	30%	Olive Gray Brown		21.3-21.4 Fine SAND, silt and clay (plastic)	SM/ML	5.0	
22								21.4-21.7: F-m Sandy Silt, trace clay; 21.8-21.85: Clay lense; 21.85-22.0:AA coarsening down to sandy silt. Sheen, odor and green product			
23		12	SS	7 5 / 5 4	25%			22-23.3: Fining down to SILT; 23.3-23.7: f-m sand, silt, trace clay		5.0	
24								23.7-24.6: f-sandy silt, and clay, sheen odor. Green lenses of coarser material			
25		13	SS	1 3 / 3 8	80%			24.6-25.2: Clayey silt		9.0	
26							Medium Dense	25.2-26.0: Layers of f-c sandy silt, f-c gravel (subrounded), and silt clay with f-sand, trace gravel.			
27		14	SS	35 17 / 9 7	25%					--	
28								26-28: F-m SAND, silt, trace clay			

Comments: Boring advanced with a fully tracked Nodwell ATV mounted CME 75 using 4-1/4 inch HSA. Sampling accomplished with a 2-inch split barrel sampler. Analytical sample collected 25' to 28' BGS, VOCs 25'-27' BGS.

PROJECT NO. 4200008BSC.15
BORING NO. P-28 S/M/D

URS Corporation	TEST BORING LOG
	BORING NO: P-28 S/M/D
PROJECT: Shoreline Drilling	SHEET: 2 of 2
CLIENT: Bethlehem Steel Corp.	JOB NO.: 4200008BSC.15
BORING CONTRACTOR: SJB Services Inc	BORING LOCATION: Approx 75'N of Smokes Ck

DEPTH FEET	SAMPLE: STRATA	NO.	TYPE	BLOWS PER 6"		REC% ROD%	DESCRIPTION: COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	REMARKS: PID	Moist
		15	SS	2	8	100%	Olive	Stiff	28.0-34.0: TILL; Silty Clay, some	ML	1.2	Wet
30				9	23		Grey	to	sand, and fine to coarse subangular	↓		↓
		16	SS	6	6	50%	Brown	Very	to subrounded gravel.		0.0	
32				5	6			Stiff	clay, some calcareous shale			
		17	SS	6	6	75%	AA with				0.0	
34				3	4		red					

Terminated boring at 34' bgs

Comments: Boring advanced with a fully tracked Nodwell ATV mounted CME 75	PROJECT NO. 4200008BSC.15
using 4-1/4 inch HSA. Sampling accomplished with a 2-inch split barrel sampler.	BORING NO. P-28 S/M/D
Analytical sample collected 25' to 28' BGS, VOCs 25'-27' BGS.	

URS Corporation

TEST BORING LOG

BORING NO:	P-29 S/M/D
SHEET:	1 of 1
JOB NO.:	4200008BSC.15
BORING LOCATION:	Approx 1400' N of Smokes Ck
GROUND ELEVATION:	575.78
DATE STARTED:	10/11/00
DATE FINISHED:	10/12/00
DRILLER:	A. Koske
GEOLOGIST:	J. Christy
REVIEWED BY:	J. Boyd

PROJECT: Shoreline Drilling
CLIENT: Bethlehem Steel Corp.
BORING CONTRACTOR: SJB Services Inc

GROUNDWATER:					CAS.	SAMPLER	CORE	TUBE
DATE	TIME	LEVEL	TYPE	TYPE		Split spoon		
11-00		3.97	Static	DIA.		2"		
				WT.		140#		
				FALL		30"		
				* POCKET PENETROMETER READING				

DEPTH FEET	STRATA	SAMPLE NO.	TYPE	BLOWS PER 6"	REC% ROD%	COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	PID	Moist
	Fill	1	SS	1, 5, 50/1	25%	Medium Brown	Very Dense	0.0-18: FILL; Slag, Fine to coarse sand and fine to coarse gravel, consisting of reworked, subangular to rounded slag fragments	SW	--	Moist
		2	SS	50/1	0%					--	Wet @ 4'
5		3	SS	55, 43, 50/3	40%					--	
		4	SS	14, 15, 21, 11	75%		Dense			1.0	
10		5	SS	7, 9, 17, 7	25%		Medium Dense			1.0	
		6	SS	10, 7, 5, 9	25%					--	
		7	SS	7, 8, 7, 3	50%					1.0	
15		8	SS	13, 16, 50/4	40%	Green	Very Dense			1.0	Dry
		9	SS	50/3	25%					2.0	
20	Silt and sand	10	SS	33, 27, 57, 50/1	100%	Olive Gray		18.0-24.0: SILT and SAND; graded beds of medium to coarse sand, fine to medium sand, fine silty sand, fine silty sand, and silt. Slight sheen and odor detected.	SM/ML	3.0	
		11	SS	34, 50/4	50%	Dark Brown				2.0	Moist
		12	SS	50/4	25%	Black				2.0	
25	Till	13	SS	8, 7, 4, 4	50%	Light Brown	Medium Stiff to Stiff	24.0-30.0: TILL; Silty Clay, some sand, and fine to coarse angular to subrounded gravel. Till is saturated clay, some calcareous shale	ML	1.0	
		14	SS	3, 3, 4, 7	100%					1.0	
30		15	SS	1, 4, 3, 3	50%					--	Wet
35								Terminated boring at 30' bgs			

Comments: Boring advanced with a fully tracked Nodwell ATV mounted CME 75 using 4-1/4 inch HSA. Sampling accomplished with a 2-inch split barrel sampler. Analytical sample collected 18'to 20' BGS.

PROJECT NO. 4200008BSC.15
BORING NO. P-29 S/M/D

URS Corporation

TEST BORING LOG

BORING NO.:	P-30 S/M/D
SHEET:	1 of 2
JOB NO.:	4200008BSC.15
BORING LOCATION:	Aprox 3000' N of Smokes Ck
GROUND ELEVATION:	574.66
DATE STARTED:	10/12/00
DATE FINISHED:	10/13/00
DRILLER:	A. Koske
GEOLOGIST:	J. Christy
REVIEWED BY:	J. Boyd

PROJECT:	Shoreline Drilling
CLIENT:	Bethlehem Steel Corp.
BORING CONTRACTOR:	SJB Services Inc

GROUNDWATER:

DATE	TIME	LEVEL	TYPE
11-00		3.18	Static

TYPE	CAS.	SAMPLER	CORE	TUBE
TYPE		Split spoon		
DIA.		2"		
WT.		140#		
FALL		30"		

* POCKET PENETROMETER READING

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6"	REC% ROD%	COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	PID	Moist
		1	SS	7, 13, 12, 12	50%	Medium Brown	Medium Dense	0.0-22.0: FILL; Slag, Fine to coarse sand and fine to coarse gravel, consisting of reworked, subangular slag fragments, some silt.	SW	0.2	Moist
		2	SS	20, 15, 48, 38	75%	Gray Black	Very Dense			0.5	
5		3	SS	14, 50, 37, 47	75%	Brown				1.0	Wet@ 5'
		4	SS	20, 18, 24, 15	75%		Dense			2.0	
10		5	SS	16, 7, 5, 6	50%		Medium Dense			1.8	
		6	SS	10, 3, 4, 6	25%		Loose			1.0	
		7	SS	8, 5, 6, 15	50%	Gray	Medium Dense			0.8	
15		8	SS	7, 44, 48, 50/3	100%	Gray Green	Very Dense			0.4	Moist
		9	SS	20, 45, 50/4	100%					1.0	
20		10	SS	25, 50/1	25%					--	
		11	SS	50/4	25%					0.2	
		12	SS	35, 35, 18, 14	100%	Medium Brown		22-24.0: Silty sand, trace rounded fine to coarse gravel	SM	0.9	Wet
25		13	SS	2, 2, 4, 9	100%	Red	Medium Stiff Plastic	24-26.0: Clay	CL	1.0	Moist
		14	SS	4, 4, 7, 12	100%	Medium Brown	Medium Dense	26-28.2: SILT and SAND w/ vertical red clay lenses, trace wood	ML SM	2.0	
30		15	SS	4, 8, 10, 22	100%	Black Brown	Very Stiff	28.2-29.1: Silt CLAY, odor fine silty sand, and silt lenses	ML	7.0	
		16	SS	7, 14, 17, 22	100%	Medium Brown	Medium Dense	24-37.3: SILT and SAND; graded beds of medium to coarse sand, f-m sand, fine silty sand, trace rounded f-gravel, trace clay at 33.8-34.0 feet.	SM	0.1	
		17	SS	16, 20, 48, 45	100%		Very Dense			0.2	
35		18	SS	15, 18, 14, 20	25%		Dense			0.0	

Comments: Boring advanced with a fully tracked Nodwell ATV mounted CME 75 using 4-1/4 inch HSA. Sampling accomplished with a 2-inch split barrel sampler. Analytical sample collected 28' to 30' BGS.

PROJECT NO.	4200008BSC.15
BORING NO.	P-30 S/M/D

URS Corporation

TEST BORING LOG

BORING NO:	P-30 S/M/D
SHEET:	2 of 2
JOB NO.:	4200008BSC.15

PROJECT: Shoreline Drilling

CLIENT: Bethlehem Steel Corp.

DEPTH FEET	SAMPLE: STRATA	SAMPLE: NO.	SAMPLE: TYPE	SAMPLE: BLOWS PER 6"		SAMPLE: REC% / ROD%	DESCRIPTION: COLOR	DESCRIPTION: CONSIST HARD	DESCRIPTION: MATERIAL DESCRIPTION	USCS	REMARKS: PID	REMARKS: Moist
		19	SS	10	7	100%	Brown	Medium Dense	24-37.3: SILT and Sand	SM	0.0	Moist
				12	13		↓	Medium Stiff	37.3-54: Massive SILTY CLAY			Wet
		20	SS	3	4	75%			↓	ML	0.0	↓
40				3	4					↓		
		21	SS	WoH	WoH	25%		Very Soft to Soft			0.0	
				2	1			↓				
		22	SS	3	3	100%					0.0	
				2	3							
45		23	SS	WoH	WoH	100%					0.0	
				1	2							
		24	SS	1	2	100%					0.0	
				3	3							
		25	SS	WoH	WoH	0%			48-50: No Recovery		0.0	
50				WoH	1							
		26	SS	WoH	WoH	100%					0.0	
				WoH	WoH							
		27	SS	WoH	2	100%	↓	↓	↓	↓	0.0	↓
				2	2							
55									End of Boring at 54' BGS			
60												
65												
70												
75												

Comments: Boring advanced with a truck mounted CME 85 utilizing 4-1/4 inch HSA.
Sampling accomplished using 2-inch diameter split spoon samplers.
WoH = Weight of Hammer

PROJECT NO.	4200008BSC.15
BORING NO.	P-30 S/M/D

URS Corporation

TEST BORING LOG

BORING NO:	P-31 S/M/D
SHEET:	1 of 2
JOB NO.:	4200008BSC.15
BORING LOCATION:	Aprox 4100' N of Smokes Ck
GROUND ELEVATION:	577.63
DATE STARTED:	10/16/00
DATE FINISHED:	10/017/00
DRILLER:	A. Koske
GEOLOGIST:	J. Christy
REVIEWED BY:	J. Boyd

PROJECT: Shoreline Drilling
CLIENT: Bethlehem Steel Corp.
BORING CONTRACTOR: SJB Services Inc

GROUNDWATER:					CAS.	SAMPLER	CORE	TUBE
DATE	TIME	LEVEL	TYPE	TYPE		Split spoon		
				DIA.		2"		
				WT.		140#		
				FALL		30"		
				* POCKET PENETROMETER READING				

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6"	REC% ROD%	COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	PID	Moist
		1	SS	15 44 50/4	50%	Brown/ Gray	Very Dense	0.0'-20.0': FILL;Fine to coarse sand fine to coarse rounded to angular grave, some silt. (slag)	SW	0.0	Dry
		2	SS	13 23 22 30	40%	Brown/	Dense			0.0	Moist
5		3	SS	30 21 50/4	50%		Very Dense			0.0	
		4	SS	5 12 8 3	25%	Dark Brown/	Medium Dense			0.0	Wet @ 8'
10		5	SS	11 9 10 14	50%					0.0	
		6	SS	13 9 5 3	10%					0.0	
		7	SS	6 5 4 3	0%		Loose	12-14: No Recovery		–	
15		8	SS	12 9 9 7	20%		Medium Dense			--	
		9	SS	8 3 2 2	0%		Loose	16-18: No Recovery		--	
20		10	SS	5 5 5 9	10%	Gray/ Brown				–	
		11	SS	22 30 23 15	75%		Very Dense	20.0-34.0: Interbedded fine to coarse SAND, fine sand, to sandy silt, silts and clays, trace angular to well rounded gravel (interbedded lacustrine and dredge spoil deposits) Sheen and odor, 22'-24'	SW SM ML	0.2	Dry
		12	SS	5 6 5 7	20%		Medium Dense			--	Wet
25		13	SS	4 8 7 5	75%					0.6	
		14	SS	3 4 5 10	100%		Loose			0.8	
30		15	SS	6 10 50/3	75%		Very Dense			0.8	
		16	SS	50/3	10%					1.0	
		17	SS	5 9 10 8	75%		Medium Dense			0.3	
35		18	SS	4 10 12 22	50%		Very Stiff	34.0-44.0: CLAY, massive to well laminated, some interbedded fine	CL/ ML	0.0	Moist

Comments: Boring advanced with a fully tracked Nodwell ATV mounted CME 75 using 4-1/4 inch HSA. Sampling accomplished with a 2-inch split barrel sampler.

PROJECT NO.	4200008BSC.15
BORING NO.	P-31 S/M/D

URS Corporation	TEST BORING LOG
	BORING NO: P-31 S/M/D
PROJECT: Shoreline Drilling	SHEET: 2 of 2
CLIENT: Bethlehem Steel Corp.	JOB NO.: 4200008BSC.15

DEPTH FEET	SAMPLE: STRATA	NO.	TYPE	BLOWS PER 6"		REC% ROD%	DESCRIPTION: COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	REMARKS: PID	Moist
		19	SS	4	10	90%	Gray/ Brown	Very Stiff	sands and silts. Some to trace rounded to well rounded gravel (lacustrine sediments)	CL/ ML	0.6	Wet
				11	15							
		20	SS	8	4	100%		Stiff			0.4	Moist
40				4	7							
		21	SS	1	2	100%		Medium Stiff			0.4	
				4	4							
		22	SS	1	1	100%		Soft			0.1	
				2	2							
45									End of Boring at 44' BGS.			
50												
55												
60												
65												
70												
75												

Comments: Boring advanced with a truck mounted CME 85 utilizing 4-1/4 inch HSA.	PROJECT NO. 4200008BSC.15
Sampling accomplished using 2-inch diameter split spoon samplers.	BORING NO. P-31 S/M/D
WoH = Weight of Hammer	

URS Corporation	TEST BORING LOG
	BORING NO: P-32 S/M/D
PROJECT: Shoreline Drilling	SHEET: 1 of 2
CLIENT: Bethlehem Steel Corp.	JOB NO.: 4200008BSC.15
BORING CONTRACTOR: SJB Services Inc	BORING LOCATION: Approx 5200' N of Smokes Ck.

GROUNDWATER:					CAS.	SAMPLER	CORE	TUBE	GROUND ELEVATION: 573.76
DATE	TIME	LEVEL	TYPE	TYPE		Split spoon			DATE STARTED: 10/23/00
				DIA.		2"			DATE FINISHED: 10/23/00
				WT.		140#			DRILLER: A. Koske
				FALL		30"			GEOLOGIST: J. Christy
				* POCKET PENETROMETER READING					REVIEWED BY: J. Boyd

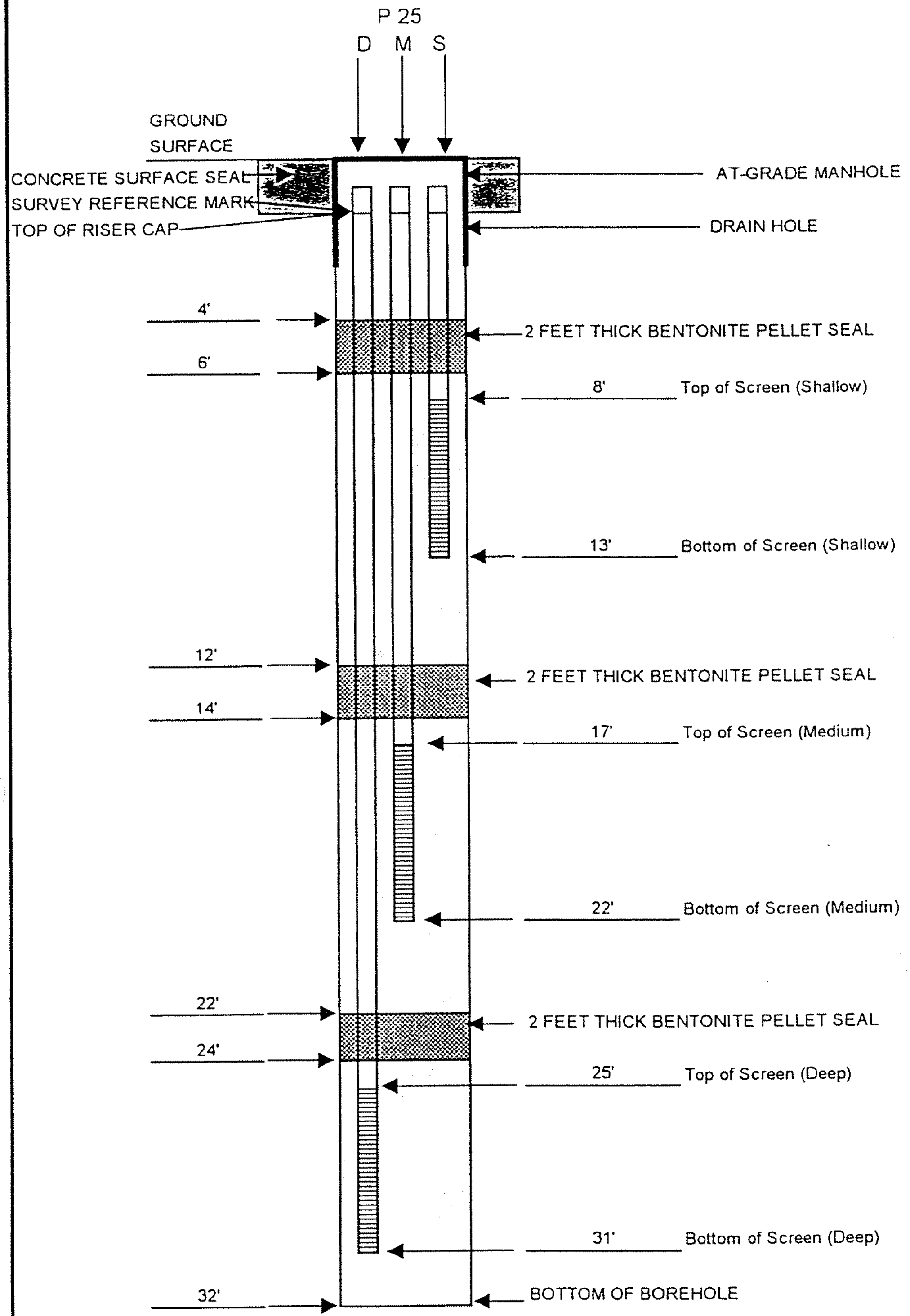
DEPTH FEET	STRATA	NO.	TYPE	BLOWS PER 6"		REC% ROD%	COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	PID	Moist
		1	SS	1	15	50%	Dark Brown	Dense	0.0-20: FILL; Slag, Fine to coarse sand and fine to coarse gravel, consisting of reworked, rounded to well rounded grains of slag, some silt, trace glass, plastic, metal.	SW	0.0	Dry
				29	18							
		2	SS	32	17	100%	Light Brown				0.1	Wet @ 4'
				16	10							
5		3	SS	9	9	<10		Medium Dense			--	
				8	7							
		4	SS	16	8	--	Olive Gray				--	
				9	11							
		5	SS	10	18	50%		Very Dense			0.1	
10				40	50/4							
		6	SS	50/3	--	10%					--	
				--	--							
		7	SS	26	50/4	25%	Gray Green				0.1	
				--	--							
15		8	SS	29	18	50%		Dense			0.1	
				27	18							
		9	SS	9	20	50%					--	
				18	16							
		10	SS	15	11	50%		Medium Dense			0.2	
20				12	16							
		11	SS	50/2	--	--		Very Dense			--	
				--	--		Olive Gray		20.0-30.0: SILT and SAND; graded beds, 4"-12" thick of medium to coarse sand, fine to medium sand, fine silty sand, and silt. (interbedded dredge spoil deposits with wood fragments and leaf matter)	SW SM ML		
		12	SS	40	15	100%		Medium Dense			5.0	
				4	5							
25		13	SS	8	10	75%					58	
				12	12							
		14	SS	7	8	50%					61	
				7	9							
		15	SS	1	3	100%	Brown				9.3	
30				7	10							
		16	SS	6	7	25%		Stiff	30.0-42.0: TILL; Silty Clay, some sand and, fine to coarse angular to subrounded gravel. Clay, some calcareous shale	ML	--	
				6	50/0							
		17	SS	20	2	<10%		Medium Stiff			--	
				3	3							
35				see pg2					see pg2			

Comments: Boring advanced with a fully tracked Nodwell ATV mounted CME 75 using 4-1/4 inch HSA. Sampling accomplished with a 2-inch split barrel sampler. Analytical sample collected 24' to 28' BGS, VOCs 26'-28' BGS.	PROJECT NO. 4200008BSC.15
	BORING NO. P-32 S/M/D

URS Corporation	TEST BORING LOG
	BORING NO: P-32 S/M/D
PROJECT: Shoreline Drilling	SHEET: 2 of 2
CLIENT: Bethlehem Steel Corp.	JOB NO.: 4200008BSC.15

DEPTH FEET	STRATA	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6"		REC% ROD%	COLOR	CONSIST HARD	MATERIAL DESCRIPTION	USCS	REMARKS PID	REMARKS Moist
35		18	SS	WoH / 1	-- / 1	75%	Brown	Soft to Very Soft	30.0-42.0: TILL; Silty Clay, some sand and, fine to coarse angular to subrounded gravel. Clay, some calcareous shale	ML	0.1	Wet
		19	SS	3 / 2	1 / 3	<10%	↓	↓	↓	↓	0.0	↓
40		20	SS	WoH / 1	1 / 2	25%	↓	↓	↓	↓	0.1	↓
		21	SS	WoH / --	-- / --	75%	↓	↓	↓	↓	0.1	↓
									Terminated boring at 42' BGS			
50												
55												
60												
65												
70												
75												

Comments: Boring advanced with a truck mounted CME 85 utilizing 4-1/4 inch HSA.	PROJECT NO. 4200008BSC.15
Sampling accomplished using 2-inch diameter split spoon samplers.	BORING NO. P-32 S/M/D
WoH = Weight of Hammer	

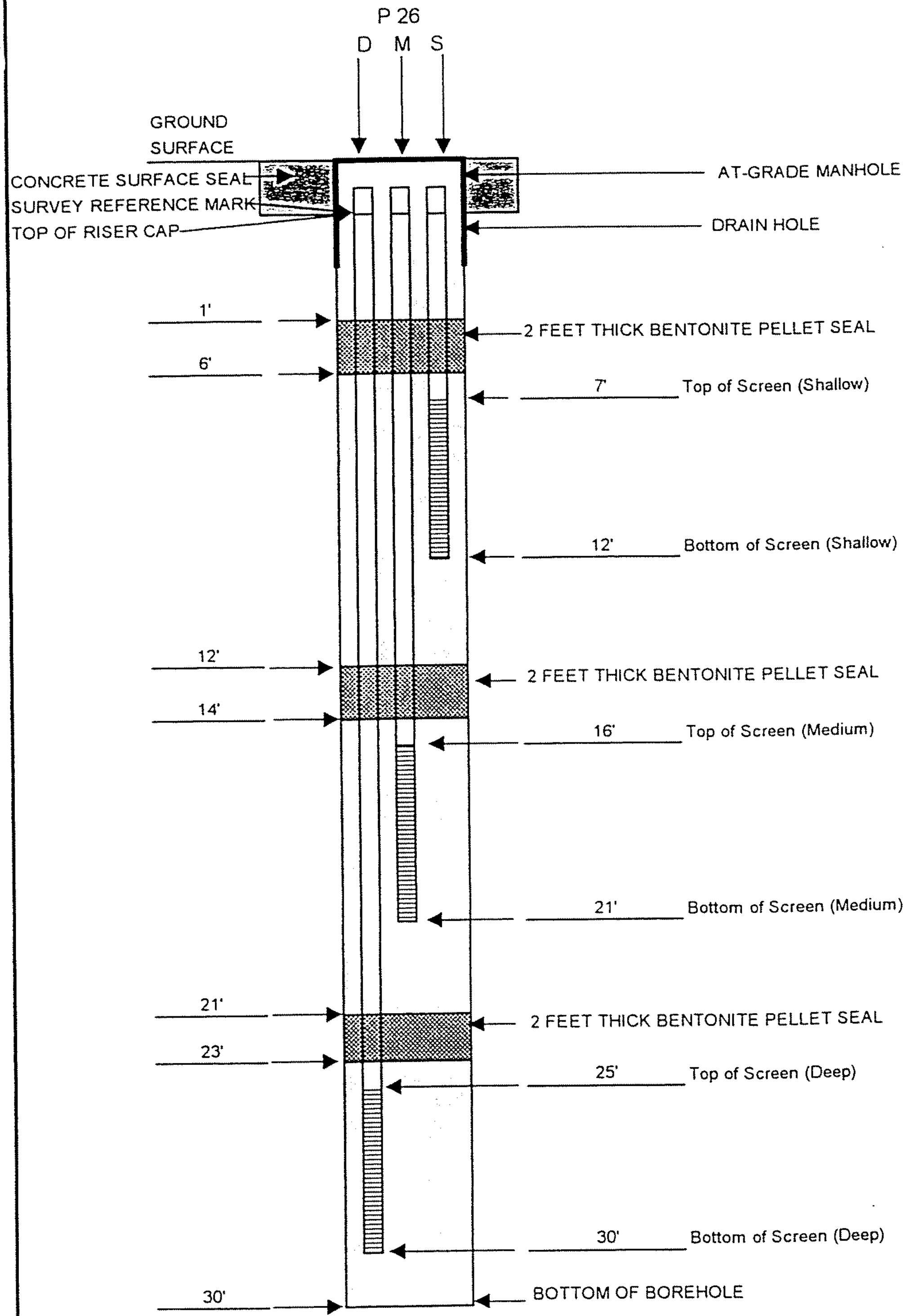


I. D. OF RISER PIPE: 3/4" ID SCHEDULE 80 PVC
TYPE OF SCREENS: 3/4" ID SCHEDULE 80 PVC
SLOT SIZE = 0.010". LENGTH = 5 FEET .
BOREHOLE DIAMETER: 6" MIN.
TYPE OF SAND PACK: No 1 Q-ROCK

BETHLEHEM STEEL CORPORATION
LACKAWANNA, NEW YORK
P 25 S/M/D

SHORELINE NESTED PIEZOMETER
COMPLETION DIAGRAM

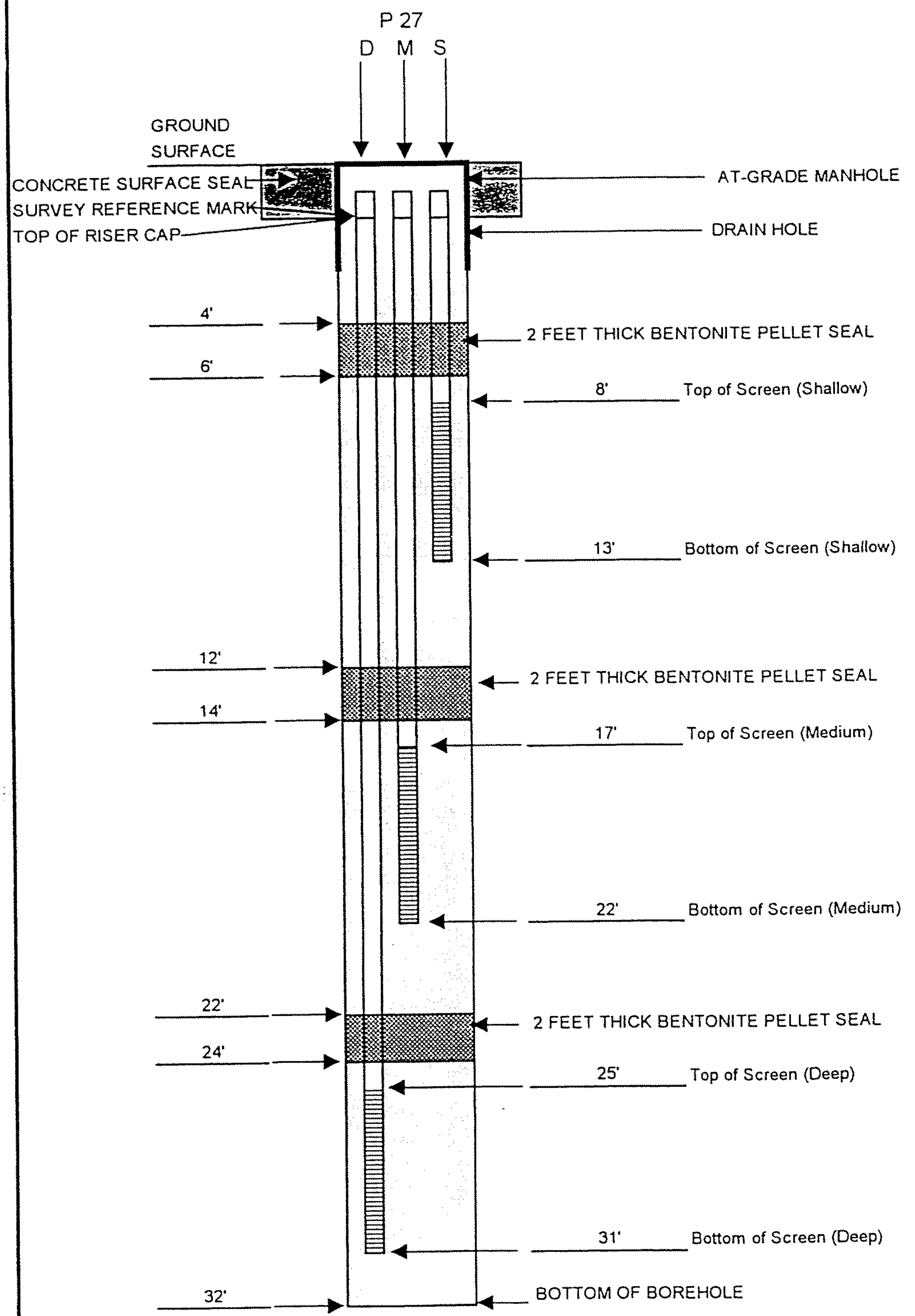
BSC piezo construction-9P 25
01/16/2001



I. D. OF RISER PIPE: 3/4" ID SCHEDULE 80 PVC
TYPE OF SCREENS: 3/4" ID SCHEDULE 80 PVC
SLOT SIZE = 0.010". LENGTH = 5 FEET .
BOREHOLE DIAMETER: 6" MIN.
TYPE OF SAND PACK: No 1 Q-ROCK

BETHLEHEM STEEL CORPORATION
LACKAWANNA, NEW YORK
P 26 S/M/D

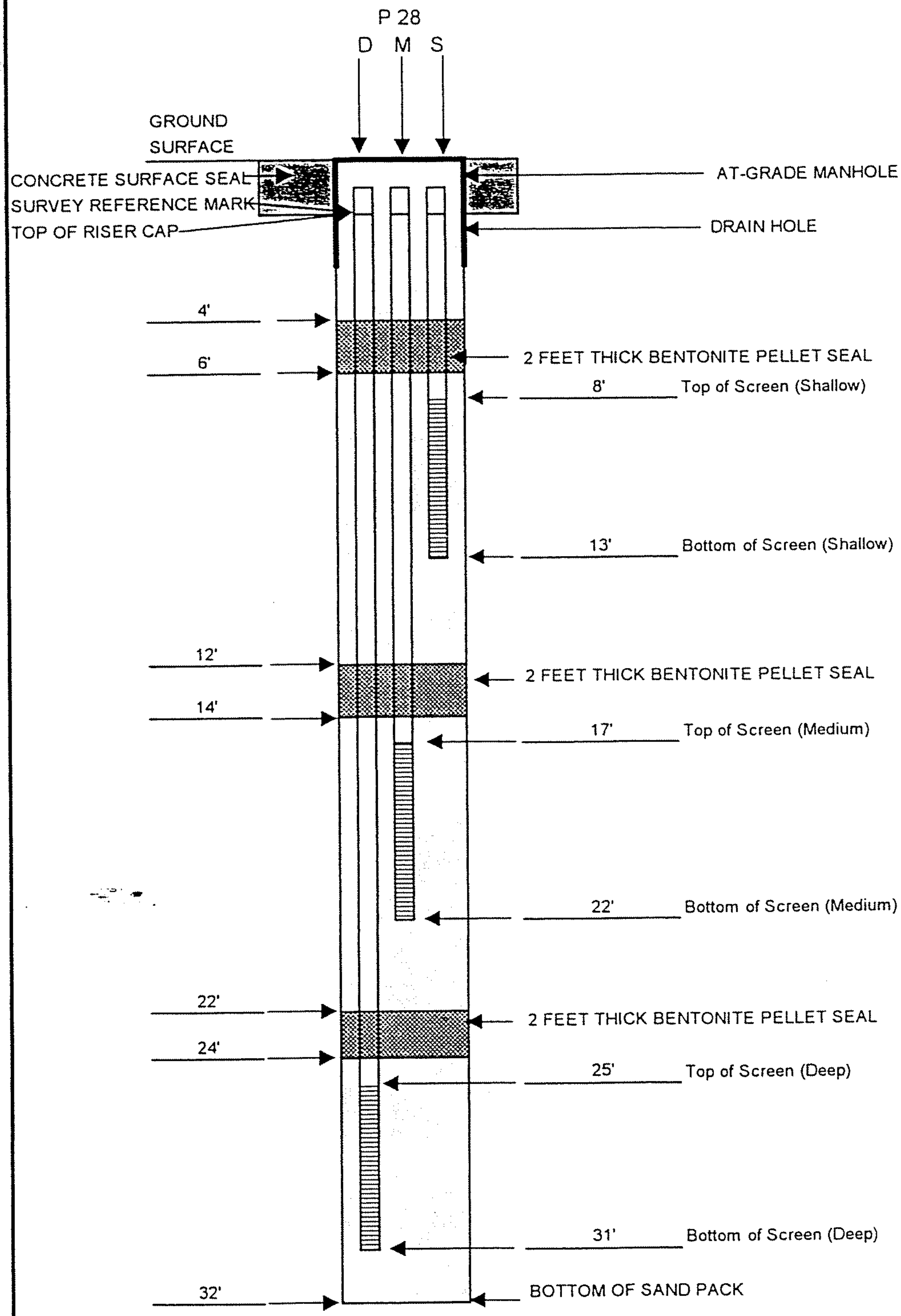
SHORELINE NESTED PIEZOMETER
COMPLETION DIAGRAM



I. D. OF RISER PIPE: 3/4" ID SCHEDULE 80 PVC
TYPE OF SCREENS: 3/4" ID SCHEDULE 80 PVC
SLOT SIZE = 0.010". LENGTH = 5 FEET .
BOREHOLE DIAMETER: 6" MIN.
TYPE OF SAND PACK: No 1 Q-ROCK

BETHLEHEM STEEL CORPORATION
LACKAWANNA, NEW YORK
P 27 S/M/D

SHORELINE NESTED PIEZOMETER
COMPLETION DIAGRAM

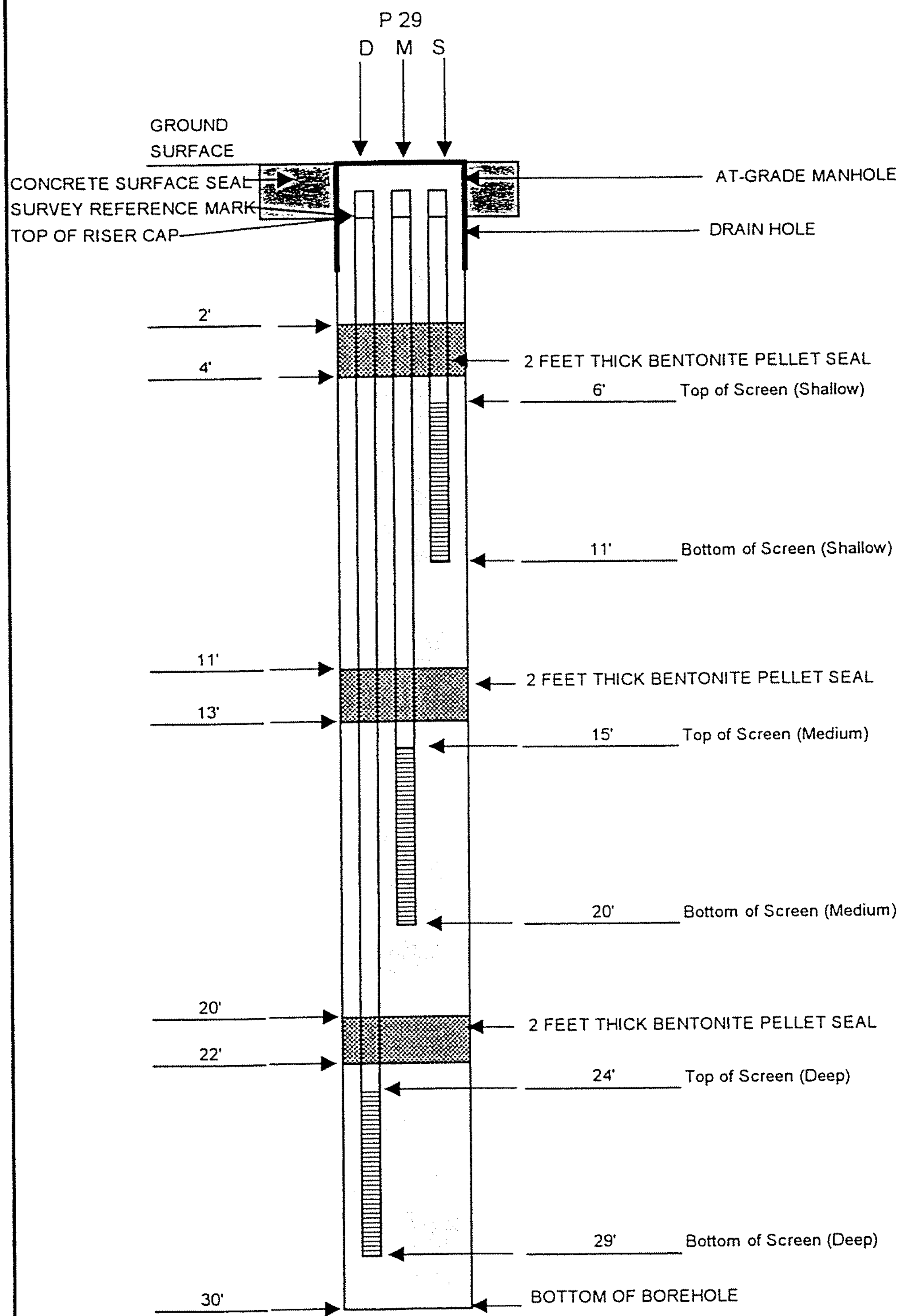


I. D. OF RISER PIPE: 3/4" ID SCHEDULE 80 PVC
TYPE OF SCREENS: 3/4" ID SCHEDULE 80 PVC
SLOT SIZE = 0.010". LENGTH = 5 FEET .
BOREHOLE DIAMETER: 6" MIN.
TYPE OF SAND PACK: No 1 Q-ROCK

BETHLEHEM STEEL CORPORATION
LACKAWANNA, NEW YORK

P 28 S/M/D

SHORELINE NESTED PIEZOMETER
COMPLETION DIAGRAM

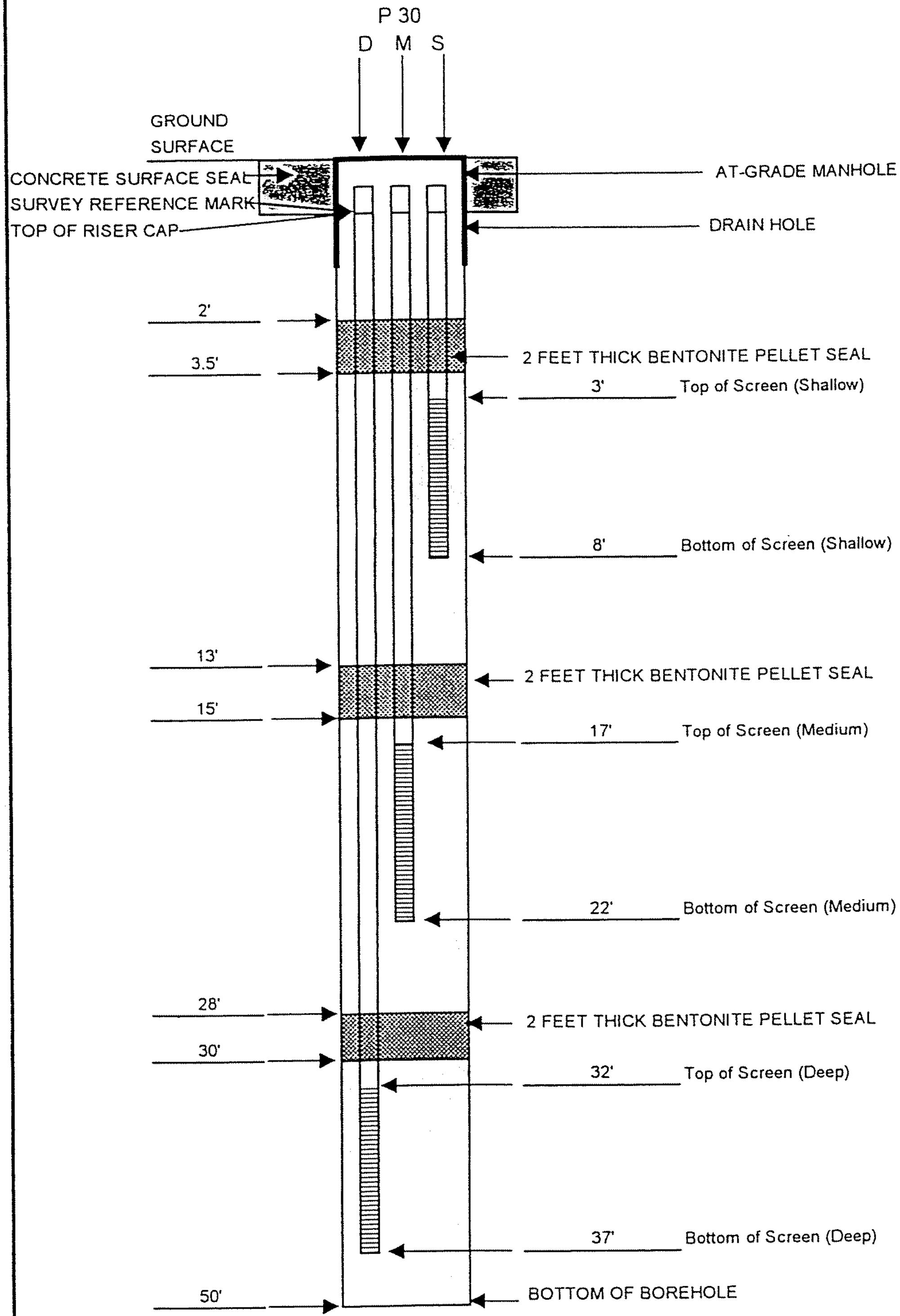


I. D. OF RISER PIPE: 3/4" ID SCHEDULE 80 PVC
TYPE OF SCREENS: 3/4" ID SCHEDULE 80 PVC
SLOT SIZE = 0.010". LENGTH = 5 FEET .
BOREHOLE DIAMETER: 6" MIN.
TYPE OF SAND PACK: No 1 Q-ROCK

BETHLEHEM STEEL CORPORATION
LACKAWANNA, NEW YORK

P 29 S/M/D

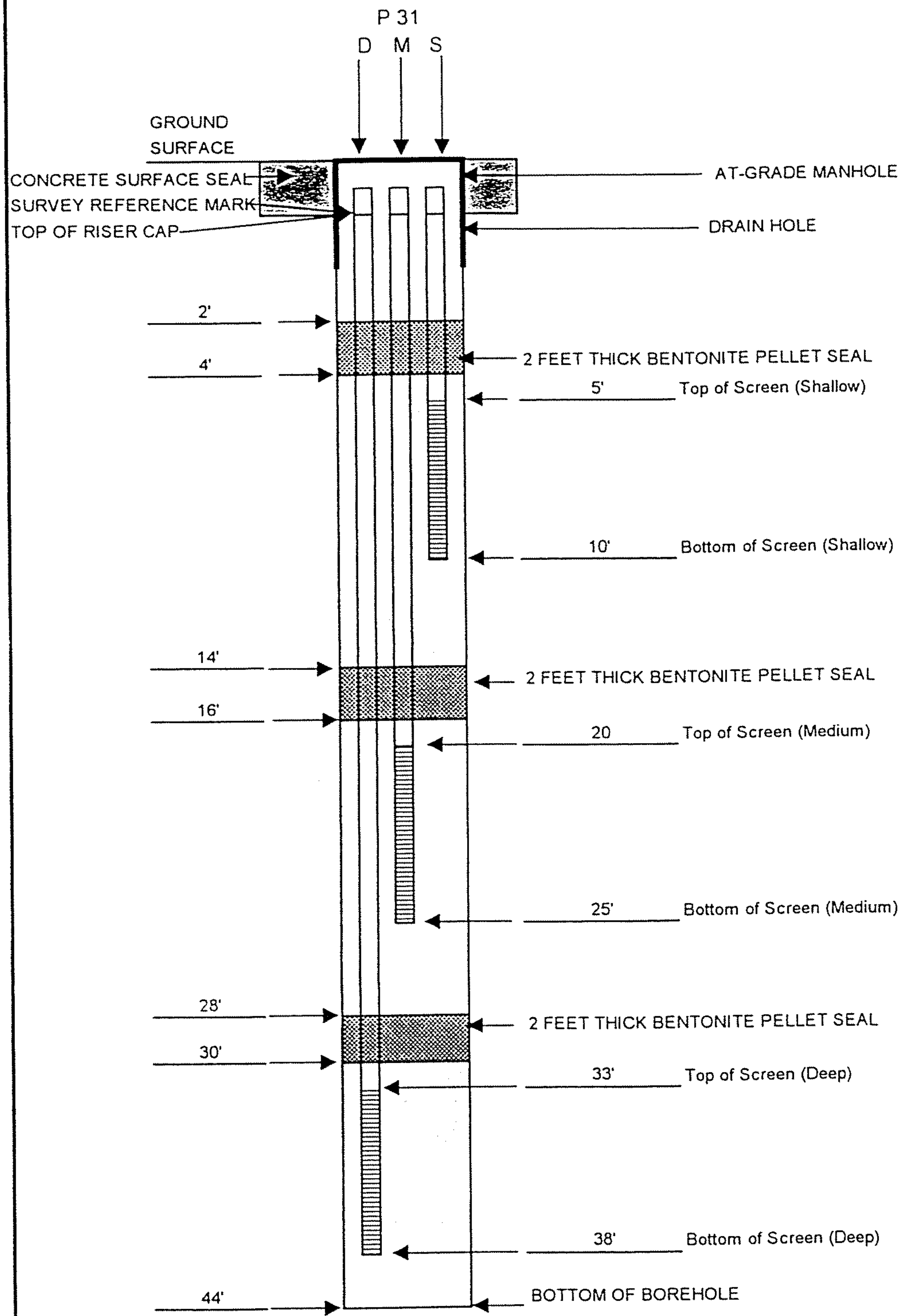
SHORELINE NESTED PIEZOMETER
COMPLETION DIAGRAM



I. D. OF RISER PIPE: 3/4" ID SCHEDULE 80 PVC
TYPE OF SCREENS: 3/4" ID SCHEDULE 80 PVC
SLOT SIZE = 0.010". LENGTH = 5 FEET .
BOREHOLE DIAMETER: 6" MIN.
TYPE OF SAND PACK: No 1 Q-ROCK

BETHLEHEM STEEL CORPORATION LACKAWANNA, NEW YORK
P 30 S/M/D SHORELINE NESTED PIEZOMETER COMPLETION DIAGRAM

BSC piezo construction-9P 30
01/16/2001

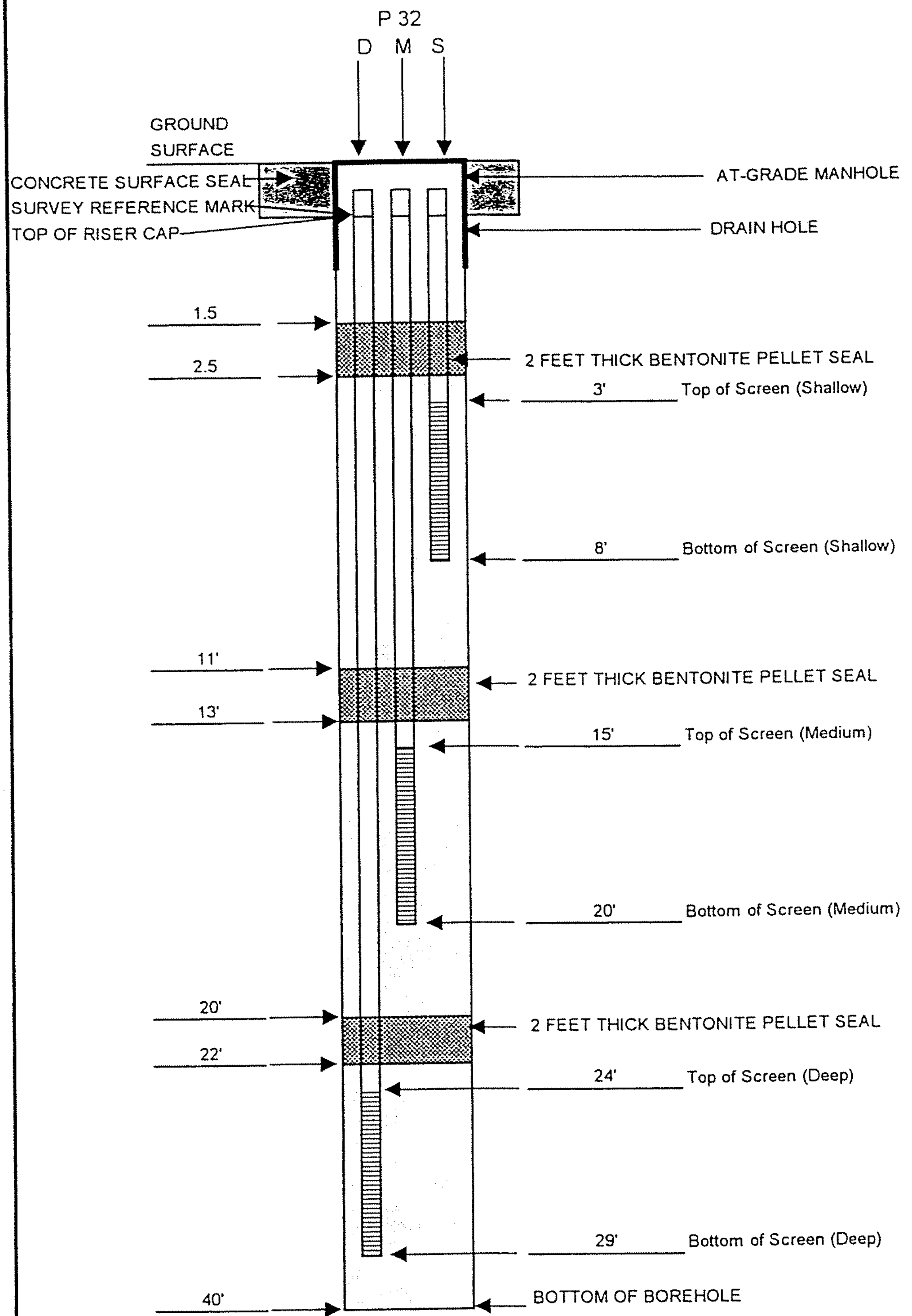


I. D. OF RISER PIPE: 3/4" ID SCHEDULE 80 PVC
TYPE OF SCREENS: 3/4" ID SCHEDULE 80 PVC
SLOT SIZE = 0.010". LENGTH = 5 FEET .
BOREHOLE DIAMETER: 6" MIN.
TYPE OF SAND PACK: No 1 Q-ROCK

BETHLEHEM STEEL CORPORATION
LACKAWANNA, NEW YORK

P 31 S/M/D

SHORELINE NESTED PIEZOMETER
COMPLETION DIAGRAM



I. D. OF RISER PIPE: 3/4" ID SCHEDULE 80 PVC
TYPE OF SCREENS: 3/4" ID SCHEDULE 80 PVC
SLOT SIZE = 0.010". LENGTH = 5 FEET .
BOREHOLE DIAMETER: 6" MIN.
TYPE OF SAND PACK: No 1 Q-ROCK

BETHLEHEM STEEL CORPORATION
LACKAWANNA, NEW YORK

P 32 S/M/D

SHORELINE NESTED PIEZOMETER
COMPLETION DIAGRAM

APPENDIX B

REFERENCES TO EXISTENCE OF DUMP AREAS

5-13

Lackawanna, New York
February 2, 1949

MEMORANDUM - RIPARIAN GRANT

In connection with L. L. Babcock letter of January 28th, information was furnished Mr. Babcock that the original depth of water on the area now under application varied from 17 to 25 feet. It was also stated that approximately 614,000 cubic yards of dumping had taken place in the area under application since the locality had been designated as a Federal dumping ground.

We also furnished photostats, sheets 1 and 2, hereto attached, to illustrate the extent of Federal dumping.

W. E. Durell

12/2
Enc.

EXPLANATION OF SHEET NO. 1

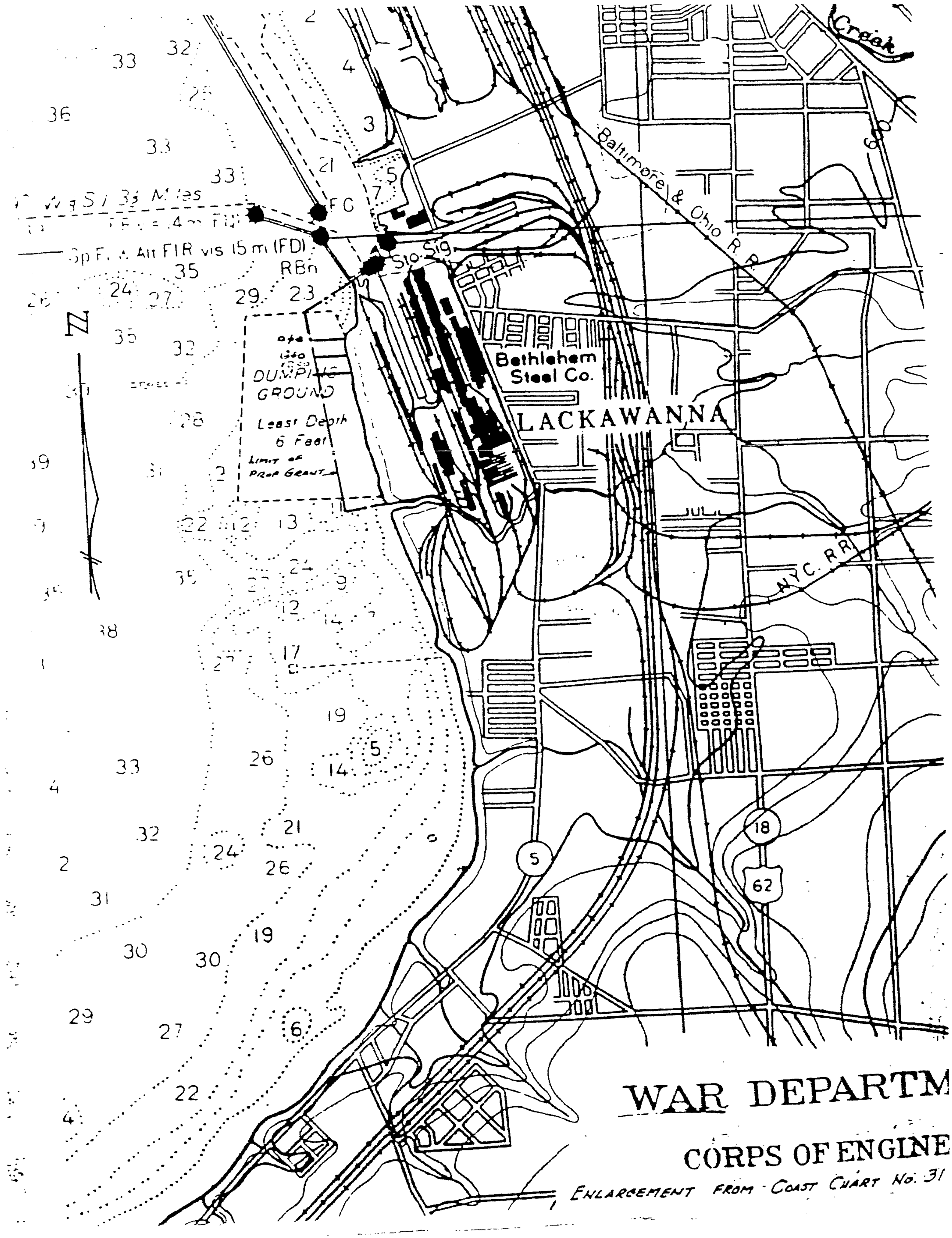
Enlargement of a portion of Coast Chart No. 31 (issue of 1941), showing the area contiguous to the Bethlehem Steel Co., to which has been added:

1. The outward limits of the present application for underwater lands, in red.
2. The location of underwater cross-sections identified as Station 0 plus 0, 6 plus 0 and 12 plus 0, as of December 1936, August 1942, October 1943 and June, 1948 as taken from the official drawings of the U. S. Corps of Engineers, in green.

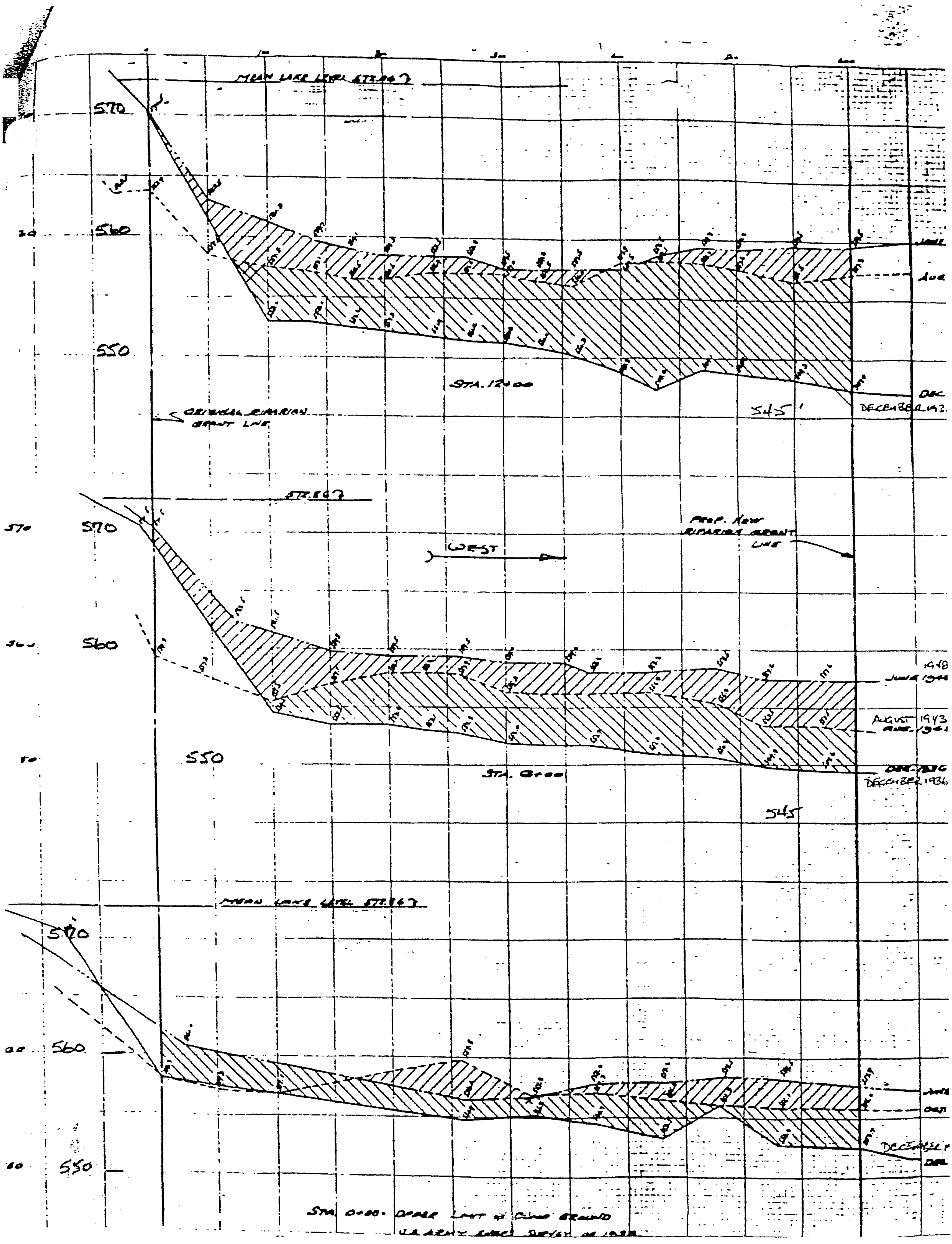
It is to be noted that the legend "Dumping Ground" and "Least Depth 6 Feet" are [redacted] legends on the original Coast Chart.

EXPLANATION OF SHEET NO. 2

Cross-sections at Stations 0 plus 0, 6 plus 0 and 12 plus 0 within the limits of the pending application for underwater lands showing the filling between December, 1936 and June, 1948 which has taken place as a result of this area being classified as a Federal dumping ground. The sections are at the location as shown in green on Sheet No. 1.

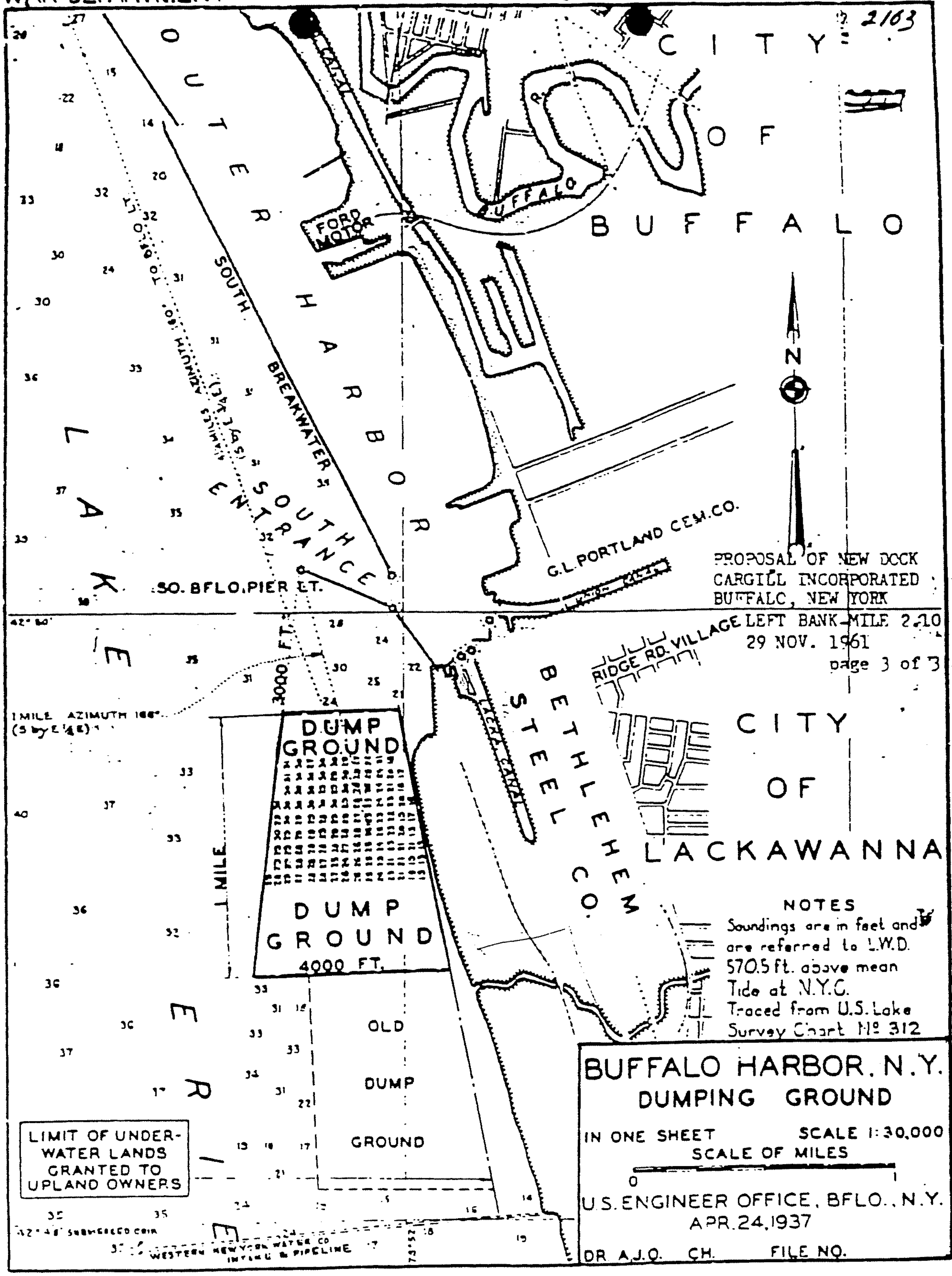


Creek
Baltimore & Ohio R.R.
Bethlehem Steel Co.
LACKAWANNA
DUMPING GROUND
Least Depth 6 Feet
LIMIT OF PROP GRANT
RBn
Sig
NYC RR
5
18
62
WAR DEPARTM
CORPS OF ENGINE
ENLARGEMENT FROM COAST CHART No. 31


MEAN LAKE LEVEL 577.967
570
560
550
545
STA. 12+00
ORIGINAL RIPARIAN GRANT LINE
DECEMBER 193
577.967
PROP. NEW RIPARIAN GRANT LINE
WEST
1948
JUNE 1948
AUGUST 1943
DECEMBER 1936
STA. 6+00
MEAN LAKE LEVEL 577.967
STA. 0+00 - UPPER LIMIT OF CAMP GROUND
U.S. ARMY ENGRS SURVEY OF 1936

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



APPENDIX C

SOIL BORING PHOTOGRAPHS

BETHLEHEM STEEL CORPORATION
Site Photos

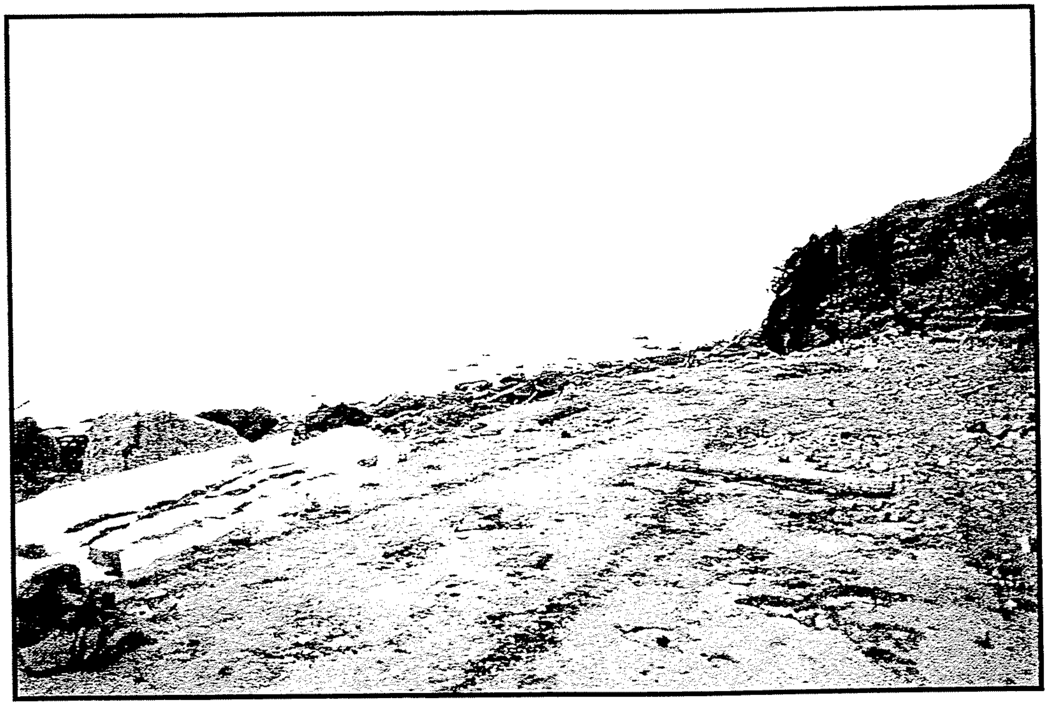


Photo #1: Drill location P-31 looking northward along Lake Erie shoreline on October 16, 2000.

URS

ORIGINAL IN COLOR

BETHLEHEM STEEL CORPORATION
Site Photos

Photo #2: Core sequence P-31
- Slag Fill at 0-20'
- Dredge Sediments at 20'-34'
- Lacustrine/Till at 34'-44'

URS

ORIGINAL IN COLOR

BETHLEHEM STEEL CORPORATION
Site Photos

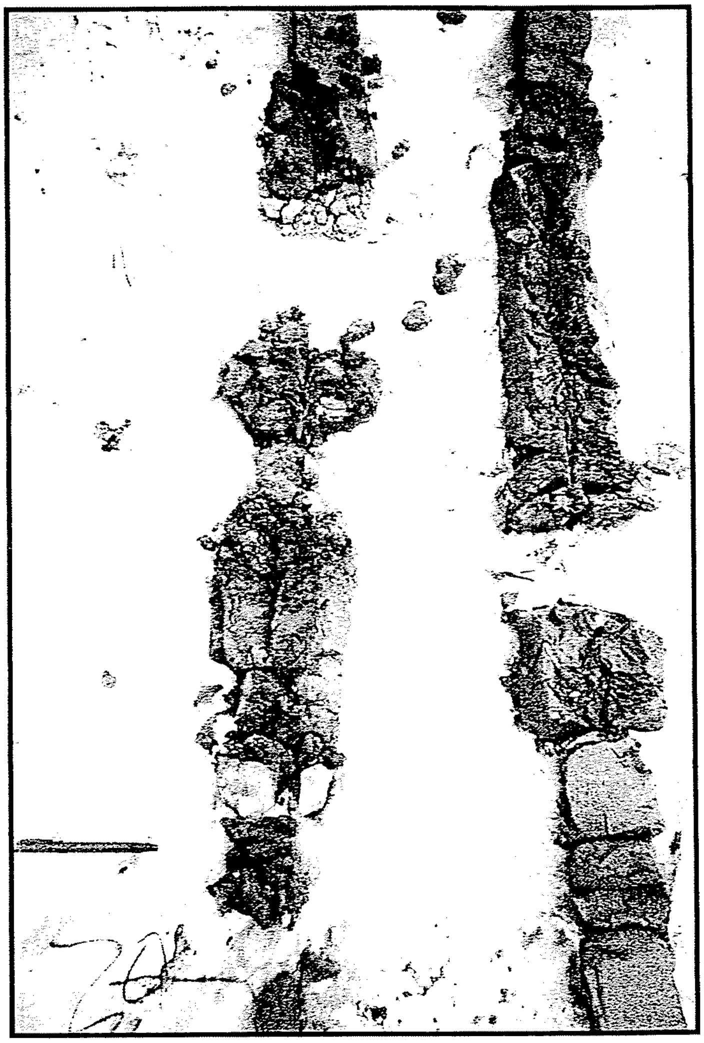


Photo #3: Boring P-31

Left Side - Dredge Sediments
Note: Disturbed appearance and occurrence of angular rock fragments in variable texture matrix.

Right Side - Lacustrine Sediments (Till)
Note: Presence of rounded gravel in finely laminated

URS

ORIGINAL IN COLOR

BETHLEHEM STEEL CORPORATION
Site Photos

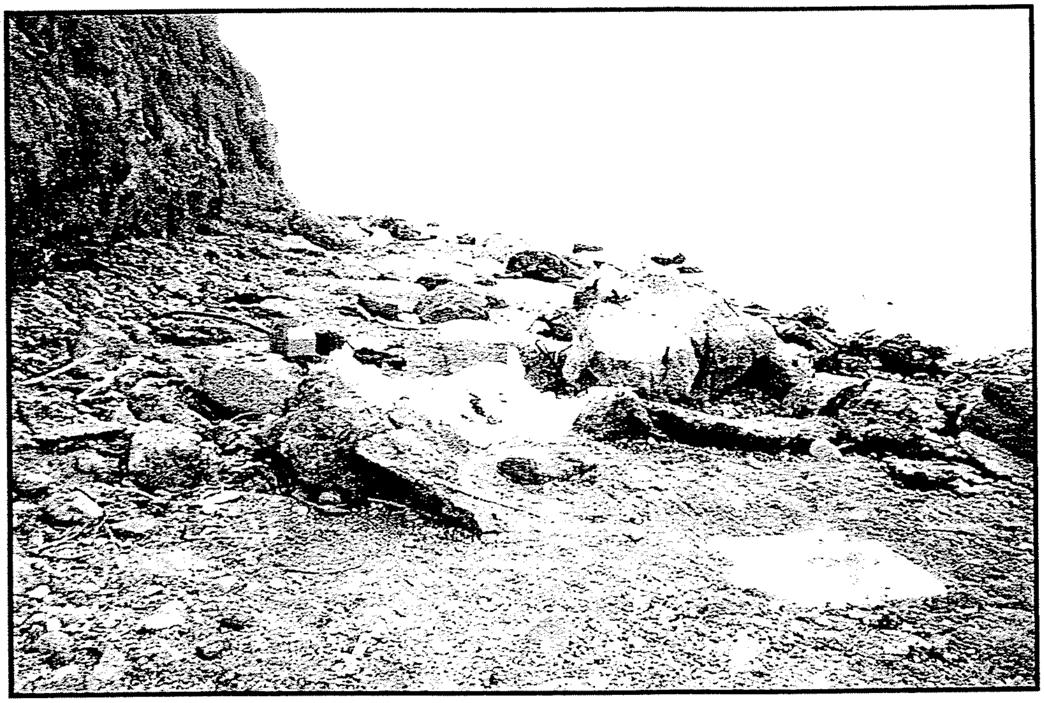


Photo #4: Drill location P-32 looking southward along Lake Erie shoreline on October 23, 2000.

URS

ORIGINAL IN COLOR

BETHLEHEM STEEL CORPORATION
Site Photos

Photo #5: Core sequence P-32
- Slag Fill at 0-20'
- Dredge Sediments at 20'-30'
- Lacustrine/Till at 30'-42'

URS

ORIGINAL IN COLOR

BETHLEHEM STEEL CORPORATION
Site Photos

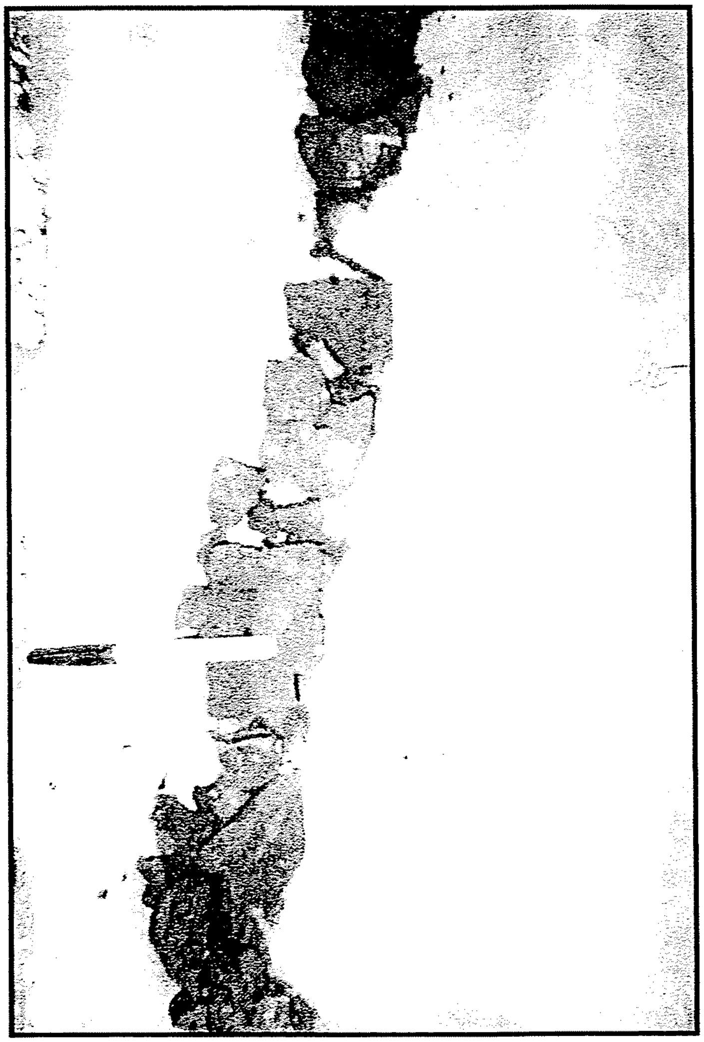


Photo #6: P-32 Dredge Sediment (26'-28')

Note: Presence of wood fiber and fragments (at approx. 25.8', 26.4', and 27.5'). Blocky structure and angular rock fragments.

ORIGINAL IN COLOR

BETHLEHEM STEEL CORPORATION
Site Photos

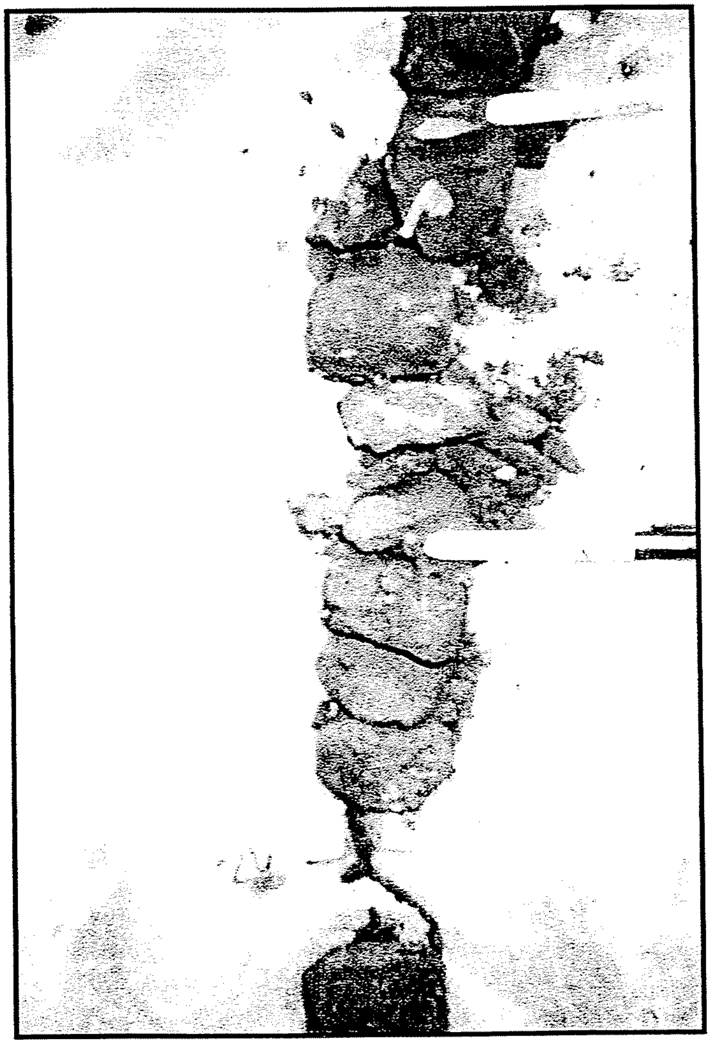


Photo #7: P-32 Dredge Sediment (24'-26')

Note: Material color variation and presence of wood, leaf, and glass fragments (at markers).

URS

ORIGINAL IN COLOR

APPENDIX D

DATA VALIDATION REPORT

DATA VALIDATION REPORT

SHORELINE SOIL BORING ANALYTICAL RESULTS
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORPORATION, LACKAWANNA, NEW YORK

From October 6 through 23, 2000, soil boring samples were collected at the Bethlehem Steel Corporation, Lackawanna, New York site as part of the shoreline investigation. Five soil samples were sent to Severn Trent Laboratories, Inc. of Pittsburgh, PA (STL) to be analyzed by United States Environmental Protection Agency (USEPA) Methods 8260B (site-specific volatiles), 8270C [site-specific semivolatiles and up to 30 tentatively identified compounds (TICs)], 6010B/7471A (site-specific total metals), 325.2 (chloride), 9012A (cyanide), 375.4 (sulfate), Lloyd Kahn [total organic carbon, (TOC)], 9020B [total organic halides (TOX)], and 9066 (total recoverable phenolics). The samples were also scanned for the presence of 2-chloroaniline and 3-chloroaniline in the 8270C analysis. On March 31, 2001, two archived soil boring samples were sent to STL to be analyzed by USEPA Method 8270C (plus TICs and scanned for n-methylaniline and n,n-diethylaniline) and for tetraethyl lead by the State of California Leaking Underground Fuel Tank (LUFT) Field Manual.

The data were reviewed for compliance with the methods referenced above, *USEPA Region II Standard Operating Procedure for the Validation of Organic Data Acquired Using SW-846 Method 8260B, SOP No. HW-24*, Rev. 1, June 1999, *Standard Operating Procedure for the Validation of Organic Data Acquired Using SW-846 Method 8270B, SOP No. HW-22*, Rev. 1, April 1995, and *USEPA Region II Evaluation of Metals Data for the Contract Laboratory Program, SOP No. HW-2*, Rev. XI, January 1992. The reason(s) for data qualification and the affected samples are presented in Table 1, while a summary of the validated analytical results is presented in Table 2. Qualifications applied to the sample results include "R" (data is unusable), "J" (estimated value due to quality control (QC) outliers or concentration below the quantitation limit) and "UJ" (estimated quantitation limit).

Volatile Organics (Method 8260B)

The relative response factor (RRF) for bromomethane and chloroethane did not meet USEPA Region II minimum response criteria (i.e., RRF greater than or equal to 0.05) in the initial and/or continuing calibrations. Following USEPA Region II validation guidelines, the results for bromomethane and/or chloroethane (all were non-detects) in the associated samples were qualified "R" (rejected).

2-Chloroethyl vinyl ether, dichlorodifluoromethane, trichlorofluoromethane, chloroethane, chloromethane, and methylene chloride exceeded the USEPA Region II %D criteria of 20% in one or more continuing calibration standards. The associated results, therefore, were qualified "J/UJ." It should be noted that the initial and continuing calibration standards complied with method requirements.

Samples P-28, P-30 and P-32 (24'-28') have elevated reporting limits because they were analyzed as medium level samples. Target volatile compounds in samples P-30 and P-28 were not detected (except m&p xylene in P-28), however, the chromatogram displayed high concentrations of non-target compounds. The samples could not be analyzed as low level because they would have saturated the detector and contaminated the instrument. No data was qualified for elevated reporting limits.

The reported result for several compounds were qualified "J" by the laboratory to indicate a concentration below the quantitation limit. No other data qualifications were made, and all other data were usable as reported.

Semivolatile Organics (Method 8270C)

The archived samples P-31 and P-32 (23'-24') were stored at ambient temperature. The samples were sent to the laboratory approximately five months after sampling. In accordance with USEPA Region II validation guidelines, the detected results were qualified "J" and the non-detect results were rejected (R).

USEPA Region II validation guidelines require that sample concentrations of compounds less than five times the concentration in an associated blank (ten times for common laboratory contaminants – phthalates) be qualified "U." Following these guidelines, all bis(2-ethylhexyl)phthalate sample concentrations less than ten times the concentration associated with method blanks were qualified "U." The tentatively identified compounds (TICs) of 2-pentanone, 4-hydroxy-4-methyl and n-hexadecanoic acid were detected in method blanks. USEPA Region II validation guidelines require that sample concentrations of TICs less than five times the concentration in an associated blank be rejected. The results for these TICs were rejected (R) in the samples listed on Table 1.

Several samples exhibited surrogate recoveries outside the laboratory's control limits. However, in accordance with Region II validation guidelines, the data was not qualified because the samples were diluted due to high concentrations of target compounds.

Hexachlorocyclopentadiene exceeded the USEPA Region II %D criteria of 20% in one or more continuing calibration standards. The associated results (all were non-detect) were qualified "UJ." It should be noted the continuing calibration was compliant with method requirements.

Benzo(a)anthracene, bis(2-ethylhexyl)phthalate, chrysene and pyrene results for sample P-29 were qualified "J" because the internal standard percent recovery associated with these compounds exceeded the upper control limit.

The reported results for several target compounds were qualified "J" by the laboratory to indicate a concentration below the quantitation limit. Results reported from a secondary dilution analysis are qualified "D." All TICs identified by a chemical abstract service (CAS) number are qualified "NJ." Unknown TICs (i.e., no CAS number) are qualified "J." No other data qualifications were made, and all other data are usable as reported.

The laboratory's TIC report lists unknowns several times (e.g., sample P-25 has an "unknown" peak at retention times 10.59, 13.39, 14.81, 14.95, 15.39, 15.90, and 16.12, an "unknown straight chain alkane" peak at retention times 11.80, 12.71, 13.59 and 17.92). The concentration listed in Table 2 represents the peak with the maximum estimated concentration.

Metals (Method 6010B/7470A)

The percent recovery for antimony, magnesium and selenium in the MS and/or MSD was less than 75%. Following USEPA Region II validation guidelines, all associated antimony, magnesium and selenium results were qualified "J/UJ."

Total cadmium, magnesium, and nickel results in the serial dilution analysis exceeded the USEPA

Region II %D criteria of 10%. Following USEPA Region II validation guidelines, all associated results greater than ten times the instrument detection limits were qualified "J."

The detection limits for selenium and thallium (non-detect in all samples except P-30) are elevated because of high concentrations of interfering metals, (calcium, iron, magnesium, potassium and/or sodium) making dilutions necessary. No data were qualified because of dilutions.

The reported results for several compounds were qualified "B" by the laboratory to indicate a concentration below the CRDL, but greater than the instrument detection limits. No other data qualifications were made, and all other data are usable as reported.

Miscellaneous Parameters

As mentioned previously, the archived samples P-31 and P-32 (23'-24') were stored at ambient temperature and sent to the laboratory approximately five months after sampling. Tetraethyl lead is an organic lead compound that degrades at ambient temperatures. Using professional judgement and following the intent of the USEPA Region II validation guidelines, the non-detect results for tetraethyl lead were rejected (R). No other data qualifications were made, and all other data are usable as reported.

TABLE 1
SUMMARY OF QUALIFIED DATA
NOVEMBER 1999 SAMPLING EVENT
BETHLEHEM STEEL CORPORATION, LACKAWANNA, NEW YORK

Sample ID	Fraction	Analytical Deviation	Qualification
P-28, P-30, P-32 (24'-28')	VOA	Initial calibration (ICAL) and/or continuing calibration (CCAL) relative response factor (RRF) less than 0.05 for chloroethane	Reject (R) non-detect results
P-28, P-30	VOA	ICAL and/or CCAL RRF less than 0.05 for bromomethane	Reject (R) non-detect results
P-25	VOA	CCAL %D greater than 20% for 2-chloroethyl vinyl ether, chloroethane	Qualify non-detects "UJ."
P-28, P-29, P-30, P-32 (24'-28')	VOA	CCAL %D greater than 20% for dichlorodifluoromethane	Qualify non-detects "UJ."
P-29	VOA	CCAL %D greater than 20% for trichlorofluoromethane, chloromethane	Qualify non-detects "UJ."
P-32 (24'-28')	VOA	CCAL %D greater than 20% for methylene chloride	Qualify non-detects "UJ."
P-31, P-32 (23'-24')	SVOA	Sample preservation and holding time exceedance	Reject (R) non-detect results and qualify detects "J."
P-29	SVOA	Bis(2-ethylhexyl)phthalate blank contamination	Raise reported value to quantitation limit and qualify "U."
P-25, P-28, P-29, P-30, P-32 (24'-28')	SVOA	Tentatively identified compound (TIC) 2-pentanone, 4-hydroxy-4-methyl blank contamination	Reject TIC
P-25	SVOA	TIC n-hexadecanoic acid blank contamination	Reject TIC
P-28, P-30	SVOA	CCAL %D greater than 20% for hexachlorocyclopentadiene	Qualify non-detects "UJ."
P-29	SVOA	Sample internal standard (IS) percent recovery greater than upper control limit	Qualify detects "J" for benzo(a)anthracene, chrysene, pyrene, and bis-(2- ethylhexyl) phthalate.
P-31, P-32 (23'-24')	Tetraethyl lead	Sample preservation and holding time exceedance	Reject (R) non-detect results.
P-25	Antimony, magnesium	Percent recovery of matrix spike and/or matrix spike duplicate below the lower control limit of 75%	Qualify detects "J."
P-28, P-29, P-30, P-32 (24'-28')	Antimony, selenium	Percent recovery of matrix spike and/or matrix spike duplicate below the lower control limit of 75%	Qualify non-detect "UJ" and detects "J."
P-25	Cadmium, nickel	Percent difference (%D) between sample and serial dilution results greater than 10%	Qualify results "J."
P-28, P-29, P-30, P-32 (24'-28')	Magnesium	%D between sample and serial dilution results greater than 10%	Qualify results "J."

DEFINITION OF VALIDATION QUALIFIERS

The following are definitions of the validation qualifiers assigned to results during the data review process.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

N The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."

NJ The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

B - Metals Only: The analyte was detected above the instrument detection limit (IDL); the reported concentration is below the contract required detection limit (CRDL).

R - The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

D - The sample results are reported from a secondary dilution analysis. The result of the initial analysis exceeded the upper limit of the calibration.

NA - The analyte was not detected (semivolatiles), or the sample was not analyzed for the parameter (volatiles, metals, general chemistry parameters).

\- - A spectral scan was performed and a tentative identification has not been made.

TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-25	P-28	P-29	P-30	P-31
Sample ID		P-25	P-28	P-29	P-30	P-31
Matrix		Soil	Soil	Soil	Soil	Soil
Depth Interval (ft)		20.0-22.0	25.0-28.0	18.0-20.0	28.0-30.0	28.0-30.0
Date Sampled		10/06/00	10/10/00	10/11/00	10/12/00	10/16/00
Parameter	Units					
Volatile Organic Compounds						
Acrylonitrile	UG/KG	120 U	7,400 U	120 U	6,200 U	NA
Benzene	UG/KG	6.1 U	370 U	3.5 J	310 U	NA
Bromochloromethane	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Bromodichloromethane	UG/KG	6.1 U	370 U	5 8 U	310 U	NA
Bromoform	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Bromomethane	UG/KG	12 U	R	12 U	R	NA
Carbon tetrachloride	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Chlorobenzene	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Chloroethane	UG/KG	12 UJ	R	12 U	R	NA
2-Chloroethyl vinyl ether	UG/KG	61 UJ	3,700 U	58 U	3,100 U	NA
Chloroform	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Chloromethane	UG/KG	12 U	740 U	12 UJ	620 U	NA
Dibromochloromethane	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Dichlorodifluoromethane	UG/KG	12 U	740 UJ	12 UJ	620 UJ	NA
1,1-Dichloroethane	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
1,2-Dichloroethane	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
1,1-Dichloroethene	UG/KG	6.1 U	370 U	5 8 U	310 U	NA
trans-1,2-Dichloroethene	UG/KG	3.0 U	190 U	2.9 U	150 U	NA
1,2-Dichloropropane	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
cis-1,3-Dichloropropene	UG/KG	6 1 U	370 U	5.8 U	310 U	NA
trans-1,3-Dichloropropene	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Ethylbenzene	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Methylene chloride	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
1,1,1,2-Tetrachloroethane	UG/KG	6.1 U	370 U	5.8 U	310 U	NA

Flags assigned during chemistry validation are shown.

Made By: GEK Date: 10/22/02
Checked By: JMM Date. 10/22/02

Detection Limits shown are PQL

TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-25	P-28	P-29	P-30	P-31
Sample ID		P-25	P-28	P-29	P-30	P-31
Matrix		Soil	Soil	Soil	Soil	Soil
Depth Interval (ft)		20.0-22.0	25.0-28.0	18.0-20.0	28.0-30.0	28.0-30.0
Date Sampled		10/06/00	10/10/00	10/11/00	10/12/00	10/16/00
Parameter	Units					
Volatile Organic Compounds						
1,1,2,2-Tetrachloroethane	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Tetrachloroethene	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Toluene	UG/KG	6.1 U	370 U	3.1 J	310 U	NA
1,1,1-Trichloroethane	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
1,1,2-Trichloroethane	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Trichloroethene	UG/KG	6.1 U	370 U	5.8 U	310 U	NA
Trichlorofluoromethane	UG/KG	12 U	740 U	12 UJ	620 U	NA
Vinyl chloride	UG/KG	12 U	740 U	12 U	620 U	NA
m-Xylene & p-Xylene	UG/KG	5.3 J	140 J	1.8 J	310 U	NA
o-Xylene	UG/KG	2.8 J	190 U	1.4 J	150 U	NA
Semivolatile Organic Compounds						
Acenaphthylene	UG/KG	2,200 J	13,000 J	920	750 J	130 J
Anthracene	UG/KG	3,300 J	16,000 J	1,700	5,500	800 J
Benzo(a)anthracene	UG/KG	3,200 J	13,000 J	3,100 J	4,000 J	600 J
Benzo(a)pyrene	UG/KG	2,500 J	11,000 J	3,200	2,600 J	410 J
Butyl benzyl phthalate	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
4-Chloro-3-methylphenol	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
4-Chloroaniline	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
bis(2-Chloroethyl)ether	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
2-Chloronaphthalene	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
Chrysene	UG/KG	3,800 J	12,000 J	3,100 J	3,600 J	710 J
Di-n-butyl phthalate	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
Di-n-octyl phthalate	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
1,2-Dichlorobenzene	UG/KG	4,900 U	20,000 U	870 U	4,300 U	440 J

Flags assigned during chemistry validation are shown

Made By: GEK Date: 10/22/02
Checked By: JMM Date: 10/22/02

Detection Limits shown are PQL

TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-25	P-28	P-29	P-30	P-31
Sample ID		P-25	P-28	P-29	P-30	P-31
Matrix		Soil	Soil	Soil	Soil	Soil
Depth Interval (ft)		20.0-22.0	25.0-28.0	18.0-20.0	28.0-30.0	28.0-30.0
Date Sampled		10/06/00	10/10/00	10/11/00	10/12/00	10/16/00
Parameter	Units					
Semivolatile Organic Compounds						
1,3-Dichlorobenzene	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
1,4-Dichlorobenzene	UG/KG	4,900 U	20,000 U	870 U	4,300 U	150 J
2,4-Dichlorophenol	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
Diethyl phthalate	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
Dimethyl phthalate	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
2,4-Dimethylphenol	UG/KG	4,900 U	20,000 U	870 U	4,300 U	28 J
4,6-Dinitro-2-methylphenol	UG/KG	24,000 U	97,000 U	4,200 U	21,000 U	R
2,4-Dinitrotoluene	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
2,6-Dinitrotoluene	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
bis(2-Ethylhexyl)phthalate	UG/KG	4,900 U	20,000 U	870 UJ	4,300 U	R
Fluoranthene	UG/KG	9,100	33,000	7,400 D	10,000	2,000 J
Fluorene	UG/KG	2,900 J	24,000	1,300	4,600	700 J
Hexachlorobenzene	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
Hexachlorobutadiene	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
Hexachlorocyclopentadiene	UG/KG	24,000 U	97,000 UJ	4,200 U	21,000 UJ	R
Hexachloroethane	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
Isophorone	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
3-Methylphenol & 4-Methylphenol	UG/KG	4,900 U	20,000 U	870 U	4,300 U	NA
2-Methylphenol	UG/KG	4,900 U	20,000 U	62 J	4,300 U	R
4-Methylphenol	UG/KG	NA	NA	NA	NA	R
Naphthalene	UG/KG	19,000	140,000	3,300	750 J	2,000 J
Nitrobenzene	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
Pentachlorophenol	UG/KG	24,000 U	97,000 U	4,200 U	21,000 U	R
Phenanthrene	UG/KG	12,000	62,000	5,200	15,000	2,200 J

Flags assigned during chemistry validation are shown

Made By: GEK Date: 10/22/02
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Detection Limits shown are PQL

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([LOGDATE] BETWEEN #10/06/00# AND #10/23/00#) AND [MATRIX] like "S*"

TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-25	P-28	P-29	P-30	P-31
Sample ID		P-25	P-28	P-29	P-30	P-31
Matrix		Soil	Soil	Soil	Soil	Soil
Depth Interval (ft)		20.0-22.0	25.0-28.0	18.0-20.0	28.0-30.0	28.0-30.0
Date Sampled		10/06/00	10/10/00	10/11/00	10/12/00	10/16/00
Parameter	Units					
Semivolatile Organic Compounds						
Phenol	UG/KG	450 J	20,000 U	74 J	4,300 U	120 J
Pyrene	UG/KG	6,400	25,000	3,500 J	6,300	1,000 J
Pyridine	UG/KG	9,800 U	40,000 U	1,700 U	8,700 U	R
2,3,4,6-Tetrachlorophenol	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
1,2,4-Trichlorobenzene	UG/KG	4,900 U	20,000 U	870 U	4,300 U	78 J
2,4,5-Trichlorophenol	UG/KG	4.900 U	20,000 U	870 U	4,300 U	R
2,4,6-Trichlorophenol	UG/KG	4,900 U	20,000 U	870 U	4,300 U	R
Tentatively Identified Semivolatiles						
11H-Benzo[b]fluorene	UG/KG	NA	NA	220 NJ	NA	NA
2-Chloroaniline	UG/KG	-	-	-	-	NA
2-Methylnaphthalene	UG/KG	NA	NA	NA	NA	680 J
3-Chloroaniline	UG/KG	-	-	-	-	NA
2-Pentanone, 4-hydroxy-4-methyl-	UG/KG	R	R	R	R	NA
Acenaphthene	UG/KG	NA	14,000 NJ	810 NJ	4,000 NJ	470 J
Aniline	UG/KG	NA	NA	NA	NA	160 J
Benzo(b)fluoranthene	UG/KG	1,200 NJ	9,200 NJ	5,100 NJ	2,000 NJ	R
Benzo(k)fluoranthene	UG/KG	NA	10,000 NJ	7,400 NJ	2,300 NJ	650 J
Benzo(ghi)perylene	UG/KG	2,400 NJ	8,400 NJ	950 NJ	1,300 NJ	110 J
Benzenamine, 4,4',4''-methylidynetris[N,	UG/KG	NA	NA	NA	NA	NA
Benzenamine, 4,4'-methylenebis[N,N-dimet	UG/KG	NA	NA	NA	1,300 NJ	NA
Benzene, 1,1'-(1-butenylidene)bis-	UG/KG	4,200 NJ	NA	NA	NA	NA
Benzene, 2,4-dimethyl-1-(phenylmethyl)-	UG/KG	23,000 NJ	NA	NA	NA	NA
Benzenemethanamine, N-ethyl-N-phenyl-	UG/KG	NA	NA	NA	5,300 NJ	NA
Biphenyl	UG/KG	NA	5,300 NJ	NA	NA	NA

Flags assigned during chemistry validation are shown

Made By: GEK Date: 10/22/02
Checked By: JMM Date: 10/22/02

Detection Limits shown are PQL

TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-25	P-28	P-29	P-30	P-31
Sample ID		P-25	P-28	P-29	P-30	P-31
Matrix		Soil	Soil	Soil	Soil	Soil
Depth Interval (ft)		20.0-22.0	25.0-28.0	18.0-20.0	28.0-30.0	28.0-30.0
Date Sampled		10/06/00	10/10/00	10/11/00	10/12/00	10/16/00
Parameter	Units					
Tentatively Identified Semivolatiles						
Carbazole	UG/KG	620 NJ	8,200 NJ	2,100 NJ	1,400 NJ	230 J
Cyclic octaatomic sulfur	UG/KG	3,700 NJ	NA	NA	NA	NA
Dibenz(a,h)anthracene	UG/KG	NA	NA	700 NJ	820 NJ	55 J
Dibenzofuran	UG/KG	1,200 NJ	15,000 NJ	710 NJ	2,500 NJ	320 J
N,N-Diethylaniline	UG/KG	NA	NA	NA	NA	R
Hexadecane, 2,6,10,14-tetramethyl-	UG/KG	8,700 NJ	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	UG/KG	1,100 NJ	8,700 NJ	1,700 NJ	1,400 NJ	130 J
n-Hexadecanoic acid	UG/KG	R	NA	NA	NA	NA
N-Methylaniline	UG/KG	NA	NA	NA	NA	R
N-Nitrosodiphenylamine	UG/KG	NA	NA	NA	NA	170 J
Naphthalene, 1,5-dimethyl-	UG/KG	NA	NA	NA	2,300 NJ	NA
Naphthalene, 1-ethyl-	UG/KG	NA	NA	NA	2,400 NJ	NA
Naphthalene, 1-methyl-	UG/KG	1,200 NJ	2,000 NJ	390 NJ	2,200 NJ	NA
Naphthalene, 2,6-dimethyl-	UG/KG	NA	NA	NA	2,000 NJ	NA
Naphthalene, 2-methyl-	UG/KG	2,200 NJ	4,400 NJ	480 NJ	3,900 NJ	NA
Pentadecane, 2,6,10,14-tetramethyl-	UG/KG	NA	NA	1,200 NJ	NA	NA
Unknown	UG/KG	6,500 J	7,600 J	2,900 J	4,000 J	1,900 J
Unknown Alkane	UG/KG	NA	17,000 J	5,700 J	NA	1,200 J
Unknown Branched Alkane	UG/KG	NA	NA	1,500 J	6,000 J	1,800 J
Unknown Cycloalkane	UG/KG	4,400 J	5,300 J	NA	2,000 J	NA
Unknown Organic Acid	UG/KG	NA	NA	160 J	NA	NA
Unknown PAH	UG/KG	4,100 J	7,000 J	3,300 J	2,900 J	330 J
Unknown Straight Chain Alkane	UG/KG	7,600 J	NA	2,300 J	3,800 J	NA
Unknown Substituted Benzene	UG/KG	6,500 J	7,900 J	NA	NA	1,200 J

Flags assigned during chemistry validation are shown.

Made By: GEK Date: 10/22/02
Checked By: JMM Date: 10/22/02

Detection Limits shown are PQL

TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-25	P-28	P-29	P-30	P-31
Sample ID		P-25	P-28	P-29	P-30	P-31
Matrix		Soil	Soil	Soil	Soil	Soil
Depth Interval (ft)		20.0-22.0	25.0-28.0	18.0-20.0	28.0-30.0	28.0-30.0
Date Sampled		10/06/00	10/10/00	10/11/00	10/12/00	10/16/00
Parameter	Units					
Tentatively Identified Semivolatiles						
Unknown Substituted Naphthalene	UG/KG	29,000 J	15,000 J	NA	4,900 J	640 J
Metals						
Antimony	MG/KG	8.2 J	5.4 J	4.3 J	1.5 J	NA
Arsenic	MG/KG	28.8	31.6	23.8	10.6	NA
Barium	MG/KG	88.5	108	89.1	69.0	NA
Cadmium	MG/KG	8.3 J	2.7	2.5	1.5	NA
Calcium	MG/KG	43,200	59,000	47,300	17,600	NA
Chromium	MG/KG	213	158	137	72.3	NA
Lead	MG/KG	418	159	141	134	NA
ıesium	MG/KG	7,900 J	11,500 J	10,500 J	7,490 J	NA
Mercury	MG/KG	0.19	0.47	0.44	1.6	NA
Nickel	MG/KG	109 J	50.4	42.4	27.9	NA
Potassium	MG/KG	1,040	1,010	873	605 B	NA
Selenium	MG/KG	1.6 U	1.6 UJ	1.4 UJ	0.28 UJ	NA
Silver	MG/KG	1.4	1.4	0.95	0.44 B	NA
Sodium	MG/KG	305 B	288 B	266 B	88.7 B	NA
Thallium	MG/KG	2.9 U	2.9 U	2.6 U	0.51 U	NA
General Chemistry Parameters						
Chloride - Leachable	MG/L	9.9	13.6	33.1	6.2	NA
Cyanide	MG/KG	1.6	1.6	2.2	0.94	NA
Sulfate - Leachable	MG/L	5.0 U	5.0 U	7.6	5.0 U	NA
Tetraethyl Lead	MG/KG	NA	NA	NA	NA	R
Total Organic Carbon	MG/KG	10,900	21,300	10,800	20,400	NA
Total Organic Halogens	MG/KG	297 U	303 U	265 U	263 U	NA

Flags assigned during chemistry validation are shown.

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TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-25	P-28	P-29	P-30	P-31
Sample ID		P-25	P-28	P-29	P-30	P-31
Matrix		Soil	Soil	Soil	Soil	Soil
Depth Interval (ft)		20.0-22.0	25.0-28.0	18.0-20.0	28.0-30.0	28.0-30.0
Date Sampled		10/06/00	10/10/00	10/11/00	10/12/00	10/16/00
Parameter	Units					
General Chemistry Parameters						
Total Recoverable Phenolics	MG/KG	0.59	0.23	0.073	0.084	NA
Total Solids	PERCENT	67.3	66.1	75.6	76.1	77.9 J

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Detection Limits shown are PQL

TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-32	P-32
Sample ID		P-32	P-32
Matrix		Soil	Soil
Depth Interval (ft)		23.0-24.0	24.0-28.0
Date Sampled		10/18/00	10/23/00
Parameter	Units		
Volatile Organic Compounds			
Acrylonitrile	UG/KG	NA	13,000 U
Benzene	UG/KG	NA	300 J
Bromochloromethane	UG/KG	NA	640 U
Bromodichloromethane	UG/KG	NA	640 U
Bromoform	UG/KG	NA	640 U
Bromomethane	UG/KG	NA	1,300 U
Carbon tetrachloride	UG/KG	NA	640 U
Chlorobenzene	UG/KG	NA	990
Chloroethane	UG/KG	NA	R
2-Chloroethyl vinyl ether	UG/KG	NA	6,400 U
Chloroform	UG/KG	NA	640 U
Chloromethane	UG/KG	NA	1,300 U
Dibromochloromethane	UG/KG	NA	640 U
Dichlorodifluoromethane	UG/KG	NA	1,300 UJ
1,1-Dichloroethane	UG/KG	NA	640 U
1,2-Dichloroethane	UG/KG	NA	640 U
1,1-Dichloroethene	UG/KG	NA	640 U
trans-1,2-Dichloroethene	UG/KG	NA	320 U
1,2-Dichloropropane	UG/KG	NA	640 U
cis-1,3-Dichloropropene	UG/KG	NA	640 U
trans-1,3-Dichloropropene	UG/KG	NA	640 U
Ethylbenzene	UG/KG	NA	410 J
Methylene chloride	UG/KG	NA	640 UJ
1,1,1,2-Tetrachloroethane	UG/KG	NA	640 U

Flags assigned during chemistry validation are shown.

Made By: GEK Date: 10/22/02
Checked By: JMM Date: 10/22/02

Detection Limits shown are PQL

TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-32	P-32
Sample ID		P-32	P-32
Matrix		Soil	Soil
Depth Interval (ft)		23.0-24.0	24.0-28.0
Date Sampled		10/18/00	10/23/00
Parameter	Units		
Volatile Organic Compounds			
1,1,2,2-Tetrachloroethane	UG/KG	NA	640 U
Tetrachloroethene	UG/KG	NA	640 U
Toluene	UG/KG	NA	390 J
1,1,1-Trichloroethane	UG/KG	NA	640 U
1,1,2-Trichloroethane	UG/KG	NA	640 U
Trichloroethene	UG/KG	NA	640 U
Trichlorofluoromethane	UG/KG	NA	1,300 U
Vinyl chloride	UG/KG	NA	1,300 U
m-Xylene & p-Xylene	UG/KG	NA	1,500
o-Xylene	UG/KG	NA	740
Semivolatile Organic Compounds			
Acenaphthylene	UG/KG	29 J	2,000 J
Anthracene	UG/KG	88 J	14,000
Benzo(a)anthracene	UG/KG	160 J	7,900 J
Benzo(a)pyrene	UG/KG	130 J	5,600 J
Butyl benzyl phthalate	UG/KG	R	8,600 U
4-Chloro-3-methylphenol	UG/KG	R	8,600 U
4-Chloroaniline	UG/KG	R	8,600 U
bis(2-Chloroethyl)ether	UG/KG	R	8,600 U
2-Chloronaphthalene	UG/KG	R	8,600 U
Chrysene	UG/KG	150 J	7,500 J
Di-n-butyl phthalate	UG/KG	R	8,600 U
Di-n-octyl phthalate	UG/KG	R	8,600 U
1,2-Dichlorobenzene	UG/KG	R	1,900 J

Flags assigned during chemistry validation are shown

Made By: GEK Date: 10/22/02
Checked By: JMM Date: 10/22/02

Detection Limits shown are PQL

TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-32	P-32
Sample ID		P-32	P-32
Matrix		Soil	Soil
Depth Interval (ft)		23.0-24.0	24.0-28.0
Date Sampled		10/18/00	10/23/00
Parameter	Units		
Semivolatile Organic Compounds			
1,3-Dichlorobenzene	UG/KG	R	8,600 U
1,4-Dichlorobenzene	UG/KG	R	8,600 U
2,4-Dichlorophenol	UG/KG	R	8,600 U
Diethyl phthalate	UG/KG	R	8,600 U
Dimethyl phthalate	UG/KG	R	8,600 U
2,4-Dimethylphenol	UG/KG	R	8,600 U
4,6-Dinitro-2-methylphenol	UG/KG	R	41,000 U
2,4-Dinitrotoluene	UG/KG	R	8,600 U
2,6-Dinitrotoluene	UG/KG	R	8,600 U
bis(2-Ethylhexyl)phthalate	UG/KG	55 J	8,600 U
Fluoranthene	UG/KG	300 J	26,000
Fluorene	UG/KG	40 J	11,000
Hexachlorobenzene	UG/KG	R	8,600 U
Hexachlorobutadiene	UG/KG	R	8,600 U
Hexachlorocyclopentadiene	UG/KG	R	41,000 U
Hexachloroethane	UG/KG	R	8,600 U
Isophorone	UG/KG	R	8,600 U
3-Methylphenol & 4-Methylphenol	UG/KG	NA	8,600 U
2-Methylphenol	UG/KG	R	8,600 U
4-Methylphenol	UG/KG	R	NA
Naphthalene	UG/KG	130 J	48,000
Nitrobenzene	UG/KG	R	8,600 U
Pentachlorophenol	UG/KG	R	41,000 U
Phenanthrene	UG/KG	250 J	38,000

Flags assigned during chemistry validation are shown.

Made By: GEK Date: 10/22/02
Checked By: JMM Date: 10/22/02

Detection Limits shown are PQL

TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-32	P-32
Sample ID		P-32	P-32
Matrix		Soil	Soil
Depth Interval (ft)		23.0-24.0	24.0-28.0
Date Sampled		10/18/00	10/23/00
Parameter	Units		
Semivolatile Organic Compounds			
Phenol	UG/KG	R	8,600 U
Pyrene	UG/KG	230 J	13,000
Pyridine	UG/KG	R	17,000 U
2,3,4,6-Tetrachlorophenol	UG/KG	R	8,600 U
1,2,4-Trichlorobenzene	UG/KG	R	8,600 U
2,4,5-Trichlorophenol	UG/KG	R	8,600 U
2,4,6-Trichlorophenol	UG/KG	R	8,600 U
Tentatively Identified Semivolatiles			
11H-Benzo[b]fluorene	UG/KG	NA	NA
2-Chloroaniline	UG/KG	NA	-
2-Methylnaphthalene	UG/KG	R	NA
3-Chloroaniline	UG/KG	NA	-
2-Pentanone, 4-hydroxy-4-methyl-	UG/KG	NA	R
Acenaphthene	UG/KG	28 J	6,800 NJ
Aniline	UG/KG	R	NA
Benzo(b)fluoranthene	UG/KG	97 J	NA
Benzo(k)fluoranthene	UG/KG	130 J	3,800 NJ
Benzo(ghi)perylene	UG/KG	60 J	NA
Benzenamine, 4,4',4''-methylidynetris[N,	UG/KG	NA	6,700 NJ
Benzenamine, 4,4'-methylenebis[N,N-dimet	UG/KG	NA	NA
Benzene, 1,1'-(1-butenylidene)bis-	UG/KG	NA	NA
Benzene, 2,4-dimethyl-1-(phenylmethyl)-	UG/KG	NA	NA
Benzenemethanamine, N-ethyl-N-phenyl-	UG/KG	NA	8,700 NJ
Biphenyl	UG/KG	NA	NA

Flags assigned during chemistry validation are shown

Made By: GEK Date: 10/22/02
Checked By: JMM Date: 10/22/02

Detection Limits shown are PQL

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TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-32	P-32
Sample ID		P-32	P-32
Matrix		Soil	Soil
Depth Interval (ft)		23.0-24.0	24.0-28.0
Date Sampled		10/18/00	10/23/00
Parameter	Units		
Tentatively Identified Semivolatiles			
Carbazole	UG/KG	R	NA
Cyclic octaatomic sulfur	UG/KG	180 NJ	NA
Dibenz(a,h)anthracene	UG/KG	R	NA
Dibenzofuran	UG/KG	R	NA
N,N-Diethylaniline	UG/KG	R	NA
Hexadecane, 2,6,10,14-tetramethyl-	UG/KG	NA	NA
Indeno(1,2,3-cd)pyrene	UG/KG	62 J	NA
n-Hexadecanoic acid	UG/KG	NA	NA
N-Methylaniline	UG/KG	R	NA
N-Nitrosodiphenylamine	UG/KG	R	NA
Naphthalene, 1,5-dimethyl-	UG/KG	NA	NA
Naphthalene, 1-ethyl-	UG/KG	NA	NA
Naphthalene, 1-methyl-	UG/KG	NA	2,100 NJ
Naphthalene, 2,6-dimethyl-	UG/KG	NA	NA
Naphthalene, 2-methyl-	UG/KG	NA	2,400 NJ
Pentadecane, 2,6,10,14-tetramethyl-	UG/KG	NA	NA
Unknown	UG/KG	NA	12,000 J
Unknown Alkane	UG/KG	NA	20,000 J
Unknown Branched Alkane	UG/KG	NA	31,000 J
Unknown Cycloalkane	UG/KG	NA	2,300 J
Unknown Organic Acid	UG/KG	140 J	NA
Unknown PAH	UG/KG	NA	NA
Unknown Straight Chain Alkane	UG/KG	NA	NA
Unknown Substituted Benzene	UG/KG	NA	NA

Flags assigned during chemistry validation are shown

Made By: GEK Date. 10/22/02
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Detection Limits shown are PQL

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TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-32	P-32
Sample ID		P-32	P-32
Matrix		Soil	Soil
Depth Interval (ft)		23.0-24.0	24.0-28.0
Date Sampled		10/18/00	10/23/00
Parameter	Units		
Tentatively Identified Semivolatiles			
Unknown Substituted Naphthalene	UG/KG	NA	NA
Metals			
Antimony	MG/KG	NA	5.4 BJ
Arsenic	MG/KG	NA	28.1
Barium	MG/KG	NA	109
Cadmium	MG/KG	NA	4.1
Calcium	MG/KG	NA	30,400
Chromium	MG/KG	NA	71.4
Lead	MG/KG	NA	235
Magnesium	MG/KG	NA	4,650 J
Mercury	MG/KG	NA	2.4
Nickel	MG/KG	NA	17.8
Potassium	MG/KG	NA	561 B
Selenium	MG/KG	NA	1.4 UJ
Silver	MG/KG	NA	1.8
Sodium	MG/KG	NA	147 B
Thallium	MG/KG	NA	2.5 U
General Chemistry Parameters			
Chloride - Leachable	MG/L	NA	184
Cyanide	MG/KG	NA	2.1
Sulfate - Leachable	MG/L	NA	5.0 U
Tetraethyl Lead	MG/KG	R	NA
Total Organic Carbon	MG/KG	NA	30,700
Total Organic Halogens	MG/KG	NA	259 U

Flags assigned during chemistry validation are shown

Made By: GEK Date 10/22/02
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Detection Limits shown are PQL

TABLE 2
ANALYTICAL SOIL SAMPLE RESULTS - SHORELINE
OCTOBER 2000 SAMPLING EVENT
BETHLEHEM STEEL CORP., LACKAWANNA, NEW YORK

Location ID		P-32	P-32
Sample ID		P-32	P-32
Matrix		Soil	Soil
Depth Interval (ft)		23.0-24.0	24.0-28.0
Date Sampled		10/18/00	10/23/00
Parameter	Units		
General Chemistry Parameters			
Total Recoverable Phenolics	MG/KG	NA	0.065
Total Solids	PERCENT	80.8 J	77.1

Flags assigned during chemistry validation are shown.

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Detection Limits shown are PQL

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APPENDIX H

HYDRAULIC GRADIENT AND RECHARGE CALCULATIONS – PHASE I

ESTIMATE OF RECHARGE TO WATER TABLE AQUIFER

Annual infiltration estimates for the Slag Fill Area were calculated by comparing fluctuations in groundwater elevations following a precipitation event. Precipitation data was recorded at the site climate station (and supplemented by NOAA, Buffalo, New York) for the period February 1991 through January 1992. Groundwater elevation data was recorded for this period on continuous water level recorders installed on monitoring well MWS-12A and MWS-13A. Weekly water level readings were used to fill data gaps in continuous readings from well MWN-13A.

The process of groundwater recharge through infiltration is a function of rainfall intensity, soil moisture, and the unsaturated characteristics of the soil. Although water table measurements can be used to analyze the occurrence of groundwater recharge during an infiltration event, used alone this data can only estimate infiltration rates since water-level fluctuations can result from a variety of hydrologic phenomena.

Groundwater recharge within the Slag Fill Area was calculated by measuring the maximum rise in the water table following a precipitation event. Results are summarized on Table D-1-1; well hydrographs are presented in Figures D-1-1 through D-1-24. As shown on the hydrographs, fluctuations in groundwater elevation were typically 4 to 5 times greater than the rainfall depth. This is due to, in part, to the porosity of the fill which is assumed to be in the range of 25 percent. The porosity of the fill has not been measured, therefore groundwater recharge for a range of porosities was calculated. As discussed above, a variety of phenomena can lead to water table fluctuations and not all are representative of groundwater recharge (Freeze, R.A. and Cherry, J.A., 1979). Additional monitoring instrumentation consisting of soil moisture devices and nested piezometers would be required to

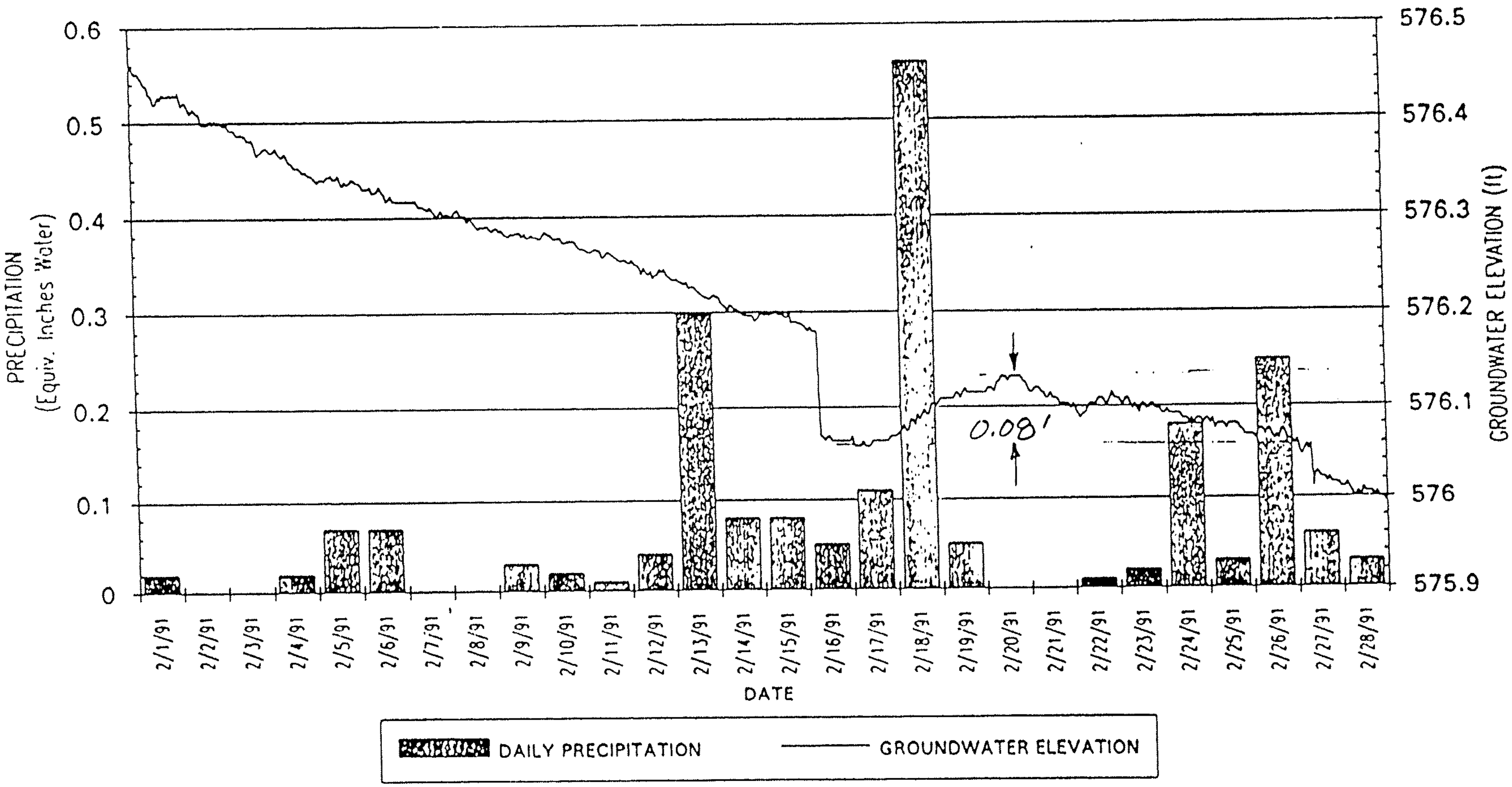
TABLE X.X

ESTIMATE OF RECHARGE DUE TO INFILTRATION
(FEBRUARY 1, 1991 TO JANUARY 31, 1992)

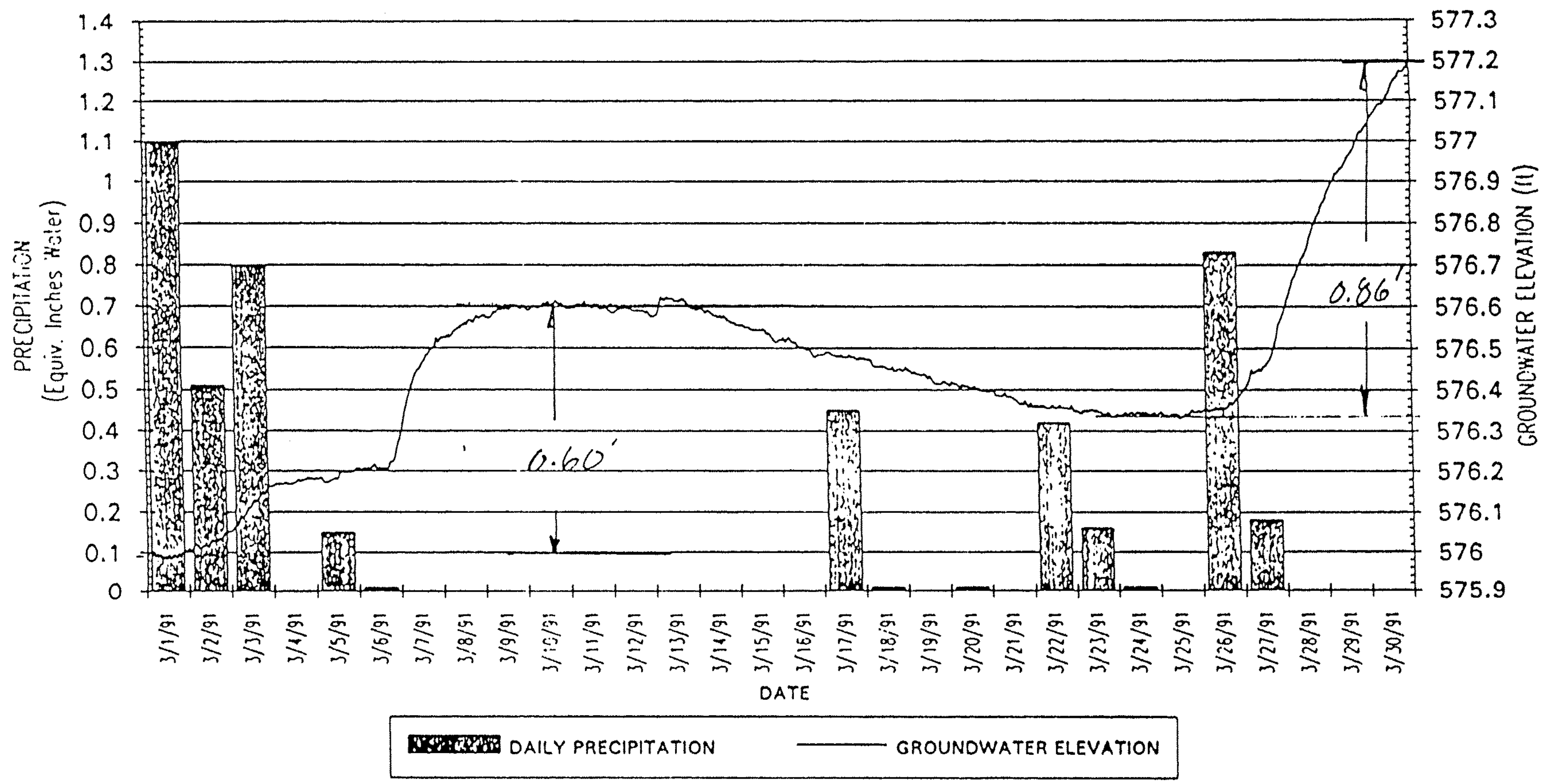
MONTH	MWS-12A RECHARGE (ft.)*	MWN-13A RECHARGE (ft.)
Feb	0.08	0.00
Mar	0.60	0.68
	0.86	
Apr	0.08	0.26
	0.42	
May	0.00	0.22
Jun	0.00	0.00
Jul	0.40	0.71
		0.09
Aug	0.48	0.00
Sep	0.08	0.04
	0.16	0.16
Oct	0.21	0.37
Nov	0.34	0.22
		0.15
		0.53
Dec	0.10	0.26
	0.29	0.44
	0.08	0.14
	0.06	
	0.10	
Jan '92	0.16	0.16
Total	4.50	4.43
Estimated Recharge Due to Infiltration		
Porosity (n) = 0.28	1.26	1.24
Porosity (n) = 0.25	1.13	1.11
Porosity (n) = 0.23	1.04	1.02
Porosity (n) = 0.21	0.95	0.93

Note: * Measured as increase in water table elevation

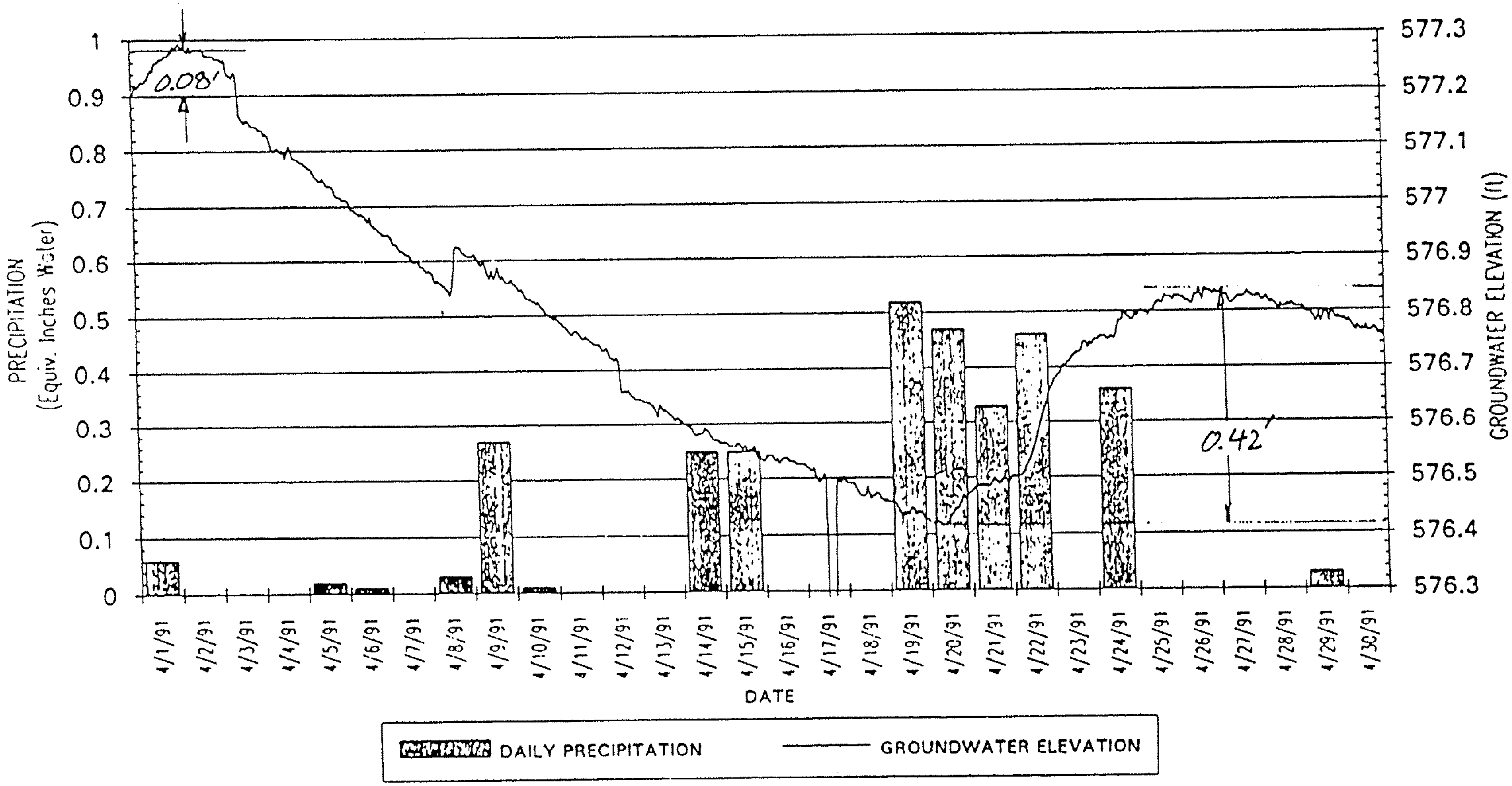
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWS-12A



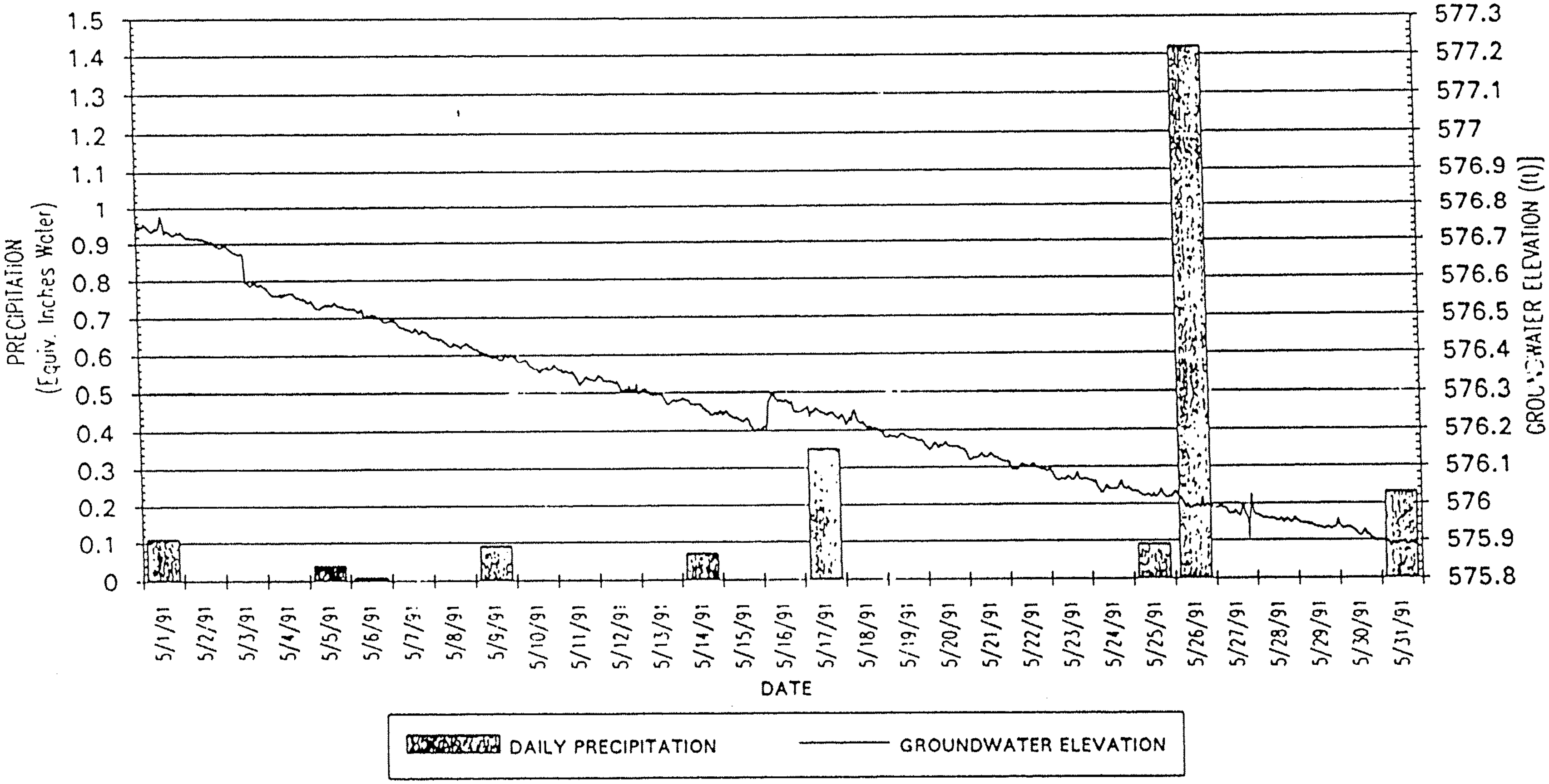
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION FOR WELL MWS-12A



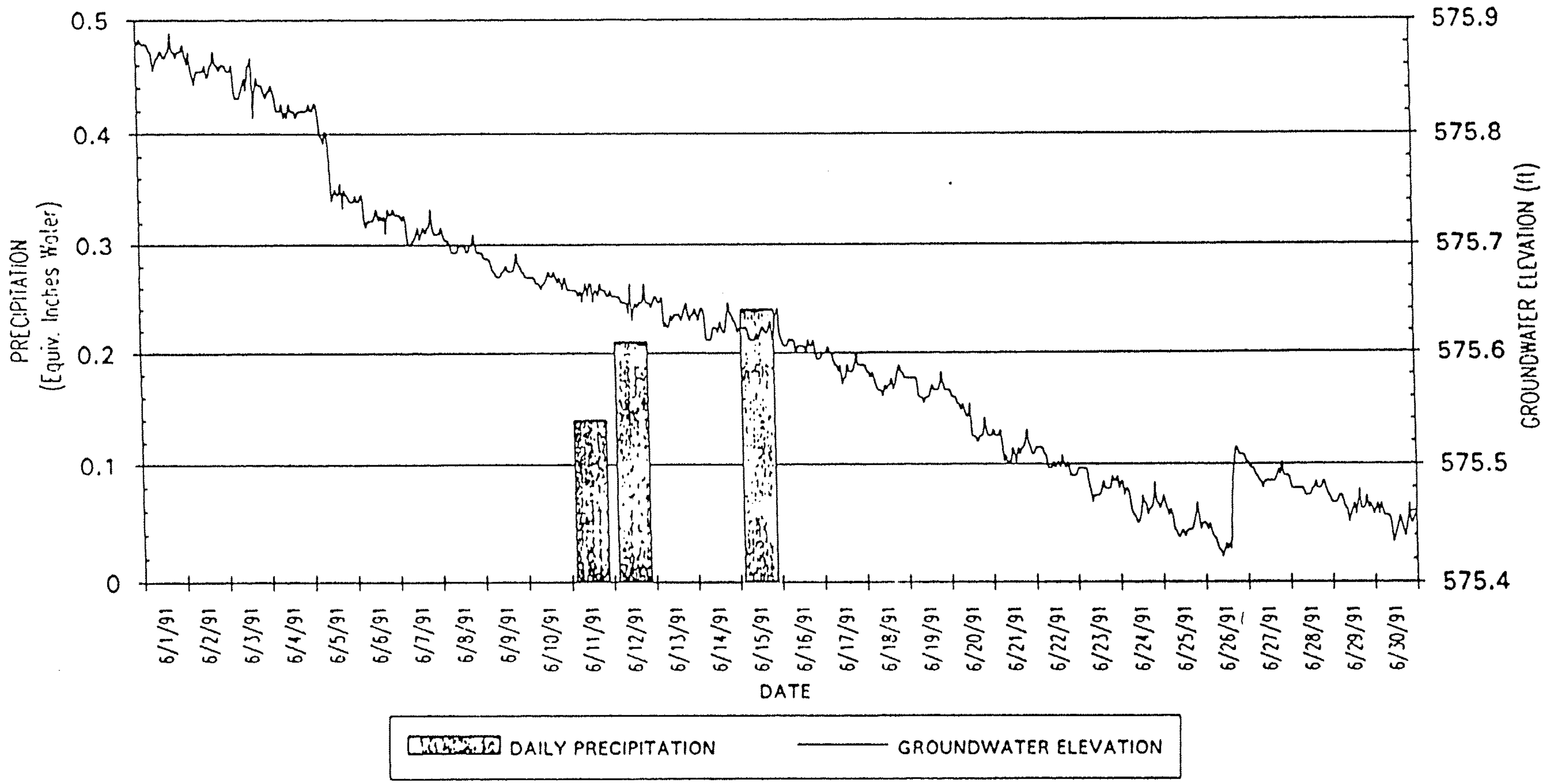
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWS-12A



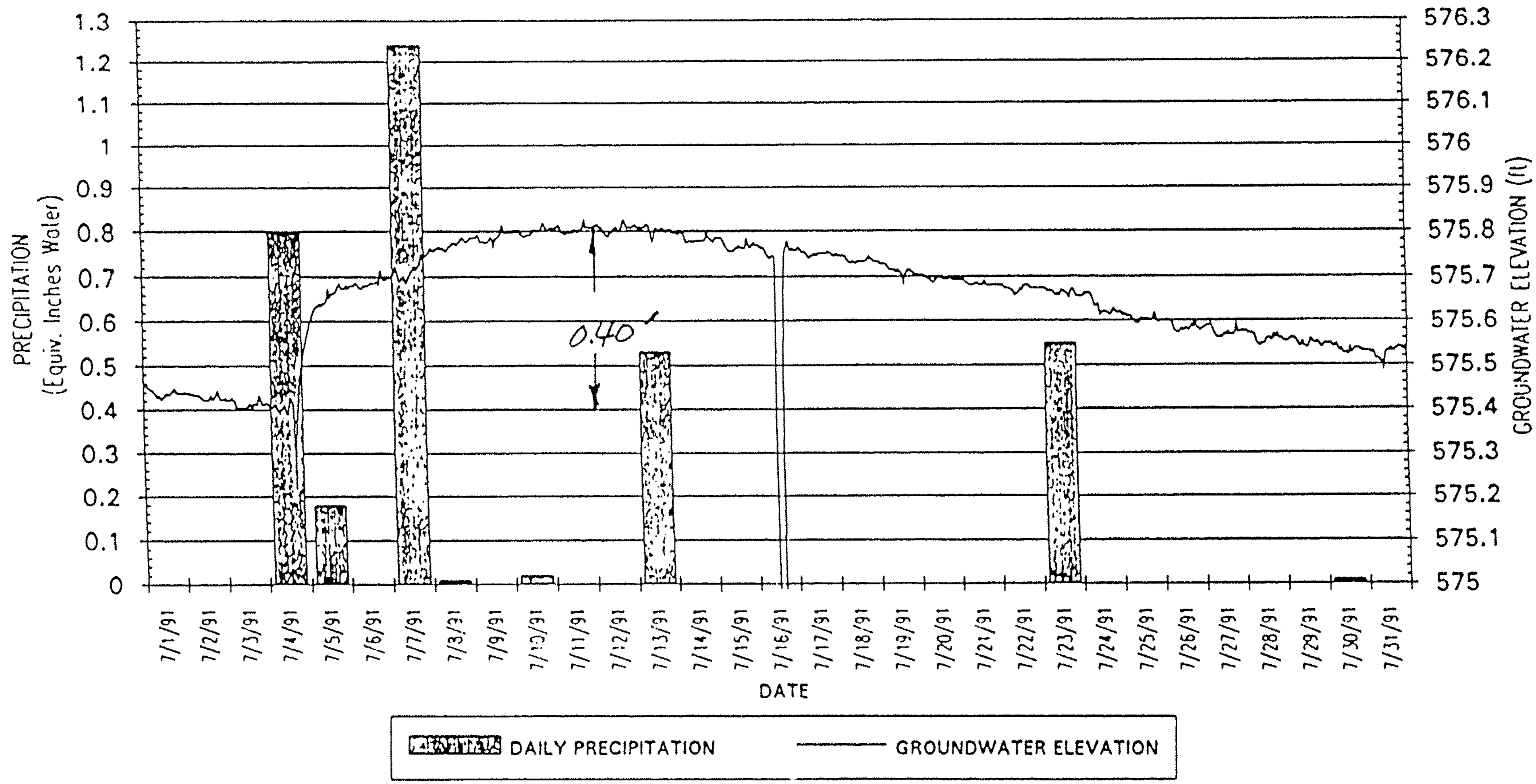
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION FOR WELL MWS-12A



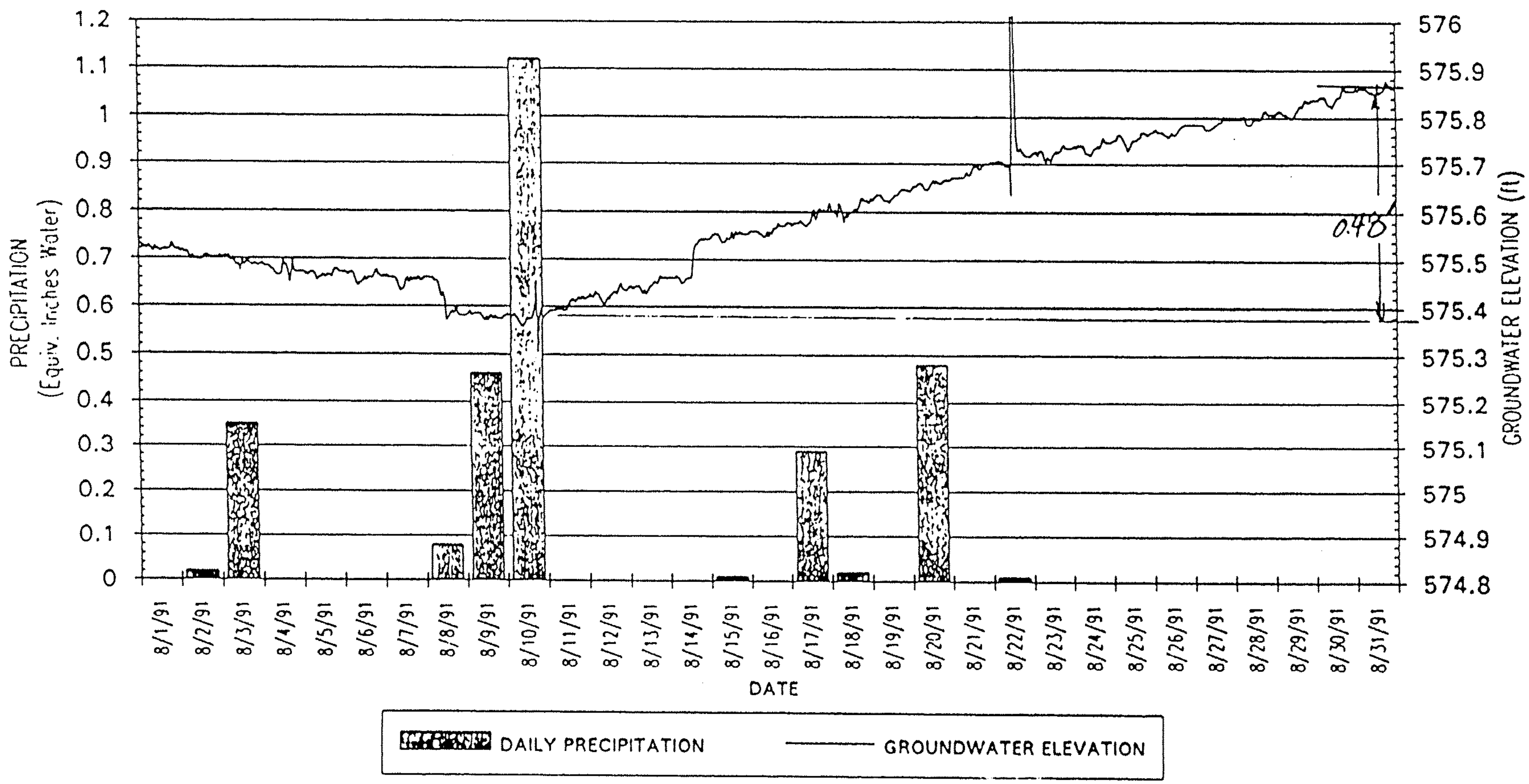
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWS-12A

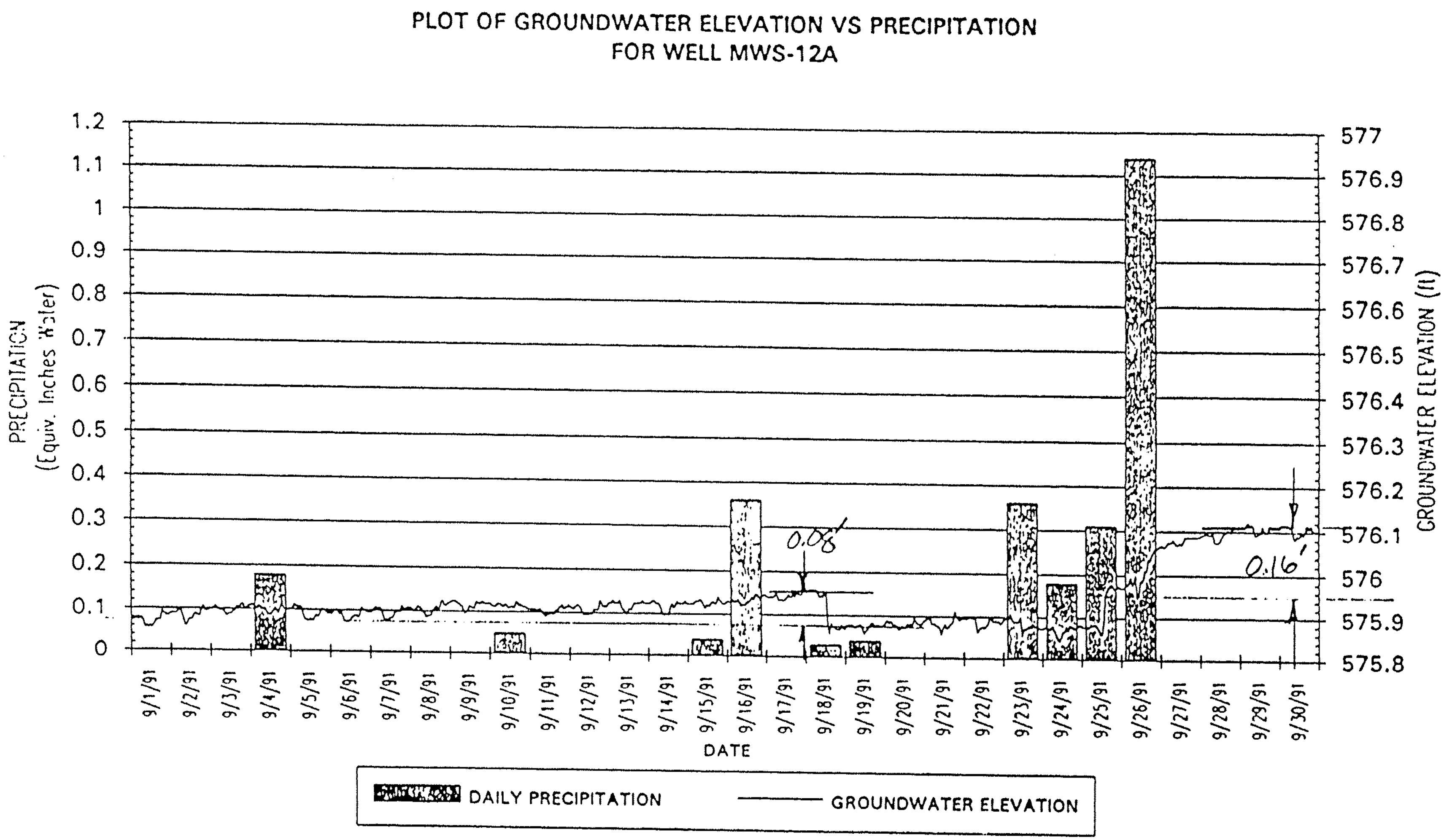


PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION FOR WELL MWS-12A

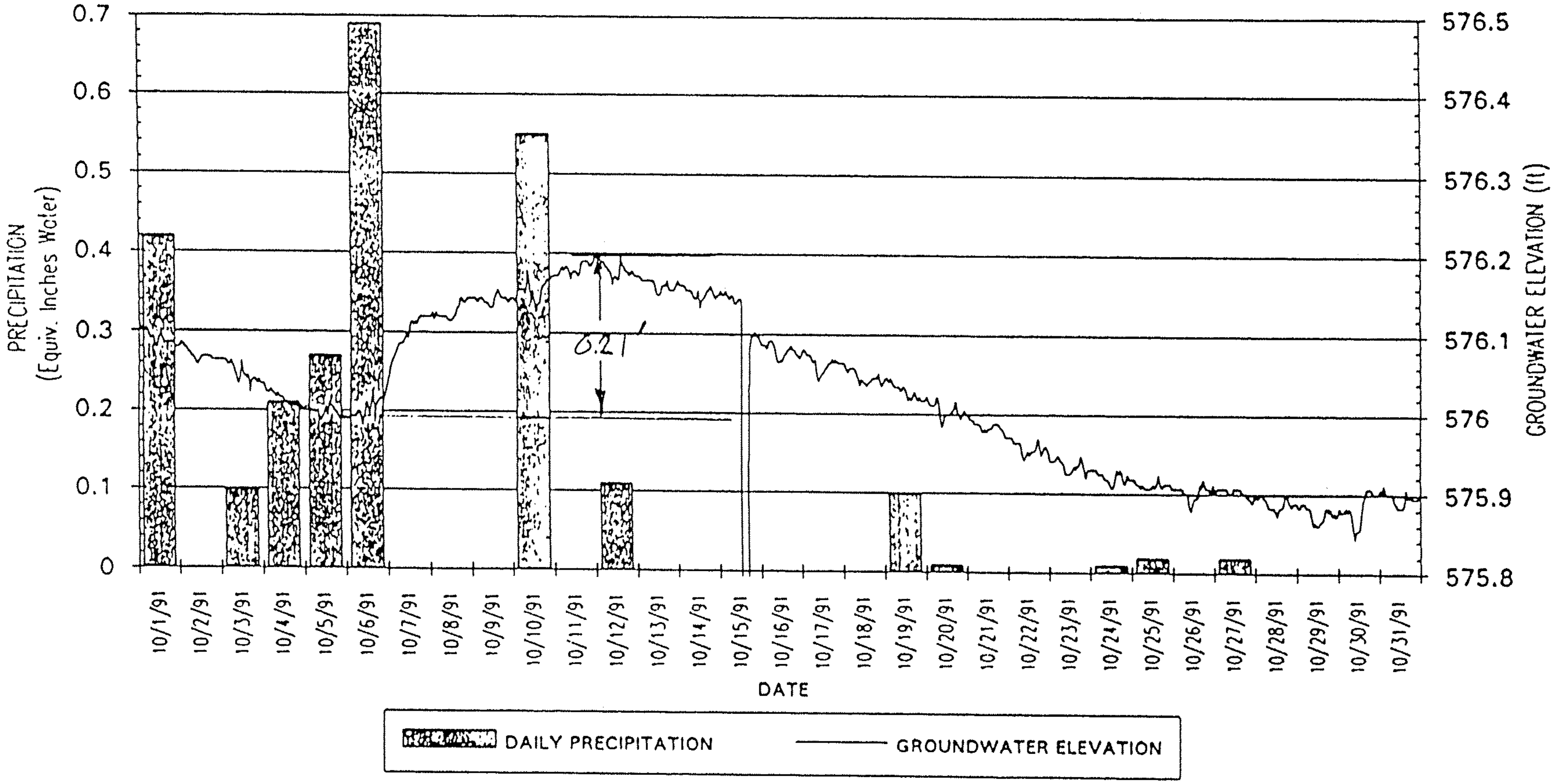


PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION FOR WELL MWS-12A

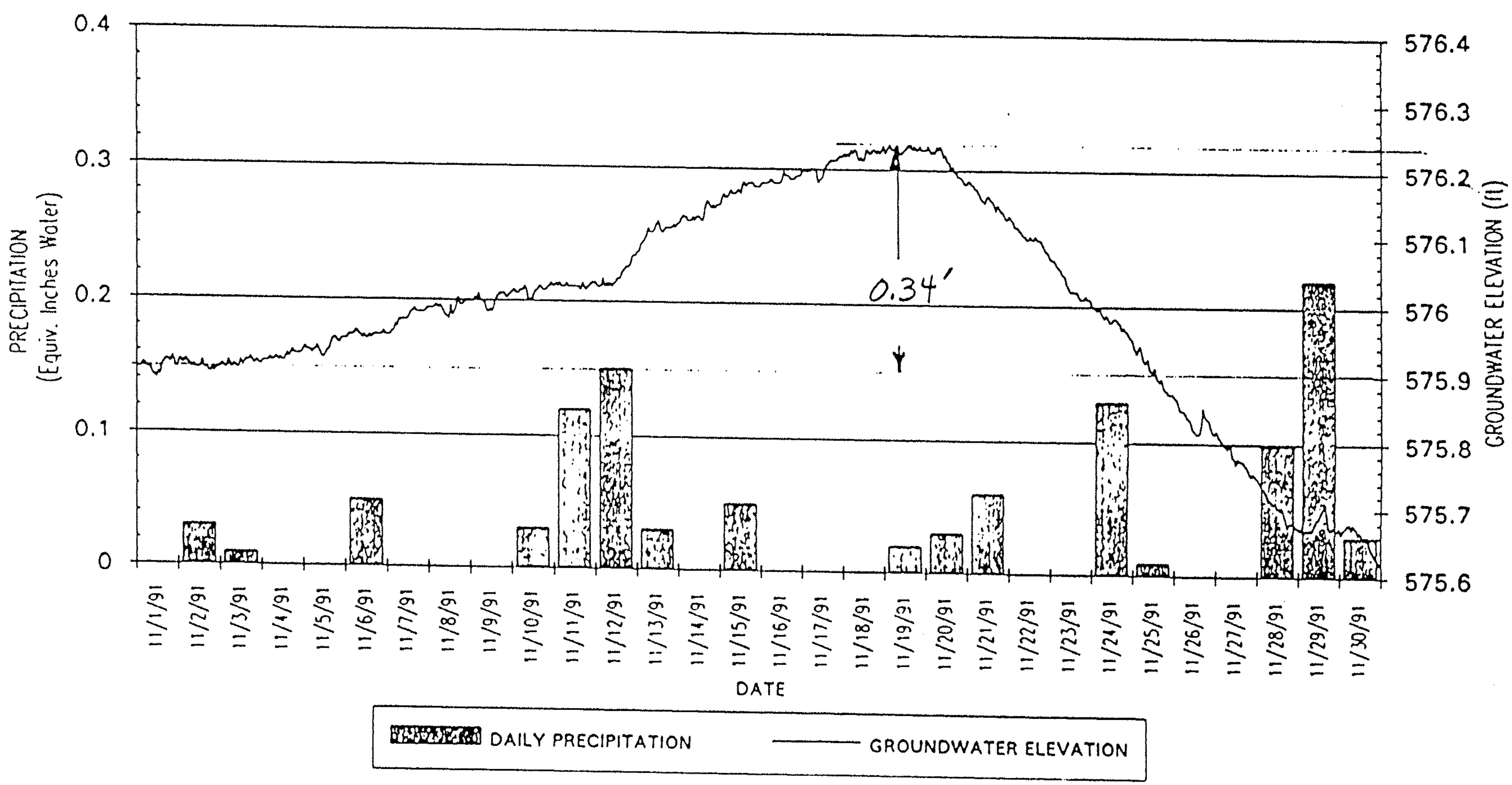



PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWS-12A
PRECIPITATION (Equiv. Inches Water)
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
GROUNDWATER ELEVATION (ft)
577
576.9
576.8
576.7
576.6
576.5
576.4
576.3
576.2
576.1
576
575.9
575.8
9/1/91
9/2/91
9/3/91
9/4/91
9/5/91
9/6/91
9/7/91
9/8/91
9/9/91
9/10/91
9/11/91
9/12/91
9/13/91
9/14/91
9/15/91
9/16/91
9/17/91
9/18/91
9/19/91
9/20/91
9/21/91
9/22/91
9/23/91
9/24/91
9/25/91
9/26/91
9/27/91
9/28/91
9/29/91
9/30/91
DATE
0.08'
0.16'
DAILY PRECIPITATION
GROUNDWATER ELEVATION

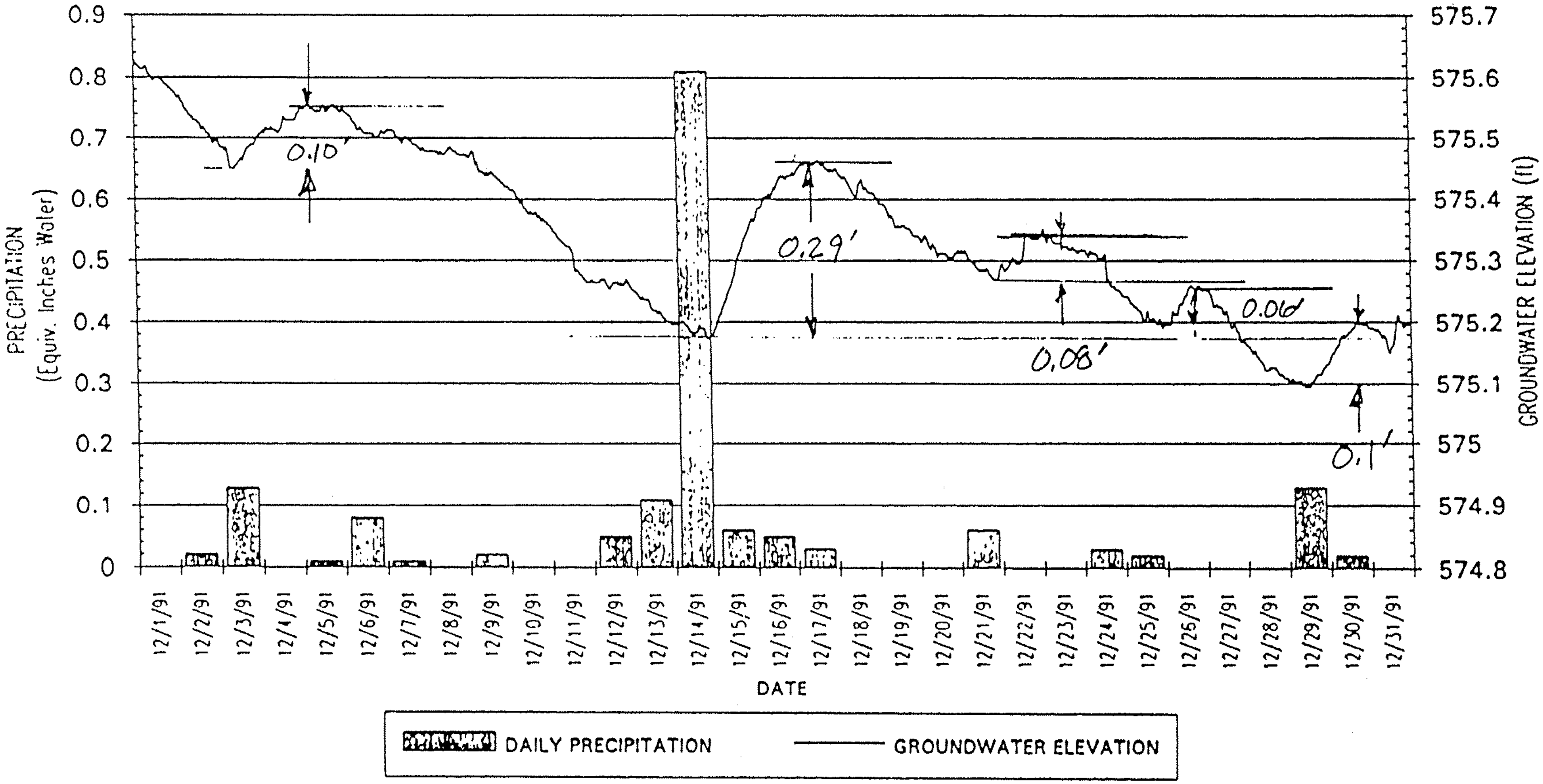
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION FOR WELL MWS-12A



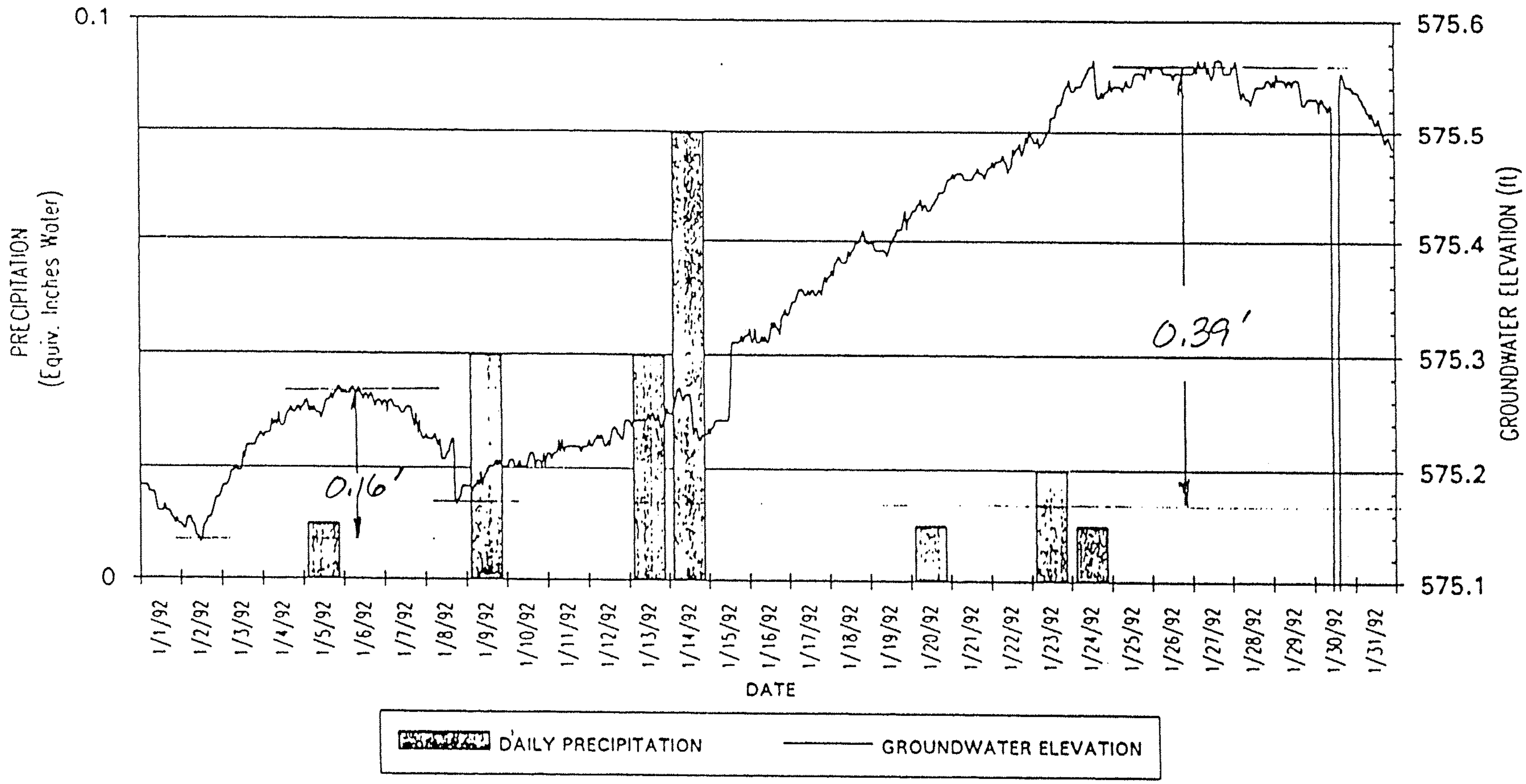
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWS-12A



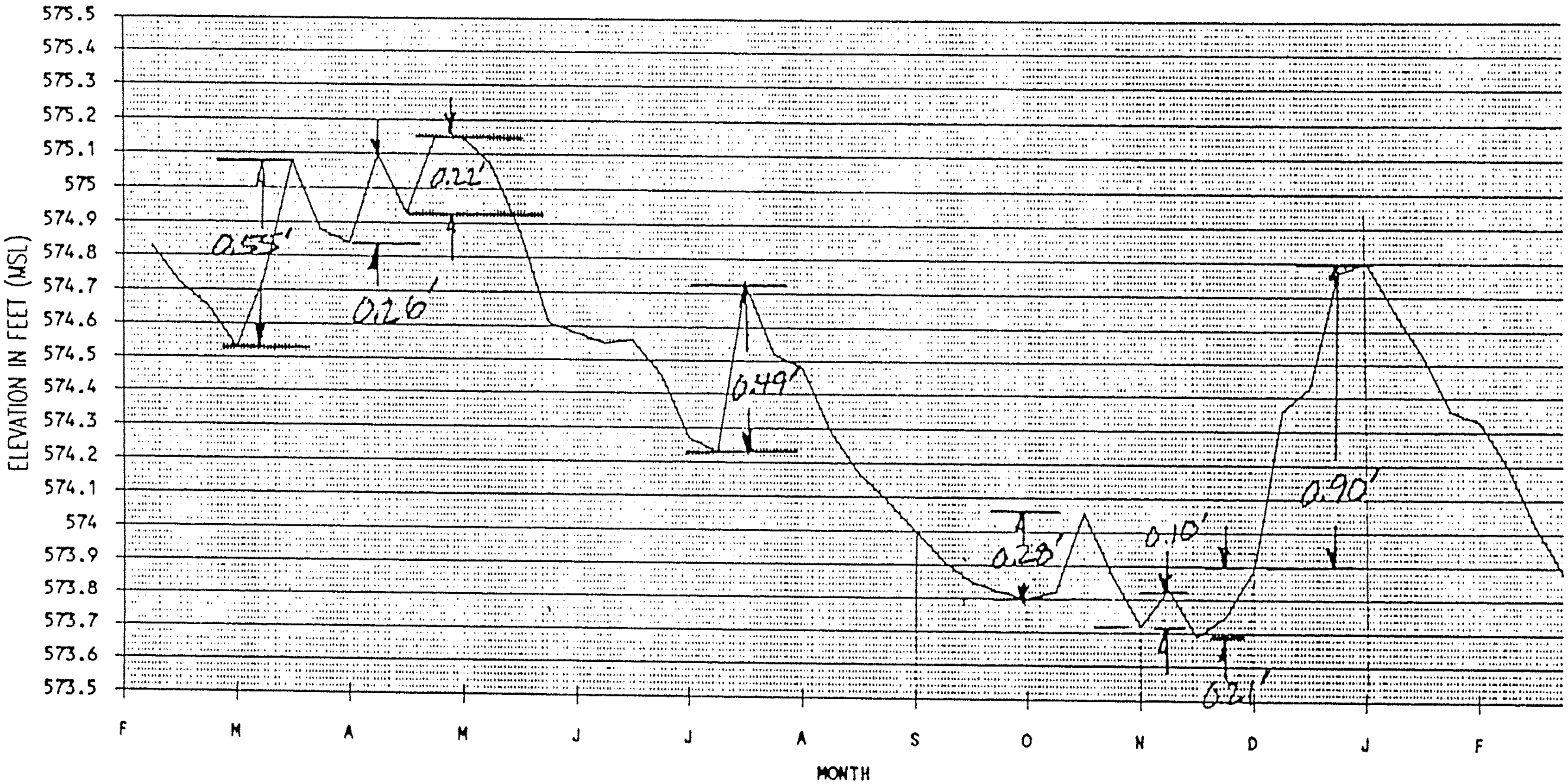
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWS-12A



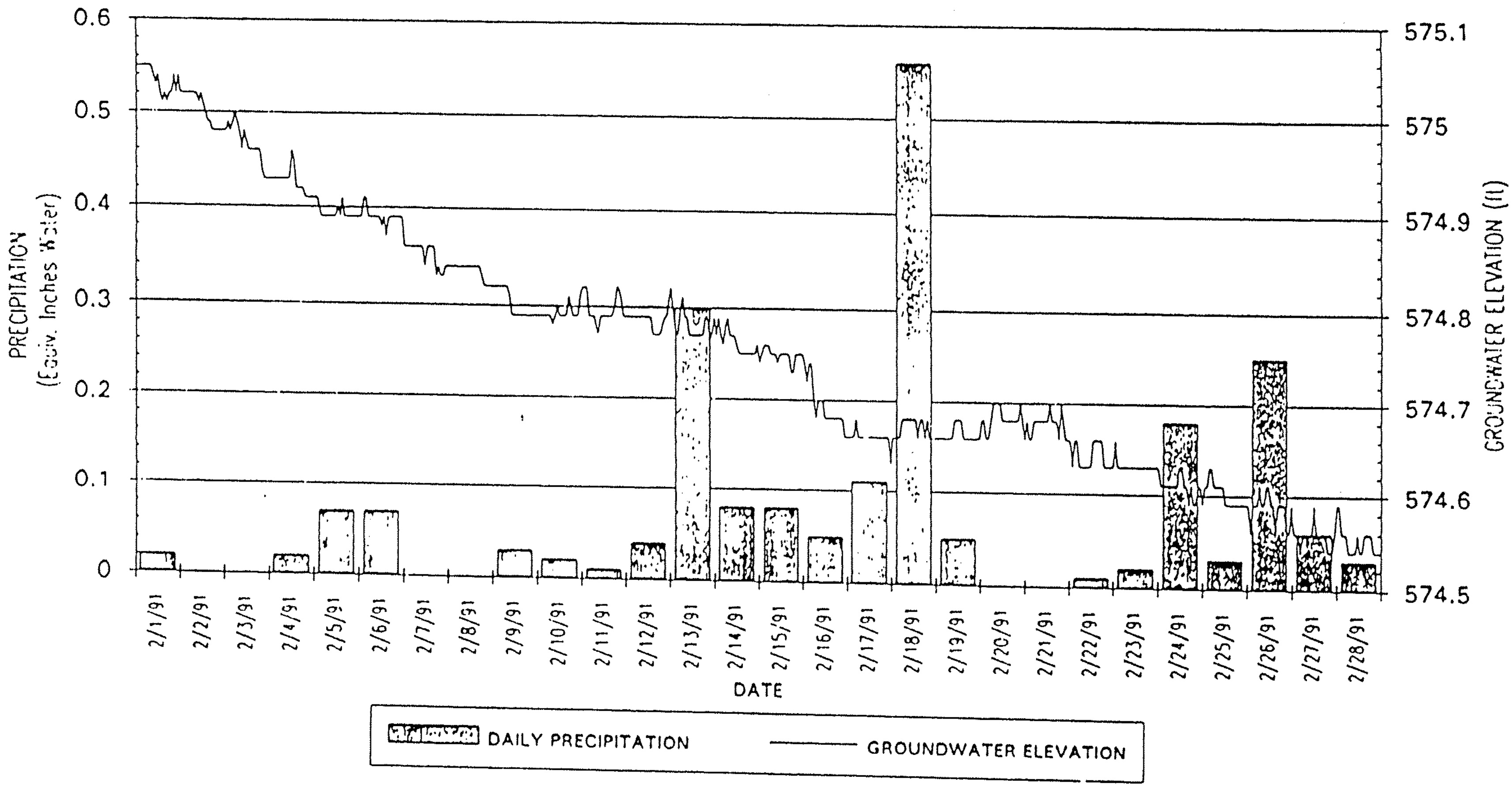
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWS-12A



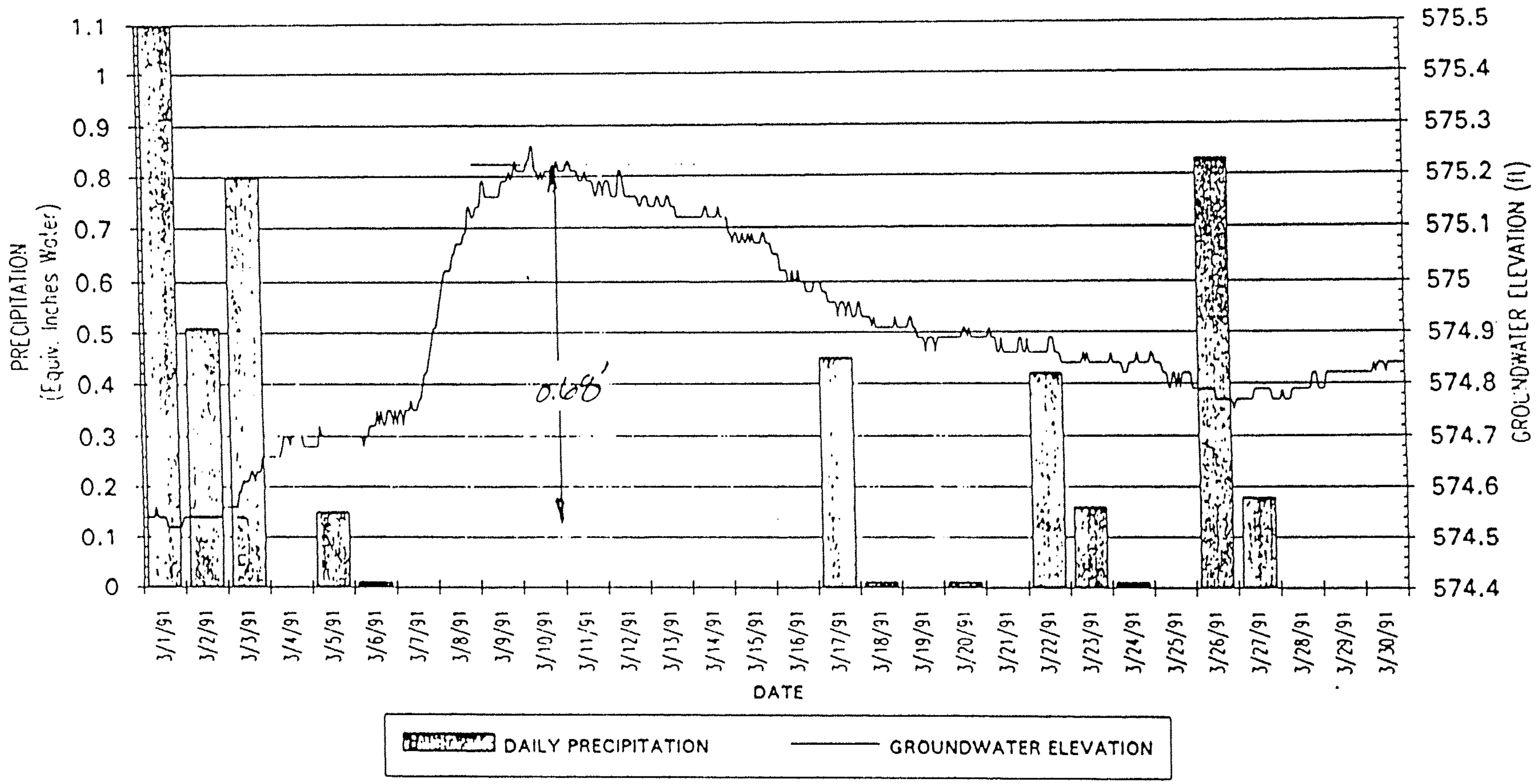
MONITORING WELL
MWN-13A



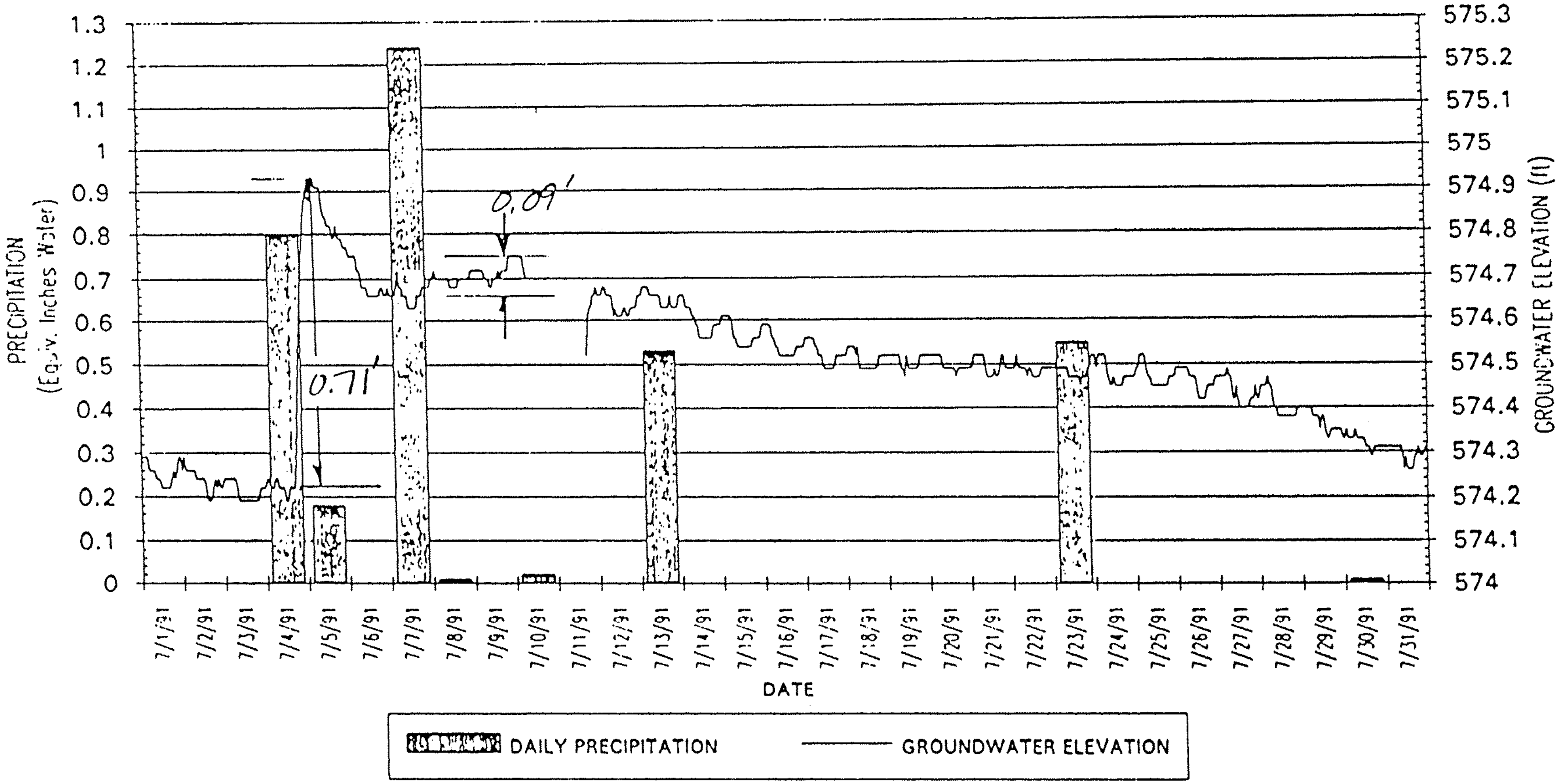
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWN-13A



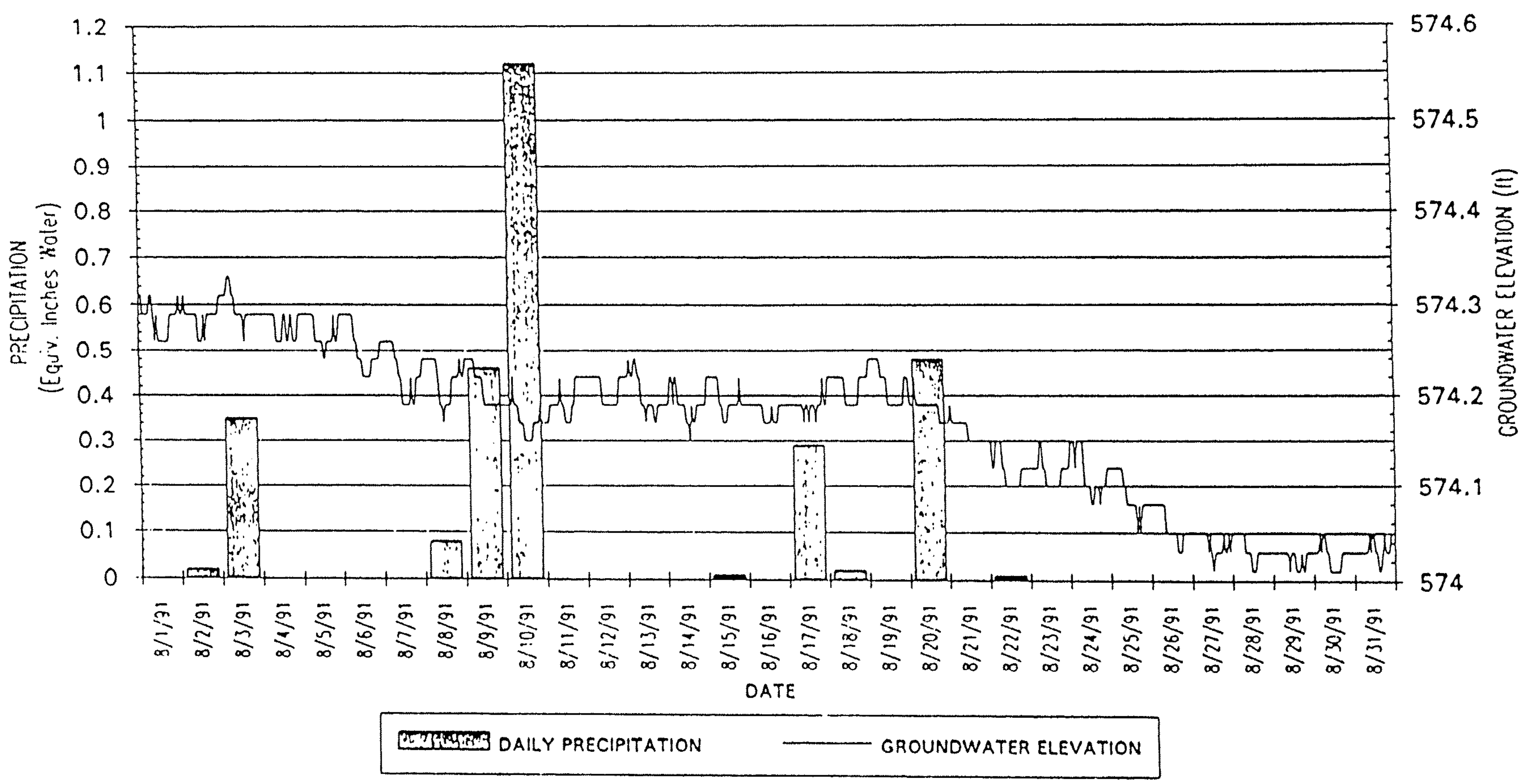
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION FOR WELL MWN-13A



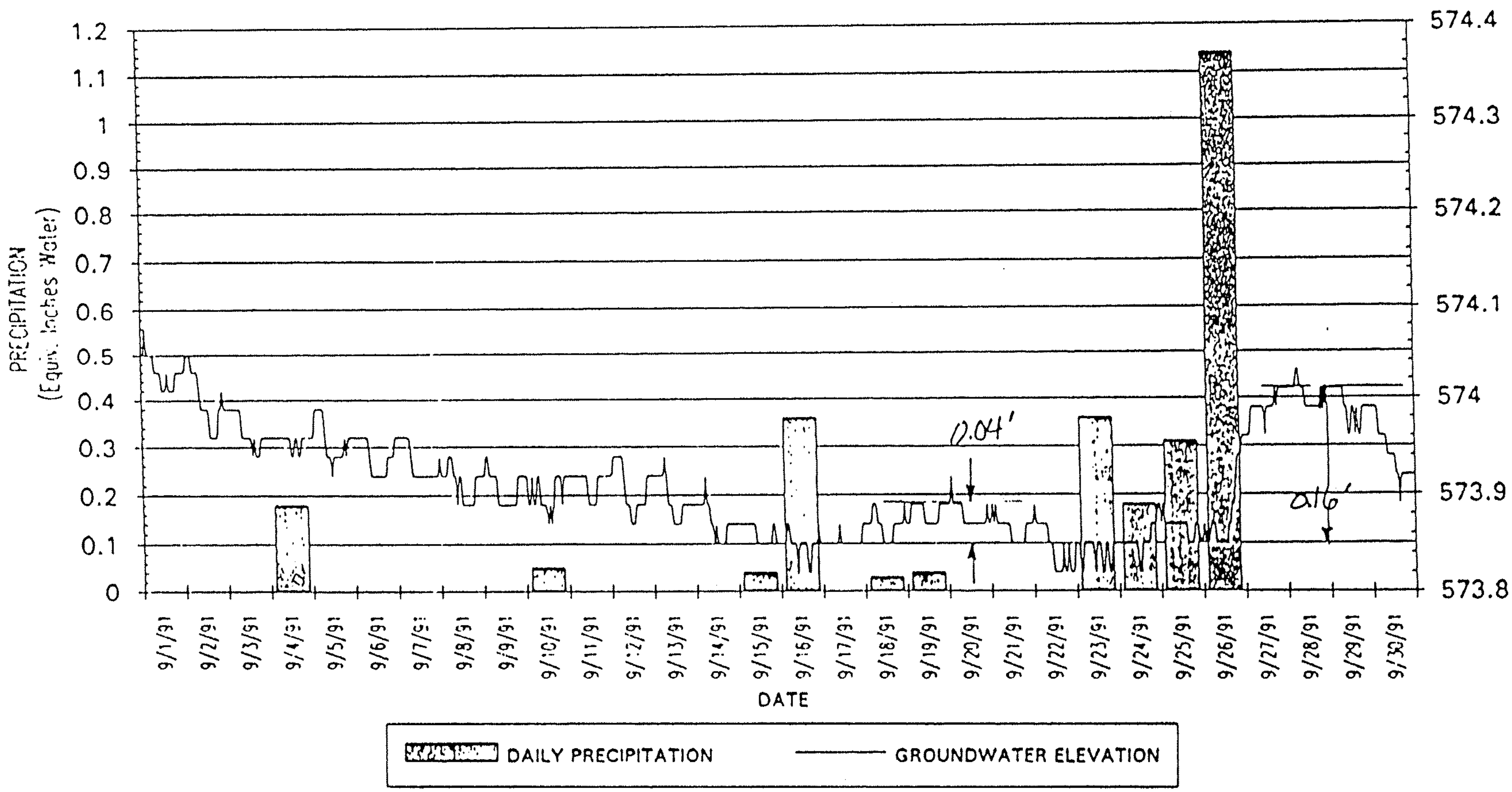
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION FOR WELL MWN-13A



PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWN-13A

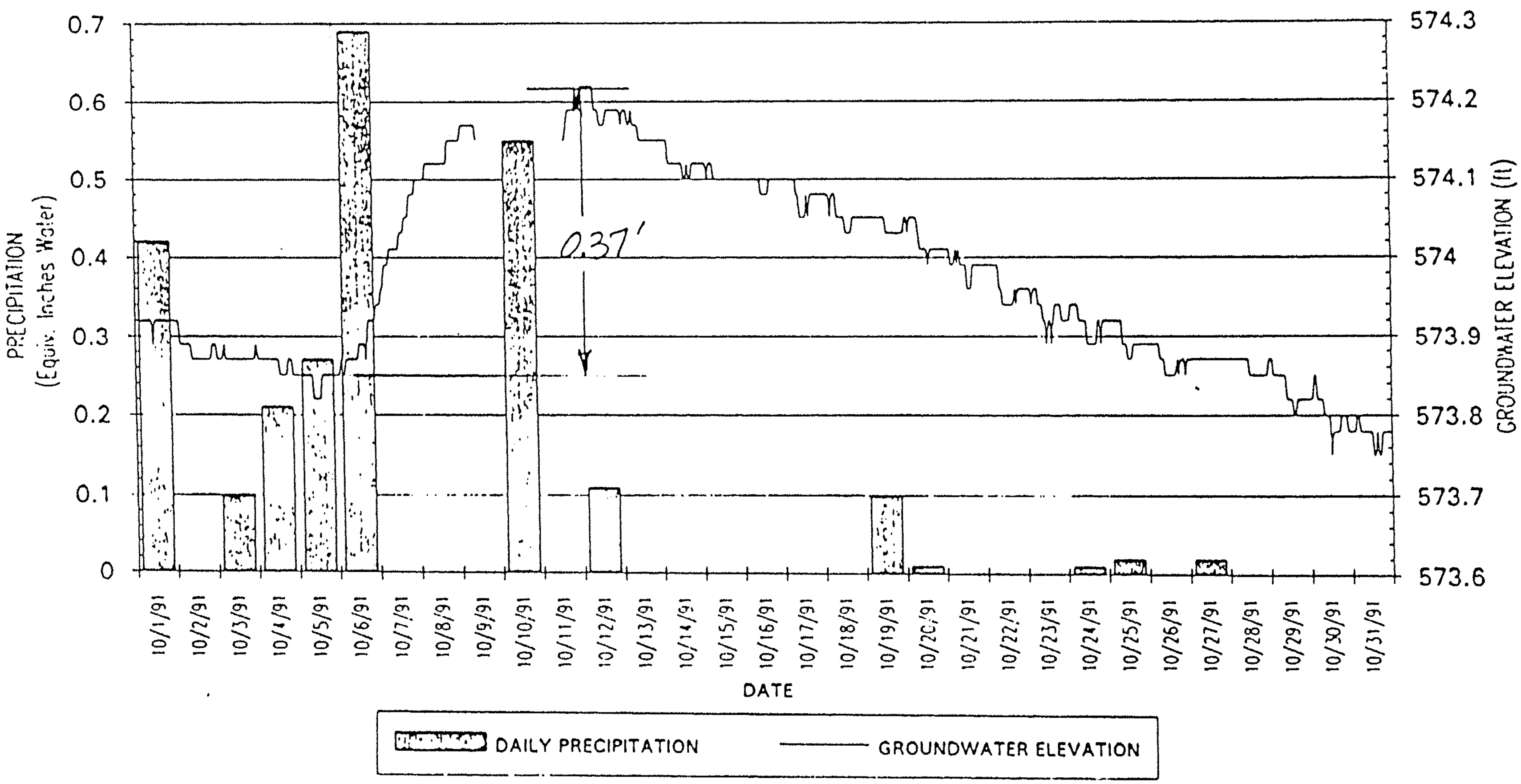


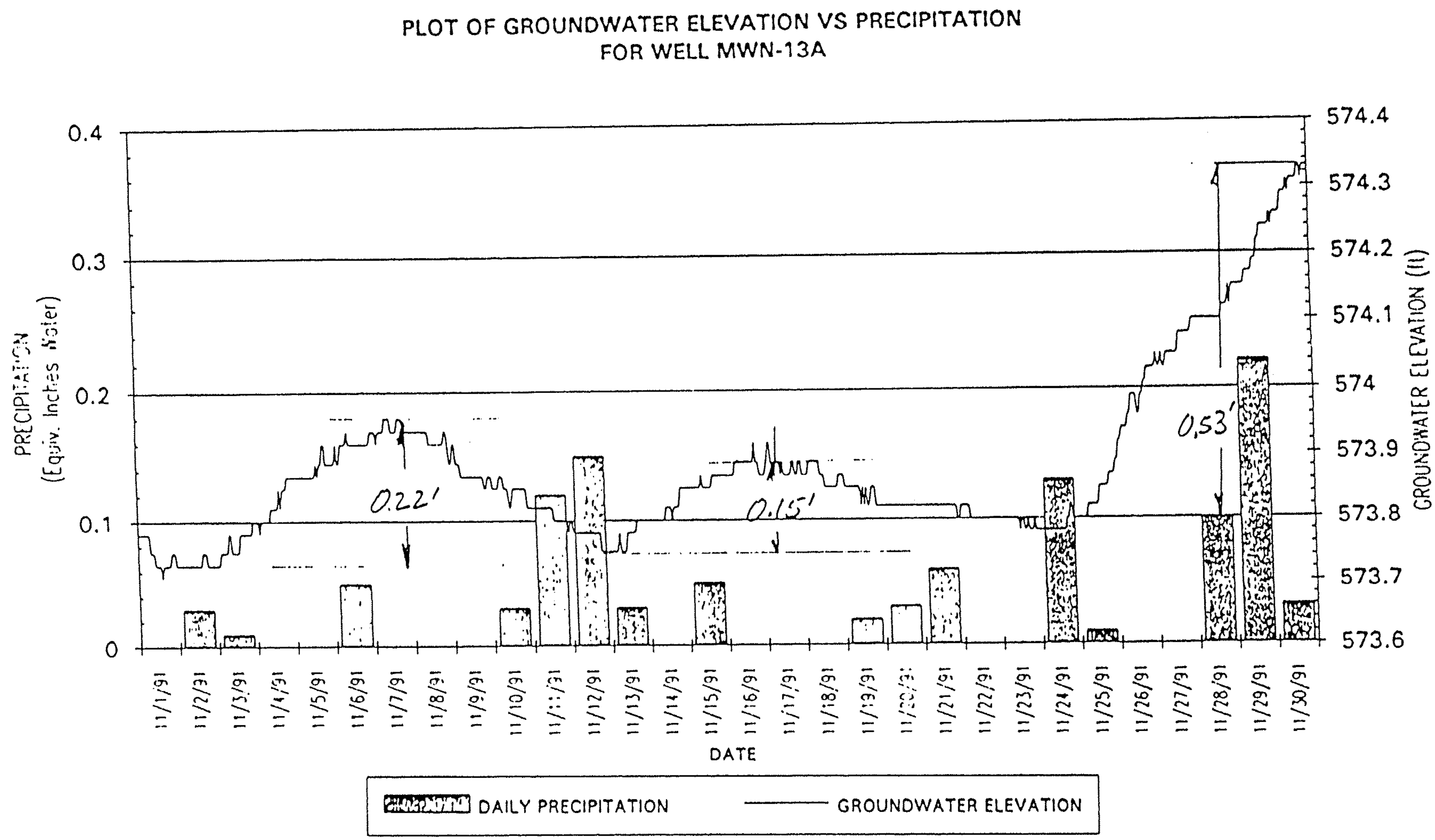
PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWN-13A



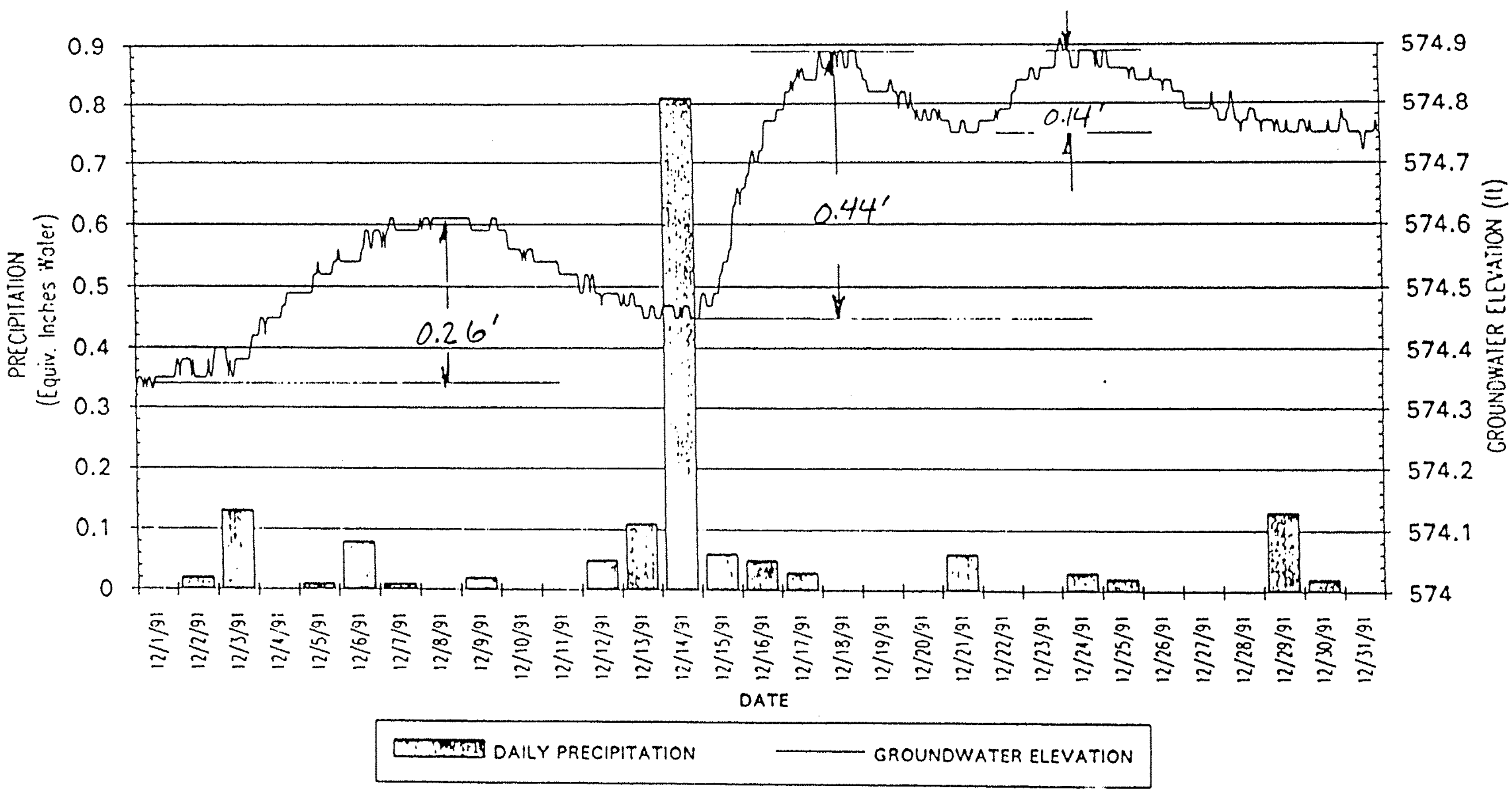
PRECIP.XLS Chart 20

PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWN-13A

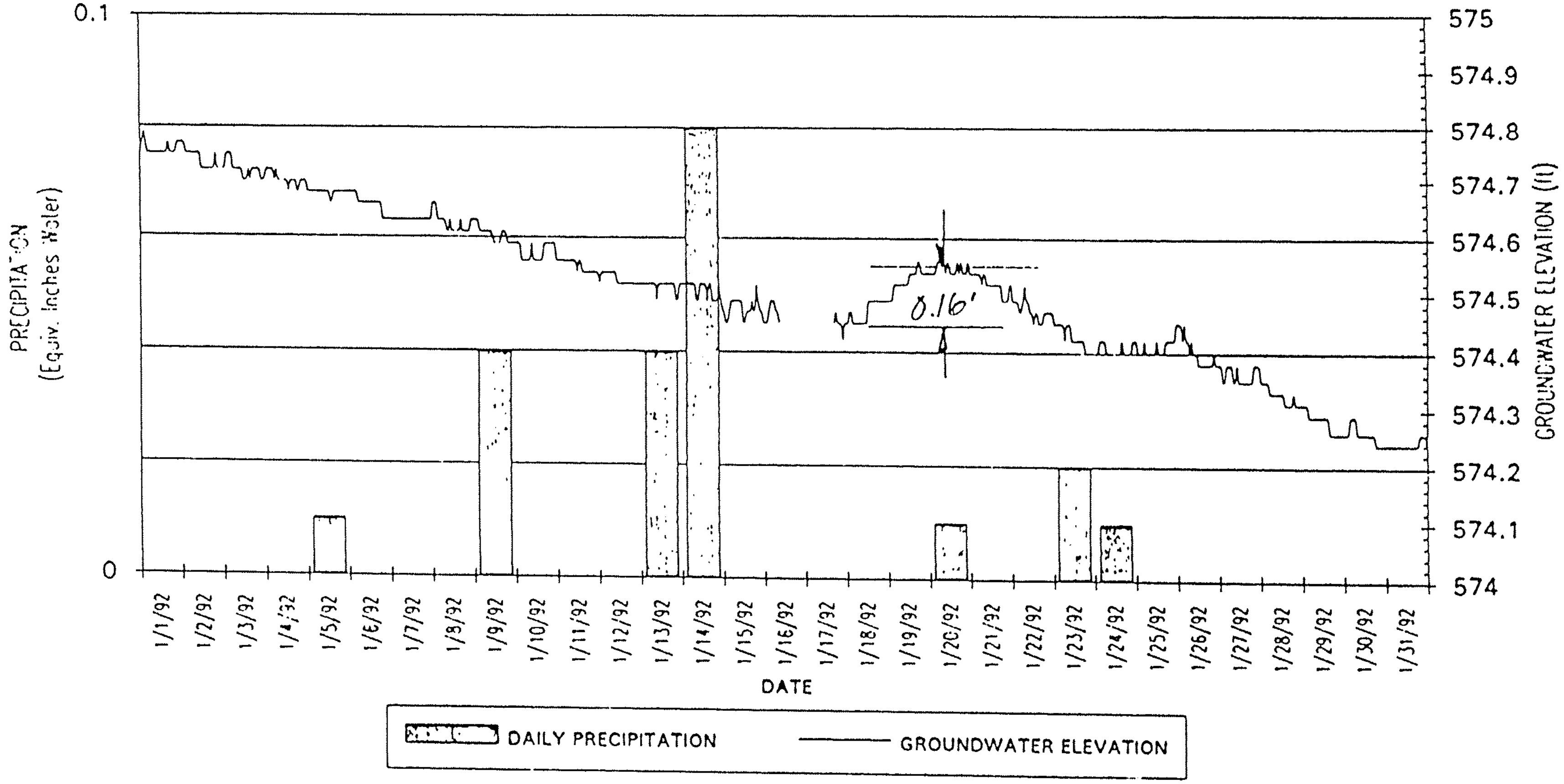



PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION
FOR WELL MWN-13A
PRECIPITATION (Equiv. Inches Water)
0.4
0.3
0.2
0.1
0
GROUNDWATER ELEVATION (ft)
574.4
574.3
574.2
574.1
574
573.9
573.8
573.7
573.6
11/1/91
11/2/91
11/3/91
11/4/91
11/5/91
11/6/91
11/7/91
11/8/91
11/9/91
11/10/91
11/11/91
11/12/91
11/13/91
11/14/91
11/15/91
11/16/91
11/17/91
11/18/91
11/19/91
11/20/91
11/21/91
11/22/91
11/23/91
11/24/91
11/25/91
11/26/91
11/27/91
11/28/91
11/29/91
11/30/91
DATE
0.22'
0.15'
0,53'
DAILY PRECIPITATION
GROUNDWATER ELEVATION

PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION FOR WELL MWN-13A



PLOT OF GROUNDWATER ELEVATION VS PRECIPITATION FOR WELL MWN-13A



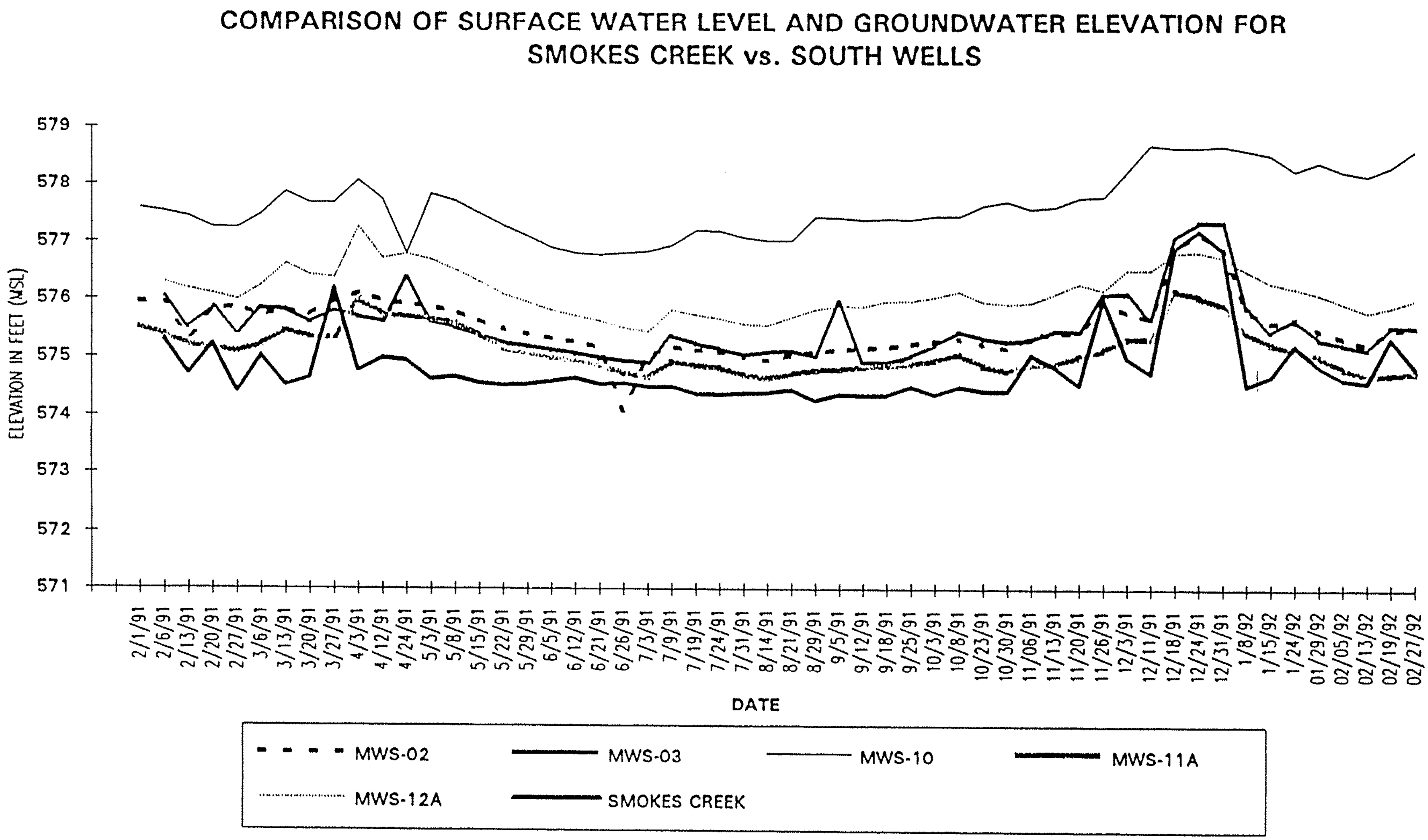
EVALUATION OF SURFACE WATER AND GROUNDWATER RELATIONSHIPS

The following three graphs present groundwater elevations relative to surface water elevations. Monitoring wells used in the evaluation are near the surface waters and further inland. The surface waters evaluated are Smokes Creek and Lake Erie. As shown on these graphs, the groundwater elevations are consistently higher than the surface water levels throughout the year. This results in a gradient causing groundwater flow to the surface waters. Based on this data, it is concluded that no reversal of this gradient occurs (surface water flow to the groundwater table). Even though the surface water elevation of Smokes Creek may rise above the groundwater elevations. However, this is short in duration and does not result in reversal of groundwater gradients. This is because rapid changes in the surface water levels are moderated by bank storage. Thus, short term fluctuations of the surface water levels are not evidenced in the interior wells and further supports the conclusion that no reversal of gradient occurs.

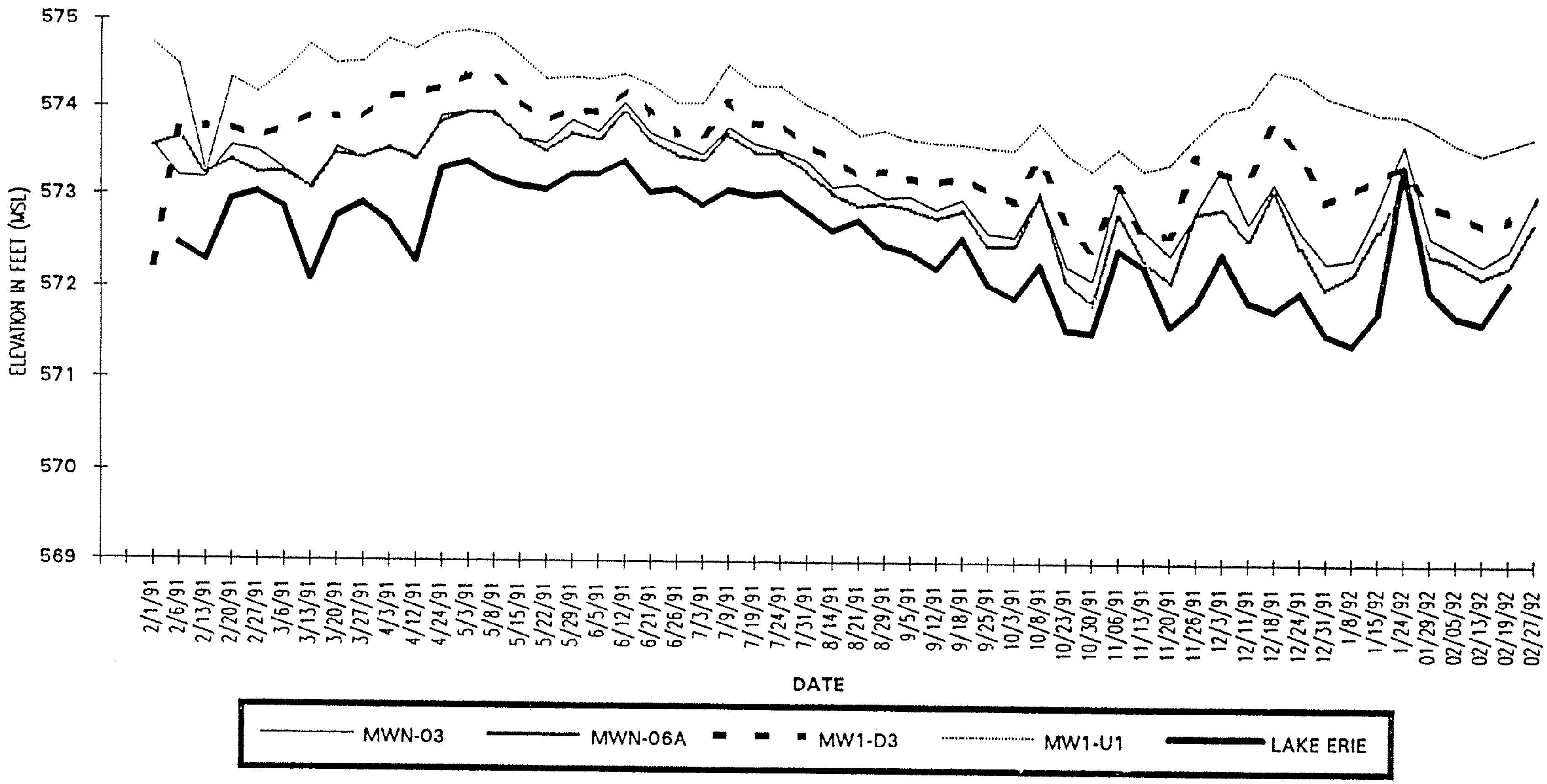
COMPARISON OF STILLING WELL LAKE LEVELS TO ARMY CORP OF ENGINEERS - CALCULATED GRADIENT

Date	Buffalo	Cleveland	Distance	Gradient
	water levels in feet (NGVD)		miles	ft/mile
Apr-91	572.97	573.1	191	0.000681
Jun-91	573.16	573.35	191	0.000995
Jul-91	572.94	573.03	191	0.000471

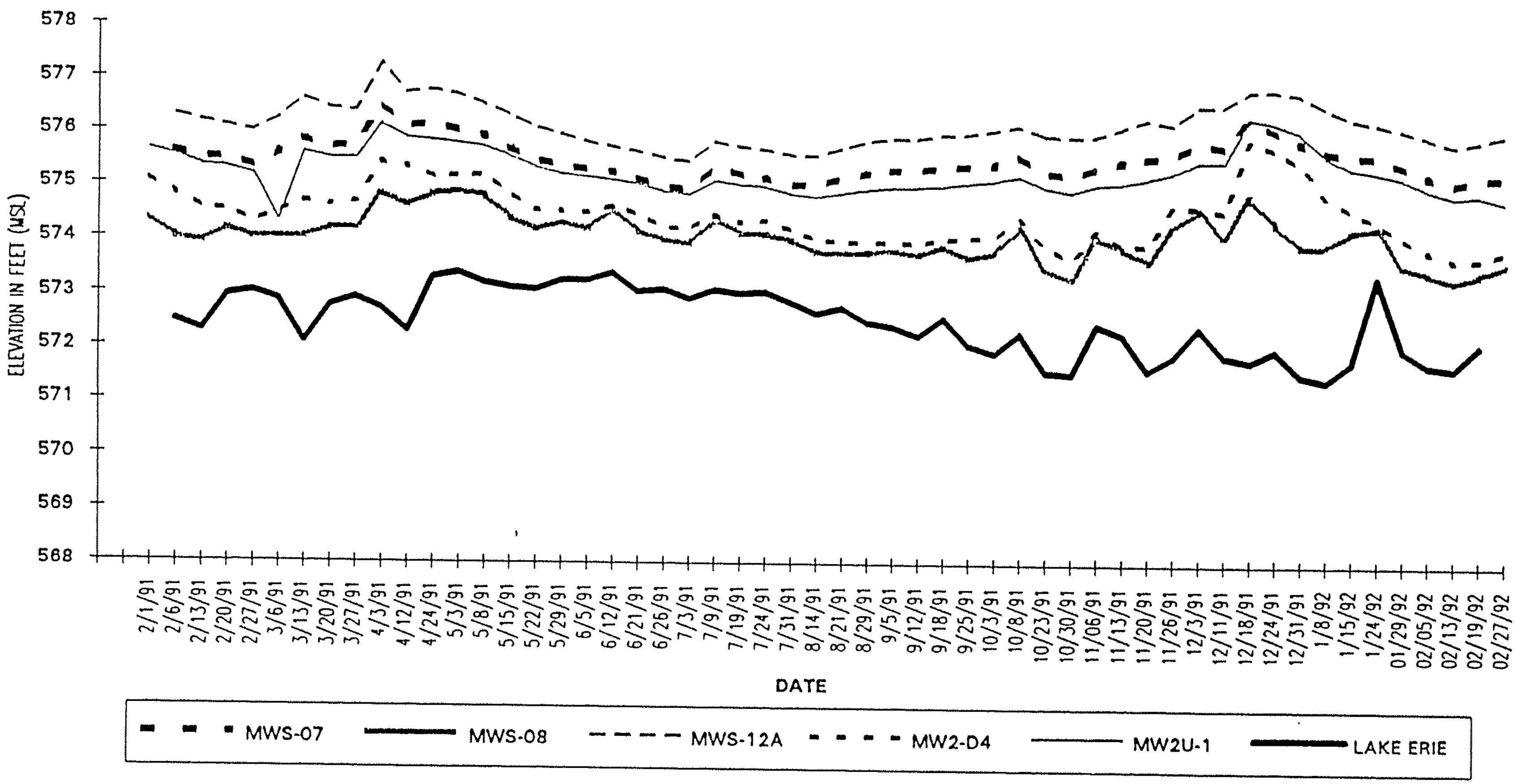
Average Gradient in ft/mile: 0.000716


COMPARISON OF SURFACE WATER LEVEL AND GROUNDWATER ELEVATION FOR
SMOKES CREEK vs. SOUTH WELLS
ELEVATION IN FEET (MSL)
579
578
577
576
575
574
573
572
571
2/1/91
2/6/91
2/13/91
2/20/91
2/27/91
3/6/91
3/13/91
3/20/91
3/27/91
4/3/91
4/12/91
4/24/91
5/3/91
5/8/91
5/15/91
5/22/91
5/29/91
6/5/91
6/12/91
6/21/91
6/26/91
7/3/91
7/9/91
7/19/91
7/24/91
7/31/91
8/14/91
8/21/91
8/29/91
9/5/91
9/12/91
9/18/91
9/25/91
10/3/91
10/8/91
10/23/91
10/30/91
11/06/91
11/13/91
11/20/91
11/26/91
12/3/91
12/11/91
12/18/91
12/24/91
12/31/91
1/8/92
1/15/92
1/24/92
01/29/92
02/05/92
02/13/92
02/19/92
02/27/92
DATE
MWS-02
MWS-03
MWS-10
MWS-11A
MWS-12A
SMOKES CREEK

COMPARISON OF SURFACE WATER LEVEL AND GROUNDWATER ELEVATION FOR LAKE ERIE vs. NORTH WELLS



COMPARISON OF SURFACE WATER LEVEL AND GROUNDWATER ELEVATION FOR LAKE ERIE AND SOUTH WELLS



APPENDIX J

GROUNDWATER TO SURFACE WATER CONSTITUENT LOADING CALCULATIONS – METHODS AND PARAMETERS

APPENDIX J

GROUNDWATER TO SURFACE WATER CONSTITUENT LOADING CALCULATIONS, METHODS AND PARAMETERS

APPENDIX J

BETHLEHEM STEEL LACKAWANNA PLANT
RCRA FACILITY INVESTIGATION
GROUNDWATER TO SURFACE WATER CONSTITUENT LOADING CALCULATIONS, METHODS AND PARAMETERS

(1) INTRODUCTION

During development of the draft RFI (BSC, July 1998) loading formulae were derived to quantify groundwater loadings to surface water at BSC's Lackawanna Facility (see Attachment A: Groundwater to Surface Water Constituent Loading Calculations – Methodologies and Parameters).

In their review comments, the USEPA responded that loading calculations that do not apportion flow, and consequently loadings, between the fill and sand unit are invalid. In response, BSC indicated loadings would be recalculated to take into account the apparent 10-fold difference in field hydraulic conductivity (and hence flow volume) between the fill and sand units (see Attachment B: BSC's 6/30/99 response comment letter – comment and response #44b and #45).

(2) PURPOSE

The purpose of this evaluation is to devise a methodology and loading formulae that takes into account the difference in flow as defined by field conductivities, between the fill and underlying sand unit. The derivation provided herein, builds upon the loading approach developed previously for the RFI (see Attachment A).

(3) DERIVATION

(A) **HYDRAULIC CONDUCTIVITY**: Representative hydraulic conductivities (K-values) derived from field test data obtained for the material units defined at the

Lackawanna site are presented in Section 2.0 of the RFI (Section 2.5.15 Hydraulic Conductivity).

For the fill and sand units, geometric mean and arithmetic mean values were evaluated (see Attachment C: Tables 2-21 and 2-22). Analysis of recharge-based and Darcy-based estimates of groundwater flow at the site, have shown that the arithmetic mean of the aquifer test data (which is approximately an order of magnitude greater than corresponding geometric mean values), provides a better estimate of hydraulic conductivity when compared with expected recharge based discharge volumes (see Attachment D: BSC's 6/30/99 response comment letter – comment and response #28g).

Therefore; representative average conductivity values to be used with this analysis are:

$$K_{FILL} = 2.04\ x\ 10^{-2}\ cm/\sec$$
$$K_{SAND} = 2.02\ x\ 10^{-3}\ cm/\sec$$

The site-wide averages for the fill and sand represent a subset of all conductivity tests performed at the site as discussed in Section 2.0. The above reported conductivity values meet the following test requirements:

(1) Test was performed for a period of greater than 0.5 minutes, and

(2) Only tests with well screens placed entirely within the unit being tested were used.

The resulting number of tests remaining in the data subsets (fill and sand units) were reviewed as sufficient for statistical evaluation and comparison.

(B) **<u>RECHARGE BASED DISCHARGE</u>**: Discharge of groundwater to all surface water bodies at the Lackawanna Facility, was determined by using a regional recharge rate ("I" in ft/yr) and multiplying the amount of infiltration by the area ("A" in ft^2) of the respective flow areas, i.e.:

$$Q_{AREA(i)} = I_{(ft/yr)}\ x\ A_{(ft2)}$$

The initial discharge estimates utilized a recharge rate of 1.0 ft/yr. The Agency, however, disputed the use of this value indicating that a higher infiltration rate would be expected due to low vegetation density and limited runoff observed at the site (see Attachment E: BSC's 11/23/98 response comment letter – comment #41).

To provide a more precise determination of the recharge rate, BSC monitored increases in groundwater levels resulting from precipitation events over a period of 1 year and multiplied the total rise in water level by the porosity of the granular fill at the site. In this way, BSC arrived at a site-specific value for recharge of 1.25 ft/yr to determine groundwater discharge (see Attachment F: BSC 3/4/99 response letter to USEPA – Specific Topic #3: Information Concerning Site Porosity and Recharge). This value was considered to be on the high side of the porosity range and would consequently provide conservative estimates of discharge.

Discharge to the Gateway Metroport Ship Canal was also calculated using the recharge method. Mounding conditions in the Coke Oven Area in the past have been attributed to lower hydraulic conductivity and artificial recharge from leaking underground water lines. Groundwater elevations were measured on June 4, 2004, almost three years after the Coke Ovens were shut down in September 2001 and about 2 years after all of the water lines in the area were deactivated. The most recent water elevation data show that the groundwater mound is essentially still the same shape and in the same locations as observed since site wide water level monitoring was begun in 1995. As a result, it seems reasonable to assume that the mound is clearly the result of physical conditions at the site and not leaking water lines (see Section 2.5.1.3). Therefore, recharge calculations are appropriate to estimate discharge to the canal.

DISCHARGE AREAS AND SHORELINE SEGMENTS: Total discharge for the Lackawanna site was divided up into six discharge flow boundary areas as shown in Figure 2-52 of Section 2.0, Part II of the RFI.. With the exception of Area #6 (east side of the Gateway Metroport Ship Canal), these areas were further partitioned into smaller subareas to conform with shoreline monitoring well designated to represent contiguous shoreline sections of the fill and sand units (Figure J-1). Lengths of the boundary zone over which discharge was estimated to occur for each area are provided in Table J-1 in Attachment G (Discharge Rate Calculations for Site Discharge Areas). Segments for the various discharge areas are shown on Figures 3-71 through 3-76 in Section 3.0 of the RFI.

Discharge from the shoreline of each segment was subsequently determined to be in proportion to the length of the shoreline segment (l_n) with respect to the entire discharge area length (l_t), i.e.:

$$Q_N = Q_{AREA(i)} \, {}^{l_n}\!/_{l_t}$$

The total groundwater discharge for each of the Discharge Areas is provided in Table J-1 in Attachment G.

(C) PARTITIONING FLOW BETWEEN FILL AND SAND UNITS:

The further apportionment of flow occurring in the respective fill and sand units within any flow segment was evaluated using Darcy's Flow Equation, i.e.,

$$Q_N = Q_{SAND} + Q_{FILL}$$

Where: Q=KiA

K = Hydraulic Conductivity

i = Hydraulic Gradient

A = Shoreline Discharge Sectional Area (length l_n x Unit thickness T)

Therefore:

$$Q_N = [K_S\, i_S\, T_S\, l_N] + [K_F\, i_F\, T_F\, l_N]$$

Assuming: $i_s = i_f = i$

$$Q_N = i\left([K_S\, T_S] + [K_F\, T_F] \right)$$

AND

$$Q_F = i\,[K_F\, T_F]$$

$$Q_S = i\,[K_S\, T_S]$$

The flow occurring through the fill and sand units would, therefore, be proportional to:

$$f_{Fill} = \frac{Q_F}{Q_N} = \frac{K_F\, T_F}{[K_S\, T_S] + [K_F\, T_F]}$$

$$f_{SAND} = \frac{Q_S}{Q_N} = \frac{K_S\, T_S}{[K_S\, T_S] + [K_F\, T_F]}$$

(NOTE: To assess flow, the average saturated thickness of the fill and sand units is used to represent the entire length of the shoreline discharge area.)

Finally, flow through the fill and sand units of any segment (l_n) would equal:

$$Q_{FILL(N)} = Q_{AREA(i)}\,\frac{l_{N\ (FILL)}}{l_t}\left[\frac{K_F\, T_F}{[K_S\, T_S] + [K_F\, T_F]}\right]$$

$$Q_{SAND(N)} = Q_{AREA(i)} \frac{l_{N(SAND)}}{l_t} \left[\frac{K_S \, T_S}{[K_S \, T_S] + [K_F \, T_F]} \right]$$

Calculation of the flow through the fill and sand units for each of the Discharge Segments is provided in Table J-1 (Attachment G).

(D) <u>CONSTITUENT LOADING</u>:

The loading of a constituent to the surface water is determined for each shoreline segment by multiplying the unit discharge by the concentration of the constituent (C_X) reported in the designated fill or sand unit well, i.e.:

$$L_{FILL(N)} = C_{X(FILL)} \, Q_{FILL(N)}$$

$$L_{SAND(N)} = C_{X(SAND)} \, Q_{SAND(N)}$$

(E) <u>CONCLUSIONS</u>:

Loading calculations were completed for Discharge Areas 1A, 1+A, 2A, 2B, 3A, 4A, 4B, and 5 at the Lackawanna facility. The total surface area of these Discharge Areas is 38.9 million square feet, and they discharge approximately 48.7 million cubic feet (i.e., 692 GPM) of groundwater to surface water each year (see Table J-1, Attachment G).

Since the hydraulic conductivity of the fill unit is estimated to be approximately 1 order of magnitude greater than the sand unit, and the sand unit is absent in some sections, 90% to 100% of the unconfined groundwater flow is predicted to occur through the fill unit.

N:\11172630.00000\GIS\PRESENT\rfl_report\ws_loading.apr SEGMENT LOCATIONS
8/3/2004

NOTE: See Figure 2-52 for location of discharge areas and groundwater flow direction.

URS

BETHLEHEM STEEL CORPORATION - LACKAWANNA, NY
SHORELINE SEGMENTS FOR LOADING CALCULATIONS

FIGURE J-1

ATTACHMENT A

DRAFT RFI-2ND INTERIM SUBMITTAL CONSTITUENT LOADING CALCULATIONS JULY 1998

APPENDIX J

GROUNDWATER TO SURFACE WATER CONSTITUENT LOADING CALCULATIONS - METHODOLOGIES AND PARAMETERS

Estimations of contaminant loadings were performed using recharge-based groundwater discharge rates to surface water bodies (Section 2.7) and the average concentrations of shoreline segments nearest the surface water bodies, as indicated by isoconcentration contours derived from the most recent data for each principal constituent at each monitoring well at the site (Figures 3-4 through 3-9).

First, the total groundwater discharge (Q) into a given surface water body was partitioned to smaller areas for a more detailed analysis, and the lengths of the boundary zones over which discharge is occurring in each area were estimated from Figure 2-47. For example, as detailed in Section 2.7.2, the total (recharge-based) discharge of groundwater from the site to Lake Erie is approximately 0.991 cfs. This discharge occurs from Discharge Areas 1, 2A, 4A, and 4B. The discharge to Lake Erie from the area north of Smokes Creek, from Discharge Areas 4A and 4B, is approximately 0.588 cfs (Section 2.7.2; Table 2-29), and occurs over a zone approximately 6,600 feet long (Figure 2-47). Similarly, the discharge to Lake Erie from the area south of Smokes Creek, i.e., from Discharge Areas 1 and 2A, is approximately 0.403 cfs (Section 2.7.2; Table 2-29), and occurs over a zone approximately 6,000 feet long (Figure 2-47). For Smokes Creek, the total site-derived groundwater discharge to this surface water body is derived from Discharge Areas 2B and 3, and their respective discharges (0.037 cfs and 0.332 cfs) are shown in Table 2-29 and discussed in Section 2.7.2. The lengths of the boundary zones for these areas are approximately 2,610 and 10,290 feet, respectively (Figure 2-47). For the Ship Canal, the total site-derived groundwater discharge to this surface water body is derived from Discharge Areas 5 and 6, and their respective discharges (0.035 cfs and 0.327 cfs) are shown in Table 2-29 and discussed in Section 2.7.2. However, because the distributions of benzene, naphthalene, and phenol show that the contaminant plumes do not exist east of the Ship Canal within Discharge Area 6, only Discharge Area 5, from which discharge occurs along a boundary zone 4,000 feet in length (Figure 2-47), was considered in the loading estimates.

Next, for a given constituent within a given area, segments between isoconcentration lines were identified. The average concentrations of these segments were taken to be the mean of the concentrations represented by the isoconcentration lines that enclosed them. For each area, the lengths of all segments with the same average concentration were summed. This was done separately for the fill and sand unit distributions, because isoconcentration contours for a given constituent in groundwater from the fill and sand units were usually different. The average thicknesses of saturated fill and sand were identified from the relevant geologic cross-sections (Figures 2-32, 2-33, 2-36, and 2-38). The total loading associated with each such composite segment was then calculated by the following formulae:

$$Loading_{fill\ unit\ segment} = Avg.\ Conc._{fill\ segment} * Q_{area} * (Length_{segment} / Length_{discharge\ area}) * (\text{saturated thickness of fill / total saturated thickness}).$$

$$Loading_{sand\ unit\ segment} = Avg.\ Conc._{sand\ segment} * Q_{area} * (Length_{segment} / Length_{discharge\ area}) * (\text{saturated thickness of sand / total saturated thickness}).$$

The next step was to add the individual loadings for each segment to obtain estimates of the total loadings for both the fill and sand units for each area. In turn, the sum of these values gave the total estimated loadings for each of the areas under consideration. The input parameters and output values for benzene, naphthalene, and phenol loadings to Lake Erie, Smokes Creek, and the Ship Canal are given in Tables J-1, J-2, and J-3. The detection levels for benzene, naphthalene, and phenol were taken to be 5 μg/L, 10 μg/L, and 10 μg/L, respectively.

When isoconcentration contours for a given segment indicated contaminant concentrations below the detection limit, a value of one-half of the detection limit was used as a conservative estimate of contaminant concentration in that segment.

In addition to estimating total loadings, the average concentration increment in the receiving surface water bodies was estimated for each constituent. This was accomplished by first calculating the average concentration of a constituent derived from a given unit (fill or sand), weighted according to individual segment lengths, according to the following formula:

$$Avg.Conc. = \frac{\sum_{i=1}^{n}(conc._{segment} * Length_{segment})}{\sum_{i=1}^{n}(Length_{segment})}$$

This calculation was also performed for the sand unit. Next, the average concentrations of the fill and sand units for a given area were then summed, taking into account the fraction of the total discharge accounted for by each, to obtain the total average concentration for groundwater originating in that area. These calculations were performed according to the following formula:

$$\text{Avg. Conc.}_{area} = (\text{Avg. Conc.}_{fill} * (\text{saturated thickness of fill / total thickness})) + (\text{Avg. Conc.}_{sand} * (\text{saturated thickness of sand / total thickness})).$$

To obtain the predicted surface water concentration increment associated with a given area, the area's average concentration was then multiplied by the groundwater discharge rate that corresponds to the fraction of the total discharge length (L) along which the constituents emanate, divided by the surface water body's mean flow rate, as follows:

$$\text{Predicted Conc. Increment} = \text{Avg. Conc.}_{area} * (Q_{area} * L_{conc.} / L_{total}) / Q_{surface\ water}.$$

ATTACHMENT B

BSC'S 6/30/99 RESPONSE LETTER
FILL AND SAND UNIT HYDRAULIC CONDUCTIVITIES

June 30, 1999

Mr. Dale J. Carpenter
Project Coordinator
United States Environmental Protection Agency - Region II
RCRA Programs Branch
Division of Environmental Planning and Protection
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: Response to EPA Comments on Sections 3 & 4 of Draft RFI Report
Bethlehem Steel Corporation
Administrative Order on Consent;
Docket No. II-RCRA-90-3008(h)-0201

Dear Mr. Carpenter:

In response to your letter of April 30, 1999 this letter provides an agenda, and other related information, for a meeting between Bethlehem Steel Corporation (BSC), U.S. Environmental Protection Agency Region II (EPA), and New York State Department of Environmental Conservation (NYSDEC).

BSC has considered EPA's comments on Section 3 (Groundwater and Surface Water) and Section 4 (Ecological Risk Assessment) presented in the letter dated March 23, 1999. For the purpose of identifying comments that BSC would like to discuss at the meeting, we have divided the comments on the major sections into categories. Each of these categories is discussed separately below.

GROUNDWATER AND SURFACE WATER

The comments on Section 3, and related Tables, Figures and Appendices may be considered in five categories:

I • Comments Requesting Changes in Wording and Minor Revisions, Clarification or Correction of Factual Issues – For most of the editorial comments in this category, BSC will make the revisions as requested. BSC will correct any information that is in error, and clarification will be provided where available. A few comments are not clear and response to Comment 24.

44. Page 3-50, Section 3.6.1

The NYSDEC believes that BSC has incorrectly apportioned recharge/discharge areas at the Site. Based on Site characteristics, the area of the Site that discharges to the Metroport Ship canal needs to be increased substantially, by setting the flow divide further west. This will increase loadings to the ship canal, since more flow will occur through a boundary with higher concentrations.

BSC Response:
Piezometric data indicate that the groundwater divide is properly located. Exactly what is meant by "based on site characteristics" needs to be clarified by the Agency before BSC can respond further to this comment.

a. Comments provided above may affect the apportionment of recharge/discharge areas at the Site.

BSC Response:
Comment noted.

b. The contaminant loading calculations to surface water include groundwater discharge assumptions based on the saturated thickness of the underlying fill or sands. However, the calculations do not appear to account for the varying hydraulic conductivity properties of the fill and sand units. Section 2.5.4, Page 2-40 of Section 2 of the Draft RFI indicated that the fill (k=3.7 ft/day) is generally ten times more conductive than the sand unit (k=0.3 ft/day). For a given saturated thickness, BSC's methodology would assign equal flows to both units, while the field data suggest the flows in each unit differ by a factor of 10. Loadings calculations that do not correctly apportion flow are invalid. Therefore, the model input parameters shall be reviewed and revised as appropriate.

The loading calculations were based on recharge-based discharge rates. No attempt was made to account for the apparent difference in hydraulic conductivity between the fill and sand units because of the results of the modeling in Appendix I, which suggested that little difference exists. However, a recalculation of the loadings that accounts for this apparent 10-fold difference in flow rate between the fill and sand units will be made.

ATTACHMENT C

AQUIFER TESTING RESULTS FOR TESTS LONGER THAN 0.5 MINUTES AND WELLS SCREENED IN ONLY THE FILL OR SAND

Table 2-21
Hydraulic Conductivity Values for Fill Wells
(>0.5 minutes and screened in Fill Unit only)
Bethlehem Steel Corporation
Lackawanna, New York

Phase/ Investigation	Well	GIS Strat Unit[1]	Test Type	K, cm/sec	Pump Test (PT), Falling (F) or Rising (R) Head Slug Test	Time (sec)	Time min)
PHASE I	MW-06A	F	Bouwer-Rice	2.42E-04	F	519	9
PHASE I	MW-08A	F	Bouwer-Rice	2.30E-05	F	5070	85
PHASE I	MW-1D1	F	Bouwer-Rice	1.40E-04	F	733	12
PHASE I	MW-1D2	F	Bouwer-Rice	2.34E-03	F	272	4.533
PHASE I	MW-1D3	F	Bouwer-Rice	1.70E-02	F	41	0.683
PHASE I	MW-1D4	F	Bouwer-Rice	6.43E-03	F	199	3.317
PHASE IIA	MW-1D6	F	Bouwer-Rice	3.70E-04	F	225	3.750
PHASE IIA	MW-1D8	F	Bouwer-Rice	1.65E-03	F	77	1.283
PHASE I	MW-2D2	F	Bouwer-Rice	4.33E-03	F	81	1.350
PHASE I	MW-2D4	F	Bouwer-Rice	2.47E-03	F	276	4.600
PHASE IIA	MWN-01	F	Bouwer-Rice	5.04E-02	R	205	3.417
PHASE I	MWN-02	F	Cooper Jacob	4.50E-01	PT	7470	124.5
PHASE I	MWN-03	F	Bouwer-Rice	6.92E-03	F	39	0.7
PHASE IIA	MWN-03	F	Bouwer-Rice	7.62E-03	R	146	2.4
PHASE I	MWN-04	F	Bouwer-Rice	2.04E-05	F	4020	67.0
PHASE IIA	MWN-04*	F	Bouwer-Rice	1.69E-06	R	15675	261
PHASE IIA	MWN-04*	F	Bouwer-Rice	2.85E-05	R	15675	261
	*MWN-04	Average value		1.51E-05	R	NA	
PHASE I	MWN-04	F	Theis	2.86E-04	PT	49800	830.0
PHASE I	MWN-05A	F	Cooper Jacob	2.77E-02	PT	2760	46.0
PHASE I	MWN-06A	F	Theis	2.35E-01	PT	5100	85.0
PHASE I	MWN-08	F	Bouwer-Rice	5.20E-03	F	517	8.62
PHASE I	MWN-09	F	Bouwer-Rice	7.00E-02	F	37	0.62
PHASE I	MWN-10	F	Bouwer-Rice	5.67E-03	R	240	4.00
PHASE I	MWN-11	F	Bouwer-Rice	1.00E-02	F	96	1.60
PHASE I	MWN-12	F	Bouwer-Rice	5.33E-03	F	184	3.07
PHASE I	MWN-13A	F	Bouwer-Rice	1.28E-04	F	3040	51
PHASE IIA	MWN-13A*	F	Bouwer-Rice	1.90E-04	R	3946	66
PHASE IIA	MWN-13A*	F	Bouwer-Rice	1.43E-05	R	4000	67
	*MWN-13A	Average value		1.02E-04	R	NA	
PHASE IIA	MWN-16B	F	Cooper Jacob	1.55E-04	PT	1576	26
PHASE IIB	MWN-21A	F	Bouwer-Rice	6.31E-03	F	116	1.93
PHASE IIB	MWN-21A	F	Bouwer-Rice	7.07E-03	R	74	1.23
PHASE IIB	MWN-26A	F	Bouwer-Rice	4.72E-03	F	107	1.78
PHASE IIB	MWN-26A	F	Bouwer-Rice	3.81E-03	R	102	1.70
PHASE III	MWN-30A	F	Bouwer-Rice	5.29E-02	R	106	1.77
PHASE III	MWN-34A	F	Bouwer-Rice	5.32E-03	F	52	0.87
PHASE III	MWN-34A	F	Bouwer-Rice	2.90E-03	R	91	1.52
Supplemental	MWN-39A	F	Bouwer-Rice	2.19E-02	R	960	16.00
Supplemental	MWN-39A	F	Bouwer-Rice	1.67E-02	F	1287	21.45
Supplemental	MWN-52A	F	Bouwer-Rice	4.62E-02	R	197.64	3.29
Supplemental	MWN-52A	F	Bouwer-Rice	5.68E-02	F	30.54	0.51
PHASE I	MWS-02	F	Bouwer-Rice	3.72E-05	F	2026	33.77
PHASE I	MWS-04	F	Bouwer-Rice	9.51E-04	F	310	5.17

Table 2-21
Hydraulic Conductivity Values for Fill Wells
(>0.5 minutes and screened in Fill Unit only)
Bethlehem Steel Corporation
Lackawanna, New York

Phase/ Investigation	Well	GIS Strat Unit(1)	Test Type	K, cm/sec	Pump Test (PT), Falling (F) or Rising (R) Head Slug Test	Time (sec)	Time min)
PHASE I	MWS-05	F	Bouwer-Rice	4.42E-03	R	430	7.17
PHASE I	MWS-05	F	Theis	1.99E-03	PT	300	5.00
PHASE I	MWS-07	F	Bouwer-Rice	1.46E-03	F	665	11.08
PHASE IIA	MWS-07	F	Bouwer-Rice	1.28E-02	R	145	2.42
PHASE I	MWS-08	F	Cooper Jacob	1.54E-02	PT	4110	33.00
PHASE I	MWS-09	F	Bouwer-Rice	2.74E-03	R	432	7.20
PHASE I	MWS-10	F	Bouwer-Rice	4.45E-05	F	1694	28.23
PHASE I	MWS-11A	F	Bouwer-Rice	2.00E-02	F	36	0.60
PHASE I	MWS-12A	F	Bouwer-Rice	1.33E-04	F	857	14.28
PHASE I	MWS-12B	F	Bouwer-Rice	1.60E-03	F	237	3.95
PHASE I	MWS-12B	F	Theis	1.18E-03	PT	680	11.33
PHASE IIB	MWS-18A	F	Bouwer-Rice	1.51E-04	F	1649	27.48
PHASE IIB	MWS-18A	F	Bouwer-Rice	5.12E-05	R	15970	266.17
PHASE III	MWS-22A	F	Bouwer-Rice	1.81E-04	F	749	12.48
PHASE III	MWS-22A	F	Bouwer-Rice	5.13E-03	R	849	14.15
1994	MWS-22A	F	Bouwer-Rice	5.68E-05	R	850	14.00
PHASE III	MWS-23A	F	Bouwer-Rice	3.18E-03	F	47	0.78
PHASE III	MWS-25A	F	Bouwer-Rice	6.36E-04	F	555	9.25
PHASE III	MWS-25A	F	Bouwer-Rice	5.78E-03	R	342	5.70

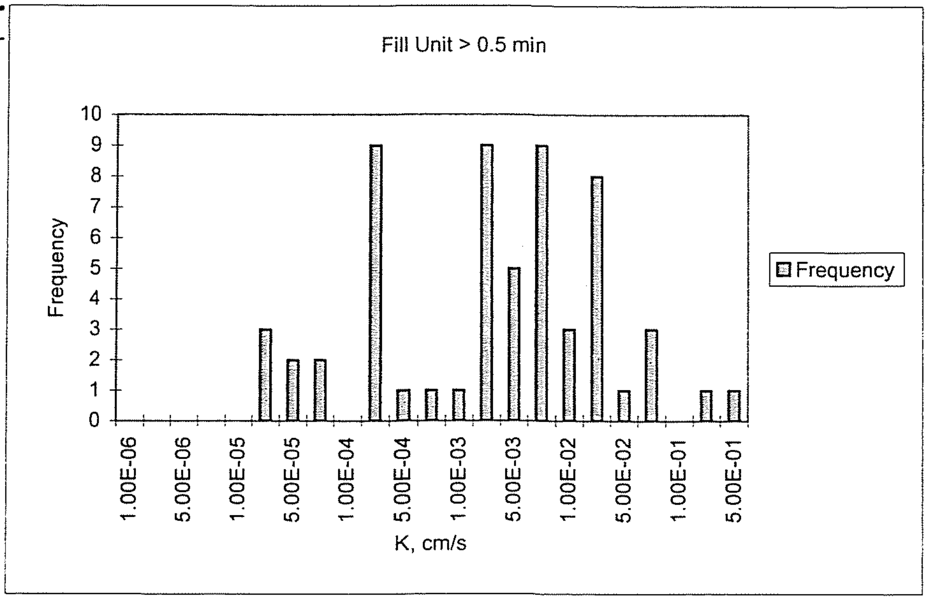
Geometric Total	3.27E-158	Arithmetic Total	1.21E+00
Geometric Mean	2.14E-03	Arithmetic Mean	2.04E-02

*Wells with same phase/method/test are averaged
(1) GIS Key F=Fill
NA - Not Available
Note: See graphs on page 3 of 3

TABLE 2-21 CONTINUED

Hydraulic Conductivity Range

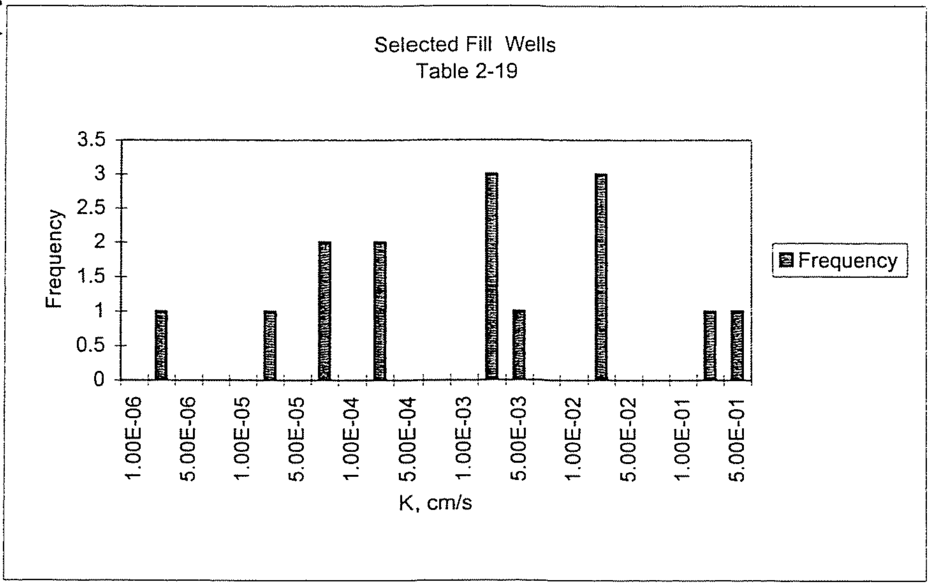
Bin	*Frequency*
1.00E-06	0
3.00E-06	0
5.00E-06	0
7.00E-06	0
1.00E-05	0
3.00E-05	3
5.00E-05	2
7.00E-05	2
1.00E-04	0
3.00E-04	9
5.00E-04	1
7.00E-04	1
1.00E-03	1
3.00E-03	9
5.00E-03	5
7.00E-03	9
1.00E-02	3
3.00E-02	8
5.00E-02	1
7.00E-02	3
1.00E-01	0
3.00E-01	1
5.00E-01	1
More	0



GEOMETRIC MEAN= 2.14E-03 ARITHMETIC MEAN= 2.04E-02

Hydraulic Conductivity Range

Bin	*Frequency*
1.00E-06	0
3.00E-06	1
5.00E-06	0
7.00E-06	0
1.00E-05	0
3.00E-05	1
5.00E-05	0
7.00E-05	2
1.00E-04	0
3.00E-04	2
5.00E-04	0
7.00E-04	0
1.00E-03	0
3.00E-03	3
5.00E-03	1
7.00E-03	0
1.00E-02	0
3.00E-02	3
5.00E-02	0
7.00E-02	0
1.00E-01	0
3.00E-01	1
5.00E-01	1
More	0



GEOMETRIC MEAN= 1.35E-03 ARITHMETIC MEAN= 5.07E-02

Table 2-22
Hydraulic Conductivity Values for Sand Wells
(>0.5 minutes and screened in Sand Unit only)
Bethelehem Steel Corporation
Lackawanna, New York

Phase/ Investigation	Well	GIS Strat Unit[1]	Test Type	K, cm/sec	Pump Test (PT), Falling (F) or Rising (R) Head Slug Test	Time (sec)	Time min)
1997	MW-2D2B	S	Theis	2.95E-05	PT	NA	
PHASE IIA	MW-2D2B	S	Theis	5.85E-05	PT	1044	17.40
PHASE IIA	MW-2D2B	S	Cooper Jacob	2.75E-05	PT	NA	
PHASE IIA	MW-2U1B	S	Bouwer-Rice	1.31E-03	F	218	3.63
PHASE IIA	MWN-02B	S	Bouwer-Rice	9.81E-04	F	183	3.05
1997	MWN-05B	S	Theis	6.54E-05	PT	4272	71.20
PHASE IIA	MWN-05B	S	Theis	1.07E-04	PT	3276	54.60
PHASE IIA	MWN-17B	S	Bouwer-Rice	1.33E-03	F	295	4.92
PHASE IIA	MWN-17B	S	Cooper Jacob	3.61E-04	PT	3685	61.42
1997	MWN-17B	S	Theis	4.92E-04	PT	NA	
PHASE IIA	MWN-17B	S	Theis	1.56E-03	PT	88	1.00
PHASE IIB	MWN-23B	S	Bouwer-Rice	1.48E-03	F	102	1.70
PHASE IIB	MWN-23B	S	Bouwer-Rice	1.16E-03	R	97	1.62
Supplemental	MWN-50B	S	Bouwer-Rice	5.84E-04	F	NA	
Supplemental	MWN-50B	S	Bouwer-Rice	9.29E-04	R	856.8	14.28
Supplemental	MWN-51B	S	Bouwer-Rice	5.95E-04	R	954	15.90
Supplemental	MWN-51B	S	Bouwer-Rice	8.22E-04	F	759	12.65
Supplemental	MWN-52B*	S	Bouwer-Rice	1.03E-02	F	997	17.00
Supplemental	MWN-52B*	S	Bouwer-Rice	1.13E-02	F	675	11.00
	Averaged MWN-52B			1.08E-02			
Supplemental	MWN-52B*	S	Bouwer-Rice	1.05E-02	R	88	1.00
Supplemental	MWN-52B*	S	Bouwer-Rice	1.11E-02	R	667	11.00
	Averaged MWN-52B			1.08E-02			
PHASE IIB	MWS-17B	S	Bouwer-Rice	3.84E-04	F	434	7.23
PHASE IIB	MWS-17B	S	Bouwer-Rice	2.98E-04	R	395	6.58
PHASE III	MWS-23B	S	Bouwer-Rice	5.19E-03	F	90	1.50
PHASE III	MWS-23B	S	Bouwer-Rice	3.27E-03	R	77	1.28

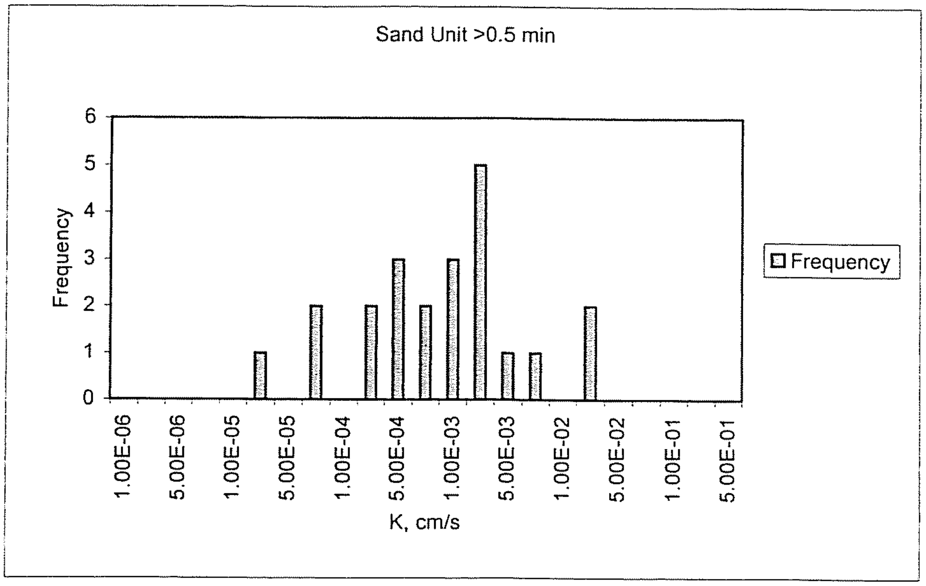
Geometric Total	1.62E-74	Arithmetic Total	4.03E-02
Geometric Mean	2.04E-04	Arithmetic Mean	2.02E-03

*Wells from same sampling event/with same method are averaged
(1) GIS Key S=Sand
NA - Not Available
Note: See graphs on page 2 of 2

TABLE 2-22 CONTINUED

Hydraulic Conductivity Range

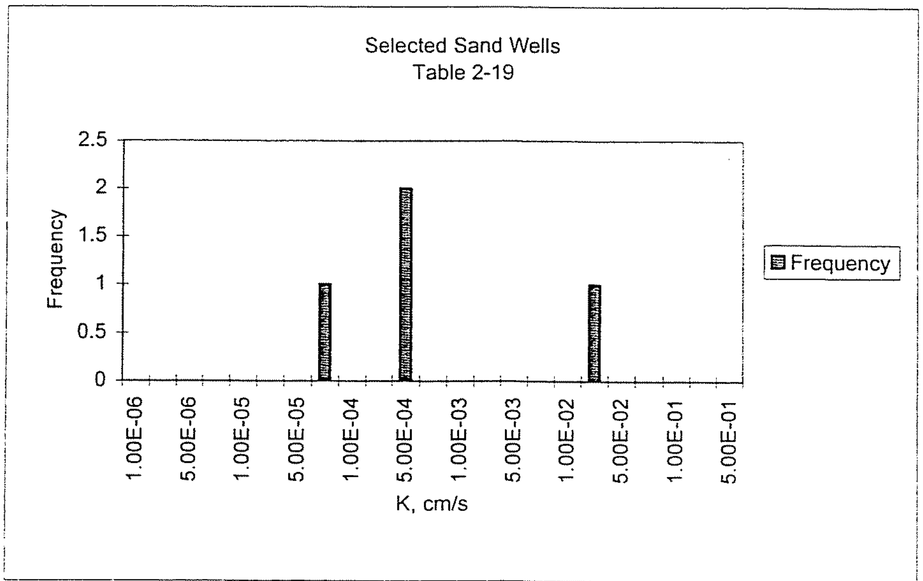
Bin	*Frequency*
1.00E-06	0
3.00E-06	0
5.00E-06	0
7.00E-06	0
1.00E-05	0
3.00E-05	1
5.00E-05	0
7.00E-05	2
1.00E-04	0
3.00E-04	2
5.00E-04	3
7.00E-04	2
1.00E-03	3
3.00E-03	5
5.00E-03	1
7.00E-03	1
1.00E-02	0
3.00E-02	2
5.00E-02	0
7.00E-02	0
1.00E-01	0
3.00E-01	0
5.00E-01	0
More	0



GEOMETRIC MEAN= 2.04E-04 ARITHMETIC MEAN= 2.02E-03

Hydraulic Conductivity Range

Bin	*Frequency*
1.00E-06	0
3.00E-06	0
5.00E-06	0
7.00E-06	0
1.00E-05	0
3.00E-05	0
5.00E-05	0
7.00E-05	1
1.00E-04	0
3.00E-04	0
5.00E-04	2
7.00E-04	0
1.00E-03	0
3.00E-03	0
5.00E-03	0
7.00E-03	0
1.00E-02	0
3.00E-02	1
5.00E-02	0
7.00E-02	0
1.00E-01	0
3.00E-01	0
5.00E-01	0
More	0



GEOMETRIC MEAN= 5.99E-04 ARITHMETIC MEAN= 3.00E-03

ATTACHMENT D

BSC'S 6/30/99 RESPONSE LETTER RECHARGE-BASED AND DARCY-BASED GROUNDWATER FLOW ESTIMATES

June 30, 1999

Mr. Dale J. Carpenter
Project Coordinator
United States Environmental Protection Agency - Region II
RCRA Programs Branch
Division of Environmental Planning and Protection
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: Response to EPA Comments on Sections 3 & 4 of Draft RFI Report
Bethlehem Steel Corporation
Administrative Order on Consent;
Docket No. II-RCRA-90-3008(h)-0201

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BSC has considered EPA's comments on Section 3 (Groundwater and Surface Water) and Section 4 (Ecological Risk Assessment) presented in the letter dated March 23, 1999. For the purpose of identifying comments that BSC would like to discuss at the meeting, we have divided the comments on the major sections into categories. Each of these categories is discussed separately below.

GROUNDWATER AND SURFACE WATER

The comments on Section 3, and related Tables, Figures and Appendices may be considered in five categories:

- Comments Requesting Changes in Wording and Minor Revisions, Clarification or Correction of Factual Issues – For most of the editorial comments in this category, BSC will make the revisions as requested. BSC will correct any information that is in error, and clarification will be provided where available. A few comments are not clear and

...nt dispersivity is used for both the tracer and the benzene, its effect should be ... out.

...fact the hydraulic conductivity for the site is higher than was assumed for the NAS, ... sulfate is not a fully conservative tracer, then biodegradation of benzene within the fill ... and sand must be occurring at a greater rate in order to match the observed distribution. BSC concurs that the times of travel are apparently unrealistically long, given the distances involved and contaminant distributions observed. See also response to Comment 28g.

28 g. **A water budget analysis comparing annual groundwater discharge along the west boundary of the Site with recharge based flow also shows that the hydrogeologic parameters used in BSC's modeling effort summarized in Table 5-1 of the NAS are invalid (See attached handwritten calculation sheets.). The groundwater discharge was calculated using BSC's hydraulic conductivity and gradient values, assuming discharge through an 11,000 foot long surface with a saturated thickness of 25 feet. For calculating the recharge volume, only the 440 acre slag fill area was considered. BSC's recharge value of 1 foot per year was used. Even though this recharge area does not represent all areas that would contribute to flow leaving the Site through the groundwater discharge surface (*i.e.*, the calculation underestimates recharge volume), the recharge derived volume is still about 23 times greater than the discharge volume estimated using the hydrogeologic parameters in Table 5-1. Since these values should be roughly equivalent, these simple calculations show that there are fundamental problems with BSC's assumptions and that the results of BSC's modeling efforts and the attempted NA demonstration are flawed and, therefore, invalid.**

BSC Response:
The Agency's calculations reveal an inconsistency between recharge-based and Darcy-based estimates for groundwater flow at the site. BSC has previously recognized this inconsistency. Rather than attribute it to an error in the assumed recharge value (this would imply a recharge on the order of 0.05 ft/yr), the cause is more likely to originate from an incorrect hydraulic conductivity value. Thus, although BSC believes it has reasonable data regarding this parameter, the overall variability of subsurface materials and conditions at the site complicate the analysis.

In order to estimate K-values that are consistent with recharge-based groundwater discharge estimates, BSC has used recharge-based discharge rates (assuming 1.25 ft/yr recharge), and measured hydraulic gradient and discharge cross-sectional area values in a variation of the Darcy equation, Q=KiA. These calculations result in K-value estimates on the order of 6×10^{-3} to 6×10^{-2} cm/sec, with an average value of 4×10^{-2} cm/sec, which is approximately 30 times higher than the geometric mean of the data obtained from aquifer tests performed at individual monitoring wells. (See Section 2.5.1.5.) The recharge-based K-value is, however, similar to the arithmetic mean of the aquifer test data for the fill unit, which is 6x10^{-2} cm/sec. In addition, the average of the sand values is 2x10^{-4} cm/sec, and that for the fill and sand together is 4x10^{-2} cm/sec. This suggests that the arithmetic mean of the aquifer test data provides a better estimate of the hydraulic conductivity of the fill than the geometric mean does. *

These recharge-based K-values give groundwater velocities of 0.83 to 1.3 feet/day, and result in travel times toward Lake Erie from Discharge Areas 1A, 2A, and 4A of 6.4 to 11 years.

Using recharge-based K-values (or the arithmetic averages of the aquifer test data), it becomes necessary to add a degradation factor to the modeled sulfate distribution south of Smokes Creek in order to match the observed distribution in this area. This is consistent with the occurrence of sulfate reduction, as is observed for the area north of Smokes Creek. (Or some other means of removing sulfate from the groundwater). Moreover, higher K-values amplify the retarded nature of the benzene distributions as they migrate from their main source areas, and as such require much higher biodegradation rates in order to match the observed benzene distribution. For the fill unit south of Smokes Creek, assuming a K-value of 4x10^{-2} cm/sec and a dispersivity value of 100 feet, the degradation rate implied for sulfate is approximately 0.0007 day^{-1}, and that for benzene is approximately 0.007 day^{-1}. This higher benzene decay rate is within the range of aerobic degradation rates quoted in the literature (p. 3-12). If this higher rate is correct, it may indicate that sulfate reduction (an anaerobic process) in this area occurs at a faster than expected rate, perhaps due to the very high sulfate concentrations. While BSC recognizes that the high pH conditions in the fill would be expected to suppress degradation processes, the balance of the evidence is that adapted processes are occurring and reducing benzene concentrations.

h. **In evaluating sulfate distribution, BSC makes unverifiable assumptions about the sulfate being co-disposed with the tar. There are many other wastes handled and placed in Zone 2 that likely serve as a source material for sulfate. Even wells in Zone 1, at the south end of the Site where waste disposal was reportedly limited to slag, have shown elevated sulfate values (e.g., MW-1A ~900 ppm).**

BSC Response:
Isoconcentration plots of sulfate distributions in the water table aquifer at the site (Figure 3-24) show the ATP area to be a definite source of sulfate on the site. Although the slag itself could represent a source of sulfate, the ATPs supply sulfate to groundwater at concentrations significantly higher than those supplied by the slag alone. The plot of sulfate concentrations for wells screened in the fill unit do indeed suggest that a secondary source of sulfate exists in the area of SWMUs s-7 and S-20, located south of Smokes Creek and west of the ATP area. This possible secondary source was recognized in the NAS modeling as well.

ATTACHMENT E

BSC'S 11/23/98 RESPONSE LETTER
GROUNDWATER INFILTRATION RECHARGE RATE

Bethlehem Steel Corporation

ROBERT B. ALLEN
MANAGER
WASTE MANAGEMENT AND REMEDIATION
ENVIRONMENTAL AFFAIRS DEPARTMENT

BETHLEHEM, PA 18016

PHONE: (610) 694-1210

November 23, 1998

Mr. Dale J. Carpenter
Project Manager
United States Environmental Protection Agency - Region II
RCRA Programs Branch
Division of Environmental Planning and Protection
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: Meeting to Discuss EPA's Comments on Sections 1 & 2 of the Draft RCRA Facility Investigation
Bethlehem Steel Corporation, Lackawanna Site RFI
Administrative Order on Consent (AOC)
Docket No. II RCRA-90-3008(h)-0201

Dear Mr. Carpenter:

In response to your letter of October 29, 1998 this letter provides an agenda, and other related information, for a meeting between Bethlehem Steel Corporation (BSC), U.S. Environmental Protection Agency Region II (EPA), and New York State Department of Environmental Conservation (NYSDEC).

BSC has considered the comments contained in EPA's letter of August 14, 1998. For the purposes of responding to the request for identification of which comments BSC would like to discuss, we have divided the comments into five categories:

- **Editorial Comments, Changes in Wording and Other Minor Revisions** - For most of the comments in this category, BSC is prepared to make revisions as requested.

- **Agency Approvals and Required RFI Activities** - BSC requests a general discussion of the use in the Draft and Final RFI Reports of all relevant data collected by observations, the groundwater infiltration rate would at most double. This increased total water flow would occur at a slower rate than estimated, because of the inverse relationship between porosity and pore water flow velocity.

41. **Page 2-34, paragraphs 3 and 4**

The calculation of the groundwater recharge rates cannot be evaluated since BSC has not yet submitted Appendix H for review. The Agencies have previously commented on the problems associated with recharge estimation data evaluated using the La Sala method. BSC notes that the estimate derived by this method agrees with published regional recharge rates. However, this is not what would be expected when conditions at the Site are compared to those in the region. The majority of the Site is devoid of vegetative cover and BSC has also indicated that there is very little, if any, run-off generated from the western portion of the Site. Under these conditions, recharge at the site would be expected to be greater than the regional rate.

BSC Response:

BSC concurs that the La Sala method results for the Lackawanna site potentially represent a low estimate for infiltration of precipitation to the groundwater aquifer. In this method, the total increase in groundwater levels directly attributable to precipitation events over a period of one year is multiplied by assumed porosity values to obtain an estimate of annual infiltration. However, the method does not consider precipitation-induced changes in the rate of decrease in groundwater levels that occur between more pronounced recharge events. For this reason, the method likely gives an underestimation of total recharge by precipitation. At Lackawanna, the average annual infiltration was estimated to be 0.95 to 1.26 feet, based on observed cumulative water table rises of approximately 4.5 feet, and assuming a range of porosities from 0.21 to 0.28. As discussed above, there is some uncertainty in the estimated porosity value assumed for the site. Higher porosity values would lead to higher estimated recharge rates.

BSC concurs that little runoff is observed at the site, and that the low vegetation density would imply a potentially higher infiltration factor than is observed regionally. Infiltration probably also varies substantially across the site, being low in paved areas and where molten slag was used for fill, and high in areas with uneven topography where puddling occurs. However, for estimation purposes and in constructing an overall general water balance for the site, a value of 1 ft/yr was used as an approximation. BSC recognizes that this is not a precise figure, but believes it is sufficiently precise for the purposes of this study.

ATTACHMENT F

BSC'S RESPONSE TO TECHNICAL COMMENTS
SPECIFIC TOPIC – 3
INFORMATION ON SITE POROSITY AND RECHARGE

Bethlehem Steel Corporation

ROBERT B. ALLEN
MANAGER
WASTE MANAGEMENT AND REMEDIATION
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BETHLEHEM, PA 18016

PHONE: (610) 694-1210

March 4, 1999

Mr. Dale J. Carpenter
Project Manager
United States Environmental Protection Agency - Region II
RCRA Programs Branch
Division of Environmental Planning and Protection
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: Responses to Technical Comments ST-1 through ST-4,
identified during meeting January 20, 1999 at EPA-II New York
Bethlehem Steel Corporation, Lackawanna Site RFI
Administrative Order on Consent (AOC)
Docket No. II RCRA-90-3008(h)-0201

Dear Mr. Carpenter:

In response to Agency comments made at our meeting of January 20, 1999, this letter transmits additional information on four specific topics (ST) regarding the RFI at Bethlehem Steel's Lackawanna, New York site, as follows:

- ST-1 Aquifer testing - technical back-up information, including pump test data sheets.
- ST-2 Ship Canal hydraulic conductivity-based groundwater discharge compared with recharge-based discharge calculations.
- ST-3 Information concerning site porosity and recharge.
- ST-4 Information concerning the North and South Return Water Trenches, in relation to groundwater flow from the area east of the BSC study area.

If you have any questions regarding this submittal, please contact me at 610-694-1210.

Very truly yours,
BETHLEHEM STEEL CORPORATION

R.B. Allen

Robert B. Allen
Manager, Site Management and Remediation

Enclosure

cc: Permits Administration Branch (EPA-II)
Mr. R. Basso (EPA-II)
Mr. J. Reidy, P.E. (EPA-II)
Mr. E. Dassatti (NYSDEC-Albany) (2 copies)
Mr. R. Murphy (NYSDEC-Albany)
Mr. L. Thomas (NYSDEC-Albany)
Mr. S. Radon (NYSDEC-Buffalo) (2 copies)
Laura Lefebvre (TRC Environmental Corp.) (2 copies)

BSC(39)152

SPECIFIC TOPIC - 3

INFORMATION CONCERNING SITE POROSITY AND RECHARGE

1.0 INTRODUCTION

This specific topic concerns the porosity of fill material at the site and previous estimates of site groundwater recharge from precipitation, which have relied upon these porosity estimates. Because the Agency believes that the use of estimated porosity values allows the relationship between precipitation and recharge at the site to be viewed only in a qualitative sense, they required (Comment # 40, August 14, 1998), that BSC "either measure fill porosity or acknowledge within the RFI that uncertainty exists in the recharge value and other values that are dependent upon the recharge value." BSC's response to this comment (November 23, 1998) pointed out that direct measurements of the porosity of the fill would not generate meaningful data because of the large variability in the nature of the fill across the site. BSC also acknowledged that the lack of measured porosity values for site materials results in some degree of uncertainty in other parameters, but that the range of uncertainty is likely to be much smaller (less than a factor of 2) than that for other parameters, such as hydraulic conductivity (possibly as much as an order of magnitude).

In response to the Agency's most recent comment (January 20, 1999), BSC is presenting a method by which the porosity of granular material may be estimated from its grain size distribution (Vukovic and Soro 1992). In general, it is well known that the porosity of granular materials depends on a number of factors, primarily grain shape, grain-size uniformity, mineralogical content, and degree of compactness. Of these, the degree of grain-size uniformity, expressed as the coefficient of uniformity η, appears to exert the highest degree of control on the porosity of natural materials (Vukovic and Soro 1992). More specifically, empirical data suggest that porosity increases when the degree of uniformity increases, i.e., when η decreases, according to the following relationship:

$$n\ (= \text{porosity}) = 0.255\ (1 + 0.83^{\eta}).$$

Vukovic and Soro (1992) present a plot of this equation, superimposed upon η and n data for natural granular materials, reproduced herein as Figure 1.

2.0 RESULTS

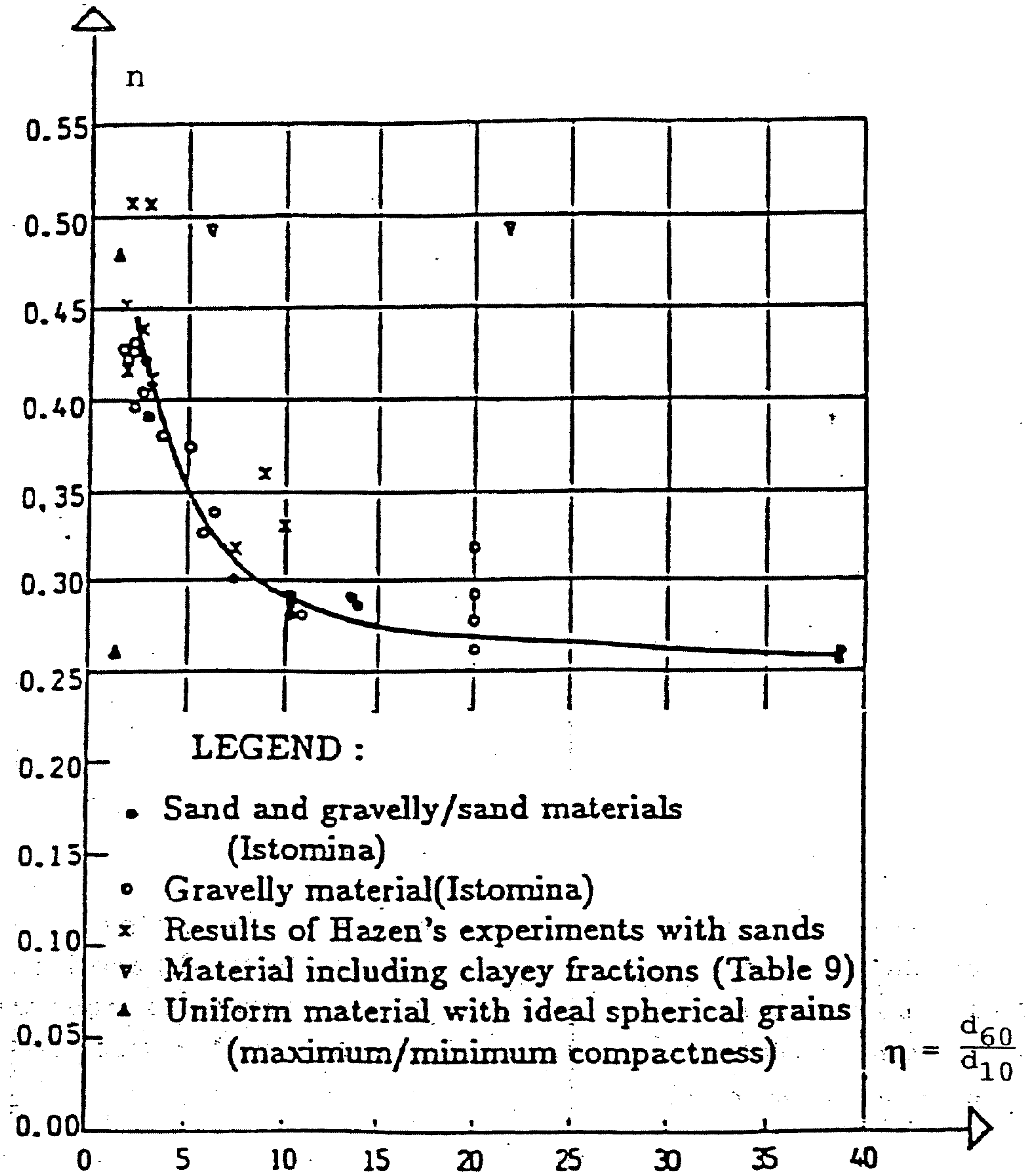
When this method is applied to grain-size distribution data obtained in 1998 by GZA Environmental for soil grab samples from three locations and blast oven furnace slag samples obtained by BSC in 1978 from the BSC's Bethlehem, Pennsylvania facility, the estimated porosities of these samples range from 0.26 to 0.31. The raw data and grain-size distribution plots are included as Attachment D. The results of these calculations are summarized in the table below:

Sample	d_{10} (mm)	d_{60} (mm)	η	Estimated Porosity
Location A-1	0.0013	2.2	1700	0.26
Location A-2	0.0034	5	1500	0.26
Location B (composite)	0.25	16	64	0.26
Fine Slag - Before Crushing and screening (wet sieve)	0.68	6.1	9.0	0.30
Fine Slag - After Crushing and screening (dry sieve)	0.45	3.9	8.7	0.31

This information will be inserted into Section 2.5.1.2 of the Draft RFI Report, First Interim Submittal. BSC feels that these data support the use of a porosity value of 0.30 in fate and transport calculations, such as those presented in Appendix I of the Draft RFI Report, First Interim Submittal. Previous estimates of recharge due to infiltration were based on an observed annual cumulative water table rise of approximately 4.5 feet and assumed porosities of 0.21 to 0.28, and ranged between 0.96 and 1.26 feet/year. BSC believes that the porosity estimates based on grain-size distribution information (presented above) support the use of a recharge value at the higher end of this range, i.e., 1.25 feet/year.

3.0 REFERENCE

Vukovic, M., and Soro, A., 1992. Determination of Hydraulic Conductivity of Porous Media from Grain-Size Composition. Water Resources Publications, Littleton, Colorado.



LEGEND:

n Porosity

η Coefficient of Uniformity $= \frac{d_{60}}{d_{10}}$

SOURCE: M. Vukovich, and A. Soro, 1992. Determination of Hydraulic Conductivity of Porous Media from Grain-Sized Composition, Water Resources Publications, Littleton, Colorado.

BETHLEHEM STEEL CORPORATION

Lackawanna, New York

FIGURE 1

GRAPH OF EMPIRICAL RELATIONSHIP BETWEEN POROSITY AND COEFFICIENT OF UNIFORMITY

Job No. 00120-194-152 Dames & Moore

ATTACHMENT G

DISCHARGE RATE CALCULATIONS FOR SITE DISCHARGE AREAS

Table J-1
Discharge Rate Calculations
Total Discharge/Area

Discharge Area ID	Discharge Area Description	Area (ft^2)	Total Discharge "X" (ft^3/year)*	Total Discharge "X" (l/year)**	Total Discharge "X" (gal/min)	Total Discharge "X" (ft^3/sec)
1	Lake Erie, South of SFA-2	11,166,033	13,957,541	395,233,602	199	0.442
1A	Blasdell Creek, North Side	1,313,303	1,641,629	46,485,755	23	0.052
2A	Lake Erie, South of Smokes Creek, Along SFA-2	2,150,338	2,687,923	76,113,498	38	0.085
2B	South Bank of Smokes Creek, Along SFA-2	1,337,383	1,671,729	47,338,092	24	0.053
3	Smokes Creek, North and South Banks (Including Area 3A, but Excluding Area 2B)	13,400,819	16,751,024	474,336,227	239	0.531
3A	North Bank of Smokes Creek, Along SFA-2	1,976,503	2,470,629	69,960,424	35	0.078
4A	Lake Erie, North Of Smokes Creek	16,748,890	20,936,113	592,844,757	299	0.663
4B	Lake Erie, North Of Smokes Creek, Outer Harbor	2,227,484	2,784,355	78,844,163	40	0.088
5	Ship Canal, West Side	1,046,629	1,308,286	37,046,545	19	0.041
6	Ship Canal, East Side	5,493,418	6,866,773	194,445,367	98	0.218
6A	Union Ship Canal, South Side	2,581,061	3,226,326	91,359,396	46	0.102
A	Off-Site Recharge to Area 1	1,015,337	1,269,171	35,938,932	18	0.040
B	Off-Site Recharge to Area 6	2,962,847	3,703,559	104,873,118	53	0.117
1 + A	Lake Erie, South of SFA-2	12,181,370	15,226,713	431,172,534	217	0.483

* = Area X 1.25'/year (sitewide infiltration to groundwater).

** - Source of Conversion Factors: "http://www.chemie.fu-berlin.de/chemistry/general/units_en.html"

Table J-1 (Continued)
Discharge Rate Calculations
Saturated Thickness/Segment

Discharge Area ID	Unit	Segment/Well	Saturated Thickness (ft)	Segment Length (ft)
1 + A (Lake Erie, South of SFA-2)	Fill	MWS-08*	13	**4,580**
	Sand		5	**4,580**
1A (Blasdell Creek, North Side)	Fill	MWS-06	10	**3,925**
2A (Lake Erie, South of Smokes Creek, Along SFA-2)	Fill	MW-2D4	16	560
		MW-2D3	16	200
		MW-2D2	14	240
		MWS-26A	14	280
		MWS-09	15	300
	Sand	MW-2D2B	10	1,580
	Total Length of Area 2A Shoreline			**1,580**
2B (South Bank of Smokes Creek, Along SFA-2)	Fill	MWS-01	14	740
		MWS-02	13	680
		MWS-19A	12	400
		MWS-18A	12	280
		MWS-20A	9	380
		MWS-03	12	320
	Sand	MWS-01B	10	1,040
		MWS-19B	4	760
		MWS-18C	3	300
		MWS-20B	2	700
	Total Length of Area 2B Shoreline			**2,800**
3A (North Bank of Smokes Creek, Along SFA-2)	Fill	MWN-01	18	960
		MWN-11	12	1,200
		MWN-44A	5	420
		MWN-24A	2	220
	Sand	MWN-01B	10	680
		MWN-23B	6	1,480
		MWN-24B	4	640
	Total Length of Area 3 Shoreline			**2,800**
4A (Lake Erie, North Of Smokes Creek)	Fill	MWN-06A	13	800
		MWN-05A	14	1,120
		MWN-04	10	1,140
		MWN-03	18	1,340
		MWN-02	16	2,260
	Sand	MWN-05B	10	2,460
		MWN-03B	8	1,940
		MWN-02B	10	2,260
	Total Length of Area 4A Shoreline			**6,660**
4B (Lake Erie, North Of Smokes Creek, Outer Harbor)	Fill	MWN-43A	5	1,900
		MWN-18A	8	1,100
	Sand**		8	3,000
	Total Length of Area 4B Shoreline			**3,000**
5 (Ship Canal, West Side)	Fill	MWN-45A	1.5	105
		MWN-47A	4.5	295
		MWN-09	6	460
		MWN-34A	12	520
		MWN-26A	10	460
		MWN-08	13	320
		MWN-49A	10	480
		MWN-52A	3.5	680
		MWN-07	9.5	740
	Total Length of Area 5 Shoreline			**4,060**

* - Segment Length = Total Length of Areas

** - Derived from interpretation of data from the boring logs of nearby wells (i.e. MWN-5D, MWN-6A & MWN-50B).

Table J-1 (Continued)
Discharge Rate Calculations
Average Total Saturated Thickness/Area

"Z" = Average Total Saturated Thickness/Area = Average Total Saturated Thickness (fill) + Average Total Saturated Thickness (sand)

Average Total Saturated Thickness (fill) = $[(B_1 \times C_1) + (B_2 \times C_2) + (B_3 \times C_3) + \ldots]/Y$

Average Total Saturated Thickness (sand) = $[(A_1 \times D_1) + (A_2 \times D_2) + (A_3 \times D_3) + \ldots]/Y$

"B_N" = Saturated thickness of fill along shoreline segment "N"
"C_N" = Length of fill segment "N"
"A" = Saturated thickness of sand along shoreline segment "N"
"D" = Length of sand segment "N"
"Y" = Total length of Area shoreline

Discharge Area ID	Average Total Saturated Thickness of Fill Unit (ft) "B"	Average Total Saturated Thickness of Sand Unit (ft) "A"	Average Total Saturated Thickness (ft) "Z"
1 + A (Lake Erie, South Of Smokes Creek)	13	5	18
1A (Blasdell Creek, North Side)*	10	Not Available	10
2A (Lake Erie, South Of Smokes Creek)	15	10	25
2B (Smokes Creek, South Side)	12	6	18
3A North Bank of Smokes Creek, Along SFA-2)	12	7	19
4A (Lake Erie, North Of Smokes Creek)	15	9	24
4B (Lake Erie, North Of Smokes Creek, Facing North)	6	8	14
5 (Ship Canal, West Side)*	8	Not Available	8

* - There was no discernable sand layer in the cross section derived from the boring logs from Areas 1A & 5. Therefore, the average total saturated thicknesses were calculated without incorporating a sand layer.

Table J-1 (Continued)
Discharge Rate Calculations
Discharge Areas 1+A
(Lake Erie, South of SFA-2)

"Q(Fill Wells)" = $X(C/Y)[K_F B/(K_S A)+(K_F B)]$

"X" = Total Discharge for Area 1 + A
"B" = Average saturated thickness of fill
"C" = Length of fill segment
"A" = Average saturated thickness of sand
"Y" = Total length of Areas 1 + A shoreline
"K_F" = Sitewide Fill Unit Conductivity (0.0006693 ft/s)
"K_s" = Sitewide Sand Unit Conductivity (0.0000663 ft/s)

Strata	Well ID	Discharge Rate "Q" (ft^3/year)	Discharge Rate "Q" (l/year)*	Discharge Rate "Q" (gal/min)	Discharge Rate "Q" (ft^3/sec)
Fill	MWS-08	14,667,874	415,347,981	209	0.465

* - Source of Conversion Factors: "http://www.chemie.fu-berlin.de/chemistry/general/units_en.html"

Note: Even though there is a sand layer depicted in the cross section for this discharge area, there are no wells along the discharge area screened in the sand layer. Therefore, only the wells screened in the fill layer utilized and the discharge rate "Q" does not equal the total area discharge "X".

(1) - For Total Discharge for Area 1 + A, Refer to Page 1 of Calculations

(2) - For Segment Length and Total Length of Area 1 + A Shoreline, Refer to Page 2 of Calculations

(3) - For Average Saturated Thickness of the Fill and Sand Units in Area 1 + A, Refer to Page 3 of Calculations

Table J-1 (Continued)
Discharge Rate Calculations
Discharge Area 1A
(Blasdell Creek, North Side)

"Q(Fill Wells)" = X

"X" = Total Discharge for Area 1A

Strata	Well ID	Discharge Rate "Q" (ft^3/year)	Discharge Rate "Q" (l/year)*	Discharge Rate "Q" (gal/min)	Discharge Rate "Q" (ft^3/sec)
Fill	MWS-06	1,641,629	46,485,755	23	0.052

* - Source of Conversion Factors: "http://www.chemie.fu-berlin.de/chemistry/general/units_en.html"

Note: There was no discernable sand layer in the cross section derived from the boring logs of the above-utilized wells. Therefore, the discharge rate was calculated without incorporating a sand layer.

(1) - For Total Discharge for Area 1A, Refer to Page 1 of Calculations

(2) - For Segment Length and Total Length of Area 1A Shoreline, Refer to Page 2 of Calculations

(3) - For Average Saturated Thickness of the Fill and Sand Units in Area 1A, Refer to Page 3 of Calculations

Table J-1 (Continued)
Discharge Rate Calculations
Discharge Area 2A
(Lake Erie, South of Smokes Creek, Along SFA-2)

"Q(Fill Wells)" = $X(C/Y)[K_FB/(K_SA)+(K_FB)]$

"Q(Sand Wells)" = $X(D/Y)[K_SA/(K_SA)+(K_FB)]$ (28.31685 liters/ft^3)*

"X" = Total Discharge for Area 2A
"B" = Average saturated thickness of fill
"C" = Length of fill segment
"A" = Average saturated thickness of sand
"D" = Length of sand segment
"Y" = Total length of Area 2A shoreline
"K_F" = Sitewide Fill Unit Conductivity (0.0006693 ft/s)
"K_S" = Sitewide Sand Unit Conductivity (0.0000663 ft/s)

Strata	Well ID	Discharge Rate "Q" (ft^3/year)	Discharge Rate "Q" (l/year)*	Discharge Rate "Q" (gal/min)	Discharge Rate "Q" (ft^3/sec)
Fill	MW-2D4	894,220	25,321,491	13	0.028
	MW-2D3	319,364	9,043,389	5	0.010
	MW-2D2	383,237	10,852,067	5	0.012
	MWS-26A	447,110	12,660,745	6	0.014
	MWS-09	479,089	13,566,300	7	0.015
Sand	MW-2D2B	164,945	4,670,721	2	0.005

* - Source of Conversion Factors: "http://www.chemie.fu-berlin.de/chemistry/general/units_en.html"

(1) - For Total Discharge for Area 2A, Refer to Page 1 of Calculations

(2) - For Segment Length and Total Length of Area 2A Shoreline, Refer to Page 2 of Calculations

(3) - For Average Saturated Thickness of the Fill and Sand Units in Area 2A, Refer to Page 3 of Calculations

Table J-1 (Continued)
Discharge Rate Calculations
Discharge Area 2B
(South Bank of Smokes Creek, Along SFA-2)

"Q(Fill Wells)" = $X(C/Y)[K_F B/(K_S A)+(K_F B)]$

"Q(Sand Wells)" = $X(D/Y)[K_S A/(K_S A)+(K_F B)]$ (28.31685 liters/ft^3)*

"X" = Total Discharge for Area 2B
"B" = Average saturated thickness of fill
"C" = Length of fill segment
"A" = Average saturated thickness of sand
"D" = Length of sand segment
"Y" = Total length of Area 2B shoreline
"K_F" = Sitewide Fill Unit Conductivity (0.0006693 ft/s)
"K_S" = Sitewide Sand Unit Conductivity (0.0000663 ft/s)

Strata	Well ID	Discharge Rate "Q" (ft³/year)	Discharge Rate "Q" (l/year)*	Discharge Rate "Q" (gal/min)	Discharge Rate "Q" (ft³/sec)
Fill	MWS-01	422,774	11,971,615	6	0.013
	MWS-02	388,495	11,000,943	6	0.012
	MWS-19A	228,526	6,471,143	3	0.007
	MWS-18A	159,968	4,529,800	2	0.005
	MWS-20A	217,100	6,147,586	3	0.007
	MWS-03	182,821	5,176,914	3	0.006
Sand	MWS-01B	26,760	757,748	0.382	0.001
	MWS-19B	19,555	553,739	0.279	0.001
	MWS-18C	7,719	218,581	0.110	0.000
	MWS-20B	18,011	510,023	0.257	0.001

* - Source of Conversion Factors: "http://www.chemie.fu-berlin.de/chemistry/general/units_en.html"

(1) - For Total Discharge for Area 2B, Refer to Page 1 of Calculations

(2) - For Segment Length and Total Length of Area 2B Shoreline, Refer to Page 2 of Calculations

(3) - For Average Saturated Thickness of the Fill and Sand Units in Area 2B, Refer to Page 3 of Calculations

Table J-1 (Continued)
Discharge Rate Calculations
Discharge Area 3A
(North Bank of Smokes Creek, Along SFA-2)

"Q(Fill Wells)" = $X(C/Y)[K_FB/(K_SA)+(K_FB)]$

"Q(Sand Wells)" = $X(D/Y)[K_SA/(K_SA)+(K_FB)]$ (28.31685 liters/ft^3)*

"X" = Total Discharge for Area 3A
"B" = Average saturated thickness of fill
"C" = Length of fill segment
"A" = Average saturated thickness of sand
"D" = Length of sand segment
"Y" = Total length of Area 3 shoreline
"K_F" = Sitewide Fill Unit Conductivity (0.0006693 ft/s)
"K_s" = Sitewide Sand Unit Conductivity (0.0000663 ft/s)

Strata	Well ID	Discharge Rate "Q" (ft^3/year)	Discharge Rate "Q" (l/year)*	Discharge Rate "Q" (gal/min)	Discharge Rate "Q" (ft^3/sec)
Fill	MWN-01	804,590	22,783,455	11	0.025
	MWN-11	1,005,738	28,479,318	14	0.032
	MWN-44A	352,008	9,967,761	5	0.011
	MWN-24A	184,385	5,221,208	3	0.006
Sand	MWN-01B	30,092	852,108	0.4	0.001
	MWN-23B	65,494	1,854,589	1	0.002
	MWN-24B	28,322	801,984	0.4	0.001

* - Source of Conversion Factors: "http://www.chemie.fu-berlin.de/chemistry/general/units_en.html"

(1) - For Total Discharge for Area 3, Refer to Page 1 of Calculations

(2) - For Segment Length and Total Length of Area 3A Shoreline, Refer to Page 2 of Calculations

(3) - For Average Saturated Thickness of the Fill and Sand Units in Area 3, Refer to Page 3 of Calculations

Table J-1 (Continued)
Discharge Rate Calculations
Discharge Area 4A
(Lake Erie, North Of Smokes Creek)

"Q(Fill Wells)" = $X(C/Y)[K_FB/(K_SA)+(K_FB)]$

"Q(Sand Wells)" = $X(D/Y)[K_SA/(K_SA)+(K_FB)]$ (28.31685 liters/ft^3)*

"X" = Total Discharge for Area 4A
"B" = Average saturated thickness of fill
"C" = Length of fill segment
"A" = Average saturated thickness of sand
"D" = Length of sand segment
"Y" = Total length of Area 4A shoreline
"K_F" = Sitewide Fill Unit Conductivity (0.0006693 ft/s)
"K_S" = Sitewide Sand Unit Conductivity (0.0000663 ft/s)

Strata	Well ID	Discharge Rate "Q" (ft^3/year)	Discharge Rate "Q" (l/year)*	Discharge Rate "Q" (gal/min)	Discharge Rate "Q" (ft^3/sec)
Fill	MWN-06A	2,364,572	66,957,236	34	0.075
	MWN-05A	3,310,401	93,740,130	47	0.105
	MWN-04	3,369,515	95,414,061	48	0.107
	MWN-03	3,960,658	112,153,370	56	0.126
	MWN-02	6,679,916	189,154,190	95	0.212
Sand	MWN-05B	462,099	13,085,195	7	0.015
	MWN-03B	364,420	10,319,219	5	0.012
	MWN-02B	424,530	12,021,358	6	0.013

* - Source of Conversion Factors: "http://www.chemie.fu-berlin.de/chemistry/general/units_en.html"

(1) - For Total Discharge for Area 4A, Refer to Page 1 of Calculations

(2) - For Segment Length and Total Length of Area 4A Shoreline, Refer to Page 2 of Calculations

(3) - For Average Saturated Thickness of the Fill and Sand Units in Area 4A, Refer to Page 3 of Calculations

Table J-1 (Continued)
Discharge Rate Calculations
Discharge Area 4B
(Lake Erie, North Of Smokes Creek, Outer Harbor)

"Q(Fill Wells)" = $X(C/Y)[K_F B/(K_S A)+(K_F B)]$

"X" = Total Discharge for Area 4B
"B" = Average saturated thickness of fill
"C" = Length of fill segment
"A" = Average saturated thickness of sand
"Y" = Total length of Area 4B shoreline
"K_F" = Sitewide Fill Unit Conductivity (0.0006693 ft/s)
"K_S" = Sitewide Sand Unit Conductivity (0.0000663 ft/s)

Strata	Well ID	Discharge Rate "Q" (ft^3/year)	Discharge Rate "Q" (l/year)*	Discharge Rate "Q" (gal/min)	Discharge Rate "Q" (ft^3/sec)
Fill	MWN-43A	1,560,673	44,193,343	22	0.049
	MWN-18A	903,548	25,585,620	13	0.029

* - Source of Conversion Factors: "http://www.chemie.fu-berlin.de/chemistry/general/units_en.html"

Note: The above-referenced borings did not advance beyond the fill layer; as a result, the depth and thickness of the underlying sand layer was derived from interpretation of data from the borings of nearby wells (i.e. MWN-5D, MWN-6A & MWN 50B). Even though it is assumed that a sand layer exists in the discharge area, there are no wells along the lake shore of the discharge area with screened intervals in the sand layer. Therefore, only the wells screened in the fill layer could be utilized and the discharge rate "Q" does not equal the total area discharge "X".

(1) - For Total Discharge for Area 4B, Refer to Page 1 of Calculations

(2) - For Segment Length and Total Length of Area 4B Shoreline, Refer to Page 2 of Calculations

(3) - For Average Saturated Thickness of the Fill and Sand Units in Area 4B, Refer to Page 3 of Calculations

Table J-1 (Continued)
Discharge Rate Calculations
Discharge Area 5
(Ship Canal, West Side)

"Q(Fill Wells)" = X(C/Y)

"X" = Total Discharge for Area 5
"C" = Length of fill segment
"Y" = Total length of Area 5 shoreline

Strata	Well ID	Discharge Rate "Q" (ft^3/year)	Discharge Rate "Q" (l/year)*	Discharge Rate "Q" (gal/min)	Discharge Rate "Q" (ft^3/sec)
Fill	MWN-45A	33,835	958,100	0.482	0.001
	MWN-47A	95,060	2,691,806	1.356	0.003
	MWN-09	148,229	4,197,392	2.114	0.005
	MWN-34A	167,564	4,744,878	2.389	0.005
	MWN-26A	148,229	4,197,392	2.114	0.005
	MWN-08	103,116	2,919,925	1.470	0.003
	MWN-49A	154,674	4,379,887	2.206	0.005
	MWN-52A	219,122	6,204,840	3.125	0.007
	MWN-07	238,456	6,752,326	3.400	0.008

* - Source of Conversion Factors: "http://www.chemie.fu-berlin.de/chemistry/general/units_en.html"

Note: There was no discernable sand layer in the cross section derived from the boring logs of the above-utilized wells. Therefore, the discharge rate was calculated without incorporating a sand layer.

(1) - For Total Discharge for Area 5, Refer to Page 1 of Calculations

(2) - For Segment Length and Total Length of Area 5 Shoreline, Refer to Page 2 of Calculations

(3) - For Average Saturated Thickness of the Fill Units in Area 5 Refer to Page 3 of Calculations