ecology and environment, inc.
International Specialists in the Environment
BUFFALO CORPORATE CENTER
368 Pleasant View Drive, Lancaster, New York 14086
Tel: 716/684-8060, Fax: 716/684-0844

November 20, 1997

Ms. Agnes Antonian
Project Engineer
Brooklyn Union
One Metro Tech Center
Brooklyn, NY 11201-3850

Mr. Dennis Harkawik, Esq.
Jaekle, Fleischmann & Mugel
12 Fountain Plaza
Buffalo, NY 14202-2292

Mr. Bill Gilday
Assistant Sanitary Engineer
NYS Department of Health
11 University Plaza
Albany, NY 12203-3399

Mr. David Crosby
Project Manager
Bureau ofConstruction Services
NYSDEC
50 Wolf Road
Albany, NY 12233-7010

Mr. Richard Gardineer/Joe O'Connell
Nigel Crawford/Shaun Bollers
NYSDEC, Region 2
Hunters Point Plaza
47-40 21st Street
Long Island City, NY 11101

Mr. Jeffery Davidson, Esq.
Hale and Dorr
1455 Pennsylvania Ave., N.W.
Washington,.D.C. 20004

P.O. No. R-302992-000
E & E No. BV-4000
Project Brooklyn Borough Gas Works Site

Re: Final Remedial Investigation Report

Enclosed with this letter are the requisite number of copies of the Final RI report as required under Item XIV of the Consent Order (D2-001-94-12). Agnes Antonian has requested that the enclosed Final RI report be forwarded to you.

If you require additional information of have any questions, please call me at 716/684-8060.

Sincerely,

Jerold C. Bastedo

Jerold C. Bastedo, P.G.
Project Manager

Enclosure

xc: F. McKosky, E & E
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Remedial Investigation Report for the Brooklyn Borough Gas Works Brooklyn, New York

November 1997

Prepared for:

BROOKLYN UNION
One MetroTech Center
Brooklyn, NY 11201-3850

International Specialists in the Environment

BUFFALO CORPORATE CENTER 368 Pleasant View Drive, Lancaster, New York 14086
Tel: 716/684-8060, Fax: 716/684-0844

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List of Acronyms

As	arsenic
AVS	Acid Volatile Sulfides
BGS	below ground surface
Brooklyn Union	Brooklyn Union Gas Company
BTEX	Benzene, toluene, ethylbenzene, and xylenes
Btu	British thermal unit
Cd	cadmium
CEC	Cation Exchange Coefficient
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPCs	chemicals of potential concern
Cr	chromium
Cu	copper
DNAPL	denser-than-water nonaqueous phase liquid
E & E	Ecology and Environment, Inc.
EPA	United States Environmental Protection Agency
FOM	Fraction of Organic Matter
GC/MS	gas chromatography/mass spectroscopy
Hg	mercury
IRM	interim response measure
LNAPL	lighter-than-water nonaqueous-phase liquid
mg/kg	milligrams per kilogram
MGP	manufactured gas plant
MSL	mean sea level
MTA	Metropolitan Transit Authority
NCP	National Contingency Plan
Ni	nickel
NYCDEP	New York City Department of Environmental Protection
NYSDEC	New York State Department of Environmental Conservation
OVA	Organic vapor analyzer
PAHs	polynuclear aromatic hydrocarbons
Pb	lead
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
ppm	parts per million
ppt	parts per thousand
QA/QC	quality assurance and quality control
RI	remedial investigation

List of Acronyms (Cont.)

Roux	Roux Associates
Sanborn	Sanborn Fire Insurance
SB	soil boring
SEMs	Simultaneously Extracted Metals
SVOCs	semivolatile organic compounds
TAGM	Technical and Administrative Guidance Memorandum
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristics Leaching Procedure
TDS	total dissolved solids
TOC	total organic carbon
TRPH	total recoverable petroleum hydrocarbons
USACE	United States Army Corps of Engineers
USDOC	United States Department of Commerce
USGS	United States Geological Survey
USTs	underground storage tanks
VOCs	volatile organic compounds
Weston	Roy F. Weston, Inc.,
Zn	zinc

1 Introduction

1.1 Purpose of Report

Under the Consent Order (Index No. D2-001-94-12) signed with the New York State Department of Environmental Conservation (NYSDEC), Brooklyn Union Gas Company (Brooklyn Union) agreed to perform a remedial investigation (RI) of the former Brooklyn Borough Gas Works property located between Neptune Avenue and Shore Parkway, just north of Coney Island, Brooklyn, New York (the property). Brooklyn Union retained Ecology and Environment, Inc., (E & E) to conduct the RI.

The purpose of this report is to combine information obtained from previous site investigations with that obtained from the supplemental RI fieldwork performed in 1996 and 1997. This report details the various sampling and investigation methods used, the locations of samples collected, and the quality and findings of the analytical data. This report is based upon all previously collected data; the data for the above-mentioned investigations are presented in their entirety in the reports. Under the Consent Order between NYSDEC and Brooklyn Union, RI and other activities relating to Coney Island Creek are deferred until they can be coordinated and performed in conjunction with other Coney Island Creek RIs being performed by others, including the City of New York. However, currently available data relating to the creek, which borders the site to the south, are provided in this report. A full RI report on the creek will await the completion of future investigation.

E & E's review of historic and current data has led to this evaluation of:

- The nature of the chemical constituents that were traditionally associated with the gas manufacturing process at the former manufactured gas plant (MGP) at the property;
- The extent of distribution of the chemical constituents in different media (e.g., soil, air, water); and
- The likelihood of migration of these constituents.

In addition, this report provides the appropriate assessments and evaluations required under the Consent Order. In accordance with the National Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] 300.430[d][2]), these assessments and evaluations include:

- Physical characteristics of the site, including important surface features, soils, geology, hydrogeology, meteorology, and ecology;
- Characteristics or classifications of air, surface water, and groundwater;
- The general characteristics of the waste, including quantities, state, concentration, toxicity, propensity to bioaccumulate, persistence, and mobility;
- The extent to which the source can be adequately identified and characterized;
- Actual and potential exposure pathways through environmental media;
- Actual and potential exposure routes (e.g., inhalation and ingestion); and
- Other factors, such as sensitive populations, that pertain to the characterization of the site or support the analysis of potential remedial action alternatives.

E & E conducted these assessments and evaluations for the RI according to the following guidance documents:

- *Guidelines for Remedial Investigations and Feasibility Studies*, Technical and Administrative Guidance Memorandum (TAGM) No. 4025, HWR-89-4025 (NYSDEC 1989); and
- *Guidance for Conducting Remedial Investigations and Feasibility Studies* (EPA 1988).

This report presents E & E's findings, which are based upon its work as described in the NYSDEC-approved RI work plan (E & E 1996a).

1.2 Site Background

1.2.1 Site Description

The site is the location of the former Brooklyn Borough Gas Works. It is bordered by the right-of-way of the Shore Parkway and a New York Metropolitan Transit Authority (MTA) railyard to the north and west, and Coney Island Creek to the south and east (see Figure 1-1).

The property is approximately 16.4 acres in size, and for the purposes of this report is divided into two areas:

- The former western area, which is currently vegetated except for several concrete foundations of former tanks and buildings and various building debris; and
- The eastern area, which formerly contained two baseball fields that had been used by the Gil Hodges Little League.

The area surrounding the property is relatively flat and occurs in a commercial/ residential zone.

Coney Island Creek borders the property to the south and east and flows into Gravesend Bay, which empties into Lower Bay and, ultimately, the Atlantic Ocean. Coney Island Creek is defined by NYSDEC as Class I (saline surface water body) and Type A (for the protection of aquatic life and for wildlife consumers of fish) (6 NYCRR 890.6). The best usage of Class I waters is secondary contact recreation and fishing; these waters are suitable for fish propagation and survival (NYSDEC 1993). The site is on Long Island; Long Island Sound (to the north) and the Atlantic Ocean (to the south) are the major surface water bodies present.

1.2.2 Site History

A 1906 Sanborn Fire Insurance (Sanborn) map showed the property as being undeveloped. According to as-built drawings supplied by Brooklyn Union, Brooklyn Borough Gas began construction of the first generator at the facility in 1908. Over the next four years, additional parcels of land were added, the facility was enlarged, and its gas production capability increased. The available information suggests that the operation was a carbureted-water gas plant. Figure 1-2 presents a general schematic of such a plant and indicates likely feed stocks and by-products.

Two 1930s aerial photos show various operational features of the facility (see Figure 1-3). Two large-capacity gas holders, a station metering house, two underground gas oil

tanks, tar conditioners, tar seal pumps, and a tar separator were located in the western portion of the site. The main gas manufacturing operations were located in the central portion of the site and contained four generators, a coal storage yard and off-loading, pump rooms, booster and exhauster rooms, two condensers, eight purifier boxes, two relief holders, an electric tar precipitator, a tar dehydrator system, two tar separators, tar storage tanks, water tanks, oil pumps, and drip oil tanks. Various storage and work buildings also were located in the central area of the property, including a blacksmith shop in the south-central area. To the east was the gas oil pump house and five gas oil tanks.

The physical facility and property changed little from the 1930s through 1960 (based on aerial photos presented on Figures 1-3, 1-4, and 1-5). Brooklyn Borough Gas transformed its gas delivery operations to a natural gas-based system, and production of manufactured gas at the Coney Island facility ceased in November 1951. According to Brooklyn Borough Gas documents, all gas deliveries to customers in 1952 were of natural gas. Between 1952 and 1959, the site's MGP capability may have been maintained and operated for the purpose of peak shaving. Brooklyn Union acquired the Brooklyn Borough Gas Company in 1959. Brooklyn Union never manufactured gas at this facility.

From 1960 to 1966, the facility was almost completely decommissioned and demolished (based on aerial photos presented on Figures 1-5 and 1-6). A 1974 aerial photo indicates that a few buildings associated with a gate station, which included an axial compressor, a small gas holder, and the largest gas holder, remained operational for providing natural gas service (see Figure 1-7). Brooklyn Union believes the gate station and gas holders were taken off line at the end of the 1970s and subsequently decommissioned and demolished in the early 1980s.

A 1994 aerial photo shows the property in recent years (see Figure 1-8).

In the early 1970s, the easternmost portion of the property was topped with fill and two baseball fields were finished in the late 1980s.

Figure 1-9 (see back pocket) presents a base map of the property and shows a general layout of the former plant.

Several investigations of the Brooklyn Union property have been conducted. Details of these investigations are presented in Section 2 of this report.

1.3 Report Organization

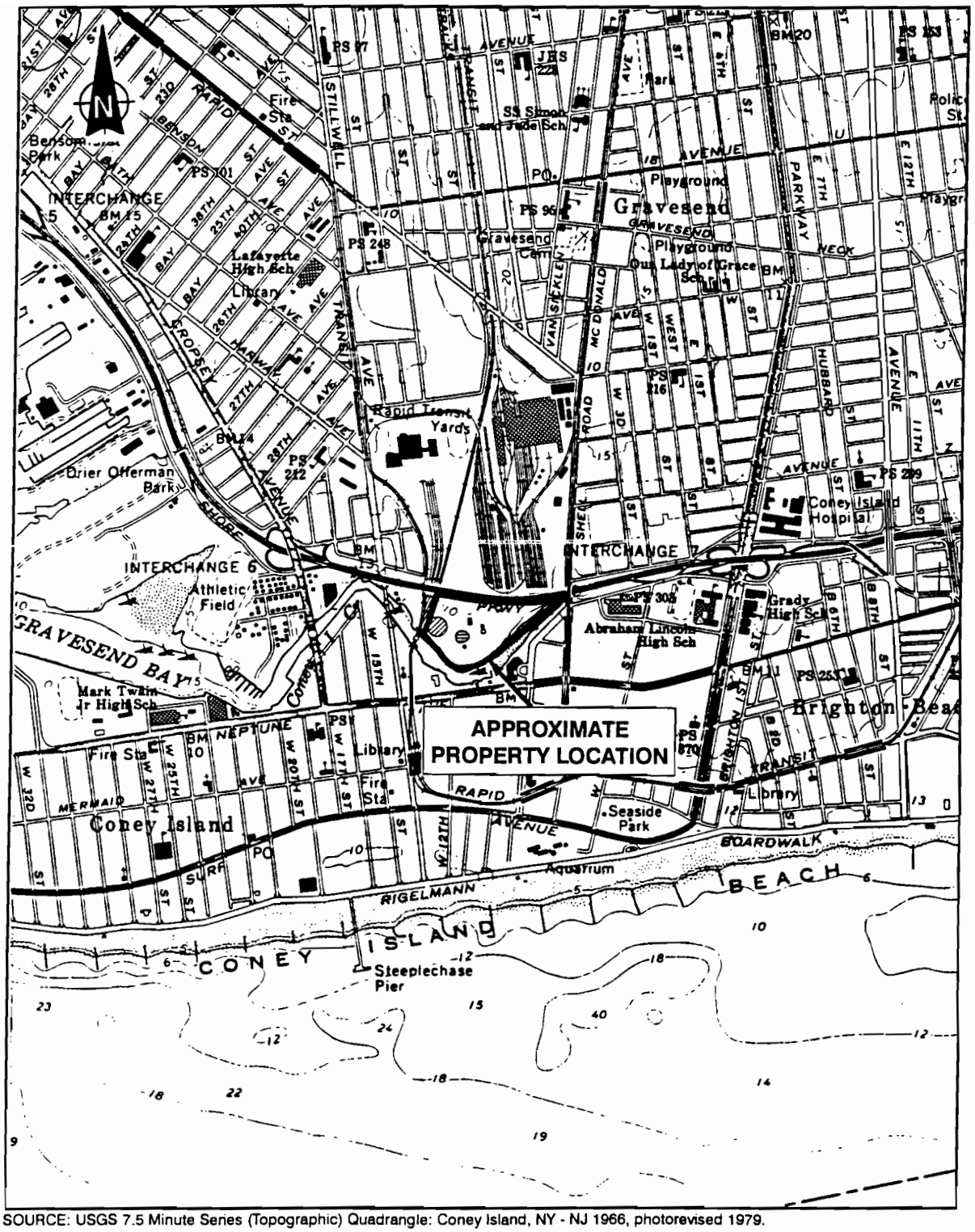
This report is divided into several sections. This section introduces the site and investigation. Section 2 summaries the investigation history and findings. An overview of

the regional and local site setting is presented in Section 3 and includes information about the geology and hydrogeology of the area and site, as well as information about the area climate, demographics, land use, and ecology. Section 4 presents an analysis of the nature and extent of various chemical constituents in the property's environmental media that were used or produced by the gas manufacturing process. The potential transport and ultimate fate of these chemical constituents are described in Section 5. The conclusions of the RI are presented in Section 6. Literature cited or used in the RI is listed in Section 7.

The report includes several appendices that:

- Summarize the quality assurance and quality control (QA/QC) aspects of the investigation process (Appendix A);
- Present the data and findings of the supplemental RI (Appendix B);
- Describe the conceptual models used in the RI (Appendix C); and
- Certify that all activities comprising the supplemental RI were performed in accordance with the work plan (E & E 1996a) (Appendix D).

Volume II of this report presents data and supporting quality assurance and quality control validation memoranda produced during the supplemental RI fieldwork, called the Phase VI investigation.



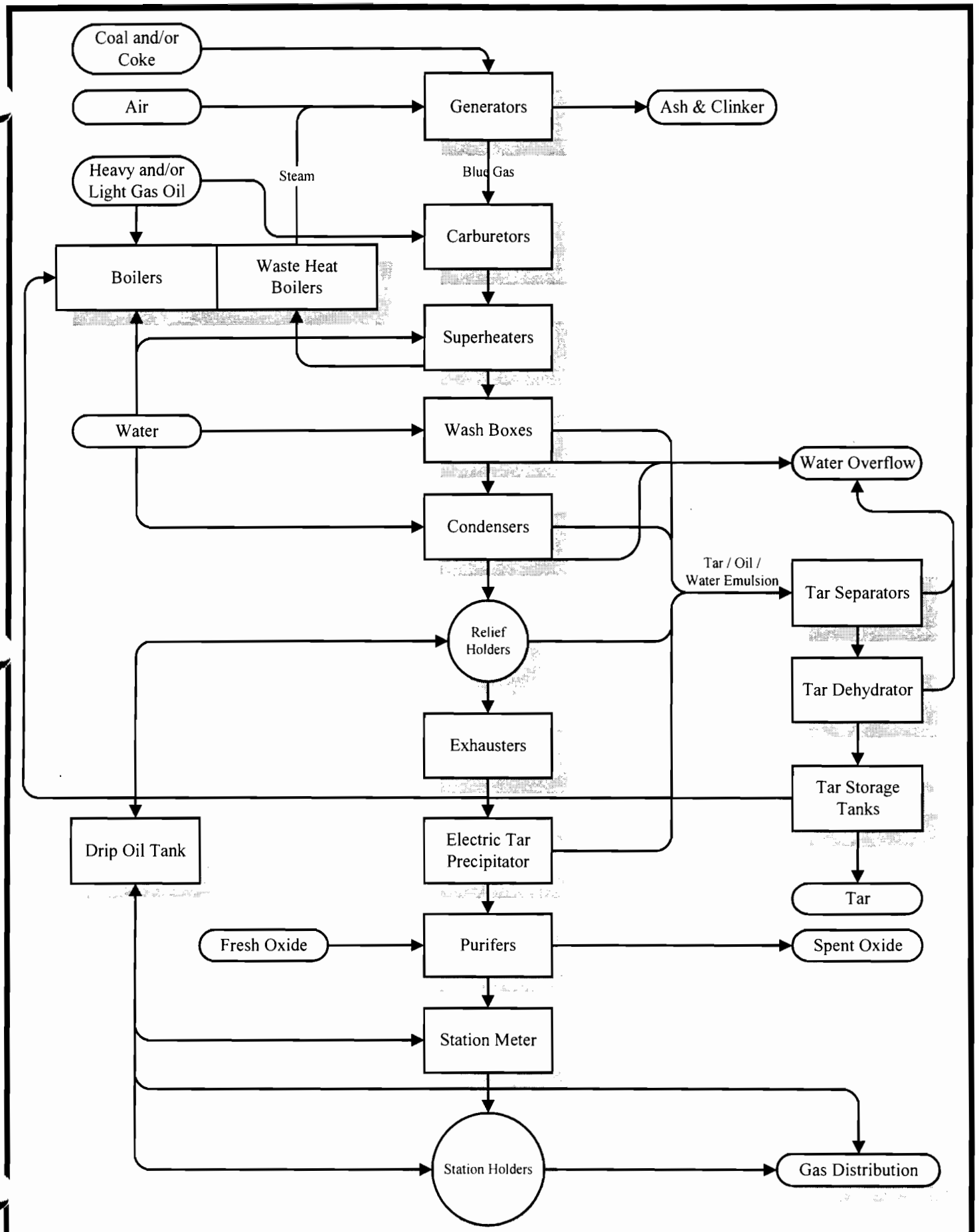
SOURCE: USGS 7.5 Minute Series (Topographic) Quadrangle: Coney Island, NY - NJ 1966, photorevised 1979.

SCALE 1:24,000

0 ½ 1 Mile

0 .5 1 Kilometer

Figure 1-1 LOCATION MAP
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK



Source: Adapted from GRI 1987 and Mon 1995

Figure 1-2 Schematic of the Carburetted Water Gas Manufacturing Process

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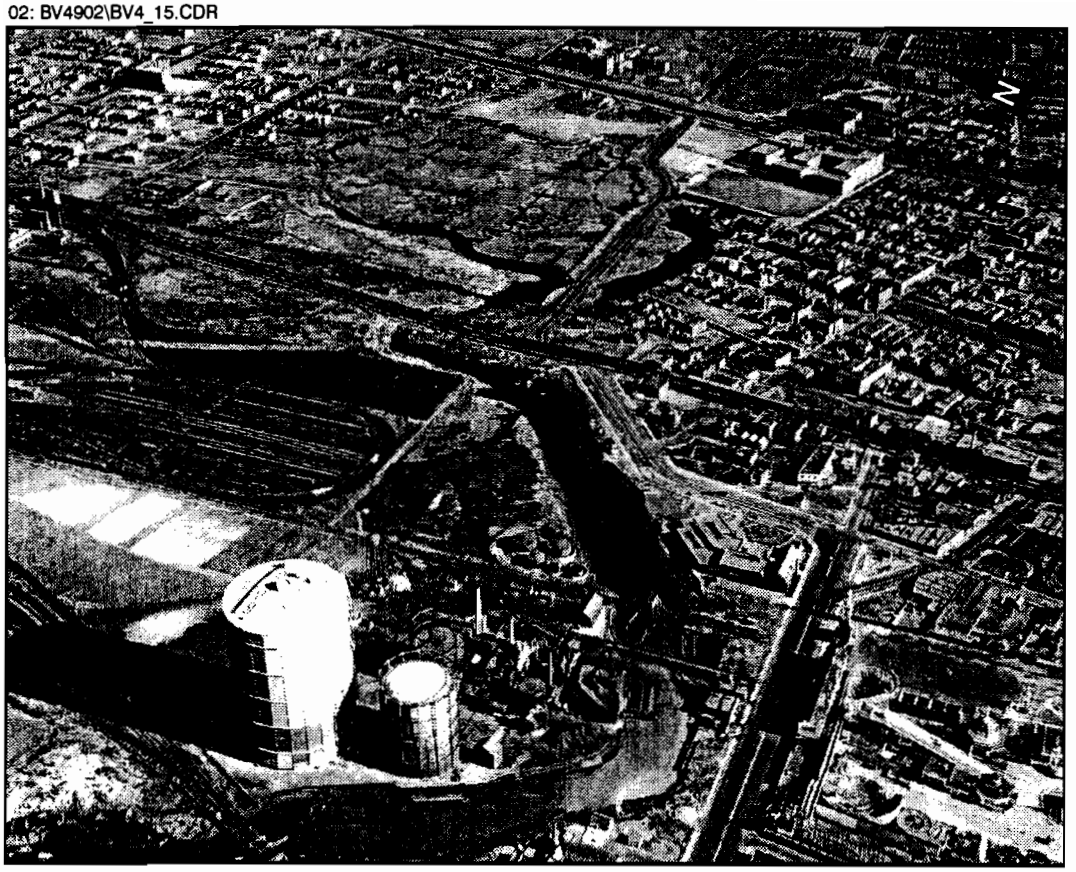

Figure 1-3 1930s AERIAL PHOTOS, BROOKLYN BOROUGH GAS WORKS

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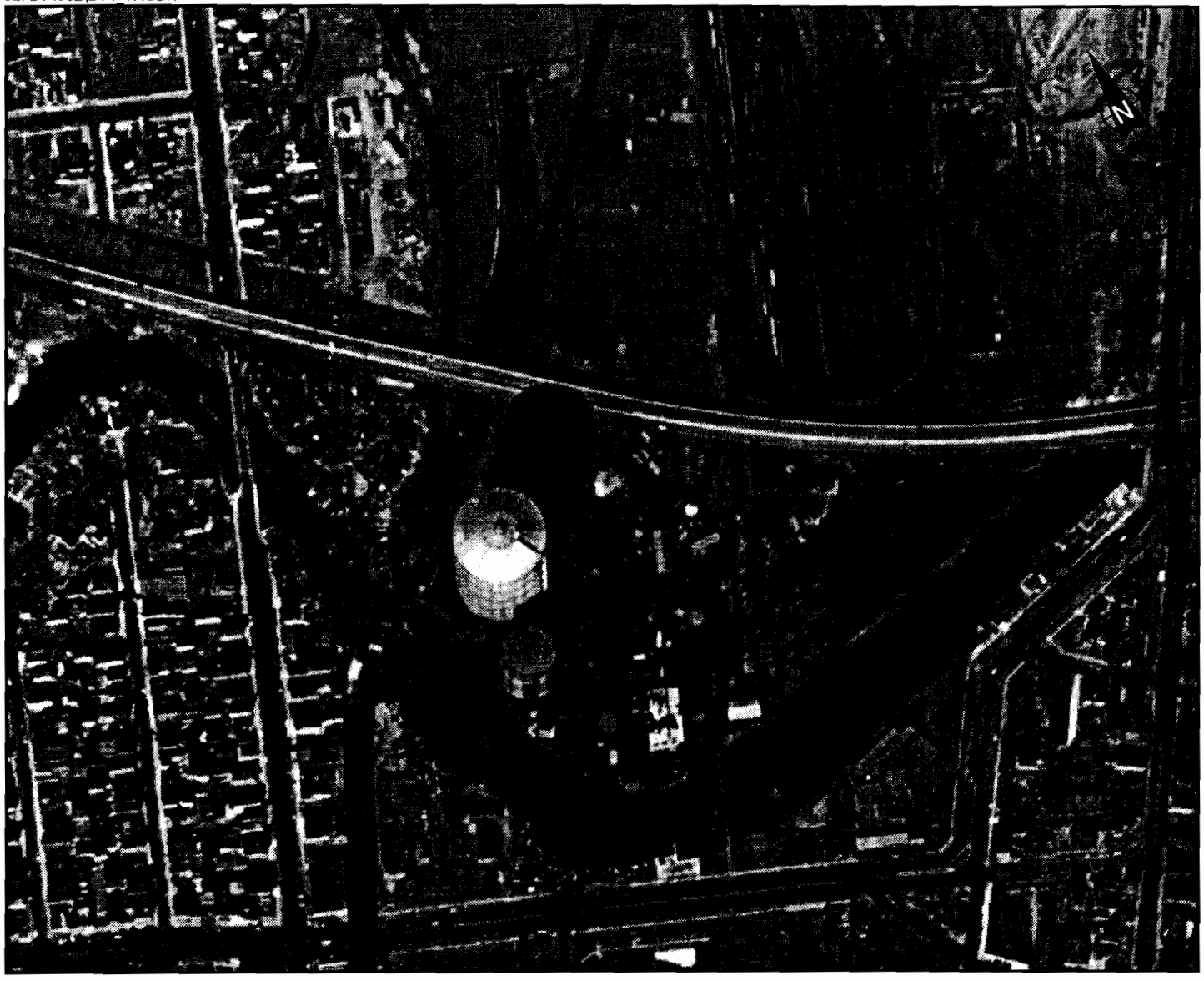

Figure 1-4 1954 AERIAL PHOTO, BROOKLYN BOROUGH GAS WORKS

02: BV4902\BV4_18.CDR

Figure 1-5 1960 AERIAL PHOTO, BROOKLYN BOROUGH GAS WORKS

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Figure 1-6 1966 AERIAL PHOTO, BROOKLYN BOROUGH GAS WORKS

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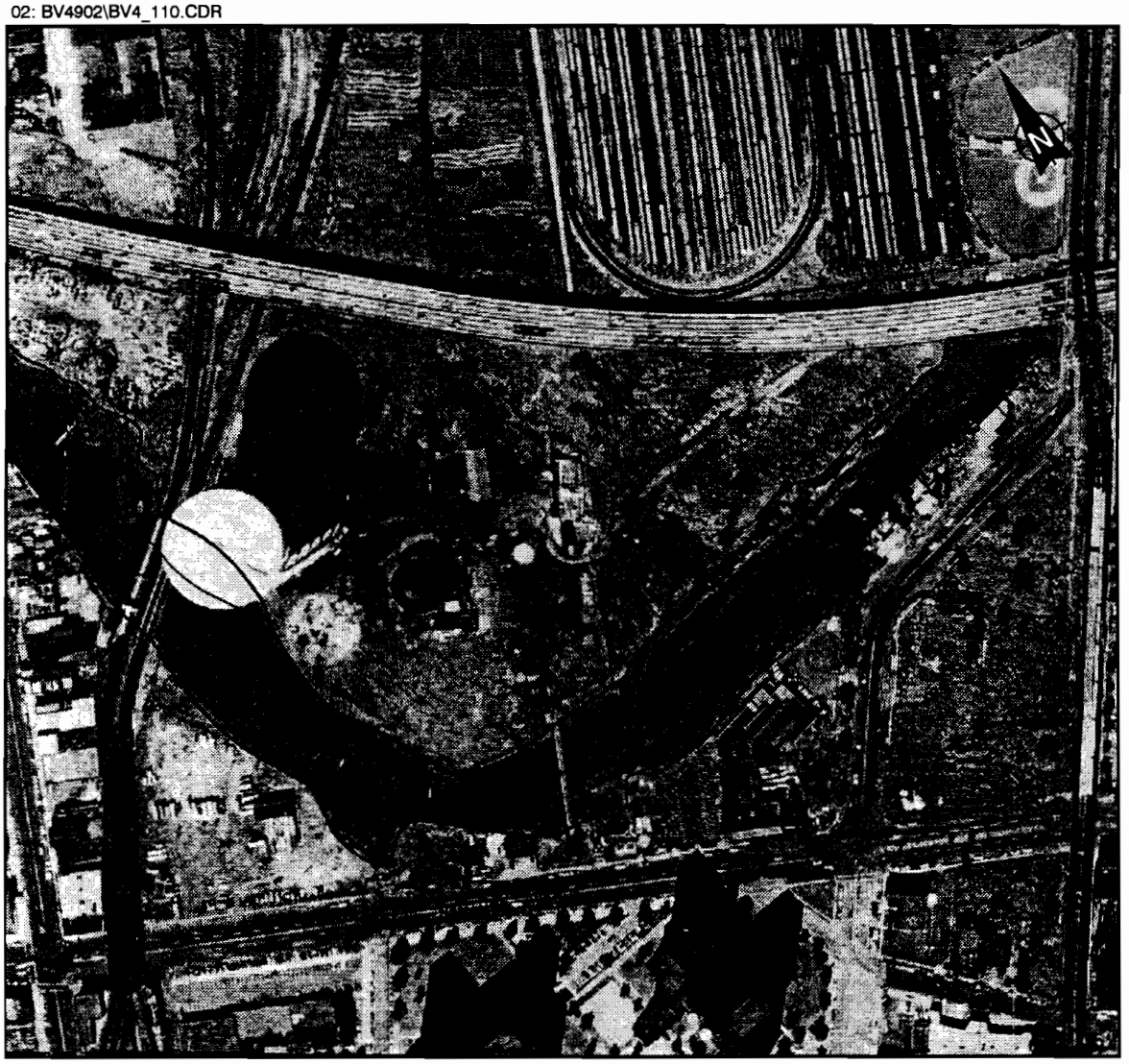

Figure 1-7 1974 AERIAL PHOTO, BROOKLYN BOROUGH GAS WORKS

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Figure 1-8 1994 AERIAL PHOTO, BROOKLYN BOROUGH GAS WORKS

2 Investigations of the Study Area

Investigation of the property has been conducted in several phases. Preliminary and voluntary property assessments were conducted by other consultants, and all subsequent phases have been conducted by E & E. A summary of the work and salient findings from each investigation are presented below.

2.1 Pre-Consent Order Investigations

2.1.1 Roux Associates

Roux Associates (Roux) conducted a limited subsurface investigation of the property (Roux 1984). In association with potential property/real estate development plans, an initial assessment was performed primarily to determine if significant tar deposits were located on site. The key findings were:

- A brown, oily free product was present in soil collected from borings CI-2 and CI-4, located in the southwest part of the property. Figure 2-1 shows the borehole locations;
- Patches of black soil with a coal-tar odor were encountered in the fill above the water table in several borings. However, the black soil was not found in all borings, indicating that the soil layer was not continuous;
- A 2- to 4-foot-thick silt-and-clay layer was encountered in CI-5 and in all borings in the eastern area (CI-7 through CI-11). This layer contained phragmites and shells, indicating it was deposited as part of a relic salt marsh. Roux noted that the tight nature of the layer would inhibit downward movement of water from overlying fill deposits to underlying permeable glacial outwash sands;
- Fill deposits were encountered in all borings and ranged in thickness from 3.5 feet (CI-1) to 16 feet (CI-7 and CI-8). The fill is thickest in the eastern area, which is topographically higher than the western part of the site;

- The gradient of the water table was measured to be 0.0045 feet per foot, or 23.8 feet per mile. Groundwater flows form north to south and southeast; all shallow groundwater discharges into the creek; and

- Oily material was observed in Coney Island Creek near boring CI-2 (see Figure 2-1).

Based on the information available at that time, the company believed that there were no disposal pits or other waste disposal areas on the site. Moreover, the site did not appear to be a significant threat to human health or the environment, nor did it appear to pose a current clean-up obligation.

2.1.2 A.D. Little

2.1.2.1 Contaminant Investigation

A.D. Little, Inc., conducted an initial investigation and contaminant transport modeling study of the property (A.D. Little 1989). The investigation involved installation of groundwater monitoring wells, collection and chemical analysis of groundwater and subsurface soil samples, water level monitoring, hydraulic conductivity testing, and contaminant transport modeling. Figure 2-2 shows the monitoring well locations. Table 2-1 summarizes the groundwater monitoring well statistics. The objectives of the study were to:

- Evaluate off-property migration rates of substances dissolved in groundwater for which reportable quantity releases under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Clean Water Act, state counterparts of those laws, or applicable local regulations have been established;

- Evaluate the potential for groundwater migration of chemical constituents onto the property from off-property locations; and

- Evaluate the likelihood that there are soil and groundwater chemical constituent sources on the property that were not identified in the previous investigation.

The following findings of this report highlight information relevant to the current investigation:

- Free product was found in the soils of CIW-4D, CIW-5, and CI-6. CIW-5-D2 contained oil in the soil at 45 feet below ground surface (BGS). Free product was also found on the surface of groundwater in CIW-1, CIW-5S, CIW-6S, and CIW-10. CIW-4, CIW-5, and CIW-6 contained heavy oil sheens, and free oil droplets were observed at depth.

- A continuous silt-and-clay layer was found on the northeast side of the property. It overlies sands and underlies fill.

- Studies of the hydraulics show groundwater flow direction on the property is reversed during higher tide. The hydraulic conductivity in the shallow aquifer was 12 feet per day; in the deep wells, it ranged form 41 to 125 feet per day. The inland distance of tidal influence from the creek was calculated to be 50 feet.

- There was little tidal fluctuation in CIW-1. It was believed that the clay layer isolates this well. The water level in CIW-3 was anomalously higher than other wells close to the creek. This well was screened partly above and partly into the clay layer possibly isolating the well. However, the exact cause of this anomaly is not known.

- No new major chemical constituent sources were present on the property. However, data from wells at the property perimeter suggest off-property sources should be investigated (see Table 2-2). CIW-2, CIW-7, CIW-8S, CIW-8D, and CIW-9 were installed at the upgradient boundary of the property to gain a preliminary indication of chemical constituents that may be flowing from neighboring properties onto the Brooklyn Borough Gas Works property. Arsenic, found in CIW-8D, was the only metal found in an upgradient well at a substantially higher concentration than found in the downgradient wells. Aroclor 1016 was found in the groundwater from CIW-7 and CIW-9. The groundwater data also indicate volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and possibly some metals may be migrating through groundwater flow onto the property from the north and west.

- A.D. Little developed estimates, expressed in terms of pounds per day, of the rate at which on-property chemical constituents were migrating across the downgradient property boundary. Table 2-3 summarizes the most likely values and uncertainty bounds for the contaminant mass migration rates; the reportable quantity releases as of December 29, 1986, were also included. The estimated migration rates were found to be less than the reportable quantity values at the time for those compounds, even at three standard deviations greater than the most likely value, except for lead.

- One of the purposes of this project was to determine whether any major contaminant sources on the property, such as waste disposal pits, had been undiscovered during the 1984 investigation. A.D. Little did not encounter any major waste deposits during monitoring well installation. However, A.D. Little noted that heavy oil sheens accumulated on the water surface in several wells, and indicated that under natural conditions (i.e., no remediation), groundwater on the property would continue to be contaminated.

Based on the information available at that time, no duty to report the historical contamination to government authorities was discovered. As before, the site did not appear to be a

significant threat to human health or the environment, nor did it appear to pose a current clean-up obligation.

2.1.2.2 Health Risk Assessment of the Former Gil Hodges Baseball Fields

A.D. Little also performed some additional investigations of the property in 1990 to support a health risk assessment of the area immediately east of the priorly investigated area, formerly called, and currently closed, Gil Hodges Little League baseball fields (A.D. Little 1992) (see Figure 1-9 in back pocket). This area had not been addressed in the prior A.D. Little study. The investigation work included:

- A soil gas analysis;
- The collection of 10 near-surface soil samples in the main baseball field, which were analyzed for VOCs, SVOCs, metals, cyanide, and sulfide; and
- The collection of four surface soil samples, which were analyzed for grain size.

Soil and soil gas sampling locations are shown on Figure 2-3.

The risk assessment followed commonly accepted practices for risk assessments. Data from this sampling round, from A.D. Little's previous work described above, and from that of Roux and R.F. Weston (see Section 2.1.3) were included in the assessment. An assumption made by A.D. Little was that the fields' sole use would be for the playing of baseball and related activities, with no construction modification. Human exposures to chemical constituents in concentrations above background were assumed to be due to potential exposure via the inhalation of vapors and airborne dust from the infields, direct dermal contact with field soils, and incidental ingestion of soil while playing. Modeling results indicated that fugitive dust emissions from the vacated western area were negligible.

Vapor exposure was modeled using actual data (soil gas analyses for benzene, toluene, xylene, ethylbenzene, cyanide, hydrogen sulfide, and mercury) or modeled data from soil concentrations. Dust exposure was modeled using soil concentration data and considered soil erosion and dispersion in air. Dermal and ingestion pathways were modeled using common algorithms.

None of the incremental exposures of ball players or any other person to soil contaminants resulted in unacceptable levels above appropriate chronic exposure criteria. For chemicals considered to be carcinogenic, none of the exposures, either individually or collectively, resulted in a cancer risk in excess of 1×10^{-7} or a 1-in-10-million chance of contracting cancer. Because

these results are acceptable according to NYSDEC and United States Environmental Protection Agency (EPA) site cleanup risk criteria, it was concluded that use of the baseball fields would not pose an unacceptable health risk.

2.1.3 R.F. Weston

Roy F. Weston, Inc., (Weston) conducted a hazardous materials survey of the property for the New York City Department of Environmental Protection (NYCDEP) (Weston 1989). The scope of the Weston study included the installation of soil borings and the collection and analysis of groundwater, soil, surface water, and sediment samples. Figure 2-4 shows the soil boring locations. Relevant study findings are summarized below:

- Free product approximately 3 feet thick was observed at the bottom of CIW-1 and CIW-4D. The product was black, oily, and yielded a strong petroleum hydrocarbon odor. Floating product was found in CIW-5S and CIW-6S. The analytical results of groundwater sampling are summarized in Table 2-4.

- Free oil was found in soil boring (SB) 2, SB3, SB4, SB7, and SB9, all at a depth of less than 4 feet. Tar was encountered in SB4. Figure 2-4 shows the locations of the soil borings.

- Higher lead concentrations were found along the western side of the property in SB10 and SB11. The highest concentration of arsenic found in soils was in the southeast portion of the property.

2.2 Phase II Geotechnical Investigation

In response to a letter from the New York City Department of Environmental Protection (NYCDEP), dated January 11, 1993, which alleged a release and threat of release of hazardous wastes and hazardous substances at and from the site, Brooklyn Union instructed E & E to conduct what may be conveniently termed the Phase II geotechnical investigation of the property (E & E 1993a). This phase of extensive field investigation (conducted from March to May 1993) consisted of the collection of surface (see Figure 2-5) and subsurface soil samples during the installation of borings (see Figure 2-6), monitoring wells (see Figure 2-7), and trenches (see Figure 2-8); the collection of groundwater samples from shallow and deep groundwater monitoring wells; and the collection of surface water and sediment samples from the adjacent Coney Island Creek (see Figure 2-9). A passive soil gas survey also was conducted (see Figure 2-10) (E & E 1993b).

In this phase of investigation, it was determined that the property generally contains a spatially discontinuous deposit of polynuclear aromatic hydrocarbons (PAHs) to a depth of 12

feet BGS. PAHs were detected to a depth of 172 feet BGS. Benzene, toluene, ethylbenzene, and xylenes (BTEX) are prevalent in a zone from the northern to the southwestern areas of the property. The high concentrations of organic chemical constituents in the northwestern and southeastern areas near the property boundaries suggest a potential off-property chemical constituent source. The inorganic chemical constituents included lead, chromium, and arsenic. Their distribution generally follows that of the organic chemical constituents. The highest concentrations occurred in the southeast corner of the property. Lead also occurred at high levels around the largest gas holder foundation on the west side of the property. Groundwater beneath the property also contains elevated levels of organic and inorganic chemical constituents.

On June 17, 1993, a seep was observed releasing what appeared to be a petroleum product from shore along the Brooklyn Borough Gas Works site into Coney Island Creek. Brooklyn Union reported the release to appropriate regulatory authorities. The United States Coast Guard directed Brooklyn Union to investigate the source of the seep and to stop the release of petroleum product into the creek.

2.3 Phase III Geotechnical Investigation

Phase III of the geotechnical investigation of the property was conducted from July 12 to 22, 1993 (E & E 1993c). This phase involved conducting a subsurface structure investigation to identify migration pathway(s) such as piping and any other structures that could serve as product migration conduits, and the collection of a second round of groundwater samples.

Various subsurface structures were observed on the property, including a previously unknown concrete vault that contained two underground storage tanks (USTs) for gas-oil in the area of the southwest gas holder pad. During this phase of investigation, a seep of light petroleum product was observed emanating into Coney Island Creek at the end of the wooden bulkhead (see Figure 2-7). A large area directly north of the seep was underlain with a floating petroleum product that appeared similar to that material entering Coney Island Creek at the seep. The seep apparently was not fed by any direct man-made subsurface structure, but rather by product migration through highly transmissive soils.

2.4 Phase IV Geotechnical and Hydrogeological Investigation

From August 9 to 16, 1993, E & E conducted the Phase IV geotechnical and hydrogeological investigation of the property (E & E 1993d). This phase of the investigation was designed to:

- Monitor behavior of the seep;
- Determine tidal influence on interceptor wells (see Figure 2-7) and the petroleum products in the groundwater;
- Determine the characteristics of the various petroleum products found on the property and seeping into the creek;
- Determine the hydraulic conductivity of the subsurface soils near the creek;
- Determine the optimal pumping rate (if one exists) for recovering petroleum products from the groundwater; and
- Obtain preliminary data on treatment of recovered groundwater.

Relevant conclusions from this phase of the investigation were:

- The rate at which the floating oil flows into IW-4A appeared to be independent of pumping rate. However, it may be a function of well diameter;
- The product depth in IW-4A varies with the tidal cycle; and
- Oil in IW-4A contains a shorter carbon chain portion, indicating that it is a more volatile oil than that in CIW-6S. These findings further support the theory that IW-04 oil is gas-oil and the oil in CIW-6S is sealant oil used at the gas holder pads.

2.5 Phase V Geotechnical and Hydrogeological Investigation

From October 11 to 21, 1993, a Phase V geotechnical and hydrogeological investigation of the property was conducted by E & E (E & E 1994a). This investigation included the placement of three new groundwater monitoring wells, 22 soil borings, and 12 test pits, and a third round of groundwater sampling analyses (see Figures 2-6, 2-7, and 2-8). In addition to those previously studied, two areas where previous data did not exist or were inconclusive, specifically along the southeastern boundary and the full western boundary of the property, were investigated. Procedures conducted were consistent with those executed by E & E during previous phases of work.

Soil samples were collected from each of these monitoring wells and submitted for analysis of VOCs, total recoverable petroleum hydrocarbons (TRPH), PAHs, metals, PCBs, and pesticides. Soil samples from boreholes were submitted for various geotechnical analyses, including grain size, Atterburg limits, and triaxial sheer. Two soil samples were collected from

selected test pits and submitted for inorganics analyses. In addition, one of these samples was also submitted for VOC, PAH, and TRPH analyses.

In addition to the subsurface investigation tasks, hydrogeologic investigation tasks were also conducted. Groundwater movement data were collected in two ways. Slug testing was conducted on 14 of the 15 shallow wells installed by E & E and the four deep wells to determine the groundwater flow rate at various locations around the property, and an 18-hour water level monitoring test of Coney Island Creek and two wells was conducted to determine the inland extent of tidal influence from the creek. A round of groundwater sampling from 15 E & E-installed shallow monitoring wells, four E & E-installed deep groundwater monitoring wells, and five of the existing wells was also completed. These samples were submitted for VOC, PAH, TRPH, PCB, pesticides, inorganics, hardness, chlorosity, and total dissolved solids (TDS) analyses. A water sample was also collected from one of the two drip pots located near the southeastern corner of the property, adjacent to Coney Island Creek, and submitted for VOC analysis. In addition, a check for the presence of oil was conducted at several wells. Oil samples were collected from wells in which oil was found.

Several conclusions were drawn from the findings of these activities.

1. Free product of varying viscosities was found in four wells and 10 test pits. Previous consultants working at the property also found oil floating in wells and in soil borings. These appear to be several different oils from different sources.

2. Observations of subsurface soils excavated during numerous test pit and borehole installations indicate that the horizontal limits of subsurface coal tar infiltration are not bounded by the current property line. Data suggest that there is an off-property TRPH source at the northwest corner of the property. Previous studies have shown the highest concentrations of lead and arsenic occurred at the property perimeter. Also, low concentrations of PCBs have been found along the property perimeter.

3. Test pits installed throughout the property exposed unstable fill material at depths of up to 8 feet. Previous consultants encountered similar material around the property.

4. A discontinuous clay/peat layer underlying the fill appears to be acting as a vertical hydrologic barrier, inhibiting and possibly stopping the downward migration of coal tars and oils.

5. Several wooden structures extending at least 25 feet inland support the wooden bulkhead. The exact numbers, consistency, and integrity of these structures are unknown. The bulkhead appears to be effectively inhibiting lateral migration of chemical constituents into the creek.

6. Inland tidal influence was determined to occur throughout the property. Tidal influence appears to be less to the west and east and decrease to the north, away from the creek. Evidence suggests that this is possibly due to the bulkhead structure on the west, and to the low permeability of the geologic formation on the east.

7. Geologic conditions identified to date suggest that if floating oil were present in the eastern area, it could be hydrogeologically directed to the central part of the property.

8. The chemical constituents found in water samples from groundwater monitoring wells were relatively consistent with the findings from previous sampling events.

2.6 Interim Response Measure for Seep

After additional investigations (Phases IV and V), E & E performed a feasibility study of several alternative approaches for mitigating the seep (E & E 1993e). From this study, a permanent hard boom with rope mop skimmers and inland recovery wells was selected as the best alternative. E & E was retained to design and install an interim response measure (IRM) to mitigate the release of lighter-than-water nonaqueous-phase liquid (LNAPL) from the property (E & E 1994b). The IRM was constructed from July to November 1994 as follows:

- Installation of inland recovery wells (see Figure 2-7 for location);
- Installation of a hard boom and end connections (see Figure 1-10 for location); and
- Installation of LNAPL skimmer system and hookup of oil collection system.

The system was tested and demonstrated to be operational in late 1994. It also was observed and verbally accepted by the U.S. Coast Guard (May 1995).

2.7 Phase VI Supplemental Remedial Investigation

In October and November 1996, and February and June 1997, E & E conducted the Phase VI supplemental RI, which consisted of geotechnical and hydrogeological investigation of the eastern area of the property. Appendix B contains a detailed report of the RI activities conducted during Phase VI, including the investigation procedures; the borehole, trench, and monitoring well construction logs; surface and subsurface soil and groundwater analytical data; and slug test data with calculated hydraulic conductivities. In addition, four surface soil samples (F-1, F-2, G-1 and G-2) were collected and submitted for lead analysis on August 27, 1997.

This phase of the field investigation included the collection of subsurface soil samples during the drilling of 21 borings (see Figure 2-6), two surface soil samples (see Figure 2-5), excavation of 27 trenches (see Figure 2-8), and installation of seven groundwater monitoring wells (see Figure 2-7). Slug tests were performed on the seven new wells to obtain hydraulic conductivities. Groundwater samples were collected in November 1996 from the seven new wells on the eastern area of the property, as well as from the 13 shallow and four deep monitoring wells on the western area of the property that were installed during Phases II and V. Additional groundwater samples were collected in June 1997 from the seven wells in the eastern area of the property, as well as three shallow wells and one deep monitoring well in the western area of the property. An old well, CIW-1, in the eastern area of the property, was also sampled.

Subsurface soil samples were collected from each of the boreholes and monitoring wells and analyzed for VOCs, TRPH, PAHs, inorganics, PCBs, and pesticides. In February 1997, six boreholes were installed and sampled for total and chlorine-amenable cyanide. In addition, 12 subsurface soil samples were collected from the 0- to 2-foot interval from 11 of the 27 trenches, all of which were installed in February 1997 in the eastern area of the property. Ten samples, including the duplicate, were analyzed for inorganics, total and chlorine-amenable cyanide, pesticides/PCBs, and TRPH. Four of these 10 samples were also analyzed for PAHs. Two of the 12 samples were analyzed for total and chlorine-amenable cyanide, only. (Total cyanide is a measurement of almost nondissociable cyanides, cyanide bound in readily dissociable complexes, and complexes of intermediate stability [APHA 1995]. In contrast, free cyanide and potentially dissociable complex cyanides are measured by the amenable-to-chlorination test. Metal cyanide complexes, especially iron cyanides, are not measured in the amenable test.) Soil samples were collected from 2-foot intervals from surface to total depth of the borings. Intervals where a sample was not recovered are noted on the borehole drilling logs in Appendix B.

In June 1997, subsurface soil samples were collected from two boreholes (BH74 and BH75) in the eastern section of the property and analyzed for VOCs, PAHs, TRPH, inorganics, pesticides, PCBs,and total and chlorine-amenable cyanide. Four subsurface soil samples were collected from 4-foot intervals from each borehole. Void spaces and compaction did not provide sufficient material for the soils to be sampled at 2-foot intervals. Nine samples, including a duplicate, were collected and submitted for analysis.

Two surface soil samples were collected at SS74 and SS75 from the 0.5-foot interval and analyzed for VOCs, PAHs, TRPH, PAHs, inorganics, PCBs, pesticides, and total and chlorine-amenable cyanide during the June 1997 Phase VI field investigation.

The hydrogeological investigation tasks consisted of slug testing being performed on the seven new wells and five complete rounds of water level measurements being collected from the

20 shallow and four deep wells installed by E & E. Groundwater levels were obtained as close as possible to high and low tides. The water level data from November 1996 are included in Appendix B. In addition, a complete round of groundwater sampling from the 20 shallow and four deep groundwater monitoring wells installed in Phases II, V, and VI was conducted. These samples were submitted for VOC, SVOC, PAH, TRPH, PCB, pesticides, inorganics, chlorosity, hardness, and total dissolved solids (TDS) analyses. Two denser-than-water nonaqueous phase liquid (DNAPL) samples were collected from shallow monitoring wells MW-04 and MW-05 on the property and submitted for petroleum hydrocarbon fingerprinting. In addition, three older wells were checked for the presence of floating oil.

In June 1997, three complete rounds of water level measurements were collected from the 20 shallow and four deep wells. Groundwater levels were obtained as close as possible to high and low tides. Ten inches of DNAPL were measured in monitoring well MW-04, and only a slight coating of DNAPL was observed on the bottom of the bailer from MW-05. In addition, 6.1 feet of oil was measured in an older monitoring well, CIW-6S. This well has had oil previously observed and measured at 3.55 feet on September 3, 1993; 4.95 feet on October 20, 1993; and 5.57 feet on June 17, 1994. The water level data from June 1997 are included in Appendix B. Groundwater samples were collected from 10 wells (MW15 through MW22, DW04, and CIW-1) and analyzed for VOCs, PAHs, Pest/PCBs, TRPH, inorganics, total and chlorine-amenable cyanide, total hardness, TDS, and chlorosity. Both filtered and unfiltered samples for the inorganics and cyanides were collected. In addition, monitoring wells MW02 and MW06 were sampled for filtered/unfiltered total and amenable cyanide.

E & E drew several conclusions from the investigation of the eastern area of the property:

- Free product was confirmed as a sheen or globules on the water, on subsurface soils, the sampling equipment, and in nine of the 21 bore-holes and six of the seven groundwater monitoring wells installed in the eastern area of the property and to the north, off site of the property;

- During the June 1997 groundwater sampling, as described in Appendix B, filtered and unfiltered samples were collected for metals and total and amenable cyanide analysis. Most of the metal analytes had reduced concentration levels, or were nondetect in the filtered samples versus the unfiltered samples. The higher concentrations of metals in the unfiltered samples indicate that the metals concentrations are largely associated with the suspended particulates and are not in the dissolved phase.

- Cyanide was detected in both the filtered and unfiltered groundwater samples collected during the June 1997 sampling event. Total cyanide

was detected in the unfiltered samples at concentrations ranging from nondetect (ND) to 16.6 mg/L; in the filtered samples, concentrations ranged from ND to 13.9 mg/L. In samples collected from deep well DW-04, total cyanide was detected at 0.064 mg/L in the unfiltered sample and at 0.072 mg/L in the filtered sample.

- Observations of subsurface soils excavated during the installation of the 21 boreholes and seven monitoring wells suggest that the horizontal limits of subsurface contamination may not be bounded by the current property line. Low levels of cyanide were detected in subsurface soil samples from all but four of the boreholes and all of the monitoring wells, particularly in the northern part of the eastern area;

- Fill material was encountered at depths of up to 16 feet in the boreholes and monitoring wells installed in the eastern area. The eastern area of the property is elevated approximately 7 to 8 feet above the western area;

- A discontinuous clay/peat/silt layer underlies the fill on the eastern area and appears to act as a vertical hydrologic barrier inhibiting, and perhaps preventing, the downward migration of denser-than-water coal tars and oils; and

- Fill material was encountered as shallow as 3 inches in one of the 27 test pits installed in the eastern area of the property.

Table 2-1

1988 GROUNDWATER MONITORING STATISTICS FOR WELLS INSTALLED BY A.D. LITTLE BROOKLYN BOROUGH GAS WORKS

Well Number	Ground Elevation[a]	Top of Casing Elevation[b] (feet)	Well Bottom Elevation[c] (feet)	6-Hour Interval Water Level Elevation[d] (feet)
CIW-1	NA	101.31	80.0	11.30 - 11.48
CIW-2	NA	100.56	76.5	8.53 - 8.50
CIW-3S	NA	100.61	—	7.82 - 7.83
CIW-3D	NA	99.26	70.0	9.73 - 9.79
CIW-4S	NA	101.76	—	12.17 - 12.31
CIW-4D	NA	100.53	62.0	11.09 - 11.19
CIW-5S	NA	98.53	—	9.61 - 9.71
CIW-5D	NA	98.52	54.0	9.58 - 9.62
CIW-5D2	NA	98.48	35.0	9.61 - 9.62
CIW-6S	NA	98.99	—	6.89 - 7.10
CIW-6D	NA	97.55	58.0	8.61 - 8.70
CIW-7	NA	101.17	—	8.68 - 8.66
CIW-8S	NA	99.91	—	6.54 - 6.53
CIW-8D	NA	98.64	—	7.76 - 7.80
CIW-9	NA	100.00	—	6.96 - 6.97
CIW-10	NA	99.28	—	6.94 - 7.72

[a] Information not available.

[b] Based on 100 foot arbitrary datum establishment.

[c] Bottom elevations based on estimates from representative well drawings (Little 1989).

[d] Water table elevations based on 6-hour intervals—morning to mid-afternoon, an approximate 6-hour difference in reading (Little 1989).

Key:

— = Not estimated.
NA = Not available.

Source: A.D. Little 1989.

Table 2-2

ORGANIC COMPOUNDS FOUND IN UPGRADIENT WELLS BY ARTHUR D. LITTLE BROOKLYN BOROUGH GAS WORKS

Compound	Concentration (µg/L)			
	CIW-7	CIW-8s	CIW-8d	CIW-9
Volatiles				
Benzene	ND	ND	ND	3.1
Xylenes	ND	ND	ND	63
1-1-Dichloroethane	ND	3.1	2.5	ND
Semivolatiles				
Fluorene	ND	BMRL(33)	BMRL(33)	46
Phenanthrene	ND	ND	ND	62
Fluoranthene	ND	ND	ND	BMRL(20)
Anthracene	ND	ND	ND	BMRL(20)
Pyrene	ND	ND	ND	BMRL(20)
Dibenzofuran	ND	ND	ND	BMRL(20)
Phenol	ND	ND	ND	BMRL(20)
bis(2-Ethylhexyl)phthalate[a]	BMRL(20)	BMRL(33)	BMRL(33)	ND
Naphthalene	ND	ND	BMRL(33)	ND
Acenaphthene	ND	BMRL(33)	47	ND
N-Nitrosodiphenylamine	ND	BMRL(33)	BMRL(33)	ND
1-Methylnaphthalene[b]	ND	22	31	ND
Acenaphthylene	ND	BMRL(33)	ND	ND
Dimethyl phthalate	ND	ND	ND	BMRL(10)
Pesticides				
Aroclor 1016	0.30	ND	NA	0.43

[a] Suspected laboratory contaminant.
[b] Tentatively identified.

Key:

BMRL(__) = Below Method Reporting Limit (Reporting Limit).
ND = Not detected.
NA = Not analyzed.

Source: A.D. Little 1989.

Table 2-3

RESULTS OF ESTIMATE OF CONTAMINANT MASS MIGRATION UNCERTAINTY ANALYSIS STUDY CONDUCTED BY A.D. LITTLE BROOKLYN BOROUGH GAS WORKS

Compound	Best Estimate (lbs/day) October 1987	1 Standard Deviation +	2 Standard Deviations +	3 Standard Deviations +	Reportable Quantity (lbs/day)
Semivolatiles					
Acenaphthene	7.1E-01	1.2E+00	1.6E+00	2.1E+00	100
Acenaphthylene	3.8E-01	6.5E-01	9.2E-01	1.2E+00	5,000
Anthracene	3.0E-01	5.7E-01	8.4E-01	1.1E+00	5,000
Benzo(a)anthracene	2.4E-01	4.4E-01	6.4E-01	8.4E-01	1
Benzo(b)fluoranthene	2.0E-01	3.7E-01	5.4E-01	7.1E-01	1
Benzo(k)fluoranthene	2.0E-01	3.7E-01	5.4E-01	7.1E-01	1
Benzo(g,h,i,)perylene	8.8E-02	1.7E-01	2.6E-01	3.5E-01	5,000
Benzo(a)pyrene	1.0E-01	2.1E-01	3.1E-01	4.2E-01	1
Chrysene	2.4E-01	4.4E-01	6.4E-01	8.4E-01	1
Fluoranthene	4.1E-01	7.7E-01	1.1E+00	1.5E+00	100
Fluorene	6.8E-01	1.2E+00	1.7E+00	2.2E+00	5,000
Naphthalene	1.3E+01	2.2E+01	3.2E+01	4.2E+01	100
Phenanthrene	1.4E+00	2.8E+00	4.3E+00	5.7E+00	5,000
Pyrene	5.8E-01	1.1E+00	1.7E+00	2.2E+00	5,000
2-Methylphenol	6.3E-04	1.5E-03	2.3E-03	3.1E-03	NA
4-Methylphenol	6.3E-04	1.5E-03	2.3E-03	3.1E-03	NA
2,4-Dimethylphenol	4.1E-02	8.0E-02	1.2E-01	1.6E-01	NA
Methylnaphthalene	2.7E+00	4.9E+00	7.1E+00	9.3E+00	NA
Dibenzofuran	2.5E-01	4.1E-01	5.8E-01	7.5E-01	NA
Pentachlorophenol	5.5E-02	1.3E-01	2.0E-01	2.7E-01	10
Bis(2-ethylhexyl) phthalate	1.2E+00	2.7E+00	4.1E+00	5.6E+00	NA
Indeno (1,2,3-c,d) pyrene	8.8E-02	1.7E-01	2.6E-01	3.5E-01	NA
Dibenzo(a,h)anthracene	6.1E-02	1.4E-01	2.2E-01	3.0E-01	NA
Cresols	2.3E-02	4.6E-02	6.9E-02	9.2E-02	1,000
Phenol	2.8E-02	5.6E-02	8.4E-02	1.1E-01	1,000
Resorcinol	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5,000
Phenols	6.4E-02	1.2E-01	1.7E-01	2.2E-01	1,000
2-Methylnaphthalene	2.7E+00	4.9E+00	7.1E+00	9.3E+00	NA
4-Methylnaphthalene	1.9E+00	3.3E+00	4.6E+00	6.0E+00	NA

Table 2-3

RESULTS OF ESTIMATE OF CONTAMINANT MASS MIGRATION UNCERTAINTY ANALYSIS STUDY CONDUCTED BY A.D. LITTLE BROOKLYN BOROUGH GAS WORKS

Compound	Best Estimate (lbs/day) October 1987	1 Standard Deviation +	2 Standard Deviations +	3 Standard Deviations +	Reportable Quantity (lbs/day)
Volatile Organics					
Benzene	3.3+0	6.6E+00	9.9E+00	1.3E+01	1,000
Chlorobenzene	0.0+00	0.0E+00	0.0E+00	0.0E+00	100
Ethylbenzene	2.3+00	5.1E+00	1.8E+00	1.1E+01	1,000
Dichlorobenzene	0.0+00	0.0E+00	0.0E+00	0.0E+00	100
Dichlorobenzene	0.0+00	0.0E+00	0.0E+00	0.0E+00	100
Trichlorobenzene	0.0+00	0.0E+00	0.0E+00	0.0E+00	100
Toluene	4.1+00	8.4E+00	1.3E+01	1.7E+01	1,000
O-xylene	5.5+00	1.1E+01	1.6E+01	2.2E+01	1,000
Ammonia	4.1-01	9.4E-01	1.5E+00	2.0E+00	NA
Metals					
Antimony	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5,000
Arsenic	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1
Beryllium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1
Chromium	2.4E-03	4.6E-03	6.8E-03	9.0E-03	1
Chromium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1
Copper	1.4E-01	2.4E-01	3.4EE-01	4.4E-01	5,000
Lead	4.7E-01	7.7E-01	1.1E+00	1.4E+00	1
Mercury	0.0E+00	0.0E+00	0.0EE+00	0.0E+00	1
Nickel	2.5E-01	4.7E-01	6.8E-01	9.0E-01	1
Selenium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	100
Silver	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1,000
Thallium	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1,000
Zinc	7.7E-01	1.2E+00	1.7E+00	2.1E+00	1,000
Other					
	6.2E-01	1.0E+00	1.4E+00	1.8E+00	10
	7.3E+00	1.3E+01	1.9E+01	2.4E+01	100

Key:

NA = Not analyzed.

Source: A.D. Little 1989, Attachment H.

Table 2-4

SUMMARY OF ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED BY ROY F. WESTON, BROOKLYN BOROUGH GAS WORKS

Sample Number	CIW-1	CIW-3S	CIW-3D	CIW-4S	CIW-4D	CIW-5S	CIW-5D	CIW-5D-2	CIW-6S
Total Volatile Organics (µg/L)	ND	ND	ND	ND	6,650	14,900	23,980	2,010	299
Total BNAs (µg/L)	278	15	16	12	13	460,000	9,572	1,020	314,700
Selected Metals (mg/L)									
Silver	ND	NA	ND	ND	ND	NA	ND	ND	ND
Arsenic	ND	NA	ND	ND	ND	NA	ND	ND	ND
Barium	ND	NA	423	ND	ND	NA	ND	420	1,010
Cadmium	ND	NA	ND	ND	ND	NA	ND	ND	ND
Chromium	ND	NA	ND	ND	ND	NA	10.6	ND	ND
Mercury	ND	NA	0.41	ND	ND	NA	ND	ND	0.44
Lead	ND	NA	ND	ND	ND	NA	ND	ND	42.3
Selenium	ND	NA	ND	ND	ND	NA	ND	ND	ND

Table 2-4

SUMMARY OF ANALYTICAL DATA FOR GROUNDWATER SAMPLES COLLECTED BY ROY F. WESTON, BROOKLYN BOROUGH GAS WORKS SITE

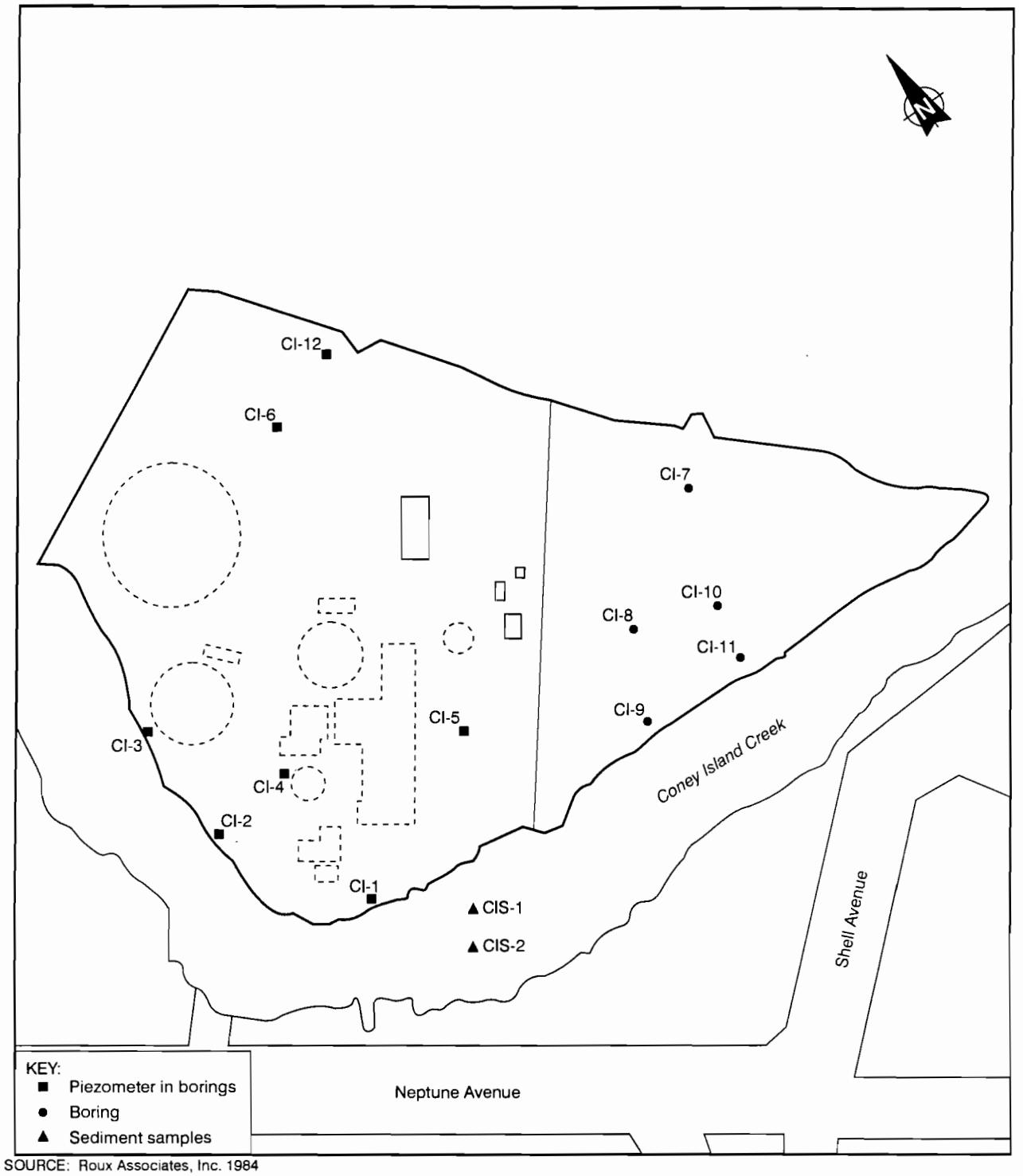
Sample Number	CIW-6D	CIW-8S	CIW-8D	CIW-9	CIW-10	RS-1	RS-2	FreeProduct
Total Volatile Organics (μg/L)	ND	ND	50	1,030	1,250	ND	ND	NA
Total BNAs (μg/L)	10	48	220	1,030	1,200	7	2	2.0×10^7
Selected Metals (mg/L)								
Silver	ND	ND	ND	ND	ND	ND	ND	NA
Arsenic	ND	ND	ND	ND	ND	ND	ND	NA
Barium	ND	ND	ND	431	ND	ND	ND	NA
Cadmium	ND	ND	ND	ND	ND	ND	ND	NA
Chromium	ND	ND	ND	ND	ND	ND	ND	NA
Mercury	ND	0.31	ND	ND	ND	ND	0.31	NA
Lead	ND	ND	ND	ND	ND	39.9	ND	NA
Selenium	ND	ND	ND	ND	ND	76.0	ND	NA

Key:

μg/L = Micrograms per liter.
mg/L = Milligrams per liter.
ND = Not Detected
NA = Not Analyzed

Source: Roy F. Weston 1989.

02: BV490221.CDR

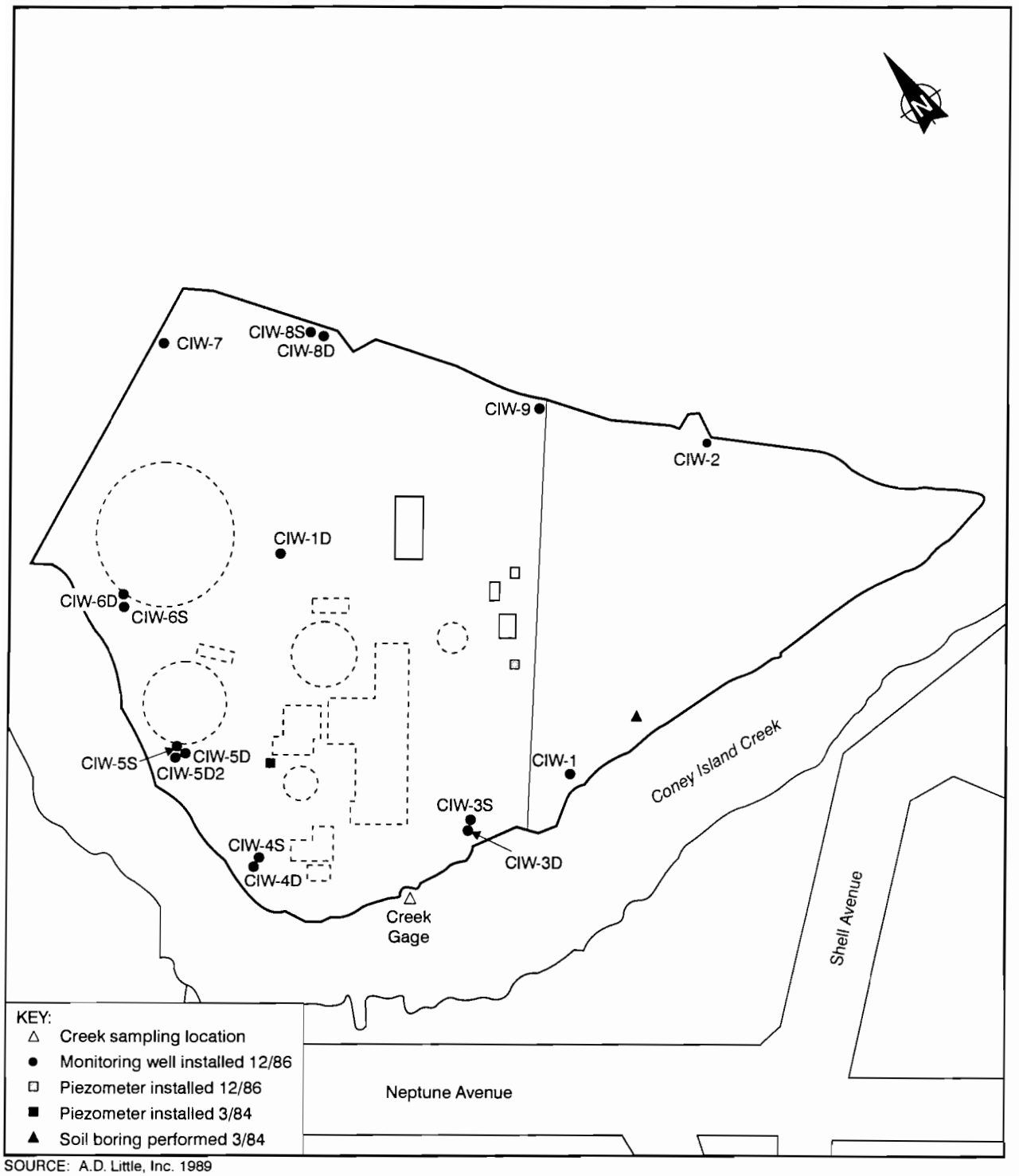


SOURCE: Roux Associates, Inc. 1984

SCALE
0 200 400 Feet

Figure 2-1 LOCATIONS OF SOIL BORINGS INSTALLED BY ROUX BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK

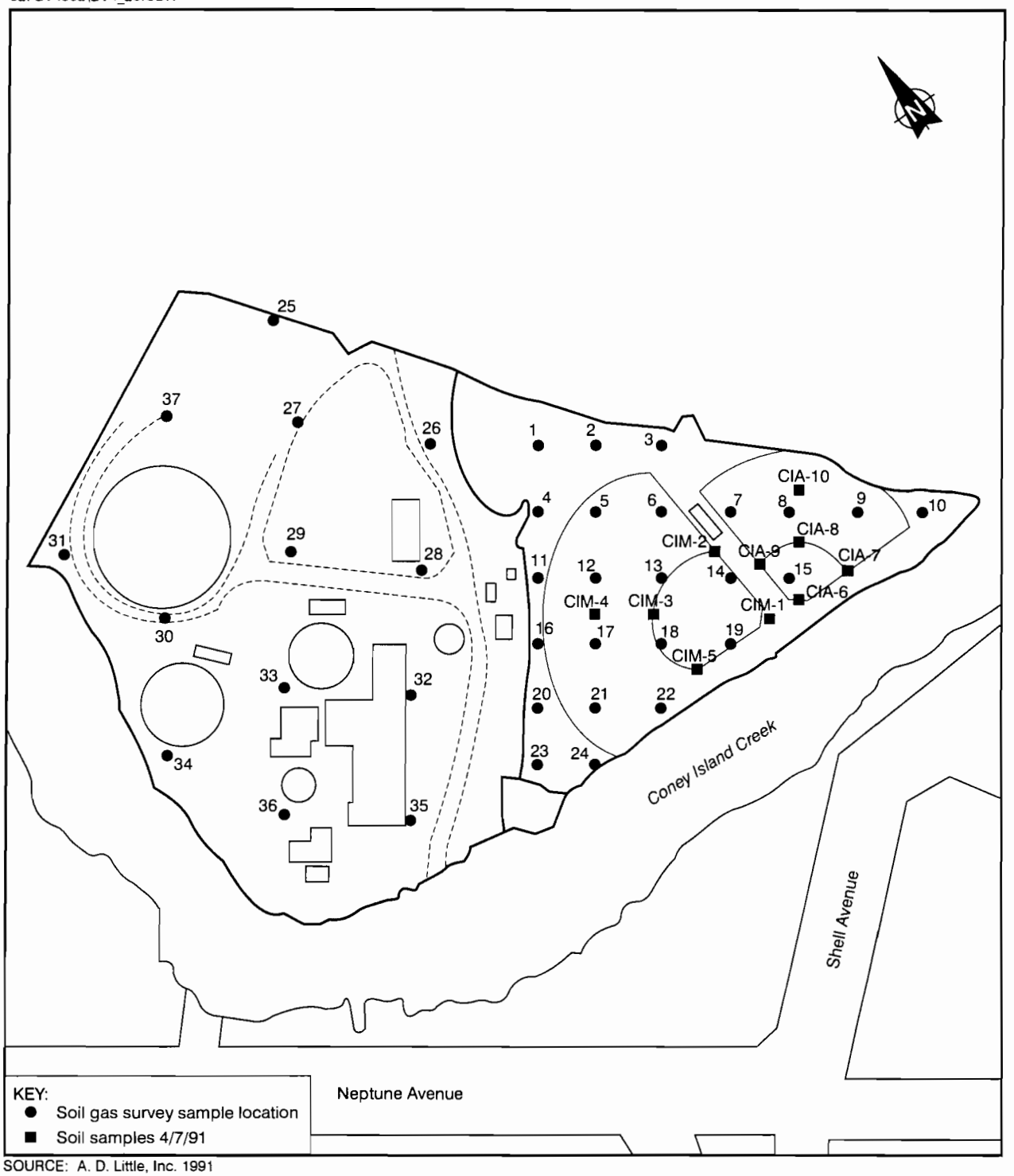
02: BV490222.CDR



SOURCE: A.D. Little, Inc. 1989

Figure 2-2 LOCATIONS OF MONITORING WELLS INSTALLED BY A. D. LITTLE, INC. BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK

02: BV4902\BV4_23.CDR

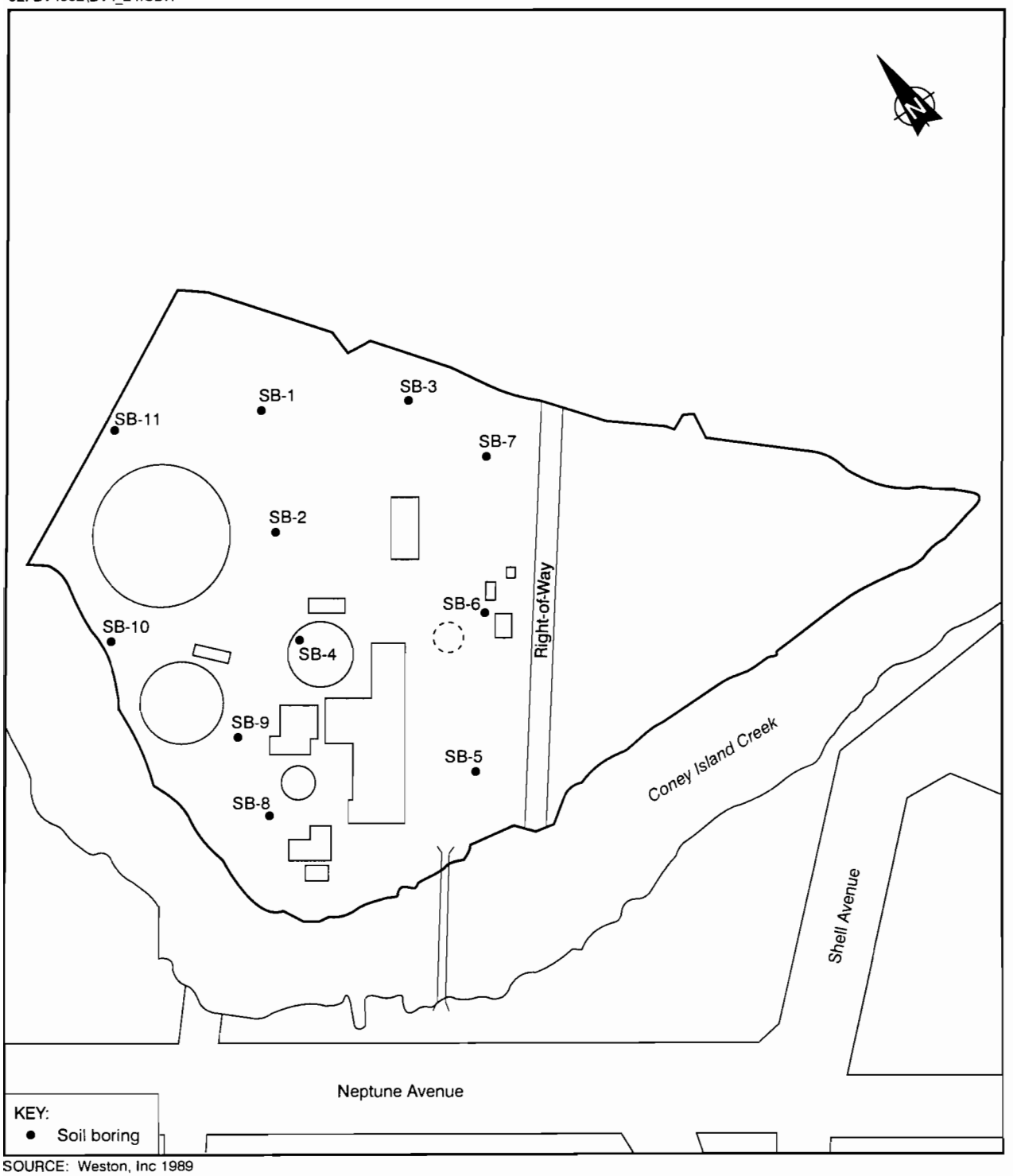


SOURCE: A. D. Little, Inc. 1991

SCALE
0 200 400 Feet

**Figure 2-3 LOCATIONS OF SOIL AND SOIL GAS SAMPLES COLLECTED BY A. D. LITTLE, INC. (1991)
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK**

02: BV4902\BV4_24.CDR



SOURCE: Weston, Inc 1989

SCALE
0 200 400 Feet

Figure 2-4 LOCATIONS OF SOIL BORINGS INSTALLED BY ROY F. WESTON, INC. BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK

BV4S30582

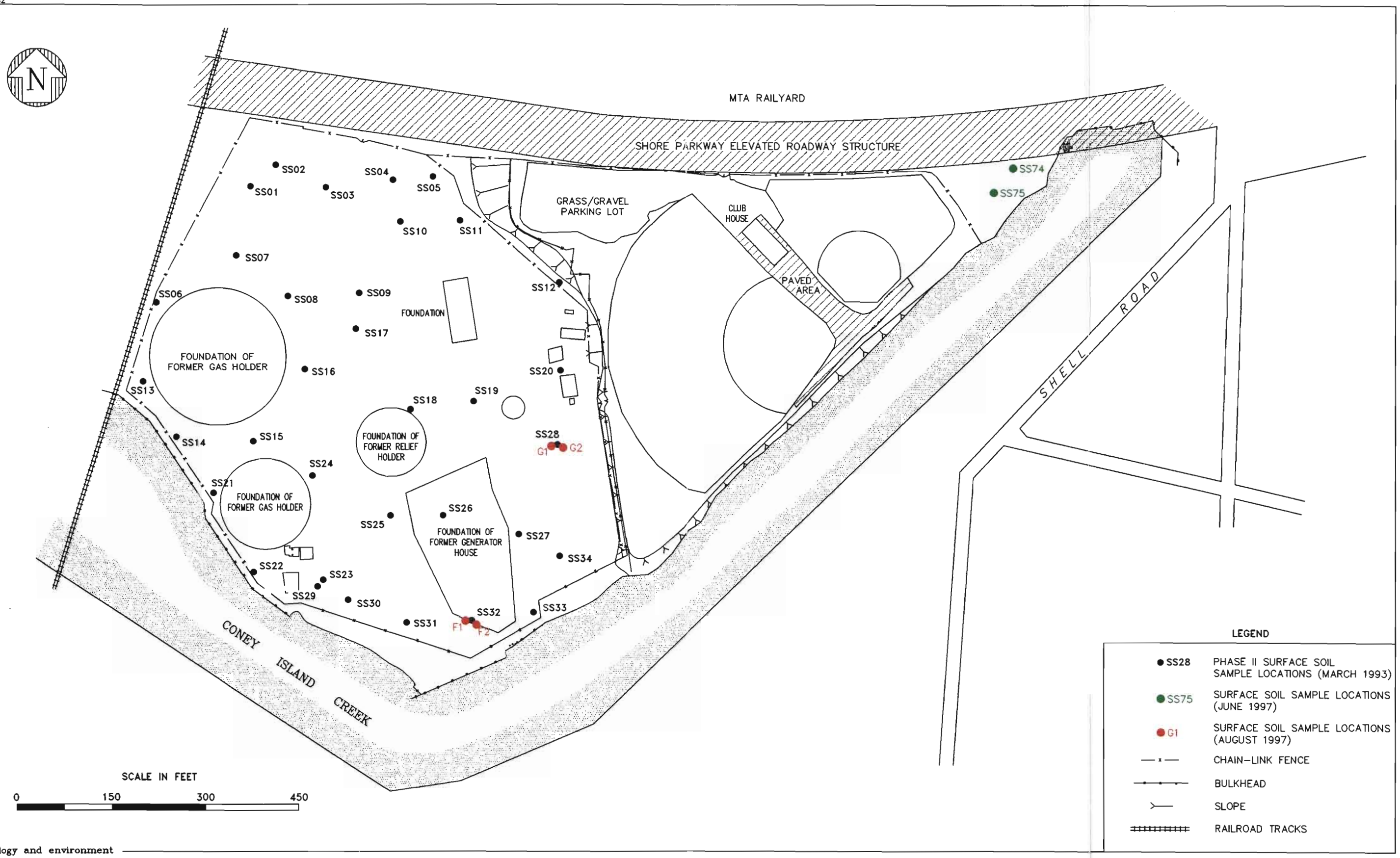
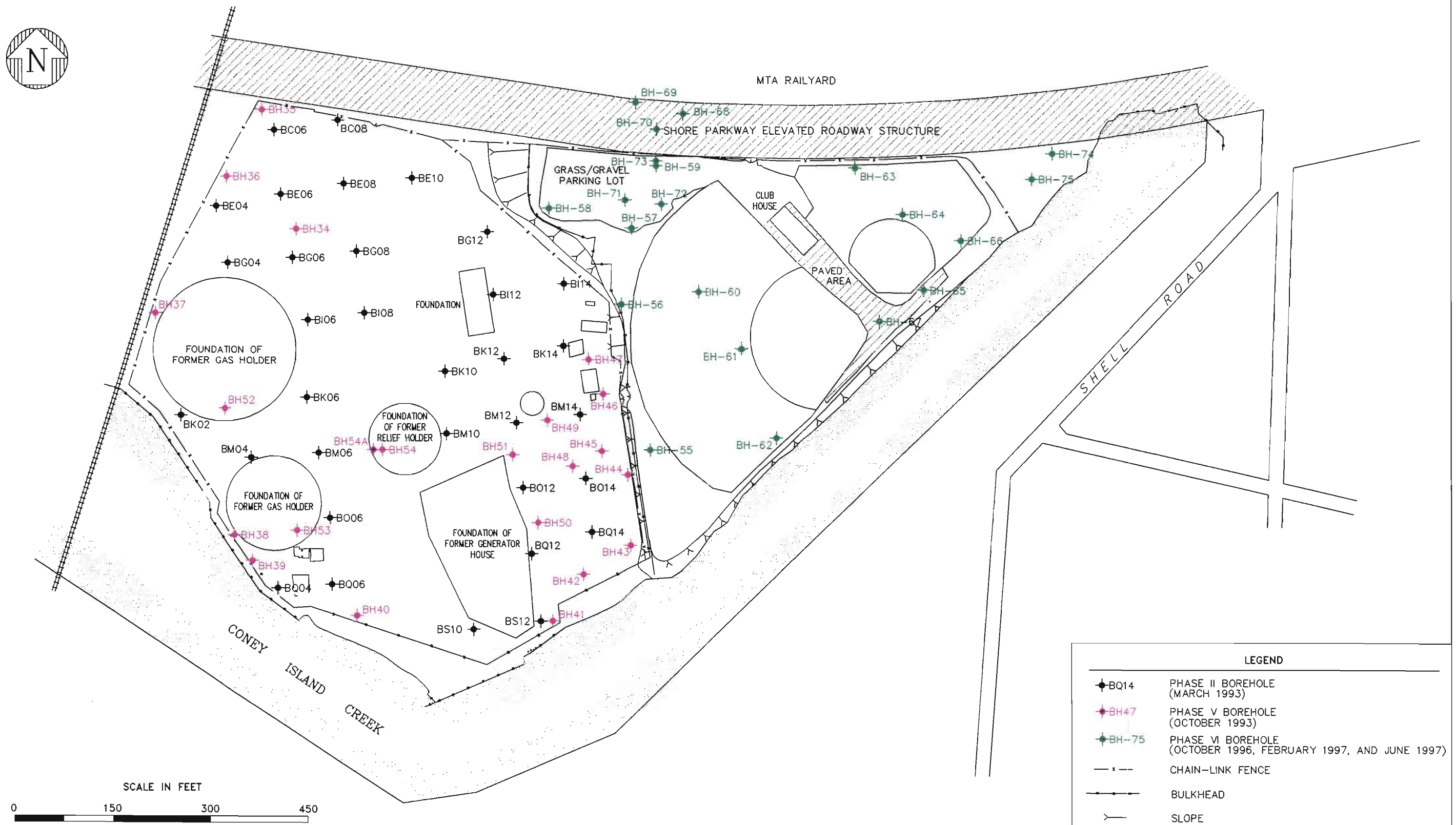


Figure 2-5 SURFACE SOIL SAMPLE LOCATIONS
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

BV4S307B

✓ OK, Does show BH 74 & 75



ecology and environment

Figure 2-6 BOREHOLE LOCATIONS
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

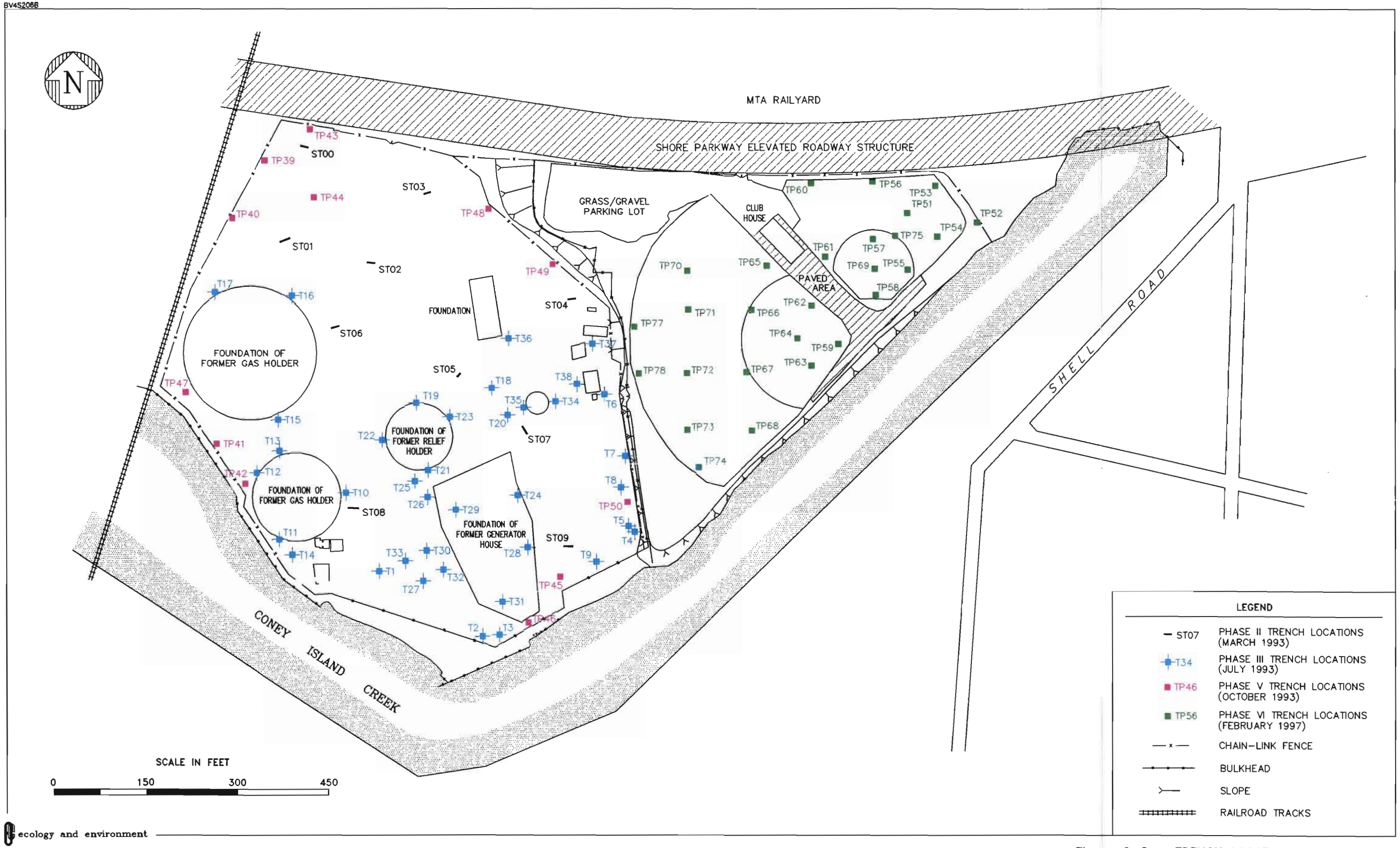


Figure 2-8 TRENCH LOCATIONS
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

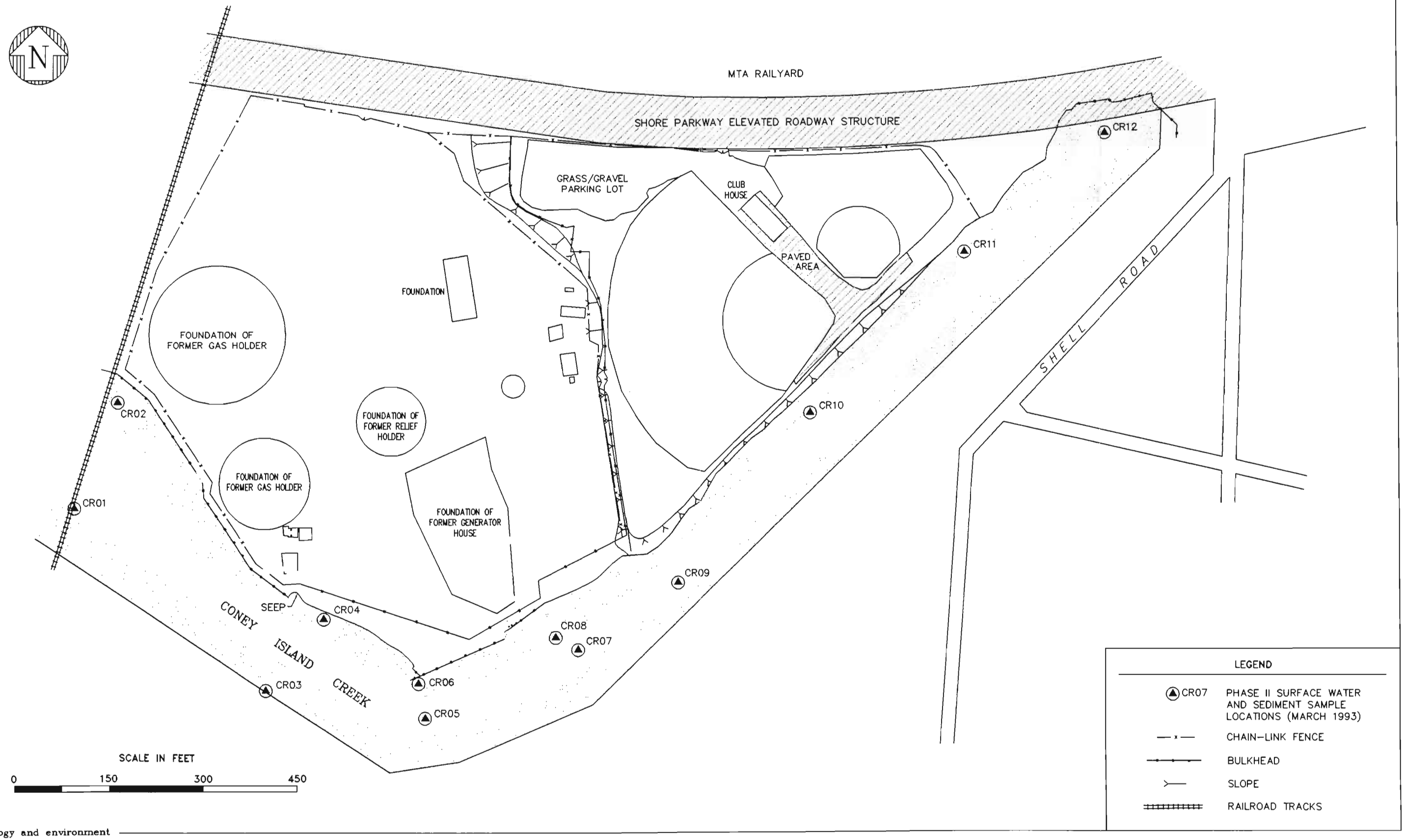


Figure 2-9 CREEK SEDIMENT AND SURFACE WATER SAMPLE LOCATIONS
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

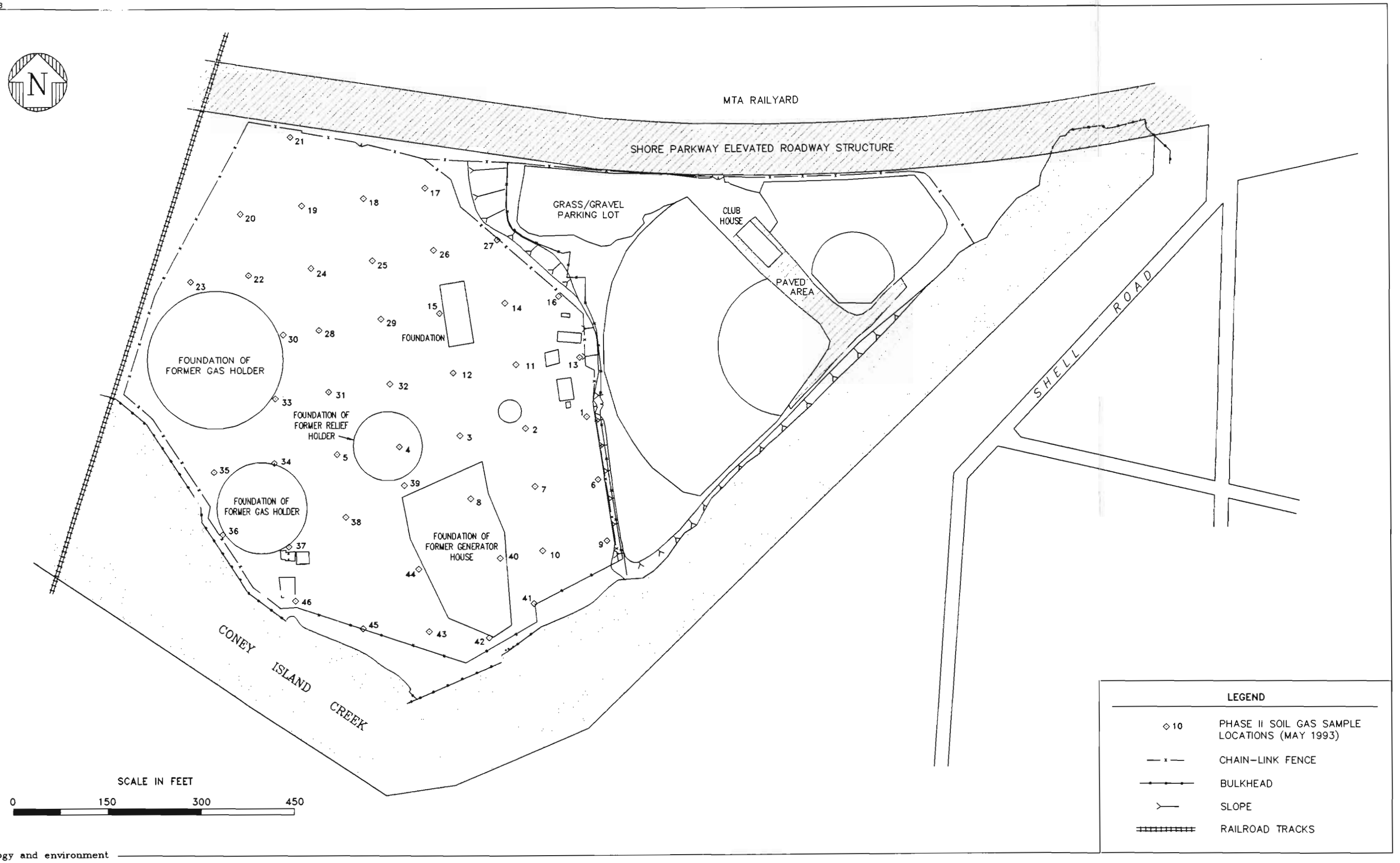


Figure 2-10 SOIL GAS SAMPLE LOCATIONS
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

3 Characteristics of the Study Area

3.1 Introduction

Field investigations of the Brooklyn Borough Gas Works site were conducted to assess its characteristics, including the surface features, soils, geology, hydrogeology, meteorology, and ecology. As previously discussed in Section 2 of this report, several phases of characterization were conducted to focus sampling efforts and increase the efficiency of the investigation. Characteristics of the air, soils, surface water, and groundwater were evaluated during the various phases of field investigation. The various phases of investigation followed the NCP (40 CFR 300.430, Subpart E for Remedial Investigations) and the *Guidelines for Remedial Investigations and Feasibility Studies*, TAGM HWR-89-4025 (NYSDEC 1989).

This section of the report describes the characteristics of the study area, which consists of the western area and the eastern (former, and currently closed, baseball fields) area of the property. The regional characteristics of topography and surface features; geology; hydrogeology, including surface water and groundwater; climate; and meteorology are discussed first. Specific study area characteristics are then discussed: topography and surface features; geology, including surface and subsurface soil conditions; hydrogeology, including surface water and groundwater; demography and land use; and ecology, including terrestrial and aquatic ecosystems and special natural features.

3.2 Regional Characteristics

3.2.1 Topography and Surface Features

The Brooklyn Borough Gas Works property is located just north of Coney Island in Brooklyn, New York. The property is approximately 16.4 acres in size and is located in a heavily populated commercial/residential zone. A New York MTA railyard borders the property on the north and west, and the elevated Shore Parkway traverses the northern

border. Coney Island Creek borders the property to the south and east. The regional topography of the site is relatively flat with some low-lying areas (see Figure 1-1).

3.2.2 Regional Geology

Coney Island, along with all of Long Island and most of Staten Island, are part of the Atlantic Coastal Plain physiographic province. This province is part of a continuous surface that extends offshore, the offshore portion being the continental shelf. The Atlantic Coastal Plain and continental shelf extend from Newfoundland to Florida (Isachsen et al. 1991).

Atlantic Coastal Plain deposits in the study area generally consist of unconsolidated quaternary glacial and marine deposits overlying poorly consolidated to unconsolidated Cretaceous sediments. Coney Island is considered a barrier island consisting of wave-deposited sand and gravel (Flint and Skinner 1977). Coney Island became connected to Long Island after a majority of Coney Island Creek silted up to form a sandbar, approximately 5 miles long and 0.25 mile to 1 mile wide (The New Encyclopedia Britannica 1988). However, the sand and gravel north of Coney Island were deposited glacially as outwash sediments by glacial meltwater near the end of the last (Wisconsin) ice age. These northern deposits consist of coarse- to fine-grained gravel with well-rounded and stratified sand (Cadwell 1989). The boundary between glacial outwash and barrier island deposits lies very near the property; therefore, the natural sands of the area may have been deposited in either environment.

The Quaternary deposits are approximately 200 feet thick in the study area (Smolensky et al. 1989). The Upper Cretaceous Monmouth group, Matawan group, and Magothy formation underlie these sands and gravel. These Upper Cretaceous Coastal Plain deposits consist primarily of silty clay, glauconitic sandy clay, sand, and gravel (Fisher et al. 1970). Consolidated Paleozoic and Precambrian bedrock underlie the Cretaceous units at a depth of approximately 650 feet (Smolensky et al. 1989).

3.2.3 Regional Hydrogeology

3.2.3.1 Surface Water

The region surrounding the Brooklyn Borough Gas Works site is relatively flat and is used primarily for commercial and residential purposes. Coney Island Creek borders the site on the south side and flows into Gravesend Bay, which empties into Lower Bay and into the Atlantic Ocean. The site is situated in the Long Island area, and the Long Island Sound (to the north) and the Atlantic Ocean (to the south) are the major surface water bodies present.

3.2.3.2 Groundwater

Above the Paleozoic and Precambrian bedrock, four main aquifers with three intervening confining layers have been described in the study area. The uppermost unit is a thin layer of Holocene-age marsh, shoreline, and fill deposits. These recent deposits are hydraulically continuous with the underlying Upper Pleistocene deposits and are, therefore, not considered a separate aquifer. The Upper Pleistocene deposits are composed of glacial till and outwash sediments and form an aquifer called the Upper Glacial aquifer. Till is poorly permeable, whereas outwash is moderately to highly permeable. The average horizontal hydraulic conductivity (K_h) of this aquifer is 270 feet per day, with that of the morainal till being about half that of the outwash. In the study area, the Upper Glacial aquifer is typically to be represented by outwash sands and is approximately 150 feet thick (Smolensky et al. 1989).

Beneath the Upper Glacial aquifer is a confining unit called Gardiners clay. This grayish-green to brown marine clay is poorly permeable with an average vertical hydraulic conductivity (K_v) of 0.001 feet per day. The Gardiners clay exists at a depth interval of approximately 150 to 200 feet in the study area and overlies the Jameco aquifer. The deepest well in the western area of the property was drilled 2 feet into the Gardiners clay, which was encountered at 170 feet. The underlying Pleistocene-age Jameco aquifer is composed primarily of brown, fine sand to cobble-sized grains of crystalline and sedimentary rocks. It is moderately to highly permeable with an average K_h of 200 to 350 feet per day and an anisotrophy of 10:1. Below the study area, the Jameco aquifer is approximately 50 feet thick and is continuous with the underlying Cretaceous Magothy aquifer because the intervening Monmouth greensand confining layer is locally absent (Smolensky et al. 1989). None of the wells installed by E & E penetrated the Jameco aquifer.

The Magothy aquifer consists of interbedded sands, gravel, clay, and sandy clay in a variety of colors. Most layers are poorly to moderately permeable, but some coarser-grained layers are highly permeable. The average K_h is 50 feet per day with an anisotrophy of approximately 100:1. The Magothy constitutes the principal aquifer used for public drinking water supply (Smolensky et al. 1989).

Underlying the Magothy aquifer is the Raritan confining unit, which is also Cretaceous in age. The Raritan consists primarily of gray, red, and white clay and is first encountered at a depth of approximately 350 feet in the study area. The Raritan clay is poorly to very poorly permeable with an average K_v of 0.001 feet per day (Smolensky et al. 1989).

Below the Raritan confining unit is the Cretaceous Lloyd aquifer at a depth of approximately 475 feet in the study area. The Lloyd aquifer consists primarily of yellow, gray, and white fine- to coarse-grained sand and gravel interbedded with layers of clay and silty clay. It is poorly to moderately permeable with an average K_h of 40 feet per day and an anisotrophy of 10:1 (Smolensky et al. 1989).

Paleozoic and Precambrian bedrock underlie the Lloyd aquifer at a depth of approximately 650 feet. The crystalline igneous and metamorphic bedrock is poorly permeable to impermeable and constitutes the lower boundary of the local groundwater reservoir (Smolensky et al. 1989). Table 3-1 summarizes the hydrogeologic units present in the area.

3.2.4 Climate/Meteorology

The New York City metropolitan area is influenced by a variety of different air masses. These combine to broadly represent a humid continental climate type. Cold, dry air masses frequently arrive from the north; prevailing winds from the south transport warm and humid air into the area; and wind from the Atlantic Ocean brings in cool, cloudy, damp weather conditions.

The following meteorological data collected at John F. Kennedy International Airport (Station No. 744860) by the National Weather Service is considered representative of conditions at the property.

Afternoon maximum temperatures at the property range from a mean maximum of 83°F in July to 38°F in January (see Table 3-2). Minimum temperatures range from a mean of 68°F in July and August to 20°F in January. The extreme maximum since 1948 is 104°F and the extreme minimum is -2°F (USDOC 1992).

Mean precipitation for the year is 41.3 inches (including liquid equivalent for snowfall). The peak monthly mean precipitation of 4.0 inches occurs in May, although precipitation is relatively evenly distributed throughout the year. The maximum 24-hour precipitation of 4.5 inches occurred in September 1965. Mean annual snowfall is 22 inches. The maximum snowfall in a 24-hour period was 20 inches (USDOC 1992) (see Table 3-3).

The prevailing wind direction is southerly on an annual basis. During April through October, the wind is from the south or west-southwest, and during November through March, it is from the northwest. Average wind speed is 12 knots; the highest gust recorded was 62 miles per hour. Average wind speeds tend to be highest from November through March (approximately 14 knots) and lowest from April through October (approximately 10 knots) (USDOC 1992) (see Table 3-2).

3.3 Study Area Characteristics

3.3.1 Topography and Surface Features

The Brooklyn Borough Gas Works property, the study area, consists of a western area and eastern (former, and currently closed, baseball fields) area. Both areas are completely fenced, with no unsupervised access permitted. North of the property, surface water collects in a low-lying area under a small section of the Shore Parkway. This area under the parkway on city property is an unauthorized dumping area that continually receives garbage, used furniture, and automobiles. Both areas of the property are relatively flat, with the western area having concrete gas holder and structural foundations present at the surface. Some low-lying areas are present, and during periods of high precipitation, surface water collects in the western area. It has also been reported that during some major storms, Coney Island Creek water levels rise and partially flood the western area.

The eastern area is elevated with fill material 7 to 8 feet above the vacant western area. A detailed description of the fill material is presented in the borehole drilling logs contained in Appendix B of this report. There are two former, and currently closed, baseball fields on this relatively flat-lying, elevated eastern area of the property, with fenced-in playing areas, a clubhouse, paved areas between the two former, and currently closed, baseball fields, and an unpaved parking area. Surface water does not appear to collect on the property. Figure 3-1 illustrates the surface elevations of both areas of the Brooklyn Borough Gas Works property.

3.3.2 Study Area Geology

The geology of the study area has been investigated during field activities conducted by Roux, A.D. Little, Weston, and E & E. Section 2 of this report provides a summary of the field investigations conducted through Phase VI. Surface and subsurface soil sampling; installation of boreholes and groundwater monitoring wells; groundwater analyses; soil gas surveys; and trench excavations provided data to interpret the geology and complex subsurface conditions at the Brooklyn Borough Gas Works property.

Lithologic units encountered during drilling were exclusively unconsolidated deposits of both the Holocene and Pleistocene epochs. The deeper Pleistocene deposits were encountered from 10 to 172 feet BGS and consisted mainly of fine- to coarse-grained sands, with a clayey silt layer from 59.5 to 60.3 feet BGS and clay from 170.3 to 172 feet BGS. The sand, which at some depths contained a trace of gravel, varied with depth in grain size and color. The deepest well, DW-04, was terminated in a dark gray, clean clay (presumably Gardiners

clay), which is reportedly 50 feet thick (see Table 3-1 and Figure 3-2) (Smolensky et al. 1989). The Pleistocene sediments were deposited from glaciers as till or by glacial meltwater as outwash sediments and shallow lacustrine deposits where reworking of the sediments by wave action in the ocean occurred.

Above the Pleistocene deposits, the Holocene-age (or recent) deposits consist of a thin (5 to 10 feet) layer of near-shore and estuary-type deposits. These shallow water sediments comprise particles ranging from clay to gravel size and contain some peat and shells. The various subsurface investigations conducted encountered a low-permeability unit that was referred to as a peat, clay, or silt layer with organic debris. In this report, this discontinuous unit is referred to as a clay/peat/silt layer that retards the downward migration of contaminants. The entire property is covered by a veneer of fill consisting of slag, demolition debris, sand, and gravel that varies from 0 to approximately 16 feet in thickness. The thickness of the fill is greater in the eastern portion of the property, underlying the former, and currently closed, baseball fields. Figure 3-3 presents 12 cross sections that transect the property to provide a detailed illustration of the subsurface. Figure 3-4 illustrates the minimum fill thickness present. Figure 3-5 illustrates the discontinuous presence of the clay/peat/silt layer.

This clay/peat/silt layer may have been formed as overbank deposits of either the nearby Coney Island Creek or one of its small tributaries, tidal channels, or oxbows. Investigation of the changes in profile of the creek bank over time has revealed at least two tributaries of Coney Island Creek that have since been buried either naturally or by placement of fill. The existence of one of these tributaries was supported by the cross sections and the presence or absence of the clay/peat/silt unit. The 1930s aerial photos (see Figure 1-3) illustrate the presence of a tributary or channel in the northeast section of the eastern area of the property. It is assumed that because the property is very flat, the areas of thickest fill once contained low spots such as streams, channels, and embayments.

3.4 Site Hydrogeology

3.4.1 Surface Water Hydrogeology

The Brooklyn Borough Gas Works property is relatively flat and is located along the north bank of Coney Island Creek, which flows generally to the west for approximately 1 mile before entering Gravesend Bay. According to a 1947 United States Army Corps of Engineers (USACE) map of the property, several small tributaries flowed into Coney Island Creek from both the north and south prior to on-site construction (USACE 1947). One such stream traversed the western side of the site near the existing largest circular concrete gas

holder foundation. The 1930s aerial photos (see Figure 1-3) show a tributary entering Coney Island Creek in the northeast section of the property.

Currently, there are no water seeps, springs, or other surface water bodies observable on site. However, during periods of heavy precipitation or following a period of snow melt, water temporarily ponds in on-site depressions in the western area of the property. The eastern area appears to have good drainage and has little to no ponding of water. All on-site surface water flows toward Coney Island Creek; no other surface water bodies exist in the immediate vicinity of the property.

Man-made features that would influence surface water migration (e.g., sewer and gas lines traversing the site) also were observed. The likely construction of an underground pipeline usually includes crushed stone in the trenches. This permeable aggregate rapidly transports liquids laterally and vertically until a discharge point or less permeable barrier is encountered. Also, an approximately 100-foot-wide zone of crushed stone riprap material exists along the north bank of Coney Island Creek. This feature may influence the surface water system.

3.4.2 Groundwater Hydrogeology

Only one aquifer was encountered during field investigations: the upper glacial aquifer that is composed entirely of the sands of the till and outwash deposits described in Section 3.3. This aquifer extends from just below the surface to 170 feet BGS. According to Smolensky et al. (1989), the regional horizontal hydraulic conductivity is 270 feet per day and the anisotrophy is approximately 10:1. Beneath the aquifer of concern, a dense layer of Gardiners clay separates the upper glacial aquifer from the deeper Jameco aquifer.

Water level measurements were collected from all 24 groundwater monitoring wells at both low and high tide on November 6, 7, and 8, 1996, to provide information on the water table dynamics at both tidal extremes. A bulkhead measurement of 7.09 feet above mean sea level (MSL) was used to measure the Coney Island Creek water levels before and after collecting all water level measurements. The water level measurements are presented in tables in Appendix B. Additionally, elevation values were extrapolated for high and low tide in Coney Island Creek from 1992 tide data tables and surveyed elevations of sample points and high water markings. The mean difference between high and low tide for surface water bodies in the Coney Island area, including Coney Island Creek, is 4.7 feet (United States Department of Commerce [USDOC] 1991).

Contours of the water table surface during low tide show a groundwater flow toward the south into Coney Island Creek (see Figure 3-6). The presence of an anomalous area

centered around MW15 and MW16, in the south-central portion of the property, suggests that groundwater may be perched on the low-conductivity layer of clay/peat/silt. There appears to be a minimal response to the tide in this area.

Contours of the water table surface during high tide also indicate a groundwater flow toward the south into Coney Island Creek (see Figure 3-7). At high tide, creek levels are greater than water table levels in the vicinity of the seep and the gradient is temporarily reversed near that location.

Comparison of low-tide and high-tide water-table contour maps reveal that the inland tidal influence is present across the entire property, although it diminishes with distance from the creek (see Figure 3-8). There is a more direct response to the monitoring wells from the creek in the area dominated by fill and sand versus the areas of fill and the clay/peat/silt layer, which is expected with the more highly permeable material.

E & E reviewed information available on the aquifers underlying the Brooklyn Borough Gas Works property and on the subsurface stratigraphy, and the historical information available on the groundwater resources underlying the site. A 1981 United States Geological Survey (USGS) Open-File Report (No. 81-1186), *Reconnaissance of the Groundwater Resources of Kings and Queens Counties, New York,* (Buxton et al. 1981) provides information on the subsurface stratigraphy and aquifers underlying the study area. The report, was prepared in cooperation with NYSDEC and NYCDEP, discussed the four primary aquifers that have historically served as the groundwater resources for the western end of Long Island.

The deepest of the four is the Lloyd aquifer, which is overlain by the Raritan clay confining layer, which is overlain by the Magothy and shallower Jameco aquifers, which are separated from the Upper Glacial aquifer by the Gardiners clay (Buxton et al. 1981). All of these aquifers underlie the study area.

The Gardiners clay, which underlies the Upper Glacial aquifer, restricts vertical flow between the upper glacial and deeper aquifers. This clay unit is a confining layer with a much lower hydraulic conductivity than that of the aquifers. The Gardiners Clay underlies most of Kings County, in particular all of the study area, and ranges up to 50 feet in thickness. The Gardiners clay pinches out well north of the property. Furthermore, DW-4 only extends into the upper 2 feet of this confining layer, and the total thickness underlying the property is unknown (Buxton et al. 1981).

The water in the upper glacial aquifer is unconfined and consists of sand, sand-and-gravel, and clay/peat/silt layers as evidenced by the monitoring wells and boreholes installed on the site. The groundwater underlying the property flows generally south toward Coney

Island Creek and out into the Atlantic Ocean. There is also local discharge from the uppermost upper glacial aquifer into Coney Island Creek.

In addition, information provided in Buxton et al. (1981) indicates that groundwater underlying the property never was used as a drinking water supply. The 1936, 1943, 1951, 1961, and 1947 water table configurations in the report reveal that the groundwater underlying the study area was never pumped for the public water supply. In 1947, all public-supply pumpage in Kings County was stopped because of salt water intrusion (Buxton et al. 1981).

The flow directions indicate that the groundwater is flowing to the south toward Coney Island Creek and the Atlantic Ocean. Immediately above the Gardiners Clay, the flow in the upper glacial aquifer is essentially horizontal. Because the source of this water is well upgradient from the site, the volatile organics and PAHs that have been detected in the four rounds of sampling at deep well DW-4 (screened interval 158 to 168 feet) originated from a source(s) probably thousands of feet or more from the site. They may also come from upgradient sources or through dissolution from DNAPL originating locally.

Deep well (DW-4) extends to the top of the Gardiners clay, at approximately 170 feet, and is screened from 158 to 168 feet. It is located on the north side of the south gas holder foundation and is nested with a shallow groundwater monitoring well (MW-4).

Because the upper glacial aquifer is generally brackish and will most likely never be used as a public water supply, the chemical constituents present do not present a threat to human health or the environment. In addition, if a pump-and-treat remedial activity were initiated to recover the VOCs at depth, it may induce additional salt water intrusion into the aquifer.

Aside from the tidal influence, local shallow groundwater flow in the study area is generally to the south, with the Atlantic Ocean and its associated bays being the ultimate receptor. Groundwater deeper than 172 feet was not explored in this study.

3.4.3 Demography/Land Use

Residential areas are within 0.5 mile to the north, south, and east and within 0.25 mile to the west of the property. Coney Island Hospital is approximately 1 mile to the east of the property. Five schools are located within 1 mile of the property: Abraham Lincoln High School and Grady High School, both approximately 0.5 mile to the east; Mark Twain Junior High School and its athletic field approximately 1 mile to the west; Lafayette High School approximately 1 mile to the northwest; and Our Lady of Grace School approximately 1 mile to the northeast.

The population within 0.5 mile of the property is approximately 24,592; within 1.5 miles it is approximately 160,108; and within 3 miles it is 452,422 (Geographical Information Service 1980). Estimated population statistics are based on the percentage that the New York State population has increased between 1980 and 1990.

Potentially exposed populations could include nearby workers and residents. Dust and manufacturing-related vapors could travel off site. Although trespassing on the property is possible, it is deemed highly improbable. Access to the property is restricted by a fence with razor wire along the north and west, and with barbed wire to the east and south. There is no evidence of regular unauthorized entry onto the property, and there is regular security staffing and a perimeter alarm system at the property.

Currently, besides security staff (who are on site 40 hours per week) there are no employees working at the property. However, in the future, it is conceivable that workers may be present at the property if it is used for industrial or commercial purposes.

Access to the banks and waters of Coney Island Creek is difficult because there are fences along the property perimeter and along the creek bank opposite the property, although it is possible to reach the creek banks from areas northeast and southwest of the property. Adults and adolescents residing near the property are possible visitors to the creek. However, because of the difficulty in accessing the creek banks, visits are most likely infrequent. No fishing activity has been sighted in this reach of Coney Island Creek.

Future uses of the property are expected to be either industrial or commercial. Future trespassers' and visitors' exposures to property-related constituents are likely to be far less frequent and of shorter duration than future property workers' exposures.

Although the property is located near residential areas, the possibility that the property would be converted to residential use in the future is very remote because of zoning. Groundwater is not currently used on or around the property primarily because of its brackishness. Furthermore, groundwater downgradient of the site empties immediately into Coney Island Creek, thereby mitigating any potential groundwater exposure.

3.4.4 Study Area Ecology

On May 11, 1993, two E & E field ecologists visited the Brooklyn Borough Gas Works property (the study area). This section describes the vegetation, wildlife, and aquatic resources that were observed in the immediate vicinity of the study area, including Coney Island Creek, during the visit.

3.4.4.1 Terrestrial Ecosystems

The study area is located in a highly urbanized area that contains roadways, railroads, and buildings; the area is very disturbed from its natural setting prior to anthropogenic influences. As a result, vegetation is characterized by numerous primary successional species. The study area does not exhibit good drainage; water is reported to pond in areas during the spring for approximately two to three weeks. In this area of poor drainage and disturbed soils, several willow (*Salix* spp.) and aspen (*Populus grandidentata*) saplings are scattered throughout the dominant cattails (*Typha* spp). The remainder of the study area consists of a very compacted, gravelly soil that supports a variety of herbaceous species, including clovers (*Trifolium* spp. and *Lespedeza* sp.), common ragweed (*Ambrosia aratemisiifolia*), goldenrod (*Solidago* spp.), common mullein (*Verbascum thapsus*), and a variety of grasses. In addition, fire cherry (*Prunus pennsylvanica*) and sumac (*Phus* spp.) saplings are scattered throughout the site. Construction debris and chunks of coal and hardened piles of tar throughout the area likely impede further vegetation.

Wildlife species most likely to occur in the general vicinity of the site are those that have adapted to urban habitat settings. In general, several small mammals have adapted to the encroachment of man and the disturbance of their habitats. In particular, mammals such as the Norway rat (*Rattus norvegius*), woodchuck (*Marmota monax*), deer mouse (*Peromyscus maniculatus*), meadow vole (*Microtus pennsylvanicus*) and numerous other mice, voles, moles, and shrews have shown adaptation to man's presence. Although these mammals were not observed at the site, they are expected to occur there based on the ecological setting observed. Several terrestrial bird species were observed on site during the field visit. These included the starling (*Sturnus vulgaris*), house finch (*Carpodacus mexicanus*), ring-necked pheasant (*Phasianus colchicus*), barn swallow (*Hirundo tustica*), catbird (*Dumetella carolinensis*), killdeer (*Charadrius vociferus*), mourning dove (*Zenaida macroura*), red-winged blackbird (*Agelaius phoeniceus*) and the rock dove (*Columba livia*). Several waterbirds were also observed in Coney Island Creek adjacent to the site (see Section 3.3.5.3).

The following observations can be made regarding wetlands in and around the site:

- Parts of Coney Island Creek are federally identified as intertidal and subtidal estuarine wetlands (USFWS 1980). NYSDEC classifies the creek as a littoral zone with areas of coastal shoals and mudflats along the banks (NYSDEC 1988). Observations of the reach of the creek along the site confirm the presence of a mudflat with tidal influence along the easternmost portion of the site;

- No upland, freshwater wetland area is currently listed by state or federal agencies (USFWS 1980; NYSDEC 1988); and

- There is an approximately 1- to 3-acre area near the center of the study area that demonstrates two wetland characteristics: hydrophytic vegetation and wetland hydrology. This area may meet the definition of an atypical wetland as defined by USACE in its Wetlands Delineation Manual (USACE 1987).

The upland wet area mentioned above exists because of the previous industrial activity at the property, which has led to hydrologic conditions favorable to the establishment of hydrophytic vegetation. Even if this area is determined to be a wetland, it is considered insignificant in terms of potential ecological impact to the study area because of its small size and lack of criticality to both flora and fauna in the general area.

3.4.4.2 Aquatic Ecosystems

There are no ponds, creeks, or streams on the property. However, Coney Island Creek is adjacent to the southern edge of the property. Because of the irregular surface topography and recent soil disturbances, a limited volume of surface water is expected to flow into the creek.

- Coney Island Creek is the primary aquatic ecosystem associated with the study area. The creek has been channelized, and its banks are heavily riprapped with large boulders. The portion of the creek adjacent to the property contains debris—including tires, barrels, and other anthropogenic nonbiodegradable waste—as well as old deteriorated wood supports from a bridge that no longer exists. Further downstream toward Gravesend Bay, both sides of the creek are heavily developed and there is no evidence of intertidal marshes. However, on the northern bank approximately 1 mile downstream (west) of the property, there is a small mudflat area (see Section 3.3.5.3).

The creek's bottom substrate appears to be a deep muck in the area adjacent to the property but becomes a more sandy substrate toward the creek's mouth. Although NYSDEC has not collected any fish from this creek and has not given it a water quality classification, a few of the fish species expected to occur in this creek include the killfish (*Fundulus* spp.), striped bass (*Morone saxatilis*), and gizzard shad (*Dorosoma cepedianum*). A small school of unidentifiable minnows were observed along the shore adjacent to the property. In addition, several persons were observed fishing in the creek approximately 1 mile downstream (west) of the property.

No state- or federally listed fish species of concern or significant recreational fisheries have been identified in the general vicinity of the study area (Buffington 1993; Clough 1993).

3.4.4.3 Special Natural Features

In conjunction with the Natural Heritage Program, NYSDEC has identified three plant species of concern located in the general vicinity of the study area: the seabeach amaranth (*Amavanthus pumilus*), seabeach knotweed (*Polygonum glaucum*), and retrorse flatsedge (*Cyperus retrosus*) (Buffington 1993). However, because of the highly disturbed nature of the property and the years during which these plants were last observed, these species of concern are not expected to occur in the study area (see Table 3-4). USFWS did not identify any federally protected species in the general vicinity of the study area (Clough 1993).

The difference in height between mean high water/tide and mean low water/tide is 4.7 feet at the mouth of Gravesend Bay; there are no data for Coney Island Creek (Geographical Information Service 1980). Therefore, the portion of Coney Island Creek that is adjacent to the property is repeatedly flooded and exposed, as are any other shallow areas located along the banks of the creek. The areas that are completely dewatered at low tide are considered by USFWS and NYSDEC as tidal mudflats (wetlands). Although anaerobic conditions often exist below the surface, these areas can support diverse populations of tube-dwelling and burrowing invertebrates, including worms, clams, and crustaceans. In addition, mudflats are commonly colonized by algae and diatoms that can form a crust or mat (Cowardin et al. 1979). Several bird species associated with open water and mudflats have been observed in areas adjacent to the site, including the double-breasted cormorant (*Phalacrocorax auritus*), green heron (*Butorides striatus*), black-crowned night heron (*Nycticorax nycticorax*), snowy egret (*Egretta thula*), laughing gull (*Larus atricilla*), ring-billed gull (*Larus delawarensis*), and herring gull (*Larus argentatus*). Table 3-5 provides a more complete list. Although various shore and wading birds can be observed occasionally throughout the year along this reach of the creek, their visits are typically transient.

Table 3-1

STRATIGRAPHIC COLUMN OF HYDROGEOLOGIC UNITS OF THE CONEY ISLAND, NEW YORK, AREA

System	Series	Geologic Unit	Hydrogeologic Unit	Approximate Thickness Below Coney Island (feet)	Character of Deposits	Water Bearing Properties	Approximate Depth Below Surface (feet)
Quaternary	Holocene	Recent deposits: Salt marsh deposits, stream alluvium, shoreline deposits and fill	Recent deposits	10	Sand, gravel, silt, clay, peat, shells, etc., of various colors.	Coarse-grained (beach) deposits are highly permeable; fine-grained (marsh) deposits are poorly permeable. Locally hydraulically connected to underlying aquifer.	0
	Pleistocene	Upper Pleistocene deposits	Upper glacial aquifer	140	Glacial till composed of clay, sand, gravel, and boulders and glacial outwash composed of fine- to very coarse-grained sand, gravel, and boulders. Also contains glaciolacustrine, marine, and reworked deposits.	Till is poorly permeable; outwash deposits are moderately to highly permeable. Average Kh is approximately 270 ft/d; conductivity of till is approximately 50% of outwash deposits; anisotrophy is approximately 10:1.	10
		Unconformity					
		Gardiners clay	Gardiners clay	50	Grayish green to brown clay with silt and a few sand layers, containing marine shells and glauconite.	Poorly permeable; constitutes a confining layer for underlying aquifer. Average Kv approximately 0.001 ft/d.	150
		Unconformity					
		Jameco gravel	Jameco aquifer	50	Brown, fine- to coarse-grained sand and gravel with a few silt and clay layers.	Moderately to highly permeable. Confined by overlying Gardiners clay. Average Kh is 200 to 300 ft/d; anisotrophy is approximately 10:1.	200

Table 3-1

STRATIGRAPHIC COLUMN OF HYDROGEOLOGIC UNITS OF THE CONEY ISLAND, NEW YORK, AREA

System	Series	Geologic Unit		Hydrogeologic Unit	Approximate Thickness Below Coney Island (feet)	Character of Deposits	Water Bearing Properties	Approximate Depth Below Surface (feet)
Cretaceous	Upper Cretaceous	Monmouth group (Monmouth greensand confining layer) - absent in study area.						
		Unconformity						
		Matawan group, Magothy formation, undifferentiated		Magothy aquifer	100	Interbedded sand, clayey sand, clay, and gravel of various colors; commonly with lignite, pyrite, and iron oxide concretions.	Most layers are poorly to moderately permeable, but some are highly permeable. Constitutes principal aquifer for public supply. Average Kh is 50 ft/d; anistrophy is approximately 100:1.	250
		Unconformity						
		Raritan formation	Unnamed clay member	Raritan confining unit	125	Variegated clay, silty clay, and a few layers of sand with lignite and pyrite common.	Poorly to very poorly permeable; constitutes confining layer for underlying Lloyd aquifer. Average Kv is approximately 0.001 ft/d.	350
			Lloyd sand member	Lloyd aquifer	175	Fine- to coarse-grained sand and gravel, commonly with a clayey matrix; also some layers of clay, silty clay, and lignite. Colors are variable.	Poorly to moderately permeable. Water is confined by overlying Raritan clay. Average Kh is 40 ft/d; anisotrophy is approximately 10:1	475
Paleozoic and Precambrian		Bedrock		Bedrock		Crystalline metamorphic and igneous rocks.	Poorly permeable to virtually impermeable; constitutes lower boundary of groundwater reservoir.	650

Key:

ft/d = Feet per day.
K_h = Horizontal hydraulic conductivity.
K_v = Vertical hydraulic conductivity.
Anisotrophy = Ratio of Kh:Kv.

Source: Adapted from Smolensky et al. 1989.

Table 3-2

MONTHLY MEAN MAXIMUM AND MINIMUM TEMPERATURES AND WIND CONDITIONS DATA COLLECTED AT JOHN F. KENNEDY INTERNATIONAL AIRPORT, 1948 TO 1990

Month	Temperature (°F)			Wind	
	Maximum	Minimum	Average	Direction[a]	Speed (kts)
January	38	26	32	NW	14
February	40	27	34	NW	15
March	48	34	41	NW	15
April	58	43	51	S	11
May	68	52	60	S	11
June	77	62	70	S	10
July	83	68	76	S	10
August	82	68	75	S	10
September	75	60	68	S	10
October	64	49	57	WSW	9
November	54	41	48	NW	13
December	43	31	37	NW	14
Annual	61	47	54	S	12

[a] Direction from which the wind is blowing.

Source: USDOC 1992.

Table 3-3

MONTHLY MEAN PRECIPITATION DATA COLLECTED AT JOHN F. KENNEDY INTERNATIONAL AIRPORT, 1947-1990 (in inches)

Month	Normal	Maximum Monthly	24-Hour Maximum
January	3.3	8.3	2.6
February	3.0	4.9	2.5
March	3.5	8.2	2.4
April	3.9	9.5	3.1
May	4.0	10.7	2.9
June	3.3	8.1	2.8
July	3.8	8.5	3.2
August	3.4	8.3	3.8
September	3.2	9.6	4.5
October	2.9	6.6	3.2
November	3.5	9.5	3.9
December	3.6	6.7	2.5
Annual	41.3	10.7 (May 1988)	4.5 (September 1965)

Source: USDOC 1992.

Table 3-4

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION NATURAL HERITAGE PROGRAM DATABASE OF RARE PLANTS, ANIMALS, AND NATURAL COMMUNITIES

Scientific Name	Common Name	Year Last Observed	EO Rank	NYS Legal Status
Amaranthus pumilus	Seabeach amaranth	1877	X	U
Polygonum glaucum	Seabeach knotweed	1990	B, C	U
Cyperus retrorus	Retrorse flatsedge	1865	H	U

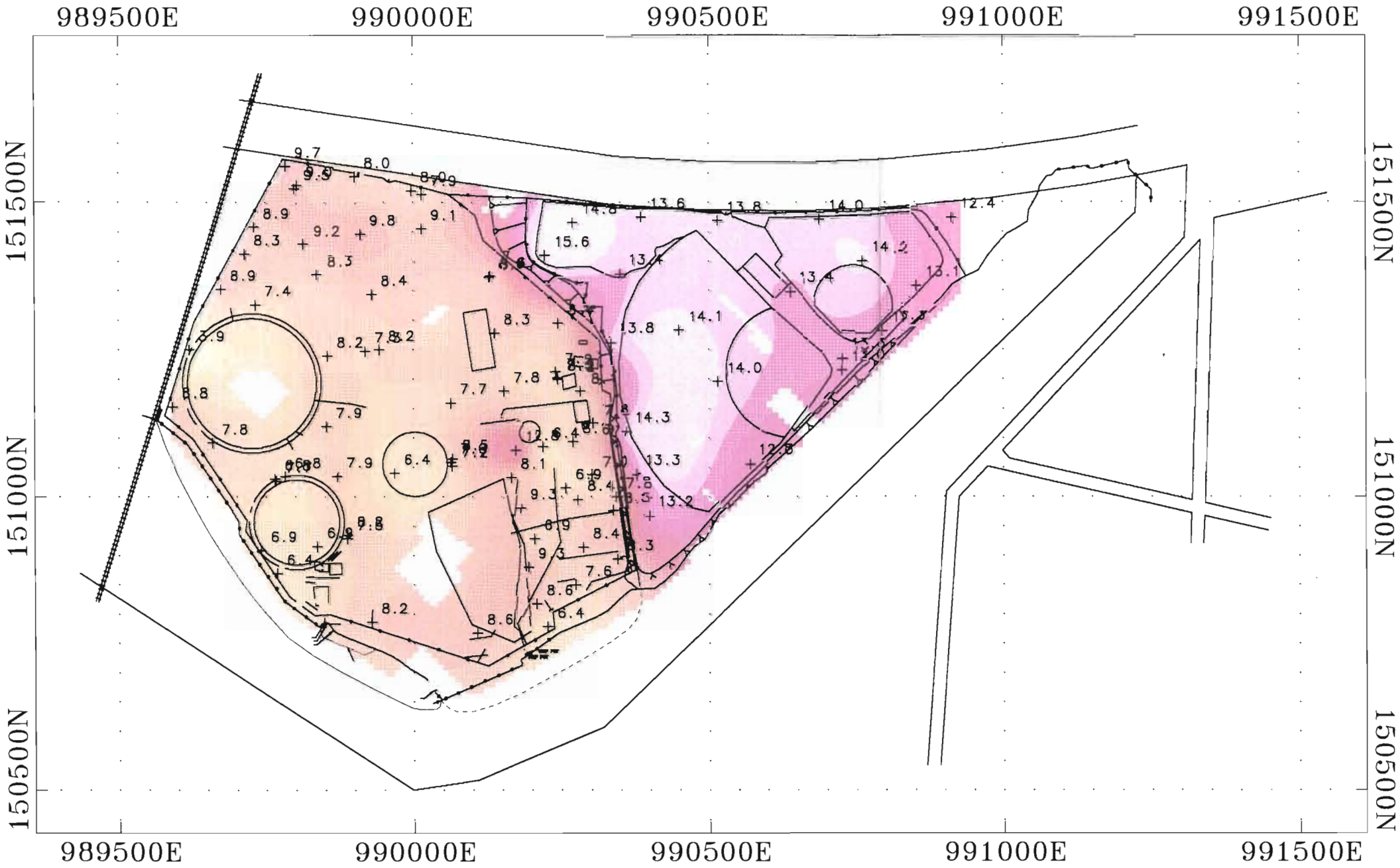
Key:

EO = Element Occurrence; B=Good, C=Marginal, X=Extirpated, H=Historical.
NYS = New York State.
U = Unprotected.

Source: Buffington 1993.

Common Name	Scientific Name
Plants	
Willow	*Salix spp.*
Aspen	*Populus grandidentata*
Cattail	*Typha spp.*
Clover	*Trifolium spp.*
Clover	*Lespedeza spp.*
Common ragweed	*Ambrosia aratemisiifolia*
Common reed	*Phragmites communis*
Goldenrod	*Solidago spp.*
Common mullein	*Verbascum thapsus*
Fire cherry	*Prunus pennsylvanica*
Sumac	*Rhus spp.*
Russian olive	*Elaeagnus commutata*
Mammals	
Least shrew	Cryptotis parva
Hairy-tailed mole	Parascalops breweri
Star-nosed mole	Condylura cristata
Keen's bat	Myotis keeni
Small-footed bat	Myotis leibii
Eastern pipistrelle	Pipistrellus subflavus
Big brown bat	Eptesicus fuscus
Eastern cottontail	Sylvilagus floridanus
Gray squirrel	Sciurus carolinensis
White-footed mouse	Peromyscus leucopus
House mouse	Mus musculus
Meadow jumping mouse	Zapus hudsonius
Raccoon	Procyon lotor
Long-tailed weasel	Mustela frenata
Striped skunk	Mephitis mephitis
Norway rat	*Rattus norvegius*
Woodchuck	*Marmota monax*
Deer mouse	*Peromyscus maniculatus*
Meadow vole	*Microtus pennsylvanicus*
Birds	
Northern Harrier	*Circus cyaneus*
Red-tailed Hawk	*Buteo jamaicensis*
American Kestrel	*Falco sparverius*
Chimney Swift	*Chaetura pelagica*
Ruby-throated Hummingbird	*Archilochus colubris*
Belted Kingfisher	*Ceryle alcyon*
Red-bellied Woodpecker	*Melanerpes carolinus*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Eastern Kingbird	*Tyrannus tyrannus*
Horned Lark	*Eremophila alpestris*
Purple Martin	*Progne subis*
Tree Swallow	*Tachycineta bicolor*
Blue Jay	*Cyanocitta cristita*
American Crow	*Corvus brachyrhynchos*
Black-capped Chickadee	*Parus atricapillus*
House Wren	*Troglodytes aedon*
American Robin	*Turdus migratorius*
Gray Catbird	*Dumetella carolinensis*
European Starling	*Sturnus vulgaris*
Common Yellowthroat	*Geothlypis trichas*
Northern Cardinal	*Cardinalis cardinalis*
Chipping Sparrow	*Spizella passerina*
Field Sparrow	*Spizella pusilla*
Savannah Sparrow	*Passerculus sandwichensis*
Song Sparrow	*Melospiza melodia*
Eastern Meadowlark	*Sturnella magna*
Common Grackle	*Quiscalus quiscalus*
Brown-headed Cowbird	*Molothrus ater*
American Goldfinch	*Carduelis tristis*
House Sparrow	*Passer domesticus*
Pied-billed Grebe	*Podilymbus podiceps*
Least Bittern	*Ixobrychus exilis*
Great Blue Heron	*Ardea herodias*
Great Egret	*Casmerodius albus*
Little Blue Heron	*Egretta caerulea*
Mute Swan	*Cygnus olor*
Canada Goose	*Branta canadensis*
American Black Duck	*Anas rubripes*
Mallard	*Anas platyrhynchos*
Northern Shoveler	*Anas clypeata*
Gadwall	*Anas stepera*
Bufflehead	*Buzephala albeola*
Redhead	*Aythya americana*
Ruddy Duck	*Oxyura jamaicensis*
American Coot	*Fulica americana*
Willet	*Catoptrophorus semipalmatus*
Spotted Sandpiper	*Actitus macularia*
Common Tern	*Sterna hirundo*
Least Tern	*Sterna antillarum*
Piping Plover	*Charadrius melodus*
Rock Dove	*Columba livia*
Common Barn-Owl	*Tyto Alba*
Fish Crow	*Corvus ossifragus*
Tufted Titmouse	*Parus bicolor*
Carolina Wren	*Thryothorus ludovicianus*
Marsh Wren	*Cistothorus palustris*
Northern Mockingbird	*Mimus polyglottos*
Grasshopper Sparrow	*Ammodramus savannarum*
Sharp-tailed Sparrow	*Ammodramus caudacutus*
Seaside Sparrow	*Ammodramus maritimus*
Starling	*Sturnus vulgaris*
House finch	*Carpodacus mexicanus*
Ring-necked pheasant	*Phasianus colchicus*
Barn swallow	*Hirundo tustica*
Catbird	*Dumetella carolinensis*
Killdeer	*Charadrius vociferus*
Mourning dove	*Zenaida macroura*
Red-winged blackbird	*Agelaius phoeniceus*
Rock dove	*Columba livia*
Double-breasted cormorant	*Phalacrocorax auritus*
Green heron	*Butorides striatus*
Black-crowned night heron	*Nycticorax nycticorax*
Snowy egret	*Egretta thula*
Laughing gull	*Larus atricilla*
Ring-billed gull	*Larus delawarensis*
Herring gull	*Larus argentatus*
Fish	
Killifish	*Fundulus spp.*
Striped bass	*Morone saxatilis*
Gizzard shad	*Dorosoma cepedianum*

Table 3-5 OBSERVED AND POTENTIAL PLANTS AND WILDLIFE ON AND IN THE VICINITY OF THE BROOKLYN BOROUGH GAS WORKS



LEGEND

14 13 12 11 10 9 8 7 6 5 4 3 2 1 -0 -1 -2 -3 -4 -5

Sample Key

+ NODE

10.0 Data Value

Elevation feet (MSL)

NOTES:

1) Based upon data collected during the Phase II (1993) through Phase VI (1996) Investigations.

Scale

250 0 250 500

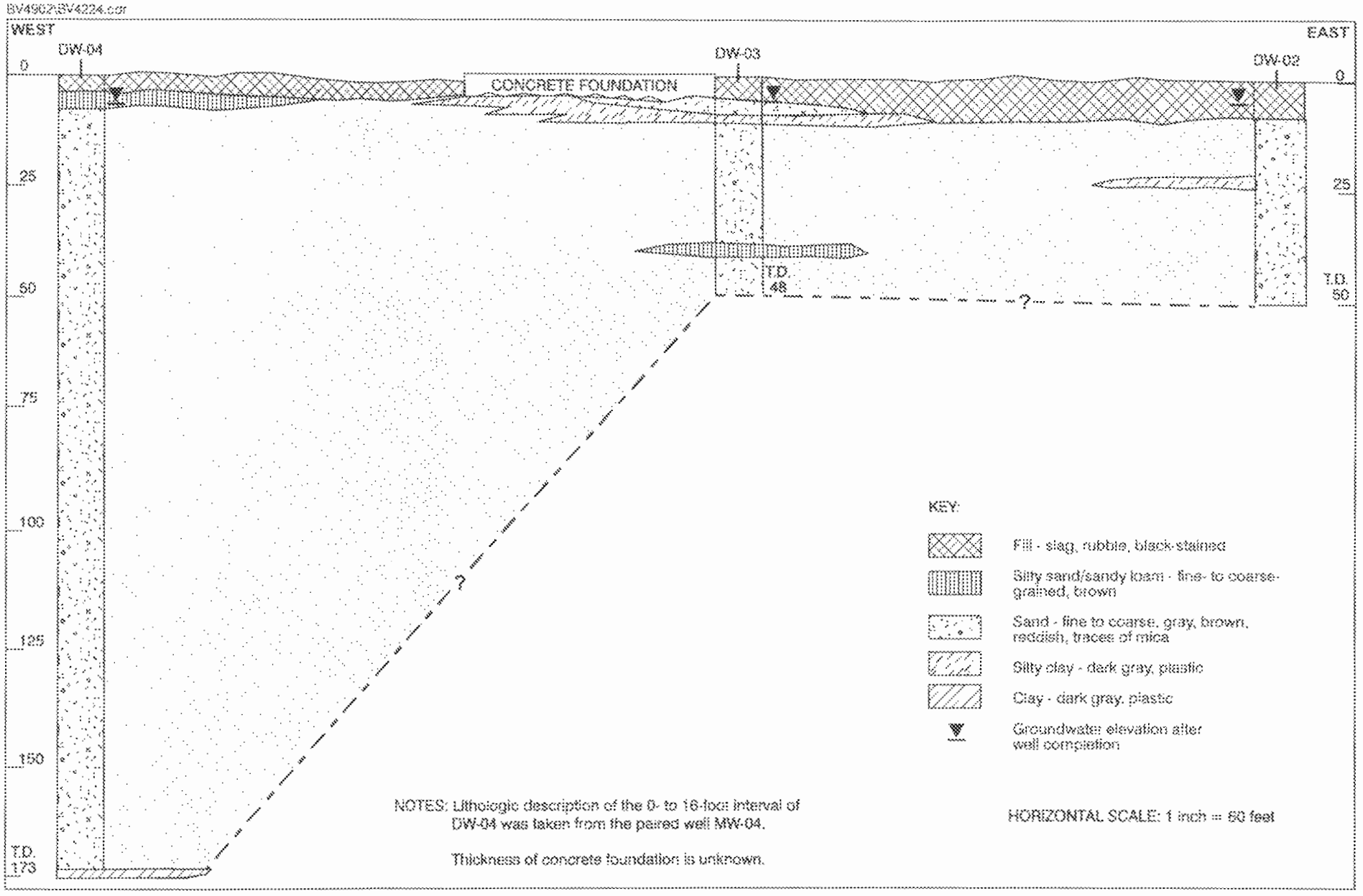
(Feet)

datafile: bv4093.xyz
gridfile: se-f.grd
basemape: basemap.plt & template.plt
plotfile: se-f.p01 /300XL/11x17
project: bv4093 Document Number: D5098

Figure 3-1

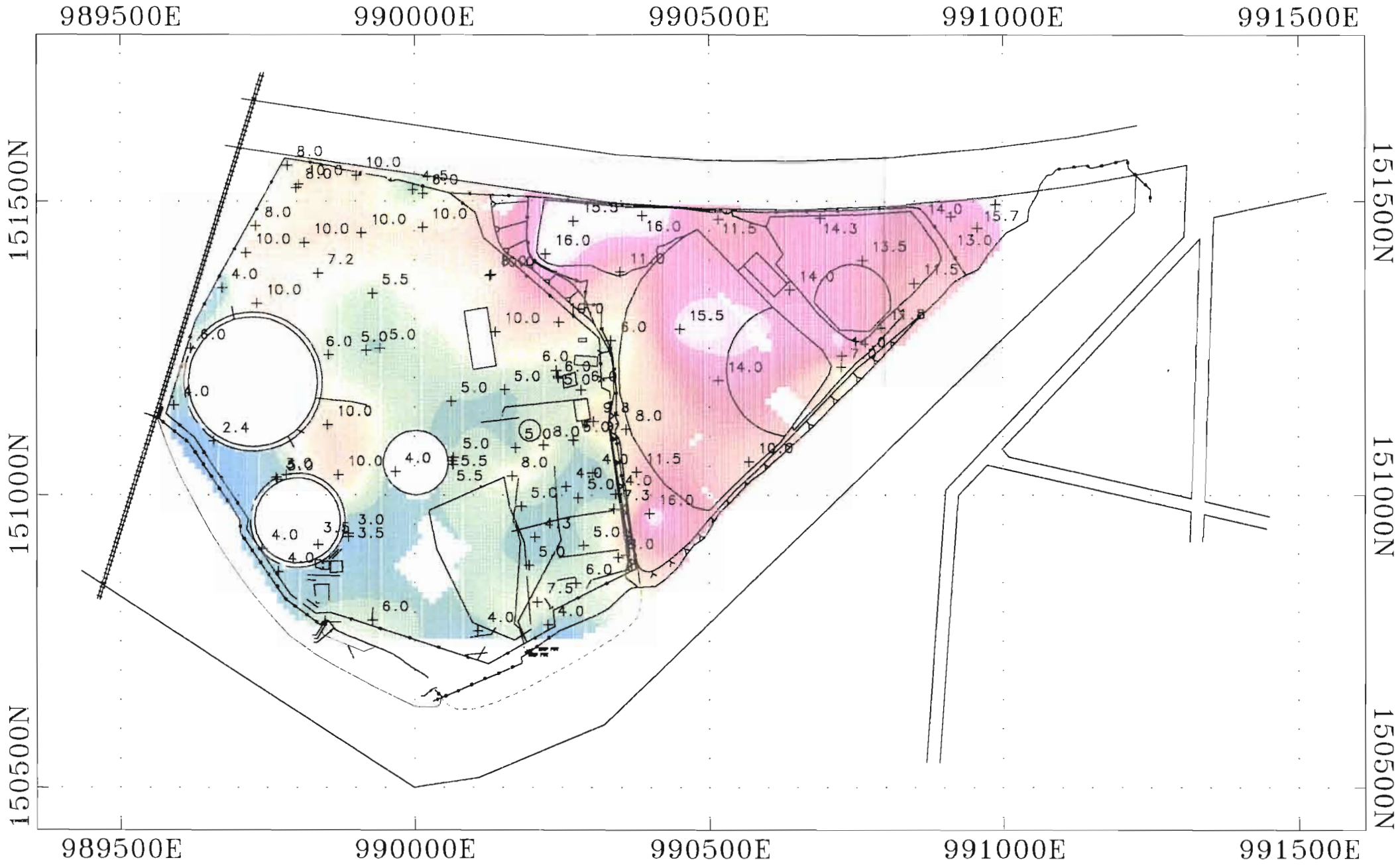
Surface Elevations
Brooklyn Borough Gas Works
Brooklyn, New York

ecology and environment, inc.



SOURCE: Ecology and Environment, Inc., 1997

Figure 3-2 DEEP WELL GEOLOGIC CROSS SECTION BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK



LEGEND

15 14 13 12 12 11 10 9 9 8 7 6 5 5 4 3 2 2 1 0

Sample Key

NODE

10.0 Data Value

Thickness in Feet

NOTES:

1) Based upon data collected during the Phase II (1993) through Phase VI (1996-97) Investigations.

Scale 1:4800

250 0 250 500

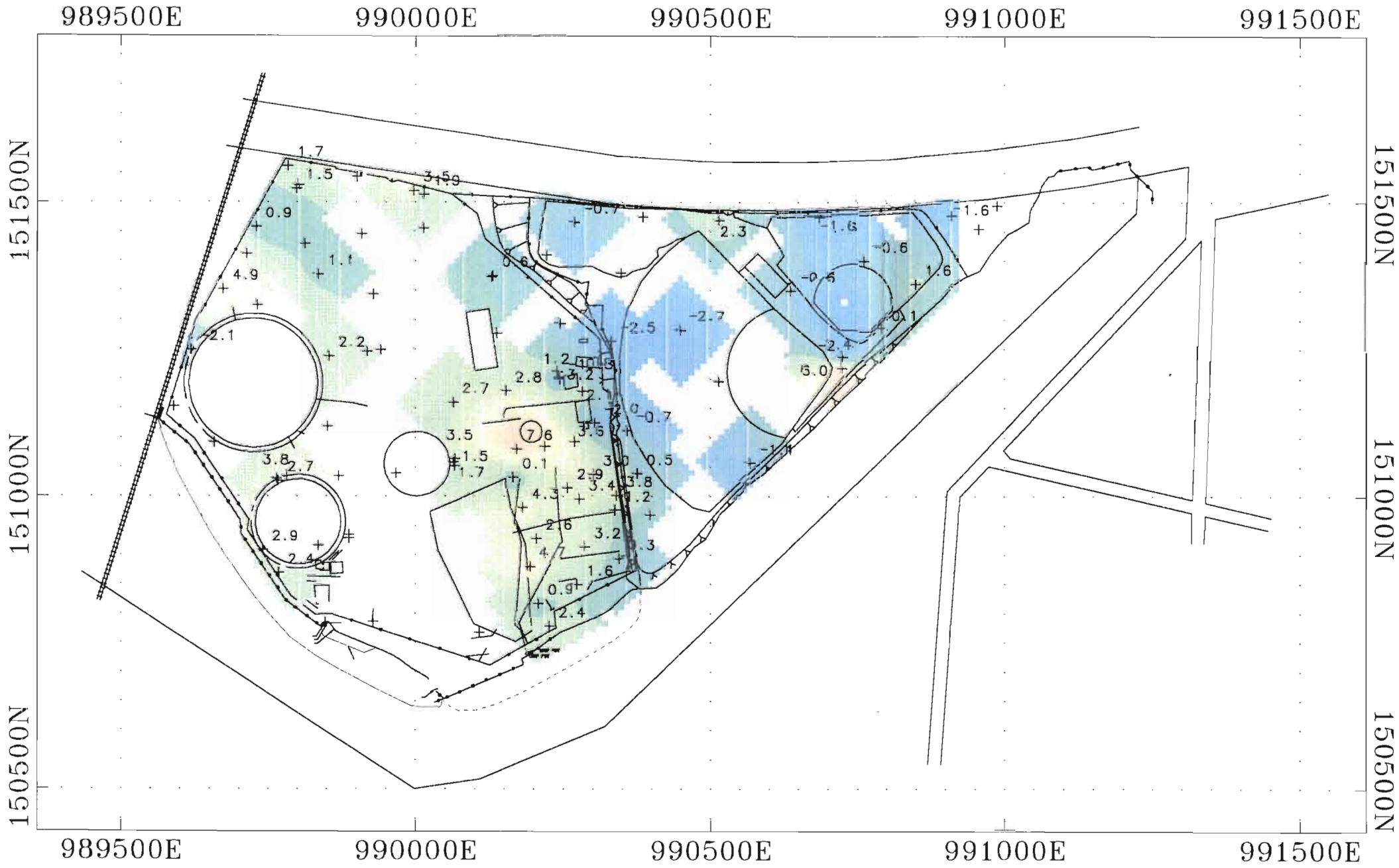
(Feet)

datafile: bv4093
gridfile: fil-th.grd
basemap: basemap.plt & template.plt
plotfile: fil-th-f.p01 /300XL/11x17
project: BV4093 Document Number: D5098

Figure 3-4

Minimum Fill Thickness
Brooklyn Borough Gas Works
Brooklyn, New York

ecology and environment, inc.



LEGEND

Sample Key

NODE

10.0 Data Value

Elevation in Feet (MSL)

NOTES:

1) Based upon data collected during the Phase II (1993) through Phase VI (1996-97) Investigations.

Scale

250 0 250 500

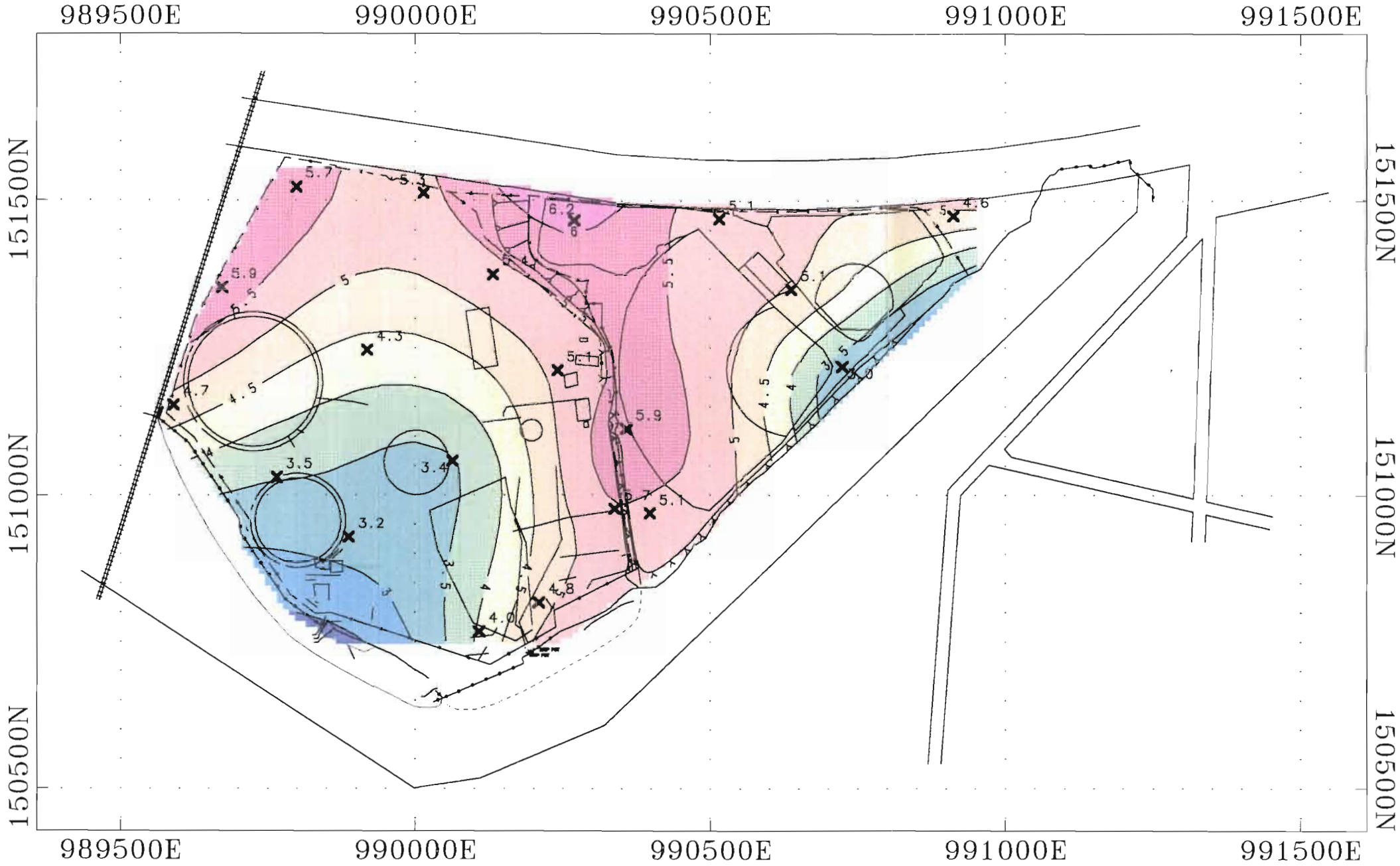
(Feet)

datafile: bv4093.xyz
gridfile: cps-t-f.grd
basemap: basemap.plt & template.plt
platfile: cps-t-f.p01 /300XL/11x17
project: bv4093 Document Number: D5098

Figure 3-5

Elevation of Top of Clay/Peat/Silt
Brooklyn Borough Gas Works
Brooklyn, New York

ecology and environment, inc.



LEGEND

6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5

Piezometric Surface
Feet (MSL)

Key

Water Level
5.2
Shallow Monitoring Well Locations

NOTES:

1)Based upon data collected during the Phase VI (1996) investigation.

Scale

250 0 250 500

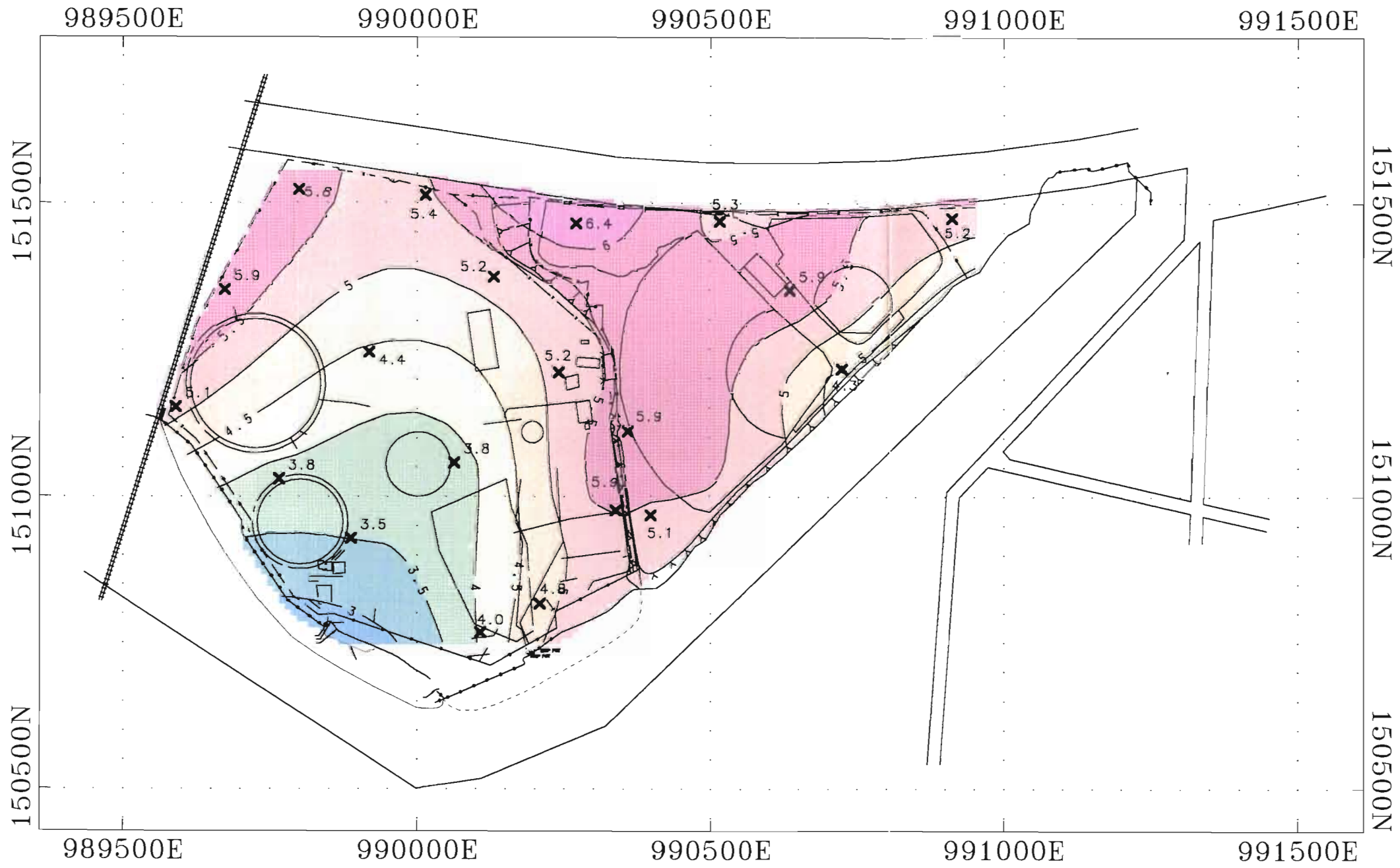
(Feet)

datafile: wlevels.xyz
gridfile: newl7wmm.grd
basemap: basemap.plt & newlow.plt
plotfile: newlow.p01 /dj650/11x17
project: bv4093 Document Number: 05098

Figure 3-6

Water Table at Low Tide on November 7, 1996, and Shallow Monitoring Well Locations
Brooklyn Borough Gas Works
Brooklyn, New York

ecology and environment, inc.



LEGEND

6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5

Key

5.2 Water Level

Shallow Monitoring Well Locations

Piezometric Surface Feet (MSL)

NOTES:

1)Based upon data collected during the Phase VI (1996) Investigation.

Scale

250 0 250 500

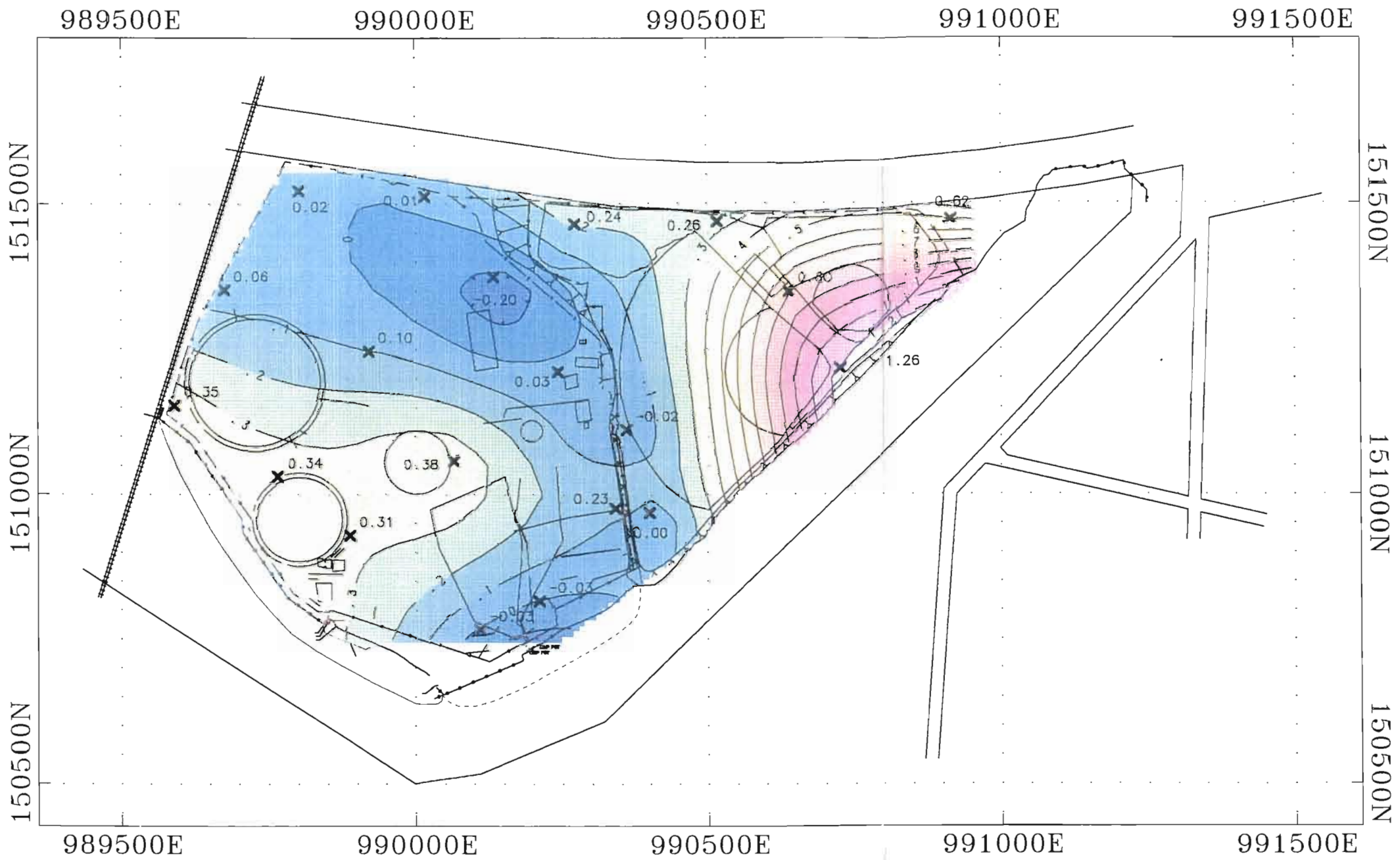
(Feet)

datafile: wlevels.xyz
gridfile: newh7wmm.grd
basemap: basemap.plt & newhigh.plt
plotfile: newhigh.p01 /dj650/11x17
project: bv4093 Document Number: D5098

Figure 3–7

Water Table at High Tide on November 7, 1996, and Shallow Monitoring Well Locations Brooklyn Borough Gas Works Brooklyn, New York

ecology and environment, inc.



LEGEND

Key

Water Level
5.2
Shallow Monitoring Well Locations

1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2

Net Change in Piezometric Surface From High Tide to Low Tide Feet (MSL)

NOTES:

1)Based upon data collected during the Phase VI (1996) Investigation.

Scale

250 0 250 500

(Feet)

datafile: nhl7.xyz
gridfile: ndifwmm.grd
basemap: basemap.plt & newdiff.plt
plotfile: newdiff.p01 /dj650/11x17
project: bv4093 Document Number D5098

Figure 3-8

Change in Water Table Because of Tide, November 7, 1996 Brooklyn Borough Gas Works Brooklyn, New York

ecology and environment, inc.

4 Nature and Distribution of Chemical Constituents in Environmental Media

4.1 Introduction

In order to characterize the nature and distribution of chemical constituents at the Brooklyn Borough Gas Works site, environmental samples were collected for visual observation and laboratory analysis. Samples were collected from various media, including surface soil, subsurface soil, sediment, surface water, and groundwater. Surface and subsurface soil samples were analyzed for VOCs, TRPH, PAHs, inorganics (i.e., metals), cyanide, PCBs, and pesticides. Groundwater samples were analyzed for VOCs, pesticides, PCBs, PAHs, TRPH, metals, total hardness, TDS, and chlorosity. During the fourth round of sampling (1996), samples were also analyzed for SVOCs.

The analytical results of the samples collected during this remedial investigation are presented in the Phase II (E & E 1993a), Phase III (E & E 1993c), Phase IV (E & E 1993d), IRM (E & E 1994b), and the Phase V (E & E 1994a) reports. The Phase VI analytical data are reported in Appendix B herein. Sections 4.2 and 4.3 present quantitative findings, by media.

4.1.1 Overview of Analysis

4.1.1.1 Soils

Soil samples were collected from boreholes, trenches, shallow monitoring wells, deep monitoring wells, and from the surface of the Brooklyn Borough Gas Works property. All samples were qualitatively characterized, and selected samples were chemically analyzed.

During the drilling of the monitoring wells and boreholes and the excavation of the trenches, fill material, coal tar, various debris (brick, metal tubing), and wood were observed over the entire property. A shallow water table was noted in the western area of the property, while the increased fill thickness of the eastern area of the property places the water table at a

deeper depth below ground surface. Tar layers were observed during both drilling and excavation. Strong coal tar odors were noted emanating from most of the boreholes and trenches. Organic vapor analyzer (OVA) readings of over 1,000 parts per million (ppm) were observed in 20 of the 75 boreholes. In four of the 77 trenches, the OVA readings were greater than 100 ppm with one trench having an OVA reading greater than 1,000 ppm (i.e., T-50 during Phase V [E & E 1994a]). All other trenches were below 100 ppm. At five of the 20 shallow monitoring wells, OVA readings were greater than 1,000 ppm. The highest OVA reading from the deep monitoring wells was recorded at DW-04 at 100 ppm. During the surface soil sampling, much of the ground was frozen, thereby minimizing the emanation of VOCs from the ground. The highest OVA reading collected during surface soil sampling was 2 ppm.

4.1.1.2 Water

In an effort to assess the condition of groundwater located beneath the Brooklyn Borough Gas Works property, a subsurface investigation was conducted. A portion of this effort entailed the collection and analysis of groundwater samples from the 24 monitoring wells. These samples were collected following development and purging of the wells and collection of field measurements.

Groundwater was also qualitatively assessed when it was encountered in the soil borings drilled throughout the site. A representative aliquot of groundwater was collected from each borehole for visual inspection and head space analysis. In most boreholes, the groundwater was dark gray or blackish in appearance and had a noticeable oil sheen on the surface. In many instances, head space analysis yielded an OVA reading of greater than 1,000 ppm.

4.1.1.3 Soil Gas

A passive, qualitative soil gas survey was conducted on the western portion of the Brooklyn Borough Gas Works property in May 1993. The purpose of the survey was to screen for the presence of VOCs and SVOCs in soils; map the areal extent of reported compounds; and attempt to indicate source areas and migration/dispersion pathways. This compares to the active, quantitative soil gas survey completed by A.D. Little (see Section 2.1.2.2, and A.D. Little 1992) of the surface soil of the eastern area of the property. The purpose of that survey was to quantitate the levels of VOCs and SVOCs in soil.

The methodologies and results of this soil gas survey are presented in detail in an August 1993 addendum to the Phase II report (E & E 1993b). Section 4.5 of this report presents a summary of the results of this survey.

4.1.1.4 Coney Island Creek

As part of the investigation of the site, conditions in Coney Island Creek were assessed, and surface water and sediment samples were collected for laboratory analyses. At each sample location, the sediment encountered was a highly organic, deep black, emulsive slurry from the surface to a depth of approximately 3 feet, at which point, native sand was observed. A petroleum odor was noted emanating from all of the surface water and sediment samples. The water of Coney Island Creek was greenish-brown, and a discontinuous oil sheen was observed on the surface.

4.1.2 Approach to Sampling

Each field investigation was designed with a very specific purpose in mind. The sampling approach differed between phases because of the differing objectives of each phase.

The first E & E field effort (Phase II) was a broad-based effort designed to address general coverage of the site. Each of the six field sampling tasks was designed to accurately represent the area or matrix under study. Surface soil sampling locations were selected on a semi-random basis. A grid was placed over the site. In each box of the grid, two soil samples were randomly collected. Borehole locations and soil gas locations were also selected by placing a grid over the site. Surface water and sediment samples were collected at the same locations. Stream sampling locations were evenly spaced along the creek. Trench locations and 10 of the initial groundwater monitoring well locations were selected based on the outcome of soil boring OVA readings. The others were selected to provide an accurate representation of the site.

Sample location selection in the successive field efforts following Phase II was designed to fill data gaps and improve delineation of conditions. The Phase III field effort targeted exploring areas of subsurface structures. Interceptor wells were installed at locations downgradient of prominent subsurface structures for the purpose of intercepting LNAPL. One well was installed during Phase IV for the purposes of oil recovery. Its location was chosen based on the existence of LNAPL in a neighboring well.

Phase V boring, trench, and well locations were selected with a bias toward further characterizing selected areas of the property where either no data existed, or where data indicated the need for a better understanding of the magnitude and extent of occurrence of various chemical constituents.

Phase VI borehole, trench, and monitoring well locations were selected to provide a general overview of the subsurface conditions of the eastern area of the property. Trench locations were selected by gridding the site.

4.1.3 Data Limitations

The usability and limitations of data should be considered from several perspectives, including analytes determined, level(s) and physical extent of chemical constituents, fate and transport, and comparisons with background and/or applicable regulatory limits.

One goal of an RI is the identification of chemicals of potential concern (COPCs), i.e., those chemicals present in amounts that may potentially present a human health or ecological risk. In early stages of investigating the site, full analytical suites were performed, including PAHs, PCBs, pesticides, volatiles, semivolatiles, and inorganics. As work continued, the list of analytes was refined, keeping those analytes that were either a COPC or would be good indicators (that is, representative of a class of chemicals whose presence is an indication of contamination by an entire class). In this manner, the western area of the property has been well characterized with respect to COPCs. Selection of the substances chosen for analysis in the recent investigation at the eastern areas was guided by knowledge gained from previous investigations, and, therefore, should be adequate for determining COPCs in this additional area.

Knowledge of the extent of a chemical's occurrence entails both the determination of the physical extent or boundaries of chemical constituents at significant concentrations, chemicals concentrations, and the distribution of the chemicals across the property. This information is typically viewed using contour plots in the case of horizontal extent and depth concentration profiles for vertical extent. The use of contour plots imposes its own data requirements, i.e., the data must be of sufficient number and the sample location of sufficient density to limit the appearance of artifacts in the contour plots. These factors of sample number and density are also dependent on the gridding and contouring techniques used and were taken into consideration when the plots were constructed. All contour plots used a random grid interpolation that fits a two-dimensional surface to the data such that the curvature of the surface is minimized. The extent and range of the gridding was determined from consideration of the nature of the constituent under consideration and best professional judgment.

Depth concentration profiles are plots of concentration versus depth. Though the formats may vary, if the data exist, the plots can be constructed. That is, there were no limitations on the construction of any of the profiles presented.

Another consideration in determining data limitations is the coverage of potential exposure pathways. Sufficient data should be collected from all environmental media potentially involved in human and/or ecological exposure in order to adequately characterize the media in terms of the extent of chemical constituents present, key fate and transport parameters, etc. Critical environmental media at this site include surface and subsurface soils, groundwater, surface water, creek sediments, and air. The density and distribution of monitoring wells at the

property are sufficient to permit development of a consistent conceptual groundwater flow model based on regional and local hydrogeological conditions. In addition, aquifer testing and soil characterization allow estimates of groundwater travel times to be made. Determination of retardation factors can be obtained from co-located soil and groundwater concentrations and, where that information is missing, from soil characterization data (i.e., soil classification and organic content). The soil characterization data gathered at the site must be and are judged to be sufficient for estimation of mass loading in air in some exposure scenarios, as well as the fluxes of volatile components at the land surface.

The data gathered in the series of investigations at the site appear to have few limitations in regard to evaluating the nature and extent of the chemical constituents on the property, or the fate and transport of chemical constituents in various environmental media.

There is, however, one exceptional limitation to the data gathered to date, and that is the lack of accurate background values for any analyte in any medium. Thus, it is not possible to unequivocally state how contaminated the site is relative to the immediate environs. There are, however, sufficient data in many cases for *ad hoc* comparisons with appropriate literature values, i.e., there are enough determinations to perform statistical hypothesis testing. This includes the groundwater data, but it should be noted that these data would not be adequate as the base data for a formal groundwater monitoring program.

4.1.4 Manufactured Gas Plant Process Residuals and Chemicals

As mentioned previously, the Brooklyn Borough Gas Works was apparently a carburetted water gas plant. A general schematic of the process used at the plant was shown in Figure 1-2 and the plant's general layout was shown in Figure 1-9.

This plant probably used bituminous coal or coke as the primary manufacturing feedstock. This feedstock was heated (retorted) in the presence of air and steam to convert the British thermal unit (Btu) content into a gaseous product called blue gas. Next, both light and heavy gas oils were used to carburete the blue gas, increasing its Btu content. The manufactured gas was then cooled in order to remove various heavy hydrocarbons (such as tars) and excess steam. After this, the gas stream was scrubbed to remove naphthalene, and additional tar was removed using an electric precipitator. Finally, the gas underwent sulfur removal in purifier boxes that held lime and iron oxide. The cleaned manufactured gas was metered and held in holder tanks until it was pumped into the pipeline distribution system.

The only solid residual from the process was ash. However, some clinker (agglomerated ash) was produced.

Coal tar was a by-product of the manufacturing process. However, because this was a carburetted water gas plant, the tars were more likely to be similar to oil gas tars. These tars were made of more hydrocarbons that distill-off at lower temperature as compared to coal tar (GRI 1987, p.12). This means that the tars are made-up of lower molecular weight hydrocarbons. In addition, these tars did not contain tar acid chemicals, such as phenols and cresols (GRI 1987, p. 15).

On-site processing of the produced tar only involved separation and dehydration. Some tar was re-used as boiler fuel or was sold. Process drawings of this MGP indicate a tar transfer pipe from a storage tank at the northern end of the western area to the dock on Coney Island Creek. Records show the tar was sold as a by-product.

Because hydrocarbons were condensed along with excess steam, a considerable amount of tar/oil/water emulsion may have been produced. This material was likely added to the tar separators and/or could have been used as boiler fuel, if the water content was below 25% (GRI 1987, p. 19).

Other hydrocarbon residuals, such as naphthalene, were scrubbed from the gas. However, whether naphthalene was actually recovered is unknown. At many MGPs, naphthalene was crystallized and sold, but it is also possible that the material could have been incorporated into the carburetion feedstock (GRI 1987, p. 23).

Lime and iron oxide were used in the plant's purifier boxes to scrub sulfur from the gas stream. This resulted in a solid product containing sulfur and various iron compounds and could have contained hydrocarbons such as tars. Spent oxide wastes from carburetted-water plants have contained low levels of various cyanide compounds (GRI 1987, p. 24).

With regard to the wastewater stream from the process, no information is available regarding treatment. Information supplied by Brooklyn Union indicates the presence of several water overflow lines running to Coney Island Creek. There were two cesspools at the plant site, but there is no indication of how they were used.

After the facility was decommissioned in the 1960s, the gas holder remained in operation to serve the natural gas distribution system, and a gate station also operated. Because of the use of oils in the compressors powering many of the natural gas transmission lines in the eastern United States (until the 1970s or so), and because Brooklyn Union's distribution lines were ultimately connected to these lines in order to receive natural gas, it is possible that PCBs could have been introduced into the natural gas distribution lines at the site. The isolated occurrence of PCBs in subsurface soils may have arisen from non-MGP activities related to the handling of natural gas pipeline liquids. The isolated occurrence of PCBs in soils along the western property boundary was probably due to off-site sources.

Based on the forgoing review of the MGP process used at this facility a list of possible site-related chemical constituents was developed (see Table 4-1).

4.2 Soils

4.2.1 Surface Soils

A total of 34 discrete surface soil samples were collected from the western area during the Phase II investigation (E & E 1993a), and two discrete surface soil samples were collected from the eastern area during the June 1997 Phase VI investigation. Samples were collected from the 0- to 6-inch depth interval and were analyzed primarily for the following constituents: VOCs, TRPH, PAHs, and inorganics. In addition, the two soil samples SS74 and SS75 collected during the June 1997 Phase VI investigation were analyzed for total and amenable cyanide. One sample was submitted for Target Compound List (TCL)/Target Analyte List (TAL) analyses only. Six of the samples were analyzed for total organic content (TOC), Fraction of Organic Matter (FOM), and Cation Exchange Coefficient (CEC), and 14 of the samples were analyzed for cyanide and grain size. In addition, two composite soil samples were collected from the 0- to 6-inch depth interval and analyzed for VOCs, TRPH, PAHs, inorganics, and cyanide.

Seven VOC compounds were detected in on-site surface soil samples. TRPH concentrations in surface soils ranged from 25 mg/kg to 16,000 mg/kg. Eighteen inorganic compounds were also detected. PAHs were detected in all surface soil samples including the two composite samples. Total PAH concentrations in the 0- to 6-inch depth interval across the site ranged from 0.612 mg/kg to 2,047 mg/kg. Noncarcinogenic PAH concentrations ranged from 0.349 mg/kg to 1,209 mg/kg. Carcinogenic PAH concentrations ranged from 0.263 mg/kg to 838 mg/kg. Figures 4-1 and 4-2 illustrate the distribution of the noncarcinogenic and carcinogenic PAHs and indicate the highest concentrations occur in the north and central portion of the property. Lead was detected in all 36 surface soil samples collected from the property. Lead concentrations ranged from 80 to 4,200 mg/kg. Figure 4-3 presents the distribution and concentrations of lead and indicates its presence in surface soils throughout the western area of the property and the two surface soil samples from the eastern area, with the highest concentrations present in the west-central section. The natural occurrence of lead in soil varies from less than 10 to more than 30 mg/kg. However, the concentration in surface soil varies widely: Next to roadways, the concentration may vary from 30 to 2,000 mg/kg, with the highest levels within the nearest 100 feet (EPA 1986a); and soil adjacent to homes with exterior lead-based paints may have concentrations in excess of 10,000 mg/kg (EPA 1986a). BTEX was detected in four of the 36 surface soils at concentrations ranging from 0.002 to 0.253 mg/kg. Figure 4-4 illustrates the distribution

and concentrations of BTEX, with the highest concentrations present in the northwest corner of the property. Sample SS20, submitted for TCL/TAL analyses, contained two SVOCs, and the PCB Aroclor 1254 at a concentration of 7.5 mg/kg. Cyanide was detected in only one of the 36 surface soil samples, from sample SS75 at 1.23 mg/kg. TOC results in surface soils ranged from 1.7% to 9.3%. FOM results ranged from 3.0% to 16%. CEC values ranged form 4.9 meq/100g to 9.9 meq/100g. The Phase II report (E & E 1993a) summarizes the analytical data from analyses of the surface soil samples.

On August 27, 1997, resampling of two Phase II surface soil locations (SS28 and SS32; see Figure 2-5) was conducted from the 0-to-6-inch depth interval. Two samples were collected from each location and submitted for lead analysis only. Samples F-1 and F-2 were collected in the area of SS32, and samples G-1 and G-2 were collected in the area of SS28. The lead concentration detected in sample F-1 was 422 mg/kg, and the concentration in F-2 was 435 mg/kg. These concentrations are below the SS32 level of 1,900 mg/kg detected in 1993. The lead concentration detected in sample G-1 was 187 mg/kg, and the concentration in G-2 was 354 mg/kg. These concentrations are below the SS28 level of 1,800 mg/kg detected in 1993.

4.2.2 Subsurface Soils

Samples from 31 of the 75 boreholes and 24 monitoring wells drilled throughout the property were collected and submitted for various analyses during Phases II, IV, V, and VI (E & E 1993a, 1993c, 1994a, and Appendix B of this report, respectively). Samples were collected at 2-foot intervals from the ground surface to the completion depth of the boring or well except in well DW-04 and boreholes BH74 and BH75. In well DW-04, samples were collected at 2-foot intervals from the ground surface to a depth of 50 feet. Between 52 feet and 80 feet, samples were collected at 6-foot intervals, and beyond 80 feet, samples were collected at 10-foot intervals. These samples were submitted for VOC, TRPH, PCBs, pesticides, PAH, inorganic metals, and cyanide analysis. Six boreholes (BH-68 through BH-73) were installed in February 1997 to further characterize cyanide detected in BH-59. Soil samples were collected at 2-foot intervals and analyzed for total and chlorine-amenable cyanide. Two boreholes (BH74 and BH75) were installed in June 1997 to further characterize the eastern area of the site. Compaction and void spaces of the subsurface material only permitted sufficient soil sample to be collected from 4-foot intervals. In addition, 10 of the samples collected during the Phase II field investigation were submitted for Toxicity Characteristic Leaching Procedure (TCLP) analysis, and two of the samples were submitted for grain-size analysis.

VOCs were detected in 48 of the 49 boreholes that had samples submitted for analysis. TRPH was detected in each of the 49 boreholes, with concentrations ranging from 10.1 to 33,600

mg/kg. Twelve metals and cyanide were detected in the borehole samples. TCLP results were all below detection limits.

PAHs were detected in all 49 borings that had samples submitted for analyses. PAHs were detected in 338 of the 349 samples collected. PAH concentrations ranged from .048 to 40,550 mg/kg. Figure 4-5 (oversize) presents the distribution and concentration of total PAHs in 2-foot intervals from 0 to 14 feet. This figure illustrates that total PAHs are present in all the 2-foot intervals from the 0- to 14-foot interval, with the highest concentration present in the southeast corner of the western area.

BTEX compounds were detected in 45 of the 47 borings sampled. BTEX was detected in 195 of the 357 samples analyzed. The concentrations ranged from 0.0011 to 2460 mg/kg. Figure 4-6 (oversize) presents the distribution and concentrations of BTEX present in all the 2-foot intervals from 0 to 14 feet. This figure illustrates that the highest concentration is present in the 2- to 4-foot interval in the southwest section of the western area.

PCBs were detected in MW-13 and MW-14 (duplicate sample) from the 0- to 2-foot interval at concentrations of 9.9 mg/kg and 1.9 mg/kg (Aroclor 1254), respectively, and these isolated occurrences are likely due to off-site sources. PCBs were detected in MW-16 from the 2- to 4-foot interval at a concentration of 22.60 mg/kg (Aroclor 1248) and 6.84 mg/kg (Aroclor 1254); from the 6- to 8-foot interval at concentrations of 28.70 mg/kg (Aroclor 1248) and 37.30 mg/kg (Aroclor 1254); and the 18- to 20-foot interval at concentrations of 17.50 mg/kg (Aroclor 1248) and 6.39 mg/kg (Aroclor 1254). MW-21 contained PCBs from the 6- to 8-foot interval at a concentration of .002 mg/kg (Aroclor 1260). PCBs were detected in borehole BH-56 from the 2- to 4-foot interval with concentrations of 1.21 mg/kg (Aroclor 1260) and the 6- to 8-foot interval with concentrations of 6.63 mg/kg (Aroclor 1260). Borehole BH-57 contained three PCB Aroclors, 1242, 1254, and 1260, from the 2- to 4-foot interval with concentrations of 0.91 mg/kg, 5.83 mg/kg, and 1.85 mg/kg, respectively. PCBs were detected in borehole BH-62 from the 6- to 8-foot interval at a concentration of 10.2 mg/kg (Aroclor 1260). These isolated occurrences are all below EPA's PCB spill policy level of 50 mg/kg, with the exception of MW-16 at the 6- to 8-foot level. No PCBs were detected in the 10 trenches sampled of the 27 installed in the eastern area of the property in February 1997.

Total cyanide was detected in 51 of the 55 borings that had samples submitted for analysis. Total cyanide was detected in 131 of 398 samples analyzed at concentrations ranging from 0.696 to 446 mg/kg. Figure 4-7 (oversize) presents the distribution and concentrations of total cyanide in all the 2-foot intervals from 0 to 16 feet. The highest concentration was present in the 10- to 12-foot interval in the northern portion of the eastern area of the property, along the boundary. Three boreholes were placed outside of the property beneath the elevated parkway

(BH-68, -69, and -70). The cyanide appears to be highly complexed with metals, probably iron, and is at most only slightly dissociable. No cyanides were detected in the 10 trenches sampled of the 27 installed in the eastern area of the property in February 1997.

The average concentrations for BTEX, total PAHs, and cyanide are plotted for each 2-foot interval from 0 to 50 feet in Figure 4-8. This figure illustrates that the concentrations of these constituents decrease with depth. Except for the total PAHs, all compounds were detected at less than 1 mg/kg below the 30- to 32-foot depth interval. This data was not adjusted to a single vertical data plane, and variations in depth may be reflected by variations in surface elevations of the individual boreholes.

Inorganics were detected in samples from all 49 boreholes. Figure 4-9 illustrates the average inorganic concentrations for each 2-foot interval for Copper (Cu); Lead (Pb); Manganese (Mn); Nickel (Ni); and Zinc (Zn). This figure illustrates a general reduction in the average concentrations with depth from 0 to approximately 26 feet BGS. Interpretation of this figure is limited because of the variation of the number of samples collected from each interval. The depth intervals presented on this figure have not been adjusted to a single elevation data plane and subsequently may vary as much as 10.4 feet.

4.3 Groundwater

Twenty shallow and four deep groundwater monitoring wells have been installed by E & E on the Brooklyn Borough Gas Works property. Shallow monitoring wells MW-1 through MW-10 and deep wells DW-1 through DW-4 have been sampled by E & E four times: April, July, and October 1993 and in November 1996. Shallow monitoring wells MW-13 through MW-15 were sampled in October 1993 and November 1996. The remaining seven shallow groundwater monitoring wells, MW-16 through MW-22, were sampled after installation in November 1996. In June 1997, shallow monitoring wells MW15 through MW-22 and CIW-1 and deep well DW-4 were sampled. The samples were analyzed for VOCs, TRPH, PAHs, PCBs, pesticides, inorganics, chlorosity, TDS, and total hardness. During the November 1996 sampling round, all 24 monitoring wells were analyzed for semivolatiles. The June 1997 sampling event included filtered/unfiltered samples for inorganics and total and amenable cyanides. In addition, two shallow wells (MW-2 and MW-6) were sampled for filtered/unfiltered total and amenable cyanide. Appendix B provides complete review of Phase VI data. Tables 4-2 and 4-3 (oversize) present the shallow and deep groundwater data, respectfully, collected during the four separate sampling rounds of the wells installed by E & E.

VOCs have been detected in 14 of 20 shallow monitoring wells and two of four deep wells during the five rounds of sampling. Ten VOCs were detected in shallow groundwater samples and nine in the deep well samples. These results are generally consistent between all five rounds of sampling.

During the November 1996 groundwater sampling event, TRPH was detected in 13 of the 20 wells with concentrations ranging from 1.3 to 213 μg/L. TRPH was detected in only one of the deep wells (DW-03) at a concentration of 2.92 μg/L. Figure 4-10 presents the shallow groundwater distribution and concentrations of TRPH detected during this sampling event. In general, the highest concentrations of TRPH in groundwater are present under the eastern area, with the highest concentration of TRPH in the shallow groundwater along the southeast corner of the eastern area of the property. The observation of low levels of TRPH in groundwater under the western area, with the highest levels occurring in the south central area at MW-08, is consistent between all four sampling rounds.

During the June 1997 groundwater sampling event, TRPH was detected in eight of the 10 shallow wells sampled with concentrations ranging from 1.34 to 98.5 µg/L. No TRPH was detected in deep well DW-04. These concentrations are consistent with the November 1996 sampling event.

BTEX was detected in 14 of the 20 shallow and two of the four deep groundwater monitoring wells during the November 1996 sampling activity. Concentrations of BTEX in the shallow monitoring well samples ranged from 2.63 μg/L to 29,640 μg/L and were 2.93 μg/L and 3.34 μg/L in deep wells DW-03 and DW-04, respectively. Figure 4-11 presents the shallow groundwater distribution and concentrations of BTEX detected during this sampling event. The figure illustrates that the highest concentration of BTEX in the shallow groundwater is located in the central portion of the western area of the property. Comparison of the Phase II, Phase V, and Phase VI shallow groundwater for the distribution and concentrations of BTEX indicate the central portion of the western area of the property in the vicinity of MW-07 has the highest concentration. The south-central section of the western area had the highest concentration of BTEX during the Phase V sampling event. The BTEX concentrations have increased during the Phase II and Phase V 1993 sampling events to their highest concentrations in the Phase VI 1996 sampling activity. The elevated concentrations of BTEX are present in the central and south-central portions of the property.

During the June 1997 sampling event, BETX was detected in four of the nine shallow and the one deep groundwater monitoring well. Concentrations ranged from 3.29 µg/L to 1,185.50 µg/L and were 8.01 µg/L in deep well DW-04. The BETX concentrations in the eastern area of the site have similar concentrations to those detected during the November 1996 sampling

event. The highest concentrations in the eastern area of the property continue to be present in monitoring well MW-20.

PAHs were detected in 17 of the 20 shallow and two of the four deep groundwater monitoring wells in November 1996. Concentrations of PAHs in the shallow monitoring well samples ranged from 5.83 to 24,980 μg/L and were 4.91 and 60.6 μg/L in deep wells DW-03 and DW-04, respectively. Figure 4-12 presents the shallow groundwater distribution and concentrations of PAHs detected during this sampling event. The figure illustrates that the highest concentration of PAHs in shallow groundwater is located in the south-central section of the western area adjacent to the south holder foundation. In addition, a second sampling location (MW-19), located in the north-central section of the eastern area of the property, has nearly the same level of PAHs present. Comparison of the PAHs detected in Phase II, Phase V, and Phase VI shallow groundwater sampling indicates that the highest concentrations remain in the south-central, central, and northwest sections of the western area of the property.

During the June 1997 sampling event, PAHs were detected in all 10 shallow and the one deep groundwater monitoring wells. Concentrations of PAHs in the shallow monitoring well samples ranged from 11.49 to 2,659.00 µg/L and were 3.79 µg/L in the deep well DW-04. The PAH concentrations in the eastern area of the site have generally decreased with the exception of MW-16 and MW-17, which have slightly increased concentrations. The highest concentrations in the eastern area of the property continue to be present in monitoring wells MW-19 and MW-20.

Inorganic metals were detected in all 20 shallow and all four deep groundwater monitoring wells during the November 1996 sampling event. Ten metals were detected in the shallow monitoring wells with concentrations ranging from 528.8 to 87,728.3 μg/L. Nine metals were detected in the deep wells with concentrations ranging from 8427.5 to 891,758.2 μg/L. During the June 1997 sampling event, metals were detected in all 10 shallow and one deep groundwater monitoring wells. Ten metals (arsenic, chromium, copper, lead, magnesium, manganese, mercury, nickel, selenium, and zinc) were detected in unfiltered samples from the shallow monitoring wells with concentrations ranging from 24,274 to 92,368.95 µg/L. Six metals (copper, lead, magnesium, manganese, selenium, and zinc) were detected in the unfiltered sample from deep monitoring well DW-04 at a concentration of 549,662.50 µg/L. Seven metals (arsenic, chromium, lead, magnesium, manganese, selenium, and zinc) were detected in filtered samples from the shallow monitoring wells with concentrations ranging from 14,516.43 to 51,969.09 µg/L. Five metals (lead, magnesium, manganese, selenium, and zinc) were detected in filtered samples from deep monitoring well DW-04 at a concentration of 630,557.3 µg/L. The elevated concentrations in the deep wells is primarily due to the high levels of magnesium, which

is one of the major constituents of salt water. Four metals, arsenic (As), chromium (Cr), lead (Pb), and zinc (Zn), are discussed in more detail below because they are four of the nine principal inorganic constituents, most frequently detected, had the highest concentrations, and are spatially distributed throughout the property. These inorganics vary over the four rounds of sampling and appear to generally decrease across sampling events. Why this occurs is unknown, but it may be an artifact of precipitation events prior to sampling that "washes" out the minerals.

Arsenic was detected during the November 1996 groundwater sampling event in 16 of 20 of the shallow and one of the deep monitoring wells. Concentrations of arsenic in the shallow monitoring wells ranged from 5.8 to 666.0 μg/L with a single detection of 6.9 μg/L in the deep well (DW-4). Figure 4-13 presents the shallow groundwater distribution and concentrations of arsenic during this sampling event. These Phase VI data illustrate that the highest concentration of arsenic in shallow groundwater is present in the north-central section of the eastern area of the property near MW-19. Over the four rounds of sampling, however, the highest levels of arsenic in groundwater are observed in the southern portion of the western area. Phase VI is the only round that included samples from wells in the eastern area. The highest levels are greater than 100 µg/L in MW-08, MW-04, and MW-14. During the June 1997 sampling event, arsenic was detected in all nine shallow groundwater monitoring wells. Concentrations of arsenic in the unfiltered samples ranged from 28.3 to 171 µg/L and in the filtered samples from ND to 6.9 µg/L. No arsenic was detected in deep well DW-04. The highest levels of arsenic were detected in MW18, MW19, and MW20 at concentrations of 126 µg/L, 171 µg/L, and 171 µg/L, respectively. The filtered samples for these same three wells had concentrations of ND, 6.9 µg/L, and ND. A published range of arsenic in seawater is 2 to 35 μg/L (Kennish 1989).

Chromium was detected during the 1996 groundwater sampling round in 16 of 20 shallow and three of four deep monitoring wells. Concentrations of chromium in the shallow groundwater ranged from 12 to 682 μg/L and from 13.5 to 24 μg/L in the deep groundwater. Figure 4-14 presents the shallow groundwater distribution and concentrations of chromium during this sampling event. This figure illustrates that the highest concentration in shallow groundwater is present in the north-central section of the eastern area near MW-19. In addition, a second monitoring location (MW-09), located in the south-central section of the western area, has a similar concentration of chromium. Generally, the highest levels of chromium occur in the south-central section of the western area over the four rounds of sampling. However, the trend in almost every well the concentration decreases significantly over the rounds of sampling with the lowest levels observed during Phase VI. The exception to this trend is MW-09 which had 90, 180, 22, and 674 µg/L of chromium, respectively, in the four rounds. It is unclear why these trends have occurred.

During the June 1997 sampling event, chromium was detected in the nine shallow groundwater monitoring wells. Concentrations of chromium in the unfiltered samples ranged from 38.6 to 376 µg/L and in the filtered samples from ND to 19.5 µg/L. No chromium was detected in deep well DW-04. The highest levels of chromium detected in unfiltered samples were in MW-18, MW-19, and MW-20 at concentrations of 296 µg/L, 140 µg/L, and 376 µg/L, respectively. The filtered samples for these three wells had concentrations of ND, ND, and 19.5 µg/L, respectively. The chromium concentration in MW-19 and MW-20 decreased from the November 1996 sampling event, and increased in MW-18.

Lead was detected during the 1996 groundwater sampling round in 16 of 20 shallow and one of four deep monitoring wells. Concentrations of lead in the shallow groundwater ranged from 8.3 to 6,820.0 μg/L and the single detection in the deep well was 6.0 μg/L. Figure 4-15 presents the shallow groundwater distribution and concentrations of lead for the Phase VI sampling round. This figure illustrates that the highest concentration in shallow groundwater is present in MW-19 in the north-central section of the eastern area of the property. Comparison of lead for all groundwater sampling events indicates the highest concentration was detected in the area of MW-08 during the first two rounds of sampling. MW-15, located in the southeast corner of the western area, has exhibited an increase in lead concentration during the last two sampling events in October 1993 and November 1996.

During the June 1997 sampling event, total lead was detected in all nine of the shallow and one deep groundwater monitoring wells. Concentrations from the unfiltered samples ranged from 33.5 to 6,570 µg/L and the filtered samples ranged from ND to 19.5 µg/L in the shallow wells. Lead was detected in deep well DW-04 at concentrations of 79.85 in the unfiltered sample and 35.0 µg/L in the filtered sample. The highest levels of lead detected in unfiltered samples were from MW-15, MW-16, MW-18, MW-19, and MW-20 at concentrations of 795 µg/L, 1,320 µg/L, 6,570 µg/L, 1,440 µg/L, and 1,160 µg/L, respectively. The filtered samples for these five wells had concentrations of ND, 11.7 µg/L, 9.6 µg/L, ND, and ND, respectively. MW-15 had a significant decrease in lead concentration since the October 1993 and November 1996 sampling events.

Zinc was detected in the 1996 sampling round in all the shallow and deep groundwater samples. Concentrations of zinc ranged from 21.6 to 7,930.0 μg/L in the shallow groundwater wells and from 11.5 to 327.0 μg/L in the deep groundwater wells. Figure 4-16 presents the distribution and concentrations of zinc in shallow groundwater. This figure illustrates that the highest concentration in shallow groundwater is present in the southeast section of the western area in MW-15. Zinc concentrations in groundwater vary considerably over the site and over the four rounds of sampling. The concentration variation differs by as much as one to two orders of

magnitude from well to well. However, the concentrations do appear to be highest along the westernmost property boundary (adjacent to the MTA right-of-way) and in the southeast corner of the western area in the vicinity of the former blacksmith shop (compare Figure 4-16 to Figure 1-10).

During the June 1997 sampling event, zinc was detected in all nine shallow and one deep groundwater monitoring well. Concentrations in the unfiltered samples ranged from 22.5 to 10,200 µg/L and in the filtered samples ranged from ND to 39.4 µg/L in the shallow wells. Zinc was detected in deep well DW-04 at concentrations of 22.5 µg/L in the unfiltered sample and 15.5 µg/L in the filtered sample. The highest levels of zinc detected in unfiltered samples were in MW-15, MW-16, and MW-18 at concentrations of 5,640 µg/L, 5,070 µg/L and 10,200 µg/L, respectively. The filtered samples had concentrations of 39.4 µg/L, ND, and ND, respectively.

Chlorosity (chloride) values ranged from 14.8 to 1,940 mg/L in the 20 shallow groundwater wells, and from 34.3 to 15,700 mg/L in the deep groundwater during the Phase VI 1996 sampling round. These results were much lower than observed in previous rounds, comparing the mean (± standard deviation) values across shallow wells:

- 1,128 ± 515 mg/l (n=10) observed during Phase II (3/93);
- 947 ± 457 mg/l (n=11) observed during Phase III (7/93);
- 820 ± 877 mg/l (n=13) observed during Phase V (10/93); and
- 506 ± 452 mg/l (n=20) observed during Phase VI (10/96).

During the June 1997 sampling event, chlorosity (chloride) values ranged from 56 to 1,580 mg/L in the shallow groundwater wells. Deep well DW-04 contained chloride at a concentration of 13,800 mg/L.

The decrease during Phase VI may be the result of recent rains introducing fresh water into shallow groundwater. TDS values in shallow groundwater ranged from 259 to 3,540 mg/l, and from 327 to 27,800 mg/l in the deep groundwater during the Phase VI 1996 sampling round. These results also were much lower than observed in previous rounds, comparing the mean (± standard deviation) values across shallow wells:

- 2,120 ± 728 mg/l (n=10) observed during Phase II (3/93);
- 2,109 ± 778 mg/l (n=11) observed during Phase III (7/93);
- 1,949 ± 1,603 mg/l (n=13) observed during Phase V (10/93); and
- 1,226 ± 831 mg/l (n=20) observed during Phase VI (10/96).

During the June 1997 sampling event, TDS values ranged from 484 to 2,850 mg/L in the nine shallow wells, and 25,600 mg/L in the deep well.

Total hardness values ranged from 144 to 1,410 mg/L $CaCO_3$ in shallow groundwater and from 57.1 to 785 mg/l $CaCO_3$ in deep groundwater, during the Phase VI sampling round. During the June 1997 sampling event, total hardness ranged from 257 to 2,690 mg/L $CaCO_3$ in shallow groundwater and were 4,060 mg/L $CaCO_3$ in the deep well. Comparing the values presented in Tables 4-2 and 4-3 indicates less variation over the rounds of sampling.

These general groundwater quality results (chlorosity, TDS, and hardness) vary near the site and demonstrate no consistent pattern as might be expected (i.e., high levels of chloride and TDS near the creek and in areas highly affected by tidal intrusion). Although there is no site-specific pattern, the results do strongly suggest considerable saltwater intrusion. These groundwaters, therefore, meet the definition of Class GSA saline groundwaters (6 NYCRR Part 701.16) and, in certain instances, exceed the levels for chloride (1,000 mg/l) and TDS (2,000 mg/l) set for Class GSB saline groundwater (6 NYCRR Part 701.17).

Appendix B contains a list of the shallow and deep groundwater results from the November 1996 and June 1997 sampling events.

4.4 Aquatic Systems

As discussed earlier, Coney Island Creek is outside the study area of this RI. However, because it does border the entire site along the south, it is useful to present the currently available information.

4.4.1 Surface Water

During its Phase II investigation, E & E collected several co-located samples of sediment and surface water in the creek (see Section 2.2 and Figure 2-7). Surface water and sediment samples were analyzed for the following parameters:

Surface Water	Sediment
VOCs	VOCs
TCL/TAL	TCL/TAL
Total Hardness	Simultaneously Extracted Metals (SEMs)
Cyanide	Cyanide
Total Dissolved Solids	Acid Volatile Sulfides (AVS)
Salinity	Fraction of Organic Matter
	Cation Exchange Coefficient
	Grain Size
	Toxicity

The surface water analysis showed that 12 VOCs, 13 metals, one phthalate, and nine PAHs were detected (see Table 4-4). Only low levels of cyanide were detected. These results indicate low concentrations of petroleum hydrocarbons and several chlorinated solvents in the creek. The source of these VOCs is unclear considering that the creek receives considerable non-point source pollution upstream and downstream of the property as well as several sewer overflows. The metals data are unremarkable.

With regard to general water quality, the waters of Coney Island Creek range in salinity from 2,900 to 12,000 Cl^- mg/L, a TDS level of 5,100 to 17,000 mg/L, and a total hardness ranging from 940 to 3,000 mg/L $CaCO_3$. These quality results are indicative of an estuarine system.

4.4.2 Sediment

Twelve sediment samples were collected from Coney Island Creek from the 0- to 6-inch depth interval. Nine VOC compounds, three inorganic compounds, and six SEMs were detected in the sediment samples. The TCL/TAL analyses identified eight pesticides, 18 metals, 10 PAHs, and six semivolatile compounds. PAHs were detected in all 12 sediment samples collected from Coney Island Creek. Total PAH concentrations in sediments ranged from 6,920 µg/L to 428,000 µg/L. Carcinogenic PAH concentrations ranged from 3,640 µg/L to 235,000 µg/L, with an average concentration of 68,000 µg/L. Concentrations of noncarcinogenic PAHs ranged from 3,100 µg/L to 193,000 µg/L with an average concentration of 68,000 µg/L. AVS results in sediment samples ranged from 0.63 a moles/g to 2,900 a moles/g. Cyanide was not detected in any of the sediment samples. TOC results ranged from 1.9% to 26%, and FOM results from 3.3% to 44% in the sediment samples. Figure 4-17 summarizes the data for the various analyses.

4.4.3 Sediment Toxicity

Two types of toxicological studies were conducted using sediment collected from Coney Island Creek. The first was a biologically-based study; the second was a chemical-based study.

An aquatic toxicity test is a procedure in which the responses of aquatic organisms are used to detect or measure the presence or effect of one or more substances, wastes, or environmental factors, alone or in combination. Toxicity tests are necessary in water pollution evaluations because chemical and physical measurements alone do not provide information on the effects of pollutants on aquatic organisms. These tests, therefore, are used to determine the

toxicity of chemical constituents to aquatic biota and the effect of environmental factors on this toxicity.

The objective of the sediment toxicity testing was to assess the toxicity of creek sediment to *H. azteca* by determining effects on 10-day and 28-day survival and growth. In addition, the effect on *H. azteca* reproduction potential was determined for the 28-day test; this was assessed by counting females with developing eggs in the oviduct or brood pouch. The approach used is described in full in E & E (1993a).

Survival data provided the most useful information for identifying and comparing the toxicity of the 12 creek sediment samples. Survival data from the two tests were very similar. In both tests, sediment samples CR01M and CR04M were the least toxic; survival of *H. azteca* exposed to these samples was not significantly different than in the 6 parts per thousand (ppt) laboratory control. In contrast, creek sediment samples CR07M and CR09M were highly toxic to *H. azteca*; in both tests, survival was less than approximately 10% for animals exposed to these samples. In Tables 4-5 and 4-6, the 12 creek sediment samples are ranked based on their effect on *H. azteca* survival.

The information provided by the growth and reproduction data was limited as a result of the high mortality caused by most sediment samples (see Tables 4-5 and 4-6). EPA guidelines (Peltier and Weber 1985) recommend that growth and reproduction data not be statistically analyzed from treatments that differ significantly from the control for survival. However, for those sediment samples (CR01M and CR04M) that did not differ in survival from the 6 ppt laboratory control, adverse effects on growth and reproduction were observed.

In summary, all of the creek sediment samples differed significantly ($p < 0.05$) from the 6 ppt lab control for 10-day survival or growth (see Table 4-5), or 28-day survival, growth, or reproduction (see Table 4-6).

Historical activities may have led to the discharge of potentially toxic heavy metals to surface waters. In particular, the metals cadmium (Cd), copper (Cu), lead (Pb), zinc (Zn), mercury (Hg), and nickel (Ni) are present in elevated concentrations possibly as a result of such activities. Because these metals readily adsorb to settling particles (Sigg 1985), high concentrations of these metals are frequently found in sediment from lakes and streams in industrialized areas. The toxicity of metals in sediments is influenced by the extent that metals bind to the sediment. Metals that are strongly bound have very low pore water concentrations and exhibit little or no toxicity. Conversely, metals that are weakly bound have comparatively higher pore water concentrations and are potentially toxic. The AVS phase in sediments has been shown to be important in ameliorating heavy-metal toxicity because it forms very insoluble sulfide precipitates with several potentially toxic heavy metals (DiToro et al. 1990; 1992). AVS is

operationally defined as the solid-phase sediment sulfides that are soluble in cold acid (0.5 M HCl). The metals that are simultaneously solubilized during the acidification step are termed SEM.

In uncontaminated sediment, AVS is composed primarily of iron and manganese monosulfides [FeS(s) and MnS(s)]. Because cadmium, copper, lead, zinc, mercury, and nickel bind more strongly with sulfide than iron and manganese, these heavy metals displace iron and manganese from AVS to form heavy-metal sulfides as shown below for cadmium.

$$Cd^{2+} + FeS(s) \rightleftharpoons CdS(s) + Fe^{2+}$$

AVS is highly reactive and able to precipitate heavy metals added to sediment quickly, on the time scale of minutes to hours. The heavy-metal sulfides are not readily bioavailable and their very low water solubility limits pore water metal concentrations to levels below those that are toxic to aquatic biota, i.e., benthic organisms.

The relative amounts of SEM and AVS are useful in predicting potential metal bio-availability in sediments. If the molar ratio of SEM to AVS is less than one, heavy metals are not bioavailable. Conversely, if the molar ratio of SEM to AVS exceeds one, toxic heavy metals in the sediment are potentially bioavailable. The relationship between SEM and AVS is useful because AVS is found in most freshwater and marine sediments, even in sediments with sandy or gravelly textures that do not resemble the anoxic sulfidic sediments that are more commonly associated with the presence of sulfide.

The SEM/AVS ratios (see Figure 4-18) and the results of the sediment toxicity tests described above together suggest that metals in creek sediment were not the cause of *H. azteca* mortality. For example, the two sediment samples (CR07 and CR09) that produced the greatest *H. azteca* mortality had an SEM/AVS ratio of much less than one. Conversely, mortality of *H. azteca* exposed to creek sediment sample CR01 was not significantly different than in the control, even though the SEM/AVS ratio of this sample was approximately five. These results suggest that other chemical constituents, not heavy metals, were the cause of *H. azteca* mortality.

PAH levels in creek sediment were an order-of-magnitude higher than the levels of any other organic constituent. Figure 4-17 shows that *H. azteca* survival in the toxicity tests was roughly inversely correlated with sediment PAH levels; survival was lowest at stations (CR07 - CR11) where sediment PAH levels were high, and was highest at stations CR01 to CR03 where PAH levels were low. These data suggest that PAHs may be a cause of toxicity to *H. azteca* in the sediment toxicity tests.

Many of the principal organic and inorganic chemicals identified in soil and groundwater at the site were also found in sediment and water from Coney Island Creek, suggesting site-related chemical constituents may be migrating off site. Chemical concentrations in Coney Island Creek were generally lowest at the three downstream sampling sites (CR01-CR03), while much higher levels were observed upstream at sampling sites CR04-CR12 (see Figure 4-17). The average PAHs concentration in sediment for the upstream sites is roughly 10 times higher than for the downstream sites. Lead concentrations were, on the average, about three times higher in sediment from the upstream sites. Lower chemical constituent concentrations downstream most likely are related to tidal cleansing.

Chemical constituent distribution in creek sediment is higher near the northern shore (bordering the site) compared with the southern shore. This can be observed for PAHs and lead (see Figure 4-17) for sampling site CRO2 compared with CRO1, for sampling site CRO4 compared with CRO3, and to a lesser extent, for sampling site CRO6 compared with CRO5. Higher concentrations in sediment from the northern shore suggests the site as a source of chemical constituents to Coney Island Creek. However, there are also several outfalls from such sources at sewers, a commercial laundry facility, and a bus depot, suggesting additional upstream, off site sources. Also, numerous non-point sources enter the creek from the south.

4.5 Soil Gas

As part of the comprehensive geotechnical investigation (Phase II), E & E conducted a soil gas survey of the western area of the property. The approach used was summarized previously in Section 2.2 and full details can be found in E & E (1993b). The results of the survey are presented below.

Aromatics, naphthalenes, heavy cycloalkanes/alkenes, and tetrachloroethene (PCE) were found to be the most prominent compounds in the soil gas. The results for each of the compound categories are discussed below.

Figure 4-19 presents the survey response for the presence of aromatics in the soil gas. The aromatics consist of toluene, benzene, ethylbenzene/xylenes, and C3 and C4 alkylbenzenes. A high response was detected near the southwestern area of the survey zone, and a more moderate response area surrounded it. Another high response area was detected near the center of the site directly east of the large western foundation. Two small areas of high response were detected in the northern area of the site, and two were detected in the eastern area of the site. Moderate response areas surround each of the high response areas. This data pattern corresponds to the data results from subsurface soils analyzed for BTEX.

Figure 4-20 presents the survey response for the presence of naphthalenes in the soil gas. The naphthalenes consist of naphthalene, ethyl naphthalene, and methyl naphthalene. A large high response area was detected in the northwestern area of the site, extending into the center of the site. Two smaller high response areas were detected in the south-central area of the site. Areas of more moderate response surround all the high response zones. The source area for naphthalenes may be located northwest of the site or on the northwest portion of the site. A specific migration pathway is not evident from the soil gas data, although the data pattern corresponds to the data results from soils analyzed for naphthalene.

Figure 4-21 presents the survey response for the presence of heavy cycloalkanes/alkenes in the soil gas. The heavy cycloalkanes/alkenes consist of cyclohexane/hexene, cyclooctane/octane, cyclopentane/pentene, and cyclononane/nonene. A large high response area was detected in the northwestern portion of the site and extends into the center of the site. Two small high response areas were detected in the south-central area of the site, and one high response area was detected in the southeast area. All four high response zones are surrounded by areas of moderate response. The relative response map for heavy cycloalkanes/alkenes is similar to the relative response map for naphthalenes. The source area for heavy cycloalkanes/alkenes may be located northwest of the site or on the northwest portion of the site.

Figure 4-22 presents the survey response for the presence of PCE in the soil gas. Two large areas of moderate response were detected in the northwestern and southern areas of the site. A much smaller area of moderate response was detected in the southeastern area of the site. A specific migration pathway is not evident from the soil gas data. The response patterns for PCE are very similar to the response patterns for heavy cycloalkanes/alkenes. Yet, the response levels for PCE are considerably lower. The PCE values from the soil data acquired during the geotechnical assessment work activities were low. The differences between the soil gas survey and soil data patterns for PCE may indicate that PCE may be present at a depth greater than the surface or borehole soil sampling depths. It should also be noted that the source of PCE most likely may be attributed to degreasers that may have been used on site.

4.6 Physical Data and Other Observations

Surficial soil and sediment samples were analyzed in the laboratory for grain size, cation exchange coefficient (CEC), and total organic carbon (TOC) during Phase II and Phase V investigations. Grain size analysis is used to classify soils and sediments and to interpret their physical properties. CEC is defined as the number of cations that a soil or sediment material can adsorb under defined conditions, usually at a specific pH, and is a measurement of the ability of

the soil or sediment to retain positively-charged cations (such as metals). Thus, materials with high CEC values will tend to retain cations from aqueous solutions, rendering them less bioavailable and retarding or preventing their movement through the soil column.

Grain size distribution analyses showed that the surface soil types and sediments materials analyzed have, in general, similar textures across the site. Results of the grain size analysis showed few lateral differences. In general, the surface soil samples have gravelly loamy sand and gravelly sand textures. By contrast, the sediment samples have finer textures that include sand, loamy sand, and silt loam textures. The presence of a high percentage of large to medium-sized particles (gravels and sands) usually indicates medium to high permeability.

Seven surface soil and eight sediment samples were analyzed for both CECs and TOC/FOM. CEC analysis of the soil and sediment samples showed a wide range of values. The average CEC value obtained for the soil samples was 7.4 meq/100 grams with values ranging from 4.9 to 9.9 meq/100 grams. By contrast, the CEC values observed for the sediment samples ranged from 4.6 to 25 meq/100 grams with an average of 15.2 meq/100 grams. The CEC values observed in these samples compare with typical values found in sandy loam soils which have CEC values ranging from 2.3 to 171.1 meq/100 grams (Brady 1978). The higher CEC values observed in the sediment sample is probably due to a higher content of fine particles (mostly silt and clay) that are usually found in sediments. A relationship does exist between TOC and organic matter (FOM). The Van Bummelon factor of 1.724 has been developed on the assumption that organic matter contains roughly 58% organic carbon (Page et al. 1982). Therefore, by measuring TOC, the organic matter concentration of a soil can be calculated. In surface soil the FOM ranged from 3% to 16%, with the average being 7.4% and compares well to mineral surface soils throughout the United States (Brady 1974, p. 155). These values indicate that the soils are generally well vegetated. Similarly, the FOM in the sediment samples ranged from 3.3% to 44%, averaging 16%.

Generally, the subsurface soil textures were gravelly sand at the surface underlain by sands. No significant vertical differences were observed. The CEC values observed in the subsurface samples varied with depth. As in the case of surface soils and sediments, the values compare with typical values observed in sandy loam soils. However, these values were lower than the ones observed for the surface soil and sediment samples.

Grain size analysis of subsurface soil samples indicate that the soil at the southern portion of the site primarily consist of sand (74.5% to 95.7%) with traces of silt (2.7% to 15.1%) and clay (1.1% to 10.4%). A very small amount of gravel (.1%) was found in one sample, but its significance is negligible. However, one sample did contain visible organics which does affect

the permeability and strength of the soil. Soils were classified as poorly graded sand (SP), silty sand (SM), and poorly graded sand with silt (SM-SP).

Atterburg limits tests are conducted to characterize fine-grained fractions of soil. Atterburg limit tests performed on the soil samples support the findings of the grain size distribution test. The Atterburg limits test was performed on five samples, four of which were found to have no liquid or plastic limits. The one sample which had a liquid limit of 75, a plastic limit of 52, and a plasticity index of 24 was collected 10 to 12-feet BGS at BH-41. These results are characteristic of a soil with very small clay content, as supported by the findings of the grain size distribution.

Permeability tests with pore pressure response was performed on three soil samples. Permeability was measured twice for each sample. Two of the three samples were characterized as sand with traces of silt and clay that had permeability coefficients (K values) of 2.11×10^{-4} and 3.84×10^{-4}, which is typical for dirty sand. The third sample identified as sand with traces of silt, clay, and organics had significantly lower K values of 1.15 to 1.54×10^{-8}, which identifies this soil as being impervious, attributable to the peat observed in the sample.

Unconsolidated-undrained triaxial sheer tests were performed on three samples. The two samples identified as being sand with traces of silt and clay had failure stresses of 40.3 and 52.6 psi. The third, which contained sand with traces of silt, clay, and organics, failed at 6.63 psi. The sand, silt, and clay samples had a much lower void ratio than the sample which contained peat (.5% as compared to 5.6), in conjunction with the natural instability of peat, lead to the lower failure stress.

Table 4-1

CHEMICAL CONSTITUENTS POSSIBLY RELATED TO THE BROOKLYN BOROUGH GAS WORKS SITE

Inorganics	Chrysene
Cyanide Compounds	Benzo(g,h,i)perylene
Metals	Dibenzo(a,h)anthracene
Aluminum	Fluoranthene
Antimony	Fluorene
Arsenic	Naphthalene
Barium	Phenanthrene
Beryllium	Pyrene
Cadmium	2-Methylnaphthalene
Chromium	**Volatile Aromatics**
Copper	Benzene
Iron	Ethyl Benzene
Lead	Toluene
Magnesium	Total Xylenes
Manganese	**Other Organics**
Mercury	Polychlorinated Biphenyls (PCBs)
Nickel	Acenaphthylene
Selenium	Anthracene
Vanadium	Benzo(a)anthracene
Zinc	Benzo(a)pyrene
Polycyclic Aromatic Hydrocarbons	Benzo(b)fluoranthene
Acenaphthalene	Benzo(k)fluoranthene

TABLE 4-4
SURFACE WATER SAMPLE RESULTS
BROOKLYN BOROUGH GAS WORKS SITE
BROOKLYN, NEW YORK

Analyte	Parameter	Sample Units	CR01 3/18/93	CR02 3/18/93	CR03 3/18/93	CR04 3/18/93	CR05 3/18/93	CR06 3/18/93	CR07 3/17/93	CR08 3/17/93	CR09 3/17/93	CR10 3/19/93	CR11 3/19/93	CR12 3/19/93
VOC	1,2-Dichloroethane	ug/l	7.3	7.6	8.5	8.7	9	ND U	8.3	ND U	8.9 B	13 B	11 B	12 B
	Acetone	ug/l	25	41	47	47	47	42	47 B	51 B	41 B	48 B	45 B	52 B
	Benzene	ug/l	8.1	9.5	16	34	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U
	Carbon disulfide	ug/l	1 J	4.8 J	ND U	1.6 J	6.8 B	ND U	ND U	3.1 B	ND U	4.1 J	ND U	3.3 B
	Chloroform	ug/l	ND U	ND U	ND U	ND U	ND U	ND U	1.2 J	1.1 J	ND U	ND U	ND U	ND U
	Chloromethane	ug/l	ND U	2.3 J	ND U	ND U	3 J	ND U	ND U	ND U	2.7 J	ND U	ND U	ND U
	[redacted]	ug/l	3.7 J	8.4	12	12	4.2 J	3 J	1.7 J	2.9 J	3.1 J	2.4 J	5.1	5.3
	Methylene chloride	ug/l	5.4 B	5.6 B	5.6 B	5.4 B	6.1 B	6.2 B	2.6 B	2.9 B	5.7 B	5.7 B	5.5 B	5.8 B
	Styrene	ug/l	ND U	ND U	ND U	8.6	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U
	Tetrachloroethylene	ug/l	18	16	14	12	11	11	3.8 J	1.6 J	3.9 J	3.8 J	4.5 J	4.4 J
	[redacted]	ug/l	5.6	6.2	11	4.9 J	3.4 J	2.7 J	1.9 J	1.6 J	ND U	2.6 J	3 J	2.5 J
	[redacted]	ug/l	8.1	8.8	11	26	4.2 J	4.9 J	1.1 J	1.3 J	3.2 J	3.6 J	3.2 J	3.5 J
SVOC	bis(2-Ethylhexyl)phthalate	ug/l	2.2 J	ND U	2.2 J	ND U	ND U	ND U	2.1 J	4.6 J	ND U	ND U	3 B	5.5 B
INORGANIC	Aluminum	ug/l	220	240	240	250	210	220	130	100	580	430	510	900
	Barium	ug/l	21	23	25	28	30	35	43	51	30	49	58	80
	Calcium	ug/l	89000	84000	78000	76000	73000	70000	110000	120000	150000	130000	120000	120000
	Chromium	ug/l	ND U	10	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	11
	Copper	ug/l	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	44	29	29	61
	Iron	ug/l	710	960	980	1100	1100	1300	1300	1700	1900	2000	2200	4100
	[redacted]	ug/l	14	16	17	18	15	16	13	11	37	34	34	84
	Magnesium	ug/l	240000	230000	190000	180000	170000	150000	240000	220000	460000	330000	290000	260000
	Manganese	ug/l	98	100	160	200	230	270	380	440	160	320	260	270
	Mercury	ug/l	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	ND U	0.26
	Potassium	ug/l	89000	88000	69000	65000	61000	55000	91000	83000	210000	130000	110000	100000
	Sodium	ug/l	2300000	2000000	1800000	1700000	1600000	1500000	260000	230000	5100000	3600000	3000000	2800000
	Zinc	ug/l	60	69	67	79	65	66	75 B	76 B	180	120	120	230
	Cyanide Total	mg/l	0.01	0.02	0.03	0.03	0.03	0.05	0.05	0.04	0.01	0.03	0.04	0.02
OTHER	Chloride	mg/l	4300	4000	3500	3200	3000	2900	5500	3900	12000	6900	6300	5000
	Residue-TDS	mg/l	7500	7000	6000	5500	5300	5100	8400	6600	17000	11000	9900	8800
	Total Hardness	mg/l	1300	1200	1000	1000	980	940	1300	1200	3000	2100	1900	1700

Key:

B = Reported result is considered as not detected because of presence in field or laboratory blanks. Reported result may be considered as an elevated quantitation limit.
J = Reported result is qualitatively accurate, but quantitatively imprecise, and is considered an estimated value. The data should be seriously considered for decision-making and are usable for many purposes.
ND U = Analyte was not detected; the reported value is the quantitation limit adjusted for sample weight/sample volume, extraction volume, percent solids, and sample dilution.

Table 4-5

SUMMARY OF RESULTS OF 10-DAY *HYALELLA AZTECA* SEDIMENT TOXICITY TEST

QC Test Number: SA-03-29-93-356
Test Organism: *Hyalella azteca*
Test Duration: 10-days

Sample Identification[a]	Survival (percent)	Mean Dry Weight Expressed as mg/organism (+S.D.)
Dechlorinated water lab control	84	0.37 (±0.05)
Lab control (6 ppt salinity)	93	0.34 (±0.04)
CR01M	83	0.25 (±0.01)[b]
CR04M	73	0.20 (±0.02)[b]
CR03M	60	0.22 (±0.04)[b]
CR02M	55[b]	0.24 (±0.06)[c]
CR05M	38[b]	0.19 (±0.04)[c]
CR12M	34[b]	0.23 (±0.03)[c]
CR08M	15[b]	0.22 (±0.03)[c]
CR11M	14[b]	0.18 (±0.02)[c]
CR10M	13[b]	0.23 (±0.03)[c]
CR09M	11[b]	0.20 (±0.05)[c]
CR07M	9[b]	0.24 (±0.07)[c]
CR06M	5[b]	0.23 (±0.06)[c]

[a] Sediment samples are listed in descending order based on survival values.

[b] Significantly different ($P = 0.05$) from 6 ppt laboratory control indicating an adverse effect.

[c] Treatments which are significant for survival are not statistically analyzed for growth, per EPA guidance.

Source: EA Engineering, Science, and Technology, Inc. 1993.

Table 4-6

SUMMARY OF RESULTS OF 28-DAY *HYALELLA AZTECA* SEDIMENT TOXICITY TEST

QC Test Number: SD-03-25-93-328
Test Organism: *Hyalella azteca*
Test Duration: 28 Days

Sample Identification[a]	Survival (percent)	Mean Dry Weight Expressed as mg/organism (±S.D.)	Reproduction Potential - Females with Eggs[b] (percent)
Dechlorinated water lab control	94	0.61 (±0.05)	100
Lab control (6 ppt salinity)	94	0.44 (±0.01)	89
CR01M	81	0.20 (±0.14)[c]	44[c]
CR06M	65[c]	0.26 (±0.09)[d]	62[d]
CR02M	58[c]	0.19 (±0.02)[d]	52[d]
CR12M	58[c]	0.21 (±0.04)[d]	72[d]
CR03M	43[c]	0.20 (±0.04)[d]	19[d]
CR05M	38[c]	0.20 (±0.03)[d]	28[d]
CR10M	25[c]	0.18 (±0.08)[d]	56[d]
CR08M	16[c]	0.17 (±0.06)[d]	100[d]
CR11M	6[c]	0.22 (±0)[d]	50[d]
CR07M	4[c]	0.14 (±0)[d]	0[d]
CR09M	0[c]	[e]	[e]

[a] Sediment samples are listed in descending order based on survival values.

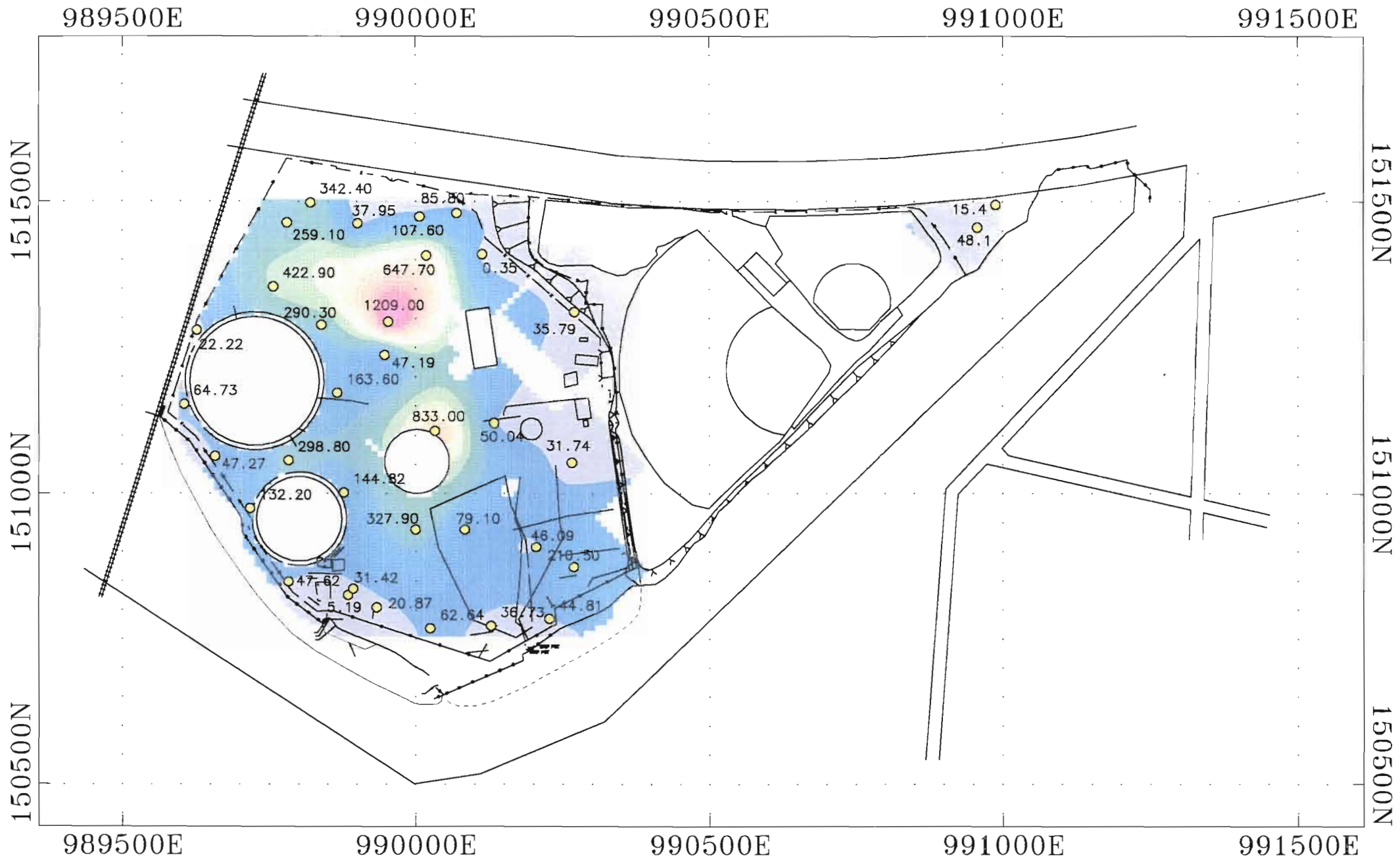
[b] Reproduction potential percentages include females with eggs forming in oviducts as well as females with eggs in brood pouch.

[c] Significantly different (P=0.05) from 6 ppt laboratory control indicating an adverse effect.

[d] Treatments which were significant for survival were not statistically analyzed for growth or reproduction potential, per EPA guidelines.

[e] Treatments which had no surviving organisms were not statistically analyzed for survival, growth, or reproductive potential, per EPA guidelines.

Source: EA Engineering, Science, and Technology, Inc. 1993.



LEGEND

1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0

Non Carcinogenic PAHs (mg/kg)

Sample Key

- Indicates a detected concentration — 3.20
- ND(0.015) — Not Detected in sample; Detection Limit

NOTES:

1) Based upon data collected during the Phase II (1993) through Phase VI (1996-97) Investigations.

Scale

250 0 250 500

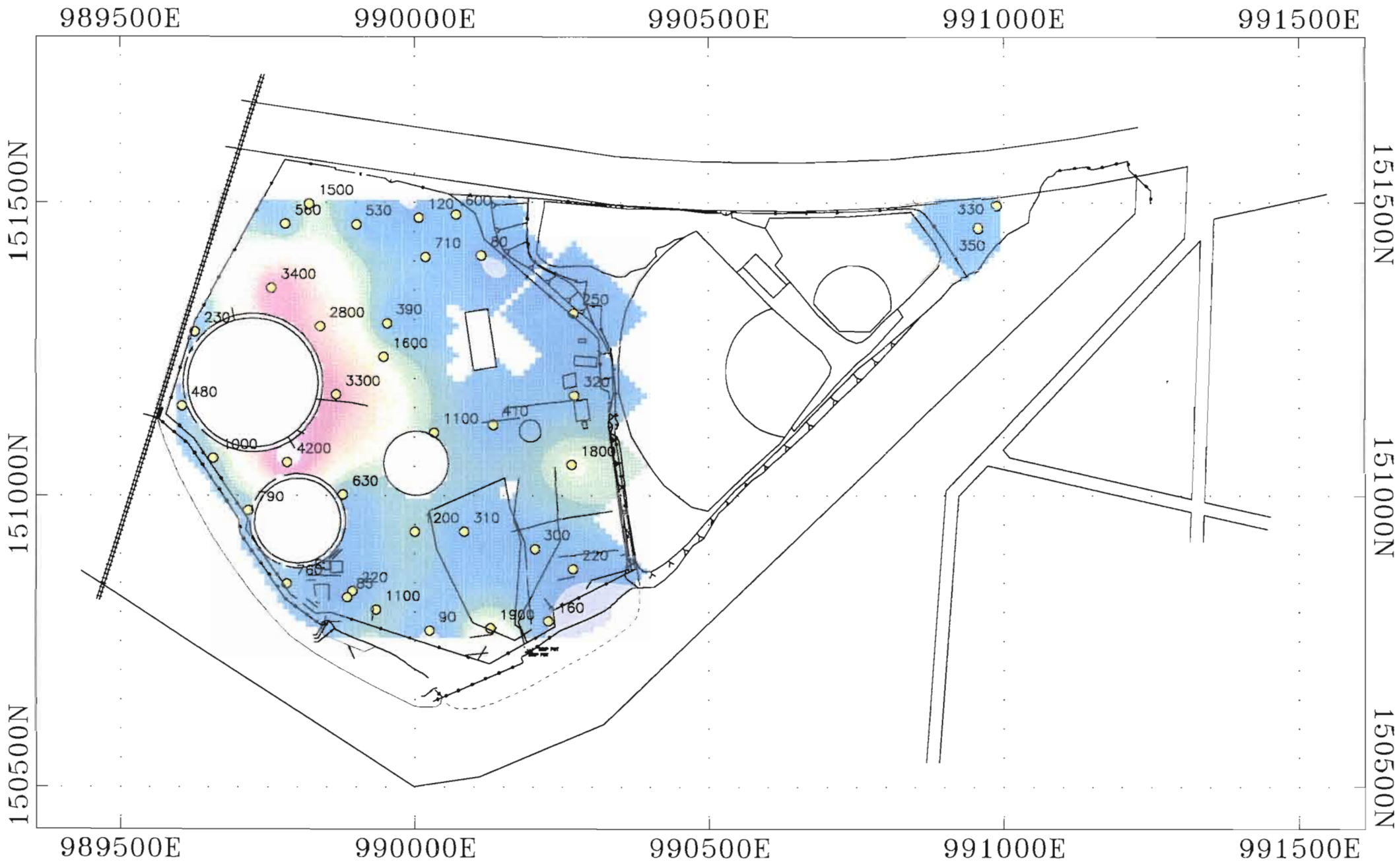
(Feet)

datafile: npahss.xyz
gridfile: npahss10.grd
basemap: basemap.plt & npahss.plt
plotfile: npahss.p01 /dj650/11x17
project: bv4093 Document Number: D5098

Figure 4-1

Noncarcinogenic PAHs in Surficial Soils (0-6 inches) Brooklyn Borough Gas Works Brooklyn, New York

ecology and environment, inc.



LEGEND

Sample Key

Indicates a detected concentration

3.20

ND(0.015)

Not Detected in sample

Detection Limit

3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0

Lead (mg/kg)

NOTES:

1) Based upon data collected during the Phase II (1993) through Phase VI (1996-97) investigations.

Scale

250 0 250 500

(Feet)

datafile: pb_ss.xyz
gridfile: pb_ssm2.grd
basemap: basemap.plt & newtem2.plt
plotfile: pb_ss.p01 /dj650/11x17
project: bv4093 Document Number: D5098

Figure 4-3

Lead in Surficial Soils (0-6 inches)
Brooklyn Borough Gas Works
Brooklyn, New York

ecology and environment, inc.

LEGEND

2317
2195
2073
1951
1829
1707
1585
1463
1341
1220
1098
976
854
732
610
488
366
244
122
0

BTEX
(mg/kg)

Sample Key

Indicates a detected concentration

3.20

ND(0.015)

Not Detected in sample

Detection Limit

NOTES:

1) Based upon data collected during the Phase II (1993) through Phase VI (1996-97) investigations.

Scale

250 0 250 500

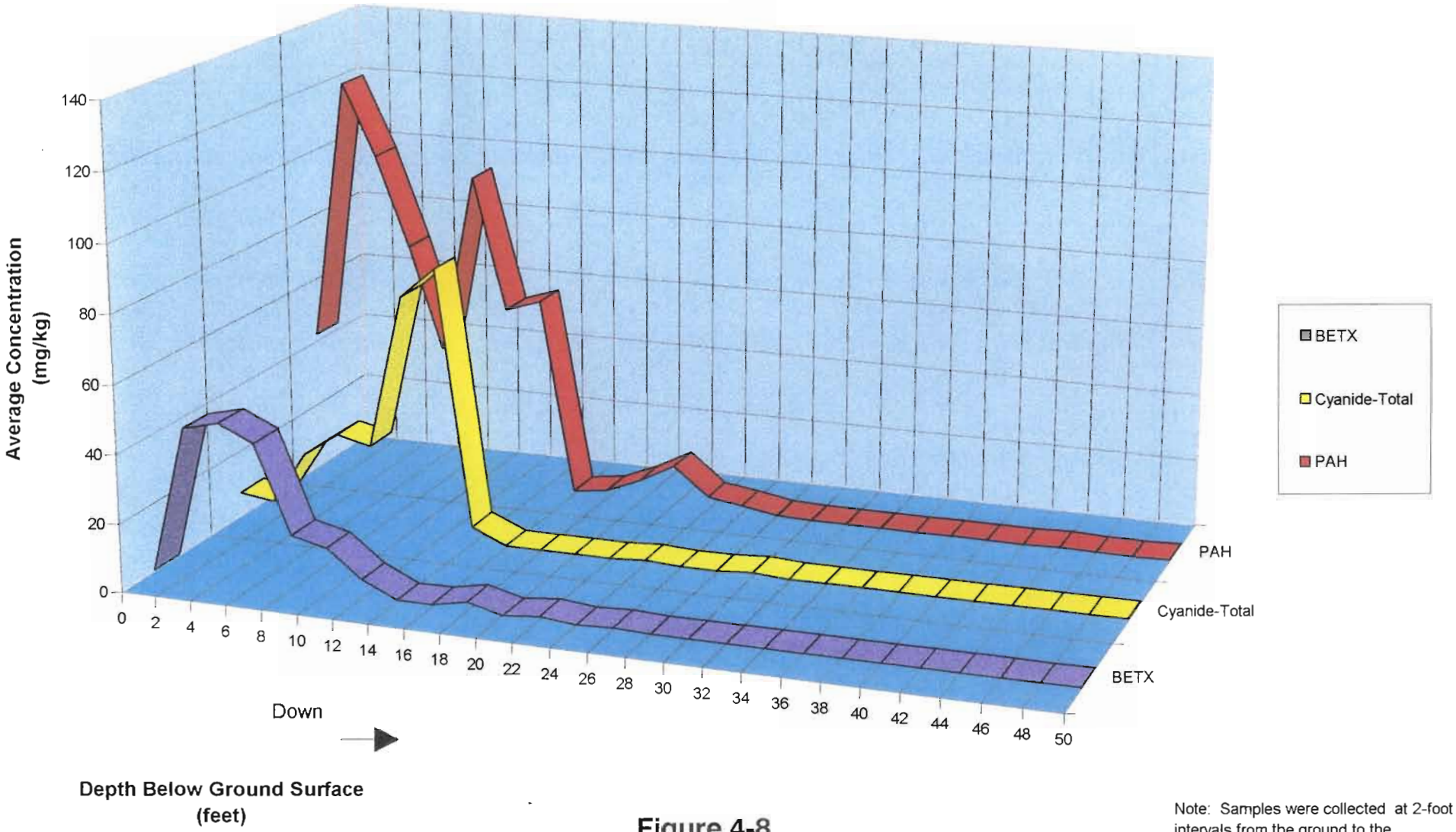
(Feet)

datafile: bx_srf-f.xyz
gridfile: bx-srf-2.grd
basemap: basemap.plt & newtemp2.plt
platfile: bx_srf-f.p01 /dj650/11x17
project: bv4093 Document Number: D5098

Figure 4-4

BTEX in Surficial Soils (0-6 inches) Brooklyn Borough Gas Works Brooklyn, New York

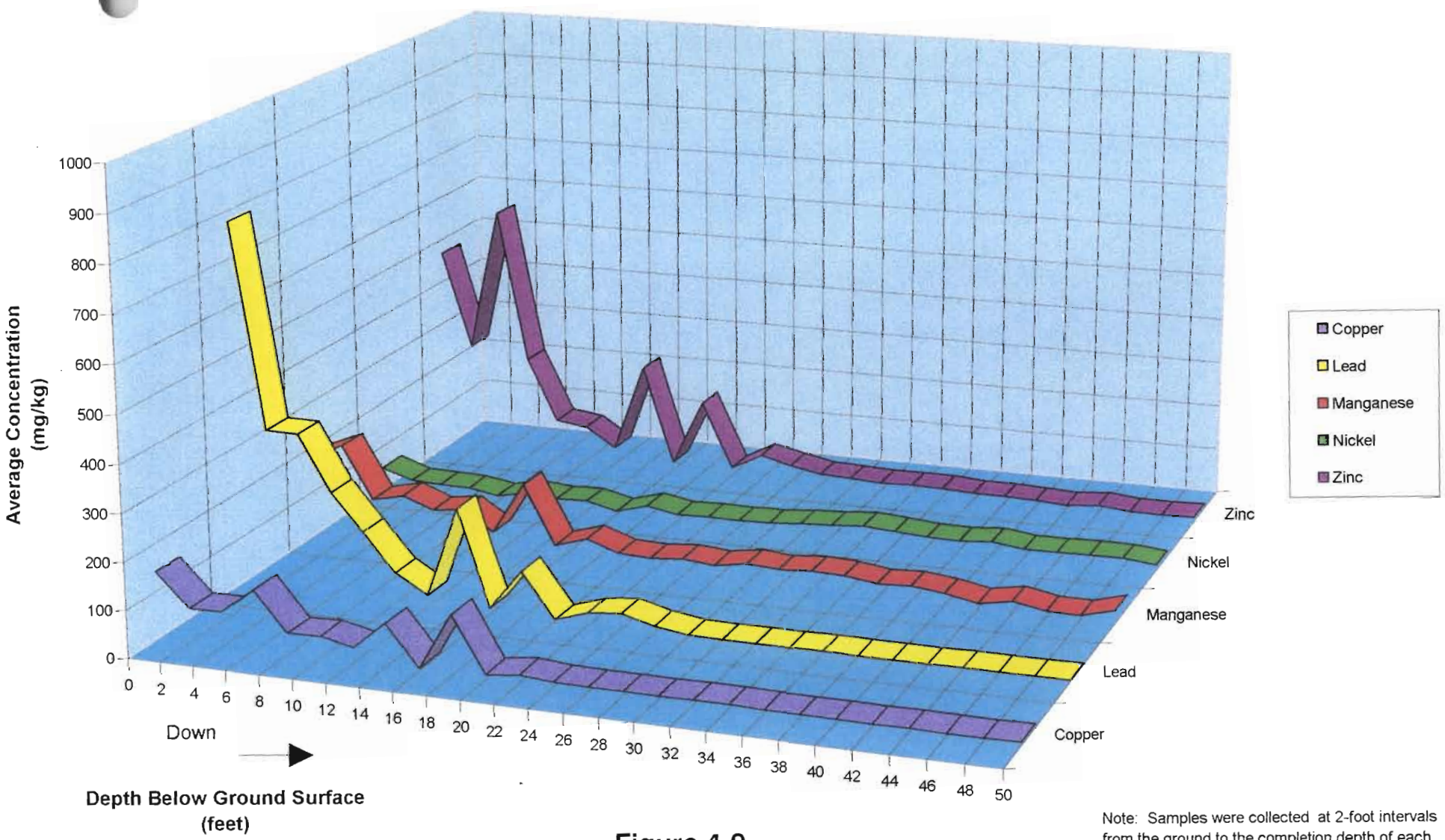
ecology and environment, inc.



Note: Samples were collected at 2-foot intervals from the ground to the completion depth of each boring.

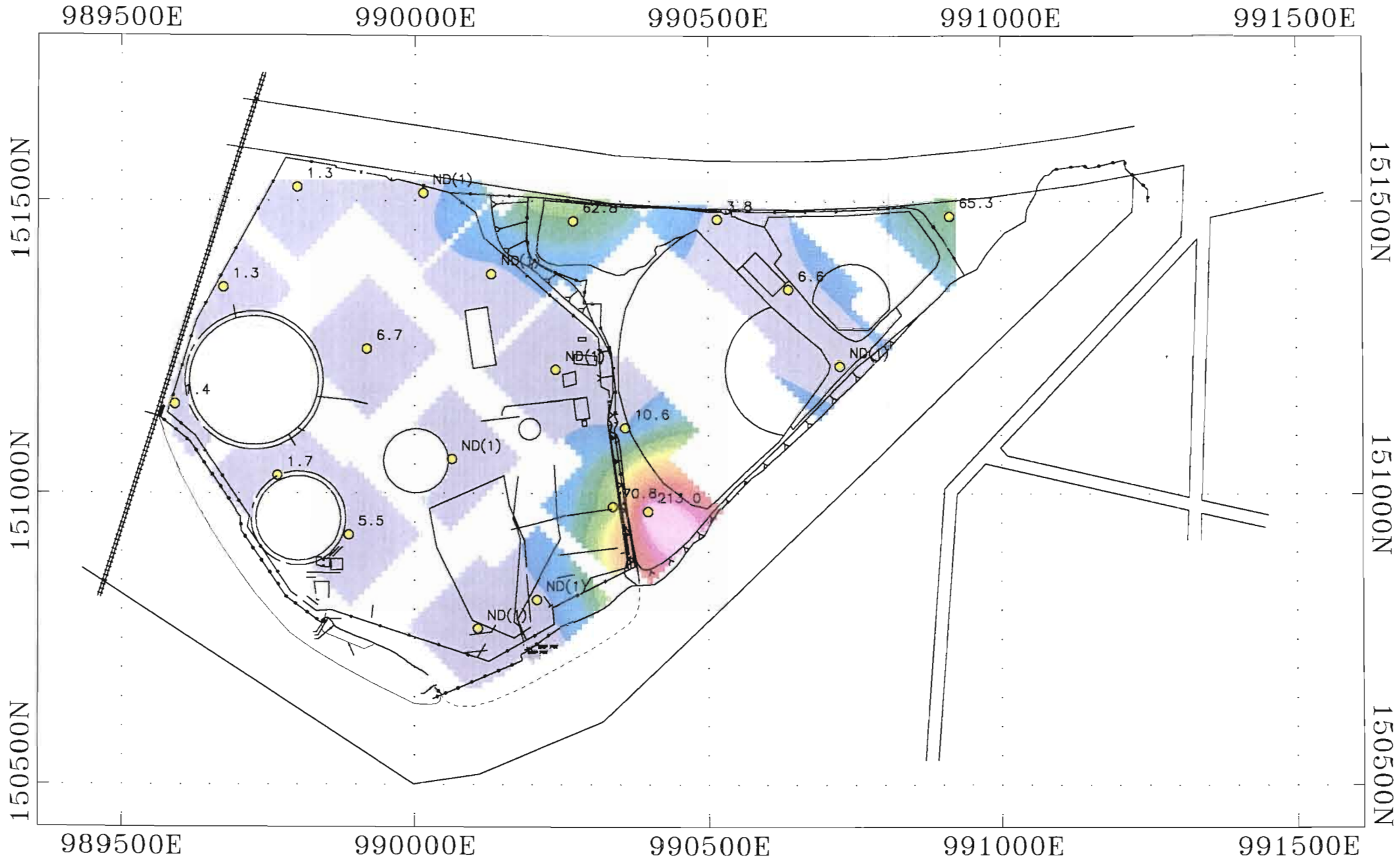
Figure 4-8

Average Concentration of Organics in Subsurface Soils with Depth



Note: Samples were collected at 2-foot intervals from the ground to the completion depth of each boring.

Figure 4-9
Average Concentration of Inorganics in Subsurface Soils with Depth



LEGEND

196
185
175
165
155
144
134
124
113
103
93
82
72
62
52
41
31
21
10
0

TRPH
(ug/L)

Sample Key

Indicates a detected concentration

3.20

ND(0.015)

Not Detected in sample

Detection Limit

NOTES:

1) Based upon data collected during the Phase VI (1996) Investigation.

Scale

250 0 250 500

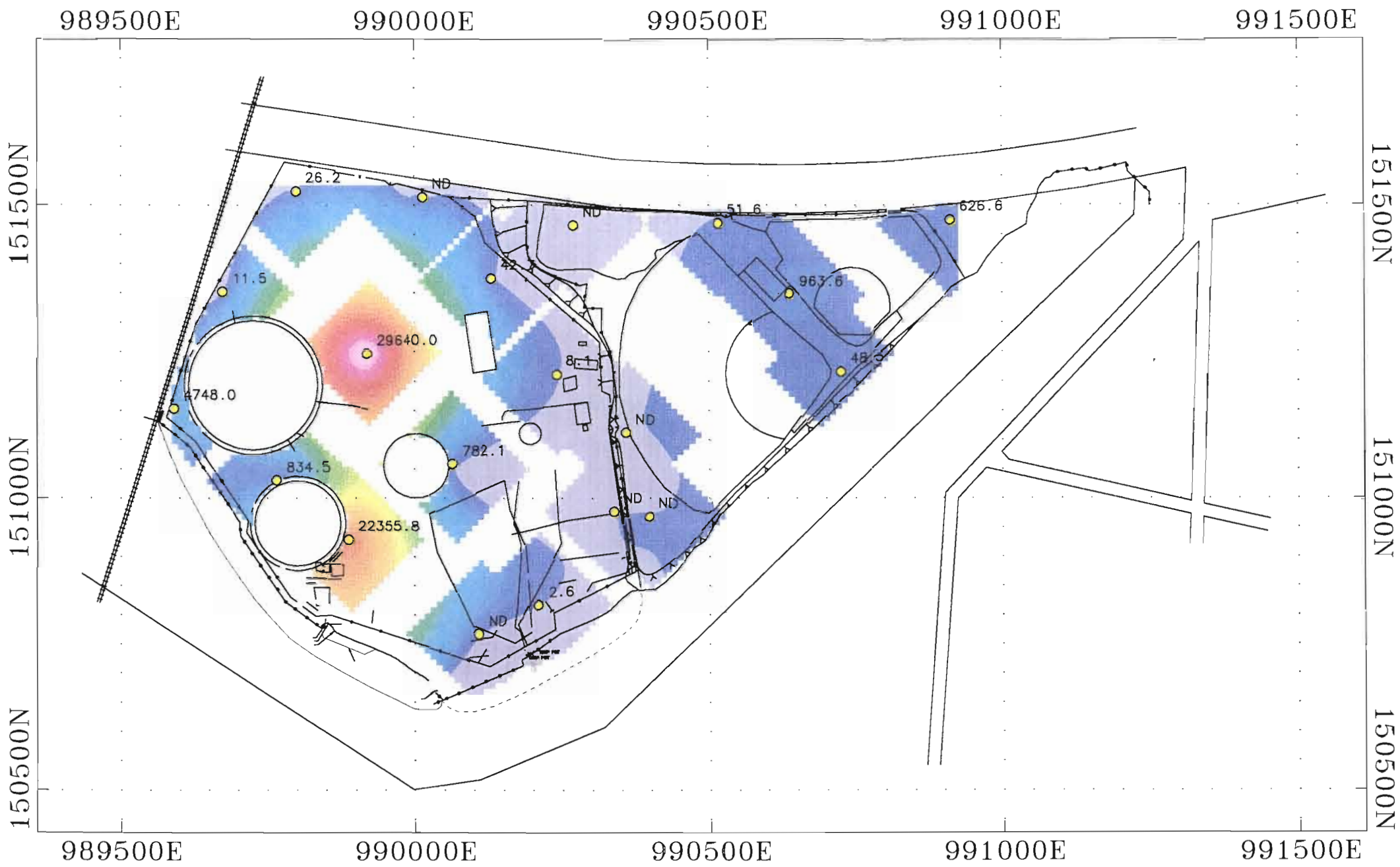
(Feet)

datafile: trph-gwf.xyz
gridfile: trph-gef.grd
basemap: basemap.plt & newtemp2.plt
plotfile: trph-gwf.p01 /dj650/11x17
project: bv4093 Document Number 05098

Figure 4-10

TRPH in Shallow Groundwater
Brooklyn Borough Gas Works
Brooklyn, New York

ecology and environment, inc.



LEGEND

BTEX (ug/L)
26950
25531
24113
22695
21276
19858
18439
17021
15603
14184
12766
11347
9929
8510
7092
5674
4255
2837
1418
0

Sample Key

- 3.20 — Indicates a detected concentration
- ND(0.015) — Not Detected in sample; Detection Limit

NOTES:

1) Based upon data collected during the Phase VI (1996) Investigation.

Scale

250 0 250 500

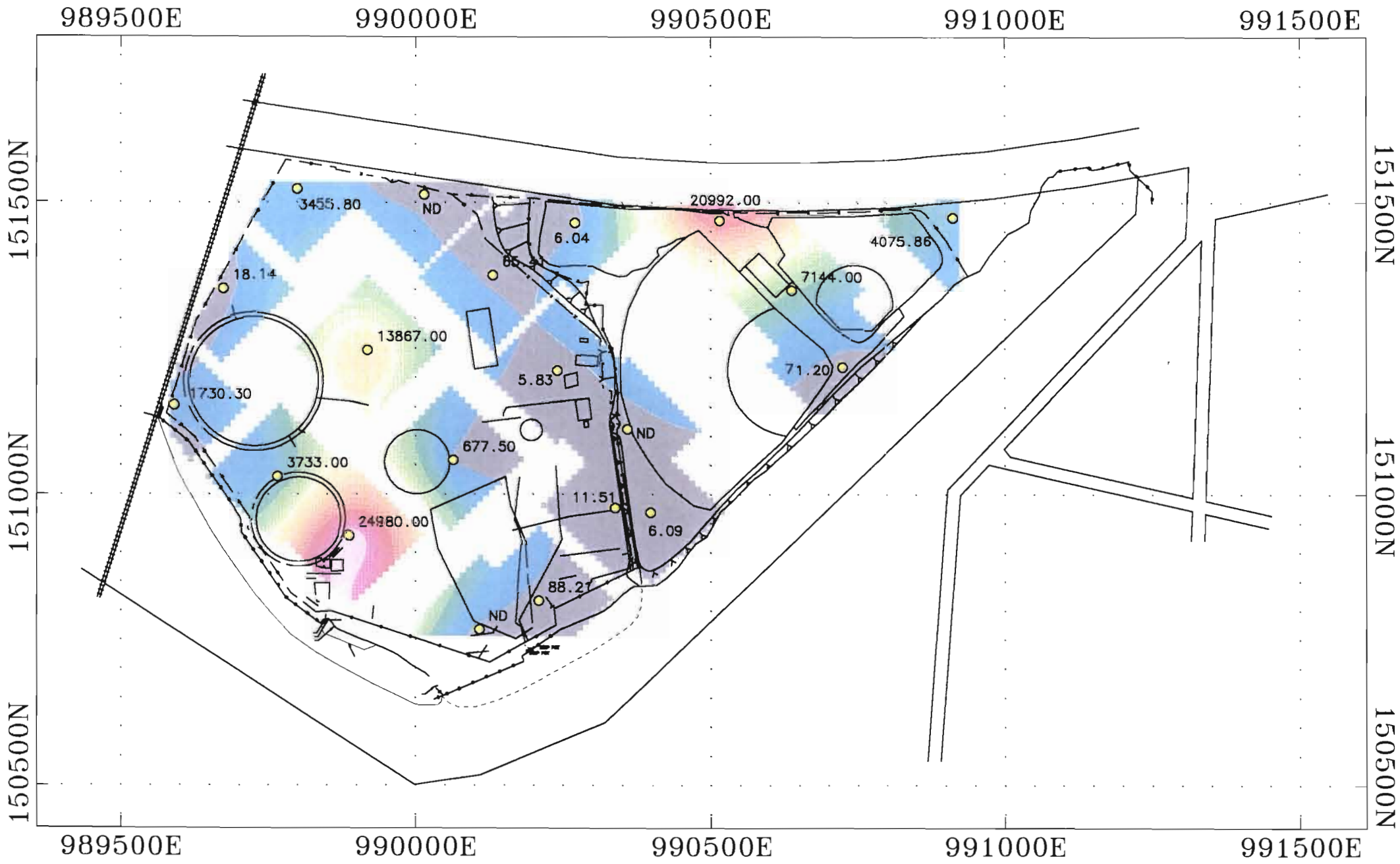
(Feet)

datafile: bx_gw-f.xyz
gridfile: bx_gw-f.grd
basemap: basemap.plt & newtem2.plt
plotfile: bx_gw-f.p01 /dj650/11x17
project: bv4093 Document Number: 05098

Figure 4-11

BTEX in Shallow Groundwater
Brooklyn Borough Gas Works
Brooklyn, New York

ecology and environment, inc.



LEGEND

23000
22000
21000
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0

Total PAHs (ug/L)

Sample Key

- 3.20 — Indicates a detected concentration
- ND(0.015) — Not Detected in sample; Detection Limit

NOTES:

1) Based upon data collected during the Phase VI (1996) Investigation.

Scale

250 0 250 500

(Feet)

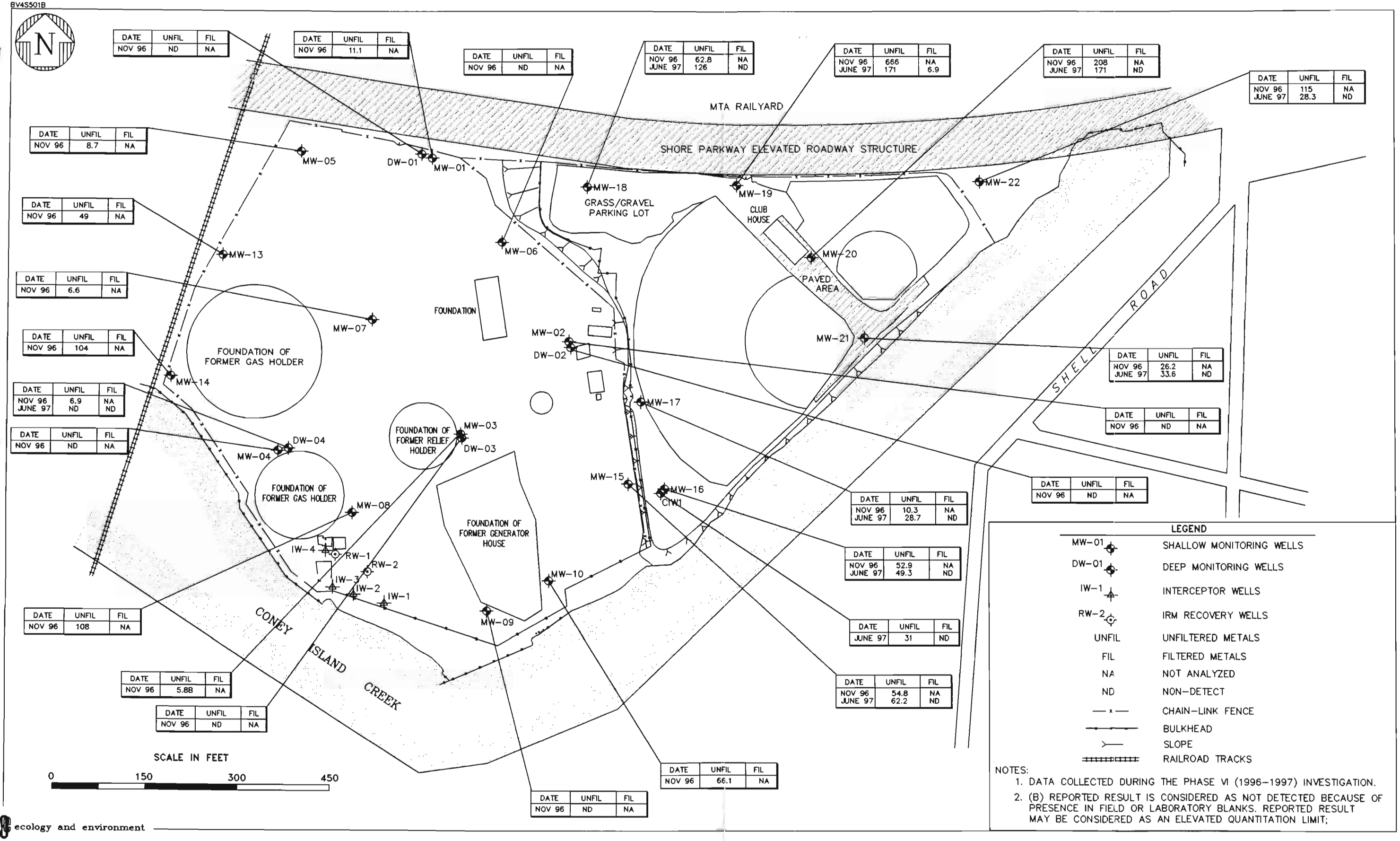
datafile: tpahgw.xyz
gridfile: tpahgwrm.grd
basemap: basemap.plt & tpahgw.plt
plotfile: tpahgw.p01 /dj650/11x17
project: bv4093 Document Number: D5098

Figure 4-12

Total PAHs in Shallow Groundwater Brooklyn Borough Gas Works Brooklyn, New York

ecology and environment, inc.

BV4S501B



DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96	11.1	NA

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	62.8 126	NA ND

DATE	UNFIL	FIL
NOV 96 JUNE 97	666 171	NA 6.9

DATE	UNFIL	FIL
NOV 96 JUNE 97	208 171	NA ND

DATE	UNFIL	FIL
NOV 96 JUNE 97	115 28.3	NA ND

DATE	UNFIL	FIL
NOV 96	8.7	NA

DATE	UNFIL	FIL
NOV 96	49	NA

DATE	UNFIL	FIL
NOV 96	6.6	NA

DATE	UNFIL	FIL
NOV 96	104	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	6.9 ND	NA ND

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96	108	NA

DATE	UNFIL	FIL
NOV 96	5.8B	NA

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	26.2 33.6	NA ND

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	10.3 28.7	NA ND

DATE	UNFIL	FIL
NOV 96 JUNE 97	52.9 49.3	NA ND

DATE	UNFIL	FIL
JUNE 97	31	ND

DATE	UNFIL	FIL
NOV 96 JUNE 97	54.8 62.2	NA ND

DATE	UNFIL	FIL
NOV 96	66.1	NA

DATE	UNFIL	FIL
NOV 96	ND	NA

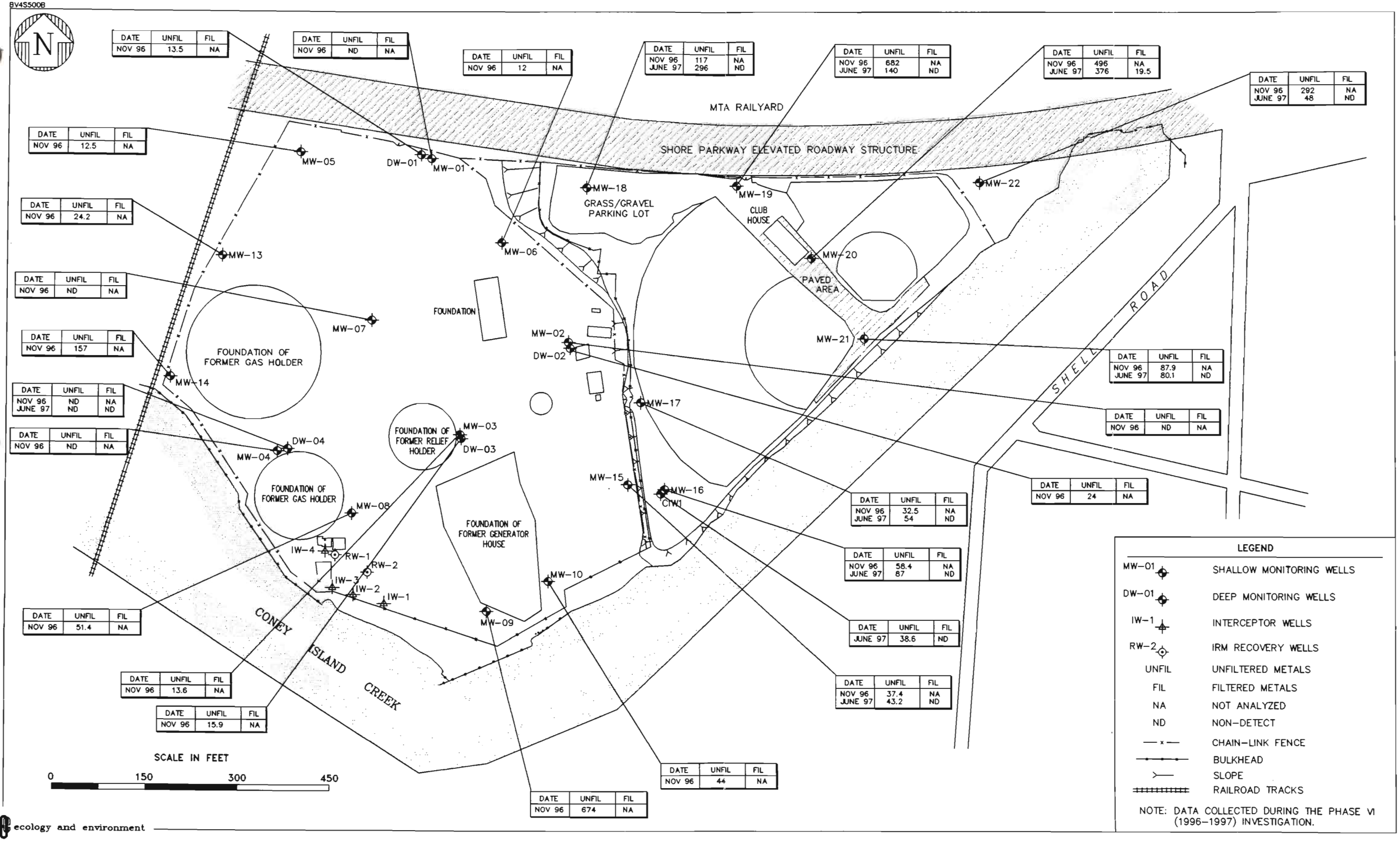
LEGEND

MW-01	SHALLOW MONITORING WELLS
DW-01	DEEP MONITORING WELLS
IW-1	INTERCEPTOR WELLS
RW-2	IRM RECOVERY WELLS
UNFIL	UNFILTERED METALS
FIL	FILTERED METALS
NA	NOT ANALYZED
ND	NON-DETECT
— x —	CHAIN-LINK FENCE
	BULKHEAD
	SLOPE
	RAILROAD TRACKS

NOTES:
1. DATA COLLECTED DURING THE PHASE VI (1996-1997) INVESTIGATION.
2. (B) REPORTED RESULT IS CONSIDERED AS NOT DETECTED BECAUSE OF PRESENCE IN FIELD OR LABORATORY BLANKS. REPORTED RESULT MAY BE CONSIDERED AS AN ELEVATED QUANTITATION LIMIT;

Figure 4-13 ARSENIC ($\mu g/L$) IN SHALLOW GROUNDWATER
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

BV4S500B



DATE	UNFIL	FIL
NOV 96	13.5	NA

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96	12	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	117 296	NA ND

DATE	UNFIL	FIL
NOV 96 JUNE 97	682 140	NA ND

DATE	UNFIL	FIL
NOV 96 JUNE 97	496 376	NA 19.5

DATE	UNFIL	FIL
NOV 96 JUNE 97	292 48	NA ND

DATE	UNFIL	FIL
NOV 96	12.5	NA

DATE	UNFIL	FIL
NOV 96	24.2	NA

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96	157	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	ND ND	NA ND

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96	51.4	NA

DATE	UNFIL	FIL
NOV 96	13.6	NA

DATE	UNFIL	FIL
NOV 96	15.9	NA

DATE	UNFIL	FIL
NOV 96	674	NA

DATE	UNFIL	FIL
NOV 96	44	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	37.4 43.2	NA ND

DATE	UNFIL	FIL
JUNE 97	38.6	ND

DATE	UNFIL	FIL
NOV 96 JUNE 97	58.4 87	NA ND

DATE	UNFIL	FIL
NOV 96 JUNE 97	32.5 54	NA ND

DATE	UNFIL	FIL
NOV 96	24	NA

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	87.9 80.1	NA ND

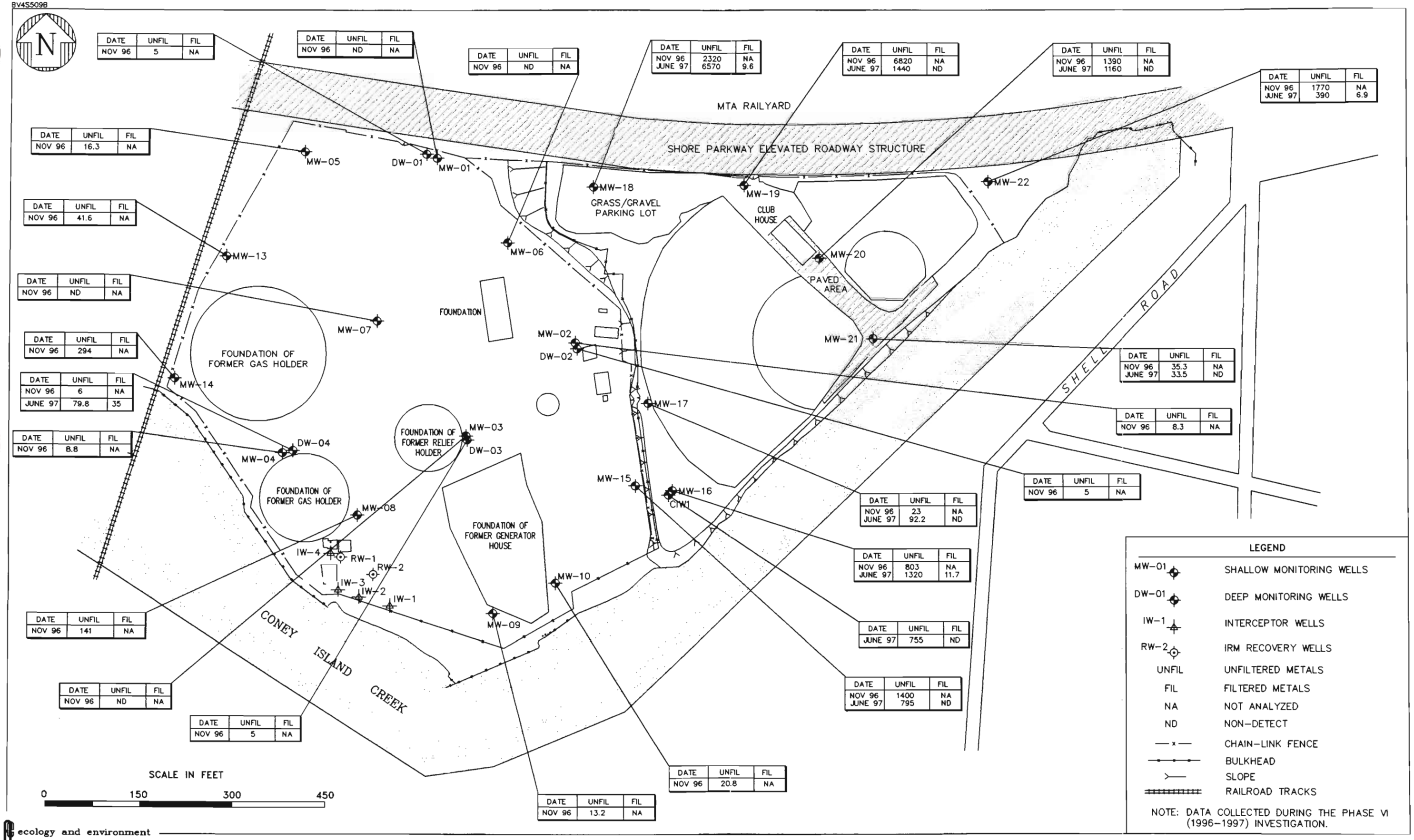
LEGEND

MW-01	SHALLOW MONITORING WELLS
DW-01	DEEP MONITORING WELLS
IW-1	INTERCEPTOR WELLS
RW-2	IRM RECOVERY WELLS
UNFIL	UNFILTERED METALS
FIL	FILTERED METALS
NA	NOT ANALYZED
ND	NON-DETECT
— x —	CHAIN-LINK FENCE
	BULKHEAD
	SLOPE
	RAILROAD TRACKS

NOTE: DATA COLLECTED DURING THE PHASE VI (1996-1997) INVESTIGATION.

Figure 4-14 CHROMIUM ($\mu g/L$) IN SHALLOW GROUNDWATER BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK

BV4S5098



DATE	UNFIL	FIL
NOV 96	5	NA

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	2320 6570	NA 9.6

DATE	UNFIL	FIL
NOV 96 JUNE 97	6820 1440	NA ND

DATE	UNFIL	FIL
NOV 96 JUNE 97	1390 1160	NA ND

DATE	UNFIL	FIL
NOV 96 JUNE 97	1770 390	NA 6.9

DATE	UNFIL	FIL
NOV 96	16.3	NA

DATE	UNFIL	FIL
NOV 96	41.6	NA

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96	294	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	6 79.8	NA 35

DATE	UNFIL	FIL
NOV 96	8.8	NA

DATE	UNFIL	FIL
NOV 96	141	NA

DATE	UNFIL	FIL
NOV 96	ND	NA

DATE	UNFIL	FIL
NOV 96	5	NA

DATE	UNFIL	FIL
NOV 96	13.2	NA

DATE	UNFIL	FIL
NOV 96	20.8	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	1400 795	NA ND

DATE	UNFIL	FIL
JUNE 97	755	ND

DATE	UNFIL	FIL
NOV 96 JUNE 97	803 1320	NA 11.7

DATE	UNFIL	FIL
NOV 96 JUNE 97	23 92.2	NA ND

DATE	UNFIL	FIL
NOV 96	5	NA

DATE	UNFIL	FIL
NOV 96	8.3	NA

DATE	UNFIL	FIL
NOV 96 JUNE 97	35.3 33.5	NA ND

Figure 4-15 LEAD ($\mu g/L$) IN SHALLOW GROUNDWATER
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

BV4S502B

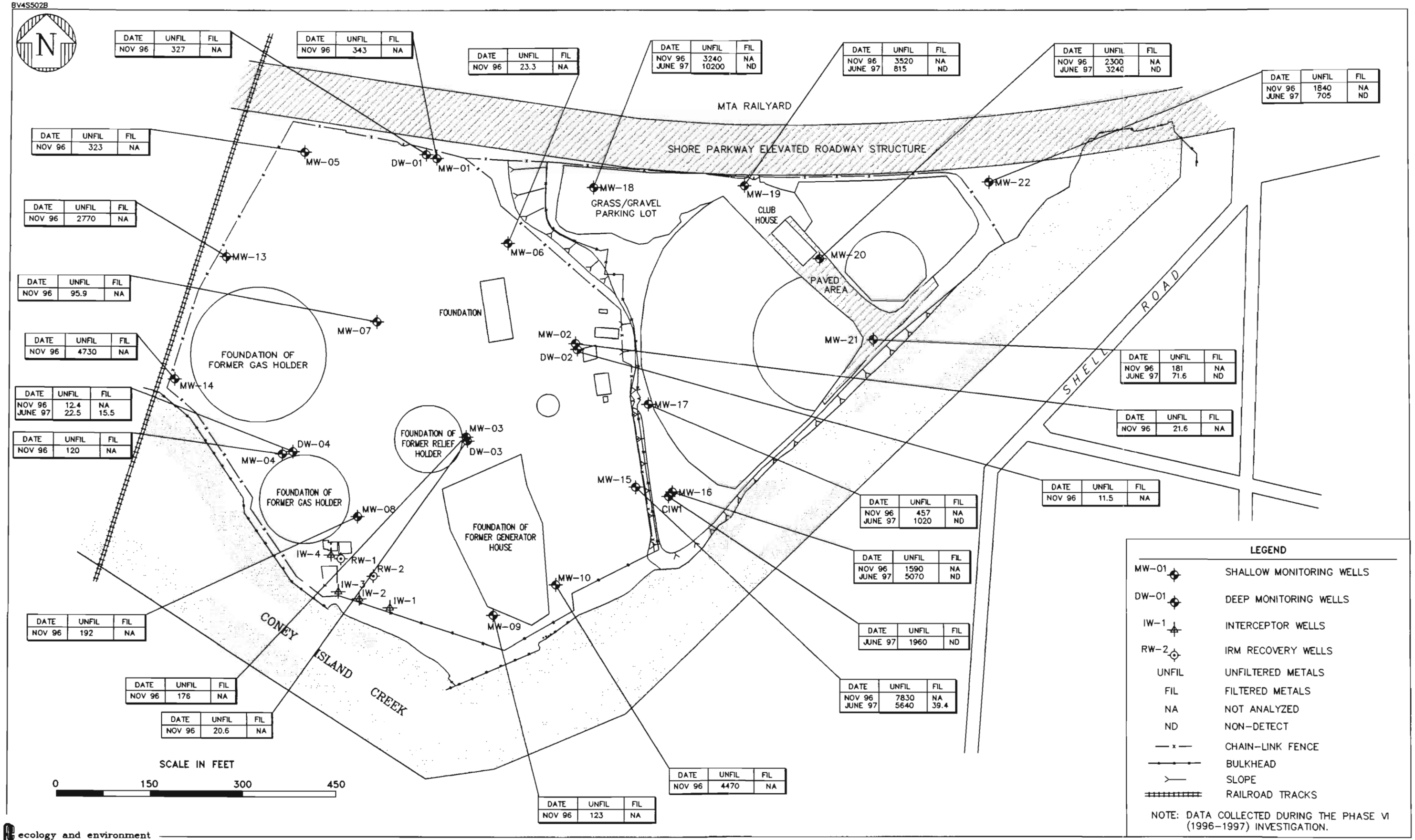


Figure 4-16 ZINC ($\mu g/L$) IN SHALLOW GROUNDWATER
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

BV4S210B

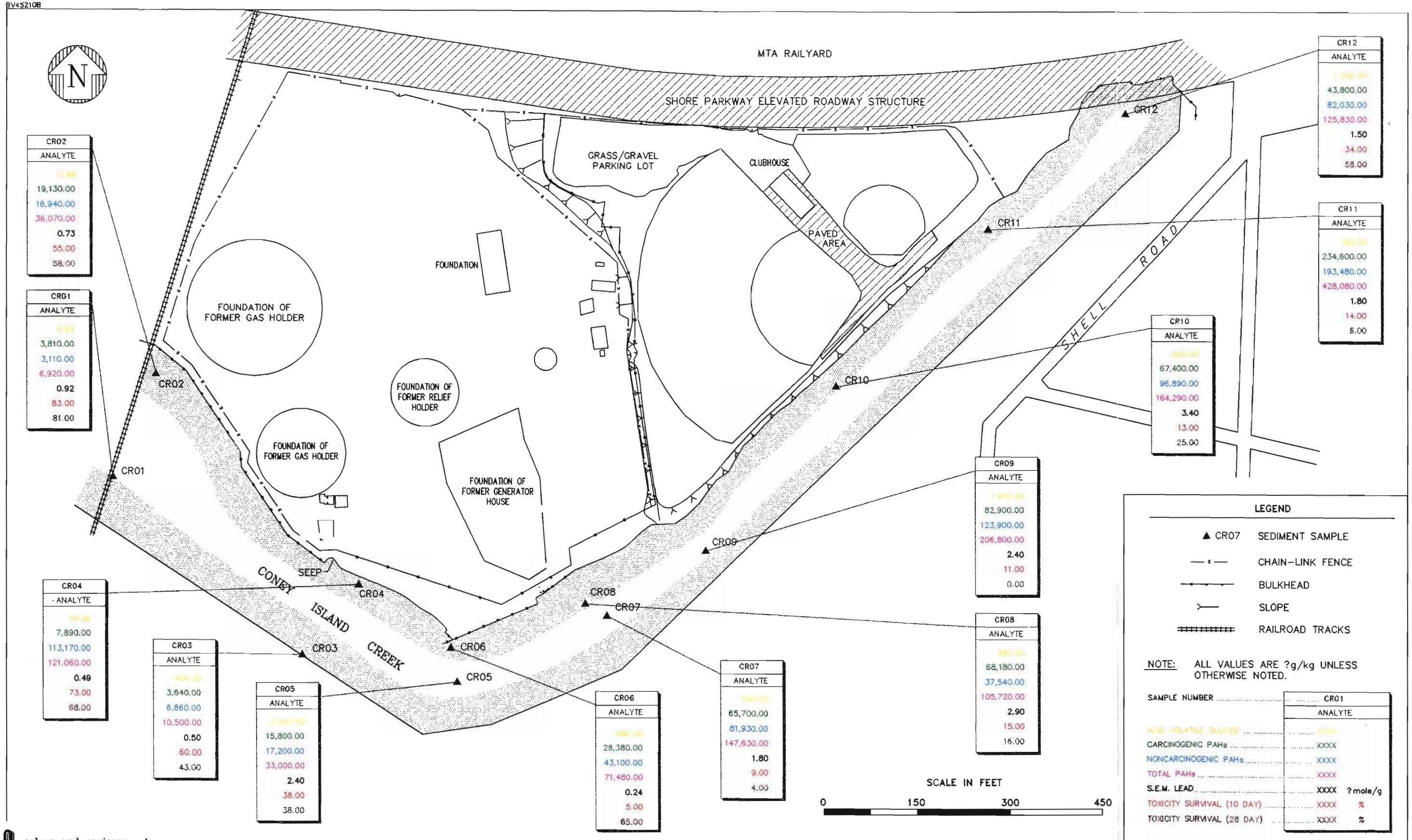
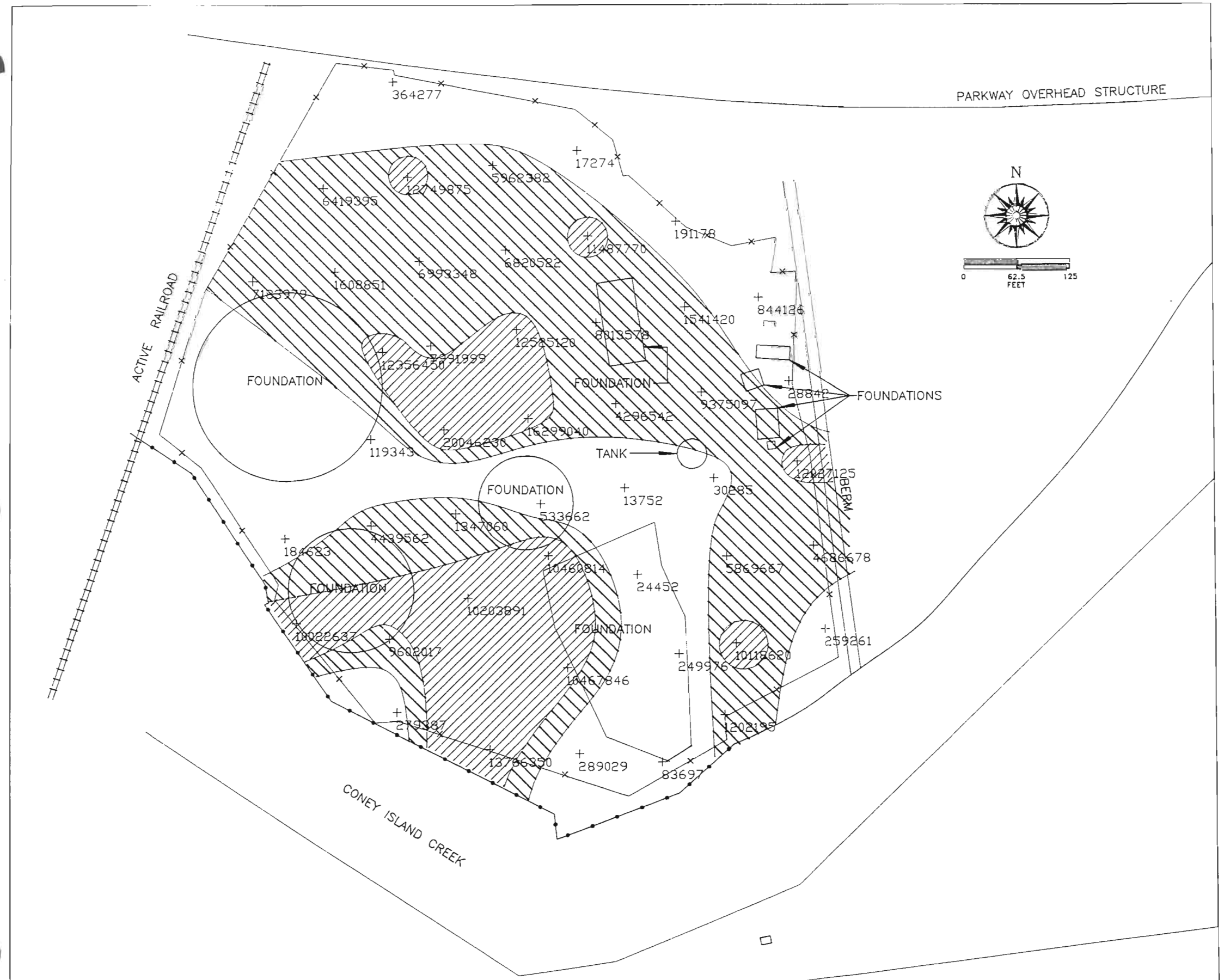


Figure 4-17 SEDIMENT SAMPLE RESULTS
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

BV4S0558



NERI
NORTHEAST RESEARCH INSTITUTE, INC.
309 Farmington Avenue
Suite A-100
Farmington Connecticut 06032
(203) 677-9666
1881E

LEGEND

Relative Response Values:

≥ 10,000,000

1,000,000 – 9,999,999

\+ Petrex Sample Location

Fence

Bulkhead

Railroad Tracks

Prepared for: Ecology & Environment

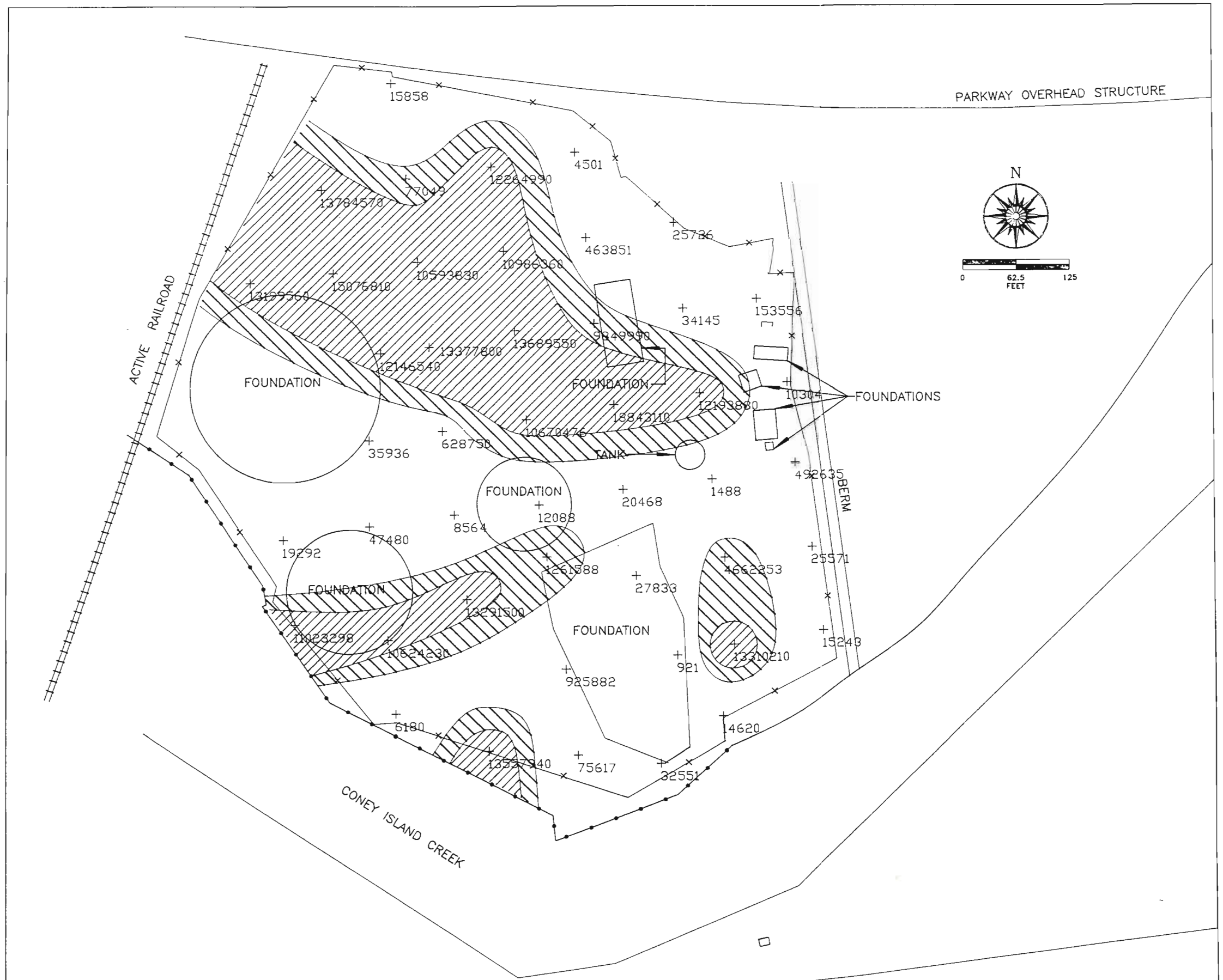
Prepared by: NERI

Figure 4-19 **RELATIVE RESPONSE, AROMATICS**
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

PETREX FINGERPRINT TECHNIQUE®

June 17, 1993

BV4S058B



NERI
NORTHEAST RESEARCH INSTITUTE, INC.
309 Farmington Avenue
Suite A-100
Farmington Connecticut 06032
(203) 677-9666
1881E

LEGEND

Relative Response Values:

≥ 10,000,000

1,000,000 – 9,999,999

\+ Petrex Sample Location

Fence

Bulkhead

Railroad Tracks

Prepared for: Ecology & Environment

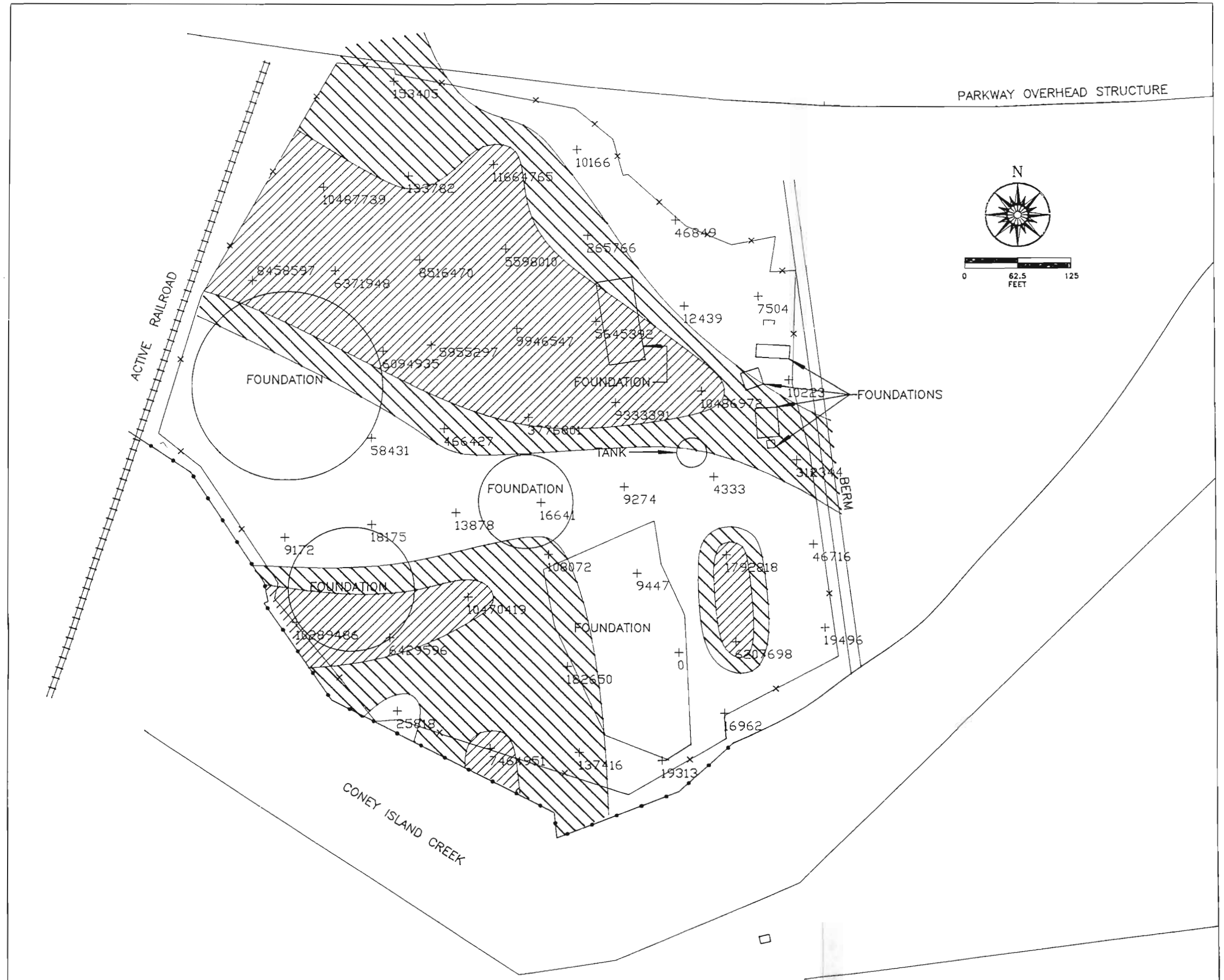
Prepared by: NERI

Figure 4-20 RELATIVE RESPONSE, NAPHTHALENES BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK

PETREX FINGERPRINT TECHNIQUE®

June 17, 1993

BV4S057B



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NORTHEAST RESEARCH INSTITUTE, INC.

309 Farmington Avenue
Suite A-100
Farmington Connecticut 06032
(203) 677-9666
1881E

LEGEND

Relative Response Values:

≥ 1,000,000

100,000 – 999,999

\+ Petrex Sample Location

Fence

Bulkhead

Railroad Tracks

Prepared for: Ecology & Environment

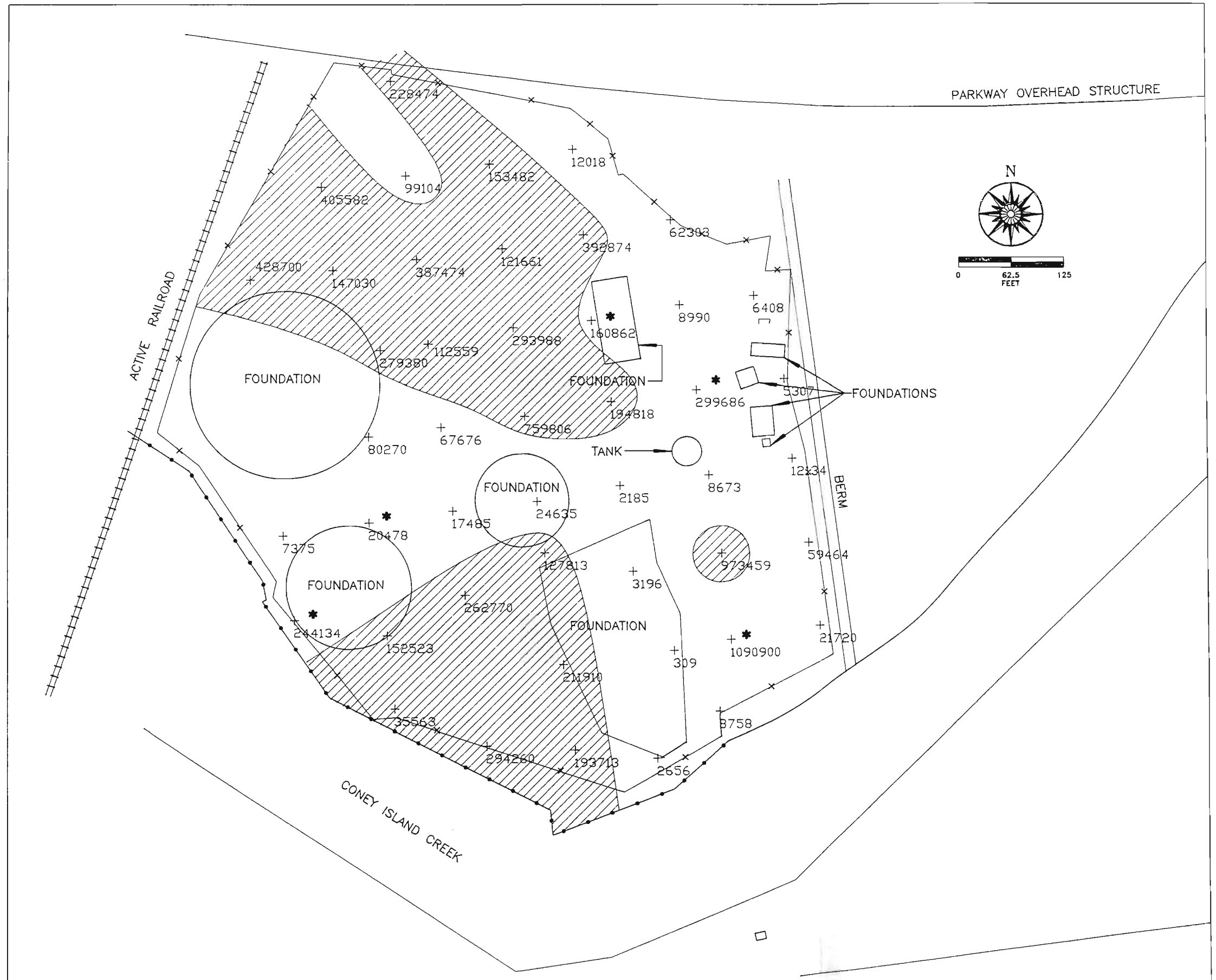
Prepared by: NERI

Figure 4-21 **RELATIVE RESPONSE, HEAVY CYCLOALKANES/ALKENES BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK**

PETREX FINGERPRINT TECHNIQUE®

June 17, 1993

BV4S058B



NERI
NORTHEAST RESEARCH INSTITUTE, INC.
309 Farmington Avenue
Suite A-100
Farmington Connecticut 06032
(203) 677-9666
1881E

LEGEND

Relative Response Values:

≥ 100,000

\+ Petrex Sample Location

Fence

Bulkhead

Railroad Tracks

* The presence of PCE was not confirmed by GC/MS analysis at these locations.

Prepared for: Ecology & Environment

Prepared by: NERI

Figure 4-22 RELATIVE RESPONSE, PCE BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK

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June 17, 1993

5 Constituent Transport and Fate

5.1 Introduction

A review of historical data and the environmental investigation results leads to the conclusion that:

- The soils and groundwater of the property contain various chemical constituents related to the gas manufacturing process that occurred at the site;
- The extent of distribution of many of these chemical constituents involves the entire property; and
- The presence of certain of the observed constituents, especially along the northern border of the site, appears to be due to off-site sources.

These conclusions lead to a concern about the likelihood of migration of these constituents.

This section first identifies the principal chemical constituents at the property and discusses their possible sources. The physicochemical properties of the chemical constituents and how these properties affect constituent transport and fate are discussed next. An analysis follows concerning how these chemicals may be migrating through the environment. Finally, a model of the risk system operating at the site is presented that includes potential exposure pathways and routes to humans and potential environmental receptors.

5.2 Identification of Principal Chemical Constituents

The purpose of identifying principal chemical constituents is to focus attention on those site-related chemicals that occur the most frequently and at the highest concentrations, that pose the greatest potential for migration through the environment, and that ultimately pose the greatest potential risk for exposure to humans and/or ecological receptors.

5.2.1 Principal Organic Chemical Constituents

Table 5-1 lists the most frequently detected organic chemical constituents at the property. The soil data demonstrate that average concentrations of PAHs, BTEX (see Figure 4-8), and styrene are significantly elevated in the upper soil layers relative to the deeper layers, most likely as a result of the operations of the MGP. PAHs, BTEX, and styrene are also elevated in groundwater monitored at the property. These chemicals most likely represent the largest contributors to the elevated levels of petroleum hydrocarbons and TRPH, which is a generalized test for hydrocarbon compounds, observed in soils and groundwater.

Several other organics were detected: Pesticides (DDT/DDD/DDE, chlordane, heptachlor and heptachlor epoxide, lindane [γ-BHC] and α-BHC, and aldrin); a solvent (methyl ethyl ketone); phenols (phenol, 2,4-dimethylphenol, and 2-dimethylphenol), which are a waste generated by the gas manufacturing process; chlorinated solvents (tetrachloroethylene, trichloroethylene, 1,1,1-trichloroethane, and 1,2-dichloroethane) that may have been used as degreasing agents in the late 1940s and 1950s; and PCBs, which may have come to the property through the natural gas distribution system in pipeline liquids (according to Brooklyn Union, PCBs were never used in equipment at the site). Some other organics were detected, but much less frequently, at lower concentrations, and demonstrating no particular pattern.

Methylene chloride and acetone were found in some blanks and samples. These highly volatile solvents are commonly used in most, if not all, analytical laboratories as part of their normal analysis procedures for the semivolatile portion of the analysis. While every effort is made to prevent escape of these solvents into the laboratory atmosphere, fugitive emissions do occur. The laboratory equipment (specifically, gas chromatography/mass spectroscopy [GC/MS]) used to measure the concentrations of chemicals in samples is extremely sensitive. Therefore, minute quantities of these solvents present in a sample as a result of fugitive emissions will be detected.

Standard QA/QC procedures are used to determine whether the source of the chemical (such as methylene chloride) found in a sample is a result of the sample itself or whether it is attributable to ambient laboratory conditions. All data used in preparing this RI report were reviewed by a QA chemist prior to data release. EPA allows detection limits to be elevated for methylene chloride when the sample concentration is less than 10 times the concentration of methylene chloride in the blank. With these data, no occurrence of these solvents was in excess of this level.

Carbon disulfide also is considered a laboratory contaminant. This is because under appropriate circumstances during VOC analysis the analytical instrument's sample heating units

interact with sulfur in the sample to form carbon disulfide. Therefore, the occurrence of this chemical in a sample was not considered further.

Principal organic chemical constituents were selected based upon their:

- Association with MGP feedstocks, by-products, and wastes;
- Frequency of detection;
- Observed concentrations;
- Trends in spatial distribution; and
- Environmental significance (i.e., toxicity, potential to bioaccumulate, persistence, and mobility potential).

Therefore, the principal organic chemical constituents currently observed at the site are BTEX, styrene, and various carcinogenic and noncarcinogenic PAHs.

The pesticides, phenols, PCBs, and chlorinated solvents were not selected as principal constituents either because of their common use in urban/industrial settings, or low concentrations and limited number of detections. However, this does not minimize their potential to pose risk either to humans or ecological receptors and any associated concern. These issues will be addressed in the risk assessment for the site.

5.2.2 Principal Inorganic Chemical Constituents

Table 5-2 lists the most frequently detected inorganic constituents at the property. Determining which concentrations of metals and inorganic compounds were considered present at elevated levels in the environmental samples from the site was complicated by the lack of data from a reasonable background site for comparison. Vertical soil-column profiles were useful for identifying principal inorganic chemical constituents. The soil data demonstrate that average concentrations of zinc, manganese, lead, nickel, copper (see Figure 4-9), arsenic, mercury, and cyanide (total) are significantly elevated in the upper soil layers relative to the deeper layers, most likely as a result of the operations of the MGP. These same metals and inorganics occur in elevated levels in groundwater, as well. However, the occurrences of elevated levels of these metals in the northernmost portion of the property are probably due to off-property sources.

Principal inorganic chemical constituents were selected in the same way as principal organic chemical constituents were selected.

Therefore, the principal inorganic chemical constituents currently observed at the site are zinc, manganese, lead, chromium, nickel, copper, arsenic, mercury, and cyanide (total).

5.3 Source Area Definition

One of the assessments required under the Consent Order is stipulated under the National Contingency Plan (40 CFR 300.430[d][2]) and involves the identification and characterization of the source(s) of waste and/or chemical constituents. As described previously, the former Brooklyn Borough Gas Works occupied the approximately 16.4-acre property. It likely began operating in 1908, suspended manufacturing operations around 1951, and ceased gas distribution operations in the late 1970s (see Figure 1-9). Figure 1-10 shows the general layout of the facility, including manufacturing areas, storage tanks, etc. Much of the manufacturing area and tank farm were decommissioned and demolished in the early 1960s, and the balance of the aboveground structures were demolished in the early 1980s. Therefore, there are no typical sources or areas (e.g., drums, tanks, impoundments, waste piles, or landfills) on the property.

In addition to the few remaining aboveground structures (e.g., building and tanks foundations), several underground structures (i.e., two gas oil USTs and piping) have been identified and, according to Brooklyn Union, emptied of their contents, or, in the case of piping, sealed. Therefore, it is unlikely that these structures are sources of chemical constituents.

Environmental investigations have documented the occurrence of various site-related chemical constituents in surface and subsurface soils and in groundwater. In addition, there is a groundwater seep along the southwestern shore of the property that releases LNAPL from the site into Coney Island Creek. In 1994 a hard boom and skimmer was placed around the seep as an interim response measure to control the release of chemical constituents from the property into the creek (E & E 1994b).

In conclusion, there are currently no classic waste or contaminant sources on the property. There are, however, various environmental media containing elevated concentrations of various organic and inorganic (metal) chemical constituents on the property (i.e., soils and groundwater). These media themselves may act as secondary sources of these chemical constituents.

5.4 Physicochemical Properties

5.4.1 Organic Constituents

The fate and transport of chemicals in the environment depend on the properties of both the chemicals and the environmental media in which they occur. Table 5-3 lists several principal organic constituents along with some of their respective physical and chemical properties (e.g., water solubility, Henry's Law Constant, octanol-water partition coefficient, organic-carbon partition coefficient).

Water solubility is the maximum concentration of a compound that dissolves in water at a specific temperature. Highly soluble compounds can be rapidly leached from soils and waste and are generally mobile in groundwater and surface water. Chemicals of low water solubility are relatively immobile in aquifers but may be transported rapidly in turbulent surface waters as suspended particles. Some water-insoluble compounds become readily mobil when in contact with organic solvents.

Vapor pressure is a measure of the volatility of a chemical in its pure state and is an important determinant of vaporization from waste sites. A compound's tendency to volatilize from water depends upon its Henry's Law Constant (K_H). K_H is the ratio, at equilibrium, of a compound's vapor pressure (atmospheres) to its water solubility (moles/m^3). Compounds with K_H greater than 10^{-3} atm-m^3/mol readily volatilize from water. Those with K_H from 10^{-3} to 10^{-5} atm-m^3/mol volatilize less readily, while those with K_H less than 10^{-5} atm-m^3/mcl volatilize slowly.

The octanol-water partition coefficient (K_{ow}) expresses the equilibrium distribution of an organic compound between octanol and water. K_{ow} is often used to estimate the extent to which a chemical will partition from water into fatty tissues of animals. Log K_{ow} values range from -2.5 to 10.5. Organic chemicals with log K_{ow} values less than 3 are generally considered not to concentrate in animal tissues; that is, they do not bioaccumulate.

The organic carbon partition coefficient (K_{oc}) is a measure of the tendency for organic compounds to sorb to soil and sediment and is expressed by this equation:

$$K_{oc} = \frac{(mg\ chemical\ sorbed\ /\ kg\ organic\ carbon)}{(mg\ chemical\ dissolved\ /\ L\ of\ solution)}$$

K_{oc} reflects the tendency of organic compounds to sorb to organic matter in soil and sediment. K_{oc} values for organic compounds range from 1 to 10^7; higher values indicate greater sorption potential. Chemicals with K_{oc} values less than 10^3 generally do not sorb strongly enough to soil to affect overall leachability.

The transport and fate of PAHs and the BTEX compounds were recently summarized by Kappleman (1993). Unless cited otherwise, the information in the following paragraphs were taken from this source.

PAHs are a major component of coal tars. PAHs consist of carbon and hydrogen atoms in the form of two to seven fused aromatic rings (usually benzene rings). The number of rings in a PAH molecule affects its biological activity, and fate and transport in the environment. For

example, two- or three-ring unsubstituted PAHs may, under certain circumstances, cause acute toxicity to some organisms but are noncarcinogenic and are typically more mobile in the environment compared to other PAHs. In contrast, four- to seven-ring PAHs are less acutely toxic, but some are carcinogenic or mutagenic, and are typically less mobile in the environment compared to other PAHs.

PAHs in soils may be volatilized to the atmosphere, degraded by soil microbes, and assimilated by plants. The subsurface PAH concentration peak in the vertical soil-column profile (see Figure 4-5) may be, at least in part, the result of volatilization and biodegradation of PAHs in surface soils. Bioaccumulation of PAHs by plants has been observed in lab studies, but has not been conclusively demonstrated in field-grown plants. Uptake can be by both leaves (from atmosphere deposition) and roots (from soil or sediment) with subsequent translocation to other plant parts. Studies involving domestic crops have shown that leaves tend to have the highest concentrations, followed by roots, fruits and seeds.

In aquatic systems, PAHs may volatilize to the air, disperse to the water column, become incorporated into bottom sediments, concentrate in biota, or undergo chemical oxidation and/or biotransformation. The chemical properties of PAHs (high K_{ow} and K_{oc} [see Table 5-3]) suggests that their most likely fate in aquatic systems is adsorption on to suspended particles, especially particles high in organic carbon. In low-turbulence systems such as the Coney Island Creek, PAHs sorbed to particles typically are deposited in bottom sediments where they degrade slowly and may persist indefinitely. This process likely occurred in the creek because sampling results show PAH contamination in sediments, but no water-column contamination. In sediments with high concentrations of organic carbon, PAHs tend to be strongly sorbed and thus have limited bioavailability.

As a result of their high lipid solubility (log K_{ow} greater than 3 [see Table 5-3]), PAHs may bioaccumulate in animals. However, PAHs of all sizes show little tendency for long-term bioaccumulation because they are quickly and extensively metabolized. Bioaccumulation is, therefore, not an important fate of PAHs because it is usually temporary in nature.

BTEX and styrene released to soils can be degraded by microbes, volatilized to the air, transported to surface waters by runoff, and transported to groundwater by leaching. The primary means by which these compounds are removed from the environment is volatilization followed by photo-oxidation. In surface waters and soil, the BTEX compounds are also biodegraded by microbes. The subsurface BTEX peaks in the vertical soil-column profile (see Figure 4-8) most likely result from a combination of volatilization, leaching, and biodegradation of these compounds from surface soils at the site. Bioaccumulation is not an important fate for BTEX compounds (log K_{ow} values typically are less than 3, [see Table 5-3]).

5.4.2 Inorganic Constituents

The transport and fate of metals in the environment are largely determined by their low water solubility and tendency to bind to clays, organic matter, and iron and manganese (oxy)hydroxides in soil and sediment. This results from the high cation exchange capacities of these substances. Consequently, metals are generally persistent in soil and sediment and are not persistent in surface waters and groundwater.

Although organic chemical constituents have a set of constants dictating their behavior (see Table 5-3), there is no corresponding set of constants for the principal inorganic chemical constituents because they are ionic species; therefore, their behavior depends on surrounding conditions. The key variables that affect metal-ion binding (i.e., adsorption) in surface and groundwater are pH, redox potential, and the concentration of complexing ligands. The influence of pH on metal ion adsorption depends on the ionic character of the metal. Metals that occur as cations in surface water and groundwater (Cu, Hg, Mn, Ni, Pb, and Zn at the site) typically are strongly bound to surfaces at high pH but tend to desorb as pH decreases. The opposite is true for metals that occur as anionic species; As and Cr at the site. These metals are more completely bound to surfaces at low pH (Benjamin 1983).

The redox potential of surface water and groundwater can affect the transport and fate of metals that occur in more than one oxidation state (As, Cr, and Mn at the site). Manganese is readily converted between Mn(II) and Mn(IV) in the environment. High concentrations of dissolved Mn(II) typically occur in waters devoid of oxygen: usually sediment porewater and groundwater. Mn(II) does not adsorb strongly to clays or organic matter and thus is potentially highly mobile in the environment. In contrast, the oxidized form of manganese, Mn(IV), which predominates in aerobic waters, is sparingly soluble and often occurs as an oxide precipitate such as MnO_2 (Stumm and Morgan 1981).

Arsenic can be found in the environment as arsenite, As(III), or arsenate, As(V). In surface or groundwater containing dissolved oxygen, As(V) species dominate but As(III) species may still be present. In anoxic systems, As(III) species are found at levels exceeding As(V) species, but As(V) species are still present. The thermodynamic disequilibrium results from redox biotransformations by fungi, bacteria, and algae (Seyler and Martin 1989). As(III) species are generally more mobile than As(V) species in subsurface environments.

Chromium is found as Cr(VI) or Cr(III) in surface and groundwater, depending on redox conditions. Thermodynamic calculations predict that Cr(VI) is stable in oxidizing conditions and that Cr(III) is stable in reducing conditions. Whereas Cr(VI), which is present as chromate, is relatively unreactive, Cr(III) is readily hydrolyzed and binds strongly to particles and organic

matter (Johnson et al. 1992). Hence, Cr(VI) is likely to be more mobile than Cr(III) in the environment.

The concentrations of dissolved ligands in surface and groundwater are another variable that influences the transport and fate of metals. Ligands are inorganic or organic compounds or elements that form complexes with metals. High concentrations of complexing ligands may result in high dissolved metal levels if the metal-ligand complexes are soluble. In estuarine systems such as the Coney Island Creek, sulfate and chloride are the two most important ligands that form dissolved complexes with the metals of potential concern at the site. The principal dissolved species for each of the eight principal metals are listed below. Except for arsenic and chromium, all form either a sulfate on a chloride. Arsenic and chromium forms oxides.

Metal	Principal Dissolved Species (Horne 1978)
As	$HAsO_4^{2-}$, $H_2AsO_4^-$, H_3AsO_4, H_3AsO_3
Cr	CrO_4^{-2}, $Cr_2O_7^{-2}$, Cr^{+3}
Cu	Cu^{2+}, $CuSO_4^o$
Hg	$HgCl_3^-$, $HgCl_4^{2-}$
Mn	Mn^{2+}, $MnSO_4^o$
Ni	Ni^{2+}, $NiSO_4^o$
Pb	Pb^{2+}, $PbSO_4^o$
Zn	Zn^{2+}, $ZnSO_4^o$

In anoxic sediments, sulfide can bind with certain divalent metals (Cu, Hg, Mn, Ni, Pb, Zn) to form sparingly soluble sulfide precipitates. Heavy metals precipitated with sulfide typically are not bioavailable (DiToro et al. 1990, 1992).

Cyanide occurs naturally in many substances found throughout the environment. However, because of the quenching process used at this facility, some waste cyanide may have been produced (GRI 1987). Cyanide may be present in many different forms in the environment and its transport, fate, and toxicity are dependent upon its particular form. In the present case, cyanide is most likely a slightly soluble metal (e.g., iron), cyanide salt, or a metal-sulfur-cyanide salt (GRI 1987 Volume III, pp. C-68 and C-69). These complexes are very stable in the environment, releasing only negligible free cyanide (GRI 1987, p. C-69).

5.5 Transport and Fate Analysis

5.5.1 Subsurface Soil and Hydrogeology Affecting Transport and Fate

As discussed in Section 3, the subsurface geology consists of unconsolidated glacial deposits of fine- to coarse-grained sands with occasional thin lenses of silty sand and silty clay that were encountered in the 10- to 172-foot depths BGS. Above these Pleistocene glacial deposits is an intermittent thin layer of nearshore and estuary type deposits of clay/peat/silt to gravel-sized sediments with some shells. A blanket of fill intermittently covers the site, ranging in thickness from 0 to more than 10 feet. Both A.D. Little and Weston installed soil borings during their respective studies. Both concluded that a blanket of sandy fill of varying thickness covered most of the site. The fill material consists of slag, ash, scrap iron, reinforcing steel, clay, gravel, coal tar, brick fragments, and wood (see Appendix D of E & E 1993a and Appendix of E & E 1994a). The thickest portion of the fill lies across the northern section of the western area, with an additional trough trending northeast to southwest and to the east in the eastern area of the property (see Figure 3-4). Test pits installed throughout the western area exposed unstable fill material consisting of bricks, slag, ash, concrete, reinforcing steel, scrap iron, and wood from the ground surface to depths of up to 8 feet. Roux, A.D. Little, and Weston found similar materials around the site. The fill materials uncovered were typical wastes generated by an MGP and may have been used as foundation material at the site. Roux noted that the fill material was thickest in the eastern area, which is topographically higher than the rest of the site. This was confirmed by E & E (see Figure 3-4). All consultants found tar masses within the fill, indicating that there is more than one source area for the chemical constituents observed.

Below the fill material, a layer of green fibrous peat intermingled with silt and clay was found at many locations in investigations performed at the site by E & E, Roux, A.D. Little, and Weston. Roux also found this layer in soil borings installed in the eastern area. MTA drilling logs generated during construction of the railyard to the north of the site and bridge support structures at the active railroad bridge at the southwestern corner of the site also show that this layer exists in the subsurface soils in these two areas (Acme Soil and Rock Drilling 1964). It is apparent from the shells and phragmites found in the clay/peat/silt that the site and those areas immediately adjacent to the site were at one time wetlands that have been covered by fill. Geotechnical analysis of this layer has shown the material to be an organic-rich mass with very low permeability and poor compressive strength. Permeability analysis shows the clay/peat/silt to have an extremely low permeability; values of 1.15×10^{-8} and 1.54×10^{-8} were measured. The low permeability of the material supports the visual observation of free-flowing product apparently floating or lying on this layer. The layer is not continuous throughout the site, as

indicated by test pit and borehole observations conducted by E & E, and observations made by Roux. Because elevated PAH concentrations have been found in soils collected at a depth of 172 feet in DW-04 during the Phase II investigation, there is a possibility that areas where the layer is discontinuous may allow for downward migration of dense petroleum products or tars. However, because of the flow regime at this site, these PAH concentrations may be from an upgradient source (see discussion in Appendix C).

On-site groundwater flow during low tide moves in the direction of Coney Island Creek. Flow direction is temporarily reversed during high tide near the Creek due to the higher hydraulic head and highly permeable sediments. Figure 3-6 illustrates the water levels during low tide and suggests that a perched water table exists as a result of the shallow clay zone present in the southeast corner of the site. The high tide water level data (see Figure 3-7) illustrate the tidal influence on the site with high water levels near Coney Island Creek and lower water levels in the central and eastern areas. The consistently higher levels present in the northern section of the site indicate that the tidal influence tends to decrease further away from Coney Island Creek (as one proceeds north across the site). A.D. Little also noted a groundwater flow direction reversal during higher tides.

During the June 1997 Phase VI field activity, three complete rounds of groundwater levels were measured; the readings are presented in Appendix B of this report. Because the groundwater contours are very similar to the November 1996 water levels, additional figures were not added to this report.

During Phase VI, the inland extent of tidal influence was found to extend across most of the property (see Figure 3-8). Although the inland tidal effect decreases with distance from Coney Island Creek, especially at the northern boundary of the property, water level measurements show it to be substantially less on the western and eastern portion of the site. One possible reason tidal effect may be inhibited in the west is due to the presence of the bulkhead, which serves as a semipermeable barrier impeding inland flow. Similarly, another possible reason the eastern side of the site may be less affected is due to the presence of what appears to be a mound of low-permeable matrix at the creek bank. The net result is a high-gradient condition in the central part of the western area down which chemical constituents flow toward the seep, which is the corridor of inflowing and outflowing water with each tidal cycle.

5.5.2 Chemical Constituent Release From Soil to Ambient Air

Possible transport mechanisms of chemicals constituents in soils to air are:

- Volatile emissions of gases or high vapor pressure, volatile organic compounds; and

- Emission of soil particulate containing sorbed organic and inorganic chemical constituents via wind erosion.

With regard to PAHs, only the low molecular weight compounds (e.g., naphthalene) are able to volatilize into soil gas in the soil pore spaces and ultimately into the ambient air. Occasionally, on days of high temperatures, [redacted] have noticed a characteristic coal tar odor while on the property. In contrast, particulate windborne transport from the property, while possible, is probably not a major transport pathway due to the moderate to coarse nature of the surface soils and their generally well-vegetated condition.

Volatile organic constituents (BTEX and styrene), because of their high vapor pressure (high Henry's constant), will demonstrate a low residence time in surface soils. This is supported by the low concentrations of these constituents in the surface soils (Figure 4-4). However, the soil gas data (see Section 2.2) indicate considerable volatile organic vapor in the soils, including aromatics, aliphatics, and chlorinated solvents. Because of the rich organic matrix in the subsurface and high water table, the majority of these chemical constituents will remain dissolved in the PAH matrix and/or L(D)NAPL. Nevertheless, some volatile emissions will slowly emanate from the soils and enter the ambient air. Finally, although total cyanide has been observed at elevated levels (several hundred parts per million) in the north-central portion of the property and immediately to the north off of the property, it appears that it is highly complexed and not readily dissociable. Therefore, it is not a potential source to the air.

5.5.3 Chemical Constituent Release From Soil to Groundwater

The water table at the site is very high (see Section 3.3.3 and Figures 3-6 and 3-7), and under episodes of high precipitation, standing water occurs at the site (E & E 1993a). Thus, the unsaturated vadose zone at the site is very thin with groundwater within 3-4 feet of ground surface.

Free product (oil) of varying viscosities, both a light or floating variety and a dense or sinking variety, has been found in the south-central portion of the site by each of the four consultants. During the Phase II, III, IV, V, and VI investigations, E & E found heavier-than-water tar throughout the site in several boreholes, test pits, and monitoring wells along the site borders. There appear to be several masses of buried coal tar within the property that have been observed with test pits and monitoring and well boreholes and that appear to be the source of the tar. Additionally, hardened coal tar, which has the physical characteristics of bituminous

pavement, was found at shallow depths in many test pits and boreholes. The hardened tar is likely to have had the same texture as the material found deeper in the test pits, wells, and boreholes at the time of initial disposal. However, this tar hardened due to a curing that occurred from exposure to the elements and loss of volatile components. Floating oil found in wells is considered to be either a type of gas oil, as was found in IW-04, or a sealant oil, as was found in CIW-6S.

These observations, together with the observations of the major occurrence of the principal organic chemical constituents from the surface to approximately 12 to 14 feet BGS at the property, indicate a continuous potential for these chemicals to be released to the groundwater. However, the water solubilities of PAHs, BTEX, and styrene are low (see Table 5-3), therefore, the process of release to groundwater will be slow. Indeed, Figures 4-10, 4-11, and 4-12 demonstrate that site-related organic chemical constituents are being released to groundwater.

Because of the higher density of coal tars compared to either fresh or saline groundwater, there is a concern that PAHs in the upper soil column may migrate vertically downward as a DNAPL. In fact, soil samples collected from the placement of DW-04 indicate the occurrence of PAHs especially around 50 to 70 feet BGS. However, as discussed in Appendix C, it is very unlikely that these PAHs are from the site because of the movement of groundwater and the retardation of the majority of site-related PAHs by the clay/peat/silt layer (even though it is discontinuous). The lack of a continuous "smear" of PAHs vertically downward in the soil column is an argument against the idea of significant DNAPL migration from the site. In fact, the occurrence of PAHs at this level may be indicative of upgradient migration of PAHs along the saline groundwater-brackish groundwater interface. At this interface, the water density changes, establishing a pycnocline. This higher-density water may be responsible for the PAHs being at this depth. PAHs are again observed at 172 feet BGS atop the Gardiners clay.

Heavy metals are detected throughout the property soils and are widely observed in the groundwater. The solubilities of metals varies considerably as discussed in Section 5.4.2. The observation of heavy metals in groundwater has not distinguished whether the metals are dissolved or merely minute solid, floating particulates. In any case, the significant fill at the site contains considerable levels of metallic materials (e.g., pipe, re-bar, etc.) that contribute to the soils acting as a source for metals in groundwater.

5.5.4 Chemical Constituent Release From Soil to Surface Water and Sediment

Transport of site-related principal constituents sorbed to soil particulate via overland flow, while possible, is not considered to be an important pathway because of the moderate-to-coarse nature of the surface soils and the generally vegetated cover of the property.

5.5.5 Chemical Constituent Release From Groundwater to Surface Water and Sediment

E & E's observations during its Phase IV and V investigations demonstrated that NAPL is released to Coney Island Creek through a seep along the southwest shore of the property (E & E 1993d, 1994a). This area is the southern-most part of a highly transmissive zone in the property subsurface soils. Because of the high permeability (therefore highly transmissive) subsurface material, the water table in this area is lower than anywhere else on site. It therefore acts as a "funnel" for NAPL from around the site allowing it to drain to the creek (see Figure 5-1). Petroleum hydrocarbon analysis of material emanating from the seep appears to be gas oil (E & E 1994a).

The drainage to the creek only occurs immediately before, during, and immediately after low tide. Beyond these times, the hydraulic pressure of the creek is such that it either holds groundwater in the site or pushes it backward (to the north northwest). Thus, NAPL floats atop the water table and when hydraulic conditions permit, it flows from the site into the creek.

Because of these observations, Brooklyn Union took an IRM to control release of NAPL into Coney Island Creek by placing a hard boom and rope mop skimmer around the seeping shoreline (E & E 1994a). This boom and skimmer IRM continues to operate and has effectively controlled the release of NAPL into the creek. It is important to note that the "funneling" affect of the shallow water table does not drain the site of LNAPL; if it had, the seep would have ceased years ago. Instead, only a small amount of LNAPL is released at each low tide, and the majority is "held" in the central and south-central portions of the western area (compare Figures 4-5, 4-6, 4-10, 4-11, and 4-12). It is theorized that the coal tar, hardened tar, and clay/peat/silt layer act as an organic "sponge" to hold the majority of the LNAPL and releasing it occasionally under appropriate conditions (e.g., water table fluctuations with sufficient gradient or physical disturbance of the subsurface). This explanation makes sense based on chemical and physical properties, i.e., like-dissolves-like, that is, the organic LNAPL will have a higher affinity for organic substrates as compared to floating on the water table or dissolving into the groundwater.

This behavior may also explain why organic constituents are observed at elevated levels in certain wells during one sampling round and at lower levels during the next round. Weather

(temperature and precipitation) prior to sampling and of course tidal levels perhaps perturb the mass of chemical constituents in the subsurface either inducing the release of LNAPL or allowing it to move either back into the mass on site or elsewhere depending upon local (micro-) conditions.

Another possible explanation of the changing constituent and LNAPL levels in wells could be a "plugging" of the well screen by tar. This plugging may be insufficient to have a remarkable impact on water levels, etc., but may act to preferentially attract and hold chemical constituents.

5.5.6 Off-Site Sources

Observations of subsurface soils excavated during numerous test pit, borehole, and monitoring well installations indicate that the horizontal limits of the subsurface occurrence of coal tar, ash, and NAPL are not bounded by the property. Intrusive testing along the northern perimeter indicates an abundance of oil, free-flowing and hardened tar, ash, and clinker. Observations of MW-18 and MW-22, and MW-19 suggest either an off-site source affecting subsurface soils and groundwater or site-related chemical constituents somehow became located beyond the current property boundaries (see Figures 4-5 to 4-16). The high levels of organics, metals, and cyanide in soils and groundwater at MW-19 suggest the possible placement of spent oxide wastes in the area along with coal tar. In contrast, MW-5 over the four rounds of sampling has shown a decreasing level of organics in the groundwater. The high levels in the early rounds of sampling strongly suggested an upgradient (north) source. Now, in Phase VI, either the source has stopped releasing material or the "slug" of organic chemicals has moved through the MW-05 zone into either Coney Island Creek or into the central portion of the western area.

Previous investigation phases by E & E also demonstrated elevated TRPH, PAH, and BTEX levels in subsurface soils and groundwater in the northwest corner of the property along the MTA right-of-way. Certainly some of the observed chemical constituents can be attributed to over 100 years of railroad operations. Although groundwater flow in this western area is expected to be toward Coney Island Creek, the specific direction is unknown (see Figures 3-6 and 3-7). Therefore, an upgradient source is possible.

The presence of various inorganic metals and total cyanide in the soils of the north-central area of the property and immediately off the property to the north suggests a possible off-property source. It also is possible that these inorganics are related to MGP purifier box waste.

5.5.7 Constituent Fate

PAHs occur in a thick discontinuous layer between 0 and 14 feet BGS throughout the property, and possibly beyond. Because of its lack of water solubility and affinity of soil the heavy molecular weight PAHs will generally remain on site. However, slowly over time some lighter molecular weight PAHs (e.g., the naphthalenes) will either off-gas exiting the site via ambient air or may dissolve into groundwater or LNAPL (PAHs will more easily dissolve in BTEX liquids as compared to groundwater). A fraction of the PAHs making up a flowable DNAPL may sink through the subsurface; however, as discussed in Appendix C, this material is expected to exit the site into the creek and not sink into deeper soils.

LNAPL floats atop and mixes in the water table aquifer under the site. During low tide, some of the LNAPL (including BTEX, styrene, and some PAHs) and perhaps some of the DNAPL are released through a seep into Coney Island Creek. Although this process has likely continued for over 60 or 70 years, considerable LNAPL remains on site.

Cyanides (probably complexed with iron and resulting from the spent oxide waste of the former MGP) occur at low levels in a discontinuous pattern throughout the property, but are most prevalent in subsurface soils in the eastern and northern portions of the property and also extend beyond current property limits. Because of their stability and general insolubility, the cyanides are not expected to migrate farther.

Principal heavy metal constituents (arsenic, chromium, copper, lead, manganese, mercury, nickel, and zinc) are naturally occurring in the environment and are persistent. Although these metals are site-related, they are also common in urban-industrial areas from human-made, non-site-related sources. They are expected to remain on site in the soils and in site groundwater, although some will be released into the creek.

Coney Island Creek sediments are a sink for any site-related chemical constituents emanating in groundwater via the seep (Figure 4-17). The PAHs and metals will persist in these sediments.

5.6 Findings

The Brooklyn Borough Gas Works site has been investigated in multiple phases. These observations have resulted in the following findings:

- Of the more than 50 detected chemicals, principal chemical constituents were selected based upon their association with MGP feedstocks, by-products, and wastes; frequency of detection; observed concentrations; trends in spatial distribution; and environmental significance (i.e., toxicity, potential to bioaccumulate, persistence, and mobility

potential). The principal chemical constituents were: PAHs, BTEX, styrene, PCBs, cyanide, arsenic, chromium, copper, lead, manganese, mercury, nickel, and zinc;

- The site is generally underlain by a coal tar (typically PAHs) deposit that occurs primarily at a depth of 4 to 12 feet BGS across the site, although material was observed from the surface to a depth of 172 feet BGS in one deep well (DW-04) on the west side of the site. BTEX and styrene were among the volatile organics detected;

- Inorganic constituents included lead, chromium, and arsenic. These appear to be associated with the industrial activity that has occurred at the site and its proximity to a railroad yard and a major roadway arterial. The distribution of inorganic chemicals generally follows that of the organic chemicals;

- Several potential off-site sources may contribute to the chemical constituents found at the Brooklyn Borough Gas Works site. These sources include the Shore Parkway, which borders the site to the north; the train yard to the north; and an unknown source across the MTA right-of-way to the northwest. The observation of PCBs in soil is perhaps best explained by the former gas distribution gate station in the middle of the site that operated from 1960 to approximately 1979;

- Groundwater under the site has measurable levels of various chemical constituents due to the deposition of these chemicals at depth. Although not used as a water source, this groundwater has seeped from the site and contributed various chemical constituents to Coney Island Creek, which traverses the southern side of the site. The creek water contains elevated levels of organics and inorganic substances, some of which may be site-related. Although the site may contribute chemical constituents to the creek, there are other significant sources (e.g., outfalls) to the creek that occur upstream (to the east of the site).

- Creek sediment contains many of the same organic and inorganic substances observed on site. Sediment bioassays were done using the amphipod *H. azteca*. These results indicated that some of the sediments were toxic. Inorganic data (i.e., the SEM/AVS ratio) would suggest that inorganic chemicals most likely do not contribute to this toxicity because the sediment samples yielding the highest toxicity had very low SEM/AVS ratios. The toxicity may be due to organic chemicals because the samples yielded high PAH concentrations. However, the sediment samples with the most significant toxicity did not have the highest levels of PAH concentration;

- Free product of varying viscosities was found throughout the site. All consultants working at the site also observed oil floating in wells and in soil borings. These appear to be several different oils from different sources associated with the MGP;

- Observations of subsurface soils excavated during numerous test pit and borehole installations indicate that the horizontal limits of subsurface coal tar infiltration are not bounded by the current property line. Data suggest that there is an off-site TRPH source at the northwest corner and a TRPH, heavy metal, and cyanide source(s) along the north-central perimeter of the site. Previous studies have shown the highest concentrations of lead and arsenic occurred at the site perimeter. Also, low concentrations of PCBs have been found along the western site perimeter and may be due to the MTA right-of-way;

- The site has unstable fill material at depths of up to 8 feet in the western area of the site and up to 16 feet in depth in the eastern area;

- A discontinuous clay/peat/silt layer underlying the fill appears to be acting as a vertical hydrologic barrier, inhibiting but not necessarily stopping the downward migration of coal tars and oils;

- Several wooden structures extending at least 25 feet inland support the wooden bulkhead. The exact numbers, consistency, and integrity of these structures are unknown. The bulkhead appears to be inhibiting, and perhaps preventing, migration of chemicals into the creek;

- The distance of inland tidal influence was determined to be across the entire site, with decreasing effect toward the northern boundary of the property. Tidal influence appears to be less to the west and east. Evidence suggests that this is possibly due to the bulkhead structure on the west, and to the low permeability of the geologic formation along Coney Island Creek in the eastern area; and

- Hydrogeologic behavior observed to date suggests that LNAPL is preferentially directed to the central part of the site, and small amounts of it seep into the creek along the southwest-central shore of the site.

- The lower concentrations of metals in the filtered samples collected during the June 1997 Phase VI groundwater sampling event indicate that the metal concentrations are largely associated with the suspended particulates. Filtering the groundwater samples effectively lowered the turbidity levels created by the suspended particulates.

- The detected analyte concentrations continued to decrease or remained at low levels in deep monitoring well DW-04 through all five sampling rounds (see Table 4-3). During the June 1997 sampling event, this well was also sampled for DNAPLS and none were detected.

- Four locations, two adjacent to SS28 (G-1 and G-2) and two adjacent to SS32 (F-1 and F-2), were resampled in August 1997. The lead concentrations detected in these samples were lower than those detected in the Phase II 1993 field investigation. In 1993, the lead concentration detected at SS28 was 1,800 mg/kg; the concentrations detected in G-1 and G-2 were 187 mg/kg and 354 mg/kg, respectively. At SS32 lead

was detected at 1,900 mg/kg; the concentrations detected in F-1 and F-2 were 422 mg/kg and 435 mg/kg, respectively.

5.7 Risk System Model of the Brooklyn Borough Gas Works Site

One of the assessments that is required in a RI is the characterization of potential exposures of the public or important ecological features to site-related chemicals. Such exposure may suggest a risk for adverse health effects or ecological impacts. For the purposes of this report, this analysis was conducted using the information collected during the RI and the findings are presented in Figure 5-1. This model will serve as the basis for the risk assessment required under Section IV, Paragraph A, p.7 of the Consent Order.

Table 5-1

OBSERVED ORGANIC CONSTITUENTS RANKED ACCORDING TO FREQUENCY OF DETECTION

Rank	Chemical	Frequency of Detection (Hits/Samples)	Concentration (Soil - mg/kg) (Groundwater - µg/L) Minimum	Maximum	Average	Association with MGP or Gas Distribution	Toxicity	Bioaccumulation Potential	Persistence	Mobility
Soil										
1	PAHs	425/434	0.034	40,550	893	Y	C/NC	Lo	Y	Lo-Mod
2	Xylenes, total	214/442	0.0015	2,500	49	Y	NC	Lo	N	Mod
3	Ethylbenzene	208/442	0.00083	780	22	Y	NC	Lo	N	Mod
4	Toluene	153/442	0.0011	1,200	20	Y	NC	Lo	N	Mod
5	Benzene	124/443	0.00136	220	5	Y	C	Lo	N	Mod
6	Styrene	39/442	0.0012	1,300	67	Y	NC	Lo	N	Mod
7	DDT DDD DDE	28/109	0.0128 0.78 0.119	0.36 0.14 0.12	0.1 0.1 0.04	N	C	Hi	Y	Lo
8	Methyl ethyl ketone	24/443	0.00439	21	1.6	N	NC	Lo	N	Mod
9	Tetrachloroethylene	24/443	0.00075	0.014	0.005	P	C	Lo	Y	Mod
10	Chlordane	19/132	0.00905	8.5	0.99	N	C	Hi	Y	Lo
11	Trichloroethylene	11/443	0.00344	0.14	0.03	P	C	Lo	Y	Mod
12	PCB	10/109	0.00208	66	16	Y	C	Hi	Y	Lo
13	1,1,1-Trichloroethane	8/442	0.0011	0.048	0.011	P	NC	Lo	Y	Mod

Key at end of table.

Table 5-1

OBSERVED ORGANIC CONSTITUENTS RANKED ACCORDING TO FREQUENCY OF DETECTION

Rank	Chemical	Frequency of Detection (Hits/Samples)	Concentration (Soil - mg/kg) (Groundwater - µg/L) Minimum	Maximum	Average	Association with MGP or Gas Distribution	Toxicity	Bioaccumulation Potential	Persistence	Mobility
14	Heptachlor Epoxide	7/132	0.00438	1.8	0.40	N	C	Hi	Y	Lo
15	Aldrin	5/109	0.0215	0.82	0.33	N	C	Hi	Y	Lo
Groundwater										
1	PAHs	61/75	1.73	144,500	9,125	Y	C/NC	Lo	Y	Lo-Mod
2	Ethylbenzene	48/75	1.29	8,720	1,102	Y	NC	Lo	N	Mod
3	Total Xylenes	48/75	1.08	17,000	2,343	Y	NC	Lo	N	Mod
4	Benzene	35/75	2.63	3,100	510	Y	C	Lo	N	Mod
5	Toluene	42/75	1.2	6,500	1,280	Y	NC	Lo	N	Mod
6	1,2-Dichloroethane	11/75	2	20	11	P	NC	Lo	N	Mod
7	Alpha-BHC	7/59	0.02	0.35	0.17	N	?	Hi	Y	Lo
8	Styrene	5/75	90	8,700	4,900	Y	NC	Lo	N	Mod
9	Lindane	3/59	0.03	0.56	0.21	N	C	Lo	Y	Mod
10	Heptachlor	2/59	0.05	0.21	0.13	N	C	Hi	Y	Lo
11	Phenol	2/24	8.1	11	9.4	Y	NC	Lo	N	Mod
12	2,4-Dimethylphenol	1/24	13.5	13.5	—	Y	N	Lo	N	Mod
13	2-Methylphenol	1/24	17.9	17.9	—	Y	NC	Lo	N	Mod

Key at end of table.

Table 5-1

OBSERVED ORGANIC CONSTITUENTS RANKED ACCORDING TO FREQUENCY OF DETECTION

Rank	Chemical	Frequency of Detection (Hits/Samples)	Concentration (Soil - mg/kg) (Groundwater - µg/L)			Association with MGP or Gas Distribution	Toxicity	Bioaccumulation Potential	Persistence	Mobility
			Minimum	Maximum	Average					
14	4-Methylphenol	1/24	19.9	19.9	—	Y	NC	LO	N	Mod
15	Bis(2-ethylhexyl) phthalate	1/24	3.86	3.86	—	N	Nc	N	Y	Lo

Key:

C = Carcinogen
Hi = High
Lo = Low
Mod = Moderate
N = No
NC = Noncarcinogen
P = Possible
Y = Yes

Table 5-2

OBSERVED INORGANIC CONSTITUENTS RANKED ACCORDING TO FREQUENCY OF DETECTION

Rank	Chemical	Frequency of Detection (Hits/Samples)	Concentration (Soil - mg/kg) (Groundwater - µg/L) Minimum	Maximum	Average	Association with MGP or Gas Distribution	Toxicity	Bioaccumulation Potential	Persistence	Mobility[a]
Soil										
1	Chromium	435/436	1.6	91	14	Y	C/NC	Lo	Y	Mod
2	Zinc	435/435	4.3	8,500	234	Y	NC	Lo	Y	Mod
3	Manganese	434/435	6.6	2,910	122	P	NC	Lo	Y	Mod
4	Lead	430/434	0.74	5,900	297	Y	NC	Lo	Y	Mod
5	Magnesium	430/435	72	24,000	2,062	N	NC	Lo	Y	Mod
6	Nickel	428/435	2.8	270	27	P	NC	Lo	Y	Mod
7	Copper	409/435	2	2,700	72	Y	NC	Lo	Y	Mod
8	Arsenic	382/436	0.56	135	8	P	C/NC	Lo	Y	Mod
9	Mercury	172/436	0.11	4.7	0.6	Y	NC	Lo	Y	Mod
10	Cyanide, Total	149/413	0.696	231	18	Y	NC	Lo	Y	Mod
11	Selenium	141/435	0.58	16	2	N	NC	Lo	Y	Mod
12	Beryllium	30/435	0.526	3.8	1.2	N	C	Lo	Y	Mod
13	Antimony	5/435	7.1	132	38	N	NC	Lo	Y	Mod

Key at end of table.

Table 5-2

OBSERVED INORGANIC CONSTITUENTS RANKED ACCORDING TO FREQUENCY OF DETECTION

Rank	Chemical	Frequency of Detection (Hits/Samples)	Concentration (Soil - mg/kg) (Groundwater - µg/L) Minimum	Maximum	Average	Association with MGP or Gas Distribution	Toxicity	Bioaccumulation Potential	Persistence	Mobility[a]
Groundwater										
1	Zinc	75/75	11.5	8,400	1,112	Y	NC	Lo	Y	Hi
2	Manganese	74/75	14.5	4,600	1,098	P	NC	Lo	Y	Hi
3	Magnesium	74/75	8,050	888,000	102,459	N	NC	Lo	Y	Hi
4	Lead	68/75	6	6,820	465	Y	NC	Lo	Y	Hi
5	Chromium	66/75	11	7,600	263	Y	C/NC	Lo	Y	Hi
6	Copper	58/75	21	3,800	476	Y	NC	Lo	Y	Hi
7	Arsenic	56/75	5.5	666	57	P	C/NC	Lo	Y	Hi
8	Nickel	56/75	21	2,300	222	P	NC	Lo	Y	Hi
9	Cyanide, Total	17/19	0.01	23	4.8	Y	NC	Lo	Y	Hi
10	Mercury	17/67	0.24	3.62	1.0	Y	NC	Lo	Y	Hi
11	Selenium	11/75	5.1	220	34	N	NC	Lo	Y	Hi
12	Beryllium	5/75	5.3	12.2	8.7	N	C	Lo	Y	Hi
13	Antimony	1/75	63	63	—	N	NC	Lo	Y	Hi

Key at end of table.

Table 5-2 (Cont.)

[a] Mobility of inorganics and metals depends upon the redox state, solubility, and salt of the particular chemical.

Key:

C = Carcinogen
Hi = High
Lo = Low
Mod = Moderate
N = No
NC = Non-carcinogen
P = Possible
Y = Yes

Table 5-3

PHYSICAL-CHEMICAL PROPERTIES OF PRINCIPAL CHEMICAL CONSTITUENTS AT THE BROOKLYN BOROUGH GAS WORKS SITE

Chemical Name	CAS Number	Molecular Weight (g/mole)	Physical State at 20°C	Water Solubility (mg/L)	Reference	K_H (atm·m³/mol)	Reference	K_{oc} (mg/L)	Reference	Log K_{ow}	Reference	Specific Gravity	Reference	Biochemical Factor	Reference
Noncarcinogenic PAHs															
1-Methylnaphthalene	90-12-0	142.2	Liquid	26 - 28 at 25°C in distilled H_2O	B	—	—	—	—	—	—	—	—	—	—
2-Methylnaphthalene	—	142.2	Solid	—	—	—	—	2.0×10^3	G	3.30	I	—	—	—	—
Acenaphthene	83-32-9	154.2	Solid	3.42	Q	1.9×10^{-4}	Q	17.8	Q	3.92	Q	—	—	—	—
Acenaphthylene	208-96-8	152.2	Solid	3.93 at 25°C in distilled H_2O	B	2.8×10^{-4}	Q	4,786	Q	4.07	Q	—	—	—	—
Anthracene	120-12-7	178.2	Solid	0.6 at 25°C in SW	B	6.5×10^{-5}	R	2.2×10^4	F	4.54	F	1.25	0	675	R
Benzo(g,h,i)perylene	191-24-2	276	Solid	0.00026 at 25°C	B	1.4×10^{-7}	Q	7.76×10^6	Q	8.1	Q	—	—	—	
Fluoranthene	206-44-0	202	Solid	0.1 ± 0.06 ppm at 22°C in SW	B	1.6×10^{-2}	Q	4.17×10^4	Q	5.2	Q	1.252	Q	—	—
Fluorene	86-73-7	116	Solid	0.8 ± 0.2 ppm at 22°C in SW	B	2.1×10^{-4}	Q	5.01×10^3	Q	4.18	Q	1.203	Q	—	—
Naphthalene	91-20-3	128.2	Solid	20 ± 2 at 22°C in SW	B	4.83×10^{-4}	R	871	R	3.30	Q	1.162	O	426	R
Phenanthrene	85-01-8	178.2	Solid	0.6 ± 0.1 at 22°C in SW	B	3.9×10^{-5}	Q	2.29×10^4	Q	4.46	B	—	—	—	—

Key at end of table.

Table 5-3

PHYSICAL-CHEMICAL PROPERTIES OF PRINCIPAL CHEMICAL CONSTITUENTS AT THE BROOKLYN BOROUGH GAS WORKS SITE

Chemical Name	CAS Number	Molecular Weight (g/mole)	Physical State at 20°C	Water Solubility (mg/L)	Reference	K_H (atm·m³/mol)	Reference	K_{oc} (mg/L)	Reference	Log K_{ow}	Reference	Specific Gravity	Reference	Bio-chemical Factor	Reference
Pyrene	129-00-0	202.3	Solid	0.032 at 24°C (practical grade)	B	1.1×10^{-5}	Q	7.6×10^{4}	Q	5.04	Q	—	—	—	—
Carcinogenic PAHs															
Benzo(a)anthracene	56-55-3	228	Solid	0.044 at 24°C (practical grade)	B	1.16×10^{-6}	A	1.91×10^{5}	G	5.60	I	—	—	—	—
Benzo(a)pyrene	50-32-8	252.3	Solid	0.005 - 0.010 at 22°C in SW	B	2×10^{-6}	Q	3.98×10^{5}	Q	6.04	Q	1.351	Q	—	—
Benzo(b)fluoranthene	205-99-2	252	Solid	2.6×10^{-4}	Q	1.4×10^{-7}	Q	7.7×10^{6}	Q	8.1	Q	—	—	—	—
Benzo(k)fluoranthene	207-08-9	252	Solid	0.00055 AT 25°C	Q	1.0×10^{-3}	Q	4.4×10^{6}	Q	6.85	Q	—	—	—	—
Chrysene	218-01-9	228.2	Solid	0.017 at 24°C in SW (practical grade)	B	7.3×10^{-20}	Q	2.4×10^{5}	Q	5.61	Q	—	—	—	—
Dibenzo(a,h)anthracene	53-70-3	278.4	Solid	5×10^{-4}	Q	7.33×10^{-9}	Q	1.6×10^{6}	Q	6.36	Q	1.282	Q	—	—
Indeno(1,2.3-cd)pyrene	193-39-5	276.3	Solid	6.2×10^{-2}	Q	3.0×10^{-20}	Q	3.1×10^{7}	Q	7.70	Q	—	—	—	—
Volatiles															
Benzene	71-43-2	78.1	Liquid	1790	E	5.43×10^{-3}	K	31	R	2.13	E	0.876	P	4.27	R
Ethylbenzene	100-41-4	106.2	Liquid	161	E	8.44	E	250	R	3.15	E	0.866	O	15	R

Key at end of table.

Table 5-3

PHYSICAL-CHEMICAL PROPERTIES OF PRINCIPAL CHEMICAL CONSTITUENTS AT THE BROOKLYN BOROUGH GAS WORKS SITE

Chemical Name	CAS Number	Molecular Weight (g/mole)	Physical State at 20°C	Water Solubility (mg/L)	Reference	K_H (atm·m³/mol)	Reference	K_{oc} (mg/L)	Reference	Log K_{ow}	Reference	Specific Gravity	Reference	Bio-chemical Factor	Reference
Styrene	100-42-5	104.1	Liquid	300	B	2.83×10^{-3}	R	920	R	2.95	R	0.905	B	13.5	R
Toluene	108-88-3	92.1	Liquid	535	E	5.94×10^{-3}	E	300	J	2.73	E	0.867	P	37	R
o-xylene	95-47-6	106.2	Liquid	175	B	—	—	284	G	2.77	B	-	—	—	—
m-xylene	108-38-3	106.2	Liquid	130	F	—	—	764	G	3.20	B	-	—	—	—
p-xylene	106-42-3	106.2	Liquid	198	B	—	—	681	G	3.15	B	-	—	—	—
PCBs	1336-36-3	328	Liquid	0.031 at 25°C	J	1.07×10^{-3}	L	5.3×10^{5}	J	6.04	J	1.44	M	10^{5}	D
Metals															
Zinc and compounds	7440-66-6	65.4	Solid	—	—	—	—	—	—	—	—	7.14	0	47	N
Manganese	7439-96-5	54.90	Solid	—	—	—	—	—	—	—	—	7.26	0	—	—
Lead and Compounds (inorganic)	7439-92-1	207	Solid	—	—	—	—	—	—	—	—	11.30	0	49	N
Chromium (III)	16065-83-1	—	Solid	—	—	—	—	—	—	—	—	—	—	—	—
Nickel	7440-02-0	58.70	Solid	—	—	—	—	—	—	—	—	8.9	0	47	N
Copper	7440-50-8	63.60	Solid	—	—	—	—	—	—	—	—	8.94	0	36	N
Arsenic and Compounds	7440-38-2	74.90	Solid	—	—	—	—	—	—	—	—	5.73	0	44	N
Mercury	7439-97-6	201	Solid	—	—	—	—	—	—	—	—	13.53	0	4,600	N
Inorganics															
Cyanide	57-12-5	26.020	Solid	—	—	—	—	—	—	—	—	—	—	—	—

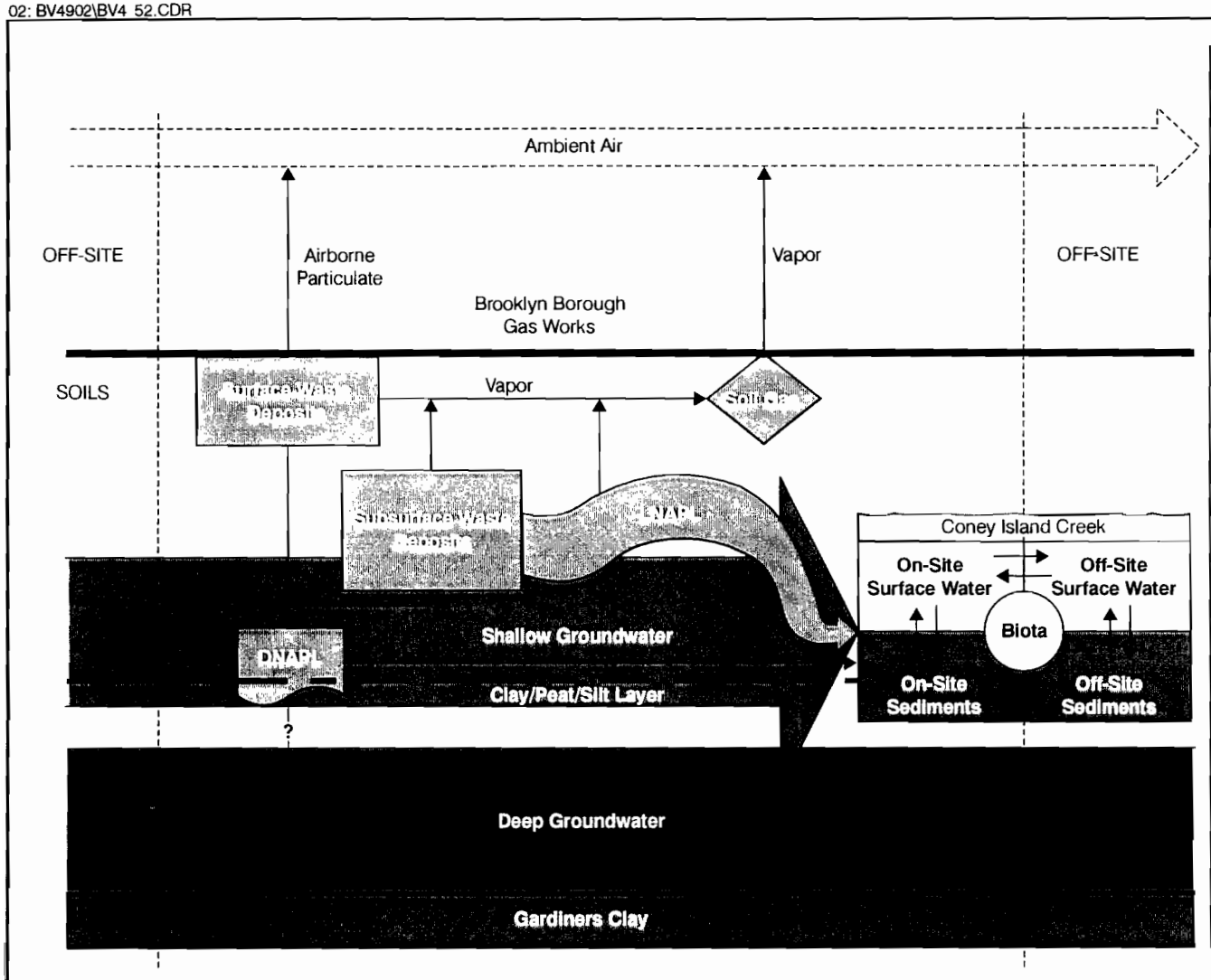
Key at end of table.

Table 5-3 (Cont.)

Key:

A = Risk Assessment Information Database (RASID), Ecology and Environment, Inc., 1993.
B = Verschueren (1983), sw = seawater.
C = Mackay and Shiu (1981).
D = Lyman *et al.* (1983).
E = Howard (1989).
F = Schlautman and Morgan (1993).
G = Calculated from log K_{oc} = log K_{ow} - 0.317 (Karickhoff 1984).
H = Ecology and Environment, Inc. 1991.
I = Ecology and Environment, Inc. 1993.
J = Mabey *et al.* (1982).
K = Mackay and Shiu (1981).
L = EPA 1986.
M = N.I. Sax 1975.
N = EPA 1980.
O = EWindholz 1976.
P = CRC 1986.
Q = Montgomary and Welkom 1990, 1991.
R = WPA 1989.

02: BV4902\BV4_52.CDR



Exposure Pathway	Exposure Route	Receptors: On-Site Worker	On-Site Trespasser	Off-Site Adult	Off-Site Adolescent	Biota Terrestrial	Biota Aquatic
Airborne Particulate	Inhalation	+	+	+	+	+	–
Vapor	Inhalation	+	+	+	+	+	–
Surface Soil	Direct Dermal Contact	+	+	–	–	+	–
	Incidental Ingestion	+	+	–	–	+	–
Subsurface Soil	Direct Dermal Contact	+	–	–	–	–	–
	Incidental Ingestion	+	–	–	–	–	–
	Vapor Inhalation	+	–	–	–	–	–
Surface Water	Direct Dermal Contact	–	–	+	+	+	+
	Incidental Ingestion	–	–	+	+	+	+
Sediment	Direct Dermal Contact	–	–	+	+	–	+
	Incidental Ingestion	–	–	+	+	–	+

SOURCE: Ecology and Environment, Inc., 1997

KEY:

+ Exposure to a Receptor through that Pathway/Route is likely

– Exposure to a Receptor through that Pathway/Route is unlikely

Figure 5-1 RISK SYSTEM MODEL OF THE BROOKLYN BOROUGH GAS WORKS

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A Quality Assurance/Quality Control Overview

A.1 Introduction

Ecology and Environment, Inc., (E & E) conducted Phases II through VI of the investigation of the former Brooklyn Borough Gas Works property as described in Section 2 of this report. Laboratory analyses for these phases were performed by E & E's Analytical Services Center (ASC). This appendix reviews the quality assurance/quality control (QA/QC) program implemented for the field investigations and laboratory analyses during all phases of E & E's work.

Specific QA/QC procedures are described in the quality assurance project plan (QAPjP) used for the Phase VI supplemental RI of the property (E & E 1996b). The QAPjP was originally produced as part of the Phase II Geotechnical Investigation in 1993 but was updated as necessary during subsequent phases of work. The QAPjP describes procedures for sample handling and collecting field QC samples, laboratory analytical methods and QC samples, and analytical data review. Procedures for sample collection are described in the individual work plans for each phase (E & E 1993f, 1993g, 1993h, 1993i, and 1996a)

A comprehensive analytical data review was performed prior to the release of the data during each phase of work. The findings are presented in data review memoranda (DRMs), which—along with the laboratory reports for each phase, including Phase VI, of the RI—are being submitted as Volume II of this RI report. The reports for the individual phases also may include a summary of the data review in a QA/QC section (E & E 1993a, 1993b, 1993c, 1993d, 1994a, 1994b, and Appendix B of this report).

Overall, the data review findings indicate the QA/QC procedures were implemented as described in the QAPjP and work plans, and that the data are usable for all purposes of this RI. Specific deviations from the QAPjP or work plans that may have minor impacts on data usability are described in the DRMs.

This appendix summarizes the overall data quality objectives (DQOs) of the RI and the general QA/QC program implemented to meet these objectives. The appendix also briefly describes the QA/QC procedures used for fieldwork, laboratory analysis, and analytical data review. The final section of this appendix summarizes the overall completeness and usability of the data.

A.2 Data Quality Objectives

The overall QA objectives of E & E's investigations are described in Section 4 of the QAPjP (E & E 1996b). For all phases of the RI, Level III-type quality was used for most analyses (as defined in EPA 1987). The analytical methods were performed to meet the

precision and accuracy criteria specified in the QAPjP. These criteria were approved as within United States Environmental Protection Agency (EPA) method requirements and New York State guidelines. Therefore, the data are useful for site characterization to evaluate the source, nature, and extent of chemical constituents in the environment and to assess the fate and transport of the constituents in environmental media. The data also may be used for risk assessment and/or evaluation of remedial alternatives. The specific data uses and objectives for various phases are described in the individual work plans. The quality of the sampling and analytical data was evaluated, as described in Section A.4 below, to determine whether the DQOs for the RI were met.

A.3 Field Quality Control Procedures

E & E collected surface and subsurface soil samples, sediment and surface water samples, and groundwater samples during five field investigation phases as described in Section 2 of this report. The proposed sample locations; analytical parameters; and sample collection procedures, container requirements, preservation, and holding times associated with the sampling effort were included in the work plan for each phase. Overall, samples were collected, preserved, and analyzed within the holding times as required by each work plan. The deviations from the work plans, which consisted of changes in sample locations or a few cases of reanalysis of samples beyond holding times, had no impact on data usability.

Field QC samples were collected to evaluate the overall effectiveness of the sample collection procedures. Field blanks were collected to assess possible sources of sample contamination during sampling and transportation to the laboratory. A rinsate blank was collected every 20 samples or at least once per sampling event. Trip blanks were shipped every day that water samples were collected for volatile organic compounds (VOCs) analyses. A field duplicates was collected every 10 samples to evaluate the overall precision of the sampling and analytical procedures. Field QC samples were collected as specified in the work plans.

A.4 Analytical Procedures

E & E's ASC in Lancaster, New York, performed chemical analyses on the original and field QC samples collected. The samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (P/PCBs), polynuclear aromatic hydrocarbons (PAHs), total recoverable petroleum hydrocarbons (TRPH), select metals, and various general chemistry parameters using the most current EPA-approved methods (see

Section 8 of the QAPjP [E & E 1996b] or the DRMs). The ASC is certified for all analytical methods by the New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) and uses NYSDOH guidelines for the analysis and reporting of all results. The laboratory analyzed and reported results for batch QC samples, including a method blank, method spike blank/laboratory control sample (MSB/LCS), and matrix spike/matrix spike duplicate (MS/MSD) or MS/matrix duplicate (MD). The laboratory also analyzed calibration and reference standards per the method and NYSDOH requirements, but the results were not summarized in the reports. The laboratory case narratives and sample tracking forms provided with the laboratory reports indicate any deviations from the approved methods or guidelines, including calibrations outside internal control criteria (see Volume II of this report). The laboratory used the most current method, internal control limits, and quantitation limits, provided that these methods or limits met or exceeded the requirements of the QAPjP. Overall, the laboratory analyses were performed as required, and any deviations that impacted data quality were generally due to sample matrix or the high-level contaminants present in the samples.

A.5 Procedures for Analytical Data Review and Evaluation

Data quality reviews focus on deviations from expected QC activities, problems encountered, and the acceptability of the methodologies used. The evaluation of the analytical data with respect to project- and method-specific quality objectives was performed using the results of laboratory batch QC samples and surrogate recoveries where applicable. Field QC data were used to evaluate the accuracy and precision of the analytical results and field sample collection methods. The sections that follow present the evaluation procedures used for laboratory and field QC samples.

A.5.1 Laboratory Data Quality Evaluation

All reported analytical data were reviewed and validated by a senior chemist for precision, accuracy, representativeness, completeness and comparability using procedures outlined in the QAPjP. Generally, the data are reviewed against the method requirements, the control limits presented in the QAPjP and the current internal control limits statistically generated by the laboratory for that method. For data qualification, E & E followed the general guidelines referenced in the following documents:

- *National Functional Guidelines for Organic Data Review* (EPA 1994a);

- *National Functional Guidelines for Inorganic Data Review* (EPA 1994b); and

- *New York State Department of Environmental Conservation (NYSDEC) Analytical Services Protocol, October 1995* (NYSDEC 1995).

Based on the guidance provided in these documents, professional judgment, and the QC limits presented in the E & E QAPjP (1996b) and the current method QC limits, data that meet acceptance limits for all laboratory and field QC were not qualified and should be considered usable as reported. Data with slight QC problems should be considered usable for this project with qualifications. No data with excessive QC problems were identified during the evaluation. A summary of the usability of the results is presented in Section A.5 of this appendix.

Analytical results are stored by the ASC laboratory in both electronic and hard-copy formats. Hard-copy data packs for each laboratory job are reviewed, and qualifiers are recorded on the data pack. DRMs documenting the analytical procedures and results of the data evaluation are created for each laboratory job and are provided with the raw analytical data. Validation qualifiers are added to these sample results in the laboratory database. The data are exported from the laboratory to an external database, and the data are sorted to generate data summary reports. The senior data review chemists performs an overall review of the electronic data when it is exported to ensure that the electronic and hard-copy data match. Laboratory QC results, including MS/MSDs and laboratory blanks, are tracked using a laboratory data management system and are not exported to the technical staff.

A.5.2 Field Data Quality

Field duplicate samples were collected to assess the quality of the field sampling activities. The results are expected to have more variability than laboratory duplicates, which measure only laboratory precision. It is also expected that soil field duplicates will exhibit greater variance than water field duplicates because of the difficulties associated with collecting identical field samples. The QC criteria used to assess field duplicate samples for this project were limits of 40% relative percent difference (RPD) for waters and 70% RPD for soils, or twice the general laboratory duplicate criteria. There are no guidelines regarding data qualification based on poor field duplicate precision. Professional judgment was used to determine whether to qualify results. To facilitate the comparison of the original and duplicate sample data, all samples were assigned a similar client identification (ID) number except that "DS" was used for the field duplicate.

Field blanks were first compared to the laboratory blanks to ensure that the source of the contamination was not the laboratory. If field blanks indicate field contamination, the source is evaluated and the data are qualified similar to the laboratory method blanks, based on professional judgment.

A.6 Data Usability Summary

Data were reviewed for laboratory precision, accuracy, and completeness in accordance with the QAPjP (E & E 1996b), EPA-approved methods, and NYSDOH guidelines. For this project, tuning/instrument performance, initial and continuing calibration, and compound identification and quantitation information were not required in the laboratory report, and therefore were not reviewed except as noted by the laboratory. Laboratory data qualifiers for compound identification and quantitation were accepted, and additional data review qualifiers were added as noted in the DRMs. Definitions of all data qualifiers used in these reviews are given as follows:

- J - Reported result is qualitatively accurate, but quantitatively imprecise, and is considered an estimated value. The data should be seriously considered for decision-making and are usable for many purposes;
- L - Reported result is qualitatively accurate, but quantitatively biased low. The data should be seriously considered for decision-making and are usable for many purposes;
- K - Reported result is qualitatively accurate, but quantitatively biased high. The data should be seriously considered for decision-making and are usable for many purposes;
- ND - Analyte was not detected; the reported value is the quantitation limit adjusted for sample weight/sample volume, extraction volume, percent solids, and sample dilution;
- UJ - Quantitation limit is an estimated value because of a variance from quality control limits;
- UL - Quantitation limit is biased low because of a result below quality control limits;
- UK - Quantitation limit is biased high because of a result above quality control limits;
- B - Reported result is considered as not detected because of presence in field or laboratory blanks. Reported result may be considered as an elevated quantitation limit;

- N - There is presumptive evidence leading to identification of the analyte, but the analyte was not confirmed by further gas chromatography/mass spectrometry (GC/MS) analysis;

- C - There is presumptive evidence leading to identification of the analyte, and the analyte was confirmed by further GC/MS analysis;

- R - Reported result or quantitation limit is rejected and unusable for all purposes. The analyte was analyzed for, but the presence of the analyte has not been verified; and

- EJ - Reported result exceeds the calibration limit for the analysis and is considered an estimated value.

All data are usable for purposes of this project, except those qualified "B" or "R" or both. Results qualified "R," as rejected ,indicate that the data are unusable for all project purposes. The "R" flag is generally used to reject results that were part of a reanalysis or dilution and to indicate which results should be used for data reporting. Results were qualified "B," as blank contaminated, if, as in most cases, the blank contamination was related to low levels of common laboratory contaminants.

Throughout the field investigations, the only problem indicated by the field blanks was the potential for cross contamination because of high concentrations of petroleum products. Overall, field procedures were modified to limit the potential for cross contamination, and the field blank results indicate that levels of cross contamination were too low to impact data usability. The field duplicate, surrogate recoveries, and MS/MSD results indicate potential data usability concerns because of the high levels of contaminants or matrix interferences present in the samples. Resampling or reanalysis will not change the quality of the data. The specific concerns are identified in the DRMs and indicated by data qualifiers. The qualification of the data does impact the use of the results for the general data needs of the RI, but qualifiers should be evaluated for specific uses such as comparison to numerical criteria.

A sample analysis was considered incomplete if any parameters included in the analysis were qualified "R" and the sample was not reanalyzed. Any matrix effects or analysis limitations confirmed by the laboratory reanalysis would be corrected by resampling or further reanalysis, and therefore the result is considered complete. Overall, the analytical data met or exceeded the 95% completeness objective for the project, and no substantial field or analytical problems were indicated.

B Phase VI Supplemental Remedial Investigation

The Phase VI supplemental remedial investigation (RI) consisted of a subsurface geological and hydrogeological investigation of the eastern area (the currently closed baseball fields) of the Brooklyn Borough Gas Works property. This study was conducted from October 28 through November 8, 1996; from February 5 through 19, 1997; from June 16 through 19, 1997; and on August 27, 1997.

The objective of this supplemental RI field effort was to collect additional subsurface soil and groundwater samples to characterize the subsurface conditions of the eastern area. This appendix reports on the supplemental RI activities conducted during Phase VI, including investigation procedures used; borehole drilling, trench excavation, and monitoring well construction logs; slug test data with calculated hydraulic conductivities; and subsurface soil and groundwater analytical data.

The field investigation included the collection of surface soil samples (see Figure 2-5), collection of subsurface soil samples during the installation of 21 borings (see Figure 2-6 of main report), and installation of 11 trenches (see Figure 2-8 of main report) and seven shallow groundwater monitoring wells (see Figure 2-7 of main report) in the eastern area. Slug tests were performed on the seven new wells to calculate hydraulic conductivities. Groundwater samples were collected from the seven new shallow wells in the eastern area and from the 13 shallow and four deep monitoring wells installed in the western area of the property during Phases II and V in February 1997. In June 1997, groundwater samples were collected from the ten shallow and one deep groundwater monitoring wells.

B.1 Borehole and Monitoring Well Installation

Surface Soil Sampling

During the June 1997 Phase VI field investigation, two surface soil samples (SS74 and SS75) (see Figure 2-5) were collected from the 0-to-6-inch interval at the locations of BH74 and BH75 prior to installing these two new boreholes. The soil samples were submitted for the analyses listed in Table B.1-1. Table B.1-15 summarizes the analytical data for parameters detected in the surface soil samples.

On August 27, 1997, resampling of two Phase II surface soil locations (SS28 and SS32; see Figure 2-5) was conducted from the 0-to-6-inch depth interval. Two samples were collected from each location and submitted for lead analysis only. Samples F-1 and F-2 were collected in the area of SS32, and samples G-1 and G-2 were collected in the area of SS28. The analytical results for these four samples are presented in Section B.2.1, Soil Sampling.

Borehole Installation

In October 1996, 20 boreholes were installed at the eastern area of the property for the purpose of characterizing the subsurface soil. Seven of these boreholes were installed as monitoring wells (MW-16 through MW-22). The Geoprobe was used to collect soil samples, and a drill rig was used for monitoring well installation. The remaining 13 borings, numbered BH-55 through BH-67, were scattered throughout other parts of the property. In the main report, Figure 2-6 shows the borehole locations and Figure 2-7 shows the monitoring well locations.

MW-21 was originally proposed to be installed in the vicinity of some underground surface drainage conduits. The Geoprobe was used to install a borehole at the desired location. However, it was discovered that installation of a monitoring well borehole adjacent to the Geoprobe borehole could not be attempted because of the presence of overhead wires close to the drilling area. The monitoring well was relocated approximately 20 feet from the initial borehole, and the Geoprobe was used to install a new borehole adjacent to this well location. As a result of this situation, the first borehole was renamed BH-67, and the new borehole was named MW-21. The borehole drilling logs and analytical samples reflect these changes.

All boreholes were installed using a Geoprobe equipped with a macro-core sampler. The macro-core sampler was equipped with precleaned liners to contain the soil samples. At each borehole location, the macro-core sampler was pushed to the desired depth in 4-foot intervals. Boreholes were installed to depths ranging from 12 to 20 feet below ground surface (BGS). Sampling of each interval was attempted, and the percent of sample recovery was recorded in a

geotechnical logbook. Poor sample recovery occurred in intervals containing obstructions such as brick and concrete and in those deep intervals in which a saturated matrix was being recovered. Intervals of no recovery are indicated on the borehole drilling logs included in this appendix.

After using an organic vapor analyzer (OVA) to measure organic vapor concentrations in a macro-core sample, sample collection was attempted from each 2-foot interval. Subsurface soil samples were submitted for the analyses listed in Table B.1-1. In most cases, sufficient sample volume was recovered to perform the analyses prescribed in the supplemental RI work plan (E & E 1996a). However, some intervals contained only enough volume to fill two volatile organic analysis (VOA) vials. Several other sample intervals yielded insufficient volume to perform any of the prescribed chemical analyses. Table B.1-2 summarizes the soil sampling conducted by listing the depth intervals sampled at each borehole location and presenting analytical data for parameters detected in the soil samples. Following completion of sampling activities, boreholes were backfilled with concrete. Table B.1-3 summarizes the groundwater sampling conducted by presenting analytical data for parameters detected in the groundwater samples.

In February 1997, six additional boreholes (BH-68 through BH-73; see Figure 2-6) were installed using a Geoprobe equipped with a macro-core sampler. The same field techniques, procedures, and sampling intervals were employed as previously discussed in this section for the October 1996 borehole installations. All of the additional subsurface soil samples collected from these borings were analyzed for total and chlorine-amenable cyanides. Table B.1-4 summarizes the soil sampling conducted by listing the depth intervals sampled at each borehole location and presenting analytical data for parameters detected in the soil samples. Following completion of sampling activities, boreholes were filled with concrete.

In June 1997, two additional boreholes (BH74 and BH75; see Figure 2-6) were installed in the eastern area of the property using a Geoprobe equipped with a macro-core sampler. The same field techniques and procedures were employed as previously discussed in this section for the October 1996 borehole installations. Due to subsurface conditions (i.e., poor recoveries), soils within BH74 and BH75 were collected and analyzed in 4-foot intervals. Analytical data for these boreholes were included within each respective 2-foot interval for the purposes of contouring subsurface analytes in Figures 4-5, 4-6, and 4-7 (e.g., for the 0-to-4-foot interval, data was included within both the 0-to-2-foot and 2-to-4-foot intervals). All of the subsurface soil samples collected from these borings were analyzed for VOCs, PAHs, Pest/PCBs, inorganics, TRPH, and total and amenable cyanide. Table B.1-16 summarizes the soil sampling conducted by listing the depth intervals sampled at each borehole location and presenting analytical data for

parameters detected in the soil samples. Following completion of sampling activities, the boreholes were filled with concrete.

Monitoring Well Installation

Seven shallow groundwater monitoring wells (MW-16 through MW-22) were installed at the property. Boreholes were augured to a depth ranging from approximately 13 to 16 feet BGS. Groundwater wells were constructed of 2-inch inside-diameter, stainless-steel screen and casing. Wells MW-16 and MW-17 were equipped with a 3-foot stickup and a locking, protective steel casing. Flush-mounted, locking curb boxes were installed over wells MW-18 through MW-22. Table B.1-5 lists the well construction data of these wells and all wells previously installed by E & E on the Brooklyn Borough Gas Works property.

Each new well was developed by use of a hand bailer. Records of pH, specific conductivity, and turbidity were maintained throughout the development process (see Table B.1-6). Development was ceased upon stabilization of pH.

Groundwater Sampling

Groundwater samples were collected from each of the seven new and 13 previously installed shallow groundwater monitoring wells, as well as from the four deep groundwater monitoring wells at the western area of the property. Initially, a headspace reading of organic vapors was obtained at each wellhead. Following this reading, a pair of liquid-level measurements were read and recorded. The first reading was the thickness of any floating oil layer, if present. The second reading was the depth to water. The datum for both readings was the top of the inner well casing. These sets of readings were recorded at both high and low tide on the first two days of sample activities, and at low tide during the third day of sampling activities. Tables B.1-7 through B.1-11 present these liquid-level readings.

Purging procedures were conducted on each well following collection of liquid-level measurements. Readings of pH, temperature, and conductivity were recorded before and after each standing well volume was purged. Purging continued until pH stabilized. Table B.1-12 lists the physical parameter readings collected during shallow groundwater monitoring well purging. Table B.1-13 lists the physical parameter readings collected during deep groundwater monitoring well purging. Following purging, groundwater samples were collected and submitted for the analyses listed in Table B.1-1. During groundwater sampling, two denser-than-water nonaqueous-phase liquid (DNAPL) samples were collected (one each from shallow monitoring wells MW-04 and MW-05 in the western area of the property) and submitted for petroleum

hydrocarbon fingerprinting. Analysis of these two samples showed they both contained creosote, which consists of a variety of PAHs. In addition, during the November 8 low-tide liquid-level reading subtask, three older wells installed by a previous consultant (C1W-1, C1W-6D, and C1W-6S) were checked for the presence of floating oil; their measurements are reported in Table B.1-11.

During the June 1997 Phase VI field investigation, groundwater samples were collected from each of the seven new and two previously installed shallow groundwater monitoring wells, as well as from one deep groundwater monitoring well. In addition, a shallow monitoring well (CIW-1) installed by a previous contractor was also sampled. A headspace reading of organic vapors was obtained at each wellhead, and three liquid-level measurements were read and recorded from the 20 shallow and four deep monitoring wells on the property. The first reading was the thickness of any floating oil layer, if present. The second reading was the depth to water. The datum for both readings was the top of the inner well casing. These sets of readings were recorded at high tide on the first two days of sample activities, and at low tide during the fourth day of sampling activities. Tables B.1-18 through B.1-21 present these liquid-level readings.

Purging procedures were conducted on each well following collection of liquid-level measurements. Readings of pH, temperature, and conductivity were recorded before and after each standing well volume was purged. Purging continued until pH stabilized. Table B.1-21 lists the physical parameter readings collected during groundwater monitoring well purging. Following purging, groundwater samples were collected and submitted for the analyses listed in Table B.1-1. During this sampling event, at the request of NYSDEC and Brooklyn Union, E & E collected filtered and unfiltered samples for inorganics and total and amenable cyanide analysis. A peristaltic pump equipped with a 0.45-micron in-line Geotech dispos-a-filter was used to collect the samples directly into the sample containers, minimizing contact with the atmosphere. In addition, during the June 17 high-tide liquid-level reading subtask, two older wells installed by a previous consultant (C1W-1 and C1W-6S) were checked for the presence of floating oil; their measurements are reported in Table B.1-18. During this water-level measurement, monitoring wells MW4, MW5, and DW4 were checked for DNAPL. MW4 was the only well that had any measurable DNAPL present (see Table 1-18).

Trenches

In February 1997, 27 trenches (TP51-TP75, TP77, and TP78) were installed in the eastern area of the property for the purpose of characterizing the shallow subsurface soils. A backhoe was used to excavate the trenches. Section B.6 contains detailed descriptions of the subsurface soils and materials encountered in each excavated trench. In the main report, Figure

2-8 shows the trench locations. Twelve soil samples, including a duplicate, were collected from 11 of the 27 trenches installed.

Trench locations were selected on an approximate 100- by 100-foot grid system (Figure 2-8). The trenches were excavated by a backhoe to an approximate size of 3 by 6 feet to varying depths. The excavations were inspected, and the subsurface soils geologically described. Excavated soils were placed on thick plastic adjacent to the trench. Samples were collected at 11 of the 27 trenches. At the completion of the inspection and sampling, all soils were returned to the excavation. The backhoe was decontaminated between each trench excavation and prior to and at completion of this field investigation to prevent any cross contamination.

Each excavation was monitored with an OVA. Each trench was surveyed with the OVA to measure organic concentrations. Twelve subsurface soil samples, including one duplicate, were collected from 11 of the 27 trenches. Ten of the samples, including the duplicate, were analyzed for total cyanide, inorganics, pesticides/polychlorinated biphenyls (PCBs), and total recoverable petroleum hydrocarbons (TRPH). Four of these 10 samples were also analyzed for PAHs. The remaining two samples, TP70S and TP78S, were collected and analyzed for total cyanides only. Table B.1-14 presents analytical data for parameters detected in the subsurface soil samples collected from the trenches.

Table B.1-1

SOIL AND GROUNDWATER SAMPLE ANALYSES
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

SOIL ANALYSES

Boreholes and Monitoring Wells (Installed in October 1996)	Boreholes (Installed in February 1997 and June 1997)	Trenches (Installed in February 1997)
Organics		
Volatile organic compounds (VOCs)		
Total recoverable petroleum hydrocarbons (TRPH)		TRPH
Polynuclear aromatic hydrocarbons (PAHs)		PAHs
Pesticides		Pesticides
Polychlorinated biphenyls (PCBs)		PCBs
Inorganics		
Selected metals	Total cyanide Chlorine-amenable cyanide	Total cyanide Chlorine-amenable cyanide
Cyanide		

GROUNDWATER ANALYSES

November 1996	June 1997
Organics	**Organics**
Volatile organic compounds (VOCs)	Volatile organic compounds (VOCs)
Total recoverable petroleum hydrocarbons (TRPH)	Total recoverable petroleum hydrocarbons (TRPH)
Polynuclear aromatic hydrocarbons (PAHs)	Polynuclear aromatic hydrocarbons (PAHs)
Semivolatile organic compounds (SVOCs)	Semi volatile organic compounds (SVOCs)
Pesticides	Pesticides
Polychlorinated Biphenyls (PCBs)	Polychlorinated Biphenyls (PCBs)
Inorganics	**Inorganics**
Selected metals	Selected metals - filtered and unfiltered
Other	**Other**
Total hardness	Total hardness
Total dissolved solids (TDS)	Total dissolved solids (TDS)
Chlorosity	Chlorosity
	Total cyanide - filtered and unfiltered
	Chlorine-amenable cyanide - filtered and unfiltered

Note: MW-2 and MW-6 were sampled only for total and chlorine-amenable cyanide in June 1997.

ANALYTICAL DATA FOR PARAMETERS DETECTED IN SOILS
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

			SAMPLE ID:	BH55S-01	BH55S-03	BH55S-05DS	BH55S-05	BH55S-07	BH55S-09DS	BH55S-09	BH56S-01	BH56S-03	BH56S-05	BH56S-06DS	BH56S-06	BH56S-07	BH57S-01	BH57S-03	BH57S-04
			DATE:	10/29/96	10/29/96	10/29/96	10/29/96	10/29/96	10/29/96	10/29/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96
			DEPTH:	2-4'	6-8'	10-12'	10-12'	14-16'	18-20'	18-20'	2-4'	6-8'	10-12'	12-14'	12-14'	14-16'	2-4'	6-8'	8-10'
ANALYSIS	PARAMETER	UNITS																	
PAH	1-Methylnaphthalene	ug/kg		ND	ND	ND	3620	ND	ND	ND	466		ND	ND	ND	ND	ND	263000	
	2-Methylnaphthalene	ug/kg		ND	ND	6570	1990	ND	ND	ND	563	806 K	ND	ND	ND	241	ND	166000	
	Acenaphthene	ug/kg		ND	ND	ND	ND	25200	ND	ND	ND	1060 K	ND	ND	ND	ND	ND	ND	
	Acenaphthylene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Anthracene	ug/kg		43.4	568	1730	1750	1640	47.1	ND	60.7	81.4 K	ND	ND	ND	ND	659	25100	
	Benzo(a)anthracene	ug/kg		119	1420	ND	ND	4910	70.6	ND	241	419 K	ND	ND	ND	ND	1480	36500	
	Benzo(a)pyrene	ug/kg		119	1180	750	409	2020	ND	ND	297	300 K	ND	ND	ND	254	1900	18800	
	Benzo(b)fluoranthene	ug/kg		109	911	600	479	1760	ND	ND	310	308 K	ND	ND	ND	ND	1500	17100	
	Benzo(ghi)perylene	ug/kg		130	734	ND	ND	ND	ND	ND	332	208 K	ND	ND	ND	ND	1360	9650	
	Benzo(k)fluoranthene	ug/kg		57.5	556	588	491	882	ND	ND	141	179 K	ND	ND	ND	ND	819	9460	
	Chrysene	ug/kg		152	1540	1500	3740	2770	ND	36.2	343	381 K	ND	ND	ND	ND	2200	51200	
	Dibenzo(a,h)anthracene	ug/kg		ND	ND	ND	ND	ND	ND	ND	227	355 K	ND	ND	ND	ND	708	7710	
	Fluoranthene	ug/kg		315	3670	9570	9000	7810	273	138	726	636 K	ND	ND	ND	ND	4840	126000	
	Fluorene	ug/kg		28.2	ND	3110	2690	768	79.3	38.8	27.1	48.4 K	ND	ND	ND	ND	668	52300	
	Indeno(1,2,3-cd)pyrene	ug/kg		92.3	604	ND	ND	995	ND	ND	176	189 K	ND	ND	ND	ND	733	4950	
	Naphthalene	ug/kg		467	3200	ND	315	ND	ND	ND	44.5 J	759 K	ND	ND	ND	ND	ND	230000	
	Phenanthrene	ug/kg		217	2130	2190	1290	5160	45.8	ND	276	261 K	ND	ND	ND	ND	3000	143000	
	Pyrene	ug/kg		315	2600	ND	ND	4030	ND	ND	506	656 K	ND	ND	ND	ND	2920	67900	
VOC	1,1,2-Trichloroethane	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND L	ND	ND	ND	ND J	ND	ND	ND
	2-Butanone	ug/kg		ND	ND	ND	4.39 J	ND	ND	ND	ND	ND L	ND	ND	ND	45.8 K	11.0 J	39.0	ND
	4-Methyl-2-pentanone	ug/kg		ND	ND	ND	ND L	ND	ND	ND	ND	ND L	ND	ND	ND	ND J	ND	ND	ND
	Acetone	ug/kg		5.96 J	ND	20.6	24.5	9.43 J	14.9	25.4 J	ND	ND L	ND	3.72 J	5.65 J	228 K	50.1	173	23.1
	Benzene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND L	ND	ND	ND	ND J	8.70	57.8	3.68 J
	Carbon disulfide	ug/kg		ND	ND	ND	ND	2.25 J	2.02 J	ND	ND	ND L	ND	ND	ND	49.5 K	ND	2.89 J	ND
	Ethylbenzene	ug/kg		ND	ND	2.63 J	ND L	6.75	ND	ND	ND	ND L	ND	ND	2.22 J	6.70 JK	2.00 J	156	ND
	Methylene chloride	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND L	ND	1.86 J	ND	ND J	ND	ND	ND
	Styrene	ug/kg		ND	ND	ND	ND L	ND	ND	ND	ND	ND L	ND	ND	ND	ND J	ND	10.1	ND
	Tetrachloroethene	ug/kg		ND	ND	ND	ND L	ND	ND	ND	ND	ND L	ND	ND	ND	ND J	ND	ND	ND
	Toluene	ug/kg		ND	ND	ND	ND L	ND	ND	ND	ND	ND L	ND	ND	ND	5.15 JK	5.60 J	95.8	ND
	Total Xylenes	ug/kg		ND	ND	2.68 J	ND L	ND	ND	ND	ND	ND L	ND	ND	ND	ND J	15.0	177	ND
	Trichloroethene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND L	ND	ND	ND	ND J	ND	ND	ND
PEST/PCB	4,4'-DDD	ug/kg		ND	16.6 J	24.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	84.7 J	ND	
	4,4'-DDE	ug/kg		ND	16.6 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	4,4-DDT	ug/kg		ND	88.8	43.0 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Aldrin	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Chlordane	ug/kg		ND	ND	ND	ND	ND	ND	ND	48.6 J	ND	ND	ND	ND	ND	174 J	ND	
	Dieldrin	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Heptachlor	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Heptachlor Epoxide	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	PCB-1242	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	909	ND	
	PCB-1248	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	PCB-1254	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5830	ND	
	PCB-1260	ug/kg		ND	ND	ND	ND	ND	ND	ND	1210	6630	ND	ND	ND	ND	1850	ND	
INORGANIC	Mercury	mg/Kg		ND	0.130	ND	ND	ND	ND	ND	0.347	0.261	ND	ND	ND	ND	0.697	ND	
	Antimony	mg/Kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	Arsenic	mg/Kg		5.08	6.22	5.06	5.75	4.62	1.03	0.718	6.95	7.96	4.29	4.76	4.97	7.68	67.4	9.78	
	Beryllium	mg/Kg		ND	ND	ND	ND	ND	ND	ND	0.674	0.590	ND	ND	ND	ND	ND	ND	
	Chromium	mg/Kg		17.6 L	23.7 L	27.0 L	45.0 L	24.4 L	4.72 L	4.40 L	25.8 J	21.7 J	11.4 J	19.9 J	29.0 J	30.8 J	21.7 J	16.6 J	
	Copper	mg/Kg		18.0	231	35.9	38.0	50.6	ND	ND	48.7	76.8	15.3	18.3	24.2	11.8	215	103	
	Lead	mg/Kg		66.6	679	99.3	33.8	223	1.35	12.9	104	127	8.75	8.04	13.2	11.0	581	105	
	Magnesium	mg/Kg		3060	3660	4350	5200	4720	648	633	8410	577	5130	3500	4300	5660	13400	1150	
	Manganese	mg/Kg		236	243	344	359	222	38.2	37.0	324 K	300 K	143 K	189 K	261 K	318 K	2910 K	76.5 K	
	Nickel	mg/Kg		24.2 L	46.3 L	86.0 L	111 L	94.2 L	5.08 L	50.3 L	26.2 L	37.8 L	72.6 L	72.0 L	108 L	23.1 L	23.6 L	24.6 L	
	Selenium	mg/Kg		1.69 L	1.56 L	1.71 L	1.61 L	1.71 L	ND L	ND L	15.9	1.56	0.969	0.951	1.11	2.44	2.75	2.67	
	Zinc	mg/Kg		76.0 L	381 L	80.3 L	67.8 L	151 L	6.59 L	6.20 L	144	148	32.5	36.2	42.7	53.2	511	42.8	
	Cyanide-Total	mg/Kg		ND	ND	ND UL	ND	ND UL	ND	ND UL	ND	ND	ND	ND	ND	ND	3.41	40.6	
TRPH	TRPH	mg/Kg		44.6 J	1680 J	8180 J	6560 J	1580 J	111 J	133 J	306 L	191 L	10.1 L	ND L	ND L	ND	1070	1560	
OTHER	Moisture Content	%		7.90	15.5	13.3	14.4	20.6	19.3	20.0	9.70	10.4	18.1	15.7	12.7	59.4	13.9	23.9	22.0

Table B.1-2

ANALYTICAL DATA FOR PARAMETERS DETECTED IN SOILS
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

ANALYSIS	PARAMETER	UNITS	SAMPLE ID:	BH57S-07	BH58S-01	BH58S-03	BH58S-05	BH58S-07	BH59S-01	BH59S-02	BH59S-03	3H59S-05DS	BH59S-05	BH59S-07	BH59S-09	BH60S-01	BH60S-02	3H60S-05DS	BH60S-05
			DATE:	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/31/96	10/29/96	10/29/96	10/29/96	10/29/96
			DEPTH:	14-16'	2-4'	6-8'	10-12'	14-16'	2-4'	4-6'	6-8'	10-12'	10-12'	14-16'	18-20'	2-4'	4-6'	10-12'	10-12'
PAH	1-Methylnaphthalene	ug/kg			ND		ND	ND	ND	ND	ND	ND	ND			ND	ND	158000	117000
	2-Methylnaphthalene	ug/kg			ND		ND	ND	ND	ND	470000	ND	1260000			ND	ND	158000	126000
	Acenaphthene	ug/kg			ND		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	Acenaphthylene	ug/kg			ND		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	Anthracene	ug/kg			ND		490	445	1400	ND	23500	902000	259000			1280	1730	ND	ND
	Benzo(a)anthracene	ug/kg			ND		1520	1330	4520	91200	39600	ND	ND			3030	3230	ND	6910
	Benzo(a)pyrene	ug/kg			29.2		1350	1580	4740	36200	ND	ND	ND			2330	3700	18400	18600
	Benzo(b)fluoranthene	ug/kg			24.8		1230	1650	3980	51900	26400	ND	118000			2800	2770	18400	13200
	Benzo(ghi)perylene	ug/kg			ND		ND	933	3010	ND	ND	ND	ND			ND	ND	ND	14600
	Benzo(k)fluoranthene	ug/kg			ND		686	603	1940	33000	16200	ND	ND			4080	2080	9350	9710
	Chrysene	ug/kg			ND		2210	1870	7640	138000	58700	ND	121000			ND	5200	17100	13300
	Dibenzo(a,h)anthracene	ug/kg			61.6		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	16000
	Fluoranthene	ug/kg			ND		5510	4020	11800	173000	144000	5150000	1580000			8970	12700	27700	26600
	Fluorene	ug/kg			ND		ND	ND	2580	47200	54300	1680000	474000			711	1850	ND	ND
	Indeno(1,2,3-cd)pyrene	ug/kg			ND		588	660	1720	ND	ND	ND	ND			1280	2080	11900	12400
	Naphthalene	ug/kg			ND		ND	2870	ND	ND	617000	ND	ND			ND	ND	553000	426000
	Phenanthrene	ug/kg			ND		2080	1580	9360	173000	191000	4120000	1210000			6760	9700	18400	16000
	Pyrene	ug/kg			ND		3060	2580	9470	145000	54300	4250000	1350000			7690	7850	27700	18600
VOC	1,1,2-Trichloroethane	ug/kg		ND	ND	ND	ND	ND L	ND	ND	48.6	ND	ND	ND	ND	ND	ND	ND L	ND
	2-Butanone	ug/kg		ND	ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	17.6 JK	ND L	ND
	4-Methyl-2-pentanone	ug/kg		ND	ND	ND	ND	ND L	ND	ND	23.8 JL	ND	33.5 J	ND	ND	ND	ND	ND L	ND
	Acetone	ug/kg		ND	ND	18.8	12.0 J	6.83 JL	10.9	94.2	79.4 J	56.4 J	120 J	60.9 J	ND	3.53 J	94.5 K	39.9 L	100
	Benzene	ug/kg		ND	ND	ND	ND	ND L	ND	119	520	44.1 J	101	30.7 J	26.8 J	ND	36.7 K	36.0 L	13.1 J
	Carbon disulfide	ug/kg		ND	ND	ND	ND	ND L	ND	ND	61.5 J	ND	ND	ND	9.20 J	ND	3.04 JK	ND L	46.7
	Ethylbenzene	ug/kg		ND	ND	ND	ND	ND L	ND	2250 EJ	10800 EJ	519	2490 EJ	2060 EJ	788	ND	23.3 K	206 L	36.3
	Methylene chloride	ug/kg		ND	ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	2.02 JB	ND L	ND
	Styrene	ug/kg		ND	ND	ND	ND	ND L	ND	ND	285	25.4 J	44.0 J	29.9 J	36.5 J	ND	5.03 JK	24.9 L	7.34 J
	Tetrachloroethene	ug/kg		ND	ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND L	ND
	Toluene	ug/kg		ND	ND	ND	ND	ND L	ND	139	1260	75.5	221	65.7	59.1	ND	13.9 K	18.3 L	14.8 J
	Total Xylenes	ug/kg		ND	ND	ND	ND	ND L	ND	73.0	3940	211	463	163	168	ND	47.3 K	78.3 L	57.2
	Trichloroethene	ug/kg		ND	ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND L	ND
PEST/PCB	4,4'-DDD	ug/kg			ND		ND	ND	37.5	ND	ND	ND	ND			ND	ND	ND	ND
	4,4'-DDE	ug/kg			ND		ND	ND	ND	ND	ND	ND	14.4 J			ND	ND	ND	ND
	4,4-DDT	ug/kg			ND		ND	ND	ND	ND	ND	ND	19.5 J			12.8 J	ND	ND	ND
	Aldrin	ug/kg			ND		45.5 K	21.5 K	ND	ND	816 K	4900 K	ND			ND	ND	ND	ND
	Chlordane	ug/kg			ND		50.6 JK	ND	517	ND	ND	ND	20.7 J			ND	ND	ND	ND
	Dieldrin	ug/kg			ND		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	Heptachlor	ug/kg			ND		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	Heptachlor Epoxide	ug/kg			ND		110 K	52.7	ND	ND	1750	1930	17.0			ND	ND	ND	ND
	PCB-1242	ug/kg			ND		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	PCB-1248	ug/kg			ND		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	PCB-1254	ug/kg			ND		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	PCB-1260	ug/kg			ND		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
INORGANIC	Mercury	mg/Kg			ND		0.321	0.763	0.170	0.561	0.543	ND	ND			0.152	0.462	ND	ND
	Antimony	mg/Kg			ND		ND	ND	ND	ND	ND	ND	132			ND	10.1	ND	ND
	Arsenic	mg/Kg			5.32 J		8.26 J	14.6 J	5.36 J	39.2 J	28.3 J	8.80 J	31.9 J			4.48	8.12	5.80	5.78
	Beryllium	mg/Kg			0.551		ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
	Chromium	mg/Kg			20.4 L		29.4 L	14.6 L	25.9 L	17.6 L	13.6 L	9.99 L	15.8 L			18.2	38.2	7.48	7.29
	Copper	mg/Kg			14.4 L		95.5 L	184 L	36.0 L	223 L	160 L	80.7 L	341 L			39.3 J	209 J	73.0 J	44.9 J
	Lead	mg/Kg			21.0 J		544 J	684 J	239 J	780 J	251 J	50.9 J	144 J			224 L	740 L	37.7 L	6.82 L
	Magnesium	mg/Kg			3650		7070	1560	5870	352	122	186	228			2560	3080	145	2450
	Manganese	mg/Kg			268 L		404 L	202 L	164 L	89.8 L	53.5 L	34.5 L	67.8 L			196	152	19.1	30.1
	Nickel	mg/Kg			35.6 L		28.2 L	16.5 L	28.3 L	23.4 L	60.6 L	18.0 L	23.6 L			35.0	56.7	17.4	23.4
	Selenium	mg/Kg			1.31		1.95	3.80	ND	6.27	4.23	ND	2.14			0.921	1.80	1.41	1.54
	Zinc	mg/Kg			45.8		385	504	200	55.7	23.8	15.5	55.9			202 J	1170 J	17.8 J	31.2 J
	Cyanide-Total	mg/Kg			ND		ND	ND	ND	220	231	27.2	213			ND	2.17	92.1	16.5
TRPH	TRPH	mg/Kg			ND		2150	187	1920	12400	12600	10000	5550			731 J	7810 J	756 J	485 J
OTHER	Moisture Content	%		13.7	7.40	18.3	18.4	30.3	7.10	36.4	31.9	22.4	30.4	41.4	36.2	14.2	13.4	24.1	24.8

ANALYTICAL DATA FOR PARAMETERS DETECTED IN SOILS
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

ANALYSIS	PARAMETER	UNITS	SAMPLE ID:	BH60S-07	BH61S-00	BH61S-01	BH61S-03	BH61S-05	BH61S-07	BH62S-01	BH62S-03	BH62S-05	BH63S-01	BH63S-03	BH63S-05	BH63S-07	BH64S-00	BH64S-01	BH64S-03
			DATE:	10/29/96	10/29/96	10/29/96	10/29/96	10/29/96	10/29/98	10/30/96	10/30/96	10/30/96	10/30/96	10/30/96	10/30/96	10/30/96	10/30/96	10/30/96	10/30/96
			DEPTH:	14-16'	0-2'	2-4'	6-8'	10-12'	14-16'	2-4'	6-8'	10-12'	2-4'	6-8'	10-12'	14-16'	0-2'	2-4'	6-8'
PAH	1-Methylnaphthalene	ug/kg		76200	ND	ND	13500	231000		ND	ND		ND	ND	ND	ND	ND	ND	308000
	2-Methylnaphthalene	ug/kg		95600	ND	ND	ND	113000		ND	ND		ND	ND	ND	ND	ND	ND	273000
	Acenaphthene	ug/kg		ND	4250 K	ND	ND	ND		ND	ND		ND	ND	ND	ND	ND	ND	ND
	Acenaphthylene	ug/kg		ND	ND	ND	ND	139000		ND	ND		ND	ND	ND	ND	ND	ND	ND
	Anthracene	ug/kg		9300	414 K	1960	2470	23100		16000	ND		1270	67900	272000	93.8	28.5	4080	17800
	Benzo(a)anthracene	ug/kg		16800	1030 K	3810	1460	54800		27500	ND		3590	156000	272000	167	92.0	2230	13000
	Benzo(a)pyrene	ug/kg		19400	1230 K	2880	1570	20200		19500	413		4750	106000	190000	250	63.5	1980	11100
	Benzo(b)fluoranthene	ug/kg		15500	928 K	2420	1680	24500		20600	378		3710	211000	150000	181	80.3	2100	10400
	Benzo(ghi)perylene	ug/kg		ND	1010 K	1270	ND	ND		11500	390		3480	111000	ND	196	105	ND	ND
	Benzo(k)fluoranthene	ug/kg		11800	716 K	1270	ND	17300 J		91600	ND		2090	70100	98000	117	ND	ND	9360
	Chrysene	ug/kg		18100	1120 K	3810	2470	49100		25200	401		4290	189000	313000	117	104	3590	15400
	Dibenzo(a,h)anthracene	ug/kg		ND	ND	2770	ND	ND		ND	ND		ND	ND	ND	ND	ND	ND	ND
	Fluoranthene	ug/kg		54300	2680 K	8300	8310	113000		63000	791		8230	612000	1140000	542	233	9900	45000
	Fluorene	ug/kg		9170	110 JK	1610	4490	31700		7450	ND		753	93400	245000	100	ND	1360	24900
	Indeno(1,2,3-cd)pyrene	ug/kg		ND	425 K	1270	ND	ND		7790	ND		2900	54500	ND	113	42.7	ND	ND
	Naphthalene	ug/kg		271000	2570 K	ND	ND	404000		ND	ND		ND	ND	2180000	708	ND	ND	521000
	Phenanthrene	ug/kg		40100	1340 K	5310	10800	105000		51500	472		4870	423000	1030000	333	93.3	6190	74600
	Pyrene	ug/kg		98200	1900 K	6000	12300	274000		44700	1090		7880	1560000	1770000	750	126	7800	46200
VOC	1,1,2-Trichloroethane	ug/kg		ND	ND	ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2-Butanone	ug/kg		ND	ND	ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	4-Methyl-2-pentanone	ug/kg		ND	ND	ND	ND	ND	ND L	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND
	Acetone	ug/kg		92.5	ND	94.1	ND	ND	2.22 JL	ND	10.5 J	ND	9.92 JB	15.2 J	ND	55.8 B	ND	20.8	44.8 J
	Benzene	ug/kg		11.8 J	ND	ND	201 J	211 J	ND L	ND	ND	ND	ND	ND	6.59 J	ND	ND	ND	31.9
	Carbon disulfide	ug/kg		15.0 J	ND	ND	ND	ND	3.48 JL	ND	ND	ND	ND	ND	12.8 J	ND	ND	ND	12.9 J
	Ethylbenzene	ug/kg		19.3 J	ND	ND	25900	67000 EJ	7.41 L	ND	ND L	ND	ND	1.57 J	359 EJ	ND	ND	ND	411
	Methylene chloride	ug/kg		ND	ND	ND	ND	ND	1.26 JB	ND	1.44 J	ND	ND	ND	ND	ND	ND	ND	ND
	Styrene	ug/kg		ND	ND	ND	ND	ND	ND L	ND	ND L	ND	ND	ND	23.5 J	ND	ND	ND	ND
	Tetrachloroethene	ug/kg		ND	ND	ND	ND	ND	ND L	ND	1.51 JL	ND	ND	ND	ND	ND	ND	ND	ND
	Toluene	ug/kg		ND	ND	ND	213 J	1060	ND L	ND	ND L	ND	ND	ND	2.54 J	ND	ND	ND	7.82 J
	Total Xylenes	ug/kg		13.6 J	ND	ND	348 J	442 J	2.53 JL	ND	ND L	ND	ND	ND	1.88 J	ND	ND	ND	66.1
	Trichloroethene	ug/kg		ND	ND	ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PEST/PCB	4,4'-DDD	ug/kg		ND	ND	ND	ND	ND		150 J	ND		15.1	ND	ND J	ND	ND	76.5	ND
	4,4'-DDE	ug/kg		ND	ND	ND	ND	ND		21.8 J	ND		ND	ND	ND J	ND	4.49 J	119	ND
	4,4-DDT	ug/kg		ND	50.3 J	ND	ND	ND		257 J	ND		ND	ND	ND J	ND	ND	18.8 JL	ND L
	Aldrin	ug/kg		ND	ND	ND	ND	ND		ND	ND		ND	ND	ND J	ND	ND	ND	ND
	Chlordane	ug/kg		ND	94.0 J	ND	ND	ND		8020	238 J		ND	ND	ND J	ND	12.5 J	ND	ND
	Dieldrin	ug/kg		ND	ND	ND	ND	ND		ND	ND		ND	ND	ND K	ND	ND	ND	ND
	Heptachlor	ug/kg		ND	ND	ND	ND	ND		ND	ND		ND	ND	ND J	ND	ND	ND	ND
	Heptachlor Epoxide	ug/kg		ND	ND	ND	ND	ND		ND	ND		ND	ND	ND J	ND	4.38 J	ND	ND
	PCB-1242	ug/kg		ND	ND	ND	ND	ND		ND	ND		ND	ND	ND J	ND	ND	ND	ND
	PCB-1248	ug/kg		ND	ND	ND	ND	ND		ND	ND		ND	ND	ND J	ND	ND	ND	ND
	PCB-1254	ug/kg		ND	ND	ND	ND	ND		ND	ND		ND	ND	ND J	ND	ND	ND	ND
	PCB-1260	ug/kg		ND	ND	ND	ND	ND		ND	10200		ND	ND	ND J	ND	ND	ND	ND
INORGANIC	Mercury	mg/Kg		ND	0.302	0.577	ND	0.245		ND	ND		0.210	ND	ND	ND	ND	0.640	0.190
	Antimony	mg/Kg		ND	ND	ND	ND	ND		ND	ND		ND	ND	ND	ND	ND	ND	ND
	Arsenic	mg/Kg		9.69	7.60	8.12	4.38	26.1		9.89	5.27		7.03	6.12	22.7	13.8	6.61 L	8.92 L	8.06 L
	Beryllium	mg/Kg		ND	ND	ND	ND	ND		ND	ND		ND	ND	ND	ND	ND L	ND L	ND L
	Chromium	mg/Kg		22.1	20.6	25.5	10.5	18.8		16.7	17.9		19.4	14.7	21.0	37.9	27.6	16.0	23.0
	Copper	mg/Kg		736 J	76.2 J	141 J	27.3 J	147 J		35.7	84.1		70.9	24.2	125	18.1	20.5 K	121 K	68.1 K
	Lead	mg/Kg		205 L	207 L	334 L	72.3 L	103 L		487	489		338	160	139	14.0	60.1	344	145
	Magnesium	mg/Kg		645	2970	6730	5570	343		2890	10000		4870	3150	239	7300	3880	10800	4190
	Manganese	mg/Kg		59.0	339	276	90.3	105		278	158		204	180	111	304	408 K	134 K	216 K
	Nickel	mg/Kg		57.6	48.8	28.4	10.3	21.9		25.4	11.7		24.3	23.1	23.3	13.6	33.2	11.1	18.1
	Selenium	mg/Kg		1.10	1.20	1.80	1.16	5.04		1.57	1.19		1.83	1.81	3.13	3.02	1.63	1.58	1.41
	Zinc	mg/Kg		336 J	1170 J	375 J	62.1 J	42.6 J		214	563		229	587	24.9	69.4	68.1	219	190
	Cyanide-Total	mg/Kg		ND	1.60	26.6	116 K	121 K		ND	ND		1.59 K	1.25 K	182 K	ND	ND	ND	13.9
TRPH	TRPH	mg/Kg		898 K	235 K	1000 K	5080 K	1520 K		210	4480		1070	207	3270	ND	34.4	463	1390
OTHER	Moisture Content	%		22.6	10.6	13.3	10.9	30.7		12.7	15.3	29.5	13.7	10.1	26.5	52.0	22.8	19.2	15.6

Table B.1-2

ANALYTICAL DATA FOR PARAMETERS DETECTED IN SOILS
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

			SAMPLE ID:	BH64S-05	BH64S-06	BH64S-07DS	BH64S-07	BH65S-00	BH65S-01	BH65S-03	BH65S-05	BH66S-00	BH66S-01	BH66S-03	BH66S-05	BH66S-07	BH66S-09DS	BH66S-09	BH67S-00
			DATE:	10/30/96	10/30/96	10/30/96	10/30/96	10/31/96	10/31/96	10/31/96	10/31/96	10/30/96	10/30/96	10/30/96	10/30/96	10/30/96	10/30/96	10/30/96	10/28/96
			DEPTH:	10-12'	12-14'	14-16'	14-16'	0-2'	2-4'	6-8'	10-12'	0-2'	2-4'	6-8'	10-12'	14-16'	18-20'	18-20'	0-2'
ANALYSIS	PARAMETER	UNITS																	
PAH	1-Methylnaphthalene	ug/kg		52800	2660000	604	613	166 J	849 K	1620 K	72500	ND	ND	ND	3210000		18000	3230	ND
	2-Methylnaphthalene	ug/kg		ND	1880000	491	455	301 J	911 K	1810 K	49500	ND	ND	ND	2630000		ND	ND	ND
	Acenaphthene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	1100	ND	ND		ND	ND	ND
	Acenaphthylene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1610000		ND	ND	ND
	Anthracene	ug/kg		4140	391000	132	102	14.9 J	110 K	205 K	9180	ND	79.3	180 K	540000		2950	582	215
	Benzo(a)anthracene	ug/kg		6850	144000	39.6	38.5	166 J	428 K	835 K	20600	285 K	287	673 K	423000		2570	388	510
	Benzo(a)pyrene	ug/kg		15700	ND	41.5	ND	203 J	472 K	933 K	11700	376 K	310	696 K	248000		2050	414	419
	Benzo(b)fluoranthene	ug/kg		7420	ND	52.8	64.8	162 J	537 K	1030 K	8690	308 K	299	763 K	234000		2180	336	430
	Benzo(ghi)perylene	ug/kg		9270	ND	ND	ND	185 J	416 K	898 K	15500	353 K	379	539 K	ND		ND	ND	ND
	Benzo(k)fluoranthene	ug/kg		9270	ND	ND	ND	90.5 J	253 K	499 K	2950	137 K	138	370 K	117000		ND	207	215
	Chrysene	ug/kg		10700	156000	50.9	47.3	292	580 K	1140 K	28900	296 K	184	483 K	394000		3470	582	390 J
	Dibenzo(a,h)anthracene	ug/kg		ND	ND	ND	ND	41.3 J	185 K	464 K	29400	ND	287	337 K	ND		ND	ND	294
	Fluoranthene	ug/kg		55600	828000	264	245	495 J	1170 K	2450 K	51000	695 K	632	1410 K	1750000		12500	2200	1080
	Fluorene	ug/kg		5280	484000	143	142	21.4 J	61.3 K	119 K	15000	ND	60.9	ND	964000		3720	750	125
	Indeno(1,2,3-cd)pyrene	ug/kg		3420	ND	ND	ND	98.5 J	284 K	552 K	2670	205 K	241	561 K	ND		ND	ND	215
	Naphthalene	ug/kg		72800	ND	ND	ND	ND	68.4 JK	128 JK	46400	ND	644	1350 K	3800000		27000	4400	ND
	Phenanthrene	ug/kg		25700	1420000	453	333	207 J	500 K	1020 K	45000	330 K	287	640 K	1900000		12800	2460	668
	Pyrene	ug/kg		27100	406000	121	114	344 J	838 K	1680 K	ND	831 K	839	1230 K	3070000		19300	3490	940
VOC	1,1,2-Trichloroethane	ug/kg		ND	ND	ND	ND	ND	ND	ND L	ND L	ND	ND	ND	ND L	ND	ND	ND	ND
	2-Butanone	ug/kg		ND	81.4	ND	ND	ND	ND	ND L	ND L	ND	ND	ND	166 L	87.7 K	ND	ND	20.3
	4-Methyl-2-pentanone	ug/kg		ND	ND	ND	ND	ND	ND	ND L	ND L	ND	ND	ND	ND L	ND	ND	ND	ND
	Acetone	ug/kg		67.8 J	306	51.3	71.5	ND	8.70 J	ND L	167	13.1 B	13.9 B	20.0	210 L	135 K	5.88 J	6.40 J	57.9 BB
	Benzene	ug/kg		155	244	16.8 J	35.9	ND	ND	ND L	195	ND	ND	1.36 J	101000 EL	766 K	ND	ND	ND
	Carbon disulfide	ug/kg		119	81.4	ND	7.06 J	ND	ND	ND L		ND	ND	ND	38.0 JL	8.64 JK	ND	ND	ND
	Ethylbenzene	ug/kg		1150	453	ND	ND	ND	ND	ND L	1210	ND	ND	1.55 J	43800 EL	885 K	ND	ND	ND
	Methylene chloride	ug/kg		ND	ND	ND	ND	ND	ND	ND L	ND L	ND	ND	ND	ND L	ND	ND	ND	ND
	Styrene	ug/kg		ND	ND	ND	ND	ND	ND	ND L	80.7	ND	ND	ND	130000 EL	1270 K	ND	ND	ND
	Tetrachloroethene	ug/kg		ND	ND	ND	ND	ND	ND	ND L	ND L	ND	ND	ND	ND L	ND	ND	ND	ND
	Toluene	ug/kg		147	236	ND	ND	ND	ND	ND L	53.2 J	ND	ND	ND	298000 EL	3060 EK	ND	ND	ND
	Total Xylenes	ug/kg		1530	1160	ND	12.7 J	ND	ND	ND L	199	ND	ND	ND	337000 EL	3240 K	ND	ND	ND
	Trichloroethene	ug/kg		ND	ND	ND	ND	ND	ND	ND L	ND L	ND	ND	ND	ND L	ND	ND	ND	ND
PEST/PCB	4,4'-DDD	ug/kg		780	ND	ND	ND	ND	ND	ND	ND	ND	3.56 J	ND	ND		ND	ND	ND
	4,4'-DDE	ug/kg		99.0 J	ND	ND	ND	7.73 J	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
	4,4-DDT	ug/kg		109 JL	ND L	ND L	ND L	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
	Aldrin	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
	Chlordane	ug/kg		ND	ND	ND	ND	193	9.05 J	ND	ND	ND	79.7	9.88 J	ND		ND	ND	ND
	Dieldrin	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	53.3 K	ND	ND		ND	ND	ND
	Heptachlor	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
	Heptachlor Epoxide	ug/kg		ND	ND	ND	ND	7.02 J	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
	PCB-1242	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
	PCB-1248	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
	PCB-1254	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
	PCB-1260	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
INORGANIC	Mercury	mg/Kg		ND	0.161	ND	ND	ND	ND	0.269	0.167	0.288	0.229	0.184	ND		ND	ND	1.26
	Antimony	mg/Kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND
	Arsenic	mg/Kg		6.70 L	14.4	13.7	14.7	6.38	10.7	15.6	36.5	5.44	97.1	5.39	19.4		3.16	1.95	10.6
	Beryllium	mg/Kg		ND L	ND	ND	ND	ND	ND	ND	ND	ND	0.586	ND	ND		ND	ND	ND
	Chromium	mg/Kg		8.89	14.8	34.0	33.3	15.9 J	8.72 J	19.2 J	36.9 J	16.9	18.3	13.7	38.4		9.35	7.17	16.2
	Copper	mg/Kg		35.9 K	117	15.5	15.7	17.1	22.8	52.9	139	34.3	132	109	85.3		5.89	2.88	44.5
	Lead	mg/Kg		16.5	45.9	11.2	12.4	61.0	90.0	183	56.1	122	355	169	64.1		6.79	2.11	135 L
	Magnesium	mg/Kg		340	433	6090	6470	3510	2320	4890	419	3470	3440	1780	153		1020	1160	3500
	Manganese	mg/Kg		84.9 K	141 K	360 K	389 K	169 K	83.7 K	160 K	158 K	255	339	ND	94.9		77.3	74.3	191
	Nickel	mg/Kg		3.95	6.69	16.3	15.8	12.8 L	10.2 L	24.6 L	38.9 L	23.9	22.4	20.6	22.5		9.33	9.67	21.9
	Selenium	mg/Kg		2.14	3.14	3.04	2.19	ND	1.19	1.39	4.48	1.16	1.85	1.34	2.83		1.55	0.828	0.827
	Zinc	mg/Kg		29.4	24.7	63.0	77.9	74.5	144	198	24.6	129	169	171	26.3		12.6	99.4	173 J
	Cyanide-Total	mg/Kg		89.7	109	ND	ND	ND	ND	ND	30.3	ND	ND	ND	33.3		7.10	ND	ND
TRPH	TRPH	mg/Kg		140	160	ND	ND	2550 L	119 L	818 L	3540 L	387	ND	ND	11000		33.1	ND	639
OTHER	Moisture Content	%		29.9	36.0	47.0	42.9	9.50	7.20	56.9	35.3	12.2	13.0	10.9	31.5	29.4	22.1	22.7	11.7

ANALYTICAL DATA FOR PARAMETERS DETECTED IN SOILS
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

ANALYSIS	PARAMETER	UNITS	SAMPLE ID:	BH67S-02	BH67S-04	BH67S-05	BH67S-06	BH67S-07	MW16S-01	MW16S-03	MW16S-05	MW16S-09	MW17S-01	MW17S-03	MW17S-04	MW17S-05	MW17S-06	MW17S-07	MW18S-01
			DATE:	10/28/96	10/28/96	10/28/96	10/28/96	10/28/96	10/29/96	10/29/96	10/29/96	10/29/96	10/29/96	10/29/96	10/29/96	10/29/96	10/29/96	10/29/96	10/30/96
			DEPTH:	4-6'	8-10'	10-12'	12-14'	14-16'	2-4'	6-8'	10-12'	18-20'	2-4'	6-8'	8-10'	10-12'	12-14'	14-16'	2-4'
PAH	1-Methylnaphthalene	ug/kg		ND	ND	13600	5630	ND	ND	ND	29300	12800	ND	269000	ND	ND	ND	ND	ND
	2-Methylnaphthalene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Acenaphthene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Acenaphthylene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Anthracene	ug/kg		119	2710	3580	1350	ND	18700	ND	4230	2810	ND	23700	378	32.3	296	ND	7050
	Benzo(a)anthracene	ug/kg		205	3860	8520	2820	ND	6170	ND	ND	ND	443	28000	921	ND	648	ND	12300
	Benzo(a)pyrene	ug/kg		269	3430	ND	ND	ND	4630	2350	1950	6010	510	ND	1160	67.0	489	ND	12300
	Benzo(b)fluoranthene	ug/kg		205	6000	ND	ND	33.5	4190	705	ND	1410	565	ND	992	35.9	694	36.8	8290
	Benzo(ghi)perylene	ug/kg		332	ND	ND	ND	ND	ND	1090	ND	ND	ND	ND	767	ND	ND	ND	ND
	Benzo(k)fluoranthene	ug/kg		125	4000	ND	ND	70.2	2210	635	1190	7930	277	ND	531	51.4	307	57.9	4700
	Chrysene	ug/kg		281	5710	2840	1220	ND	8050	1410	2930	8310	920	32300	1060	ND	830	ND	13400
	Dibenzo(a,h)anthracene	ug/kg		269	3710	ND	ND	ND	ND	11800	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Fluoranthene	ug/kg		563	17100	14800	5260	ND	26500	1020	19500	12300	1550	183000	1890	ND	1930	ND	42600
	Fluorene	ug/kg		ND	2140	5560	2330	ND	8380	ND	6950	8060	ND	39800	ND	39.5	364	ND	9290
	Indeno(1,2,3-cd)pyrene	ug/kg		ND	1710	ND	ND	ND	2320	ND	ND	ND	333	ND	756	ND	341	ND	5040
	Naphthalene	ug/kg		ND	ND	ND	ND	813 J	ND	ND	ND	ND	ND	936000	3070	ND	6710	ND	ND
	Phenanthrene	ug/kg		358	13000	6790	1710	ND	33100	611	7930	4220	887	26900	1530	45.5	2500	ND	35800
	Pyrene	ug/kg		371	21400	29600	6730	ND	25400	1880	ND	ND	1550	269000	1170	ND	1820	ND	35800
VOC	1,1,2-Trichloroethane	ug/kg		ND	ND	ND	ND L	ND L	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2-Butanone	ug/kg		20.8 J	ND	154	ND L	10.8 JL	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	4-Methyl-2-pentanone	ug/kg		ND	ND	ND	ND L	ND L	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Acetone	ug/kg		50.3 BB	42.1	256 B	37.0 L	26.5 L	ND	ND L	ND	21.9 J	42.5	ND	6.00 J	8.67 J	ND	33.2 K	ND
	Benzene	ug/kg		ND	ND	25.4	37.2 L	21.1 L	ND	ND L	ND	ND	ND	ND	ND	ND	ND	17.1 K	ND
	Carbon disulfide	ug/kg		ND	ND	ND	ND L	2.14 JL	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Ethylbenzene	ug/kg		ND	ND	38.6	49.1 L	39.2 L	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Methylene chloride	ug/kg		ND	ND	ND	ND L	ND L	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Styrene	ug/kg		ND	ND	ND	ND L	ND L	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Tetrachloroethene	ug/kg		ND	ND	ND	ND L	ND L	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Toluene	ug/kg		ND	ND	ND	ND L	2.09 JL	ND	ND L	15.7 J	ND	ND	ND	ND	ND	ND	ND	ND
	Total Xylenes	ug/kg		ND	ND	69.5	48.2	30.3 L	ND	ND L	18.3 J	ND	ND	ND	ND	ND	ND	ND	ND
	Trichloroethene	ug/kg		ND	ND	ND	ND L	ND L	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
PEST/PCB	4,4'-DDD	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND J
	4,4'-DDE	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	39.2 J
	4,4-DDT	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	68.3 J
	Aldrin	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND J
	Chlordane	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	40.5 J	ND	ND	ND	ND	ND	146 J
	Dieldrin	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	25.8 K
	Heptachlor	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND J
	Heptachlor Epoxide	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND J
	PCB-1242	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND J
	PCB-1248	ug/kg		ND	ND	ND	ND	ND	22600	28700	ND	17500	ND	ND	ND	ND	ND	ND	ND J
	PCB-1254	ug/kg		ND	ND	ND	ND	ND	6840	37300	ND	6390	ND	ND	ND	ND	ND	ND	ND J
	PCB-1260	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND J
INORGANIC	Mercury	mg/Kg		1.62	0.499	ND	0.192	ND	0.287	1.03	ND	0.435	0.133	0.129	ND	ND	ND	ND	0.249
	Antimony	mg/Kg		ND	ND	ND	ND	ND	ND	ND	ND	10.8	7.10	ND	ND	ND	ND	ND	ND
	Arsenic	mg/Kg		9.91	15.7	4.38	4.94	5.44	8.14	12.0	7.32	12.3	6.39	6.91	5.66	8.61	26.6	8.25	7.08
	Beryllium	mg/Kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chromium	mg/Kg		23.4	28.0	16.8	17.9	15.7	34.2 L	22.1 L	18.1 L	46.3 L	17.0 L	15.9 L	16.6 L	22.4 L	15.1	41.2 L	13.9
	Copper	mg/Kg		47.7	46.0	12.2	21.2	8.09	196	233	82.6	488	101	171	43.1	34.9	56.0 J	15.5	46.8
	Lead	mg/Kg		138 L	153 L	15.7 L	41.7 L	31.6 L	741	667	64.5	749	200	101	43.6	11.7	28.8 L		239
	Magnesium	mg/Kg		8160	7230	1850	2840	2010	3410	2510	3930	4780	5690	2940	3310	506	7700	6540	3860
	Manganese	mg/Kg		347	453	60.7	125	110	233	210	215	226	195	156	261	165	78.7	305	217
	Nickel	mg/Kg		24.6	29.7	15.2	18.0	27.4	79.3 L	67.0 L	37.9 L	116 L	24.2 L	45.1 L	49.2 L	156 L	132	21.2 L	19.4
	Selenium	mg/Kg		2.88	2.03	ND	ND	0.813	2.84 L	2.44 L	0.908 L	4.96 L	0.931 L	ND L	1.07 L	1.79 L	ND	3.07 L	2.05
	Zinc	mg/Kg		165 J	251 J	24.9 J	50.9 J	115 J	897 L	1150 L	83.8 L	1160 L	106 L	41.6 L	83.4 L	295 L	77.1 J	60.0 L	211
	Cyanide-Total	mg/Kg		ND	23.1	ND	ND	ND	ND L	0.696 L	ND L	ND L	3.11	19.0	1.10	ND	ND	ND	ND
TRPH	TRPH	mg/Kg		9410	747	2260	817	ND	851 J	4060 J	19600 L	12700 J	155 J	64.4 J	5150 J	411 J	3090 K	ND J	312
OTHER	Moisture Content	%		21.8	30.0	19.0	18.3	37.3	9.30	14.9	7.90	21.8	9.80	7.10	15.3	16.4	12.1	43.0	10.7

B.1-11

Table B.1-2

ANALYTICAL DATA FOR PARAMETERS DETECTED IN SOILS
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

ANALYSIS	PARAMETER	UNITS	SAMPLE ID:	MW18S-03	MW18S-05	MW18S-07	MW19S-01	MW19S-02DS	MW19S-02	MW19S-05	MW20S-00	MW20S-01	MW20S-03	MW20S-04	MW20S-06	MW20S-07	MW21S-01	MW21S-03	MW21S-04DS
			DATE:	10/30/96	10/30/96	10/30/96	10/29/96	10/29/96	10/29/96	10/29/96	10/28/96	10/28/96	10/28/96	10/28/96	10/28/96	10/28/96	10/31/96	10/31/96	10/31/96
			DEPTH:	6-8'	10-12'	14-16'	2-4'	4-6'	4-6'	10-12'	0-2'	2-4'	6-8'	8-10'	12-14'	14-16'	2-4'	6-8'	8-10'
PAH	1-Methylnaphthalene	ug/kg		ND	ND	ND	ND	ND	ND	83100	ND	ND	1120000	685000	645000	2860	ND	ND	ND
	2-Methylnaphthalene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	764000	740000	493000	ND	ND	ND	ND
	Acenaphthene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Acenaphthylene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	396000	137000	ND	ND	ND	ND	ND
	Anthracene	ug/kg		15400	1300	2300	3070	316000	194000	46500	ND	14400	235000	8490	96100	421	284	846	ND
	Benzo(a)anthracene	ug/kg		27000	2460	3300	7790	224000	205000	19700	1890	84500	191000	ND	80900	387	884	2860	ND
	Benzo(a)pyrene	ug/kg		29600	2590	3020	11800	ND	82100	14100	1560	19600	141000	7530	48000	219	1260	2860	ND
	Benzo(b)fluoranthene	ug/kg		25700	2590	2590	8260	ND	60400	8310	1780	26800	117000	10700	50600	337	1370	3200	ND
	Benzo(ghi)perylene	ug/kg		20600	1550	2160	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1010	1600	ND
	Benzo(k)fluoranthene	ug/kg		12900	1300	1290	6260	ND	29600	ND	ND	13400	69000	9730	27800	ND	726	1830	ND
	Chrysene	ug/kg		34700	2850	1080	13000	197000	217000	26800	2110	26800	206000	8630	79600	337	1000	3200	ND
	Dibenzo(a,h)anthracene	ug/kg		ND	ND	ND	24800	ND	ND	ND	ND	ND	ND	16400	ND	ND	737	ND	ND
	Fluoranthene	ug/kg		63000	7250	9340	20100	1000000	684000	141000	4330	90700	675000	26000	265000	2690	2840	9600	ND
	Fluorene	ug/kg		5530	648	1190	ND	368000	217000	53500	ND	16500	264000	19200	107000	370	211	606	42.4
	Indeno(1,2,3-cd)pyrene	ug/kg		16700	1190	1580	5080	ND	ND	ND	ND	ND	ND	ND	ND	ND	663	1490	ND
	Naphthalene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	1910000 J	5890000	2020000 J	11800 J	ND	ND	ND
	Phenanthrene	ug/kg		42400	4660	7330	10500	1220000	741000	94400	2560	52600	822000	34200	260000	1600	1580	4230	ND
	Pyrene	ug/kg		78400	7510	10100	22400	1840000	1250000	74600	3220	227000	1130000	58900	493000	3030	1790	5370	ND
VOC	1,1,2-Trichloroethane	ug/kg		ND L	ND	ND	ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2-Butanone	ug/kg		36.0 L	ND	ND	ND	ND	ND	37.5 JL	ND	ND	ND	ND	ND	ND	ND	ND	ND
	4-Methyl-2-pentanone	ug/kg		ND L	ND	ND	ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Acetone	ug/kg		147 L	31.5	80.3 J	13.2	ND	ND	82.5 L	13.9	ND	ND	ND	ND	11.2 J	ND	ND	ND
	Benzene	ug/kg		ND L	ND	ND	ND	9630	12900	35.2 L	ND	ND	8340	3440	3030	ND	ND	ND	ND
	Carbon disulfide	ug/kg		3.21 JL	ND	ND	ND	ND	ND	ND L	ND	ND	ND	701	ND	2.68 J	ND	ND	ND
	Ethylbenzene	ug/kg		6.38 JL	ND	ND	1.25 J	17900	22000	34.4 JL	5.76	155000	28000	8080	10600	ND	ND	ND	ND
	Methylene chloride	ug/kg		ND L	ND	ND	ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Styrene	ug/kg		ND L	ND	ND	ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Tetrachloroethene	ug/kg		ND L	ND	ND	6.19	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Toluene	ug/kg		ND L	ND	ND	ND	9470	9520	25.6 JL	ND	2940	3410	929	982	ND	ND	ND	ND
	Total Xylenes	ug/kg		ND L	ND	ND	3.80 J	15000	24300	35.6 L	9.92	ND	59300	11300	7420	ND	ND	ND	ND
	Trichloroethene	ug/kg		ND L	ND	ND	3.44 J	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND
PEST/PCB	4,4'-DDD	ug/kg		77.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	4,4'-DDE	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	36.7	ND	ND
	4,4-DDT	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	61.1	360	ND
	Aldrin	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chlordane	ug/kg		591	28.5 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	152	8510	ND
	Dieldrin	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Heptachlor	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	237 K	ND
	Heptachlor Epoxide	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	PCB-1242	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	PCB-1248	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	PCB-1254	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	PCB-1260	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.08 J	ND
INORGANIC	Mercury	mg/Kg		0.591	0.253	1.38	0.484	0.263	0.137	ND	0.209	ND	0.186	ND	ND	ND	0.218	0.736	ND
	Antimony	mg/Kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Arsenic	mg/Kg		13.4	135	18.2	8.58	8.37	8.42	13.1	6.76	15.4	14.7	17.0	12.1	11.9	8.33 J	11.2 J	5.08 J
	Beryllium	mg/Kg		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.526	ND	ND
	Chromium	mg/Kg		19.4	20.9	17.4	31.5 L	15.7 L	12.8 L	9.96 L	11.9	12.3	23.2	38.9	25.0	29.6	24.1 L	24.2 L	19.1 L
	Copper	mg/Kg		92.4	65.8	246	75.2	39.3	37.3	33.0	85.8	87.8	122	322	207	16.7	31.8 L	74.3 L	48.7 L
	Lead	mg/Kg		544	334	1930	1130	88.9	115	36.6	140 L	52.2 L	162 L	160 L	169 L	12.7 L	240 J	318 J	9.36 J
	Magnesium	mg/Kg		2610	6260	1150	16200	2460	1190	283	4170	488	2280	1280	1050	6920	7820	8580	1850
	Manganese	mg/Kg		150	256	270	213	176	87.1	50.3	202	113	144	103	77.1	296	308 L	306 L	73.1 L
	Nickel	mg/Kg		24.8	39.7	7 42	43.4 L	21.8 L	15.3 L	20.4 L	19.3	20.2	37.6	47.0	74.7	26.3	27.1 L	34.4 L	18.8 L
	Selenium	mg/Kg		1.99	1.92	4.47	0.868 L	1.96 L	1.94 L	1.59 L	1.70	2.25	4.02	5.38	2.34	2.54	1.04	1.05	ND
	Zinc	mg/Kg		539	409	2300	367 L	83.6 L	39.5 L	16.6 L	142 J	48.2 J	113 J	171 J	119 J	70.0 J	142	571	24.5
	Cyanide-Total	mg/Kg		ND	ND	0.934 K	10.3	28.7	48.4	7.13	ND	3.64	10.0	129	36.8	ND	ND	2.46	ND
TRPH	TRPH	mg/Kg		474	355	2580	2110 J	14000 J	20800 J	3190 J	5730	33600	4440	3150	1140	ND	1940	315	ND
OTHER	Moisture Content	%		22.2	22.8	30.4	15.3	24.0	12.3	29.0	10.0	3.00	31.9	27.0	20.9	40.6	5.00	12.5	17.4

ANALYTICAL DATA FOR PARAMETERS DETECTED IN SOILS
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

			SAMPLE ID:	MW21S-04	MW21S-05	IW21S-06DS	MW22S-00	MW22S-01	MW22S-02	MW22S-05	MW22S-06
			DATE:	10/31/96	10/31/96	10/28/96	10/28/96	10/28/96	10/28/96	10/28/96	10/28/96
			DEPTH:	8-10'	10-12'	12-14'	0-2'	2-4'	4-6'	10-12'	12-14'
ANALYSIS	PARAMETER	UNITS									
PAH	1-Methylnaphthalene	ug/kg		ND	1060	10000	ND	126000	ND	ND	436000
	2-Methylnaphthalene	ug/kg		ND	316	ND	ND	138000	ND	147000	363000
	Acenaphthene	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND
	Acenaphthylene	ug/kg		ND	704	ND	ND	ND	ND	ND	ND
	Anthracene	ug/kg		ND	35.9	2510	107000	35600	20300	26900	58900
	Benzo(a)anthracene	ug/kg		ND	64.7	5140	125000	32100	22500	34100	63000
	Benzo(a)pyrene	ug/kg		ND	94.8	766	136000	28700	20300	35800	58800
	Benzo(b)fluoranthene	ug/kg		ND	138	789	79400	20600	14600	28700	37500
	Benzo(ghi)perylene	ug/kg		ND	84.8	ND	ND	ND	ND	ND	ND
	Benzo(k)fluoranthene	ug/kg		ND	64.7	478	54400	12600	10000	17200	24200
	Chrysene	ug/kg		ND	144	2150	136000	35600	27000	41200	58300
	Dibenzo(a,h)anthracene	ug/kg		ND	111	1200	ND	32100	23600	44800	6800
	Fluoranthene	ug/kg		ND	316	9330	465000	126000	85600	120000	164000
	Fluorene	ug/kg		ND	187	4190	159000	56200	29300	37600	82300
	Indeno(1,2,3-cd)pyrene	ug/kg		ND	58.9	ND	ND	ND	ND	11500	ND
	Naphthalene	ug/kg		ND	575	ND	ND	161000 J	102000 J	125000 J	908000 J
	Phenanthrene	ug/kg		ND	138	2150	431000	138000	80000	118000	230000
	Pyrene	ug/kg		ND	172	9930	828000	229000	146000	197000	351000
VOC	1,1,2-Trichloroethane	ug/kg		ND	ND L	ND	ND L	ND L	ND L	ND	ND
	2-Butanone	ug/kg		ND	49.1 L	ND	8.37 JL	21.6 L	ND L	ND	ND
	4-Methyl-2-pentanone	ug/kg		ND	ND L	ND	ND L	ND L	ND L	ND	ND
	Acetone	ug/kg		ND	204 L	ND	31.3 L	99.7 L	33.1 L	ND	6.37 J
	Benzene	ug/kg		ND	6.88 JL	32.2	ND L	4.59 JL	3.46 JL	5480	110
	Carbon disulfide	ug/kg		ND	3.68 JL	ND	ND L	ND L	ND L	ND	12.5
	Ethylbenzene	ug/kg		ND	88.1 L	55.4	6.20 L	167 L	96.5 L	3760	51.3
	Methylene chloride	ug/kg		ND	ND L	ND	ND L	ND L	ND L	ND	ND
	Styrene	ug/kg		ND	ND L	ND	ND L	ND L	ND L	ND	ND
	Tetrachloroethene	ug/kg		ND	ND L	ND	ND L	ND L	ND L	ND	ND
	Toluene	ug/kg		ND	5.78 JL	15.7	ND L	4.61 JL	5.12 JL	9120	19.6
	Total Xylenes	ug/kg		ND	43.0 L	78.8	10.5 L	55.2 L	43.0 L	33900	211
	Trichloroethene	ug/kg		ND	ND L	ND	ND L	ND L	ND L	ND	ND
PEST/PCB	4,4'-DDD	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND
	4,4'-DDE	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND
	4,4-DDT	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND
	Aldrin	ug/kg		ND	ND	ND	679	ND	ND	ND	ND
	Chlordane	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND
	Dieldrin	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND
	Heptachlor	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND
	Heptachlor Epoxide	ug/kg		ND	ND	ND	901	ND	ND	ND	ND
	PCB-1242	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND
	PCB-1248	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND
	PCB-1254	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND
	PCB-1260	ug/kg		ND	ND	ND	ND	ND	ND	ND	ND
INORGANIC	Mercury	mg/Kg		ND	ND	0.182	0.347	0.249	0.363	0.192	ND
	Antimony	mg/Kg		ND	ND	ND	ND	ND	ND	ND	ND
	Arsenic	mg/Kg		3.37 J	9.02 J	4.86	9.37	8.61	7.31	9.52	2.70
	Beryllium	mg/Kg		ND	ND	ND	ND	ND	ND	ND	ND
	Chromium	mg/Kg		15.7 L	26.3 L	17.7	18.4	15.8	18.1	19.4	5.29
	Copper	mg/Kg		37.9 L	30.2 L	17.6	96.6	70.1	52.4	76.5	19.4
	Lead	mg/Kg		8.45 J	34.9 J	33.5 L	340 L	299 L	275 L	224 L	17.8 L
	Magnesium	mg/Kg		1790	2460	2520	3930	3590	3150	4440	357
	Manganese	mg/Kg		70.3 L	143 L	104	193	335	168	132	40.1
	Nickel	mg/Kg		16.8 L	43.1 L	19.4	45.5	31.2	30.5	29.9	6.32
	Selenium	mg/Kg		ND	ND	1.22	1.89	1.15	10.8	2.60	ND
	Zinc	mg/Kg		24.0	259	44.5 J	451 J	221 J	249 J	208 J	22.5 J
	Cyanide-Total	mg/Kg		ND	ND	ND L	12.8	ND	18.0 J	26.6 J	98.2
TRPH	TRPH	mg/Kg		ND	ND	1350 L	261 L	464 L	384 L	698 L	69.6 L
OTHER	Moisture Content	%		15.9	30.4	16.4	11.8	12.8	11.2	44.2	17.4

Table B.1-2 (Cont.)

Key:

B	=	Reported result is considered as not detected because of presence in field or laboratory blanks. Reported result may be considered as an elevated quantitation limit;
C	=	There is presumptive evidence leading to identification of the analyte, and the analyte was confirmed by further GC/MS analysis;
EJ	=	Reported result exceeds the calibration limit for the analysis and is considered an estimated value.
J	=	Reported result is qualitatively accurate, but quantitatively imprecise, and is considered an estimated value. The data should be seriously considered for decision-making and are usable for many purposes;
K	=	Reported result is qualitatively accurate, but quantitatively biased high. The data should be seriously considered for decision-making and are usable for many purposes;
L	=	Reported result is qualitatively accurate, but quantitatively biased low. The data should be seriously considered for decision-making and are usable for many purposes;
N	=	There is presumptive evidence leading to identification of the analyte, but the analyte was not confirmed by further gas chromatography/mass spectrometry (GC/MS) analysis;
NA	=	Not analyzed;
ND	=	Analyte was not detected; the reported value is the quantitation limit adjusted for sample weight/sample volume, extraction volume, percent solids, and sample dilution;
R	=	Reported result or quantitation limit is rejected and unusable for all purposes. The analyte was analyzed for, but the presence of the analyte has not been verified;
UJ	=	Quantitation limit is an estimated value because of a variance from quality control limits;
UK	=	Quantitation limit is biased high because of a result above quality control limits; and
UL	=	Quantitation limit is biased low because of a result below quality control limits.

Table B.1-3
ANALYTICAL DATA FOR PARAMETERS DETECTED IN GROUNDWATER
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

ANALYSIS	PARAMETER	UNITS	WELL / DATE	DW01 NS 11/7/96	DW02 NS 11/8/96	DW03 NS 11/8/96	DW04 NS 11/7/96	MW01 NS 11/8/96	MW02 NS 11/8/96	MW03 NS 11/8/96	MW04 NS 11/7/96	MW05 NS 11/7/96	MW06 NS 11/8/96	MW07 NS 11/7/96	MW08 NS 11/7/96	MW09 NS 11/8/96	MW10 NS 11/8/96	MW13 DS 11/7/96
PAH	1-Methylnaphthalene	ug/L		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2-Methylnaphthalene	ug/L		ND	ND	ND	ND	ND	ND	37.7 J	490	490	ND	667 J	2650	ND	ND	ND
	Acenaphthene	ug/L		ND	ND	60.6	ND	ND	5.83 J	15.8 J	160 J	282	37.7	ND	ND	ND	17.5	10.8
	Acenaphthylene	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	81.8 J	ND	ND	ND	ND	3.68 J	ND
	Anthracene	ug/L		ND	ND	ND	ND	ND	ND	ND	60.2 J	ND	2.08 J	ND	ND	ND	6.49 J	ND
	Benzo(a)anthracene	ug/L		ND	ND	ND	ND	ND	ND	ND	44 J	ND	ND	ND	ND	ND	ND	ND
	Benzo(a)pyrene	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Benzo(b)fluoranthene	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Benzo(ghi)perylene	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Benzo(k)fluoranthene	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chrysene	ug/L		ND	ND	ND	ND	ND	ND	ND	48.1 J	ND	ND	ND	ND	ND	ND	ND
	Dibenzo(a,h)anthracene	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Fluoranthene	ug/L		ND	ND	ND	ND	ND	ND	ND	76.7 J	ND	2.5 J	ND	ND	ND	8.92 J	ND
	Fluorene	ug/L		ND	ND	ND	ND	ND	ND	ND	150 J	183 J	3.06 J	ND	ND	ND	22.9	5.24 J
	Indeno(1,2,3-cd)pyrene	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Naphthalene	ug/L		ND	ND	ND	4.91 J	ND	ND	624	2170	2230	6.49 J	13200	21900	ND	2.52 J	ND
	Phenanthrene	ug/L		ND	ND	ND	ND	ND	ND	ND	366	189 J	9.51 J	ND	430 J	ND	14.9	ND
	Pyrene	ug/L		ND	ND	ND	ND	ND	ND	ND	168 J	ND	4.07 J	ND	ND	ND	11.3	ND
VOC	1,2-Dichloroethane	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Acetone	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	61.9	ND	ND	ND	ND	ND	ND
	Benzene	ug/L		ND	ND	2.93 J	ND	ND	7.05	240	67.1	10.3	16.7	2530	75.8 J	ND	2.63 J	6.07
	Carbon disulfide	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chlorobenzene	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.59 J	ND	ND	ND	ND
	Ethylbenzene	ug/L		ND	ND	ND	1.29 J	ND	ND	247	257	5.57	11.9	8720	3670	ND	ND	3.07 J
	Methylene chloride	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	4.56 J	ND	ND	ND	ND	ND	ND
	Styrene	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6520	ND	ND	ND
	Toluene	ug/L		ND	ND	ND	ND	ND	ND	85.1	94.4	3.82 J	1.28 J	1990	3310	ND	ND	ND
	Total xylenes	ug/L		ND	ND	ND	2.05 J	ND	1.08 J	210	416	6.46	12.8	16400	15300	ND	ND	3.49 J
SVOC	2,4-Dimethylphenol	ug/L		ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	2-Methylphenol	ug/L		ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	4-Methylphenol	ug/L		ND	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	bis(2-Ethylhexyl)phthalate	ug/L		3.86 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Dibenzofuran	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.48 J	ND
	Phenol	ug/L		10.8	ND	ND	ND L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PEST/PCB	Alpha-BHC	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	0.035	ND	ND	ND	ND	ND
	Gamma-BHC (Lindane)	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Heptachlor	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Heptachlor epoxide	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	0.39	ND	ND	ND	ND	ND	ND
INORGANIC	Antimony	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Arsenic	ug/L		ND	ND	ND	6.9	11.1	ND	5.8 B	ND	8.7	ND	6.6	108	ND	66.1	48.7
	Beryllium	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12.2	ND
	Chromium	ug/L		13.5	24 J	15.9 J	ND	ND	ND	13.6 J	ND	12.5	12 J	ND	51.4	674 J	44 J	24.6
	Copper	ug/L		22.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	205	174	24.5	20.3
	Lead	ug/L		ND	ND	ND	6	ND	8.3	ND	8.8	16.3	ND	ND	141	13.2	20.8	52.5
	Magnesium	ug/L		8050	48400	48500	888000	21800	27700	45700	38000	ND	86900	37300	22500	61300	9210	17700
	Manganese	ug/L		14.5	36.1 J	36.5 J	3740	1130	393 J	1300 J	306	177	793 J	398	554	52.5 J	267 J	1520
	Mercury	ug/L		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Nickel	ug/L		ND	ND	25.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	136	39.7	31.8
	Selenium	ug/L		ND	ND	ND	ND	ND	5.8 B	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Zinc	ug/L		327	11.5 J	20.6 J	12.2	343	21.6 J	176 J	120	323	23.3 J	95.9	192	123 J	4470 J	3010
	Cyanide-Total	ug/L		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TDS	Residue-TDS	mg/L		327	ND	1280	27800	834	662	1840	1920	519	1940	1270	1200	1610	342	745
TPH	TRPH	mg/L		ND	ND	2.92	ND	ND	ND	ND	1.7	1.3	ND	6.7	5.52 J	ND	ND	1.5
OTHER	Chloride	mg/L		34.3	232	356	15700	197	140	632	921	174	883	586	417	776	14.8	229
	Hardness	mg/L		57.1	362	446	985	453	343	1390	520	144	697	339	591	482	299	328

Table B.1-3
ANALYTICAL DATA FOR PARAMETERS DETECTED IN GROUNDWATER
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

ANALYSIS	PARAMETER	WELL / DATE / UNITS	MW13 NS 11/7/96	MW14 NS 11/7/96	MW15 DS 11/8/96	MW15 NS 11/8/96	MW16 NS 11/6/96	MW17 DS 11/6/96	MW17 NS 11/6/96	MW18 NS 11/6/96	MW19 NS 11/6/96	MW20 NS 11/7/96	MW21 NS 11/7/96	MW22 NS 11/6/96
PAH	1-Methylnaphthalene	ug/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2-Methylnaphthalene	ug/L	ND	107	ND	ND	ND	ND	ND	ND	628 J	294 J	ND	403
	Acenaphthene	ug/L	11.7	48.8 J	3.43 J	2.58 J	3.38 J	ND	ND	ND	1480 J	ND	4.51 J	5.22 J
	Acenaphthylene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.05 J
	Anthracene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	1320 J	ND	ND	2.09 J
	Benzo(a)anthracene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	1150 J	ND	ND	ND
	Benzo(a)pyrene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	840 J	ND	ND	ND
	Benzo(b)fluoranthene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	462 J	ND	ND	ND
	Benzo(ghi)perylene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	440 J	ND	ND	ND
	Benzo(k)fluoranthene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	572 J	ND	ND	ND
	Chrysene	ug/L	ND	ND	2.01 J	ND	ND	ND	ND	ND	1230 J	ND	ND	ND
	Dibenzo(a,h)anthracene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Fluoranthene	ug/L	ND	ND	3.5 J	2.62 J	ND	ND	ND	ND	2440	ND	ND	ND
	Fluorene	ug/L	6.44 J	24.5 J	ND	3.34 J	ND	ND	ND	ND	1810 J	ND	4.09 J	16.4
	Indeno(1,2,3-cd)pyrene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Naphthalene	ug/L	ND	1550	ND	ND	ND	ND	ND	2.22 J	1020 J	6850	62.6	3630
	Phenanthrene	ug/L	ND	ND	ND	ND	ND	ND	ND	3.82 J	3440	ND	ND	14.1
	Pyrene	ug/L	ND	ND	4.88 J	2.97 J	2.71 J	ND	ND	ND	4160	ND	ND	ND
VOC	1,2-Dichloroethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Acetone	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Benzene	ug/L	5.91	1700	ND	ND	ND	ND	ND	ND	11.9	625	18.5	160
	Carbon disulfide	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	28.8
	Chlorobenzene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Ethylbenzene	ug/L	2.55 J	1180	ND	ND	ND	ND	ND	ND	17.8	214	14.9	4.59 J
	Methylene chloride	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Styrene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Toluene	ug/L	ND	1060	ND	ND	ND	ND	ND	ND	8.66	30.1	2.88 J	176
	Total xylenes	ug/L	3.06 J	808	ND	ND	ND	ND	ND	ND	13.2	94.5	12.2	286
SVOC	2,4-Dimethylphenol	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13.5
	2-Methylphenol	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	17.9
	4-Methylphenol	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	19.9
	bis(2-Ethylhexyl)phthalate	ug/L	ND	ND	3.97 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Dibenzofuran	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Phenol	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.13 J
PEST/PCB	Alpha-BHC	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	0.343	ND	ND	ND
	Gamma-BHC (Lindane)	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Heptachlor	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Heptachlor epoxide	ug/L	ND	ND	ND	ND	ND	ND	ND	ND J	ND	ND	ND	ND J
INORGANIC	Antimony	ug/L	ND	ND	ND L	ND	ND	ND	ND	ND	63.2	ND	ND	ND
	Arsenic	ug/L	49	104	43.9	54.8	52.9	29.3	10.3	62.8	666	208	26.2	115
	Beryllium	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	10.9	5.3	ND	6.6
	Chromium	ug/L	24.2	157	30.6	37.4	58.4	81.6	32.5	117	682	496	87.9	292
	Copper	ug/L	ND	193	351	434	779	122	33.3	861	2310	2580	90.2	415
	Lead	ug/L	41.6	294	1100	1400	803	81.6	23	2320	6820	1390	35.3	1770
	Magnesium	ug/L	17300	22800	43600	40200	50100	24100	16100	22100	30800	66300	44500	75400
	Manganese	ug/L	1530	261	968	1020	2310	1250	917	2280	1870	3060	3380	2340
	Mercury	ug/L	ND	ND	0.816	1.47	0.572	ND	ND	3.62	1.32	1.1	ND	1.37
	Nickel	ug/L	28.5	87.5	125	141	122	354	109	38.3	946	441	46.7	264
	Selenium	ug/L	ND	5.1	ND	6.4 B	7.2	ND	ND	8.5	52.3	26.8	5.6	17
	Zinc	ug/L	2770	4730	6350 K	7930 K	1590	1670	457	3240	3520	2300	181	1840
	Cyanide-Total	ug/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TDS	Residue-TDS	mg/L	754	259	22	1090	475	530	535	3540	1060	908	2100	2200
TPH	TRPH	mg/L	1.3	1.4	51.1 L	70.8	213	13	10.6	62.8	3.8	6.6	ND	65.3
OTHER	Chloride	mg/L	207	196	500	466	275	63.4	61.8	1940	360	224	873	783
	Hardness	mg/L	443	276	464	299	558	303	312	703	522	1410	1080	995

Table B.1-3 (Cont.)

Key:

B = Reported result is considered as not detected because of presence in field or laboratory blanks. Reported result may be considered as an elevated quantitation limit;
C = There is presumptive evidence leading to identification of the analyte, and the analyte was confirmed by further GC/MS analysis;
EJ = Reported result exceeds the calibration limit for the analysis and is considered an estimated value.
J = Reported result is qualitatively accurate, but quantitatively imprecise, and is considered an estimated value. The data should be seriously considered for decision-making and are usable for many purposes;
K = Reported result is qualitatively accurate, but quantitatively biased high. The data should be seriously considered for decision-making and are usable for many purposes;
L = Reported result is qualitatively accurate, but quantitatively biased low. The data should be seriously considered for decision-making and are usable for many purposes;
N = There is presumptive evidence leading to identification of the analyte, but the analyte was not confirmed by further gas chromatography/mass spectrometry (GC/MS) analysis;
NA = Not analyzed;
ND = Analyte was not detected; the reported value is the quantitation limit adjusted for sample weight/sample volume, extraction volume, percent solids, and sample dilution;
R = Reported result or quantitation limit is rejected and unusable for all purposes. The analyte was analyzed for, but the presence of the analyte has not been verified;
UJ = Quantitation limit is an estimated value because of a variance from quality control limits;
UK = Quantitation limit is biased high because of a result above quality control limits; and
UL = Quantitation limit is biased low because of a result below quality control limits.

Table B.1-4
Analytical Data for Parameters Detected in Subsurface Soils from Boreholes (February 1997)
Phase VI Supplemental RI
Brooklyn Borough Gas Works, Brooklyn, New York

Sample ID	Depth (ft)	Sample Date	Cyanide, Total (mg/kg)	Cyanide-Amenable (mg/kg)	Moisture (%)
BH68S-00NS	0-2	05-Feb-97	ND	ND	13.1
BH68S-01NS	2-4	05-Feb-97	5.78	ND	10
BH68S-02NS	4-6	05-Feb-97	36.4	7.88	13.7
BH68S-03NS	6-8	05-Feb-97	302	207	19.3
BH68S-04NS	8-10	05-Feb-97	17.1	ND	15.8
BH68S-05NS	10-12	05-Feb-97	4.12	ND	16.8
BH68S-06NS	12-14	05-Feb-97	6.53	ND	13.8
BH68S-07NS	14-16	05-Feb-97	76.2	ND	44.2
BH69S-00NS	0-2	05-Feb-97	ND	ND	10.6
BH69S-01DS	2-4	05-Feb-97	ND	ND	10.8
BH69S-01NS	2-4	05-Feb-97	ND	ND	12.5
BH69S-02NS	4-6	05-Feb-97	ND	ND	18.8
BH69S-03NS	6-8	05-Feb-97	ND	ND	10.8
BH69S-04NS	8-10	05-Feb-97	ND	ND	19.3
BH69S-05NS	10-12	05-Feb-97	ND	ND	15.6
BH69S-06NS	12-14	05-Feb-97	ND	ND	14.1
BH69S-07NS	14-16	05-Feb-97	ND	ND	18.4
BH70S-00NS	0-2	05-Feb-97	ND	ND	12.9
BH70S-01NS	2-4	05-Feb-97	ND	ND	6.6
BH70S-02NS	4-6	05-Feb-97	193 J	NDJ	24.8
BH70S-03DS	6-8	05-Feb-97	179 J	NDJ	27.3
BH70S-03NS	6-8	05-Feb-97	11.1 J	ND	22.6
BH70S-04NS	8-10	05-Feb-97	20.5 J	ND	21.6
BH70S-05NS	10-12	05-Feb-97	1.24 J	NDJ	15.1
BH70S-06NS	12-14	05-Feb-97	ND	ND	18.3
BH70S-07NS	14-16	05-Feb-97	293 J	NDJ	43.4
BH71S-00NS	0-2	05-Feb-97	ND	ND	8.4
BH71S-01NS	2-4	05-Feb-97	ND	ND	12.4
BH71S-02NS	4-6	05-Feb-97	8.15 J	NDJ	13.7
BH71S-03DS	6-8	05-Feb-97	32.8 J	NDJ	20.1
BH71S-03NS	6-8	05-Feb-97	14.7 J	NDJ	17.2
BH71S-04NS	8-10	05-Feb-97	ND	ND	19.9
BH71S-05NS	10-12	05-Feb-97	ND	ND	18.4
BH71S-06NS	12-14	05-Feb-97	ND	ND	16.4
BH71S-08NS	16-18	05-Feb-97	ND	ND	20.3
BH71S-09NS	18-20	05-Feb-97	ND	ND	16.9
BH72S-00NS	0-2	05-Feb-97	ND	ND	11.7
BH72S-01NS	2-4	05-Feb-97	ND	ND	18.8
BH72S-02NS	4-6	05-Feb-97	ND	ND	16.6
BH72S-03NS	6-8	05-Feb-97	69.6 J	NDJ	24.2
BH73S-00NS	0-2	05-Feb-97	ND	ND	12
BH73S-01NS	2-4	05-Feb-97	ND	ND	20.7
BH73S-02NS	4-6	05-Feb-97	113 J	NDJ	26.7
BH73S-03DS	6-8	05-Feb-97	109 J	NDJ	39.1
BH73S-03NS	6-8	05-Feb-97	50.3 J	NDJ	23.3
BH73S-04NS	8-10	05-Feb-97	10.2 J	NDJ	25.2
BH73S-05NS	10-12	05-Feb-97	446 J	NDJ	13.6
BH73S-06NS	12-14	05-Feb-97	21.9 J	NDJ	14.9
BH73S-07NS	14-16	05-Feb-97	ND	ND	47.1

Table B.1-5
Summary of Groundwater Monitoring Well Construction Information
Brooklyn Borough Gas Works
Brooklyn, New York

Well Number	Date Drilled and Installed	Depth (ft. BGS)	Elevation Ground Surface (ft. MSL)	Elevation Top of Inner Casing (ft. MSL)	State Plane Coordinate (ft.) North	State Plane Coordinate (ft.) East	Screened Interval (ft. BGS)	Sand Pack Interval (ft. BGS)	Bentonite Seal Interval (ft. BGS)	Riser Stickup (ft. MSL)
MW-01	30-Mar-93	14.5	7.88	11.01	151513.401	990014.156	4-14	3-14.5	2-3.0	3.13
DW-01	30-Mar-93	43.0	7.99	10.84	151519.896	989997.155	33-43	31-43	29-31	2.85
MW-02	29-Mar-93	14.5	7.23	10.28	151211.687	990240.217	4-14	3-14.5	2-3.0	3.05
DW-02	2-Apr-93	50.0	7.23	10.05	151201.888	990243.220	40-50	38-50	36-38	2.82
MW-03	26-Mar-93	20.0	7.03	10.13	151058.552	990063.273	9-19.5	8.5-20	5-8.5	3.10
DW-03	1-Apr-93	48.0	7.22	9.09	151052.054	990065.275	38-48	36-48	34-36	1.87
MW-04	23-Mar-93	14.5	6.83	9.83	151030.675	989765.306	4-14	3-14.5	2-3.0	3.00
DW-04	8-Apr-93	172.0	6.83	9.47	151034.479	989782.303	158-168	155-172	152-155	2.64
MW-05	22-Mar-93	14.5	9.46	12.10	151523.343	989799.171	4-14	3-14.5	2-3.0	2.64
MW-06	29-Mar-93	14.5	8.59	11.55	151374.644	990130.183	4-14	3-14.5	2-3.0	2.96
MW-07	26-Mar-93	14.5	7.32	10.39	151246.498	989918.235	4-14	3-14.5	2-3.0	3.07
MW-08	23-Mar-93	14.5	7.47	10.52	150928.516	989887.323	4-14	3-14.5	2-3.0	3.05
MW-09	24-Mar-93	14.5	8.62	11.10	150767.489	990107.347	4-14	3-14.5	2-3.0	2.48
MW-10	25-Mar-93	14.5	8.63	11.82	150817.012	990208.326	4-14	3-14.5	2-3.0	3.19
MW-13	14-Oct-93	14.5	8.93	9.93	151352.323	989673.227	4-14	3-14.5	2-3.0	1.00
MW-14	14-Oct-93	14.5	8.79	9.79	151153.018	989590.288	4-14	3-14.5	2-3.0	1.00
MW-15	15-Oct-93	14.5	8.48	10.48	150976.733	990337.272	4-14	3-14.5	2-3.0	2.00
MW-16	29-Oct-96	20.0	13.17	15.66	150968.750	990396.960	5.5-15.5	5-15.5	2.1-5	2.49
MW-17	29-Oct-96	16.0	14.33	17.14	151112.200	990358.030	5.6-15.6	5.2-15.6	2.2-5.2	2.81
MW-18	30-Oct-96	16.0	14.79	14.34	151465.510	990269.560	5.9-15.9	5.4-15.9	2.1-5.4	-0.45
MW-19	29-Oct-96	14.0	13.82	13.69	151469.020	990514.870	2-12.8	2.8-12.8	1.5-2.8	-0.13
MW-20	31-Oct-96	16.0	13.37	12.62	151349.290	990636.830	5.6-15.6	2.8-15.6	1.5-2.8	-0.75
MW-21	31-Oct-96	15.5	13.00	12.38	151217.620	990723.660	5.5-15.5	5-15.5	2.1-5	-0.62
MW-22	31-Oct-96	16.0	12.36	11.76	151474.270	990911.800	5.5-15.5	4.9-15.4	2-4.9	-0.60

Key:
ft. BGS = Feet below ground surface.
ft. MSL = Feet above/below mean sea level.

Table B.1-6

WELL DEVELOPMENT DATA
EASTERN AREA
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

Well	Gallons Purged	pH	Specific Conductivity (μmohs/cm)	Turbidity (NTUs)
MW-16	40	6.95	2,480	78
	60	6.97	2,160	67
	80	6.96	2,110	62
MW-17	30	6.27	740	>100[a]
	35	6.39	710	>100[a]
	40	6.41	720	>100[a]
MW-18	70	7.00	6,890	>100[a]
	85	7.04	6,780	>100[a]
	100	7.05	6,790	>100[a]
MW-19	70	7.15	1,420	>100[a]
	85	7.11	1,400	>100[a]
	100	7.09	1,360	>100[a]
MW-20	70	6.49	1,810	>100[a]
	85	6.51	1,910	>100[a]
	100	6.49	1,850	>100[a]
MW-21	5	6.35	2,780	>100[a]
	7	6.39	2,740	>100[a]
	9	6.40	2,880	>100[a]
MW-22	40	6.97	3,340	>100[a]
	55	6.98	3,250	>100[a]
	70	6.99	3,270	>100[a]

[a] Turbidity readings are suspected to have been affected by iron flocculation that occurred before turbidity testing could be conducted. Samples appeared to have a turbidity of less than 100 NTUs in the field, with the exception of water from wells MW-21 and MW-17, which are the lower-yielding wells.

Key:

μmhos/cm = Micromhos/centimeter.
NTUs = Nephelometric turbidity units.

Table B.1-7

LOW-TIDE LIQUID-LEVEL READINGS TAKEN NOVEMBER 6, 1996, IN MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Time	Liquid Level[a] (feet)	Comments
MW-1	0905	5.55	
MW-2	0912	5.19	
MW-3	0935	6.71	
MW-4	0929	6.29	Short oil flash on OWIP
MW-5	0900	6.20	Oil flash on OWIP
MW-6	0910	6.15	
MW-7	0941	6.10	
MW-8	0926	7.29	Short oil flash on OWIP
MW-9	0923	7.07	Oil flash on OWIP
MW-10	0920	6.99	
MW-13	0855	4.10	
MW-14	0850	5.13	Oil flash on OWIP
MW-15	0918	4.82	
MW-16	0831	10.55	
MW-17	0825	11.24	
MW-18	0820	8.57	Oil flash on OWIP
MW-19	0815	7.69	Oil flash on OWIP
MW-20	0813	8.26	Short oil flash on OWIP
MW-21	0810	9.79	Oil flash on OWIP
MW-22	0805	7.81	Oil flash on OWIP
Bulkhead	0741	5.28	Oil sheen on water
Bulkhead	0943	6.56	Oil sheen on water

[a] MW-18 through MW-22 are flush-mounted wells. The liquid levels in these wells were measured from the ground level. Liquid levels in the remaining wells were measured from the top of the inner casing.

Key:

OWIP = Oil-water interface probe.

Table B.1-8

HIGH-TIDE LIQUID-LEVEL READINGS TAKEN NOVEMBER 6, 1996, IN MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Time	Liquid Level[a] (feet)	Comments
MW-1	1640	5.66	Oil flash on OWIP
DW-1	1641	7.02	Oil flash on OWIP
MW-2	1635	5.06	Oil flash on OWIP
DW-2	1634	6.57	Oil flash on OWIP
MW-3	1630	6.42	Little oil flash on OWIP
DW-3	1629	5.61	Oil flash on OWIP
MW-4	1621	6.09	Little oil flash on OWIP
DW-4	1620	7.06	Oil flash on OWIP
MW-5	1642	6.47	Oil flash on OWIP
MW-6	1637	6.10	Oil flash on OWIP
MW-7	1645	6.01	Oil flash on OWIP
MW-8	1619	7.05	
MW-9	1626	7.08	Oil flash on OWIP
MW-10	1627	6.89	Oil flash on OWIP
MW-13	1647	4.04	Oil flash on OWIP
MW-14	1623	7.47	Oil flash on OWIP
MW-15	1632	4.71	Oil flash on OWIP
MW-16	1653	10.58	Oil flash on OWIP
MW-17	1656	11.26	Oil flash on OWIP
MW-18	1649	8.45	Oil flash on OWIP
MW-19	1645	8.50	Oil flash on OWIP
MW-20	1643	7.48	Oil flash on OWIP
MW-21	1640	8.92	Oil flash on OWIP
MW-22	1635	7.22	Oil flash on OWIP
Bulkhead	1616	2.85	
Bulkhead	1650	3.03	

Table B.1-8 (cont.)

a MW-18 through MW-22 are flush-mounted wells. The liquid levels in these wells were measured from the ground level. The liquid levels in the remaining wells were measured rom the top of the inner casing.

Key:

OWIP = Oil-water interface probe.

Table B.1-9

LOW-TIDE LIQUID LEVEL READINGS TAKEN NOVEMBER 7, 1996, IN MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Time	Liquid Level[a] (feet)	Comments
MW-1	1232	5.67	Oil flash on OWIP
DW-1	1231	7.42	
MW-2	1236	5.16	
DW-2	1237	6.98	Oil flash on OWIP
MW-3	1222	6.73	Oil flash on OWIP
DW-3	1221	6.09	Oil flash on OWIP
MW-4	1208	6.34	Oil flash on OWIP
DW-4	1209	7.68	Oil flash on OWIP
MW-5	1229	6.37	Oil flash on OWIP
MW-6	1234	6.19	Oil flash on OWIP
MW-7	1225	6.06	Oil flash on OWIP
MW-8	1213	7.30	
MW-9	1215	7.09	Oil flash on OWIP
MW-10	1217	7.01	Oil flash on OWIP
MW-13	1227	4.07	Oil flash on OWIP
MW-14	1210	5.04	Oil flash on OWIP
MW-15	1219	4.78	
MW-16	1215	10.58	
MW-17	1217	11.26	
MW-18	1213	8.64	
MW-19	1212	8.76	
MW-20	1211	8.30	
MW-21	1209	9.98	
MW-22	1206	7.80	
Bulkhead	1205	6.35	
Bulkhead	1242	5.91	

Table B.1-9 (cont.)

[a] MW-18 through MW-22 are flush-mounted wells. The liquid levels in these wells were measured from the ground level. The liquid levels in the remaining wells were measured from the top of the inner casing.

Key:

OWIP = Oil-water interface probe.

Table B.1-10

HIGH-TIDE LIQUID-LEVEL READINGS TAKEN NOVEMBER 7, 1996, IN MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Time	Liquid Level[a] (feet)	Comments
MW-1	1712	5.66	Oil flash on OWIP
DW-1	1715	6.94	Oil flash on OWIP
MW-2	1707	5.13	Oil flash on OWIP
DW-2	1705	6.53	Oil flash on OWIP
MW-3	1701	6.35	Little oil flash on OWIP
DW-3	1700	5.53	Oil flash on OWIP
MW-4	1650	6.0	Oil flash on OWIP
DW-4	1651	7.0	Oil flash on OWIP
MW-5	1717	6.35	Oil flash on OWIP
MW-6	1709	6.39	Oil flash on OWIP
MW-7	1720	5.96	Oil flash on OWIP
MW-8	1653	6.99	Oil flash on OWIP
MW-9	1655	7.12	Oil flash on OWIP
MW-10	1657	7.04	Oil flash on OWIP
MW-13	1719	4.01	Oil flash on OWIP
MW-14	1648	4.69	Little oil flash on OWIP
MW-15	1703	4.55	Oil flash on OWIP
MW-16	1702	10.58	
MW-17	1704	11.28	
MW-18	1649	8.40	
MW-19	1644	8.50	
MW-20	1659	7.50	
MW-21	1655	8.72	
MW-22	1652	7.18	
Bulkhead	1645	2.56	
Bulkhead	1725	2.56	

Table B.1-10 (cont.)

a MW-18 through MW-22 are flush-mounted wells. The liquid levels in these wells were measured from the ground level. The liquid levels in the remaining wells were measured from the top of the inner casing.

Key:

OWIP = Oil-water interface probe.

Table B.1-11

LOW-TIDE LIQUID-LEVEL READINGS TAKEN NOVEMBER 8, 1996, IN MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Time	Liquid Level[a] (feet)	Comments
MW-1	1143	5.53	Oil flash on OWIP
DW-1	1143	7.32	Oil flash on OWIP
MW-2	1140	5.29	Oil flash on OWIP
DW-2	1140	6.93	
MW-3	1138	6.58	Oil flash on OWIP
DW-3	1138	5.99	
MW-4	1229	7.61	
DW-4	1229	6.19	
MW-5	1145	6.24	Oil flash on OWIP
MW-6	1141	6.40	Oil flash on OWIP
MW-7	1148	6.88	
MW-8	1131	7.15	
MW-9	1133	7.17	Oil flash on OWIP
MW-10	1135	7.21	Oil flash on OWIP
MW-13	1147	3.95	
MW-14	1127	4.85	Oil flash on OWIP
MW-15	1136	4.60	Oil flash on OWIP
MW-16	1203	10.55	
MW-17	1200	11.30	
MW-18	1154	8.50	
MW-19	1148	8.50[b]	Oil present on probe
MW-20	1138	7.53[b]	
MW-21	1144	8.82[b]	
MW-22	1135	7.10[b]	
Bulkhead	1124	6.53	
Bulkhead	1151	6.66	
CIW1	1205	11.67	Oil at 11.65 feet
CIW6D	1220	5.71	Oil at 5.70 feet

Table B.1-11

LOW-TIDE LIQUID-LEVEL READINGS TAKEN NOVEMBER 8, 1996, IN MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Time	Liquid Level[a] (feet)	Comments
CIW6S	1223	12.50	Oil at 6.69 feet

a MW-18 through MW-22 are flush-mounted wells. Liquid levels were measured from the ground level in the flush-mounted wells unless otherwise noted. The liquid levels in the remaining wells were measured from the top of the inner casing unless otherwise noted.

b Measurement is from top of inner casing.

Key:

OWIP = Oil-water interface probe.

Table B.1-12

PHYSICAL PARAMETERS OF GROUNDWATER PURGED FROM SHALLOW MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Volume (gal)	pH	Conductivity (μmhos/cm)	Temperature (°F)	Turbidity (NTUs)	Date
MW-01	Initial	NC	2,650	58.5	46.4	11/6/96
	1.8	NC	2,980	58.2	465	
	3.6	NC	3,130	58.3	384	
	5.5	NC	3,180	58.3	276	
MW-02	Initial	NC	1,830	65.4	49.8	11/7/96
	2	NC	1,810	64.8	703	
	4	NC	1,860	69.9	452	
	6	NC	1,830	64.8	328	
MW-03	Initial	NC	2,880	65.5	62.1	11/7/96
	2	NC	2,810	65.4	>1,000	
	4	NC	2,790	65	>1,000	
	6	NC	2,800	64.9	>1,000	
MW-04	Too much oil present to collect physical parameters data.					
MW-05	Initial	6.42	780	60.8	34.7	11/6/96
	6	6.5	790	61	18.7	
	12	6.7	870	60.6	227	
	18	6.48	1,010	60	121	
MW-06	Initial	7.01	2,810	63.3	32	11/7/96
	5	7.02	4,180	62.6	233	
	10	7.16	4,330	62.5	329	
	15	7.24	4,330	62.2	291	
MW-07	Initial	6.10	1,890	60.7	25	11/6/96
	6	6.12	1,900	60.9	116	
	12	6.5	2,000	61	120	
	18	6.7	1,800	60.8	119	

Table B.1-12

PHYSICAL PARAMETERS OF GROUNDWATER PURGED FROM SHALLOW MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Volume (gal)	pH	Conductivity (μmhos/cm)	Temperature (°F)	Turbidity (NTUs)	Date
MW-08	Initial	6.17	790	6.17	61.1	11/6/96
	6	6.53	>1,000	6.53	61.6	
	12	6.20	>1,000	6.20	61.9	
	18	6.2	>1,000	6.2	61.3	
MW-09	Initial	6.72	1,862	67.1	933	11/7/96
	4.5	6.97	2,460	65.5	>1,000	
	9	7.09	2,660	65.2	>1,000	
	14	7.17	2,530	65.2	>1,000	
MW-10	Initial	6.73	369	66.8	178	11/7/96
	4.5	5.91	374	67	>1,000	
	9	5.82	394	66.2	689	
	14	5.75	393	66.4	393	
MW-13	Initial	5.78	1,090	60.6	NC	11/6/96
	6	5.8	1,070	61	NC	
	12	6.0	1,050	60.8	NC	
	18	5.5	1,090	60.9	NC	
MW-14	Initial	6.25	1,390	64.2	NC	11/6/96
	5	6.30	1,420	64.7	NC	
	10	6.2	1,350	65	NC	
	15	6.7	1,500	65	NC	
MW-15	Initial	6.34	1,230	66.4	76	11/7/96
	6	6.82	1,341	65.5	>1,000	
	12	6.94	1,106	65.8	>1,000	
	18	6.94	1,051	64.8	>1,000	
MW-16	Initial	8.18	1,446	62.5	170	11/6/96
	1.3	8.69	1,351	61.8	>1,000	
	2.3	8.74	1,505	61.4	>1,000	
	3.9	8.79	1,586	61.3	>1,000	
	5.2	9.03	1,676	61.6	>1,000	

Table B.1-12

PHYSICAL PARAMETERS OF GROUNDWATER PURGED FROM SHALLOW MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Volume (gal)	pH	Conductivity (μmhos/cm)	Temperature (°F)	Turbidity (NTUs)	Date
MW-17	Initial	6.80	798	61.2	21.4	11/6/96
	1	6.78	846	60.9	872	
	2	6.88	811	60.9	>1,000	
	3	6.91	806	61.0	>1,000	
MW-18	Initial	5.94	4,070	62.5	400	11/6/96
	4	5.82	4,000	63.1	>1,000	
	8	5.97	4,050	64	>1,000	
	12	5.91	3,970	63.8	>1,000	
MW-19	Initial	6.18	1,710	63.4	NC	11/6/96
	3	6.15	1,720	63.9	NC	
	6	6.25	1,820	64	NC	
	9	6.35	1,800	64.1	NC	
MW-20	Initial	6.57	2,020	62.5	342	11/6/96
	4	6.62	1,970	63.5	>1,000	
	8	6.72	2,020	64	>1,000	
	12	6.74	2,030	64.1	>1,000	
MW-21	Initial	6.51	2,730	6.36	>1,000	11/6/96
	4	6.43	2,520	63.6	>1,000	
	8	6.33	2,640	63.3	>1,000	
	12	6.23	2,610	63	>1,000	
MW-22	Initial	6.40	3,290	61.8	351	11/6/96
	4	6.55	3,400	61.7	>1,000	
	12	6.39	3,450	61.9	>1,000	
	16	6.99	3,300	61.8	>1,000	

Key:

NC = Parameter not collected because of a malfunction of the instrument.
NTUs = Nephelometric turbidity units.
μmhos/cm = Micromhos per centimeter.

Table B.1-13

PHYSICAL PARAMETERS OF GROUNDWATER PURGED FROM DEEP MONITORING WELLS ON THE BROOKLYN UNION GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Volume	pH	Conductivity (μmohs/cm)	Temperature (°F)	Turbidity (NTUs)	Date
DW-01	Initial	NC	546	57.4	3.43	11/6/96
	7	NC	886	57.2	4.38	
	14	NC	872	57.2	9.88	
	21	NC	880	57.2	10.0	
DW-02	Initial	NC	1,188	69.0	37.3	11/7/96
	7	NC	2,030	63.9	114	
	14	NC	2,170	62.9	45.3	
	21	NC	2,170	61.3	42	
DW-03	Initial	NC	2,020	65.1	17.9	11/7/96
	7.5	NC	2,140	64.1	31.1	
	15.0	NC	2,220	64	28.2	
	18.0	NC	2,240	63.8	28.5	
DW-04	Initial	NC	1,383	57.8	2.68	11/6/96
	27	NC	>10,000	58.1	.71	
	54	NC	>10,000	58.3	.71	
	81	NC	>10,000	57.6	.29	

Key:

μmohs/cm = micromohs per centimeter.
NC = Parameter not collected because of a malfunction of the instrument.
NTUs = Nephelometric turbidity units.

Table B.1-14
Analytical Data for Parameters Detected in Subsurface Soils From Trenches (February 19, 1997)
Phase VI Supplemental RI
Brooklyn Borough Gas Works, Brooklyn, New York

	SAMPLE NO.		TP51S-NS	TP53S-DS	TP53S-NS	TP58S-NS	TP59S-NS	TP61S-NS	TP62S-NS	TP66S-NS	TP67S-NS	TP70S-NS	TP73S-NS	TP78S-NS
GROUP	PARAMETER	UNITS												
PAH	2-Methylnaphthalene	mg/kg						123	ND	ND	ND			
	Acenaphthylene	mg/kg						9.48	ND	ND	ND			
	Anthracene	mg/kg						120	0.123	0.896	0.542			
	Benzo(a)anthracene	mg/kg						12.2	0.503	3.25	1.53			
	Benzo(a)pyrene	mg/kg						3.9	0.447	1.68	1.65			
	Benzo(b)fluoranthene	mg/kg						7.79	ND	2.35	1.88			
	Benzo(ghi)perylene	mg/kg						2.21	0.279	1.57	0.978			
	Benzo(k)fluoranthene	mg/kg						2.73	0.302	1.12	1.18			
	Chrysene	mg/kg						12.2	0.637	4.14	1.77			
	Fluoranthene	mg/kg						77.9	1.79	13.4	5.77			
	Fluorene	mg/kg						35.1	ND	0.537	0.353			
	Indeno(1,2,3-cd)pyrene	mg/kg						1.3	0.268	0.907	0.836			
	Naphthalene	mg/kg						33.8	ND	ND	ND			
	Phenanthrene	mg/kg						93.5	0.659	5.49	3.18			
	Pyrene	mg/kg						44.2	0.883	5.15	2.83			
PESTICIDE	4,4'-DDD	mg/kg	0.254	ND	0.0239	0.00587	0.00973	0.04	0.0402	0.0776	0.0903		ND	
	4,4'-DDE	mg/kg	0.166	ND	0.0336	0.007	0.0177	0.0253	0.0227	0.0508	0.038		0.00167	
	4,4-DDT	mg/kg	ND	0.00403	0.071	0.0178	0.0624	0.0195	0.015	ND	0.0212		0.00212	
	Chlordane	mg/kg	3.28	0.00225	0.337	0.159	1.05	0.143	5.26	36.1	0.528		0.00201	
	Dieldrin	mg/kg	ND	ND	0.0252	0.0163	0.0139	0.0101	ND	ND	0.0184		ND	
	Heptachlor epoxide	mg/kg	ND	ND	0.0581	ND	ND	0.0188	ND	ND	ND		ND	
METALS	Arsenic	mg/kg	6.95	6.91	7.43	6.53	6.48	7.7	6.99	4.88	7.18		3.9	
	Chromium	mg/kg	16.7	16.5	17.6	6.91	10.3	17.4	14.4	12.8	17		11.8	
	Copper	mg/kg	53.3	19.1	26.5	19	21.3	63.1	30.1	25.3	46.2		23.9	
	Lead	mg/kg	487	75.8	122	65.6	77.1	303	101	109	298		33	
	Magnesium	mg/kg	3700	3150	3220	1450	2000	2670	3350	2840	3620		3860	
	Manganese	mg/kg	267	253	246	131	164	218	327	240	247		293	
	Mercury	mg/kg	0.461	ND	0.14	0.147	0.111	0.429	0.123	0.112	0.577		ND	
	Nickel	mg/kg	45	29.9	29.8	11.7	17.4	29.6	28.6	30.5	38.2		28.9	
	Selenium	mg/kg	ND	0.596	0.825	ND	0.729	0.74	ND	0.789	ND		0.569	
	Zinc	mg/kg	295	63.3	132	115	105	269	132	123	293		49.5	
OTHER	TRPH	mg/kg	111	ND	129	ND	47	288	118	149	172		ND	
	Cyanide-Total	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Moisture Content	%	24	11.1	21.2	11.5	9.52	23	10.5	10.7	15.1		10.4	

ANALYTICAL DATA FOR PARAMETERS DETECTED IN SURFACE SOILS
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

		Units	BH7401NS (0-4')	BH7403NS (4-8')	BH7405NS (8-12')	BH7407NS (12-16')	BH7501DS (0-4')	BH7501NS (0-4')	BH7503NS (4-8')	BH7505NS (8-12')	BH7507NS (12-16')	SS7400NS (0-0.5')	SS7500NS (0-0.5')
PAH	Acenaphthylene	mg/kg	0.86 J	1.7 J	0.33 J	ND	5	0.75 J	1 J	0.98 J	ND	0.81 J	3.7
	Anthracene	mg/kg	0.39	0.66	0.21	0.13	3.2	0.48	0.17 J	0.43	0.13 J	0.22	1.1
	Benzo(a)anthracene	mg/kg	1.4	1.9	0.79	0.52	8.4	1.4	0.92	4.8	0.56	0.86	3.1
	Benzo(a)pyrene	mg/kg	1.7	1.8	0.92	0.6	6	1.5	1.1	1.4	0.6	0.98	3.3
	Benzo(b)fluoranthene	mg/kg	1.8	2.1	1.2	0.49	7	1.5	1	1.5	0.58	0.96	2.7
	Benzo(ghi)perylene	mg/kg	2.2	2.1	1.6	0.82	6	1.6	1.9	1.3	1.2	1.3	4
	Benzo(k)fluoranthene	mg/kg	0.55	0.68	0.36	0.17	2.3	0.48	0.31	0.5	0.17	0.31	0.92
	Chrysene	mg/kg	3	5	1.6	1.7	21	3.8	2.6	5.4	5.3	2.1	8.4
	Dibenzo(a,h)anthracene	mg/kg	3.7 J	5.4 J	2.3 J	2.3 J	17 J	3 J	5.6 J	2.5 J	2.9 J	3.9 J	12 J
	Fluoranthene	mg/kg	2.6	4.1	1.8	0.84	16	2.6	1.4	3	0.81	1.5	5.6
	Fluorene	mg/kg	0.68	1	0.41	0.11 BJ	3.3 J	0.75	0.28 J	0.63	0.36 J	0.47	1.9
	Indeno(1,2,3-cd)pyrene	mg/kg	1.3	1.1	0.71	0.5	3.7	0.65	0.93	0.78	0.38	0.79	2.2
	Naphthalene	mg/kg	4 B	ND	2.4	0.86 BJ	12	3.3 BJ	2.1 BJ	2.6 BJ	0.9 BJ	2.8 BJ	10
	Phenanthrene	mg/kg	2.3	2.9	1	0.27	13	2.4	1.1	2.2	0.6 J	1.7	7.8
	Pyrene	mg/kg	4.7	5.7	2.5	1.2	23	4.5	3.1	4.8	2.2	2.7	10
PEST/PCB	4,4'-DDD	mg/kg	ND	ND	0.0232 J	0.0151 J	0.0155 J	0.00781 J	0.0156 J	0.125	ND	ND	0.016 J
	4,4'-DDE	mg/kg	0.0247 J	0.0157 J	0.0394 J	0.0151 J	0.0674	0.0502	0.0767	0.0575 J	ND	ND	0.0798
	4,4'-DDT	mg/kg	0.0494 J	0.0145 J	0.0452 J	0.014 J	0.0619 J	0.0413 J	0.0878 J	0.047 J	ND	0.0507 J	0.0852 J
	Aldrin	mg/kg	ND	ND	0.0197 J	ND	0.0519	0.0368	0.0344	ND	ND	0.0191 J	0.0447
	Chlordane	mg/kg	0.0854 J	ND	0.0255 J	0.0198 J	0.0884 J	0.0949 J	0.0389 J	0.0749 J	ND	0.0169 J	0.0436 J
	Delta-BHC	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Dieldrin	mg/kg	ND	ND	0.0128 J	ND	0.0785	0.0547	ND	ND	ND	ND	0.0192 J
	Heptachlor	mg/kg	ND	ND	ND	ND	0.0243	0.0279	0.0122 J	ND	ND	ND	ND
	Heptachlor Epoxide	mg/kg	0.0236 J	0.0169 J	0.0464	ND	ND	0.0636	ND	0.0244 J	ND	0.0349 J	ND
	Acenaphthene	mg/kg	ND	13	2.9	0.95 J	14	2 J	ND	ND	1.4 J	2.6 J	ND
VOC	Acetone	mg/kg	ND	0.174	0.00981 J	0.0381	ND	ND	ND	0.0279	0.0286	ND	ND
	Carbon disulfide	mg/kg	ND	0.00427 J	ND	0.0015 J	ND	ND	ND	ND	0.00774	ND	ND
	Methyl ethyl ketone	mg/kg	ND	0.0281	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Methylene chloride	mg/kg	0.00238 J	0.00215 J	0.00132 J	0.00179 J	ND	0.00117 J	ND	ND	0.00228 J	0.00149 J	ND
	Toluene	mg/kg	0.00256 J	0.00126 J	ND	ND	ND	ND	ND	ND	ND	ND	ND
INORGANIC	Antimony	mg/kg	ND	ND	ND	12.9	ND	ND	ND	ND	ND	ND	ND

Table B.1-15

ANALYTICAL DATA FOR PARAMETERS DETECTED IN SURFACE SOILS
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

		Units	BH7401NS (0-4')	BH7403NS (4-8')	BH7405NS (8-12')	BH7407NS (12-16')	BH7501DS (0-4')	BH7501NS (0-4')	BH7503NS (4-8')	BH7505NS (8-12')	BH7507NS (12-16')	SS7400NS (0-0.5')	SS7500NS (0-0.5')
	Arsenic	mg/kg	5.42	9.62	5.88	12.7	6.2	4.98	61.6	12.3	16.6	5.35	6.03
	Beryllium	mg/kg	0.573	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chromium	mg/kg	17.8	14.5	18.4	19.2	20.1	12.5	17.6	25.1	19.9	24.9	23.3
	Copper	mg/kg	60.6	77.6	96.3	83.9	48.7	45.8	240	211	38.7	115	51.6
	Lead	mg/kg	290	331	242	356	283	200	246	1010	206	303	350
	Magnesium	mg/kg	3740	3720	4720	3210	5220	2960	3980	3990	2800	4140	9080
	Manganese	mg/kg	227	180	219	212	222	217	661	178	171	255	227
	Mercury	mg/kg	0.225	0.242	0.336	0.675	0.287	0.301	0.211	0.61	ND	0.203	0.543
	Nickel	mg/kg	31.5	23.2	25.9	37	42.8	25	62.6	48.8	17.4	59.8	37.5
	Selenium	mg/kg	1.54	2.31	1.95	1.41	1.35	1.31	1.48	1.93	1.63	1.69	1.6
	Zinc	mg/kg	290	389	334	743	245	213	191	955	132	363	300
	Cyanide-Total	mg/kg	ND	ND	ND	ND	0.694	ND	3.03	1.74		ND	1.23
	Cyanide-Amenable	mg/kg	ND	ND	ND	ND	0.694	ND	ND	1.74	ND	ND	1.23
TPH	TRPH	mg/kg	372	251	123	263	224	228	119	738	739	258	204
OTHER	Moisture Content	%	11	17.4	13.8	14.1	9.5	10.4	10	42.6	32.6	11.2	6.07

Table B.1-16

ANALYTICAL DATA FOR PARAMETERS DETECTED IN SUBSURFACE SOILS
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

	Units	BH7401NS (0-4')	BH7403NS (4-8')	BH7405NS (8-12')	BH7407NS (12-16')	BH7501DS (0-4')	BH7501NS (0-4')	BH7503NS (4-8')	BH7505NS (8-12')	BH7507NS (12-16')
Acenaphthylene	mg/kg	0.86 J	1.7 J	0.33 J	ND	5	0.75 J	1 J	0.98 J	ND
Anthracene	mg/kg	0.39	0.66	0.21	0.13	3.2	0.48	0.17 J	0.43	0.13 J
Benzo(a)anthracene	mg/kg	1.4	1.9	0.79	0.52	8.4	1.4	0.92	4.8	0.56
Benzo(a)pyrene	mg/kg	1.7	1.8	0.92	0.6	6	1.5	1.1	1.4	0.6
Benzo(b)fluoranthene	mg/kg	1.8	2.1	1.2	0.49	7	1.5	1	1.5	0.58
Benzo(ghi)perylene	mg/kg	2.2	2.1	1.6	0.82	6	1.6	1.9	1.3	1.2
Benzo(k)fluoranthene	mg/kg	0.55	0.68	0.36	0.17	2.3	0.48	0.31	0.5	0.17
Chrysene	mg/kg	3	5	1.6	1.7	21	3.8	2.6	5.4	5.3
Dibenzo(a,h)anthracene	mg/kg	3.7 J	5.4 J	2.3 J	2.3 J	17 J	3 J	5.6 J	2.5 J	2.9 J
Fluoranthene	mg/kg	2.6	4.1	1.8	0.84	16	2.6	1.4	3	0.81
Fluorene	mg/kg	0.68	1	0.41	0.11 BJ	3.3 J	0.75	0.28 J	0.63	0.36 J
Indeno(1,2,3-cd)pyrene	mg/kg	1.3	1.1	0.71	0.5	3.7	0.65	0.93	0.78	0.38
Naphthalene	mg/kg	4 B	ND	2.4	0.86 BJ	12	3.3 BJ	2.1 BJ	2.6 BJ	0.9 BJ
Phenanthrene	mg/kg	2.3	2.9	1	0.27	13	2.4	1.1	2.2	0.6 J
Pyrene	mg/kg	4.7	5.7	2.5	1.2	23	4.5	3.1	4.8	2.2
4,4'-DDD	mg/kg	ND	ND	0.0232 J	0.0151 J	0.0155 J	0.00781 J	0.0156 J	0.125	ND
4,4'-DDE	mg/kg	0.0247 J	0.0157 J	0.0394 J	0.0151 J	0.0674	0.0502	0.0767	0.0575 J	ND
4,4'-DDT	mg/kg	0.0494 J	0.0145 J	0.0452 J	0.014 J	0.0619 J	0.0413 J	0.0878 J	0.047 J	ND
Aldrin	mg/kg	ND	ND	0.0197 J	ND	0.0519	0.0368	0.0344	ND	ND
Chlordane	mg/kg	0.0854 J	ND	0.0255 J	0.0198 J	0.0884 J	0.0949 J	0.0389 J	0.0749 J	ND
Delta-BHC	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	mg/kg	ND	ND	0.0128 J	ND	0.0785	0.0547	ND	ND	ND
Heptachlor	mg/kg	ND	ND	ND	ND	0.0243	0.0279	0.0122 J	ND	ND
Heptachlor Epoxide	mg/kg	0.0236 J	0.0169 J	0.0464	ND	ND	0.0636	ND	0.0244 J	ND
Acenaphthene	mg/kg	ND	13	2.9	0.95 J	14	2 J	ND	ND	1.4 J
Acetone	mg/kg	ND	0.174	0.00981 J	0.0381	ND	ND	ND	0.0279	0.0286
Carbon disulfide	mg/kg	ND	0.00427 J	ND	0.0015 J	ND	ND	ND	ND	0.00774
Methyl ethyl ketone	mg/kg	ND	0.0281	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	mg/kg	0.00238 J	0.00215 J	0.00132 J	0.00179 J	ND	0.00117 J	ND	ND	0.00228 J
Toluene	mg/kg	0.00256 J	0.00126 J	ND	ND	ND	ND	ND	ND	ND
Antimony	mg/kg	ND	ND	ND	12.9	ND	ND	ND	ND	ND
Arsenic	mg/kg	5.42	9.62	5.88	12.7	6.2	4.98	61.6	12.3	16.6

Table B.1-16

ANALYTICAL DATA FOR PARAMETERS DETECTED IN SUBSURFACE SOILS
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

	Units	BH7401NS (0-4')	BH7403NS (4-8')	BH7405NS (8-12')	BH7407NS (12-16')	BH7501DS (0-4')	BH7501NS (0-4')	BH7503NS (4-8')	BH7505NS (8-12')	BH7507NS (12-16')
Beryllium	mg/kg	0.573	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	mg/kg	17.8	14.5	18.4	19.2	20.1	12.5	17.6	25.1	19.9
Copper	mg/kg	60.6	77.6	96.3	83.9	48.7	45.8	240	211	38.7
Lead	mg/kg	290	331	242	356	283	200	246	1010	206
Magnesium	mg/kg	3740	3720	4720	3210	5220	2960	3980	3990	2800
Manganese	mg/kg	227	180	219	212	222	217	661	178	171
Mercury	mg/kg	0.225	0.242	0.336	0.675	0.287	0.301	0.211	0.61	ND
Nickel	mg/kg	31.5	23.2	25.9	37	42.8	25	62.6	48.8	17.4
Selenium	mg/kg	1.54	2.31	1.95	1.41	1.35	1.31	1.48	1.93	1.63
Zinc	mg/kg	290	389	334	743	245	213	191	955	132
Cyanide-Total	mg/kg	ND	ND	ND	ND	0.694	ND	3.03	1.74	ND
Cyanide-Amenable	mg/kg	ND	ND	ND	ND	0.694	ND	ND	1.74	ND
TRPH	mg/kg	372	251	123	263	224	228	119	738	739
Moisture Content	%	11	17.4	13.8	14.1	9.5	10.4	10	42.6	32.6

ANALYTICAL DATA FOR PARAMETERS DETECTED IN GROUNDWATER
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

ANALYSIS	PARAMETER	WELL DATE UNITS	DW04 DS 6/18/97	DW04 DS-F 6/18/97	DW04 NS 6/18/97	DW04 NS-F 6/18/97	MW02 NS 6/19/97	MW02 NS-F 6/19/97	MW06 NS 6/19/97	MW06 NS-F 6/19/97	MW15 NS 6/17/97	MW15 NS-F 6/18/97	MW16 NS 6/17/97	MW16 NS-F 6/17/97	MW17 NS 6/17/97	MW17 NS-F 6/17/97
PAH	1-Methylnaphthalene	ug/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2-Methylnaphthalene	ug/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Acenaphthene	ug/L	ND	NA	0.64 J	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Acenaphthylene	ug/L	1.4 J	NA	0.75 J	NA	NA	NA	NA	NA	ND	NA	ND	NA	4.2	NA
	Anthracene	ug/L	0.089 J	NA	ND JU	NA	NA	NA	NA	NA	0.62 BJ	NA	4.7 J	NA	0.062 BJ	NA
	Benzo(a)anthracene	ug/L	0.015 J	NA	0.036	NA	NA	NA	NA	NA	2	NA	9.4	NA	0.047	NA
	Benzo(a)pyrene	ug/L	ND JU	NA	0.067 J	NA	NA	NA	NA	NA	0.85 J	NA	4 J	NA	0.022 J	NA
	Benzo(b)fluoranthene	ug/L	ND	NA	0.057	NA	NA	NA	NA	NA	1	NA	5.3	NA	0.032	NA
	Benzo(ghi)perylene	ug/L	ND JU	NA	0.14 B	NA	NA	NA	NA	NA	0.64 B	NA	ND JU	NA	ND JU	NA
	Benzo(k)fluoranthene	ug/L	ND	NA	0.018 J	NA	NA	NA	NA	NA	0.43	NA	1.9	NA	0.012 J	NA
	Chrysene	ug/L	0.089 J	NA	0.15	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Dibenzo(a,h)anthracene	ug/L	ND JU	NA	ND JU	NA	NA	NA	NA	NA	2.5 J	NA	13 J	NA	ND JU	NA
	Fluoranthene	ug/L	0.14 J	NA	0.14 J	NA	NA	NA	NA	NA	1.8 J	NA	7.7 J	NA	0.08 J	NA
	Fluorene	ug/L	0.096 BJ	NA	0.086 BJ	NA	NA	NA	NA	NA	2.6	NA	10 B	NA	0.31	NA
	Indeno(1,2,3-cd)pyrene	ug/L	ND	NA	0.053	NA	NA	NA	NA	NA	0.34 J	NA	1.9 J	NA	ND	NA
	Naphthalene	ug/L	1.9 BJ	NA	1.3 BJ	NA	NA	NA	NA	NA	ND	NA	ND	NA	6.3	NA
	Phenanthrene	ug/L	0.85	NA	0.098 BJ	NA	NA	NA	NA	NA	0.54 BJ	NA	4.5 BJ	NA	0.32 BJ	NA
	Pyrene	ug/L	0.3	NA	0.25	NA	NA	NA	NA	NA	ND	NA	10	NA	0.11 J	NA
VOC	1,2-Dichloroethane	ug/L	ND	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Acetone	ug/L	ND	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Benzene	ug/L	1.98 J	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Carbon disulfide	ug/L	ND	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Chlorobenzene	ug/L	ND	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Ethylbenzene	ug/L	28.7 J	NA	1.54 J	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Methylene chloride	ug/L	ND	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Styrene	ug/L	ND	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Toluene	ug/L	ND	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Total xylenes	ug/L	38.6 J	NA	6.47 J	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
PEST/PCB	4,4'-DDD	ug/L	ND J	NA	ND	NA	NA	NA	NA	NA	0.07	NA	0.055 J	NA	ND	NA
	Alpha-BHC	ug/L	ND J	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Chlordane	ug/L	ND J	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Delta-BHC	ug/L	ND J	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Endrin	ug/L	ND J	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Gamma-BHC (Lindane)	ug/L	ND J	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Heptachlor	ug/L	ND J	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
	Heptachlor epoxide	ug/L	ND J	NA	ND	NA	NA	NA	NA	NA	ND	NA	ND	NA	ND	NA
INORGANIC	Antimony	ug/L	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND
	Arsenic	ug/L	ND	ND	ND	ND	NA	NA	NA	NA	62.2	ND	49.3	ND	28.7	ND
	Beryllium	ug/L	ND	ND	ND	ND	NA	NA	NA	NA	ND	ND	ND	ND	ND	ND
	Chromium	ug/L	ND	ND	ND	ND	NA	NA	NA	NA	43.2	ND	87	ND	54	ND
	Copper	ug/L	28.7	ND	38.4	ND	NA	NA	NA	NA	338	ND	593	ND	103	ND
	Lead	ug/L	45.1 J	25.7	79.8 J	35	NA	NA	NA	NA	795	ND	1320	11.7	92.2	ND
	Magnesium	ug/L	588000	628000	548000	629000	NA	NA	NA	NA	21500	18800	83200	50700	21600	13800
	Manganese	ug/L	1600	1540	1510	1490	NA	NA	NA	NA	913	711	1850	1250	1030	711
	Mercury	ug/L	ND	ND	ND	ND	NA	NA	NA	NA	0.83	ND	2.25	ND	0.25	ND
	Nickel	ug/L	ND	ND	ND	ND	NA	NA	NA	NA	191	ND	232	ND	305	ND
	Selenium	ug/L	18.7	20.2	11.8	16.8	NA	NA	NA	NA	11	8.15	14.7	7.39	16.8	5.43
	Zinc	ug/L	ND	13.2	22.5	15.5	NA	NA	NA	NA	5640	39.4	5070	ND	2020	ND
	Cyanide-Amenable	ug/L	0.012	0.019	ND	0.019	0.048	0.065	ND	ND	ND	ND	ND	ND	ND	0.343
	Cyanide-Total	ug/L	0.069	0.081	0.064	0.072	0.318	0.309	0.031	ND	ND	0.085	ND	0.117	0.294	0.345
TDS	Residue-TDS	mg/L	26600	NA	25600	NA	NA	NA	NA	NA	685	NA	1940	NA	484	NA
TPH	TRPH	mg/L	ND	NA	ND	NA	NA	NA	NA	NA	54.5	NA	98.5	NA	1.34	NA
OTHER	Chloride	mg/L	13300	NA	13800	NA	NA	NA	NA	NA	189	NA	620	NA	56	NA
	Hardness	mg/L	4070	3890	4060	3950	NA	NA	NA	NA	356	318	887	679	285	257

ANALYTICAL DATA FOR PARAMETERS DETECTED IN GROUNDWATER
PHASE VI SUPPLEMENTAL RI
BROOKLYN BOROUGH GAS WORKS, BROOKLYN, NEW YORK

ANALYSIS	PARAMETER	WELL DATE UNITS	MW18 NS 6/17/97	MW18 NS-F 6/17/97	MW19 NS 6/17/97	MW19 NS-F 6/17/97	MW20 NS 6/17/97	MW20 NS-F 6/17/97	MW21 NS 6/17/97	MW21 NS-F 6/17/97	MW22 DS 6/17/97	MW22 DS-F 6/17/97	MW22 NS 6/17/97	MW22 NS-F 6/17/97	CIW1W NS 6/18/97	CIW1W NS-F 6/18/97
PAH	1-Methylnaphthalene	ug/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2-Methylnaphthalene	ug/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Acenaphthene	ug/L	ND	NA	120	NA	ND	NA	5.1	NA	ND	NA	ND	NA	ND	NA
	Acenaphthylene	ug/L	ND	NA	100	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
	Anthracene	ug/L	0.72 J	NA	75 J	NA	12 J	NA	0.16 J	NA	3.6 J	NA	ND JU	NA	5.6 J	NA
	Benzo(a)anthracene	ug/L	0.31	NA	87	NA	9	NA	0.03	NA	4.3	NA	4.6	NA	11	NA
	Benzo(a)pyrene	ug/L	0.22 J	NA	100 J	NA	10 J	NA	ND JU	NA	5.7 J	NA	6.2 J	NA	13 J	NA
	Benzo(b)fluoranthene	ug/L	0.25	NA	62	NA	6.4	NA	ND	NA	3.6	NA	3.9	NA	10	NA
	Benzo(ghi)perylene	ug/L	0.29 J	NA	120 J	NA	19 J	NA	ND JU	NA	8 B	NA	8.4 J	NA	15 J	NA
	Benzo(k)fluoranthene	ug/L	0.079	NA	23	NA	2.5	NA	ND	NA	1.3	NA	1.4	NA	3.5	NA
	Chrysene	ug/L	ND	NA	580	NA	30	NA	ND	NA	15	NA	16	NA	11	NA
	Dibenzo(a,h)anthracene	ug/L	0.82 J	NA	420 J	NA	ND JU	NA	ND JU	NA	ND JU	NA	30 J	NA	49 J	NA
	Fluoranthene	ug/L	1	NA	210	NA	15	NA	0.15 J	NA	7.5 J	NA	7.8	NA	16	NA
	Fluorene	ug/L	1.1	NA	100	NA	32	NA	48	NA	13	NA	16	NA	1.6 BJ	NA
	Indeno(1,2,3-cd)pyrene	ug/L	0.16	NA	70	NA	10	NA	ND	NA	3.8	NA	4.9	NA	12	NA
	Naphthalene	ug/L	2 B	NA	42 BJ	NA	1700	NA	19	NA	280	NA	630	NA	ND	NA
	Phenanthrene	ug/L	2.7	NA	160	NA	60	NA	0.4 BJ	NA	11 BJ	NA	16	NA	ND	NA
	Pyrene	ug/L	0.2	NA	390	NA	29	NA	0.19 J	NA	17	NA	17	NA	33	NA
VOC	1,2-Dichloroethane	ug/L	ND	NA	ND	NA	ND	ND	ND	NA	ND	NA	ND	NA	ND	NA
	Acetone	ug/L	ND	NA	ND	NA	ND	ND	ND	NA	ND	NA	ND	NA	ND	NA
	Benzene	ug/L	ND	NA	3.29 J	NA	788	575	23.6	NA	75.9	NA	73.6	NA	ND	NA
	Carbon disulfide	ug/L	ND	NA	ND	NA	ND	ND	ND	NA	3.09 J	NA	3.05 J	NA	ND	NA
	Chlorobenzene	ug/L	ND	NA	ND	NA	ND	ND	ND	NA	ND	NA	ND	NA	ND	NA
	Ethylbenzene	ug/L	ND	NA	ND	NA	259	144	12	NA	8.5	NA	8.02	NA	ND	NA
	Methylene chloride	ug/L	ND	NA	ND	NA	ND	ND	ND	NA	ND	NA	ND	NA	ND	NA
	Styrene	ug/L	ND	NA	ND	NA	ND	ND	ND	NA	ND	NA	ND	NA	ND	NA
	Toluene	ug/L	ND	NA	ND	NA	35.5	22.6 J	ND	NA	25.6	NA	24.3	NA	ND	NA
	Total xylenes	ug/L	ND	NA	ND	NA	103	62.6	2.05 J	NA	126	NA	124	NA	ND	NA
PEST/PCB	4,4'-DDD	ug/L	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	0.082	NA
	Alpha-BHC	ug/L	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
	Chlordane	ug/L	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	0.037	NA
	Delta-BHC	ug/L	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	0.043	NA
	Endrin	ug/L	ND	NA	ND	NA	ND	NA	0.15 J	NA	ND	NA	ND	NA	ND	NA
	Gamma-BHC (Lindane)	ug/L	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
	Heptachlor	ug/L	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
	Heptachlor epoxide	ug/L	ND	NA	0.05 J	NA	ND	NA	ND	NA	ND	NA	ND	NA	ND	NA
INORGANIC	Antimony	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Arsenic	ug/L	126	ND	171	6.9	171	ND	33.6	ND	28.4	ND	28.3	ND	31	ND
	Beryllium	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chromium	ug/L	296	ND	140	ND	376	19.5	80.1	ND	58.1	ND	48	ND	38.6	ND
	Copper	ug/L	2140	ND	459	ND	1920	ND	61.3	ND	84.4	ND	77.8	ND	408	ND
	Lead	ug/L	6570	9.6	1440	ND	1160	ND	33.5	ND	419	5.1	390	6.9	755	ND
	Magnesium	ug/L	23800	15800	20400	16200	57900	45300	45600	42500	44800	38600	44600	40300	53000	49800
	Manganese	ug/L	3050	1630	739	498	2420	1400	1450	1180	885	603	861	634	1340	1050
	Mercury	ug/L	25	ND	4.5	ND	1.33	ND	ND	ND	0.25	ND	0.25	ND	0.5	ND
	Nickel	ug/L	158	ND	263	ND	383	ND	57.6	ND	67.3	ND	63.4	ND	117	ND
	Selenium	ug/L	21.4	7.59	13.5	8.4	21	6.81	12.4	12.3	9.83	8.11	10.5	12.5	13.2	ND
	Zinc	ug/L	10200	ND	815	ND	3240	ND	71.6	ND	662	ND	705	ND	1960	15.7
	Cyanide-Amenable	ug/L	ND	ND	ND	1.11	ND	ND	ND	ND	ND	1.4 J	ND	3.09 J	ND	0.019
	Cyanide-Total	ug/L	ND	0.054	1.29	1.68	16.6	13.5	3.56	3.63	13.8	12.3	14.1	13.9	0.032	0.119
TDS	Residue-TDS	mg/L	2850	NA	1610	NA	1840	NA	1850	NA	2410	NA	2100	NA	1130	NA
TPH	TRPH	mg/L	27.7	NA	97.5	NA	6.4	NA	ND	NA	1.9	NA	ND	NA	47.4	NA
OTHER	Chloride	mg/L	1580	NA	681	NA	133	NA	777	NA	575	NA	575	NA	270	NA
	Hardness	mg/L	646	432	427	372	2690	1120	668	1110	975	821	865	821	717	657

Table B.1-18

HIGH-TIDE LIQUID-LEVEL READINGS TAKEN JUNE 16, 1997, IN MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Time	Liquid Level[a] (feet)	Comments
MW-1	1344	6.10	
DW-1	1347	7.47	
MW-2	1332	5.58	
DW-2	1334	6.96	
MW-3	1325	6.84	
DW-3	1327	6.05	
MW-4	1422	6.31	Measured 10 in DNAPL[b]
DW-4	1419	7.25	
MW-5	1353	6.66	
MW-6	1338	6.62	
MW-7	1403	6.35	
MW-8	1306	7.36	
MW-9	1311	7.41	
MW-10	1315	7.43	
MW-13	1408	4.41	
MW-14	1414	5.12	
MW-15	1319	4.79	
MW-16	1617	10.86	
MW-17	1611	11.66	
MW-18	1357	8.40	
MW-19	1350	8.81	
MW-20	1528	7.78	
MW-21	1541	8.98	
MW-22	1522	7.30	
CIW-1	1620	11.97	

Table B.1-18

HIGH-TIDE LIQUID-LEVEL READINGS TAKEN JUNE 16, 1997, IN MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS PROPERTY BROOKLYN, NEW YORK

Monitoring Well	Time	Liquid Level[a] (feet)	Comments
CIW-6S	1638	12.62 (water)	Oil contact at 6.52 feet (6.1 feet of oil present)
Bulkhead	1302	5.73	
Bulkhead	1442	3.75	
Bulkhead	1653	2.17	

[a] Measurement from top of inner casing.
[b] Denser-than-water nonaqueous phase liquid.

Table B.1-19

HIGH-TIDE LIQUID LEVEL READINGS TAKEN JUNE 17, 1997, IN MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK

Monitoring Well	Time	Liquid Level[a] (feet)	Comments
MW-1	0808	6.08	<1 ppm
DW-1	0809	7.21	9 ppm
MW-2	0803	5.49	45 ppm
DW-2	0801	6.67	<1 ppm
MW-3	0756	6.51	<1 ppm
DW-3	0758	5.7	1 ppm
MW-4	0829	6.15	190 ppm, oil on probe
DW-4	0830	7.13	<1 ppm
MW-5	0812	6.68	180 ppm, 15 ppm w/carbon tip
MW-6	0805	6.57	<1 ppm
MW-7	0815	6.23	500 ppm, 180 ppm w/carbon tip
MW-8	0745	7.05	40 ppm
MW-9	0748	7.39	1 ppm
MW-10	0751	7.25	<1 ppm
MW-13	0818	4.37	<1 ppm
MW-14	0826	4.89	1.5 ppm
MW-15	0755	4.80	30 ppm
MW-16	0902	10.88	<1 ppm
MW-17	0905	11.72	<1 ppm
MW-18	0928	8.42	>1,000 ppm, mostly methane
MW-19	0923	8.82	>1,000 ppm, mostly methane
MW-20	0915	7.79	>1,000 ppm, mostly methane
MW-21	0918	9.04	<1 ppm
MW-22	0935	7.28	15 ppm
Bulkhead	0742	3.75	
Bulkhead	0839	4.62	
Bulkhead	0945	5.58	

[a] Measurement from top of inner casing .

Table B.1-20

LOW-TIDE LIQUID LEVEL READINGS TAKEN JUNE 19, 1997, IN MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK

Monitoring Well	Time	Liquid Level[a] (feet)	Comments
MW-1	1252	6.09	
DW-1	1249	7.59	Pad badly broken up
MW-2	1249	5.22	Broken pad and cover need replacement
DW-2	1248	7.10	Pad broken
MW-3	1243	6.79	Pad cracked
DW-3	1245	6.19	Pad cracked
MW-4	1310	6.42	
DW-4	1308	7.91	
MW-5	1257	6.69	Oil stain on end of probe
MW-6	1251	6.70	
MW-7	1302	6.32	
MW-8	1233	7.29	Pad cracked
MW-9	1238	7.40	
MW-10	1239	7.46	
MW-13	1304	4.42	
MW-14	1306	5.04	
MW-15	1241	4.80	
MW-16	1329	10.88	
MW-17	1333	11.80	
MW-18	1348	8.51	
MW-19	1352	8.85	
MW-20	1339	7.82	
MW-21	1343	9.34	
MW-22	1356	7.25	
Bulkhead	1230	6.75	
Bulkhead	1315	7.27	
Bulkhead	1412	7.26	

[a] Measurement is from top of inner casing.

Table B.1-21

PHYSICAL PARAMETERS OF GROUNDWATER PURGED FROM MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK

Monitoring Well	Volume (gal)	pH	Conductivity (umhos/cm)	Temperature (°F)	Turbidity (NTUs)	Date
CIW-1	initial	6.41	1,630	60.6	90.1	6/17/97
	1	6.47	1,500	58.9	497	
	2	6.45	1,280	58.4	485	
	3	6.44	1,330	57.7	416	
DW-4	initial	7.27	>20,000	63.6	1.73	6/17/97
	20	7.26	>20,000	61	4.11	
	40	7.24	>20,000	61	8.5	
	60	7.26	>20,000	61.1	3.34	
	85	7.24	>20,000	60.9	4.79	
MW-2	initial	6.65	2,020	63.3	74.3	6/18/97
	2	6.72	1,650	61.3	202	
	3	6.7	1,540	60.5	316	
	5	6.69	1,610	60.3	548	
MW-6	initial	6.89	2,480	62	47.1	6/18/97
	2	6.95	2,570	61.1	60	
	3	6.94	2,610	61.6	68.4	
	4.5	6.95	2,580	61.5	82.7	
MW-15	initial	6.13	8,800	63.1	615	6/17/97
	2	6.07	8,960	61.5	969	
	4	6.05	8,220	59.2	>1,000	
	6	6.04	8,460	59.2	>1,000	
MW-16	initial	6.56	2,100	61.4	>1,000	6/17/97
	2	6.69	2,470	59.3	>1,000	
	4	6.71	2,000	60.6	>1,000	
	6	6.7	2,020	59	>1,000	
MW-17	initial	6.47	9,520	60.9	224	6/17/97
	1	6.4	6,090	59.7	416	
	2	6.45	6,020	57.7	1,000	
	3	6.39	5,970	57.8	>1,000	
MW-18	initial	6.54	4,220	64.2	>1,000	6/17/97
	2	6.96	3,650	61.7	>1,000	
	3	6.99	3,550	60.3	>1,000	
	4	6.96	3,690	59.1	>1,000	
MW-19	initial	6.36	2,520	64.2	>1,000	6/17/97
	1	6.25	1,980	61.7	>1,000	
	2	6.19	1,930	60.3	>1,000	
	3	6.16	1,900	59.1	>1,000	
MW-20	initial	6.25	1,580	60.1	>1,000	6/17/97
	1.5	6.12	1,650	60.6	>1,000	
	3	6.05	1,580	59.6	>1,000	
	5	6	1,640	59.3	>1,000	

Table B.1-21

PHYSICAL PARAMETERS OF GROUNDWATER PURGED FROM MONITORING WELLS ON THE BROOKLYN BOROUGH GAS WORKS BROOKLYN, NEW YORK

Monitoring Well	Volume (gal)	pH	Conductivity (umhos/cm)	Temperature (°F)	Turbidity (NTUs)	Date
MW-21	initial	6.3	2,700	61.7	>1,000	6/17/97
	1.1	6.24	2,060	62.6	>1,000	
	2.2	6.15	2,250	60.5	>1,000	
	2.5	5.94	2,600	62.6	>1,000	
MW-22	initial	6.31	2,560	66.1	115	6/17/97
	1.5	6.38	2,420	62.9	>1,000	
	3	6.33	2,430	62.7	>1,000	
	5	6.34	2,350	62.5	>1,000	

Key:

NTUs = Nephelometric turbidity units.
umhos/cm = Micromhos per centimeter.

B.2 Findings

B.2.1 Soil Sampling

As previously discussed in Section B.1, complete soil samples were not recovered from every 2-foot segment during soil boring installation. Subsurface obstructions, the loose nature of the soils, and the dry nature of some residue encountered all resulted in the sampling sleeve seldom containing an entire 4-foot-long soil record. The supplemental RI work plan specified collection and submittal for chemical analysis of one soil sample from every 2-foot interval (E & E 1996a). Because of the lack of material collected by the sampling tool, sufficient soil for a sample was not collected from all of the 2-foot increments. Some increments contained volume sufficient only for analyses for volatile organic compounds (VOCs). Several sample increments contained little to no volume; there are no analytical data for such increments.

Table B.1-1 lists the analyses performed on soil samples. Tables B.1-2, B.1-4, B.1-5, B.1-15, and B.1-16 list all analytes detected, and the concentrations at which they were detected. Analytical results of samples collected from surface soil (SS74, SS75, F-1, F-2, G-1, and G-2), soil borings (BH-55 through BH-75), trenches (TP51, TP53, TP58, TP59, TP61, TP62, TP66, TP67, TP70, TP73, and TP78), and monitoring wells (MW-16 through MW-22) are discussed below. Note that this discussion excludes data pertaining to the quality assurance/quality control (QA/QC) samples (i.e., duplicate samples, field blanks, and trip blanks).

Organics

One hundred and four soil samples were collected and analyzed for VOCs; 13 VOCs were detected. Ethylbenzene was found at the lowest concentration (0.00125 milligrams per kilogram [mg/kg]). Total xylenes were found at the greatest concentration (337 mg/kg).

One hundred and two soil samples were collected and analyzed for PAHs; 18 of the PAHs were detected. Anthracene was detected at the lowest concentration (0.0149 mg/kg). The PAH found at the greatest concentration was fluoranthene (5,890 mg/kg). Of the 102 samples analyzed for PAHs, the greatest number of samples containing any one PAH compound (anthracene) was 91. The 10 most commonly detected PAH compounds were present in at least 81 of the 102 samples.

Analyses were conducted for four PCBs (Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260), each of which was detected in at least one soil sample. Concentrations ranged from 0.002 mg/kg to 37 mg/kg.

Seven pesticides were each detected in at least one soil sample. The most commonly detected pesticide was chlordane; it was present in 36 of the 105 samples submitted for pesticide

analyses. Chlordane ranged in concentration from 0.0098 mg/kg to 8.51 mg/kg. The pesticides 4,4-DDT; 4,4-DDE, and 4,4-DDD were found in 26, 25, and 21 soil samples, respectively. Because of the very complex nature of the matrix analyzed, individual pesticides present in small quantities could not be confirmed by the methods and instrumentation used. Thus, data reporting the presence of the pesticides heptachlor, heptachlor epoxide, and dieldrin in three, fourteen, and ten soil samples, respectively, are considered anomalous. This issue is discussed in the QA/QC data review memoranda presented in Volume II with the raw data.

Inorganics

One hundred and seven of the 164 soil samples collected were analyzed for 12 selected metals. Arsenic, chromium, copper, magnesium, nickel, and zinc were detected in each of the 107 soil samples. Antimony was detected in five samples, beryllium in six samples, and mercury in 65 samples. Manganese was detected in all but one soil sample, and selenium was detected in all but 13 samples. Of all the metals detected, magnesium was found at the highest concentration (16,200 mg/kg), and mercury was detected at the lowest concentration (0.111 mg/kg). On August 27, 1997, four samples (F-1, F-2, G-1, and G-2) were collected from the manufacturing area of the site and submitted for lead analysis. The lead concentration detected in sample F-1 was 422 mg/kg, and the concentration in F-2 was 435 mg/kg. These concentrations are below the SS32 level of 1,900 mg/kg detected in 1993. The lead concentration detected in sample G-1 was 187 mg/kg, and the concentration in G-2 was 354 mg/kg. These concentrations are below the SS28 level of 1,800 mg/kg detected in 1993. Resampling of the areas on either side of surface soil sample locations SS28 and SS32 was conducted within 10 feet of the original sampling locations; however, resampling probably did not occur exactly at the original sampling locations due to difficulties in the field. The significantly lower concentrations of lead detected in the more recent samples is attributable to the heterogeneity of the soils present on the site. In addition, both samples were collected from areas in which the manufacturing facilities and operations would not have contributed as direct sources of lead.

DOH wording

Cyanide was detected in 61 soil samples and at all depths except the 18- to 20-foot interval. Concentrations ranged from 0.934 mg/kg to 446 mg/kg.

A TRPH concentration was detected in 93 samples; it was present at least once in all 10 depth intervals. TRPH concentrations ranged from 10.1 mg/kg to 33,600 mg/kg.

B.2.2 Groundwater

Twenty-four groundwater samples were collected: one sample each from the 20 shallow groundwater monitoring wells and four deep groundwater monitoring wells installed on the property by E & E during Phases II, V, and VI (November 1996). In June 1997, 12 groundwater samples were collected: one from each of the nine shallow groundwater monitoring wells and the deep groundwater monitoring well, and two shallow wells were also sampled only for total and amenable cyanide.

Each groundwater sample was analyzed for the parameters listed in Table B.1-1. Tables B.1-3 and B.1-17 present the shallow and deep groundwater monitoring well sampling analytical data by listing concentrations of analytes detected in at least one groundwater sample. The findings are discussed below.

Shallow Groundwater Monitoring Wells

Organics

Each of the 24 groundwater samples was analyzed for VOCs; nine VOCs were detected. Xylene was detected at both the lowest and highest concentrations of all of the VOCs detected; it ranged from 1.08 micrograms per liter (µg/L) to 16,400 µg/L. The five most commonly detected VOCs were benzene, ethylbenzene, toluene, total xylenes, and styrene, which were also the most commonly detected VOCs in the soil samples.

The 24 groundwater samples were analyzed for PAHs; 15 PAHs were detected. Naphthalene was the PAH detected at the highest concentration (21,900 µg/L); anthracene was detected at the lowest concentration (0.089 µg/L). No PAHs were detected in the groundwater samples from four shallow wells. Groundwater in the sample from MW-19 contained 14 PAHs in November 1996 and 15 PAHs in June 1997, the most PAHs of any of the samples.

Besides PAHs, five other semivolatile organic compounds (SVOCs) were detected during the November 1996 sampling. Dibenzofuran was detected at the lowest concentration (2.5 µg/L); 4-methylphenol was detected at the highest concentration (19.9 µg/L).

No PCBs were detected in these samples. Two pesticides were detected: alpha-BHC in two samples and heptachlor epoxide in one sample. The three concentrations ranged from 0.035 to 0.39 µg/L. TRPH concentrations ranged from 1.3 mg/L to 213 mg/L.

Inorganics

Twelve metals were detected in the shallow groundwater samples. Mercury was present at the lowest concentration (0.25 µg/L); magnesium was present at the highest concentration (86,900 µg/L). The most prevalent analytes were manganese and zinc, both of which were present in all 20 shallow well samples. Antimony was the least common; it was present in only one shallow groundwater well sample.

Chloride concentrations ranged form 14.8 to 1,940 mg/L. Total dissolved solid (TDS) values ranged from 259 mg/L to 3,540 mg/L, and total hardness values ranged from 144 mg/L $CaCO_3$ to 2,690 mg/L $CaCO_3$.

Deep Groundwater Monitoring Wells

Organics

Of the four deep monitoring well groundwater samples submitted for analysis, one sample contained two VOCs (ethylbenzene and total xylenes) and one contained benzene. Individual VOC concentrations ranged from 1.29 to 2.93 µg/L in November 1996, and in deep well DW-04 were 8.01 µg/L in June 1997. Two samples each contained one PAH, and a third sample contained two SVOCs other than PAHs in November 1996. TRPH (2.92 mg/L) was detected in only one sample in November 1996; no TRPH was detected in June 1997. Neither PCBs nor pesticides were detected in any of the samples. In June 1997, 10 PAHs were detected in DW-4 at low concentrations.

Inorganics

Of the 12 metals analytical parameters, eight were detected in deep groundwater monitoring well water samples. Lead was detected at the lowest concentrations (6 µg/L); magnesium was detected at the highest concentration (888,000 µg/L). In June 1996, six metals were detected.

Chloride concentrations ranged from 33.4 to 15,700 mg/L. Total hardness values ranged from 57.1 mg/L $CaCO_3$ to 985 mg/L $CaCO_3$. TDS readings were only detected in three samples; values ranged from 327 mg/L to 27,800 mg/L.

B.3 Analysis

B.3.1 Chemical Data

B.3.1.1 Soils

Organics

Of the VOCs detected, benzene, toluene, ethylbenzene, and total xylene (BTEX) and styrene concentrations were similarly substantially higher than those of the other VOCs. Similar concentrations of BTEX present in a sample indicate the presence of a fuel oil. BTEX was most prevalent in samples collected from BH-59, BH-64, BH-66, MW-19, MW-20, and MW-22. These five boreholes are all located at the northeastern part of the eastern area of the property.

PAHs were found in all boreholes installed on the eastern area of the property. The boreholes containing the highest total concentrations of PAHs were BH-63, BH-66, MW-20 and MW-22. BH-59 and MW-19 also contained comparatively high PAH concentrations. These boreholes are located along the northeast portion of the eastern area of the property.

Styrene is a product of the coal gasification process, formed during the carburetion process. Styrene was found in elevated concentrations in the same soil samples that contained high concentrations of BTEX. These findings are congruous, given the nature of the gasification process.

PCBs were found in soil samples collected from five boreholes: BH-56, BH-57, BH-62, MW-16, and MW-21. These boreholes are located along the southern (BH-62, MW-16, and MW-21) and western portions (BH-56, and BH-57) of the eastern portion of the property. PCBs were only detected in the 2- to 4-foot, 6- to 8-foot, and 18- to 20-foot depth intervals. Each of the four aroclors was detected in the 2- to 4-foot depth interval in at least one of the five boreholes. MW-21, BH-56, and BH-57 all contained Aroclor 1260 at the 6- to 8-foot depth interval. MW-16 contained Aroclors 1248 and 1254 at the 18- to 20-foot depth interval. MW-16 contained the highest PCB concentrations detected in any one borehole; Aroclor 1248 was found in three samples, with concentrations ranging from 17.5 mg/kg to 28.7 mg/kg.

Pesticides were found in all boreholes and trenches except BH-67, MW-16, MW-19, and MW-20. BH-67 and MW-19 are located along the divide between the two former, and currently closed, baseball fields. MW-19 is located in the parking lot access area, and MW-16 is located outside the former, and currently closed, baseball field area.

TRPH concentrations were found in all boreholes and all but two trenches, TP58 and TP73, installed in the eastern area. Concentrations varied with depth and location. The highest concentration (33,600 mg/kg) was found in the borehole of MW-20 at the 2- to 4-foot depth interval. Boreholes MW-16, MW-19, MW-20, BH-59, and BH-66 all contained TRPH concen-

trations exceeding 10,000 mg/kg in at least one depth interval. MW-22 contained TRPH concentrations at the greatest number (six) of depth intervals.

Inorganics

The metals analyses do not show clear trends. However, it is noted that the 2- to 4-foot depth interval most commonly contains the highest concentration, although the 6- to 8-foot, 10- to 12-foot, and 14- to 16-foot depth intervals are also noted as containing the highest concentrations at certain boreholes. Given the proximity of the overhead expressway traversing the northern boarder of the property, one would expect to find high lead, copper, zinc, and chromium concentrations in the surface soils of the northern portion of the property. Higher concentrations of these four metals were found in the subsurface.

Cyanide can also be associated with MGP wastes. It was found more frequently and in higher concentrations in boreholes located in the northeast portion of the property. This is consistent with the findings of high BTEX, styrene, and PAH concentrations at that portion of the property. Additional characterization activities in February 1997 aided in the vertical and horizontal characterization of total cyanide in the area adjacent to BH-59.

B.3.1.2 Groundwater

B.3.1.2.1 Shallow Monitoring Wells

BTEX was found in wells MW-03, MW-04, MW-05, MW-06, MW-07, MW-08, MW-14, MW-19, MW-20, MW-21, and MW-22. The total BTEX concentrations were particularly higher in wells MW-03, MW-04, MW-07, MW-14, MW-21 and MW-22, as compared with the concentrations in the other wells. As stated in the discussion of soils, above, the presence of BTEX indicates the presence of fuel oil compounds. The wells are not clustered in any one portion of the site. The central, western, northwestern, and northeastern portions of the site all contain at least one well in which BTEX has been found. One possible indication is that because groundwater is flowing from north to south, BTEX may be flowing onto the property from the north. Of particular note is that only one of these wells, MW-08, contains styrene in addition to BTEX, suggesting that the BTEX in the center of the site may be related to MGP operations.

Of the PAHs analyzed, acenaphthene and naphthalene were detected most frequently in the samples analyzed. Considering the PAH-rich nature of coal tar, the frequency of finding coal tar on the property, and the low water solubility of PAHs, these findings are consistent with other findings on the site.

PCBs were not detected in any of the Phase VI groundwater samples. These findings are not surprising considering PCBs have an extremely low water solubility and were not associated with MGP operations.

Of all the samples analyzed, the metals concentrations were typically much higher in samples from MW-19 and MW-20, and likely due to off-site sources. MW-18 and MW-22 were the second two most metal-rich samples. Chromium concentrations were elevated in these samples but were below 60 µg/L in all other samples except those from MW-09 and MW-14.

Seven samples contained hardness values (as $CaCO_3$) outside the typical range of shallow liquid samples found on other parts of the property. The liquid hardness of MW-05 was significantly lower, whereas liquid from MW-03, MW-06, MW-18, MW-20, MW-21, and MW-22 had significantly higher hardness values. The low MW-05 value may be related to its greater distance from the tidal influence. The high values of the other wells may result from their locations along a relic tributary to the creek. Although the tributaries have been filled, the fill material is highly porous, possibly allowing for some minor tidal influence. This rationale would also explain the higher chloride concentration in MW-06, MW-18, MW-21, and MW-22.

B.3.1.2.2 Deep Monitoring Wells

Analysis of the deep groundwater monitoring well data indicates that DW-04 is drawing in saline water. Its chloride content was more than 44 times greater than the highest chloride concentration in the other three deep wells. Also, the magnesium and manganese contents of this well water are extraordinarily high as compared with the concentrations in other deep well water samples, and the TDS concentration in DW04 is very high. The water entering this well is very brackish or brine.

Comparisons to Previous Studies

As stated in Section 2 of the main report, Roux had installed several wells on this site (see Figure 2-1). Roux reported seeing free product in soil from boring of wells CI-2 and CI-4. E & E well MW-05 is close to CI-2 and contained BTEX, although at one of the lower total concentrations as compared to what was found in the other E & E wells. E & E well MW-09 is slightly east of CI-4; no volatiles were detected in it during this round of sampling. These results show the extremely variable nature of the chemical constituents present at the property.

As noted in Section 2 of this report, A.D. Little found floating oil on the surface of water in CIW-1, a well in proximity to E & E well MW-16. During Phase VI sampling, E & E found an oil sheen on the MW-16 groundwater sample during high tide. VOC analysis of the ground-

water sample did not detect any VOCs. Little also found a floating sheen in wells CIW-5, CIW-6, and CIW-10, which are near E & E wells MW-08, MW-04, and MW-07, respectively. MW-04 and MW-07 contained oil sheens during sampling. All three wells also contained BTEX, although only MW-04 and MW-08 contained the highest concentrations of BTEX on the property. This indicates that the oil distribution may have changed over the years, but the overall oil presence beneath the site has remained.

Two wells installed by Little on the eastern area of the property are relatively close to E & E wells. MW-16 is close to CIW-1, and MW19 is close to former CIW-2. Little did not collect a sample from CIW-2. Comparison of groundwater data collected by Little from CIW-1 to data from MW-16 shows the data are similar in one way: no VOCs were detected in either sample. CIW-1 contained higher SVOC concentrations (276 µg/L versus 6.09 µg/L in MW-16), but no metals were detected in this the CIW-1 sample. This is extremely unusual. Analysis of MW16 groundwater detected 10 metals at concentrations ranging from 0.572 µg/L to 50,100 µg/L. Roux (1984) and Weston (1989) did not collect groundwater analytical data from eastern area wells during their studies.

During the June 1997 sampling event, CIW-1 and MW-16 were sampled and provided very similar groundwater data. The same 10 metals were detected in each well, with the concentrations being higher for each metal in MW-16. During this sampling event, most of the inorganic analytes had reduced concentration levels (or were ND) in the filtered versus the unfiltered samples. There did not appear to be any direct correlation between the cyanide concentration levels in the filtered and unfiltered samples. CIW-1 contained higher PAH concentrations (179.1 µg/L versus 55.9 µg/L). No VOCs were detected in either sample.

B.3.2 Geologic Findings

Analysis of the soil boring and trench logs generated from the Phase VI borehole installation activities shows several noteworthy features. The entire eastern area of the property is covered with a silty clay loam layer approximately 0.25 foot in thickness. A 1- to 3-foot-thick layer of silty sand underlies this silty clay loam. This is underlain by a 0.75- to 2.5-foot-thick layer of sand or gravelly sand in all boreholes except MW-19, where this layer was not present. A 3-inch sandy loam topsoil, with grass, was found overlying fill in trench TP73 located on site in the former, and currently closed, baseball field area. Beneath the silty clay loam or sand/gravelly sand lies a fill layer consisting of yellow brick, red brick, concrete chunks, wood, cinders, ash, and small quantities of silty sand. In addition, coal tar and/or oil was observed in the fill layer in 14 of the 15 boreholes, six of the seven monitoring wells, and 20 of the 27 trenches. The fill ranged in thickness from 6 feet thick in BH-56 to 16 feet in BH-59. In

boreholes BH-55, BH-60, BH-62, BH-63, BH-64, BH-65, BH-66, BH-67, BH74, and BH75 and the boreholes for MW-18, MW-19, MW-20, and MW-22, the fill was underlain directly by a clay/peat/silt layer containing much root matter. In all other boreholes, the fill sat atop either a sand, silty sand, or gravel layer. Those boreholes penetrating deeper revealed the presence of a gray quartz sand underlying the peat layer. The trenches ranged in depth from 0.75 foot in TP62 to 7.25 feet in TP78. None of the 27 trenches was excavated through the fill to groundwater.

One noteworthy feature was found at BH-65: fill, sand, and gravel were interbedded. This indicates a series of activities involving emplacement of fill followed by emplacement of sand. A.D. Little (1989) discovered a similar feature during its installation of well CIW-1, substantially to the west of BH65.

Roux (1984) encountered a very similar subsurface profile during its installation of six boreholes on this portion of the property in its study of the eastern area. However, Roux reported the upper sand layer to be from 2 to 4 feet thick and found a much thicker clay/peat/silt layer. Roux reported the clay/peat/silt layer as varying from 2 to 4 feet in thickness. E & E intentionally stopped drilling when the clay/peat/silt layer was encountered. However, in the two instances when this layer was penetrated, the total thickness of the clay/peat/silt layer was found to be only a few inches to 0.5 foot thick.

Like Roux, E & E noted a preponderance of root matter in the peat layer. However, E & E noted far less shell matter present. Still, E & E's findings agree with Roux that the geologic column underlying the fill material indicates the former presence of a tidal estuarine environment. E & E noted that OVA readings from sands underlying the clay/peat/silt layer consisted almost entirely of methane, not other organic vapors. This indicates that the higher OVA readings found in the overlying fill layers may result from contents in the groundwater that are sitting on top of this clay/peat/silt layer. Although the clay/peat/silt layer is certainly not impermeable, it significantly retards downward migration of upper groundwater. Thus, downward migration of oils and coal tar has been retarded by the presence of this layer, resulting in significantly lower OVA readings from strata underlying it.

Weston's 1989 study did not involve subsurface soil exploration on the eastern area of the property.

B.3.3 Hydrogeologic Findings

B.3.3.1 Distance of Inland Tidal Influence

E & E used the Phase VI groundwater elevation data to analyze the behavior of the site groundwater with respect to the tidal cycle. These data are presented on Figure 3-8 of the main report. During Phase VI, the tidal influence was found to extend inland across most of the property (see Figure 3-8). Although the inland tidal effect decreases with distance from Coney Island Creek, especially at the northern boundary of the property, water level measurements show it to be substantially less on the western and eastern sides of the site. A.D. Little (1989) determined the distance of inland tidal influence to be 50 feet. Neither Weston (1989) nor Roux (1989) made such estimations.

B.3.3.2 Hydraulic Gradient

Based on the same groundwater contour data referenced above, E & E calculated the hydraulic gradient to range from 0.005 to 0.05 over this site. Variations in gradient result primarily from geologic variations, although subsurface structures such as remnant pipes, unconsolidated concrete chunks, and tanks can also affect groundwater level data and thus affect gradient calculations.

A.D. Little calculated a groundwater gradient of 0.012 feet at the area of well CIW-1. Roux measured a site gradient of 0.0045 feet per foot, or 23.8 feet per mile. Weston did not calculate a groundwater gradient.

B.3.3.3 Hydraulic Conductivity and Transmissivity

Slug testing was used to determine hydraulic conductivity and transmissivity, two aquifer characteristics used in predicting contaminant migration and in evaluating the effectiveness of using various remediation options at the site. Slug tests involve instantaneously removing, adding, or displacing a volume of liquid in a well and measuring the resulting fluctuations of the hydraulic head over time. Only discrete portions of the aquifer can be estimated by a slug test. Slug testing began by recording an initial liquid-level measurement and total depth of well measurement to verify the volume of liquid in the well. A pressure transducer located within the liquid column was used to measure the change in liquid level within the well. The transducer was connected to a datalogger that recorded the liquid-level changes following injection or removal of the slug. Periodic hand measurements of liquid depth were made to verify the datalogger readings.

Slug testing was conducted on the seven new shallow groundwater monitoring wells installed by E & E during the Phase VI fieldwork. Both falling-head and rising-head slug tests were performed. These tests were accomplished by injection and withdrawal of a precleaned, 5-foot-long, sand-filled, polyvinyl chloride (PVC) slug.

Pressure transducer data were recorded with a Hermit 2000 datalogger and downloaded to a portable laptop computer. The data were then analyzed using the AQTESOLV software package. Fourteen monitoring well response curves were plotted from the slug test data collected during Phase VI: one each for the rising- and falling-head tests conducted on each of the seven wells. Hydraulic conductivity values measured during falling-head tests ranged from 0.0028 foot per minute in MW-17 to 0.0311 foot/minute in MW-16. Rising-head tests resulted in hydraulic conductivity ranging from a low of 0.0047 foot/minute in MW-21 to a high of 0.0398 foot/minute in MW-20. The test plots are presented in Section B.4. Table B.3-1 lists the results of the Phase IV slug testing.

All wells exhibited fast to extremely fast recharge rates. The fast recharge observed in most wells on the property can be attributed to the presence of fine- to medium-grained sand or fill containing little silt within the screened section of the wells. Because of the fast recharge in most wells, the usable portion of data is generally from the first several seconds after injection or withdrawal of the slug. Data from wells near the creek recorded at later time intervals were also affected by tidal fluctuations that prevented water levels in wells from equalizing back to the initial zero reference level.

Comparison with Previous Data

During Phase V, E & E conducted much slug testing on the Brooklyn Borough Gas Works property. Thirty monitoring well response curves were produced from analysis of the field data. Multiple curves were produced for some of the tests. These were produced from identical field data sets but used slightly differing data-editing techniques within the SLUGIX™ program. Hydraulic conductivity values ranged from 1.033×10^{-3} to 1.398×10^{-2} feet/minute. Transmissivity values ranged from 0.1736 to 2.350 square feet/minute. In general, there is strong correlation between falling- and rising-head tests performed in the same well. This is because the screened portion of both the shallow and deep wells are below the top of the water table, thereby minimizing sand-pack effects. Hydraulic conductivity and transmissivity values are summarized in Table B.3-2. Response curve plots are presented in Section B.5.

The hydraulic conductivity values reported by A.D. Little (1989) are similar to the results obtained by E & E. Shallow well CIW-3S was reported to have a conductivity of 12 feet/day. This falls within the range of the shallow wells tested by E & E (1.75 to 13.40

feet/day). A.D. Little tested two other wells, CIW-5D and CIW-8D, and estimated the hydraulic conductivities of these wells to be 41 and 125 feet/day, respectively. E & E did not conduct slug testing on these wells. However, it is probable that the screened interval in these wells was not entirely submerged during the time of testing. This would cause the very highly permeable sand pack around the screen to affect the hydraulic conductivity readings. Also, the A.D. Little hydraulic conductivity values were based on use of a different testing method and were also estimated. A.D. Little calculated hydraulic conductivity in the shallow aquifer to be 12 feet per day and found that it ranged from 41 to 125 feet per day in its deep wells. Roux and Weston did not calculate hydraulic conductivity.

Table B.3-1

HYDRAULIC CONDUCTIVITY DATA FROM PHASE VI SLUG TESTING

	Falling Head		Rising Head	
	ft/min	cm/sec	ft/min	cm/sec
MW-16	0.0311	0.0158	0.0295	0.0150
MW-17	0.0028	0.0014	0.0069	0.0035
MW-18	0.0094	0.0048	0.0111	0.0056
MW-19	0.0253	0.0129	0.0246	0.0125
MW-20	0.0215	0.0109	0.0398	0.0202
MW-21	0.0032	0.0016	0.0047	0.0024
MW-22	0.0173	0.0088	0.0131	0.0067

Key:

ft/min = Feet per minute.
cm/sec = Centimeters per second.

Table B.3-2

HYDRAULIC CONDUCTIVITY DATA FROM SLUG TESTING
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

	Conductivity (cm/sec)		Transmissivity (ft^2/min)	
	Falling Head	Rising Head	Falling Head	Rising Head
MW-16	0.0158	0.0150	0.0311	0.0295
MW-17	0.0014	0.0035	0.0028	0.0069
MW-18	0.0048	0.0056	0.0094	0.0111
MW-19	0.0129	0.0125	0.0253	0.0246
MW-20	0.0109	0.0202	0.0215	0.0398
MW-21	0.0016	0.0024	0.0032	0.0047
MW-22	0.0088	0.0067	0.0173	0.0131

Key:

cm/sec = Centimeters per second.
ft^2/min = Square feet per minute.

B.4 Borehole Drilling Logs

DRILLING LOG OF BORING NO. BH 55

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 151039.390 E 990375.250 State Plane Coord NAD

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Hickerson

Total Depth of Hole (feet BGS): 20.0

Ground Elevation (feet above MSL): 13.31

Reveal at (feet BGS): NA

Date Started / Finished: 10-29-96 / 10-29-96

W.O. #: B.4003

ground elevation 13.31 ft. DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL	RUN NUMBER	BLOW COUNT	% RECOVERY	OVA	COMMENTS
		0-.25' SILT: LOAM.						Drill Method:
1		.25-1.0' SILT: SAND, red-brown.						Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
2		1.0-2.0' SAND, tan, fine grain, with 5mm to 10mm pebble inclusions.						Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
3		2.0-4.0' FILL, concrete and asphalt chunks in sand matrix.						
4		4.0-8.0' FILL, sand with pebbles up to 5mm and concrete chunks; much void space; metal fragments present, water at 7.5' or 8'; wood chunk at 5'.						All OVA readings are from above background.
8		8.0-11.5' FILL, brown sand fill, stained black from 11.2' to 11.5'. Black stain appears to be coal tar.						OVA reading >1,000ppm of methane on the sample.
11.5		11.5-12.0' CLAY-PEAT-SILT, morous, and methane rich.						
12		12.0-20.0' SAND, gray fine to medium grain, saturated with water, loose, no visual contamination or odors.						
20								

DRILLING LOG OF BORING NO. BH 55

Project: Brooklyn Borough Gas Works Site

Total Depth of Boring Feet BGS: 20.0

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE INTERVAL / SAMPLE NUMBER / BLOW COUNT / % RECOVERY / O/A	COMMENTS
0				O.A reading 300ppm to 400ppm of metrane on the sample.

DRILLING LOG OF BORING NO. BH 56

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 151263.390 E 990331.75 State Plane Coord NAD

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Nickerson

Total Depth of Boring: feet BGS: 16.0

Ground Surface Elevation: feet above MSL): 13.83

Returned at feet BGS: NA

Date Started: Finished: 10-31-96 / 10-31-96

Logged By: B.Adam

gs elevation 13.83 ft DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER & SAMPLE INTERVAL	BLOW COUNT	% RECOVERY	OVA	COMMENTS
0		0-0.25' SILT - LOAM, brown.					Drill Method.
1		0.25-1.0' SAND, brown, fine-to medium-grain sand and fine, rounded gravel.					Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
2		1.0-2.5' SAND AND GRAVEL, with angular, 2mm to 10mm inclusions.					Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
3		2.5-6.0' FILL, concrete chunks with some fine to medium grain sand and angular gravel.					
4							At OVA readings are from above back ground.
5							
6		6.0-11.5' SAND, fine-to medium-grain sand with angular gravel inclusions up to 10mm; coal chunks at 6'; water at 7.5'.					
7							
8							
9							
10							OVA reading 10ppm methane on the sample.
11							
12		11.5-12.0' SILTY SAND, gray.					OVA reading 1ppm methane on the sample.
13		12.0-15.0' SAND, brown, fine-to medium-grain sand with fine gravel and coarse sand, and angular concrete inclusions up to 10mm.					
14							
15		15.0-16.0' CLAY-PEAT-SILT, part gray, very [illegible] grading to peat and silt at 16'.					OVA reading 2200ppm methane on the sample.
16							
17							
18							

DRILLING LOG OF BORING NO. BH 57

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 151379.51 E 990347.83 State Plane Coord NAD27

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Tuckerson

Total Depth of Hole (feet BGS): 20.0

Ground Elevation (feet above MSL): 13.4'

Reference Point Elev: NA

Date Started / Finished: 10-31-96 / 10-31-96

Rig #: [illegible]

Ground elevation 13.4 ft.	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL	SAMPLE NUMBER	PENETRATION / RECOVERY	OVA	COMMENTS
	1		0-1.0' SAND, SILT, GRAVEL.	BH5TS-01NS	BH5TS-01NS	4" / 4"	16	Drill Method: Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe. Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
	2		1.0-2.0' FILL, concrete.					
	3		2.0-4.0' FILL, sandy, black silt with gravel, wood, and vegetative matter; moist.				5.0	
	4		4.0-5.0' FILL, concrete.	BH5TS-02NS	BH5TS-02NS	4" / 4"	190	All OVA readings are from above background
	5		5.0-11.0' FILL, black silty sand with cinders and dried coal tar chunks; yellow powdery substance from 7' to 7.2'.				185	
	6			BH5TS-03NS	BH5TS-03NS	4" / 4"	10	Sample BH5TS-04NS was submitted for VOC analysis only, due to poor recovery.
	7							
	8							
	9							
	10							
	11		11.0-15.0' SAND, black, fine-grained sand with silt; wet at 10'; grades to brown at 15'.	BH5TS-04NS	BH5TS-04NS	4" / 4"	5	Sample BH5TS-03NS was submitted for VOC analysis only, due to poor recovery.
	12							
	13							
	14							
	15		15.0-16.0' SAND, brown, with some organic fibers.	BH5TS-05NS	BH5TS-05NS	4" / 4"	2	OVA reading 0 ppm of methane on the sample.
	16		16.0-20.0' SAND, black, fine-grained sand.					OVA reading 0 ppm of methane on the sample.
	17							
	18							

DRILLING LOG OF BORING NO. BH 57

Project: Brooklyn Borough Gas Works Site

Total Depth of Boring: Feet BGS: 20.0

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SPLIT SPOON (SPT) BLOW COUNT PER 6"	RECOVERY %	COMMENTS
-5					
19					
20					
21					
22					
23					
-10					
24					
25					
26					
27					
28					
-15					
29					
30					
31					
32					
33					
-20					
34					
35					
36					
37					
-25					
38					

DRILLING LOG OF BORING NO. BH 58

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 151409.78 E 990222.79 State Plane Coord NAD27

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Nicherson

Total Depth of Hole (feet BGS): 20.0

Ground Elevation (feet above MSL): 15.60

Bedrock at (feet BGS): NA

Date Started / Finished: 10-21-96 / 10-31-96

PID =: 5.4 CF

DEPTH (ft elevation 15.60 ft)	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE TYPE	BLOW COUNT / % RECOVERY	OVA	COMMENTS
0						Drill Method Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
1		0-.25' SILTY LOAM, brown.				Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analysed.
2		.25-4.0' SAND, brown, fine-grain sand with trace of pebbles and gravel.				
3		1.0-4.0' FILL, concrete, gravel, brown sand, and wood.				
4		4.0-10.0' FILL, wood chunks, plywood, concrete, red brick, dried tar chunks, some brown sand, and silt.				All OVA readings are from above background.
5						
6						
7						
8						
9						
10		10.0-12.0' FILL, black silt, 5mm to 10mm gravel, pink, white, and black ash; dried tar pieces at 10'. Slag and cinders present.				
11						
12		12.0-16.0' SILTY SAND, black, with angular gravel up to 10mm, and trace of ash and cinders.				
13						
14						
15						
16						
17		16.0-20.0' SAND, black, fine-grain sand; very saturated.				
18						

DRILLING LOG OF BORING NO. BH 58

Project: Brooklyn Borough Gas Works Site

Total Depth of Hole Feet BGS: 20.0

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	PHOTOIONIZATION DETECTOR (PID) READINGS (ppm)	COMMENTS
19				
20				
-5				
23				
24				
25				
-10				
26				
29				
30				
-15				
31				
33				
34				
35				
-20				
36				
37				
38				
39				

DRILLING LOG OF BORING NO. BH 59

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 5147481 E 990385.8 State Plane Coord. TABLE

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Fluckerson

Total Depth of Hole (feet BGS): 20.0

Ground Surface Elevation (feet above MSL): 13.58

Reference Point (feet BGS): N/A

Date Started / Finished: 10-31-96 10-31-96

Logged By: E.A.[illegible]

95 elevation 13.58 ft. DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL (FEET)	RUN NUMBER	PID (ppm) / FID (ppm)	% RECOVERY	COMMENTS
1		0'-.25' SILT - LOAM, brown.	BH59-1	RUN-1		75	Drill Method: Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
2		.25'-1.0' SAND, brown, fine-grain sand with inclusion of angular, 5mm to 10mm, gravel.					Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
3		1.0'-3.7' FILL, concrete, gravel, and sand.				5	
4		3.7'-5.0' FILL, black cinders, sand, and silt, with wood chunks; coal tar odor on sample; red brick at 5'.	BH59-2	RUN-2		0	All OVA readings are from above background.
5							
6							
7							
8		8.0'-12.0' FILL, black cinders and coal tar chunks with silt and sand; some clay-rich crystals present; water at 10'.	BH59-3	RUN-3		15	
9							
10						0	
11						40	
12		12.0'-16.0' FILL, black gravel with fine sand; grain mostly 2mm to 8mm, with some 8mm to 10mm.	BH59-4	RUN-4		15	Sample BH59-8-WTNS was collected for VOC analysis only, due to poor recovery.
13							
14							
15							
16							
17		16.0'-20.0' SAND AND GRAVEL, brown, coarse sand and fine gravel; no sheen present; coal tar odor on sample.	BH59-5	RUN-5		0	
18							

DRILLING LOG OF BORING NO. BH 59

Project: Brooklyn Borough Gas works Site

Total Depth of Hole Feet BGS: 20.0

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER & SAMPLE INTERVAL	RUN NUMBER	BLOW COUNT	% RECOVERY	O/A	COMMENTS
-5								
-10								
-15								
-20								
-25								

DRILLING LOG OF BORING NO. BH 60

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 151282.37 E 990446.17 State Plane Coord NAD27

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Nicklerson

Total Depth of Hole (feet BGS): 16.0

Ground Elevation (feet above MSL): 14.40

Water Level (feet BGS): NA

Date Started / Finished: 10-29-96 / 10-29-96

Rig: B-40D

Ground Elevation (14.40 ft.)	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE INTERVAL / AREA WELL	SAMPLE NUMBER / BLOW COUNT	% RECOVERY	OVA	COMMENTS
	0		0-.25' SILT + SAM,					Drill Method:
	1		.25-3.0' SILT + SAND, brown, fine-grain sand, with rounded pebble inclusions.					Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
	2							
	3		3.0-4.0' FILL, red brick at 3', then ceramic and plastic chunks, black, with some sand and silt.					Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
	4		4.0-8.0' FILL, fine-to medium-grain sand and silt, with powdered red brick, concrete chunks, tar, rubber chunks, and rounded and angular gravel up to 10mm. At approximately 5', a layer of concrete was penetrated, followed by black cinders with some slag.					All OVA readings are from above background.
	5							
	6							
	7							
	8		8.0-12.0' FILL, cinders and slag, with some silt and sand, all stained black; cinder chunks up to 15mm; tar odor; water with oil on top at 12'.					
	9							
	10							
	11							
	12		12.0-15.8' FILL, black cinders and slag, with little silt and sand.					
	13							
	14							
	15							
	16		15.8-16.0' [illegible] SILT, [illegible]					Methane reading 30 ppm of methane on the sample at 15.8'.
	17							
	18							

DRILLING LOG OF BORING NO. BH 61

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 191195.14 E 990514.6 State Plane Coord. NAD[illegible]

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon McIlverson

Total Depth of Hole (feet BGS): 18.0

Ground Elevation (feet above MSL): 14.02

Depth to Water (feet BGS): N/A

Date Started / Finished: 10-28-96 / 10-29-96

Rig #: [illegible] 4000

93 elevation 14.02 ft.	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL	RUN NUMBER	BLOW COUNTS	% RECOVERY	OVA	COMMENTS
	1		0-.25' SAND, SILT, LOAM.	BH1-1 (0-2')	RUN 1				Drill Method:
			.25-2.0' SAND, brown, fine-to medium grained sand with 5mm to 10mm pebble inclusions. Gravel, slate and concrete present.						Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
	2		2.0-5.0' FILL, concrete chunks, red brick, silt and sand, gray to black, with chunks of hardened tar, no noticeable odor.						Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
10	3						15		
	4								All OVA readings are from above background.
	5		5.0-7.0' FILL, white concrete.	BH1-2 (4-6')	RUN 2		10		
	6						60		
	7								
	8		7.0-8.0' FILL, dark coal tar, with black-stained fine and fine to coarse gray sand; some ash may be present.						
5	9		8.0-10.0' FILL, concrete.	BH1-3 (8-10')	RUN 3		15		
	10						100		
	11		10.0-11.5' FILL, silty old tar with <10% gravel; brick.						OVA reading 100ppm of methane on the sample at 11'.
	12		11.5-14.0' FILL, black, oil-soaked cinders; water at 15'.	BH1-4 (12-14')	RUN 4		12		
0	13								
	14		14.0-16.0' SAND, gray, fine-to medium-grained, no odor or visual contamination, wet.				100		
	15								
	16		16.0-18.0' SAND, gray, fine-to medium-grained, no odor or visual contamination, wet.	BH1-5 (16-18')			100		
	17								
	18								

DRILLING LOG OF BORING NO. BH 62

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 151057.34 E 990667.60 State Plane Feet NAD27

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker Jon Nickerson

Total Depth of Hole (Feet BGS): 12.28

Ground Elevation (Feet above MSL): 10.35

Reference Elevation: TOC

Date Started - Finished: 10-30-96 / 10-30-96

Rig #: Ex-450H

gs elevation in 95 ft.	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE INTERVAL / SAMPLE NUMBER / BLOW COUNTS / PID READINGS	COMMENTS
			0-0.5' SILT, [illegible], brown.	BH-2 0-2' RUN-1	Dual Method
			0.5-2.0' SILT, brown, with 2mm to 4mm pebble inclusions.		Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
			2.0-2.5' SAND, dark brown, fine to medium grain.		
			2.5-4.0' FILL, concrete chunks, brown, medium- to fine-grain sand, red brick fragments and silt.		Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
			4.0-6.0' FILL, concrete chunks up to 10mm.	BH-2 4-6' RUN-2	All OVA readings are from above background.
			6.0-7.8' FILL, black stained silt with foam rubber. Fill has cemented binder-like material present (brick or clinker).		
			7.8-8.0' SILT, brown, moist, with white, irregular particles <1mm.	BH-2 8-10' RUN-3	Samples BH62S-03NS and BH62S-05NS were only submitted for VOC analysis due to poor recovery.
			8.0-10.0' FILL, concrete chunks and red brick fragments up to 15mm; red silt at 10'; water at 9'.		
			10.0-12.0' CLAY-PEAT-SILT, black, with an oily appearance; peat at the bottom of the interval soaked at 11.5'.		

DRILLING LOG OF BORING NO. BH 63

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 151471.55 E 990687.63 State Plane Coord. NAD27

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Nickerson

Total Depth of Boring (feet BGS): 16.0

Ground Elevation (feet above MSL): 13.99

Reference Elevation (feet above BGS): NA

Date Started / Finished: 10-30-96 / 10-30-96

Type: BV 4091

13.99 Elevation	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER	BLOW COUNT / % RECOVERY	OVA	COMMENTS
	1		0-1.0' SILTY SAND, brown.				Drill Method.
	2		1.0-6.5' FILL, concrete and red brick fragments; brown, fine-grain sand, and angular gravel up to 10mm; wood chunks.	BH63-1		0	Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
	3						
10	4						Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
	5			BH63-2		0	
	6						All OVA readings are from above background.
	7		6.5-11.0' FILL, black cinders, up to 6mm, and brick chunks, with silt and sand; water at approximately 10.5'.			10	
	8						
5	9			BH63-3		100	
	10						
	11		11.0-14.3' SAND, dark brown, with gravel, grading to coarse sand and fine gravel from 12' to 14.5'; some cinders present in the gravel.			5	
	12						
	13						
0	14			BH63-4		5	
	15		14.3-16.0' CLAY-PEAT-SILT, very tan, clay, firm, gray, high plastic, with roots; grey sand at the bottom of the sample interval.			40	
	16						O.A reading 100ppm of methane on the sample at 15.5'
	17						
	18						

DRILLING LOG OF BORING NO. BH 64

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 151400.96 E 990760.52 State Plane Coord. NAD27

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker Jon Nickerson

Total Depth of Hole (feet BGS): 16.0

Surface Elevation (feet above MSL): 14.20

Reference at (feet BGS): N/A

Date Started / Completed: 10-30-96 / 10-30-96

Logged By: B.Kelly

Ground elevation in 20 ft.	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL	RECOVERY (inches)	OVA
	1		0-1.5' SILTY CLAY LOAM, brown, with rounded pebble inclusions up to 5mm;	BH-1 (0-4')	36	0
	2		1.5-2.0' SILTY LOAM, red.			
	3		2.0-4.0' FILL, black to dark gray, clay, concrete chunks, cinders, red brick fragments up to 10mm, and wood chunks. Some coal tar or oil mixed with sand matrix present.	BH-1 (4-8')	48	0 18
10	4					
	5		4.0-6.0' FILL, brick and concrete with some brown, fine to coarse silty sand; yellow, fibrous, material encountered at 6', appears to be vegetative matter.	BH-2 (0-4')	48	0 0
	6		6.0-8.0' FILL, black-stained cinders, dried tar pieces, and 5mm to 10mm rounded gravel. Some brick and concrete at 8.0'.	BH-2 (4-8')	48	0 40
	8				12	
	9		8.0-12.0' FILL, black cinders, with some silt and faint coal tar odor present.	BH-3 (0-4')	48	0 0
5	10					
	11			BH-3 (4-8')	48	0 0
	12		12.0-13.5' GRAVEL, black, fine gravel and black cinders.	BH-4 (0-4')	18	0
	13					
	14		13.5-14.5' CLAY-PEAT-SILT, dark gray, fibrous, trace of the peat has black staining.	BH-4 (4-8')	12	0 0
0	15					
	16					
	17					
	18					

COMMENTS

Drill Method.

Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.

Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.

All OVA readings are from above background.

OVA reading 100ppm of methane on the sample at 15.5'.

DRILLING LOG OF BORING NO. BH 65

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 151284.90 E 990793.25 State Plane Coord. NAD27

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Nickerson

Total Depth of Hole (feet BGS): 12.0

Ground Elevation (feet above MSL): 13.25

Depth to Water (feet BGS): NA

Date Started / Finished: 10-31-96 / 10-31-96

Logged By: B.4-17

93 Elevation 13.25 ft.	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER (BH65-1 thru BH65-4)	SAMPLE INTERVAL	% RECOVERY	OVA	COMMENTS
	0		0-0.5' ASPHALT, and gravel.	BH65-1	0-4'	50	0	Drill Method:
	1		0.5-1.5' SAND, brown, fine-grain sand; stained bright orange from 1' to 1.5'.					Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
	2		1.5-2.5' FILL, concrete chips, angular gravel up to 10mm, and brown fine- to medium-grain sand.					Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
NC	3		2.5-5.0' SAND, brown, fine to medium grain sand with rounded pebble inclusions. Concrete layer from 2.8' to 3.2'.					All OVA readings are from above background.
	4							
	5		5.0-6.5' GRAVEL, round gravel up to 5mm, with sand. Concrete layers and concrete fragments present.	BH65-2	4-8'	75	0	
	6							
	7		6.5-7.0' FILL, cobble.					
S	8		7.0-10.0' SAND, brown, fine- to medium-grain sand, with trace wood; weathered coal tar blob at 10'. Trace cinders and coal.					OVA reading .2ppm methane on this sample.
	9							Samples BH65S-03NS and BH65S-05NS were only submitted for VOC analysis due to poor recovery.
	10			BH65-3	8-12'	50	0	
	11		10.0-11.8' FILL, coal tar coated gravel with oily sheen on water at 11'. Noticeable odor.					
C	12		11.8-12.0' CLAY-PEAT-SILT, fibrous, clay at 12'. Peat has no odor or coal contamination.					
	13							
	14							
	15							
	16							
	17							
	18							

DRILLING LOG OF BORING NO. BH 66

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Boring Coordinates/Reference System: N 15136103 E 990849.15 State Plane Coord NAD27

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Nickerson

Total Depth of Hole (feet BGS): 20.0

Ground Elevation (feet above MSL): 13.06

Refusal at (feet BGS): NA

Date Started / Finished: 10-30-96 / 10-30-96

Type: S.400

gs elevation 13.06 ft.	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE TYPE & SAMPLE INTERVAL	SAMPLE NUMBER	BLOW COUNTS	% RECOVERY	OVA	COMMENTS
	1		0-1.5' SAND, SILT, LOAM, brown.						Drill Method.
	2		1.5-5.0' FILL, concrete chunks, angular, 5mm to 10mm, red brick fragments with gravel and trace fine sand and silt; very sandy layer from 3.5' to 4'.						Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
10	3								Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
	4								
	5		5.0-6.2' FILL, dark gray, fine silty sand; granular red brick from 6' to 6.2'. Concrete present.						All OVA readings are from above back ground
	6								
	7		6.2-8.0' FILL, brown silt with coarse gravel and fine-grain sand. Red brick and wood present.						
5	8								
	9		8.0-11.5' FILL, granular cinders, slag, and silt, stained black, with chunks of dried, hardened coal tar mixed with fine, rounded gravel; water at approximately 11'.						
	10								
	11								
	12		11.5-12.0' CLAY-PEAT-SILT, fibrous, with 50% silt.						
0	13		12.0-16.0' SAND, gray fine-grain sand, with subrounded gravel up to 12mm. No odor or visual contamination.						
	14								
	15								Sample BH66S-07NS was submitted for VOC analysis only, due to poor recovery.
	16		16.0-20.0' SAND, gray, wet, very fine- to medium-grain sand. No odor or visual contamination.						
	17								
	18								

DRILLING LOG OF BORING NO. BH 66

Project: Brooklyn Borough Gas Works Site

Total Depth of Hole (feet BGS): 20.0

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL / BLOW COUNT / RECOVERY	COMMENTS
19			RUN-5	
20				
21				
22				
-10 23				
24				
25				
26				
27				
-15 28				
29				
30				
31				
32				
-20 33				
34				
35				
36				
37				
-25 38				
39				

DRILLING LOG OF BORING NO. BH67

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn Union Gas

Boring Coordinates/Reference System: N 151237.64 E 990734.99 State Plane Coord. NAD27

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Nickerson

Total Depth of Hole (feet BGS): 16.0

Ground Elevation (feet above MSL): 13.25

Vertical Datum (feet BGS): NA

Date Started / Finished: 10-28-96 / 10-28-96

Logged By: Brooklyn, NY

ft. elevation 13.25 ft.	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL	RECOVERY	OVA	COMMENTS
	1		0-.25' ASPHALT				Drill Method.
			0.25-1.3' SAND, yellow to light brown, fine-grained sand, with rounded pebble inclusions.				Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
	2		1.3-1.5' FILL, powdered concrete and red brick.				
			1.5-1.8' CLAY AND SILT, dry, brown clay and silt with 2mm to 5mm pebbles.				Soil samples were submitted for: TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
	3		1.8-4.0' SILTY CLAY, dry, black to dark gray, with little rounded pebbles. Concrete and red brick fragments present. Some ash may be present.				
	4						
	5		4.0-7.5' CLAY, black, cohesive, plastic, with rounded pebble inclusions. Some ash may be present.				All OVA readings are from above back ground.
	6						
	7						
	8		7.5-8.0' SAND AND GRAVEL, asphalt-like sand and gravel layer that may contain coal tar; however, there is no odor.				
			8.0-9.5' SILT, black, some angular gravel 5mm to 10mm; thin layer of light, black, very plastic clay at 9.5'.				
	10		9.5-10.5' SAND, brown.				
	11		10.5-11.5' SAND, stained black, with a sheen present from 10.5' to 11'; contains angular, 5mm to 7mm gravel from 10.5' to 11'. Coal tar odor.				
	12		11.5-14.0' SILTY SAND, saturated, stained black with an oily sheen; very fine gravel inclusions from 13.5' to 14'. Oil and tar appear to be present, possibly a tree product.				
	13						
	14		14.0-14.3' SAND, brown, no staining.				
	15		14.3-14.7' CLAY-PEAT-SILT, no oil, tar, or visual contamination or odor.				
	16		14.7-16.0' SILTY SAND, fine grained, gray, no oil, tar, or contamination or odor.				
	17						
	18						

DRILLING LOG OF BORING NO. BH-68

Project: Brooklyn Borough Gas Works

Location: Brooklyn, NY

Boring Coordinates/Reference System: N / E

Drilling Company: Aquifer Drilling & Testing, Inc.

Driller/Geologist: Rich Walker / Jerry Eastedo

Total Depth of Hole (feet BGS): 15

Ground Surface Elevation (feet above MSL): [illegible]

Bottom of Well (feet BGS): NA

Date Started / Finished: 2-5-97 / 2-5-97

Logged By: B.A. [illegible]

Elevation (ft.)	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL	RECOVERY (Inches)	PID/FID OVA	COMMENTS
	1		0.0-15.0' FILL: Sandy gravel, concrete, red brick, black stained gravel.				Drill Method: Geoprobe direct push, 2" ID. Split-spoon sampler, 4' length/2" ID.
	2						All samples collected within 2' intervals.
	3						No blow count recorded for this drilling method.
	4		Wood in tip of sampler, glass fragments in shoe.				
-5	5		Sandy gravel, wood fragments, coal tar odor, black broken cinders, some concrete.				4" OVA readings are from above background.
	6						Ground surface elevation was not measured, horizonal locations were measured from previously surveyed boreholes and wells.
	7		Sampler wet at 7.0' BGS, coal tar, cinders, some gravel sized slag.				
	8		Sandy, gravel, black, some quartz gravel at 8.0' BGS.				
	9						
-10	10		6" of brown sand at 10.0' BGS, 4" of tar at 10.5' BGS, slag below tar, gravel - black, peat at 11.0' BGS.				
	11						
	12		Gravel, coarse grained, sand, black, coal tar.				
	13						
	14						
-15	15		CLAY/PEAT SILT: at bottom of boring, 15.0' BGS.				
	16						
	17						
	18						

Brooklyn Borough Gas Works - Brooklyn, NY

ecology and environment, inc.

BUGBOR

DRILLING LOG OF BORING NO. BH-69

Project: Brooklyn Borough Gas Works

Location: Brooklyn, NY

Boring Coordinates/Reference System: N / E

Drilling Company: Aquifer Drilling & Testing, Inc.

Driller/Geologist: Rich Walker - Jerry Bastedo

Depth Drilled (feet BGS): 16

Ground Elevation (feet above MSL): [illegible]

Depth to Bedrock (feet BGS): NA

Date Started / Finished: 2-5-97 / 2-5-97

Rig #: B.419

~GS elevation ft.	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER & SAMPLE TYPE (S=Split Spoon)	BLOW COUNTS (per 6")	PID/FID READINGS (ppm)	COMMENTS
	1		0.0-15.0' FILL: Red brick, sandy gravel, black staining, brick gravel, brown silt and sand, wood fibers and fragments, dry.				Drill Method Geoprobe direct push, 2"ID, Split-spoon sampler, 4' length/2" ID
	2		Gravel at top, brown sand, black staining beneath sand, no odor, concrete fragments at bottom, red brick in geoprobe shoe, dry.				All samples collected within 2' intervals.
	3						No blow count recorded for this drilling method.
	4		Medium sand, brown to tan silt, trace mica, fine to medium grain size, moist.				All OVA readings are from above background.
-5	5						
	6		Sand with gravel, discolored, stained black, brown and discolored, stained black, push probe through concrete, moist to wet.				Ground surface elevation was not measured, horizontal locations were measured from previously surveyed boreholes and wells.
	7						
	8		Sand, silt and gravel, wet.				
	9						
-10	10		Sand, silt and clay, brown sand, redish silt and clay, trace coarse gravel, dry.				
	11						
	12		Sand and silt, brown to 15' BGS, gray below 15' BGS, moist.				
	13						
	14		H2S odor from core, moist.				Liner in split spoon SS04 jammed with sand, material had to be knocked out of liner and core barrel, no analytical samples collected.
-15	15						
	16		Bedrock at bottom of boring, 16.0' BGS.				
	17						
	18						

Brooklyn Borough Gas Works - Brooklyn, NY

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BUSBOR

DRILLING LOG OF BORING NO. BH-70

Project: Brooklyn Borough Gas Works

Location: Brooklyn, NY

Boring Coordinates/Reference System: N / E

Drilling Company: Aquifer Drilling & Testing, Inc.

Driller/Geologist: Rich Walker / Jerry Bastedo

Total Depth of Boring (feet BGS): 16

Ground Elevation (feet above MSL): —

Reference (feet BGS): NA

Date started / Finished: 1-5-97 / 2-5-97

Rig #: B-47D

~gs elevation ft.	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER & SAMPLE INTERVAL	BLOW COUNT PER 6" INCREMENT	RECOVERY	OVA	COMMENTS
	1		0.0-11.0' FILL: gravel, silt, fine sand, gray, with red brick fragments, wet.					Drill Method: Geoprobe direct push, 2" ID. Split-spoon sampler, 4' length/2" ID.
	2		Sand and gravel, brown, concrete fragments, [illegible] of sample stained black, some ash-like material, [illegible]					All samples collected within 2' intervals.
	3						0.0	No blow count recorded for this drilling method.
	4		Sand and silt, brown from 4.0 to 4.5' BGS, stained black from 4.5' BGS, stained wood fragments with some tar, moist.					All OVA readings are from above background.
-5	5						0.0	Ground surface elevation was not measured, horizontal locations were measured from previously surveyed boreholes and wells.
	6		Sand grading to coal tar, sand stained black, [illegible] sheen on surfaces, coal tar odor, some broken clinkers, gravel, metallic slag - like copper, moist.					OVA reading for 5.0-8.0' BGS excludes methane.
	7						25.0	
	8							
	9		Coarse gravel, sand, red brick fragments, brown to black sand.					
-10	10							
	11							
	12		11.0-14.0' GRAVEL and SAND: stained black, coal tar, oily sheen on surfaces, trace well rounded, quartz, fine grained gravel, strong odor, moist.					
	13		Gravel and sand, quartz gravel, stained black.					
	14							
	15		14.0-16.0' SAND with CLAY, PEAT/SILT: upper 0.5' stained black, oily sheen on surfaces, thin clay lens at top of [illegible] brown sand below.					
	16							
	17							
	18							

DRILLING LOG OF BORING NO. BH-71

Project: Brooklyn Borough Gas Works

Location: Brooklyn, NY

Boring Coordinates/Reference System: N / E

Drilling Company: Aquifer Drilling & Testing, Inc.

Driller/Geologist: Rich Walker / Jerry Bastedo

Total Depth of Boring (feet below BGS): 20

Ground Elevation (feet above MSL): —

Reference Elevation (feet MSL): NA

Date Started / Finished: 2-5-97 / 2-5-97

Logged By: E. Gilbert

gs elevation ft.	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE INTERVAL AND RECOVERY	PID/FID HEADSPACE READINGS (ppm)	COMMENTS
	1		0.0-19.3' FILL: Silty sand, gravel, brown			Drill Method: Geoprobe direct push, 2"ID. Split-spoon sampler, 4' length/2" ID
	2					4' samples collected within 2' intervals.
	3		Silty sand, gravel, red brick fragments, concrete fragments, glass fragments, wood fragments, bituminous fragments, stained, dry.			No blow count recorded for this drilling method.
	4					All OVA readings are from above back ground.
-5	5		Sand Silt, and gravel, fragments of red and tan brick, stained black, dry.			
	6		Sand and gravel, stained black, brown brick fragments, glass fragments, coal fragments, bituminous slag, grades from stained to brown sand at bottom of core to coal tar and slag in shoe, dry.			Ground surface elevation was not measured, horizontal locations were measured from previously surveyed boreholes and wells.
	7					
	8		Sand and gravel, wet.			
	9					
-10	10					
	11		Sand, fine to medium grained, with red brick fragments, black stained at bottom of core, wet.			
	12		12.0-16.0' Sand, fine to medium grained, with oil sheen, wet.			
	13					
	14					
-15	15					
	16		Sand and gravel, black stained, wet.			
	17					
	18		Sand and gravel, black stained, glass, bituminous coal, wet.			

DRILLING LOG OF BORING NO. BH-71

Project: Brooklyn Borough Gas Works

Total Depth Drilled: feet BGS: 20

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE TYPE AND SAMPLE INTERVAL	BLOW COUNT & RECOVERY	COMMENTS
19					
-20 20		Clay, peat, and greenish coloured, some sterling.			
21					
22					
23					
24					
-25 25					
26					
27					
28					
29					
-30 30					
31					
32					
33					
34					
-35 35					
36					
37					
38					
39					

DRILLING LOG OF BORING NO. BH-72

Project: Brooklyn Borough Gas Works

Location: Brooklyn, NY

Boring Coordinates/Reference System: N / E

Drilling Company: Aquifer Drilling & Testing, Inc.

Driller/Geologist: Rich Walker / Jerry Bastedo

Total Depth of Hole (feet BGS): 8

Grid and Elevation (feet above MSL):

Returned at (feet BGS): 114

Date Started / Finished: 2-5-97 / 2-5-97

Weather: [illegible]

gs elevation 0 ft. DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL	RUN NUMBER	BLOW COUNT	% RECOVERY	OVA	COMMENTS
0		0.0-8.0'						Drill Method.
1		FILL: Brown and black, sand, gravel, silty clay, red brick fragments, dry.	0-2'	1		100	100	Geoprobe direct push, 2" ID. Split-spoon sampler, 4' length/2" ID
2								All samples collected within 2' intervals.
3		Abundant wood fragments, red brick, green glass, sand, gravel, and concrete, dry.	2-4'				500	No blow count recorded for this drilling method.
4								All OVA readings are from above back ground.
-5 5		Concrete fragments, black stained, sand, silt, and gravel, discolored, dry.	4-6'	2			1000	
6								Ground surface elevation was not measured, horizonal locations were measured from previously surveyed boreholes and wells.
7		Sand, silt, gravel, discolored, coal ash/cinders (black), non-cohesive, dry.	6-8'				100	
8								All OVA readings for 4.0-8.0' BGS exclude methane.
9								
-10 10								
11								
12								
13								
14								
-15 15								
16								
17								
18								

DRILLING LOG OF BORING NO. BH-73

Project: Brooklyn Borough Gas Works

Location: Brooklyn, NY

Boring Coordinates/Reference System: N / E

Drilling Company: Aquifer Drilling & Testing, Inc.

Driller/Geologist: Rich Walker / Jerry Basteda

Total Depth of Hole (feet BGS): 15

Surface Elevation (feet above MSL): —

Borehole Diameter (inches): DA

Date Started / Finished: 2-5-97 / 2-5-97

PID: 0.4 ppm

gs elevation ft.	DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL	PID READING (ppm)	COMMENTS
	1–18		See geologic description for BH-53. BH-73 was installed adjacent to BH-53 to collect additional soil samples to be analyzed for organics amenable to cyanide and total metals.			Drill Method: Geoprobe direct push, 2" ID. Split-spoon sampler, 4' length/2" ID. All samples collected within 2' intervals. No blow count recorded for this drilling method. All OVA readings are from above background. Ground surface elevation was not measured, horizontal locations were measured from previously surveyed boreholes and wells. OVA readings from 2.0–6.0', 8.0–10.0', and 12.0–15.0' BGS exclude methane. OVA reading from 10–12' BGS includes 100 ppm methane.
	15		CLAY, PEAT and SILT			

DRILLING LOG OF BORING NO. BH-74

Project: Brooklyn Borough Gas Works
Total Depth of Hole (feet BGS): 16
Location: Brooklyn, NY
Ground Elevation (feet above MSL): _____
Boring Coordinates/Reference System: N / E
Refusal at (feet BGS): NA
Drilling Company: Aquifer Drilling & Testing, Inc.
Date Started / Finished: 6-18-97 / 6-18-97
Driller/Geologist: Lloyd Adams / Jerry Bastedo
Job#: BV4091

gs elevation 5 ft. DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL / RUN NUMBER	BLOW COUNT	% RECOVERY	OVA	COMMENTS
1–4		0.0–4.0' FILL: sandy loam, pebbles (quartz), red brick, concrete, glass, cinders, granite, white material. Red brick in bottom of first run, dry.	SS01		40	<2	Drill Method: Geoprobe direct push, 2"ID. Split-spoon sampler, 4' length/2" ID. No blow count recorded for this drilling method. All OVA readings are from above background. Ground surface elevation was not measured, horizonal locations were measured from previously surveyed borehole and wells.
-5 5–8		4.0–8.0' FILL: red brick, sandy loam, concrete, dry, moist at 7.1' BGS also black stained pebbles, wood, gravel, and sandy material.	SS02		40	1–40	
-10 8–12		8.0–12.0' FILL: red brick at top, sandy loam: brown to tan, gravel, wood, black zone at bottom 19", silty sand, wood, concrete, black shale, sample wet.	SS03		55	>1000	
12–15		12.0–15.7' FILL: black sandy gravel, angular, red brick, peat layer with gray clay and angular shale chunks, stained black, dark brown sand – stained black, gray clay at bottom, sample wet.	SS04		25	50	
15–16		15.7–16.0' CLAY/PEAT/SILT: gray clay, at bottom of core.					
16–18							

Brooklyn Borough Gas Works – Brooklyn, NY

ecology and environment, inc. BUGBOR

DRILLING LOG OF BORING NO. BH-75

Project: Brooklyn Borough Gas Works

Location: Brooklyn, NY

Boring Coordinates/Reference System: N E

Drilling Company: Aquifer Drilling & Testing, Inc.

Driller/Geologist: Lloyd Adams / Jerry Bastedo

Total Depth of Hole (feet BGS): 16

Ground Elevation (feet above MSL):

Refusal at (feet BGS): NA

Date Started / Finished: 6-18-97 / 6-18-97

Job#: BV4091

gs elevation ft. / DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL	RUN NUMBER	BLOW COUNT	% RECOVERY	OVA	COMMENTS
0		0.0-4.0' FILL: 0.0-1.0' brown sandy loam, pebbles, concrete, green glass, dry. 1.0-2.0' concrete, sandy brown loam, nail in concrete section, 2.0-4.0' red brick and silty sandy loam with pebbles at bottom, dry.	SS01			75	<1	Drill Method: Geoprobe direct push, 2"ID. Split-spoon sampler, 4' length/2" ID.
1								No blow count recorded for this drilling method.
2								All OVA readings are from above background.
3								Ground surface elevation was not measured, horizonal locations were measured from previously surveyed boreholes and wells.
4		4.0-8.0' FILL: upper 8" dry, brown sandy silt, pebbles, coal-black, concrete, moist red brick, silty sand pebbles, wood at 10" from bottom with brown silty loam with pebbles.	SS02			50	<1	
-5 5								
6								
7								
8		8.0-12.0' FILL: brown sandy silty loam, pebbles, stained black, black rubber tire, red brick fragments, heavily stained black at bottom, organic weeds at bottom, wet, coal tar smell present at bottom of core.	SS03			40	30	
9								
-10 10								
11								
12		12.0-14.0' FILL: Upper 12" black stained, redbrick, cinders.	SS04			75	600	
13								
14		14.0-16.0' CLAY/PEAT/SILT: pebbles and sheen on water, shell fragments at bottom of core.						
-15 15								
16								
17								
18								

Brooklyn Borough Gas Works - Brooklyn, NY

ecology and environment, inc.

BUGBOR

DRILLING LOG OF WELL NO. MW16

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Well Coordinates/Reference System: N 150968.75 / E 990396.96 / State Plane Coord NAD27

Date Started/Finished: 10-29-96 / 10-29-96

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Nickerson

Total Depth of Hole (feet BGS): 20.0

Ground Elevation (feet above MSL): 13.17

Casing Elevation (inner / outer): 15.66 / 16.13

Groundwater Depth (feet BGS):

10-29-96: 7.50

11-06-96: 5.5

ELEVATION / DEPTH	WELL COMPLETION DIAGRAM	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL / RECOVERY / BLOW COUNT	OVA (ppm)	COMMENTS
0= elevation 13.17 ft.			*ground surface (gs)*			
	Grout		0-.25' LOAM			Drill Method:
			.25-3.0' SAND, tan, fine grain, with 2mm to 5mm pebbles.			Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
	Bentonite Seal					Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
			3.0-4.0' FILL, black brick fragments and silt, with some concrete; wood at 3'; plastic fragments at 3.5'.			Well Material:
						Stainless-steel screen and inner casing.
			4.0-8.0' FILL, mixture of brown, fine grain silty sand with brick and concrete fragments; angular and rounded pebble inclusions from from 2mm to 10mm.			All OVA readings are from above background.
	Sand					
			8.0-14.0' FILL, medium-grain, gravelly, sand, oil-stained from 8.5' to 12'; angular clasts from 8mm to 10mm; wet from 10'; saturated wood fragments at 12'.			

DRILLING LOG OF WELL NO. MW16

Project: Brooklyn Borough Gas Works Site

Total Depth of Well Bore: 20.0

ELEVATION / DEPTH	WELL COMPLETION DIAGRAM	GRAPHIC LOG	SOIL ROCK DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL / PID READING (BREATHING ZONE)	PID READING (BACKGROUND)	COMMENTS
11	Sand				40	
12			12.0-16.0' GRAVELLY SAND, oil-stained, medium-grain, gravelly sand; water in the sample has small oily blobs floating on the surface.			
13						
14					30	
15						Lock #: 3221
16			16.0-20.0' SAND, black, oil-stained, fine- to medium-grain quartz sand, no inclusions.			Water from sample tube contained a floating oil layer. Head space analysis of the water was 40ppm.
17						
18					15	
19						
20						
21						
22						
23						
24						

DRILLING LOG OF WELL NO. MW17

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Well Coordinates/Reference System: N 151112.20 / E 990358.03 / State Plane Coord NAD27

Date Started/Finished: 10-28-96 / 10-28-96

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Nickerson

Total Depth of Hole (feet BGS): 16.0

Ground Surface Elevation (feet above MSL): 14.33

Casing Elevation (inner / outer): 17.14 / 17.50

Groundwater Depth (feet BGS):

10-29-96: 5.05

10-30-96: 5.24

ELEVATION / DEPTH	WELL COMPLETION DIAGRAM	GRAPHIC LOG	SOIL BORING DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL (ft BGS)	FIELD ANALYSIS (FLAME IONIZATION DETECTOR)	O, A (ppm)	COMMENTS
ground elevation 14.33 ft.			ground surface (gs)				
	Grout		0-.25' LOAM				Drill Method:
			.25-.5' FILL, concrete.				Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
			.5-3.5' FILL, sand, loam fill with concrete, pebbles up to 10mm and wood fragments; brown, fine-grain sand from 3.5'-4.0'.	MW17-1			Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
	Bentonite Seal		4.0-5.0' FILL, containing red brick.				Well Material: Stainless-steel screen and riser casing.
			5.0-8.0' FILL, fine-grain, silt, sand with pebble inclusions up to 10mm, few cinder chips, dry, with little odor; stained black from 5'-6.5' and brown with iron staining from 6.5'-8'. Trace black ash, slag, and tar-cemented sand.	MW17-2			All OVA readings are from above back ground.
	Sand		8.0-10.0' SILT AND SAND, iron-stained, fine-grain sand grading to silt at 10'; wet, with a slight sheen, from 8'-10'.	MW17-3			

DRILLING LOG OF WELL NO. MW17

Project: Brooklyn Borough Gas Works Site

Total Depth of Hole (Feet BGS): 16.0

ELEVATION / DEPTH	WELL COMPLETION DIAGRAM	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL / PID READINGS	BLOW COUNT / RECOVERY	OVA ppm	COMMENTS
11	Sand		10.0–11.5' SAND, brown, fine-to-medium-grain sand, some silt.				Lock #: 3229
12			11.5–12.0' SILTY SAND, black staining on fine-to medium-grain silty sand; no odor, wet.				
13			12.0–14.0' SILTY SAND, with pebble inclusions.				
14			14.0–15.0' SILTY SAND, black, with pebble inclusions 5mm–10mm.				
15			15.0–16.0' CLAY, PEAT, SILT, fibrous, silt and clay are dark gray.				1. A reading at 15 feet appears to represent methane, based on carbon filter results.
16							
17							
18							
19							
20							
21							
22							
23							
24							

DRILLING LOG OF WELL NO. MW18

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Well Coordinates/Reference System: N 151465.51 / E 990269.52 / State Plane Coord NAD27

Date Started/Finished: 10-30-96 / 10-30-96

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker - Jon Nickerson

Total Depth of Hole (feet BGS): 16.0

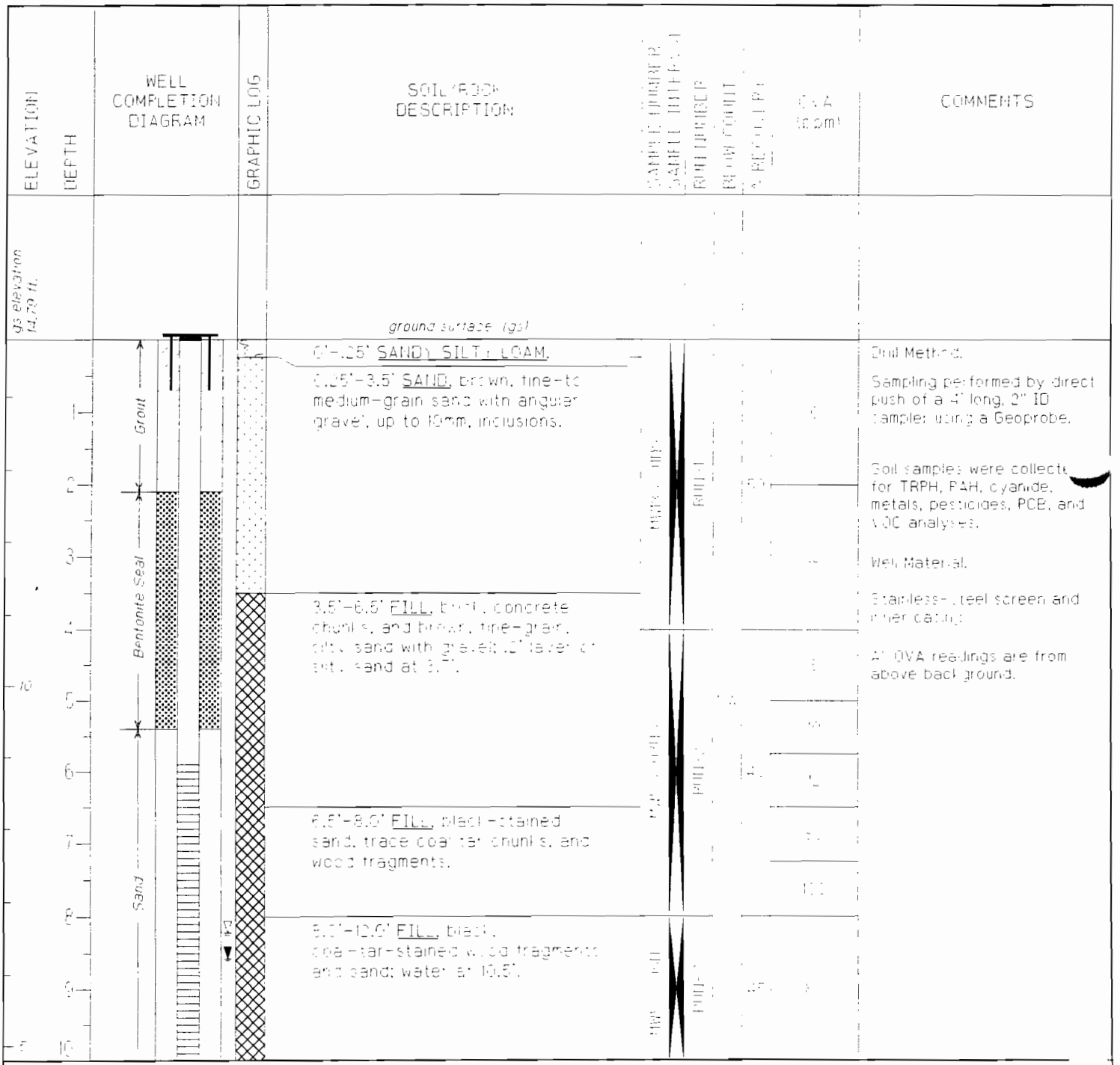
Ground Elevation (feet above MSL): 14.79

Casing Elevation (inner / outer): 14.34 / 14.87

Groundwater Depth (feet BGS):

10-31-96: 8.28

11-12-96: 8.57

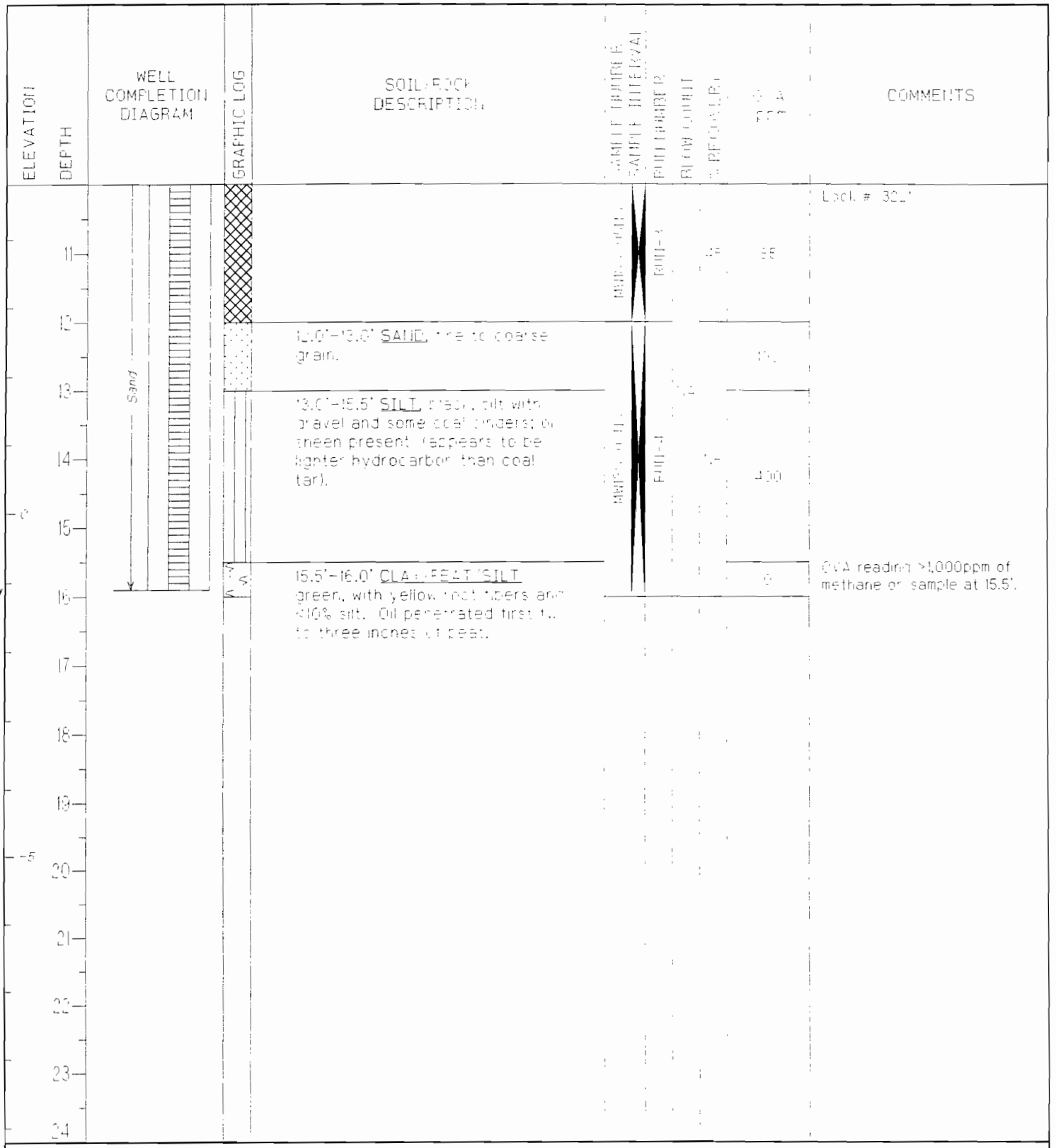


Brooklyn Borough Gas Works Site - Brooklyn, NY

DRILLING LOG OF WELL NO. MW18

Project: Brooklyn Borough Gas Works Site

Total Depth of Hole (feet BGS): 16.0



DRILLING LOG OF WELL NO. MW19

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Well Coordinates/Reference System: N 151469.02 / E 990514.97 / State Plane Coord NAD27

Date Started/Finished: 10-28-98 10-28-98

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Nickerson

Total Depth of Hole (feet BGS): 14.0

Ground Surface Elevation (feet above MSL): 13.82

Casing Elevation (inner / outer): 13.68 / 13.90

Static Water Depth (feet BGS):

10-29-98: 7.46

11-06-98: 7.69

ELEVATION / DEPTH	WELL COMPLETION DIAGRAM	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL / RECOVERY / BLOW COUNT / PID READING	OVA (ppm)	COMMENTS
Ground Elevation 13.82 ft			ground surface (gs)			
0	Grout		0-0.25' GRAVEL, tan.			Drill Method:
			0.25-4.0' FILL, brick and concrete chunks, some silt, clay, trace to few cinders, shredded sheet plastic, and pebbles up to 5mm. Small slag pieces from 3.0 to 3.5'.			Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
4	Bentonite Seal		4.0-4.5' SAND, brown, fine grain, with 2mm to 5mm pebbles, some silt.			Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
			4.5-5.0' SAND, with tar, old and dry.			Well Material:
5	Sand		5.0-8.0' FILL, tar-coated slag and cinders, black, slightly oil., some sand present, few concrete chunks and glass fragments, some organic material (leaves, twigs).			Stainless-steel screen and inner casing.
8			8.0-11.5' FILL, cinders and slag, with 10% fine sand on sheen on sample; water at approximately 8'. Predominant hydrocarbon present appears to be coal tar with minor gasoline present.			All OVA readings are from above background.
10						

DRILLING LOG OF WELL NO. MW19

Project: Brooklyn Borough Gas Works Site

Top Casing Elevation in feet BSL: 14.0

ELEVATION / DEPTH	WELL COMPLETION DIAGRAM	GRAPHIC LOG	SOIL FIELD DESCRIPTION	WELL MATERIAL AND INTERVALS	PID/FID READINGS	BLOW COUNTS	SOIL SAMPLE NUMBER AND RECOVERY	COMMENTS
11 / 12 / 13 / 14 / 15 / 16 / 17 / 18 / 19 / 20 / 21	Sand		11.5-12.0' CLAY, SILT, dark gray, fibrous root matter. 12.0-14.0' No Recovery, free product on the sampler, light oil.					Lock #: 3321

DRILLING LOG OF WELL NO. MW20

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Well Coordinates/Reference System: N 151349.29 / E 990636.53 / State Plane Coord NAD27

Date Started/Finished: 10-31-96 / 10-31-96

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker Jon Nickerson

Total Depth of Hole (feet BGS): 16.0

Ground Elevation (feet above MSL): 13.37

Datum Elevation (Inner / Outer): 13.62 / 13.37

Static Water Level (feet BGS):

10-31-96: 6.28

11-06-96: 6.26

ELEVATION / DEPTH	WELL COMPLETION DIAGRAM	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE TYPE / SAMPLE NUMBER / BLOW COUNT / RECOVERY	O V A (ppm)	COMMENTS
Datum Elevation 13.37 ft.			ground surface (gs)			
	Grout		0-0.5' ASPHALT			Drill Method:
			0.25-5' SAND, brown, fine to medium sand, some silt.			Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe
			0.5-4.0' Fill, black, 5mm to 10mm gravel, cinders and slag, with trace sand.		3.0	Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analyses.
	Bentonite Seal				7.0	Well Material:
			4.0-6.0' Fill, black, cinders and slag, fine-to-medium sand, odorous, with fine brick and concrete at 5'.		10.0	Stainless-steel screen and riser casing.
	Sand		6.0-6.5' Fill, granular fire brick fragments.		14.0	All OVA readings are from above background.
			6.5-7.0' Fill, tar, cinders, and coal-tar-stained sand.			
			7.0-8.0' Fill, laminated, black, tar-like gel, tar-saturated material. Hardened, dry tar with water present at 7.5'.		18.0	
			8.0-10.0' Fill, black slag, 5mm to 10mm pieces.		19.0	

DRILLING LOG OF WELL NO. MW20

Project: Brooklyn Borough Gas Works Site

Total Depth of Hole (feet BGS): 16.0

ELEVATION / DEPTH	WELL COMPLETION DIAGRAM	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	SAMPLE NUMBER / SAMPLE INTERVAL	FIELD MEASUREMENTS (Photo-ionization / Petroleum)	COMMENTS
10 / 11	Sand		10.0–10.5' FILL, with chunk.			
			10.5–12.0' FILL, black, loose, moist, oily, slag with silt, sand, and fine gravel. Petroleum present appears to be coal tar with some lighter weight petroleum.		1SF / NR	
12 / 13			12.0–14.0' SAND AND GRAVEL, black, medium to coarse sand and fine gravel, with oil, sheen and product present. [illegible]		[illegible]	
14 / 15			14.0–16.0' CLAY, PEAT, SILT, fibrous, with H_2S odor, dark gray clay, highly plastic, moist, with shell fragments. No petroleum odor or visible contamination.		1SF / NR	Lock #: 321'
16 / 17						
18 / 19						
20 / 21						
22 / 23						
24						

DRILLING LOG OF WELL NO. MW21

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Well Coordinates/Reference System: N 151217.62 / E 990723.66 / State Plane Coord. NAD83

Date Started/Finished: 10-31-96 / 10-31-96

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Nickerson

Total Depth of Hole (feet BGS): 15.5

Surface Elevation (feet above MSL): 13.00

Casing Elevation (inner / outer): 12.38 / 13.00

Static Water Depth (feet BGS):

[illegible]: 9.35

[illegible]: 9.79

ELEVATION / DEPTH	WELL COMPLETION DIAGRAM	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	PERMIT NUMBER / SAMPLE NUMBER / RUN NUMBER / BLOW COUNT / % RECOVERY	OVA (ppm)	COMMENTS
0' elevation 13.00 ft.			*ground surface (gs)*			
	Grout		0-0.25' ASPHALT.			Drill Method:
			0.25-0.5' GRAVEL.			Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
	Bentonite Seal		0.5-7.0' FILL, yellow staining from 1' to 3', mixture of brown sand w/ rounded gravel up to 10mm from 1' to 3', concrete and red brick chunks, red-pink sandstone, and marble chips.			Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analytes.
	Sand					Well Material:
						Stainless-steel screen and inner casing.
						All OVA readings are from above background.
			7.0-11.0' SILTY SAND, brown, fine-grain sand with some fine roots.			

DRILLING LOG OF WELL NO. MW21

Project: Brooklyn Borough Gas Works Site

Total Depth of Hole (feet BGS): 15.5

ELEVATION / DEPTH	WELL COMPLETION DIAGRAM	GRAPHIC LOG	SOIL FIELD DESCRIPTION	SAMPLE NUMBER AND INTERVAL	BLOW COUNT per 6 inches	O.V.A. ppm	COMMENTS
11	Sand		11.0-12.0' CLAY/PEAT SILT with yellow fibers, and fine silt, clay.				O.V.A reading 0ppm metnane on the sample
12							
13							
14							
15							Lost #, 3LL?
16							
17							
-5 16							
19							
20							
21							
22							
-10 23							
24							

DRILLING LOG OF WELL NO. MW22

Project: Brooklyn Borough Gas Works Site

Location: Brooklyn, NY

Well Coordinates/Reference System: N 151474.27 / E 99081.60 / State Plane Coord. System

Date Started/Finished: 10-28-96 / 10-28-96

Drilling Company: Aquifer Drilling and Testing

Driller/Geologist: Rich Walker / Jon Hickerson

Total Depth of Hole (feet BGS): 16.0

Ground Elevation (feet above MSL): 12.36

Casing Elevation (inner / outer): 11.76 / 12.36

Groundwater Depth (feet BGS):

On 10-31-96: 7.37

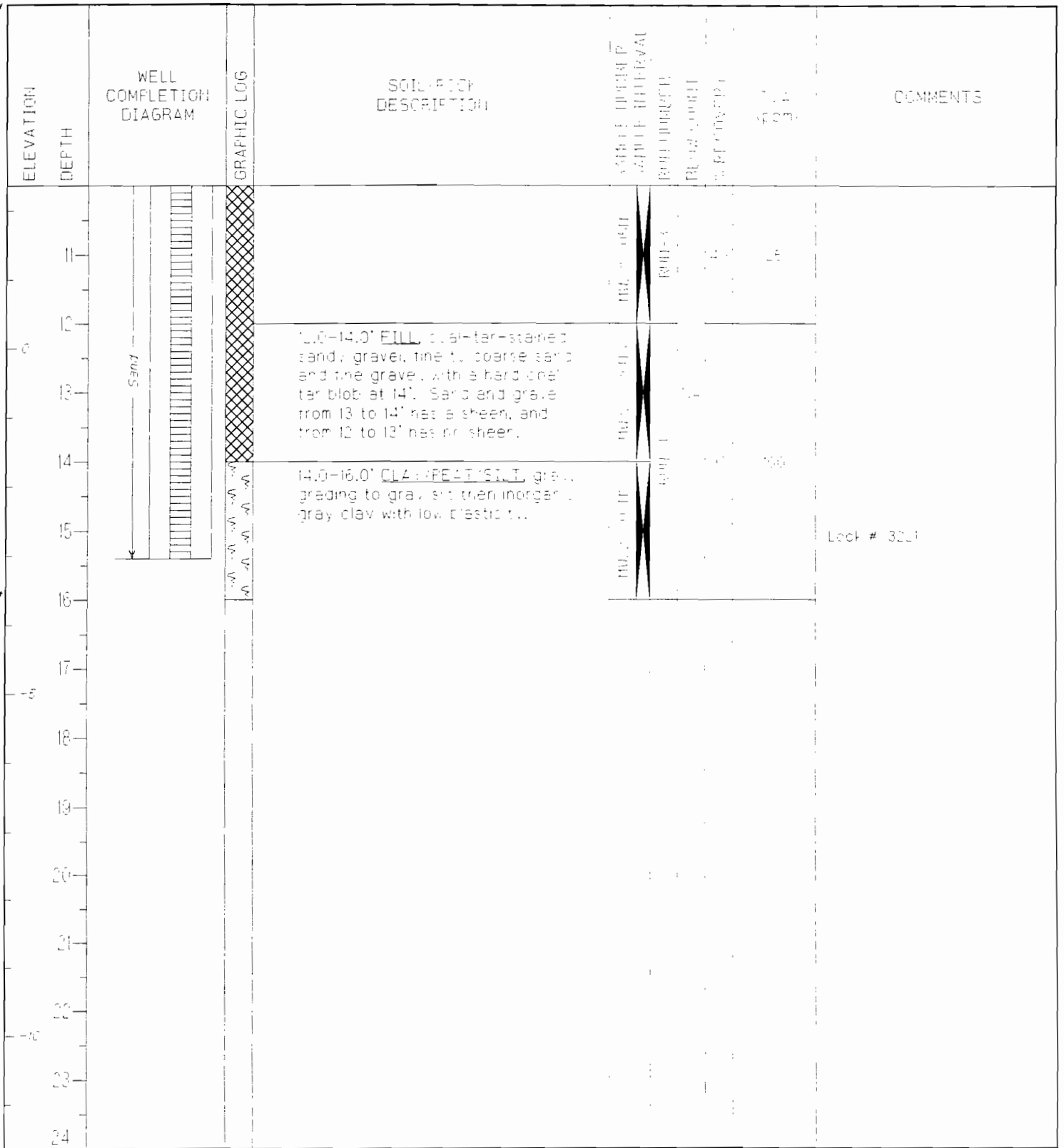
On 11-06-96: 7.8'

ELEVATION / DEPTH	WELL COMPLETION DIAGRAM	GRAPHIC LOG	SOIL/ROCK DESCRIPTION	PID/FID (ppm)	OVA ppm	COMMENTS
ge elevation 12.36 ft.			ground surface 0'0"			
0	Grout		0-.25' LOAM			Drill Method:
2	Bentonite Seal		0.25-1.5' SILT - SAND, fine sand with 4mm to 8mm rounded pebble inclusions.			Sampling performed by direct push of a 4' long, 2" ID sampler using a Geoprobe.
4			1.5-3.0' FILL, brick fragments, pebbles and concrete, with some fine sand and silt.			Soil samples were submitted for TRPH, PAH, cyanide, metals, pesticides, PCB, and VOC analytes.
6			3.0-3.5' FILL, red brick fragments with some fine sand and silt.			Well Material:
8	Sand		3.5-8.0' FILL, concrete chunks with cinders, and black, coal-tar-coated sand, fine- to medium-grain, trace silt, brown-gray, saturated at 7.8', 7 inches of concrete from 7.8' to 8.0', water encountered at the bottom of the interval.			Stainless-steel screen and inner casing.
10			8.0-8.3' FILL, red brick fragments.			All OVA readings are from above background.
			8.3-16.0' SILT - SAND, fine to coarse, black, with concrete chunks up to 10mm and a sheen present in the sample, wet, loose.			

DRILLING LOG OF WELL NO. MW22

Project: Brooklyn Borough Gas Works Site

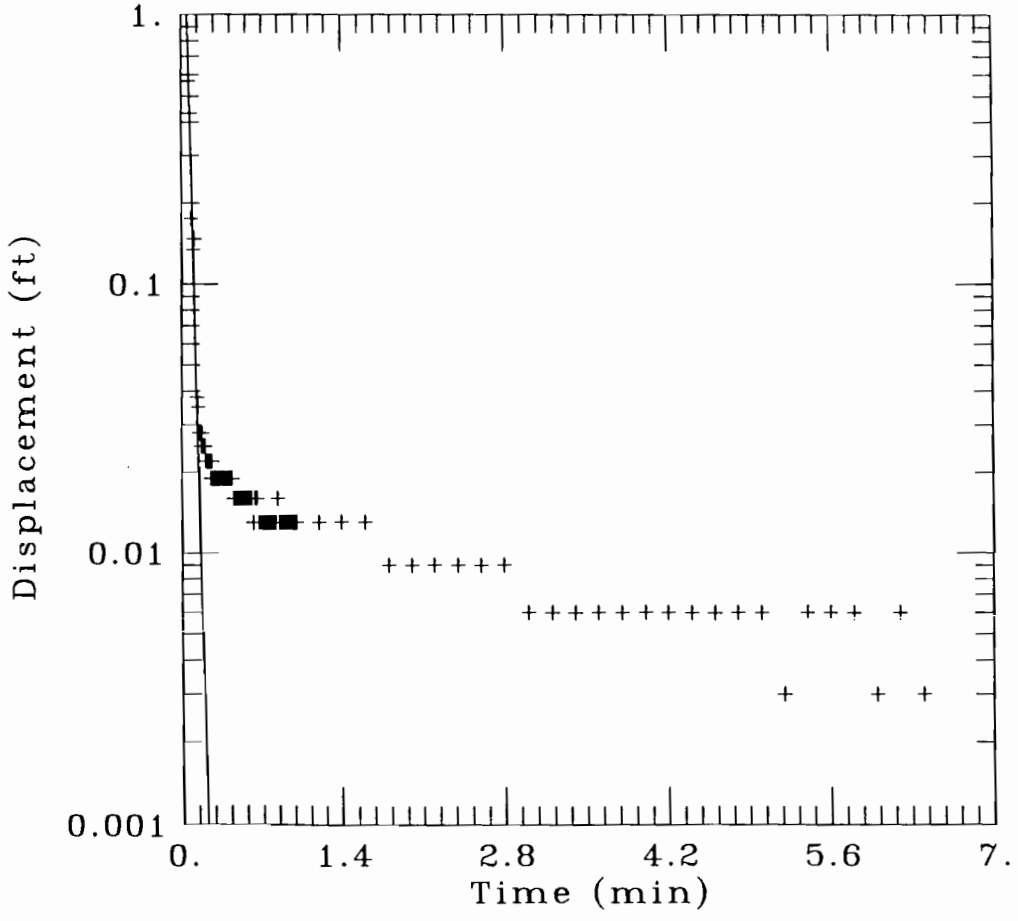
Total Depth of Hole feet BGS: 16.0



B.5 Slug Tests and Hydraulic Conductivity Tests

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union - Ball Fields

MW-16-F



DATA SET:
mw16-f prn
12/04/96

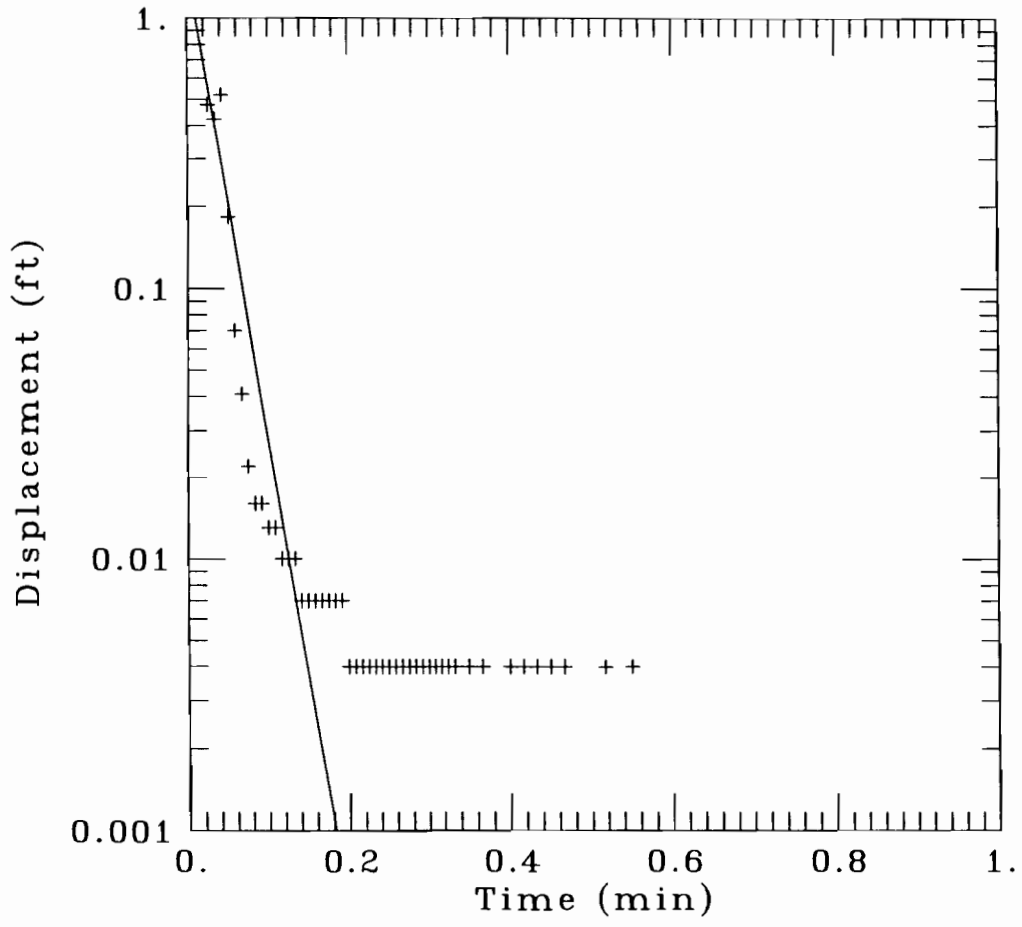
AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.03111 ft/min
y0 = 9.421 ft

TEST DATA:
H0 = 0.566 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 15.5 ft
H = 7.96 ft

Ecology & Environment, Inc.	Client: **Brooklyn Union Gas**
Project No.: **BV-4091**	Location: **Brooklyn Union – Ball Fields**

MW-16-R



DATA SET:
mw16-r.prn
12/04/96

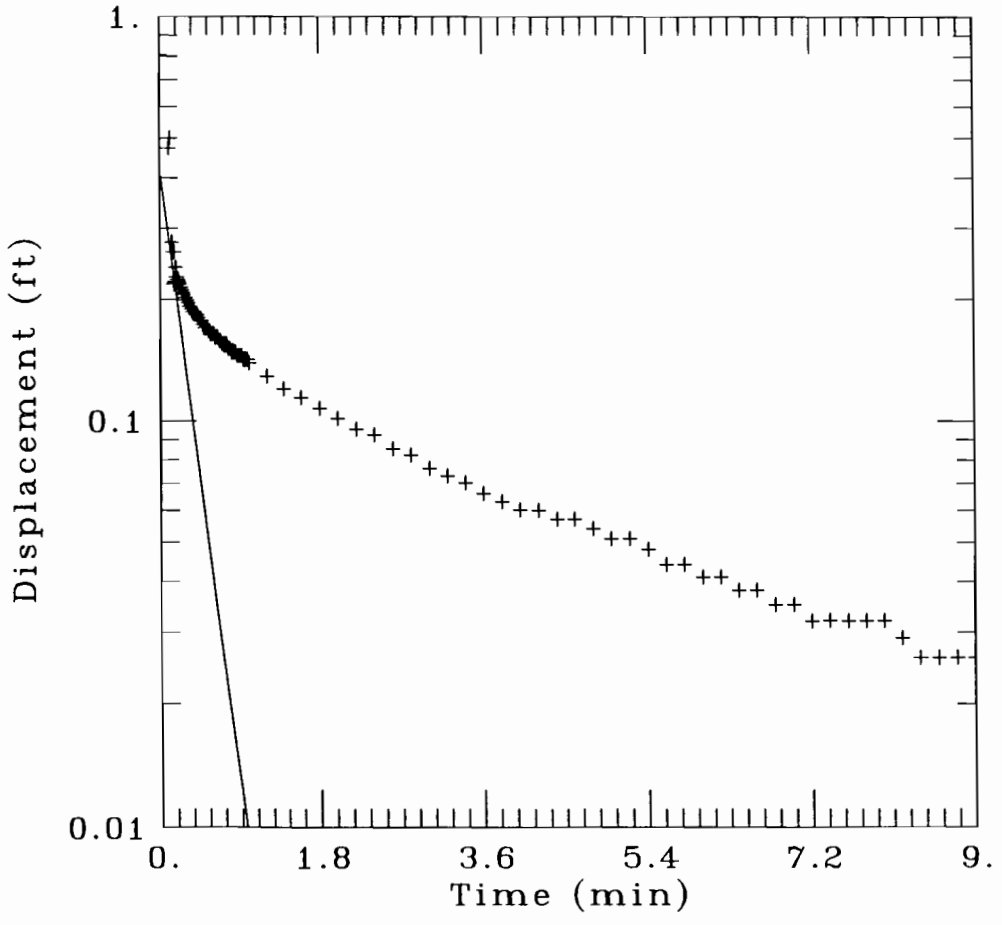
AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.02948 ft/min
y0 = 1.528 ft

TEST DATA:
H0 = 1.357 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 15.5 ft
H = 7.96 ft

Ecology & Environment, Inc.	Client: **Brooklyn Union Gas**
Project No.: **BV-4091**	Location: **Brooklyn Union – Ball Fields**

MW-17-F



DATA SET:
mw17-fb.prn
12/05/96

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

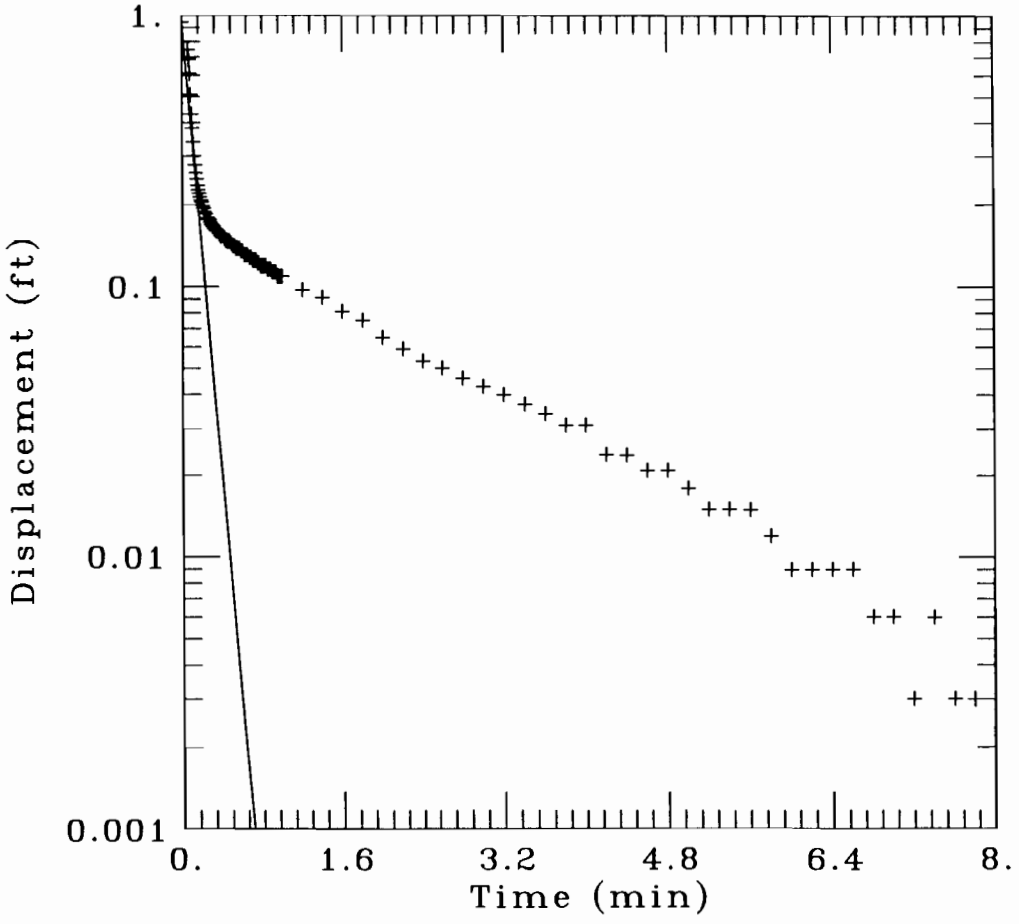
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.002754 ft/min
y0 = 0.4182 ft

TEST DATA:
H0 = 0.806 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 15.5 ft
H = 6.72 ft

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union - Ball Fields

MW-17-R



DATA SET:
mw17-r.prn
12/04/96

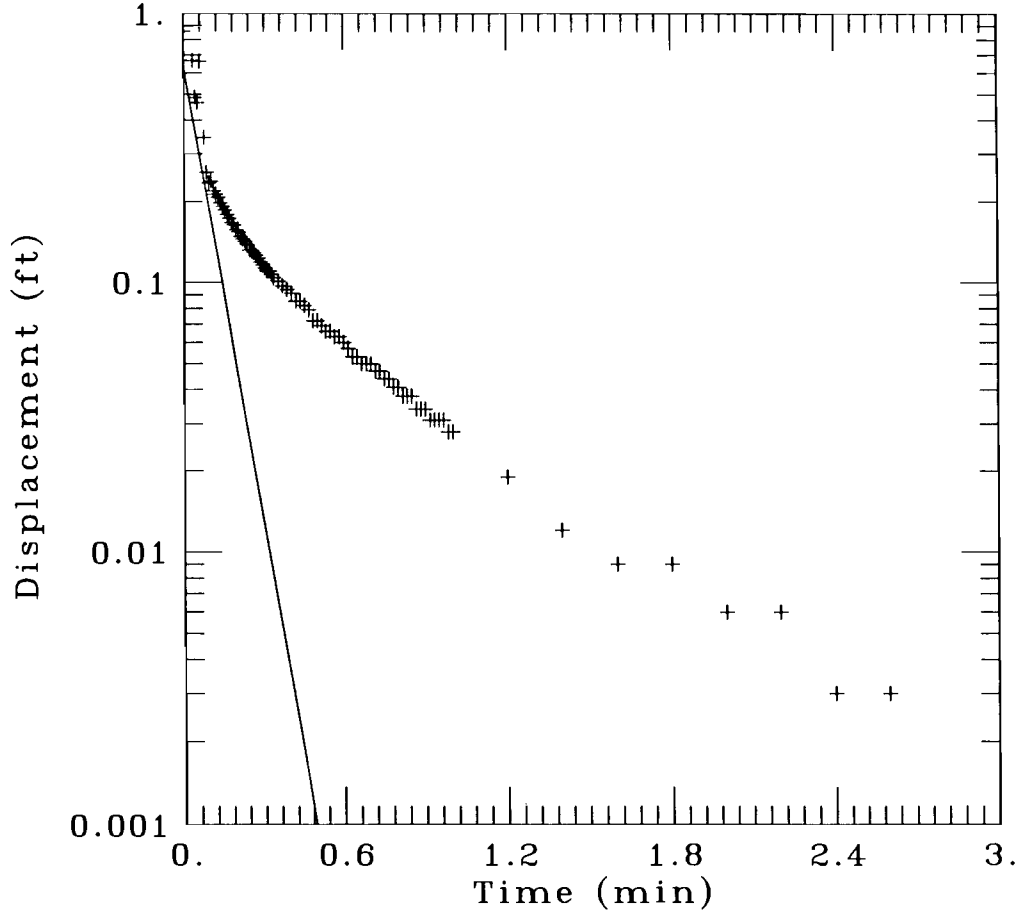
AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.006859 ft/min
y0 = 0.9197 ft

TEST DATA:
H0 = 0.944 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 15.5 ft
H = 6.72 ft

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union - Ball Fields

MW-18-F



DATA SET:
mw18-f.prn
12/04/96

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

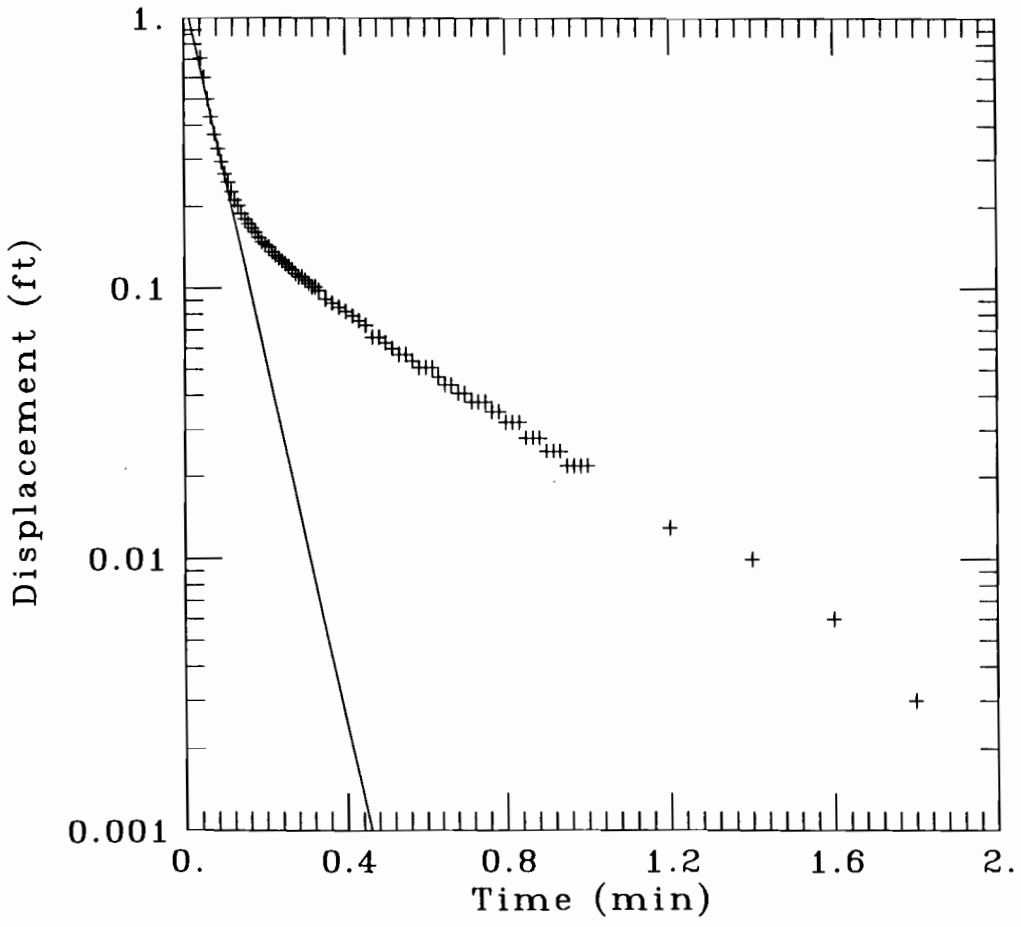
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.00943 ft/min
y0 = 0.6287 ft

TEST DATA:
H0 = 0.858 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 16. ft
H = 7.39 ft

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union - Ball Fields

MW-18-R



DATA SET:
mw18-r.prn
12/04/96

AQUIFER TYPE:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

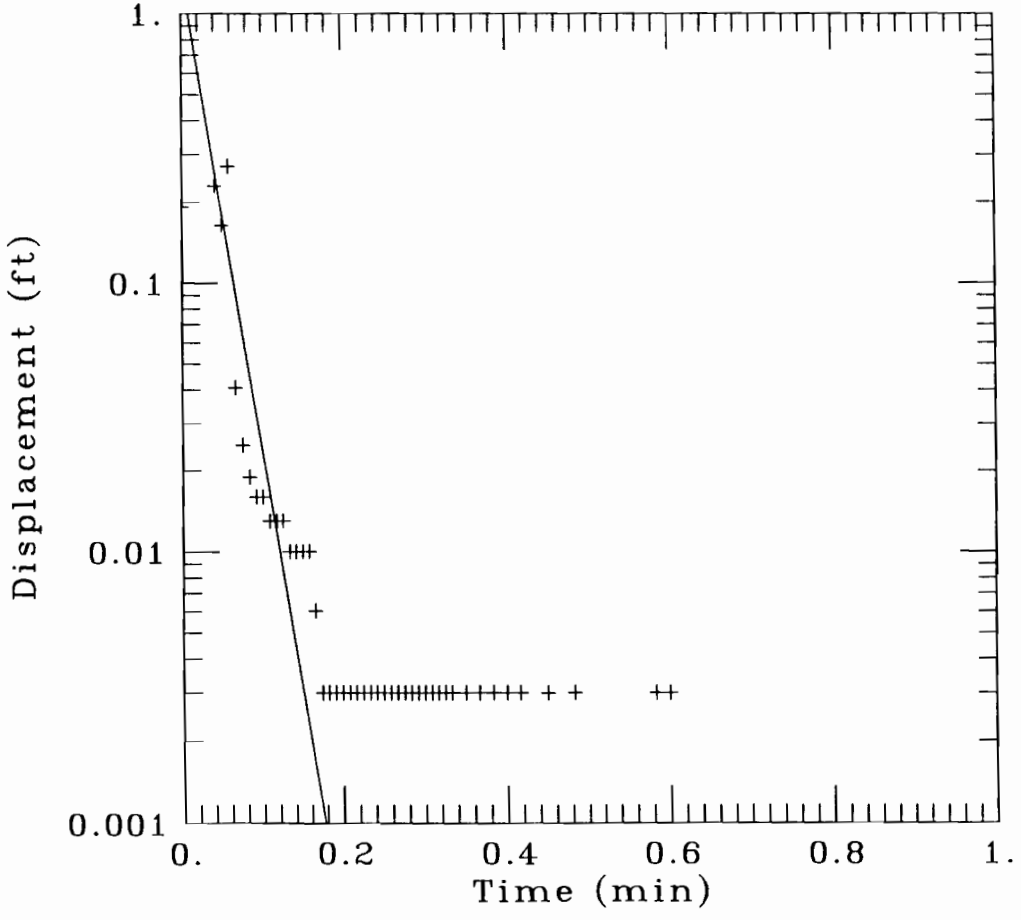
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.01109 ft/min
y0 = 1.212 ft

TEST DATA:
H0 = 0.866 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 16. ft
H = 7.39 ft

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union - Ball Fields

MW-19-Fb



DATA SET:
mw19-fb.prn
12/04/96

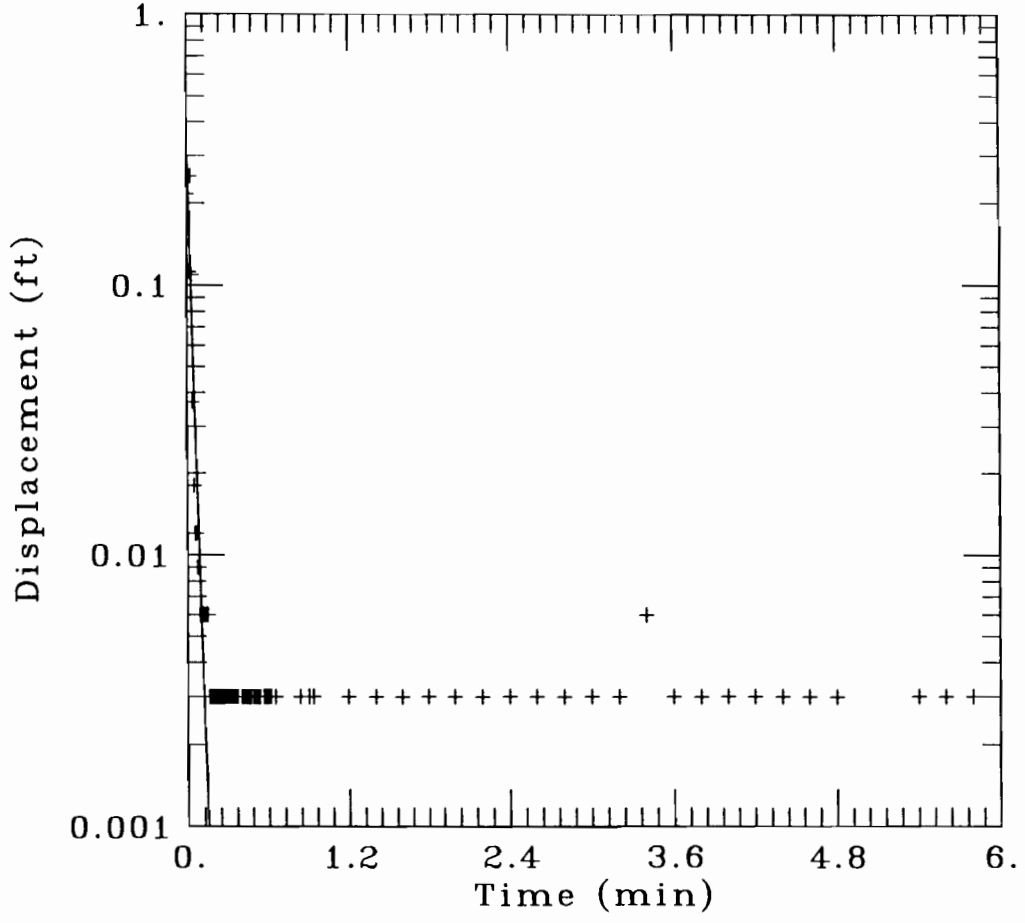
AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.02533 ft/min
y0 = 1.396 ft

TEST DATA:
H0 = 0.192 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 13.75 ft
H = 4.29 ft

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union - Ball Fields

MW-19-Rb



DATA SET:
mw19-rb.prn
12/04/96

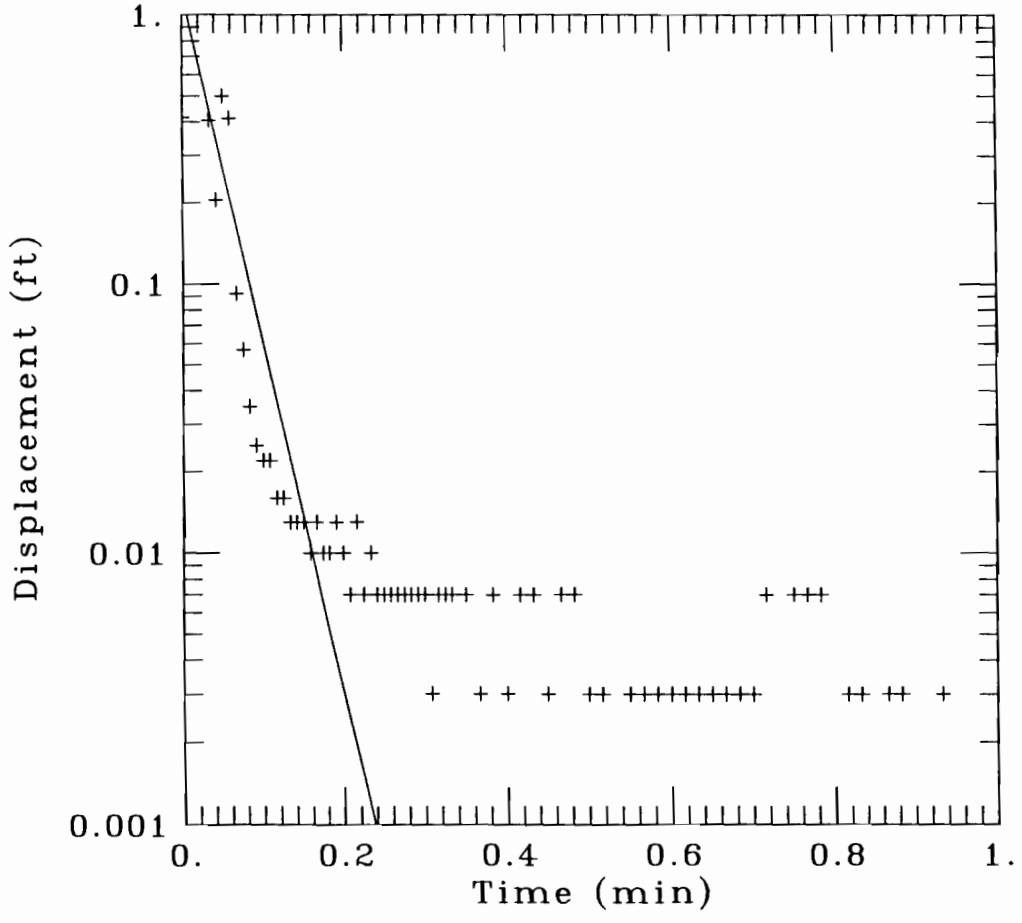
AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.02455 ft/min
y0 = 0.3492 ft

TEST DATA:
H0 = 0.216 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 13.75 ft
H = 4.29 ft

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union - Ball Fields

MW-20-F



DATA SET:
mw20-f.prn
12/04/96

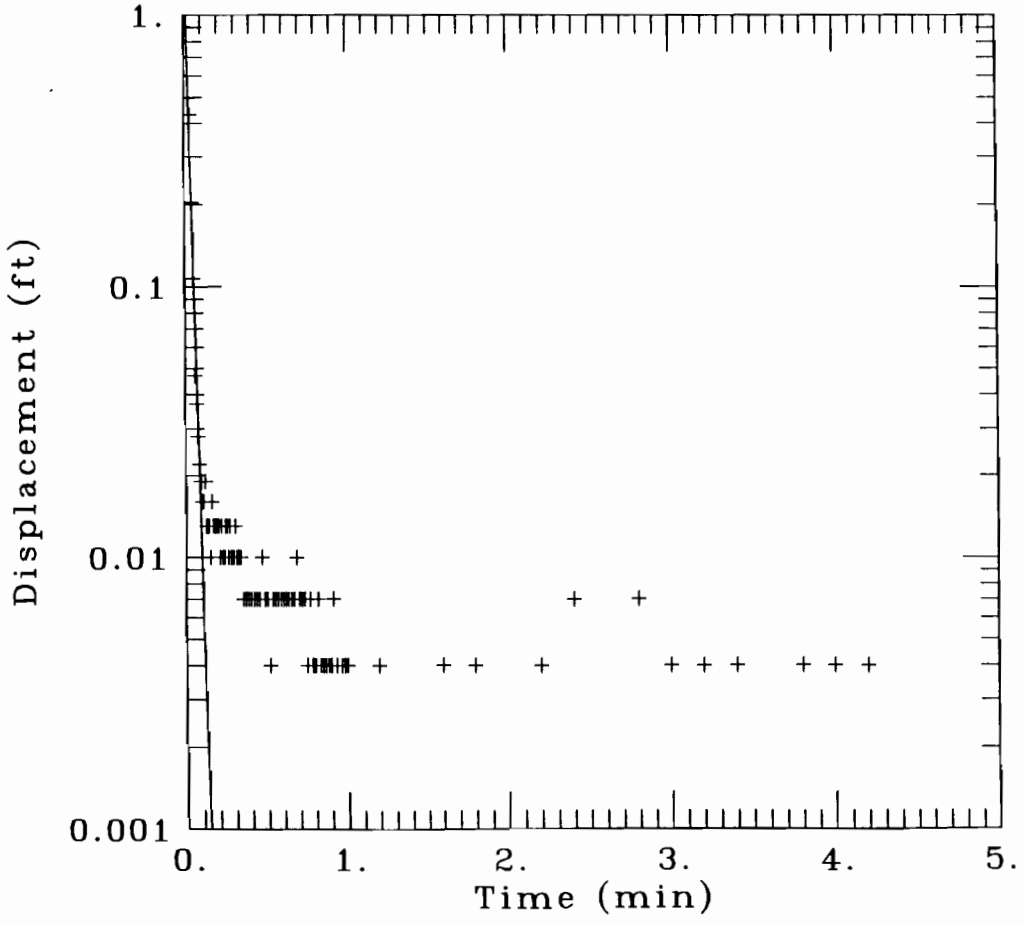
AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.02154 ft/min
y0 = 1.208 ft

TEST DATA:
H0 = 0.416 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 15.5 ft
H = 7.43 ft

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union - Ball Fields

MW-20-R



DATA SET:
mw20-r.prn
12/04/96

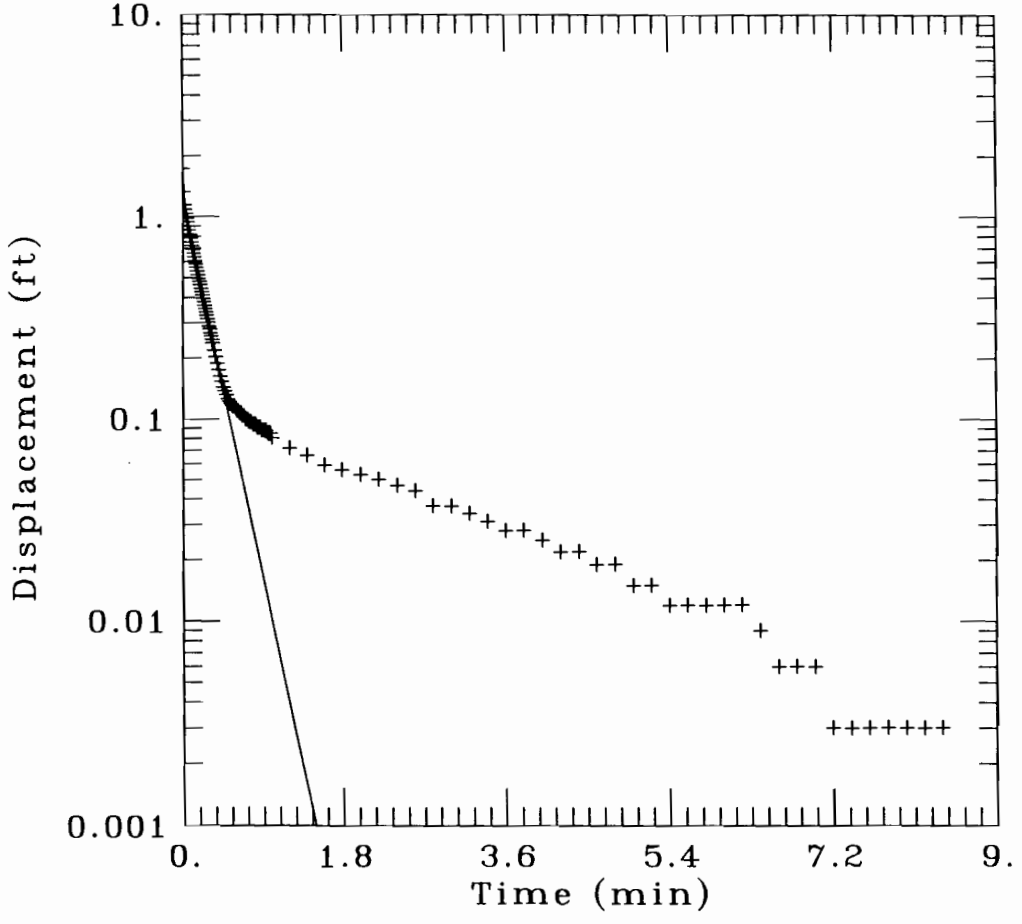
AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.0398 ft/min
y0 = 2.134 ft

TEST DATA:
H0 = 0.906 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 15.5 ft
H = 7.43 ft

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union - Ball Fields

MW-21-R



DATA SET:
mw21-r.prn
12/04/96

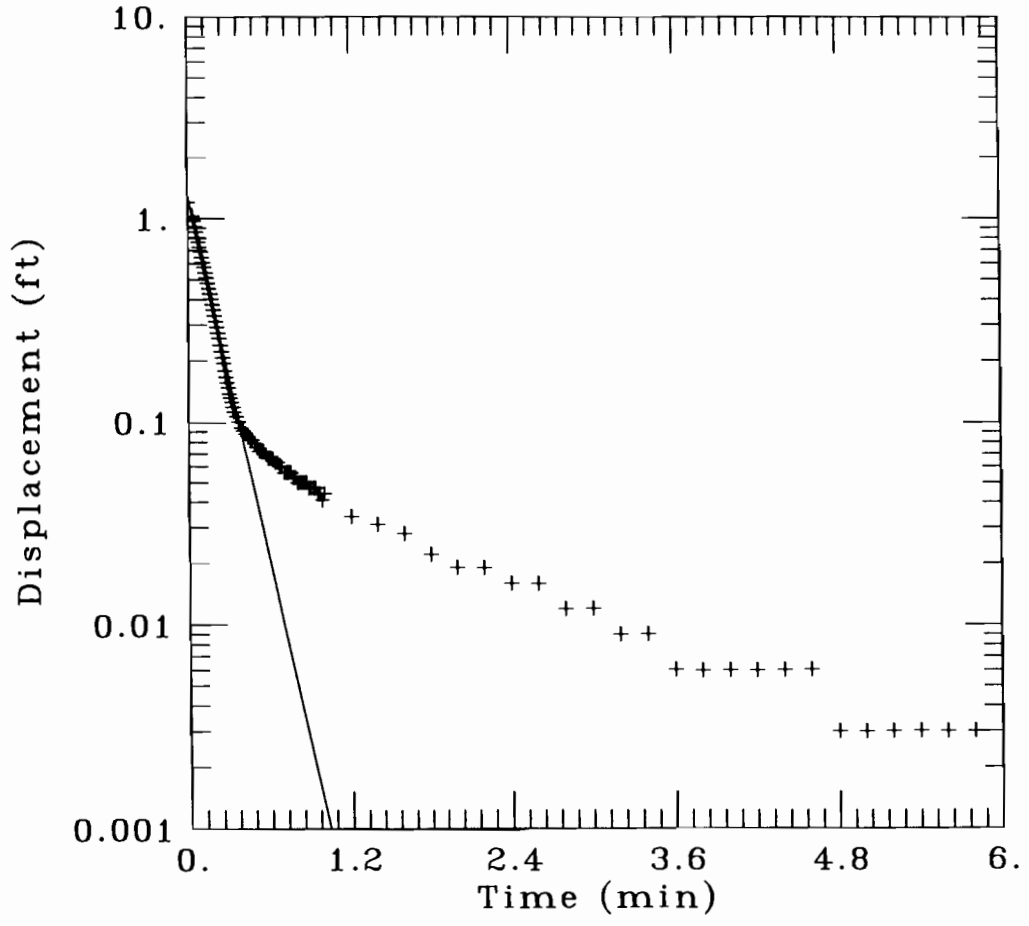
AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.003235 ft/min
y0 = 1.205 ft

TEST DATA:
H0 = 1.735 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 15.5 ft
H = 5.81 ft

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union - Ball Fields

MW-21-Rb



DATA SET:
mw21-rb.prn
12/04/96

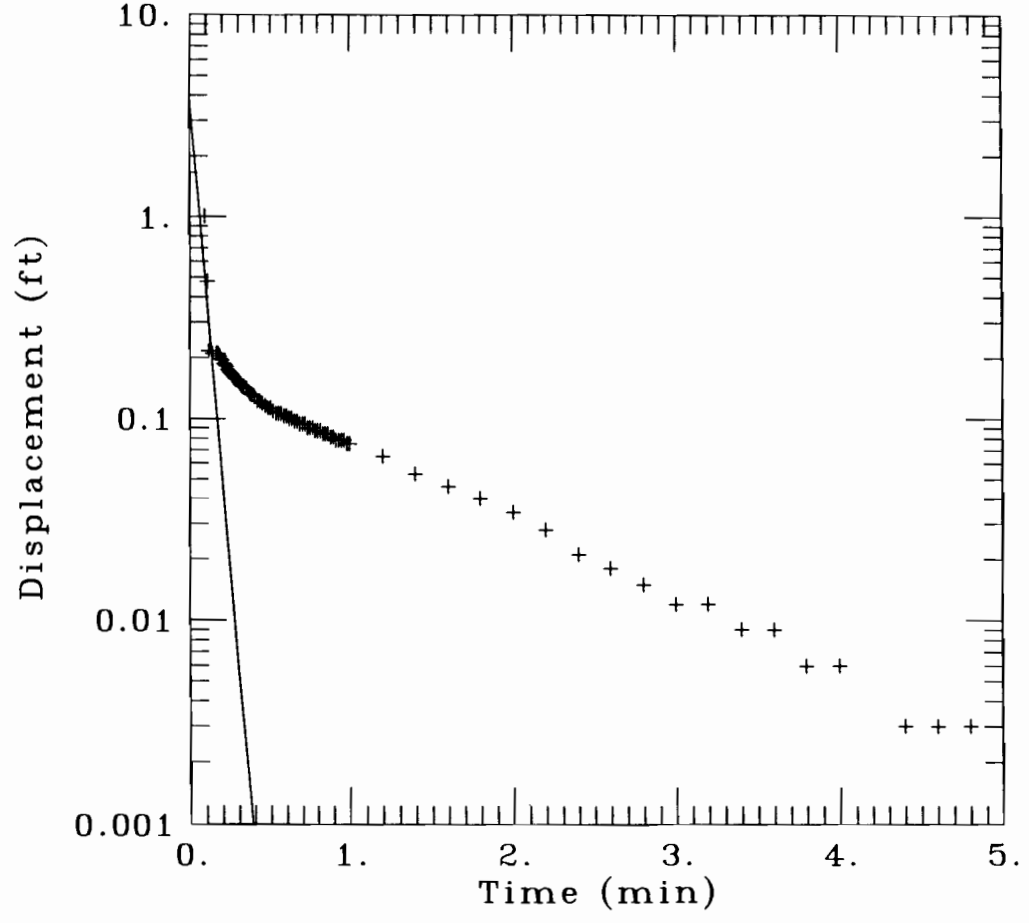
AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.004709 ft/min
y0 = 1.29 ft

TEST DATA:
H0 = 1.206 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 15.5 ft
H = 5.86 ft

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union - Ball Fields

MW-22-F



DATA SET:
mw22-f.prn
12/04/96

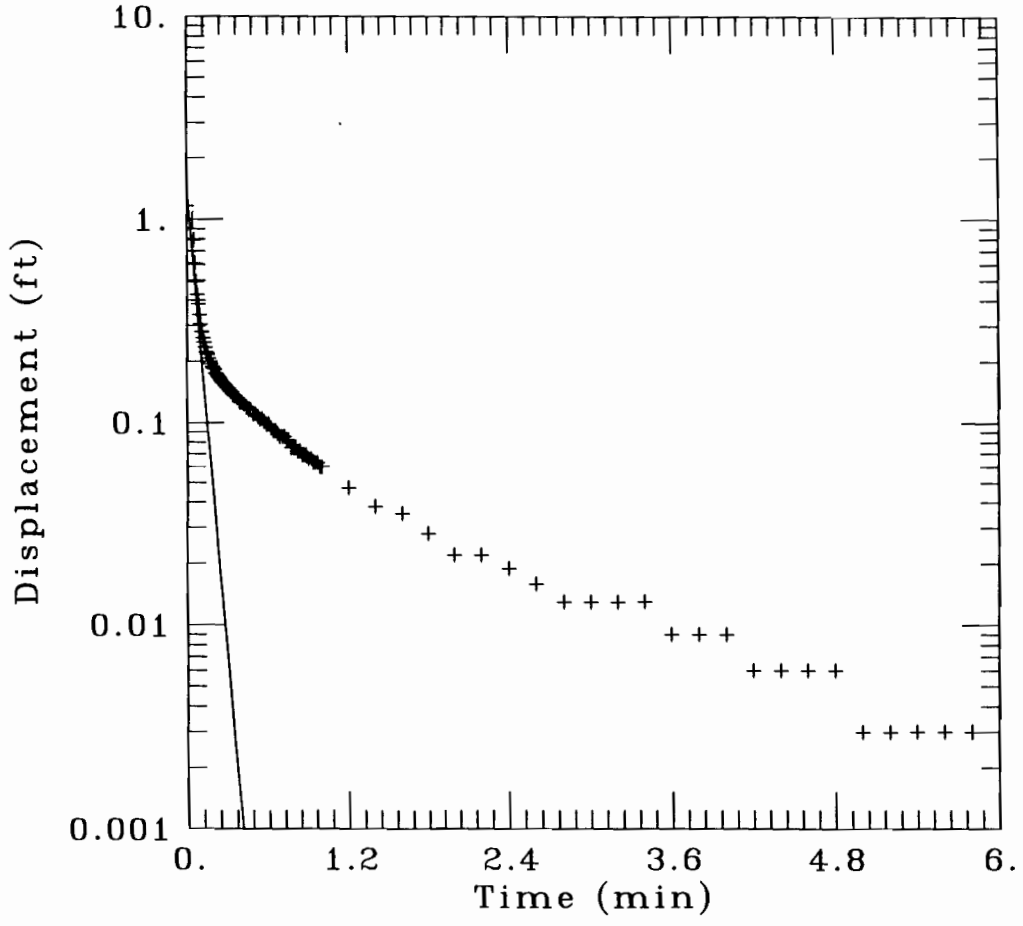
AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.01728 ft/min
y0 = 3.823 ft

TEST DATA:
H0 = 1.658 ft
rc = 0.083 ft
rw = 0.25 ft
L = 10. ft
b = 15.5 ft
H = 7.76 ft

Ecology & Environment, Inc.	Client: Brooklyn Union Gas
Project No.: BV-4091	Location: Brooklyn Union – Ball Fields

MW-22-R



DATA SET:
mw22-r.prn
12/04/96

AQUIFER TYPE:
Unconfined
SOLUTION METHOD:
Bouwer-Rice
TEST DATE:
5-Nov-96

ESTIMATED PARAMETERS:
K = 0.01313 ft/min
y0 = 1.391 ft

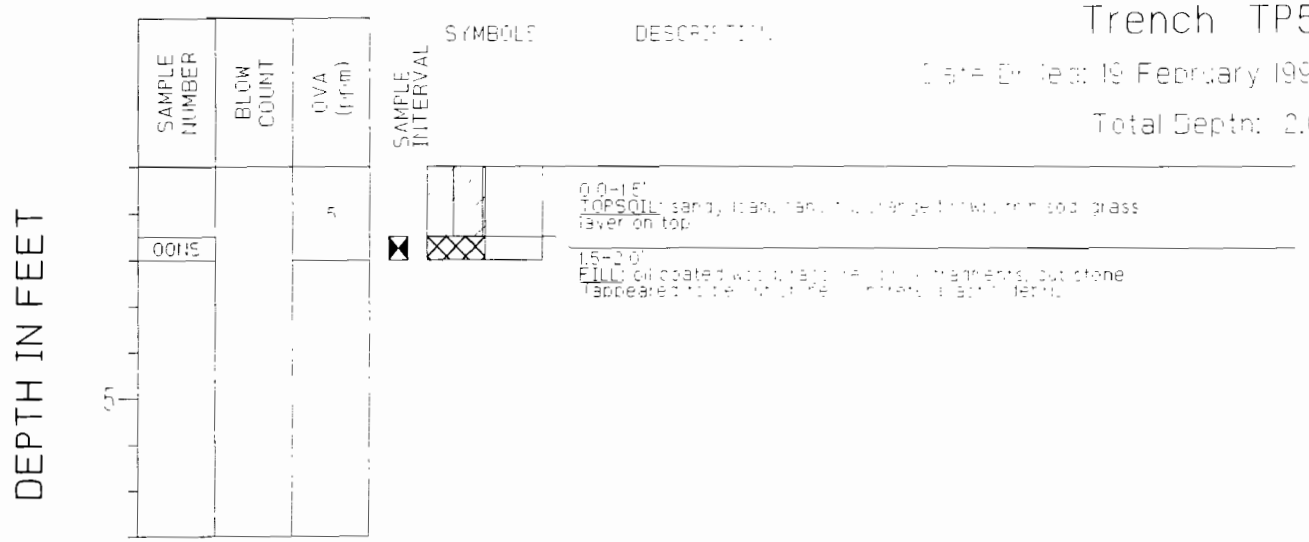
TEST DATA:
H0 = 1.165 ft
rc = 0.083 ft
rw = 0.3333 ft
L = 10. ft
b = 15.5 ft
H = 7.76 ft

B.6 Trench Profiles

Trench TP51

Date Drilled: 19 February 1997

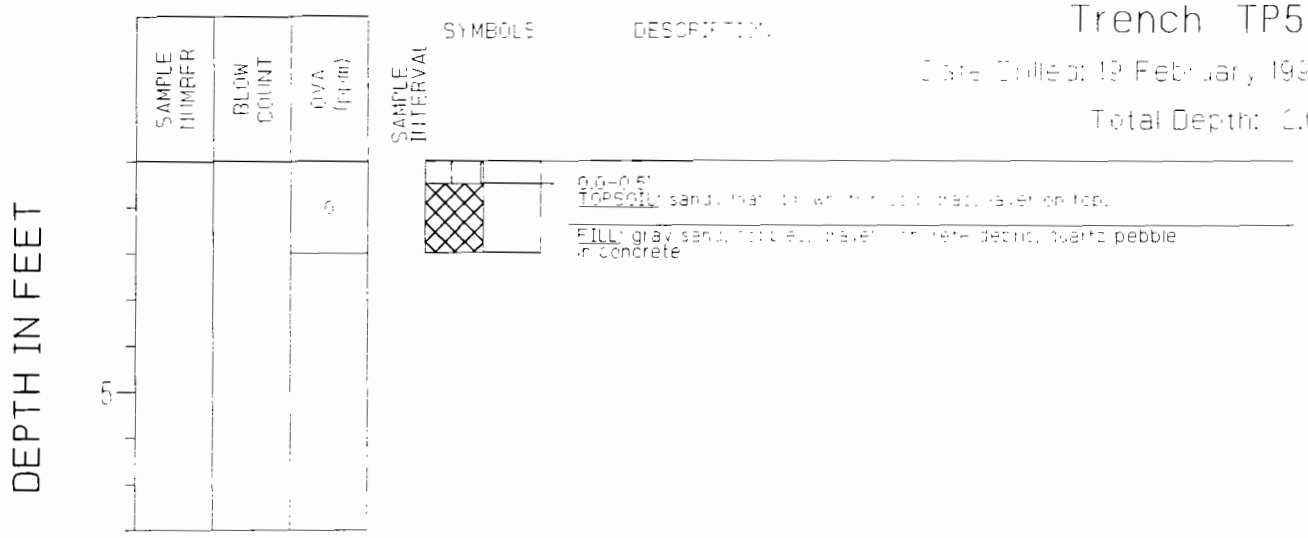
Total Depth: 2.0'



Trench TP52

Date Drilled: 19 February 1997

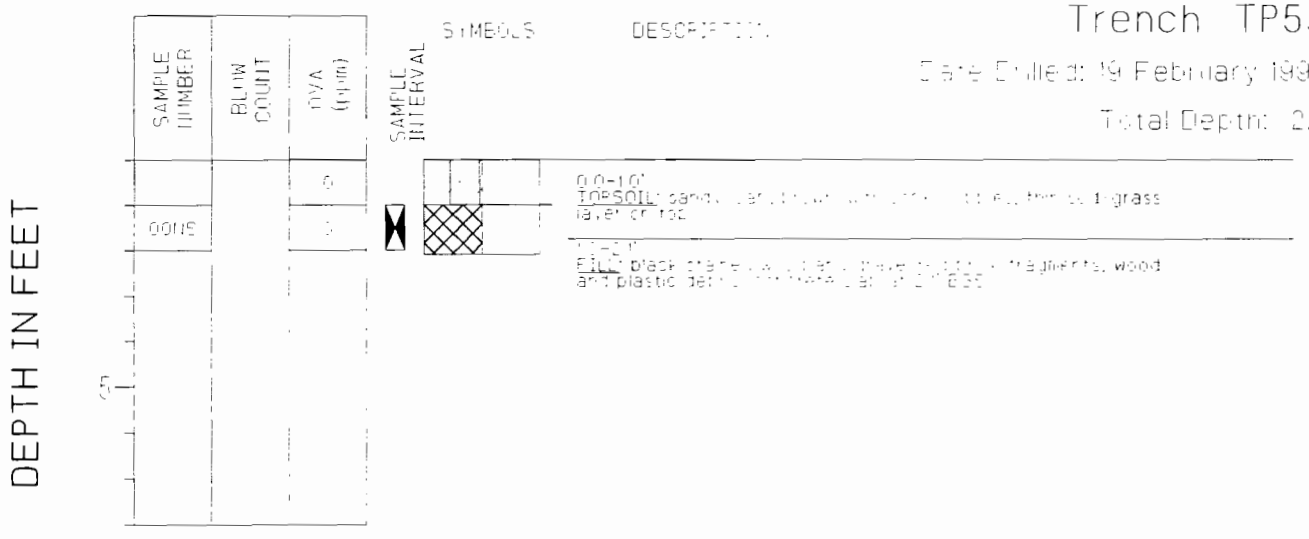
Total Depth: 2.0'



Trench TP53

Date Drilled: 19 February 1997

Total Depth: 2.1'



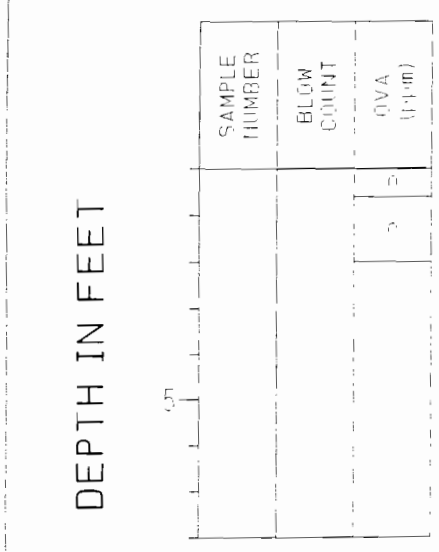
ecology & environment, Inc.
International Specialists in the Environment

Former Brooklyn Borough Gas Works
Brooklyn, NY

Trench TP54

Date Dug: 18 February 1997

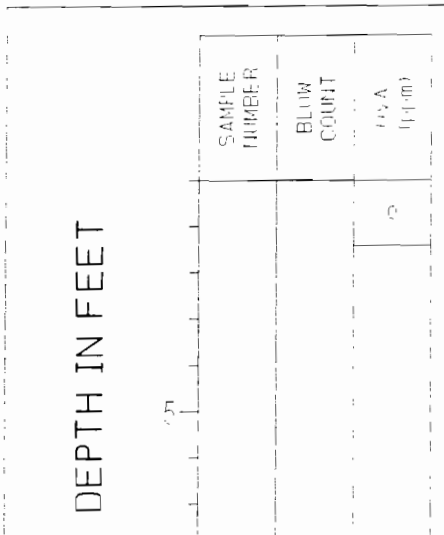
Total Depth: 2.0'



Trench TP55

Date Dug: 19 February, 1997

Total Depth: 1.42'



Trench TP56

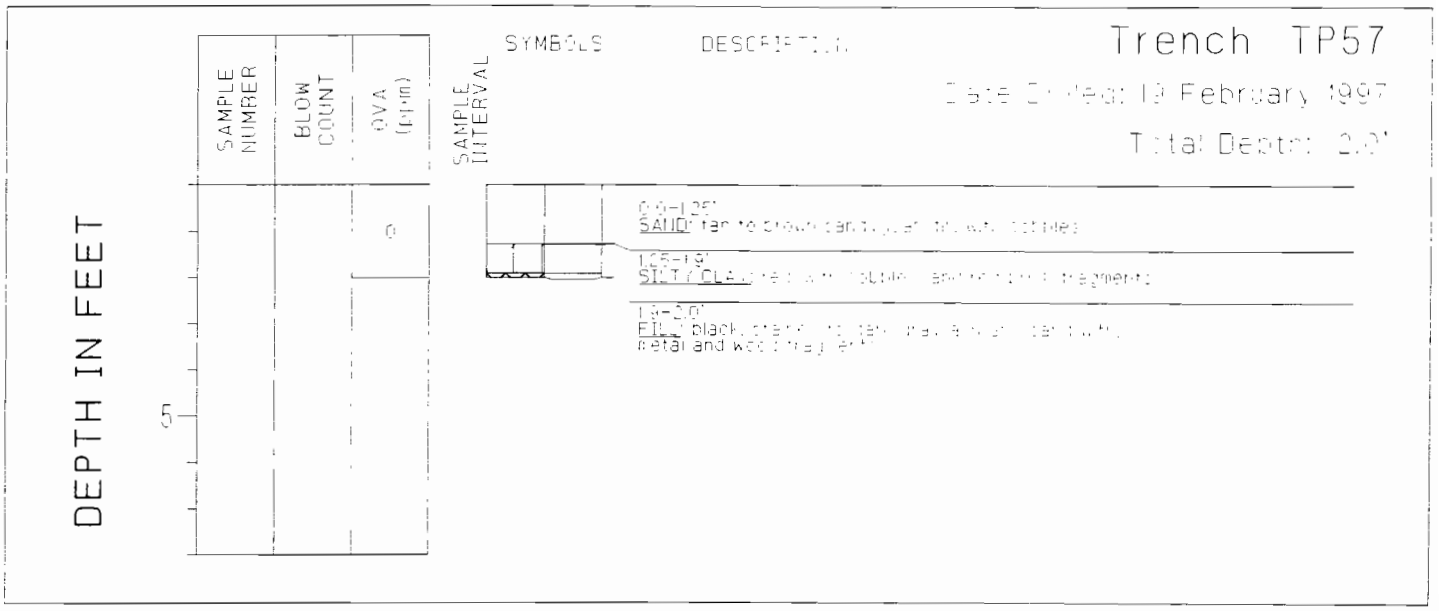
Date Dug: 19 February, 1997

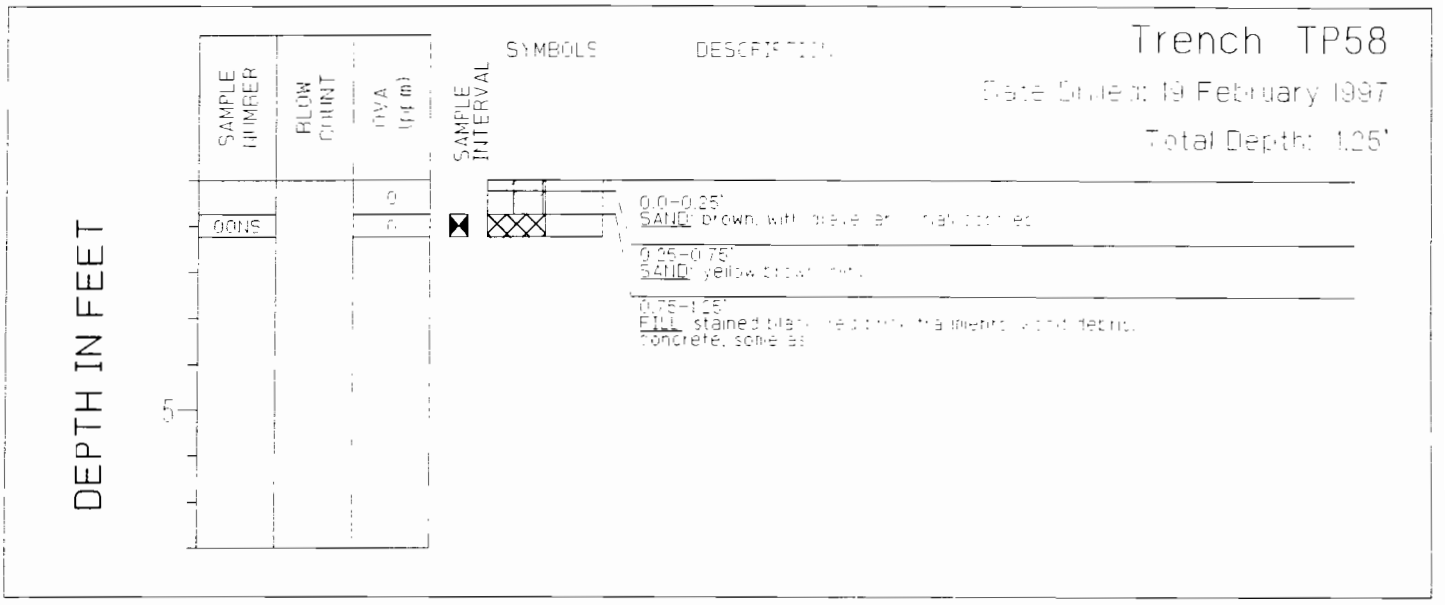
Total Depth: 1.25'

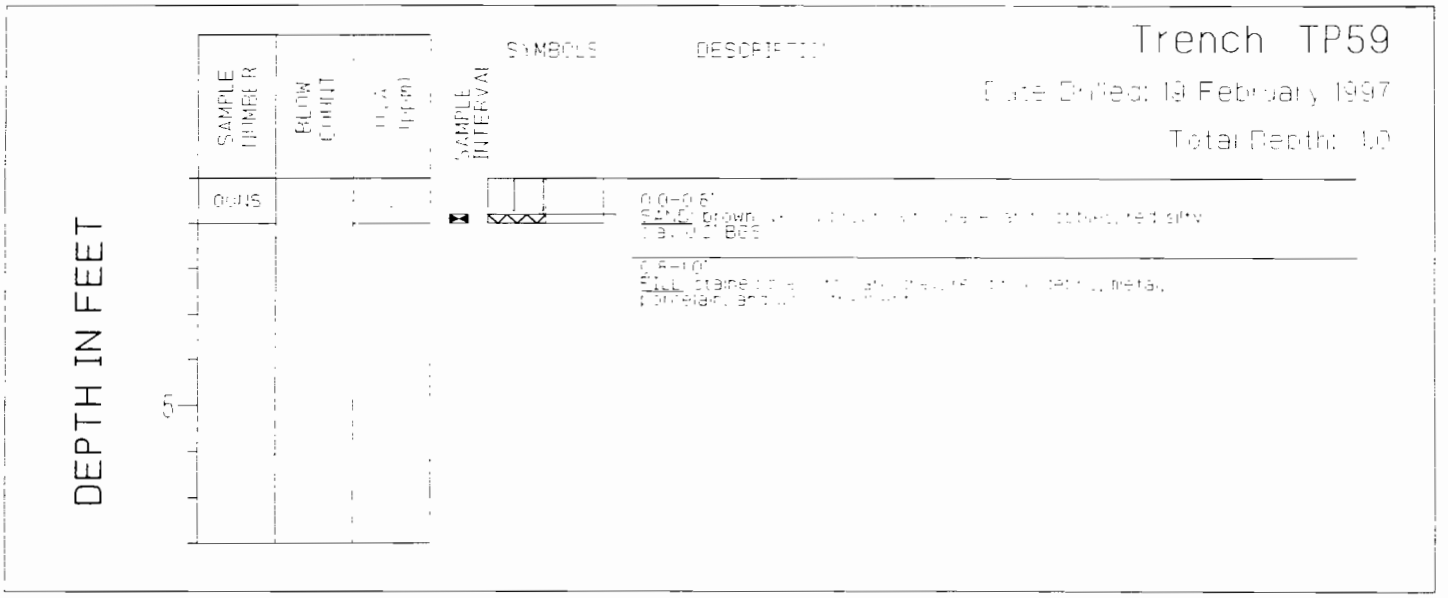
ecology & environment, Inc.

International Specialists in the Environment

Brooklyn Navy Yard Cogeneration Facility
Brooklyn, NY



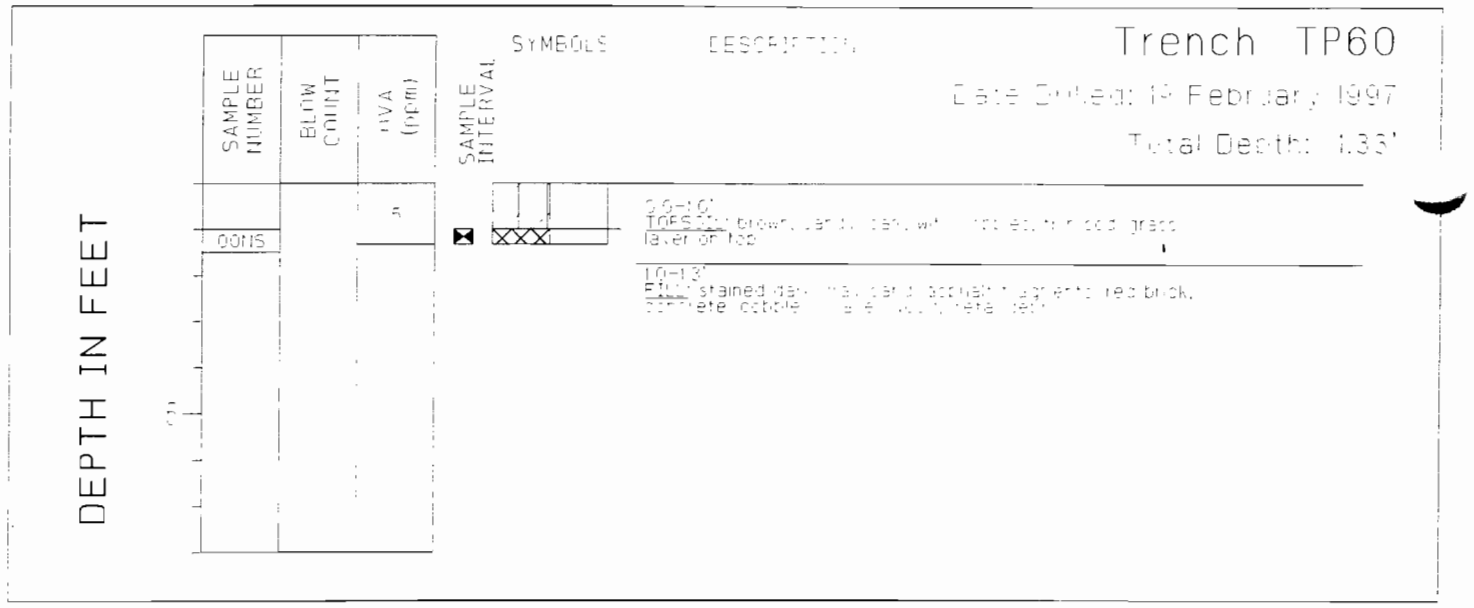


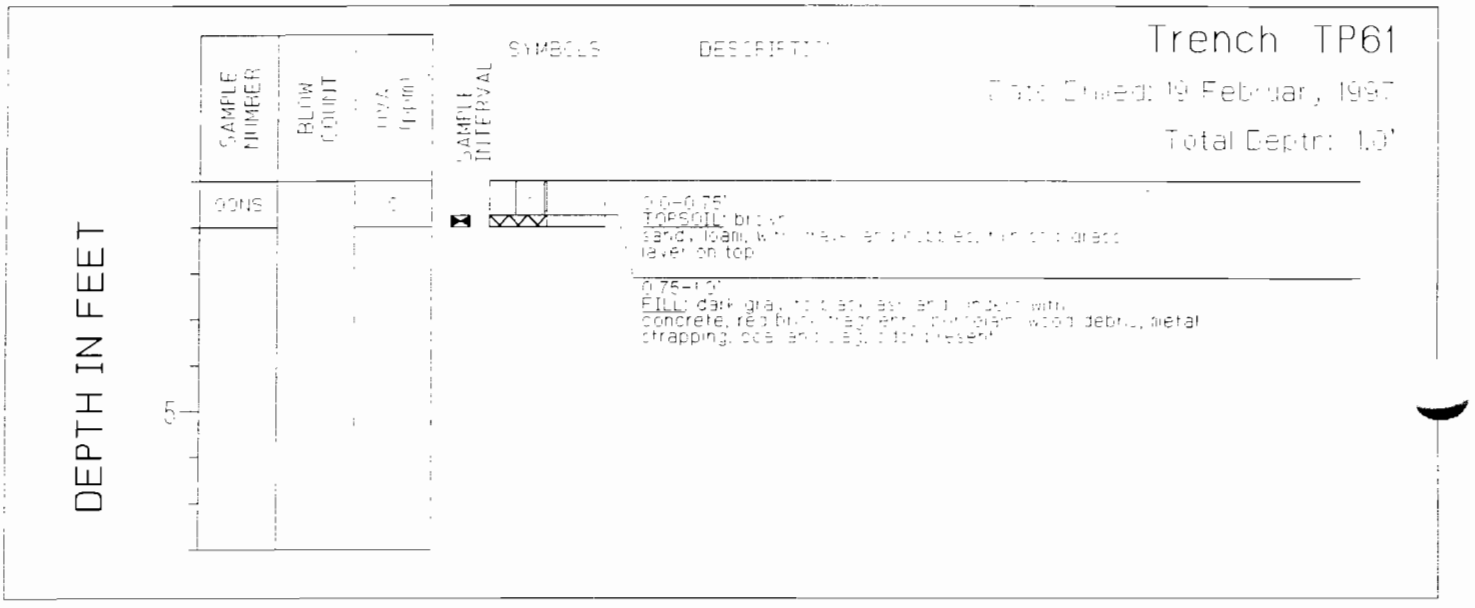


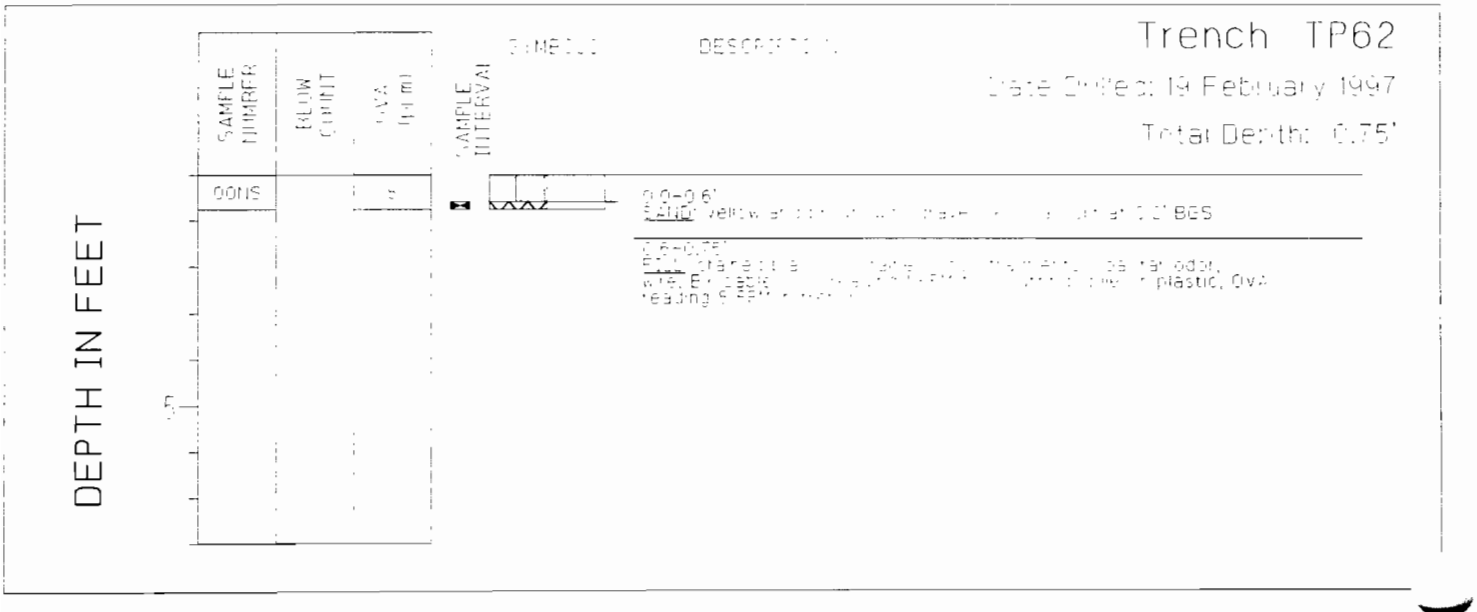
ecology & environment, Inc.
International Specialists in the Environment

[illegible]

Brooklyn Borough Gas Works
Brooklyn, NY







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Brooklyn Borough Hall Works
Brooklyn, NY

Trench TP63

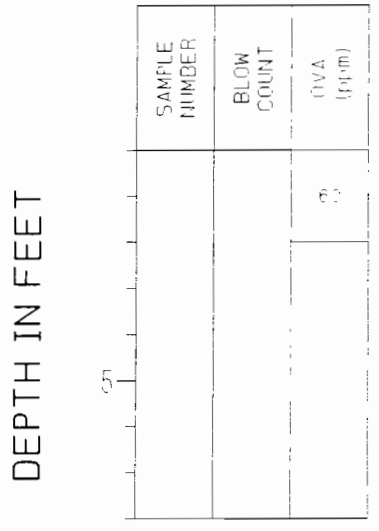
Date Drilled: 19 February 1997

Total Depth: 1.0

Trench TP64

Date Drilled: 19 February 1997

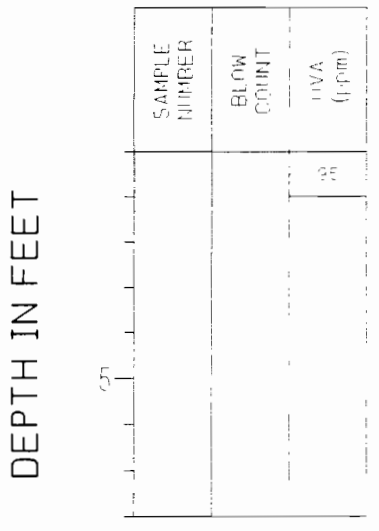
Total Depth: 2.0'



Trench TP65

Date Drilled: 19 February 1997

Total Depth: 1.0'



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International Specialists in the Environment

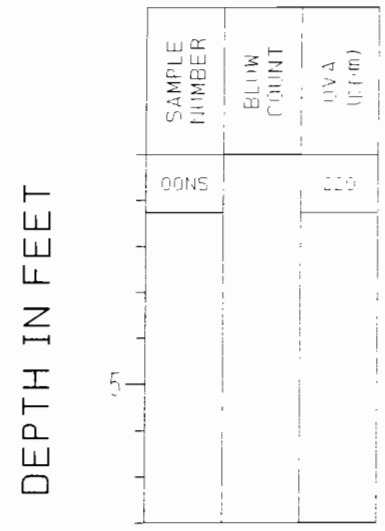
OPERATOR: Dominic Bonina
GEOLOGIST: Jean Bartel
METHOD: Backhoe with [illegible] bucket

Brooklyn Borough Gas Works
Brooklyn, NY

Trench TP66

Date Drilled: 19 February, 1997

Total Depth: 1.25



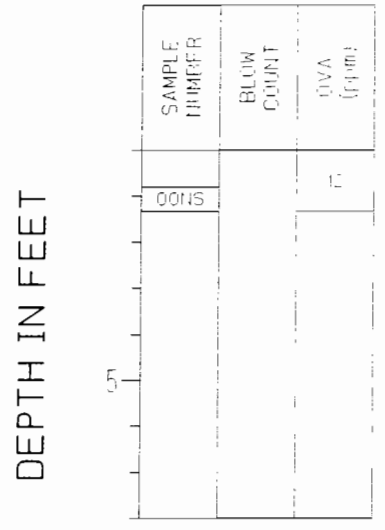
0.0-1.0'
TOPSOIL: brown, gravelly, silty, sandy clay, thin sod/grass layer at top, roots throughout, wet and black poly bag containing debris encountered at 0.5' depth.

1.0-1.25'
FILL: stained black, clayey silt and fine gravel, wood and gravel debris.

Trench TP67

Date Drilled: 19 February 1997

Total Depth: 1.33'



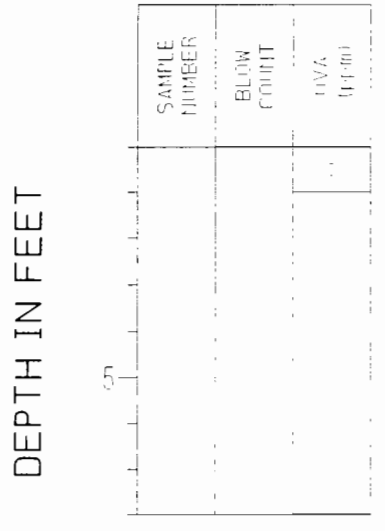
0.0-0.8'
SAND: sand, brown, [illegible]

0.8-1.33'
FILL: black cobbles, [illegible] and aluminum debris, [illegible]

Trench TP68

Date Drilled: 19 February, 1997

Total Depth: 1.0



0.0-0.5'
TOPSOIL: reddish brown, [illegible] and cobbles, [illegible]

0.5-1.0'
FILL: dark brown, clayey, [illegible] debris, 1"-gallon paint can, [illegible] and fragments, metal debris.

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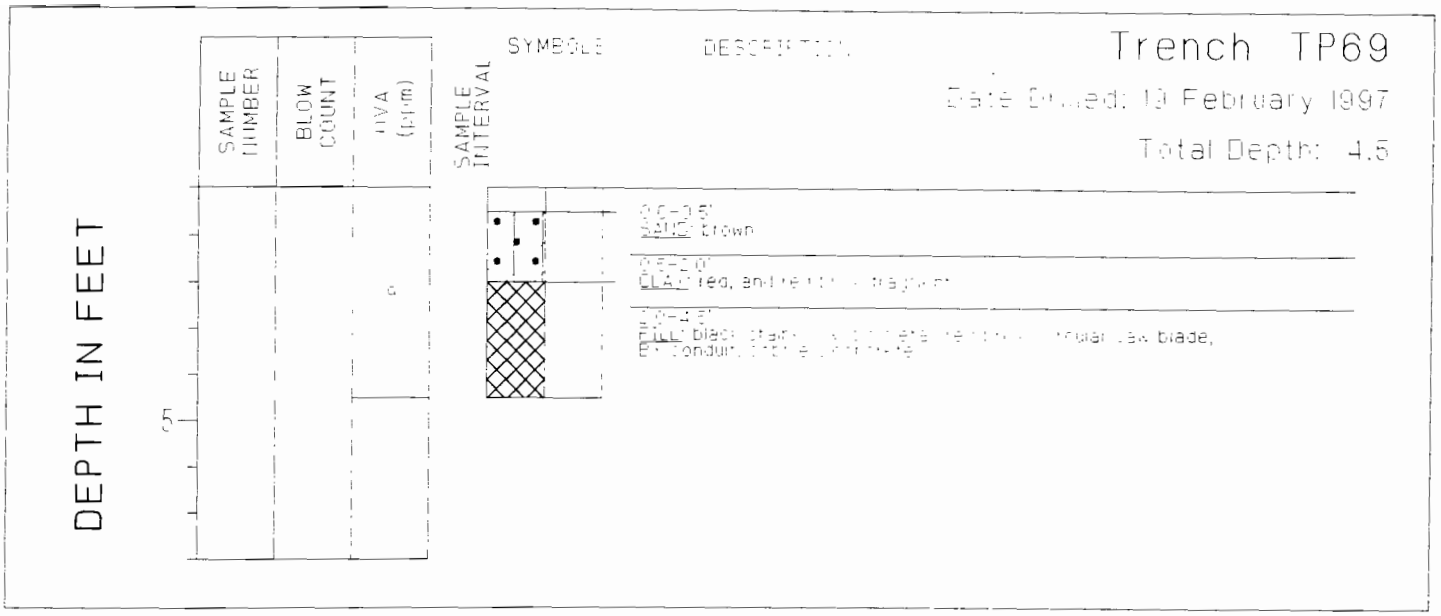
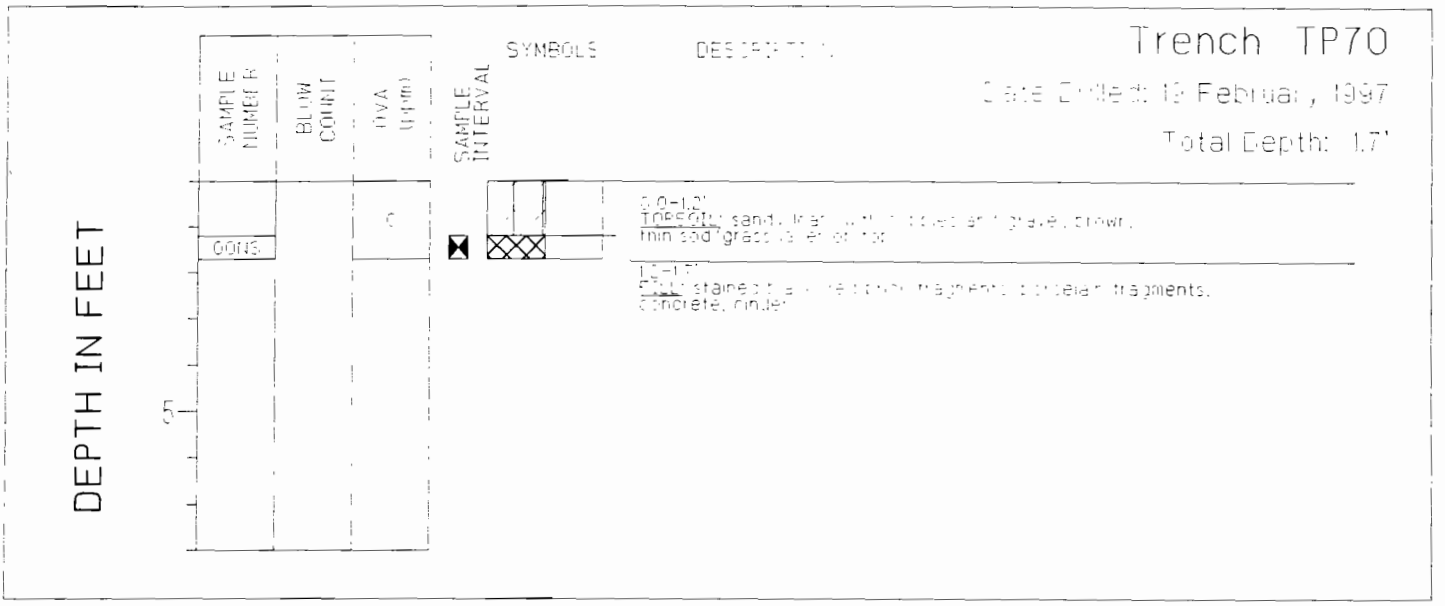
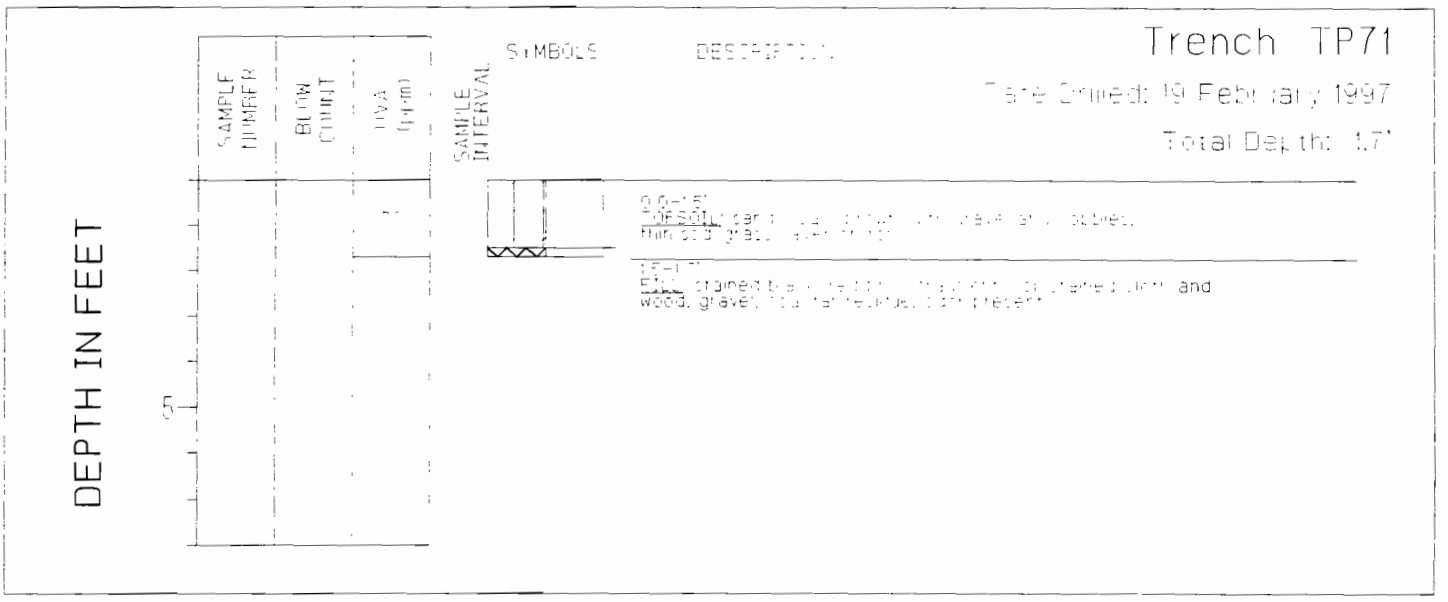
OPERATION: [illegible]
SITE LOCATION: [illegible]
METHOD: Backhoe with [illegible]

[illegible]lyn Borough Gas Works
Brooklyn, NY







ecology & environment, Inc.
International Specialists in the Environment

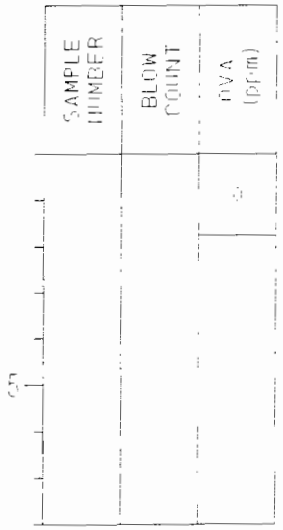
OPERATION: Demolition Excavation
GEOLOGIST: Kevin Barker
METHOD: Backhoe with 24" bucket

Brooklyn Borough Gas Works
Brooklyn, NY

Trench TP72

Date Excavated: 19 February, 1997

Total Depth: 1.75'



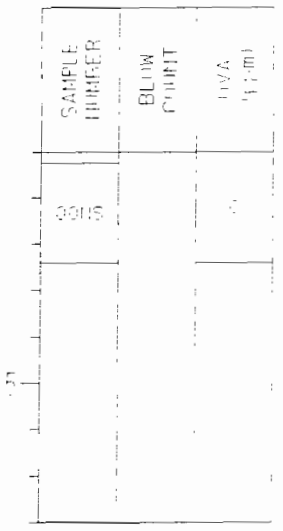
0.0-1.0'
TOPSOIL: sand, [illegible] brown, [illegible]

1.0-1.75'
FILL: [illegible] moist, [illegible] gravel, [illegible] bottom of [illegible] [illegible] may have ash present

Trench TP73

Date Excavated: 19 February, 1997

Total Depth: 2.4'



0.0-1.0'
TOPSOIL: sand, [illegible] dark brown to reddish-brown, [illegible] gravel, [illegible]

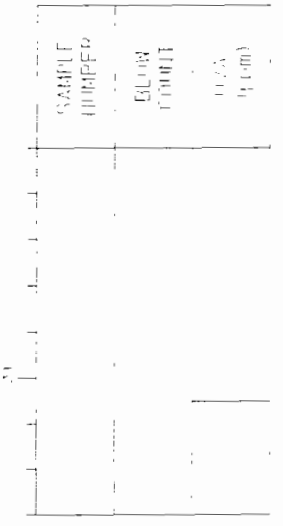
1.0-2.0'
FILL: [illegible]

2.0-2.4'
FILL: [illegible] moist, [illegible] gravel, [illegible] bottom of [illegible] [illegible] may have ash [illegible]

Trench TP74

Date Excavated: 19 February, 1997

Total Depth: 5.5'



0.0-[illegible]'
[illegible]

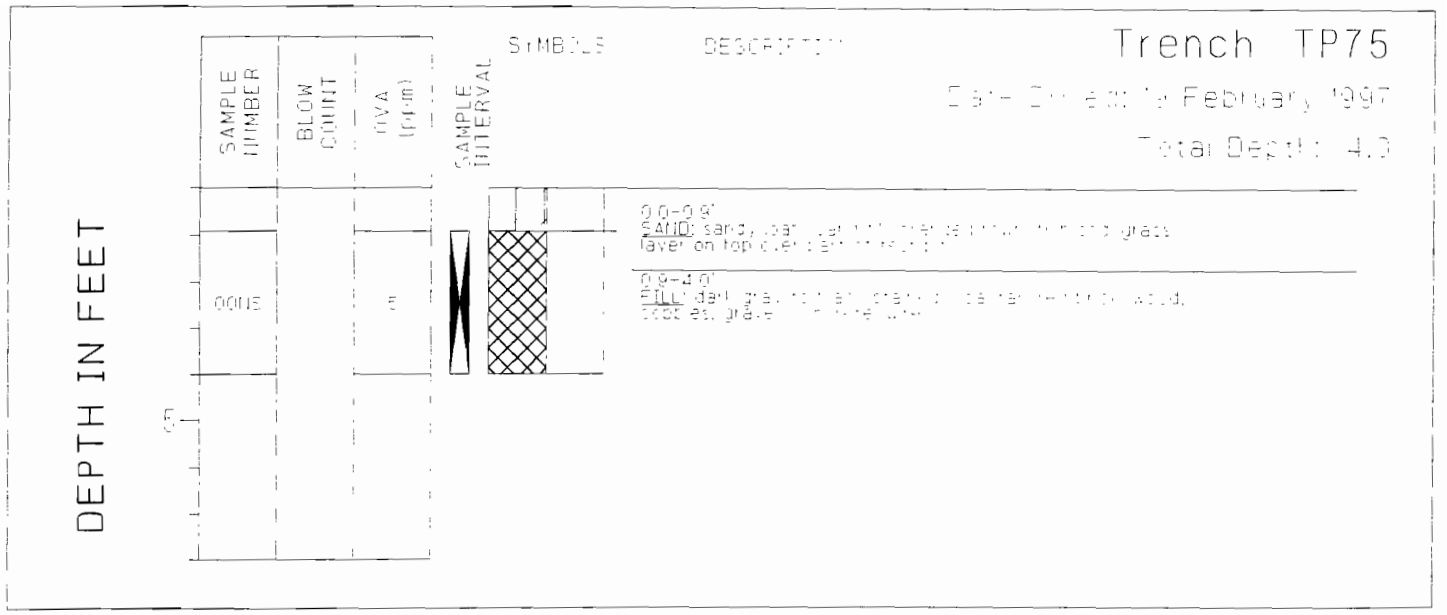
[illegible]-5.5'
FILL: [illegible] moist, [illegible] gravel, [illegible] bottom of [illegible] [illegible]

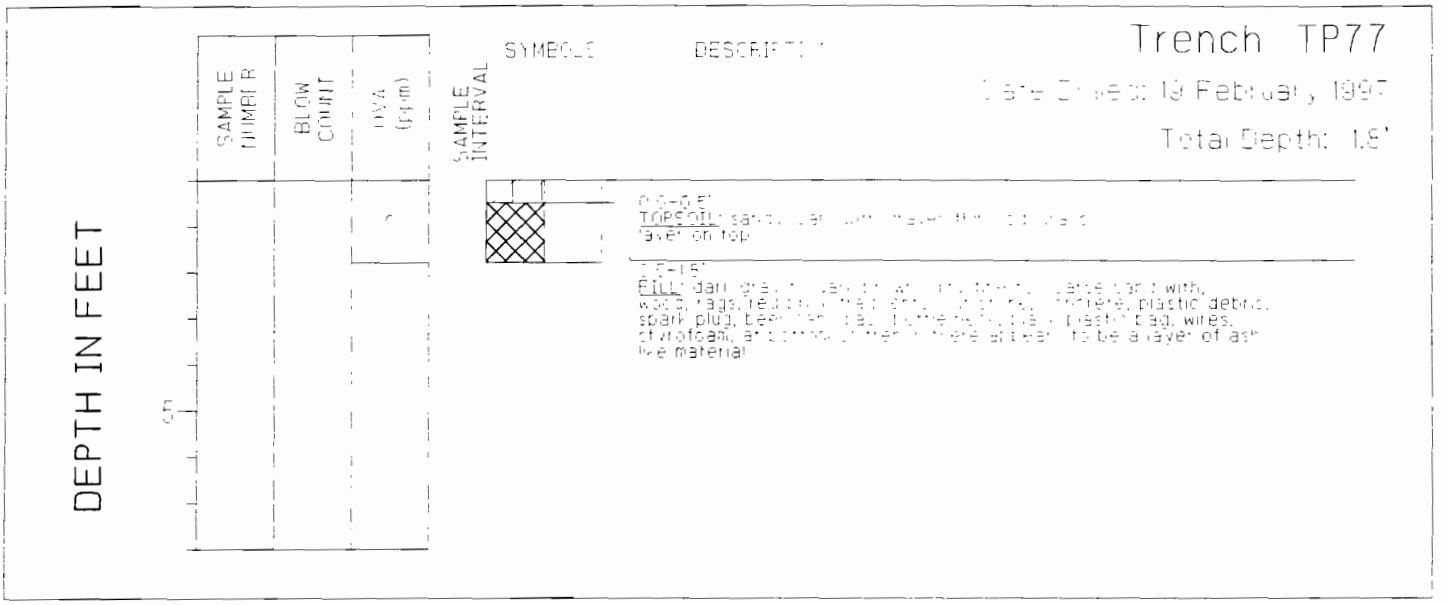
ecology & environment, Inc.
International Specialists in the Environment

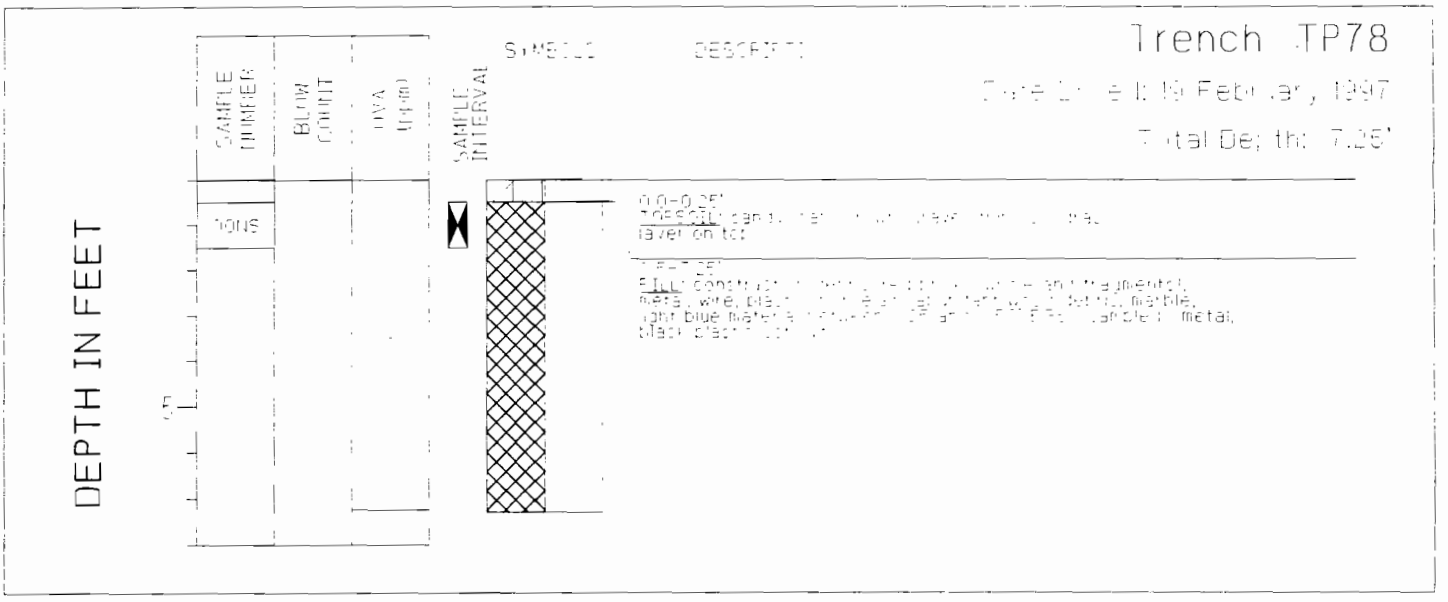
[illegible]

[illegible]

Brownfield Borough Gas Works
Brownfield, NY


Trench TP75
Total Depth: 4.0
DEPTH IN FEET
SAMPLE NUMBER
BLOW COUNT
OVA (ppm)
SAMPLE INTERVAL
SYMBOLS
DESCRIPTION
0.0-0.9'
SAND: sandy, dark
layer on top
0.9-4.0'
FILL: dark gray
5'


Trench TP77
Total Depth: 1.8'
DEPTH IN FEET
SAMPLE NUMBER
BLOW COUNT
OVA (ppm)
SAMPLE INTERVAL
SYMBOLS
DESCRIPTION
0.0-0.5'
TOPSOIL: sandy
layer on top
0.5-1.8'
FILL: dark gray
wood, rags, red
spark plug, beer
styrofoam, a
5'


Trench TP78
DEPTH IN FEET
SAMPLE NUMBER
BLOW COUNT
OVA (ppm)
SAMPLE INTERVAL
SYMBOLS
DESCRIPTION
0.0-0.25'
TOPSOIL: sandy
layer on top
0.25-7.25'
FILL: construction
metal, wire, plastic
light blue
black plastic
5'

C Conceptual Models

Conceptual models of the movement of chemicals dissolved in the groundwater and the movement of free-phase chemicals in the subsurface of the Brooklyn Borough Gas Works site are discussed in this appendix. There are three sections in the appendix. In the first, observations or findings from previous investigations at the property that provide critical insight in the construction of the conceptual models are presented. The conceptual models based on these observations and accepted principles taken from the literature are then described in the second section. The third and final section of this appendix is a general discussion of the behavior of free-phase organic chemicals in geologic environments.

C.1 Bases of the Conceptual Models

This section presents the observations and findings from previous investigations used in the construction of the conceptual models for the movement of chemical constituents in the subsurface at the site. The following is a list of principles and assumptions, presented from the general to the specific.

1. The distribution and movement of subsurface chemical constituents at the site involves multiple-liquid phases: groundwater and two or more nonaqueous-phase liquids (NAPLs). NAPLs having a density less than water are designated as lighter-than-water nonaqueous-phase liquids (LNAPLs). At this site, the LNAPLs appear to be fuel oils. NAPLs having a density greater than water are designated as denser-than-water nonaqueous-phase liquids (DNAPLs). At this site, the DNAPLs appear to be coal tars.

2. Process-related chemical constituents appear in the groundwater and exist in both the unsaturated zone (i.e., above the capillary fringe) and in the saturated zone below the fringe. (The capillary fringe is a zone of complete saturation that lies immediately above the water table. It arises as a result of capillary forces in the soil pores pulling groundwater up above the water table. The capillary fringe exists in all water table aquifers, and is generally thicker in low-permeability media and shallower in more-permeable media.)

3. Three major factors determine shallow groundwater flow at the site. First, the site is located at or near the discharge end of the regional flow system and, in particular, at the discharge end of the uppermost aquifer of that system. Second, the uppermost aquifer, a water table aquifer, discharges into Coney Island Creek, which is effectively an arm of the Atlantic Ocean. Thus, a saltwater wedge (deMarsily 1986, p.220; Verruijt and Bear 1987, p.196; and Domenico and Schwartz 1990, p.217) should exist in the deeper portions of the aquifer under the site. Third, several local geohydrological features impact groundwater flow at the site, including: the bulkhead running along the bank of Coney Island Creek in the western half of the property; an implied barrier in the subsurface in the eastern half of the property, between the old gas/oil tank farm and Coney Island Creek to the east; and the existence of natural clay/peat/silt deposits in the subsurface sands.

The location of the site at the discharge end of a regional water table aquifer and the discharge of that aquifer into saltwater are fundamental boundary conditions that determine the basic geometry of the flow onto and from the site. The local geohydrological features determine the distribution of aquifer properties (e.g., hydraulic conductivity), which determine the details of the flow at the site.

The bulkhead is clearly visible and, with the exception of the NAPL seep into Coney Island Creek, is generally intact. Thus, it is expected to impede flow from the uppermost portion of the aquifer into the creek. The observed water levels in the shallow monitoring wells installed in the western portion of the property, except in MW-14, are consistent with this interpretation.

The presence of a subsurface barrier between the old gas/oil tank farm and Coney Island Creek is evidenced by three observations at the property. First, the water table contours, developed for both high-tide and low-tide conditions, indicate a gradient to the east, beneath the eastern area. Second, large quantities of free-phase LNAPL have been found in the shallow monitoring wells in that area. Third, no organic-phase seeps have been observed along that stretch of Coney Island Creek (E & E 1994a). The simplest explanation for the lack of seeps is that a barrier, either man-made or natural, must exist in the subsurface between the old tank farm, where the LNAPL has been observed, and the creek.

4. The NAPLs present on the property include both LNAPLs and DNAPLs. Because both have been observed as free-flowing phases in the shallow monitoring wells, it is reasonable to assume large quantities of the materials are present. In addition, smaller amounts of these materials are present in near-surface soils over the entire property. These materials are consistent with the process history of the facility formerly located on the property.

5. The apparent movement and distribution of the LNAPLs found on the property can be explained in terms of the expected behavior of such materials in groundwater systems (EPA 1991). No observations of either the groundwater system or the NAPL distribution suggest the need for unusual mechanisms or factors to be evoked in the conceptual model.

6. DNAPL (presumably coal tar from the former MGP) has been observed as a free phase in some shallow monitoring wells. In addition to suggesting that significant quantities of the material may exist on site, the observation of the dense phase in the shallow wells suggests that there are, at least in some places, barriers to the downward movement of the DNAPL. The logical choice for such barriers is the observed low-permeability clay/peat deposits scattered about the subsurface at the property.

7. Consistent with the existence of a saltwater wedge as mentioned above, saline water (11,000 to 17,000 mg/L of chloride) has been observed in one deep monitoring well, DW-04. The average density of this saline water was estimated by developing a linear regression for density versus chlorosity for reference seawater. The chlorosity values used to develop the regression equation were taken as the product of the density and chlorosity of reference seawater as tabulated in the *CRC Handbook of Chemistry and Physics, 55th Edition*, 1974-1975, p. D-221. Densities of saline water were obtained from the same table. Based on the residuals from the regression, the error in the resulting density-

versus-chlorosity regression equation was less than 2 parts in 10,000 over the range of interest.

Using the average DW-04 chloride value as an approximate chlorosity in the regression equation, the average density of the DW-04 samples was estimated to be 1.02 g/ml. This estimate is slightly low, however, because the small amount of bromide present was not included in the chlorosity estimates.

Finally, typical densities of coal tars range from 1.20 to 1.25 g/ml (EPRI 1984). Because the coal tar density is much greater than the density of the saline waters beneath the property, any significant amount of coal tar migrating down from the near surface would not be stopped at the density interface (or pycnocline between the groundwater and saltwater wedge), but would continue on down through the saltwater wedge, presumably stopping at the top of the Gardiners clay layer, approximately 170 feet BGS.

8. The existence of denser saline water beneath the property is significant because it confirms the existence of a saltwater wedge beneath the property. This, when considered along with the salinity/brackishness of Coney Island Creek and the observed water quality in several shallow wells on and near the property, leads to the conclusion that the water table aquifer in the vicinity of the property must discharge entirely into Coney Island Creek. This means that migration of dissolved process-related chemical constituents through the groundwater to locations east of the creek does not occur.

9. Because the site is adjacent to the ocean (in the form of Coney Island Creek), the interface between the salt water and the overlying groundwater (and not the Gardiners clay layer at 170 feet BGS) is the effective bottom of the water table aquifer. Because flow lines in an aquifer do not cross or mix, the shallow waters beneath the site must originate from upgradient locations closer to the site than the origins of deeper groundwaters. Thus, any dissolved chemical constituents present in the groundwater or soils near the density interface beneath the site probably originate from one or more sources well upgradient, i.e., inland or north, of the site.

   In particular, the concentration data of chemical constituents in soil from boreholes at the site (see E & E 1993a, p. 9-9) indicate that the concentrations of a number of coal tar components are high near ground surface and subsequently decrease with increasing depth until approximately 60 feet BGS, where there is a significant increase in the concentrations. Continuing further down in the subsurface soils, however, the concentrations rapidly decrease. Based on the foregoing discussion, waters at these depths must come from further upgradient. Thus, the observed chemical constituents in soils at depth most likely did not originated as dissolved chemical constituents (DNAPL) at the site.

   Another mechanism that likely leads to coal tar components being found at depth beneath the property is the downward migration of DNAPL from near-surface sources. However, this should result in significant residual DNAPL saturation in the soil along the entire length of the soil column. This was not observed in the concentration profiles (e.g., DW-4). However, the migration would have occurred decades ago, and in the interim the continuous flow of groundwater past the residual materials may have altered the distribution.

C.2 Conceptual Models of the Movement of Chemical Constituents

Conceptual models of the movement of chemical constituents consider the transport of dissolved chemical constituents, LNAPLs, and DNAPLs. As such, they are qualitative descriptions of the processes believed to have occurred, be occurring, or both at the site. The conceptual models incorporate mechanisms widely accepted in the literature and features specific to the property.

Chemical Constituents Dissolved in the Groundwater

The movement of dissolved chemical constituents in the groundwater at the site is controlled by the local patterns of groundwater flow and by physical, chemical, and biological processes occurring in the subsurface. Groundwater flow, at least in the immediate vicinity of the property, is relatively simple. The property is located at the terminus of the uppermost regional aquifer, i.e., a water table aquifer. Because the physical extent of the property is small in comparison to the upgradient area of the aquifer's recharge zone, it is virtually certain that all precipitation infiltrating on the property discharges into Coney Island Creek. Consequently, any chemical constituents dissolved in the infiltrating water as a result of contact with source materials (e.g., soils containing process-related chemicals constituents and/or free-phase organics [NAPLs]) will eventually be discharged into the creek. Thus, from the perspective of these dissolved constituents, the details of groundwater flow at the site are not important.

It should be noted that if some coal tar, a DNAPL, has managed to migrate downward into the deeper portions of the aquifer, any dissolved chemical constituents resulting from the groundwater contacting the tar would still discharge into Coney Island Creek. The eventual fate of any materials moving deeper, for example into the saltwater wedge, is unknown at this time.

The rate of movement of dissolved chemical constituents at any location will be equal to or less than the rate of movement of groundwater at that location. This is the result of a number of physical and chemical processes, referred to as retardation effects, involving particular chemicals, groundwater, and the soil matrix, itself a composite material. Retardation processes entail the continual partitioning and departitioning of the chemicals between the moving aqueous phase and the stationary soil matrix. If a third phase, e.g., an immobile free-phase organic, is present, it also can participate in the retardation processes. Retardation is discussed in more detail in Section 5. The net result of retardation is the reduction in rate

of movement of a dissolved chemical constituent relative to the rate of movement of the groundwater.

Finally, there is one other important process in the transport of dissolved organic chemicals, i.e., biodegradation. Microorganisms in soil regularly metabolize organic chemicals in groundwater and the soil matrix. Biodegradation occurs in stages and may result in the complete breakdown of a chemical, or incomplete breakdown in which only intermediate compounds are produced. The concentrations of the parent compound are attenuated, as are any risks associated with it, although new risks may because of the appearance of the biodegradation products.

LNAPLs

The conceptual model of the movement of LNAPLs at the site is relatively simple. Because LNAPLs move "downhill" with the water table gradient (actually the capillary fringe), much of the LNAPL movement at the property will be toward the deep water table trough located near the western area. The material will then move down the trough toward the creek and eventually exit the site, through the seep. This movement is certain for a reasonably large quantity of LNAPL located in the western half of the property, where the trough acts as a funnel, "draining" the entire area underneath the western area and gas holder tanks. A possible exception is the anomalous area in the immediate vicinity of MW-14, located in the extreme western tip of the property. Given the available information, it is unclear how this particular area behaves.

Large quantities of LNAPLs have also been observed in the shallow monitoring wells installed on the eastern half of the property. In addition, water table gradients in that area are toward the creek; therefore, some movement of the LNAPLs beneath the former tank farm area into the creek would be expected. However, there are no known seeps along that reach of the creek (E & E 1994a). The absence of seeps—when the existence of a large source of LNAPLs and all available information about the water table gradients indicate that there should be some—suggests the presence of a subsurface barrier between the source and the creek. If such a barrier exists, it could be either man-made or natural, e.g., clay/peat/silt deposits. Another possibility is that the LNAPLs beneath the former tank farm may be moving, at least in part, to the west into the trough located in the western half of the property. Indirect evidence can be seen in the elevation contours for the top of the clay/peat deposits (see Figure 3-5), where there appears to be a break in the deposits separating the former, and currently closed, baseball field area from the western half of the property. This break in the deposits appears to be reflected in the water table contours.

Finally, the extent to which the flow of groundwater from the site to the creek is impeded by the bulkhead in the western half of the site and the unseen subsurface barrier in the eastern half of the site cannot be determined from the available data. Contouring the available water table elevations with and without interaction with the creek leads to qualitative differences near the creek for the two cases. This, however, is not of a concern with respect to LNAPL movement on the property because, in both cases, LNAPL movement is confined to the top of the water table and eventually directed toward the observed "troughing" of the piezometric surface or water table.

Ignoring the creek surface water elevation when contouring the water table results in gradients that are already directed toward the trough. If creek elevations are included in the contouring, the resulting water table gradients again result in some LNAPL flow to the trough, but some movement toward the creek is also indicated. LNAPLs moving in that direction on the western half of the property would eventually encounter the bulkhead and be diverted eastward, toward the seep. Little can be said about the eastern half of the site because nothing is known about the hypothesized subsurface barrier.

DNAPLs

Although a DNAPL (coal tar) has been observed in some of the shallow monitoring wells, there is, to date, insufficient evidence to indicate that the material has migrated. The fact that it is observed in the shallow wells suggests that its ability to migrate deeper is limited by the clay/peat/silt deposits found in the subsurface of the property. Thus, the major concern at present from a risk perspective is that the free DNAPLs found at the site are a long-term source of dissolved groundwater chemical constituents. Currently, there is no need for a conceptual model of DNAPL transport at the site. Even if DNAPLs have migrated or may migrate downward, the ultimate discharge location would be Coney Island Creek. The fate of any chemical constituents in the saltwater wedge, however, cannot be predicted, because the flow in that system is not yet understood. Nevertheless, the chemical constituents would likely be of little consequence under present water usage schemes.

C.3 Summary of the Behavior of Nonaqueous-Phase Liquids in Geologic Environments

NAPLs are liquids that do not readily dissolve in water and, therefore, can exist as a separate liquid phase. NAPLs that are lighter than water, i.e., less dense, are referred to as LNAPLs; those heavier, or denser, than water are referred to as DNAPLs. Because LNAPLs and DNAPLs have been observed in the subsurface at the property, a discussion of the

behavior of both types of NAPLs in the ground is relevant. The behavior of LNAPLs and DNAPLs can be understood in terms of three basic concepts: residual saturation, gravity-driven flow, and buoyancy.

As NAPL moves through a soil in the unsaturated zone above the capillary fringe (i.e., the zone of saturation immediately above the water table), it displaces both water and air from the soil pore spaces. Because water wets the surfaces of soil particles better than NAPL or air, NAPL tends to move through the center of the pore spaces. In the saturated zone, below the capillary fringe, there is little or no air in the pore spaces and NAPL will displace the water present. The displacement is not complete, however, because a small amount of soil water is immobile. Similarly, water displacing NAPL in a NAPL-saturated soil will not be able to displace all of the NAPL. The immobile NAPL remaining in this circumstance is referred to as residual saturation. Residual saturation is removed by dissolution in groundwater flowing around it and by biodegradation. Both removal mechanisms are slow; thus, residual saturation may serve as a source of chemical constituents for decades.

In the event of a release at or near the surface, NAPL initially moves through the unsaturated zone under the influence of gravity. Because gravity provides the main driving force for flow in the unsaturated zone, the direction of movement of the release is, like normal infiltrating rain precipitation, vertically downward. As the mass of the release migrates downward from the near-surface into uncontaminated soil, it enters soil pores, displacing soil water in those pores. As the main body of the release moves further down, some of the NAPL will drain, by gravity, from the soil pores in the upper parts of the soil column. However, a significant fraction of the NAPL will not drain; it will remain in the soil as residual saturation. Thus, the mobile mass of the release moving deeper will gradually decrease, leaving a column of soil containing the residual NAPL.

If the initial mass of the release is small, the NAPL will be completely depleted by losses to residual saturation, and the downward movement of the release will stop before the NAPL reaches the water table. It will remain in the soil column until it is dissolved by infiltrating precipitation, biodegrades, or is removed by remediation. As long as the NAPL remains in the soil column and is being dissolved into infiltrating water, it will be a source of groundwater chemical constituents. In addition, air is also present in the unsaturated zone, and volatile components in the NAPL will partition into that air. The vapors can then diffuse into adjoining soil areas, where the vapors will partition back into clean groundwater and soil, thereby extending the area of chemical constituents. Some diffusion of the vapors to the land surface also may occur.

In the case of larger releases, NAPL will move down from the surface and eventually reach the capillary fringe. At this point, the behaviors of the LNAPLs and DNAPLs diverge. In the case of DNAPLs, dissolved components moving in advance of the LNAPL enter the pore space at the top of the capillary fringe, reducing the wetting properties of the pore water and eventually lowering the residual water content. The net result is a reduction in the height of the capillary fringe. The main body of the LNAPL is less dense than water and floats on top of the capillary fringe. As more LNAPL arrives, the pressure "head" of the LNAPL increases and depresses the water table. LNAPL accumulates in the resulting depression and begins to spread laterally on the top of the capillary fringe. For a water table with a nearly horizontal gradient (i.e., a very flat water table), much of the lateral spreading is radial, with a bias for downgradient movement. For water tables with higher gradients, however, significant lateral movement, again downgradient, away from the release location may occur. If the size of the release is not too large, the extent of lateral movement of the LNAPL may ultimately be limited by losses along the way as residual saturation.

In cases where a large release has occurred or is occurring, LNAPL will flow downgradient atop the capillary fringe to a surface discharge location. The LNAPL then enters the surface environment as a distinct nonaqueous phase. A continuous trail of residual saturation will remain in the vicinity of the capillary fringe from the release location to the discharge location.

After the source of the release is contained or removed, LNAPL will drain out of the unsaturated zone, to the fringe, and then laterally along the top of the fringe. This results in a decrease of the head at the LNAPL/water table interface, causing the water table to rebound. Some LNAPL, however, remains below the water as residual saturation. Groundwater flowing past the residual chemical constituents slowly dissolves LNAPL constituents, forming a chemical constituent plume. The movement of the plume is determined by the groundwater flow system. That is, the main body of the plume moves along groundwater flow lines, where some dispersion occurs, both in the direction of flow as determined locally by flow lines and, to a lesser extent, perpendicular to the direction of flow.

When DNAPLs reach the capillary fringe, they must overcome the capillary forces between the water and the soil before they can go farther. This only happens as more DNAPL arrives at the top of the fringe and accumulates, eventually building up to the critical height required to overcome the capillary forces. In the case of fine-grained materials such as clays and silts, the capillary forces may be very large because of the small pore sizes in the matrix and the wetability of the minerals involved. As a result, it may not be possible to accumulate a sufficient depth of DNAPL to overcome the capillary forces.

Thus, these natural materials are often effective barriers to the downward migration of DNAPLs.

After a DNAPL penetrates the aquifer, it will continue to move downward, its mass decreasing as a result of losses to residual chemical constituents in the soil column. If large amounts of DNAPL are involved, some may reach the impermeable bottom of the aquifer, forming pools in depressions. Alternatively, if the impermeable bottom is sloping, the DNAPL will flow "downhill" atop the impermeable layer in the direction of the steepest gradient. Similar pooling and lateral movement may occur before the DNAPL reaches the bottom of the aquifer, if the aquifer is heterogeneous, having low-permeability lense and discontinuous layers. Groundwater flowing past the residual chemical constituents left by the DNAPL slowly dissolves them, forming a chemical constituent plume. The movement of such a plume is determined by the groundwater flow system.

D Certification

In accordance with Section III, Paragraph D, No. 3, of the Consent Order, E & E certifies that all activities comprising the Remedial Investigation were performed in full accordance with the approved work plan for the site.

Signature _____ *Date* November 19, 1997

Jerold C. Bastedo
E&E Project Manager

Sworn to this 19th day of November 1997.

Notary _____

[illegible]
Notary Public, State of New York
Qualified in [illegible] County
My Commission Expires May 2, 99

E Comments and Responses to Draft Supplemental RI Report

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-7010

John P. Cahill
Acting Commissioner

MAY 2 2 1997

FAX

Post-it® Fax Note 7671	Date 5/22	# of pages ▶ 16
To Agnes Antonian	From Dave Crosby	
Co./Dept. Brooklyn Union	Co. DEC	
Phone #	Phone # (518) 457-9285	
Fax # (718) 488-1761	Fax # 457-7743	

Ms. Agnes Antonian
Associate Environmental Engineer
Brooklyn Union
One Metro Tech Center
Brooklyn, New York 11201-3850

Re: Coney Island Former MGP
Remedial Investigation Report

The Department has complete the review of the Remedial Investigation Report for the Brooklyn Borough Gas Works. Comments are forth coming for the Cold Patch Asphalt Treatability Study/Beneficial Use Determination. The Department is still having internal discussions on that document.

With regards to the Remedial Investigation Report (the RI Report), the Department's comments are attached as attachment #1. In general, the RI Report provides a good summary of the field work conducted to date. However, as outlined in the comments the Department maintains that some additional work is necessary to fully characterize the nature and extent of contamination. Please respond to the RI Report comments by June 13, 1997.

If you have any questions or wish to discuss the project further, please feel free to contact me at (518) 457-9285.

Sincerely,

David A. Crosby

David A. Crosby, P.E.
Project Manager
Central Field Services Section
Bureau of Construction Services
Division of Environmental Remediation

cc: Dennis Harkawik - Jaeckle, Fleischman and Mugel
Tracey Bell - Brooklyn Union
Larry Liebs - Brooklyn Union

Attachment #1
NYSDEC Comments on the Remedial Investigation Report
for the Brooklyn Union Gas Works, dated March 1997.

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1. The Department has concerns with the possibility of Non-Aqueous Phase Liquid (NAPL) being confined behind the wooden bulkhead at the south western boundary of the site adjacent to Coney Island Creek. Both Figure 3.6 and 3.7 indicate a shallow groundwater flow pattern which could direct light NAPL which originates in the vicinity of MW-8 and MW-7 to a point just west of the current IRM system. Further, the highest subsurface benzene soil results are found near MW-08 (2-4') and near MW-07 (6-8'). This potential contaminant pathway could be a reason for the elevated benzene contamination that is found in the water column samples in the Coney Island Creek.

   The RI Report states that there is a continuous release of NAPL into Coney Island Creek. The hypothesis for NAPL migration presented by Brooklyn Union on page 5-13 and 5-14 is plausible; however, another explanation for the continuous release could be that the NAPL is pooled behind the wooden bulkhead. The RI Report describes the bulkhead as "..semi-impermeable.." and if NAPL is pooled behind the bulkhead the tidal fluctuation could be causing a release towards the eastern edge of the bulk head. The potential of NAPL pooling behind the bulk head is a source of uncertainty which will be very important to the upcoming feasibility study. As we discussed during our meeting of April 30, 1997, the reduction of contaminant loading to Coney Island Creek is an important issue to the Department for the upcoming feasibility study.

   To characterize the potential for light phase NAPL behind the bulk head, the Department requests the installation of a series of shallow wells along the southwestern boundary of the site with Coney Island Creek. After installation, the wells should be periodically checked for the NAPL and sampled for chemicals of potential concern (COPC). These well may be installed using a direct push techniques as a cost savings measure.

2. The Department has concerns with the property to the east of the site which is the location of the former "garden area". It is our understanding that this approximately 1/4 acre parcel is not owned by Brooklyn Union. However, from both field observations and an evaluation of Figure 1.7 and 1.8 (Aerial photos

from 1974 and 1994 respectively) it appears that site history and grading is similar to that of the ball field area and therefore, it is possible that the disposal history is similar. Further, groundwater analysis of MW-22 (the monitoring well to the east of this area) indicates the potential for waste disposal in this area.

To characterize the nature and extent of potential contamination in this area, the Department requests additional sampling of surface soil and subsurface soil to be analyzed for COPC. Further, if waste disposal practices in this area appear to be similar to the remainder of the ball field area, the Department will require that this area be incorporated into the feasibility study.

3. The Department recommends that selected monitoring wells be re-sampled for inorganic constituents. It is our understanding that the monitoring wells installed during the phase VI had problems with excessive turbidity. Therefore, the following sampling plan is suggested to evaluate the extent of inorganic contamination in this area. One sample should be collected as previously done during the investigation. A duplicate sample should be collected from each well with a low-flow submersible pump equipped with a 0.45 micron in-line sampling filter in such a way as the sample does not contact the atmosphere.

4. The Department requests that the monitoring wells installed during the Phase VI (MW- 16-22) and MW-02, MW-06 and MW-15 be sampled for both total and free cyanide. Given the elevated subsurface cyanide soil contamination found in the northern portion of the eastern area (BH-68 thru 70) it is prudent to sample the groundwater to determine if this material is migrating. A cyanide detection in MW-02 (16 ppm 'total') suggests that the subsurface cyanide detected in the eastern area could be the possible source of the groundwater contamination. As with the inorganic analysis described above, both filtered and unfiltered samples should be collected and analyzed.

Further, the RI Report on page 4-10 states that the cyanide in the eastern area "is at most only slightly dissociable". What is the basis for this statement?

5. Groundwater contamination levels appear to be decreasing in deep monitoring wells. In particular DW-04, which is the deepest well at the site, shows a decreasing trend approaching non-detectable levels. It is requested that the deep monitoring wells on the site be sampled for site contaminants to see if this trend in the data continues or if there is seasonality to the trend (note that the highest levels found in DW-4 was in a sample collected in April).

6. During our meeting of April 30, 1997, Brooklyn Union expressed the desire to conduct an Interim Remedial Measure (IRM) at the Coney Island site and suggested the possibility of doing work at the former oil storage area. If such an IRM is considered, it is suggested that Brooklyn Union evaluate the need for additional field data which may be necessary for design of the IRM system. If necessary, the supplementary RI field activities would be a good opportunity to collect additional information for the IRM design.

With regards to Citizen Participation activities for the proposed IRM, the Department maintains that this is a good time to conduct the initial public availability session for the Coney Island site for the following reasons:

i. Brooklyn Union has conducted a number of environmental studies on the site and has summarized the work in a comprehensive report. This provides a basis for informing the public of work done to date.

ii. As per Division of Environmental Remediation, Technical and Administrative Guidance Memorandum #4048, 'Interim Remedial Measures', the IRM proposal must be presented to the public. An availability session would allow greater public participation and comment and "...should be considered, particularly for large IRMs and IRMs that generate a great deal of public interest...".

iii. The recently finalized Citizen Participation Plan on page 4.6 states that public input for partial IRMs can be in the form of a "scheduled meeting" depending on the nature and extent of the proposed IRM. Given the amount of environmental investigation conducted at the site and this being the second IRM conducted at the site, an availability session seems appropriate.

The Department is sensitive to the concerns that Brooklyn Union has in this area however at some point we need to address the public and it is our desire to do it well before the Proposed Remedial Action Plan phase of the project.

7. Section 5.5, Transport and Fate Analysis: The Department does not agree with the statement made on 5-10 and 5-12 which describes the source of PAH contamination found with depth as " .... these PAH concentrations are more likely from an upgradient source". The dense nature of the coal tar waste and the geologic makeup of the site does raises the possibility that site contamination migrating vertically. There may be upgradient source of deeper PAH

contamination but the potential for site contamination with depth is high.

8. Section 5.5, Transport and Fate Analysis: It is unclear how table 2.1 or 4.1 support the discussion of NAPL at the site presented on page 5-12.

9. The following comment is from the NYSDEC, Division of Fish and Wildlife.

The data indicate that site soils and groundwater are significantly contaminated with numerous organic and inorganic substances. In addition it appears that Coney Island Creek has been impacted by site contaminants.

Section 5.7 discusses a risk assessment for the site that will include an evaluation of ecological impacts. The assessment is to be based on the model shown in figure 5-1. Although not illustrated in the figure, the assessment must include effects on terrestrial organisms as correctly stated in the accompanying table.

Based on the information presently available the isolation and removal of on-site sources of contamination to Coney Island Creek needs to be evaluated.

Further, based on the levels of PAHs noted in Coney Island Creek it appears that in the future site remediation will, at a minimum, need to include the removal of toxic sediments.

The following comments are provided by the New York State Department of Health

1. What is the future intended use of the now closed baseball fields? Also, the background section should state who owns the baseball fields?

2. I understand that the Health Risk/Exposure Assessment performed in 1990 will be updated based on new data. Will this also apply to the ball fields?

3. Section 5.3 mentions that piping associated with two underground storage tanks has been sealed. There is no mention of other underground piping which might have existed or still exists.

4. Are there any underground utilities in the area? If so, these may need to be investigated since Brooklyn Union Gas has no control over off-site buried utility work performed by municipal or private utility workers.

5. If buried utilities exist, then notification should be made to local municipal authorities regarding the environmental status of the site. This will ensure that utility workers take the necessary precautions with respect to contaminants (if any) prior to entering manways or digging in the area.

C:\...\ricmt.bu

Brooklyn Union

One MetroTech Center
Brooklyn, New York 11201-3850

June 5, 1997

Mr. David Crosby, P.E.
Project Manager
Central Field Services Section
Bureau of Construction Services
Division of Environmental Remediation
NYSDEC
50 Wolf Road
Albany, New York 12233-7010

RE: Former Brooklyn Borough Gas Works MGP Site
Remedial Investigation (RI) Report

Dear Mr Crosby:

This is a response to the Department's comments on the Draft RI Report for the former Brooklyn Borough Gas Works Site. Brooklyn Union agrees to perform the activities outlined below that were addressed in the May 22, 1997 Department comments:

- Re-sample monitoring wells installed during Phase VI for site contaminants. The inorganics samples will be collected using both filtered and unfiltered techniques (sampling description provided in Attachment 2.)
- Re-sample selected wells [MW-02, MW-06, MW-15, MW-16-22] for both total and free cyanide. Both filtered and unfiltered samples will be collected.
- Re-sample deep monitoring well [DW-04] for site contaminants.
- Brooklyn Union is proposing to place an additional two boreholes in the former "garden area" which is currently owned by the City of New York (NYC) (see attached map for proposed locations). Both surface and subsurface soil samples will be taken for site contaminants. Brooklyn Union has notified NYC regarding the planned investigation and will perform the additional work unless prohibited to do so by NYC officials. If this does occur, Brooklyn Union will notify the Department immediately.

If the Department approves, Brooklyn Union plans to conduct the additional investigation work during the week of June 16, 1997 (all work will be performed in accordance with the Remedial Investigation Work Plan dated October 1996). Further responses to comments addressing specific language in the Draft RI Report are provided in Attachment 1.

Brooklyn Union

Response to Other NYSDEC Comments:

As we discussed during the June 2, 1997 phone conversation, Brooklyn Union believes that placement of additional monitoring wells adjacent to the wooden bulkhead area of the site is not necessary at the present time. Brooklyn Union has performed extensive investigation in this area including test pits, boreholes and monitoring wells, during 1993 to determine the extent of NAPL pooling behind the bulkhead. These efforts confirmed the presence of NAPL in the area and the fact that the levels do not indicate a greater than normal potential for release into the Coney Island Creek.

During prior investigations tie backs that act as a securing mechanism for the bulkhead were discovered. In fact, several of these tie backs were destroyed during the installation of the monitoring wells, boreholes, and test pits in October 1993. Brooklyn Union is concerned that additional disturbance in the area adjacent to the bulkhead could further undermine the structural integrity of the wooden bulkhead. However, Brooklyn Union does understand the Department's desire that the upcoming feasibility study address the contaminant loading to the Coney Island Creek. If the need arises during the feasibility study for additional testing behind the wooden bulkhead Brooklyn Union is willing to re-address this issue at that time.

As we discussed previously, Brooklyn Union desires to conduct a groundwater treatment Interim Remedial Measure (IRM) in the vicinity of the former oil storage area by September 1997. We believe that installation of this IRM is an important and timely step in the remediation of the site. However, it is our desire to postpone the "scheduled citizen participation meeting" until a later date and instead release a notification form. This will allow the company time to prepare a more cohesive and better executed public participation protocol geared to our awareness of the importance of having information presented to the public in a clear, straight-forward and accurate manner.

Response to NYSDEC, Division of Fish and Wildlife Comments:

Brooklyn Union agrees that the future Risk Assessment (RA) should include effects on terrestrial organisms.

Brooklyn Union recognizes that a major focus of the site remediation will be to mitigate the current discharge of product into the Coney Island Creek. The removal of onsite contamination and its effects on the Creek will be evaluated further during the feasibility study.

Contamination in the Coney Island Creek and in its sediments, below the mean high water mark, has multiple existing and historical sources, including City of New York discharges from its combined sewer system. In recognition of this situation, the Consent Order provides that:

1. RI activities in the Creek and Creek sediments shall be coordinated with remedial investigations being performed by other persons, including the City of New York, and

2. The Department will establish an operable unit involving the Creek and Creek sediment remediation separate from any operable unit involving remediation above the Creek's high water mark. Consent Order at ¶ II(C).

This provision was agreed to by the Department and Brooklyn Union because it was recognized that unilateral Creek remediation in the absence of a coordinated approach to the Creek would not be effective. Therefore, Brooklyn Union has not yet performed an RI of the Creek and Creek sediments below the high water mark and is awaiting coordination with other potential sources of past and present contamination before commencing an RI. In addition, until a comprehensive RI is completed, it is premature to discuss any possible remediation, and by whom.

Brooklyn Union

Response to New York State Department of Health Comments:

Brooklyn Union is the current owner of the now closed Gil Hodges Baseball Fields. The company has reached a decision to keep the ball fields closed to the public for the duration of the investigation and cleanup activities.

The revised Health Risk Assessment that will be performed under the current Order will include the additional data gathered during the Phase VI ball field investigation.

In an effort to cut-off potential migration pathways, Brooklyn Union conducted a search for underground piping along the western and south eastern site perimeter (where the site is bounded by the Coney Island Creek) during 1988. All piping that was discovered was subsequently capped to alleviate any possible discharge of product into the Creek via pipe conduits.

Brooklyn Union is aware of the existence of electrical conduit that supplies electricity to the NYC MTA Rail Yard, located to the north of the site, along the service road. However, this utility is located outside the area of known contamination that is associated with the former Brooklyn Borough Gas Works MGP Site. There are several other underground utilities, located under the Belt Parkway, that previously supplied utilities to the Brooklyn Union site but these are no longer in service.

In summary, Brooklyn Union hopes that this letter adequately addresses the Department's comments and concerns. Please feel free to contact me if you have any further questions regarding this matter.

Respectfully,

Agnes Antonian
Environmental Engineer

Enclosure

cc: Dennis Harkawik, Jaeckle, Fleischmann and Mugel
Lawrence Liebs, Brooklyn Union

ATTACHMENT I

Responses to NYSDEC Comments on the Remedial Investigation Report for the Brooklyn Union Gas Works

Comment 4. NYSDEC requests that ten wells (MW02, MW06 and MW15 through MW22) be sampled for both total and free cyanide. The RI report on page 4-10 states that the cyanide in the eastern area "is at most only slightly dissociable". What is the basis for this statement?

Response. The basis for the statement that cyanide in the eastern area "is at most only slightly dissociable" is related to the fact that cyanide occurs as a ferrocyanide, a chemical complex, in which the cyanide is tightly bound. Cyanide gas or salts are minimal because of the strong bonding which occurs in the complex. As this cyanide is tightly bound, this is the basis for the statement "..is at most slightly dissociable".

Comment 7. Section 5.5, Transport and Fate Analysis: The Department does not agree with the statement made on page 5-10 and 5-12 which describes the source of PAH contamination found with depth as "... these PAH concentrations are more likely from an upgradient".

Response. Although the coal tar waste and the geologic makeup the site raises the possibility that the site contamination migrates vertically, it is E & E's belief that PAH concentrations may also have an upgradient source. The site is located near a discharge area of the aquifer and waters deep below the site must originate in the upland recharge areas. Given that free phase DNAPL has not been observed to date at these depths, the dissolved PAHs are reasonably assumed to originate from one or more upgradient sources. Also, dissolved PAH concentrations observed in the deep well, DW04, are far below saturation; this suggests that these waters may be a distance from the source.

E & E recommends that "more likely" be replaced with "may be".

Comment 8. Section 5.5, Transport and Fate Analysis: It is unclear how Table 2.1 or 4.1 support the discussion of NAPL at the site presented on page 5-12.

Response. The reference to Table 2.1 and 4.1 does not relate to the text on page 5.12 and will be removed in the final copy.

ATTACHMENT II

Proposed characterization activities for the Brooklyn Borough Gas Works

Soil Sampling

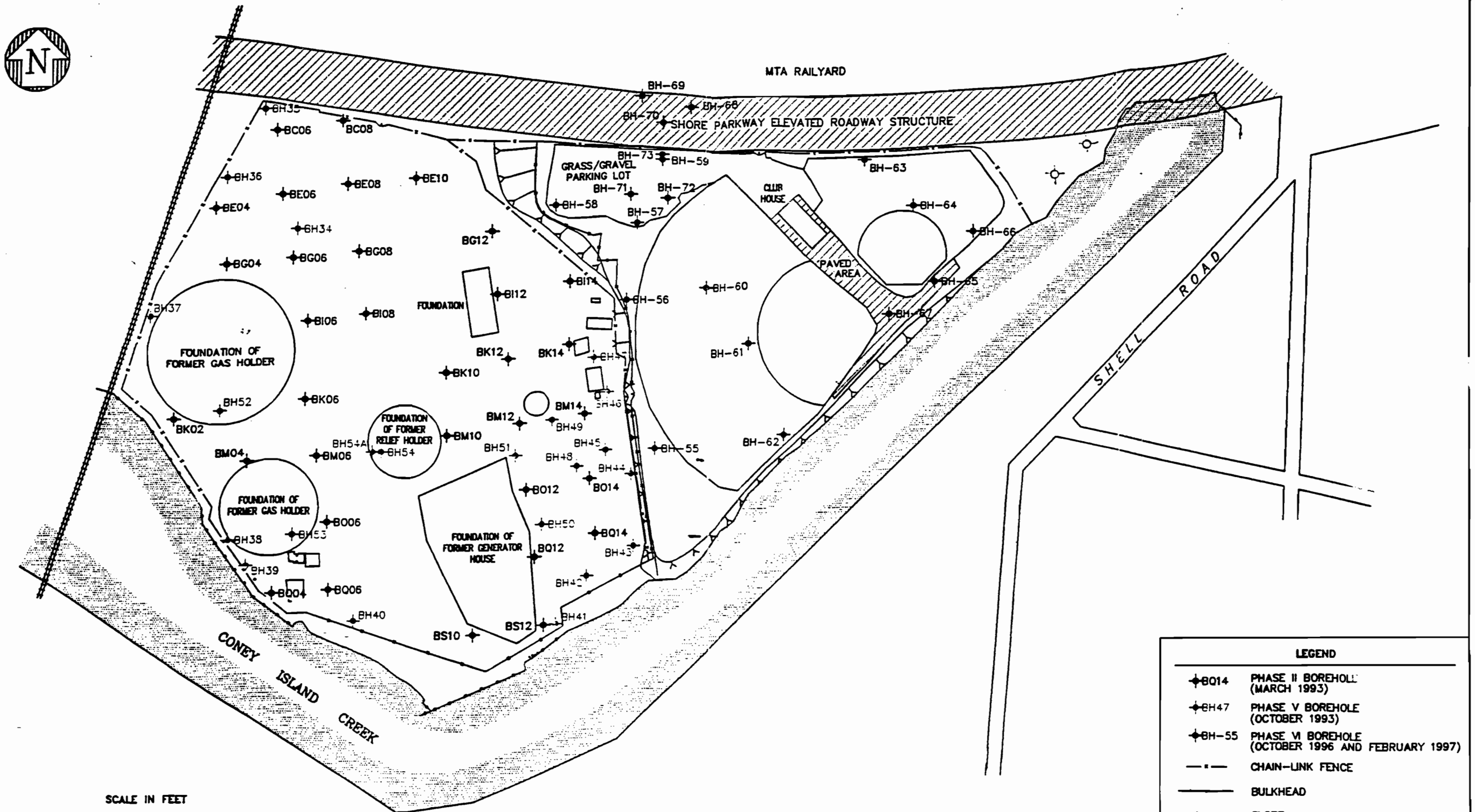
E & E proposes to install two boreholes in the property east of the site, which is the location of the former "garden area". The boreholes are proposed to characterize the surface and subsurface soils and are projected to be installed to a depth of 16 feet. In addition to a surface soil sample, subsurface samples will be collected from two foot intervals from the surface to the total depth of the borehole. The soil samples will be submitted for analysis for volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), inorganics, pesticides/polychlorinated biphyenols (Pest/PCBs), cyanide, and total recoverable hydrocarbons (TRPH). Sampling procedures will follow those previously employed on the site and presented in the October 1996 NYSDEC and Brooklyn Union approved work plan.

Groundwater Sampling

E & E proposes to collect groundwater samples from nine wells (MW15 through MW22 and DW04) and analyze them for VOCs, PAHs, Pest/PCBs,TRPH, inorganics, total and amenable cyanide, total hardness, total dissolved solids (TDS), and cholorsity. Both filtered/unfiltered samples for the inorganics and cyanides will be collected. In addition, monitoring wells MW02 and MW06 will be sampled for filtered/unfiltered total and amenable cyanide. E & E will employ the appropriate sampling procedures for the filtered/unfiltered samples as approved by NYSDEC.

Water levels will be measured in all 24 groundwater monitoring wells, with one set each being collected as near low and high tide as possible, with an oil/water interface probe.

Sampling procedures will follow those previously employed on the site and presented in the October 1996 NYSDEC and Brooklyn Union approved work plan.



ecology and environment

Figure 1 BOREHOLE LOCATIONS
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-7010

JUL 01 1997

John P. Cahill
Commissioner

FAX

Ms. Agnes Antonian
Associate Environmental Engineer
Brooklyn Union
One Metro Tech Center
Brooklyn, New York 11201-3850

Re: Coney Island Former MGP
Remedial Investigation Report
Response to Comments

The Department has completed the review of Brooklyn Union's Response to Department's Comments dated June 5, 1997, on the Remedial Investigation (RI) Report for the Brooklyn Borough Gas Works.

The Department appreciates the efforts of Brooklyn Union to complete the Remedial Investigation by quickly scheduling the additional sampling which we requested. As we discussed when we met on-site on June 18, 1997, the additional investigation can be submitted as an appendix of the RI Report which the Department hopefully will approve by the end of the summer. As such, the Department accepts Brooklyn Union's response to the Department's comment letter of May 22, 1997, with the exception of comment/response #7.

The Department still believes that there is a high probability that the deeper PAH groundwater contamination is site related. Given the nature and volume of coal tar waste found and the geological makeup of the site, we still cannot agree with the statements made in the report. However, as we discussed on June 18, 1997, shallow groundwater contamination and the migration of coal tar constituents to Coney Island Creek is a more important issue to the Department and we can 'agree to disagree' on this issue. As such, the wording proposed in your response is accepted.

With regards to citizen participation for the proposed IRM, the Department is willing to allow the IRM to go forward with the release of a "fact Sheet" which will be forwarded to the mailing list for site. Please allow sufficient time for the Department's of Conservation and Health to review the draft fact sheet and the associated mailing list. However, as stated in my letter of May 22, 1997, it is the Department's position that an "availability session" must be held well before the proposed remedial action plan stage of the project. Therefore, the Department requests that Brooklyn Union commit to a public availability session to be held near the site in the fall of this year.

If you have any questions or wish to discuss the project further, please feel free to contact me at (518) 457-9285.

Sincerely,

David A. Crosby

David A. Crosby, P.E.
Project Manager
Central Field Services Section
Bureau of Construction Services
Division of Environmental Remediation

cc: Dennis Harkawik - Jaeckle, Fleischman and Mugel
Tracey Bell - Brooklyn Union
Larry Liebs - Brooklyn Union

DOH STATE OF NEW YORK
DEPARTMENT OF HEALTH

11 University Place Albany, New York 12203-3399

Barbara A. DeBuono, M.D., M.P.H.
Commissioner

Dennis P. Whalen
Executive Deputy Commissioner

RECEIVED
OCT 24 1997
BUREAU OF
CONSTRUCTION SERVICES

October 22, 1997

Mr. David Crosby, P.E.
NYS Dept. of Environmental Conservation
Div. of Environmental Remediation
50 Wolf Road, Room 267
Albany, NY 12233-7010

RE: Brooklyn Borough Gas Works
Coney Island, Kings County
Site # 224026

Dear Mr. Crosby:

I have reviewed the Draft Revisions and Additions to Remedial Investigation Report, dated September 1997, for the above referenced site. I have the following comments.

1. The revised Figures 2-5 and 2-6 should have been included in this package. The locations of BH74 and BH75 are nowhere depicted in the package.

2. The ball diamonds should be sketched in on Figures 2-1 and 2-2.

3. The color maps in Chapters 3 and 4 are very impressive. Consistent with a previous comment, these would be improved (especially for public use) by including several identifiers such as street names and the Coney Island Creek.

4. The oversize prints, Figures 4-5, 4-6, and 4-7, are equally impressive. However, inasmuch as the remedial investigation is preparatory to a risk assessment and feasibility study, the plots should attempt to reflect health-based criteria. This would require changing one scale and preparing two additional prints. Regarding the scale for Total PAHs, Figure 4-5, the lower end of the color range (i.e., gray to blue demarcation) should begin at 10 mg/kg rather than 1000 mg/kg. If presentation of the full range would not be possible beginning at 10 mg/kg, consideration should be given to using a logarithmic scale if the graphics software can accommodate such.

5. Two additional prints should be prepared, one for benzene and one for benzo(a)pyrene Toxic Equivalence. While a BTEX map is useful to visualize areas of gross contamination, benzene will become the contaminant of consideration from this category during health-based

assessments. Similarly, while Total PAHs is helpful as an indicator of the magnitude of contamination, health-based considerations will specifically examine the benzo(a)pyrene Toxic Equivalency. Color ranges for plots of each of these should begin at 1 mg/kg.

6. Oversize Table 4-2 is an impressive array of data. It would be improved by placing a thick horizontal line or similar break every five analytes. As an alternative, the list of analytes could also be placed midway in the table.

7. The new text should suggest a reason why soil-lead concentrations at SS28 and SS32 are considerably lower in 1997 than in 1993. This could be done in either the new paragraph on page 4-8, in the third bullet on page 5-18, and/or in the middle paragraph on page B.2-2. Despite the new, lower results for lead, Figure 4-3 relies on the earlier results (1800 and 1900 ppm).

8. The new text on page B.1-4 states that "three liquid-level measurements were read and recorded..." and then defines two. It is not clear from the text nor the referenced tables (Tables B.1-18 through B.1-21) what the third reading was.

Thank you for providing the New York State Department of Health with the opportunity to review this document. If you have any questions about or wish to discuss these comments, please contact me at 458-6305.

Sincerely,

William Gilday

William Gilday
Assistant Sanitary Engineer
Bureau of Environmental Exposure Investigation

cc: A. Carlson, Ph.D.
Mr. S. Bates
Mr. A. Rockmore (NYSDEC) 10/24
Mr. R. Gardineer (NYSDEC Reg 2)
Dr. L. Kan (NYCDEP)

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New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-7010

NOV 1 3 1997

John P. Cahill
Commissioner

FAX

Ms. Agnes Antonian
Associate Environmental Engineer
Brooklyn Union
One Metro Tech Center
Brooklyn, New York 11201-3850

Re: Coney Island Former MGP
Remedial Investigation Report

The Department has completed the review of Brooklyn Union's Revised Remedial Investigation Report for the Brooklyn Borough Gas Works. As we discussed on November 6, 1997, it is our understanding that you will incorporate the appropriate Department of Health comments. Therefore, the Department accepts Brooklyn Union's changes to the draft report, including the wording proposed in your consultant's fax transmission of November 10, 1997, regarding interpretation of the lead analytical results. Please prepare the final RI Report for our approval.

With regards to site related citizen participation, it is our understanding that Brooklyn Union tentatively plans to hold a public informational meeting the week of December 8, 1997. Please allow sufficient time for the Departments of Environmental Conservation and Health to review the draft fact sheet which announces the public meeting.

The Department appreciates Brooklyn Union's continuing efforts in conducting a remedial program for the Coney Island Former MGP site. If you have any questions or wish to discuss the project further, please feel free to contact me at (518) 457-9285.

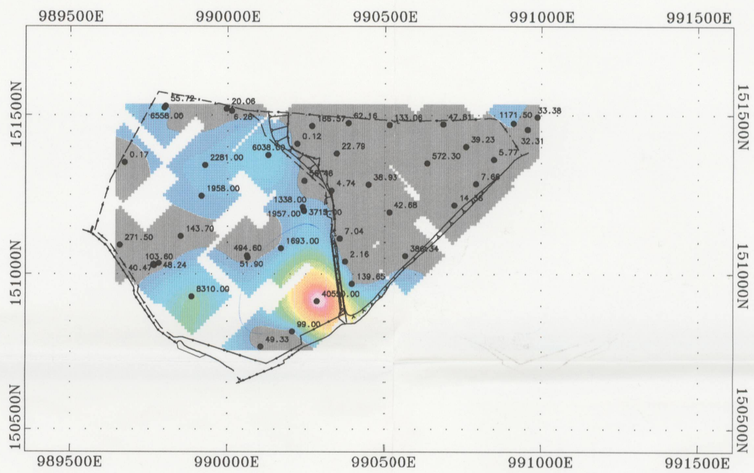
Sincerely,

David A. Crosby, P.E.
Project Manager
Central Field Services Section
Bureau of Construction Services
Division of Environmental Remediation

Enclosure

cc: Dennis Harkawik - Jaeckle, Fleischman and Mugel
Larry Liebs - Brooklyn Union
Jerry Bastedo - Ecology & Environment
Steve Bates/Bill Gilday - NYSDOH

(0–2')



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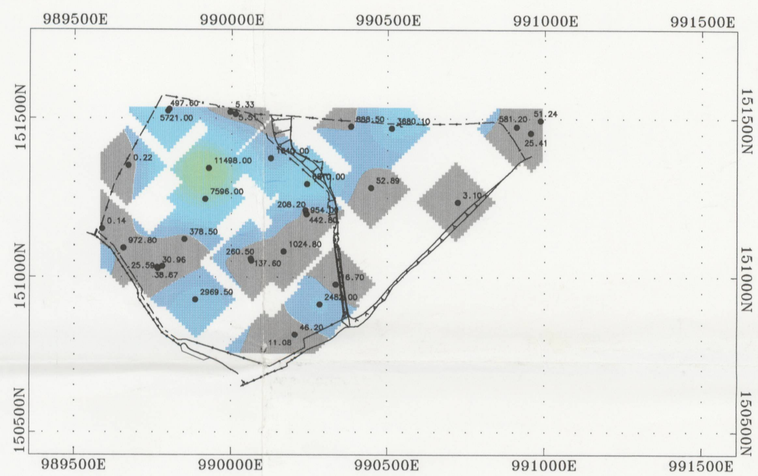

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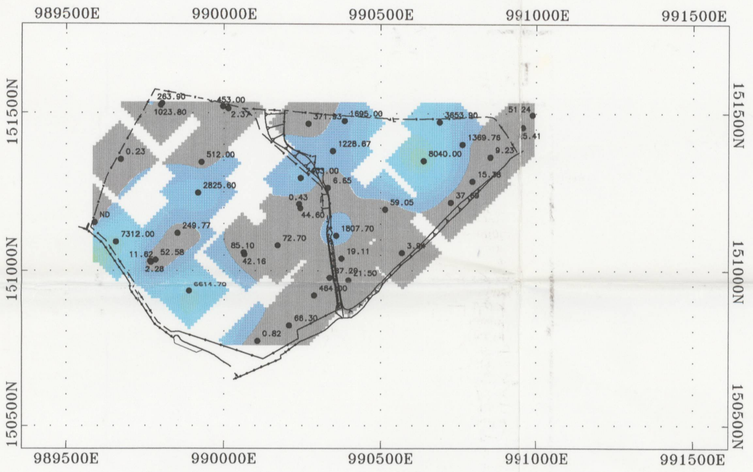

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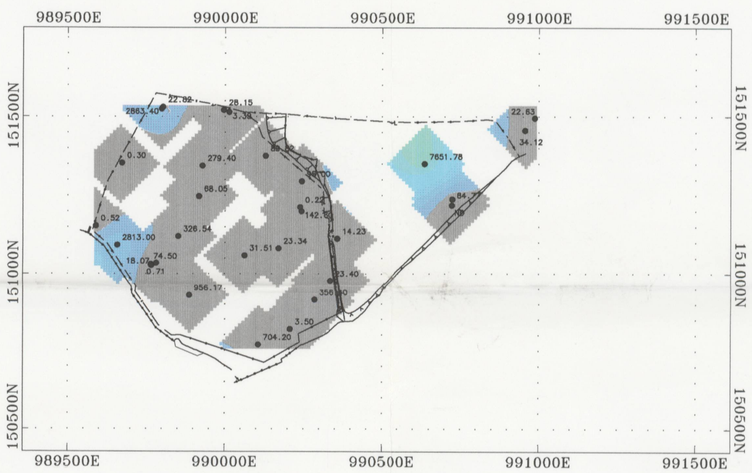

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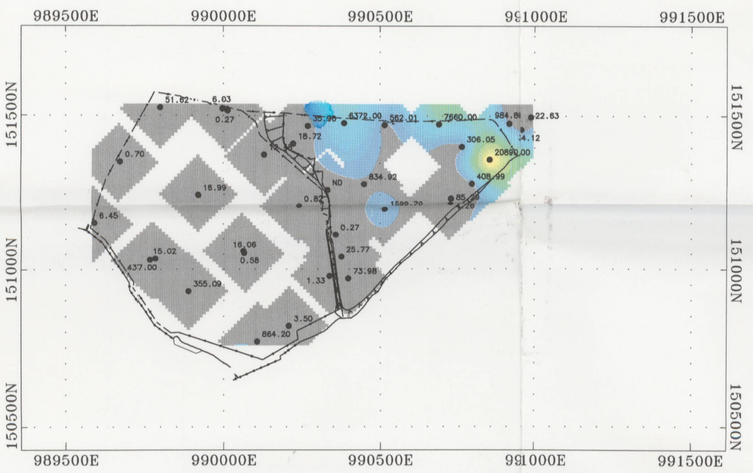

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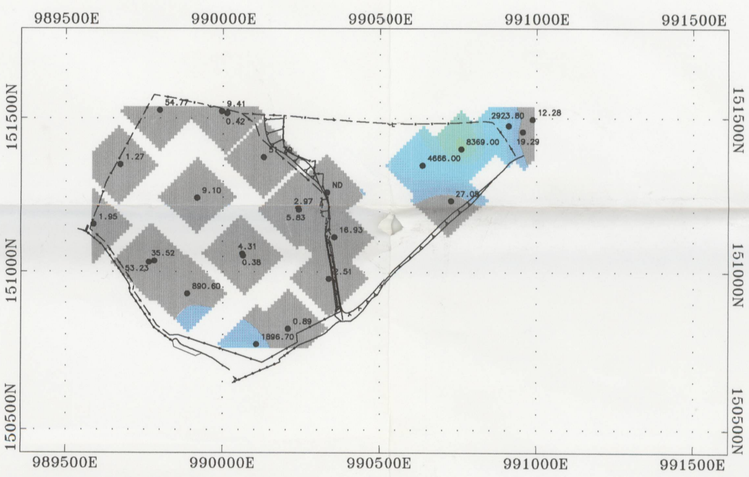


(12–14')

Legend

Total PAHs (mg/kg)

37000
36000
35000
34000
33000
32000
31000
30000
29000
28000
27000
26000
25000
24000
23000
22000
21000
20000
19000
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0

N

Sample Key

Indicates a detected concentration

3.20

ND

Not Detected in sample

Scale

250 0 250 500

(Feet)

Notes:

1) Based upon data collected during the Phase II (1993) through Phase VI (1996–97) investigations.

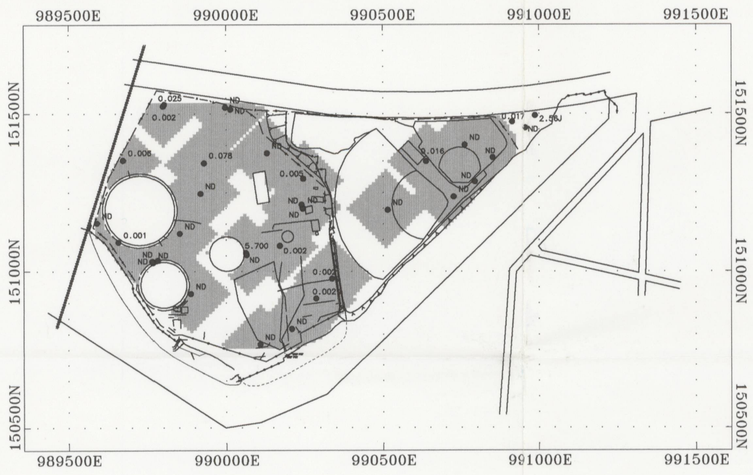
2) Due to subsurface conditions (i.e. poor recoveries), soils within boreholes BH–74 & BH–75 were collected in 4' increments. Data for these boreholes were included within each respective 2' interval for the purposes of contouring (e.g. 0–4' data was included within both the 0–2' and 2–4' intervals).

datafile: 0p, 2p, 4p, 6p, 8p, 10p, & 12p.xyz
gridfile: pah0m, pah2, pah4, pah6, pah8, pah10, & pah12
basemap: basemap.plt, pahout.plt, ftemp.plt
plotfile: pahout.p01 /dj0SO/daize
project: bv4083 Document Number: D5098

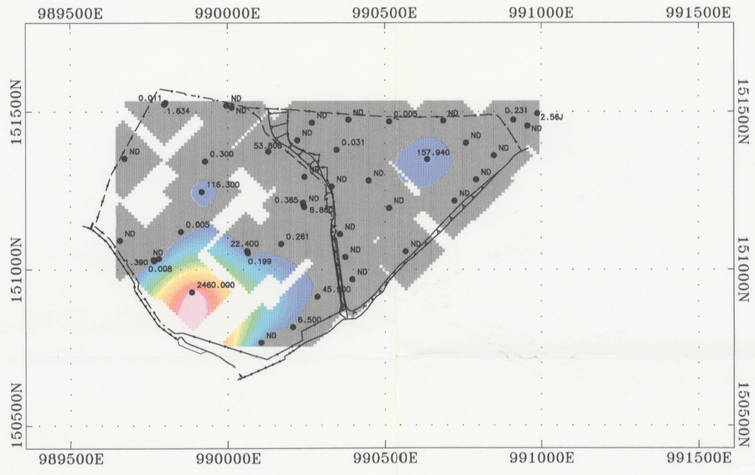
Figure 4–5

Total PAHs in Subsurface Soils
Brooklyn Borough Gas Works
Brooklyn, New York

ecology and environment, inc.



(0–2')



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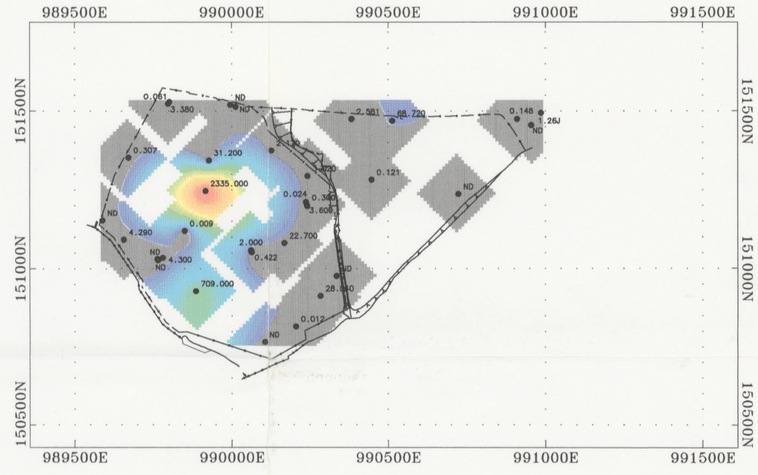

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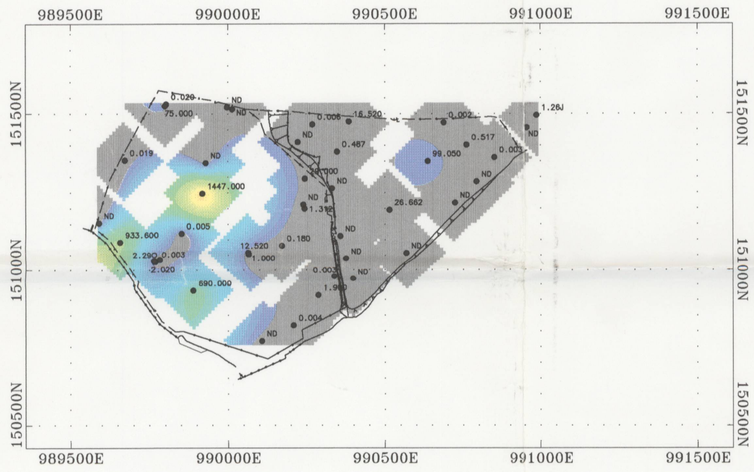

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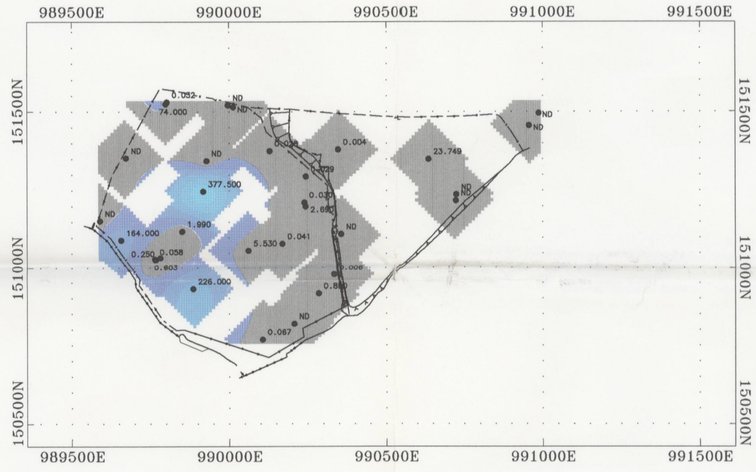
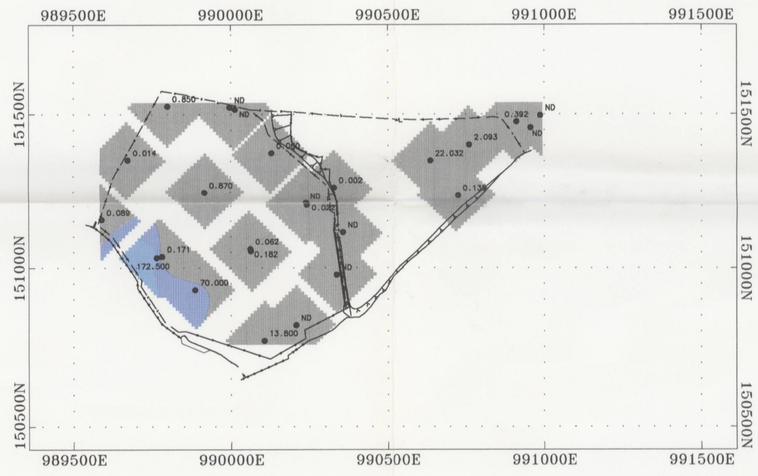


(8–10')

(10–12')



(12–14')

Legend

BTEX (mg/kg)

2378
2317
2256
2195
2134
2073
2012
1951
1890
1829
1768
1707
1646
1585
1524
1463
1402
1341
1280
1220
1159
1098
1037
976
915
854
793
732
671
610
549
488
427
366
305
244
183
122
61
0

Sample Key

Indicates a detected concentration

3.20

ND

Not Detected in sample

Scale

250 0 250 500

(Feet)

Notes:

1) Based upon data collected during the Phase II (1993) through Phase VI (1996–97) investigations.

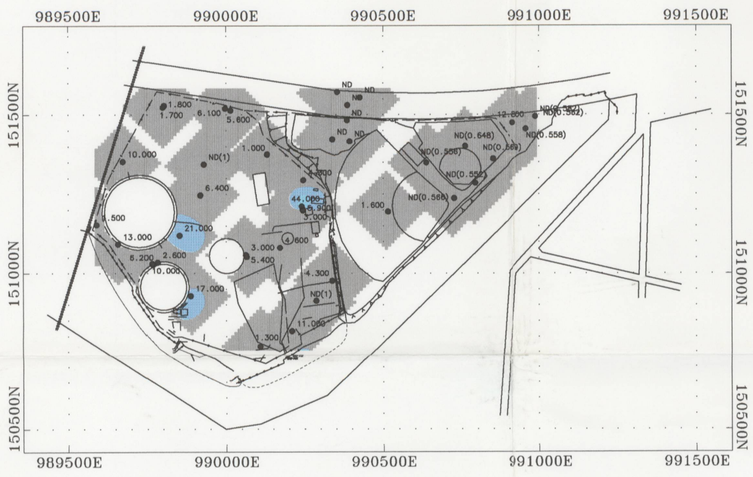
2) Due to subsurface conditions (i.e. poor recoveries), soils within boreholes BH–74 & BH–75 were collected in 4' increments. Data for these boreholes were included within each respective 2' interval for the purposes of contouring (e.g. 0–4' data was included within both the 0–2' and 2–4' intervals).

Figure 4–6

BTEX in Subsurface Soils
Brooklyn Borough Gas Works
Brooklyn, New York

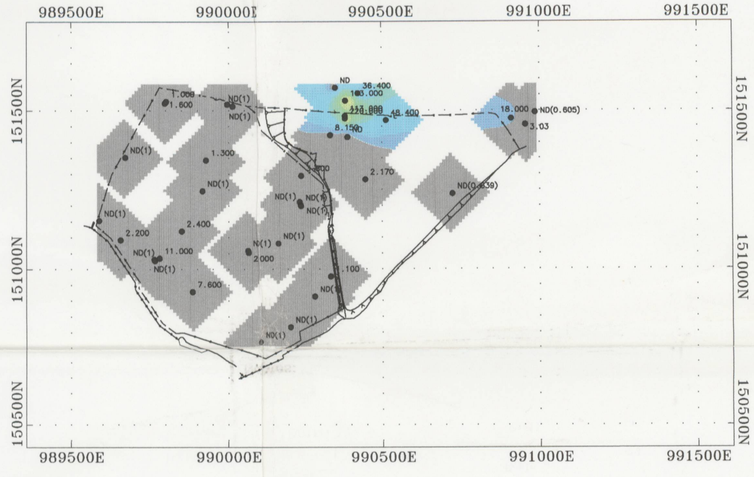
ecology and environment, inc.

datafile: bpan0, bpan2, bpan4, bpan6, bpan8, bpan10, & bpan12.xyz
gridfile: bpan2,bpan4,bpan6,bpan8,bpan10, & bpan12.grd
basemap: btexout.plt
plotfile: btexout.p01 /dj650/dsize
project: bv4093 Document Number 05098



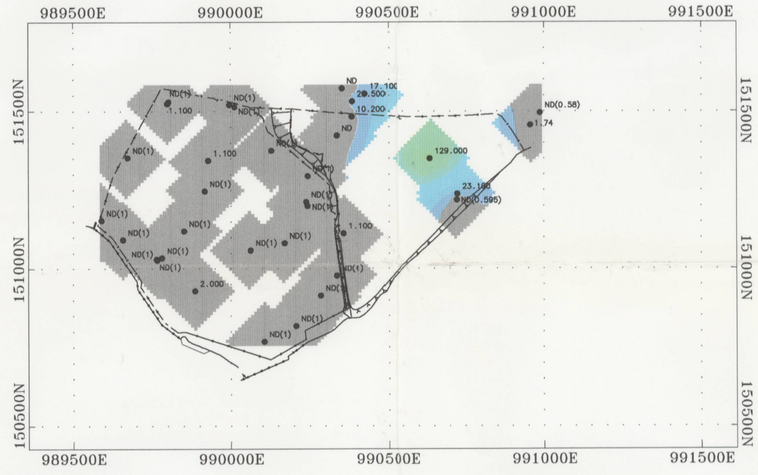
(0–2')

(2–4')

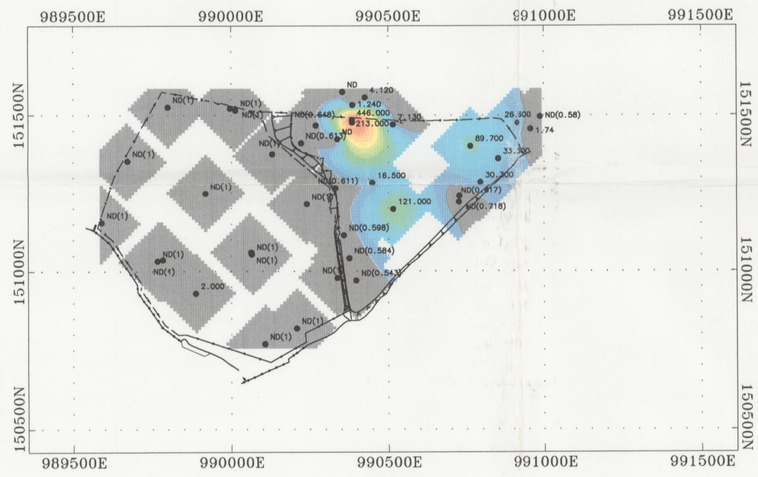


(4–6')

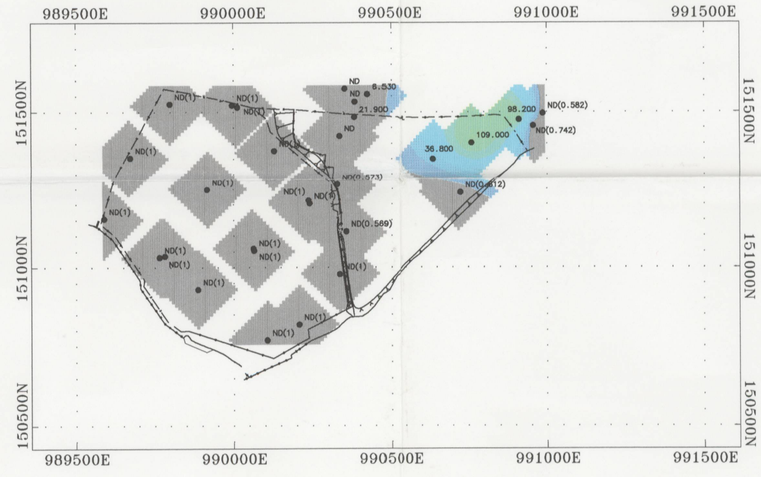
(6–8')



(8–10')



(10–12')



(12–14')

Legend

Total Cyanide (mg/kg)

420
405
390
375
360
345
330
315
300
285
270
255
240
225
210
195
180
165
150
135
120
105
90
75
60
45
30
15
0

Sample Key

Indicates a detected concentration

3.20

ND(0.62) — Detection Limit

Not Detected in sample

Scale

250 0 250 500

(Feet)

Notes:

1) Based upon data collected during the Phase II (1993) through Phase VI (1996–97) investigations.

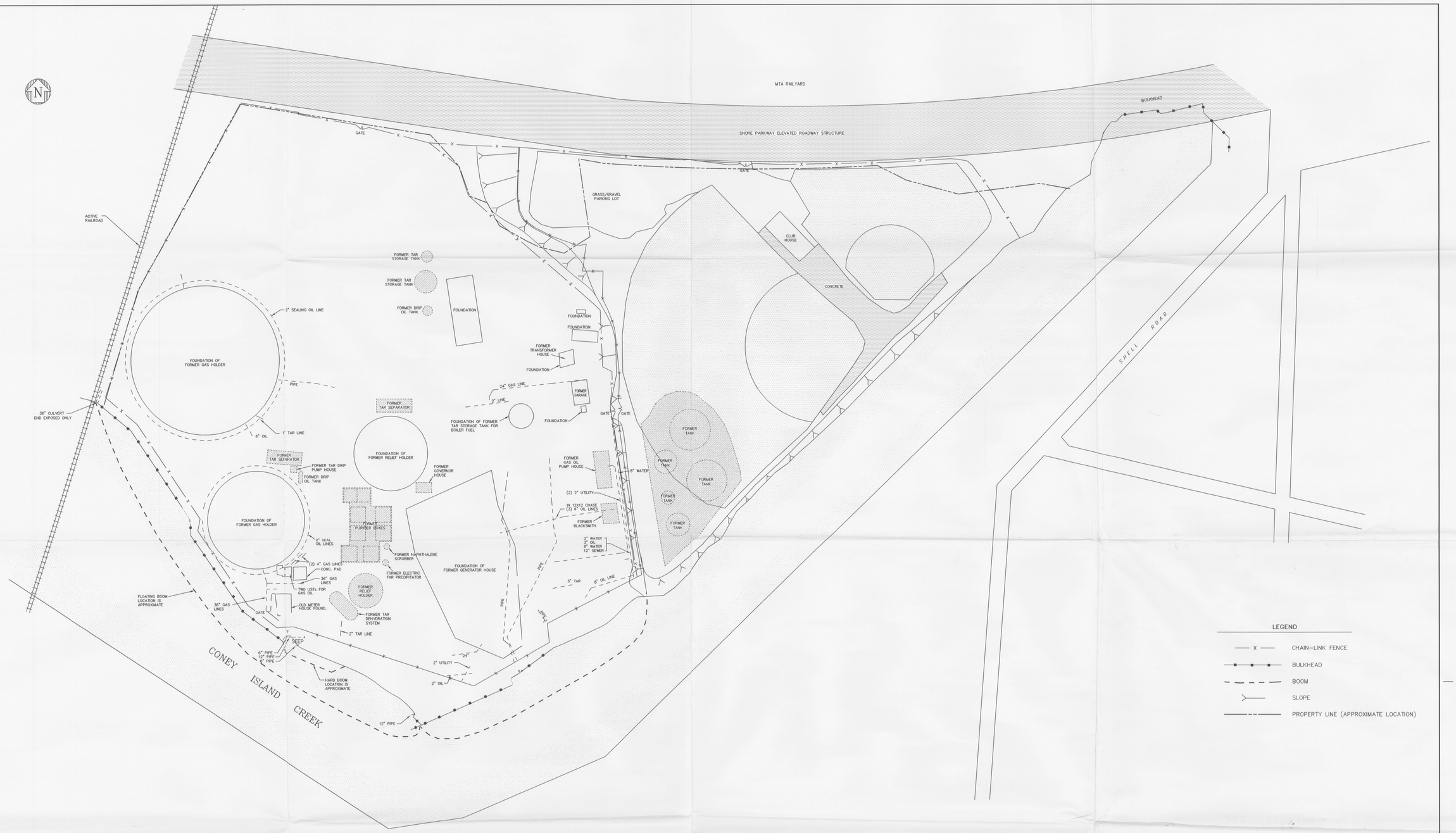
2) Due to subsurface conditions (i.e. poor recoveries), soils within boreholes BH–74 & BH–75 were collected in 4' increments. Data for these boreholes were included within each respective 2' interval for the purposes of contouring (e.g. 0–4' data was included within both the 0–2' and 2–4' intervals).

Figure 4–7

Total Cyanide in Subsurface Soils
Brooklyn Borough Gas Works
Brooklyn, New York

ecology and environment, inc.

datafile: cp0, cp2, cp4, cp6, cp8, cp10, & cp12
gridfile: cp0mt, cp2, cp4, cp6, cp8, cp10, & cp12
basemap: basemap.plt & cyanout.plt
plotfile: cyanout.p01 /g803/disire
project: bv4093 Document Number: D5098



NO.	DATE	DWN	APP'D	DESCRIPTION
REVISIONS				

ecology and environment, inc.
International Specialists in the Environment

DESIGNED BY	CHECKED BY
S. WALCK	J. BASTEDO
DRAWN BY	APPROVED BY
R. BIDELL	K. FRANTZEN

Figure 1-9
BASE MAP OF THE
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

SCALE	DATE ISSUED	C.A.D. FILE NO.	DRAWING NO.	REV.
1"=60'	02/28/97	BV5S301D	BV5000 —	

B:/FF Plotted 02/28/97

TABLE 4-3
DEEP GROUNDWATER DATA COLLECTED SINCE 1993
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

PARAMETER	UNITS:	DW01-NS 4/5/93	DW01-NS 7/19/93	DW01-NS 10/18/93	DW01-NS 11/7/96	DW02-DS 4/6/93	DW02-NS 4/6/93	DW02-NS 7/19/93	DW02-NS 10/18/93	DW02-NS 11/8/96	DW03-NS 4/5/93	DW03-DS 7/19/93	DW03-NS 7/19/93	DW03-DS 10/19/93	DW03-NS 10/19/93	DW03-NS 11/8/96	DW04-NS 4/8/93	DW04-DS 7/20/93	DW04-NS 7/20/93	DW04-NS 10/19/93	DW04-NS 11/7/96	DW04-NS 6/18/97	DW04-NSF 6/18/97	DW04-DS 6/18/97	DW04-DSF 6/18/97	PARAMETER
1-Methylnaphthalene	ug/L	ND	ND	ND		4 J	4.7 J	ND	ND		ND	53	58	14	13		12	170	170	3.1 J						1-Methylnaphthalene
2-Methylnaphthalene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.7 J	220	220	ND	ND					2-Methylnaphthalene
Acenaphthene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	97	130	150	94	92	60.6	4.1 J	170	170	21	ND	0.64 J		ND		Acenaphthene
Acenaphthylene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	31	65	36	ND	ND	ND	ND	ND	ND	ND	ND	0.75 J		1.4 J		Acenaphthylene
Anthracene	ug/L	ND	ND	ND	ND	0.4 J	0.42 J	ND	ND	ND	0.38 J	0.92 J	1.1	ND	ND	ND	1.5	ND	ND	0.45 J	ND	ND JU		0.089 J		Anthracene
Benzo(a)anthracene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND	ND	ND	ND	0.036		0.015 J		Benzo(a)anthracene
Benzo(a)pyrene	ug/L	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND J	ND J	ND	ND	ND	2.2	ND	ND	ND	ND	0.067 J		ND J		Benzo(a)pyrene
Benzo(b)fluoranthene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.57 J	ND	ND	ND	ND	0.057		ND		Benzo(b)fluoranthene
Benzo(ghi)perylene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1 J	ND	ND	ND	ND	0.14 B		ND J		Benzo(ghi)perylene
Benzo(k)fluoranthene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.6	ND	ND	ND	ND	0.018 J		ND		Benzo(k)fluoranthene
Chrysene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2	ND	ND	ND	ND	0.15		0.089 J		Chrysene
Dibenzo(a,h)anthracene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND JU		ND J		Dibenzo(a,h)anthracene
Fluoranthene	ug/L	ND	ND	ND	ND	1.2 J	1 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.8	ND	ND	ND	ND	0.14 J		0.14 J		Fluoranthene
Fluorene	ug/L	ND	ND	ND	ND	0.69 J	0.62 J	ND	ND	ND	3.4	5.2	6	3.7	3.4	ND	2.9	17 J	19 J	2.8	ND	0.086 BJ		0.096 BJ		Fluorene
Indeno(1,2,3-cd)pyrene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.82 J	ND	ND	ND	ND	0.053		ND		Indeno(1,2,3-cd)pyrene
Naphthalene	ug/L	ND	2.4 J	ND	ND	ND	ND	ND	ND	ND	7.8	52	57	ND	ND	ND	30	1800	1600	ND	4.91 J	1.3 BJ		1.9 BJ		Naphthalene
Phenanthrene	ug/L	ND	ND	ND	ND	1.1	1.3	ND	ND	ND	0.47 J	0.79 J	0.99 J	ND	ND	ND	6.9	ND	ND	2	ND	0.098 BJ		0.85		Phenanthrene
Pyrene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.2	ND	ND	ND	ND	0.25		0.3		Pyrene
1,1,1-Trichloroethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		1,1,2-Trichloroethane
1,1-Dichloroethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		1,1-Dichloroethane
1,1-Dichloroethene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		1,1-Dichloroethene
1,2-Dichloroethane	ug/L	7.8 B	ND	ND	ND	9.7 B	12 B	2 B	ND	ND	7.3 B	ND	ND	ND	ND	ND	40	ND	ND	ND	ND	ND		ND		1,2-Dichloroethane
1,2-Dichloroethene (total)	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	19	20	11	9.2	2.93 J	ND	750	690	31	ND	ND		1.98 J		1,2-Dichloroethene (total)
1,2-Dichloropropane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		1,2-Dichloropropane
2-Butanone	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		2-Butanone
2-Chloroethylvinyl ether	ug/L	ND	ND	ND		ND	ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND		ND		2-Chloroethylvinyl ether
2-Hexanone	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		2-Hexanone
4-Methyl-2-pentanone	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		4-Methyl-2-pentanone
Acetone	ug/L	14 B	ND	ND	ND	27 B	21 B	ND	ND	ND	17 B	5.8 B	3.7 B	ND	ND	ND	60 B	ND	ND	ND	ND	ND		ND		Acetone
Benzene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	19	20	11	9.2	2.93 J	ND	750	690	31	ND	ND		1.98 J		Benzene
Bromodichloromethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Bromodichloromethane
Bromoform	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Bromoform
Bromomethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Bromomethane
Carbon disulfide	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.9 A	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Carbon disulfide
Carbon tetrachloride	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Carbon tetrachloride
Chlorobenzene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Chlorobenzene
Chloroethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Chloroethane
Chloroform	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Chloroform
Chloromethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Chloromethane
cis-1,3-Dichloropropene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		cis-1,3-Dichloropropene
Dibromochloromethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Dibromochloromethane
Ethylbenzene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.8 J	69	73	4.3 J	2.3 J	ND	14	2200	2000	290 J	1.29 J	1.54 J		28.7 J		Ethylbenzene
Methylene chloride	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.7 B	7.5 B	ND	ND	ND	3 J	30 B	21 B	ND	ND	ND		ND		Methylene chloride
Styrene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Styrene
Tetrachloroethene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Tetrachloroethene
Toluene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.6 B	2.1 B	ND	ND	ND	12	3800	3600 J	340 J	ND	ND		ND		Toluene
Total xylenes	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	4 J	21	23	ND	ND	ND	13	2500 B	2400	330 J	2.05 J	6.47 J		38.6 J		Total xylenes
Trans-1,3-dichloropropene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Trans-1,3-dichloropropene
Trichloroethene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Trichloroethene
Vinyl acetate	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Vinyl acetate
Vinyl chloride	ug/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND		ND		Vinyl chloride
1,2,4-Trichlorobenzene	ug/L				ND					ND						ND					ND					1,2,4-Trichlorobenzene
1,2-Diclorobenzene	ug/L				ND					ND						ND					ND					1,2-Diclorobenzene
1,3-Diclorobenzene	ug/L				ND					ND						ND					ND					1,3-Diclorobenzene
1,4-Diclorobenzene	ug/L				ND					ND						ND					ND					1,4-Diclorobenzene
2,2'-oxybis(1-Chloropropane)	ug/L				ND					ND						ND					ND					2,2'-oxybis(1-Chloropropane)
2,4,5-Trichlorophenol	ug/L				ND					ND						ND					ND L					2,4,5-Trichlorophenol
2,4,6-Trichlorophenol	ug/L				ND					ND						ND					ND L					2,4,6-Trichlorophenol
2,4-Dichlorophenol	ug/L				ND					ND						ND					ND L					2,4-Dichlorophenol
2,4-Dimethylphenol	ug/L				ND					ND						ND					ND L					2,4-Dimethylphenol
2,4-Dinitrophenol	ug/L				ND					ND						ND					ND L					2,4-Dinitrophenol
2,4-Dinitrotoluene	ug/L				ND					ND						ND					ND					2,4-Dinitrotoluene
2,6-Dinitrotoluene	ug/L				ND					ND						ND					ND					2,6-Dinitrotoluene
2-Chloronaphthalene	ug/L				ND					ND						ND					ND					2-Chloronaphthalene
2-Chlorophenol	ug/L				ND					ND						ND					ND L					2-Chlorophenol
2-Methylphenol	ug/L				ND					ND						ND					ND L					2-Methylphenol
2-Nitroaniline	ug/L				ND					ND						ND					ND					2-Nitroaniline
2-Nitrophenol	ug/L				ND					ND						ND					ND L					2-Nitrophenol
3,3'-Dichlorobenzidine	ug/L				ND					ND						ND					ND					3,3'-Dichlorobenzidine
3-Nitroaniline	ug/L				ND					ND						ND					ND					3-Nitroaniline
4,6-Dinitro-2-methylphenol	ug/L				ND					ND						ND					ND L					4,6-Dinitro-2-methylphenol
4-Bromophenylphenylether	ug/L				ND					ND						ND					ND					4-Bromophenylphenylether
4-Chloro-3-methylphenol	ug/L				ND					ND						ND					ND L					4-Chloro-3-methylphenol
4-Chloroaniline	ug/L				ND					ND						ND					ND					4-Chloroaniline
4-Chlorophenylphenylether	ug/L				ND					ND						ND					ND					4-Chlorophenylphenylether
4-Methylphenol	ug/L				ND					ND						ND					ND L					4-Methylphenol
4-Nitroaniline	ug/L				ND					ND						ND					ND					4-Nitroaniline
4-Nitrophenol	ug/L				ND					ND						ND					ND L					4-Nitrophenol
Benzoic acid	ug/L				ND					ND						ND					ND L					Benzoic acid
Benzyl alcohol	ug/L				ND					ND						ND					ND					Benzyl alcohol
bis(2-Chloroethoxy)methane	ug/L				ND					ND						ND					ND					bis(2-Chloroethoxy)methane
bis(2-Chloroethyl)ether	ug/L				ND					ND						ND					ND					bis(2-Chloroethyl)ether
bis(2-Ethylhexyl)phthalate	ug/L				3.86 J					ND						ND					ND					bis(2-Ethylhexyl)phthalate
Butylbenzylphthalate	ug/L				ND					ND						ND					ND					Butylbenzylphthalate
di-n-Butylphthalate	ug/L				ND					ND						ND					ND					di-n-Butylphthalate
di-n-Octylphthalate	ug/L				ND					ND						ND					ND					di-n-Octylphthalate
Dibenzofuran	ug/L				ND					ND						ND					ND					Dibenzofuran
Diethylphthalate	ug/L				ND					ND						ND					ND					Diethylphthalate
Dimethylphthalate	ug/L				ND					ND						ND					ND					Dimethylphthalate
Hexachlorobenzene	ug/L				ND					ND						ND					ND					Hexachlorobenzene
Hexachlorobutadiene	ug/L				ND					ND						ND					ND					Hexachlorobutadiene
Hexachlorocyclopentadiene	ug/L				ND					ND						ND					ND					Hexachlorocyclopentadiene
Hexachloroethane	ug/L				ND					ND						ND					ND					Hexachloroethane
Isophorone	ug/L				ND					ND						ND					ND					Isophorone
n-Nitroso-di-n-propylamine	ug/L				ND					ND						ND					ND					n-Nitroso-di-n-propylamine
n-Nitrosodiphenylamine	ug/L				ND					ND						ND					ND					n-Nitrosodiphenylamine
Nitrobenzene	ug/L				ND					ND						ND					ND					Nitrobenzene
Pentachlorophenol	ug/L				ND					ND						ND					ND UL					Pentachlorophenol
Phenol	ug/L				10.8					ND						ND					ND L					Phenol
4,4'-DDD	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		4,4'-DDD
4,4'-DDE	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		4,4'-DDE
4,4'-DDT	ug/L		ND	ND J	ND L			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND L	ND		ND J		4,4'-DDT
Aldrin	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Aldrin
Alpha-BHC	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	0.02	ND		ND	ND	ND	ND	ND		ND J		Alpha-BHC
Beta-BHC	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Beta-BHC
Chlordane	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Chlordane
Delta-BHC	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Delta-BHC
Dieldrin	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Dieldrin
Endosulfan I	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Endosulfan I
Endosulfan II	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Endosulfan II
Endosulfan sulfate	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Endosulfan sulfate
Endrin	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Endrin
Endrin aldehyde	ug/L		ND	ND J				ND	ND			ND	ND	ND	ND			ND	ND	ND	ND					Endrin aldehyde
gamma-BHC (Lindane)	ug/L		ND	0.03 J	ND			0.56	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		gamma-BHC (Lindane)
Heptachlor	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Heptachlor
Heptachlor epoxide	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Heptachlor epoxide
Methoxychlor	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Methoxychlor
PCB-1016	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		PCB-1016
PCB-1221	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		PCB-1221
PCB-1232	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		PCB-1232
PCB-1242	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		PCB-1242
PCB-1248	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		PCB-1248
PCB-1254	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		PCB-1254
PCB-1260	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		PCB-1260
Toxaphene	ug/L		ND	ND J	ND			ND	ND	ND		ND	ND	ND	ND	ND		ND	ND	ND	ND	ND		ND J		Toxaphene
Antimony	ug/L	ND	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	Antimony
Arsenic	ug/L	16	ND	8.9 J	ND	ND	ND	ND	6 J	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND	6.9	ND	ND	ND	ND	Arsenic
Beryllium	ug/L	ND	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Beryllium
Chromium	ug/L	150	86	110 J	13.5	24	29	24	90 J	24 J	20	64	57	92	89	15.9 J	49	17	14	11 B	ND	ND	ND	ND	ND	Chromium
Copper	ug/L	440	120	270 J	22.5	25	23	ND	110 J	ND	ND	38	42	56	59	ND	68	ND	ND	ND	ND	38.4	ND	28.7	ND	Copper
Lead	ug/L	150	60	110 J	ND	10	9.1	12	50 J	ND	6.2	24	32	34	39	ND	95	190	150	7.4	6	79.8 J	35	45.1 J	25.7	Lead
Magnesium	ug/L	74000	55000	56000 J	8050	58000	57000	48000	69000 J	48400	72000	82000	82000	80000	83000	48500	760000	250000	400000	550000	888000	548000	629000	588000	628000	Magnesium
Manganese	ug/L	530	280	270 J	14.5	92	94	46	140 J	36.1 J	62	310	350	410	420	36.5 J	4600	1000	2000	4300	3740	1510	1490	1600	1540	Manganese
Mercury	ug/L	ND	ND J	ND J	ND	ND	ND	ND J	ND J	ND	ND	ND J	ND J	ND	ND	ND	0.39			ND	ND	ND	ND	ND	ND	Mercury
Nickel	ug/L	440	190	220 J	ND	41	40	ND	130 J	ND	ND	94	100	150	150	25.5	49	ND	ND	ND	ND	ND	ND	ND	ND	Nickel
Selenium	ug/L	ND	ND J	ND J	ND	ND	ND	ND J	ND J	ND	ND	ND J	ND J	ND	ND	ND	ND	ND	ND	ND	ND	11.8	16.8	18.7	20.2	Selenium
Zinc	ug/L	280	470	190 J	327	30	29	160	110 J	11.5 J	24	100	120	270	430	20.6 J	190	240	200	70 B	12.2	22.5	15.5	ND	13.2	Zinc
Cyanide-Amenable	mg/L														0.02	0.02						ND	0.019	0.12	0.019	Cyanide-Amenable
Cyanide-Total	mg/L			0.14					1											ND		0.064	0.072	0.69	0.081	Cyanide-Total
Chloride	mg/L	160	140	92	34.3	150	160	140	140	232	300	260	260	280	290	356	17000	11000	9400	17000	15700	13800		13300		Chloride
Hardness	mg/L	430	390	410	57.1	440	430	440	430	362	630	660	630	640	640	446	6500	3000	3600	5100	985	4060	3950	4070	3890	Hardness
Residue-TDS	mg/L	880	890	790	327	930	990	1000	1100	ND	1300	1400	1400	1300	1300	1280	30000	20000	17000	29000	27800	25600		26600		Residue-TDS
TRPH	mg/L	ND	ND	ND J	ND	ND	ND	ND	ND J	ND	ND	ND	ND	ND J	ND J	2.92	ND	2.6	2.9	ND	ND	ND		ND		TRPH

Key:
F - Filtered Sample
B = Reported result is considered as not detected because of presence in field or laboratory blanks. Reported result may be considered as an elevated quantitation limit;
C = There is presumptive evidence leading to identification of the analyte, and the analyte was confirmed by further GC/MS analysis;
EJ = Reported result exceeds the calibration limit for the analysis and is considered an estimated value.
J = Reported result is qualitatively accurate, but quantitatively imprecise, and is considered an estimated value. The data should be seriously considered for decision-making and are usable for many purposes;
K = Reported result is qualitatively accurate, but quantitatively biased high. The data should be seriously considered for decision-making and are usable for many purposes;
L = Reported result is qualitatively accurate, but quantitatively biased low. The data should be seriously considered for decision-making and are usable for many purposes;
N = There is presumptive evidence leading to identification of the analyte, but the analyte was not confirmed by further gas chromatography/mass spectrometry (GC/MS) analysis;
NA = Not analyzed;
ND = Analyte was not detected; the reported value is the quantitation limit adjusted for sample weight/sample volume, extraction volume, percent solids, and sample dilution;
R = Reported result or quantitation limit is rejected and unusable for all purposes. The analyte was analyzed for, but the presence of the analyte has not been verified;
UJ = Quantitation limit is an estimated value because of a variance from quality control limits;
UK = Quantitation limit is biased high because of a result above quality control limits; and
UL = Quantitation limit is biased low because of a result below quality control limits.

TABLE 4-2
SHALLOW GROUNDWATER DATA COLLECTED SINCE 1993
BROOKLYN BOROUGH GAS WORKS
BROOKLYN, NEW YORK

WELL:		MW-01				MW-02						MW-03			
SAMPLE ID:		MW01-NS	MW01-NS	MW01-NS	MW01-NS	MW02-NS	MW02-NS	MW02-NS	MW02-NS	MW02-NS	MW02-NS-F	MW03-NS	MW03-NS	MW03-NS	MW03-NS
DATE:		4/1/93	7/19/93	10/17/93	11/8/96	4/1/93	7/19/93	10/18/93	11/8/96	6/19/97	6/19/97	4/1/93	7/19/93	10/18/93	11/8/96
PARAMETER	UNITS:														
1-Methylnaphthalene	ug/L	ND	ND	ND		87	ND	7.8				190	330	270	
2-Methylnaphthalene	ug/L	ND	ND	ND	ND	89	ND	2.9 J	ND			150	460	120	37.7 J
Acenaphthene	ug/L	ND	ND	ND	ND	38	ND	13	5.83 J			200	220	190	15.8 J
Acenaphthylene	ug/L	ND	ND	ND	ND	100	10	5.9	ND			ND	280	300	ND
Anthracene	ug/L	ND	ND	ND	ND	1.8	5.7	0.75 J	ND			5.9	15	6	ND
Benzo(a)anthracene	ug/L	ND	ND	0.75 J	ND	ND	9.6	ND	ND			0.55 J	9.6	3.2 J	ND
Benzo(a)pyrene	ug/L	ND	ND J	0.76 J	ND	ND	8.4 J	ND	ND			ND	4.6 J	ND	ND
Benzo(b)fluoranthene	ug/L	ND	ND	ND	ND	ND	6.9	ND	ND			ND	4.5 J	ND	ND
Benzo(ghi)perylene	ug/L	ND	ND	ND	ND	ND	5.9 J	ND	ND			ND	ND	ND	ND
Benzo(k)fluoranthene	ug/L	ND	ND	ND	ND	ND	6.3	ND	ND			ND	ND	ND	ND
Chrysene	ug/L	ND	ND	0.9 J	ND	ND	7.2	ND	ND			0.73 J	14	ND	ND
Dibenzo(a,h)anthracene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Fluoranthene	ug/L	ND	ND	ND	ND	2.7	19	1.7 J	ND			5.3	42	10 J	ND
Fluorene	ug/L	ND	ND	ND	ND	18	7.9	3.2	ND			39	42	28	ND
Indeno(1,2,3-cd)pyrene	ug/L	ND	ND	0.53 J	ND	ND	4.2 J	ND	ND			ND	ND	ND	ND
Naphthalene	ug/L	ND	ND	ND	ND	150	ND	ND	ND			940 X	2700 J	110	624
Phenanthrene	ug/L	ND	ND	1.1	ND	9.5	14	2.2	ND			28	40	22	ND
Pyrene	ug/L	ND	ND	1.9 J	ND	ND	11 J	ND	ND			ND	40	6.5 J	ND
1,1,1-Trichloroethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
1,1,2-Trichloroethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
1,1-Dichloroethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
1,1-Dichloroethene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
1,2-Dichloroethane	ug/L	9.3 B	ND	ND	ND	7.7 B	ND	ND	ND			ND	ND	ND	ND
1,2-Dichloroethene (total)	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
1,2-Dichloropropane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
2-Butanone	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
2-Chloroethylvinyl ether	ug/L	ND	ND	ND		ND	ND	ND				ND	ND	ND	
2-Hexanone	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
4-Methyl-2-pentanone	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Acetone	ug/L	38 B	5.2 B	ND	ND	31 B	ND	ND	ND			100 B	33 B	ND	ND
Benzene	ug/L	ND	ND	ND	ND	8.6	10	15	7.05			210	1500	680	240
Bromodichloromethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Bromoform	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Bromomethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Carbon disulfide	ug/L	ND	4.1 J	ND	ND	ND	10 A	ND	ND			ND	14 J	ND	ND
Carbon tetrachloride	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Chlorobenzene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Chloroethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Chloroform	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Chloromethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
cis-1,3-Dichloropropene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Dibromochloromethane	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Ethylbenzene	ug/L	ND	ND	ND	ND	7.8	ND	1.7 J	ND			240	2900 J	1900	247
Methylene chloride	ug/L	ND	6.9 B	ND	ND	ND	6.2 B	ND	ND			ND	180 B	ND	ND
Styrene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Tetrachloroethene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Toluene	ug/L	ND	ND	ND	ND	3.6 J	ND	ND	ND			33 J	4000 J	2100	85.1
Total xylenes	ug/L	ND	ND	ND	ND	22	1.2 B	2.5 J	1.08 J			23 J	3800 J	3500	210
Trans-1,3-dichloropropene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Trichloroethene	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Vinyl acetate	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
Vinyl chloride	ug/L	ND	ND	ND	ND	ND	ND	ND	ND			ND	ND	ND	ND
1,2,4-Trichlorobenzene	ug/L				ND				ND						ND
1,2-Diclorobenzene	ug/L				ND				ND						ND
1,3-Diclorobenzene	ug/L				ND				ND						ND
1,4-Diclorobenzene	ug/L				ND				ND						ND
2,2'-oxybis(1-Chloropropane)	ug/L				ND				ND						ND
2,4,5-Trichlorophenol	ug/L				ND				ND						ND
2,4,6-Trichlorophenol	ug/L				ND				ND						ND
2,4-Dichlorophenol	ug/L				ND				ND						ND
2,4-Dimethylphenol	ug/L				ND				ND						ND
2,4-Dinitrophenol	ug/L				ND				ND						ND
2,4-Dinitrotoluene	ug/L				ND				ND						ND
2,6-Dinitrotoluene	ug/L				ND				ND						ND
2-Chloronaphthalene	ug/L				ND				ND						ND
2-Chlorophenol	ug/L				ND				ND						ND
2-Methylphenol	ug/L				ND				ND						ND
2-Nitroaniline	ug/L				ND				ND						ND
2-Nitrophenol	ug/L				ND				ND						ND
3,3'-Dichlorobenzidine	ug/L				ND				ND						ND
3-Nitroaniline	ug/L				ND				ND						ND
4,6-Dinitro-2-methylphenol	ug/L				ND				ND						ND
4-Bromophenylphenylether	ug/L				ND				ND						ND
4-Chloro-3-methylphenol	ug/L				ND				ND						ND
4-Chloroaniline	ug/L				ND				ND						ND
4-Chlorophenylphenylether	ug/L				ND				ND						ND
4-Methylphenol	ug/L				ND				ND						ND
4-Nitroaniline	ug/L				ND				ND						ND
4-Nitrophenol	ug/L				ND				ND						ND
Benzoic acid	ug/L				ND				ND						ND
Benzyl alcohol	ug/L				ND				ND						ND
bis(2-Chloroethoxy)methane	ug/L				ND				ND						ND
bis(2-Chloroethyl)ether	ug/L				ND				ND						ND
bis(2-Ethylhexyl)phthalate	ug/L				ND				ND						ND
Butylbenzylphthalate	ug/L				ND				ND						ND
di-n-Butylphthalate	ug/L				ND				ND						ND
di-n-Octylphthalate	ug/L				ND				ND						ND
Dibenzofuran	ug/L				ND				ND						ND
Diethylphthalate	ug/L				ND				ND						ND
Dimethylphthalate	ug/L				ND				ND						ND
Hexachlorobenzene	ug/L				ND				ND						ND
Hexachlorobutadiene	ug/L				ND				ND						ND
Hexachlorocyclopentadiene	ug/L				ND				ND						ND
Hexachloroethane	ug/L				ND				ND						ND
Isophorone	ug/L				ND				ND						ND
n-Nitroso-di-n-propylamine	ug/L				ND				ND						ND
n-Nitrosodiphenylamine	ug/L				ND				ND						ND
Nitrobenzene	ug/L				ND				ND						ND
Pentachlorophenol	ug/L				ND				ND						ND
Phenol	ug/L				ND				ND						ND
4,4'-DDD	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
4,4'-DDE	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
4,4'-DDT	ug/L		ND	ND	ND L		ND	ND J	ND				ND	ND J	ND
Aldrin	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Alpha-BHC	ug/L		ND	ND	ND		ND	0.12 J	ND				ND	ND J	ND
Beta-BHC	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Chlordane	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Delta-BHC	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Dieldrin	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Endosulfan I	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Endosulfan II	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Endosulfan sulfate	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Endrin	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Endrin aldehyde	ug/L		ND	ND			ND	ND J					ND	ND J	
gamma-BHC (Lindane)	ug/L		ND	ND	ND		ND	0.05 J	ND				ND	ND J	ND
Heptachlor	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Heptachlor epoxide	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Methoxychlor	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
PCB-1016	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
PCB-1221	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
PCB-1232	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
PCB-1242	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
PCB-1248	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
PCB-1254	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
PCB-1260	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Toxaphene	ug/L		ND	ND	ND		ND	ND J	ND				ND	ND J	ND
Antimony	ug/L	ND J	ND	ND J	ND	ND J	ND	ND J	ND			ND J	ND	ND J	ND
Arsenic	ug/L	5.5	8.6	14 J	11.1	37	ND	ND J	ND			88	ND	17 J	5.8 B
Beryllium	ug/L	ND	ND	ND J	ND	ND	ND	ND J	ND			ND	ND	ND J	ND
Chromium	ug/L	28	ND	18	ND	120	40	ND J	ND			310	72	46	13.6 J
Copper	ug/L	34	ND	30 J	ND	350	160	68 J	ND			170	43	32 J	ND
Lead	ug/L	62	23	81 J	ND	1100	550	240 J	8.3			160	25	20 J	ND
Magnesium	ug/L	26000	43000	26000 J	21800	75000	59000	73000 J	27700			80000	35000	38000 J	45700
Manganese	ug/L	310	290	160 J	1130	1400	780	730 J	393 J			3900	1200	1400 J	1300 J
Mercury	ug/L	ND	ND J	ND J	ND	1.2	0.49 J	ND J	ND			ND	ND J	ND J	ND
Nickel	ug/L	50	ND	28 J	ND	130	62	ND J	ND			550	99	53 J	ND
Selenium	ug/L	ND J	ND J	ND J	ND	ND J	ND J	ND J	5.8 B			ND J	ND J	ND J	ND
Zinc	ug/L	160	190	1000 J	343	2700	1200	530 J	21.6 J			440	140	220 J	176 J
Chloride	mg/L	2000	900	270	197	1400	1100	1100	140			930	500	520	632
Hardness	mg/L	510	550	340	453	830	750	820	343			590	340	420	1390
Residue-TDS	mg/L	3200	2100	1000	834	2500	2500	2500	662			2000	1300	1400	1840
TRPH	mg/L	ND	ND	ND J	ND	ND	1.3 J	ND J	ND			3.4	2.5	1.9 J	ND
Cyanide-Amenable	mg/L									0.048	0.065				
Cyanide-Total	mg/L			0.04				16		0.318	0.309			21	

Key:
F - Filtered Sample
B = Reported result is considered as not detected because of presence in field or laboratory blanks. Reported result may be considered as an elevated quantitation limit;
C = There is presumptive evidence leading to identification of the analyte, and the analyte was confirmed by further GC/MS analysis;
EJ = Reported result exceeds the calibration limit for the analysis and is considered an estimated value.
J = Reported result is qualitatively accurate, but quantitatively imprecise, and is considered an estimated value. The data should be seriously considered for decision-making and are usable for many purposes;
K = Reported result is qualitatively accurate, but quantitatively biased high. The data should be seriously considered for decision-making and are usable for many purposes;
L = Reported result is qualitatively accurate, but quantitatively biased low. The data should be seriously considered for decision-making and are usable for many purposes;
N = There is presumptive evidence leading to identification of the analyte, but the analyte was not confirmed by further gas chromatography/mass spectrometry (GC/MS) analysis;
NA = Not analyzed;
ND = Analyte was not detected; the reported value is the quantitation limit adjusted for sample weight/sample volume, extraction volume, percent solids, and sample dilution;
R = Reported result or quantitation limit is rejected and unusable for all purposes. The analyte was analyzed for, but the presence of the analyte has not been verified;
UJ = Quantitation limit is an estimated value because of a variance from quality control limits;
UK = Quantitation limit is biased high because of a result above quality control limits; and
UL = Quantitation limit is biased low because of a result below quality control limits.