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FINAL ~~Draft~~ Remedial Investigation Report
Volume I

Pfohl Brothers Landfill

Cheektowaga, New York
Site Number 9-15-043

Prepared For:

New York State
Department Of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Thomas C. Jorling
Commissioner

Division Of Hazardous Waste Remediation

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EXECUTIVE SUMMARY

The Pfohl Brothers site is a 120-acre inactive landfill that was formerly used for the disposal of municipal and industrial wastes, including hazardous wastes. It is located in the Town of Cheektowaga, northeast of the Buffalo International Airport in Erie County, New York. The landfill has been classified by New York State Department of Environmental Conservation (NYSDEC) as a Class 2 site, indicating there is a significant threat to human health or the environment and remedial action is required.

The landfill was operated by the Pfohl family from 1932 to 1971. The quantity of waste material and nature of all of the wastes disposed of at the site are unknown; however, in addition to municipal waste, industrial wastes such as phenolic tars, waste solvents, paints, thinners, pine tar pitch, and rubber and scrap metal are known to have been deposited within the landfill. There is also documentation that the landfill accepted sludges, capacitors with polychlorinated biphenyls (PCBs), and phenol tars with chlorinated benzenes and dioxins.

The site first came under investigation in June 1982 when the United States Environmental Protection Agency (EPA) contracted Fred C. Hart Associates to perform a hazardous ranking of the site. This investigation revealed the presence of benzene, chlorinated benzenes and nitrogen compounds in water samples from a spring flowing into a drainage ditch along the south side of Aero Lake. In February 1984, the property owner's law firm commissioned Ecology and Environment Inc. to perform an additional investigation of the site. This investigation revealed elevated levels of barium in a leachate seep sample. Polycyclic aromatic hydrocarbons (PAHs), phenols, and elevated concentrations of nickel were detected in the soils. The shallow ground water revealed elevated concentrations of barium, lead, chromium, and cadmium. In November 1986, the New York State Department of Health (NYSDOH) analyzed samples of leachate, soil and waste from surface drums containing a tar-like material. The drums revealed elevated levels of PAHs. Soil samples collected south of Aero Lake revealed PCBs, as well as elevated concentrations of arsenic, barium, cadmium, chromium, lead, and mercury.

For purposes of this investigation, the landfill has been divided into three geographical areas. These are areas A, B, and C.

Area A, located north of the New York State Thruway access ramp, is occupied by a private trucking firm that has placed fill material over a large portion of the area to elevate the land surface. A large metal building is located north of the access ramp along with a number of tractors and trailers.

Area B, located south of Area A, is situated between Transit Road and Aero Drive. This portion of the site consists of undulating terrain with thick underbrush, phragmite weeds and thorny-stemmed bushes. Small secondary growth trees are present. The area is littered with bottles, household refuse, tires, tubing, scrap metal, refrigerators, constr'uction materials and rusted sections of car bodies. Several drum disposal areas exist, in which many of the drums are rusted, corroded, and crushed. During the early spring, leachate seeps appear along the perimeter of the landfill. These seeps range from red to brownish-orange in color. Many seeps also have a sheen that is most likely attributable to oil and metals. Oil slicks have been noted on the water surface in the wetland area parallel to Aero Drive near the intersection with Transit Road. An unnamed stream flows along the northern perimeter of Area B (hereafter referred to as Aero Creek). Aero Lake is located north of this stream in the northwest corner of Area B. This 40-acre lake originated from a borrow pit excavated for fill material during the construction of the New York State Thruway. The lake is currently used by local residents for fishing and boating. It may also be used occasionally for swimming.

Area C is situated south of Aero Drive and west of Transit Road. The area closely resembles Area B with respect to the distribution and occurrence of drums, sludge, debris, terrain, and vegetation. Leachate seeps are also present along the perimeter of Area C in early spring. Several drum disposal areas are located within this area. An active truck repair company is situated in Area C, approximately 975 feet from the intersection of Transit Road and Aero Drive. South of Area C, there are several private residences. Ellicott Creek, a major tributary to the Erie-Niagara Basin, is located approximately 1,000 feet south of Area C. The creek is primarily used for primary contact recreation and fishing.

The entire landfill, except for the area along the northern perimeter of Area B and southeast corner of Area C, is fenced. "No Trespassing" and "Hazardous Waste Area" signs are posted along the border of the site. The site is predominately an upland area. Land in the immediate vicinity of the site is mostly urbanized. Two freshwater wetlands regulated by New York State Department of Environmental Conservation (NYSDEC) are located within and adjacent to the site. The site is used as a resident animal habitat for white-tailed deer, and small mammals, birds, and ducks. White-footed mice, raccoons, and cottontail rabbits are also common at the landfill. There is no information available that indicates the presence of rare or endangered species at the site.

The elevation of the landfill ranges between 3 to 4 feet above the normal elevation of 690 feet. Most of the native soils have been removed and replaced with other soil types. Area A has mostly loamy, earthy fill material, mixed with construction and demolition debri. Areas B and C consist primarily of fill material, including trash and refuse, partially covered or mixed with earthy material.

The advancement, melting, and subsequent retreat of the glacial ice sheet resulted in the deposition of till and lacustrine sediments in the area now occupied by the Pfohl Brothers Landfill. The lacustrine deposits typically consist of clay with discontinuous stringers of very fine sand and silt. The near surface deposits at the site, a mixture of silty clay and sand, are glaciofluvial and lacustrine in origin. Basal glacial sediments in contact with the bedrock were deposited as a compact lodgement till. The underlying Onondaga Limestone is the principal aquifer within the study area. Most of the ground water flow is through secondary porosity features such as interconnected solution cavities and fractures.

Recharge to the unconsolidated aquifer comes from precipitation which averages about 36 inches per year. Recharge to the bedrock aquifer occurs by direct infiltration of precipitation, vertical recharge from the overlying unconsolidated aquifer, and, to some extent, vertical leakage of surface waters.

According to personnel from the Erie County Department of Health, there are private wells within less than 0.5 mile radius of the site. These wells were constructed in the unconsolidated aquifer and were used prior to 1983 as a source of potable water. In 1983, the water district within the area of the Pfohl Brothers landfill was formed and public water lines were installed. Currently there is no known homes or businesses within a 0.5 mile radius using private wells in the unconsolidated aquifer for potable purposes. However, some homeowners in the area use their wells for lawn watering and/or cleaning their cars. There is a potable water supply well, however, constructed within the bedrock aquifer, located at a commercial property to the east of Area A. Based on the current understanding of the bedrock aquifer flow patterns, this well should not be affected by contaminant migration from the landfill. This is being investigated further by the New York State Department of Health.

The Buffalo Crushed Stone Company (BCS) quarry, located one and one-half mile east of the study area, utilizes two dewatering pumps, each capable of purging 400,000 gallons/hour per pump. The water is either discharged to Ellicott Creek via a drainage ditch, or used in the on-site processing plant. The radius of the cone of depression created by the dewatering operations is approximately 2,500 feet. The observed boundaries of the cone of depression is approximately 5,000 feet east of Transit Road. As a result, it does not appear that quarry dewatering is drawing contaminants towards the quarry.

The Phase I remedial investigation for the Pfohl Brothers landfill consisted primarily of six major field activities. These included a geophysical survey, sampling of surface water, leachate seep and sediments, gamma surveys, test pit investigations, soil boring installations, and ground water testing.

The results of these investigations indicate that the landfill contains large quantities of household garbage, rubber products, wood, wire, coal ash, scrap metal, drums, and large home applicances.

A total of 113 drums were visually observed in areas B and C of the landfill. Some of the drums were partially full; others were empty. The majority of the buried drums, and almost all of the crushed drums at the surface, were empty. A total of 64 drums were found in Area B, with the majority of the drums located in the western and central regions. A total of 49 drums were found in Area C; most of the drums were located in the central and eastern regions. Leaking drums were stacked in rows of three and were situated below the water surface in the eastern region of Area C.

Leachate seeps (at least 40) flow from the surface of the landfill in early spring. Some of the leachate seeps are in relatively close proximity to residents. In some locations, leachate seeps flow into drainage ditches located along the perimeter of the landfill where they eventually enter Aero Creek and Ellicott Creek.

Several glaciofluvial deposits are found beneath the trash. The upper layer of glacial deposits consist of discontinuous layers of clay, silt, sand, silty clay, and silty sand. A till layer, ranging from zero to two feet overlays the bedrock. Fill material ranges in thickness from 6 to 22 feet. In the northeastern region of Area B, the clay appears to have been stripped away during landfilling operations. The absence of clay at this location may provide a conduit allowing contaminants to migrate more rapidly from the overlying soils and ground water into the bedrock aquifer.

The regional ground water flow in the unconsolidated aquifer is in a south-southwest direction, eventually discharging to Ellicott Creek. Aero Lake, and the wetlands during the wet seasons, serve as local discharge areas for the unconsolidated aquifer. During the month of May, the shallow ground water moves radially outward from the landfill as a result of local ground water mounding. In the months of January and June, ground water moves radially outward from the site in all directions, except to the northeast. The average linear velocity of ground water moving through the glacial aquifer is estimated at 0.57 feet per day, or 208 feet per year.

If an isotropic flow field is assumed, water entering the deep ground water flow system from the northeast moves in a south/southeasterly and southwesterly direction in the bedrock aquifer. The velocity of ground water in the bedrock aquifer cannot be accurately determined with existing data. Fracture occurrence may have a significant influence on the direction of ground water flow. If such fractures exist, the bulk of contaminants in the ground water would migrate from the site preferentially through fractures in a southeast and southwest direction. Most of the bedrock wells appear to be hydraulically connected. Long-term monitoring of water levels and/or pumping tests are necessary to confirm and fully evaluate the hydraulic interconnection between the bedrock and unconsolidated aquifers. It also appears that ground water in the bedrock aquifer upgradient of the site is recharging Aero Lake.

The nature and extent of contamination is presented in three ways: through dot plots of contaminant concentrations per media across the site; through a tabular presentation of concentration ranges of contaminant groups by media across the site; and through a narrative presentation of contaminant distribution by media across the site. Concentrations of organic and inorganic constituents were compared to background levels or regulatory standards to develop the various data presentations.
Acetone and methylene chloride were detected in several of the sample media, however, it is uncertain whether or not their presence is attributable to source materials in the landfill. Acetone, for example, is commonly used as a solvent in analytical laboratories and for equipment decontamination in the field. Acetone is also a natural degradation product of organic matter. Methylene chloride is used as a common laboratory solvent and is common in soil extraction procedures.

Analysis of the waste drummed material indicates that a wide variety of organic compounds were disposed of at the landfill. Elevated levels of volatile organics, primarily a variety of aromatic and chlorinated aliphatic hydrocarbons, were observed in the waste samples. In addition, a wide variety of semi-volatile organic compounds were detected in the drums. These principally include phenols, dibenzofuran, and phthalates. Pesticides, PCBs and PAHs were also detected at elevated concentrations in a portion of the drums. Almost all of the inorganics analyzed for were detected at concentrations in excess of background soil sample levels. The concentrations of barium, cadmium, chromium, cobalt, copper, iron, lead, nickel, silver, sodium, and zinc exceeded background concentrations most frequently. Arsenic, mercury, and vanadium were also observed in many samples well above background concentrations.

The compound 2,3,7,8 TCDD was detected at qualified concentrations ranging from 100 to 370 ppb in the drum and soil samples collected during the test pit investigation. Of the 18 samples tested, 50% of the samples revealed the presence of this compound. No pattern of contamination was observed in either area B or C. Data on six samples were rejected during data validation because of non-compliance with QA/QC protocol. However, the analytical results for these samples are reported, with an explanation provided for their inclusion, in the accompanying report.

Rubber-like polymer disks were evidenced over most of the landfill surface. Data on the one disk selected for 2,3,7,8 TCDD analysis were rejected during data validation because of non-compliance with QA/QC protocol, however, it is likely that the sample did not contain this compound.

The soils in Area A do not represent a major source of organic contamination at the site. However, a number of inorganic constituents were detected in Area A that exceeded background concentrations. Many of the organic compounds detected in the drums were also present in the soil samples in Areas B and C. In some cases, both the organic and inorganic compounds present in the drums were detected at higher concentrations in the soil samples. Most of the inorganics detected in the soil samples from Areas B and C exceeded background in one or more samples. For the most part, a greater number of inorganic constituents were detected at higher concentrations in Areas B and C than in samples from Area A.
Radiological contamination appears to be scattered randomly throughout areas B and C, and except for a few locations, appears as isolated spots with small quantities of industrial waste. The sources of elevated gamma readings are attributed to both natural materials (such as rocks and coal ash) and man-made materials (construction debris, metal rods and disks, and white vermiculite material).

Organic compounds detected in the drums and soil samples were also detected, for the most part, in the unconsolidated ground water aquifer, including: halogenated hydrocarbons, aromatics, PAHs, phenols, dibenzofuran, and several phthalates. In addition, one pesticide and PCB isomer was detected in one and two samples, respectively. Several organic constituents exceeded ARARs in the shallow aquifer. These included aromatics, halogenated hydrocarbons, phenol, phthalates and the PCB arochlor-1232. The compound 2,3,7,8 TCDD was not detected in the shallow ground water samples.

Many inorganic constituents were detected in the unconsolidated ground water aquifer above background concentrations and several, including iron, magnesium, sodium, antimony, barium, cadmium, chromium, copper, lead, manganese, and mercury, were detected above ground water quality standards.

Ground water samples from the bedrock aquifer were also contaminated with several organic compounds that were also found in the waste, soil, and shallow ground water samples, including: halogenated hydrocarbons, aromatics, phenol, and phthalates. Concentrations were found to be much lower in the bedrock aquifer as compared to the shallow ground water. Aldrin was also detected in one well. Only a few organic constituents exceeded ground water quality standards. These included benzene, trans 1,2 dichloroethene, phenol, and aldrin. The compound 2,3,7,8 TCDD was not detected in the bedrock aquifer.

Arsenic, cadmium, copper, nickel, and potassium were detected above background levels in approximately 50 percent of the samples. However, only a limited number of inorganic constituents exceeded ground water quality standards. These included iron, sodium, antimony, chromium, magnesium, and manganese.

The leachate seep samples revealed organic contamination similar to that found in the drum, soil, and shallow ground water samples. The groups of organic compounds primarily include halogenated hydrocarbons, aromatics, phenols, dibenzofuran, PAHs, and phthalates. The concentrations of the phthalates were indicative of field/laboratory contamination. Several pesticides that were found in one or more of the other media were also detected in the leachate seep samples. Except for dieldrin, the pesticides detected in the leachate seep samples were not detected in the corresponding sediment samples. Several groups of organic constituents exceeded ground water quality standards, including aromatics, a halogenated hydrocarbon and phthalate, phenol, pesticides, and PAHs.

All of the inorganic constituents analyzed were detected above baseline levels with the exception of antimony, thallium, and selenium. Lead, magnesium, manganese, sodium, cadmium, copper, iron, zinc, barium, beryllium, chromium, mercury, and selenium exceeded ground water quality standards. Suspended solids present in these samples may be contributing significantly to the elevated metals concentrations found in these samples.

Three volatile organic compounds (methylene chloride, acetone, and chlorobenzene) were detected in the leachate seep sediments. Of these, only chlorobenzene was detected in the leachate seep samples. Other organic compounds detected in the seep sediments include various PAHs, dibenzofuran, five pesticides, and PCB isomers, all of which were either detected in the drum or soil samples. Fly ash that was used as cover material during the landfill operation may be the source of PAHs. The compound 2,3,7,8 TCDD was not detected in the leachate seep sediment samples.

All of the inorganics were detected above background levels in one or more samples except for aluminum and antimony. The locations of the samples where the highest concentration of specific inorganic constituents were detected are all in very different sections of the site. This indicates that there is widespread and varied contamination by metals.

Low levels (relative to the seep samples) of four volatiles and three semivolatiles were detected in a limited number of drainage ditch/intermittent streams surface water samples, including acetone, chlorobenzene, 1,2-dichlorbenzene, and 2,4-dimethylphenol. Di-n-octyl phthalate was also detected in one sample. There were no organic constituents detected in the surface water drainage ditches that exceeded surface water quality standards. The compound 2,3,7,8 TCDD was not detected in any of the surface water sediment samples. It should be noted, however, that these data were qualified during the data validation process due to non-compliant initial and continuing calibration, low surrogate recoveries, and/or the ending column performance check was outside of 12 hours. Data for the background sample (SE-01) does not rigorously support the non-detect results reported, although it is likely that 2,3,7,8 TCDD is not present. Except for antimony, chromium, selenium, silver, thallium, and cyanide, which were not detected, the remaining inorganics were detected in at least one sample above background levels. Iron, cadmium and mercury exceeded surface water quality standards.

As with acetone in the drainage ditches/intermittent stream surface water samples, acetone and methylene chloride were in general detected in the corresponding sediments at levels that were similar to those in the trip and/or method blanks and would be attributable to either laboratory or field contamination. Dibenzofuran and phthalate ester were also detected. Various PAHs were detected primarily along the ditches along the roadways. Three pesticides were detected that were also found in the seep sediment samples and other site media. All inorganics except for silver, thallium, antimony, and selenium were detected above background in at least one sample.

Only one organic compound, bis(2-ethylhexyl)phthalate, was detected in surface water samples from Aero Lake at concentrations that could be attributable to laboratory and/or field contamination. No organic constituents were detected in Aero Lake at concentrations exceeding surface water quality standards.

Except for barium, mercury, potassium, sodium, zinc, and cadmium, inorganics were either not detected or were not detected above background in the lake. Mercury was the only inorganic constituent that exceeded surface water quality standards.

Acetone, 2-butanone, and methylene chloride were the only organics detected in the sediment samples collected from Aero Lake. Except for the sample collected from the middle of the lake, most of the inorganics were detected below or equal to background levels. All of the inorganic constituents, except for beryllium, calcium, copper, lead, and zinc were found at levels above background in this sample.

No organics were detected in the one surface water sample collected from Ellicott Creek. Chlorobenzene, however, was detected in the surface water of a tributary to Ellicott Creek at a concentration exceeding surface water quality standards.

Six metals (aluminum, cadmium, calcium, iron, potassium, and zinc) were detected at concentrations above those found in the background samples.

Iron, zinc, aluminum, cadmium, and lead exceeded surface water quality standards.

Both acetone and methylene chloride were detected in the sediments of Ellicott Creek. The concentration of these compounds, however, were at levels that are typically attributable of laboratory/field contamination. Three PAHs were detected in concentrations below background and within those typically found in urban environments. A wide variety of inorganic constituents were detected in the sediments that exceeded background levels.

In summary, there is evidence that the drums and soils in the landfill represent a source of organic and inorganic contamination to the shallow and deep aquifers, as well as the drainage ditches that surround the site. The most frequently detected organic and inorganic compounds across the site are similar to the types of waste material allegedly disposed of at the site. The most widespread and frequently detected organic contaminants include phenols, aromatics (toluene, xylenes, and chlorobenzene), and polycyclic aromatic hydrocarbons (dibenzofuran). Halogenated hydrocarbons (i.e., chlorinated solvents) and polychlorinated biphenyls (PCBs) were also detected, but at lower frequencies. There is widespread contamination by inorganics. The most frequently detected inorganics include aluminum, barium, cadmium, lead, and zinc. Arsenic, chromium, copper, nickel, vanadium, and mercury were also detected at concentrations exceeding background levels in many of the sample media.

Wastes apparently were not segregated during the landfilling operation, resulting in the heterogenous distribution of waste material over the site. This would account for the somewhat random distribution of contaminants detected in the onsite soils which, in turn, complicate the identification of ground water contaminant plumes and the subsequent development of remedial technologies.

Typical mechanisms of contaminant transport include volatilization and/or airborne dust, discharge of contaminated ground water and/or leachate from the shallow ground water to adjacent surface waters, overland runoff, and migration of contaminants from the soils and shallow ground water to the underlying bedrock aquifer and potential migration into the deeper bedrock aquifer offsite. Some of these mechanisms are involved in contaminant transport at the Pfohl Brothers site.

Although the concentrations in the ground water indicate that contamination is continuing to occur, the overall concentrations in most of the samples are low compared to the values found in several of the subsurface soil and drum samples. This may indicate that these contaminants are being bound to the soils or wastes, infiltration and subsequent transport is limited, precipitation and ground water flow is diluting the concentration and carrying the contaminants offsite, that the release of chemicals from the drums has not yet occurred, or that sampling has not been performed in the areas where contaminants have migrated.

Overall, there does not appear to be widespread contravention of surface water and ground water quality standards offsite. Currently, Aero Lake and Ellicott Creek do not appear to have been adversely impacted by ground water discharged from the unconsolidated aquifer, potential discharges from the bedrock aquifer, discharge from leachate seeps, surrounding ditches and streams, or from run-off or erosion of contaminated soils.
Additional data are needed in off-site areas (i.e., surface water and ground water monitoring wells downgradient of ground water flow) to determine the full nature and extent of contamination, the mechanisms of transport, and the need for offsite remediation. A Phase II remedial investigation will be undertaken to further define the nature and extent of contamination.

The drums represent a continuing source of contamination, in addition to being a physical hazard at the landfill. Drum clusters in the western portion of Area B and the eastern portion of Area C should be considered for removal or secured in order to prevent further discharge of hazardous chemicals.

(PBLF5/20)MP

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Section 1

1.0 BACKGROUND AND HISTORY OF THE SITE

1.1 PURPOSE OF STUDY AND REPORT

As part of the State of New York's program to clean up inactive hazardous waste sites, the New York State Department of Environmental Conservation (NYSDEC) entered into contract with Camp Dresser & McKee to undertake a remedial investigation and feasibility study (RI/FS) for the Pfohl Brothers landfill site located in the town of Cheektowaga, Erie County, New York. The RI/FS for this site is being performed with funds allocated under the New York State Superfund Program.

The Pfohl Brothers site is a 120-acre landfill that received both municipal and industrial wastes. The facility was operated from 1932 to 1971.

The purpose of the overall RI/FS process is to perform a remedial investigation to determine the nature and extent of contamination at the site, the sources of contamination, and the risk to public health and the environment, as well as to perform a feasibility study that will identify and evaluate mitigation alternatives and recommend a cost-effective, environmentally sound and long-term remedial action, if necessary.

This document, the Remedial Investigation Report for the Pfohl Brothers landfill site, summarizes the findings of the Phase I Remedial Investigation. This report begins with a summary of the background and history of the site (section 1) and its existing physical conditions (section 2). These are followed in section 3 by a summary of the field investigations performed to date. The nature and extent of contamination at the landfill are then described in detail in section 4. In section 5, a conceptual model of contaminant transport is discussed. The report provides, in section 6, the conclusions of the remedial investigation and, in section 7, recommendations for the second phase remedial investigation. References are provided in section 8.

In order to determine the full extent of the contamination, it is necessary to expand the remedial investigations to areas further away from the landfill. The Phase II remedial investigation, as currently proposed, will use the information gained from the first phase to identify data gaps and prioritize future data collection efforts. This supplemental information will be used in assessing the nature and extent of contamination and identifying mechanisms of contaminant transport beyond the physical boundaries of the site.

1.2 SITE LOCATION AND OWNERSHIP

The Pfohl Brothers landfill is located in the town of Cheektowaga in the northeastern portion of Erie County, Cheektowaga, New York (figure 1-1). The landfill is inactive and is located in a commercial/residential area northeast of the Buffalo International Airport, encompassing approximately 120 acres. It has been identified by NYSDEC as a Class 2 site, indicating there is a significant threat to human health or the environment and action is required. The landfill is bounded on the east by Transit Road, on the west by the New York State Electric and Gas (NYSEG) utility lines, on the north by land adjacent to the New York State (N.Y.S.) Thruway, Route 90, and to the south by Pfohl Road.

From 1932 to 1971, the 120 acres of land owned by the Pfohl family was used for landfilling. The site accepted municipal and industrial wastes from surrounding townships and industrial wastes from a number of companies in the manufacturing and utilities industries; however, the quantity of waste disposed is unknown. Through generators, some of the industrial wastes were identified as pine tar pitch, waste paints and thinners, waste cutting oils, oil-contaminated Fuller's earth, phenol tar containing chlorinated benzenes, and oil and capacitors laden with polychlorinated biphenyls (PCBs). No records were kept on the quantity of wastes received other than an estimated 125 tons of phenol tar (Recra Research, Inc. 1983).

For the purposes of this investigation, the landfill has been divided into three areas, designated as Areas A, B, and C. Each of these areas is easily distinguished by its geographical setting relative to major roadways

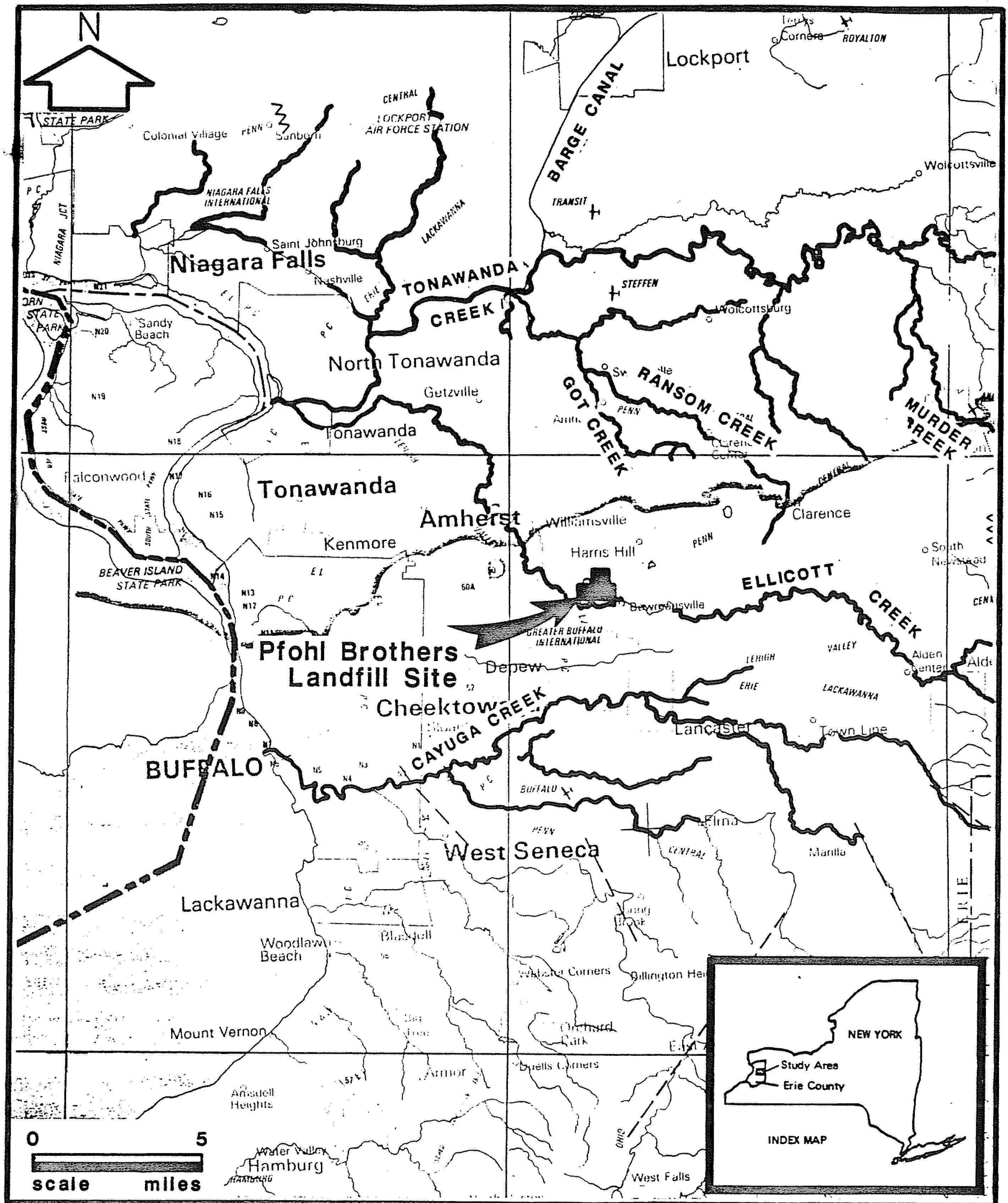

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Figure 1-1

Location Plan

Pfohl Brothers Landfill, Cheektowaga, New York

and other natural environmental features. Dividing the site into discrete areas facilitates the interpretation and presentation of the data, as well as the subsequent development of remedial measures for specific problematic areas within the landfill.

The boundaries of Area A are the N.Y.S. Thruway to the north and west. Transit Road borders Area A on the east, and an unnamed stream running south of the N.Y.S. Thruway exit ramp forms the southern boundary. Area B is bounded on the north by Aero Lake and the aforementioned stream, on the west by a NYSEG utility line easement, on the south by Aero Drive, and on the east by Transit Road.

The northern and western boundaries defining Area C consist of Aero Drive and a driveway servicing a trucking company, respectively. The southern boundary of Area C can be distinguished by drawing a diagonal line from the southern end of the driveway (marking the western edge of Area C) to the intersection of Pfohl Road and the railroad tracks. The southern boundary continues northeast along the railroad tracks to Transit Road.

1.3 HISTORY OF WASTE DISPOSAL

The Pfohl Brothers landfill was operated between 1932 and 1971 in the three discrete areas--A, B, and C--shown in figure 1-2. There are no historic records indicating that hazardous substances were disposed of in Area A. Soil from this area was used primarily by the New York State Transit Authority for fill material. Areas B and C included a cut-and-fill operation with overland dumping. Figures 1-3 through 1-7 depict the active areas of the landfill between the years 1951 to 1972 as interpreted from aerial photographs.

When the landfill was in operation, regular customers were issued stickers by the Pfohl Brothers office personnel to be placed on truck windshields to allow entry into the landfill. Customers who used the landfill less frequently would pay cash at the gate to the tractor driver who would then oversee the incoming load. Drums that were filled with substances that

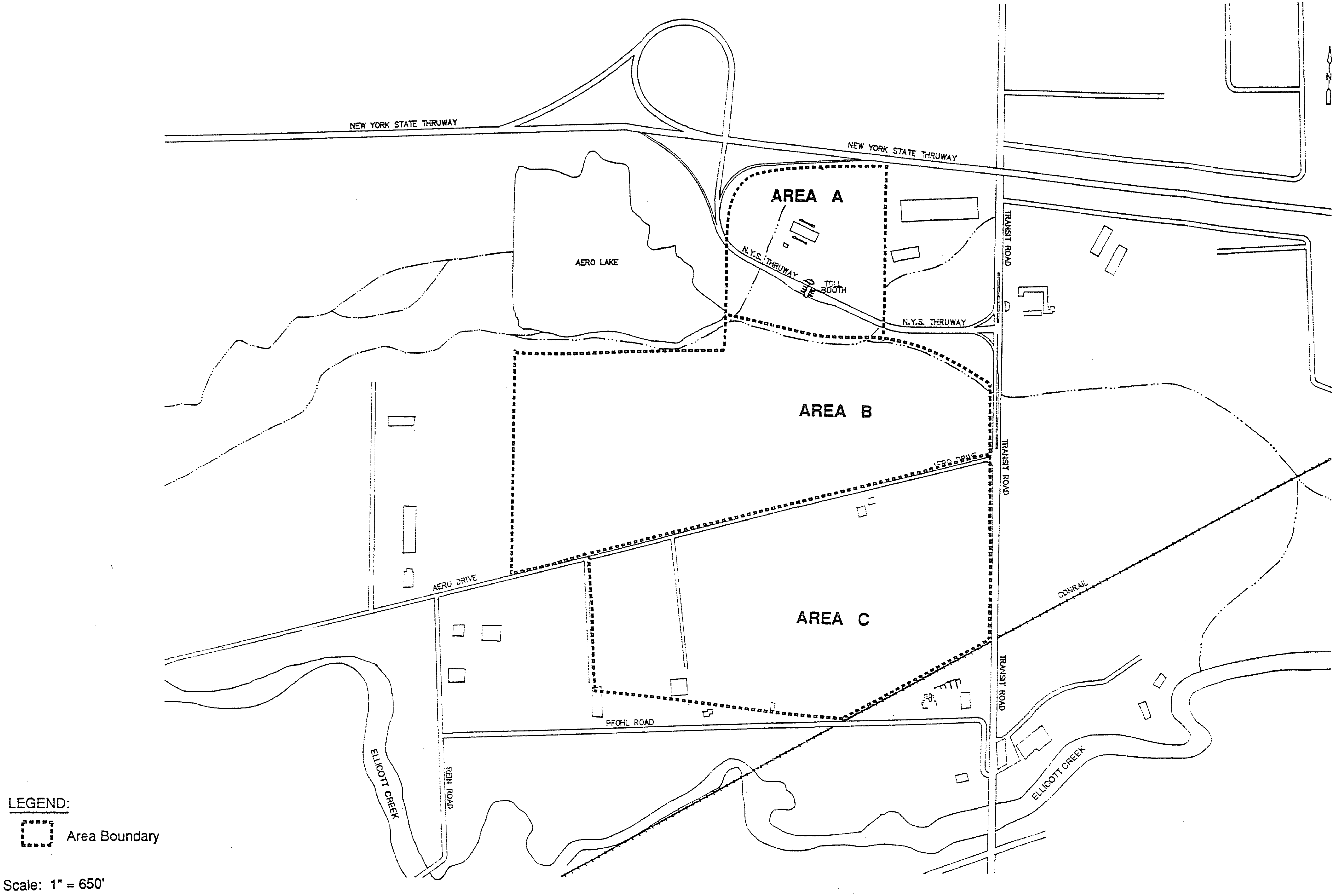

Figure 1-2

Pfohl Brothers Landfill Site

Pfohl Brothers Landfill, Cheektowaga, New York

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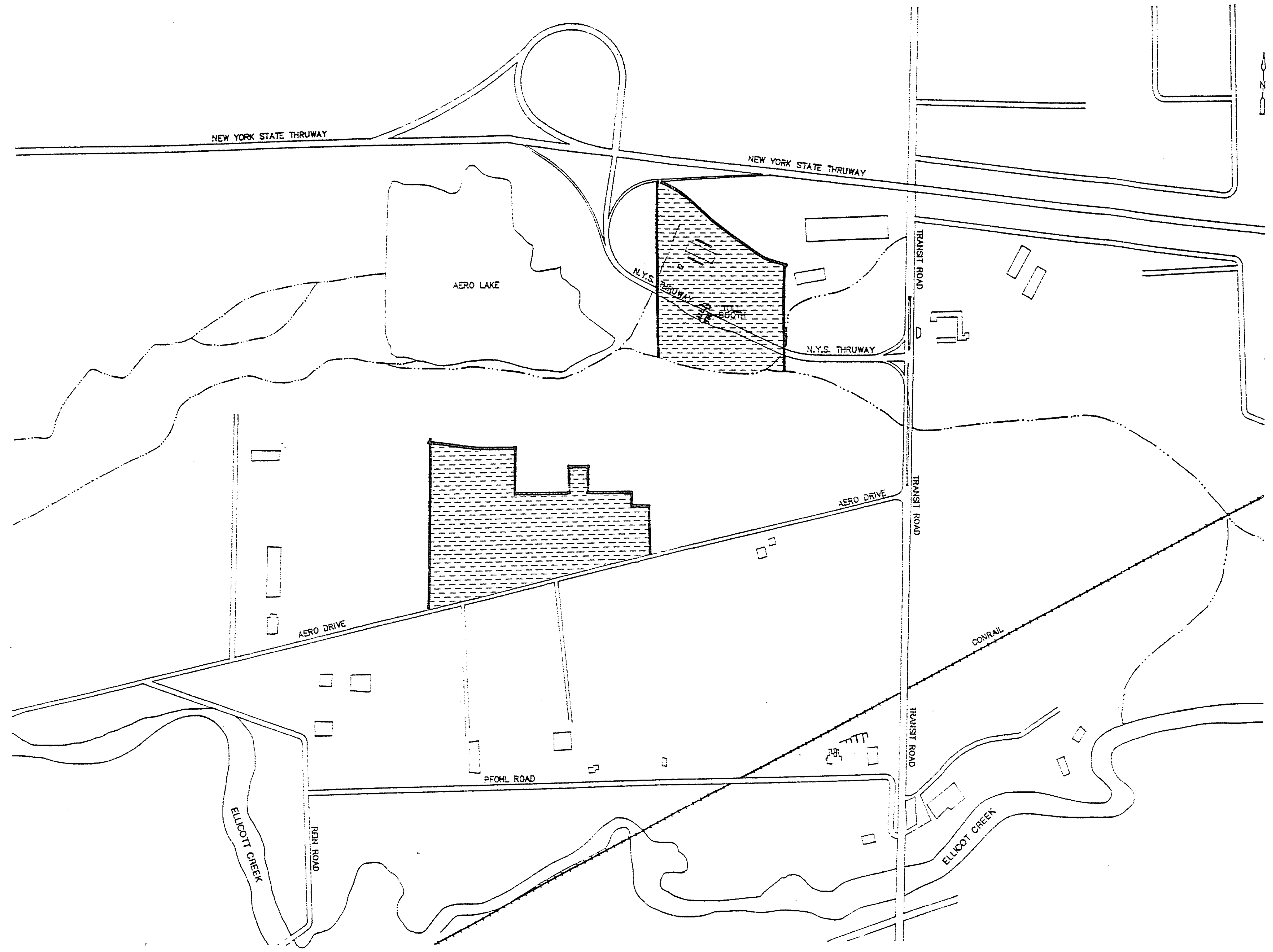

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Figure 1-3
Photographic Interpretation
of Active Landfilling (1951)
Pfohl Brothers Landfill, Cheektowaga, New York

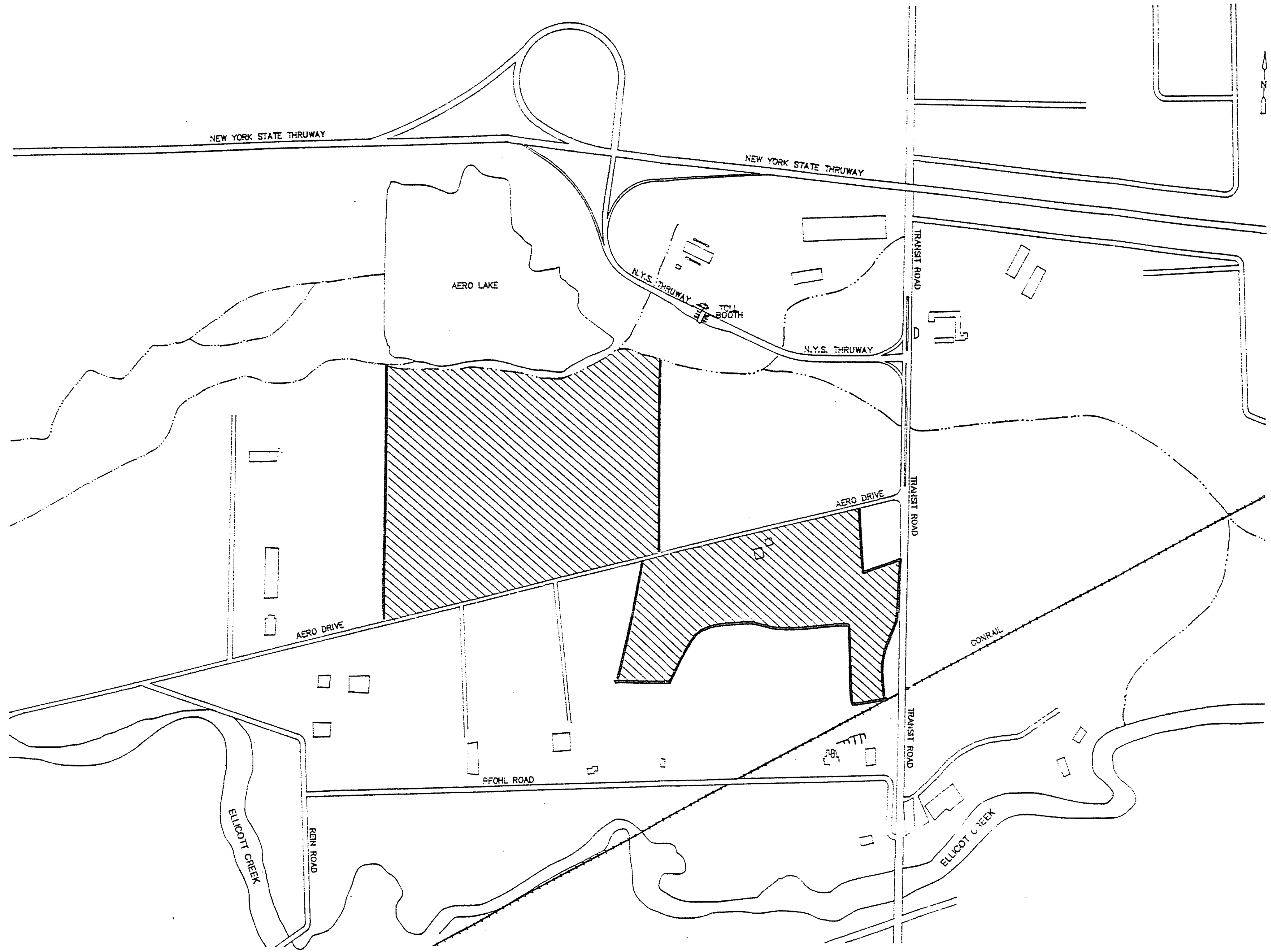

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Figure 1-4

Photographic Interpretation of Active Landfilling (1958-1959)

Pfohl Brothers Landfill, Cheektowaga, New York

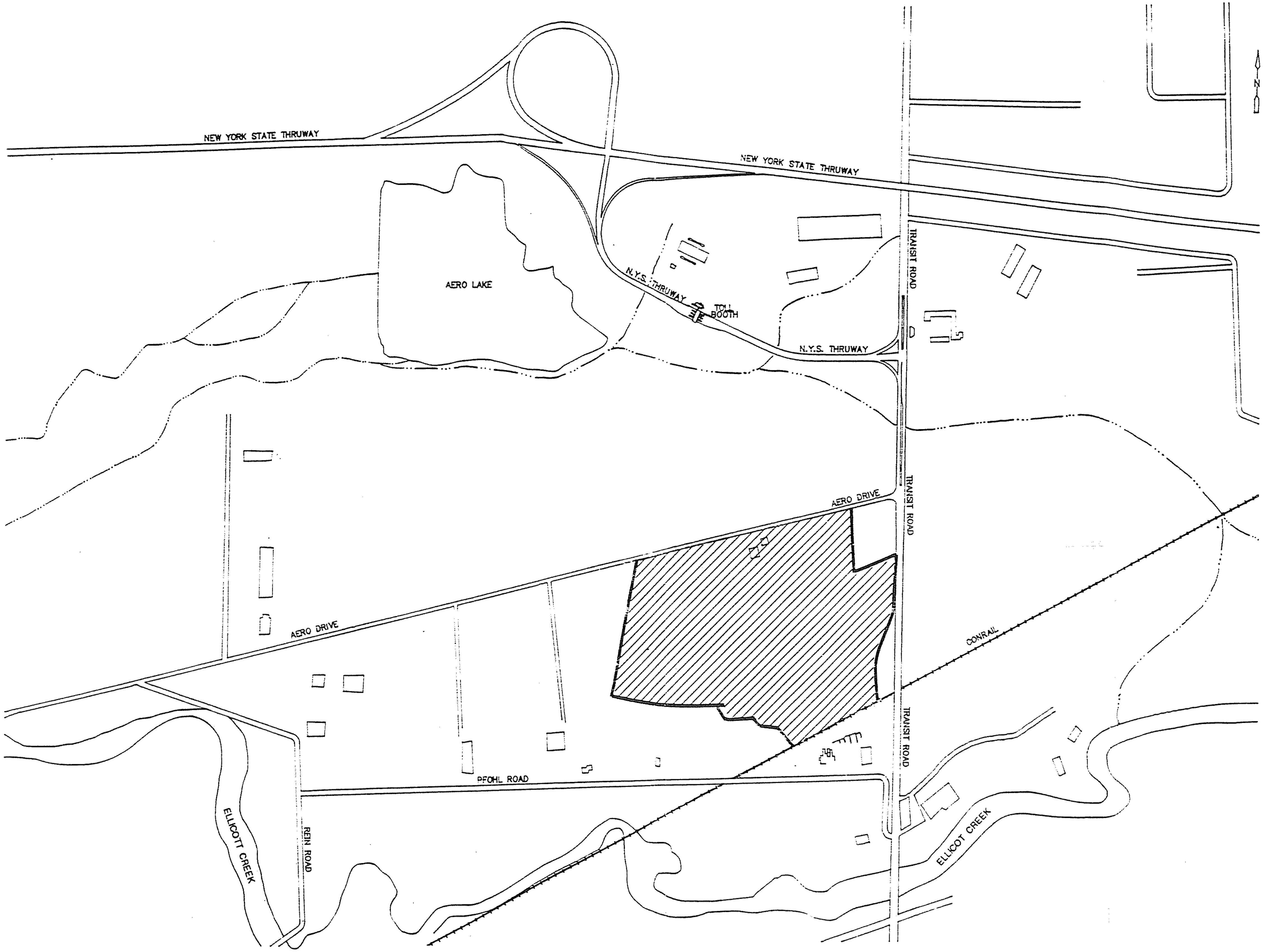

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Figure 1-5

Photographic Interpretation
of Active Landfilling (1960)

Pfohl Brothers Landfill, Cheektowaga, New York

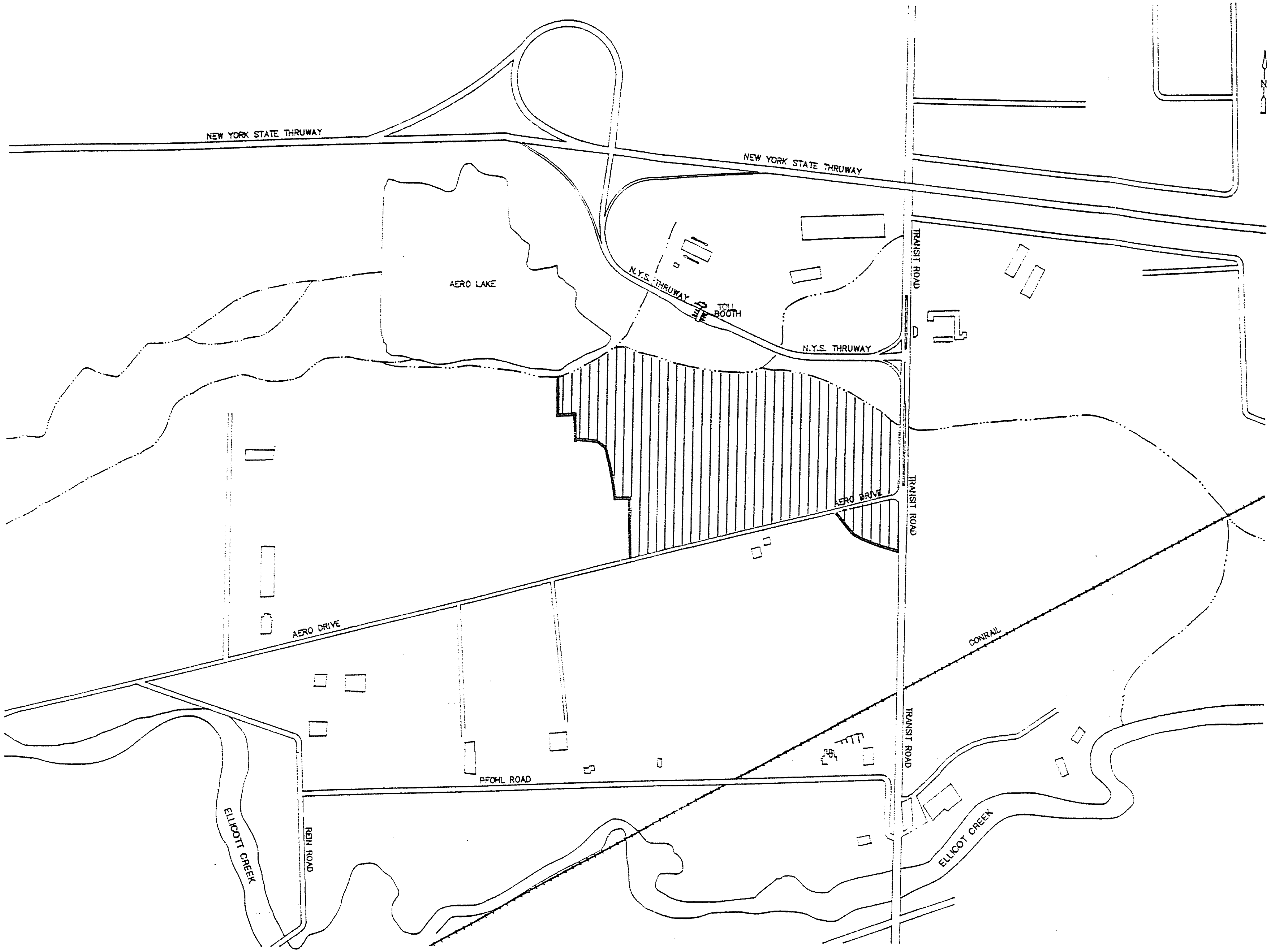

Figure 1-6

Photographic Interpretation of Active Landfilling (1965)

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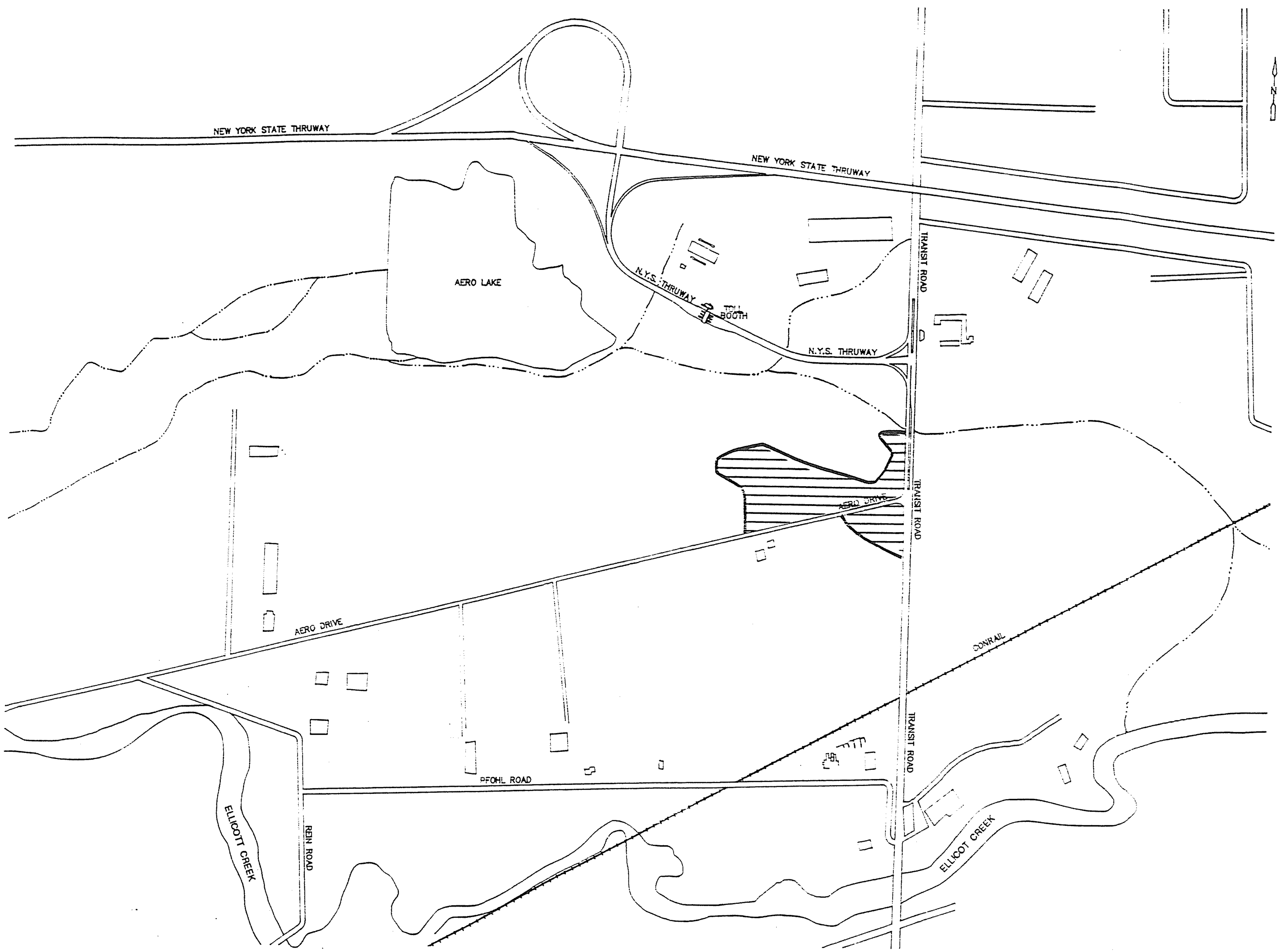

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Figure 1-7
Photographic Interpretation of Active Landfilling (1969-1972)
Pfohl Brothers Landfill, Cheektowaga, New York

could be spilled out were emptied and then salvaged. Cells (dumping areas) were prepared by removing the topsoil and placing it in a separate storage area. A bulldozer then pushed the remaining fill and clay into an embankment (berm) approximately 15 feet around the perimeter of the dumping area. Each excavation was approximately 2 feet deep and approximately 150 feet in diameter. At the end of each day, the bulldozer ran back and forth over the area to compress the material. When the area was full, fly ash and fill material were spread over it.

The management practices of the landfill are generally unknown. However, a previous site inspection field report (Recra Research, Inc. 1983) cited NYSDEC correspondence (Campbell 1983) suggesting that the presence of pockets of exposed contents in the landfill indicated poor compaction practices.

Records documenting disposal practices at the Pfohl Brothers landfill are sketchy. Aerial photographs taken during the 1950s, 60s and 70s document, to some extent, the timing and location of excavation and dumping at the site. Very little information, however, is available concerning the types of waste actually dumped there and the companies generating and transporting that waste. The following information was obtained from historical files provided by NYSDEC.

In one of the earliest reports available, the Erie County Department of Environment and Planning (ECDEP) (Koczaja 1981) indicates that, in addition to domestic and commercial waste, the site is suspected to have received sizable amounts of industrial waste. Furthermore, the report cites the 1979 Interagency Task Force Report on Hazardous Wastes, which found evidence that industrial wastes were taken to the landfill. Among the firms whose wastes were reportedly disposed of in the landfill are steel and metal manufacturers, chemical and petroleum companies, utilities, manufacturers of optical and furnace-related materials, and other large manufacturing and processing concerns. According to ECDEP (Koczaja 1981), the Task Force Report listed several haulers who both provided services to a number of industries and also used the Pfohl Brothers landfill. However, what wastes, if any, the haulers disposed of at the site is unknown.

Documentation in the Erie County DEP files indicates that a tanker was abandoned on the site along Aero Drive and that PCB-laden oil spilled onto the ground. Although the date of the incident was not specified, the contaminated soil was reportedly excavated subsequent to the spill (Burmeier 1988).

In a NYSDEC memorandum (Wilding 1981), three companies were cited as potential contributors of hazardous waste at the Pfohl Brothers landfill. From 1946 to 1956, a manufacturer of optical materials disposed of unknown quantities of waste solvents, paints, thinners, and cutting oils in 55-gallon drums and five-gallon pails in the landfill. From 1946 to 1966, another large industrial concern disposed of some refuse at the site; its hazardous materials are reported to have been disposed of at the Chemtrol Pollution Services facility in Model City, New York. More detail on the wastes generated by this industrial company is contained in New York State Department of Health (NYSDOH) files that allege that the company disposed of trichloroethylene, paint, chloride and cyanide salts, mercury sweepings, liquid and solid PCB waste, freon, and methylene chloride.

Both the optical manufacturer and industrial companies discussed above were listed in the 1985 Inactive Hazardous Waste Disposal Site Report (Lacey 1986) as having contributed industrial wastes to the Pfohl Brothers landfill. Both companies allegedly disposed of paint thinners, pine tar pitch, cellulose, rubber, and scrap metal.

The NYSDOH files also refer to 125 tons of phenol tar from a third potential hazardous waste contributor--in connection with an iron and metal company--from 1969 to 1971. The iron/metal company's role in the generation, transportation, and disposal of the phenol tar is not clear.

The waste disposal practices of the third company are documented in a 1984 NYSDEC Hazardous Waste Generator Form (Walia 1988). According to the form, this company dumped 100 tons of phenol tar at the Pfohl Brothers landfill between 1969 and 1971. The transporter of the waste is listed as unknown. In the 1985 Inactive Hazardous Waste Disposal Site Report, this company is again described as "reportedly" having dumped phenol tars at the site.

NYSDEC Region 9 has compiled a table of wastes (table 1-1) "possibly dumped at Pfohl Brother landfill" (Walia, 1988). The information contained in the table was compiled during a search of the Division of Environmental Enforcement's files for companies suspected of dumping wastes at the Pfohl Brothers landfill.

The Phase I Remedial Investigation Report for the Pfohl Brothers site prepared by Recra Research, Inc. in 1983 also contains information on contaminants dumped at the landfill and companies suspected of generating and/or transporting them. In that report, the landfill is said to have accepted sludges, solids, and liquids; paints and thinners, phenol tar with chlorinated benzenes and dioxins, and capacitors with PCBs were also included.

1.4 PREVIOUS INVESTIGATIONS

In June 1982, the United States Environmental Protection Agency (EPA) contracted with Fred C. Hart Associates to perform a hazardous ranking of the site. Ten water and four sediment samples were obtained at various seep locations, drainage ditches, and domestic wells and were analyzed for organics, inorganics, sulfide, cyanide, and ammonia. The contaminants detected in water samples obtained from a spring flowing into a drainage ditch along the south side of Aero Lake were most notably chlorobenzene, benzene and N-nitrosodiphenylamine at concentrations of 85, 34, and 11 parts per billion (ppb), respectively.

In February 1984, the property owner's law firm, Hodgson, Russ, Andrews, Woods and Gaudier, commissioned Ecology and Environment, Inc., to perform an additional investigation of the site. The objective of the investigation was to determine if the landfill at that time posed, or had the potential to pose, either an environmental or public health threat according to Superfund and related State legislation and regulations. As part of the investigation, ground water, sediment, and leachate seep samples were collected and analyzed for volatile organics, (BNA) organics, heavy metals, phenols, PCBs, and oil and grease.

TABLE 1-1

WASTES POSSIBLY DUMPED AT PFOHL BROTHERS LANDFILL

Waste paint and paint thinners
Waste lithographic inks, solvents, pigments
Stumps, lumber
Waste from scrap reprocessing
Municipal and residential garbage
Degreasing solvents, paint solvents
Waste solvents from vapor degreasing
Waste degreasing solvents, waste paint solvents, waste caustic soda, PCBs, pigment
Septic and holding tank waste
Roofing debris
Still bottoms from degreaser
Dipentene, sulfuric acid, degreasing solvents, mineral spirits
Waste solvents, cyanides, plating sludges
Construction and demolition material
Cement, solvents, waste paints
Waste paint solvents, degreasing solvents, PCBs
Waste paint sludge, waste paint solvents, degreasing solvents, lubricating oil and cutting oil
Listed hazardous refinery wastes
PCB-contaminated wastes
Phenol tar

Source: New York State Department of Environmental Conservation files on Environmental Enforcement (Walia 1988)

In the western portion of Area B, barium concentrations of 49,600 parts per million (ppm) were detected in a leachate seep sample, and concentrationsof chrysene, anthracene, and nickel were detected in the soil at 2.74, 2.08, and 94.1 ppm, respectively. Soil samples obtained at the southeastern corner of Area A had concentrations of fluoranthene and pyrene at 5.21 and 2.39 ppm, respectively. Acenaphthene was detected in the soil at the southeastern corner of Area C at a concentration of 76 ppm. Phenols and oil and grease were detected, but generally at low concentrations. Metal concentrations were high in many of the wells. Elevated concentrations of barium, lead, chromium, and cadmium were detected.

In November 1986, samples of leachate, soil, and waste from surface drums that contained a tar-like material were analyzed by NYSDOH. The contaminants detected in the waste samples from the drums were fluorine and phenanthrene at concentrations of 5,500 and 790 ppm, respectively. Within Area B, along the south side of Aero Lake arochlor 1248 and arochlor 1254 were also found in the soil samples at concentrations of 0.07 and 0.03 ppm, respectively. Various heavy metals were also found in the soil, such as arsenic (38.9 ppm), barium (7,400 ppm), cadmium (48 ppm), chromium (60 ppm), lead (1,760 ppm), and mercury (1.4 ppm) (NYSDOH 1986).

1.5 SUMMARY OF SITE BACKGROUND AND HISTORY

The Pfohl Brothers site is a 120-acre inactive landfill that was formerly used for the disposal of municipal and industrial wastes, including hazardous wastes. It is located in the Town of Cheektowaga, northeast of the Buffalo International Airport in Erie County, New York. The landfill has been classified by New York State Department of Environmental Conservation (NYSDEC) as a Class 2 site, indicating there is a significant threat to human health or the environment and remedial action is required.

The landfill was operated by the Pfohl family from 1932 to 1971. The quantity of waste material and nature of all of the wastes disposed of at the site are unknown; however, in addition to municipal waste, industrial wastes such as phenolic tars, waste solvents, paints, thinners, pine tar pitch, and rubber and scrap metal are know to have been deposited within the landfill. There is also documentation that the landfill accepted sludges, capacitors with polychlorinated biphenyls (PCBs), and phenol tars with chlorinated benzenes and dioxins.

The site first came under investigation in June 1982 when the United States Environmental Protection Agency (EPA) contracted Fred C. Hart Associates to perform a hazardous ranking of the site. This investigation revealed the presence of benzene, chlorinated benzenes and nitrogen compounds in water samples from a spring flowing into a drainage ditch along the south side of Aero Lake. Two years later, in February 1984, the property owner's law firm commissioned Ecology and Environment Inc., to perform an additional investigation of the site. This investigation revealed elevated levels of barium in a leachate seep sample. Polycyclic aromatic hydrocarbons (PAHs), phenols, and elevated concentrations of nickel were detected in the soils. The shallow ground water revealed elevated concentrations of barium, lead, chromium, and cadmium. Finally, in November 1986, the New York State Department of Health (NYSDOH) analyzed samples of leachate, soil and waste from surface drums containing a tar-like material. The drums revealed elevated levels of PAHs. Soil samples collected south of Aero Lake revealed PCBs, as well as elevated concentrations of arsenic, barium, cadmium, chromium, lead, and mercury.

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Section 2

Section 2

2.0 EXISTING CONDITIONS

2.1 INTRODUCTION

A major component of the remedial investigation process is to develop the nature and extent of contamination at the site. To better define the nature and extent, the physical characteristics of the site must be evaluated. Thus, existing data on the site's physical features are used to develop a detailed site description. The analysis of the existing data serves to provide a better understanding of waste sources, pathways, and potential receptors at and around the site. This information aids in the development of a conceptual understanding of the site and its contamination. In addition to assisting in identifying locations where more investigations is needed, the conceptual site model assists in the identification of potential remedial alternatives. This section of the report provides the detailed description of the existing conditions at the Pfohl Brothers landfill needed to fully characterize the site and the nature and extent of its contamination.

2.2 SURFACE FEATURES

Different surface features characterize each of the areas at the landfill. A large portion of Area A is paved. The northern half is occupied by a private trucking firm that has placed fill material over a large portion of this area in order to elevate the land surface. The unpaved portion is relatively flat. The New York State (N.Y.S.) Thruway access ramp and toll booths are located within this area. A large metal building is located north of the N.Y.S. Thruway access ramp along with a number of tractors and trailers owned by a motor express company.

The majority of Area B consists of undulating terrain with thick underbrush and hidden active animal burrows. Several areas are covered with phragmites or with thorny-stemmed bushes; other areas are open and grassy. Small secondary growth trees with 6-inch-diameter trunks are present in the heavily vegetated areas. Several leachate seeps flow into the drainage ditch that runs along Aero Drive and the drainage ditch located parallel to the southern boundary of Aero Lake. Oil slicks have been noted on the water surface in the wetland area parallel to Aero Drive near the intersection with Transit Road.

Scattered debris is found throughout Area B, including bottles, household refuse, tires, tubing, scrap metal, refrigerators, construction materials, and rusted sections of car bodies. Several drum disposal areas exist, in which many of the drums are rusted, corroded, and crushed. Throughout the site are drums that generally contain either a black, unidentified rubber-like substance or a red, crystalline granular solid.

Many isolated drums and drum clusters lie in the center of the western portion of Area B. The drums are located on or protruding just above the fill surface. At some locations, the fill has settled and large depressions have formed. The depressions reveal a large number of drums that appear to be stacked on top of one another. More than 100 drums have been observed in this drum disposal area.

The eastern side of Area B contains a large number of reinforced concrete pipe sections, ranging from 2 to 6 feet in diameter. In the northeast corner of Area B there is a green and black sludge pile. Several drums in this corner contain the red, crystalline granular solid. A large area of partially buried drums lies just south of the stream.

Directly in line with the billboard in the southwest corner of Area B is a wetland area containing several drums. Another group of drums is located northeast of the wetland adjacent to a large tree.

A large gravel pile is located in the approximate center of Area B. A large berm rises approximately 10 feet above the surrounding terrain immediately west of the gravel pile. West of the berm lies an area containing a large number of drums covered with gravel and surrounded by a snow fence to prevent access. This action was taken by NYSDEC in 1987 following sampling events in November 1986 to prevent exposure to the community. Immediately to the north of the fenced area is another smaller berm. There is no visible evidence indicating what is contained within the berms; the area is completely covered with grass.

Overall, Area C resembles Area B with respect to the distribution and occurrence of drums, sludge debris, terrain, vegetation, and leachate seeps. Several drum disposal areas are located within Area C. A large area of partially buried drums is located in the approximate center of Area C. Several drums, piles of debris, and leachate seeps are located in the wetlands on the western border of Area C. Several drums in Area C also contain either the black, unidentified rubber-like substance or the red, crystalline granular solid.

Several leachate seeps flow into the drainage ditch parallel to the power lines and railroad tracks on the southeast side of Area C. A red liquid with a metallic sheen flows from the leachate seeps into the stream. A large seep exists just west of the Transit Road railroad overpass. Another seep flows off site near well 9S.

An active truck repair company is situated in Area C, approximately 975 feet from the intersection of Transit Road and Aero Drive. Their property contains two corrugated steel buildings and a large parking area for tractor trailers. The parking area is composed of cinder and gravel with some oil staining present. The back parking area has been covered with asphalt, concrete pieces, and concrete tailings from C & B Concrete. Behind this parking area is a scrap area apparently developed by the truck repair company. Black viscous material was often observed at the surface of this scrap area. Large chunks of concrete, piping, and other miscellaneous construction debris are found in piles and scattered throughout the property. Truck parts and rusty drums are located on the ground adjacent to the building.

2.3 DEMOGRAPHY AND SURROUNDING LAND USE

The Pfohl Brothers landfill site is located in the northeast corner of the Town of Cheektowaga. The Town of Cheektowaga is part of an economic growth area bordering the site. The population estimated for 1990 for the town is

90,612 residents, living within 34,661 households that each average 2.5 inhabitants. The last official census taken prior to remedial investigation activities was in 1980. At that time, the total number of household residents was 91,544. There are two mobile home communities south of Ellicott Creek.

Most of the site is fenced. The areas that are were not fenced were located in heavily vegetated, swampy areas, which in and of themselves are expected to limit access. The area not fenced include part of the northern boundary of Area B, separated from Aero Lake and the landfill by a deep ditch (Aero Creek) and swamp areas, and along the eastern boundary of Area C near the railroad tracks. Land use at the Pfohl Brothers landfill site and its surrounding area is varied. "No Trespassing" and "Hazardous Waste Area" signs are posted around the border of the Pfohl Brothers landfill.

The N.Y.S. Thruway now borders Area A on the north. A toll plaza and access ramp for the thruway are located in the southern half of Area A. The northern half of Area A is occupied by a private trucking firm.

Area B is bordered immediately on the west by a New York State Electric and Gas (NYSEG) utility line easement. Areas B and C are bordered on the east by Transit Road which is heavily trafficked and supports a number of businesses such as motels, office parks and retail establishments. Within the site on Aero Drive and immediately west of Area C are several light and general industrial-type businesses on Rein Road.

J & J Trucking Company is situated in the northern portion of Area C. Pfohl Road and several private residences, railroad tracks, and a utility easement for NYSEG are located along the southern portion of Area C. Ellicott Creek is located south of Pfohl Road.

2.4 UTILITIES

Utilities in the vicinity of the Pfohl Brothers site are maintained by NYSEG. Overhead electric transmission and distribution facilities in the area operate at 34,500 and 4,800 volts, respectively. The transmission facilities parallel the north side of the railroad right-of-way that traverses the site from east to west. NYSEG distribution facilities parallel all the roads in the area except the N.Y.S. Thruway. These facilities vary in size and service capabilities (Wagner 1990).

NYSEG also owns and operates the Rein Road substation located on the northeast corner of Genesee Street and Rein Road. The substation serves the residential, commercial, and industrial loads in the area surrounding the site, including the Buffalo International Airport Complex. In addition, the Niagara Mohawk Power Corporation has electric transmission facilities in the area. NYSEG does not have gas facilities in this area; those facilities are owned by the National Fuel Gas Corporation (Wagner 1990).

The water supply system in the vicinity of the Pfohl Brothers site (figure 2-1) consists of a 24-inch main that runs along Transit Road and 8-inch lines that run along Pfohl Road, Rein Road, and Scott Place. In addition a 12-inch line runs east along Aero Drive, ending just east of Rein Road. However, much of the section of Aero Drive between Rein and Transit Roads does not contain a water transmission line.

The residences and businesses located along Pfohl Road, Rein Road, and Scott Place, as well as the section of Aero Drive that runs east until Rein Road, are serviced by 8-inch sanitary sewer lines (figure 2-2). The sewage is treated by the City of Buffalo.

Stormwater runoff from in and around the site is transmitted through a system of drainage ditches that run along the roads and through 24-inch corrugated metal pipes that run underneath roads or driveways (figure 2-3). All runoff from the site eventually drains into Ellicott Creek.

2.5 CLIMATE/METEOROLOGY

The Buffalo area has a humid continental climate with warm summers and cold winters. Seasonal temperatures generally range between 90°F in the summer and -10 °F in the winter. The reported mean annual precipitation obtained from the U.S. Weather Service station at the Buffalo International Airport

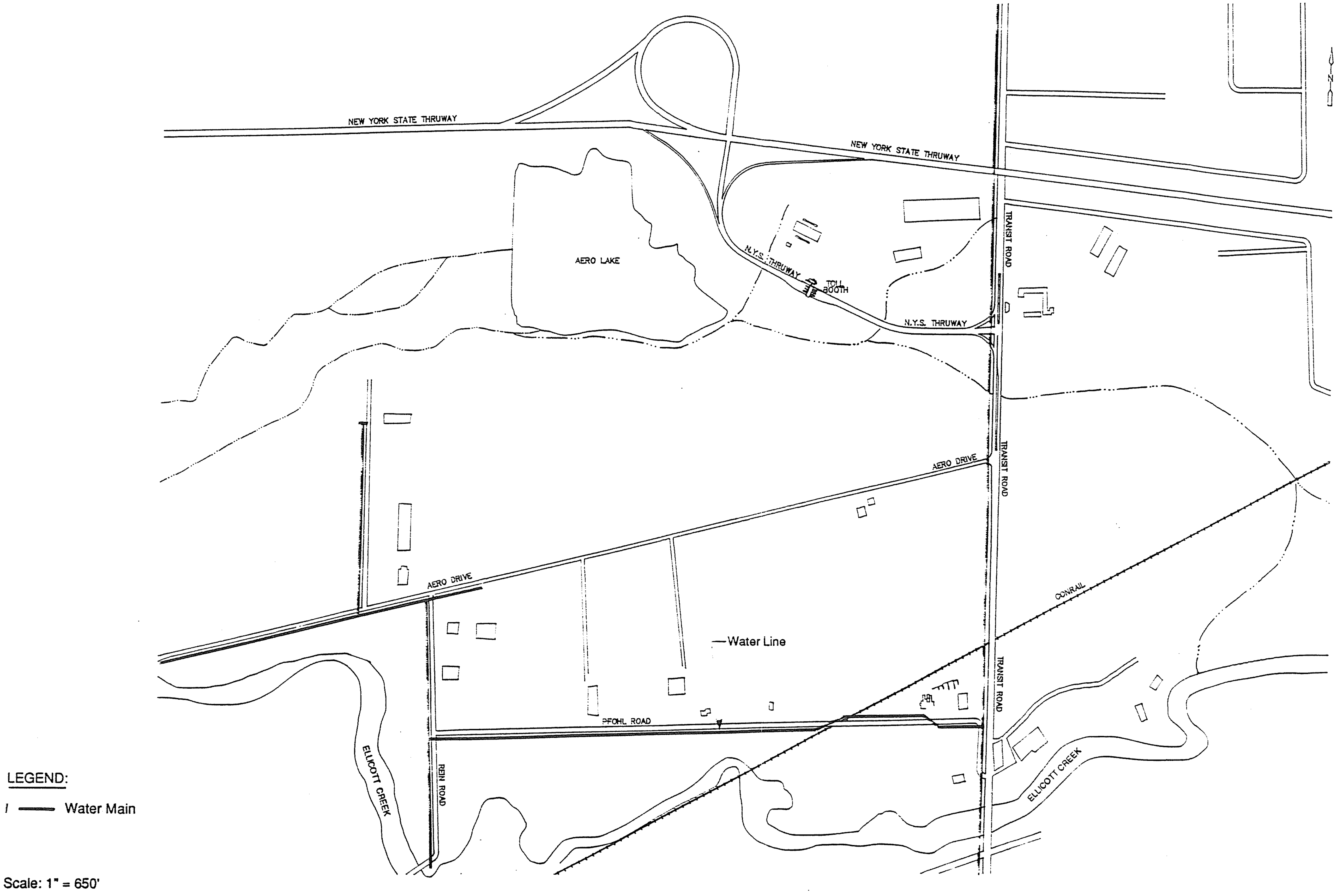

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Figure 2-1
Water Supply Schematic

Pfohl Brothers Landfill, Cheektowaga, New York

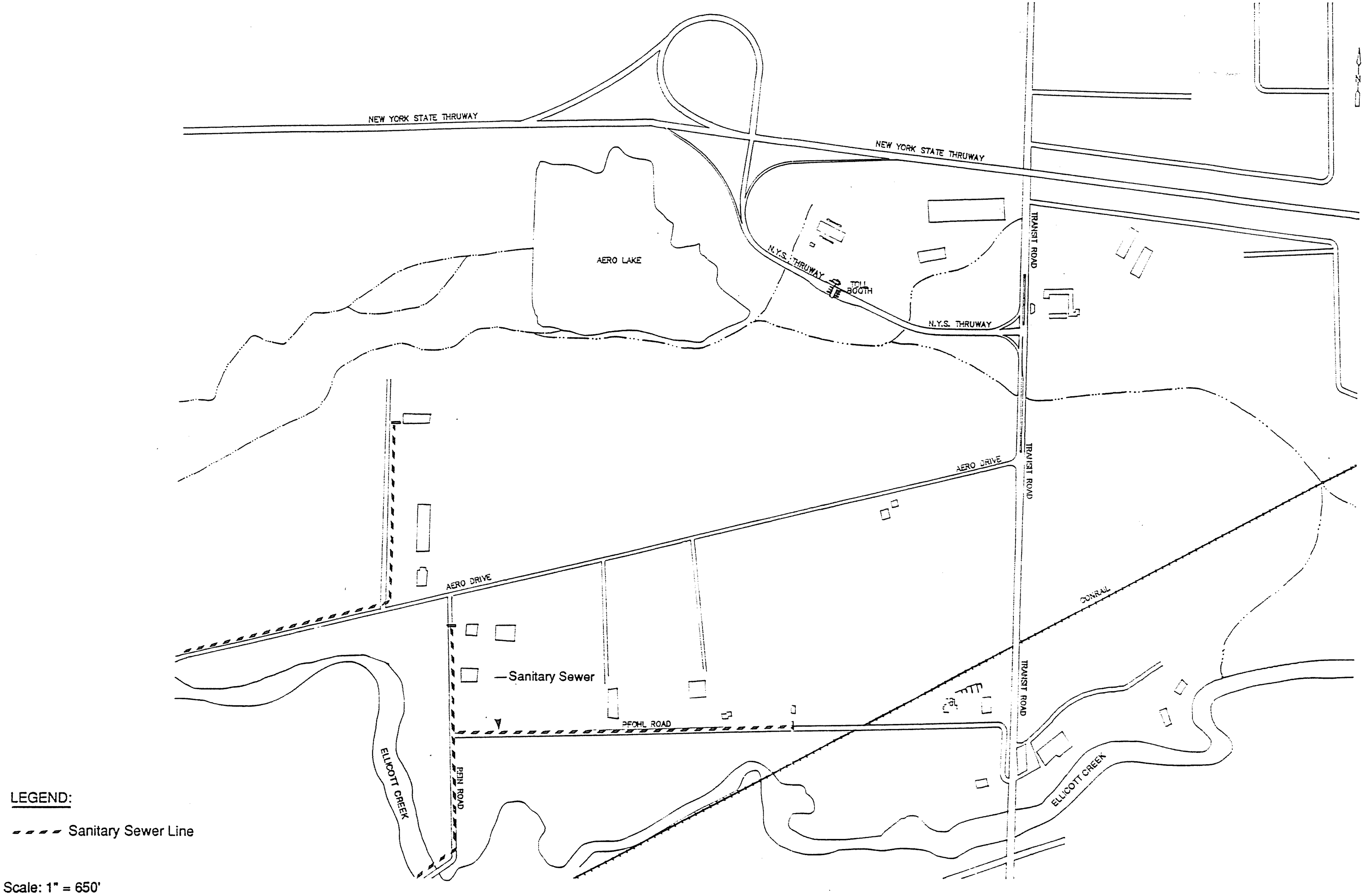

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Figure 2-2

Sanitary Sewer Schematic

Pfohl Brothers Landfill, Cheektowaga, New York

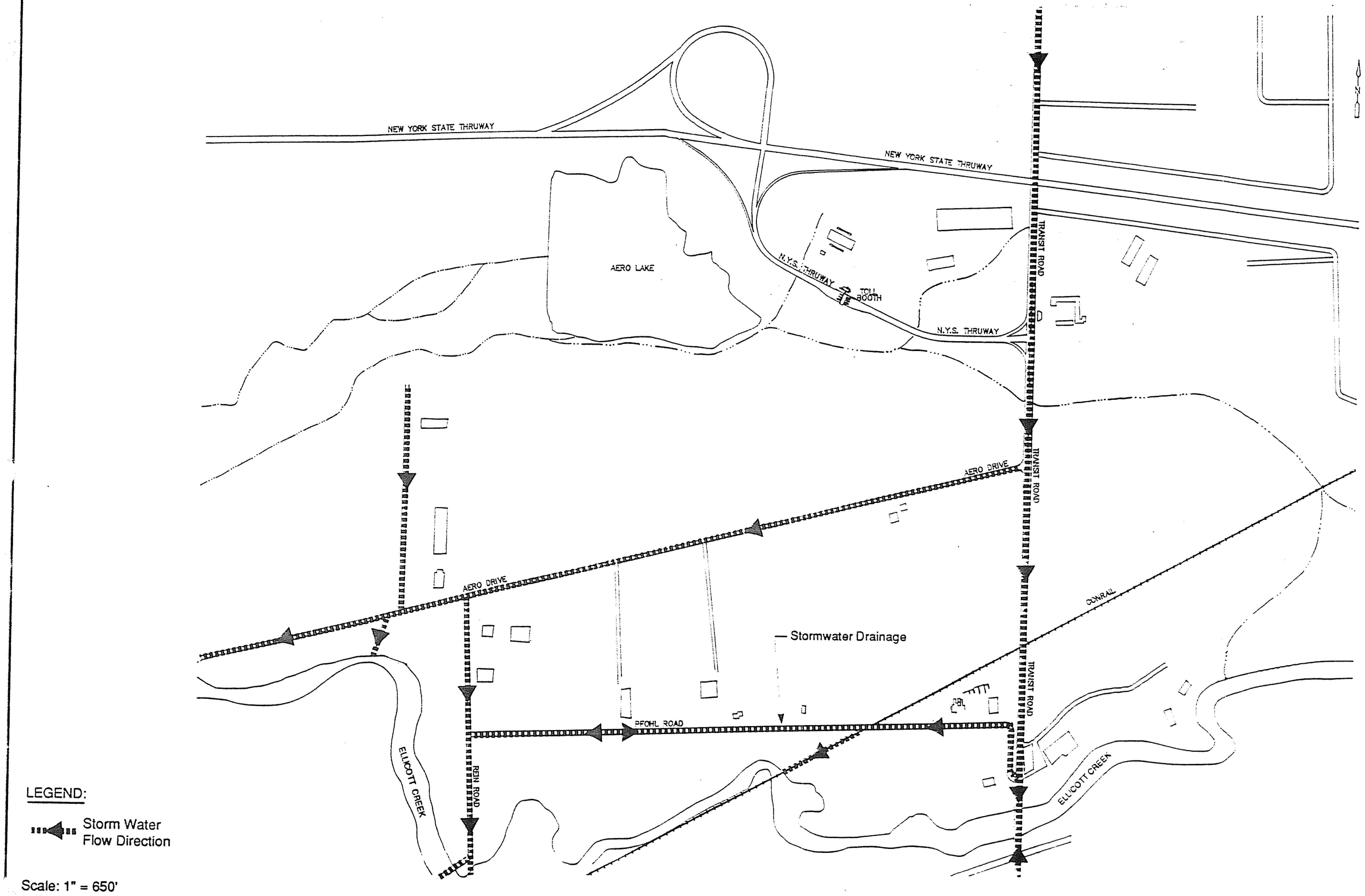

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Figure 2-3
Stormwater Drainage Schematic

Pfohl Brothers Landfill, Cheektowaga, New York

(southwest of the site) is 37.6 inches and is fairly uniformly distributed throughout the year. The reported mean monthly precipitation is 3.13 inches, with slightly higher precipitation occurring in the months of August, September, November, and December, with slightly less precipitation in February and June. The snowpack reaches its maximum depth in February and decreases in March and early April. Surface water and ground water recharge both increase appreciably during snowmelt periods. Within the study area, the monthly potential evapotranspiration exceeds monthly precipitation during the summer and fall, greatly reducing both surface water runoff and ground water recharge (Staubitz and Miller 1987).

2.6 TOPOGRAPHY

The study area is situated in the Erie-Ontario Plain physiographic province (Staubitz and Miller 1987). The land surface is slightly undulating, reflecting the topography of the bedrock surface. The ground surface in the vicinity of the site ranges from 690 to 700 feet above mean sea level (msl). Slightly higher elevations, greater than 700 feet above msl, occur locally at berms within the landfill. The elevation of the actual site area has been raised approximately 3 to 4 feet above the normal elevation of 690 feet.

2.7 SOILS

All of the native soils have been removed from the Pfohl Brothers landfill and replaced with two types of material. Thus, two soil-type designations are given for the site (United States Soil Conservation Service 1986). The soil in Area A is designated Uc-Udorthents. These soils are formed in deep man-made lots or fills and consist of various kinds of excavated earthy material that has been stockpiled for use as fill or topdressing. The soils also include soil and rock materials that have been trucked in from other areas and leveled, or native soil deposits that are left in areas previously excavated or deeply scalped. The soil portion of Udorthent-type soils is typically variable in composition, but loamy, earthy material is dominant.

The soil surface onsite is mostly level or gently sloping, but some areas are steeper, particularly at the edge of cuts and along the sides of mounded fill such as highway embankments. Most areas are idle and support scattered weeds and grasses. A few areas have reverted to brush and tree saplings. Usually, Udorthent-type soils are excessively drained to moderately well drained. The fill is often placed on very poorly to moderately drained soils.

The soils in Areas B and C are designated Dp-Dumps. Such areas are described as consisting of excavations that are filled with rubbish and debris. Some areas consist of piles of rubbish where the landscape has only been slightly altered. More commonly, landfills are made by removing soils and subsequently dumping trash and refuse into the excavated areas. The refuse is partially covered or mixed with earthy material. These areas are usually 3 to 50 feet deep with steep sides. Rubbish consisting mostly of garbage and trash, such as old tires, bottles, cans, and old appliances, line the pit floor. Although some dumps host no vegetation, others, like the Pfohl Brothers landfill, have scattered bushes, grass, and deciduous plants because the cover material has not been disturbed for a long period of time.

2.8 GEOLOGY

2.8.1 GLACIAL DEPOSITS

Unconsolidated Pleistocene glacial deposits mantle the bedrock throughout New York State. Glacial deposits are either laid down directly by the ice sheet, such as till--an unsorted mixture of particles ranging in size from clay to boulders--or as glaciofluvial material deposited by melt waters. Glaciofluvial deposits are typified by such features as kames, outwash plains, and lacustrine (lake) sediments.

The Pfohl Brothers landfill is located in the Lake Erie Plain, a smooth to gently rolling surface 6 to 12 miles in width formed by Pleistocene glaciation. The Lake Erie Plain was covered by pre-glacial lakes prior to the formation of Lake Erie. Within and surrounding the lakes were sandy beach ridges and bottom deposits of varved red clay that formed in the developing basin. The varved red clay deposits typically occur in the vicinity of Cheektowaga (Buehler and Tesmer, 1963). The alternating light and dark banding associated with varved deposits is the result of seasonal variation in sediment runoff. The advancement, melting, and subsequent retreat of the glacial ice sheet resulted in the deposition of till and lacustrine sediments in the area now occupied by the Pfohl Brothers landfill. The lacustrine deposits typically consist of clay with discontinuous stringers of very fine sand and silt.

The near surface deposits at the Pfohl Brothers landfill, a mixture of silty clay and sand, are glaciofluvial and lacustrine in origin. A hydrogeologic study conducted several miles northeast of the site determined that the basal glacial sediments in contact with the bedrock were deposited as a compact lodgement till (Miller and Staubitz 1985). The basal sediments identified at the Pfohl Brothers site were found to share similar characteristics.

2.8.2 BEDROCK

The site is located over Devonian- and Silurian-aged sedimentary rocks that strike (trend) east-west and dip slightly to the south at about 40 feet per mile (LaSala 1968). Information is limited regarding the bedrock beneath the site. A subsurface water study was conducted approximately 5 miles east of the Pfohl Brothers landfill in the town of Clarence by Todd Giddings and Associates (1980). The Todd Giddings and Associates (1980) report indicates that the bedrock underlying Clarence consists of nearly horizontal carbonate rock units that can be divided up into three formations. The lowest unit, the Camillus Shale, consists of shale, limestone, dolomite, and gypsum beds that were deposited during the Silurian age. The next youngest rock unit is the Bertie Formation; it consists of thin-to-massive bedded gray and brown dolomite and dolomitic limestone that has an average thickness of 55 feet. The third unit, consisting of Akron Dolomite, is a greenish-gray dolomite that has an average thickness of 8 feet. The cap rock for the area is the Onondaga Limestone. The limestone unit is approximately 110 feet thick, massive, argillaceous (contains clay-sized particles) and gray (Buehler and Tesmer 1963).

The primary porosity of the Onondaga Limestone is insignificant. However, secondary porosity features, such as joints and fractures play an important role in the flow of ground water through the limestone (LaSala 1968).

LaSala (1968) identified two main vertical fracture sets trending northeast and northwest through the region. The fractures are reported to be spaced 30 to 50 feet apart and to be between 50 and 300 feet in length at the surface. Staubitz and Miller (1987) report that Goldberg-Zoino Associates (1984) identified numerous vertical joints in the Clarence-Newstead area, approximately 5 miles northeast of the Pfohl Brothers landfill. The fractures are typically 5 to 18 feet apart, penetrate 10 to 25 feet, and are preferentially oriented N75E, N40W, and N5E. The development of the fractures is probably due to differential isostatic rebound subsequent to glacial retreat. The frequency of fractures diminishes with depth, but no limiting depth of fracture occurrence has been defined (Todd Giddings and Associates 1980). Horizontal fractures also occur in the rock along bedding planes. The occurrence and orientation of fractures within the study area, however, is unknown.

The aperture width of the secondary porosity features varies with the intensity of chemical solutioning that has taken place. Karst features such as sink-holes, widened joints, and swallets have been identified approximately 2 miles northeast of the Pfohl Brothers landfill in the town of Harris Hill (Miller and Staubitz 1985).

Sinkholes are surface depressions, typically several feet to several tens of feet in diameter, that form when unconsolidated sediments subside into enlarged subsurface caverns. The large subsurface openings are produced as a result of a chemical reaction between the natural ground water and the limestone. Swallets are sink holes into which a stream flows. Swallets generally form over solution-widened joints in the limestone. Although these features are not readily observed at the Pfohl Brothers landfill site, similar solutioning-type activity may be occurring below the site.

2.9 HYDROGEOLOGY

2.9.1 GLACIAL SEDIMENTS

Lacustrine deposits typically have a very low permeability and are, therefore, generally not conducive to the development of a potable water supply. Several shallow wells installed in glacial till and lacustrine deposits were hydraulically (slug) tested at the Union Road site, located 5 miles southwest of the study area. The tests were performed as part of a remedial investigation at an inactive hazardous waste disposal facility. The calculated values of hydraulic conductivities range between 2 and 50 feet per day with a mean of 10 feet per day (D'virka and Bartilucci Consulting Engineers 1989). In contrast, typical values for hydraulic conductivities of silt, sandy silts, clayey sands, and till range from less than 0.1 foot per day to approximately 2 feet per day; hydraulic conductivities of silty and fine sands range from 0.1 to 28 feet per day (Fetter 1988).

2.9.2 ONONDAGA LIMESTONE

The primary aquifer within the study area is the Onondaga Limestone. The limestone outcrops locally in the Buffalo Crushed Stone Company quarry one and one-half miles to the east of the site. The aquifer productive with wells typically yielding between 10 and 300 gallons per minute (gpm). Most of the ground water flow is through secondary porosity features such as interconnected solution cavities and fractures (LaSala 1968).

Drillers have reported a decrease in hydraulic head with depth in the Onondaga Limestone (Todd Giddings and Associates 1980). A decrease in hydraulic head with depth is resulting from an increase in transmissivity in the Camillus Shale.

Although there is an element of vertical flow, the effective discharge of ground water appears to be essentially horizontal due to preferential flow in near-surface fractures. At the Union Road site, described previously, the limestone was found to be very competent (that is, having few fractures) from 10 to 25 feet below the bedrock surface. Natural gas was detected below this confining layer during installation of most of the wells at a depth of 25 to 29 feet below the bedrock surface. The investigators hypothesized that ground water flow was through near surface fractures within 10 feet of the surface of the bedrock (D'virka and Bartilucci Consulting Engineers 1989). Staubitz and Miller (1987) have suggested that ground water is transmitted mostly through bedding planes, fractures, and vertical joints that occur in the upper 5 to 15 feet of the limestone.

The hydraulic properties of the Onondaga Limestone vary greatly throughout the flow domain. Staubitz and Miller (1987) report that LaSala (1968) found transmissivity to range from 40 to 3342 square feet a day. Dye studies were conducted by the U.S. Geological Survey in several sinkholes in the area including the Harris Hill sink hole, which is located approximately 3 miles northeast of the landfill. The dye was injected into the sinkhole and its occurrence was monitored in a limited number of monitoring wells, as well as at spring faces along the Onondaga Escarpment and Buffalo Crushed Stone Company quarry (Staubitz and Miller 1987). The dye was never observed at any of the monitoring points, indicating that the aquifer likely has preferential flow paths.

2.9.3 GROUND WATER RECHARGE

Recharge to the unconsolidated aquifer comes from precipitation which averages about 36 inches per year. Allowing for evapotranspiration and surface discharge to streams, approximately 4.2 to 8.4 inches of precipitation per year actually reach the ground water system (LaSala 1968).

Recharge to the bedrock aquifer occurs by direct infiltration of precipitation, vertical recharge from the overlying unconsolidated aquifer, and, to some extent, vertical leakage of surface waters.

2.9.4 GROUND WATER DISCHARGE

An east-west trending ground water divide exists approximately 9,000 feet northeast of the site as shown in figure 2-4. The divide separates two surface water drainage basins. North of the divide, ground water flows north discharging into streams that have their head waters at the base of the Onondaga Escarpment. Ground water south of the divide flows south discharging into Ellicott Creek and quarries. (Miller and Staubitz 1985).

Ground water movement in the Onondaga aquifer generally follows the east to west slope of the Erie-Niagara Basin, moving from higher elevations in the basin to lower elevations, eventually discharging to Lake Erie or the Niagara River. The flow paths in the underlying Akron and Bertie Dolomites and Camillus Shale are similar to those of the Onondaga aquifer except that the Akron and Bertie Formations also have a downward flow component. The downward vertical gradient occurs because the transmissivity of the underlying Camillus Shale is greater than the Onondaga Limestone. The local ground water flow direction at the Pfohl Brothers landfill is from northeast to southwest toward Ellicott Creek.

On a local scale, the hydraulic gradient in the unconsolidated aquifer generally follows the topography of the bedrock surface. The topographic lows, which correspond to wetlands or creeks, are discharge areas for the unconsolidated aquifer. Site-specific discharge areas include Ellicott Creek and Aero Lake.

The water level in the unconsolidated aquifer varies considerably throughout the year indicating low permeability. During the drier months, discharge of ground water to streams, wetlands, and the bedrock aquifer exceeds recharge, and the water table declines (Miller and Staubitz 1985). The wetland generally act as recharge points during drier months and discharge points during the wet seasons.

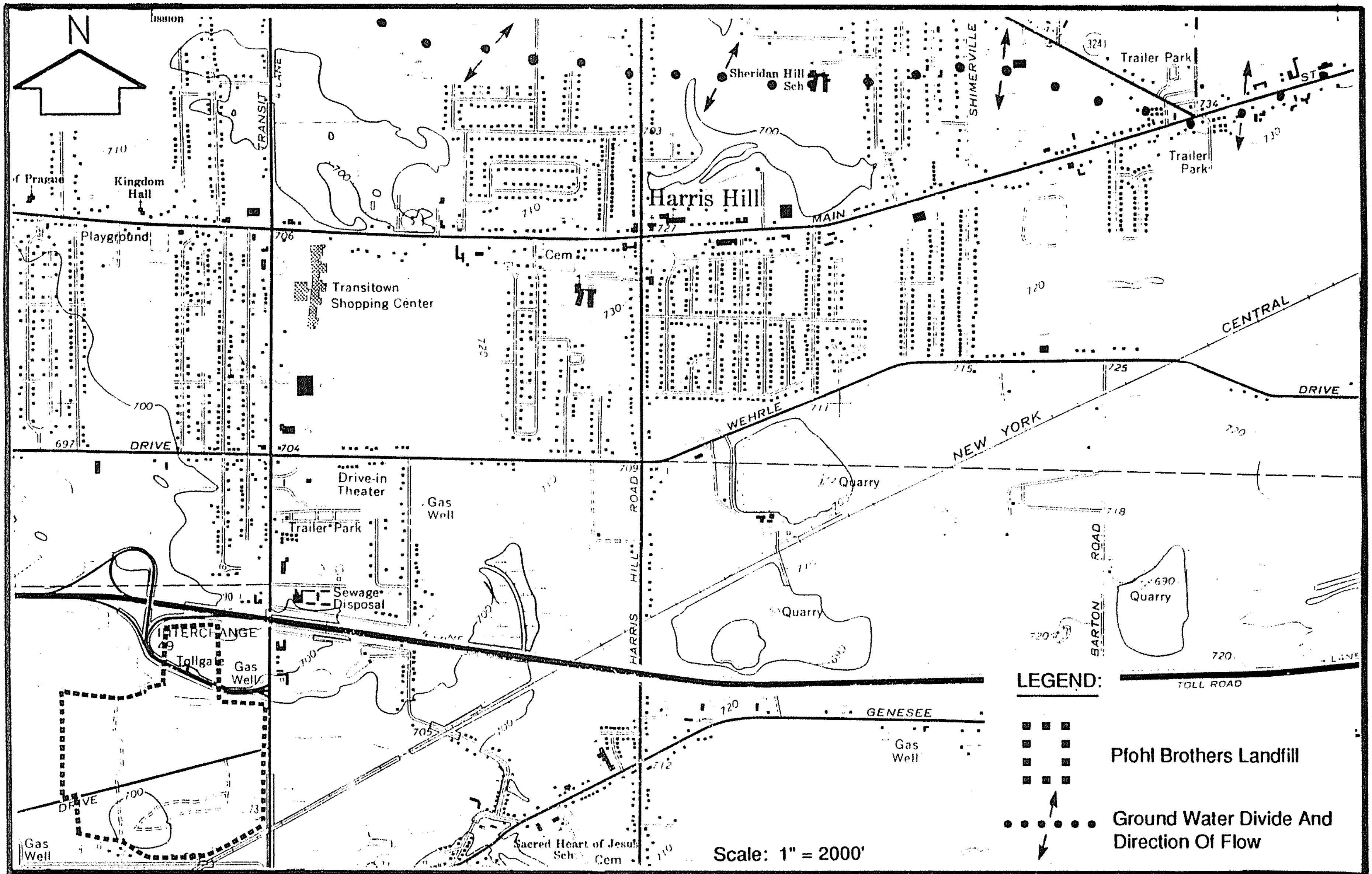

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Figure 2-4

Location Of Ground Water Divide

Pfohl Brothers Landfill, Cheektowaga, New York

2.9.5 GROUND WATER USAGE

The public water in the towns of Cheektowaga, Bowmansville, and Williamsville is either directly supplied by or purchased from the Cheektowaga Water Authority (CWA). The location of these towns with respect to the Pfohl Brothers landfill is shown in figure 2-5. The source of water for CWA is from Lake Erie and/or the Niagara River.

Cheektowaga and Williamsville are fully developed, residential, suburban communities of the city of Buffalo. Although every home has access to public water lines, there is no mandatory hook-up law requiring residents to connect to the public water system.

According to CWA (Rosenberg 1990), nearly all areas in Bowmansville are served by public water supply. However, a few outlying rural homes may still use private wells for their potable water supply. There is no record available at CWA or the Erie County Department of Health on the number or

location of residents using ground water as their primary source. Ground water is probably used more frequently as a secondary source (for example, irrigation) in these areas.

2.9.6 GROUND WATER PUMPAGE

The Buffalo Crushed Stone Company (BCS) quarry, located approximately one and one-half miles east of the study area, began operation in 1904. The quarry consists of two pits in which two dewatering pumps have been installed, each capable of purging 400,000 gallons/hour per pump. The water is either discharged to Ellicott Creek via a drainage ditch, or used in the on-site processing plant. Records of discharge rate have not been maintained.

A potentiometric map of the Onondaga aquifer for eastern Erie County (Staubitz and Miller 1987) (figure 2-6) includes the effect of pumping at the BCS quarry. Water levels taken from site-specific monitoring wells were used to extend the map into the boundaries of the Pfohl Brothers

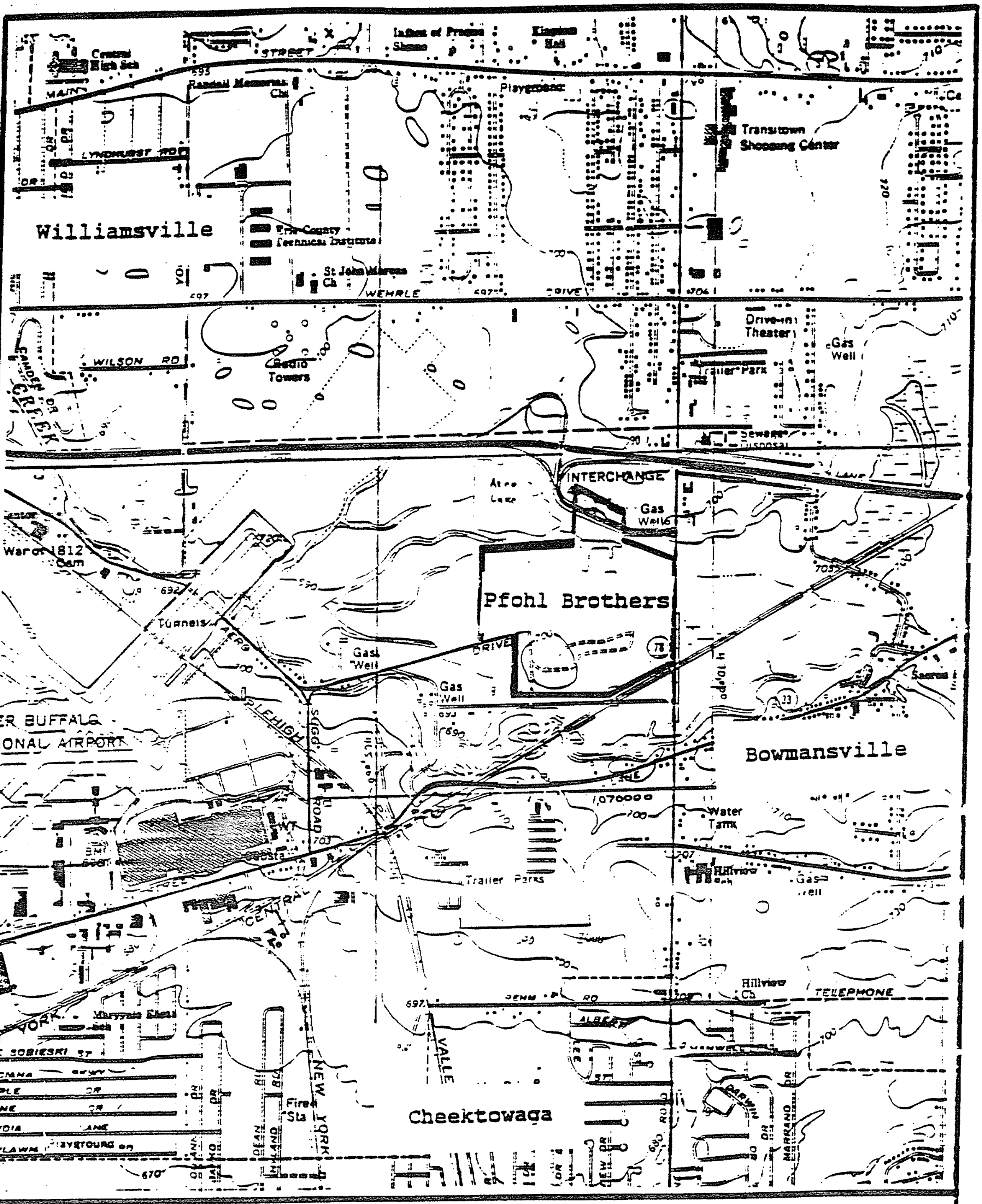

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Figure 2-5

Location Of Neighboring Towns

Pfohl Brothers Landfill, Cheektowaga, New York

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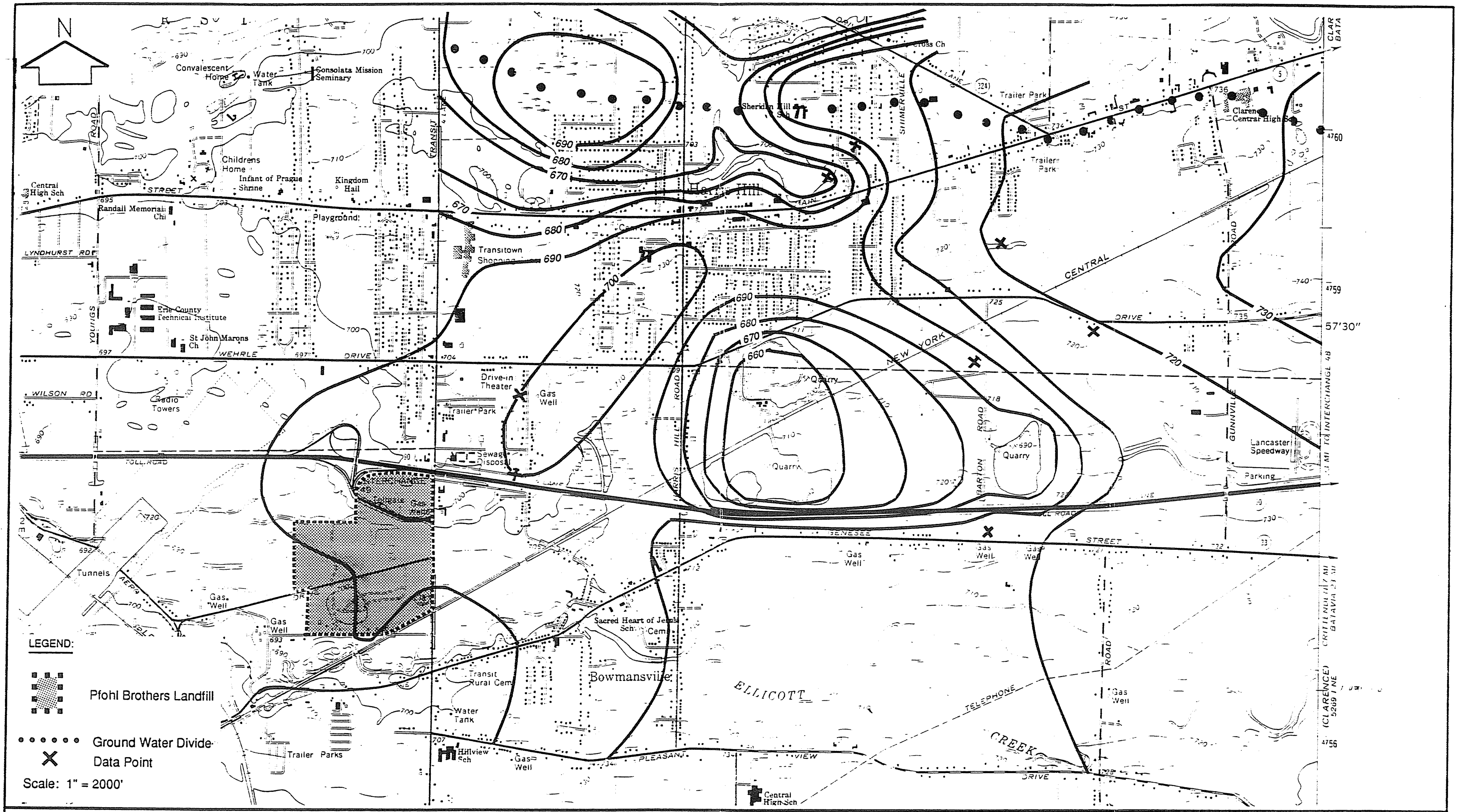

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Source: Giddings, 1980
(Modified By Camp Dresser & McKee, 1990)

Figure 2-6
Effect Of Quarry Pumping On The Potentiometric Surface Of The Onondaga Aquifer
Pfohl Brothers Landfill, Cheektowaga, New York

landfill. The cone of depression created by the BCS quarry dewatering pumps extends to within 5,000 feet of Transit Road, east of the landfill. As a result, it does not appear that quarry dewatering is drawing contaminants toward the quarry.

2.10 SURFACE WATER

The Pfohl Brothers landfill lies within the Erie-Niagara drainage basin. Surface water bodies surrounding the site include Aero Lake and Ellicott Creek, which are north and south of the landfill, respectively. Water is supplied to both water bodies from direct discharge of the unconsolidated and/or bedrock aquifer, as well as from surface runoff during rain or snow fall events. The average annual runoff for the area is about 15 inches (Harding and Gilbert 1969).

Aero Lake is a man-made, 40-acre lake that originated from a borrow pit which was excavated for fill material during the construction of the N.Y.S. Thruway. Approximately 20 feet deep, the lake is used by local residents for fishing in the warmer months. The lake is classified as Class D water, indicating the water is suitable for both fishing and boating.

A major tributary to the Erie-Niagara basin, Ellicott Creek, which is located to the south of Area C, flows in a westerly direction through the towns of Williamsville, Amherst, and Tonawanda, where it eventually discharges into the Niagara River. Classified throughout most of its reach as Class B water, Ellicott Creek is conducive to supporting fish of the trout species. The natural flow of the creek is augmented along its reach near Bowmansville by the discharge of ground water that is pumped from the BCS quarry.

2.11 SURFACE DRAINAGE

The land surface is characterized by moderately developed karst features such as sinkholes, swallets, caves, and underground solution passages, as well as by an absence of surface streams. Formation of karst features results from limestone dissolution and precipitation.

The surface outflow from Aero Lake drains along two intermittent streams located on the western and southern shore of the Lake. The drainage is to the southwest.

The southern portion of the site is drained by Ellicott Creek and several intermittent streams that flow from November through April. Ellicott Creek flows to the west-northwest approximately 12 miles into Tonawanda Creek. Ellicott Creek is fed by several small tributaries and by water pumped from three quarries located to the east of the site. The flow in Ellicott Creek is well sustained throughout the summer, partly by the contribution from quarry pumpage (Staubitz and Miller 1987). The Ellicott Creek drainage basin is bordered on the east by the Murder Creek drainage basin and on the south by the Cayuga Creek drainage basin. The northern portion of the site is drained by tributary streams to Tonawanda Creek, which flow westward to the Niagara River in Tonawanda.

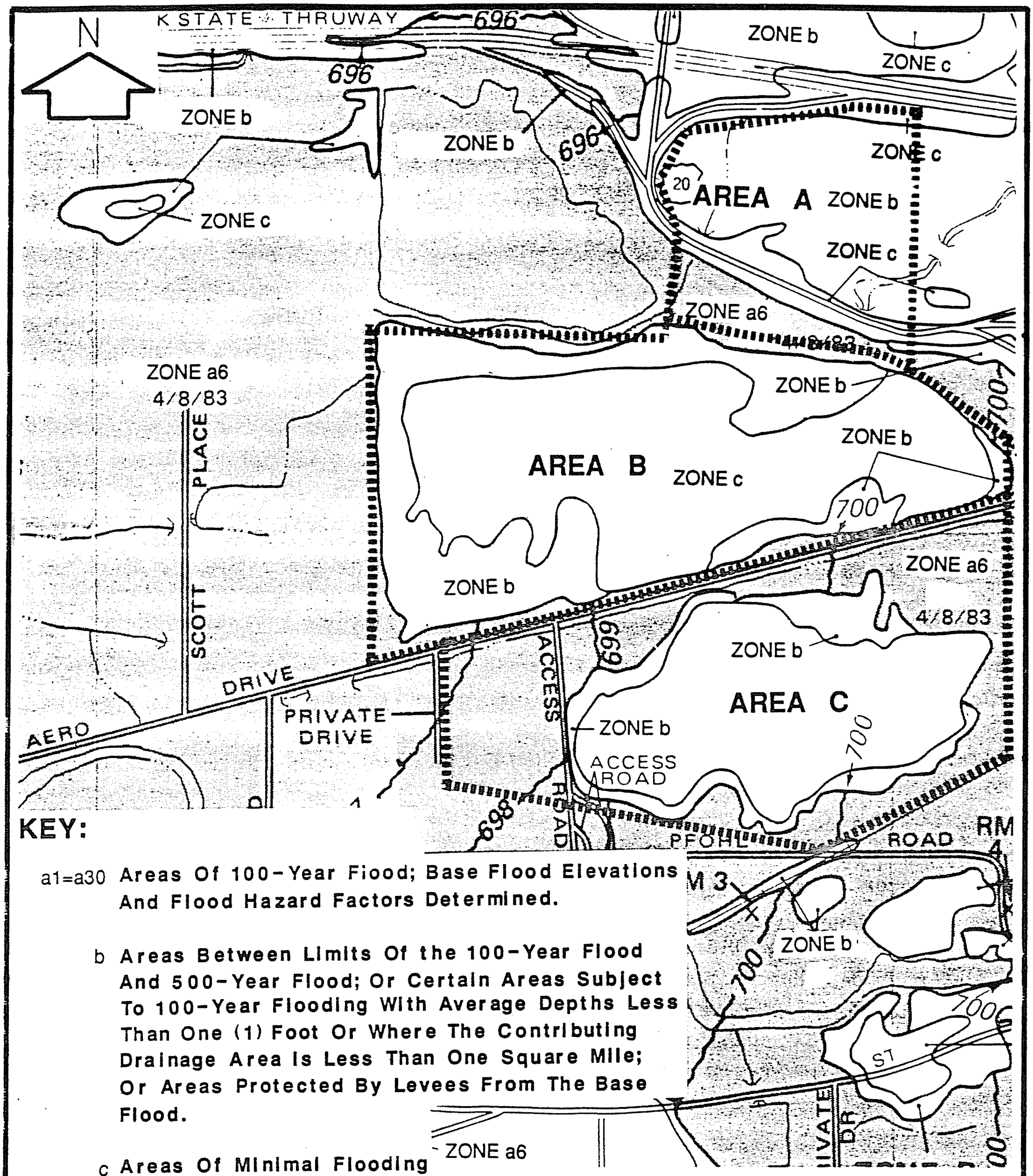
Drainage ditches run parallel to Aero Drive, the southern side of Aero Lake, and the railroad tracks that are located in the southeastern section of the site. Drainage ditches also flow along the eastern boundaries of Areas B and C.

2.12 FLOOD PLAINS

Flooding potential of the Pfohl Brothers landfill site, as mapped by the Federal Emergency Management Agency, is shown in figure 2-7. Major portions of Areas A, B, and C are subject to minimal flooding. Land areas adjacent to Aero Lake and several streams in the vicinity of the landfill are located between the limits of the 100- and 500-year flood zones.

2.13 ECOLOGY

The information and data on the ecological setting of the Pfohl Brothers site was collected during the initial site reconnaissance on March 30, 1988, and has been supplemented by observations made during field operations in the months since then. Additional information was obtained through regulators, wildlife specialists, and similar studies conducted in the area.



KEY:

a1=a30 Areas Of 100-Year Flood; Base Flood Elevations And Flood Hazard Factors Determined.

b Areas Between Limits Of the 100-Year Flood And 500-Year Flood; Or Certain Areas Subject To 100-Year Flooding With Average Depths Less Than One (1) Foot Or Where The Contributing Drainage Area Is Less Than One Square Mile; Or Areas Protected By Levees From The Base Flood.

c Areas Of Minimal Flooding

Not To Scale

SOURCE: Federal Emergency Management Agency, 1983
(Modified By CDM, 1990)

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Figure 2-7
Pfohl Brothers Landfill Site
Flood Potential

Pfohl Brothers Landfill, Cheektowaga, New York

2.13.1 HABITAT TYPES

The Pfohl Brothers landfill site is predominantly an upland area. Land in the immediate vicinity of the site is mostly urbanized. A considerable number of stream and creek corridors run through it. The majority of the site itself is overgrown with vegetation typical of a disturbed environment.

The vegetation and terrain are quite similar across Areas B and C. Topographic lows, found throughout both areas, are either moist or contain pools of standing water. Active animal burrows are abundant, posing a hazard to foot travel.

The underbrush across most portions of Areas B and C is very thick. Dominant plants include reed grass (*Phragmites spp.*) and unidentified, thorny-stemmed bushes. Small, secondary-growth trees with up to 6-inch-diameter trunks are present in the heavily vegetated areas. Elsewhere, the land is open and grassy.

In contrast, Area A is largely paved over with minimal vegetation and undisturbed terrain.

2.13.2 WETLANDS

Two freshwater wetlands regulated by New York State Department of Conservation (NYSDEC) are located within and adjacent to the Pfohl Brothers site. The first is called the Buffalo Airport Wetland and is designated as LA-5 (NYSDEC 1982). The bulk of the wetland's 59 acres lies between Area B and the N.Y.S. Thruway (figure 2-8). One strip of the wetland forms the boundary between Areas A and B. The small portion of wetland east of Transit Road lies within the Urbanized Area as defined in the 1970 Bureau of Commerce Census of Housing Block Statistics Report for Buffalo.

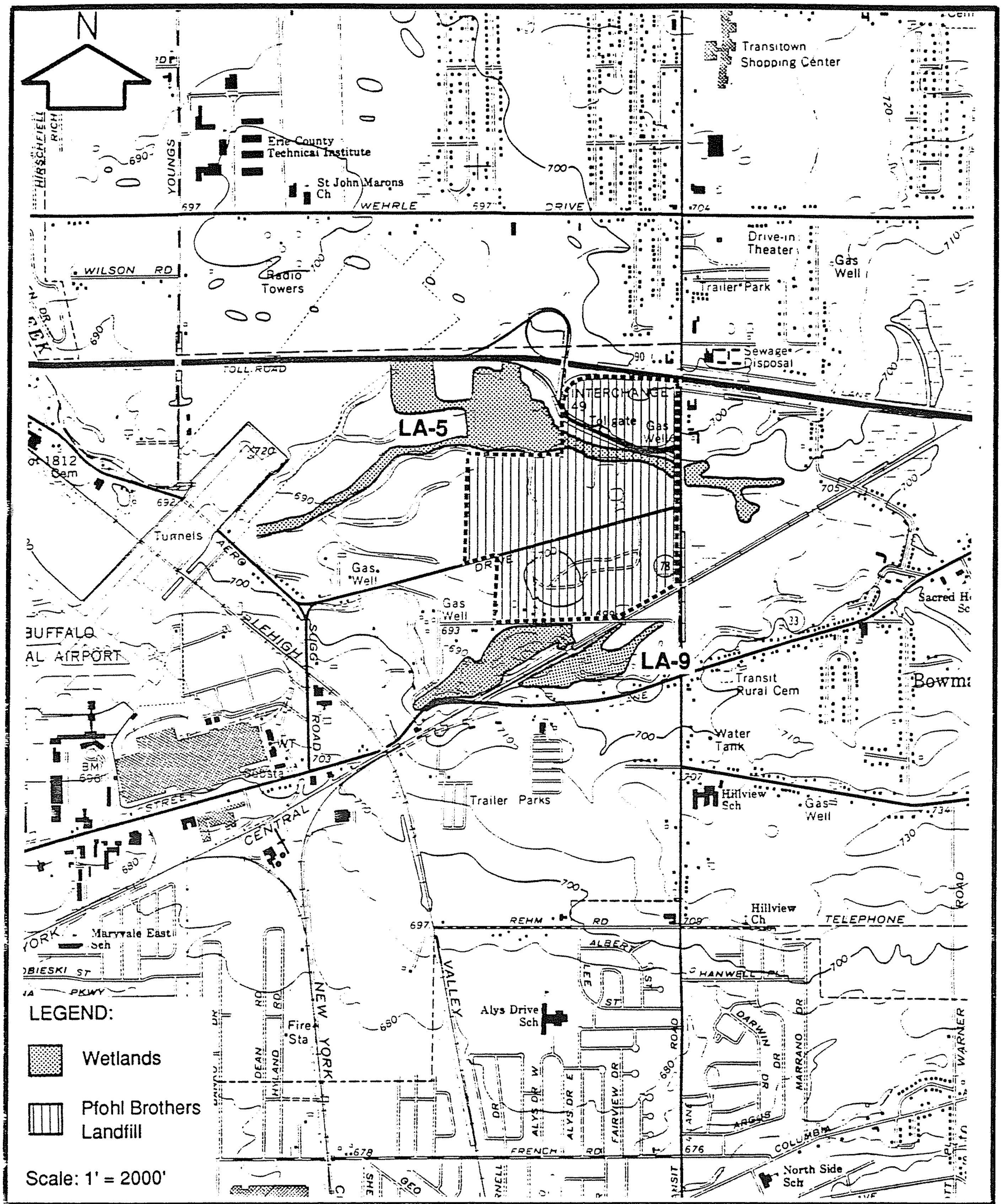

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Figure 2-8

NYSDEC
Regulated Wetlands
Pfohl Brothers Landfill, Cheektowaga, New York

The Buffalo Airport Wetland is designated as a Class II wetland because of several defining characteristics.

- A portion is located within an urbanized area.
- The wetland is contiguous to a Class C or higher stream (that is, it has intermittent stream connection to Ellicott Creek).
- The wetland has archaeological and/or paleontological significance.
- The wetland is one of the three largest wetlands in the town of Cheektowaga.
- The wetland contains two or more wetland structural groups (that is, herbaceous, woody, and water).

Five vegetative cover types occur with the Buffalo Airport Wetland. Twenty-nine percent of the area is characterized as emergent marsh, 20 percent is deciduous swamp, 6 percent is shrub swamp, and 45 percent is a combination of floating/submergent vegetation and wetland open water.

Additional features of the wetland identified by NYSDEC include possible migratory bird use and a flood protection value that is probably quite high.

Freshwater wetland LA-9, the Pfohl Wetland, lies between Area C and Genesee Street to the south (figure 2-8). Also a Class II wetland (NYSDEC 1983), Pfohl Wetland possesses the same five defining characteristics as the Buffalo Airport Wetland and similarly provides "significant flood protection in a substantially developed area." The cover types at the Pfohl Wetland are deciduous swamp (32 percent), shrub swamp (56 percent), and wetland open water (12 percent). Special features noted at the Pfohl Wetland during the NYSDEC inspection include the site's use as a resident animal habitat for

white-tailed deer
raccoon
mallard
wood duck
black duck
great blue heron
muskrat
great horned owl

Furthermore, the wetland serves as a traditional migration habitat for mallard, wood duck, black duck, and wood cock. According to NYSDEC, the occurrence of diverse habitat types is why this wetland provides such good wildlife habitats. Its location in a highly urbanized area makes it unique from a local standpoint.

Special hydrological and pollution control features of the wetland were also noted during NYSDEC's site review. The Pfohl Wetland is supported primarily by Ellicott Creek and several convolutions and ponded areas associated with the creek. Thus, the floodplain nature of the wetland provides a natural storm water retention facility during peak run-off periods.

2.13.3 WILDLIFE

In addition to the species noted in the wetland inventory, the Pfohl Brothers landfill and its surrounding waterbodies are populated by a variety of mammals, birds, waterfowl, and fish. Small mammals that may be found on site include mink, muskrat, weasel, and beaver. Any of these species may use Ellicott Creek and Aero Lake (Roblee 1990). White-footed mice, raccoons, and cottontail rabbits are also common at the landfill (Moore 1990). White-tailed deer have also been spotted on the site; these occurrences are not unusual since the entire town of Cheektowaga is within the confines of a closed hunting area. These areas are specified portions of New York State where the taking of deer is prohibited by the Environmental Conservation Law (Snyder 1990).

A number of bird and water fowl species are known to populate the area. The Buffalo Museum of Science has a checklist of birds populating the Niagara Frontier that includes more than 300 species (Clark 1990). Common species at the Pfohl Brothers site include pheasants, wood cocks, Canadian geese, mallards, diving ducks, and other water birds using Aero Lake and Ellicott Creek. Other common species of birds that typically frequent disturbed lands and may be found at the site include sparrows, crows, red-winged blackbirds, gulls, mourning doves, killdeer, and robins (D'virka and Bartilucci Consulting Engineers 1989). The osprey, which may soon be delisted from its status as a threatened species to one of special concern, and the bald eagle, an endangered species, may use the Cheektowaga area (as well as other areas in western New York) not as a residence, but as a migratory route (Moore 1990). Otherwise, no endangered bird species are known to reside in the vicinity of the Pfohl Brothers site (Clark 1990).

Aero Lake and Ellicott Creek contain a variety of freshwater fish. Individuals from the most abundant species were collected during a 1988 NYSDEC sampling program (Skinner 1988). They are listed in table 2-1. Other species noted during that sampling event are also listed in table 2-1 (Mooradian 1990). Additional species identified in Aero Lake, Ellicott Creek (near the airport and in Bowmansville), and from a tributary to Ellicott Creek are listed in table 2-1 (Skinner 1990).

TABLE 2-1

Freshwater Fish Found in the Surface Waters
Near the Pfohl Brothers Landfill

Collected in 1988	Observed in 1988	Collected in 1990
Black crappy	Blunt-nose minnow	Bluegill
Bluegill	Green sunfish	Brown bullhead
Large-mouth bass	Hogsucker	Common shiner
Pumpkinseed	Johnny darter	Large-mouth bass
Rockbass	Rainbow darter	Northernpike
White sucker	Rainbow trout	Rockbass
	Stone rollers	White sucker

Although the reptile and amphibian populations are relatively small, several snakes, probably water snakes, have been spotted at the Pfohl Brothers site.

2.13.4 SIGNIFICANT HABITATS AND SPECIES OF SPECIAL CONCERN

Having reviewed the files of the Significant Habitat Program and the Natural Heritage Program, NYSDEC has concluded that there is no information to indicate the presence of rare or endangered elements, natural communities, or other significant habitats at the Pfohl Brothers site. As such, no potential impacts to endangered, threatened, or special concern wildlife species; rare plant, animal, or natural community occurrences; or other significant habitats were identified. Although these conclusions are not based on site-specific surveys and should not be taken as a definitive statement on the presence or absence of particular species, habitats, or communities (Buffington 1990), the extent of development at the site minimizes the chance of occurrence of significant species or habitats (Moore 1990). According to NYSDEC's Region 9 Wildlife Manager, no such ecological features are found there (Moore 1990).

2.14 SUMMARY OF EXISTING CONDITIONS

For purposes of this investigation, the landfill has been divided into three geographical areas. These are areas A, B, and C.

Area A, located north of the New York State Thruway access ramp, is occupied by a private trucking firm that has placed fill material over a large portion of the area in order to elevate the land surface. A large metal building is located north of the access ramp along with a number of tractors and trailers.

Area B, located south of Area A, is situated between Transit Road and Aero Drive. This portion of the site consists of undulating terrain with thick underbrush, phragmites and thorny-stemmed bushes. Small secondary growth trees are present. The area is littered with bottles, household refuse, tires, tubing, scrap metal, refrigerators, construction materials and rusted sections of car bodies. Several drum disposal areas exist, in which many of the drums are rusted, corroded, and crushed. Oil slicks have been noted on the water surface in the wetland area parallel to Aero Drive near the intersection with Transit Road. Aero Lake, formed from a borrow pit, is located in the northwest corner of Area B. This 40-acre lake was originated from a borrow pit excavated for fill material during the construction of the New York State Thruway. The lake is currently used by local residents for fishing and boating. It may also be used occasionally for swimming.

Area C is situated south of Aero Drive and west of Transit Road. The area closely resembles Area B with respect to the distribution and occurrence of drums, sludge debris, terrain, vegetation, and leachate seeps. Several drum disposal areas are located within this area. An active truck repair company is situated in Area C, approximately 975 feet from the intersection of Transit Road and Aero Drive. South of Area C, there are several private residences. Ellicott Creek, a major tributary to the Erie-Niagara Basin, is located approximately 1,000 feet south of Area C. The creek is primarily used for primary contact recreation and fishing.

The entire landfill, except for the area along the northern perimeter of Area B and southeast corner of Area C, is fenced. "No Trespassing" and "Hazardous Waste Area" signs are posted along the border of the site. The site is predominately an upland area. Land in the immediate vicinity of the site is mostly urbanized. Two freshwater wetlands regulated by New York State Department of Environmental Conservation (NYSDEC) are located within and adjacent to the site. The site is used as a resident animal habitat for white-tailed deer, and small mammals, birds, and ducks. White-footed mice, raccoons, and cottontail rabbits are also common at the landfill. There is no information available that indicates the presence of rare or endangered species at the site.

The elevation of the landfill ranges between 3 to 4 feet above the normal elevation of 690 feet. Most of the native soils have been removed and replaced with other soil types. Area A has mostly loamy, earthy fill material, mixed with construction and demolition debris. Areas B and C consist primarily of fill material, including trash and refuse, partially covered or mixed with earthy material.

The advancement, melting, and subsequent retreat of the glacial ice sheet resulted in the deposition of till and lacustrine sediments in the area now occupied by the Pfohl Brothers Landfill. The lacustrine deposits typically consist of clay with discontinuous stringers of very fine sand and silt. The near surface deposits at the site, a mixture of silty clay and sand, are glaciofluvial and lacustrine in origin. Basal glacial sediments in contact with the bedrock were deposited as a compact lodgement till. The underlying Onondaga Limestone is the principal aquifer within the study area. Most of ground water flow is through secondary porosity features such as interconnected solution cavities and fractures.

Recharge to the unconsolidated aquifer comes from precipitation which averages about 36 inches per year. Recharge to the bedrock aquifer occurs by direct infiltration of precipitation, vertical recharge from the overlying unconsolidated aquifer, and, to some extent, vertical leakage of surface waters.

According to personnel from the Erie County Department of Health, there are private wells within less than 0.5 mile radius of the site. These wells were constructed in the unconsolidated aquifer and were used prior to 1983 as a source of potable water. In 1983, the water district within the area of the Pfohl Brothers landfill was formed and public water lines were installed. Currently there is no known homes or businesses within a 0.5 mile radius using private wells in the unconsolidated aquifer for potable purposes. However, some homeowners in the area use their wells for lawn watering and/or cleaning their cars. There is a potable water supply well, constructed within the bedrock aquifer, located on a commercial property to the east of Area A. Based on the current understanding of the bedrock aquifer flow patterns, this well should not be affected by contaminant migration from the landfill. This is being investigated further by the New York State Department of Health.

The Buffalo Crushed Stone Company (BCS) quarry, located a little more than a mile east of the study area, utilizes two dewatering pumps, each capable of purging 400,000 gallons/hour per pump. The water is either discharged to Ellicott Creek via a drainage ditch, or used in the on-site processing plant. The cone of depression created by the dewatering operations extends to within 5,000 feet of Transit Road, east of the landfill. As a result, it does not appear that quarry dewatering is drawing contaminants towards the quarry.

(PBLF5/8)MP

Section 3

3.0 STUDY AREA INVESTIGATIONS

The remedial investigation (Phase I) for the Pfohl Brothers landfill site consisted primarily of six major field activities. These included:

- Geophysical Survey
- Surface Water, Leachate Seep, and Sediment Sampling
- Gamma Survey - Phases I and II
- Test Pit Investigation
- Soil Boring Investigation
- Ground Water Investigation

Additionally, NYSDEC and the New York State Department of Health (NYSDOH) collected supplemental data on ground water, surface water, surface soil and sediment quality from April 1989 through June 1990. These data are presented in separate reports prepared by NYSDEC and NYSDOH (Table 3-1).

The following information presents an overview of each field activity. A summary description of each activity is provided in table 3-2. Details on each of these activities are provided in the interim reports prepared by CDM, and the supplemental reports prepared by the NYSDEC and NYSDOH. This section of the report focuses on the physical environment of the site, including the geologic and hydrogeologic characteristics. A detailed discussion of the analytical sampling results is presented in section 4.0, Nature and Extent of Contamination. A complete listing of samples collected and analyses performed can be found in Appendix A.

3.1 GEOPHYSICAL SURVEY

In September 1988, Camp Dresser & McKee (CDM) contracted with Technos Inc., through Larsen Engineers, to conduct a geophysical survey at the Pfohl Brothers landfill. The objectives of the survey were to

- Locate and map the boundaries of the landfill material.
- Locate and map any trenches within Areas B and C.
- Determine the nature of the fill material (ferrous vs. non-ferrous) within the trenches.
- Locate and map clusters of drums.

TABLE 3-1

LIST OF INTERIM REPORTS ON REMEDIAL INVESTIGATIONS AT THE PFOHL BROTHERS LANDFILL SITE

Camp Dresser & McKee. 1989. Report on the Phase I Walk Over Gamma Radiation Survey at the Pfohl Brothers Landfill, Cheektowaga, New York. Camp Dresser & McKee, New York, New York. Report prepared for the New York State Department of Environmental Conservation, Albany, New York.

Camp Dresser & McKee. 1990. Interim Report on Leachate, Surface Water and Sediment Investigation, Pfohl Brothers Landfill, Cheektowaga, New York. Camp Dresser & McKee, New York, New York. Report prepared for the New York State Department of Environmental Conservation, Albany, New York.

Camp Dresser & McKee. 1990. Interim Report on the Phase II Radiation Investigation, Pfohl Brothers Landfill, Cheektowaga, New York. Camp Dresser & McKee, New York, New York. Report prepared for the New York State Department of Environmental Conservation, Albany, New York.

New York State Department of Health and New York State Department of Environmental Conservation. 1989. Radiochemical Analysis, Pfohl Brothers Landfill, Cheektowaga, New York.

New York State Department of Health and New York State Department of Environmental Conservation. 1990. Radiochemical Analysis Addendum No. 1: Groundwater, Pfohl Brothers Landfill, Cheektowaga, New York.

New York State Department of Health and New York State Department of Environmental Conservation. 1990. Radiochemical Analysis Addendum No. 2: Soil/Waste Sampling, Pfohl Brothers Landfill, Cheektowaga, New York.

New York State Department of Health and New York State Department of Environmental Conservation. 1990. June 1990 Supplemental Sampling, Pfohl Brothers Landfill, Cheektowaga, New York.

Camp Dresser & McKee. 1990. Interim Report on the Drum Investigation, Pfohl Brothers Landfill, Cheektowaga, New York. Camp Dresser & McKee, New York, New York. Report prepared for the New York State Department of Environmental Conservation, Albany, New York.

Camp Dresser & McKee. 1990. Interim Report on the Soil Borings and Ground Water Investigation. Camp Dresser & McKee, New York, New York. Report prepared for the New York State Department of Environmental Conservation, Albany, New York.

Technos Inc. 1988. Geophysical Survey of the Pfohl Brothers Landfill, Cheektowaga, New York. Technos Inc, Consultant in Applied Earth Sciences, Miami, Florida. Report prepared for Camp Dresser & McKee.

TABLE 3-2

SUMMARY OF REMEDIAL INVESTIGATIONS PERFORMED BY CAMP DRESSER & McKEE

Dates	Activity	Scope-of-Work	Objectives
3/88	Initial Site Reconnaissance	Walk-Over & Surveillance	o To gather new field data and verify previous field observations & historical information.
	Site Clearing	Conventional hand-held equipment for clearing lines (traverses) 50 feet apart across the landfill.	o To gain access to sampling locations and improve visibility of surface conditions.
9/88	Geophysical Investigation Conductivity.	Magnetometry & Terrain	o Locate & map boundaries of the landfill. o Locate & map trenches in Areas B & C. o Determine the nature of the fill material. o Locate & map clusters of drums.
11/11-18/88	Site Survey	Walk-Over/Surveillance & field monitoring	o Document the location & magnitude of exposed drums over each 50 foot traverse. o Perform a gamma radiation survey over each traverse & identify areas of elevated readings.
4/10-26/89	Surface Water, Sediment & Leachate Seep Sampling	Surface water & sediments (16) were collected from Aero Lake, drainage ditches & Ellicott Creek. Leachate seep & sediments (18) were collected along the perimeter of the landfill. Samples were analyzed for TCL parameters. Select leachate & surface water samples were analyzed for conventional parameters. Sediment samples were analyzed for radiological constituents.	o Characterize the nature & extent of chemical & radiological surface contamination potentially migrating off-site.
4/17-27/89	Gamma Survey Phase I	Two to four personnel walked four straight lines between 50 foot traverses & measured gamma readings 2" off the ground.	o Obtain a better understanding of the nature & extent of gamma readings across the site.

TABLE 3-2

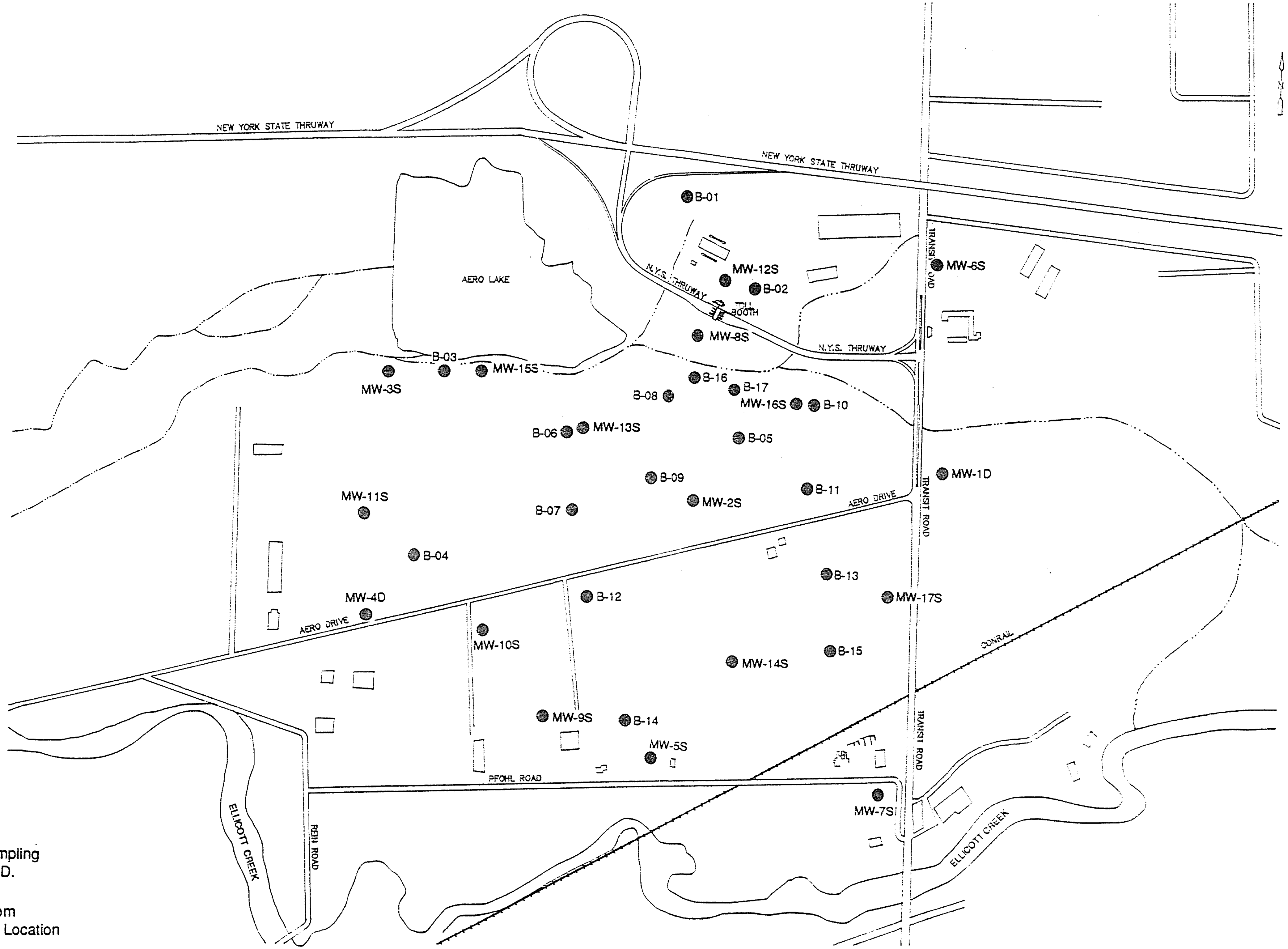
SUMMARY OF REMEDIAL INVESTIGATIONS PERFORMED BY CAMP DRESSER & McKEE
(Continued)

Dates	Activity	Scope-of-Work	Objectives
9/89-10/89	Gamma Survey Phase II	A total of 172 source characterizations were investigated. A shovel was used to move material from the area with the highest gamma readings; a hand auger was used at greater depths. Test pits or "digs" were excavated at six locations and samples were collected from all artifacts and surrounding soils. Selected samples were analyzed for radiological constituents.	o To characterize the type of contamination on-site by performing confirmatory activities.
10/88-12/89	Soil Boring Investigation	Soil borings (17) were installed by hollow-stem auger. Two borings were installed in Area A, eleven in Area B, and four in Area C. Analytical samples were taken from each borehole and analyzed for TCL parameters.	o Characterize local hydrogeology, extent of soil contamination, thickness of fill material & depth to bedrock. o Assist in the interpretations of the geophysical & test pit data.
10/11-11/89	Test Pit Investigation	A total of 42 test pits were excavated; 27 in Area B & 15 in Area C. Waste samples were collected from all accessible drums and from stained soils. At least one sample per pit was analyzed for TCL parameters; 11 samples were also analyzed for 2,3,7,8-TCDD.	o Provide a better understanding of the general nature & distribution of contamination within the landfill by the excavation of test pits & sampling of selected drums, waste material and native soil. o Confirm the results of the geophysical survey & investigate anamalous zones to allow a better interpretation of the geophysical data. o Provide chemical/engineering data for identifying appropriate remedial technologies.
10/88-12/89	Ground Water Investigation	Installation of 24 monitoring wells consisting of 6 off-site	o Define the hydrogeologic conditions at the site.

TABLE 3-2

SUMMARY OF REMEDIAL INVESTIGATIONS PERFORMED BY CAMP DRESSER & McKEE
(Continued)

Dates	Activity	Scope-of-Work	Objectives
		well clusters, one on-site well cluster, and nine shallow monitoring wells using the hollow stem auger technique. Soil samples were collected during installation & analyzed for TCL parameters. Hydraulic test were performed on each well. Six (6) rounds of water level measurements were performed. Two rounds of ground water samples were collected and analyzed for TCL parameters, radiological constituents and 2,3,7,8-TCDD. Select samples were analyzed for conventional parameters & dissolved metals.	o Collect ground water samples to identify potential ground water contamination in both the unconsolidated and bedrock aquifers.
	Aerial photography, surveying and topographic mapping	Provide aerial photography & mapping for entire landfill site at 100 foot scale with 1 foot contours tied to the NGS system. Establish project baseline/benchmark. Provide property line survey/map/ and set 25 corners of site. Establish 50 foot grid covering the site and a 200 foot ban outside of the landfill boundaries. Locate horizontal & vertical monitoring wells. Survey selected property lines in preparation for installation of a boundary fence.	o To establish longitudinal, latitudinal, location & elevation control.



LEGEND:

● SB-06 Soil Boring Sampling Location And I.D.

● Soil Sample From Monitoring Well Location

Scale: 1" = 650'

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New York, New York 10005

Figure 3-3
Soil Boring Sampling Locations

Pfohl Brothers Landfill, Cheektowaga, New York

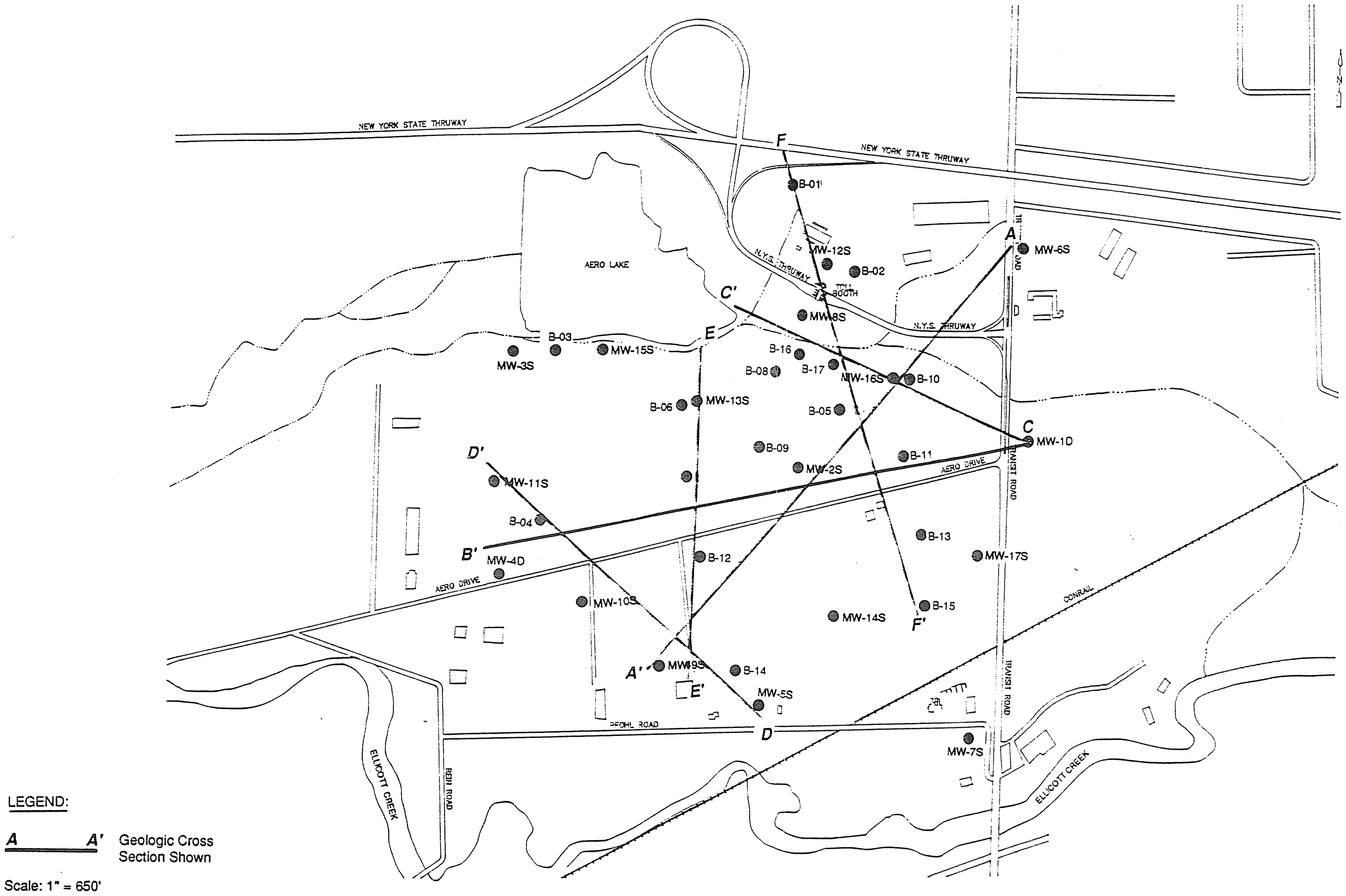

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Figure 3-4

Cross Section Location Map

Pfohl Brothers Landfill, Cheektowaga, New York

067420

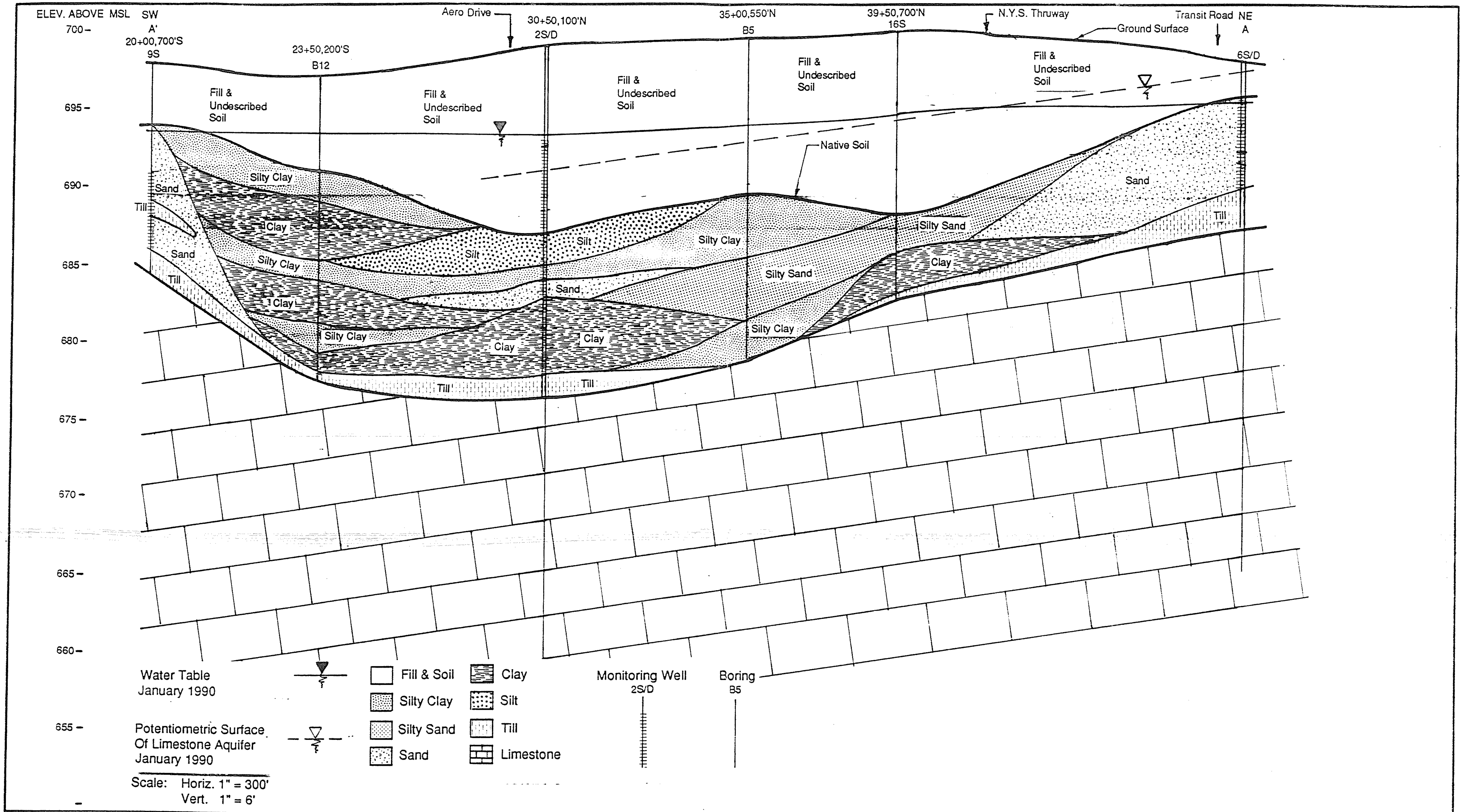

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Figure 3-5

Geologic Cross Section A-A'

Pfohl Brothers Landfill, Cheektowaga, New York

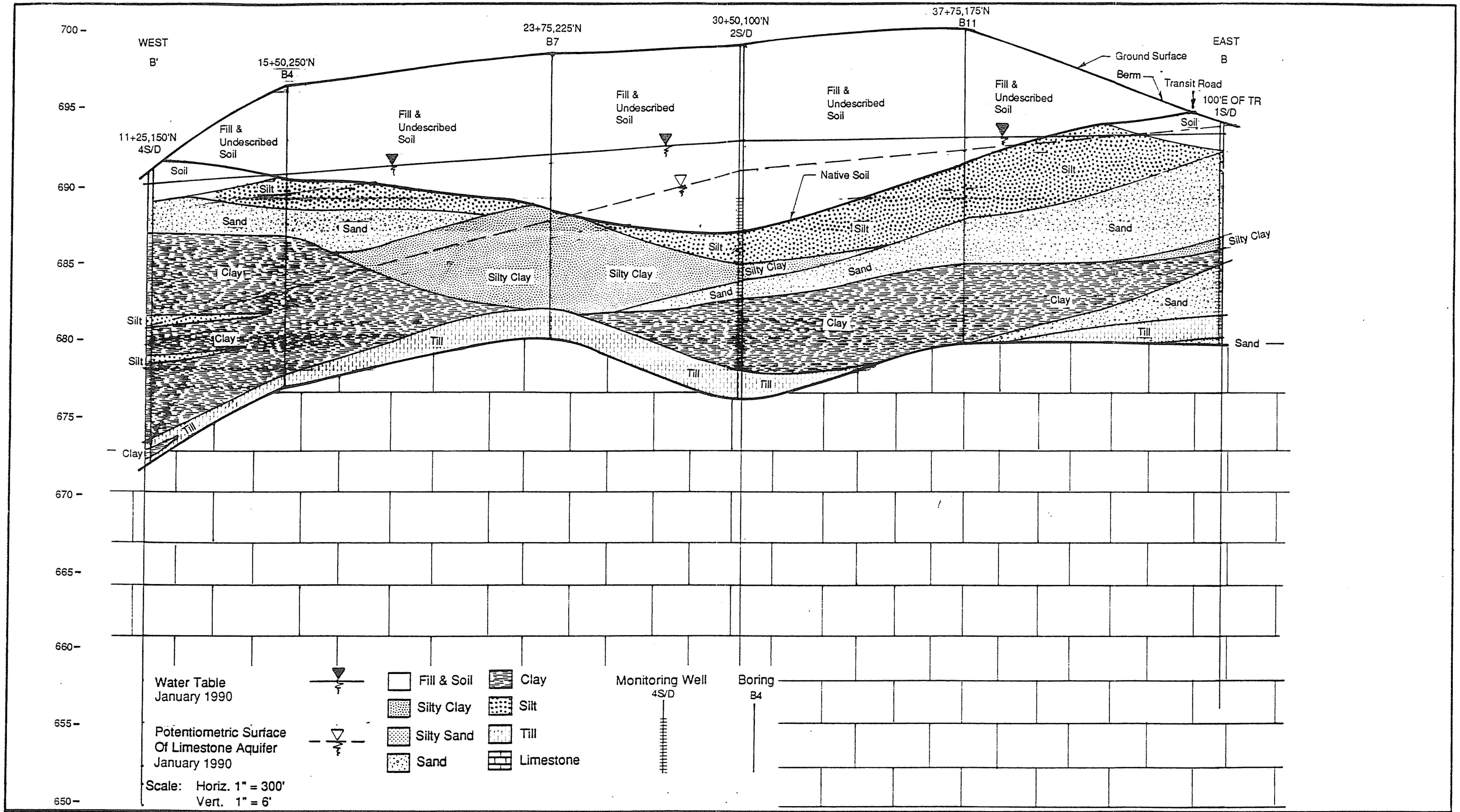

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Figure 3-6

Geologic Cross Section B-B'

Pfohl Brothers Landfill, Cheektowaga, New York

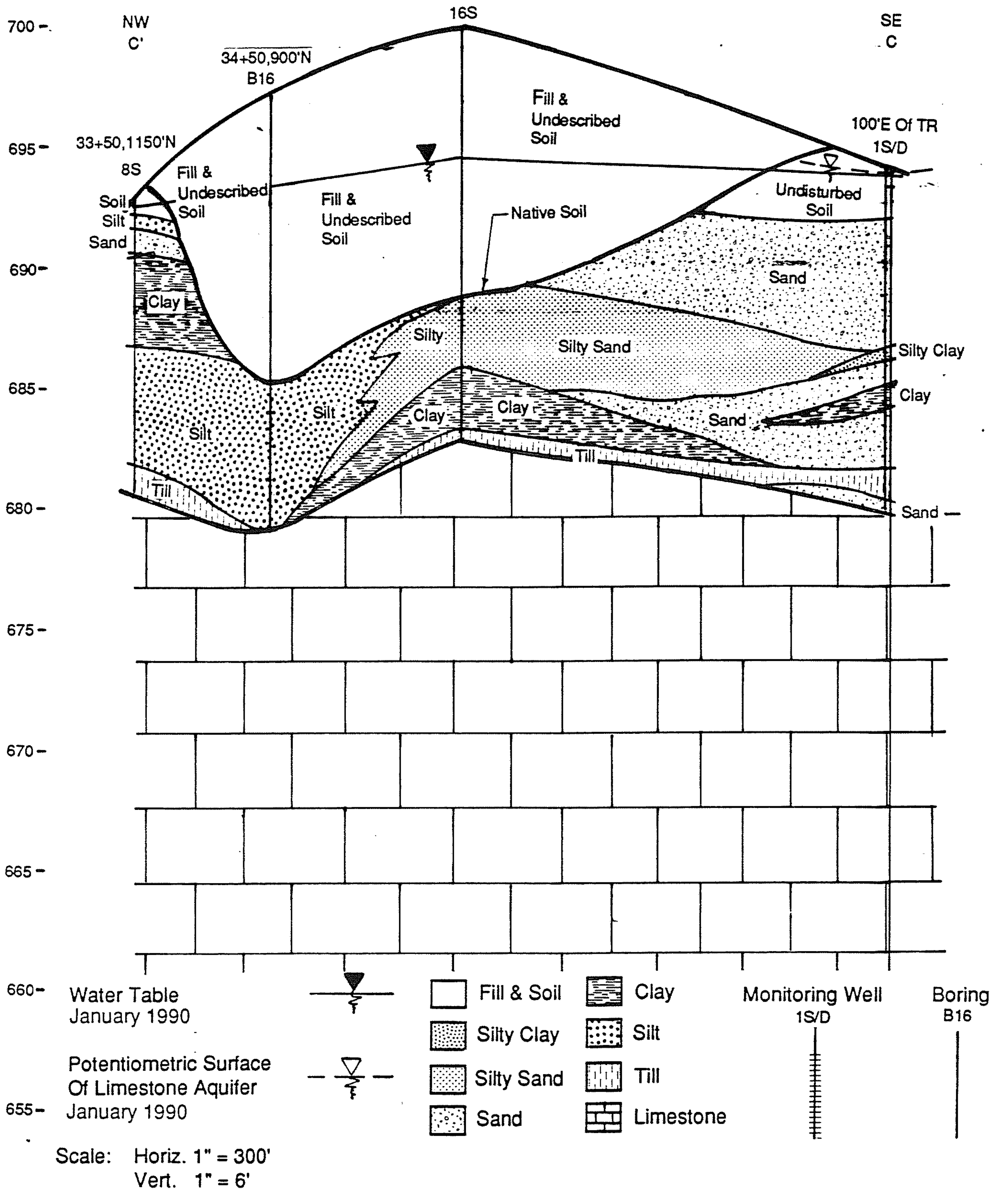

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Figure 3-7

Geologic Cross Section C-C'

Pfohl Brothers Landfill, Cheektowaga, New York

The surveys were conducted using magnetic and electromagnetic techniques. Surveys were performed along lines spaced 50 feet apart, and the data were continuously recorded. Approximately 26 linear miles of magnetometer and electromagnetic data were collected.

The purpose of the magnetometer survey was to detect the presence of ferrous metals and locate trenches, possibly filled with steel drums to depths of approximately 6 to 8 feet.

The electromagnetic survey was used to map electrical conductivity variations, as well as to identify ferrous and non-ferrous metals, such as buried pipes, drums, tanks, or scrap metal to a depth of approximately 20 feet.

Data from this investigation revealed a high ferrous metal content with low conductivity in Area A, indicating that the soils may contain construction debris.

Magnetometry data for Area B indicated an extensive amount of ferrous metal was present. Conductivity data for most of Area B were unusable due to a strong influence from the presence of metals. The western and northeastern boundaries of Area B~~,~~ however, were well defined by both the magnetometer and conductivity data; the north, east, and southern boundaries were less clearly defined. The sharp decrease to background conductivity values along the western and northeastern boundaries implies that there was no detectable inorganic contaminant migration off site in those areas.

The presence of ferrous metals decreased along Aero Drive, but some targets were still detected. Aero Drive appeared to constitute the southern boundary of Area B. A strong magnetic response in a topographically elevated area running parallel to Aero Creek, coupled with a noticeable drop in magnetic response in the creek itself, suggests that the creek may be the northern boundary. The general trend shows that the area of large magnetic response is concentrated toward the creek and decreases toward Aero Drive.

The magnetic data indicate that almost all of Area C is covered with ferrous metals to some extent, although to a lesser degree than Area B. The highest magnetic response was measured in the middle of Area C. The northern boundary of Area C appeared to be Aero Drive and possibly south of Aero Drive toward the east. Ferrous metals were not detected south of Pfohl Road. Conductivity data were again unusable for most of Area C due to a strong influence from the presence of metals. The boundaries of Area C were better defined by the magnetometer data. The western boundary was estimated to be in close proximity to traverse 25+50. However, because of the numerous random targets throughout the area, no clear boundaries were observed. The only portion in Area C where the extent of inorganic contaminant migration could be clearly assessed was in the northeast corner of the site where conductivity values decreased to background levels.

3.2 SURFACE WATER, LEACHATE SEEP, AND SEDIMENT SAMPLING

In April 1989, CDM collected a total of 16 surface water/sediment and 18 leachate seep/sediment samples on and around the Pfohl Brothers landfill site. The locations of the sampling stations are presented on figure 3-1. Samples were collected to determine the nature and extent of contaminant migration associated with surface water and seeps at the landfill.

Surface water samples were collected in Aero Lake and Ellicott Creek, and in intermittent streams or drainage ditches around the site. Sampling was performed during the spring when ground water and surface water levels were at their highest stages and the leachate seeps reached maximum flows. Sampling locations were selected that would provide full area coverage of the landfill and the water bodies on and off site.

At the onset of the leachate seep sampling event, a total of 40 seeps was observed in Areas B and C. No leachate seeps were observed in Area A. Of the 40 seeps, 18 sampling locations were selected. The criteria used in selecting the seep locations included flow conditions (that is, volume of flow), relative location of the seeps (proximity to residences and/or receiving waters), and relative position to other leachate seep sampling locations.

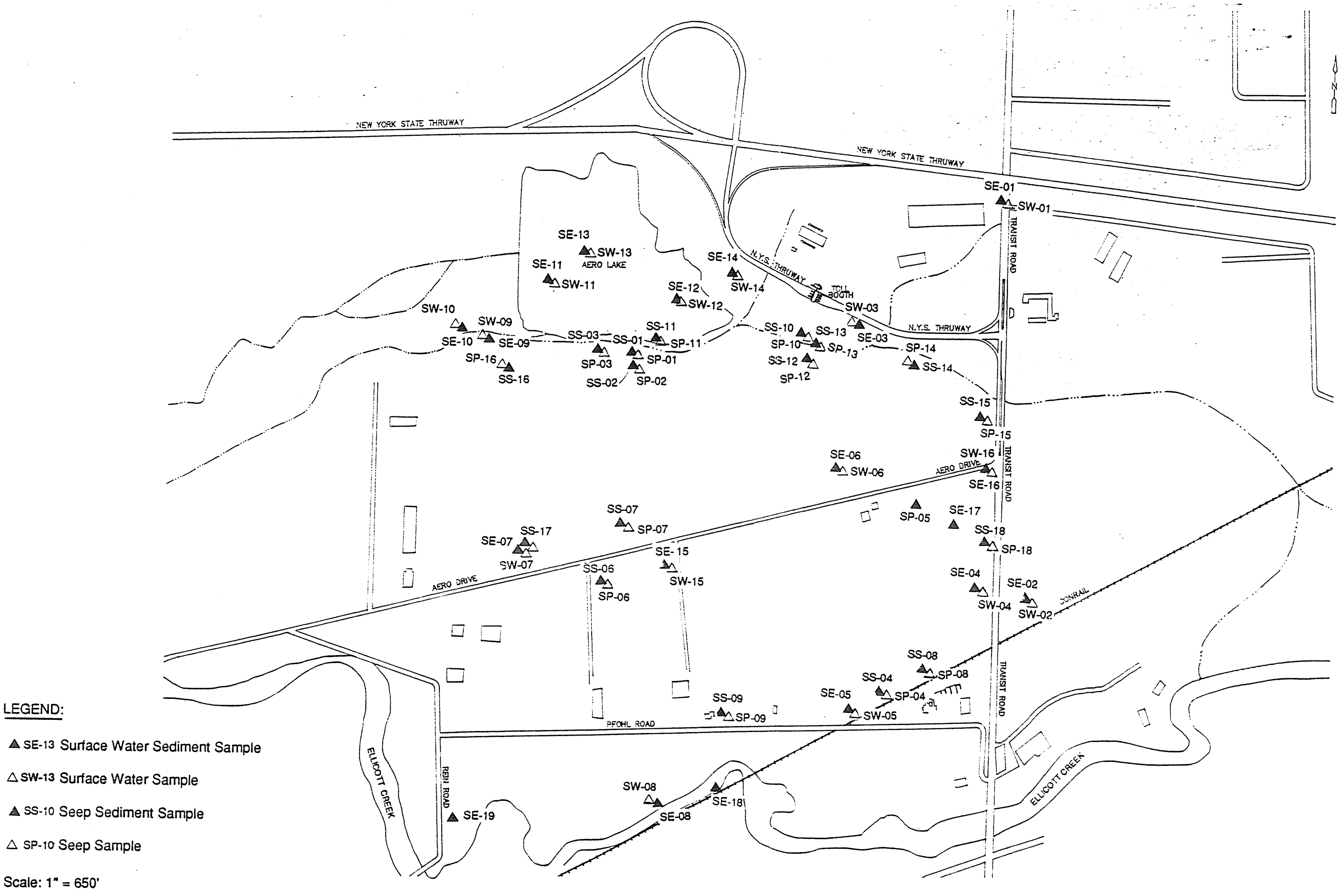

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Figure 3-1
Surface Water, Seep And
Sediment Sampling Locations
Pfohl Brothers Landfill, Cheektowaga, New York

The flow rate of many of the surface water drainage ditches and intermittent streams were negligible, with the exception of sample stations SW-1 and SW-3 where the flow rate was estimated at 10 gpm. Most of the seeps also had neglible flow rates. A flow rate of 0.5 gpm was measured at sample location SP-6. Stations SP-5, SP-9, and SP-11 revealed slightly higher flow rates of approximately 3, 10, and 15 gpm, respectively.

3.3 GAMMA SURVEY - PHASE I

In September 1988, CDM performed an initial radiation investigation that involved a walk-over gamma radiation survey along paths that had been cleared across the landfill. The paths were cleared along lines running in a north-south direction across the landfill, spaced 50 feet apart. These cleared paths became known as traverses.

The results of the fall investigation prompted an additional gamma radiation (Phase I) survey that was performed in April 1989. The Phase I gamma survey was conducted in areas on and between the existing traverses in order to better characterize the extent or frequency of spots with elevated radiation levels. Both the initial and the phase I gamma radiation "walk-over" surveys were performed by CDM employees using a 2- by 2-inch sodium iodide gamma scintillation detector with a portable ratemeter.

Several areas of elevated gamma radiation were found to exist at the site--one large area in Area B and four major areas in Area C. The highest gamma radiation measurements were not found in any one specific location, but were scattered throughout these areas. The sources of the elevated measurements were both natural materials (such as rocks and coal ash) and man-made materials (such as metal rods and disks).

The man-made objects could be broken down into three main categories: machined metal materials such as rods, disks, and other metal objects; white sandy or vermiculite material (presumably originating from drums); and finally, building materials such as tar or cement-covered objects. Due to the low energy emissions of the machined metal materials, detection of all such objects was not possible because their emissions were easily shielded by soil cover.

In Area C, the extent and level of contamination was more difficult to define due to the wetness of the area. The moisture in the soil could have attenuated the gamma measurements enough so that areas with elevated gamma radiation presented readings at background or just slightly greater than background and, therefore, were undetected during the surveys.

3.4 GAMMA SURVEY - PHASE II

In September and December 1989, CDM performed a second radiation survey to better characterize the nature and extent of radiological contamination. Subsurface surveys were conducted at identified locations of elevated gamma radiation. The source material was sampled to identify and quantify the radionuclides responsible for the elevated measurements. Because so many locations were identified during Phase I and because the source of the elevated measurements was often within the first foot of soil, the Phase II radiation survey was modified to include an interim phase of exploratory sampling (digs) of the subsurface soil beneath the representative locations.

Few patterns were found to exist for locations of elevated gamma radiation identified in Area B. In general, a white material resembling vermiculite was found within 300 to the south of Aero Creek. The only exception to this was in the center of Area B (traverse 26+00 to 29+50) where the material was found from 450 to 650 feet north of Aero Drive. In addition, several drums were found with elevated gamma readings; all of which contained the white chunks of material. Construction materials and rocks accounted for much of the elevated readings along the northeast edge of this area. Metallic discs and artifacts were found dispersed across Area B in a random manner, with somewhat more found in the northwest corner of the area.

The contamination in Area C was found in four general areas. In the first area, coal ash ranged from traverse 18+50 to 26+00, 75 to 1,075 feet south of Aero Drive. The surface soil in this entire area was elevated to approximately 15,000 counts per minute (cpm). A few discs with very high gamma radiation readings (2.0 to 2.6 million cpm) were also found in this area.

The second area, from traverse 27+50 to 32+50, 840 to 1,240 feet south of Aero Drive, consisted of elevated levels of sand and rocks; a drum containing material with elevated gamma reading was also found. Rocks and construction material were also the source of elevated gamma readings in the third area, from traverse 31+00 to 34+00, 150 to 650 feet south of Aero Drive; several locations with the white vermiculite material were also noted.

In the fourth area, from traverse 34+00 to 40+00, 550 to 1,100 feet south of Aero Drive, the source of elevated readings was extremely variable, including rocks, white material, coal ash, and metal artifacts. In general, fewer artifacts were found in Area C, but no pattern of contamination existed for them.

Most investigations were ended after excavating only one foot of soil because the source material was identified. The deepest investigation went to 3.5 feet. In approximately 20 locations, no source was found and the reading at the bottom of the hole was either the highest in the hole or was still considerably elevated relative to background. The results of the gamma radiation scans of the test pits, and downhole gamma logging of the boreholes that were located in areas of background gamma radiation indicate that large areas of subsurface radiological contamination are not present at the site. The contamination appears to be scattered randomly throughout Areas B and C, and, except for the few locations noted above, appears as isolated spots with small quantities of industrial waste.

Subsurface gamma radiation measurements were also obtained during the soil boring and ground water investigation. At ten locations, a PVC pipe was inserted into each borehole to prevent collapse (the PVC pipe was not required if the borehole was less than 5 feet deep). The gamma scintillometer was lowered down the borehole and the gamma exposure rates were recorded at 6-inch intervals until the total depth of the borehole was reached. Although these boreholes were not placed in areas of elevated gamma radiation, the information gained was useful because it was the only deep (greater than 3 feet) subsurface radiation information collected on the site.

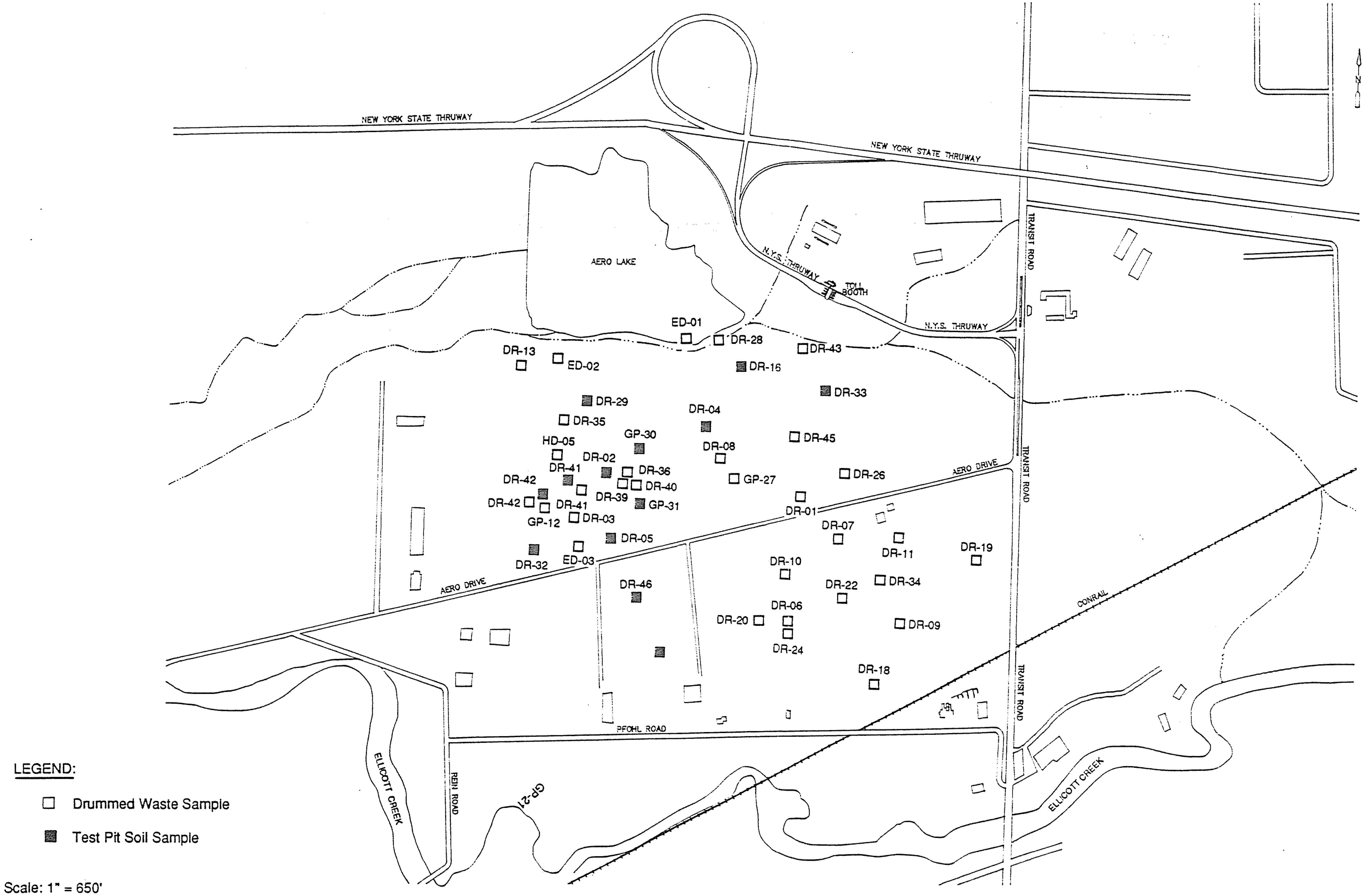
The borehole gamma survey results for borings B-3, B-4, B-5, B-7, B-9, B-10, B-11 and B-13 ranged from 1,470 cpm to 10,450 cpm. All readings above the background level of 12,000 cpm were considered elevated. The highest readings on the site were logged in boreholes B-12 and B-14. Gamma readings in these boreholes reach as high as 13,740 and 15,940, respectively. The elevated readings appeared to correspond in depth to regions where coal ash was identified.

3.5 TEST PIT INVESTIGATION

From October 3 through November 9, 1989, CDM performed a test pit investigation at 42 locations on the Pfohl Brothers landfill site. The test pit locations are shown on figure 3-2. The test pit logs detailing the conditions encountered during the investigation are included in appendix B.

The objectives of this investigation were to provide information on the general subsurface conditions of the landfill, the number and distribution of drums, sources of elevated gamma readings, identification of suspected trenches evidenced in aerial photographs, and identification of potential responsible parties (PRP) through markings on the drums.

During the excavation of the first ten test pits, only three drums were unearthed. Since the primary objective of this investigation was to locate drums and characterize the contents of each, the remaining test pits were excavated in those areas where there was a higher likelihood of encountering drums (that is, areas where partially exposed drums were observed). As such, test pit locations were subsequently chosen in those areas of the landfill where the heaviest concentrations of exposed drums were evidenced.



LEGEND:

☐ Drummed Waste Sample

■ Test Pit Soil Sample

Scale: 1" = 650'

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Figure 3-2

Test Pit Sampling Locations

Pfohl Brothers Landfill, Cheektowaga, New York

CDM subcontracted Sevenson Environmental Services (SES) of Buffalo, New York, to excavate the test pits and assist in the sampling. The test pits were excavated using a track-mounted backhoe that was capable of extending 28 feet.

The excavations were terminated upon reaching the native soil horizon. In most instances, a sample was collected and retained from the native soil. The test pits were then backfilled with the soil and fill that were originally removed from the excavation.

A total of 113 drums was observed at the site during the drum investigation. Some of the drums were partially full; others were empty. The majority of the buried drums and almost all of the crushed drums at the surface were empty. The material that was remaining in the drums varied in color and texture.

A total of 64 drums was observed in Area B, with the majority of the drums (36) located in the western region. A large number of drums (20) was also encountered in the central region.

A total of 49 drums was observed in Area C. The central and eastern regions were found to contain a similar number of drums (25 and 24, respectively). No drums were encountered in the western region. In the eastern region of Area C, leaking drums were found to be stacked in rows of three or more and most were situated below the surface of the water table. Ground water was encountered in 27 of the 42 test pits.

The trench identified in a 1964 aerial photograph in the northeast region of Area B was confirmed by test pit 33. In this pit, refuse was observed down to bedrock--a depth of 8 feet. The layer of undisturbed clayey soil above the bedrock that was observed in many of the other test pits was not evidenced at this location. The fact that waste was directly in contact with bedrock indicates there is a potential conduit for contaminant migration directly into the bedrock at this location.
The drum investigation did not provide useful information regarding the identification of potential responsible parties because most of the drums

were unmarked or crushed to the point that any markings were indistinguishable.

Much of the landfilled material consisted of household garbage, as well as rubber products, wood, wire, coal ash, newsprint, and other paper products. The soil was stained black in many of the test pits. Most test pits contained construction debris consisting of insulation, roofing material, and cinder blocks. In addition, excavations uncovered scrap metal, which occasionally consisted of large home appliances.

Drums were found at 27 of the 42 test pit locations; however, far fewer drums were unearthed than originally anticipated. Apparently, the anomalous magnetic and electromagnetic readings recorded during the geophysical survey were the result of buried metals other than drums.

3.6 SOIL BORING INVESTIGATION

In October 1988 and from October to December 1989, CDM supervised the installation and sampling of 17 exploratory borings in Areas A, B, and C. Two borings were installed in Area A, 11 in Area B, and 4 in Area C. The locations of the boreholes are shown on figure 3-3. Split-spoon samples were selected from each borehole using the following criteria:

- Total volatile organic content measured in the sample headspace and in the split spoon sample.
- Visual observations (that is, stains or discolorations).
- Geologic profile (for example, change in soil type).
- Sample depth.
- Hydraulic profile (such as saturated vs. unsaturated strata).

Selected samples from each borehole were shipped to Keystone Laboratories for analysis of Target Compound List (TCL) parameters, plus cyanide.

Several glaciofluvial deposits were identified beneath the trash as shown on the soil boring logs in appendix C. The upper layer of glacial deposits consisted of discontinuous layers of clay, silt, sand, silty clay, and silty sand. The majority of the borings encountered between zero and 2 feet of till at the base of the boring. The till consisted of a mixture of silty sand, gravel, and clay. A cross section location plan is presented in figure 3-4. Geological cross sections illustrating these strata are shown in figures 3-5 through 3-10.

Fill material was encountered in nearly every boring, ranging in thickness from 6 to 22 feet (plate 1). The thickness of the fill layer was greatest in the western portion of Area B (maximum of 22 feet) and the eastern portion of Area C (maximum of 14 feet). The thickness of fill decreased to between 6 and 8 feet in Area A.

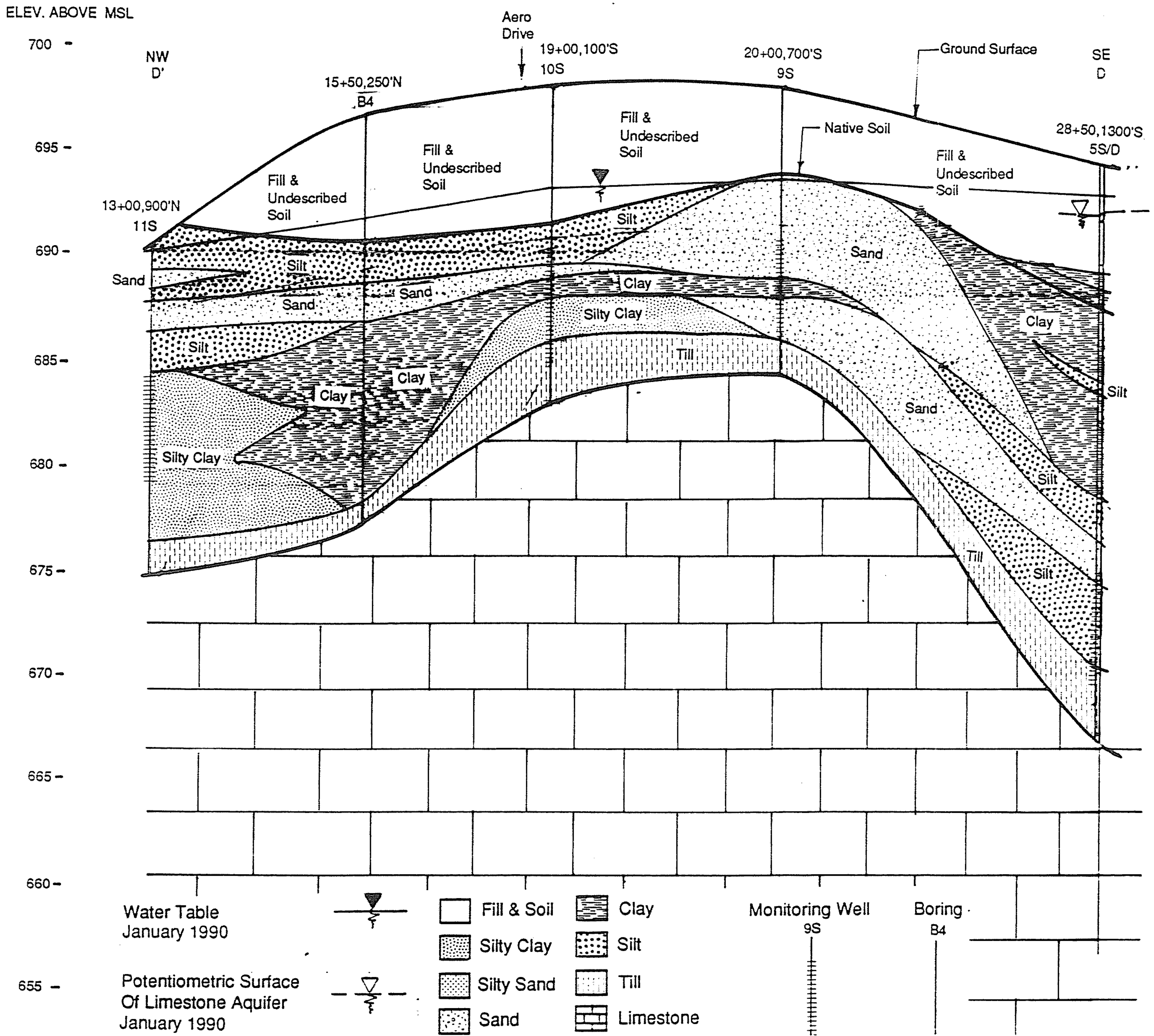
The thickness of the native soil varied considerably across the site. The undisturbed native soil in the western portion of Area B was at least 8 feet in thickness and approximately 36 feet in thickness in the eastern portion of Area C (plate 2). Approximately 6 feet of native soil was encountered in the eastern portion of Area B.

The location of the trench, identified on historic aerial photographs and reportedly excavated down to bedrock, was not confirmed in any of the borings. However, the location was confirmed in the northeastern portion of Area B during the excavation of test pit 33, as mentioned previously. Although the test pit verified the existence of a trench, the boundaries of a trench were not defined.

A contour map of the bedrock surface was constructed from borehole data and is shown in plate 3. The general slope of the bedrock surface is from north to south. The bedrock is nearest the land surface in the northeastern corner of the site, and deepest in the southeastern corner near well 7S/7D. A slight mound exists in the southwestern corner of the site near wells 10S and 9S.

3.7 GROUND WATER INVESTIGATION

From October to December 1989, a total of 24 monitoring wells were installed in and around the site. Seven of these wells were installed as paired wells; one well extended through the glacial deposits to the bedrock surface and its counterpart extended 20 feet into the bedrock (appendix D).



Scale: Horiz. 1" = 300'
Vert. 1" = 6'

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Figure 3-8

Geologic Cross Section D-D'

Pfohl Brothers Landfill, Cheektowaga, New York

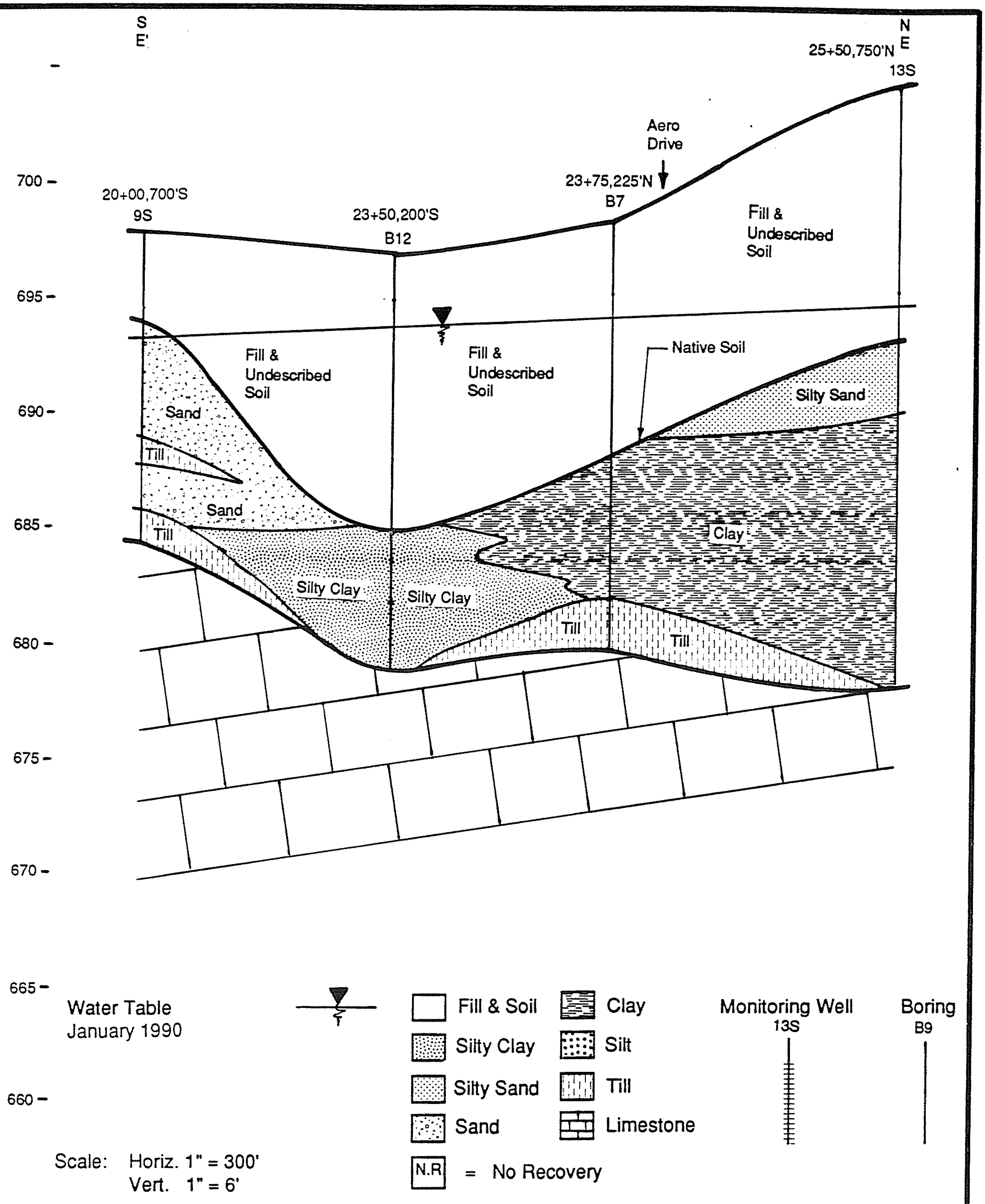

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Figure 3-9

Geologic Cross Section E-E'

Pfohl Brothers Landfill, Cheektowaga, New York

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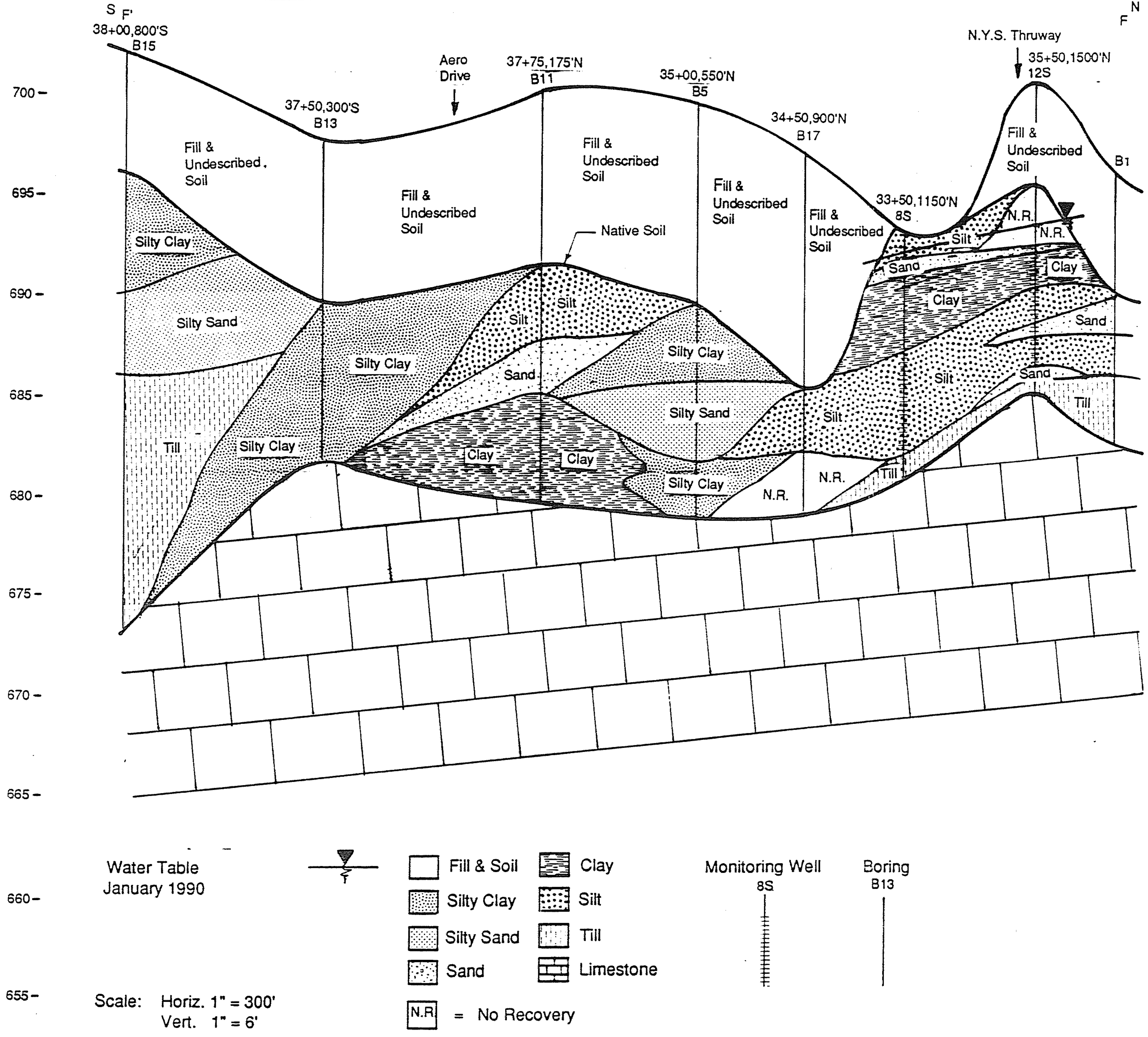

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Figure 3-10

Geologic Cross Section F-F'

Pfohl Brothers Landfill, Cheektowaga, New York

These well pairs were used to evaluate the hydraulic and chemical characteristics across the unconsolidated (shallow) and bedrock (deep) aquifers.

Monitoring wells were installed in selected locations (figure 3-11) that would provide a broad view of the soil and ground water contamination in and around the entire site. Well pair 6S/6D was installed approximately 1,000 feet northeast of the landfill to provide background soil and ground water quality data.

Three water table maps (plates 4 through 6) were constructed from water level measurements taken from the unconsolidated wells in January, May, and June 1990. These maps illustrate that the water table fluctuates significantly from season to season. During the month of May, the direction of ground water moves radially outward from the landfill. In the months of January and June, ground water moves radially outward from the site in all directions, except to the northeast.

Regionally, ground water in the shallow unconsolidated aquifer flows south-southwest under an average hydraulic gradient of 0.0029. The water table maps indicate that the unconsolidated aquifer is discharging into Aero Lake and Ellicott Creek. Without additional wells south of Ellicott Creek, however, it is unknown at this time if the creek serves as a no-flow boundary.

Low stress hydraulic tests (slug tests) were conducted on most wells, however, most of the data were not usable. The change-in-head measurements that were recorded in several wells showed either extreme oscillation or insufficient head displacement by the slug. The almost instantaneous response in head that was observed is contrary to the response typically

expected from wells installed in lacustrine environments. The relatively flat response of the slug tests indicates a high conductivity. The effective radius (hydraulic stress) of the slug test apparently was not great enough, and the test results are a measure of the permeability of the coarse sand filter pack that is surrounding the well screen.

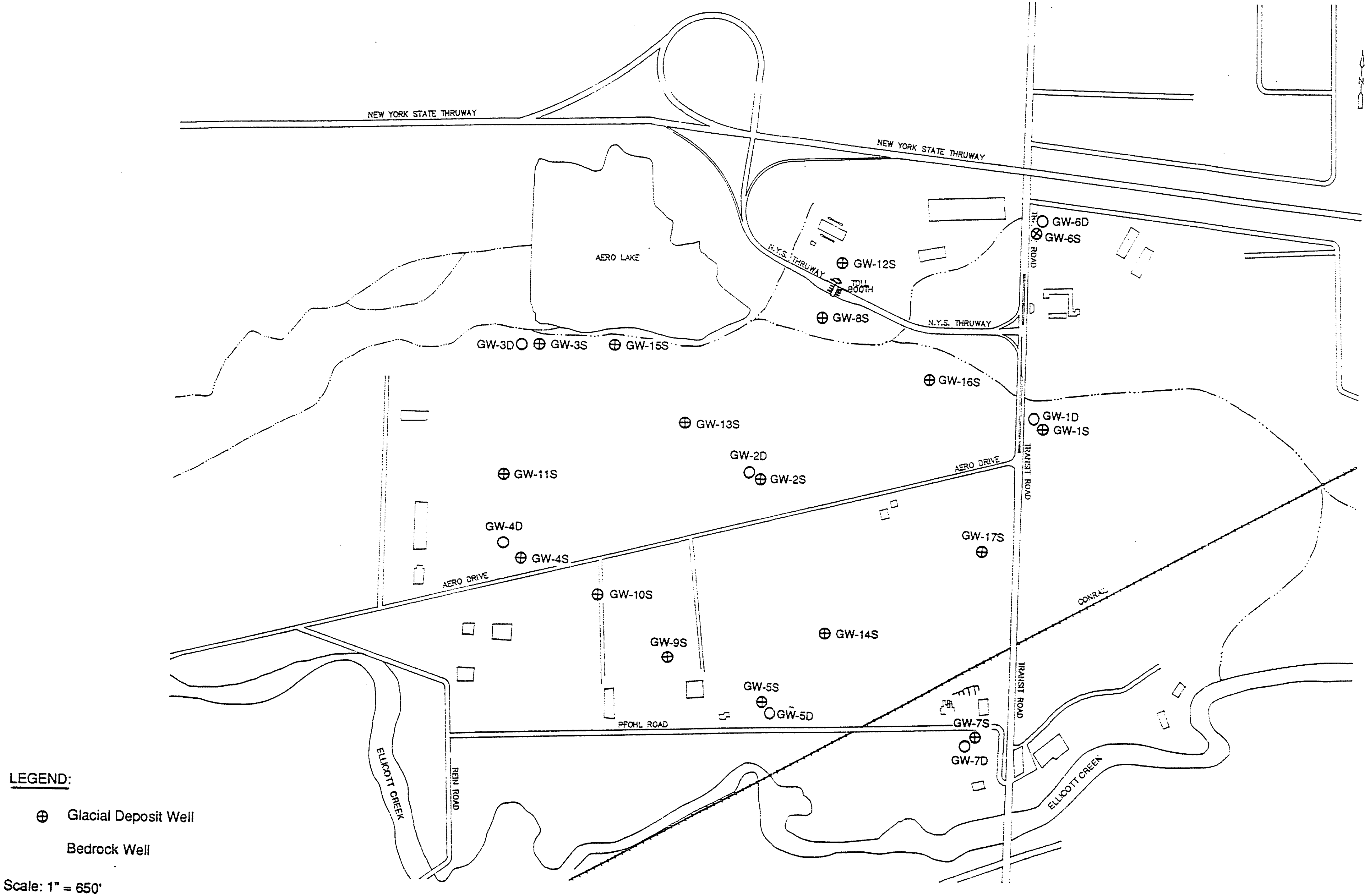

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Figure 3-11

Ground Water Sampling Locations

Pfohl Brothers Landfill, Cheektowaga, New York

The oscillation in head that appeared during the early portion of several tests was possibly caused by the inertia of the initial change in hydraulic head. In other words, the oscillation could be similar to ripples that are created upon throwing a pebble into a puddle. In retrospect, a larger slug and/or a wider diameter well may have resulted in improved and consistent slug testing data.

Based on the usable results of the slug tests (appendix E), the average hydraulic conductivity of the shallow wells was found to be 23 feet per day. This value is within the range reported by D'virka and Bartilucci Consulting Engineers (1989) for the Union Road site and is within the range typical of silty and fine sands (Fetter 1988). However, water levels in the shallow wells fluctuate significantly throughout the year indicating a low hydraulic conductivity. Therefore, the hydraulic conductivity of the unconsolidated aquifer may be lower than that determined by slug testing. Additional hydraulic testing would be necessary in order to refine the hydraulic conductivity value.

Walton (1985) suggests that the range for effective porosity of sandy clays is from 3 to 20 percent. Assuming an average effective porosity of the lacustrine deposits of approximately 12 percent, the average linear velocity of ground water moving through the glacial aquifer is estimated at 0.57 feet per day, or 208 feet per year.

Elevation contour maps of the potentiometric surface of the limestone aquifer, shown on plates 7 through 9, were constructed from water level measurements taken in January, May, and June 1990. The maps do not show significant seasonal variations in the water level of the bedrock aquifer. The hydraulic head across all three maps suggest that ground water enters the site from the northeast. If an isotropic flow field is assumed, water entering the ground water flow system near well 6S would be driven south/southeasterly under an average hydraulic gradient of 0.0043, and southwesterly under a hydraulic gradient of 0.0040.

Fracture occurrence may have a significant influence on the direction of ground water flow. If the hydraulic behavior of the limestone aquifer is anisotropic, the hydraulic gradient observed on the potentiometric maps (plates 7 through 9) may not accurately indicate flow direction. Given the northeast and northwest fracture orientation observed by LaSala (1968) and Goldberg-Zoino Associates (1984), ground water could possibly flow preferentially along fracture pathways. If this were the case, the bulk of contaminants in the ground water would migrate from the site preferentially through fractures (as opposed to diffuse flow) in a southeast and southwest direction.

A potentiometric ridge evidenced in the south-central portion of the site may indicate that ground water in the overlying glacial sediments is recharging the bedrock aquifer in the southern portion of the site. A consistent downward gradient is observed at well pairs 2S/2D, 5S/5D, 4S/4D, and 7S/7D, thus, supporting the notion of vertical recharge. However, water levels measured in paired wells located in the northern portion of the site (1S/1D, 3S/3D, and 6S/6D) indicate that there is a potential for upward vertical flow across the bedrock/soil contact.

The degree of hydraulic interconnection between the bedrock aquifers was evaluated by comparing the water level data in each of the bedrock wells (appendix F). With the exception of 4D, all bedrock wells showed a consistent pattern of rising and falling water levels from January to May, May to June, and June to August 1990. This pattern suggested that most of the bedrock wells were hydraulically connected. Further, observations between the water levels in each of the well pairs, showed consistent fluctuations in rising and falling water levels only in wells 3S/3D, 6S/6D, and 7S/7D during this same period. Long-term monitoring of water levels and/or pumping tests are necessary to confirm and fully evaluate the hydraulic interconnection between the bedrock and unconsolidated aquifers.

By comparing the elevation of the potentiometric surface observed in wells 4D, 5D, and 7D to the land surface contours along Ellicott Creek, it does not appear that ground water from the bedrock aquifer is discharging to the creek. However, it is possible that ground water flowing through near surface fractures in the bedrock may discharge to the shallow ground water system of the Ellicott Creek drainage basin. Stage measurements, combined with water level measurements in wells south of the creek, are required to confirm these speculations.

Only five (1D, 2D, 3D, 5D, and 6D) of the seven bedrock wells intercepted significant water bearing fractures. These wells produced a sufficient volume of water for specific capacity measurements. The values of transmissivity that were derived from specific capacity tests are presented in appendix G. The values of transmissivity range from 180 to 8440 square feet a day.

Slug testing also provided useful information regarding the hydraulic characteristics of the bedrock wells. Although quantitative values derived from applying traditional granular porous-media slug test solution methods to fractured media are questionable, slug tests can still be useful for evaluating the relative permeability of the bedrock wells. The transmissivity values determined from slug testing the bedrock wells range from approximately 1 to 3750 square feet a day. The results of the slug test analyses using the Hvorslev (1951) method for confined aquifers are also provided in appendix G.

The hydraulic conductivity of the bedrock aquifer and velocity of the ground water is not possible to determine with the existing data. Better estimates of saturated thickness and effective porosity are necessary before a reasonable estimate of velocity is possible. A more accurate estimate of these hydraulic parameters could be obtained through pump, packer and tracer testing and, the use of down-hole velocity meters in conjunction with surface and borehole geophysical testing.

In general, hydraulic testing of the bedrock wells illustrates that there is extreme variability in hydraulic conductivity across the landfill. Additional hydraulic stress tests would be necessary to accurately determine the hydraulic parameters and anisotropy of the bedrock aquifer.

3.8 SUMMARY OF STUDY AREA INVESTIGATIONS

The Phase I remedial investigation for the Pfohl Brothers landfill

consisted primarily of six major field activities. These included a geophysical survey, sampling of surface water, leachate seep and sediments, gamma surveys, test pit investigations, soil boring installations, and ground water testing.
The results of these investigations indicate that the landfill contains large quantities of household garbage, rubber products, wood, wire, coal ash, scrap metal, drums, and large home appliances.

A total of 113 drums were observed in the landfill. Some of the drums were partially full; others were empty. The majority of the buried drums, and almost all of the crushed drums at the surface, were empty. A total of 64 drums was found in Area B, with the majority of the drums located in the western and central regions. A total of 49 drums were observed in Area C; most of the drums were located in the central and eastern regions. The leaking drums were stacked in rows of at least three and were situated below the surface of the water table in the eastern region of Area C.

Radiological contamination appears to be scattered randomly throughout Areas B and C, and, except for the few locations, appears as isolated spots with small quantities of industrial waste. The sources of elevated gamma readings are attributed to both natural materials (such as rocks and coal ash) and man-made materials (construction debris, metal rods and disks, and white vermiculite material).

Leachate seeps (at least 40) flow from the surface of the landfill in early spring. Some of the leachate seeps are in relatively close proximity to residents. In some locations, leachate seeps flow into drainage ditches located along the perimeter of the landfill where they eventually enter Aero Lake and Ellicott Creek.

Several glaciofluvial deposits are found beneath the trash. The upper layer of glacial deposits consist of discontinuous layers of clay, silt, sand, silty clay, and silty sand. A till layer, ranging from zero to two feet overlays the bedrock. Fill material ranges in thickness from 6 to 22 feet. During the excavation of testpit 33 in the northeastern region of Area B (figure 3-2), it was revealed that the clay layers and basal till had been stripped away during landfilling operations. It is possible that similar deep "trenches" exist at other locations across the landfill. In an area of the landfill were the vertical hydraulic gradient is downward, the absence of clay and till could provide a conduit that allows contaminants to migrate from the overlying soils and ground water to the bedrock aquifer.

The ground water in the unconsolidated aquifer flows in a south-southwest direction and discharges to both Aero Lake and Ellicott Creek. During the month of May, the shallow ground water moves radially outward from the landfill. In the months of January and June, ground water moves radially outward from the site in all directions, except to the northeast. The average linear velocity of ground water moving through the glacial aquifer is estimated at 0.57 feet per day, or 208 feet per year.

Ground water within the bedrock aquifer beneath the site generally flows in a south/southeasterly and southwesterly direction. However, the velocity of ground water in the bedrock aquifer cannot be accurately determined with existing data. Fracture occurrence may have a significant influence on the direction of ground water flow. If such fractures exist, the bulk of contaminants in the ground water would migrate from the site preferentially through fractures in a southeast and southwest direction. Most of the bedrock wells appear to be hydraulically connected. Long-term monitoring of water levels and/or pumping tests are necessary to confirm and fully evaluate the hydraulic interconnection between the bedrock and unconsolidated aquifers. It appears that ground water in the bedrock aquifer is not recharging the creek.

(PBLF5/5)MP

Section 4

4.0 NATURE AND EXTENT OF CONTAMINATION

4.1 INTRODUCTION

The purpose of this section is to present the nature and extent of contamination at the Pfohl Brothers landfill and to identify site-related contaminants that exceed Applicable or Relevant and Appropriate Requirements (ARARs). This section discusses the occurrence and distribution of organic and inorganic constituents at the site. A complete list of the samples collected during the remedial investigation and the analyses performed are included in appendix A. A complete set of analytical data for these samples, used in this presentation, is also found in the appendices. All sampling locations are depicted in plate 10.

Because there was no significant trend or pattern observed in the distribution of contaminants across the site and because natural environmental influences (i.e., geochemistry) may have a significant impact on the concentrations of certain inorganic constituents in various media, the organic and inorganic data are analyzed separately.

The first step in the analyses of the organic and inorganic constituents involved establishing baseline quality for the various sample media. Compounds that exceeded their perspective reference concentrations were subsequently divided into eleven chemical groups based on similarities in their chemical structures and physical properties. The eleven groups are:

- Aromatics: benzene, toluene, xylenes, chlorobenzene, ethyl benzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and benzoic acid
- Phenolics: phenol, 2-chlorophenol, 2,4-dimethylphenol, 2-methylphenol, 4-methylphenol, and pentachlorophenol
- Polycyclic Aromatic Hydrocarbons
- Halogenated Hydrocarbons: chloroethane, 1,1-dichloroethane, 1,2-trans-dichloroethene, 1,1,1-trichloroethane, trichloroethene, 1,1-dichloroethene, and tetrachloroethene
- Ketones: 2-butanone and 4-methyl-2-pentanone

- Furans: dibenzofuran
- Phthalate Esters: bis(2-ethylhexyl)phthalate, di-n-octyl phthalate, di-n-butyl phthalate, diethylphthalate, butyl benzyl phthalate, and dimethyl phthalate
- Pesticides: aldrin, alpha-, beta-, and gamma-BHC, gamma-chlordane, DDD, DDT, endrin, endosulfan, heptachlor, heptachlor epoxide, endosulfan sulfate, dieldrin, and methoxychlor
- Nitrogen Compounds: n-nitrosodiphenylamine
- Polychlorinated Biphenyls: Aroclor 1242, Aroclor 1248, Aroclor 1254, and Aroclor 1260
- Inorganics: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, zinc, and cyanide

Although the inorganics are grouped as a category, individual inorganic parameters were evaluated separately since they may not share similar physical or chemical properties in the environment.

2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) data for the various sample media were presented in tabular form and discussed separately in the narrative.

The concentrations of the organic and inorganic compounds were determined and portrayed as concentration "dot plots" and presented as various sized symbols to indicate concentration ranges per media across the site. In addition, summary tables presenting the range of concentrations for each group and distribution by media were constructed to facilitate analysis. A narrative discussing the general distribution of individual compounds by media is presented to further aid in the understanding of the nature and extent of contamination within and immediately surrounding the landfill.

The following discussion describes the approach used in evaluating the data, including a discussion of the development of background or baseline conditions, special considerations in data interpretation, and a presentation of the data by chemical groups through dot plots, summary tables, and an overview of contaminant distribution by media.

4.2 DEVELOPMENT OF BASELINE CONCENTRATIONS

Baseline concentrations for organics and inorganics were developed separately and are presented in the following sections.

4.2.1 Organic Contamination

Synthetic organic chemicals, unlike inorganic chemicals, do not typically occur in nature; most are the result of anthropogenic activities. Indeed, the presence of some petroleum-related organic chemicals in the soils and ground water in the Buffalo area may be attributable to nearby natural gas wells, Buffalo International Airport, and the N.Y.S. Thruway. The "background levels" observed there generally reflect the largely urban setting. Regional values for the Buffalo area are not available.

Because of this, a conservative approach was used in establishing the baseline concentration of organic contaminants in the various sample media. The baseline concentration of organic contaminants corresponds to their analytical detection limits. Therefore, the total concentration of organic compounds comprising a particular group are considered site contaminants at concentrations above their respective analytical detection limit. These concentrations are indicated on the dot plots and concentration range tables in each of the environmental media using these criteria.

Special consideration is given in this presentation to two of the organic compounds found at the Pfohl Brothers landfill. Both acetone and methylene chloride commonly occur in each of the media sampled in all areas of the site. However, their presence in samples collected on and offsite may not be attributable to source materials at the landfill itself. Acetone, for example, is commonly used as a solvent in analytical laboratories and for equipment decontamination in the field. Methylene chloride is also used as a common laboratory solvent and is common in soil extraction procedures. Both acetone and methylene chloride were commonly found in trip and laboratory blanks. As such, it is difficult to determine if these constituents are derived from the site, or if they were introduced into the sample during collection and/or lab analysis. For these reasons, the data summaries and subsequent evaluation do not include occurrences of acetone in the presentation of ketones, and methylene chloride concentrations are not included in the presentation of the halogenated hydrocarbons. Because acetone has been reportedly dumped at the site and is a natural degradation product of organic matter, as well as a common constituent of municipal landfill leachates, it will be discussed in the following narrative. Methylene chloride has also been reportedly dumped at the site so it, too, will be discussed further.

4.2.2 Inorganic Constituents

Twenty-four inorganics constituents were analyzed in samples collected from drummed waste and soils, shallow and deep ground water, leachate seeps and surface waters, and their corresponding sediments.

For the dot plots generated during this study, the presence of an inorganic contaminant was recorded if the concentration found in a sample exceeded the established baseline level for that particular inorganic parameter.

Ground Water

Baseline levels for ground water were based on New York State Primary and Secondary Drinking Water Standards for Ground Water. These standards identified the maximum acceptable concentrations of these 18 inorganic parameters:

- Antimony
- Arsenic
- Barium
- Beryllium
- Cadmium
- Chromium
- Copper
- Iron
- Lead
- Magnesium
- Manganese
- Mercury
- Selenium
- Silver
- Sodium
- Thallium
- Zinc
- Cyanide

The other six metals on the Target Compound List (aluminum, calcium, cobalt, nickel, potassium, and vanadium) had no corresponding standards; therefore, these metals were compared to the background water quality that was measured in monitoring wells 6S/6D. If an inorganic constituent for which a standard exists was detected in wells 6S/6D, the lower of the two values was used as the baseline concentration. The baseline concentrations for inorganic parameters found in the ground water are provided in table 4-1. A complete set of the ground water analytical data is presented in appendix H.

Soil

Soil collected from boring MW-6S was used as the baseline for subsurface soil quality. Two subsurface soil samples were collected from boring MW-6S. If similar inorganic constituents were detected in both samples, the lower of the two concentrations was used as the baseline concentration. The soil quality baseline concentrations are shown on table 4-2, and the complete set of analytical data is presented in appendix I.

To ensure representative background soil quality, each of the values presented in table 4-2 was compared to the soil quality of samples collected from an EPA study (U.S. Environmental Protection Agency 1985) in which samples of subsurface soils, presumed to be native and undisturbed, were collected from several greater Buffalo area cemeteries and parks and analyzed for seven metals (cadmium, chromium, copper, lead, mercury, nickel, and zinc). The samples were used by EPA as representative background soils in the Buffalo area. A comparison of these data with the site background samples show concentrations of the seven metals in the EPA study to be greater than those in the site background samples.

Seeps and Sediments

The seeps (leachate) occur where the water table comes in contact with the ground surface. The natural chemistry of the seeps falls somewhere between that of ground water and surface water. For this study, a conservative approach was taken in establishing the background water quality of the seeps. Ground water quality data from the shallow background well (6S) were used in establishing baseline criteria.

TABLE 4-1

BASELINE GROUND WATER QUALITY

Inorganic parameter	Symbol	Ground water standards or Guidance Values[1] (ppb)	Background well 6S/6D (ppb)
Aluminum	Al	(a)	91.0
Antimony	Sb	3.0	(b)
Arsenic	As	25.0	(b)
Barium	Ba	1,000.0	(b)
Beryllium	Be	3.0	(b)
Cadmium	Cd	10.0	(b)
Calcium	Ca	(a)	68,600.0
Chromium	Cr	50.0	(b)
Cobalt	Co	(a)	2.0
Copper	Cu	200.0	(b)
Iron	Fe	300.0	(b)
Lead	Pb	25.0	(b)
Magnesium	Mg	35,000.0	(b)
Manganese	Mn	300.0	(b)
Mercury	Hg	2.0	(b)
Nickel	Ni	(a)	13.1
Potassium	K	(a)	1850.0
Selenium	Se	10.0	(b)
Silver	Ag	50.0	(b)
Sodium	Na	20,000.0	(b)
Thallium	Tl	4.0	(b)
Vanadium	Vn	(a)	1.0
Zinc	Zn	300.0	(b)
Cyanide	CN	100.0	(b)

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[a] Standards are unavailable for these parameters.

[b] The ground water standard or guidance value was used instead of the background concentrations for these parameters.

(1) 6 NYCRR Part 703 Class GA Standards for Potable Water

(LG9/30)MP

TABLE 4-2

BASELINE SOIL QUALITY

Inorganic Parameter	Symbol	Soil (ppm)	Estimated Mean-Eastern United States (a) (mg/kg)	Estimated Mean from Buffalo/ Tonawanda (b) (mg/kg)
Aluminum	Al	4,480.0	57,000	
Antimony	Sb	12.4	0.76	
Arsenic	As	2.3	7.4	
Barium	Ba	30.6	420	
Beryllium	Be	0.02	0.85	
Cadmium	Cd	0.84	1.0 (c)	5.5
Calcium	Ca	28,000.0	6,300	
Chromium	Cr	6.8	52	15
Cobalt	Co	2.4	9.2	
Copper	Cu	11.6	22	18
Iron	Fe	7,820.0	25,000	
Lead	Pb	10.0	17 (d)	74
Magnesium	Mg	3,660.0	4,600	
Manganese	Mn	103.0	640	
Mercury	Hg	0.12	0.12	0.15
Nickel	Ni	5.9	18	23
Potassium	K	624.0	50-37,000	
Selenium	Se	0.54	0.45	
Silver	Ag	0.65	0.1	
Sodium	Na	114.0	7,800	
Thallium	Tl	0.61	8.6	
Vanadium	Vn	13.0	66	
Zinc	Zn	61.7	52	65
Cyanide	CN	0.58	--	

(a) Schaklette and Boergner, 1984.

(b) Source: EPA 1985. Data were available for these compounds only.

(c) Source: EPA 1984.

(d) Source: EPA 1982. Urban concentrations of lead in soils in the United States cities can range from 99 to 834 mg/kg.

(HA1/23)MP

A surficial soil sample (SUSL-4) collected from a protected wetland located 2.5 miles southwest of the Pfohl Brothers landfill was used as the background sample for leachate sediments. The sample was collected by D'virka and Bartilucci Consulting Engineers in 1989 as part of a phase I remedial investigation for the Union Road site in Cheektowaga, New York. The baseline concentrations for seep and sediment samples are listed in table 4-3.

Surface Water and Sediments

Surface water and sediment samples SW/SE-1 and SW/SE-14 were collected at upstream locations outside the physical boundaries of the landfill. The samples, in conjunction with the New York State Surface Water Standards for Class B (Ellicott Creek) and Class D (Aero Lake) waters, served as baseline concentrations for all surface water samples collected. Surface water sediment concentrations were compared to background concentrations. Samples SW/SE-5 and SW/SE-8 were collected in and along Ellicott Creek and, therefore, are subject to Class B surface water quality standards. Samples SW/SE-2 through SW/SE-4, SW/SE-6, and SW/SE-7, SW/SE-9 through SW/SE-13, and SW/SE-15 and SW/SE-16 were collected in and around Aero Lake and the drainage ditches and consequently were subject to Class D surface water quality standards. The lower value between the standard and the highest of the two background samples were used as the baseline criteria where standards were available. For inorganic constituents with no corresponding standards, the highest concentration found in the two background samples was used for the baseline quality for surface water. A complete set of the analytical data is presented in appendix J, and the baseline values for surface water samples and sediments are presented in table 4-4.

The analytical sampling results of subsurface soils, ground water, seeps, surface water, and sediments collected during the investigation were compared against the baseline criteria listed above in tables 4-1 through 4-4. A sample was said to contain a particular inorganic constituent when the concentration of the compound exceeded the baseline. These exceedances are displayed on dot plots, with the size of the dot corresponding to the concentration found at each location.

TABLE 4-3

BASELINE SEEP AND SEDIMENT QUALITY

Inorganic	Symbol	Seep (ppb)	Seep sediment (ppm)
Aluminum	Al	91.0	12,000.0
Antimony	Sb	24.0	10.2
Arsenic	As	1.9	12.2
Barium	Ba	30.7	47.9
Beryllium	Be	0.1	0.38
Cadmium	Cd	3.6	0.77
Calcium	Ca	111,000.0	2,980.0
Chromium	Cr	1.0	12.7
Cobalt	Co	2.0	5.5
Copper	Cu	10.6	15.4
Iron	Fe	201.0	17,900.0
Lead	Pb	5.9	741.0
Magnesium	Mg	32,400.0	2,380.0
Manganese	Mn	1080.0	228.0
Mercury	Hg	0.2	0.08
Nickel	Ni	13.1	14.1
Potassium	K	1,960.0	994.0
Selenium	Se	2.0	0.46
Silver	Ag	2.0	0.55
Sodium	Na	84,000.0	173.0
Thallium	Tl	1.0	0.28
Vanadium	Vn	1.4	21.7
Zinc	Zn	8.8	75.2
Cyanide	CN	10.0	0.67

TABLE 4-4

BASELINE SURFACE WATER AND SEDIMENT QUALITY

Inorganic	Symbol	Surface water Class B/ background (ppb)	Surface water Class D/ background (ppb)	Surface water sediment (ppm)
Aluminum	Al	77.0	77.0	7,030.0
Antimony	Sb	37.5	37.5	8.7
Arsenic	As	2.2	2.2	3.5
Barium	Ba	77.0	77.0	54.8
Beryllium	Be	0.4	0.4	0.46
Cadmium	Cd	1.7	3.5	2.3
Calcium	Ca	115,000.0	115,000.0	67,400.0
Chromium	Cr	3.4	3.4	13.2
Cobalt	Co	2.8	2.8	4.6
Copper	Cu	6.8	6.8	27.8
Iron	Fe	300.0	300.0	10,800.0
Lead	Pb	6.3	10.6	131.0
Magnesium	Mg	25,300.0	25,300.0	14,900.0
Manganese	Mn	244.0	244.0	313.0
Mercury	Hg	0.2	0.2	0.13
Nickel	Ni	12.8	12.8	12.8
Potassium	K	2,740.0	2,740.0	1,060.0
Selenium	Se	1.0	2.4	0.6
Silver	Ag	.1	3.1	0.73
Sodium	Na	308,000.0	308,000.0	545.0
Thallium	Tl	2.5	2.5	0.63
Vanadium	Vn	2.4	2.4	14.6
Zinc	Zn	30.0	33.3	165.0
Cyanide	CN	5.2	10.0	1.3

It should be noted that although each inorganic is presented and later discussed in a uniform manner, they do not all possess uniform status as potential pollutants. This is particularly true for aluminum, calcium, iron, magnesium, and potassium. All five metals were detected at high concentrations in many samples at the site, and therefore serve as valuable indicators of landfill leachate. They are not, however, selected as chemicals of concern from a risk assessment standpoint since they are typically obtained via food and mineral supplements and are homeostatically regulated to maintain appropriate body function. Therefore, they are of less concern as potential pollutants with respect to offsite migration. Although they pose no significant risk, they are included in this discussion of the nature and extent of contamination because they may be useful as indicators of the presence of landfill leachate both on and off site. However, they are common, naturally occurring metals and their concentrations may be significantly influenced by natural sources. Of particular concern is the influence of natural sources of calcium and magnesium, which are major components of the limestone in the bedrock aquifer.

4.3 DATA PRESENTATION

Dot plots, the data summary table, and the narrative developed to clarify the nature and extent of contamination are presented below.

4.3.1 Dot Plots

Once the concentration of the organic and inorganic constituents were determined and compared to baseline values, they were portrayed as concentration "dot plots". There is one dot plot for each organic group (plates 10 through 19) and one dot plot for each inorganic constituent (plates 20 through 43) in appendix K. In a dot plot, every sample is represented by a symbol plotted at its corresponding sample location. Unique symbols are used for each sample medium. For the organic compounds, the relative size of the symbol corresponds to the total concentration of all compounds in that group. The totals are the sum of all contaminant concentrations above baseline. Rejected data were not included in the group totals. If more than one sample was collected at a sampling location, the highest concentration of each compounds was summed to determine the total concentration. Concentrations on the organic dot plots are given in parts per billion. Since each inorganic constituent is addressed individually, no totals were used. Concentrations on the inorganic dot plots are given in parts per million.

The analytical data on which the dot plots are based were collected during several different field activities under the remedial investigation. The sampling dates range from April 1988 through December 1989. The dot plots do not, therefore, represent the distribution of organic and inorganic constituents at any one time. Instead, they are a composite of all available data collected during the twenty months of this investigation.

4.3.2 Contaminant Distribution Summary Table

In addition to the dot plots, the nature and extent of contamination is presented in a table which shows concentration ranges of constituents or organic contaminant group per sample media according to area across the landfill. The same criteria used to develop the dot plots was also used to develop these concentration ranges as presented in table 4-5 and appendix L.

The following section presents an overview of the nature and extent of contamination at the Pfohl Brothers landfill through a narrative presentation of the distribution of chemicals by media across the site. It should be emphasized that this presentation is limited in that data was collected from locations in close proximity to the landfill and therefore the full extent of contamination is not yet known.

4.3.3 Overview

From the graphical presentations of the data that were previously described, it appears that no significant waste disposal and contaminant migration patterns are observed. The following discusses the contaminant distribution by media.

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TABLE 4-5

AREA A - ONSITE

CONCENTRATION RANGES DETECTED FOR EACH GROUP OF ORGANIC CONTAMINANTS IN VARIOUS SAMPLE MEDIA PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Phthalates		3,000	5 - 202			780 - 1300		
Nitrogen Compounds		190						
Phenols								
Polycyclic Aromatic Hydrocarbons		620 - 5,787				2,845 - 15,350		
PCBS								
Pesticides						13 - 62		
Halogenated Hydrocarbons		5 - 18	31.6					
Ketones								
Furans								
Aromatics								

Note: Quantities are in ppb

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TABLE 4-5

AREA A - ONSITE

CONCENTRATION RANGES FOR EACH INORGANIC CONSTITUENT DETECTED IN VARIOUS SAMPLE MEDIA PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Al		5,940 - 10,800	0.606 - 3.96		0.164	20,600		
Sb		13.4 - 20.3				15.1		
As		3.1 - 3.8				7.9		
Ba		37 - 93.5				161		
Be		0.39 - 0.44				0.85		
Cd						5.4		
Ca		43,2[illegible]0 - 121,000	124 - 345		115			
Cr		9.6 - 16	0.196			41.2		
Co		4.3 - 8.0	0.0045			7.6		
Cu		16.5 - 21.3			0.0114	52.2		
Fe		11,600 - 18,700	1.27 - 5.65		0.465 - 0.507	18,800		
Pb		16.9 - 49.1			0.0125	1,180		
Mg		15,500 - 60,000	62.9 - 203					
Mn		382 - 667	0.520 - 1.130					
Hg		0.31 - 0.71	0.0032			0.43		
Ni		10.4 - 17.4	0.113 - 0.180			25.6		
K		1,200 - 2,190	3.1		3.30	1,420		
Se								
Ag								
Na		164 - 263	287		135 - 308	623		
Tl								
Vn		14.3 - 21.6	0.0061 - 0.0081			31.2		
Zn		68 - 97.2			0.0986	362		
CN								

Note: Quantities are in ppm

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TABLE 4-5

AREA A - OFFSITE

CONCENTRATION RANGES DETECTED FOR EACH GROUP OF ORGANIC CONTAMINANTS IN VARIOUS SAMPLE MEDIA PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Phthalates		470	25	3				
Nitrogen Compounds		190						
Phenols								
Polycyclic Aromatic Hydrocarbons		1,298						
PCBS								
Pesticides								
Halogenated Hydrocarbons								
Ketones								
Furans								
Aromatics								

Note: Quantities are in ppb

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TABLE 4-5

AREA A - OFFSITE

CONCENTRATION RANGES FOR EACH INORGANIC CONSTITUENT DETECTED IN VARIOUS SAMPLE MEDIA
PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Al		6,000	0.227	0.326				
Sb				0.0304				
As		3.5						
Ba		34.9						
Be								
Cd								
Ca		57,900	116	118				
Cr		7.8		0.191				
Co								
Cu		18.9						
Fe		10,500	2.14	1.20	0.507			
Pb		30.7						
Mg		25,100	35.6					
Mn		414	1.67					
Hg								
Ni		8		0.033				
K		981	3.35	5.11				
Se								
Ag								
Na		205	130	127				
Tl								
Vn		16.1						
Zn		73.6						
CN								

Note: Quantities are in ppm

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TABLE 4-5

AREA B - ONSITE

CONCENTRATION RANGES DETECTED FOR EACH GROUP OF ORGANIC CONTAMINANTS IN VARIOUS SAMPLE MEDIA
PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Phthalates	129 - 14,900	120 - 219,000	3 - 26	12		8,200	9 - 13	180 - 990
Nitrogen Compounds	5,900	1,800					5 - 9	
Phenols	9,000 - 4,500,000	146,000 - 251,000	959				7 - 10	
Polycyclic Aromatic Hydrocarbons	150 - 1,854,000	3 - 250,000				5,184	2 - 39	530 - 69,200
PCBS	7,500	3,700 - 8,700	110					4,000 - 7,700
Pesticides	110 - 14,000	41.7 - 1,014	320	0.05		19	0.007 - 0.06	16 - 92
Halogenated Hydrocarbons	3,259 - 92,000	31 - 86,144,000	21,040	17	4			
Ketones		26 - 360						
Furans	18 - 49,000,000	150 - 1,900,000	15				20 - 63	2,400 - 13,000
Aromatics	148 - 340,000	8 - 424,000	12,257				4 - 22	10

Note: Quantities are in ppb

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TABLE 4-5

AREA B - ONSITE

CONCENTRATION RANGES FOR EACH INORGANIC CONSTITUENT DETECTED IN VARIOUS SAMPLE MEDIA
PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Al		4,860 - 108,000	0.323 - 51.6	1.63	0.121	12,300	0.101 - 303	
Sb	39.2		0.033			9.7 - 14		
As	0.44 - 54.5	3.1 - 575				7.6	0.0035 - 0.0167	13.2 - 19.5
Ba	0.57 - 2,820	39.7 - 12,500	1.22 - 1.84			280	0.112 - 10	119 - 2,220
Be	0.17 - 1.8	0.33 - 2.3			0.00046	0.83	0.0148	0.46 - 0.59
Cd	1.3 - 5.1	1.3 - 39.4				4.7	0.0049 - 0.122	2.2 - 18.5
Ca	42.4 - 216,000	36,000 - 78,200	164 - 463	125	178 - 179		151 - 603	7,900 - 222,000
Cr	1 - 537	8.3 - 18,100	0.0997			27.7	0.0524 - 0.426	16.2 - 38.2
Co	1.7 - 23.2	4.1 - 74.7	0.0469		0.003	9.1	0.0034 - 0.157	7 - 17.8
Cu	1.9 - 29,400	16.9 - 1,650	3.06		0.0087 - 0.021	63.2	0.0139 - 0.784	71 - 270
Fe	162 - 465,000	8,080 - 489,000	26.3 - 178	2.41	0.439 - 0.522	37,200	44 - 494	21,200 - 317,000
Pb	0.54 - 3,180	12.6 - 36,200	0.0391 - 0.331			177	0.0501 - 1.640	
Mg	9.3 - 28,900	3,780 - 48,300	52.5 - 140		33.2 - 36.9	27,500	43.6 - 165	2,470 - 12,200
Mn	4.6 - 4,490	198 - 4,430	0.316 - 2.710			444 - 1,100	0.648 - 16.1	238 - 1,760
Hg	0.25 - 3.7	0.14 - 4.4	3.3			0.21 - 0.4	0.0021 - 0.0047	0.18 - 1.2
Ni	7.3 - 359	9.5 - 565	0.141	0.0264		28.5	0.0204 - 0.521	16.5 - 125
K	82.2 - 33,000	640 - 5,210	21.0 - 83.5	8.2	15 - 15.5	1,330	11.3 - 54.2	1,100 - 1,450
Se	0.52 - 3	0.6 - 28						0.67 - 5.3
Ag	1.3 - 13.5	0.92 - 11.2						1.8 - 4.8
Na	22.4 - 19,500	184 - 8,320	97.5		66.3 - 113	1,510	209	241 - 519
Tl		1.2						
Vn	1.7 - 106	16.4 - 43.1	0.0028 - 0.0965	0.0353		22.9	0.0037 - 0.471	25.9 - 26.4
Zn	7.1 - 8,440	70.2 - 35,300				299	0.263 - 8.27	510 - 2,770
CN	1.4 - 2.8	0.74 - 33.4				1.5		1.5 - 8

Note: Quantities are in ppm

1/4/91 pfholeo2
[filenam = bofforg]

TABLE 4-5

AREA B - OFFSITE

CONCENTRATION RANGES DETECTED FOR EACH GROUP OF ORGANIC CONTAMINANTS IN VARIOUS SAMPLE MEDIA PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Phthalates		140 - 1,500	3 - 66	3 - 24				
Nitrogen Compounds								
Phenols								
Polycyclic Aromatic Hydrocarbons						340 - 990		
PCBS								
Pesticides								
Halogenated Hydrocarbons								
Ketones		29						
Furans								
Aromatics		1 - 3	67	26				

Note: Quantities are in ppb

1/4/91 pfholeo2
[filename = boffinor]

TABLE 4-5

AREA B - OFFSITE

CONCENTRATION RANGES FOR EACH INORGANIC CONSTITUENT DETECTED IN VARIOUS SAMPLE MEDIA
PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Al		9,770 - 13,100	1.050 - 4.460	0.316	0.383	10,800 - 11,000		
Sb				0.0351				
As		3.3 - 4.9				3.8 - 4.6		
Ba		38.8 - 94.7		0.0388		139 - 154		
Be		0.17 - 0.59						
Cd					0.0073 - 0.0092	3		
Ca		65,400 - 78,300	257	121	114			
Cr		10.6 - 16.3		0.131 - 0.728				
Co		4.3 - 11.1	0.0041	0.0071				
Cu		16.2 - 17.6			0.0094 - 0.0129			
Fe		15,800 - 21,400	1.720 - 9.120	2.26 - 4.51	0.672 - 1.310	15,700		
Pb		11.9 - 20.8			0.0109 - 0.0126		0.67	
Mg		23,400 - 31,900	46.6 - 56.5		32.1			
Mn		323 - 520	0.591 - 1.62	0.428	0.427	327		
Hg		0.17 - 0.22			0.00025 - 0.0003	0.22 - 0.23		
Ni		10.3 - 22.3	0.0137 - 0.0342	0.0174 - 0.198				
K		801 - 3,010	2.05 - 3.89	3.11 - 15.6	4.33 - 22.7			
Se		0.85						
Ag								
Na		155 - 239	86	85.8	144			
Tl								
Vn		19.3 - 25.2	0.0041 - 0.0084	0.0068	0.003	19.5 - 19.7		
Zn		64 - 92.6			0.0633			
CN								

Note: Quantities are in ppm

1/4/91 pfholeo2
[filename = aeroorg]

TABLE 4-5

AERO LAKE

CONCENTRATION RANGES DETECTED FOR EACH GROUP OF ORGANIC CONTAMINANTS IN VARIOUS SAMPLE MEDIA PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Phthalates					22			
Nitrogen Compounds								
Phenols								
Polycyclic Aromatic Hydrocarbons								
PCBS								
Pesticides								
Halogenated Hydrocarbons								
Ketones						54		
Furans								
Aromatics								

Note: Quantities are in ppb

1/4/91 pfholeo2
[filename = aeroinor]

TABLE 4-5

AERO LAKE

CONCENTRATION RANGES FOR EACH INORGANIC CONSTITUENT DETECTED IN VARIOUS SAMPLE MEDIA PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Al						11,200		
Sb								
As						5.9		
Ba						117		
Be								
Cd					0.006	4.7		
Ca								
Cr						18.6		
Co						7		
Cu								
Fe						14,000 - 19,800		
Pb								
Mg						15,500 - 16,500		
Mn						438		
Hg					0.00025 - 0.00048			
Ni						20.3		
K					3.54 - 4.09	1,810		
Se								
Ag								
Na					132 - 138	585		
Tl								
Vn						20.4 - 22.8		
Zn								
CN								

Note: Quantities are in ppm

1/4/91 pfholeo2
[filename = conorg]

TABLE 4-5

AREA C - ONSITE

CONCENTRATION RANGES DETECTED FOR EACH GROUP OF ORGANIC CONTAMINANTS IN VARIOUS SAMPLE MEDIA
PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Phthalates	4 - 28,000	61 - 131,000	21 - 872	7	14	490 - 3,100	9 - 60	
Nitrogen Compounds								
Phenols	870 - 141,430	310 - 550	6 - 4,777		4		30	
Polycyclic Aromatic Hydrocarbons	150 - 650,200	680 - 1,595				400 - 25,100		1,080 - 26,000
PCBS	13,000 - 10,020,000		110					
Pesticides	2,410 - 70,900	5.8 - 420	0.69			5.3 - 520	0.0032 - 0.388	6.3 - 107
Halogenated Hydrocarbons	4,890 - 92,000	6			6		2.3 - 92.1	
Ketones	240,000							
Furans	280 - 360,000	140 170	20			260		
Aromatics	278 - 4,213,000	1	3 - 47.7		14	160	2.0 - 140	23

Note: Quantities are in ppb

1/4.91 pfholeo2
(filename = coninor)

TABLE 4-5

AREA C - ONSITE

CONCENTRATION RANGES FOR EACH INORGANIC CONSTITUENT DETECTED IN VARIOUS SAMPLE MEDIA
PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Al		,500 - 15,000	0.521 - 74,000	0.234	0.146 - 1.090	9,100 - 11,800	0.145 - 1.410	
Sb			0.0244			9		
As	0. 2 - 72	.1 - 21.8				3.6 - 7.2	0.0060 - 0.008	29.9
Ba	0. 3 - 4,910	51.7 - 2,240	1.22 - 1.53			82.7 - 171	0.0803 - 1.21	95.5 - 320
Be	0. 3 - 1.8	0.32 - 1.4				0.53		0.4 - 0.63
Cd	1. - 28.7	3 - 5.9	0.012		0.005 - 0.0138	2.5 - 6.2	0.0043 - 0.0204	2.5 - 9.8
Ca	4 - 48,100	52,100 - 88,900	156 - 593	138	125 - 233	75,700 - 98,300	145 - 323	16,900 - 114,000
Cr	2. - 703	7.8 - 37.5	0.115			14 - 49.1		14.7 - 43.1
Co	7. - 378	4.1 - 13.5	0.0103 - 0.0441			5.3 - 14.2		6.4 - 13.5
Cu	1. - 692	17.2 - 337			0.007 - 0.0268	32.1 - 107	0.0197 - 0.216	26.2 - 113
Fe	1 - 254,000	8,660 - 33,100	2.53 - 131	5.27	0.424 - 4	17,800 - 28,000	75.7 - 376	36,800 - 97,800
Pb	1 - 651	12 - 882	0.0506 - 0.369		0.010 - 0.0201	462 - 915	0.0796 - 0.476	985
Mg	1 2 - 3,110	4,470 - 28,500	45.6 - 175	44.4	33.8 - 43.0	19,600 - 26,100	40.8 - 65.9	2,530 - 19,400
Mn	1 - 1,400	223 - 643	0.391 - 3.45		0.323 - 0.401	503 - 635	0.711 - 1.420	374 - 1,770
Hg	0 - 1.4	0.14 - 1.2			0.0003	0.41 - 0.57		0.2 - 0.9
Ni	4. - 445	8.1 - 34.8	0.0249 - 0.136	0.0211	0.0135	17.9 - 76.4	27.7 - 84.1	14.9 - 61.5
K	2 - 1,300	680 - 3,130	30.7 - 42.7	12.4	3.82 - 24.2	1,230 - 2,830	5.5 - 20.6	1,200 - 2,420
Se	8 39.2	2				0.93		1 - 2.9
Ag	1 - 11.9	0.68 - 2.4						
Na	4 7 - 23,800	143 - 345	183 - 201	354	58.3 - 269	3,770	187	271 - 4,490
Tl	1.							0.59
Vn	3 - 52.3	14.5 - 36.6	0.0028 - 0.124		0.0036	18.0 - 29.8	0.0033 - 0.0037	26.4
Zn	6 - 4,460	69.4 - 1,150			0.0398 - 0.0766	315 - 910	0.066 - 3.360	110 - 1,770
CN	0 3 - 4	1.2				10		4 - 6.6

Note: Quantities are in ppm

1/4/91 pfholeo2
[filename = cofforg]

TABLE 4-5

AREA C - OFFSITE

CONCENTRATION RANGES DETECTED FOR EACH GROUP OF ORGANIC CONTAMINANTS IN VARIOUS SAMPLE MEDIA
PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Phthalates		150	73	42				
Nitrogen Compounds								
Phenols				16				
Polycyclic Aromatic Hydrocarbons		190				430		
PCBS								
Pesticides		35						
Halogenated hydrocarbons								
Ketones								
Furans								
Aromatics				8				

Note: Quantities are in ppb

1/4/91 pfhole02
[filename = coffinor]

TABLE 4-5

AREA C - OFFSITE

CONCENTRATION RANGES FOR EACH INORGANIC CONSTITUENT DETECTED IN VARIOUS SAMPLE MEDIA
PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Al			0.610	1.590		19,200		
Sb						14.9		
As		3.7						
Ba						133		
Be		0.24				0.89		
Cd								
Ca		55,400		244				
Cr		7.3				27.4		
Co		3.9				10.3		
Cu								
Fe			1.08	0.953		24,100		
Pb		18.5						
Mg		21,800						
Mn		321						
Hg		0.37						
Ni		0.0061				32.2		
K		1,270	3.09	23.3		1,640		
Se								
Ag								
Na		169						
Tl								
Vn						33.4		
Zn		78.1			0.0361			
CN								

Note: Quantities are in ppm

1/4/91 pfholeo2
[filename = elliorg]

TABLE 4-5

ELLICOTT CREEK

CONCENTRATION RANGES DETECTED FOR EACH GROUP OF ORGANIC CONTAMINANTS IN VARIOUS SAMPLE MEDIA
PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Phthalates								
Nitrogen Compounds								
Phenols								
Polycyclic Aromatic Hydocarbons						245		
PCBS								
Pesticides								
Halogenated Hydrocarbons								
Ketones								
Furans								
Aromatics								

Note: Quantities are in ppb

1/4/91 pfholeo2
[filename = elliinor]

TABLE 4-5

ELLICOTT CREEK

CONCENTRATION RANGES FOR EACH INORGANIC CONSTITUENT DETECTED IN VARIOUS SAMPLE MEDIA
PFOHL BROTHERS LANDFILL

CONTAMINANT	WASTE	SUB SOIL	SHALLOW GROUND WATER	DEEP GROUND WATER	SURFACE WATER	SURFACE WATER SEDIMENTS	LEACHATE SEEPS	LEACHATE SEEP SEDIMENTS
Al					0.190	8,750 - 9,010		
Sb								
As								
Ba						74.7		
Be						0.54 - 0.57		
Cd					0.0086			
Ca					133			
Cr						14		
Co						4.7 - 5.7		
Cu						2,160		
Fe					0.462	12,600 - 14,500		
Pb						14.8 - 36.7		
Mg								
Mn								
Hg						0.18 - 0.25		
Ni						14.2 - 18.7		
K					2.84	1,180 - 1,210		
Se								
Ag								
Na					33.6			
Tl								
Vn						16		
Zn					0.0476			
CN								

Note: Quantities are in ppm

Drummed Waste

The drum waste data and test pit sample data, as presented in the Interim Report: Drum Investigation (CDM 1990a), have been summarized herein to aid in visualizing the contaminant distribution and diversity of the source material. A complete set of the analytical data is provided in appendix M.

There are several types of waste containers in areas B and C from which samples were collected during this investigation: ruptured drums, exposed drums, buried drums, and waste material from test pit where no drums were encountered. These types of samples are discussed below.

Following initial testing with the hydroax equipment (used to clear heavy vegetation from the site), it was noted that several drums located at the landfill surface in the western portion of Area B had ruptured. As described in the Interim Report, samples were collected from these drums (designated sample numbers HD). Organic and inorganic analysis was performed on the samples from the ruptured drums collected by CDM in August and September 1988.

Exposed drums present at the surface of the landfill (designated sample numbers ED) have not been observed by CDM personnel in Area A of the landfill. However, drums are present at the surface of the landfill in Areas B and C. The greatest number of drums visible at the surface of the landfill are located in the western portion of Area B. Some drum clusters are also visible in the central portion of Area B. Scattered drums are visible throughout the eastern portion of Area B and the western and central portions of Area C. The majority of the crushed drums at the surface of the landfill are empty. Drums that did contain materials were sampled, whenever possible. Three drums from Area B (two from the western and one from the central portion) were sampled.

Drums were also observed in some of the test pits in areas B and C (designated sample numbers DR and GP). A total of 64 buried drums were found in the 27 test pits that were excavated in Area B. Forty-nine drums were found in the fifteen test pits excavated in Area C. Materials were not present in many of the buried drums and most of the drums had been crushed. A total of 36 samples and two duplicates were collected to characterize the materials present in the test pit drums. Some of these samples were considered waste and others were considered soil samples. In addition, where no drums were encountered in a test pit, solid waste or soil samples were collected. Waste samples were collected from two test pits in area B (TP-12 and TP-27). Soil samples were collected from test pits TP-30 and TP-31 in area B, and TP-21 in area C. Soil sample results will not be discussed in this section but rather with the other soil sample results.

The materials in the drums do not appear to be homogeneous in nature, as the duplicate samples did not exhibit a high degree of precision. For example, compounds were detected in one sample, but were not found in the duplicate. For many of the compounds detected in both the sample and the duplicate, the concentrations detected were widely disparate. This is most likely due to the lack of homogenicity within the materials within a drum, especially since the duplicate samples were collected as collocated samples (samples located next to one another) and is not indicative of laboratory problems.

On a larger scale, the distribution of materials found in the drums do not reflect any pattern in waste disposal practices or source material. The following briefly gives an overview of the constituents detected in the samples collected during the drum investigation.

Twelve volatile organics were detected in the waste samples collected from in or around observed drums. Included are the aromatics: ethyl benzene, chlorobenzene, benzene, toluene, 1,2- and 1,4-dichlorobenzene, and xylene; the halogenated hydrocarbons: methylene chloride, 1,1,1-trichloroethane (1,1,1-TCA), and tetrachloroethene (PCE); and the ketones: acetone and 4-methyl-2-pentanone. Of these, toluene, xylene, methylene chloride, and acetone were detected in both areas B and C at concentrations in excess of 10,000 ug/kg. In addition, ethyl benzene was detected well in excess of 10,000 ug/kg in the central portion of area C (at 320,000 ug/kg in DR-24), while 1,1,1-TCA, PCE, and 4-methyl-2-pentanone were detected in the eastern portion of area C at 23,000 ug/kg (DR-19), 22,000 ug/kg (DR-19), and 240,000 (DR-9), respectively. Xylene and methylene chloride were detected most frequently, while the remainder was detected in less than fifty percent of the samples.

Twenty-two semivolatile organic compounds were also detected in one or more of these samples. These included five phenolic compounds (phenol, 4-methyl phenol, 2-methyl phenol, 2,4-dimethyl phenol, and penta chlorophenol), a furan (dibenzofuran), phthalate esters (bis(2-ethylhexyl)phthalate and dimethylphthalate), and the various polycyclic aromatic hydrocarbons (including benzo(a)pyrene). Phenol and dibenzofuran were the two most frequently detected semivolatiles in both Areas B and C. Both of these compounds were detected in several portions of Areas B and C in excess of 10,000 ug/kg and both were detected above 1,000,000 ug/kg in a sample collected from the western portion of Area B (ED-3). Other compounds that were detected less frequently, yet were detected in one or more samples above 10,000 ug/kg, include 2-methyl phenol and 4-methyl phenol in the western and eastern portion of Area B.

In addition, several PAHs were detected at elevated levels (above 10,000 ug/kg) in both areas, including: naphthalene, 2-methyl naphthalene, fluorene, acenapthene, anthracene, phenanthrene, fluoranthene, and pyrene in DR-34 (eastern portion of Area C). Anthracene (above 10,000 ug/kg), and fluorene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, and benzo(a)pyrene were detected in excess of 100,000 ug/kg in a sample collected from the western portion of Area B (ED-3). The term PAHs refers to a diverse class of chemicals consisting of two or more fused benzene rings. Some of the man-made and natural sources of PAHs in the environment include the combustion of wood, coal, petroleum, petroleum derivatives, and refuse; automobile exhaust; forest fires; and volcanoes. In addition, PAHs are found in the following industrial products: carbon black (used in tires and elastomers), coal tar, creosote, asphalt, and bitumen.

Seven pesticides were detected in these samples. Alpha- and gamma-BHC were detected in samples collected from both Areas B and C, while heptachlor epoxide was only detected in Area B and methoxychlor, heptachlor, dieldrin, and endrin were only detected in Area C. Both alpha- and gamma-BHC were detected above 10,000 ug/kg in DR-19 (at 430,000 and 69,000 ug/kg, respectively).

Although PCBs were detected in both areas, they were detected at higher concentrations and more frequently (although still only at a few locations) in Area C. Aroclor 1242 was detected in both areas. Aroclor 1242, 1254, and 1260 were detected at concentrations as high as 9,600,000 ug/kg (DR-7), 420,000 ug/kg (DR-7), and 31,000 ug/kg (DR-11), respectively, in samples collected from the central and eastern portion of Area C.

Samples revealing the greatest variety of organic compounds include ED-3, HD-2, HD-5, and DR-42 in the western portion of Area B, and DR-19 and DR-24 in the central and eastern portions of Area C, respectively.

The compound 2,3,7,8-TCDD was detected at qualified concentrations ranging from 100 to 370 ppb. Of the 18 samples tested, 50% of the samples revealed the presence of this compound. No pattern of contamination was observed in either area B or C. Table 4-6 presents a summary of the 2,3,7,8-TCDD data collected during the test pit investigation.

Rubber-like polymer disks were evidenced over most of the landfill surface. One of these disks, Sample PD-001-001, was collected and analyzed for 2,3,7,8,-TCDD. The analytical results of this sample were rejected during data validation because a method blank was not provided and no ending performance check solution analysis was performed. Although the analytical sequence was not complete and there was not a method blank associated with this sample extraction, it is likely that the sample did not contain 2,3,7,8-TCDD. However, this opinion cannot be rigorously supported by the data.

Four samples, DR-008-001, DR-019-001, DR-020-001, and DR-036-001, were rejected solely because the ending performance check solution analysis was not performed. These samples revealed positive results for the 2,3,7,8-TCDD. The presence of the 2,3,7,8 TCDD ions 259, 320, and 322

TABLE 4-6

2,3,7,8-TCDD DATA

PFOHL BROTHERS LANDFILL

TEST PIT AND DRUM SAMPLES

SAMPLE ID NUMBER	RESULT (ppb)	FOOTNOTES
DR-003-001	ND(1.1) R2	1,3,7,9,11
DR-008-001	110 R1	1,3,7,9,12
DR-013-001	ND(10) Q	1,3,4,9,11
DR-019-001	290 R1	1,3,4,7,12
DR-020-001	200 R1	1,3,7,9,12
DR-022-001	ND(0.49) R2	1,3,7
DR-036-001	370 R1	1,3,7,9,12
DR-042-001	170 Q	1,3,4,6,12
ED-003-001	100 Q	1,3,4
GP-012-001	ND(1.6) Q	1,3,4
GP-027-001	ND(0.28) Q	1,3
HD-001-001	ND(1.4) Q	1,3
HD-002-001	ND(16) Q	1,3,4,11
HD-004-001	ND(1.3) Q	1,3
HD-005-001	140 Q	1,3,12
HD-005-004	170 Q	1,3,4,9,10,12
HD-005-005	140 Q	1,3,9,10,12
PD-001-001	ND(0.17) R2	1,3,7,9,13

FOOTNOTES

File: PBDIOX2

ND = Non detection
R1 = Data rejected - most likely present.
R2 = Data rejected - most likely not present.
Q = Data qualified during data validation.
1 = Data qualified due to non-compliant initial calibration (three-point).
3 = Data qualified as estimated due to non-compliant continuing calibration concentration (0.2 ng/ul).
4 = Data qualified as estimated due to low surrogate recovery, i.e, < 30%.
6 = Wrong response factor used by laboratory, correctly calculated concentration included in parentheses, corrected data has been resubmitted by laboratory.
7 = Data rejected because no ending column performance check standard was analyzed.
9 = Data qualified because method blank maximum possible concentration (MPC) exceeds 1.0 ppb due to aliquot amount required because of sample matrix interferences.
10 = Data qualified because continuing calibration relative response factors (RRFs) exceed 10% difference but are less than 15%, as required by SW-846 Method 8280.
11 = Data qualified as estimated due to small sample aliquot used for extraction because of matrix interferences.
12 = Small sample aliquot used for extraction due to high native 2,3,7,8-TCDD concentration.
13 = Data rejected beacuse method blank was not extracted with sample.

within the correct ion ratios clearly indicate the presence of this compound, despite the fact that non-compliance of QA/QC protocol caused the data to be rejected during the validation process.

Conversely, the analytical data for samples DR-003-001 and DR-022-001 do not support the reported non-detect values, although it is likely that they do not contain 2,3,7,8-TCDD.

Almost all of the inorganics were detected in the drum samples at concentrations exceeding those of the background soil samples. The concentrations of barium, cadmium, chromium, cobalt, copper, lead, manganese, nickel, silver, sodium, and zinc exceeded background soil concentrations most frequently. Antimony, thallium, selenium, potassium, and vanadium were detected at low frequencies at concentrations in excess of background. Of interest are arsenic detected at a concentration of 575 mg/kg, cadmium at 39.4 mg/kg, cobalt at 378 mg/kg, mercury at 3.7 mg/kg, selenium at 39.2 mg/kg, silver at 11.9 mg/kg, and vanadium at 106 mg/kg. In addition, copper was detected at percent levels in more than one sample.

Soils

CDM collected a total of 49 soil samples (excluding background, duplicates and QA/QC samples) at the Pfohl Brothers landfill. Soil samples collected within the boundaries of areas A, B, or C were referred to as "onsite". Soil samples collected outside the existing boundaries of areas A, B, and C were referred to as "offsite". A total of 4 borings were installed in Area A; 15 borings in Area B with 7 additional borings installed outside Area B; and 10 borings in Area C with 2 installed outside Area C. The results of this investigation are described in the Interim Report: Soil Boring and Groundwater Investigation (CDM 1990e). In addition, soil samples were collected during the drum investigation from test pits located primarily in Area B, with two samples collected in the western portion of Area C.

The samples from the borings were collected at depths ranging from 0 to 2 feet (at one location in Area C) to depths just above the bedrock interface (depths between 10 to 30 feet). Samples collected during the drum investigation were collected at various depths.

In addition, New York State Department of Environmental Conservation and New York State Department of Health had various surface and subsurface materials analyzed for various radioactive isotopes to further evaluate "hot spots" or suspect material encountered during a radiation survey. The elevated radiation areas were those areas which had radiation readings greater than three times the typical background level of radiation established for the vicinity of this site. Soils, radium discs, and miscellaneous samples were collected and analyzed.

Area A. Although no drums were observed in Area A, six soil samples were collected from this area. Two volatiles were detected in these samples: acetone and methylene chloride. The concentrations of these compounds are suggestive of laboratory contamination (concentrations less than 100 ug/kg).

Three semivolatile compounds were detected in the samples collected from Area A. Bis(2-ethylhexyl)phthalate (DEHP) was detected in one sample at 3,000 ug/kg. DEHP was also detected in the laboratory method blank. However, this detection is either suggestive of disposal or the analysis of a small piece of plastic in the sample. Varying concentrations of PAHs were detected in three of the soil samples. The detected concentrations were higher than those found in the background samples but were for the most part within concentration ranges typically found in urban areas. No PCBs or pesticides were detected in Area A.

Nineteen inorganics were detected in the soil samples; all of which exceeded background concentrations. Of these ninteen inorganics, four exceeded two times the background levels (beryllium, cobalt, mercury, and nickel). These four metals were also found at concentrations above background in one or more other site media.

Area B (onsite). Twenty-one samples were collected from soil borings and analyzed in this area. In addition, soil samples were collected from twelve test pits during the drum investigation.

Many of the same organic compounds detected in the drum samples were also present in the soil samples collected from areas B and C. In some cases, the organic compounds present in the drums were detected at higher concentrations in the soil samples. Most of the organic compounds were detected infrequently in the samples. In general, a greater variety of organic compounds were detected at higher concentrations in Area B compared to Area C.

A total of eighteen volatile organic compounds were detected in Area B. Acetone was the most frequently detected compound. However, it was detected at relatively low concentrations (less than 1000 ug/kg). One other ketone, 2-butanone, was detected less frequently than acetone. Aromatics that were detected in one or more samples include chlorobenzene, ethylbenzene, benzene, xylenes, and benzoic acid. Of these, ethylbenzene and xylenes were detected most frequently in all three portions of Area B in excess of 10,000 ug/kg; the highest concentration of each was found in sample SB-7 (located in the western zone) at 1,000,000 ug/kg and 1,700,000 ug/kg, respectively. Benzoic acid occurs in free and combined forms in nature; most berries contain appreciable amounts of benzoic acid. It is also excreted as hippuric acid by almost all vertebrates except fowl (Merck 1983). However, the concentration detected at several locations would indicate probable disposal of this compound by industry. In addition, ten aliphatics were detected in this area, all of which were detected at the highest concentration in two samples located in the central portion of the site (samples MW-2S and SB-7). The aliphatics include methylene chloride, 1,1,1- and 1,1,2-TCA, 1,1-dichloroethane, 1,1- and 1,2-dichloroethene, chloroethane, trichloroethene, tetrachloroethene, and carbon disulfide. With the exception of carbon disulfide, all of the aliphatics were detected at levels in excess of 10,000 ug/kg in either one of these samples. In addition to these compounds, methylene chloride (3,200,000 ug/kg), 1,1,1-TCA (83,000,000 ug/kg), and 1,1-dichloroethane (2,100,000 ug/kg) were detected above 1,000,000 ug/kg. Except for 1,1,2-trichloroethane, all of these compounds were found in one or more of the media that will be described within this section.

Twenty-three semivolatiles were detected in the soil samples; again most of the compounds were detected in one to five samples with the exception of DEHP, butylbenzyl phthalate, and the noncarcinogenic PAHs, which were detected more frequently. Of the semivolatiles detected, four are phenolic compounds (phenol, 2- and 4-methyl phenol, 2,4-dimethylphenol); three are phthalate esters (bis(2-ethylhexyl)phthalate, butylbenzyl phthalate, di-n-butyl phthalate); one is dibenzofuran; and fifteen are PAHs. Of the PAHs, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, naphthalene, 2-methyl naphthalene, and benzo(b)fluoranthene were detected above 10,000 ug/kg. Most of the PAHs were found in the sample DR-4, collected from the central portion of the site. Phenol, dibenzofuran, and DEHP were detected above 10,000 ug/kg in one or more samples collected from the western zone of Area B. Dibenzofuran was detected as high as 1,900,000 ug/kg in SB-3-06. The other phenolic compounds were detected in the central and eastern portion of the area above 10,000 ug/kg in at least one location.

Seven pesticides were detected in a sample from the western portion of the site at concentrations below 200 ug/kg, including DDD, DDT, dieldrin, aldrin, gamma-BHC, endrin, and heptachlor. DDE was detected at 560 ug/kg. The pesticides were found in samples taken from clay immediately above the bedrock, silty clay about 4.5 feet from the bedrock, from the top of the basal clay, and in the fill material mixed with ash. Another pesticide detected in Area B includes gamma-chlordane. It should be noted that aldrin was not detected in the soil samples collected from monitoring well 2S even though it was found in the deep aquifer and that endosulfan II was not detected in the soil sample collected from monitoring well 5S (this compound was detected in the shallow well at this location). As a matter of fact, endosulfan II was not detected in any of the subsurface soil samples. The only detect of aldrin was in the northeast corner of the site in a sample collected from boring B-10.

Two PCB isomers, Aroclor 1242 and 1254, were detected below 10,000 ug/kg in one sample each from the eastern and western portions of Area B, respectively.

Most of the inorganics were detected above background concentrations in one or more samples in this area. Borings B-10 and B-4 and soil samples from MW-13S and MW-15S had the highest concentrations of metals detected in Area B. Boring B-4 is located in the southwestern corner of Area B, MW-15S is located in the northwestern corner of Area B, MW-13S is located in the center of Area B, and B-10 was located in the northeast corner of Area B. The highest concentrations of arsenic, barium, chromium, nickel, and cyanide were found in the samples from B-10. The highest concentration of beryllium was detected in boring MW-13S and the highest concentration of mercury was detected in boring B-4. Arsenic was detected in two samples at concentrations greater than 10 mg/kg. Chromium exceeded 100 mg/kg in one sample, copper exceeded 200 mg/kg in three samples, lead exceeded 100 mg/kg in five samples, mercury exceeded 1 mg/kg in one sample, nickel exceeded 100 mg/kg in two samples and zinc exceeded 100 mg/kg in seven samples.

Area B (offsite). Six samples were collected from four borings. Five volatile organics were detected in the soils. Toluene and 4-methyl-2-pentanone were detected in only one sample at concentrations below the detection limit. 4-Methyl-2-pentanone was not detected in any of the other site media, except in one sample collected from a buried drum. DEHP was the only semivolatile detected in all samples. In four out of five samples, it was detected within the sample quantitation range and is most likely representative of field/laboratory contamination. Pesticides and PCBs were not detected.

Nineteen inorganics were detected in the samples. The concentrations detected were only slightly above background and none exceeded two times background.

Area C (onsite). Fifteen soil samples were collected from this area of the landfill. Five volatile organics were detected in the samples; acetone and methylene chloride were detected most frequently, while the other three were detected only once or twice (toluene, 1,1,1-TCA, and carbon disulfide). Four semivolatiles (phenol, dibenzofuran, DEHP, and butylbenzyl phthalate) were detected in the samples. Only DEHP was found in at least half of the samples. Phenol was detected above 10,000 ug/kg in the soil sample collected from MW-17S. In addition, several PAHs were detected at relatively low concentrations at several locations in Area C. The pesticides delta-BHC and methoxychlor were detected in one sample from the western zone of Area C at concentrations below 5 ug/kg. No PCBs were detected in the soil samples.

Twenty-one inorganics were detected in the soil samples at the site. Sixteen were found in all fifteen samples. Seventeen of the metals exceeded twice the background concentration. The highest concentrations of metals in Area C were found in boring B-12. This boring had the highest concentration of cadmium, lead, vanadium, and zinc found over the entire site, as well as the second highest concentrations of arsenic, barium and mercury found site-wide. Arsenic exceeded 10 mg/kg in two samples, copper exceeded 200 mg/kg in one sample, lead exceeded 100 mg/kg in two samples, mercury exceeded 1 mg/kg in two samples, and zinc exceeded 100 mg/kg in four samples.

Area C (offsite). Only one sample was collected from this area. Methylene chloride and two semivolatiles were detected (DEHP and PAHs). One pesticide (DDT) was also detected. No PCBs were found. Eighteen inorganics were detected but only two, beryllium and mercury, exceeded twice background concentrations.

Radiological Analysis. The following is a summary of the radiochemical analysis report as reported by New York State Department of Environmental Conservation (NYSDEC) and New York State Department of Health. Three of the eighteen soil samples analyzed had levels of Uranium-238 and/or Thorium-232 over 1000 picoCuries per gram (pCi/g), which is over the 0.05% or 0.25% weight percent uranium or thorium content requiring classification for source materials. Fourteen soil samples had Radium-226 at 15 Ci/g or above, and several were above 100 pCi/g.

Although the levels of radionuclides were elevated, they are in the class of NORM (Naturally Occurring Radioactive Materials) and are most likely waste materials. While some of the materials may have been formerly exempt from regulation, and come from various industries in western New York, others may have been regulated materials that were subsequently improperly disposed. The volume of NORM materials present in the landfill is unknown. Their report concluded that while the materials present apparently are located in "hot spots", these "hot spots" are dispersed over most of the site. In addition, it was determined that this pattern over the site was consistent with continuous disposal of industrial process materials over a period of years in discrete batches of limited volume, rather than disposal of very large quantities of ore residues, as has been the case at some other sites.

In addition to the soil samples, six radium discs were found at the site and analyzed. High levels of Radium-226 were found on these discs, ranging from 0.8 to 25 microCuries, which was attributed to what was suspected to be luminous paint on these objects.

Three other types of samples were collected: a bag of green powder, the soil surrounding a disc, and a small piece of metal. The green powder was found to contain high levels of thorium-232 and was thought to be a process waste from either the metallurgical processing or glass processing industries. Analysis of the soil surrounding one of the radium discs indicated background levels for all constituents, with radium-226 levels being slightly above background. Radium-226 levels were still within the normal range for radium in soils of 0.2 to 2.0 pCi/g. The small metal disc sampled contained uranium and was suspected to be metallurgical waste.

Their report concluded that although many of the soils sampled in elevated areas were many times that of background levels, the large majority of the elevated readings were in areas of only a few square feet, indicating the presence of discrete materials. In addition, the large variations in radionuclide concentrations present at the site suggested that while there were areas of higher soil activity, it was not uniformly spread throughout the site.

Ground Water: Unconsolidated Aquifer

Two rounds of samples were collected from the shallow wells in August and December 1989. During the first round, all wells except for 2S/2D, 11S, and 13S to 17S were sampled. All monitoring wells were sampled during the second round of analysis and one duplicate sample was collected at well number 14S. Analysis of the volatile organic fraction of Well 5S were not available from the second round of sampling, therefore the well was resampled by NYSDEC in June 1990. No volatile organic compounds were detected in ground water from well 5S during the second round of sampling. Samples from the unconsolidated and bedrock aquifers from both rounds of sampling were analyzed by NYSDEC for radiological parameters. The first round of samples were analyzed for gross alpha and beta radiation, uranium series radionuclides, thorium series radionuclides, and other radionuclides. The second round of samples were analyzed for gross alpha and beta radiation. The New York State Department of Health (DOH) has reported that there were no contravention of New York State standards for the ground water collected from either of the sampling rounds.

Results from a total of 26 samples should have been available for chemical analysis. However, results that were rejected through the data validation process were excluded from this analysis. Most of the acid extractable data from wells 2S, 3S, 7S, and 5S were rejected. Other exceptions for the total number of analyses used for this evaluation include chlorobenzene and the dichlorobenzenes. Chlorobenzene can be detected in both the 8010 and 8020 methods, resulting in a potential of 50 detects. The three dichlorobenzenes (1,2-, 1,3-, and 1,4-) are analyzed as part of the 8020 and the CLP semivolatile organic methods. Therefore, a total of 51 sample results were available for the dichlorobenzenes.

Bis(2-ethylhexyl)phthalate (DEHP) and di-n-octyl phthalate were the only compounds detected in the laboratory blanks. DEHP was detected at concentrations ranging from 6 to 176 ug/l and di-n-octyl phthalate was detected once at 42 ug/l.

Volatile organic compounds were not detected in any of the monitoring well samples during the first round. However, several chlorinated aliphatic, chlorinated aromatic, and nonchlorinated aromatic compounds were detected in several of the wells located throughout the landfill during the second round of analysis. These compounds include benzene, chlorobenzene, toluene, xylenes, 1,4-dichlorobenzene, chloroethane, 1,1-dichloroethane, 1,1- and 1,2-trans-dichloroethene, and 1,1,1-trichloroethane. Two chlorinated benzenes, 1,2- and 1,3-dichlorobenzene, were detected only once and were not detected in both analytical methods which would have confirmed their presence in the media.

The greatest number and highest concentrations of volatile organics were detected in 16S (located in the northeast corner of Area B) and 2S (located near the middle of the southern boundary of Area B). Chlorobenzene in 16S and 1,1-dichloroethane and 1,1,1-trichloroethane in 2S were detected in excess of 1,000 ug/l.

Benzene was detected most frequently and found in samples collected from four different wells. Benzene was detected in 16S (along with, xylenes, chlorobenzene, and dichlorobenzenes). Benzene and toluene were detected in 3S and 9S during the second round of sampling, although they were not detected during the first round of sampling. The lack of detection in the first round of sampling may be due to the loss of volatiles during sample handling in the field or during sample preparation and storage in the laboratory. Benzene and toluene were also detected in the sample collected from 14S, but were not found in the duplicate sample. The difference in the detections of the samples from 14S cannot be easily explained. However, both of these compounds were found in other media at the site. Benzene was detected in the leachate seeps that are located near 3S.

Several semivolatile organic compounds were detected during the two sampling rounds, including benzoic acid (an aromatic), phenol, phenolic compounds, dibenzofuran, and phthalate esters. Although the majority of the semivolatile compounds were detected in less than three wells, DEHP was detected in eleven out of twenty-five samples, primarily during the second round of sampling. The other three phthalate esters (di-n-octyl phthalate, di-n-butyl phthalate, and benzyl butyl phthalate) were only detected during the first sampling round. DEHP was detected in 9S at 840 ug/l. However, most of the other detections of DEHP were at concentrations similar to those typically related to laboratory/field contamination. Thus, the presence of DEHP in the shallow ground water may not actually be related to site conditions.

Although benzoic acid was detected only in 5S in the first round, this compound was not detected in the second round. Benzoic acid was found at the low concentration of 8 ug/l and can occur naturally in the environment.

Phenol (detected as high as 4,000 ug/l), 2,4-dimethylphenol, 2-methylphenol, and 4-methylphenol were detected in 17S (located in the eastern portion of Area C). 2-Chlorophenol and 2,4-dimethylphenol were detected in 16S (located in the northeastern section of Area B). Dibenzofuran was detected in the sample and duplicate collected from 14S (at 20 and 15 ug/l, respectively); phenol was only detected in the duplicate. However, the presence of this compound in other samples collected from the site, as well as in other shallow ground water samples would indicate that this compound may actually be present in the well.

One pesticide (endosulfan II) and a PCB isomer (Aroclor 1232) were detected during the second round of sampling in one (14S in central area C) and two (15S located in the northwestern and 16S in the northeastern section of Area B) samples, respectively. Endosulfan II was also detected in a leachate seep located fairly close to this well. PCBs were detected infrequently in all of the samples collected from the site. However, it is known through a review of historical records that both liquid and solid PCBs were disposed of at the site.

The compound 2,3,7,8-TCDD was not detected in ground water collected from the shallow wells. It should be noted, however, that these data were qualified during the data validation process due to non-compliant continuing calibration and, in some cases, low surrogate recoveries. All continuing calibration standards analyzed were at 0.2 nanograms per microliter (ng/ul) concentration of 2,3,7,8-TCDD. This concentration differs from the protocol which requires a concentration of 0.5 ng/ul for the continuing calibration standard. The notations in the footnotes of table 4-7 are strictly based on a deviation from the protocol rather than on a percieved technical problem. In fact, the analysis of the lower concentration standard by the laboratory and their application of acceptance criteria normally used for the higher concentration standard, constitutes more stringent quality control than that required by the method. The analysis of these low concentration standards tend to support the validity of the non-detect results.

Aluminum, cobalt, manganese, nickel, and vanadium, were also detected at concentrations significantly above baseline quality in a majority of the samples. Inorganic constituents, such as calcium, iron, magnesium, potassium and sodium, that are common landfill leachate indicators, were elevated above background levels in many of the shallow wells. Elevated levels of antimony, chromium, copper, lead, and zinc were detected in several samples.

Wells with consistently higher than average concentrations of inorganics included wells 3S, 14S, 16S, and 17S. Well 3S is located offsite to the west of Area B. High concentrations of inorganics were also found in the leachate seep and sediment sample (SP/SS-16) collected near this area. Well 16S is located in the northeast corner of Area B. Wells 14S and 17S are located in Area C.

Table 4-8 presents a summary of the constituents exceeding ARARs. Well 8S, located in the northern section of Area B revealed concentrations of butylbenzyl phthalate exceeding ARARs; well 9S, located in the southwestern section of Area C, revealed bis(2-ethylhexyl)phthalate concentrations exceeding ARARs.

During the second round of sampling, at which time all the onsite wells were sampled for the first time, a wide variety of organic contaminants were detected at concentrations exceeding ARARs.

Wells 3S and 16S, located northwest and northeast of Area B, respectively,

TABLE 4-7

2,3,7,8-TCDD DATA

PFOHL BROTHERS LANDFILL

GROUNDWATER SAMPLES

SAMPLE ID NUMBER	RESULT (ppb)	FOOTNOTES
GW-MW-1D-002	ND(0.081) Q	3
GW-MW-2D-001	ND(0.44) Q	3
GW-MW-3D-002	ND(0.13) Q	3
GW-MW-4D-002	ND(0.068) Q	3
GW-MW-5D-002	ND(0.038) Q	3
GW-MW-6D-002	ND(0.10) Q	3
GW-MW-7D-002	ND(0.044) Q	3
GW-MW-1S-002	ND(0.12) Q	3
GW-MW-2S-001	ND(0.15) Q	3
GW-MW-3S-002	ND(0.032) Q	3
GW-MW-4S-002	ND(0.40) Q	3,4
GW-MW-5S-002	ND(0.087) Q	3
GW-MW-6S-002	ND(0.067) Q	3
GW-MW-7S-002	ND(0.058) Q	3
GW-MW-8S-002	ND(0.44) Q	3
GW-MW-9S-002	ND(0.33) Q	3,4
GW-MW-10S-002	ND(0.25) Q	3
GW-MW-11S-001	ND(0.45) Q	3,4
GW-MW-12S-002	ND(0.22) Q	3
GW-MW-13S-001	ND(0.46) Q	3,4
GW-MW-14S-001	ND(0.17) Q	3
GW-MW-15S-001	ND(0.11) Q	3
GW-MW-16S-001	ND(0.21) Q	3
GW-MW-17S-001	ND(0.18) Q	3

FOOTNOTES

File: PBDIOX2

ND = Non detection
Q = Data qualified during data validation.
3 = Data qualified as estimated due to non-compliant continuing calibration concentration (0.2 ng/ul).
4 = Data qualified as estimated due to low surrogate recovery, i.e., < 30%.

PFOHL BROTHERS LANDFILL GROUND WATER DATA

TABLE 4-8
SUMMARY OF CONSTITUENTS IN SHALLOW AQUIFER EXCEEDING ARARs
ROUNDS 1 AND 2
Page 01 of 05

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		ROUND 1			CONCENTRATIONS in ug/l				
SAMPLE NUMBER :	GW ARARs	GW-1S-01	GW-3S-01	GW-4S-01	GW-5S-01	GW-6S-01	GW-7S-01	GW-8S-01	GW-9S-01
VOLATILES									
SEMI VOLATILES									
Butylbenzylphthalate	50 b							150.0 DJ	
bis(2-Ethylhexyl)Phthalate	50 a								840.0 BJ
Di-n-Octyl Phthalate	50 b						73.0 J		
PESTICIDES/PCBs									
INORGANICS									
IRON ***	300 a	5070.0	7360.0	1720.0	2370.0		429.0	5650.0	13200.0
MAGNESIUM	35000 b	41700.0	44600.0					61200.0	41400.0
MANGANESE ***	300 a	1580.0	1620.0	591.0	576.0	1080.0		520.0	2280.0
MERCURY	2 a								
SODIUM	20000 a	70100.0	22400.0		27700.0	84000.0 B	24000.0	21500.0	30400.0

FOOTNOTES :
a = ARARs are 6 NYCRR Part 703.5 Class GA standards for potable water.
b = ARARs are 6 NYCRR Part 703.5 Class GA TOGS guidelines for potable ground water (ug/l).
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
*** = Combined total for Iron and Manganese exceeds 500 ug/l for all samples except GW-7S-01.
→

PFOHL BROTHERS LANDFILL GROUND WATER DATA

TABLE 4-8 (contd)
SUMMARY OF CONSTITUENTS IN SHALLOW AQUIFER EXCEEDING ARARs
ROUNDS 1 AND 2
Page 02 of 05

12/11/90

		ROUND 1	CONCENTRATIONS in ug/l
SAMPLE NUMBER :	GW ARARs	GW-10S-01	GW-12S-01
VOLATILES			
SEMI VOLATILES			
Butylbenzylphthalate	50 b		
bis(2-Ethylhexyl)Phthalate	50 a		
Di-n-Octyl Phthalate	50 b		
PESTICIDES/PCBs			
INORGANICS			
IRON ***	300 a	2740.0	547.0
MAGNESIUM	35000 b	150000.0	188000.0
MANGANESE ***	300 a	391.0	451.0
MERCURY	2 a		3.2
SODIUM	20000 a	126000.0	206000.0

FOOTNOTES :
a = ARARs are 6 NYCRR Part 703.5 Class GA standards for potable water.
b = ARARs are 6 NYCRR Part 703.5 Class GA TOGS guidelines for potable ground water (ug/l).
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
*** = Combined total for Iron and Manganese exceeds 500 ug/l for all samples except GW-7S-01.→

PFOHL BROTHERS LANDFILL GROUND WATER DATA

TABLE 4-8 (contd)
SUMMARY OF CONSTITUENTS IN SHALLOW AQUIFER EXCEEDING ARARs
ROUNDS 1 AND 2
Page 03 of 05

12/11/90

		ROUND 2			CONCENTRATIONS in ug/l				
SAMPLE NUMBER :	GW ARARs	GW-1S-02	GW-2S-02	GW-3S-02	GW-4S-02	GW-5S-02	GW-6S-02	GW-7S-02	GW-8S-02
VOLATILES									
1,1-Dichloroethene	5 a		240.0						
1,1-Dichloroethane	5 a		4900.0 J						
1,1,1-Trichloroethane	5 a		15000.0 J						
Benzene	ND a			26.0 J					
Toluene	5 a			41.0 J					
Chlorobenzene	5 a								
Xylenes(total)	5 a								
SEMI VOLATILES									
Phenol *	1.0 a								
1,4-Dichlorobenzene	** a								
1,2-Dichlorobenzene	** a								
bis(2-Ethylhexyl)Phthalate	50 a			66.0 J					
PESTICIDES/PCBs									
Aroclor-1232 ****	.1 a								
INORGANICS									
ANTIMONY	3 b								
BARIUM	1000 a								
CADMIUM	10 a								
CHROMIUM	50 a								
COPPER	200 a								
IRON ***	300 a	9120.0	39100.0	1160.0		2530.0	2140.0	1060.0	327.0
LEAD	25 a		74.9 J						
MAGNESIUM	35000 b	56500.0	60900.0	48100.0			35600.0		62900.0
MANGANESE ***	300 a	1390.0 J	2100.0 J	580.0 J		845.0 J	1670.0 J		341.0 J
MERCURY	2 a								
SODIUM	20000 a	86000.0	63700.0			27300.0	130000.0	28500.0	35500.0
ZINC	300 a								

FOOTNOTES :
a = ARARs are 6 NYCRR Part 703.5 Class GA standards for potable water.
b = ARARs are 6 NYCRR Part 703.5 Class GA TOGS guidelines for potable ground water (ug/l).
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
* = The ARAR value shown includes a total of: phenol, pentachlorophenol, and 2,4-dichlorophenol.
** = ARARs indicate that the combined total for 1,4-dichlorobenzene and 1,2-dichlorobenzene may not exceed 4.7 ug/l.
*** = The combined total for Iron and Manganese exceeds 500 ug/l for all samples except GW-4S-02 and GW-11S-02.
**** = The ARAR value for total PCBs is .1 ug/l. Total PCBs include: Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, and Aroclor-1260. Aroclor-1232 was the only PCB detected.
ND = Non-detect.→

PFOHL BROTHERS LANDFILL GROUND WATER DATA

TABLE 4-8 (contd)
SUMMARY OF CONSTITUENTS IN SHALLOW AQUIFER EXCEEDING ARARs
ROUNDS 1 AND 2
Page 04 of 05

12/11/90

		ROUND 2			CONCENTRATIONS in ug/l				
SAMPLE NUMBER :	GW ARARs	GW-9S-02	GW-10S-02	GW-11S-02	GW-12S-02	GW-13S-02	GW-14S-02	GW-15S-02	GW-16S-02
VOLATILES									
1,1-Dichloroethene	5 a								
1,1-Dichloroethane	5 a				5.6 J				
1,1,1-Trichloroethane	5 a				26.0				
Benzene	ND a	2.8 J					2.7		290.0
Toluene	5 a						43.0 J		
Chlorobenzene	5 a								11000.0 J
Xylenes(total)	5 a								400.0 J
SEMI VOLATILES									
Phenol *	1.0 a						6.0 J		
1,4-Dichlorobenzene	** a								38.0 J
1,2-Dichlorobenzene	** a								4.0 J
bis(2-Ethylhexyl)Phthalate	50 a								
PESTICIDES/PCBs									
Aroclor-1232 ****	.1 a							110.0 J	
INORGANICS									
ANTIMONY	3 b								33.0 BJ
BARIUM	1000 a						1220.0	1840.0 J	1220.0
CADMIUM	10 a								
CHROMIUM	50 a				196.0		115.0		99.7
COPPER	200 a						258.0 J		3060.0 J
IRON ***	300 a	7240.0	1170.0		1270.0	38000.0	131000.0 J	26300.0	176000.0
LEAD	25 a					39.1	369.0		331.0 J
MAGNESIUM	35000 b	45600.0	97000.0	46600.0	203000.0	52500.0	173000.0	79000.0	140000.0
MANGANESE ***	300 a	1920.0 J	375.0 J		1130.0 J	316.0 J	3450.0 J		2710.0 J
MERCURY	2 a								3.3
SODIUM	20000 a	31400.0	183000.0	53200.0	287000.0	60700.0	47500.0	97500.0	31100.0
ZINC	300 a						780.0 J		1490.0 J

FOOTNOTES :
a = ARARs are 6 NYCRR Part 703.5 Class GA standards for potable water.
b = ARARs are 6 NYCRR Part 703.5 Class GA TOGS guidelines for potable ground water (ug/l).
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
* = The ARAR value shown includes a total of: phenol, pentachlorophenol, and 2,4-dichlorophenol.
** = ARARs indicate that the combined total for 1,4-dichlorobenzene and 1,2-dichlorobenzene may not exceed 4.7 ug/l.
*** = The combined total for Iron and Manganese exceeds 500 ug/l for all samples except GW-4S-02 and GW-11S-02.
**** = The ARAR value for total PCBs is .1 ug/l. Total PCBs include: Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, and Aroclor-1260. Aroclor-1232 was the only PCB detected.
ND = Non-detect.→

PFOHL BROTHERS LANDFILL GROUND WATER DATA

TABLE 4-8 (contd)
SUMMARY OF CONSTITUENTS IN SHALLOW AQUIFER EXCEEDING ARARs
ROUNDS 1 AND 2
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		ROUND 2 CONCENTRATIONS in ug/l
SAMPLE NUMBER :	GW ARARs	GW-17S-02
VOLATILES		
1,1-Dichloroethene	5 a	
1,1-Dichloroethane	5 a	
1,1,1-Trichloroethane	5 a	
Benzene	ND a	
Toluene	5 a	
Chlorobenzene	5 a	
Xylenes(total)	5 a	
SEMI VOLATILES		
Phenol *	1.0 a	4000.0 D
1,4-Dichlorobenzene	** a	
1,2-Dichlorobenzene	** a	
bis(2-Ethylhexyl)Phthalate	50 a	
PESTICIDES/PCBs		
Aroclor-1232 ****	.1 a	110.0 J
INORGANICS		
ANTIMONY	3 b	24.4 BJ
BARIUM	1000 a	1530.0 J
CADMIUM	10 a	12.0 J
CHROMIUM	50 a	
COPPER	200 a	
IRON ***	300 a	32500.0
LEAD	25 a	50.6
MAGNESIUM	35000 b	175000.0
MANGANESE ***	300 a	1320.0 J
MERCURY	2 a	
SODIUM	20000 a	201000.0
ZINC	300 a	

FOOTNOTES :
a = ARARs are 6 NYCRR Part 703.5 Class GA standards for potable water.
b = ARARs are 6 NYCRR Part 703.5 Class GA TOGS guidelines for potable ground water (ug/l).
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
* = The ARAR value shown includes a total of: phenol, pentachlorophenol, and 2,4-dichlorophenol.
** = ARARs indicate that the combined total for 1,4-dichlorobenzene and 1,2-dichlorobenzene may not exceed 4.7 ug/l.
*** = The combined total for Iron and Manganese exceeds 500 ug/l for all samples except GW-4S-02 and GW-11S-02.
**** = The ARAR value for total PCBs is .1 ug/l. Total PCBs include: Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor1248, Aroclor-1254, Aroclor-1260. Aroclor-1232 was the only PCB detected.
ND = Non-detect.→

revealed concentrations of benzene exceeding ARARs. Wells 9S and 14S, both located in Area C, also revealed benzene at concentrations exceeding ARARs. Toluene concentrations in well 14S also exceeded ARARs.

Two wells (14S and 17S) in Area C revealed phenol at concentrations exceeding ARARs. There were no contravention of ARARs detected elsewhere on the site.

The PCB Arochlor 1232 exceeded ARARs in two wells. One well 15S, is located south of Aero Lake in Area B; the second well (17S) is located in the eastern section of Area C.

Chlorinated aliphatic hydrocarbons, specifically 1,1-dichloroethane (DCA), and 1,1,1-trichloroethane (TCA) were detected at concentrations exceeding ARARs in two wells (2S and 12S) located in areas A and B. In addition, 1,1-dichloroethene (DCE) was also detected in well 2S at concentrations exceeding ARARs. Well 16S, located in the eastern section of Area B, revealed the widest range of organic constituents exceeding ARARs. In addition to the benzene concentrations, mentioned previously, this well revealed chlorobenzene, xylenes, 1,4-dichlorobenzene, and 1,2-dichlorobenzene at concentrations exceeding ARARs.

Evidence of offsite contaminant migration was observed in well 7S during the first round of sampling and in well 3S during the second round of sampling. Well 7S revealed di-n-octylphthalate concentrations exceeding ARARs. Benzene, toluene and bis(2-ethylhexyl)phthalate were detected in well 3S at concentrations exceeding ARARs.

Several inorganic constituents were detected at concentrations exceeding ARARs in the background shallow ground water wells in both rounds of sampling. Manganese and sodium exceeded ARARs in Round 1. These same constituents exceeded ARARs in the second round of sampling, in addition to iron and magnesium.

Iron, magnesium, manganese and sodium were detected in the majority of shallow onsite wells at concentrations exceeding ARARs. Lead was detected in areas B and C at concentrations exceeding ARARs in five of the onsite shallow wells. Barium was detected in well 15S, south of Aero Lake, in well 16S, located northeast of Area B, and in 14S and 17S, located in the central and northeastern section of Area C. Chromium concentrations exceeded ARARs in all three areas of the landfill during the second round of sampling.

One shallow well (16S) in Area B and one shallow well (14S) in Area C revealed copper concentrations exceeding ARARs. The zinc concentrations in both of these wells also exceeded ARARs.

Antimony was detected in two wells (16S and 17S) at concentrations exceeding ARARs. One exceedance was observed in both areas B and C. One well in Area A (12S) exceeded ARARs for mercury in the first round of sampling. Mercury concentrations in well 16S, located in Area B, exceeded ARARs in the second round of sampling. There was one exceedance of cadmium in 17S, located in Area C, during the second sampling round.

Iron, sodium, magnesium, and manganese were detected most frequently at concentrations exceeding ARARs in the shallow offsite wells during both rounds of sampling.

Groundwater: Bedrock Aquifer

Two rounds of ground water quality data were collected from seven bedrock wells installed by CDM. During the first round, all wells except monitoring well 2D were sampled. One duplicate sample was collected and analyzed from well 3D during the first round. All of the monitoring wells were sampled during the second round, although no duplicate sample was collected.

The acid extractable data for wells 2D and 3D and all of the pesticide/PCB data for wells 1D and 4D (second round only) were rejected during the data validation process. As previously mentioned, the only compounds detected in the laboratory method blanks were DEHP and di-n-octyl phthalate.

During the first round of sample analysis, the only organic compounds detected were benzoic acid, phenol, and DEHP, all semivolatile compounds. With the exception of DEHP, phenol and benzoic acid were only detected once in well 7D and were not found in the second round. Phenol was also present in the subsurface soils and drum samples, as well as in the shallow ground water.

Although DEHP was found in several wells during the first and second rounds of sampling, the majority of DEHP concentrations were within the sample quantitation range and all were indicative of laboratory/field contamination. In addition, DEHP was not found consistently between sampling rounds.

Five volatile organics (benzene, chloroethane, 1,1-dichloroethane, 1,2-trans-dichloroethene, and toluene) and one pesticide (aldrin) were detected in the second round of sampling. Of these compounds, chloroethane, toluene, and aldrin were detected at or below the sample quantitation limit. All were detected below 10 ug/l. Benzene and toluene were detected in the shallow well corresponding to the bedrock well where they were detected (3S and 3D, located to the northwest of area B). The other compounds were all detected in well 2D (located in the south central portion of Area B). Both chloroethane and 1,1-dichloroethane were found in the shallow well 2S. 1,2-trans-dichloroethene was not detected in the shallow well, however, 1,1-dichloroethene was detected in this well.

The detection of aldrin in well 2D is difficult to explain. Aldrin was found infrequently at the site. In addition, this compound was not found in the shallow ground water well or in the boring samples taken from this location. However, until additional sampling is performed it cannot be determined if the detection of this compound is due to a false positive detection by the laboratory or if this compound is actually present in the ground water.

The compound 2,3,7,8 TCDD was not detected in ground water from the bedrock aquifer (Table 4-7).

Inorganics that were detected at levels above baseline in approximately 50 percent of the bedrock wells include aluminum, calcium, iron, nickel, and potassium. In addition, antimony, chromium, sodium and vanadium were detected at concentrations greater than two times baseline but in fewer samples.

Few contaminants were detected in the bedrock aquifer at concentrations in excess of potable water standards or guidelines (Table 4-9).

Bedrock well 2D, located in Area B, revealed concentrations of trans 1,2-dichloroethene exceeding ARARs, as well as the pesticide aldrin. Well 7D, located southeast of Area C, revealed elevated concentrations of phenol that exceeded ARARs, while benzene concentrations in 3D exceeded ARARs.

Ground water from the background well revealed both iron and sodium at concentrations exceeding ARARs in the first round of sampling. These same constituents exceeded ARARs in the second round of sampling, in addition to antimony and chromium.

Sodium was detected in all the deep offsite wells at concentrations exceeding ARARs. Iron concentrations also frequently exceeded ARARs in the majority of the deep offsite wells.

Antimony was detected at concentrations exceeding ARARs in one well, 1D, during the second round of sampling. Chromium concentrations exceeded ARARs in both wells 3D and 4D only during the first round of sampling.

Leachate Seeps and Sediments

A total of 18 of a possible 40 leachate seeps flowing in or from the landfill were sampled by CDM in April 1989 (appendix N). One duplicate sample was collected during this sampling event.

PFOHL BROTHERS LANDFILL GROUND WATER DATA

TABLE 4-9

SUMMARY OF CONSTITUENTS FROM BEDROCK AQUIFER EXCEEDING ARARs

Page 01 of 02

ROUNDS 1 AND 2

12/11/90

		ROUND 1			CONCENTRATIONS in ug/l		
SAMPLE NUMBER :	GW ARARs	GW-1D-01	GW-3D-01	GW-4D-01	GW-5D-01	GW-6D-01	GW-7D-01
VOLATILES							
SEMI VOLATILES							
Phenol *	1.0 a						16.0
PESTICIDES/PCBs							
INORGANICS							
CHROMIUM	50 a		131.0 J	728.0 J			
IRON ***	300 a		4510.0	2260.0	5270.0	424.0	
MAGNESIUM	35000 b				36800.0		
SODIUM	20000 a	38800.0	67900.0	41100.0	131000.0	127000.0	58000.0

FOOTNOTES :

a = ARARs are 6 NYCRR Part 703.5 Class GA standards for potable water.
b = ARARs are 6 NYCRR Part 703.5 Class GA TOGS guidelines for potable ground water (ug/l).
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
* = The ARAR value shown includes a total of : Phenol, Pentachlorophenol & 2,4 dichlorophenol
*** = Combined total for Iron and Manganese exceeds 500 ug/l for all samples except GW-1D-01, GW-6D-01 and GW-7D-01→

PFOHL BROTHERS LANDFILL GROUND WATER DATA

TABLE 4-9 (contd)

SUMMARY OF CONSTITUENTS FROM BEDROCK AQUIFER EXCEEDING ARARs
Page 02 of 02

12/11/90

	ROUND 2			CONCENTRATIONS in ug/l				
SAMPLE NUMBER :	GW ARARs	GW-1D-02	GW-2D-02	GW-3D-02	GW-4D-02	GW-5D-02	GW-6D-02	GW-7D-02
VOLATILES								
Benzene	ND			23.0				
trans 1,2-Dichloroethylene	5 a		9.2					
SEMI VOLATILES								
PESTICIDES/PCBs								
Aldrin	ND		0.05 J					
INORGANICS								
ANTIMONY	3 b	35.1 BJ					30.4 BJ	
CHROMIUM	50 a						191.0 J	
IRON ***	300 a		2410.0	2510.0	594.0	1250.0	1200.0	933.0
MAGNESIUM	35000 b					44400.0		
MANGANESE ***	300 a			428.0 J				
SODIUM	20000 a	41400.0	68200.0	85800.0	34300.0	354000.0	76900.0	55000.0

FOOTNOTES :
a = ARARs are 6 NYCRR Part 703.5 Class GA standards for potable water.
b = ARARs are 6 NYCRR Part 703.5 Class GA TOGS guidelines for potable ground water (ug/l).
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
*** = Combined total for Iron and Manganese exceeds 500 ug/l for all samples except GW-1D-02
ND = Non-Detect→

The criteria used in selecting the seep locations included the following:

- Flow conditions (i.e., the flow volume of the seep)
- The location of the seep (i.e., selection of seeps located across the site to provide for a full assessment of leachate produced by the site)
- The proximity of the seep to residences,
- The proximity of the seep to other surface water features surrounding the landfill
- The relative position of the seep to other leachate seep locations

Because seeps were not observed in Area A of the landfill, seep sampling was conducted only in areas B and C. Sampling was conducted during the spring when the leachate seeps reached maximum flow conditions. The results of this sampling episode are summarized below and more fully described in the CDM Interim Report: Leachate, Surface Water, and Sediment Investigation (CDM 1990c).

As discussed earlier, the leachate seeps are believed to be derived from ground water from the unconsolidated aquifer, therefore, the ground water sample collected from the upgradient well (MW-6S) was used to represent background quality for the leachate. The selection of this well provided a level of comparison, although the concentrations of chemicals (higher-molecular-weight organics and inorganics) in the ground water would not necessarily be expected to to be the same as in landfill leachate. This is because the leachate would be expected to contain high concentrations of suspended solids that could contain compounds that typically are sorbed onto sediment particles.

Benzene was detected in the trip blank collected with these samples at an estimated concentration of 2 ug/l. Chloroform (0.92 to 1.2 ug/l) and methylene chloride (2 to 4.9 ug/l) were also detected in the two of the trip blanks. Methylene chloride (4 to 8 ug/l), acetone (6 to 14 ug/l), and an unknown phthalate (250 ug/l) were detected in several of the sediment laboratory method blanks. Endrin, endosulfan II, beta-BHC, and DDE were detected in two of the sediment laboratory method blanks. This would indicate that carry-over contamination was possibly occurring.

Bis(2-ethylhexyl)phthalate (2 to 15 ug/l) was detected in several of the leachate seep laboratory method blanks.

Leachate Seeps. The leachate seep samples revealed organic contamination similar to that found in the drum, soil and shallow ground water samples. Ten volatile organics were detected in the leachate seep samples. Most of these volatiles were detected infrequently, and all were detected below 140 ug/l (the one time high of chlorobenzene). However, all of these volatiles were found in other media at the site, which indicates that some contamination of the leachate by organics is occurring.
Of the ten volatiles, the aromatics benzene and chlorobenzene were detected in the three leachate locations (SP-1, SP-2 and SP-11) along the northern boundary of Area B and to the south of Aero Lake and the drainage ditch. Benzene was also detected in other site media within this area. Although chlorobenzene was not detected consistently in both the 8010 and 8020 analyses (i.e., it was detected in the 8010 analysis but not in the 8020 analysis at SP-2 and SP-11), it was found in one other leachate seep sample, as well as in other media collected from the site. Chloroethane was detected in two of the seeps (SP-12 and SP-13) located along the northeastern boundary of Area B, south of Area A and the intermittent stream.

The most contaminated seep is the large seep, SP-4, located along the southern boundary of Area C, north of the railroad track and Pfohl Road. A total of nine volatiles was detected in this seep. One aromatic (chlorobenzene) and three halogenated hydrocarbons (1,1-dichloroethane, 1,2-dichloroethene, and 1,2-dichlorobenzene) were detected in both the sample and its duplicate. In this sample, 1,3-dichlorobenzene was detected in the semivolatile analysis but not in the 8020 analysis. 1,3-Dichlorobenzene was detected in both analyses of the duplicate although at a much lower concentration. The remaining four volatiles, 1,4,-dichlorobenzene, trichloroethene, benzene, and ethylbenzene were only detected in the duplicate sample. Although this would indicate that there is some problem with the quality of the data from this location or in the sampling technique, these compounds are most likely to be present because they were found in other samples collected from the site near this location. Exact concentrations are not known. 1,4-Dichlorobenzene was detected at an estimated concentration below the contract required detected limit in SP-5.

Fifteen semivolatiles and five pesticides were also detected in the leachate seep samples. Semivolatiles and pesticides were detected in seven of the samples. Except for bis(2-ethylhexyl)phthalate (DEHP), these chemicals were detected infrequently.
Phenol, dibenzofuran, and N-nitrosodiphenylamine were detected in SP-1 and SP-2. Phenol and dibenzofuran are two of the semivolatile compounds detected most frequently at the site, in general. N-Nitrosodiphenylamine was detected very infrequently at the site although it was found during past investigations performed by other firms. This chemical is not a naturally occurring substance; it is a man-made chemical that is no longer produced in the United States (EPA 1987). The only semivolatile detected in SP-4 was 2,4-dimethylphenol. 2,4-Dimethylphenol was not found in any of the other leachate samples; however, this compound was found in other media sampled in Area C.

Benzoic acid was detected at an estimated concentration of 22 ug/l in the leachate sample collected from SP-16. Benzoic acid occurs in free and combined forms in nature; most berries contain appreciable amounts of benzoic acid. It is also excreted as hippuric acid by almost all vertebrates except fowl (Merck 1983). The detection of benzoic acid in SP-16 may be due to natural source conditions (e.g., the presence of wetlands within this area) rather than the Pfohl Brothers Landfill. This compound was found very infrequently at the site, with one detection each in the unconsolidated aquifer, the bedrock aquifer, the subsurface soil samples, and the drum samples. However, the concentrations in the one subsurface soil sample and the one drum sample were at levels that would indicate probable disposal of this compound by industry at the site.

Several of the DEHP concentrations were within the sample quantitation range and all were detected at concentrations indicative of laboratory/ field contamination. (Phthalate esters are common laboratory and field contaminants because of the use of both field and laboratory equipment that

are made from flexible plastics.) DEHP was detected in both the field blanks and in the method blanks. However, this compound was detected at concentrations in several of the boring and drum samples that may indicate disposal at this site. The high concentrations detected in the soil borings and in the drum samples may be indicative of plastic present in these samples rather than indicative of disposal of phthalate esters at the site. In addition, DEHP was not detected in any of the corresponding sediment samples. Based on the physicochemcial properties, it is expected that this compound would be present in the sediment samples.
Polycyclic aromatic hydrocarbons (PAH) were detected in SP-2, SP-10, SP-14 and SP-16. Individual PAHs that were detected include benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, chrysene, fluoranthene, fluorene, phenanthrene, and pyrene. All were detected below 100 ug/l and only fluoranthene, pyrene, and phenanthrene were detected more than once. It is most unusual to detect chemicals such as PAHs and pesticides in "water" samples because these chemicals typically sorb to sediments. Because the leachate samples were collected in the spring when flow conditions were high and when run-off carries particulates, it is likely that the samples in which these compounds were found had high suspended solids concentrations. Where PAHs were found in the leachate sample, these same compounds were detected in the corresponding sediment sample.

Five pesticides were detected infrequently and at concentrations below 0.03 ug/l (endrin in SP-7) in the seep samples, including aldrin, dieldrin, DDD, endrin, and endosulfan II. Except for the detection of dieldrin in both the leachate and sediment from SP-16, the pesticides found in the leachate samples were not detected in the corresponding sediment samples and vice versa. This may be due to the fact that the detection limits for the leachate seep samples were significantly lower than those for sediment samples (due to the inherent matrix effect and moisture problems with sediment samples). However, pesticides that were found in the leachate were different that those found in the sediment locations. Except in a few isolated instances, the pesticides were not frequently detected in the site media, or if detected, were detected at concentrations that could be indicative of anthropogenic levels. Dieldrin, endrin, aldrin, and endosulfan II were detected in the drums and soil samples. In addition, aldrin was also detected in the shallow ground water samples.

Contamination of the leachate itself by inorganics appeared to be fairly widespread across the site. The most contaminated seeps in terms of inorganic compounds were SP-7 and SP-16, with the greatest number of inorganics and the highest concentrations typically found in both these seeps. SP-7 was located near the drainage ditch north of Aero Drive, while SP-16 is located off site--to the west of Area B. All inorganics, except for antimony and thallium, which were not detected in any of the seeps, and selenium, which was detected within the sample quantitation range, were detected at concentrations significantly above background (baseline) in one or more samples. Cyanide was detected in three of the leachate seeps. The higher-than-average concentrations of metals in the leachate samples may be due more to the presence of suspended particulates in these samples than to the actual presence of these metals in the leachate.

Leachate seeps along the northwestern perimeter of Area B, south of Aero Lake, revealed several organic constituents at concentrations exceeding ground water ARARs (Table 4-10). Sample station SP-01 revealed benzene, chlorobenzene, and phenol at concentrations exceeding ARARs. Seep sample SP-02, located in close proximity to SP-01, also revealed benzene and phenol at concentrations exceeding ARARs. Benzene concentrations in SP-11, located in the vicinity of SP-01 and SP-02, also exceeded ARARs.

Seep sample SP-05, situated along the northern perimeter or Area C, had slightly lower concentrations of benzene exceeding ARARs.

Seep sample SP-04, located along the southern perimeter of Area C, north of the railroad tracks, revealed chlorobenzene, trans 1,2-dichloroethene, 1,4-dichlorobenzene, and 1,2-dichlorobenzene, at concentrations exceeding ARARs.

Bis(2-ethylhexyl)phthalate was detected at concentrations exceeding ARARs in seep sample SP-09, located along the southcentral perimeter of Area C along Pfohl Road. This compound, however, was also detected in the laboratory blank sample.

PFOHL BROTHERS LANDFILL LEACHATE DATA

TABLE 4-10
SUMMARY OF CONSTITUENTS IN LEACHATE SEEPS EXCEEDING ARARs

Page 01 of 03

12/11/90

		CONCENTRATIONS in ug/l							
SAMPLE NUMBER :	GW ARARs	SP-01	SP-02	SP-03	SP-04	SP-05	SP-06	SP-07	SP-08
VOLATILES									
Benzene	ND a	4.0	8.0			3.0			
Chlorobenzene	5 a	11.0			140.0				
trans 1,2-Dichloroethylene	5 a				85.0				
SEMI VOLATILES									
Phenol *	1.0 a	10.0	7.0 J						
1,4-Dichlorobenzene	** a				6.0 J				
1,2-Dichlorobenzene	** a				17.0				
Benzo(a)Anthracene	.002 b								
Chrysene	.002 b								
bis(2-Ethylhexyl)Phthalate	50 a								
Benzo(b)Fluoranthene	.002 b								
Benzo(a)Pyrene	ND a								
PESTICIDES/PCBs									
Aldrin	ND a								
Dieldrin	ND a								0.0032 JM
Endrin	ND a							0.028 JM	
4,4'-DDD	ND a								
INORGANICS									
BARIUM	1000 a		1030.0				1210.0	10000.0	
BERYLLIUM	3 b							14.8	
CADMIUM	10 a				15.1	20.4		61.2	13.1
CHROMIUM	50 a							426.0	
COPPER	200 a							784.0	216.0
IRON ***	300 a				75700.0	136000.0			376000.0
LEAD	25 a	58.8	50.1	54.4	231.0		79.6	1640.0	476.0
MAGNESIUM	35000 b	57200.0	59100.0	64500.0	65100.0		43100.0	165000.0	65900.0
MANGANESE ***	300 a	1060.0	648.0	1310.0	1300.0	751.0	891.0	16100.0	1420.0
MERCURY	2 a							4.7 JS	
SELENIUM	10 a								
SODIUM	20000 a	37100.0	40600.0	38200.0	52000.0		27000.0	36100.0	74400.0
ZINC	300 a	314.0		715.0	991.0			3730.0	3360.0

FOOTNOTES :

a = ARARs are 6 NYCRR Part 703.5 Class GA standards for potable water.
b = ARARs are 6 NYCRR Part 703.5 Class GA TOGS guidelines for potable ground water (ug/l).
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
* = The ARAR value shown includes a total of: phenol, pentachlorophenol, and 2,4-dichlorophenol.
** = ARARs indicate that the combined total for 1,4-dichlorobenzene and 1,2-dichlorobenzene may not exceed 4.7 ug/l.
*** = The combined total for Iron and Manganese exceeds 500 ug/l for all samples except SP-09.
ND = Non-detect.→

PFOHL BROTHERS LANDFILL LEACHATE DATA

TABLE 4-10 (contd)
SUMMARY OF CONSTITUENTS IN LEACHATE SEEPS EXCEEDING ARARs

Page 03 of 03

12/11/90

		CONCENTRATIONS in ug/l	
SAMPLE NUMBER :	GW ARARs	SP-17	SP-18
VOLATILES			
Benzene	ND a		
Chlorobenzene	5 a		
trans 1,2-Dichloroethylene	5 a		
SEMI VOLATILES			
Phenol *	1.0 a		
1,4-Dichlorobenzene	** a		
1,2-Dichlorobenzene	** a		
Benzo(a)Anthracene	.002 b		
Chrysene	.002 b		
bis(2-Ethylhexyl)Phthalate	50 a		
Benzo(b)Fluoranthene	.002 b		
Benzo(a)Pyrene	ND a		
PESTICIDES/PCBs			
Aldrin	ND a	0.0081 JM	
Dieldrin	ND a		
Endrin	ND a		
4,4'-DDD	ND a		0.011 JM
INORGANICS			
BARIUM	1000 a	1200.0	
BERYLLIUM	3 b		
CADMIUM	10 a	10.8	
CHROMIUM	50 a		
COPPER	200 a	325.0	
IRON ***	300 a	110000.0	
LEAD	25 a	123.0	98.6
MAGNESIUM	35000 b	43600.0	
MANGANESE ***	300 a	1580.0	711.0
MERCURY	2 a		
SELENIUM	10 a		
SODIUM	20000 a	25200.0	187000.0
ZINC	300 a	636.0	

FOOTNOTES :

a = ARARs are 6 NYCRR Part 703.5 Class GA standards for potable water.
b = ARARs are 6 NYCRR Part 703.5 Class GA TOGS guidelines for potable ground water (ug/l).
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
* = The ARAR value shown includes a total of: phenol, pentachlorophenol, and 2,4-dichlorophenol.
** = ARARs indicate that the combined total for 1,4-dichlorobenzene and 1,2-dichlorobenzene may not exceed 4.7 ug/l.
*** = The combined total for Iron and Manganese exceeds 500 ug/l for all samples except SP-09.
ND = Non-detect.→

PFOHL BROTHERS LANDFILL LEACHATE DATA

TABLE 4-10 (contd)
SUMMARY OF CONSTITUENTS IN LEACHATE SEEPS EXCEEDING ARARs

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12/11/90

	CONCENTRATIONS in ug/l								
SAMPLE NUMBER :	GW ARARs	SP-09	SP-10	SP-11	SP-12	SP-13	SP-14	SP-15	SP-16
VOLATILES									
Benzene	ND a			4.0					
Chlorobenzene	5 a								
trans 1,2-Dichloroethylene	5 a								
SEMI VOLATILES									
Phenol *	1.0 a								
1,4-Dichlorobenzene	** a								
1,2-Dichlorobenzene	** a								
Benzo(a)Anthracene	.002 b						5.0 J		
Chrysene	.002 b						5.0 J		
bis(2-Ethylhexyl)Phthalate	50 a	60.0 B							
Benzo(b)Fluoranthene	.002 b						7.0 J		
Benzo(a)Pyrene	ND a						5.0 J		
PESTICIDES/PCBs									
Aldrin	ND a								0.0074 JM
Dieldrin	ND a				0.007 J	0.02 J			0.028 JM
Endrin	ND a								
4,4'-DDD	ND a								
INORGANICS									
BARIUM	1000 a								3910.0
BERYLLIUM	3 b								
CADMIUM	10 a			18.1	13.5	12.4	11.4		122.0
CHROMIUM	50 a								52.4
COPPER	200 a		204.0	232.0	612.0	433.0	653.0		727.0
IRON ***	300 a		65800.0		214000.0	118000.0	90700.0	44000.0	494000.0
LEAD	25 a		295.0		167.0	214.0	511.0		670.0
MAGNESIUM	35000 b	40800.0	71100.0	54200.0	74500.0	68200.0	44300.0	43800.0	64000.0
MANGANESE ***	300 a		3130.0	1360.0	3520.0	3660.0	971.0	1300.0	3150.0
MERCURY	2 a			3.1 JS			2.1 JS		2.8 JS
SELENIUM	10 a		12.0 JS				12.8 JS		
SODIUM	20000 a	25600.0	34800.0	46000.0	37800.0	33600.0	37300.0	209000.0	40600.0
ZINC	300 a		979.0	1160.0	2420.0	1690.0	1610.0		8270.0

FOOTNOTES :

a = ARARs are 6 NYCRR Part 703.5 Class GA standards for potable water.
b = ARARs are 6 NYCRR Part 703.5 Class GA TOGS guidelines for potable ground water (ug/l).
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
* = The ARAR value shown includes a total of: phenol, pentachlorophenol, and 2,4-dichlorophenol.
** = ARARs indicate that the combined total for 1,4-dichlorobenzene and 1,2-dichlorobenzene may not exceed 4.7 ug/l.
*** = The combined total for Iron and Manganese exceeds 500 ug/l for all samples exept SP-09.
ND = Non-detect. →

Seep sample SP-14 revealed a wide range of polycyclic aromatic hydrocarbons at concentrations exceeding ARARs. These included benzo(a)anthracene, chrysene, benzo(b)fluoranthene, and benzo(a)pyrene.

Pesticides were detected at concentrations exceeding ARARs in several of the seep samples. Endrin was detected in seep sample SP-07, located along the southern perimeter of Area B, along Aero Drive, at concentrations exceeding ARARs. Dieldrin was detected in four seep samples, SP-08, SP-12, SP-13, and SP-16 at concentrations exceeding ARARs. Seep samples SP-16 and SP-17 revealed aldrin concentrations exceeding ARARs. The pesticide 4,4'-DDD was detected only once in sample SP-18 at concentrations exceeding ARARs.

A wide range of inorganic constituents were detected in most of the seep samples at concentrations exceeding ARARs. Magnesium, manganese and sodium were detected most frequently at concentrations exceeding ARARs. Copper, iron, lead, zinc, and cadmium were also detected in many of the samples at concentrations exceeding ARARs. Barium and mercury concentrations exceeded ARARs in approximately 25 to 30% of the samples, with selenium, chromium, and beryllium exceeding ARARs in only 1 or 2 of the 18 samples analyzed.

Leachate Seep Sediments. Three volatile organics (methylene chloride, acetone, and chlorobenzene) were detected in the leachate seep sediments. Except for chlorobenzene, the volatile organics found in the seeps were not detected in the leachate seep sediment samples. Chlorobenzene was detected in SS-14 (this compound was not detected in the leachate seep sample from this location) and in the duplicate sediment sample from SS-4. Because soil/sediment samples for volatile analysis are not homogenized, a degree of differentiation between samples is not unusual. Chlorobenzene was also found in the leachate seep sample (SP-04) and in drum, soil, and shallow ground water samples.

Methylene chloride was detected in the majority of the leachate sediment samples and acetone was detected in almost half of the samples. Acetone is commonly used in the field (e.g., acetone is used in decontaminating field equipment) and both are used by laboratories. These compounds were detected in the field, trip and laboratory method blanks associated with these samples. Except for the detection of acetone at levels greater than 100 ug/kg, the concentrations detected were similar to those associated with field and laboratory contamination. Although it is known from historical records that methylene chloride was disposed of at the site, the presence of both these compounds in the sediment sample is suspect for the following reasons. Based on estimates for an unsaturated topsoil model (AMRL 1985), significant amounts of methylene chloride would be expected to be present in the soil-water (33%) and the soil-air (11%) phases. Given the physicochemical properties of acetone, the same assumptions would hold true. However, methylene chloride and acetone were not detected in the leachate seep samples. In addition, even though methylene chloride and acetone are fairly mobile in the environment (acetone is one of the most mobile chemicals) and could readily be expected to be present in the ground water (especially since these compounds were also detected in the drum samples), neither of these compounds was detected in the ground water. Based on the physicochemical properties of these compounds and the lack of detection in a water medium, it could easily be assumed that these compounds are not associated with the site, but with laboratory or field contamination.

Varying concentrations and types of PAHs were detected in the leachate seep sediment samples including acenapthene, anthracene, benzo(a)anthracene, benzo(b)fluoranthrene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3,cd)pyrene, phenanthrene, and pyrene. The detected concentrations were higher than those found in the background sample but were, for the most part, within the range (100 ug/kg to 10,000 ug/kg) typically found in urban areas. The PAHs fluoranthene and pyrene were detected most often. Fly ash, which contains PAHs, was used as a cover medium during landfill operations. The presence of PAHs at the surface of the site is most likely due to this source.

Dibenzofuran was detected in leachate seep sediment samples SS-1 and SS-2 at concentrations of 2400 and 13,000 ug/kg, respectively. Dibenzofuran was also detected in the leachate seeps at these two locations, as well as in other site media.

Two phthalate esters, di-n-butyl phthalate and diethylphthalate, were detected in one sample each. As previously described, phthalate esters are typically associated with field and laboratory contamination of the samples, especially at the concentrations detected in these samples. DEHP, another phthalate ester that could readily be expected to be found in the sediments based on its detection in the leachate, was not detected in the corresponding sediment samples.

Five pesticides were detected in the seep sediment samples. Endosulfan II, which was detected in one leachate seep sample, was not detected in the sediments. Gamma-chlordane was detected in five sediment samples and beta-BHC was detected in two samples. The remaining three pesticides, aldrin, DDD, and dieldrin, were detected only once. The detected concentrations are similar to typical concentrations found in sediments across the United States. However, these pesticides may have been disposed of at the site and all were detected in the drum and/or soil samples. PCBs are organic compounds formed by the chlorination of biphenyls. Commercial PCB mixtures were manufactured under a variety of trade names. The trade name standards used by NYSDEC in its TCL list is Aroclor. The Aroclor compound is followed by a four digit code (e.g., Aroclor-1248); biphenyls are generally indicated by the number 12 in the first two positions, while the last two digits refer to percent by weight of the chlorine mixture. Aroclor-1248 was detected in two samples (SP-1 and SP-2) and Aroclor-1254 was detected in the sample collected from SP-13. PCBs were also detected in samples from the drums.

The compound 2,3,7,8-TCDD was not detected in any of the leachate seep sediment samples (Table 4-11). Again, it should be noted that data for these samples were qualified due to non-compliant initial and/or continuing calibration, low surrogate recoveries, and/or the ending column performance check was outside of 12 hours.

Antimony was not detected in any of the sediment samples and thallium was only detected once. Aluminum, arsenic, cadmium, chromium, copper, lead and nickel were detected in all seep sediment samples. Mercury and vanadium were detected in a majority of the sediment samples.

TABLE 4-11

2,3,7,8-TCDD DATA

PFOHL BROTHERS LANDFILL

LEACHATE SEEP SEDIMENT SAMPLES

SAMPLE ID NUMBER	RESULT (ppb)	FOOTNOTES
SS-001-001	ND(0.27) Q	1,3
SS-002-001	ND(0.083) Q	1,3
SS-003-001	ND(0.12) Q	1,3
SS-004-001	ND(0.009) Q	1,3,8
SS-005-001	ND(0.013) Q	1,3,8
SS-006-001	ND(0.012) Q	1,3
SS-007-001	ND(0.014) Q	1,3
SS-008-001	ND(0.055) Q	1,3
SS-009-001	ND(0.034) Q	1,3
SS-010-001	ND(0.058) Q	1,3
SS-011-001	ND(0.090) Q	1,3
SS-012-001	ND(0.15) Q	1,3
SS-013-001	ND(0.097) Q	1,3
SS-014-001	ND(0.094) Q	1,3
SS-015-001	ND(0.12) Q	1,3
SS-016-001	ND(0.11) Q	1,3
SS-017-001	ND(0.15) Q	1,3
SS-018-001	ND(0.33) Q	1,3,4

FOOTNOTES

File: PBDIOX2

ND = Non detection
Q = Data qualified during data validation.
1 = Data qualified due to non-compliant initial calibration (three-point).
3 = Data qualified as estimated due to non-compliant continuing calibration concentration (0.2 ng/ul).
4 = Data qualified as estimated due to low surrogate recovery, i.e., < 30%.
8 = Data qualified as estimated because ending column performance was outside 12 hour clock.

The highest concentrations of metals were typically found in SS-16. This location had the highest concentrations of cadmium and cobalt, the second highest concentrations of copper, mercury and nickel, and the third highest concentration of selenium. This location also had several of the highest detections of inorganics in the leachate seep sample. This location is of special concern since it is off site just west of Area B near several intermittent streams. Other sample locations where inorganics were above two times background level were at seep locations SS-1, SS-8, SS-10, SS-11, and SS-18. These locations are all in very different sections of the site, indicating widespread contamination by metals.

All detections of aluminum and antimony were below the highest sediment sample background concentration. Arsenic, beryllium, lead, selenium, silver, thallium, and vanadium were detected at concentrations greater than background in at least one and often in several samples. The remaining inorganic constituents were detected more frequently at concentrations in excess of background concentrations.

Surface Water and Sediment Samples

Surface water and sediment samples were collected from the surrounding surface water bodies (Aero Lake and Ellicott Creek), intermittent streams, and ditches. Ditches are located along the northern boundary of the site (north of Area B), on both sides of Transit and Aero Roads, and just north of the Conrail railroad tracks (south of Area C). Except for the three sediment samples SE-17, 18 and 19, all samples were collected in April 1989. Three surface water and sediment samples were collected from Aero Lake. One surface water and sediment sample was collected from Ellicott Creek in the ponded area located south of the landfill and west of the railroad trestle. Two additional sediment samples (SE-18 and 19) were collected from Ellicott Creek in December 1989: the first station was located adjacent to the railroad trestle and the second was located to the west of the ponded area. Sample SE-17 was collected in a swampy area located in the eastern portion of Area C also in December 1989. Ten surface water and sediment samples and the one duplicate sample were collected from the surrounding drainage ditches and intermittent streams.

Methylene chloride and acetone were detected in the trip blanks and the laboratory method blanks. Concentrations of methylene chloride in these blanks ranged from an estimated concentration of 4 ug/l to 64 ug/l, while acetone was found at concentrations ranging from 14 to 17 ug/l. Chloromethane, chloroform, and 1,1,2,2-tetrachloroethane were also detected in one of the trip blanks. (A trip blank is used to determine the potential for contamination of volatile organic samples during shipping, handling, and storage.) None of these compounds were detected in any of the surface water samples. DEHP was detected in the laboratory method blanks at concentrations ranging from 3 to 18 ug/l.

The compound 2,3,7,8-TCDD was not detected in any of the surface water sediment samples (Table 4-12). As with the 2,3,7,8-TCDD data presented previously, these data were also qualified for the same reasons given earlier. Data for sample SE-001-001 does not rigorously support the non-detect results reported for this sample, although it is likely that 2,3,7,8-TCDD is not present.

Drainage Ditches/Intermittent Streams: Surface Water. Four volatiles and three semivolatiles were detected in these surface water samples. Pesticides and PCBs were not detected in any of the surface water samples.

Acetone was detected at a concentration similar to that found in the trip and method blanks (18 ug/kg as compared to 17 ug/l) from the northern ditch located along Aero Drive near J and J Electric and Diesel Service. 1,2-Dichloroethene was detected in the sample and duplicate collected from the western end of Area B in the northern ditch along Aero Drive.

One phthalate was detected; di-n-octyl phthalate was found in the sample collected from the southern ditch located along Aero Drive.

Antimony, chromium, selenium, silver, thallium and cyanide were not detected in any of the ditch samples. All other inorganic constituents were detected at least in one sample above background levels.

TABLE 4-12

2,3,7,8-TCDD DATA

PFOHL BROTHERS LANDFILL

SURFACE WATER SEDIMENT SAMPLES

SAMPLE ID NUMBER	RESULT (ppb)	FOOTNOTES
SE-001-001	ND(0.15) R2	1,3,7
SE-002-001	ND(0.0086) Q	1,3,8
SE-003-001	ND(0.028) Q	1,3,4,8
SE-004-001	ND(0.010) Q	1,3,8
SE-005-001	ND(0.0097) Q	1,3,8
SE-006-001	ND(0.0059) Q	1,3,8
SE-007-001	ND(0.0084) Q	1,3,8
SE-008-001	ND(0.018) Q	1,3,8
SE-009-001	ND(0.035) Q	1,3,8
SE-010-001	ND(0.034) Q	1,3,8
SE-011-001	ND(0.010) Q	1,3,8
SE-012-001	ND(0.019) Q	1,3,8
SE-013-001	ND(0.010) Q	1,3,8
SE-014-001	ND(0.013) Q	1,3,8
SE-015-001	ND(0.0096) Q	1,3,8
SE-016-001	ND(0.20) Q	1,3,4,8
SE-017-001	ND(0.012) Q	1,3
SE-018-001	ND(0.013) Q	3
SE-019-001	ND(0.036) Q	3,4

File: PBDIOX2

FOOTNOTES

ND = Non detection
R2 = Data rejected - most likely not present.
Q = Data qualified during data validation.
1 = Data qualified due to non-compliant initial calibration (three-point).
3 = Data qualified as estimated due to non-compliant continuing calibration concentration (0.2 ng/ul).
4 = Data qualified as estimated due to low surrogate recovery, i.e., < 30%.
7 = Data rejected because no ending column performance check standard was analyzed.
8 = Data qualified as estimated because ending column performance was outside 12 hour clock.

No organic constituents were detected in the surface waters of the drainage ditches that exceeded ARARs (Table 4-13). Iron was the only inorganic constituent detected in the background sample SW-01 that exceeded ARARs.

Sampling station SW-04, located in Area C, west of Transit Road, generally revealed the highest concentration of inorganic constituents that exceeded ARARs for cadmium, iron, and mercury. The same three inorganic constituents exceeded ARARs in the drainage ditches located to the southwest of Aero Lake. However, the concentrations of these constituents were generally lower than those detected at sample station SW-04.

Sample station SW-15, located in the northwestern section of Area C, adjacent to Aero Drive, revealed both chromium and iron at concentrations exceeding ARARs.

Surface water samples from the drainage ditches along the north and south side of Aero Drive revealed iron at concentrations exceeding ARARs.

<u>Drainage Ditches/Intermittent Streams: Sediment.</u> Acetone and methylene chloride were detected in six and three of the ditches, respectively. For the most part, the concentrations detected were similar to those found in the trip and/or method blanks and would be attributable to either field or laboratory contamination. The concentration of acetone (240 ug/kg) found in the swamp near the eastern end of Area C (sample SE-17) is higher than the concentrations that would typically be attributable to field/laboratory contamination. However, as previously described, this compound can be formed naturally in the environment. The concentration of methylene chloride detected in the ditch along Transit Road was 120 ug/kg (sample SE-16).

Dibenzofuran was detected at 260 ug/kg in the ditch along Transit Road midway between Aero Drive and Pfohl Road (sample SE-4). Of the phthalate esters, DEHP was detected in one sample and diethylphthalate was detected in three samples. Except for the detection of diethylphthalate at 8,200 ug/kg (SE-7, located along Aero Drive), the detected concentrations were in the range attributable to laboratory contamination.

PFOHL BROTHERS LANDFILL SURFACE WATER DATA
DRAINAGE DITCHES AND STREAMS

TABLE 4-13
SUMMARY OF CONSTITUENTS EXCEEDING ARARs

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12/11/90

		CONCENTRATIONS in ug/l							
SAMPLE NUMBER :	CLASS D TOGS	SW-01	SW-02	SW-03	SW-04	SW-06	SW-07	SW-09	SW-10
VOLATILES									
SEMI VOLATILES									
PESTICIDES/PCBs									
INORGANICS									
CADMIUM	7 a				13.8			9.2	7.3
IRON	300 a	507.0		462.0	2460.0	522.0	439.0	672.0	1310.0
MERCURY	.2 b				0.3			0.3	0.3

FOOTNOTES :

a = ARARs are 6 NYCRR Part 701 & 702 Class D standards.
b = ARARs are 6 NYCRR Part 701 & 702 Class D TOGS guidelines.
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
→

PFOHL BROTHERS LANDFILL SURFACE WATER DATA
DRAINAGE DITCHES AND STREAMS

TABLE 4-13 (contd)
SUMMARY OF CONSTITUENTS EXCEEDING ARARs

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12/11/90

		CONCENTRATIONS in ug/l		
SAMPLE NUMBER :	CLASS D TOGS	SW-14	SW-15	SW-16
VOLATILES				
SEMI VOLATILES				
PESTICIDES/PCBs				
INORGANICS				
CADMIUM	7 a		7.1	
IRON	300 a		768.0	424.0
MERCURY	.2 b			

FOOTNOTES :
a = ARARs are 6 NYCRR Part 701 & 702 Class D standards.
b = ARARs are 6 NYCRR Part 701 & 702 Class D TOGS guidelines.
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
→

PAHs were detected in several of the sediment samples at concentrations below 10,000 ug/kg--mainly in the ditches located along the roadways. PAHs that were detected include acenaphthene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(g,h,i)-perylene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, napthalene, phenanathrene, and pyrene. Thus, the concentrations of PAHs detected in many of these samples may be attributable to roadway run-off rather than to the landfill. For the most part, the concentrations of PAHs detected were all below background and all were below typical concentrations found in urban environments. However, fly ash was used as a cover material for the landfill, therefore it is possible that the ditches contain PAHs, in part, from landfill runoff. Many of these PAHs were also detected in drums, soil, leachate seeps, and sediments.

Three pesticides were detected in the sediment samples: beta-BHC, gamma chlordane and DDT. The concentrations detected were within typical values found in sediments in the United States. These three pesticides were also found in the seep sediment samples and other site media.

Silver and thallium were not detected in any of the sediment samples. Selenium was detected in only two samples within the sample quantitation limit. All other inorganics were found in at least one, if not more than one, sample at a concentration greater than background levels. The greatest number and the highest concentration of inorganics were found in sediment samples SE-3, SE-7, SE-15 and SE-17. SE-17 was the one sediment sample collected from an onsite wetlands within Area C. Station SE-3 is in the intermittent stream crossing Area A, SE-7 is the station located farthest west in the northern Aero Drive ditch, and SE-15 is the station located within the southern Aero Drive ditch.

Aero Lake: Surface Water. DEHP was the only organic detected (detected once) in the three surface water samples collected from Aero Lake. The concentration of DEHP detected in the one sample (22 ug/l) was below the quantification limits and its detection is most likely attributable to laboratory and/or field contamination because the detect was just slightly above the highest concentration found in the blanks. No volatiles, other semivolatiles, pesticides or PCBs were detected in the surface water samples.

Only barium, mercury, potassium, and cadmium were detected above background levels. With the exception of cadmium, these inorganics were detected at levels above background in all three samples (i.e., mercury and barium were not found in any of the background samples). Cadmium was detected in SW-13 at 4.7 ug/l. Mercury was detected in all three samples at 0.25 in SW-11 and 12 to 0.42 ug/l in SW-13.

No organic constituents were detected in the surface water of Aero Lake that exceeded ARARs (Table 4-14).

Mercury was the only inorganic constituent detected in the surface water that exceeded ARARs and was detected at all three of the sampling locations in the lake.

Sediments. Acetone was detected in two of the sediment samples, 2-butanone was detected in one sediment sample, and methylene chloride was detected in all three sediment samples collected from Aero Lake. Semivolatiles, pesticides and PCBs were not detected in any of the sediment samples.

Methylene chloride was detected at concentrations equal to those found in the trip and laboratory blanks. Although the one detect of acetone at 360 ug/kg is higher than what would typically be attributable to laboratory or field contamination, it should be noted that acetone is produced naturally. 2-Butanone is often present when acetone is detected in high concentrations. This compound can be a contaminant of acetone and could possibly be present as a laboratory/field contaminant. 2-Butanone was detected in one off site soil boring location, in four ruptured drums and in three of the buried drums. Currently, it cannot be determined if the the detection of acetone and 2-butanone is related to contamination of the lake by the landfill, to laboratory/field contamination, or to natural sources (acetone alone).

PFOHL BROTHERS LANDFILL SURFACE WATER DATA
AERO LAKE

TABLE 4-14
SUMMARY OF CONSTITUENTS EXCEEDING ARARs

Page 01 of 01

12/11/90

		CONCENTRATIONS in ug/l		
SAMPLE NUMBER :	CLASS D TOGS	SW-11	SW-12	SW-13
VOLATILES				
SEMI VOLATILES				
PESTICIDES/PCBs				
INORGANICS				
IRON	300 a			
MERCURY	.2 b	0.3	0.5 JS	0.3

FOOTNOTES :

a = ARARs are 6 NYCRR Part 701 & 702 Class D standards.

b = ARARs are 6 NYCRR Part 701 & 702 Class D TOGS guidelines.

ug/l (micrograms per liter) = ppb (parts per billion).

J is a data qualifier indicating estimated values (appendix A).

B = For organics, analyte was detected in the method blank.

B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.

→

The compound 2,3,7,8-TCDD was not detected in the surface water sediment sample of Aero Lake (samples SE-11-01, SE-12-01, and SE-13-01). All data were qualified for the reasons presented previously (Table 4-12).

Because of the difference in the depth of the ditches and intermittent streams to Aero lake, the inorganics detected in the background samples may not necessarily be representative of those that could be present in Aero Lake (e.g., soil types are not the same at these depths). It should be noted that mercury was not detected in any of the three sediment samples collected from Aero Lake even though this metal was found in all of the surface water samples (sample quantitation limits of 0.13 to 0.27 ug/kg). Antimony, selenium, silver, cyanide, and thallium were also not detected in any of the samples. All of the other inorganic constituents, except for beryllium, calcium, copper, lead, and zinc were found at levels above background in SE-13.

Except for the sample collected from the middle of the lake (SE-13), most of the inorganics were detected below or equal to background levels. The highest concentrations of aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, manganese, nickel, vanadium and zinc were found at SE-13.

Ellicott Creek: Surface Water. No organics were detected in the one surface water sample collected from Ellicott Creek. Twelve metals, however, were detected in the Ellicott Creek surface water sample. Six metals (aluminum, cadmium, calcium, iron, potassium, and zinc) were detected at concentrations above those found in the background samples. However, only cadmium was detected at a level over two times background. It is noted that the background samples may not necessarily be representative of the background in Ellicott Creek due to the extensive discharge of water from the quarry pits located east of the landfill into Ellicott Creek.

Chlorobenzene, 1,2-dichlorobenzene, 1,2-dichloroethene, and 2,4-dimethylphenol were detected in the surface water sample collected from the ditch adjacent to the railroad tracks that feeds into Ellicott Creek.

Chlorobenzene was the only organic constituent detected at surface water sample station SW-05, adjoining Ellicott Creek, at concentrations that exceeded ARARs (Table 4-15).

Station SW-05 revealed iron, lead, and zinc at concentrations exceeding ARARs. Sample station SW-08 revealed similiar constituents exceeding ARARs. These included iron and zinc, as well as aluminum and cadmium.

Ellicott Creek: Sediment. Three sediment samples were collected from Ellicott Creek and one from the ditch adjacent to the railroad tracks that feeds into Ellicott Creek. Acetone was detected in two of the samples and methylene chloride was detected in three of these samples. The concentrations of acetone and methylene chloride were at levels that are typically attributable to laboratory or field contamination. Three PAHs (benzo(b)fluoranthene, fluoranthene, and pyrene) were detected at concentrations below background and within the range typically found in the urban environment. Diethylphthalate was detected in the drainage ditch sample at 490 ug/kg.

No pesticides or PCBs were detected in two of the sediment samples collected from Ellicott Creek. The entire analysis was rejected in the third sediment sample (SE-8) collected from Ellicott Creek. Beta-BHC was detected at 34 ug/kg in the drainage ditch samples (SE-5).

The compound 2,3,7,8-TCDD was not detected in the sediment samples of Ellicott Creek (samples SE-05-01 and SE-08-01). Data were qualified due to the reasons mentioned previously (Table 4-12).

The sediment samples collected at SE-18 and SE-19 typically had the higher concentrations of inorganics than sample SE-8. Concentrations of calcium, magnesium, manganese, potassium, and sodium were substantially higher in SE-5. Selenium, silver, thallium and cyanide were not detected in any of the sediment samples. While iron, mercury, and potassium were found in excess of background in all of the samples, aluminum, barium, beryllium, chromium, cobalt, copper, magnesium, manganese, nickel, sodium and vanadium were detected in excess of the background concentrations in only one or two samples.

PFOHL BROTHERS LANDFILL SURFACE WATER DATA
ELLICOTT CREEK

TABLE 4-15
SUMMARY OF CONSTITUENTS EXCEEDING ARARs

Page 01 of 01

12/11/90

	CONCENTRATIONS in ug/l		
SAMPLE NUMBER :	CLASS B TOGS	SW-05	SW-08
VOLATILES			
Chlorobenzene	5 a	10.0	
SEMI VOLATILES			
PESTICIDES/PCBs			
INORGANICS			
ALUMINUM	100 a		190.0 B
CADMIUM	1.7 a		8.6
IRON	300 a	4000.0	462.0
LEAD	6.3 a	10.0	
ZINC	30 a	76.6	47.6

FOOTNOTES :

a = ARARs are 6 NYCRR Part 701 & 702 Class B standards.
b = ARARs are 6 NYCRR Part 701 & 702 Class B TOGS guidelines.
ug/l (micrograms per liter) = ppb (parts per billion).
J is a data qualifier indicating estimated values (appendix A).
B = For organics, analyte was detected in the method blank.
B = Analyte value is between the contract required detection limit (CRDL) and the instrument detection limit (IDL) for inorganics.
→

4.4 SUMMARY

The nature and extent of contamination is presented in three ways: through dot plots of contaminant concentrations per media across the site; through a tabular presentation of concentration ranges of contaminant groups by media across the site; and through a narrative presentation of contaminant distribution by media across the site. Concentrations of organic and inorganic constituents were compared to background levels or regulatory standards to develop the various data presentations. Tables 4-16 and 4-17 provide an overview of the frequency at which organic and inorganic constituents detected at the site exceed baseline quality. Table 4-18 and 4-19 provide a summary of the frequency at which organic and inorganic constituents detected at the site exceed ARARs.

Although acetone and methylene chloride were detected in several of the sample media, it is uncertain whether or not their presence is due to laboratory/field contamination. The following summarizes the findings of the sampling activities conducted during the remedial investigation.

The materials found in the drums and soil samples do not reflect any significant pattern in waste disposal practices or source material. No drums were observed in Area A. However, drums were observed at and below the surface of the landfill in areas B and C. The majority of drums were observed in Area B.

Analysis of the waste drummed material indicates that a wide variety of organic compounds were disposed of at the landfill. Elevated levels of volatile organics, primarily a variety of aromatic and chlorinated aliphatic hydrocarbons were observed in the waste samples. In addition, a wide variety of semi-volatile organic compounds were detected in the drums. These principally include phenols and dibenzofuran. Pesticides, PCBs, phthalates and PAHs were also detected at elevated concentrations in a portion of the drums. Almost all of the inorganics analyzed for were found at concentrations in excess of background soil sample levels. The concentrations of barium, cadmium, chromium, cobalt, copper, iron, lead, nickel, silver, sodium, and zinc exceeded background concentrations most

Constituent	Media											
			Groundwater		Leachate		Drainage Ditch/ Intermittent Stream		Aero Lake		Ellicott Creek	
	Drums	Soil	Shallow	Bedrock	Seeps	Sediment	Surface Water	Sediment	Surface Water	Sediment	Surface Water	Sediment
Aluminum	○	☐●	☐●	☐◒	☐●	○	☐◒	☐●	○	○	☐◒	●
Antimony	☐○	○	☐○	☐○	○	○	○	◒	○	○	○	○
Arsenic	☐○	☐●	○	○	☐◒	○	○	☐●	○	○	○	○
Barium	☐◒	☐●	○	○	☐●	☐●	☐◒	☐●	●	☐○	○	◒
Beryllium	☐○	☐●	○	○	○	◒	○	◒	○	○	○	◒
Cadmium	☐◒	☐○	○	○	☐●	☐●	☐◒	☐●	○	☐○	☐◒	○
Calcium	☐○	☐●	☐●	☐●	☐●	☐●	☐●	☐●	○	○	●	○
Chromium	☐●	☐●	☐○	☐○	☐●	☐●	○	☐●	○	○	○	◒
Cobalt	☐◒	☐●	☐◒	○	☐◒	☐◒	○	☐●	○	○	○	●
Copper	☐●	☐●	☐○	○	☐●	☐●	☐●	☐◒	○	○	◒	☐○
Iron	☐○	☐●	☐●	☐●	☐◒	☐●	☐●	☐●	○	◒	☐●	●
Lead	☐◒	☐●	☐○	○	☐●	○	◒	☐◒	○	○	○	○
Magnesium	☐○	☐●	☐●	○	●	☐●	◒	☐○	○	◒	◒	○
Manganese	☐◒	☐●	☐●	○	◒	☐◒	○	☐◒	○	○	◒	○
Mercury	☐○	☐◒	○	○	☐●	☐●	○	☐◒	☐●	○	○	●
Nickel	☐◒	☐●	☐●	☐◒	☐●	☐●	○	☐◒	○	○	◒	●
Potassium	☐○	☐●	☐●	☐●	●	◒	☐●	◒	●	○	☐●	☐●
Selenium	☐○	☐○	○	○	☐○	☐◒	○	○	○	○	○	○
Silver	☐○	☐○	○	○	☐◒	☐◒	○	○	○	○	○	○
Sodium	☐◒	☐●	☐●	☐●	○	☐●	○	☐○	○	○	○	○
Thallium	☐○	○	○	○	○	○	○	○	○	○	○	○
Vanadium	☐○	☐●	☐●	☐○	☐○	○	○	☐●	○	◒	○	○
Zinc	☐◒	☐●	☐○	○	☐●	☐●	☐◒	☐◒	○	○	☐●	○
Cyanide	☐○	☐○	○	○	○	☐●	○	☐○	○	○	○	○

○ Constituent detected in less than 1/3 of the samples above baseline

◒ Constituent detected at a frequency of 1/3 to 2/3 above baseline

● Constituent detected at a frequency greater than 2/3 above baseline

☐ Constituent detected above twice baseline levels in one or more samples

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Table 4-16

Summary of Inorganic Constituents Detected at the Site Above Baseline Quality

Pfohl Brothers Landfill, Cheektowaga, New York

Constituent	Media											
			Groundwater		Leachate		Drainage Ditch/ Intermittent Stream		Aero Lake		Ellicott Creek	
	Drums	Soil	Shallow	Bedrock	Surface Water	Sediment	Surface Water	Sediment	Surface Water	Sediment	Surface Water	Sediment
Aromatics	☐◒	☐○	☐○	○	☐○	○	○	○	○	○	○	○
Halogenated Hydrocarbons (w/o methylene chloride)	☐○	☐○	☐○	○	○	○	○	○	○	○	○	○
Methylene Chloride	☐◒	☐◒	○	○	○	●	○	◒	○	●	○	●
Ketones (w/o acetone)	○	○	○	○	○	○	○	○	○	○	○	○
Acetone	☐○	◒	○	○	○	◒	○	○	○	◒	○	○
Phenols	☐◒	☐○	☐○	○	○	○	○	○	○	○	○	○
dibenzofuran	☐◒	☐○	○	○	○	☐○	○	○	○	○	○	○
Nitrogen compounds	○	○	○	○	○	○	○	○	○	○	○	○
phthalate esters	○	☐◒	◒	●	○	○	○	○	○	○	○	○
PAHs	☐○	☐◒	☐○	○	○	☐●	○	◒	○	○	○	○
Pesticide	☐○	○	○	○	○	○	○	○	○	○	○	○
PCBs	☐○	○	○	○	○	☐○	○	○	○	○	○	○

○ Constituent detected in less than 1/3 of the samples above baseline

◒ Constituent detected at a frequency of 1/3 to 2/3 above baseline

● Constituent detected at a frequency greater than 2/3 above baseline

☐ At least one constituent in the group was found in one sample at a significant concentration as defined below:
- all groups in soil except PCBs/pesticides = 10,000 mg/kg
- PCBs and pesticides in soil = 1000 mg/kg
- all constituent groups in water = 100 mg/kg

* Methylene chloride was detected at significant concentrations at a low frequency.

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Table 4-17

Summary of Organic Constituents Detected at the Site Above Baseline Quality

Pfohl Brothers Landfill, Cheektowaga, New York

Organic Constituent	Media					
	Groundwater		Leachate	Drainage Ditch/ Intermittent Stream	Aero Lake	Ellicott Creek
	Shallow	Bedrock	Seeps	Surface Water	Surface Water	Surface Water
Benzene	○	○	○			
Chlorobenzene	○		○			◒
Trans 1,2-Dichloroethene		○	○			
1,1-Dichloroethene	○					
1,1-Dichloroethane	○					
1,1,1-Trichloroethane	○					
Toluene	○					
Xylenes	○					
Phenol	○	○	○			
1,4 Dichlorobenzene	○		○			
1,2 Dichlorobenzene	○		○			
Bis (2-ethylhexyl) phthalate	○		○			
Butylbenzylphthalate	○					
Di-n-octylphthalate	○					
Aldrin		○	○			
Dieldrin			○			
Endrin			○			
4-4'- DDD			○			
Arochlor - 1232	○					
Benzo (a) anthracence			○			
Chrysene			○			
Benzo (b) fluoranthene			○			
Benzo (a) pyrene			○			

○ Constituent detected in less than 1/3 of the samples above ARARs

◒ Constituent detected at a frequency greater than 2/3 above ARARs

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Table 4-18

Summary of Organic Contaminants Exceeding ARARs

Pfohl Brothers Landfill, Cheektowaga, New York

Inorganic Constituent	Media					
	Groundwater		Leachate	Drainage Ditch/ Intermittent Stream	Aero Lake	Ellicott Creek
	Shallow	Bedrock	Seeps	Surface Water	Surface Water	Surface Water
Aluminum						◒
Antimony	○	○				
Arsenic						
Barium	○		○			
Beryllium			○			
Cadmium	○		◒	◒		◒
Calcium						
Chromium	○	○	○			
Cobalt						
Copper	○		◒			
Iron	●	●	◒	●		●
Lead	○		●			◒
Magnesium	●	○	●			
Manganese	●	○	●			
Mercury	○		○	○	●	
Nickel						
Potassium						
Selenium			○			
Silver						
Sodium	●	●	●			
Thallium						
Vanadium						
Zinc			◒			●
Cyanide						

○ Constituent detected in less than 1/3 of the samples above ARARs

◒ Constituent detected at a frequency of 1/3 to 2/3 above ARARs

● Constituent detected at a frequency greater than 2/3 above ARARs

Table 4-19

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Summary of Inorganic Constituents Exceeding ARARs

Pfohl Brothers Landfill, Cheektowaga, New York

frequently. Arsenic, mercury, and vanadium were also observed in many samples well above background concentrations.

The compound 2,3,7,8-TCDD was detected at qualified concentrations ranging from 100 to 370 ppb in the drum and soils samples collected during the test pit investigation. Of the 18 samples tested, 50% of the samples revealed the presence of this compound. No pattern of contamination was observed in either area B or C. Data on six samples were rejected during data validation because of non-compliance with QA/QC protocol. However, the analytical results for these samples are reported, with an explanation provided for their inclusion.

Rubber-like polymer disks were evidenced over most of the landfill surface. Data on the one disk selected for 2,3,7,8-TCDD analysis were rejected during data validation because of non-compliance with QA/QC protocol, however, it is likely that the sample did not contain this compound.

The detection of only small amounts of a few organic compounds throughout Area A indicates that Area A is not a major source of organic contamination. However, many of the same organic compounds detected in the drums were also present in the soil samples in areas B and C. In some cases, the organic compounds present in the drums were detected at higher concentrations in the soil samples. Most of the inorganics detected in the soil samples from areas B and C exceeded background in one or more samples. In some cases, more inorganic constituents were found at greater concentrations in areas B and C than in samples from Area A. Several of the inorganics were detected at higher concentrations in the soil samples as opposed to the drum samples.

NYSDEC and NYSDOH have reported that the radiological analysis of soils and other objects indicate that a large majority of the elevated gamma readings are in areas of only a few square feet, indicating the presence of discrete materials. The large variations in radionuclide conentrations present at the site suggested that while there are areas of higher soil activity, it is not uniformly spread throughout the area.

Organic compounds detected in the drums and soil samples were also detected, for the most part, in the unconsolidated ground water aquifer, including: halogenated hydrocarbons, aromatics, phenols, dibenzofuran, and several phthalates and PAHs. In addition, one pesticide and PCB isomer was detected in one and two samples, respectively. Many inorganic constituents were detected above background concentrations and several, including antimony, barium, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, and sodium were detected above ground water quality standards. In addition, common landfill leachate inorganic parameters were found to be elevated above background.

Several organic constituents exceeded ARARs in the shallow aquifer. These included aromatics, halogenated hydrocarbons, phenol, phthalates and the PCB arochlor-1232.

Iron, magnesium, manganese, and sodium exceeded ARARs most frequently, followed by antimony, barium, cadmium, chromium, copper, lead, and mercury.

The bedrock aquifer revealed the presence of several organic contaminants including aromatics, halogenated hydrocarbons, phenol, a pesticide and phthalate ester. With the exception of the phthalate ester, the remaining organic constituents exceeded ARARs in some of the wells.

Inorganics that were detected at levels above baseline in approximatly 50 percent of the bedrock wells include aluminum, calcium, iron, nickel, and potassium. In addition, antimony, chromium, sodium and vanadium were detected at concentrations greater than two times baseline but in fewer samples.

Iron, sodium, antimony and chromium concentrations in some of the bedrock wells exceeded ARARs.

The leachate seep samples revealed organic contamination similar to that found in the drum, soil, and shallow ground water samples. The organic compounds classes primarily include halogenated hydrocarbons, aromatics, phenols, dibenzofuran, PAHs, and phthalates. The concentrations of the phthalates were indicative of field/laboratory contamination. Several pesticides that were found in one or more of the other media were also detected in the leachate seep samples. Except for dieldrin, the pesticides detected in the leachate seep samples were not detected in the corresponding sediment samples. All of the inorganic constituents analyzed were detected significantly above baseline levels with the exception of antimony, thallium, and selenium. Suspended solids present in these samples may be contributing significantly to the elevated metals concentrations found in these samples.

Several groups of organic constituents exceeded ARARs, including aromatics, a halogenated hydrocarbon and phthalate, phenol, pesticides, and PAHs. Magnesium, manganese, and sodium exceeded ARARs most frequently. Cadmium, copper, iron, lead and zinc exceeded ARARs at slightly lower freqencies, followed by barium, mercury, selenium, chromium and beryllium.

Three volatile organic compounds (methylene chloride, acetone, and chlorobenzene) were detected in the leachate seep sediments. Of these, only chlorobenzene was detected in the leachate seep samples. Other organic compounds detected in the seep sediments include various PAHs, dibenzofuran, two phthalates esters, five pesticides, and PCB isomers, all of which were either detected in the drum or soil samples. Fly ash that was used as cover material during the landfill operation may be the source of PAHs. All of the inorganics were detected above background levels in one or more samples except for antimony. The locations of the samples where the highest concentration of specific inorganic constituents were detected are in very different sections of the site, indicating widespread and varied contamination by metals.

Low levels (relative to the seep samples) of two volatiles and one semivolatile were detected in a limited number of drainage ditch/intermittent streams surface water samples, including acetone, 1,2-dichlorobenzene, and di-n-octyl phthalate. None of the organics were detected at concentrations exceeding ARARs.

Iron exceeded ARARs most frequently in the surface water drainage ditches; cadmium and mercury also exceeded ARARs, only to a lesser degree.

Except for antimony, chromium, selenium, silver, thallium, and cyanide, which were not detected, the remaining inorganics were detected in at least one sample above background levels.

As with acetone in the drainage ditches/intermittent stream surface water samples, acetone and methylene chloride were, in general, detected in the corresponding sediments at levels that were similar to those in the trip and/or method blanks and would be attributable to either laboratory or field contamination. Dibenzofuran and a phthalate ester were also detected. Various PAHs were detected primarily in the ditches along the roadways. Three pesticides were detected that were also found in the seep sediment samples and other site media. All inorganics except for silver, thallium, and selenium were detected above background in at least one sample.

Only one organic compound, bis(2-ethylhexyl)phthalate, was detected in surface water samples from Aero Lake at concentrations that could be attributable to laboratory and/or field contamination. Except for barium, mercury, potassium, and cadmium, inorganics were either not detected or were not detected above background. Mercury was the only constituent (either organic or inorganic) in the surface water that exceeded ARARs.

Acetone, 2-butanone, and methylene chloride were the only organics detected in the sediment samples collected from Aero Lake. Except for the sample collected from the middle of the lake, most of the inorganics were detected below or equal to background levels. All of the inorganic constituents, except for beryllium, calcium, copper, lead, and zinc were found at levels above background in this sample.

No organics were detected in the one surface water sample collected from Ellicott Creek. However, chlorobenzene, 1,2-dichlorobenzene, 1,2-dichloroethene, and 2,4-dimethylphenol were detected in the drainage ditch that feeds Ellicott Creek. Seven metals (aluminum, cadmium, calcium, iron, lead, potassium, and zinc) were detected at concentrations above those found in the background samples.

Chlorobenzene was the only organic constituent detected in the surface water of a tributary to Ellicott Creek at a concentration exceeding ARARs. Iron and zinc exceeded ARARs most frequently. Aluminum, cadmium, and lead also frequently exceeded ARARs.

Both acetone and methylene chloride were detected in the sediments of Ellicott Creek. The concentration of these compounds, however, were at levels that are typically attributable to laboratory/field contamination. Three PAHs were detected in concentrations below background and within those typically found in urban environments. Diethyphthalate and beta-BHC were detected in the drainage ditch sample only. A wide variety of inorganic constituents were detected in the sediments that exceeded background levels.

No 2,3,7,8-TCDD was detected in the shallow or deep ground water wells, leachate seep sediments, or surface water sediment samples. It should be noted, however, that these data were qualified during the data validation process due to non-compliant initial and continuing calibration, low surrogate recoveries, and/or the ending column performance check was outside of 12 hours. Data for the background sample (SE-01) does not rigorously support the non-detect results reported, although it is likely that 2,3,7,8-TCDD is not present.

(LL9/8)DG

Section 5

5.0 CONCEPTUAL MODEL OF CONTAMINANT TRANSPORT

The following section provides further discussion on the major contaminants detected in the various media, potential sources, the mechanisms of contaminant transport (i.e., air, leachate, overland runoff and ground water) and the factors affecting contaminant migration (i.e., hydrogeology, solubility in water, and sorption onto soils, etc.). A more detailed discussion of contaminant fate and transport, in particular with respect to persistence and toxicity, as well as routes of migration and potential/impacted receptors, is presented in the supplemental document to this report entitled, Baseline Human Health Risk Assessment for the Pfohl Brothers Landfill.

In developing a conceptual model of contaminant transport, it is essential to begin with a full understanding of the regional and local hydrogeology. This information is then used in conjunction with the analytical data and physical/chemical properties of the individual compounds to determine the likely pathways of contaminant migration.

5.1 REGIONAL HYDROGEOLOGY

The regional hydrostratigraphy consists of a thin veneer of unconsolidated glacial sediments that mantle the underlying carbonate aquifers. The glacial sediments have low transmissivity and are not conducive to water supply development.

The Onondaga Limestone is the uppermost bedrock formation, ranging in thickness from 25 to 110 feet in eastern Erie County. Depending on the thickness of the limestone, transmissivity values range from 40 to 3,342 square feet a day (LaSala, 1968). Because of its relatively low concentration of total dissolved solids, the Onondaga aquifer is preferred over the underlying formations as a water supply (Staubitz and Miller, 1987).

Underlying the Onondaga Limestone, in places, are the Bertie and Akron Dolomites. The dolomites have a relatively low vertical hydraulic conductivity and therefore, form a leaky confining bed over the Camillus Shale. Their combined thicknesses vary from 0 to approximately 63 feet (Staubitz and Miller, 1987).

The Camillus Shale is the most transmissive of the carbonate formations. The transmissivity is enhanced because of gypsum dissolution. As a result, the Camillus Shale is 2 to 3 times more transmissive than the Onondaga Limestone and 8 to 30 times more transmissive than the Bertie and Akron Dolomites (Staubitz and Miller, 1987). Transmissivities in the Camillus Shale are reported to range between 935 and 9,358 square feet per day (LaSala, 1968).

Approximately 37 inches of precipitation a year is recorded at the Buffalo International Airport, and approximately 6.3 inches of it actually reaches the ground water (LaSala, 1968). The long-term annual potential evapotranspiration rate in eastern Erie County is approximately 25 inches. Subsequently, approximately 5.7 inches of precipitation a year leaves the hydrologic system by surface water runoff (Staubitz and Miller 1987).

Recharge to the unconsolidated glacial aquifer occurs primarily by precipitation, and to a limited extent, by the discharge of quarry pumping. The bedrock aquifer, on the other hand, is recharged by various means. Recharge occurs when precipitation infiltrates into the joints, fractures and solution openings that exist at, or near the ground surface. Recharge to the bedrock aquifer also occurs by vertical seepage from the overlying unconsolidated deposits (Staubitz and Miller, 1987).

During periods of high evapotranspiration (late spring through early fall), the water table declines below the level of the wetlands, streams and lakes. During this period the surface waters serve as a recharge area for the ground water (Miller and Staubitz, 1987).

Conversely, during the wetter months, the water table rises and the surface waters become discharge areas for the ground water (Staubitz and Miller, 1987).

Surface water sinks or swallets, such as the one that exists near Harris Hill, also contribute to the recharge of the bedrock aquifer, with a minor component of recharge resulting from the discharge of quarry pumping (Staubitz and Miller, 1987).

The position of the ground water divide between Ellicott Creek and the Onondaga Escarpment is controlled by the surface water drainage pattern and the elevation of the discharge points (figure 2-6). Ground water flow south of the divide is predominantly south and southwestward eventually discharging into Ellicott Creek basin. Ground water north of the divide flows north, emerging from spring faces along the base of the Onondaga Escarpment, eventually discharging into tributaries of Tonawanda Creek (Staubitz and Miller, 1987). The ultimate discharge point of ground water north and south of the divide is west toward Lake Erie and the Niagara River.

5.2 LOCAL HYDROGEOLOGY

Recharge to the unconsolidated aquifer at the Pfohl Brothers landfill is the result of infiltration by precipitation. A portion of the precipitation leaves the site as runoff through drainage ditches. The runoff eventually discharges into Ellicott Creek and Aero Lake. In the summer months the landfill is covered with a dense, leafy underbrush that promotes evapotranspiration. Figure 5-1 presents a conceptual hydrogeologic model of the site.

Generally, horizontal ground water movement in the unconsolidated aquifer is radial from the landfill. The potential vertical movement of ground water is somewhat impeded by the presence of a discontinuous clay layer. The shallow ground water discharges into Aero Lake and Ellicott Creek. The leachate seeps that are evident around the boundary of the landfill are topographic spring faces created when the

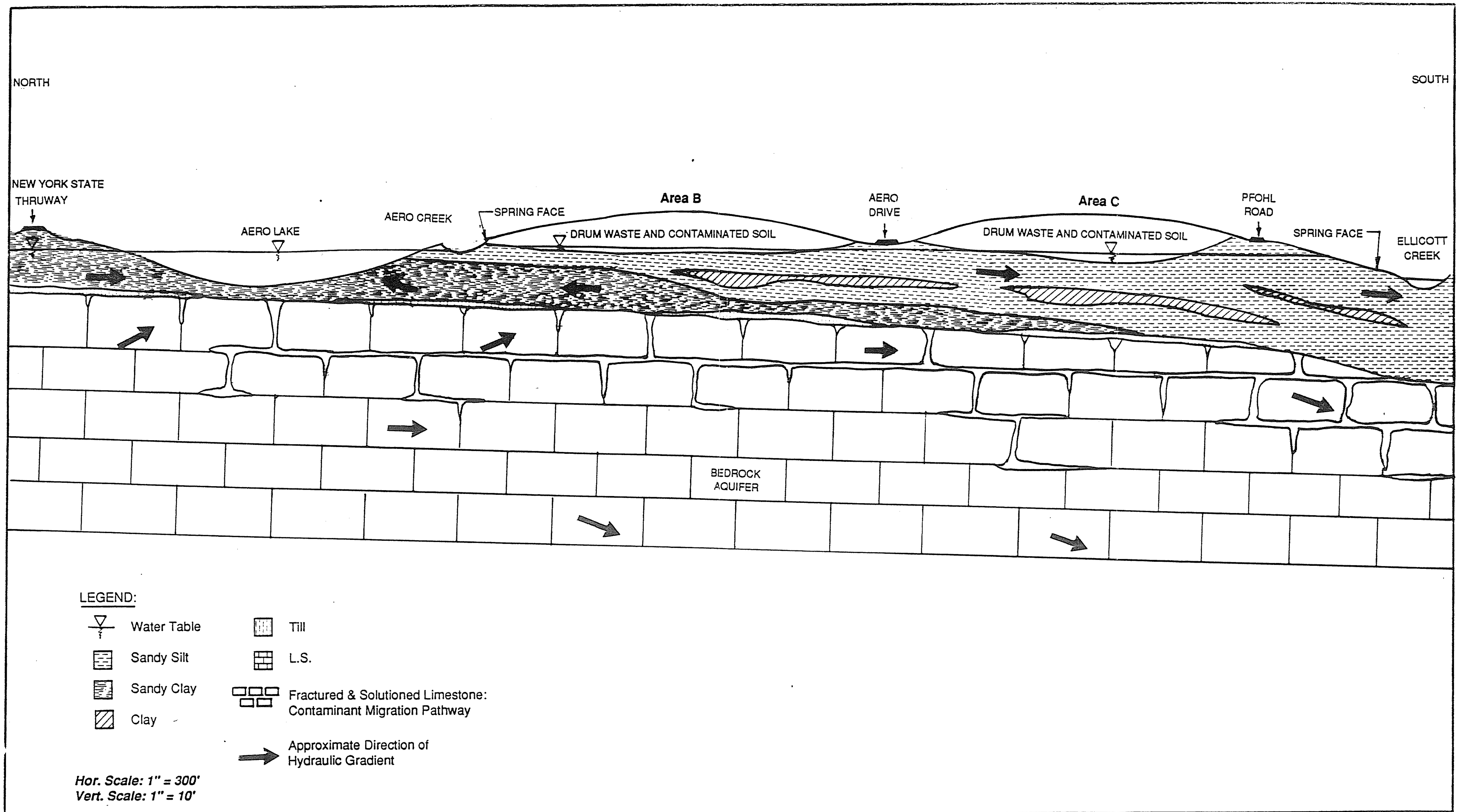

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Figure 5-1

Conceptual Hydrogeologic Model

Pfohl Brothers Landfill, Cheektowaga, New York

water table rises, due to excessive precipitation, to an elevation bove that of the land surface. These seeps feed many of the sites drainage ditches, as well as Aero Lake and Ellicott Creek.
The shallow ground water flows vertically. A downward vertical hydraulic gradient was evidenced in the southern portion of the site indicating that there is a potential for the bedrock aquifer to be recharged from the overlying unconsolidated aquifer. In contrast, an upward vertical hydraulic gradient was observed in the northern portion of the landfill suggesting that Aero Lake may serve as a discharge point for both aquifers.

The potentiometric surface maps (Plates 7-9) indicate that ground water movement in the bedrock aquifer is predominantly to the south-southwest. Flow within the limestone is predominantly through fractures and along bedding planes. Fracture density generally decreases with depth, therefore, the greatest flux of ground water is most likely to occur near the bedrock surface. The magnitude and direction of flux is a function of the hydraulic gradient, fracture frequency, orientation and aperture. Because of the increased transmissivity in the Camillus Shale, a downward vertical gradient also exists in the Onondaga aquifer (Staubitz and Miller, 1987).

Available information is inadequate to fully develop a hydrogeologic conceptual model of the site. Specifically, additional information is needed regarding the degree of hydraulic interconnection between the two aquifers, as well as the degree of hydraulic connection throughout the bedrock aquifer. In addition, better estimates of effective porosity, saturated thickness and vertical permeability is necessary in order to accurately determine ground water velocity and direction in the bedrock aquifer. These data gaps will be addressed in Phase II of the Remedial Investigation.

5.3 CONTAMINANT TRANSPORT MECHANISMS

The following section discusses the factors affecting the transport of contaminants from the source through the various environmental media.

These factors include the site hydrogeology and geochemistry, nature of the source material, and relative mobility of the individual chemical constituents.

Organic and inorganic compounds have been detected in the drummed and uncontained wastes, subsurface soils, leachate seep and sediment samples, surface water and sediment samples, and in the shallow and bedrock ground water samples collected in and around the Pfohl Brothers landfill. By viewing the entire landfill as the source of contamination, there are five possible transport media by which contaminants could be released from the site. These include soil, air, surface water, ground water, and waste.

The primary sources of contamination at the site are wastes deposited within the landill through the dumping of liquid or solid materials, wastes present in drums both within or at the surface of the landfill, and wastes deposited at the landfill surface. The potential migration of contaminants from the wastes can occur through several media and mechanisms:

- To the atmosphere through the volatilization of organic compounds or through the generation of dust from contaminated soils or wastes via wind erosion or mechanical disturbances of the soils or wastes.
- To the surrounding surface water bodies through the discharge of contaminated ground water and/or leachate or through overland run-off.
- To the ground water through the percolation of rain water through the soils.

Certain organic compounds present on the surface of the landfill can be expected to volatilize, depending on their specific chemical and physical properties. Other chemicals will adsorb to soil particulates and be transported into the air in the form of fugitive dust.

Precipitation, either through rain or snow events, could result in significant surface run-off of chemicals in surface soils either in the dissolved phase or in the solid phase (i.e., compounds adsorbed to sediments). According to individuals who were responsible for site operations, wastes deposited in the landfill were covered with materials after the cell was filled. These cover materials included such items as native soil and fly ash. Wastes in drums, debris and other rubbish, as well as several piles of wastes are present at the surface of the landfill. The distribution of contaminants at the Pfohl Brothers site indicate that the surface soils may be a significant source of contamination to other media via snow-melt and rain water runoff.

The rain water and snow-melt that infiltrate the surface of the landfill can dissolve chemicals within the landfill while moving through the soils and waste materials. This process generates a liquid waste referred to as leachate. Many of the chemical components of leachate are common to all municipal landfills (EPA 1977). These include sodium, potassium, calcium, magnesium, iron, manganese, and ammonia. Other common constituents include chloride, sulfate, phosphate, and bicarbonate. Since calcium and magnesium are natural constituents of limestone and do not pose a threat to human health, they will not be discussed further in this section. Compounds such as synthetic organic chemicals and certain heavy metals, however, are not typical of municipal landfill leachate and are most often associated with other types of wastes.

Because an impermeable cap does not cover the Pfohl Brothers landfill, rain water that infiltrates the landfill can carry contaminants vertically into the ground water. Once in the ground water, contaminants can flow horizontally along different paths. They may flow downwards into the lower bedrock aquifer or downgradient and offsite as shallow ground water, or they may flow downgradient and reemerge at the ground surface as a leachate seep. These seeps feed many of the drainage ditches along the boundary of the site, as well as the surface waters of both Aero Lake and Ellicott Creek.

The discontinuous nature of the clay layer across the site allows contaminants to migrate vertically and horizontally, relatively unimpeded, into the underlying aquifer. Areas of the site where the clay layer was removed during landfilling operations, such as in the northeastern section of Area B, provide a conduit for the contaminants to migrate more rapidly into the bedrock aquifer.

There is evidence that organic and inorganic contaminants in the wastes and soils of the landfill have reached the ground water. Ground water from monitoring wells installed both on- and off-site reveal contamination in both the shallow and deep aquifers, with more contaminants detected in the shallow aquifer than in the bedrock aquifer. These findings are consistent with the vertical hydraulic gradients which indicate that there is a downward flow in some areas and an upwards flow in other areas.

Historical records indicate that a wide variety of wastes were allegedly dumped at the site. These include waste paint and solvents, degreasing solvents, PCBs, phenol tars, construction and demolition debris, cyanides and plating sludges, and scrap metal (table 1-1).

Wastes apparently were not segregated during the landilling operation, resulting in the heterogenous distribution of waste material over the site. This would account for the somewhat random distribution of contaminants detected in the onsite soils which, in turn, complicates the identification of ground water contaminant plumes and the subsequent development of remedial technologies.

5.3.1 Organic Contamination

Drummed Wastes and Soils

The organic compounds detected in the drums and soils of the site are similar to the types of waste material allegedely disposed of at the site. The most widespread and frequently detected organic contaminants include phenols, aromatics (toluene, xylenes, chlorobenzene, and ethylbenzene), and polycyclic aromatic hydrocarbons (i.e., dibenzofuran). Phthalates and polycyclic aromatic hydrocarbons (PAHs) were detected at relatively high frequencies (approximately 30% of the samples). Pesticides were detected at low frequencies (approximately 10%). Halogenated hydrocarbons (i.e., chloroethane, di- and trichloroethanes) were detected less frequently (approximately 5-15% of the samples). Polychlorinated biphenyls (PCBs) were also detected in approximately 5% of the drum and onsite soil samples.

Shallow Ground Water

The aromatics and chlorinated aliphatics have relatively high water solubilities and low K_{oc} values. The physiochemical properties of these compounds would indicate that these chemicals are mobile and would be expected to be present in the ground water. These compounds were present in six of the shallow ground water wells and in two of the deep wells.

Although the concentrations present in the ground water indicate that contamination is continuing to occur, the overall concentrations in most of the samples are low compared to the values found in several of the subsurface soil samples and in the drum samples. This may indicate that these chemicals are being bound to the soils or wastes, infiltration and subsequent transport is limited, release from the drums still has not occurred, or that sampling has not been performed in the areas where contaminants have migrated.

Phenol and several low-molecular weight phenolic compounds were detected in ground water samples from both the shallow and deep aquifers. Most of the detections of these compounds in the ground water were along the eastern side of the landfill and to the southeast of the landfill. This class of compounds would not be expected to be adsorbed to the soils based on their K_{oc} values. In saturated, deep soil (containing no soil air and negligible soil organic carbon), a much higher fraction is likely to be present in the soil-water phase and to be transported with flowing ground water (U.S. Airforce, 1985). Based on the concentrations found in the ground water, as compared to the concentrations found in the subsurface soil and drum samples, only limited contamination of the ground water by this group of compounds appears to have occurred. This may be due to the fact that the phenolic compounds were disposed of as phenolic tars and that the complexation of the tars may be significantly altering the sorption properties, thereby rendering them less mobile.

The PCB Arochlor-1232 was detected in two wells installed in the shallow aquifer. The pesticide endosulfan II and dibenzofuran were also detected in one well each.

Bedrock Aquifer

In the deep aquifer, aldrin was detected once. These compounds are typically not found in ground water due to their low water solubilities and high K_{oc} values. However, it is possible that these compounds were transported to the ground water through decreased soil adsorption and corresponding higher mobility arising from the presence of organic solvents in infiltrating water. Although significantly high concentrations of organic solvents were not detected in the ground water samples where these compounds were found, significant levels of chlorinated solvents (1,1,1-trichloroethane and chlorobenzene) were detected in two of the wells. However, chlorinated solvents were not generally detected in the soil borings, or wells within the unconsolidated or bedrock aquifer. Therefore, the transport of contaminants that have a low water solubility should be limited.

Leachate Seeps and Sediments

Aromatics (i.e., benzene and chlorobenzene) were most frequently detected (approximately 25%) in the leachate seep samples. One chlorinated benzene (1,4-dichlorobenzene) and a halogenated hydrocarbon (1,1-dichloroethane) were detected at slightly lower frequencies (approximately 15%). The halogenated hydrocarbons chloroethane, and 1,2-dichloroethene, and the aromatic 1,2-dichlorobenzene, were detected even less frequently (approximately 10%) in the samples; trichloroethene, and ethylbenzene were detected only once.

Phenols and dibenzofuran were also detected in the seep samples at relatively low frequencies (approximately 10%). Several pesticides, including dieldrin, endosulfan II, and aldrin were detected in 10% to 20% of the samples, while DDD and endrin were detected only once. The leachate sediments revealed similar organic contamination as that found in other media of the site, principally chlorobenzene, dibenzofuran and PCBs.

Surface Waters and Sediments

The chemical composition of the surface water in the drainage ditches also revealed similar contamination as that found elsewhere on the site. Again, both aromatics and halogenated hydrocarbon compounds were detected in a small percentage (10-30%) of the samples. These compounds included 1,2-dichlorobenzene, 1,2-dichloroethene, and chlorobenzene. Phenolic compounds were also detected in one of the samples. As common to all sample media, dibenzofuran was detected once in the sediments of the drainage ditches. The pesticide, beta-BHC was detected in approximately 25% of the samples, while gamma-chlordane and DDT were detected only once.

No organic constituents were detected in the surface waters of Aero Lake or Ellicott Creek that were directly attributable to the landfill.

5.3.2 Inorganic Constituents

Drummed Wastes and Soils

The inorganic chemical composition of the drummed wastes and soils were also similar to the types of wastes believed to have been disposed of in the landfill. For example, the presence of chromium, lead, and nickel at elevated concentrations in the drums and soil may result from the deposition of plating sludges which are typically contaminated with these metals. Elevated concentrations of lead in the drums and soils may have been derived from the waste paints that were also believed to have been disposed of at the site. Waste cyanide and mercury sweeping were also believed to have been disposed of in the landfill. Both of these metals were detected at elevated concentrations in the onsite soils.

The inorganic consitituents detected in the drummed wastes and soils that exceeding background concentrations most frequently included aluminum, arsenic, barium, chromium, cobalt, copper, lead, nickel, and zinc. Silver and cyanide were detected at concentrations above background levels in a number of samples. Mercury exceeded background concentrations in almost half of the samples.

Shallow Ground water

A wide range of inorganic constituents, in particular, aluminum, arsenic, barium, and chromium were detected at concentrations exceeding background levels in greater than 75% of the samples. Copper, mercury, and cobalt exceeded background levels in at least 25% or more of the samples. Nickel, zinc, and vanadium were also detected above background concentrations in more than half of the samples. Silver and lead were detected at concentrations exceeding background levels at slightly lower frequencies (approximately 15-20%). Cyanide was detected above background levels in one sample.

Bedrock Aquifer

The deep aquifer revealed several inorganic constituents at concentrations exceeding background levels. Aluminum and chromium were detected most frequently (at least 90% of the samples). Barium exceeded background levels in more than 50% of the samples. These same constituents were also elevated in both the soils and shallow ground water samples. Approximately 50% of the samples exceeded background levels for arsenic, cadmium, copper and nickel.

Leachate Seeps and Sediments

The leachate seep samples revealed a wide range of inorganic constituents. Those most frequently detected and most often exceeding background levels included aluminum, barium, copper, lead and zinc. For the most part, these same inorganic constituents were detected in the soil and shallow ground water samples at elevated concentrations. Less frequently detected constituents at concentrations above background levels include arsenic, cadmium, and vanadium (20-50% of the samples).

Leachate sediment samples also revealed the presence of a wide range of inorganic constituents. Those constituents that most often exceeded background levels included barium, lead, mercury, and zinc. Aluminum and copper were detected in all the samples with concentrations most often exceeding background levels. Arsenic, cadmium, chromium, nickel, and silver were detected at concentrations exceeding background levels in more than half of the samples. As with the leachate seeps, many of the same constituents were frequently detected at elevated concentrations in media throughout the site.

Surface Waters and Sediments

The most frequently detected inorganics at concentrations exceeding background levels in the surface water of the drainage ditches were aluminum, barium, copper, lead and zinc. Other inorganics, including arsenic and cadmium, also exceeded background levels in 30% to 50% of the samples, respectively. Nickel and vanadium concentrations exceeded background concentrations less frequently (10% to 20% of the samples).

The inorganic constituents most frequently detected in the sediments of the drainage ditches and at concentrations exceeding background levels, include aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, lead, nickel, vanadium and zinc. Both antimony and mercury exceeded background concentrations in approximately 45% to 65% of the samples, respectively.

In the surface water of Aero Lake, most inorganic constituents were not detected above background concentrations, with the exception of mercury and barium, which were detected most frequently at concentrations exceeding background levels. Since both constituents were detected in many of the onsite sampling media, their presence in the lake suggests contamination from the landfill. For the most part, the inorganic constituents detected in the sediment samples of the lake were below background concentrations. One sample near the center of the lake, however, revealed a wider range of inorganic constituents. Additional samples are necessary for determining the source of inorganic contamination. It is likely that the elevated concentrations of inorganics constituents are, at least in part, derived from the landfill.

Four metals (aluminum, cadmium, calcium, and zinc) were detected in the surface waters of Ellicott Creek at concentrations above those found in the background samples. Several metals were also detected in the sediments of the creek (aluminum, barium, copper, beryllium, chromium, cobalt, mercury, nickel and vanadium) at concentrations considerably above background levels. These above-background concentrations, however, were not found consistently in the samples collected from the creek. Additional background samples are necessary before a determination can be made as to whether or not contamination from the landfill is impacting the creek.

5.4 CONTAMINANT FATE AND TRANSPORT

It is difficult to predict the migration of contaminants from the landfill because of its large size and the heterogenous nature of the drummed and uncontained wastes. To date, the remedial investigation has focused primarily on the landfill itself and the immediate area surrounding the site.

Predicting the fate and transport of contaminants from the landfill to the surrounding area requires that the field investigations be expanded to areas further from the source. Additional ground water and surface water data are required offsite before a better understanding of the nature and extent of contamination can be gained.

A simple screening model (appendix O) was developed to predict the mobility of chemicals within the landfill and their subsequent migration offsite. The application of this model, however, is best suited to evaluate relative mobilities of solutes as they are being transported away from the source areas. Within the source areas, factors relating to the times of waste disposal, nature of wastes, and general site heterogeneity are perhaps more important.

The application of a chemical mobility model at this point in the investigation would be premature since additional data are needed to fully define the nature and extent of contamination at the site.

Organic Contaminants

There are many factors that affect the mobility of organic compounds, including density, viscosity, and the tendency to adsorb to soil. Other factors affecting mobility include the relative persistence of the compound, transport pathways (i.e., Non-Aqueous Phase Liquid (NAPL) movement, vapor transport, and the attachment to mobile colloidal particles), time of release to the environment, and the ground water flow regime.

Inorganic Constituents

Because of the mix of soils and fill that comprise the bulk of the source materials at the landfill, the conventional estimates of soil sorption and moisture parameters, both of which are used in predicting the fate and transport of inorganic constituents, may not apply.

The natural chemistry of the aquifers at the site play a major role in the movement of inorganics. The limestone that makes up the deep aquifer is strongly ionic. Complexing of metals is an ongoing process that is difficult to predict in such an environment. The shallow aquifer, on the other hand, is composed largely of fine sand, silt, clay and till. Clay is also strongly ionic, affecting the transport of inorganic contaminants. Furthermore, since the parent material of the till is, in part, derived from the limestone bedrock below, it, too, is strongly ionic.

The pH of the ground water also plays a role in the movement of inorganic contaminants. For the most part, ground water samples from the shallow aquifer were slightly alkaline (pH ranging from 7.04 to 7.99). Only three samples from the shallow aquifer were slightly acidic, with pH values ranging from 6.92 to 6.98. Ground water samples from the bedrock aquifer revealed a wider range of pH values (7.02 to 9.2). The general alkaline condition of the ground water samples suggests that metals would tend to precipitate out, rather than remain in solution, thereby impeding their movement through the ground water system.

The many factors affecting the fate and transport of contaminants must be considered when developing a conceptual model of the site. However, this can only be accomplished after suffient data have been collected and a better understanding of the nature and extent of contamination has been gained. A refined conceptual model of contaminant transport will be developed after completion of the Phase II remedial investigation.

5.5 SUMMARY

In summary, there is evidence that the drums and soils in the landfill represent a source of organic and inorganic contamination to the shallow and deep aquifers, as well as the drainage ditches that surround the site. The most frequently detected organic and inorganic compounds across the site are similar to the types of waste material allegedly disposed of at the site. The most widespread and frequently detected organic contaminants include phenols, aromatics (toluene, xylenes, and chlorobenzene), and polycyclic aromatic hydrocarbons (dibenzofuran). Halogenated hydrocarbons (i.e., chlorinated solvents) and polychlorinated biphenyls (PCBs) were also detected, but at lower frequencies. There is widespread contamination by inorganics. The most frequently detected inorganics include aluminum, barium, cadmium, lead, and zinc. Arsenic, chromium, copper, nickel, vanadium, and mercury were also detected at concentrations exceeding background levels in many of the sample media.

Wastes apparently were not segregated during the landfilling operation, resulting in the heterogenous distribution of waste material over the site. This would account for the somewhat random distribution of contaminants detected in the onsite soils which, in turn, complicate the identfication of ground water contaminant plumes and the subsequent development of remedial technologies.

Typical mechanisms of contaminant transport include volatilization and/or airborn dust, discharge of contaminated ground water and/or leachate from the shallow ground water to adjacent surface waters, overland runoff, and migration of contaminants from the soils and shallow ground water to the underlying bedrock aquifer and potential migration into the deeper bedrock offsite.

Although the concentrations in the ground water indicate that contamination is continuing to occur, the overall concentrations in most of the samples are low compared to the values found in several of the subsurface soil and drum samples. This may indicate that these contaminants are being bound to the soils or wastes, infiltration and subsequent transport is limited, precipitation and ground water flow is diluting the concentration and carrying the contaminants offsite, that the release of chemicals from the drums has not yet occurred, or that sampling has not been performed in the areas where contaminants have migrated.

The inorganic constituents detected at elevated levels in the surface water and sediments of Aero Lake and Ellicott Creek are similar to those found in various media throughout the site. It is likely that such contamination is, at least in part, attributable to the landfill. Additional data are needed in off-site areas (i.e., surface water and ground water monitoring wells downgradient of ground water flow) to determine the full nature and extent of contamination, the mechanisms of transport, and the need for offsite remediation.

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Section 6

6.0 CONCLUSIONS

The Pfohl Brothers Landfill site is a source of hazardous substances, as are the leachate seeps and sediments, and surface water and sediments. There is evidence that hazardous substances are migrating offsite through surface water and the shallow aquifer. However, there does not appear to be widespread contravention of ground water and surface water quality standards offsite. Currently, Aero Lake and Ellicott Creek do not appear to have been adversely impacted by ground water discharged from the unconsolidated aquifer, potential discharges from the bedrock aquifer, discharge from leachate seeps, surrrounding ditches and streams, or from run-off or erosion of contaminated soils.

There is a potential that methylene chloride, acetone and 2-butanone may be present in the sediment of Aero Lake. However, it is also possible that these compounds represent false-positive detection by the laboratory and are not present. Further sampling may be necessary to determine if these compounds are actually present in the Aero Lake sediments. The PAHs that were detected in Ellicott Creek sediments were similar to those found in the background sediment samples, as well as to anthropogenic levels in rural areas. Therefore, the presence of PAHs did not appear to be related to the site.

Mercury was detected in all three surface water samples from Aero Lake, though it was not found in any of the sediment samples within the given detection limits. Mercury was not detected in the one surface water sample collected from Ellicott Creek; however, this compound was found in all three sediment samples. Cadmium was detected in one surface water and two sediment samples from Aero Lake and the one surface water sample from Ellicott Creek and in two of the three sediment samples.

There are three possible explanations as to the presence of mercury and cadmium in these two surface water bodies:

1. Regional concentrations within the overburden, till, and bedrock.

2. Past waste disposal practices at the landfill

3. Atmospheric deposition from airborne sources including mercury present at the surface of the fill.

The most probable source of mercury, and possibly of cadmium to these surface water bodies is from atmospheric deposition from the landfill and/or other airborne sources. This is based on the conclusions of Sorensen et al. (1990) and the fact that almost no other contaminants that were present in the ground water, leachate seeps, and surrounding ditches were found in these samples. It is noted that geologically, cadmium was found above typical mean levels in soils from Buffalo and Tonawanda. Thus, it is also is possible that cadmium may be present in the surface water bodies due to natural geologic conditions within the area.

The one abnormal detect of copper in the Ellicott Creek sediment cannot be readily explained. Currently it does not appear that the presence of copper is related to the site because this metal was not found above background concentrations in any other sediment samples collected from Ellicott Creek and was found at significantly lower levels in the ditch that feeds into Ellicott Creek, in surrounding leachate seeps and sediments, and in soil samples collected from the site.

In the absence of source control remedies, (i.e. capping of the landfill and intercepting the flow from the leachate seeps) contamination will continue to migrate offsite.

Section 7

7.0 RECOMMENDATIONS

Sampling and analysis of various environmental media indicate that the drums represent a continuing source of contamination, in addition to being a physical hazard at the landfill. Drum clusters in the western portion of Area B and the eastern portion of Area C should be considered for removal or secured in order to prevent further discharge of hazardous chemicals.

Soil borings should be installed in Area A to provide a better understanding as to the source of elevated inorganic constituents. Historical records indicate that this portion of the landfill received construction and demolition debris. There is no evidence that hazardous substances were disposed of in this area. This requires further investigation.

Several additional borings are needed to further define the western and southwestern boundaries of Area C. Besides delineating the extent of fill material, the borings would provide additional information on the depth to bedrock and thickness of the native soils.

Several exploratory borings should also be installed in the eastern portion of Area C in order to obtain additional information on subsurface conditions in this area of the landfill.

Long-term water level measurements should be collected in all monitoring wells. Each round of measurements should include stage and lake level measurements in Ellicott Creek and Aero Lake, respectively. A continuous water level recorder should also be installed in a well cluster for an extended period of time. This information would be useful for evaluating the hydraulic connection between the aquifers, as well as the connection between the aquifers and surface waters.

Next, the hydraulic properties of the bedrock aquifer should be evaluated through a long-term pump test. Three additional bedrock wells should be installed in proximity to the existing bedrock well that is selected for the long-term pumping test.

Additional nested monitoring wells should be installed at greater distances from the landfill. The location and number of wells would be guided by the results of the pumping test. These wells would provide additional information on ground water movement and quality.

The final step in delineating the extent of contaminant migration would include additional sampling of the surface water and sediment in Aero Lake Ground water samples should also be collected from existing and proposed monitoring wells and analyzed for Target Compound List (TCL) parameters, as well as conventional parameters and dissolved metals.

These recommended activities are intended to achieve several goals: (1) to delineate the extent of offsite contamination, (2) to better define the aquifers' hydraulic properties, and (3) to further refine the list of onsite contaminants. The implementation of these activities should provide a better understanding of the nature and extent of contamination at the Pfohl Brothers landfill site.

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Section 8

8.0 REFERENCES

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Approved by: ARCHITECTURAL Date:

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK

PFOHL BROTHERS LANDFILL
SAMPLE LOCATIONS

Date	Ch'k'd.	Revision

Designed by: NRS
Drawn by: JDR/TGZ
Checked by:
Approved by:
Date: DECEMBER, 1990
Scale: 1" = 200'

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CDM
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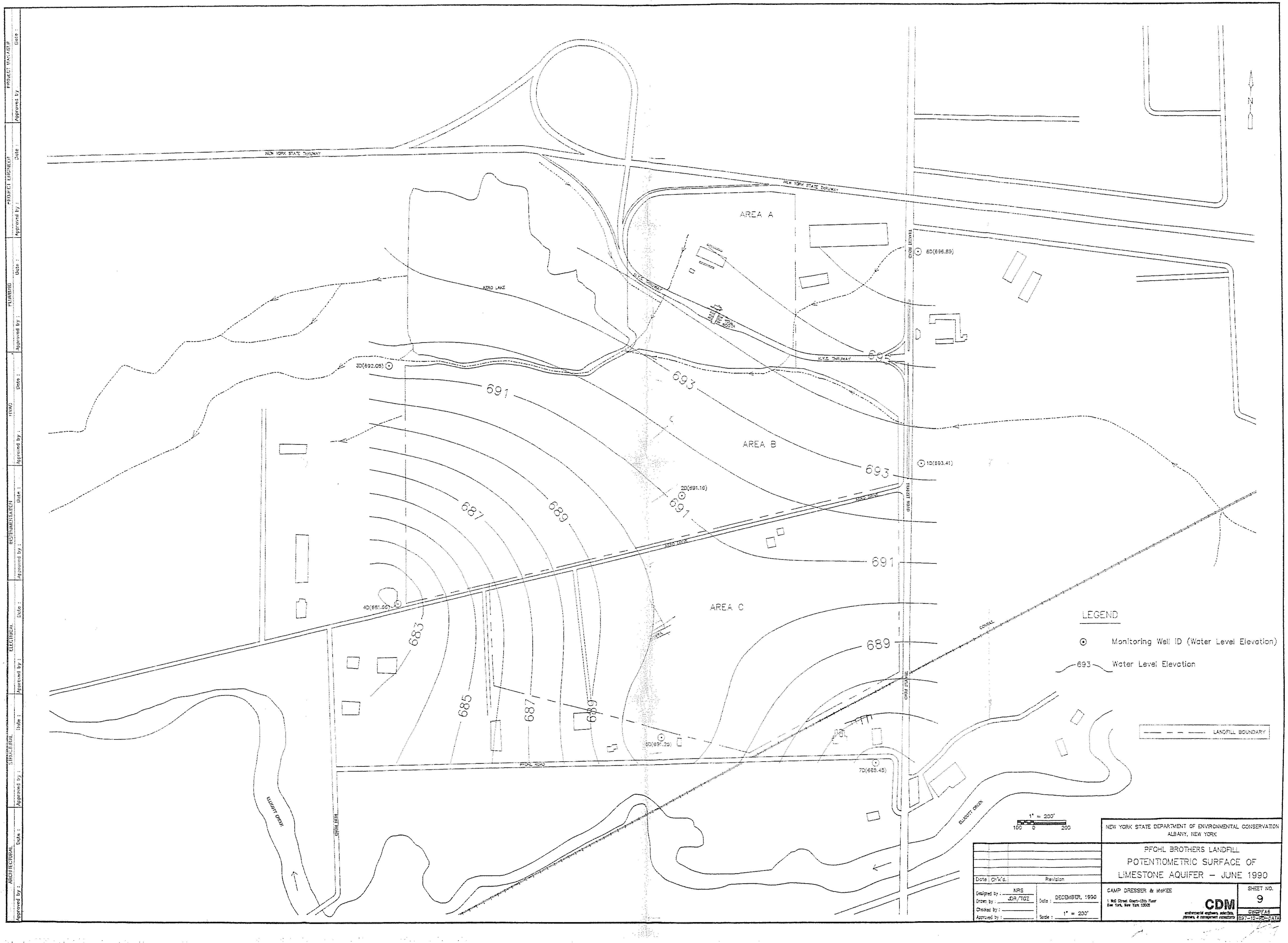
SHEET NO.
10
LOCATION
897-12-RD-DATA



NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK

PFOHL BROTHERS LANDFILL
POTENTIOMETRIC SURFACE OF
LIMESTONE AQUIFER – JUNE 1990

Date	Ch'k'd.	Revision

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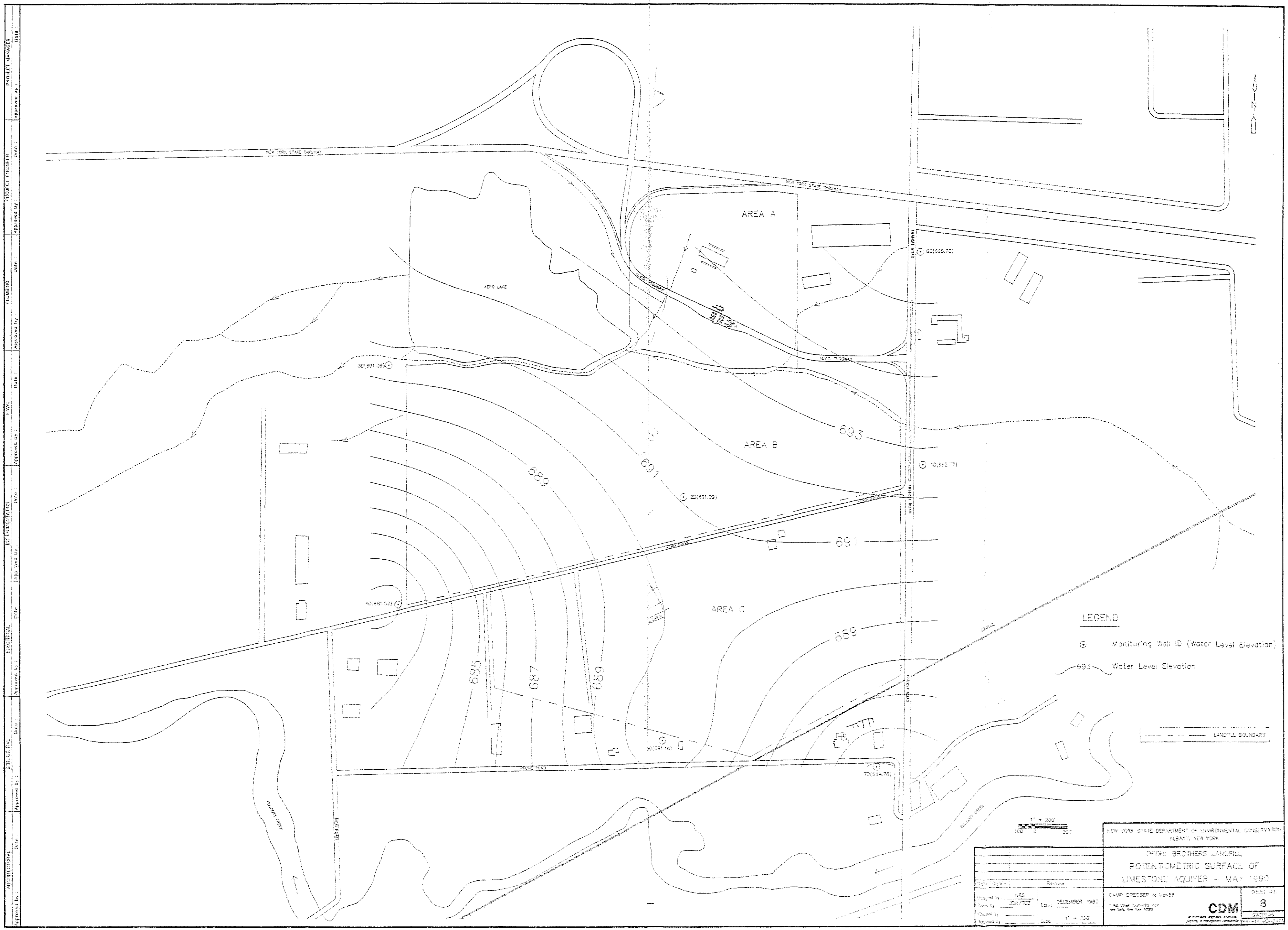
9
GWCPFA6
897-12-RD-DATA



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PFOHL BROTHERS LANDFILL
POTENTIOMETRIC SURFACE OF
LIMESTONE AQUIFER – MAY 1990

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8

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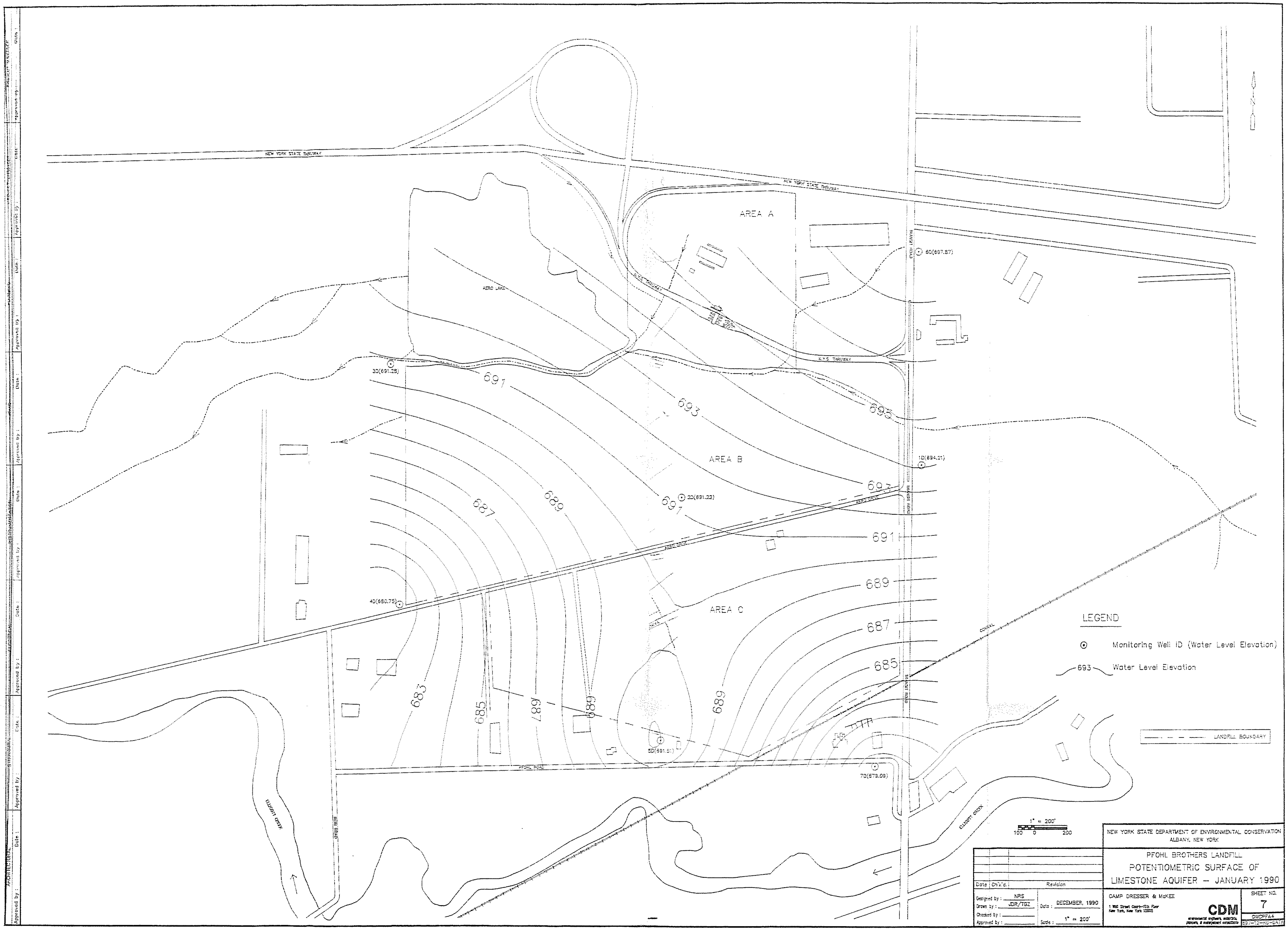
ELECTRICAL Approved by : Date :
INSTRUMENTATION Approved by : Date :
HVAC Approved by : Date :
PLUMBING Approved by : Date :
PROJECT ENGINEER Approved by : Date :
PROJECT MANAGER Approved by : Date :



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PFOHL BROTHERS LANDFILL
POTENTIOMETRIC SURFACE OF LIMESTONE AQUIFER – JANUARY 1990

Date	Ch'k'd.	Revision

Designed by : NRS
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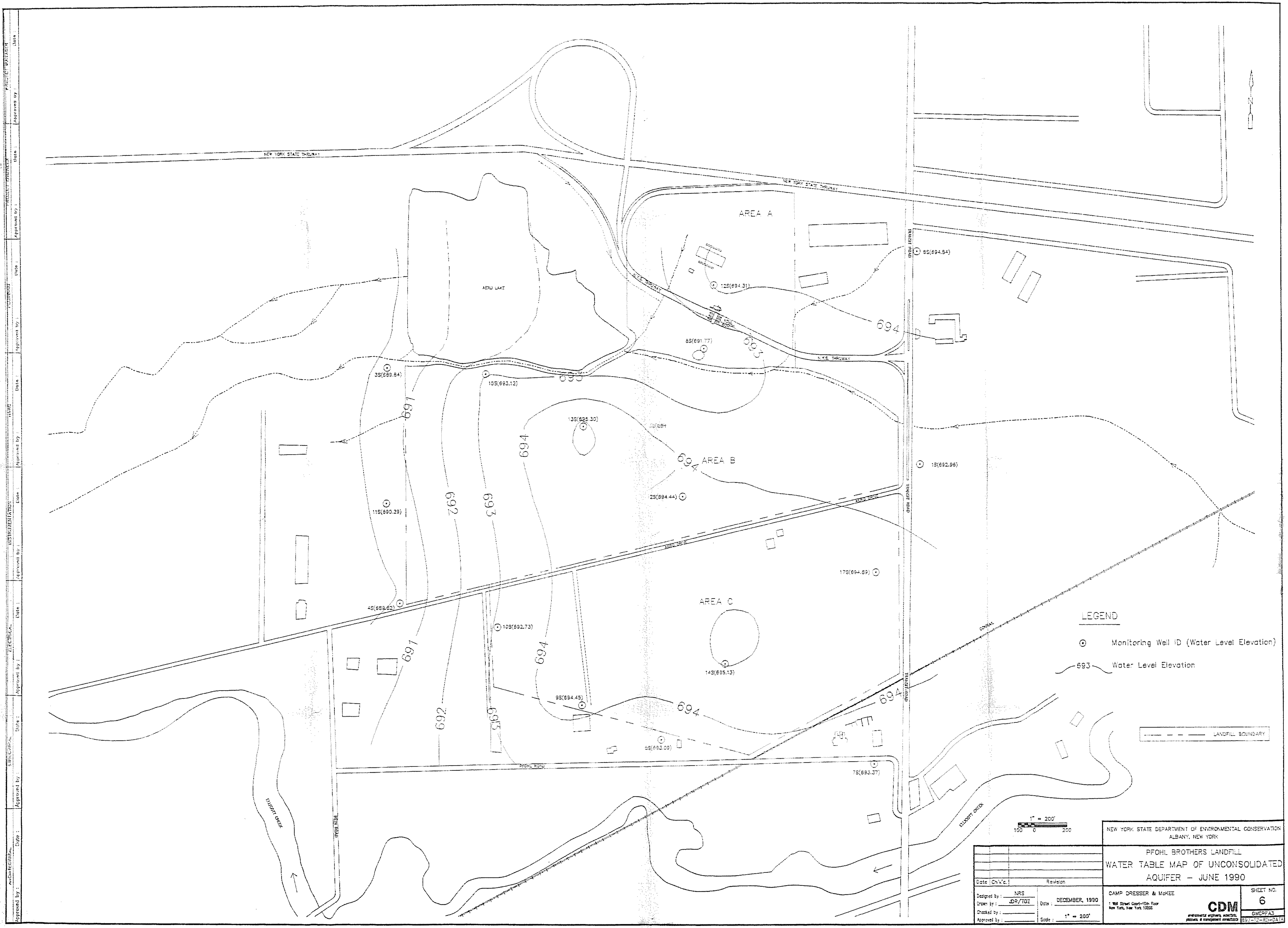
SHEET NO.
7
GWCPFA4
697-12-RD-DATA



LEGEND

⊙ Monitoring Well ID (Water Level Elevation)

693 Water Level Elevation

LANDFILL BOUNDARY

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
ALBANY, NEW YORK

PFOHL BROTHERS LANDFILL
WATER TABLE MAP OF UNCONSOLIDATED
AQUIFER – JUNE 1990

Date	Ch'k'd.	Revision

Designed by : NRS
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Date : DECEMBER, 1990
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6
GWCPFA3
897-12-RD-DATA

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PFOHL BROTHERS LANDFILL
WATER TABLE MAP OF UNCONSOLIDATED
AQUIFER -- MAY 1990

Date | Ch'k'd. | Revision

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GWCPFA2

ARCHITECTURAL Approved by: Date:
STRUCTURAL Approved by: Date:
ELECTRICAL Approved by: Date:
INSTRUMENTATION Approved by: Date:
HVAC Approved by: Date:
PLUMBING Approved by: Date:
PROJECT ENGINEER Approved by: Date:
PROJECT MANAGER Approved by: Date:

ARCHITECTURAL Approved by : Date :
STRUCTURAL Approved by : Date :
ELECTRICAL Approved by : Date :
INSTRUMENTATION Approved by : Date :
HVAC Approved by : Date :
PLUMBING Approved by : Date :
PROJECT ENGINEER Approved by : Date :
PROJECT MANAGER Approved by : Date :

LEGEND

⊙ Monitoring Well ID (Water Level Elevation)

693 Water Level Elevation

LANDFILL BOUNDARY

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
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PFOHL BROTHERS LANDFILL
WATER TABLE MAP OF UNCONSOLIDATED
AQUIFER – JANUARY 1990

Date | Ch'k'd. | Revision

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SHEET NO.
4
DWGPFA1
[illegible]-DATA

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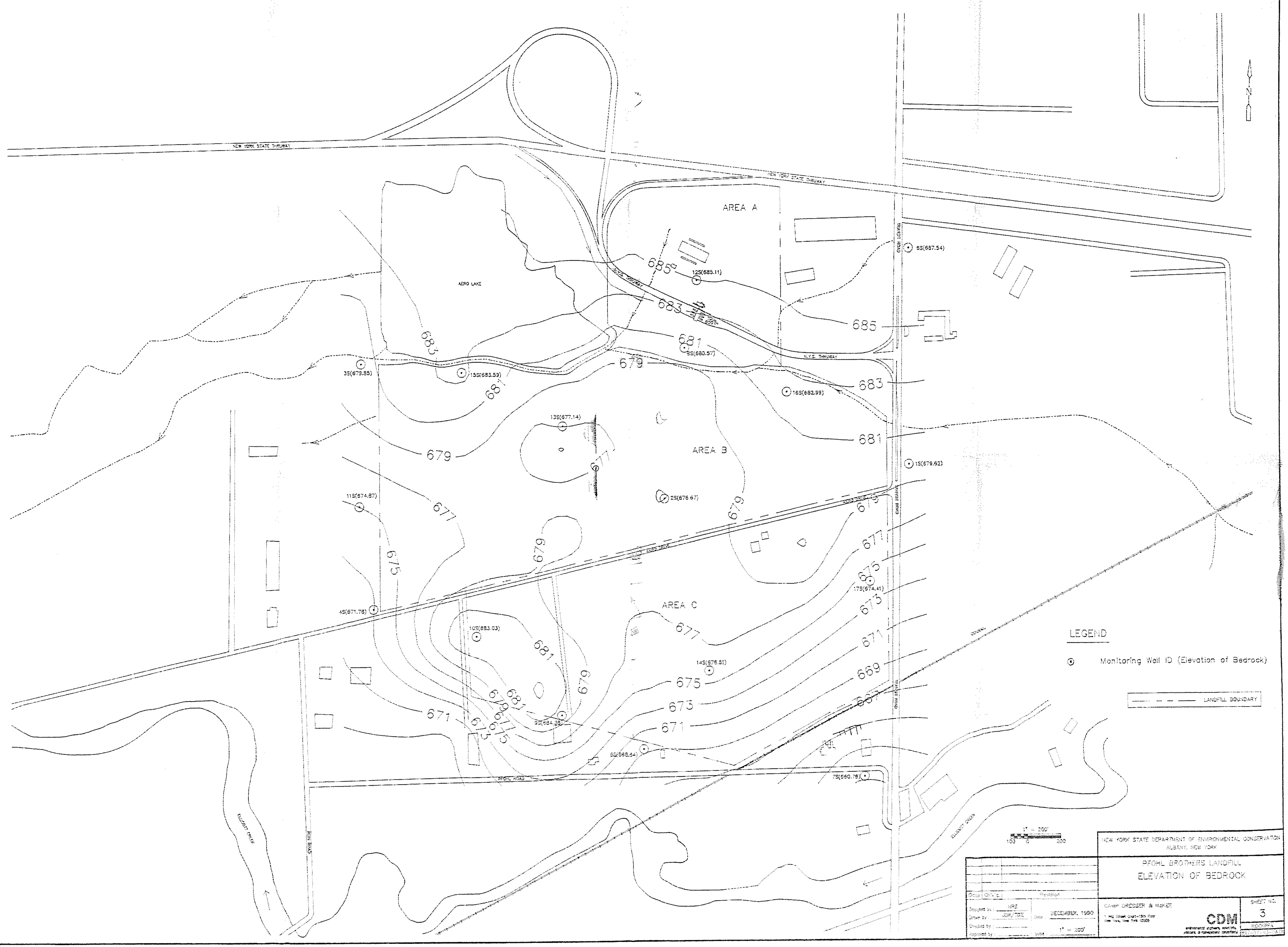
INSTRUMENTATION Approved by : Date :
HVAC Approved by : Date :
PLUMBING Approved by : Date :
PROJECT ENGINEER Approved by : Date :
PROJECT MANAGER Approved by : Date :



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ALBANY, NEW YORK

PFOHL BROTHERS LANDFILL
ELEVATION OF BEDROCK

Date	Chk'd	Revision

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3
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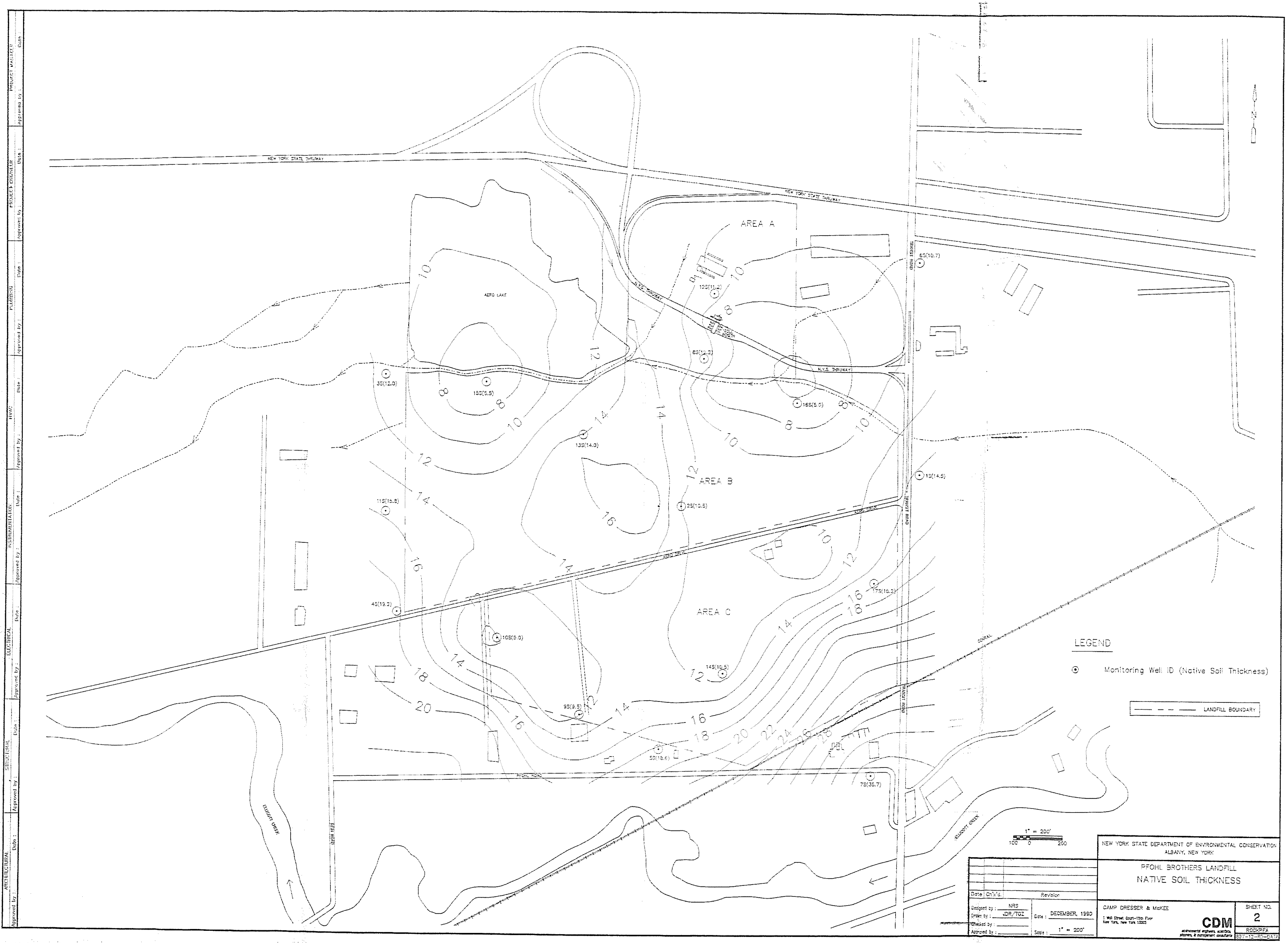

LEGEND

⊙ Monitoring Well ID (Native Soil Thickness)

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ALBANY, NEW YORK

PFOHL BROTHERS LANDFILL
NATIVE SOIL THICKNESS

Date	Ch'k'd.	Revision

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ROCKPFA
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ELECTRICAL Approved by : Date :
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HVAC Approved by : Date :
PLUMBING Approved by : Date :
PROJECT ENGINEER Approved by : Date :
PROJECT MANAGER Approved by : Date :