80061

VOLUME I OF III

REMEDIAL INVESTIGATION

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Prepared For:

Waste Management of Illinois, Inc.
Westchester, Illinois

Prepared By:

Montgomery Watson
2100 Corporate Drive
Addison, Illinois

January 1997

MONTGOMERY WATSON

TABLE OF CONTENTS

Section **Page**

TABLE OF CONTENTS (continued)

Section **Page**

TABLE OF CONTENTS (continued)

Section **Page**

TABLE OF CONTENTS (continued)

Section **Page**

TABLE OF CONTENTS (continued)

Section **Page**

TABLE OF CONTENTS (continued)

LIST OF TABLES

TABLE OF CONTENTS (continued)

LIST OF DRAWINGS

LIST OF FIGURES

TABLE OF CONTENTS (continued)

LIST OF APPENDICES

TABLE OF CONTENTS (continued)

PMS/dlp\CCH
J:\2386\0096\RI_FINAL\RI_TEXT\TOC_NEW2.DOC

EXECUTIVE SUMMARY

This document has been prepared to provide a summary and evaluation of data collected during the Remedial Investigation (RI) performed at the H.O.D. Landfill located in the Village of Antioch, Lake County, northeastern Illinois. The purpose of the RI is to define the nature and extent of contamination, assess risks to human health and the environment, and provide information to support the Feasibility Study (FS).

The RI report includes the information presented in Technical Memorandum Number 1, and the results of the Supplemental Investigation. The Baseline Risk Assessment was prepared by ICF Kaiser/Weinberg Consulting Group and submitted to the United States Environmental Protection Agency (U.S. EPA) as a separate document. The work was conducted in accordance with an Administrative Order on Consent executed on August 20, 1990 by U.S. EPA and Waste Management of Illinois, Inc. (WMII).

The Preliminary Assessment was performed in 1983 and the Site Inspection was conducted in 1984. The site was given a score of 52.02 in 1985, in part, based upon the detection of an elevated level of zinc in a groundwater sample. U.S. EPA proposed to list the site on the National Priorities List (NPL) in September 1985. In response to public comments on the NPL proposal, U.S. EPA conducted the Expanded Site Inspection between 1986 and 1989. The site was re-scored (34.68) in January 1990 based upon the occurrence of contaminants in the surficial sand, but not in the deep sand and gravel. The site was placed on the NPL in February 1990.

The site is bordered on the south and west by Sequoit Creek. A residential area is located to the east, and agricultural land, scattered residences and undeveloped land are located to the north. An industrial park, constructed on former landfill areas unrelated to the H.O.D. site, is located to the west of the site across Sequoit Creek.

The H.O.D. Landfill is located on a 121.47 acre parcel, approximately 51 acres of which have been landfilled. The 51 acre landfill is divided into two portions, the 24.2 acre "old landfill" and the immediately adjacent 26.8 acre "new landfill." Operations began in the "old landfill" in 1963, and wastes were placed into excavated trenches and covered with the excavated materials from the next trench. The base of the southern portion of the "old landfill" is underlain by the surficial sand, and the northern portion of the "old landfill" is underlain by the clay diamict (a poorly to non-sorted sediment containing a wide range of particle sizes) which separates the surficial sand from the deep sand and gravel.

Operations in the "new landfill" began in 1975 and included the construction of a clay barrier between the "old" and "new" landfills, and the installation of a leachate collection system. The "new landfill" is underlain by the native clay diamict, or a constructed clay bottom layer (in locations where the native clay was not present). The leachate collection system consists of a system of vertical wells and a subgrade pipe system which drains a portion of the base of the "new landfill." Landfill gas is managed using passive gas flares on vertical gas extraction wells.

The "new landfill" was closed in 1984, and the entire landfill was covered with a continuous clay cap. Based on information obtained during investigation activities, the cap thickness ranges from 49 inches to 87 inches. There are some areas where erosional rills and gullies, and bare spots in the vegetation have developed in the clay cap. Remnants of a former cap were observed during the installation of the present cap on the "old landfill". Typical hydraulic conductivities determined for the low permeability clay layer of the present cap were in the 10^{-8} cm/s range.

Refuse thickness ranges from 12 ft to 36 ft in the "old landfill" and from 36 ft to 64 ft in the "new landfill," with a total estimated in-place volume of 1.5 million cubic yards of waste at the site. Landfill gas generated within the landfill has been found to be migrating horizontally away from the landfill in the subsurface, and vertically through the cap. This indicates that the current rate of gas extraction has not sufficiently reduced the gas pressure within the landfill. Leachate is being extracted from the landfill, but wet areas and surface seeps exist in the cap, indicating that the current rate of leachate extraction has not sufficiently reduced the leachate levels in the landfill.

The unconsolidated deposits under and around the area of the H.O.D. Landfill site are predominantly glacial drift overlying the dolomite bedrock. The unconsolidated deposits encountered at the site consist of surface soils, the surficial sand, a clay-rich diamict (till), and a deeper sand and gravel layer. The surface soils range from topsoil, to peat and organic-rich silt and clay. The surficial sand is an east-west trending feature of local extent which is located on the southern side of the site and is bounded by the clay-rich diamict laterally and at its base. This surficial sand layer contains groundwater but is not used for water supply purposes. The groundwater flow direction in the surficial sand is towards Sequoit Creek.

The clay-rich diamict is continuous beneath the site. The thickness of the clay-rich diamict ranges from an estimated 40 ft to over 70 ft beneath the majority of the site, with small areas where the thickness ranges from greater than 90 ft to less than 30 ft. The clay diamict has a low hydraulic conductivity and provides resistance to vertical flow from the surficial sand to the deep sand and gravel. The inorganic chemistry of RI groundwater samples plotted on a Piper diagram indicates that samples collected from the surficial sand and the deep sand and gravel are enriched in bicarbonates, calcium, and magnesium, with generally lower concentrations of sodium, potassium, sulfate, and chloride. The only exception noted was the sample collected from W6S, which contained higher concentrations of sulfate and chloride. Groundwater samples collected from the intermediate (clay till) wells were generally noted as containing higher concentrations of carbonates than the shallow (surficial sand) or deep (deep sand and gravel aquifer) wells.

A deep sand and gravel layer is laterally extensive and is present beneath the entire site. The full thickness of this unit is not known, but it is at least 185 ft thick in the vicinity of the site. This deep sand and gravel layer is used for water supply purposes both by private residents and by the Village of Antioch. Groundwater flow in this deep sand and gravel layer, in the vicinity of the site, is to the west-southwest.

The H.O.D. Landfill leachate and gas contain volatile organic compounds (VOCs). Groundwater samples collected from wells immediately adjacent to the southwest corner of the H.O.D. Landfill site were found to contain only concentrations of some alkene compounds and carbon disulfide. This indicates that the contaminants potentially migrating from the landfill are being attenuated since entire group of VOCs are not detected in the groundwater samples.

VOCs were not detected in the on-site well completed in the deep sand and gravel layer (US4D). This well is nested with a shallower well where VOCs were detected on-site (US4S), indicating that VOCs are not migrating through the clay diamict and impacting the deep sand and gravel in the vicinity of well US4D. It is possible that the VOC concentrations that were detected in groundwater samples obtained from the surficial sand wells are due to landfill gas migration. The compounds detected in these groundwater samples have also been detected in the landfill gas and landfill gas has been found to be present in this area. This conclusion is also supported by the carbon isotope study previously performed by WMII. Evidence of landfill leachate migration to the surficial sand groundwater was not found based upon the carbon isotope results (i.e., the surficial sand groundwater was found to be depleted, rather than enriched in ^{13}C). Enrichment of ^{13}C in the groundwater would be expected if leachate contamination of the groundwater was present.

The compounds detected in the surficial sand groundwater samples were not detected in the surface water samples, indicating that the VOCs are being further attenuated as the surficial sand groundwater migrates towards, and discharges to, Sequoit Creek. Samples from the surficial sand groundwater monitoring wells located on the opposite side of the creek from the H.O.D. Landfill (i.e., off-site) also were not found to contain VOCs, indicating that this off-site groundwater is not being impacted by VOCs from the landfill or another source.

Trichloroethene (TCE) was detected at 1 to 2 ug/l in the groundwater samples obtained from well US6I, which is screened in the clay diamict. These TCE concentrations have decreased over time and can be expected to continue to decline further.

In the deep sand and gravel, VOCs were only detected in groundwater samples collected from one monitoring well, US3D, which is located in the industrial park to the west of the site. The decrease in the groundwater concentrations of VOCs in samples from well US3D to the nearest village well (VW-4) may indicate that the VOCs are being attenuated to nearly undetectable levels in the water pumped from well VW-4. It is also possible that vinyl chloride was not detected in the VW-4 sample due to either dilution (possibly resulting from the extraction of groundwater through a 20 foot screened interval versus a 5 foot screened interval in US3D) or to the volatilization of the chemical constituents (due to the use of the high capacity pumping system for sampling). However, the type of VOCs detected could also indicate that there is a separate source for the VOCs present in the sample from well VW-4 other than the H.O.D. site.

One potential mechanism for the transport of VOCs to the off-site deep sand and gravel layer is via leaking abandoned boreholes and/or leaking well seals. The variability of the chloride concentrations in the groundwater samples obtained from the deep sand and gravel layer could be explained by such a mechanism. The potential for leaking well seals was demonstrated at well PZ2, which was abandoned after the well seal was found to be leaking as demonstrated by the progressively increasing water levels measured in that well over time.

In a previous site study by Patrick Engineering, it was stated that the exploratory boreholes for the village well may provide a pathway for contaminant transport from the surficial sand to the deep sand and gravel. Village well No. 4 (VW-4) was apparently constructed without a double-casing through the surficial sand. The greatest potential for well seal leakage is where the hydraulic head difference is greatest, such as at a pumping well. An intermittently pumped well like VW-4 would allow for periods of leakage into the deep sand and gravel without immediate collection by the extraction pump.

Other potential sources of contamination in the industrial park area include:

- The past discharge of untreated waste by Quaker Industries
- The former Cunningham Dump (located west of Sequoit Creek)
- The former Quaker Dump (located west of Sequoit Creek)
- Fill areas in the Sequoit Acres Industrial Park
- Industries in the Sequoit Acres Industrial Park

VW-4 is reportedly constructed through waste in the Cunningham Dump. The potential exists for contaminants to migrate downward via the borehole annulus and into the well and the deep sand and gravel aquifer. VW-4 is reportedly no longer used regularly and is scheduled for abandonment.

The Baseline Risk Assessment was developed using the U.S. EPA's "Presumptive Remedy for CERCLA Municipal Landfill Sites", September 1993 (EPA 540-F-93-035), which identifies containment as the presumptive remedy. The response action objectives listed in this Presumptive Remedy Guidance are:

- Preventing direct contact with the landfill contents

- Minimizing infiltration and the resulting contaminant leaching to the groundwater

- Controlling surface water runoff and erosion

- Containment of the groundwater contaminant plume and preventing further migration from source areas, and

- Controlling and treating landfill gas

Preventing direct contact with waste, minimizing infiltration, controlling leachate generation, and controlling landfill gas are typically addressed by capping the site and installing leachate and gas collection systems. Each of these components already exist at the site, but require some improvements to enhance their effectiveness. The VOCs in the surficial sand were not found to be migrating off-site, indicating that active controls may not be needed. Control of the VOCs in the on-site surficial sand can be remediated by improved gas collection, if landfill gas is the source of these concentrations.

The VOCs found in the off-site deep sand and gravel layer may be present there due to their migration from the surficial sand downward via well or borehole seal leakage (i.e., via potential annular seal leakage in Village of Antioch Well No. 4). Analytical results indicate that contaminants are not migrating off-site within the upper aquifer. A potential source for the lower aquifer impact is via the possible VW-4 annular seal leakage of contaminants from the Former Cunningham/Quaker Village Dump. VW-4 was apparently installed through the refuse material of the Cunningham Dump. The potential for such leakage will be reduced by the abandonment of VW-4. The abandonment of VW-4 will seal off a potential migration pathway for sources located in the industrial park area, and generally reduce the downward gradient due to the cessation of pumping operations at this well. The remedial action objective for the off-site deep sand and gravel layer is to prevent its exposure to VOC impacted groundwater. This may be accomplished though the abandonment of VW-4 and through the creation of institutional controls to prevent the construction of new wells in the industrial park area.

PMS/dlp
J:\2386\0096\RI_FINAL\RI_TEXT\EXEC_SUM.DOC

1

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

This report presents the results of the Remedial Investigation (RI) for the H.O.D. Landfill Site. The purpose of the Remedial Investigation (RI) is to define the nature and extent of contamination, assess risks to human health and the environment, and provide information for the Feasibility Study. The RI report includes the information presented in Technical Memorandum No. 1 (Tech Memo), and the results of the Supplemental Investigation. The Baseline Risk Assessment has been prepared as a separate report by others.

The work was conducted in accordance with an Administrative Order on Consent (AOC) executed on August 20, 1990 by the U.S. Environmental Protection Agency (U.S. EPA) and Waste Management of Illinois, Inc. (WMII).

1.2 REPORT ORGANIZATION

Section 1 provides an introduction and describes the site, site history, the areas surrounding the site and the environmental history of the industrial area located west of the site. Section 2 describes the methods used in the field work. Section 3 provides a description of the physical characteristics of the site. Section 4 presents a discussion of contaminant nature and extent. Section 5 describes contaminant fate and transport processes. Section 6 provides a summary and conclusions based on the information obtained from the RI. Section 7 lists the references cited in this RI. Table 1-1 presents a list of acronyms and abbreviations.

This report is presented in three volumes. Volume I consists of the report text, tables, figures, and drawings. Volumes II and III consist of the data appendices.

1.3 BACKGROUND

1.3.1 Site Location and Description

The site is located within the eastern boundary of the Village of Antioch in Lake County in northeastern Illinois (Township 46 North, Range 10 East, SE 1/4, SE 1/2, Section 8 and West 1/2, SW 1/4 of Section 9, Figure 1).

The site consists of a total of 121.47 acres, approximately 51 acres of which have been landfilled. Although the landfilled area is continuous, it consists of two separate landfill areas, identified as the old and the new landfills. The old landfill consists of 24.2 acres situated on the western third of the property. The new landfill consists of 26.8 acres situated immediately east of the old landfill (Figure 2). Undeveloped land north of the northeast section of the "new" landfill is owned by WMII and has been used as a borrow area for landfilling operations. The two landfill areas have been legally delineated and a division line established under a special condition of permits (No. 1975-22-DE and No. 75-329) issued by the IEPA, Division of Land Pollution Control. The legal description of the site is provided on Figure 3.

Site Engineering

"Old" Landfill. In 1963, Murrill Cunningham began placing waste in the northern portions of what is now referred to as the "old" landfill portion of the H.O.D. Landfill (Figure 2). Waste was placed into excavated trenches of unknown (probably varying) size. Cover was applied occasionally to prevent blowing litter and odor problems. When a trench was filled, the wastes were covered with excavated material from the next trench. A fence with a gate was installed to help eliminate indiscriminate dumping. However, based on site inspection reports prepared by the supervising sanitarian of the Division of Environmental Health, Lake County Health Department (LCHD), the gate was left open overnight occasionally during the first years of operation and the landfill was left unattended during operating hours on occasion.

In 1965, H.O.D. Disposal Inc. took over the Site. The method of landfilling remained about the same. Sequoit Creek was diverted to flow along the southern and western boundaries of the present H.O.D. Landfill. Prior to its diversion and channelization, the creek was characteristic of a slough or marsh which traversed the now-landfilled area from the vicinity of Silver Lake (southeast of the Site) to the northwest corner of the Site. The creek diversion provided more acreage to landfill and reduced contaminant release to Sequoit Creek. C.C.D. Disposal, Inc. took over the Site in 1972 and continued operation of the "old" landfill by the trench method. In 1973, WMII merged with C.C.D. Disposal and H.O.D. Disposal, allowing C.C.D. Disposal to continue landfilling activities. Landfill operations began to be conducted more consistently. Daily cover was applied to prevent blowing litter and odor problems, and burning was discontinued.

In June 1974, WMII applied to IEPA for expansion onto portions of the adjacent 60-acre parcel. A survey line was established at the eastern fringe of the 20-acre landfilled area when the new portion was under development. This line now designates the barrier between the "old" and "new" landfill portions of the Site.

"New" Landfill. Preparations for the "new" landfill began in 1975 when WMII received Development Permit No. 1975-22-DE. Operation of the "old" landfill continued while the development of the "new" landfill proceeded (Figure 2).

The development activities required before landfilling could begin in the "new" landfill included:

- Installation of a clay barrier wall between the "old" and "new" landfills
- Installation of leachate collection pipe and manholes on the east and west side of the barrier wall between the "old" and "new" landfills

- Construction of a flood storage area between Sequoit Creek and the area to be landfilled.

The flood storage area was provided to protect the environmental setting of Sequoit Creek and Silver Lake. The flood storage area provides 27 acre-feet for seasonal overflow of Sequoit Creek, and was constructed by removing a portion of the northern bank of Sequoit Creek that was constructed to re-route the creek earlier.

Waste Placement. The method of operation for the "new" landfill was initially the trench method, but was changed in 1978 to the area method. The trench method utilized at the "new" landfill was comprised of 70 foot wide trenches extending from north to south across the area to be landfilled. Trenches were excavated at a 1:1 side slope down to an elevation of approximately 750 feet MSL. The depth of cuts below existing ground varied from 10 to 25 feet. The clay from the trench excavation was stockpiled and used for daily cover. Prior to excavation of a trench, the surface layer of peat and organic material was removed. The area of the "new" landfill operated using the trench-fill method covered approximately 11 acres and was located adjacent to the "old" landfill area to the west. The location of this area is shown on Figure 2.

In 1978, the method of landfilling was changed to the area method. The area fill method was utilized for the remainder of the landfilling operations. The area-filled portion of the landfill is shown on Figure 2. The area method eliminated the walls separating each trench. A continuous trench was dug with newly excavated clay being used for cover material. The surface layer of peat and organic material was removed. Elimination of the clay walls between trenches provided more volume to place wastes without altering the integrity of the engineered containment system.

Waste was placed into cells in compacted lifts that comprised one day's receipts of waste. Some liquid wastes were dumped along with the solid waste. Under the operational permit for the site liquid waste disposal was allowed at the Site as long as the liquids were spread across the solid waste. Under the operational permit, each day the waste was to be covered with a minimum of 6 inches of clay. Daily cover within 100 feet of the landfill boundary was removed before more waste was placed in those areas.

A 6-acre portion in the northeastern corner of the landfill was operated as a deep trench area. Clay was needed for a seal along the southern edge of the landfill (see next subsection), and soil borings performed by TSC in 1981 indicated the northeastern landfill area had ample clay for this purpose. The deep trench area was excavated to approximately 720 feet MSL in three phases. The location of the deep trench area is shown on Figure 2.

A minimum of 4 feet of compacted clay was placed over the refuse when filling was completed to the final elevation of about 790 feet MSL. The compacted clay was covered with a minimum of 4 inches of topsoil to support vegetation.

Clay Barrier and Seals. IEPA directed WMII to create a distinct separation between the "old" and "new" landfills. WMII constructed a 12-foot wide compacted clay barrier wall along the west side of the "new" landfill (between the "old" and "new" landfills) and extended east along the northern and southern limits of proposed fill. The clay barrier wall was extended upward and keyed into the clay cap. Clay barrier walls, keyed into existing natural clay, were installed in areas where sand and gravel were found. Clay barrier walls were keyed into the final clay cap when the cap was constructed.

In addition to the clay barrier walls, bottom clay seals were added in areas where the bottom of the landfill was found to be a material other than clay. A minimum of 10 feet of undisturbed natural clay was required, or else 6 feet of compacted clay was placed. The location of clay seals was estimated based upon soil borings drilled for the site operational permit and supplemental permits.

A supplemental permit was granted in 1981 to increase depth across a 6-acre area in the northeastern corner and install bottom and perimeter seals along the southern boundary of the "new" landfill. Soil borings performed by TSC in February 1981 and landfill excavation disclosed an area along the southern boundary of the "new" landfill containing sand and silt layers not indicated by the original soil borings used in the operational permit application. The bottom and perimeter seals were built in accordance with the initial operating permit (10 ft of natural clay or 6-foot thick compacted clay seals, 12-foot wide compacted clay walls). Soil borings were performed in the "new landfill" area in July and August 1980, and soil samples were collected for geotechnical analysis. Laboratory tests conducted by TSC on clay samples collected in 1980 indicated permeability ranged from 7.3×10^{-8} cm/sec to 8.1×10^{-9} cm/sec.

To obtain material for the seals, modification of the bottom of the excavation was necessary. The 6-acre deep trench area provided the extra clay for the additional seals. The clay seals were keyed into natural clay or previously constructed seals to provide containment of landfilled material.

Leachate Collection. When the clay barrier wall was constructed between the "old" and "new" landfills, the leachate collection system was started. A 6-inch perforated pipe was installed west of the barrier wall to collect leachate from the "old" landfill. The "old" landfill pipe was connected to a manhole (MHW). The bottom of MHW is at approximately 758.5 ft MSL. The leachate collection pipe west of the clay barrier wall is sloped to flow into MHW.

Another 6-inch perforated pipe was installed east of the clay barrier wall, running north and south along the western limits of the "new" landfill. The 6-inch perforated pipe was also extended east approximately 250 feet along the northern and southern limits of the new landfill. All of this piping is connected to a manhole (MHE) east of the clay barrier wall. The bottom of MHE is below the landfill base.

Initially, the subgrade leachate collection pipe was installed at least 140 feet ahead of the operating trench. Gas bubbles were observed in the manholes in 1978 and, to solve the problem, WMII modified the leachate collection system. The subgrade leachate collection pipe stopped approximately 250 feet east of MHE, and piezometers were installed at approximately 500-foot intervals along the outer limits of the fill.

Six leachate piezometers (P1, P2A, P3A, P8, P9, and P10) were installed to the bottom of the landfill in 1983 and 1984. The piezometers were installed to collect leachate and monitor leachate levels in the "new" landfill, and are now used for leachate extraction. Leachate piezometer installation information is summarized in Table 3-3.

Leachate levels have been checked monthly since late 1983. Prior to 1987, no leachate was extracted. Leachate extraction began in 1987 and WMII has attempted to maintain the leachate head 2 feet below the downgradient groundwater level in well G11D since that time. A historical comparison of leachate head elevations and groundwater elevations measured in G11D indicate an outward gradient toward G11D. Leachate flow, however, is restricted due to the low-permeability of the clay-rich soils. Extracted leachate is shipped off-Site by tanker trucks for treatment and disposal.

Piezometers are used to withdraw leachate. The piezometers are hooked to an automatic pumping system that constantly pumps leachate into a 2500-gallon accumulation tank. When the tank fills, the pumps shut off and the tank is emptied into a tanker truck. The pumps are set 1 foot from the bottom of the leachate piezometers.

A pump is placed at the bottom of each manhole to remove leachate and maintain a 2 foot head differential below downgradient groundwater. Leachate extracted from the manholes is pumped to a tank that is emptied into a tanker truck when filled.

Gas Venting. When modification of the leachate collection system was approved by IEPA, no provisions were made for collection of landfill gas. In June 1988, 14 gas wells were installed. The gas wells were not drilled to document the base of the refuse, and therefore refuse thickness information was not obtained. The wells are hooked to individual flares. Information obtained during gas flare installation is summarized in Table 3-3.

Leachate piezometer borings LP1 through LP14 were installed during the RI to document the base of the refuse. Refuse thickness information obtained during leachate piezometer installation is summarized in Table 3-3.

1.3.2 Surrounding Property and Land Use

The site is bordered on the south and west by Sequoit Creek. The Silver Lake residential subdivision is located east of the site and agricultural land, scattered residential areas, and undeveloped land is located to the north. A large wetland area extends south of the site from Sequoit Creek (Figure 29). Silver Lake is approximately 200 feet southeast of the site. A large industrial park area (Sequoit Acres Industrial Park), constructed on former landfill and fill areas, is located west of the site and borders Sequoit Creek (Figure 1).

Sequoit Acres Industrial Park contains at least five companies that are small quantity hazardous waste producers, five registered underground storage tanks ranging in size from 60 gallons to 200,000 gallons, and a fill area that was, at least in part, a waste dump (Cunningham Dump and Quaker Dump). Companies that are small quantity hazardous waste producers include:

- Quaker Industries
- Chicago Ink and Research Company, Inc.
- Galdine Electronics, Inc.
- Major Industrial Truck, Inc.
- Nu-Way Speaker Products, Inc.
- Roll Foil Laminating, Inc.

Patrick Engineering, Inc. (Patrick) has investigated the development and environmental history of the Sequoit Acres Industrial Park (Patrick Engineering, 1989). A discussion of the activities at Sequoit Acres is presented in Section 1.3.4.

Water Supply/Groundwater Use
The Village of Antioch obtains its water from five water supply wells screened in the deep sand and gravel. Village wells are located west of the site and are shown on Figure 7. Under normal operating conditions, the Village wells are automatically activated in alternating cycles when the water pressure from aboveground water storage tanks drops below a designated level; wells 1 and 4 operate simultaneously, as do wells 2 and 3. Well 5, when activated, pumps alone. The pumps in wells 3, 4, and 5 are rated at 500, 650 and 750 gallons per minute (gpm), respectively. Well 4 was pumped at 575 gpm during the U.S. EPA/USGS pump test. Wells 1 and 2 are reported to produce 150 and 250 gpm, respectively (Ecology and Environment, 1989). These wells are finished at depths ranging from 131 to 231 feet. Municipal well information is summarized in Table 1-2.

Privately owned wells in the vicinity of the site (i.e., Silver Lake residential subdivision) are screened in the same deep sand and gravel used by the Village of Antioch or the underlying dolomite. These wells are finished at depths ranging from approximately 85 to 250 feet. Household wastewater from the Silver Lake subdivision is discharged to septic tanks.

1.3.3 Site History

Ownership. Waste disposal activities began at H.O.D. Landfill in 1963 and continued through Site closure in 1984. The Site has been owned and operated by three distinct companies:

- Cunningham Cartage and Disposal Company (1963-1965)
- Disposal Inc. (1965-1972)

- Disposal, Inc. (1972 - present, including merger with WMII).

Murrill Cunningham, owner, operator, and president of Cunningham Cartage and Disposal Company operated a 20-acre landfill at the Site from 1963 until August 1965. The property was then purchased by John Horak and Charles Dishinger, who operated the Site under the name H.O.D. Disposal, Inc. In December 1972, the 20-acre landfill was conveyed to C.C.D. Disposal, Inc. and C.C.D. Disposal, Inc. purchased the adjacent 60-acres of land to the east of H.O.D. Landfill. WMII merged with H.O.D. Disposal, Inc., and C.C.D. Disposal, Inc. gaining ownership of the entire Site. H.O.D. Disposal, Inc. and C.C.D. Disposal, Inc. became subsidiaries of WMII through the merger. WMII operated the landfill from 1973 until 1984 when the Site was closed. During the time WMII operated the landfill, portions of the 60-acre property were opened for landfilling (Ecology and Environment, 1989).

Waste Disposal Activities

Murrill Cunningham began operating a sanitary landfill on the 20-acre property in 1963 under a Lake County Health Department (LCHD) permit. Cunningham Cartage applied to LCHD for a permit to expand landfilling operations onto the adjacent land parcel. The permit was denied by LCHD because the adjacent area was not zoned for a sanitary landfill (Ecology and Environment, 1989).

In August 1965, H.O.D. Disposal, Inc. took over operation of the 20-acre landfill. H.O.D. Disposal Inc. operated under a LCHD permit from August 1965 through March 12, 1975 when the IEPA approved the state permit. In October 1965, H.O.D. Disposal, Inc. applied to LCHD for expansion of the landfill area to 80 acres. The application was rejected because of zoning. In 1971, all solid waste disposal facilities in Illinois were required by State law to obtain operator permits from IEPA. In October 1973, WMII submitted a zoning request to the Village Zoning Board for operation of an 80-acre landfill. WMII submitted a permit application to IEPA on June 26, 1974. The IEPA set a July 27, 1974 deadline for WMII to acquire a permit. The IEPA fined WMII in August 1974 for not having an approved permit. On October 21, 1974 the zoning request was approved and on March 12, 1975 the IEPA approved the development permit.

Development Permit No. 1975-22-DE issued by IEPA on March 12, 1975 allowed disposal of general solid waste, excluding liquid and special wastes, on the 60-acre expansion. The permit specified special conditions, including:

- Leachate collection
- A surveyed separation between the "old" and "new" landfill areas
- Groundwater monitoring
- Allowance for a compensatory flood storage area for Sequoit Creek overflow.

Between July 1975 and the closing of the landfill in 1984, various supplemental permits were granted by IEPA to WMII to modify development and operational permits for the Site. The supplemental permits include, but are not limited to:

- Installing a fence around the entire Site and a berm along the east side
- Modification of the leachate collection system
- A change in the method of landfilling
- An increase in depth on a portion of the landfill to install seals along the southern boundary
- Various supplemental permits allowing disposal of special wastes.

A woven wire mesh fence with barbed wire was installed around the north, south and west sides of the Site with a locking chain-link gate across the access road. The east side was fenced with screened chain-link fence with barbed wire. Also on the east side, an 8-foot high clay berm with shrubs was constructed to further reduce noise and visual exposure to residences to the east.

During operation of the Site, permits were issued by the IEPA for the disposal of municipal, industrial, and special wastes. Table 1-3 presents a summary of the industrial and special waste permits. Based on a review of WMII records, special permitted wastes account for approximately 2% of the total volume of wastes disposed.

In 1982, WMII applied to the IEPA for a supplemental permit to expand landfilling operations onto adjacent land to the north which had been used as a borrow area for cover materials. The permit application was denied. WMII then applied for a supplemental permit to raise final contours. The request was denied based in part on the argument from the Village of Antioch that the modifications would make it impossible to implement its plans to build a light industrial park over the H.O.D. Landfill. WMII appealed the decision through the Illinois judicial system to the Illinois Supreme Court. The court upheld the IEPA's decision to deny expansion. WMII ceased accepting waste for disposal at the Site in 1984.

History of Regulatory Agency Response Actions
In June 1981, WMII submitted to the U.S. EPA a Hazardous Waste Site Notification form as required by Section 103(c) of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The form indicated solvents, heavy metals, and cutting and hydraulic oils may have been disposed at the Site, as well as municipal waste.

A Preliminary Assessment (PA) was prepared by the E&E Field Investigation Team (FIT) for U.S. EPA in 1983 (Ecology and Environment, 1983). The FIT conducted a Site Inspection (SI) on July 10, 1984. The FIT prepared a Hazard Ranking System (HRS) model score and submitted it to U.S. EPA in April 1985. The Site was scored 52.02 based, in part, on an "observed" release of contaminants from the Site to groundwater. The presence of zinc at a concentration of 2040 ug/L in a groundwater sample collected from monitoring well G103 (subsequently replaced by well R103) was used to document the release of contaminants to groundwater. See Figure 5 for location of well R103. WMII contended that the zinc was related to a deteriorating galvanized steel protector pipe.

On September 18, 1985, U.S. EPA proposed that the Site be placed on the National Priorities List (NPL) as an uncontrolled hazardous waste site. In 1986, Versar prepared a report titled "H.O.D. Landfill Responsible Party Search Draft Final Report" for the U.S. EPA.

An Expanded Site Inspection (ESI) was conducted by E&E during the period 1986 through 1989 resulting in an ESI report being submitted to U.S. EPA on September 22, 1989. The goal of the ESI was to respond to public comments related to the HRS score and proposed listing of the Site on the NPL; specifically, to collect data related to Site geology, hydrogeology, and groundwater quality including the contention that the deteriorating protective well casing caused the false appearance of a zinc release. Data collection activities conducted for the ESI are summarized on Table 1-4. In January 1990, the H.O.D. Landfill was rescored under the HRS resulting in a revised score of 34.68 based on the occurrence of contaminants in the surficial sand, but not in the deep sand and gravel. The ESI report indicated the high zinc concentrations during PA sampling may have been related to deteriorating galvanized steel well protector pipes. However, the report indicated that this premise could not be justified solely using the results of the ESI.

In February 1990, the Site was officially placed on the NPL. A number of Potentially Responsible Parties (PRPs) were identified by U.S. EPA. However, only WMII responded to U.S. EPA and agreed to participate in the RI/FS. In early 1990, WMII entered into discussions with the U.S. EPA regarding the conduct of an RI/FS under an AOC that was, following public review and comment, executed on August 20, 1990. In May 1990, Warzyn Inc. (Warzyn) was contracted by WMII to support WMII's RI/FS effort by preparing the Work Plan or Preliminary Site Evaluation Report/Technical Scope (PSER/TS) and to subsequently perform the RI.

Previous Site Investigations

Several investigations have been conducted at the Site. These investigations are briefly discussed in the following paragraphs. Soil boring and groundwater monitoring well locations are shown in Figure 4. Monitoring well locations are also shown on Figure 5. Tables 1-5 and 1-6 summarize monitoring well and soil boring information, respectively. Soil boring logs and well construction details for these wells are presented in Appendix C of the PSER/TS.

A soil investigation was conducted by Testing Services Corporation (TSC) in 1973 to assess conditions for the expansion of the landfill and the construction of an on-site maintenance building. Twenty-five borings were drilled and sampled (TSC, 1973).

TSC installed six groundwater monitoring wells (G11S, G11B, G14S, G14D, G102 and G103) for WMII in May 1974.

A hydrogeologic report for the proposed landfill expansion to the north was prepared in 1982 (McComas, 1982). The report was based in part on 26 soil borings drilled by TSC at the Site in 1981.

IEPA prepared a trend analysis report summarizing chemical analysis of samples collected from monitoring wells at the Site and submitted the report attached to a letter dated May 7, 1982 to the Illinois Attorney General's Office. The report summarized the analytical data collected between November 1974 and December 1981 from the six on-site monitoring wells (IEPA, 1982).

A Preliminary Assessment was completed on February 11, 1983 by the FIT at the request of the U.S. EPA. The PA identified several data gaps including determination of waste quantity and information related to possible groundwater or surface water contamination.

A Site Inspection was conducted on July 10, 1984 by the FIT. Groundwater samples were collected from on-Site monitoring wells. Analysis of groundwater samples, particularly from well G103, reportedly revealed the presence of elevated concentrations of zinc, lead, and cadmium. Analysis of surface water samples did not reveal elevated levels of analyzed parameters.

Well G103 was replaced with well R103 on October 31, 1985 because the well pipe was damaged during removal of the well protector pipe. After consultation with IEPA, the galvanized protector pipe for well G103 was removed because WMII suspected that zinc detected in the groundwater sample collected by FIT during the July 1984 SI was the result of deterioration of the protector pipe, of which at least one section was constructed of galvanized steel. The presence of zinc in the groundwater was used by the U.S. EPA to document Site groundwater contamination in the first HRS package (1985).

Dames and Moore conducted a hydrogeologic assessment of the Site at the request of WMII. The assessment was described in a report dated November 12, 1985. The report provided a brief summary of past groundwater sampling activities and an evaluation of chloride, zinc, and total dissolved solids in samples collected from the Village of Antioch Well 4, monitoring well G103, and a leachate sample (Dames and Moore, 1985).

On January 9, 1986, IEPA collected groundwater samples from four residential wells located east of the Site. The samples were analyzed for nitrates, organic compounds and trace metals. The results of the chemical analysis indicated no trace metals and no organic compounds were detected.

An Expanded Site Investigation (ESI) was conducted by the FIT (Ecology and Environment, 1989) during the period 1987 through 1989. The ESI consisted of the following activities:

- Review of existing records
- EM survey
- Drilling 15 soil borings
- Installing 13 monitoring wells
- Measuring groundwater and surface water levels
- Hydraulic conductivity testing

- Pump testing
- Soil and groundwater sampling and analysis.

A summary of ESI field investigation activities is presented on Table 1-4.

During the period 1989 through July 1990, P.E. LaMoreaux & Associates, Inc. (PELA), on behalf of WMII, conducted various Site investigations. These investigations included the following activities:

- Drilling borings
- Temporary piezometer and staff gauge installation
- Water level measurements
- Grain size and permeability testing of soil samples
- Domestic well inventory
- Geophysical logging
- Selected survey at Village of Antioch Well 4
- X-ray diffraction analysis of soil samples.

The objective of PELA's investigation was to fully characterize Site geology and hydrogeology. The results of investigation activities listed above were used to determine:

- The lateral and vertical extent of the surficial sand

- The lateral and vertical extent of the clay diamict (a poorly to non sorted sediment containing a wide range of particle sizes, regardless of sediment genesis) which separates the surficial sand from the deep sand and gravel.

- The direction of groundwater flow in the surficial sand and the deep sand and gravel aquifer

- The potential for hydraulic connection between the surficial sand and deep sand and gravel aquifer

- The relationship between the shallow groundwater flow system and Sequoit Creek

- The depositional history of glacial deposits in the Site vicinity.

The well construction report for Village Well 4 indicates fill is present at that location. The nature of the fill was not specified on the well construction report. The Lake County Health Department reported that industrial waste and garbage had been disposed in this area. Monitoring well US3D, located approximately 100 feet east of Village Well 4 (Figure 4) indicates four feet of fill/refuse is present in this area.

Video camera logging of Village Well 4 was conducted by PELA. Some areas of the well appeared to be badly pitted. Prior to the video logging, PELA removed approximately 80 to 100 gallons of oil from the well (a column of oil on top of the water in the well approximately 15 feet thick). The oil was apparently the result of a malfunctioning pump oiling mechanism. It is not clear how long the oil may have been present in the well. WMII has not conducted additional video camera logging or monitoring to determine whether this problem has been fixed. Well maintenance is the responsibility of the Village of Antioch. Samples of the oil were collected with a teflon bailer prior to removing the oil. Analysis of the oil detected the presence of toluene (up to 35,170 ug/kg), xylenes (up to 1203 ug/kg) and ethylbenzene (up to 188 ug/kg). Vinyl chloride was not detected in the oil and it is not a degradation product of compounds detected in the oil.

Volatile organic compounds (VOCs) were detected inconsistently at low levels in Village Well 4 during the period February 1 through September 13, 1989 (see Table 1-7).

Village Well 4 is screened in the deep sand and gravel at a depth of 108 feet to 128 feet below ground surface. The gravel pack extends from a depth of 40 feet to 141 feet below ground surface. The clay diamict which separates the surficial sand (and the surficial refuse at Village Well 4) from the deep sand and gravel is present at a depth of 23 feet to 80 feet below ground surface at Village Well 4. The annular space seal (redi-mix concrete) was placed from ground surface to a depth of 40 feet. Therefore only 17 feet of redi-mix concrete separates the surficial sand from the gravel pack at this well. This seal may not be adequate to prevent migration of fluids through the drill hole annulus.

Patrick prepared an Environmental Audit of Sequoit Acres Industrial Park in 1989 on behalf of WMII. The purpose of the investigation was to identify potential contaminant sources within the industrial park and evaluate potential routes of contaminant migration. The investigation evaluated aerial photographs, published data on geology/hydrogeology, and history of land uses. Soil borings were performed to define site stratigraphy.

Patrick's findings regarding land use have been presented in Section 1.3.4. Patrick concluded that several potential sources of soil and/or groundwater contamination existed in the Sequoit Acres Industrial Park, including industry and landfilled areas containing both fill and refuse. The Patrick report further indicated "The isopach of refuse (Figure 13 in the Patrick report) indicates that it is probable that the fill described in the water well drillers log for well No. 4, was actually refuse."

Prior to drilling and constructing Village Well 4, three test holes (1-65, 2-65 and 3-65) were drilled in the Sequoit Acres Industrial Park area (Appendix A). Each of these holes was drilled through the clay diamict into the deep sand and gravel. The holes were reportedly plugged with clay slurry (Patrick Engineering, 1989). If the clay slurry seals are not competent, the potential for groundwater movement through these holes exists.

Shallow borings were drilled at three locations on October 23, 1989 by Patrick for Geoservices Inc. of Boynton Beach, Florida to collect samples of the clay diamict for laboratory permeability testing. Hydraulic conductivity values for the clay soils ranged from 2.1x10^{-7} cm/sec to 9x10^{-9} cm/sec. Results of the permeability testing of the clay diamict soils are summarized in Table 5 of the PSER/TS.

Five temporary leachate piezometers (TLP1 through TLP5) were installed at the "old" landfill for WMII by Stratigraphics, Inc. on July 24 and 25, 1990 (see Figure 4 for locations). Prior to piezometer installation, a piezometric cone penetration test was performed at each location to determine subsurface conditions. The Stratigraphics report indicated clay underlies refuse at each of the temporary leachate piezometer locations. Leachate samples were collected for laboratory analysis from temporary leachate piezometers TLP1 through TLP4 on July 27, 1990. Samples were collected from TLP2, TLP4, and TLP5 on August 10, 1990. Samples were analyzed for organics, metals and indicator parameters. Low levels of VOCs (primarily alkenes and aromatics) were detected in each of the leachate samples. Few detections of SVOCs were noted in the leachate samples, with naphthalene being the most commonly detected of the SVOCs.

A Hydropunch groundwater sample was collected near monitoring well US4S in May 1990. The sample was collected from a fine to medium sand at a depth of 20 to 21 ft below ground surface and was submitted for VOC analysis. The hydropunch was advanced at a location approximately 18 ft north of US4S in the southwestern corner of the site. VOCs detected in the groundwater sample included cis-1,2-DCE (110.3 ug/L), trans-1,2-DCE (1.4 ug/L), methylene chloride (2.7 ug/L) and vinyl chloride (188.4 ug/L). The analytical reports are included in Appendix F6 of the PSER/TS.

Groundwater quality samples were collected by WMII at ten on-site monitoring wells on July 25 and 26, 1990. Samples were analyzed for organics, metals and groundwater quality indicator parameters. Analytical results indicates that VOCs were only detected in samples collected from wells US4S (cis-1,2-DCE @ 39.7 ug/L; trans-1,2-DCE @ 1.8 ug/L), US6D (TCE @ 0.7 ug/L) and R103 (cis-1,2-DCE @ 0.5 ug/L; TCE @ 4 ug/L). The analytical reports are included in Appendix F2 of the PSER/TS.

Leachate samples were collected from the "new" landfill (east manhole, and leachate piezometers WP1, 22A, MP3A, P8, P9, and P10) and for the "old" landfill (west manhole) on June 28, 1990 samples were analyzed for organics.

The U.S. Geological Survey (USGS), in cooperation with the U.S. EPA, performed an evaluation of the aquifer pump test data collected during the ESI Report and presented the results in a report titled "Determination of Hydraulic Properties In The Vicinity Of A Landfill Near Antioch, Illinois" (USGS, 1990). A USGS Administrative Report which was issued prior to the final report and which presents an abbreviated discussion of the test is presented in Appendix B.

1.3.4 Summary of Environmental History of Sequoit Acres Industrial Park Through 1989

The Sequoit Acres Industrial Park, which is located west of the site on the western bank of Sequoit Creek, contains several companies which are RCRA small quantity hazardous waste generators, five registered underground storage tanks, and fill areas that were, at least in part, waste dumps (the Cunningham Dump and the Quaker Dump). The status of waste storage and disposal activities practiced by the small quantity generators prior to RCRA is not known. Figure 8 shows the locations of these facilities. The following discussion of the industrial park is based on an environmental audit conducted by Patrick Engineering, Inc. (Patrick Engineering, 1989).

Landfilling Activities
West of the H.O.D. Landfill, on the eastern portions of the Sequoit Acres Industrial Park, the naturally low lying areas were filled as part of a dump operation. Filling began south of the bend in McMillen Road, in the area that now makes up the Quaker Industries parking lot. Other areas along Sequoit Avenue and Anita Avenue have also been filled for industrial development (Figure 9). The makeup of the fill in these areas is unknown.

Possibly of as early as 1959, north of McMillen Road and adjacent to and west of H.O.D. Landfill, waste disposal occurred in the Cunningham Dump operated on land owned by Quaker Industries. It has been reported that this dump was open for dumping of any material, and in general there was no supervision of dumping activities. Combustible materials were periodically burned. Private waste disposal on the Quaker property, which is in the same general area as the Cunningham Dump, continued until 1965. The exact location of this disposal area is not known. This operation and disposal areas will be referred to as the Quaker Dump. Figure 9 shows the filled and landfilled areas in the Sequoit Acres Industrial Park.

Quaker Industries
Quaker Industries, Inc. (Quaker) is a manufacturer of wood and metal tray tables. Quaker is currently located south of McMillen Road, but Quaker also formerly owned land north of McMillen Road and west of Sequoit Creek that was used as the Cunningham Dump in the early 1960s. After landfilling started at the H.O.D. Landfill, Quaker built a storage warehouse over the location of the closed Cunningham Dump. Quaker sold this warehouse to Malnekoff Closeouts in 1987.

Potentially, hazardous wastes generated from Quaker's operations include: paint thinners, sludges, and lacquers. This statement is based on information provided by Quaker to U.S. EPA. Supplemental disposal permits obtained by the H.O.D. Landfill allowed the site to dispose of Quaker paints, coolants, paint booth oversprays, and water soluble oils and stains.

A January 30, 1968 letter from Applied Engineering Company (consultant to the Village of Antioch) to the State of Illinois Sanitary Board, indicated that Quaker discharged untreated industrial effluent to the wetlands in this area which discharged to Sequoit Creek. Attached to the letter was a summary of chemicals used in Quaker's manufacturing processes at that time. The chemicals used by Quaker included paint strippers containing chlorinated hydrocarbons. This effluent was discharged to Sequoit Creek and the nearby wetlands via an existing discharge pipe located near the southwestern corner of the H.O.D. Landfill Site.

It is unclear for how long of time the discharge occurred. Prior to the rerouting of Sequoit Creek, the area to the east of McMillen Road was wetlands. It is likely that at the time the surface water flow in this area was toward the east and northeast, across the area now occupied by the H.O.D. Landfill, to Sequoit Creek. Therefore, there was the potential for the discharge from Quaker to spread over a relatively large area of the present H.O.D. site. The area of this effluent discharge overlies the surficial sand, and the Quaker effluent, which included chlorinated hydrocarbons, potentially moved downward into the surficial sand.

The State of Illinois Sanitary Board replied in their February 15, 1968 letter to Applied Engineering, that this discharge of untreated waste was not acceptable. An NPDES permit for Quaker's non-contact cooling water discharge was issued in 1974. Quaker currently maintains this NPDES permit for their discharge of approximately 30,000 gallons per day (gpd) of non-contact cooling water to Sequoit Creek.

Quaker has stored drums containing hazardous waste on their property. Review of aerial photographs taken over the period 1980-1981 indicated that several dozen 55-gallon drums were present at that time (Patrick Engineering, 1989). In 1980, Quaker applied for a RCRA permit for their storage of hazardous wastes. This permit application was withdrawn in 1983. In 1984, the U.S. EPA informed Quaker that they were a small quantity generator and that they were not required to obtain a RCRA permit (Patrick Engineering, 1989).

Other potential contamination sources include floor drains within Quaker's manufacturing facility, Quaker's discharge to the sanitary sewer, and Quaker's air emissions. Solvents were used in Quaker's manufacturing processes and may have entered the facility's floor drains and/or sanitary sewer. The sewer line serving Quaker's facility runs north from the facility along Anita Avenue. Quaker's facility uses hot and cold solvent processes and, until 1980, discharged VOCs into the air.

Quaker historically has had underground storage tanks (USTs) on their property. A 10,000-gallon steel UST containing oil was installed in approximately 1961 and was removed in 1989. The 10,000-gallon tank was removed by Quaker because it was no longer needed. A 200,000-gallon concrete UST for water was installed by Quaker in 1964. This water tank was necessary for the operation of a sprinkler system at the Quaker factory, and was last used in 1975. Another steel UST (500 to 750 gallons) is reportedly currently used at the Quaker for storage of used oil and/or water (Patrick Engineering, 1989).

Antioch Township Highway Department

The Antioch Township Highway Department (the Department) is responsible for maintaining the township's roads. The Department performs truck maintenance, and uses fuels, road salts, paints, and solvents.

The Department has three registered USTs. A 4,000-gallon unlined steel UST is used for gasoline storage and a 1,000-gallon unlined steel UST is used for diesel fuel storage. These two USTs were painted externally before they were installed to resist corrosion. The third

UST on the Department's property has not been used since August 1983 and is of an unspecified size. This unlined UST was apparently used for gasoline storage, and it is not known if this UST was painted externally prior to installation to resist corrosion.

Chicago Ink and Research Company, Inc.
Chicago Ink and Research Company, Inc. (Chicago Ink) manufactures industrial inks. Chicago Ink has been operating in the Sequoit Acres Industrial Park since 1956. Hazardous wastes generated by Chicago Ink may include the following: solvent washes and sludges, caustic washes and sludges, and water washes and sludges generated from cleaning the equipment that is used in the production of ink from pigments; soaps, and stabilizers containing chromium and lead (Patrick Engineering, 1989). Chicago Ink has a registered 60-gallon UST that is both internally lined and externally painted to resist corrosion. The present contents and use, if any, of this tank is unknown.

Galdine Electronics, Inc.
Galdine Electronics, Inc. is a manufacturer of printed electronic circuit boards and has operated at their current location in the Sequoit Acres Industrial Park for approximately 21 years. Hazardous wastes generated by Galdine Electronics include: methylene chloride, a hydrochloric acid mixture, a chromic acid solution, a plating sludge, and a flammable liquid waste (Patrick Engineering, 1989). Rinse water from Galdine Electronics' manufacturing processes is currently discharged into the Village of Antioch's sanitary sewer system for treatment at the Village of Antioch's Publicly Owned Treatment Works (POTW).

Major Industrial Truck, Inc.
Major Industrial Truck, Inc. is concerned with the sales, service, and rental of forklifts and has been at their current location in the Sequoit Acres Industrial Park for approximately 9 years. They are a service company and do not manufacture any products on-site. In September 1988, Major Industrial Truck notified the IEPA that they would be shipping the small quantity of ignitable hazardous waste which they generated to Safety Kleen Corporation in Elgin, Illinois (Patrick Engineering, 1989).

NU-Way Speaker Products, Inc.
Nu-Way Speaker Products, Inc. (Nu-Way) is a manufacturer of non-metallic components for loudspeakers and has been in business at their current location in the Sequoit Acres Industrial Park for approximately 14 years. Hazardous materials that are generated by Nu-Way's manufacturing process are acetone and phenol (Patrick Engineering, 1989).

NCG Electronics, Inc.
NCG Electronics, Inc., was an affiliate of Galdine Electronics, Inc. and once occupied a building in the Sequoit Acres Industrial Park. NCG Electronics was also a manufacturer of printed circuit boards. A spent copper etching solution, a by-product of their manufacturing process classified as non-hazardous was generated by NCG Electronics (Patrick Engineering, 1989).

Roll Foil Laminating, Inc.

No information was available regarding the manufacturing processes at this facility. In March 1987, a Notification of Hazardous Waste Activity report was filed by Roll Foil Laminating, Inc. with the U.S. EPA indicating that they generate less than 1000 kilograms per month of F003 and F005 non-halogenated solvents (Patrick Engineering, 1989).

PMS/dlp
J:\2386\0096\RI_FINAL\RI_TEXT\SECTION1.DOC

2.0 REMEDIAL INVESTIGATION ACTIVITIES

The Remedial Investigation (RI) characterizes and delineates suspected contamination at a site, and attempts to quantify the risks to public health and the environment. A description of the activities and rationale for the data collection activities conducted at the H.O.D. Landfill is presented in this section.

2.1 SITE MAPPING AND SURVEYING

An updated topographic base map of the property was prepared by photogrammetric methods to identify physiographic and cultural features. The topographic base map was prepared by Warzyn from an aerial photograph taken on July 21, 1993 by Aero-Metric Engineering, Inc. (Figure 2).

In March of 1993, a survey was conducted by Gentile and Associates, Inc. to field stake the proposed-well, monitoring well, leachate well, gas probe, and test pit locations prior to the RI investigation activities. Another survey was completed by Gentile and Associates, Inc. to determine the locations and elevations of the existing wells, staff gages, and stand pipes, as well as the new monitoring wells, gas probes, soil borings, and leachate wells installed by Warzyn during the RI investigation activities.

Locations of the investigation points were surveyed on June 28 through July 1, 1993 and are based on the Illinois State Plane Coordinate system. A site grid was also developed to assist in referencing site features. The grid shown on Figure 2 shows the state plane coordinate system used during the RI. Elevations were measured relative to mean sea level datum with an accuracy of ±0.1 ft for ground surface, ±0.01 ft for top of casing and well pipe, and ±0.1 ft for horizontal locations.

2.2 SOURCE CHARACTERIZATION

The following activities were performed for the source characterization:

- Landfill Cap Evaluation
- Leachate Collection System Evaluation
- On-Site Surficial Soil/Sediment Sampling
- Leachate Well/Gas Well Installation
- Perimeter Landfill Gas Probe Installation
- Downhole Geophysical Logging
- Leachate Sampling
- Landfill Gas Sampling
- Landfill Soil Borings
- Evaluation of Off-Site Contaminant Sources

2.2.1 Landfill Cap Evaluation

The landfill cap evaluation consists of three main elements: a test pit investigation including geotechnical testing of the in-place cover soils, in-field conductivity testing of the landfill cap, and an estimate of the moisture percolation rate through the cap.

2.2.1.1 Test Pits. Ten test pit locations were selected based on locations shown in the Work Plan (Figure 4). Locations were selected to include site areas that appeared to be representative of the range of cover soil materials; such as typical areas, stressed areas, no vegetation areas, and poorly to well drained areas. Test pits were excavated vertically in the selected areas in May 1993 using a track-mounted excavator. Each test pit was excavated into the cover soils to the depth at which refuse was encountered. Soil profiles and field observations were documented by a Warzyn soil scientist. Field observations of each test pit included:

- Vegetation characteristics
- Root penetration depths
- Visual soil classification
- Extent of inhomogeneities
- Photographic documentation

In-place density tests, proposed in the work plan to be performed in the field during test pit excavation, were not conducted because alternate techniques could provide the needed data. Unit/weight density tests were performed in the laboratory using Shelby tube soil samples collected from the test pits.

After each test pit was excavated to a depth of at least 60 inches, a detailed cap profile description was made from one of the test pit walls. For safety reasons, in those pits which extended below 60 inches, the remainder of the cap profile below 60 inches was described from outside the test pit, using soil brought up in the excavator bucket.

Test pit logs describing the materials, thicknesses, structure, root growth, vegetative cover, and sample type and depths are included in Appendix C. The soil descriptions are based on the Soil Conservation Service Classification Criteria [U.S. Department of Agriculture (USDA) Handbook No. 436] and soils were visually classified using the Unified Soil Classification System (USCS) and the USDA methods.

Individual test pit samples were submitted to Warzyn's soil laboratory for tests which included:

- Grain Size (ASTM D422-63)
- Atterberg limits (ASTM D4318-84)
- Natural moisture content (ASTM D4959-89)
- Clay mineralogy by x-ray diffraction
- Modified Proctor (ASTM D1557-91)

- Laboratory falling head permeability (U.S. Army Corp. of Engineers, Engineering Manual EM1110-2-1906)

Soil samples to be analyzed for grain size, Atterberg limits, moisture content and clay mineralogy, were collected from each layer in the test pit, and placed in appropriate sample jars. Samples sent for analysis were selected, based on field observations, from the most representative zone of the moist, homogeneous clay material layer (the apparent low permeability layer), and various other layers, in each test pit.

Samples for the Modified Proctor tests were obtained with a bucket auger through the bottom casing of the Boutwell unit after completion of the permeability tests (described below), and placed inside double lined garbage bags.

Four Shelby tube samples collected for laboratory falling head permeability, density and moisture content analysis were obtained from the apparent low permeability layer from each test pit, utilizing three-inch diameter Shelby tubes pushed vertically into the soil using the excavator bucket, and retrieved vertically with as little sample disturbance as possible. The Shelby tube samples were randomly selected from test pits excavated from both the old and the new landfill areas for analysis (Appendix D).

After completion of each test pit sampling, the test pit was backfilled with the original material , which was placed in the test pit in reverse order of removal and compacted in approximate 1-ft lifts using the excavator bucket.

2.2.1.2 In-Field Landfill Cap Conductivity Tests. The Boutwell method (ASTM draft method "Standard Test Method for Field Measurement of Hydraulic Conductivity of Porous Materials Using the Two-Stage Borehole Procedure") was followed, less stage 2, for the conductivity tests run on the landfill cap. Ten tests were conducted in June 1993. The conductivity tests were performed within a 20 to 25-ft radius of each test pit, allowing for the use of test pit information in placing and running the conductivity tests. Boutwell test results are presented in Appendix D.

The Boutwell method measures the rate of flow of water into soil through the bottom of a sealed, cased borehole, utilizing a standpipe in the falling-head procedure. In stage 1, which measures maximum vertical conductivity, the bottom of the borehole is flush with the bottom of the casing. Stage 2, in which the borehole is advanced below the bottom of the casing, and which measures maximum horizontal conductivity, was not used during this investigation. According to the ASTM description of the Boutwell method, stage 2 can be omitted if the purpose of the investigation is to "...verify that the vertical hydraulic conductivity...is less than some specified value, and the apparent vertical conductivity...is less than that value...." The purpose of these tests was to obtain information on the apparent maximum vertical conductivity of the landfill cap. Therefore, stage 2 was not necessary.

The Boutwell apparatus was installed by hand digging a hole down to the low permeability layer based on the corresponding test pit information. When the low permeability layer was reached, the hole was advanced approximately 4 to 8 in. into the layer. The Boutwell apparatus was placed into the hole and the annular space sealed with bentonite chips or pellets.

As described in the test method, the casing was filled with water and the system was checked for leaks. The tests began when the stand pipe was full. A stop watch was used for timing, and calibrated standpipe readings were taken at various intervals and recorded. When the drop rate of water in the standpipe became steady over time, the test was completed.

Several of the Boutwell tests were run over a period of two days. Each Boutwell apparatus was pre-wetted for 6 to 12 hours before the test began to help induce the saturated conditions necessary to produce the quasi-steady final results. A rainfall event occurred after the installation of the Boutwell units associated with test pits 6, 9, and 10, causing the excavation surrounding the Boutwell units to fill with water. The water was bailed out of the excavation to a point below the top of the units' lower casings. Because the hydrated bentonite seal prevents seepage of water around the base casing of the Boutwell unit, and because stage 1 measures the vertical conductivity of the cover, which is not affected by water in the excavation, the presence of water in the excavation caused no net effect on the results of these three Boutwell tests.

Boutwell hydraulic conductivity calculations allow for correction for the expansion and contraction effect due to water temperature changes inside the units during the length of the test run, based on a sealed dummy unit. However, the expansion/contraction correction was not applied because of the variability between the dummy unit and each Boutwell unit. Because of shading caused by cloud cover during the course of the apparatus readings, the depth each unit was installed in the cover, the location of each unit relative to shading from the west tree line, and the location of the scale and support struts on the standpipe, condensation on the inside of the standpipes varied considerably between Boutwell units, although it changed slowly throughout the test runs of each individual unit. Sensitivity analysis was used to check the outcome of varying volume changes due to temperature fluctuation, and it was determined that it had a negligible affect on the final calculated hydraulic conductivity rate. However, because of this minor departure from the test method, these test results should not be considered absolute values, but rather relative representations of the permeabilities at each test pit location.

2.2.2 Leachate Collection System Effectiveness

The leachate collection system effectiveness was to be evaluated by pumping from the leachate collection system and monitoring the change in leachate head in nearby leachate wells. However, the evaluation was not performed as part of the RI because of the results of a similar test run prior to the RI by WMII. During this test, WMII found that leachate could be pumped from the system only until the liquid in storage in the manhole, leachate pipe, and backfill was drained. Then, a recovery period was necessary before more liquid could be pumped.

2.2.3 On-Site Surficial Soil/Sediment Sampling

Five surface soil/sediment samples (SU01 through SU05) were collected on May 14, 1993 from areas which were identified during an inspection of the landfill cap and surrounding area (Figure 10). Surface soil/sediment samples were collected from surface water run-off routes and on-site depositional areas which were observed to have discolored soil and/or water and/or vegetation. Surface soil sample SU01 was collected from an apparent leachate seep located within a deep surface water runoff erosional cut into the landfill cap which emptied into the seasonally flooded area south of the new landfill area. Sample SU02 was collected in an area on the landfill cap surface which was barren of vegetation, and after periods of rain, was observed to produce gas bubbles through small openings, causing black discoloration of the surrounding surface soils. Sample SU03 was collected in the seasonally flooded depositional area south of the new landfill and east of the old landfill from an area which had discolored standing surface water and vegetation. Samples SU04 and SU05 were collected from shallow run-off erosional cuts in the landfill cap which had discolored soils and/or water.

Samples were analyzed for target compound list (TCL) organics, target analyze list (TAL) inorganics, and total organic carbon (TOC). Several geotechnical index parameter tests including grain size analysis, Atterberg limits (to determine the liquid limit and plasticity index), and natural moisture content were performed on the samples. The results of the analysis of the surface soil/sediment samples were used to determine possible routes of contaminant transport.

2.2.4 Leachate Well/Gas Well Installation

During the RI, Environmental and Foundation Drilling, Inc. (E&F) and Warzyn installed 14 leachate wells/gas wells into the landfill refuse during the period of April 6 to May 4, 1993. The purpose of these wells was to collect leachate and landfill gas quality data (Figure 6). Five of the leachate wells were located in the new landfill area (LP5 through LP9) and the remaining nine were installed in the old landfill (LP1 through LP4 and LP10 through LP14). The leachate well borings were drilled using 10 1/4-inch inner diameter (ID) hollow stem augers. The soil borings were sampled with a 2-inch outer diameter (OD) split spoon at five foot intervals from approximately ten feet above the estimated base of the refuse to 2 to 7 feet below the base of the refuse to determine the depth and composition of the material underlying refuse in each soil boring. This information was also used to determine the in-place refuse volume. Soil boring logs for the leachate well borings are located in Appendix E.

The leachate wells were constructed using a washed pea gravel filter pack around 6-inch inner diameter (ID) schedule 80 PVC 0.020-inch slotted screen, with hydrated bentonite filling the annular space above the filter pack around the 6 inch PVC riser pipe. Locking protective casings were installed.

The leachate wells/gas wells were screened from approximately 0 to 5 feet above the base of the landfill to approximately 0.5 to 4.6 feet below the base of the landfill cap. Leachate well construction details are located in Appendix E. This construction method was used so that the leachate wells/gas wells could be used to withdraw both leachate and landfill gas, if necessary, during the Remedial Action (RA) portion of the project.

While drilling the leachate wells an Organic Vapor Meter (OVM) photoionization detector (PID); an Industrial Scientific oxygen, hydrogen sulfide, and combustible gas meter; and a Monitox hydrogen cyanide meter were used to screen drill cuttings and the immediate atmosphere. Soils with PID readings above 5 parts per million (ppm), as well as refuse material, were transported and placed into an on-site roll-off box. The roll-off box is covered and will remain on-site pending implementation of the source control remedy. Soils with a PID reading less than 5 ppm were left at the boring.

2.2.5 Perimeter Landfill Gas Probe Installation

Three of five proposed perimeter gas probes (GP3, GP4A, and GP5A) were installed on April 15, 21, and 22, 1993, respectively, by E&F and Warzyn (Figure 6). Adjacent property owners would not allow WMII/Warzyn to install off-site gas probes GP1 and GP2 to the north-northwest of the landfill.

The perimeter gas probes were installed to determine if landfill gas is migrating into or through natural clay soils surrounding the landfill. While drilling gas probes GP4 and GP5, refuse was encountered in the clay fill material. These soil borings were subsequently abandoned and gas probes GP4A and GP5A were drilled and installed in their present locations approximately 30 to 60 feet away from soil borings GP4 and GP5, respectively. The top of the gas probe screens were placed at approximately 5 feet below ground surface. The bottom of the screens varied from 16 to 26 feet below ground surface. Gas probe soil boring logs and construction diagrams are located in Appendix F.

The gas probe soil borings were drilled using 4 1/4-inch ID hollowstem augers and were continuously sampled using a 5-foot long CME sampling tube to the terminus of the borings. The gas probes were constructed using a washed pea gravel filter pack around a 2-inch ID schedule 40 PVC 0.020-inch slotted screen, with hydrated bentonite filling the annular space above the filter pack and around the PVC riser pipe (Appendix F). Locking protective casings were installed.

2.2.6 Downhole Geophysical Logging

Each of the leachate/gas wells installed by Warzyn were logged using natural gamma, neutron, gamma-gamma and fluid temperature downhole logging tools by Wooddell Logging Inc. on June 14, 19 and 20, 1993 (Figure 6). The natural gamma logging was used to assess the landfill structure; primarily to determine if intermediate clay cover layers exist within the refuse. The geophysical logs are located in Appendix G.

2.2.7 Leachate Sampling

Five leachate samples were collected by Warzyn from the leachate/gas wells (LP1, LP6, LP8 and LP11) and the leachate collection manhole East (MHE) on May 12 and 13, 1993 (Figure 6). Sampling was completed using a stainless steel bailer. Sampling equipment was decontaminated in accordance with the Sampling and Analysis Plan.

The leachate wells were sampled for TCL/TAL parameters and the following indicator parameters as listed in the PSER/TS and Table 1-3 of the QAPP.

Field temperature
Alkalinity
Field pH
Total hardness
Field specific conductance
Nitrate nitrogen
Field Eh
Nitrite nitrogen
Field dissolved oxygen
Ammonia nitrogen
Chloride
Total organic carbon
Sulfate
Total dissolved solids

The field parameters were measured using a Beckman pH meter; a YSI conductivity, dissolved oxygen, and temperature meter; and an Orion Eh meter. One duplicate sample and one field blank were collected during the leachate sampling. These QA/QC samples were analyzed for the TCL/TAL and indicator parameters as listed in the QAPP. Sampling and analysis was conducted according to the protocols listed in the QAPP and the Sampling Plan. The samples were analyzed by Warzyn and ETC laboratories. Analytical results are summarized in Appendices O-3 through O-7. Results of field parameter testing are summarized in Table 2-1.

2.2.8 Landfill Gas Sampling

Landfill gas samples were collected from the leachate/gas wells (LP1, LP6, LP7, LP8 and LP11) on June 4, 1993 to chemically characterize the landfill gas (Figure 6). The gas samples were collected using a Summa Passivated Sampling Canister after removing one well volume of gas and purging the Tygon tubing sampling line with an SKC pump. A trip blank and filtered duplicate were collected using this same method, as specified in the QAPP. Sampling and analysis was conducted according to the protocols listed in the QAPP and Sampling Plan.

The landfill gas samples were analyzed by ENSECO Laboratories for volatile organic compounds (VOC). Methane, oxygen and carbon dioxide concentrations were measured at the leachate/gas wells, as well as in perimeter gas probes GP3, GP4A and GP5A using a GEM 500 meter. Analytical results are presented in Appendix O-2.

2.2.9 Landfill Soil Borings

Six landfill soil borings (B1 through B5 and B2A) were drilled and sampled by E&F and Warzyn on April 23 through April 27, 1993 (Figure 4). These soil borings were drilled along the southern perimeter of the old landfill to assess subsurface conditions and evaluate the need for/feasibility of constructing a barrier slurry wall along the perimeter of the landfill to contain leachate. A geologic cross-section of the southern portion of the old landfill was completed using these soil borings to aid in the slurry wall evaluation (Figure 11- cross-section location; Figure 14 - cross-section C-C'). These borings were also used to estimate refuse volume and to aid in determining the extent and thickness of the surficial sand (Figure 17). Soil boring logs used in generation of cross-sections are included in Appendix S.

The soil borings were drilled with 4 1/4-inch ID hollow stem augers and continuously sampled with a 2-inch OD split spoon according to American Society of Testing and Materials (ASTM) Standards (ASTM:D 1586-84). Soil sample stratigraphy was visually classified in the field by a Warzyn geologist according to the Unified Soil Classification System (USCS). Soil boring logs are located in Appendix H.

One sample from each distinct stratigraphic unit was collected from each soil boring for geotechnical analysis which included grain size analysis, (sieve plus hydrometer) and Atterberg limits (to determine the liquid limit and plastic index) from samples collected from the clay-rich diamict. The diamict is defined as poorly to nonsorted sediment containing a wide range of particle sizes, regardless of sediment genesis. Results of the geotechnical analysis are located in Appendix I.

An OVM PID; an Industrial Scientific oxygen, hydrogen sulfide, and combustible gas meter; and a Monitox hydrogen cyanide meter were used to screen drill cuttings and the immediate atmosphere. Soils with PID readings above 5 parts per million (ppm), as well as all refuse material, were transported and placed into a on-site roll-off box container pending implementation of the source control remedy. Soils with a PID reading less than 5 ppm were left at the boring.

2.3 HYDROGEOLOGIC INVESTIGATION

The RI hydrogeologic investigation was performed to further evaluate subsurface and groundwater flow conditions. This investigation included eight additional borings and the subsequent installation of four additional water table monitoring wells and four additional deep sand and gravel aquifer wells (Figure 4). These new investigation points were used, along with the existing wells, to further define physical hydrogeologic characteristics (i.e., groundwater flow direction, hydraulic conductivity) and groundwater chemistry.

2.3.1 Evaluation of Existing Wells

The existing groundwater monitoring wells were inspected to confirm their integrity for the RI. This activity was performed by Warzyn during other RI field activities in order to determine the condition of the surface seals, protective casings and surface drainage from the wells.

The condition of the surface seals and protective casings were visually inspected to determine if any visible deterioration had occurred. Based on the visual observations the surfaces seals and protective casings, the monitoring wells appeared to be in satisfactory condition with the exception of monitoring wells US7S, US6S and US6D. The protective casing and concrete pad of US7S had frost heaved approximately 1 foot and would allow surface water to drain into the annular space. However, the construction of the well indicates that a 23 foot bentonite seal exists and it is unlikely that the integrity of this well would be significantly affected. The protective casing of US6D could not be secured due to a broken locking cover plate. The protective casing and concrete pad had subsided to a level which the stainless steel well riser pipe prevented the securing of the cover plate on US6S.

Standing water was observed around PELA wells installed in the wetland areas during various times of the year.

Total well depth and water levels measurements were also collected and used to determine the amount of siltation in the monitoring wells. However, many of the wells had permanent well wizard pumps installed in them and were not removed to obtain total depth measurements to avoid potentially contaminating the pumps and tubing. As such, these wells were assumed to be in adequate condition for the RI, since many of them are used for routine quarterly monitoring. The amount of siltation observed in the other wells was acceptable for the requirements of the RI with less than a foot of silt measured in the wells.

2.3.2 Monitoring Well Installation

Four new water table monitoring wells (W4S, W5S, W6S, and W3SA) and four new deep wells (W2D, W3SB, W3D, and W7D) were installed by E & F and Warzyn (Figure 5). These wells were installed in the locations specified in the PSER/TS with the exception of W1S and the W3S/W3D. An adjacent property owner would not allow WMII/Warzyn to install off-site well W1S which was to be located to the southeast of the landfill.

The PSER/TS stated that the monitoring well nest W3S/W3D would be placed south of the "old" landfill where previous borings suggested the clay diamict was thinnest. This nest was placed approximately 60 feet north-northwest of this location due to accessibility problems which included primarily the thawing wetland and the type of all terrain vehicle rig used, and the distance from the support areas (i.e. the nearest road). The existing location of the well nest was approved by all parties involved before drilling activities began.

The present location of the W3S/W3D well nest location should have a minimal effect on the results and conclusions. The bottom of the clay diamict in this area appears to be relatively flat and well W3D is screened close to the diamict in the deep sand and gravel. Based on the potentiometric surface maps, W3D is placed downgradient of the area where potential contaminant migration through the diamict and into the deep sand and gravel aquifer may occur.

The well borings, with the exception of W3SB and W3D, were drilled with 4 1/4-inch ID hollow stem augers and were continuously sampled with the Central Mine Equipment (CME) 5-foot long sampling tube and/or a 2-inch OD split spoon. Soil sample lithology was visually classified in the field by a Warzyn geologist according to the Unified Soil Classification System (USCS). Soil boring logs are located in Appendix J. Stratigraphic information from these borings, as well as the existing soil borings and wells, was also used to determine the extent and thickness of the surficial sand and the clay-rich diamict (Figures 17 and 18). Geologic cross-sections along the western and southern boundaries of the landfill were constructed to aid in determining the hydrogeology of the area (Figures 12 through 14). Soil boring logs used in generation of cross-sections are included in Appendix S.

The wells were constructed using a No. 30 sand pack around a 2-inch ID schedule 40 PVC 0.010-inch slotted screen, with a bentonite slurry mixture and/or hydrated bentonite filling the annular space above the filter pack around the PVC riser pipe. Locking protective casings were installed. The well construction diagrams are located in Appendix J.

Wells W2D and W7D were installed in the deep sand and gravel aquifer on April 17 and 13, 1993 respectively. Wells W2D and W7D were installed to measure potentiometric head, as well as to collect groundwater samples to monitor groundwater quality between the landfill and the private water supply wells located to the east of the Site (Figure 19 and Appendix B). Both wells were constructed with a five foot screen located approximately 5 feet below the base of the clay-rich diamict. Soil samples were collected from each of the Stratigraphically distinct surface deposits, clay-rich diamict, and deep sand and gravel zones of each boring. These samples were analyzed for grain size (sieve plus hydrometer), and samples collected from the diamict were also tested for Atterberg limits. A Shelby tube was also collected from the clay-rich diamict at each of these borings. The Shelby tube sample collected from soil boring W2D was analyzed for rigid wall hydraulic conductivity, total organic carbon, and porosity. The Shelby tube sample collected from W7D was not analyzed for these parameters according to the SAP, and was collected for back up purposes in case samples from W3D or W2D could not be analyzed.

Wells W3SA, W3SB, and W3D were installed on April 6, 7, and May 25, 1993, respectively, in the wetland area south of the old landfill. Wells W3SA and W3SB were screened in the surficial sand, while well W3D was installed through the clay-rich diamict and screened in the deep sand and gravel. This nest of wells was installed to assess the hydrogeologic continuity of the clay-rich diamict in this area and to evaluate the groundwater quality in the surficial sand and the deep sand and gravel.

Because the wetland is a semi-permanently flooded area, the water table is near or above the wetland surface. Therefore, the top of the well screen for well W3SA was placed below

the water table surface. The intermediate well W3SB was screened at the base of the surficial sand. The deep well W3D was screened in the deep sand and gravel.
Well W3SB was also drilled with hollow stem augers, but was continuously split spoon sampled starting from the completion depth of W3SA. Well W3D was installed using rotary wash drilling methods. The upper approximately 35 feet was drilled using 8-inch diameter tri-cone bit in order to install and cement grout a permanent 6-inch ID schedule 40 PVC casing in place approximately 5 feet into the clay-rich diamict (located approximately 30 feet below the ground surface). The casing was installed to minimize the potential for cross contamination of the deep sand and gravel aquifer and surficial sand during drilling operations. The rest of the boring was drilled using a 6-inch diameter tri-cone bit and was continuously split spoon sampled (with the exception of the 56 to 60 foot sampling interval) starting from the completion depth of W3SB.

One soil sample from the surficial sand was collected from well boring W3SB for grain size analysis, and one clay-rich diamict sample was collected from boring W3D for grain size analysis and Atterberg limits. A Shelby tube sample of the clay-rich diamict was also collected from boring W3D and analyzed for rigid wall hydraulic conductivity, total organic carbon, and porosity to evaluate the potential for fluid movement and attenuation of potential contaminants. Geotechnical analytical results are located in Appendix I.

Monitoring well W4S was installed on the west side of Sequoit Creek on the Quaker Industries property on May 26, 1993 (Figure 5) to confirm the lateral extent of the surficial sand and to evaluate the groundwater flow direction on the west side of Sequoit Creek. Well W4S was screened in the surficial sand and the screened interval intersected the water table.

Water table monitoring wells W5S and W6S were installed on April 21 and 16, 1993, respectively, adjacent to existing shallow U.S. EPA wells US4S and US5S, respectively, since wells US4S and US5S were screened below the water table. The new wells were screened across the water table to monitor potential contaminants at the water table surface. Two soil samples were collected from boring W5S and one from boring W6S for geotechnical analysis.

All of the new wells were developed according to the QAPP, most of them by removing at least 10 to 12 well volumes of groundwater using a decontaminated stainless steel bailer and cable. Wells W2D, W3D, W3SB and W7D were developed by removing at least the estimated volume of water that was lost into the formation during drilling plus ten well volumes. A Keck pump was used to develop W2D and W7D. Well development data is located in Appendix J.

2.3.3 Downhole Geophysical Logging

The new wells installed into the deep sand and gravel (W2D, W3D, and W7D), as well as, U.S. EPA wells US4D and US6D, also screened in the deep sand and gravel, were geophysically logged by Wooddell Logging Inc. on June 3 and 4, 1993. These wells, except for W3D, were logged using natural gamma, neutron, and gamma-gamma (or density) logging methods. Well W3D was logged using only the gamma logging tool due to time constraints in the field. The geophysical logging was performed to further assess the physical and hydrogeologic characteristics of the surficial sand, clay-rich diamict, and deep sand and gravel as an aid to correlating stratigraphy. The geophysical logs are located in Appendix G.

2.3.4 In-Situ Hydraulic Conductivity Testing

Single well in-situ hydraulic conductivity tests have been performed at the Site during previous investigations. Rising head hydraulic conductivity tests were repeated at wells US3S, US3D, US4S, US4D, US6S, US6D, and US1S. These locations were chosen to re-evaluate hydraulic conductivity of the surficial sand (wells US1S, US3S, US4S, and US6S) and deep sand and gravel (US3D, US4D, and US6D) near the southern boundary of the old landfill (US4S, US4D, US6S, and US6D) and near Village well No. 4 (US3S and US3D). Hydraulic conductivity tests were also performed at new wells (W4S, W5S, and W7D). The hydraulic conductivity tests were conducted by Warzyn during the period of June 2, 3, 4 and 9, 1993. The resultant data will be used in conjunction with existing hydraulic conductivity data to assess groundwater flow rates.

The tests were performed on the deeper wells by using a pressurization apparatus to depress the water level in the well. As the pressure was released, a pressure transducer and automatic data logger were used to record the resultant rise in water level. Water table wells were tested by quickly removing one bailer of groundwater from the well and recording the rise in the water level over time with a pressure transducer and automatic data logger. Hydraulic conductivity tests were analyzed using a PC-based aquifer analysis program (AQTESOLV). Tests performed on the water table wells were analyzed using the Bouwer and Rice method for unconfined aquifers. Tests performed on the deeper wells were analyzed using the Cooper method (confined conditions) and the Bouwer and Rice method (unconfined conditions). The Bouwer and Rice method provided a better curve match and therefore was used to estimate hydraulic conductivity. The results of the hydraulic conductivity testing are summarized in Section 3.7.2 and presented in Appendix K.

2.3.5 Groundwater Level Measurements

A full round of water levels were collected by Warzyn on June 8 and 9, 1993 and March 28, 1994 during the Supplemental RI activities (Section 2.10.4.2). Western Gulf Coast Laboratories, Inc. subsequently collected a round of groundwater levels during the period of August 18, 19, 20, and September 3, 1993, (see section 2.10.4.2 for additional information). Daily pumping rates for village wells VW3 and VW4 were obtained from the Village of Antioch for the months of June, September, October, and December 1993 and March 1994 (Appendix L). Water level measurements were obtained using an electronic water level indicator, decontaminated with a phosphate free Liquinox wash and rinsed with distilled water prior to collecting water level data and between wells.

The water levels obtained from June 1993, were used to calculate vertical hydraulic gradients, which were used to assess the hydraulic interconnection between the surficial sand and deep sand and gravel.

2.4 HYDROLOGIC EVALUATION

A hydrologic evaluation was completed to assess the connection between the groundwater in the surficial sand and the surface water in Sequoit Creek and to evaluate the potential for surface water contamination. The investigation included measuring surface water levels in Sequoit Creek, measuring flow in the creek, and observing the creek banks.

2.4.1 Surface Water Flow Measurements

Sequoit Creek flow measurements were obtained at the four staff gage locations (PSG1 through PSG4) on June 8, 1993 using a Gurley flow meter (Figure 4). Flow measurements were obtained at one foot spacings across the open channel of the creek at staff gage locations PSG1 through PSG3 and at two foot spacings at staff gage location PSG4. Prior to collecting the flow measurements, the creek banks were observed to determine their physical nature and vegetation type. This information was used to assess stream loss and gain and the hydrologic connection of Sequoit Creek to the surficial sand and associated wetland.

2.4.2 Surface Water Level Measurements

Surface water level measurements were obtained at existing staff gauges PSG1, PSG2, PSG3 and PSG4 and in the associated standpipes SC1A-D, SC2A-D, SC3B-D and SC4A-D prior to collecting flow measurement data. However, water level measurements collected from standpipe SC3D and SC4A were not used in the evaluation because broken casings made the measurements unreliable. The water levels were read directly from the staff gages and with a electric water level indicator in the standpipes on June 8 and 9, 1993. See Section 2.10.4.2 for additional surface water level measurements.

2.5 SOIL/SEDIMENT EVALUATION

A soil/sediment evaluation was conducted to assess the potential for contaminated surface soils and/or sediments. The investigation consisted of an observation of the Site, (including Sequoit Creek), and a hydrologic evaluation of the creek. Refer to Section 2.2.3 of Source Characterization, On-Site Surficial Soil and Sediment Sampling, for details on sampling locations.

A Site observation was performed to assess the potential for soil contamination. Soil sampling locations were identified based on the presence of leachate seeps, discolored soils and other visual observations. Proposed sampling locations were presented to U.S. EPA, for approval, prior to sampling.

2.6 AIR EVALUATION

Existing meteorological data is presented in Appendix M and provides regional wind direction, windspeed, temperature, and precipitation. The potential for air contamination has been assessed by others in the Baseline Risk Assessment.

2.7 HUMAN POPULATION EVALUATION

Information has been collected to identify, enumerate, and characterize human populations which could be exposed if contaminants were released from the Site. For a potentially exposed population, information will be collected on population size and location. As part of the Baseline Risk Assessment (submitted previously to U.S. EPA) these populations will be linked with the potential contaminants of concern (i.e., those that are mutagenic, teratogenic, etc.) to identify potential risk.

2.8 ECOLOGICAL EVALUATION

An ecological assessment was conducted on July 21, 1993 as described in the U.S. EPA "Region V Scope of Work for Ecological Assessments" which describes the following eight tasks:

- Task 1 - Characterize Site based on existing data and limited field work
- Task 2 - Prepare preliminary ecological assessment
- Task 3 - Prepared detailed Work Plan for further Site investigation
- Task 4 - Conduct Site investigation
- Task 5 - Revise Work Plan, conduct additional investigation
- Task 6 - Prepare summary of biological and chemical data
- Task 7 - Prepare draft Ecological Assessment Report
- Task 8 - Submit final Ecological Assessment Report

Tasks 1, 2, and 7 have been completed and are presented in a separate Ecological Assessment Preliminary Screening Report. The Ecological Risk Assessment was included in the Baseline Risk Assessment.

2.9 POTENTIAL MIGRATION PATHWAY/ CONTAMINANT CHARACTERIZATION

The objective of the potential migration pathway/contaminant characterization is to evaluate the magnitude and extent of contamination. Each potential migration pathway was evaluated including:

- Groundwater, including private residence wells and Village of Antioch water supply wells

- Surface water
- Sediments/soils
- Air

2.9.1 Groundwater

The following groundwater monitoring wells were sampled during the period of May 10, 11, 12, and 14, 1993 and were analyzed for U.S. EPA TCL/TAL parameters list and water quality indicator parameters list specified in the QAPP.

US1S and 1D	US6S, 6I and 6D
US3S, 3I, and 3D	W7D
US4S and 4D	G11S and 11D
W6S	W5S

Monitoring wells W4S, W3SB, and W3D were sampled on June 1, 1993.

These samples were analyzed to determine the nature and extent of potential contamination of the surficial sand and the deep sand and gravel.

As part of the sampling procedures, a minimum of three well volumes were removed before samples were collected from each well. The samples were collected, preserved and handled in accordance with the QAPP. Proper chain of custody procedures; quality control sampling; and sample labeling were also performed according to the QAPP. Temperature, pH, specific conductance, Redox, and dissolved oxygen were measured in the field. Analytical results are discussed in Section 4, Nature and Extent of Contamination.

2.9.2 Private and Village of Antioch Water Supply Wells

Arrangements were made by WMII and Warzyn to sample a number of Village of Antioch water supply wells and private residence wells sampled. Four of the five private residence well owners allowed samples to be collected from their wells (Figure 19):

- PW1 Anton and Margitta E. Kahler
  22731 West Silver Lake Avenue

- PW2 Kenneth Kull
  North Lakeview Drive

- PW3 Robert Lecki
  North Lakeview Drive

- PW4 Mrs. Darnell
  North Lakeview Drive
  (no sample collected - refused access)

- PW5 Gary and Ellen Hanenberger
  North Lakeview Drive

Private wells PW2, PW3, and PW5 were sampled on June 29, 1993. Private well PW1 was sampled on July 1, 1993. Private well PW4 was not sampled because the property owner would not allow access. Village of Antioch water supply wells VW3 and VW5 were also sampled on June 29, 1993 (Figure 7). Samples were analyzed for the TCL/TAL parameters list. The samples were collected, preserved and handled according to the QAPP. Village Well No. 4 was not sampled by Warzyn during the RI due to the following reasons. The PSER/TS stated that Village No. 4 would not be sampled since it was to be decommissioned. In addition, a significant volume of oil (more than 100 gallons) was present in the well when it was video logged. The oil present in the well may have biased the results of any sampling activity.

Three of the private residence wells (PW1, PW2 and PW5) were sampled from an outside faucet, while one private well (PW3) was sampled from an inside kitchen faucet. Once the water was determined not to be filtered or softened at the sampling point, the faucet was opened to purge water until the well pump was automatically activated. The water was then allowed to run for at least 15 minutes at which point the attached hose (PW1, PW2, and PW5 only) was removed and the samples were collected. Field pH, specific conductivity, and temperature were measured. The results of the private well sampling are presented in Section 4.

2.9.3 Surface Water Sampling

Surface water samples were collected on May 14, 1993 at three locations along Sequoit Creek: upstream at sampling location S101, near the bend in the creek at sampling location S201, and at the northwest corner of the Site, at sampling location S301 (Figure 10). The collected surface water samples were analyzed for the TCL/TAL parameters list.

The sampling was completed using a decontaminated stainless steel sampling pail. Samples were collected, preserved and handled according to the QAPP.

2.9.4 Sediment and Soil Sampling

Sections 2.2.3 and 2.5 describe the surface soil/sediment sampling locations and methods. These samples were collected and analyzed to characterize the surface soils/sediments and to determine potential contaminant migration pathways.

2.10 SUPPLEMENTAL REMEDIAL INVESTIGATION ACTIVITIES

Based on the RI results presented in Technical Memorandum Number 1 (Tech Memo) and the U.S. EPA's comments to the Tech Memo, additional investigation activities were deemed necessary to more fully characterize the contaminant source, the physical and migration pathways, and to further delineate suspected contaminant impact along pathways of concern. The following investigation activities were performed as part of the supplemental RI:

- Landfill Cap Inspection
- Sequoit Creek Sediment/Surface Water Sampling
- Abandon Well PZ2 and Install Replacement Well W8D
- Groundwater Monitoring Well Sampling and Water Levels
- Landfill Gas Readings

2.10.1 Landfill Cap Inspection

A landfill cap inspection was completed to provide additional information concerning the integrity of the cap as part of the landfill cap evaluation presented in Section 2.2.1. The condition of the landfill cover was visually observed during a walk-over evaluation conducted on March 23 and 24, 1994 by a Warzyn Soil Scientist and Geologist (Figure 20). The walk-over was performed to identify any physical irregularities or breaks in the cover. The landfill top was crossed on approximate 20-foot interval transects, and the side slopes were each individually walked and inspected. Cover features were noted in the field on an aerial photograph, and were later transferred to a base map of the site (Figure 20).

2.10.2 Sequoit Creek Sediment/Surface Water Sampling

Eight sediment and surface water samples were collected from Sequoit Creek on March 28 and 29, 1994. Sediment and surface water samples were collected from the three previous surface water sampling points: upstream at location S101; near the bend in the creek at location S201; downstream near the northwest corner of the landfill at location S301 (Figure 10). Two additional sediment and surface water samples were collected from the stream in the wetland area from Sequoit Creek staffgage locations PSG1 and PSG2 located between sampling locations S101 and S201 Three additional upstream sediment and surface water samples were collected. These samples were collected from Silver Lake at location S601 and from Sequoit Creek at location S501, located between sampling locations S101 and S601. The third upstream sample was collected from the "south branch" of Sequoit Creek, at location S401, which appears to be the primary discharge route for Silver Lake (Figure 10).

The surface water and sediment samples were collected using a stainless steel sampling pail and immediately transferred to appropriate sampling containers. Samples were collected, preserved and handled according to the requirements of the QAPP. The furthest downstream surface water sample was collected at the S301 location first then the sediment sample was collected. Sampling proceeded in this manner upstream until each of the samples had been collected. The surface water samples were analyzed for the TCL/TAL parameters list and field parameters pH, specific conductivity, temperature, oxidation/reduction potential and dissolved oxygen. Sediment samples were analyzed for TCL/TAL parameters.

2.10.3 Abandon PZ2 and Install Replacement Well W8D

A new monitoring well (W8D) was installed by Stearns Drilling Company and Warzyn (Figure 5) using a CME 850 track mounted drill rig. This well was installed as a replacement well for monitoring well PZ2 which appeared to, based on numerous elevated water levels, have a leaking well seal. The water levels may have been representative of the potentiometric head in the lower portion of the clay. In either case, the well was replaced. The purpose of this well is to collect accurate and representative water levels of the deep sand and gravel aquifer.

The boring was drilled with 4.25-inch ID hollow-stem augers to a depth of approximately 52 feet and continuously sampled to approximately 6 feet into the clay diamict. Samples were collected at two foot sampling intervals using standard split spoon methods (ASTM D1586-84). The boring was then reamed with 8.25-inch ID hollow stem augers to install and cement grout a 6 inch ID black carbon steel surface casing approximately 4.5 feet into the clay (Appendix J). The surface casing was installed to minimize the potential for leakage from the upper sand and gravel unit into the lower sand and gravel. The remainder of the boring was completed using rotary wash drilling methods with a 6-inch tri-cone roller bit to a completion depth of 99 feet. Samples were collected at two-foot continuous sampling intervals or five foot sampling intervals (Appendix J). The monitoring well was installed at a depth of 94 feet in the deep sand and gravel.

Soil samples were collected for grain size analysis from the three lithologic units; the surficial sand, the clay diamict and the deep sand and gravel. These samples were collected and analyzed to obtain information for comparison with the other geotechnical samples collected during the RI. Geotechnical analytical results are presented in Appendix I.

After the well was installed and allowed to remain undisturbed for two days, the well was developed by Stearns Drilling Company using a surge block to surge and purge the well for 30 minutes as required by the QAPP. Approximately 300 gallons of water was removed after surging using a rod pump until the water was fairly clear (Appendix J). Water levels were collected from the well after development to verify that expected water levels were observed to determine if appropriate well development was completed for adequate hydraulic communication with the well.

Monitoring well PZ2 was abandoned by Stearns Drilling Company and Warzyn on March 22, 1994 in accordance with the Lake County and Illinois Department of Public Health requirements. A Lake County Health Department representative was on-site to view part of the abandonment procedures and provide required documentation.

The well was abandoned by first removing the protective stick-up well box and then placing A-size drilling rods to the bottom of the well for stabilization while being overdrilled with 4.25 inch hollow stem augers. Once the augers were drilled to the completion depth of well PZ2 at 80 feet, the stainless steel well pipe was removed. A bentonite grout was then tremied from the bottom of the boring to the surface and was topped off as the augers were removed until the boring was completely filled with grout.

2.10.4 Groundwater Sampling and Water Levels

A second round of ground water samples were collected by Warzyn during the period of March 28 through 30, 1994 from the following groundwater monitoring wells and were analyzed for U.S. EPA TCL volatiles only.

- **Deep Sand and Gravel Aquifer Wells**
  US1D, US3D, US4D, US6D, W3D, and W7D

- **Shallow Wells**
  US1S, US3S, US4S, US6S, W3SB, W4S, W5S, W6S, G11S

- **Intermediate Clay Till Wells**
  US3I, US6I, G11D

These samples were collected and analyzed for comparison with the first round of sample results in determining the nature and extent of potential contamination of the surficial sand and the deep sand and gravel during the RI.

As part of the sampling procedures, a minimum of three well volumes were removed before samples were collected from each well. The samples were collected, preserved and handled in accordance with the QAPP. Proper chain of custody procedures; quality control sampling; and sample labeling were also performed according to the QAPP. Temperature, pH, specific conductance, redox, and dissolved oxygen were measured in the field . Analytical results are discussed in Section 4, Nature and Extent of Contamination.

2.10.4.1 Village of Antioch Well Sampling. Arrangements were made by Warzyn to have Village of Antioch water supply wells sampled. Village wells VW3, VW4, and VW5 were sampled on March 31, 1994. The groundwater samples collected from the village wells were analyzed for low level TCL volatile organic compounds. The samples were collected, preserved and handled according to the QAPP.

Field measurements of pH, specific conductivity, and temperature were measured in the field. The results of the village well sampling are presented in Section 4.

2.10.4.2 Water Levels. A full round of groundwater levels were collected from the monitoring wells, standpipes and surface water staffgages by Warzyn on March 28, 1994. A round of liquid levels were also collected from the leachate piezometers. Bimonthly water levels have been collected by Weston Gulf Coast Laboratories, Inc. and EMT since August 1993. Daily pumping rates for the village wells VW3 and VW4 were obtained from the village of Antioch for the months of March, 1994 and June, September, October, and December 1993 (Appendix L). Water level measurements were obtained using a electronic water levels indicator. Water levels were measured approximately two to three times to verify that the water levels in the wells were in equilibrium with atmospheric pressure.

This round of water levels, as well as, the water levels collected by Weston and EMT were used to determine groundwater flow characteristics of the water table, the surficial sand, and the deep sand and gravel aquifer. These water were also used to obtain the influent/effluent potential of Sequoit Creek. Pumping rate information from the village wells was considered in evaluating observed groundwater flow conditions.

2.10.5 Landfill Gas Readings

Landfill gas screening measurements were obtained from each of the on-site shallow monitoring wells (except for well US7S) and perimeter landfill gas probes to determine if landfill gas is migrating out of the landfill into subsurface media. The gas readings were obtained using health and safety air monitoring instruments. The Industrial Scientific meter was used to measure percent oxygen and percent LEL. The Gastech meter was used to measure percent gas (i.e. percent methane). The measurements were collected for screening purposes only by inserting the probe or Tygon tubing attached to the instrument into the well and directly reading the measurements from the instrument.

PMS/dlp
J:\2386\0096\RI_FINAL\RI_TEXT\SECTION2.DOC

3

3.0 SITE PHYSICAL CHARACTERISTICS

3.1 LANDFILL CHARACTERISTICS

The landfill characteristics evaluation consisted of a landfill cap observation and evaluation; a determination of the landfill structure/refuse characteristics; and, an analysis of landfill gas composition and potential migration.

3.1.1 Landfill Cap Inspection

The cover walk-over identified erosional rills and gullies, wet areas, bare spots, leachate seeps, gas venting, and surface water sheens, as identified on Figure 20. The erosion rills and gullies varied in size from several inches to approximately one foot in both depth and width, and were in various areas on the cover. Wet areas consisted of inundated and/or saturated soil, were diverse in size and shape, and appeared to be concentrated in the depressional areas and side slopes of the cover. Bare spots, where no vegetative growth was observed, were scattered across both portions of the landfill cover.

The leachate seep and the gas venting areas were observed along the south side slope of the new landfill. The leachate seep was at the bottom of an erosional gully approximately two-thirds of the way up the side slope, and was surrounded by reddish orange soil. Gas venting could be observed in areas of the cover bubbling through saturated soils.

A sheen was observed on surface water in two areas on the north portion of the new landfill. It could not be determined if this sheen was associated with the landfill or organic matter decay. Additionally, an area of what appeared to be exposed garbage was noted north of the old landfill.

In addition to the items noted on Figure 20, numerous animal burrows were observed across the landfill, especially in the western and southern side slope areas adjacent to Sequoit Creek.

3.1.2 Landfill Cap Physical Observations and Cap Evaluation

Based on information obtained during excavation of test pits (TP1 through TP10) and drilling of boreholes for installation of leachate piezometers (LP1 through LP14), the landfill cover thickness ranges from 49 inches to 87 inches. Based on 75 cover probes drilled by TSC between July 1989 and February 1991, the cap thickness is at least 4 ft thick along the sides of the landfill. Documentation of the cover probes is provided in Appendix C7 of the PSER/TS. The apparent low permeability layers (homogeneous and undisturbed with no structure and no root penetration) ranged from 6 to 14 inches thick on the old portion of the landfill, and from 25 to 63 inches thick on the new portion of the landfill. Remnants of the former landfill cap were observed in the lower profile of the old portion of the landfill, beneath the apparent low permeability layer. Some of the remnants appeared to have been scraped off the former upper profile (although roots were still evident) prior to placement of the new cap, while others had relatively intact, undisturbed, profiles. Refuse was generally encountered below the low permeability layer on the new landfill. No fissures or deformities were observed in any of the apparent low permeability layers. Appendix C contains the test pit logs.

The clay content of the cap consists primarily of illite, with small amounts of scattered iron-chlorite and smectite, based on X-ray Diffraction Analysis performed on samples from the test pits (Appendix D). Illite is a 2:1 layer silicate that is a non expanding clay; therefore, it has a very low shrink/swell capacity. Iron-chlorite and smectite are also 2:1 layer silicates; however, iron-chlorite is a partially expanding clay, and smectite is an expanding clay, so their shrink/swell capacity is higher than that of illite.

Grain size analysis and Atterberg limits tests (Appendix D) identified the apparent low permeability layer materials as lean clay (CL) with trace to some sand and trace gravel. Natural density tests (Appendix D and Table 3-1) resulted in densities ranging from 105.7 to 128.3 lbs/cu ft. When compared to the maximum density calculated from the Modified Proctor tests (Appendix D and Table 3-1) this results in a level of compaction ranging between 87 to 92 percent. Natural moisture content (Appendix D and Table 3-1) ranged between 13.7% and 33.6%, with all but test pit TP9 falling below 24%. However, natural moisture content measured from the Shelby tube sample collected from test pit TP9 was 14.5%.

Based on the test pit data, the landfill cover appears to be continuous and composed of clay in both the new and the old sections of the landfill. The general profiles for each section were similar in the order of the basic layers that make up the cover, although each layer was encountered at varying depths and was of varying thicknesses. The Boutwell unit installations confirmed this in each locations with the exception of the unit installed by TP-1, where the cover material in the immediate area was variable. The variability is discussed below.

Vertical hydraulic conductivity of the landfill cap was estimated by Boutwell testing and laboratory testing. The boutwell results indicate that the cap contains a clay layer of low permeability with typical conductivities in the 10^{-8} cm/sec range. Results are contained in Tables 3-1 and 3-2. Boutwell test tabulations and conductivity plots are contained in Appendix D.

Based on TP9 test pit data and the test pit TP9 laboratory falling head permeability test of 3×10^{-8} cm/sec, the physical characteristics of the apparent low permeability layer are consistent with the observations for other test pits. The test pit data shows soil structure and apparent low permeability layer thickness similar to most of the other test pits on the landfill; therefore, its conductivity should also be similar. The laboratory falling head permeability test confirms this in similar conductivity results as the other three laboratory falling head permeabilities. The Boutwell results are not considered representative of the low permeability layer.

At test pits TP8 and TP9, Boutwell tests were conducted in the soils above the apparent low permeability layer, and so the hydraulic conductivities are representative of the soil materials above the apparent low permeability layer. The laboratory test samples were collected from the low permeability layer and these results are consistent with observations for other laboratory test samples of the apparent low permeability layer collected from other test pits are the site.

3.1.3 Landfill Structure/Refuse Characteristics

Refuse thickness data was obtained from the newly installed leachate piezometers/gas wells and the landfill soil borings (Table 3-3). Cap thickness was determined from the test pits and the previously existing gas well flare logs, as well as the leachate piezometers and landfill borings. Warzyn test pit, leachate piezometer and soil boring logs are located in Appendices C, E, and H respectively.

The refuse thickness in the old landfill ranged from 12 feet in leachate piezometer/gas well LP13 to 36 feet in leachate piezometer/gas well LP4. The refuse thickness in the new landfill ranged from 35.5 feet in leachate piezometer/gas well LP6 to 63.5 feet in leachate piezometer gas well LP8. Based on refuse thickness data, the overall volume of refuse in the landfill was estimated to be approximately 1.5 million cubic yards. Refuse thickness ranged from 3.3 feet in landfill soil boring B1 to 12 feet in boring B5, located along the southern boundary of the old landfill. Geologic cross-section C-C' shows the southern portion of the old landfill structure with respect to the natural geology of the area (Figure 14). Cross-sections D-D' (Figure 15) and E-E' (Figure 16) transect the landfill in east-west and north-south directions, respectively. The locations of these cross-sections in plan view is shown on Figure 11.

The geophysical logging was also used to assess landfill structure. Primarily, the logs were used to determine if intermediate clay cover layers exist within the refuse. The presence of these clay layers would affect movement of leachate within the landfill and ultimately influence the effectiveness of any leachate collection system. The geophysical logs are presented in Appendix G. The geophysical logs did not suggest that distinct intermediate clay cover layers were present.

The basal material underlying the refuse in the northern portion of the old landfill and underlying the entire new landfill, based on drilling conducted during the RI, consists primarily of gray silty clay. However, refuse in the southern area of the old landfill was underlain by peat and/or sand in leachate piezometers LP12, LP13, and LP14 and in landfill borings B1 through B5 (Appendix E and H, Figure 4). Peat material was detected in leachate piezometer LP11. The basal material in leachate piezometer LP3 was a clayey silt and sand material. Because sand and/or gravel was not encountered in leachate piezometers LP4 (northeast of LP3), LP10 (south of LP3) or LP11 (southeast of LP3), the occurrence of sand/gravel in LP3 is considered an isolated "lens". A physical description of each sub-refuse material is located on the leachate piezometer logs in Appendix E.

3.1.4 On-Site Landfill Gas Assessment

To perform the on-site landfill gas assessment, data was collected from the leachate piezometer/gas wells (LP1, LP6, LP7, and LP11) and the three perimeter gas probes (GP3, GP4A, and GP5A). A discussion of landfill gas quality (presence of VOCs) is presented in Section 4.2.

Landfill gas is being produced and is being vented through a system of wells fitted with flares. The field measurements of methane, oxygen and carbon dioxide collected from the leachate piezometers/gas wells and the perimeter gas probes are summarized in Table 3-4. Consistent levels of methane, carbon dioxide and oxygen were observed in the gas wells located in the new landfill (LP6, LP7 and LP8). Methane concentrations ranged from 65.4% in gas well LP7 to 67.7% in gas well LP6; carbon dioxide concentrations ranged from 31.1% in gas well LP8 to 34.4% in gas well LP7; and, oxygen levels were only 0.1% due to displacement of oxygen by the methane and carbon dioxide.

Concentrations of these compounds in gas well LP11 located in the old landfill (72.3% methane, 26.7% carbon dioxide and 0.1% oxygen) were consistent with the samples collected in the new landfill. However, the field measurements at gas well LP1 indicated atmospheric levels of oxygen at 20.5% and carbon dioxide at 0.4%. Methane was not detected in gas well LP1. No landfill gases were detected in the three perimeter landfill gas probes; only atmospheric concentrations of oxygen ranging from 20.8% to 20.9% were detected.

The supplemental RI gas readings from the on-site monitoring wells W5S and G102 indicates that landfill gas is migrating out of the landfill in the southwest corner of the old landfill. Measurements of percent methane and percent LEL were detected at concentrations of 20 %, and 100% in monitoring well W5S, in which the water level is below the top of the well screen (Tables 1-5, 3-4, and 3-5). Similar concentrations of these screening results were detected in monitoring well G102 at 20% and 170%, respectively.

The landfill cap inspection noted landfill gas was escaping through the cap in certain areas. The release of landfill gas through the subsurface and though the cap indicates that landfill gas being generated is not being sufficiently controlled by the venting system

3.1.5 Landfill Hydraulics

Leachate is pumped from MWE, MHW, P1, P8, P9, and P10 in an attempt maintain the leachate head levels within the landfill to two (2) feet below the water elevation simultaneously measured in G11D. The water level elevation in G11D, which is screened in the clay below the surfical sand, is typically lower than that in wells screened in the surficial sand. This leachate maintenance level reduces the differential potential hydraulic head, which is the driving force for leachate to migrate out of the landfill. The buildup of leachate in the landfill indicates that more water has entered the landfill than has exfiltrated the landfill. This situation of leachate buildup is typically due to the presence of low permeability materials at the base of the landfill. Groundwater elevations measured in

G11D are used as a datum for comparing to leachate elevations, and thus measuring the effectiveness of leachate collection.

Leachate removal did not begin until 1987. Based upon 1993 records, an average of 37,500 gallons of leachate is removed each month, for a yearly removal estimate of 450,000 gallons. One inch per year of net infiltration into the landfill results in the generation of approximately one million gallons of leachate. This indicates that the leachate levels would continue to rise at this pumping rate unless leachate exfiltrates to groundwater or exits through surface seeps. The value of one-inch per year of net infiltration was obtained from the Hydrologic Evaluation of Landfill Performance (HELP) model. The results of HELP modeling, in addition to assumptions used for modeling, are presented in Appendix Q.

Leachate elevations and thickness of saturated refuse based upon leachate piezometers LP1 to LP14 are presented in Table 3-6. The leachate elevations did not vary more than a few feet over the measurement period. The following discussion of landfill hydraulics is based on leachate and groundwater measurements obtained on March 28, 1994. Leachate elevations in the old landfill range from 764.57 feet msl at leachate piezometer LP13 to 772.15 feet msl at leachate piezometer LP4 prior to pumping. Leachate elevations in the new landfill range from 760.82 feet msl at leachate piezometer LP5 to 779.37 feet msl at leachate piezometer LP6 prior to pumping. The leachate level measurements do not show an increasing trend, so it is possible that approximately 0.65 inch of leachate (based upon one inch of net infiltration) is potentially contributing to leachate seeps and exfiltration to groundwater.

The WMII pump test conducted at MHE indicated that the leachate cannot be continuously extracted at a 30 gpm to 40 gpm rate beyond the system storage capacity (i.e., manhole, lateral piping, gravel bedding) (Appendix N). After removing the leachate from storage, the manhole went dry and recharged at a slow rate. Based upon refuse porosity estimates ranging from 0.38 to 0.52, the leachate volume in the landfill ranges from 69 million gallons to 96 million gallons.

Surface seeps and wet areas in the cap indicate that the combination of pumping the manholes and the leachate piezometers has not sufficiently reduced the leachate levels throughout the landfill. At one inch of annual infiltration, the leachate collection system is approximately 45% efficient at removing the annual infiltration. The leachate elevations measured in LP1 to LP14 indicate that the current rate of leachate removal does not result in an increasing or decreasing trend in the leachate elevations.

3.2 CLIMATE

The Site is located within a continental climatic belt characterized by frequent variations in temperature, humidity and wind direction. The average daily minimum temperature is 15° F in January and the average daily maximum temperature is 83° F in July. The average annual precipitation is 32.5 inches. The wettest months are April through September (USDA, 1970). Meteorological data is presented in Appendix M.

3.3 PHYSIOGRAPHY

The Site is situated within the Valparaiso Morainic System (Willman, 1975). The topography of the area is generally characterized by gentle slopes with poorly defined surface drainage patterns, depressions, and wetlands. The maximum relief in Lake County is 340 feet.

The topography in the vicinity of the Site is generally flat. The most prominent topographic feature in the area is the landfill. The maximum elevation of the landfill is approximately 800 feet mean sea level (MSL). The elevation of Sequoit Creek is approximately 762 feet MSL. Maximum ground surface relief at the Site is approximately 40 feet.

3.4 SURFACE HYDROLOGY

Surface drainage around the Site is generally toward the Fox River, located approximately 5 miles to the west. Locally, surface water flows from the Site toward Sequoit Creek. Sequoit Creek originally flowed northwest from Silver Lake to a point that is now the approximate center and northern boundary of the Site, where it then flowed west toward the Village of Antioch. However, Sequoit Creek was rerouted to flow west from Silver Lake along what is currently the southern boundary of the Site sometime between 1964 and 1967 (Figure 1). At the southwestern corner of the landfill, the creek was routed to flow north along the western boundary of the Site. Approximately 250 feet north of the northwestern corner of the Site, the creek flows toward the west approximately 2 miles before discharging into Lake Marie. Lake Marie eventually discharges to the Fox River. Based on aerial photographs and a 1960 USGS topographic map of the Site area, the eastern portion of the Site was shown as a wetland prior to landfill development.

Currently Sequoit Creek flows from Silver Lake by way of two stream channels which join west of staffgage PSG1. The stream then proceeds through a wetland along the southern portion of the site (Figure 2). The surficial sand unit located at the site underlies the northern portion of the wetland. Based on visual observations during the supplemental RI activities, stream flow from the southern channel or "south branch" of Sequoit Creek appeared to provide much of the stream flow for Sequoit Creek in this area. However, the wetland area also discharges groundwater and surface water to Sequoit Creek as it flows through it.

Water levels collected from the staff gages located in Sequoit Creek and the stand pipes located along Sequoit Creek from June 1993 to April 1994, as well as the information collected during the stream flow measurements, were used to assess the groundwater-surface water hydrologic relationship between the Sequoit Creek and the surficial sand. The water level measurements at staff gages PSG1 through PSG4 located in Sequoit Creek and their associated stand pipes (SC1A and B), (SC2A, B, C, and D), (SC3B, C, and D), and (SC4A, B, C and D), respectively, are summarized in Table 3-5. The Sequoit Creek flow measurement results are located in Table 3-7.

The stream flow measurements collected at the four staff gage locations were used to calculate total discharge rates of surface water flowing in Sequoit Creek (Table 3-7). The results of the stream flow measurements from the staff gages located along stretch of Sequoit Creek that flows through the surficial sand (PSG1 through PSG3), indicated that stream discharge was increasing from no measurable flow located at staff gage PSG1 to approximately 3 cubic feet per second (ft^3/sec) at staff gage PSG2, then to approximately 6 ft^3/sec at staff gage PSG3. Discharge then decreased slightly to approximately 5 ft^3/sec at staff gage PSG4 located in the stretch of the creek that is flowing primarily over the clay till material outside of the limits of the surficial sand.

Based on the results of the water level elevations of the staff gages and stand pipes during the period from June 1993 to April 1994, Sequoit Creek was gaining (effluent) and losing (influent) at staff gage location PSG1, gaining (effluent) at staff gage PSG2 and PSG3 within the surficial sand (Tables 3-8 through 3-10). This indicates that the area near staffgage PSG1 in Sequoit Creek is a groundwater recharge area to the surficial sand during various times of the year and at other times groundwater discharges to the creek. Stream water from the "south branch" of Sequoit Creek provides input to the increased discharge from staff gage PSG1 to staff gage PSG2. Sequoit Creek was a gaining stream along the stretch of the stream between PSG2 and PSG3 where measured stream flow discharge was increasing. Based on the groundwater levels observed in the stand pipes with respect to the staff gauges located along Sequoit Creek, groundwater adjacent to and below the creek was observed to have vertically upward and horizontal components of flow discharging primarily into the creek under low hydraulic gradients at staffgage PSG2 and PSG3.

Sequoit Creek was a losing (influent) stream at staff gage PSG4 where the measured stream discharge had decreased by 1 ft^3/sec (Table 3-7 and 3-11). The calculated decrease in the stream discharge measurements from staff gage location PSG3 to PSG4 could be reflective of the stream gauging method used at the site. The measured water levels at staff gage PSG4 indicated that Sequoit Creek was discharging surface water to the underlying stream bed materials, and the stream loss could be reflective of this.

The hydraulic relationship between Sequoit Creek and the surficial sand is dependent on the relationship between the groundwater elevations in the underlying surficial sand relative to the surface water levels in Sequoit Creek. At the upstream area, in the vicinity of staffgage PSG1, within the wetland, the stream is gaining and/or losing depending upon the hydraulic conditions (Figure 4). From staff gage PSG2 to PSG3 along the southern portion of the old landfill within the wetland, Sequoit Creek was observed to be a gaining stream, where groundwater from the surficial sand discharges to the stream. North of staff gage

PSG3 to PSG4, Sequoit Creek is no longer underlain by the surficial sand, but is underlain by the clay rich diamict.

3.5 SURFACE SOILS

The following surface soil types were present at the site prior to site development, and may still be present in undeveloped areas.

- Houghton muck, wet
- Morley silt loam
- Zurich silt loam
- Peotone silty clay loam
- Peotone silty clay loam, wet
- Mundelein silt loam
- Miami silt loam.

The Houghton muck and Peotone silty clay loam are classified by the USDA Soil Conservation Service (SCS) as hydric soils. The Zurich silt loam and Mundelein silt loam are non-hydric soils that may contain hydric inclusions. The distribution of pre-development surface soils is illustrated on Figure 23. A brief description of each soil type follows.

The **Houghton** series consists of deep, level to depressional, very poorly drained organic soil that formed in fibrous plant remains deposited in swampy areas. The Houghton muck generally receives run off from surrounding uplands and is subject to ponding. The water table is at or near the surface most of the year.

The **Morley** series consists of deep, gently sloping to steep, well drained to moderately well drained soils that formed in thin silty deposits in the underlying calcareous glacial till. The Morley silt loam is generally found on tops of morainic ridges.

The **Zurich** series consists of deep, level to moderately steep, well drained to moderately well drained soils that formed in 2 to 3 feet of silty material and the underlying calcareous stratified silt and sand. The Zurich loam is found on outwash plains.

The **Peotone** series consists of deep, level to depressional, very poorly drained soils that formed in thick silt and clay, water deposited materials. These soils are in low areas throughout the county. The Peotone silty clay loam, wet, is subject to ponding from water that runs off surrounding uplands. The water table is at or near the surface most of the year. The Peotone silty clay loam is also subject to ponding, but is drained artificially.

The **Mundelein** series consists of deep, level to gently sloping, somewhat poorly drained soils that formed in 2 to 3 feet of silty material over calcareous stratified silt and sand. The

Mundelein silt loam occurs on outwash plains mainly in the valley of the Des Plaines River.

The **Miami** series consists of deep, gently sloping to strongly sloping, well drained to moderately well drained soils that formed in thin silty deposits and the underlying calcareous glacial till. The Miami silt loam is generally found in morainal areas.

3.6 REGIONAL HYDROGEOLOGIC SETTING

3.6.1 Regional Geology

3.6.1.1 Unconsolidated Deposits. The bedrock surface in Lake County is completely overlain by thick sequences of glacial deposits. These unconsolidated deposits exhibit evidence of multiple episodes of glacial advances and retreats of late Wisconsinian glaciation. The surface topography of the area is characterized by a series of parallel, onlapping moraines and intermorainal valleys. This morainal complex is composed of deposits of the Wadsworth Till Member of the Wedron Formation. Deposition of the Wadsworth Till represents the last retreat of the Joliet Sublobe of the Lake Michigan Lobe (Willman et.al., 1975). The moraines decrease in age toward the east and are onlapped by lacustrine deposits of the Lake Chicago plain. Figure 25 presents a generalized stratigraphic column, which summarized the glacial geology in the Site vicinity.

Approximately 90 to 325 feet of Woodfordian age glacial deposits overlie bedrock in northeastern Illinois. The Wadsworth Till Member of the Wedron Formation is the primary unconsolidated deposit in Lake County and ranges in thickness from 5 to 150 feet. The Wadsworth Till Member is underlain sequentially by the Haeger Till Member and Tiskilwa Till Member. The Tiskilwa Till Member overlies the Racine Dolomite. A regional geologic cross section is presented on Drawing 10010201-F3. The glacial deposits are discussed in order of deposition in the following paragraphs.

A reddish-gray, silty clay till (Tiskilwa Till Members) overlies the Racine Dolomite in the region. This till unit is generally regarded as the lowermost member of the Wedron Formation that is present in the area (Willman, et.al., 1975). The unit is interpreted to be basal till probably deposited by lodgement (Johnson, et. al., 1985). The Tiskilwa Till Member consists of a lower unit consisting of a sandy silt with clay and a massive main unit which consists of approximately equal percentages of sand, silt and clay. No Site borings have penetrated this unit.

In the vicinity of Antioch, the Tiskilwa Till Member is overlain by the Haeger Till Member of the Wedron Formation. The Haeger Till Member was deposited by the Harvard Sublobe of the Lake Michigan Lobe, is laterally extensive and consists of sand and gravel outwash deposits with some clay rich diamicts present. Outwash and till deposits of the Haeger Till Member outcrop locally along the western edge of Lake County and westward into McHenry County (see Drawing 10010201-F3).

The Wadsworth Till Member overlies the Haeger Till Member. The Wadsworth ice of the Joliet Sublobe advanced westward across Lake County entraining recently deposited lake sediment and Paleozoic shales and limestone, resulting in a clay-rich debris load. The ice advance terminated near the Chain of Lakes lowlands. As the ice retreated the clay-rich load was deposited as the Wadsworth Till. The Wadsworth Till is characterized by gray, fine-grained clay rich diamict, and interbedded, sorted silts, sands and gravels. Diamict is defined as poorly to nonsorted sediment containing a wide range of particle sizes, regardless of sediment genesis. The diamict is laterally extensive and is present near the surface in most of Lake County.

3.6.1.2 Bedrock Geology. Lake County is located along the northeastern flank of a *northwest/southeast tending structural high known as the Kankakee Arch.* The bedrock surface of northeastern Illinois varies in depth from 90 to 325 feet below the ground surface (Woller and Gibb, 1976). The bedrock surface dips gradually toward the east and exhibits an uneven surface as the result of pre-glacial erosion.

Throughout most of Lake County, the uppermost bedrock unit is the Silurian dolomite of the Niagaran Series. This dolomite unconformably overlies Upper Ordovician, Maquoketa Group shales, and ranges in thickness from 0 to 270 feet. The Maquoketa Group is the uppermost bedrock unit in small isolated areas along the western portion of the county. The Maquoketa Group ranges in thickness from 100 to 240 feet and consists primarily of thick non-water-bearing shales. The Maquoketa Group is underlain by a sequence of Cambrian and Ordovician sandstones and dolomites which, in turn, overlie Precambrian granite rock. Bedrock stratigraphy is summarized in Figure 24.

3.6.2 Regional Hydrogeology

There are three major aquifers in northeastern Illinois:

- Unconsolidated deposits of glacial origin (such as the deep sand and gravel at H.O.D.).
- The shallower dolomite aquifer of Silurian age
- The deep Cambrian-Ordovician aquifer

3.6.2.1 Unconsolidated Deposits. Sand and gravel deposits, which occur as confined, semiconfined and unconfined aquifers associated with the unconsolidated glacial deposits are fairly extensive throughout Lake County. The majority of the confined units are located in the western portion of the county. Many residential wells in the Antioch area, and the Village of Antioch's public water supply system, obtain groundwater from glacially derived sand and gravel deposits. The deep sand and gravel is confined in the area of the site. The deep sand and gravel (Haeger Till Member) used by the Village of Antioch and nearby private water supply wells, is recharged in the Fox River Valley, located approximately 4 to 5 miles west of the Site. The unit is present near ground surface in the Fox River Valley area and water from precipitation, lakes, and the Fox River can enter the sand and gravel (Drawing 10010201-F3). Groundwater within this unit flows from this recharge area to the east toward Lake Michigan.

Depths of wells in the sand and gravel are generally less than 140 feet. The highest yielding sand and gravel wells (greater than 500 gpm) are generally located in major valley systems. The generalized stratigraphy of the unconsolidated deposits in northern Illinois is shown on Figure 25.

3.6.2.2 Bedrock Hydrogeology. Groundwater producing units in the deep Cambrian-Ordovician aquifer include the Galena-Platteville Dolomite, Glenwood-St. Peter Sandstone, Ironton-Galesville Sandstone, and Mount Simon Sandstone. The Mount Simon is sometimes considered a separate aquifer because it is separated from the overlying Ironton-Galesville Sandstone by the Eau Claire Shale aquiclude. The shallower dolomite aquifer is separated from the deeper aquifers by the Maquoketa Shale. In some locations, the deeper sand and gravel directly overlie the shallower dolomite aquifer and the two units are hydraulically connected. The generalized stratigraphy of rocks in northern Illinois are shown on Figure 24.

Of the bedrock aquifers, the Silurian dolomite is the primary source of groundwater in Lake County. However, the sand and gravel aquifers provide only slightly less groundwater than the bedrock aquifers (Woller and Gibb, 1976). The yield capacity of the Silurian dolomite aquifer varies depending upon interconnection of fractures and aquifer thickness (Woller and Gibb, 1976). The aquifer is recharged by the downward migration of water from the overlying glacial deposits where sand and gravel deposits are in contact with the bedrock surface.

The depth of wells in the deep aquifer averages about 1,300 feet, and many of the wells yield over 700 gpm. Wells in the shallow dolomite are set to an average depth of about 300 feet.

3.7 SITE HYDROGEOLOGIC SETTING

3.7.1 Site Geology

The Site area is underlain by differentiated deposits of sand, gravel, and silty clay. Soil boring and monitoring well locations are shown on Figure 4. Results of grain size analyses, Atterberg limits testing, TOC analyses, and permeability testing conducted on soil samples during the RI are presented on Table 3-12. Results of soil testing conducted prior to the RI are presented on Table 3-13.

The unconsolidated deposits encountered in borings drilled at the Site consist of a depositional sequence of till and outwash deposits associated with the surficial Cahokia alluvium (Holocene) and underlying Wadsworth and Haeger Till Members of the Wedron Formation. The unconsolidated deposits are divided into four distinct depositional units, in order of increasing depth and age:

Surface soils

- An elongated surficial sand deposit (that includes deposition within the Wadsworth Till Member and post glacial sand) of limited vertical and lateral extent which is present near the southern boundary of the landfill
- A clay-rich diamict (Wadsworth Till Member)
- A deep sand and gravel (Haeger Till Member).

A conceptual representation of glacial stratigraphy as it relates to Northern Illinois is shown on Figure 25. Each of these four units is discussed individually in the following paragraphs. Geologic cross-sections depicting Warzyn's interpretation of the glacial deposits underlying the site are presented in Figures 12 through 14. Figure 11 shows the locations of the geologic cross-sections.

3.7.1.1 Surface Soils. Natural surface soils encountered during the RI included 1 to 1.5 feet of reddish to black topsoil formed as weathered surface of the clay diamict in borings W2D and W7D (Appendix J). Five feet of peat and organic rich clay and silts were found overlying the surficial sand in soil borings drilled in the wetland area (W3SA and W6S). The peat and organic rich clays are representative of fine-grained post-fluvial environments such as wetland or overbank deposits. Four feet of fill (disturbed soil) was also observed overlying 4 feet of peat in soil boring W4S and overlying surficial sand materials in soil boring W5S. See Section 3.5 for a description of natural surface soils underlying the landfill.

3.7.1.2 Surficial Sand. The surficial sand is present only along the southern portion of the site and is not used for public or private water supply. It exhibits an elongated east-northeast to west tending geometry (Figure 17). Structurally the surficial sand thickens from its furthest lateral extent toward the center line of the deposit, reaching its thickest point of 54 feet at soil boring LB4A south of the old landfill (Figure 17). The surficial sand was not observed in the northern portion of the landfill (Figure 17). However, the sandy materials observed in LP3 is considered an isolated lens due to the lack of evidence of sand in LP10 and LP4. Geologic cross-section B-B' (Figure 13) illustrates the extent of the deposit from a north-south perspective. As shown on geologic cross-section C-C' (Figure 14), the surficial sand underlies refuse in the southern portion of the old landfill. Geologic cross-section A-A' (Figure 12) illustrates the vertical extent of the surficial sand along the southern portion of the old and new landfill.

The surficial sand generally consists of light brown to gray, fine to coarse grained sand, with varying amounts of gravel, silt, and clay. The USCS classification of the surficial sand samples collected from the borings drilled during the RI is SM: a silty sand, sand silt mixture (Table 3-12). A total organic carbon content of 11.7% was detected in a sample collected from soil boring W5S (7-9 ft depth).

3.7.1.3 Clay-Rich Diamict. The clay-rich diamict is a laterally extensive deposit which contains various amounts of sand, gravel, and silt mixed in a matrix of clay, which contains discontinuous layers and lenses. The clay-rich diamict is present beneath most of Lake County and its regional extent is shown on Drawing 10010202-F3. The clay-rich diamict represents deposits of the Wadsworth Till Member and is present beneath the entire site, based on borings drilled at the site.

The horizontal and vertical extent of the clay-rich diamict in the vicinity of the site is shown on Figure 18. Many of the TSC borings did not penetrate the clay till (which were used by PELA to estimate the thickness of the clay till) and were not used to construct Figure 18. Therefore, Figure 18 presents an estimate (primarily in the vicinity of the "new landfill") of the clay thickness.

Based on the soil borings drilled in the vicinity of the site, the surficial sand is separated from the deep sand and gravel aquifer by the clay-rich diamict. The top of the clay diamict is present immediately beneath the surface soils along the northern portion of the site and may be as deep as 54 feet below ground surface (boring LB4A) where it underlies the surficial sand south of the site. Based on a review of boring logs which penetrated the diamict, the thinning structure of the diamict generally corresponds to the thickening structure of the surficial sand (Figures 17 and 18). Geologic cross section B-B' (Figure 13) illustrates the thinning clay rich diamict.

The geotechnical analysis and the soil samples collected during the RI, shows that the clay-rich diamict is typically light to dark gray massive silty to lean clay, with trace to some sand and trace gravel. The samples submitted for geotechnical analysis are USCS classified as inorganic clays of medium to low plasticity, gravelly, sandy, silty, and lean clays (CL) to (CL-ML) (Table 3-12). Discontinuous thin layers and lenses of sand and silt were also encountered in the soil borings penetrating the diamict (borings W3D, W2D, and W7D).

The geotechnical analysis of the Shelby tube samples collected from the clay-rich diamict in soil borings W2D and W3D indicated that total organic carbon content ranged from 3.6% in soil sample W2D (29 feet to 31 feet depth) and 1.64% in soil sample W3D (36 feet to 38 feet depth). The estimated total porosity ranged from 38% to 24% in these Shelby tube samples collected from W2D and W3D, respectively (Table 3-12).

3.7.1.4 Deep Sand and Gravel. The deep sand and gravel is laterally extensive and is present beneath the entire site. The full thickness of the deep sand and gravel is not known, but the unit is at least 185 feet thick in the site vicinity (Ecology and Environment, Inc. 1989). Based on the results of the sieve analysis of the samples collected from the deep sand and gravel from borings W2D, W3D, and W7D, the upper portion of this unit consists of brown to gray fine to coarse sand, with trace to some gravel, trace to little silt, and trace clay (Table 3-12 and 3-13). Lower portions of this unit are poorly sorted and contain greater percentages of gravel. The deep sand and gravel represents outwash deposits associated with the Haeger Till Member (Willman, et. al., 1975).

3.7.2 Site Specific Hydrogeology

As discussed in the previous section, three major aquifers underlie the Site. The following discussion focuses on the deposits of glacial or recent origin. Water-bearing glacial or recent deposits consist of the surficial sand, underlying clay-rich diamict aquitard and deep sand and gravel.

Groundwater level data was collected by Warzyn on June 8 and 9, 1993 and March 28, 1994, (Table 3-5). Water table maps for the surficial sand (Figure 21 and 22) and piezometric surface maps for the deep sand and gravel (Figure 26 and 27) have been prepared to illustrate groundwater flow directions.

Slug tests were performed on monitoring wells during the RI to estimate horizontal hydraulic conductivity. Resultant hydraulic conductivity estimates are presented in Table 3-14. Conductivity test results obtained from the previous investigations are located in Table 3-15. Laboratory constant head permeability tests were performed on samples collected from the clay diamict by Warzyn during the RI and those test results are located in Table 3-12. Laboratory constant head permeability test results obtained during the previous investigations of the site are also presented in Table 3-13.

3.7.2.1 Surficial Sand. Water level elevations from the water table wells and standpipes screened in the surficial sand indicate that the water table is near the surface and that the groundwater in the surficial sand is flowing into Sequoit Creek under a shallow hydraulic gradient at staffgages PSG2 and PSG3 (Figure 21 and 22; Tables 3-8 through 3-11). A groundwater recharge area is located around staff gage PSG1 during various times of the year. The rate of horizontal and vertical groundwater flow in the surficial sand is controlled by the hydraulic gradient and the hydraulic conductivity of the surficial sand.

The results of the single well hydraulic conductivity slug tests performed in the surficial sand wells (W3SB, W4S, W5S, US1S, US3S, US4S, and US6S) indicate that the horizontal hydraulic conductivity of the surficial sand ranges from 2.10E-02 to 3.60E-04 centimeters per second (cm/s) (Table 3-14 and 3-15). These results indicate that groundwater flow can readily take place in the surficial sand deposits and are typical for these types of soil materials (Freeze and Cherry, 1979).

Based on the water level elevations obtained from well nest W3SA and W3SB, in June 1993 a very slight downward vertical hydraulic gradient of 0.002 feet per foot was observed from the water table surface to the base of the surficial sand (Table 3-16).

3.7.2.2 Clay-Rich Diamict. The clay-rich diamict acts as an aquitard, separating the surficial sand from the deep sand and gravel. Groundwater movement within the clay-rich diamict is primarily downward. Groundwater equipotential lines within the diamict are shown on Figures 12, 13, and 14. The rate of groundwater movement within the diamict is controlled by the hydraulic conductivity of the diamict and the hydraulic gradient across the diamict.

The results of the single well hydraulic conductivity slug tests performed in wells screened in the clay diamict (wells US3I, US6I and US7S) during previous investigations at this site are located in Table 3-15. Horizontal hydraulic conductivities calculated using the Hvorselv Method from the slug tests were 7.9E-06 cm/s in piezometer US3I and 8.0E-06 cm/s in piezometer US6I. Piezometer US7S was screened through a sand layer and the resultant hydraulic conductivity of 5.80E-03 cm/s is not indicative of the clay-rich diamict, and is more representative of the sand layer within the screened interval.

Warzyn did not perform slug tests on wells screened in the clay diamict during the RI, rather, laboratory constant head permeability tests were performed on Shelby tube samples collected from the clay diamict. Laboratory constant head permeability results, obtained from diamict samples collected from monitoring well W2D and W3D, indicated that the vertical hydraulic conductivity of the clay-rich diamict is on the order of 1.50E-08 cm/s to 1.70E-08 cm/s (Table 3-12). The vertical hydraulic conductivity of the clay diamict ranged from 1.0E-08 cm/s to 6.9E-07 cm/s, based on constant head permeability tests performed on samples collected from soil borings LB2, LB3, LB4A and LB10 during the previous site investigations (Table 3-13). These results indicate that the vertical and horizontal hydraulic conductivities of the clay-rich diamict are low, and as a result, poor hydraulic communication exists between the surficial sand and the deep sand and gravel.

Poor hydraulic communication between the surficial sand and the deep sand and gravel is also substantiated based on the piezometric head elevation differences, measured on June 8 and 9, 1993, and March 28, 1994, observed between wells screened in each unit. Groundwater elevations obtained from wells screened in the surficial sand ranged from 761.84 feet MSL in wells G102 and W5S to 764.39 feet MSL in well US1S on June 8, 1994 (Table 3-5), while head elevations in the deep sand and gravel ranged from 728.14 feet MSL in well US3D to 731.64 feet MSL in piezometer PZ1 (Table 3-5). On March 28, 1994 groundwater elevations from surficial sand wells ranged from 762.02 ft msl in wells US4S and W5S to 765.05 ft msl in well G14S. Deep sand and gravel groundwater well elevations ranged from 729.38 in US3D to 730.47 ft msl in W7D. Approximately 30 to 35 feet of head elevation difference exists between the surficial sand and the deep sand and gravel.

Vertical hydraulic gradients were calculated based on the head elevation differences between wells screened in the surficial sand and the clay-rich diamict, between wells screened in the clay-rich diamict and the deep sand and gravel, and between wells screened in the surficial sand and the deep sand and gravel (Table 3-16). The gradients ranged from 0.4 ft/ft in wells US3I, US3D to 2 ft/ft in wells US6S, US6I.

3.7.2.3 Deep Sand and Gravel. The deep sand and gravel is used for public water supply by the Village of Antioch and for private well use by nearby residences located east of the Site. This deep sand and gravel occurs beneath the entire site based on soil borings drilled during the previous site investigations and the RI. The thickness of the deep sand and gravel is not known, because site soil borings have not entirely penetrated this unit.

Regionally, the deep sand and gravel exists under confined and unconfined conditions. Groundwater recharge to the deep sand and gravel occurs primarily from the Fox River Valley where it outcrops (See Section 3.6.2.1; Drawing 10010201-F3).

As discussed in the previous section, the clay-rich diamict overlies the deep sand and gravel over the entire site and, based on the piezometric head elevations obtained during the RI, the deep sand and gravel exists under confined conditions. June 1993 piezometric head elevations ranged from 728.41 feet MSL in well US3D to 731.64 feet MSL in well PZ1 (Table 3-5). The top of the deep sand and gravel ranges in elevation from approximately 685 ft MSL in soil boring LB7 to 702.77 feet MSL in soil boring VA5.

The groundwater flow direction in the deep sand and gravel is illustrated on Figures 26 and 27. Based on the piezometric head elevations collected on June 8 and 9, 1993 and March 28, 1994 (Table 3-5), the groundwater of the deep sand and gravel appears to be flowing from northeast to southwest under a low hydraulic gradient (Figures 26 and 27). The groundwater flow direction along the western portion of the site appears to be influenced by the pumping of the Village water supply wells located to the west and southwest of the site based on the potentiometric surface maps for June 8 and 9 1993 and March 28, 1994.

Approximately 2,690 and 838 gallons of groundwater were pumped from village well VW4 on June 6 and 7, 1993, respectively, prior to collecting the June 8, 1993 groundwater levels (Appendix L). Approximately 4,486 gallons of water were pumped from the deep sand and gravel from village well VW4 on June 8, 1993. Approximately 804 and 603 gallons of water were pumped from village well VW3 on June 6 and June 8, 1993. Village well VW3 was not pumped on June 7, 1993, one day prior to the collection of the water level measurements (Appendix L).

Village well VW4 was not pumped on March 26, 1994, two days before groundwater levels were collected during the supplemental RI activities on March 28, 1994. However, approximately 3,137 and 1,191 gallons of groundwater pumped from village well VW4 on March 27 and 28, 1994 respectively (Appendix L). Approximately 2,473 gallons, 733 gallons, and 280 gallons of water was pumped from village well VW3 on March 26, 27 and 28, 1994, respectively.

The amount of groundwater pumped from village well VW4, one to two days prior to, and on the same day as the collection of the June 8, 1993 and March 28, 1994 round of groundwater levels appears to have influenced groundwater flow in the deep sand and gravel toward the pumping well VW4. This is represented as a cone of depression depicted on the deep sand and gravel potentiometric surface maps (Figures 26 and 27).

A groundwater divide in the deep sand and gravel was shown on the piezometric map included in the PSER/TS. The divide was controlled by the relatively higher groundwater elevation in well PZ2, located south of the landfill. Elevated potentiometric head levels were also measured in well PZ2 by Warzyn (737.02 feet MSL) in June of 1993 and by Weston Gulf Coast Laboratories (737.44 feet MSL) in August of 1993 (Table 3-5). A graph of the water levels from PZ2 and the other deep sand and gravel groundwater monitoring wells show that the water level is PZ2 have been tending upward since it was installed unlike the other wells which show upward and downward variations over same period (Table 3-17). The water level trend in PZ2 indicates that the seal may be progressively deteriorating or is reflecting the groundwater head in the lower portion of the clay-rich diamict and not the deep sand and gravel. As such, water levels collected from PZ2 were unreliable and replacement well W8D was installed in its place.

Collected water levels from well W8D appear to be much more consistent with observed water levels from other deep sand and gravel groundwater monitoring wells (Table 3-5). With the new water level data from well W8D, the potentiometric surface maps for the deep sand and gravel show a more accurate representation of the expected potentiometric surface (Figures 26 and 27).

The horizontal hydraulic conductivity of the deep sand and gravel was estimated using single well slug tests on wells W3D, US3D and US6D. Hydraulic conductivities ranged from 1.10E-03 cm/s to 3.80E-04 cm/s (Table 3-14). The estimated hydraulic conductivities that were calculated from slug tests performed during the previous site investigations were similar, and ranged from 2.1E-03 cm/s to 5.24E-04 cm/s (Table 3-15). These results indicate that groundwater in the deep sand and gravel has the ability to transmit groundwater readily enough for municipal and private use.

PMS/dlp
J:\2386\0096\RI_FINAL\RI_TEXT\SECTION3.DOC

4

4.0 RESULTS AND DISCUSSION

RESULTS

Results of the RI are discussed by media and compound groups in the following subsections. The Round 1 and Round 2 analytical results are presented in Appendices O and P, respectively. The data quality summary and data qualifier definitions for both sampling Rounds are presented at the beginning of Appendix O and Appendix P.

4.1 LEACHATE

Leachate samples were collected from five locations and were analyzed for the TAL/TCL and indicator parameters. The results are presented in tabular form in Appendices O-3 through O-7. The following discusses the detection of constituents and the range of detected constituents in the H.O.D. Landfill leachate. The results are discussed below by constituent group. Analytical results for organics are summarized in Table 4-1.

4.1.1 Leachate Volatiles

The volatile organic compounds (VOCs) detected in the leachate samples collected from leachate piezometers LP1, LP6, LP8, LP11 and the east manhole (MHE) can generally be divided into four groups: ketones, aromatics, alkenes and alkanes. As groups, ketones (4-methyl-2-pentanone, 2-butanone, and acetone) were detected at the highest concentrations, followed by aromatics (toluene and xylenes), with the alkenes (vinyl chloride, 1,2-dichloroethene, trichloroethene, and tetrachloroethene) and alkanes (chloroethane; 1,1-dichloroethane; 1,2-dichloroethane; and 1,2-dichloropropane) groups detected at the lowest concentrations.

Acetone and 2-butanone were detected in each of the samples at concentrations for 2-butanone ranging from 120 ug/l (MHE) to 12,000 ug/l (LP8), and acetone concentrations ranging from 110 ug/l (LP1) to 19,000 ug/l (LP8). 4-methyl-2-pentanone was detected in samples collected from leachate piezometers LP1, LP6, LP8, and MHE at concentrations ranging from 22 ug/l (LP1) to 450 ug/l (LP8), but was not detected in the sample collected from LP11. The compound 2-hexanone was only detected in the sample collected from leachate piezometer LP1 at a concentration of 14 ug/l.

Toluene was detected in each of the leachate samples with concentrations ranging from 62 ug/l (MHE) to 740 ug/l (LP11). Total xylenes were detected in the samples collected from leachate piezometers LP1, LP6, LP11 and MHE with the concentrations ranging from 41 ug/l (MHE) to 330 ug/l (LP11), but total xylenes were not detected in the sample from LP8. Ethylbenzene was not detected in the samples from MHE, or leachate piezometers LP6 and LP8. Ethylbenzene was detected in the samples from LP1 (52 ug/l), and LP11 (130 ug/l). Benzene was not detected in the samples from leachate piezometers LP6, LP8, and LP11.

Benzene was detected in the samples collected from leachate piezometer LP1 and MHE at 12 ug/l and 22 ug/l, respectively.

Tetrachloroethene was not detected in samples from leachate piezometers LP6, LP8, or LP11, but it was detected in samples from leachate piezometers LP1 (9 ug/l) and MHE (9 ug/l). Trichloroethene was not detected in samples from leachate piezometers LP1, LP6, LP8, or LP11, but was detected in the sample from MHE (14 ug/l). 1,2-dichloroethene was not detected in samples from LP6 or LP8, but it was detected in samples from LP1 (7 ug/l), MHE (70 ug/l), and LP11 (190 ug/l). 1,1-dichloroethene was not detected in samples from leachate piezometers LP1, LP6, LP8, or LP11, but was detected in the sample from MHE (5 ug/l). Vinyl chloride was not detected in samples from leachate piezometers LP1, LP6, LP8, or LP11, but it was detected in the sample from MHE (18 ug/l).

Methylene chloride was not detected in the samples from leachate piezometers LP6 or LP11, but it was detected in the samples from LP1 (160 ug/l), LP6 (58 ug/l) and MHE (44 ug/l). Tentatively identified VOC compounds were detected in each of the leachate samples except that from LP8 at concentrations ranging from 3 ug/l to 1100 ug/l.

4.1.2 Leachate Semi-Volatiles

The semi-volatile organic compounds (SVOCs) detected in the leachate samples collected from leachate piezometers LP1, LP6, LP8, LP11 and the east manhole (MHE) can generally be divided into three groups: phenols, polynuclear aromatic hydrocarbons (PAHs), and phthalates. As groups, the phenols (phenol, 2,4-dimethylphenol, 4-methylphenol) were detected at the highest concentrations, followed by PAHs (naphthalene) and phthalates (diethylphthalate and bis(2-ethylhexl) phthalate).

Phenol, 2,4-dimethylphenol and 4-methylphenol) were detected in each of the leachate samples. Phenol concentrations ranged from 5 ug/l (LP11) to 840 ug/l (LP8), 2,4-dimethylphenol concentrations ranged from 3 ug/l (LP11) to 20 ug/l (LP8), and 4-methylphenol concentrations ranged from 5 ug/l (MHE) and 2,200 ug/l (LP8). The compound 2-methylphenol was only detected in the sample collected from leachate piezometer LP6 (16 ug/l).

Diethylphthalate was not detected in the samples from leachate piezometers LP6, LP8, and MHE, but was detected in samples collected from leachate piezometer LP1 (32 ug/l) and LP11 (4 ug/l). Bis(2-ethylhexyl)phthalate was only detected in the sample from LP11 (42 ug/l).

Naphthalene was the only PAH compound detected in the samples collected from the leachate piezometers LP1, LP6, LP8, LP1. No PAH compounds were detected in the sample from MHE. The detected naphthalene concentrations ranged from 6 ug/l (LP6) to 34 ug/l (LP1-dup). The concentration for the LP1 sample was from a duplicate sample. Naphthalene was not detected in the first sample.

1,4-dichlorobenzene was not detected in the samples from LP1, LP8, or MHE, but was detected at concentrations of 5 ug/l and 20 ug/l in samples collected from leachate piezometers LP6 and LP11, respectively. Tentatively identified SVOCs were detected in each of the leachate samples at concentrations ranging from 5.7 ug/l to 1200 ug/l.

4.1.3 Leachate Pesticides/PCBs

Pesticide compounds were not detected in the leachate samples. Polychlorinated biphenyls (PCBs) were not detected in the samples from LP6, LP8, LP11, or MHE. Aroclor-1016 was detected in the leachate sample collected from leachate piezometer LP1 at a concentration of 4.6 ug/l (6.3 ug/l-duplicate sample).

4.1.4 Leachate Inorganics/Indicators

In general, municipal landfills have a high inorganic component of the leachate. For the most part, the results of the H.O.D. Landfill leachate analyses are consistent with the general values identified by the IEPA as shown in Table 4-2. The following discusses the detection of constituents and the ranges of detected constituents in the H.O.D. Landfill leachate.

4.1.4.1 Major Metals. The major metals calcium, magnesium, manganese, iron, aluminum, potassium, and sodium were detected in each of the leachate samples. Calcium was detected at concentrations ranging from 90,300 ug/l (MHE) to 1,410,000 ug/l (LP1-Duplicate). Magnesium concentrations ranged from 138,000 ug/l (MHE) to 780,000 ug/l (LP1-Duplicate). Potassium concentrations ranged from 82,000 ug/l (LP11) to 507,000 ug/l (LP6). Concentrations of sodium ranged from 238,000 ug/l (LP11) to 1,530,000 ug/l (LP8).

Manganese ranged from 76.2 ug/l (MHE) to 9,020 ug/l (LP1-Duplicate). Iron concentrations ranged from 7,900 ug/l (MHE) to 612,000 ug/l (LP1-Duplicate). Aluminum concentrations ranged from 151 ug/l (MHE) to 222,000 ug/l (LP1-Duplicate).

4.1.4.2 Indicators. Chloride was detected in each of the leachate samples and the concentrations ranged from 196 milligrams per liter (mg/l) (LP11) to 2,070 mg/l (LP8). Sulfate was also detected in each of the leachate samples and the detected concentrations ranged from 17 N/J mg/l (LP8) to 530 N/J mg/l (LP11).

The total alkalinity of the leachate samples ranged from 1,700 mg/l (MHE) to 4,360 mg/l (LP6). The hardness of the leachate samples ranged from 768 mg/l (MHE) to 3,460 mg/l (LP1). Total dissolved solids (TDS) ranged from 2,430 mg/l (MHE) to 10,200 mg/l (LP1-Duplicate).

Total organic carbon (TOC) was detected in each of the leachate samples and the TOC concentrations ranged from 30.5 mg/l (LP1-Duplicate) to 120 mg/l (LP11). Ammonia was also detected in each of the leachate samples and the concentrations ranged from 45 (mg/l) (LP11) to 378 mg/l (LP8). Nitrate-nitrogen was not detected in samples from leachate piezometers LP6, LP8 or LP1 (duplicate), but nitrate-nitrogen was detected in the samples collected from leachate piezometers LP1 (0.06 mg/l), LP11 (0.02 mg/l), and from MHE (0.05 mg/l). Nitrite-nitrogen was not detected in the sample from MHE, but it was detected in samples from the leachate piezometers LP1, LP6, LP8, and LP11, and its concentrations ranged from 0.03 mg/l (LP1) to 0.19 mg/l (LP6).

4.1.4.3 Field Parameters. Leachate pH measurements ranged from 6.75 (LP11) to 7.19 (LP1-duplicate). Leachate temperature measurements ranged from 10 degrees Celsius (^{0} C) (LP1) to 25 ^{0} C (LP8). Specific conductance measurements, corrected to 25 ^{0} C, ranged from 3,947 umhos/cm (LP11) to 12,900 umhos/cm (LP8). Dissolved oxygen measurements of the leachate samples ranged from 0.8 mg/l (LP-Duplicate) to 4.2 mg/l (LP11). Leachate oxidation/reduction potential measurements ranged from -50 millivolts (mV) (LP6) to 82 mV(LP8).

4.1.4.4 Other Minor Inorganic Constituents. Antimony was not detected in any of the leachate samples. Arsenic was detected in each of the leachate samples and the arsenic concentrations ranged from 4.1 B ug/l (MHE) to 51.3 ug/l (LP11). Barium was detected in each of the leachate samples and the concentrations ranged from 257 ug/l (LP6) to 1,710 LP1(Duplicate).

Beryllium and cadmium were each detected in LP1, LP6, LP8, LP1, but were not in the sample from MHE. Detected beryllium concentrations ranged from 1.2 B ug/l (LP6) to 12.5 ug/l (LP1-duplicate). Detected cadmium ranged from 5.6 ug/l (LP8) to 67.9 ug/l (LP1D). Chromium, cobalt, copper, and lead were detected in each of the leachate samples. The chromium concentrations ranged from 9.9B ug/l (MHE) to 418 ug/l (LP1-duplicate), cobalt concentrations ranged from 8.1B ug/l (MHE) to 185 ug/l (LP1-duplicate), copper concentrations ranged from 9.4B (MHE) to 755 ug/l (LP1-duplicate), and lead ranged from 6.2 MN/J ug/l (MHE) to 1,930 ug/l (LP11).

Mercury was not detected in the leachate samples from LP6 or MHE, but mercury was detected in leachate piezometers LP1, LP8, and LP11 at 0.43 J ug/l (LP1), 1.8 ug/l (LP1D), and 1.3 ug/l (LP8 and LP11). Nickel was detected in each of the leachate samples and the concentrations ranged from 21.9B ug/l (MHE) to 560 ug/l (LP1-duplicate). Selenium was not detected in any of the leachate samples.

Silver was not detected in the leachate samples from LP6, LP8 or MHE, but was detected in the samples from LP1 and LP11 at concentrations ranging from 3.0 ug/l (LP1) to 10.9 ug/l (LP1D). Thallium was not detected in samples from LP6, or LP11, but was detected in MHE, LP1, and LP8 at concentrations ranging from 2 BNW/J ug/l (MHE, LP1) to 2.2 ug/l (LP8). Vanadium was detected in each of the leachate samples at concentrations ranging from 2.4B ug/l (MHE) to 386 ug/l (LP1-duplicate). Zinc was not detected in the samples from leachate piezometers LP1, LP6, LP8, LP11, or MHE, but was detected in the duplicate sample LP1 at 8,280 ug/l. Cyanide was only detected in one leachate sample at a concentrations of 37.8 ug/l (LP11).

4.1.4.5 Leachate Tentatively Identified Compounds

Tentatively identified volatile organic analytes (TVOAs) were detected in leachate samples from locations LP1, LP6, LP11 and MHE at concentrations ranging from 3J ug/l to 1,100J ug/l. Tentatively identified semi-volatile compounds TSVOCs were detected in the samples from location LP1, LP6, LP8, LP11, and MHE ranging in concentration from 5.7J ug/l to 1,200J ug/l.

4.2 LANDFILL GAS

Landfill gas samples were collected from five leachate piezometer/landfill gas well locations. The results are presented in tabular form in Appendix O-2 and summarized in Table 4-3. The VOCs detected can generally be divided into five groups: ketones, aromatics, alkenes, alkanes, and other VOCs. The constituents detected and the ranges of detected constituents are discussed below.

2-Butanone was detected in each of the five samples at concentrations ranging from 21 ppb (v/v) (LP1) to 22,000 ppb (v/v) (LP8). Acetone was not detected in the samples from LP1 or LP11, but was detected in the other three samples ranging in concentration from 730 ppb (v/v) (LP6) to 15,000 ppb (v/v) (LP8).

Benzene, ethylbenzene, toluene, and xylene were detected in each of the five samples. Benzene concentrations ranged from 10 ppb (v/v) (LP1) to 970 ppb (v/v) (LP7), ethylbenzene concentrations ranged from 34 ppb (v/v) (LP1) to 11,000 ppb (v/v) (LP7), toluene concentrations ranged from 540 ppb (v/v) LP1 to 66,000 ppb (v/v) (LP7), and xylene concentrations ranged from 52 ppb (v/v) (LP1) to 30,000 ppb (v/v) (LP7).

Tetrachloroethene was not detected in the sample from location LP1, but was detected in each of the samples from the other four locations ranging in concentration from 270 ppb (v/v) (LP6) to 4,400 ppb (v/v) (LP7). Trichloroethene was detected in the samples from the four locations LP6, LP7, LP8, and LP11, ranging in concentration from 160 ppb (v/v) (LP6) to 2,500 ppb (v/v) (LP7), but was not detected in the sample from location LP1. 1,2-Dichloroethene was detected in each of the five samples in concentrations ranging from 6.3 ppb (v/v) (LP1) to 5,400 ppb (v/v) (LP7). 1,1-Dichloroethene was detected only once in the sample from LP7 (480 ppb(v/v)). Vinyl chloride was not detected in the sample from LP1, but it was detected in the samples from the four other locations (LP6, LP7, LP8, LP11), ranging in concentration from 1,100 ppb (v/v) (LP11) to 21,000 ppb (v/v) (LP7).

Chloroethane was detected in only two of the five samples at concentrations ranging from 47 ppb (v/v) (LP1) to 810 ppb (v/v) (LP6).

Other VOCs detected include freons, 4-ethyl toluene, carbon disulfide, chloromethane, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and methlyene chloride.

4.3 GROUNDWATER MONITORING WELLS (GROUNDWATER)

Eighteen monitoring wells were sampled in the vicinity of the H.O.D. Landfill site. Round 1 samples were analyzed for the TAL/TCL parameters and indicator parameters, and the second Round of samples were analyzed for TCL VOCs. Round 1 and Round 2 results are presented in tabular form in Appendices O-13 through O-17, and P-7, respectively. Four on-site (US4S, US6S, W5S, and W6S) and four off-site (US1S, US3S, W3SB, and W4S) surficial sand groundwater monitoring wells were sampled. G11S, which is screened within shallow sand/clay fill on the north side of the site unconnected to the surficial sand on the south side of the site was also sampled. Two on-site (US6I, G11D) and one off-site (US3I) clay diamict wells were sampled. Three on-site (US4D, US6D, and W7D) and three off-site (US1D, US3D, and W3D) deep sand and gravel groundwater monitoring wells were sampled. The Round 1 and Round 2 groundwater VOC concentrations are presented in Figure 30 and are summarized in Table 4-4.

4.3.1 Groundwater Volatile Organic Compounds

4.3.1.1 Surficial Sand. VOCs were not detected in the Round 1 or Round 2 samples collected from wells US1S, US3S, W3SB, W4S, and US6S. Carbon disulfide was the only VOC detected in the Round 1 and Round 2 samples collected from well G11S at concentrations of 0.8J ug/l and 18 ug/l, respectively. The only VOC detected in the Round 1 and Round 2 samples from well US4S was 1,2-dichloroethene at 35 ug/l and 44 ug/l, respectively.

Vinyl chloride (19 ug/l) was the only VOC detected in the Round 1 sample from well W5S, but the presence of VOCs was not confirmed in the Round 2 sample from well W5S because no VOCs were detected. Similarly the presence of VOCs in the groundwater in the vicinity of well W6S was not confirmed in the second Round of sampling. 1,2-Dichloroethene (2J ug/l) was the only VOC detected in the Round 1 sample from well W6S, but no VOCs were detected in the Round 2 sample from well W6S.

4.3.1.2 Clay Diamict. VOCs were not detected in the Round 1 or Round 2 samples collected from wells G11D and US3I. Trichloroethene was the only VOC detected in the Round 1 and Round 2 samples from well US6I at concentrations of 2 J ug/l and 1 J ug/l, respectively.

4.3.1.3 Deep Sand and Gravel. VOCs were not detected in the Round 1 or Round 2 samples collected from wells US1D, W3D, US4D, US6D, and W7D. The only VOCs detected in the Round 1/ Round 2 samples collected from well US3D were vinyl chloride (28 ug/l; 35 ug/l) and 1,2-dichloroethene (11 ug/l; 18 ug/l).

4.3.2 Groundwater Semi-Volatile Organic Compounds

SVOCs were not detected in the surfical sand, clay diamict, or deep sand and gravel well groundwater samples collected in Round 1. Round 2 samples were not analyzed for SVOCs.

4.3.3 Groundwater Pesticides/PCBs

Pesticide and PCBs were not detected in the Round 1 groundwater samples collected from surficial sand, clay diamict, or deep sand and gravel wells. Round 2 groundwater samples were not analyzed for pesticides or PCBs.

4.3.4 Groundwater Inorganics/Indicators

4.3.4.1 Major Metals. The major metals as defined in the leachate section are calcium, magnesium, sodium, potassium, manganese, iron, and aluminum and are discussed below.

4.3.4.2 Surficial Sand. Calcium was detected in each of the surfical sand groundwater samples collected and the concentrations generally ranged from 83,700 E/J ug/l (US1S) to 163,000 ug/l (W4S), except for the sample from well W6S (353,000 E/J ug/l). Magnesium was detected in each of the surficial sand groundwater samples collected and the concentrations generally ranged from 29,600 ug/l (US3S) to 55,000 ug/l (W3SB) with the exception of the sample result for well W6S (126, 000 ug/l). Sodium was detected in each of the surficial sand groundwater samples and the concentrations generally ranged from 16,800 ug/l (US6S Dup) to 64,300 ug/l (US3B). Potassium was not detected in the sample from well US1S, but was detected in each of the other surficial sand wells sampled. The potassium concentrations detected ranged from 1290 B ug/l (US6S) to 4620 B ug/l W6S, with the exception of the sample result from well W4S (duplicate) (14,100 ug/l).

Manganese was detected in each of the surficial sand groundwater samples collected. The manganese concentrations ranged from 50.1 ug/l (US3S) to 261 ug/l (US1S) for wells US1S, US3S, US4S, US6S, and W3SB. For wells W4S, W5S, and W6S, the manganese concentrations ranged from 692 ug/l (W5S) to 1,110 ug/l (W4S-duplicate). Iron was detected in each of the surficial sand groundwater samples collected. Iron was detected at 805 ug/l in the sample from well US1S. Iron concentrations ranged from 238 ug/l (W4S) to 3600 E/J ug/l (W6S). Aluminum was not detected in the surfical sand and gravel groundwater samples collected.

4.3.4.3 Clay Diamict. Calcium, magnesium, sodium, and potassium were detected in each of the clay diamict wells. The calcium concentrations ranged from 45,500 E/J ug/l (US3I) to 112,000 E/J ug/l (G11D). The magnesium concentrations ranged from 34,000 ug/l (US3I) to 98,600 ug/l (G11D). The sodium concentrations ranged from 33,700 ug/l (G11D) to 36,200 ug/l (US3I). The potassium concentrations ranged from 1,710 B ug/l (US3I) to 3050 B ug/l (G11D).

Manganese was detected in each of the samples from the clay diamict wells and the concentrations ranged from 20.3 ug/l (US6I) to 39.6 ug/l (US3I). Iron and aluminum were not detected in the samples from the clay diamict wells.

4.3.4.4 Deep Sand and Gravel. Calcium was detected in each of the samples from the deep sand and gravel wells. The calcium concentrations generally ranged from 36,500 ug/l (W7D) to 58,800 ug/l E/J (US1D) with the results from wells US3D (96,500 E/J ug/l) and W3D (115,000 ug/l) outside of this range. Magnesium was detected in each of the deep sand and gravel wells sampled. The magnesium concentrations ranged from 21,800 ug/l (W7D)to 46,200 ug/l (US3D) except for the sample result for well W3D (62,500 ug/l). Sodium was detected in each of the deep sand and gravel well samples and the concentrations ranged from 57,300 ug/l (W7D) to 67,500 ug/l (US3D). Potassium was detected in each of the samples from the deep sand and gravel at concentrations ranging from 1400 ug/l (US4D Dup) to 2610 ug/l (W3D).

Iron was not detected in the samples collected from wells US4D or W7D, but was detected in the samples collected from wells US1D (660 E/J ug/l), US3D (2,400 E/J ug/l), US4D-Dup (225 E/J ug/l), US6D (845 E/J ug/l), and W3D (707 ug/l). Manganese was detected in each of the deep sand and gravel wells sampled and the concentrations ranged from 16 ug/l (US4D-duplicate) to 141 ug/l (W3D). Aluminum was not detected in any of the deep sand and gravel well samples collected.

4.3.5 Indicators

4.3.5.1 Surficial Sand. Chloride were detected in each of the surficial sand wells samples and the concentrations ranged from 43 mg/l (US6S-Duplicate) to 104 mg/l (US3S). Sulfate was not detected in the sample from well W4S. Detected sulfate concentrations sulfate ranged from 31 mg/l (US6S) to 790 mg/l (W6S).

Nitrate was not detected in samples from well US6S and W3SB. Detected nitrate concentrations ranged from 0.02 mg/l (US4S) to 0.14 mg/l (US3S). Ammonia-nitrogen was not detected in samples from wells US1S, US4S, US6S, and W3SB. Ammonia was detected in samples from wells US3S (1.02 mg/l), W4S/W4S-duplicate (14.5 mg/l; 22.8 mg/l) , W5S (3.73 mg/l), and W6S (0.78 mg/l). Nitrite-nitrogen was not detected in any of the surfical sand well samples. TOC was detected in each of the surficial sand well samples with concentrations ranging from 1.2 mg/l (US1S) to 13 mg/l (W4S).

The hardness of the surficial sand groundwater samples ranged from 514 mg/l (US4S) to 1,800 mg/l (W6S). The total alkalinity of the surficial sand samples ranged from 310 mg/l (US1S) to 640 mg/l (W6S). Total dissolved solids ranged from 448 */J mg/l (US1S) to 1,800 mg/l */J (W6S).

4.3.5.2 Clay Diamict. Chloride was detected at concentrations of 8 mg/l and 27 mg/l in the samples collected from the clay diamict wells US3I and US6I, respectively. Sulfate was detected at 30 mg/l (US3I) and 32 mg/l (US6I). Nitrate-nitrogen was detected in the US3I sample at a concentration of 0.04 mg/l, but was not detected in the sample from well US6I. Ammonia-nitrogen was detected at a concentration of 0.28 mg/l (US6I), but was not detected in the sample from well US3I. Nitrite-nitrogen was not detected in either of the samples from wells US3I and US6I. TOC was detected in the US6I sample at a concentration of 2.3 mg/l, but was not detected in the sample from well US3I. Hardness was measured at 900 mg/l and 416 mg/l in the US3I and US6I samples, respectively. The total alkalinity of the US3I and US6I samples was 303 mg/l and 328 mg/l, respectively. Total dissolved solids were detected at concentrations of 304 */J mg/l (US3I) and 392 */J mg/l (US6I).

4.3.5.3 Deep Sand and Gravel. Chloride and sulfate were detected in each of the samples collected from Deep Sand and Gravel wells. Chloride was detected at concentrations ranging from 3 mg/l (US4D) to 22 mg/l (US1D), with results outside this range in samples from US3D (144 mg/l) and W3D (153 mg/l). Sulfate concentrations ranged from 49 N/J mg/l (US1D and US3D) to 124 N/J mg/l (W7D).

Ammonia-nitrogen was not detected in samples from wells US3D and W3D, but was detected in US1D (0.77 mg/l), US4D (0.79 mg/l), US6D (0.75 mg/l), and W7D (0.71 mg/l). Nitrate-nitrogen was not detected in samples from the Deep Sand and Gravel wells US1D, US4D, US6D, W3D, and W7D, but was detected in the sample from well US3D (0.03 mg/l). Nitrite was not detected in samples collected from the Deep Sand and Gravel wells. TOC was not detected in the samples from the Deep Sand and Gravel wells US3D, US4D, and W7D, but was detected in samples from well US1D (1.3 mg/l), US4D-duplicate (1.2 mg/l), US6D (5.5 mg/l), and W3D (1.3 mg/l).

The hardness of the samples from the Deep Sand and Gravel wells ranged from 216 mg/l (US4D) to 620 mg/l (US3D), and the total alkalinity ranged from 181 mg/l (W7D) to 393 mg/l (W3D). Total dissolved solids ranged from 344 mg/l (US4D) to 788 mg/l (W3D).

4.3.6 Field Parameters

4.3.6.1 Surficial Sand. Round 1 pH measurements ranged from 6.79 units (W5S) to 7.38 units (US1S). Round 2 pH measurements ranged from 6.65 (W5S) to 7.18 (US3S). Round 1 specific conductance measurements ranged from 760 umhos/cm (US1S) to 2,229 umhos/cm (W6S). Round 2 specific conductance measurements ranged from 726 umhos/cm (US1S-duplicate) to 1,840 umhos/cm (W6S-duplicate). Dissolved oxygen determinations ranged from 3.5 mg/l (US6S) to 9.6 mg/l (W4S). The oxidation/reduction potential ranged from 76 mV (W5S) to 224 mV (US3S).

4.3.6.2 Clay Diamict. Round 1 pH measurement were 8.12 units and 8.17 units in the samples from wells US3I and US6I, respectively. Round 1 specific conductance measurements were 626 umhos/cm (US3I) and 680 umhos/cm (US6I). Round 1 dissolved oxygen measurements were 6.9 mg/l (US3I) and 5.4 mg/l (US6I). Round 1 oxidation/reduction potential measurements were 84 mV (US3I) and 65 mV (US6I).

In the second Round groundwater samples collected from the clay diamict wells (US3I, US6I, and G11D), sample pH ranged from 7.79 (G11D) to 8.76 (US6I). Round 2 specific conductance measurements ranged from 506 umhos/cm (US6I) to 1,149 umhos/cm (G11D). Dissolved oxygen ranged from 4.4 mg/l (US6I) to 11.8 mg/l in the G11D). The oxidation/reduction potential ranged from 79 mV (US3I) to 139 mV (US6I).

4.3.6.3 Deep Sand and Gravel. Round 1 pH measurements ranged from 7.34 units (US3D) to 7.88 units (W7D). Round 2 pH measurements ranged from 7.07 (US3D) to 7.82 (W7D). Round 1 specific conductance measurements ranged from 546 umhos/cm (US4D) to 1,410 umhos/cm (W3D). Round 2 specific conductance measurements ranged from 527 umhos/cm (US4D) to 1,233 umhos/cm (W3D). Round 1 dissolved oxygen ranged from 3.2 mg/l (W7D) to 4.7 mg/l (US3D). Round 2 dissolved oxygen determinations ranged from 6.4 mg/l (US4D) to 14 mg/l (W3D). The Round 1 oxidation/reduction potential ranged from 20mV (US6D) to 98 mV (W3D), and in Round 2 ranged from 110 mV (US3D) to 194 mV (US1D).

4.3.7 Other Minor Inorganic Constituents

4.3.7.1 Surficial Sand. Antimony was not detected in any of the samples collected from the Surficial Sand wells. Arsenic was not detected in samples from wells US1S, US3S, US4S, US6S, W3SB, W4S, W5S, or W6S, but was detected in the W4D-duplicate sample at 4.1B ug/l. Barium was detected in each of the Surficial Sand well samples and ranged in concentration from 34.9 B ug/l (US1S) to 363 ug/l (W4S). Beryllium and Cadmium were not detected in any of the samples collected from the Surficial Sand wells. Chromium was not detected in US1S, US3S, US4S, US6S, W3SB, W4S (Duplicate), or W5S, but was detected in the samples from W4S (4.4 B ug/l) and W6S (4.4 B ug/l).

Cobalt was not detected in any of the Surficial Sand well samples except for W4S/W4S-duplicate (9 B ug/l; 4.4 B ug/l). Copper, lead and mercury were not detected in any of the Surficial Sand well samples. Nickel was only detected in the samples from wells W3SB (6 B ug/l) and W4S (8.4 B ug/l), and not in any other Surficial Sand well sampled.

Silver, thallium, vanadium, selenium and cyanide were not detected in any of the Surficial Sand well samples. Zinc was not detected in samples from the Surficial Sand wells US1S, US3S, US4S, US6S, W5S, or W6S, but was detected in samples from wells W3SB (352 ug/l) and W4S/W4S-duplicate(248 ug/l; 333 ug/l).

4.3.7.2 Clay Diamict. Antimony was not detected in the samples from the clay diamict wells. Arsenic was detected in the sample from wells G11D (3.1 B ug/l), US31 (6.3 B ug/l), and US6I (9.5 B ug/l). Barium was detected in each clay diamict well with the detected concentrations ranging from 41.1 B ug/l (US3I) to 282 ug/l (G11D). Beryllium was not detected in the samples from the clay diamict wells. Cadmium was detected in the sample from G11D (5.6 ug/l), but was not detected in the samples from US3I or US6I. Chromium was detected in the sample from well G11D (3.5 B ug/l), but was not detected in the samples from wells US3I and US6I.

Cobalt, copper, lead, mercury, nickel, silver, vanadium, selenium, zinc, and cyanide were not detected in the samples from the clay diamict wells. Thallium was not detected in the samples from wells US3I and US6I, but was detected in the sample from well G11D (2.1 BWJ ug/l).

4.3.7.3 Deep Sand and Gravel. Antimony, arsenic, beryllium, cadmium, cobalt, copper, lead, mercury, silver, thallium, vanadium, selenium, and cyanide were not detected in the samples from the Deep Sand and Gravel wells. Barium was detected in each of the sample from the Deep Sand and Gravel wells at concentrations ranging from 59.1 B ug/l (US4D-duplicate) to 163 B ug/l (W3D).

Chromium and nickel were each only detected once in the sample from well W3D (4.3 B ug/l; 5.2 B ug/l; respectively), and not in the other samples from the Deep Sand and Gravel wells. Zinc was detected in the samples from well US3D (474 E ug/l) and W3D (314 ug/l), and not in the other samples from the Deep Sand and Gravel wells.

4.3.7.4 Groundwater Tentatively Identified Compounds. TVOAs were detected in Round 1 samples from wells G11S, US3D, US3I, US4D, US4S, US6D, US6S, and W5S at concentrations ranging from 5 ug/l to 38 ug/l. TVOAs were detected in Round 2 only the sample from well W5S at concentrations ranging from 7 ug/l to 26 ug/l, and the trip blanks at concentrations ranging from 3 BJ ug/l to 11 BJ ug/l

4.3.8 Analytical Results Comparison of Upgradient vs. Downgradient Wells

4.3.8.1 VOCs *VOCs were not detected in Round 1 or 2 groundwater samples collected* from the upgradient monitoring wells (i.e., W7D, US1S/US1D). VOCs were detected in down-gradient upper aquifer monitoring wells W5S (Vinyl chloride: Round 1, 19 ug/L; Round 2, non-detect), US4S (1,2-DCE: Round 1, 35 ug/L; Round 2, 44 ug/L). VOCs were detected in down-gradient lower aquifer monitoring well US3D (Vinyl chloride: Round 1, 28 ug/L; Round 2, 35 ug/L; 1,2-DCE: Round 1, 11 ug/L; Round 2, 18 ug/L). Results are summarized in Table 4-4.

4.3.8.2 SVOCs SVOCs were not detected in any groundwater samples collected during Round 1. Round 2 groundwater samples were not analyzed for SVOCs.

4.3.8.3 Pesticides/PCBs Pesticides/PCBs were not detected in any groundwater samples collected during Round 1. In accordance with the Work Plan, the Round 2 groundwater samples were not analyzed for Pesticides/PCBs because these compounds were not detected in Round 1 samples.

4.3.8.4 Groundwater Inorganics/Indicators The major metals as defined in the leachate section are calcium, magnesium, sodium, potassium, manganese, iron, and aluminum.

Lower Aquifer Wells - A comparison of results from upgradient (US1D and W7D) and downgradient (US4D, US6D and US3D) lower aquifer wells indicates that no well-defined consistent differences were noted in major metals or indicators concentrations in samples collected from the lower aquifer wells.

Upper Aquifer Wells - A comparison of results from upgradient (US1S) and downgradient (US6S, US4S, W5S and W6S) upper aquifer wells indicates that average concentrations of the major metals calcium, magnesium, sodium, iron, and potassium were generally higher in the downgradient wells. Manganese was noted at a higher concentration in downgradient well US6S compared to upgradient well US1S, but at lower concentrations in all of the other downgradient wells. Aluminum was not detected in any of the wells listed, so no comparison was possible.

The major indicators alkalinity, TOC, and TDS were consistently higher in the downgradient wells than in upgradient well US1S. A comparison of the remaining indicator parameters revealed no consistent trends.

4.4 VILLAGE/PRIVATE WELLS

Village wells VW3 and VW5, and private wells PW1, PW2, PW3, and PW5 were sampled during the Round 1, and were analyzed for VOCs, SVOCs, and metals. Round 2 samples were collected from village wells VW3, VW5 and VW4, and were analyzed for VOCs only. Round 1 and Round 2 results are presented in tabular form in Appendices O-18 through O-21, and P-8, respectively. Detected organic compounds are summarized in Table 4-5.

4.4.1 Village/Private Well Volatile Organic Compounds

4.4.1.1 Village Wells. The compound carbon disulfide was the only VOC detected in any of the Round 1 village samples. Carbon disulfide was detected in village well sample VW5/VW5-duplicate (0.6 J ug/l/0.6 J ug/l). No VOCs were detected in village well sample VW3 in the Round 1 samples.

Acetone and 1,2-dichloroethene were detected at concentrations of 11 J ug/l and 0.7 J ug/l, respectively, in the Round 2 sample from village well VW3. Acetone and cis-1,2-dichloroethene were detected at concentrations of 6 J ug/l and 0.5 J ug/l, respectively, in the Round 2 sample collected from village well VW4. Cis-1,2-dichloroethene and chloroform were detected at concentrations of 0.7 J ug/l and 0.5 J ug/l, respectively, in the duplicate sample collected from village well VW4. 1,2-Dichloroethene was the only compound detected in the Round 2 sample collected from village well VW5 (0.8 J ug/l).

4.4.1.2 Private Wells. No VOCs were detected in the Round 1 private well samples.

4.4.2 Village/Private Well Semi-Volatile Organic Compounds

4.4.2.1 Village Wells. 2-Methylphenol was detected in village well VW5 (0.5 J ug/l) sample, but not in the sample VW5-duplicate. 4-Chloroaniline was detected in village well VW3 sample at a concentration of 0.7 J ug/l. No other SVOCs were detected in the village wells.

4.4.2.2 Private Wells. 2-Methylphenol (0.9 J ug/l) was detected in the sample collected from private well PW2.

4.4.3 Village/Private Well Pesticides/PCBs

4.4.3.1 Village Wells. No pesticides or PCBs were detected in the Round 1 village well samples.

4.4.3.2 Private Wells. No pesticides or PCBs were detected in the Round 1 private well samples.

4.4.4 Village/Private Well Inorganics

4.4.4.1 Major Metals The major metals are defined in the leachate section are calcium, magnesium, sodium, potassium, manganese, iron and aluminum, and are discussed below.

4.4.4.2 Village Wells. Calcium, magnesium sodium and potassium were detected in each of the village well samples. The calcium concentrations ranged from 41,000 ug/l (VW3) to 55,400 ug/l (VW5). Magnesium concentrations ranged from 29,800 ug/l (VW3) to 37,400 ug/l (VW5-duplicate). Potassium concentrations ranged from 1,490 B ug/l (VW3) to 1,590 B ug/l (VW5). Sodium concentrations ranged from 27,800 ug/l (VW5) to 41,300 ug/l (VW3).

Aluminum was only detected in the sample collected from village well VW5 at a concentration of 55 B ug/l, and was not detected in the VW5 duplicate sample or in the VW3 sample. Manganese was detected at a concentration of 10 B ug/l in both the VW5 sample and VW5-duplicate sample. Iron was detected at concentrations of 646 ug/l (VW3) and 1,100 ug/l in the VW5/VW5-duplicate.

4.4.4.3 Private Wells. Calcium ranged from 25,600 ug/l (PW5) to 82,700 ug/l (PW1). Magnesium ranged from 14,500 ug/l (PW3) to 47,600 ug/l (PW1). Potassium ranged from 1,060 B ug/l (PW5) to 2,320 B ug/l (PW1). Sodium concentrations ranged from 53,000 ug/l (PW2) to 60,600 ug/l (PW5).

Aluminum was only detected in private well PW3 at a concentration of 75 B ug/l and not in any of the other three samples. Concentrations of iron ranged from 162 ug/l (PW5) to 3,050 ug/l (PW1). Manganese was not detected in samples from wells PW2, PW3, or PW5, but was detected in the sample from PW1 (26 ug/l).

4.4.5 Field Measurements

4.4.5.1 Village Wells. Round 1 pH measurements for village well samples VW3 and VW5 were 7.45 and 7.52 units respectively. Round 1 Specific conductivity measurements were 658 umhos/cm and 750 umhos/cm respectively for VW3 and VW5.

Round 2 pH measurements ranged from 7.32 (VW3) to 7.61 units (VW4). Round 2 specific conductivity measurements ranged from 574 umhos/cm (VW3) to 685 umhos/cm (VW5).

4.4.5.2 Private Wells. The field measurements pH and specific conductivity were measured for private well PW2, PW3 and PW5 samples. pH measurements ranged from 7.59 units (PW3) to 8.13 units (PW5). Specific conductance measurements ranged from 610 umhos/cm (PW3) and 625 umhos/cm (PW2 and PW5).

4.4.6 Other Minor Inorganic Constituents

4.4.6.1 Village Wells. Antimony, beryllium, cadmium, cobalt, copper, lead, mercury, nickel, thallium, selenium, vanadium and cyanide were not detected in the village well samples. Arsenic was detected in village well samples ranging from 2.1 B ug/l (VW3) to 4.5 B ug/l (VW5-duplicate). Barium was detected at concentrations ranging from 59B ug/l

(VW3) to 94 B ug/l (VW5). Zinc was detected at a concentration of 25 ug/l in the sample collected from village well VW3, but was not detected in village well VW5 samples. Chromium was not detected in village well sample VW3, but was detected in village well VW5 at concentrations of 0.25 B ug/l (VW5) and 0.24 B ug/l (VW5-duplicate).

4.4.6.2 Private Wells. Antimony, beryllium, cadmium, mercury, nickel, thallium, selenium, and cyanide were not detected in the private well samples. Barium and chromium were detected in each of the private well samples. Barium concentrations ranged from 61 B ug/l (PW5) to 260 ug/l (PW1). Chromium ranged from 0.2 B ug/l (PW3) to 0.89B ug/l (PW1). Zinc was detected in the PW1 sample (73 ug/l) and the samples collected from private wells PW3 (608 ug/l) and PW5 (48 ug/l), but was not detected in the sample from PW2. Cobalt was detected at a concentration of 10 B ug/l in the PW2 sample but not in the other private well samples. Copper (26 ug/l), lead (5.5 ug/l), and vanadium (2.7 B ug/l) were detected in the sample collected from private well PW1, and were not detected in the samples from the other private wells.

4.5 SURFACE WATER

Three surface water samples were collected from sampling locations in Sequoit Creek (upstream at location S101, down stream at location S301, and at a location between these two sampling points at S201) during the first Round of sampling and the samples were analyzed for TCL/TAL parameters.

In addition to collecting surface water samples from these sampling locations during the second Round of sampling, surface water samples were also collected from staff gage locations PSG1 and PSG2 and from three other sampling locations (S401, S501 and S601). Samples collected from sampling locations PSG1, S401 and S501 are upstream samples as is the sample collected from the S601 location, however, S601 was collected directly from Silver Lake. These samples were analyzed for TCL/TAL parameters.

Round 1 and 2 results are presented in tabular form in Appendices O-22 through O-26, and P-9 through P-13, respectively. Analytical results for detected organic compounds are summarized in Table 4-6.

4.5.1 Surface Water Volatile Organic Compounds

2-Hexanone and 4-methyl-2-pentanone were only VOCs detected in the Round 1 surface water samples at concentrations of 3 J ug/l and 2 J ug/, respectively, in the sample collected from the sampling location S301. These compounds were not found in the duplicate sample collected at location S301.

No VOCs were detected in Round 2 surface water samples.

4.5.2 Surface Water Semi-Volatile Organic Compounds

SVOCs were not detected in any of the first or second Round surface water samples.

4.5.3 Surface Water Pesticides/PCBs

No pesticides or PCB compounds were detected in any of the first or second Round surface water samples.

4.5.4 Surface Water Inorganics

4.5.4.1 Major Metals. The major metals as defined in the leachate section are calcium, magnesium, sodium, potassium, manganese, iron and aluminum, and are discussed below.

Calcium, magnesium, potassium and sodium were detected in each of the surface water samples collected during the first and second sampling Round s. Calcium ranged from 46,700 ug/l (S201) to 52,600 ug/l (S101) based upon Round 1 samples. In Round 2, Calcium was detected at concentrations ranging from 42,400 ug/l (S601) to 49,000 ug/l (PSG2). In Round 1, magnesium ranged from 24,900 ug/l (S201) to 25,700 ug/l (S101), and in Round 2, magnesium ranged from 24,200 ug/l (S601) to 26,200 ug/l (PSG1).

Sodium ranged from 26,000 ug/l (S101) to 35,000 ug/l (S301) in Round 1, and in Round 2, concentrations of sodium ranged from 24,100 ug/l (S601) to 35,600 ug/l (S401-dup.). Potassium concentrations ranged from 2,010 B ug/l (S301-duplicate) to 2,210 B ug/l (S101) based upon Round 1 results, and potassium concentrations ranged from 2,430 B ug/l (S601) to 2,760 B ug/l (PSG2) in Round 2.

Concentrations of manganese ranged from 50.9 ug/l (S101) to 56.8 ug/l (S201). in Round 1 and in Round 2, manganese concentrations ranged from 24.2 ug/l (S401) to 130 ug/l (S601). Round 1 concentrations of iron ranged from not detected in sample collected from sampling location S101 to 424 ug/l in the S201 sample. In Round 2, iron was not detected in samples from locations S101, PSG1, S401, S501, and S601, but was detected in at PSG2 (190 ug/l), S201 (192 ug/l), S301 (193 ug/l), and S401-duplicate (163 ug/l). Aluminum was detected in each of the samples collected during the first sampling Round and ranged from 55.5 B ug/l (S301) to 113 ug/l B (S101). Aluminum was not detected in Round 2 samples.

4.5.4.2 Field Parameters. Round 1 pH measurements ranged from 7.65 (S201) to 8.05 (S101). Round 2 pH measurements ranged from 7.55 (PSG2) to 8.07 (S601). Round 1 specific conductance measurements ranged from 500 umhos/cm (S101) to 597 umhos/cm (S301), and Round 2 specific conductance measurements ranged from 533 umhos/cm (S601) to 606 umhos/cm (S401-duplicate).

Round 1 dissolved oxygen determinations ranged from 4.6 mg/l (S301) to 9 mg/l (S201). During Round 2, PSG1, S401, S401-duplicate samples had dissolved oxygen measurements greater than 15 mg/l. Dissolved oxygen ranged from 7 mg/l (S201) to 15 mg/l (PSG2, S501 and S601) for the remaining Round 2 surface water locations. Round 1 oxidation/reduction potential determinations ranged from 61mV (S201) to 118 mV (S101, S301). Round 2 oxidation/reduction potential determinations ranged from 133 mV (PSG2) to 223 mV (S201).

4.5.4.3 Minor Constituents. Arsenic, beryllium, cobalt, mercury, nickel, silver, selenium, thallium, vanadium, zinc and cyanide were not detected in Round 1 or Round 2 surface water samples.

Antimony was detected at a concentration of 27.6 B ug/l in the Round 1 S301-duplicate sample, but was not detected in the other Round 1 or Round 2 samples. Barium was detected in each Round 1 sample, ranging in concentrations from 19.4 ug/l (S101) to 22.2 ug/l (S201; S301 duplicate). Barium was detected in Round 2 samples at concentrations ranging from 16.5 B ug/l (S501) to 22.6 B ug/l (S301).

Cadmium and chromium were only detected in the Round 1 S101 sample at concentrations of 3.3 B ug/l and 3.2 B ug/l, respectively, and they were not detected in the other Round 1 or Round 2 samples. In Round 1, copper was detected at concentrations of 2.3 B/J ug/l (S101) and 2.1 B/J ug/l (S201), but was not detected in the other Round 1 sample or the Round 2 samples. Lead was detected at 2.0 B ug/l (S301), but not in any of the other Round 1 or Round 2 samples.

4.5.5 Surface Water Tentatively Identified Compounds

One TOVA was detected in the Round 1 surface water samples at 5 J ug/l (S301). No tentatively identified compounds were found in the surface water samples from Round 2.

4.5.6 Analytical Results Comparison of Upstream vs. Downstream Surface Water Samples

4.5.6.1 VOCs 2-Hexanone (3J ug/L) and 4-methyl-2-pentanone (2J ug/L) were detected in the downstream sample S301, however these compounds were not detected in the S301 duplicate sample. No other VOCs were detected in any of the Round 1 surface water samples,. and no VOCs were detected in any of the Round 2 surface water samples. These results indicate that the surface water has not been impacted by VOCs, and therefore, a comparison of upstream versus downstream samples is neither possible nor necessary.

4.5.6.2 SVOCs SVOCs were not detected in any of the Round 1 or Round 2 surface water samples.

4.5.6.3 Pesticides/PCBs Pesticides/PCBs were not detected in any of the Round 1 or Round 2 surface water samples.

4.5.6.4 Inorganics Concentrations of barium were generally higher in the downstream samples (i.e., S301; 22.6 ug/L) when compared to the upstream samples (i.e., S601; 16.8 ug/L); concentrations of sodium were generally higher in the downstream samples (33,900 ug/L in S301) when compared to the upstream samples (24,100 ug/L in S601). Sample S301 was collected from Sequoit Creek near the northwest corner of the H.O.D. site. Conversely, manganese concentrations were higher in the upstream samples (130 ug/L in S601) when compared to the downstream samples (39.6 ug/L in S301). Sample S601 was collected from Silver Lake, which is southeast of the Site.

4.6 SEDIMENTS

Sediment samples were collected from the bed of Sequoit Creek during the second Round of sampling co-located with the surface water sample locations (S101 through S601, PSG1 and PSG2). Tabular results are presented in Appendices P-2 through P-6, and detected concentrations are summarized in Table 4-7. The upstream locations are S101, S401, S501, and S601. The downstream locations are S201, S301, PSG1, and PGS2. Sediments samples were not collected during the first sampling Round. The sediment samples were analyzed for TCL/TAL parameters, total organic carbon (TOC) and total solids.

4.6.1 Sediment Volatile Organic Compounds

No VOCs were detected in the sediment samples.

4.6.2 Sediment Semi-Volatile Organic Compounds

SVOCs were not detected in samples collected from locations S101, S401, S501, S601, PSG1, and PSG2. SVOCs were detected in the sediment samples collected from locations S201 and S301.

Fluoranthene, pyrene and bis(2-ethylhexyl)phthalate were detected in the S201 sediment sample located in the creek near the southwest corner of the site at concentrations of 380 J micrograms per kilogram (ug/kg), 370 J ug/kg, and 940 J ug/kg, respectively.

Phenanthrene (310 J ug/kg), fluoranthene (680 J ug/kg), pyrene (580 J ug/kg), benzo(a)anthracene (250 J ug/kg), chrysene (300 J ug/kg), bis(2-ethylhexyl)phthalate (1,500 ug/kg), benzo(b)fluoranthene (430 J ug/kg) and benzo(a)pyrene (290 J ug/kg) were detected in the sediment sample collected from the S301 location, which is near the northwest corner of the site.

The presence of SVOCs was noted primarily in sediment sample S301, collected from the bed of Sequoit Creek adjacent to the northwest corner of the site. Concentrations of selected SVOCs, primarily PNAs, may be due to impact from either on-site sources (i.e., the landfill) or may be associated with potential off-site sources (i.e., the historical operations of the Sequoit Acres Industrial Park). As shown on Figure 9, a fill area of unknown composition is located adjacent to the west bank of Sequoit Creek (near the S301 sampling location). With the exception of bis(2-ethylhexyl)phthalate, the SVOC compounds detected in the S301 sample (Table 4-7) were not detected in the leachate samples from the H.O.D. site (Table 4-7). The SVOC compounds detected in leachate samples consisted primarily of phenols and phthaltes.

4.6.3 Sediment Pesticides/PCBs

No pesticide or PCBs were detected in any of the sediment samples.

4.6.4 Sediment Inorganics

The upstream-downstream relationships among the sediment sample inorganic results were evaluated in the Baseline Risk Assessment (ICF/Weinberg, Aug. 1994) using a t-test at a 0.05 level of significance, and determined that only arsenic was detected at statistically significant concentrations in downstream samples. The upstream concentrations ranged from not detected (S601) to 4.5 mg/kg (S401 Dup), while the downstream concentrations ranged from 5.5 (S301) to 7.2 (PSG1) mg/kg.

4.6.5 Sediment Tentatively Identified Compounds

TSVOCs were detected in each of the sediment samples ranging in concentration from 290 J ug/kg to 16,000 NJ ug/kg.

4.6.6 Analytical Results Comparison of Upstream vs. Downstream Sediment Samples

VOCs and Pesticides/PCBs were not detected in sediment samples, therefore, no evaluation for these constituents is necessary. The SVOC data indicates that the downstream impacts on sediments may be due to either on-site or off-site sources. No other sediment samples contained SVOCs, therefore, a more involved upstream-downstream comparison is not warranted. As noted (and briefly discussed) in Section 4.6.4, a comparison of inorganic constituents was conducted as part of the Baseline Risk Assessment.

4.7 SURFACE SOILS

Five surface soil samples (SU01 through SU05) and one duplicate (SU04 Dup) and analyzed for TCL/TAL parameters. Tabular results are presented in Appendices O-8 through O-12, and results are summarized in Table 4-8. The sample SU01 was collected from the leachate seep located on the south slope of the new landfill. The SU02 sample is located in the area of landfill gas seepage through the cap in an area on the south slope of the new landfill. The SU04 and SU05 samples are also located on the new landfill in areas where discolored soil or standing water was observed. The SU03 sample was collected from an area located near the southeast corner of the old landfill in the wetland area. This sample was collected in an area of discolored surface soil and stressed vegetation.

4.7.1 Surface Soil Volatile Organic Compounds

VOCs were not detected in the surface soil SU05, but were detected in surface soil samples SU01, SU02, SU03, and SU04. The VOCs detected can generally be divided into the aromatics (benzene, ethylbenzene, toluene and xylenes) group and the methylene chloride/acetone group.

Benzene was detected only once at 7 ug/kg in the sample from location SU01. Ethylbenzene was detected only in the samples from locations SU01 (240 ug/kg) and SU02 (12 ug/kg). Toluene was detected in the samples from locations SU01 (55 ug/kg), SU02 (3 ug/kg), SU04 Dup (2 ug/kg), but not in the SU04 or SU05 samples. Xylenes were detected in the samples from location SU02 (37 ug/kg) and SU01 (280 ug/kg).

Methylene chloride was not detected in the sample from location SU05, but was detected in the samples collected from the other four locations. The methlyene chloride detected concentrations ranged from 48B ug/kg (SU03) to 1,200B ug/kg (SU04). Acetone was not detected in the samples collected from locations SU04 and SU05 but was detected in the other samples ranging from 8 ug/kg (SU03) to 140 ug/kg (SU01).

4.7.2 Surface Soil Semi-Volatile Organic Compounds

The SVOCs detected in the surface soil samples can generally be grouped into phthalates (bis (2-ethylhexyl)phthalate), and PAHs (acenaphthene, anthracene, benzo(b)fluoranthene, carbazole, dibenzofuran, fluoranthene, fluorene, 2-methlynaphthalene, naphthalene, phenanthrene, and pyrene).

The compound bis (2-ethylhexyl)phthalate was detected in each of the surface soil samples and ranged from 160 ug/kg (SU01) to 9,600 ug/kg (SU05).

PAHs were detected in each of the collected surface soil samples. Acenaphthene was detected in the sample from locations SU01 (120 ug/kg) and SU02 (1000 ug/kg). Anthracene was detected only once in the sample from location SU01. Benzo(b)fluoranthene was detected only once in the sample collected from location SU03 (110 ug/kg). Carbazole was detected only once in the sample from location SU01 (130 ug/kg). Dibenzofuran was detected only in the samples from locations SU01 (59 ug/kg) and SU02 (620 ug/kg). Pyrene and fluoranthene were detected in the samples collected from locations SU01, SU03, SU04 and SU05 but not in the SU02 sample. Pyrene ranged from 52 ug/kg (SU04) to 110 ug/kg (SU03), and the fluoranthene concentrations ranged from 59 ug/kg (SU04) to 160 ug/kg (SU03).

Fluorene was detected only in the samples from locations SU01 (68 ug/kg) and SU02 (500 ug/kg). Phenanthrene was detected in each of the surface soil samples, excluding SU04 Dup, at concentrations ranging from 36 ug/kg (SU04) to 250 ug/kg (SU01). 2-methlynaphthalene was detected only in the samples from locations SU01 (61 ug/kg) and SU02 (390 ug/kg). Naphthalene was detected only in the samples from locations SU01 (320 ug/kg) and SU02 (630 ug/kg).

The compound 1,4-dichlorobenzene was detected at a concentration of 130 ug/kg in the SU01 sample.

4.7.3 Surface Soil Pesticides/PCBs

PCBs were not detected in the surface soil samples. The only pesticide detected was 4,4-DDD in the sample collected from the SU01 location at a concentration of 4.3 ug/kg.

4.7.4 Surface Soil Inorganics

Background/site soil relationships among the sediment sample inorganic results were evaluated in the Baseline Risk Assessment (ICF/Weinberg, Aug. 1994) using a t-test at a 0.05 level of significance, and they determined that none of parameters were statistically significantly above the available background Round data. Aluminum, beryllium, cadmium, and chromium were identified as chemicals of potential concern due to the lack of background Round data for these parameters.

Aluminum was detected in each of the five soil samples with concentrations ranging from 6,260 (SU02) mg/kg to 8,740 mg/kg (SU04). Beryllium was detected in each of the soil samples at concentrations ranging from 0.5 B mg/kg (SU04) to 0.74 B mg/kg (SU05). Cadmium was detected only in the soil samples from location SU03 (1 mg/kg) and SU05 (1.3 mg/kg). Chromium was detected in each of the soil samples at concentrations ranging from 10.4 mg/kg (SU02) to 16.1 mg/kg (SU05).

4.7.5 Surface Soil Tentatively Identified Compounds

TVOAs were detected in the soil samples from SU01 and SU02 ranging in concentration from 4 ug/kg to 150 ug/kg. TSVOCs were detected in each of the soil samples ranging in concentration from 170 ug/kg to 3300 ug/kg.

DISCUSSION

A discussion of the RI results follows in these subsections.

4.8 SURFICIAL SAND

The H.O.D. Landfill leachate and gas contain VOCs in the ketone, aromatic, alkene, alkane groups, and a miscellaneous group. The groundwater samples collected from wells in the surficial sand immediately adjacent to the landfill in which VOCs were detected were found to only contain alkenes and carbon disulfide. This indicates that contaminants potentially migrating from the landfill are being attenuated such that entire groups are not detected in these groundwater samples.

The concentrations of the VOCs detected in the surficial sand well groundwater samples immediately adjacent to the landfill are relatively low (i.e., ranging up to 44 ug/l). In addition, the presence of VOCs in the groundwater samples appears to vary over short distances as indicated by the results from wells well groups W6S and US6S, and US4S and W5S. In the case of well group W6S and US6S, VOCs were not detected in the samples from US6S, and VOCs were only detected in one of the two samples collected from well W6S. In the case of well group US4S and W5S, 1,2-dichoroethene was detected in both samples from well US4S, but was not detected in the samples from W5S. Vinyl chloride was detected in a sample from well W5S, but was not confirmed in the second sampling Round.

The compounds detected in these groundwater samples were not detected in either Round of the surface water samples, indicating that the VOCs are being further attenuated as the surficial sand groundwater migrates towards and discharges to the creek. Surficial sand wells located on the opposite side of the creek relative to the landfill also were not found to contain VOCs in either Round of sampling, indicating that such groundwater is not being impacted by a release of VOCs from the H.O.D. Landfill, or any other potential source of VOCs (i.e., disposal activities at the Sequoit Acres Industrial Park)(Figure 9).

It is possible that the VOCs in the groundwater samples collected from the surficial sand well are being impacted by landfill gas. The compounds detected in the groundwater samples were detected in the landfill gas and landfill gas has been found to be present in the area. A carbon isotope study previously performed by WMII indicated that the sample results from wells US4S, US1S, US6S, G14S, G102, R103 in the on-site surficial sand, well G14D in the on-site clay diamict, and wells US1D, US5D, and US6D in the deep sand and gravel were depleted in ^{13}C isotope. A depletion in the ^{13}C isotope indicates no evidence of leachate mixing with the groundwater in the vicinity of these samples. Baedecker and Back (1979) found that landfill generation of carbon dioxide and methane via biological decay results in an enrichment of ^{13}C in the landfill leachate, because ^{12}C is preferentially utilized during the biological processes. The H.O.D. Landfill leachate is enriched with ^{13}C, consistent with the results of Baedecker and Back (1979), included as Appendix R. (WMII, 1991)

The presence of dissolved manganese may be due to reduction of manganese minerals in the surficial sand during biodegradation processes (Derek, 1991).

4.9 CLAY DIAMICT

Trichloroethene (TCE) was detected in the groundwater sample from well US6I at 2J ug/l and 1 J ug/l. The TCE concentrations in samples collected from well US6I since 1987 exhibit a decreasing trend. In 1987 the TCE concentration was 7 ug/l, in 1988 the TCE concentration was 5.3 ug/l (5/88) and 5 ug/l (8/88) (Table 4-9).

4.10 DEEP SAND AND GRAVEL

VOCs were only detected in the groundwater samples from the deep sand and gravel well US3D, which is located off-site in the industrial park to the west. The VOCs detected were vinyl chloride (28 ug/l to 35 ug/l) and 1,2-dichloroethene (11 ug/l to 18 ug/l). Acetone (6 J ug/l) and 1,2-dichloroethene (0.5 J ug/l) were the only VOCs detected in the sample from village well VW4, which is the closest water supply well to well US3D. The concentration of compounds detected in wells US3D and VW4 indicate that the VOCs in the vicinity of well US3S are being attenuated to nearly undetectable levels in the water pumped from well VW4. However, presence of acetone and absence of vinyl chloride in the sample from well VW4 could also indicate that there is a different source of VOCs in the sample from well VW4, or that a longer screen length (20 ft) as compared to US3D (5 ft) resulted in the dilution of the sample. Also, the sample collection method utilized for VW4 may have resulted in volatilization of these compounds. The presence of acetone may be due to laboratory contamination.

VOCs were detected in the on-site surficial sand wells US4S and W5S, but not in the on-site deep sand and gravel well US4D, indicating that VOCs in the surficial sand at that location are not migrating through the clay diamict to impact the deep sand and gravel in the vicinity of US4D. However, the screened interval may not be optimally located (vertically) to allow for the detection of VOCs detected in US3D located west of US4D. The screened interval in US3D is placed approximately 10 ft below the base of the clay diamict, whereas the screened interval of US4D is located approximately 30 ft below the base of the diamict. This may account for the lack of VOCs in the sample collected from US4D.

The groundwater inorganic chemistry plotted on a Piper diagram (Figure 28) indicates that samples collected from the surficial sand and the deep sand and gravel are enriched in carbonate, calcium, and magnesium, with generally lower concentrations of sodium, potassium, sulfate, and chloride. The only exception noted, was the sample collected from W6S, which contained higher concentrations of sulfate and chloride. Samples collected from the intermediate clay till wells were generally noted as containing higher concentrations of carbonates than the shallow or deep wells.

The continuity, thickness and texture of the clay-rich diamict indicates that it serves as an aquitard between the surficial sand and the deep sand and gravel. Numerous soil borings have been performed in the vicinity of the H.O.D. Landfill (Figure 4) to define the subsurface conditions. The clay-rich diamict isopach map shows the estimated lateral extent and thickness of the unit in the vicinity of the site (Figure 18). Based upon the available data, the clay-rich diamict is continuous beneath the site. The regional cross-section indicates that the clay-rich diamict is regionally extensive (Drawing 10010202-F3). Beneath the majority of the site, the clay-rich diamict thickness ranges from an estimated 40 ft to over 70 ft, with small areas with estimated thicknesses greater than 90 ft to less than 30 ft. The geotechnical analyses classify the clay-rich diamict samples as a gravelly, sandy, silty, or lean clay (CL to CL-ML).

The differences in the hydraulic heads from the surfical sand and the deep sand and gravel also indicates that the clay diamict is continuous and provides resistance to downward vertical flow (i.e., low hydraulic conductivity). Based upon water level elevations observed at the site, there is approximately 30 to 35 ft of hydraulic head decrease between the surficial sand and the deep sand and gravel (Table 3-5).

The USGS pump test evaluation determined that the hydraulic conductivity of the clay diamict is 2.1E-06 cm/sec (Appendix B). Slug testing performed in previous studies indicated that the hydraulic conductivity ranged from 7.9E-06 cm/s to 8.0E-06 cm/s (Table 3-15). Laboratory permeability test results indicate that the hydraulic conductivity of the clay-rich diamict ranges from 1.5 0E-08 cm/s to 1.70E-08 cm/s (Table 3-12). Each of these results indicate that the hydraulic conductivity is much lower than the hydraulic conductivity of the deep sand and gravel, or the surficial sand (Tables 3-14 and 3-15).

Nevertheless, VOCs have been detected in samples from wells screened in the off-site deep sand and gravel. One potential mechanism to transport VOCs to the off-site deep sand and gravel is via leaking abandoned boreholes and leaking well seals. Patrick Engineering (1989) indicated that the exploratory boreholes for the Village wells may provide a pathway from the surficial sand to the deep sand and gravel. The results of the USGS aquifer pumping test conducted in VW-4 noted that drawdown was not observed in shallow (i.e., upper aquifer) wells during the test, and it was further concluded that the test results could not be used to determine conclusively whether a hydraulic connection exists between the upper aquifer and the clay diamict, or between the upper and lower aquifers.

The variability in the chloride concentrations in samples from the off-site deep sand and gravel wells could be explained by such a mechanism. The chloride concentrations in the on-site deep wells ranges from 3 mg/l (US4D) to 8 mg/l (US6D). In the off-site deep sand and gravel wells, chlorides were observed as follows: 22 mg/l (US1S), 144 mg/l (US3D) and 153 mg/l (W3). This wide variation could indicate localized releases of chloride-impacted groundwater from the surficial sand to the deep sand and gravel through leaking boreholes/well seals. A general release of chlorides from the surficial sand would result in generalized chloride impacts to the clay diamict and the deep sand and gravel.

The potential for leaking well seals was demonstrated at well PZ2, which was found to have a leaking seal as indicated by the water level trends, and was replaced with a double-cased well. Village Well No. 4 (VW-4) was apparently constructed without a double-casing through the surficial sand, as no such casing is reported on the drillers log. The greatest potential for well seal leakage is where the hydraulic head difference is greatest, such as at a pumping well. An intermittently pumped well would allow for periods of leakage into the deep sand and gravel without immediate collection by the extraction pump. VW-4 is reportedly drilled through the waste of the Cunningham Dump (Patrick, 1989). The potential exists for contaminants to migrate downward via the borehole annulus into the deep sand and gravel aquifer.

4.11 SEQUOIT CREEK SURFACE WATER RESULTS

VOCs were only detected in one surface water sample collected during Round 1. 2-Hexanone (3J ug/L) and 4-methyl-2-pentanone (2J ug/L) were detected at the S301 sampling location adjacent to the northwest corner of the landfill in Round 1. No other VOCs were detected in any of the other Round 1 or Round 2 samples. In addition, no SVOCs or Pesticides/PCBs were detected in any of the Round 1 or Round 2 surface water samples.

Based on an upstream versus downstream comparison of the inorganic analytical results presented in Section 4.5.6.4., the surface water samples collected from the downstream locations (i.e., S201 and S301) indicated elevated concentrations of sodium when compared to the upstream sample locations (S601). The inorganic concentrations detected in the surface water samples are much lower than the concentrations detected in the leachate samples (Section 4.1.4.1). These results, therefore, indicate that the site leachate has not had a noticeable effect on the surface water quality of Sequoit Creek.

4.12 SEQUOIT CREEK SEDIMENT RESULTS

No VOCs or Pesticides/PCBs were detected in any of the sediment samples collected. The SVOCs that were detected consisted only of PNAs, with the exception of bis(2-ethylhexyl) phthalate. As discussed in Section 4.6.2, the presence of SVOCs may be due to either on-site or off-site sources (i.e., the "fill areas of unknown composition" located just west of the north-south leg of Sequoit Creek).

4.13 SURFACE SOILS RESULTS

Surface soil samples (collected during the Round 1 sampling activities) were collected from areas exhibiting discolored soils, leachate seeps, stressed vegetation, or standing water. These locations were chosen as "worst case" samples in order to document the effects of landfill gas and/or leachate generation on the shallow surface soils covering and/or immediately surrounding the landfill area.

The analytical results generally indicate that, in areas with potential visible evidence of impact, actual impact by VOCs (primarily aromatics and methylene chloride/acetone) and SVOCs (primarily phthalates and PNAs) were more prevalent. The highest concentrations of these compounds were noted in samples collected from areas where leachate and landfill gas seeps were documented (SU01 and SU02). No VOCs and few SVOCs were detected in the sample collected from the SU05 location north of the "new landfill" in an area of standing water and apparent stressed vegetation. Similarly, fewer VOCs and SVOCs (as compared to SU01 and SU02) were detected in the sample from the SU03 location (collected from the wetland area near the southeast corner of the "old landfill") and the SU04 location (collected from the area east of the "new landfill"). Based on these analytical results, it is apparent that leachate and landfill gas seepage through the landfill cap has resulted in impacts to the shallow soils in isolated areas (primarily VOCs and SVOCs).

PMS/dlp
J:\2386\0096\RI_FINAL\RI_TEXT\SECTION4.DOC

5

5.0 CONTAMINANT FATE AND TRANSPORT

5.1 INTRODUCTION

This section provides a review of physical and chemical mechanisms that may affect the concentration and behavior of chemicals of potential concern identified in the Risk Assessment. Potential migration pathways are identified, and the fate and migration of specific contaminants found in various media in and in the vicinity of the site are discussed.

5.2 SOURCE OF CHEMICALS OF POTENTIAL CONCERN

Chemicals of potential concern have been detected in leachate within the landfill at the H.O.D. site and in the landfill gas samples collected from leachate piezometers at the landfill. The source of these chemicals in the leachate and gas is assumed to be the municipal refuse deposited within the landfill. Potentially, these same compounds may also be generated by the waste buried in the "dump" areas located west of the landfill (i.e., the former Quaker/Cunningham Dump). Therefore, in the vicinity of the H.O.D. landfill, the contaminant source(s) is located in the subsurface environment.

5.3 PRIMARY TRANSPORT PATHWAYS OF CONTAMINANTS OF CONCERN

Migration pathways are defined as routes along which contaminants migrating out of and away from a contaminant source (e.g. landfill leachate, off-site waste dumps) and travel towards groundwater, surface soil, surface water, and sediments.

The primary vehicle for mobilization of chemicals is the interstitial water in the waste. The primary transport of these chemicals from the source areas is through gas and groundwater migration.

Gas is created as organic wastes are anaerobically biodegraded and decomposed. Concentrations of constituents of the gas are dependent on the rate, volume, and composition of landfill gas generated. The rate of landfill gas generation is dependent on the age and moisture content of the refuse, the size and composition of the landfill, the quantity and quality of available nutrients, temperature, and the pH and alkalinity of the landfill. Gas generation in the reducing environment of the landfill is largely the product of the anaerobic decomposition of the refuse. Gas generation may be inhibited by either limitations on the above factors, or by the presence of toxic organic solvents or the common salts of sodium, potassium, magnesium, calcium, sulfides, or ammonium.

Gas pressure within the landfill builds up and gas migrates out of the waste through paths of least resistance. Gas produced in the off-site dump areas would migrate through the unsaturated soils overlying the refuse or through the refuse. At the H.O.D. Landfill, gas flares have been installed in the landfill to burn off excess gas. Landfill gas is migrating horizontally away from the landfill and through the landfill cap in several areas as described in Section 3.

Some landfill gas constituents may partition into the subsurface soil water, and potentially the groundwater, as the gas moves through the vadose zone. This is based on the tendency for a compound to diffuse from one phase in a direction towards establishing equilibrium between all phases. Henry's Law constants are essentially air-water partition coefficients, therefore, the potential for individual chemicals to partition between the landfill gas and soil water can be approximated through the review of the Henry's Law constants presented in Table 5-1. The potential diffusion for an individual chemical from landfill gas to water will generally be inversely related to its Henry's Law constant.

Leachate is produced through the solution/suspension of chemicals mobilized by the interaction of water with the refuse/waste. Water available for the production of leachate may enter the landfill interior in the following ways: 1.) precipitation, 2.) groundwater, and 3.) liquids included with waste at disposal.

Leachate may migrate out of the landfill in the following ways. Leachate may be released to groundwater, transported by the migration of the groundwater, or migrate to the surface water and sediments. Also, leachate may migrate through the landfill cover and potentially be released to the surface soils, surface water and sediments.

Leachate may be produced in the off-site dump areas in a similar manner and may also migrate to the groundwater, surface water, sediments, and soils.

Within the landfill, some chemicals are more easily mobilized than others, and as the leachate moves through the waste, its characteristics change and its ability to dissolve the various substances in the waste change. The characteristics of the surrounding and underlying geologic materials which determine how effectively chemicals are contained within the landfill (i.e., how effectively chemicals will be prevented from moving out of the landfill via migration mechanisms and pathways into the external environment).

The "new' portion of the H.O.D. landfill was planned and designed to contain these wastes and limit the migration of chemicals from the landfill structure. Measures included in the landfill design to limit off-site migration include:

- Constructing the landfill over geologic features which have low permeability, which limit leakage from the landfill.
- Emplacement of clay seals in areas where higher permeable materials were encountered during landfillling.
- Collection of leachate through a horizontal drain system and vertical wells.

- Including a layer or layers of low permeability materials in the landfill cover over both the "old" and "new" landfill (i.e., capping the landfill), to minimize infiltration of precipitation, thus minimizing the generation of leachate.

- Establishing and maintaining a dense stabilizing cover of vegetation to minimize erosion and maintain the integrity of the landfill cap covering both the "old" and "new" landfills. A dense stand of vegetation also serves to reduce deep infiltration, by evapotranspiring a portion of the precipitation which infiltrates the upper layer of the landfill cover.

- Installing gas flares which gradually release and destroy the landfill gas as it is vented to the atmosphere from both the "old" and "new" landfills.

5.4 CONTAMINANT TRANSPORT PATHWAY ATTENUATION MECHANISMS

5.4.1 Attenuation Mechanisms of Gas Migration

As chemical compounds dissolved within gas generated in the landfill or dump areas and migrate out of these source areas, the concentration of contaminants in the gas will be attenuated primarily through two processes as discussed below.

5.4.1.1 Dilution. As gas migrates away from the source area, dilution of the gas decreases the contaminant concentrations as it is transported away from the source. Dilution occurs through diffusion in air, which is the movement of contaminant constituents from areas of higher to areas of lower concentration and dispersion (i.e., mixing). Dilution of landfill gas in ambient air is rapid due to high concentration gradients between landfill gas and the atmosphere and the thorough mixing due to wind velocity and turbulent flow.

5.4.1.2 Photolysis. Certain chemicals of potential concern are subject to reactions initiated by the energy of sunlight. These reactions would occur in the air where potential chemicals of concern are readily exposed to sunlight. These reactions are affected by temperature and the presence of other reactive species.

5.4.2 Attenuation Mechanisms in Groundwater Systems

Subsurface physical and chemical mechanisms occurring in groundwater systems play a large role in the fate and migration of organic and inorganic contaminants. A mechanism may cause a contaminant to remain in solution, precipitate out of solution, be adsorbed to a surface, or transform or degrade into another compound or other compounds.

When water containing various chemical constituents moves through soil or groundwater containing different constituents, the concentration of materials in the outflow solution will change in composition in a manner which depends on the processes occurring in the soil or groundwater. Hydrodynamic dispersion, molecular diffusion, chemical reactions and exchange processes, and physical adsorption each may influence the composition of the solution flowing with the groundwater.

The following discussion summarizes each of the mechanisms commonly involved contaminant fate and transport in soil and hydrogeological formations.

5.4.2.1 Dilution. A chemical (solute) introduced into groundwater from a source, decreases in concentration as it is transported away from the source. This decrease in concentration (dilution) is generally mediated by three processes: (1) diffusion, which is the movement of solute molecules from areas of higher concentration to areas of lower concentration, and (2) dispersion, which has two components, transverse and longitudinal dispersion. Transverse dispersion results from the collision of solute elements which result in a change of movement direction. Longitudinal dispersion is a direct result of differential pore velocities. These processes each may contribute to the reduction of solute concentration with increased distance from the source. Attenuation by dilution of a chemical is independent of other mechanisms which may also affect solute concentrations during transport. Solutes, such as chloride, are affected only by dilution and these are referred to as "non-reactive" or "conservative".

5.4.2.2 Adsorption/Desorption. Solutes may be adsorbed or desorbed by organic matter and soil, often strongly influencing the rate of migration. Strongly adsorbed contaminants are relatively immobile and with limited transport by groundwater.

Adsorption/Desorption of Organic Compounds in Groundwater Systems - Hydrophobic organic compounds dissolved in aqueous solutions tend to adsorb onto solid phases that the water contacts as it moves through the soil. The amount of contaminant that is adsorbed is a function of soil grain size, mineral composition, organic content, solute composition, and solid concentration.

Of the variety of soil components that can influence adsorption rates, organic carbon content is generally the most significant. Based on a chemical's organic carbon/water partition coefficient (K_{OC}), and the soil organic carbon content (f_{OC}), the relative affinity of a compound for a soil matrix can be estimated. This can provide an estimate of the effect of adsorption on transport rates for various chemicals.

The retardation factor of a chemical describes the effect of sorption in decreasing the rate of contaminant transport in the liquid phase. The retardation factor is indexed to a species unreactive with the soil. A nonreactive species, such as chloride, would have a transport rate equal to the groundwater flow and would have a retardation factor equal to one (Rf=1).

The retardation factor is calculated as follows:

$Rf = 1 + (Pb/n) \times K_d$ (*Groundwater Chemicals Desk Reference*,
Montgomery, Welkom, 1990)
Where:
Rf = Retardation Factor (unitless)
Pb = aquifer bulk density (g/m3)
n = effective porosity (unitless)

K_d = distribution coefficient (ml/g)

and

$K_d = K_{oc} \times f_{oc}$

where:

K_{oc} = organic carbon partition coefficient
f_{oc} = organic carbon fraction

Aquifer bulk density (Pb) and effective porosity (n) are assumed to be 1.8 g/cm^3, and 0.3; typical values for sand and gravel soils. These values were assumed to represent the conditions in the surficial sand and deep sand and gravel provide estimates for a comparison of the effective rate of transport for various chemicals detected at the HOD Landfill Site. Retardation factors were calculated for a range of f_{oc} values which could conceivably be encountered at the HOD Landfill Site. Table 5-1 presents retardation factors for f_{oc} values of 0.05%, 0.1%, 0.5% and 0.1%. As shown, estimated retardation factors vary considerably between compounds, and for individual compounds, are directly related to the organic carbon content of the aquifer soil matrix. For example, at a foc of 0.1%, retardation factors for 1,2-dichloroethene and 1,4-dichlorobenzene are 1.2 and 11, respectively. Therefore, 1,2-dichloroethene would be expected to travel more quickly than 1,4-dichlorobenzene. PAHs such as benzo(b)fluoranthene, with retardation factors 1,000 times higher, would be expected to move very slowly.

Temperature, pH, Eh, and competition by other species may also have an effect on the adsorption of organic chemicals to the soil. These surfaces adsorb contaminants through a pH dependent charge. Decreasing groundwater pH generally increases positive charge and favors anion retention, while increasing pH favors cation adsorption.

Adsorption/Desorption of Inorganic Species in Groundwater Systems - The adsorption/desorption processes of inorganic species in groundwater systems cannot be directly calculated because there are many more variables potentially affecting the processes than those variables affecting adsorption/desorption of organic species. These factors affecting inorganic species adsorption (and, in some cases, organic species adsorption) include: pH, redox potential, microbial activity, presence and competition of other ionic species, and distribution of charge on the soil. While these factors are known to affect the adsorption/desorption processes, reliable methods are not available to quantify the factors in natural hydrogeologic environments.

Inorganic species may have multiple valence states exhibiting different adsorption behavior. Hydrogeochemical conditions affect how each chemical reacts. Geological matrix components such as hydrous metal oxides (Fe, Mn), amorphous aluminosilicates, layer lattice silicates (clays), and organic matter each provide significant adsorptive surfaces. These surfaces adsorb chemical ions due to a pH dependent charge. Decreasing reducing the dissolved metals concentration in the groundwater. The solubility of metal species present in the aquifer matrix controls precipitation of metals from groundwater.

5.4.2.6 Volatilization. Volatilization is the process of the transfer of a chemical from the liquid or solid phase to the gas phase. Because groundwater is a subsurface liquid, it and its constituents do not get the high degree of exposure to a gaseous medium needed for a significant amount of volatilization to take place. Subsurface air in the vadose zone is in contact with the water table surface. There may be an increase in the air-water surface contact in the vadose zone due to a fluctuating water table.

5.4.2.7 Hydrolysis. In an aqueous solution such as groundwater, free metal ions are complexed with water, i.e., they are hydrated. These hydrated metal ions may interact with acids and bases by donating a proton to water; or water may dissociate and donate a proton to a base. These reactions are called hydrolysis. The equilibria of such reactions are affected by pH and the buffering capacity of the solution. Although hydrolysis is not a primary process in attenuation of chemical concentration in groundwater, it may occur in specific environments.

5.4.3 Attenuation Mechanisms in Other Media

Chemicals of potential concern may also migrate into media other than groundwater and they may migrate from groundwater into other media including:

- Surface water
- *Sediment*
- Surface soil

Physical and chemical attenuation mechanisms occur in these media. The following discussion focuses on the mechanisms and identifies the media in which the mechanism may be operating at or in the vicinity of the H.O.D. site. The processes involved with most of the attenuation mechanisms were described in the discussion of attenuation mechanisms in groundwater.

5.4.3.1 Dilution. Dilution of solutes occurs in each of the above listed media. Dilution in surface water can occur more readily than in groundwater, because these fluids are not constrained by a soil or aquifer matrix, and mixing can be very thorough, due to turbulence of flow. Temperature varies more, contributing to greater circulation and mixing of solutions.

Sediments may be exposed to different units of surface water in a flowing stream (Sequoit Creek) and to a lesser degree in lakes, although mixing will occur due to temperature induced currents, especially in spring, when temperature inversion in the lake initiates vertical mixing.

Dilution occurs in the surface soil matrix by the mixing of closely held soil water containing chemicals of potential concern, with infiltrating precipitation water. Some of

5.5 FATE AND MIGRATION OF SITE CONTAMINANTS

5.5.1 Landfill Gas

Once generated, the gas migrates from areas of high gas pressure to areas of low pressure above the fluid levels in the landfill and is emitted through the following release pathways. Landfill gas migrates to the ambient air through leachate piezometer/gas wells, unlit gas flares, horizontally away from the landfill, in the subsurface and through areas of the landfill cap. The ensuing dilution of the gas is affected by wind speed, turbulence, temperature, height of the release point above the surrounding area, roughness of the surrounding area and decomposition through direct photolysis.

As described in Section 5.3, some landfill gas constituents may partition into the vadose zone soil water. Infiltration of the vadose zone soil water may present a potential transport pathway for landfill gas constituents to enter the shallow sand aquifer.

5.5.2 Organic Compounds in Leachate

Leachate samples collected from the H.O.D. Landfill contained a variety of compound groupings, including chlorinated alkanes and alkenes, ketones, aromatics, phenols, phthalates, PNAs, and PCBs.

The biodegradation of refuse materials under the reducing environment present in the landfill produces various degradation compounds in leachate. The biodegradation process may be consuming much of the organic contaminant mass and producing ammonia, methane, CO_2 and other anaerobic biodegradation abiological intermediate and end products. These chemical products are detected in the landfill leachate and gas. The indicator parameters, as well as, field parameters also indicate that a high level of anaerobic biodegradation is occurring.

Leachate percolating through the landfill mass provides the transport and mixing vehicle that promotes anaerobic biological and abiotic degradation of constituents. During this process some constituents and degradation products remain or are reintroduced into the liquid leachate, while some constituents partition into the gas phase and are found in the landfill gas. The chlorinated alkenes and alkanes which were detected in the leachate tend to biodegrade more readily under the reducing conditions present in the landfill.

The landfill leachate that is removed by the collection system is treated off-site, the remaining leachate moves out of the landfill mass into the surrounding subsurface soils or groundwater, or as surface seeps as described at the end of this section. As leachate moves from the landfill mass, conditions become less anaerobic (i.e., less reducing), providing an environment more favorable to aerobic degraders. It is under these conditions that the phenols, ketones, aromatics and to a lesser degree the PNAs and phthalates will more readily biodegrade.

In addition to the biodegradation, many of the same attenuation mechanisms described for groundwater in Section 5.4.2, would affect leachate constituents. Adsorption occurs in both the landfill mass and in the subsurface environment as leachate moves through the system. Adsorption is likely a significant attenuation mechanism for the relatively less soluble/less degradable leachate constituents such as the PNAs, phthalates and PCBs. Leachate from the landfill can mix with and be transported by groundwater, where dilution and groundwater attenuation mechanisms also influence contaminant concentrations.

In addition to the subsurface movement, a leachate seep was observed in a erosional cut in the cover near the center of the south slope of the new landfill. The leachate was flowing from the landfill and down the erosional cut towards the base of the landfill where standing water was observed during wet seasons.

5.5.3 Inorganics In Leachate

Relatively higher concentrations of metals were detected in the leachate than those which were detected in other media. Metals in leachate will migrate into the surface and subsurface environments along the same pathways described above. Metals concentrations in the leachate will tend to increase due to metal complexes dissolving into leachate from the refuse/waste in highly reducing anaerobic biodegradation conditions. These conditions are not suitable for metal precipitation which would reduce the metals concentrations. Metals in leachate migrating to surface and subsurface environments would be attenuated through dilution, adsorption, precipitation and oxidation reduction.

5.5.4 Organic Species in Groundwater

5.5.4.1 Surficial Sand/Clay Till. VOCs of concern were only detected in groundwater samples from one or both rounds from the shallow sand monitoring wells (1,2-dichlororethene: US4S/W6S and vinyl chloride: W5S). The dissolved organic contaminants of concern detected in the surficial sand are transported with groundwater flow. Groundwater from the vicinity of wells US4S and W5S is migrating west to southwest towards Sequoit Creek.

As discussed in Section 3.8.2, shallow groundwater within the surficial sand flows toward, and discharges to, Sequoit Creek. Groundwater elevation data also indicates the presence of a very slight downward vertical gradient (0.002 ft/ft) within the surficial sand aquifer. Groundwater elevation data also indicates the presence of a very slight downward vertical gradient across the clay-rich diamict aquitard. The measured gradient ranges from 0.4 ft/ft (calculated using data collected from wells US3I and US3D) to 2 ft/ft (calculated using data collected from wells US6S and US6I).

Although there exists a downward vertical component of groundwater flow within the upper aquifer and across the clay-rich diamict, preferential groundwater flow and contaminant migration is characterized by lateral flow within the surficial sand aquifer, with the groundwater discharging to Sequoit Creek in the vicinity of PSG2 (down-gradient from W6S) and PSG3 (down-gradient from US4S and W5S). These conclusions regarding groundwater flow and contaminant migration are primarily based on the hydraulic conductivity data collected during the RI field activities. These results indicate that the hydraulic values for the surficial sand are approximately two to four orders of magnitude greater than those values obtained for the clay-rich diamict (results discussed in Section 3.8.2.1 and 3.8.2.2).

Based on the information presented, groundwater flow and contaminant migration in the vicinity of the southeast (W6S) and southwest (US4S and W5S) corners of the old landfill is toward Sequoit Creek, with groundwater discharging to the Creek. The surface water and sediment analytical results indicate that the contaminants detected in shallow groundwater samples are either attenuated prior to discharge of groundwater into the Creek, or the concentrations are decreased due to dilution from surface water flow.

The carbon disulfide detected in the sample from well G11S in the sand lens located in the northwest corner of the old landfill is migrating with groundwater. The sand lens is being recharged by Sequoit Creek and groundwater is flowing away from the stream either towards the landfill or downward under a vertical gradient.

Along these pathways contaminants will be attenuated by dilution, adsorption and biodegredation. The fact that only low levels of two ketone compounds were detected in only the S301 surface water sample, indicates that the low levels of organic contaminants in the surficial sand are diluted, and consumed to low enough levels through biodegradation, that when they enter the stream water they are diluted and/or volatilize to undetectable or nearly undetectable levels.

Trichloroethene was detected in the clay till at well US6I. This compound will migrate with groundwater flow in the clay till. Groundwater flow is slow, predominantly downward, through the low permeable clay under a high hydraulic gradient. Although, within the clay the attenuation of organic and inorganic contaminants would be high primarily through adsorption. Further dilution would also occur and biodegradation would probably be limited with the clay till.

5.5.5 Deep Sand and Gravel

Contaminants of concern determined in the Risk Assessment were only detected in the off-site deep sand and gravel at village wells VW3, VW4 and VW5 and monitoring well US3D. The organic contaminants of concern in the first round samples collected from the village wells include carbon disulfide and 2-methylphenol (VW5), and 4-chloroaniline (VW3). Village well VW4 was not sampled. During the second round of sampling, contaminants of concern include acetone (VW3 and VW4), chloroform (VW4 duplicate), cis-1,2-dichloroethene (VW3, VW4 and VW4 duplicate), 1,2-dichloroethane (VW3 and VW5). The organic contaminants of concern in monitoring well US3D include vinyl chloride and 1,2-dichloroethene in both sampling rounds.

The contaminants detected in the deep sand and gravel will be transported with groundwater flow in the deep sand and gravel towards the pumping village well VW4 and

VW3 and into these discharge points. Contaminants will be attenuated through dilution biodegradation and adsorption.

5.5.5.1 Inorganic Species in Groundwater. Manganese detected in the surficial sand and deep sand and gravel was determined to be a contaminant of concern, in the Risk Assessment, were chosen based on one of two default reasons: 1) There were fewer than three samples in the data grouping; and 2) because regional background data was were not available.

Manganese may be from the identified contaminant sources; it may be naturally occurring, or it may be mobilized (such as through biodegradation) from soil matrices as metal complexes are dissolved into solution in various environments. Once in solution in groundwater it is then transported with groundwater and attenuated through various mechanisms.

Metals concentrations are reduced or increased based on the environment in which they are migrating. They are subject to the physical attenuation of dilution and through adsorption. Metals may assist in biodegradation but are not typically directly consumed by it. Indirectly biodegradation affects the attenuation of metals in groundwater due to changes in the environment (e.g. oxidizing/reducing) that may be caused by microbial activity reducing/increasing the concentrations of various chemicals. The metals may be attenuated through precipitation as the metal complex migrates from areas of reducing environments to areas of oxidation.

5.5.6 Surface Water

Surface water may become a migration pathway for chemicals of potential concern if the chemicals are carried in groundwater discharging into surface waters (as previously discussed), runoff from the landfill, and/or leachate seeping out of the landfill. Low concentrations of two ketone compounds were detected in the surface water S301 sample. These results were not repeated in the second round of surface water sample collection. As previously discussed, these compounds would be significantly attenuated by absorption, dilution and volatilization in surface water.

Inorganic contaminants of concern include the metals antimony, barium, and lead. Barium was the only metal determined to be a contaminant of concern in the Risk Assessment due to a significant difference of in a t-test with regional background data. The other two metals were chosen by default due to the lack of background data. These metals in the surface water would attenuate through the physical attenuation of dilution, adsorption to particulate matter and precipitation along the above discussed pathways.

5.5.7 Sediments

As described in the groundwater section, only semi-VOC compounds were detected in two (S201 and S301) sediment samples collected from Sequoit Creek along the perimeter of the old landfill. The primary transport mechanism for the migration of these organic compounds from the landfill to the Sequoit Creek sediments is probably the migration and discharge of groundwater to Sequoit Creek. As the dissolved contaminants in the groundwater/leachate mixture in the landfill flow from the landfill via groundwater and discharge to Sequoit Creek, the semi-VOCs are attenuated by dilution biodegradation and adsorbed to soils and sediments. Once entrained in the soil and sediments, these organic compounds will be consumed through biodegradation and/or released to surface water and groundwater being further transported and attenuated by dilution.

The metals of concern in sediments are arsenic and thallium based on the Risk Assessment. Arsenic was chosen due to a significant difference in a t-test with background data. These metals would be attenuated to soils and sediments through adsorption and precipitation as they migrated through them along the above discussed pathways. The metals may then be released to surface water due to physical agitation or be dissolved into surface water through the reduction of the metals in a reducing sediment environment. Once in the surface water oxidation would then cause the metal complex to precipitate and be transported with surface water.

5.5.8 Surface Soils

Surface soil organic and inorganic impact appear to be primarily related to the gas venting and leachate seeping through the landfill cap. As the leachate and gas migrates through the cap material, many of the VOC contaminant compounds are volatilized into air during overland flow. Other less volatile and inorganic contaminants are adsorbed to soils. Acetone, aromatic compounds, phthalates, and PAHs were detected in the samples collected from the gas venting area (SU02) and the leachate seep (SU01) on the south slope of the new landfill at similar concentrations. The pesticide 4,4-DDT was detected in the SU01 sample. The other samples were collected from areas where discolored soils or standing surface water were observed (SU03 through SU05). Many of the contaminants detected in the SU01 and SU02 samples were not detected in these samples. Aromatic compounds such as benzene, toluene, and xylene undergo volatilization and biodegradation in soils. Precipitation may then transport dissolved contaminant compounds to surface water and/or groundwater through overland run-off and infiltration.

Phthalates are strongly adsorbed to organic carbon (the surface soils have an average total organic carbon concentration of 2.6 %), and thus will strongly resist leaching into the groundwater. Biodegradation may also occur in surface soils to a limited extent. Phthalates were not detected in surface waters or ground waters.

PNAs found in the surface soils are strongly adsorbed to soils and have low water solubilities, and are not expected to leach to water. Under aerobic conditions PAHs will undergo biodegradation. PAHs were not detected in groundwater and surface water samples.

The metals determined as contaminants of concern in the Risk Assessment were selected because of the lack of regional background data. These metals will be strongly attenuates in the surface soils. Precipitation/oxidation will also occur attenuating the metals as the metal complexes are exposed to the atmosphere and/or oxygenated surface along these pathways.

PMS/dlp
J:\2386\0096\RI_FINAL\RI_TEXT\SECTION5.DOC

6

6.0 SUMMARY AND CONCLUSIONS

6.1 LANDFILL CHARACTERISTICS

The landfill cover is continuous across the site. Based on information obtained during the test pit excavations and drilling for the installation of the leachate piezometers, the total landfill cover thickness ranges from 49 inches to 87 inches. The apparent low permeability layer composed of clay ranges from 6 inches to 14 inches in thickness on the "old" portion and from 25 inches to 63 inches in thickness on the "new" portion of the landfill. The typical vertical hydraulic conductivity of the apparent low permeability layer was in the 10^{-8} cm/s range. Remnants of the former landfill cap were observed beneath the present cap in the area of the" old landfill". Refuse was generally encountered beneath the cap in the "new landfill" areas. Erosional rills and gullies, wet areas, vegetation bare spots, leachate seeps, gas venting, animal burrows, and surface water sheens were observed on the cap.

Grain size analyses and Atterberg limits testing identified the apparent low permeability layer as a lean clay (CL) with a trace to some sand, and a trace of gravel. The clay content of the cap consists primarily of illite with small amounts of iron-chlorite and smectite. The clay is estimated to have been compacted to approximately 87% to 92% of its Modified Proctor density.

The refuse thickness ranges from 12 ft to 36 ft in the "old landfill" and from 35.5 ft to 63.5 ft in the "new landfill." The in-place refuse volume is estimated to be 1.5 million cubic yards. The base material underlying the refuse in the northern portion of the "old landfill" consists primarily of gray silty clay. The refuse in the southern area of the "old landfill" is underlain by peat and/or sand.

Landfill gas is being produced and vented through a system of wells fitted with flares. The measured methane concentrations in the gas wells ranged from 65.4% to 67.7%. Landfill gas is migrating horizontally through the subsurface in the southwest corner of the landfill. Landfill gas was also found to be escaping through some area of the cap.

The leachate generated by the H.O.D. Landfill has constituents typical of municipal landfill leachate. Leachate removal began in 1987. Based upon 1993 records, an average of 37,500 gallons of leachate are removed from the landfill each month for a yearly removal estimate of approximately 450,000 gallons. The measured leachate elevations within the landfill were higher than the water level elevations in wells adjacent to the site. Leachate extraction is being conducted in an attempt to maintain the leachate head levels within the landfill to two feet below the water level elevation simultaneously measured in G11D. One inch per year of precipitation infiltration into the waste results in the generation of approximately 1 million gallons per year, of leachate. At one inch of annual infiltration, the current leachate collection system is approximately 45% efficient in removing this estimated annual one inch per year of infiltration.

6.2 HYDROGEOLOGY

The unconsolidated deposits in the area of the H.O.D. Landfill site are predominantly glacial drift overlying the dolomite bedrock. These unconsolidated deposits consist of the surface soils, the surficial sand, the clay-rich diamict (till), and the deep sand and gravel. The surface soils ranged from topsoil, to peat and organic rich silt and clay. The surficial sand is an east-west trending feature of local extent located on the southern side of the site which is bounded by the clay diamict laterally and at its base. The surficial sand is not used for water supply purposes. The groundwater flow direction in the surficial sand is toward Sequoit Creek.

The clay-rich diamict is continuous beneath the site. The thickness of the clay-rich diamict ranges from an estimated 40 ft to over 70 ft beneath the majority of the site, with small areas where the thickness ranges from greater than 90 ft to less than 30 ft. The clay diamict has a low hydraulic conductivity and provides resistance to vertical flow from the surficial sand to the deep sand and gravel. The inorganic chemistry of the RI groundwater samples plotted on a Piper diagram indicates that samples collected from the surficial sand and the deep sand and gravel are enriched in carbonate, calcium, and magnesium, with generally lower concentrations of sodium, potassium, sulfate, and chloride. The only exception noted, was the sample collected from W6S, which contained higher concentrations of sulfate and chloride. Samples collected from the intermediate clay till wells were generally noted as containing higher concentrations of carbonates than the shallow or deep wells.

The deep sand and gravel is laterally extensive and is present beneath the entire site. The full thickness of this unit is not known, but it is at least 185 ft thick in the vicinity of the site. The deep sand and gravel is used for water supply purposes by private residents and by the Village of Antioch. The groundwater flow direction within the deep sand and gravel, in the vicinity of the site, is west-southwest towards the village water supply wells.

6.3 GROUNDWATER

VOCs and two metals (arsenic and manganese) are the constituents identified as chemicals of concern in the Baseline Risk Assessment. Arsenic was only selected as a chemical of concern for the village wells by default due to the few number of background samples, but arsenic is believed to be a background chemical not a site-related chemical. The presence of manganese may be due to the reduction of manganese from saturated soils during the biodegradation of organic matter.

Surficial Sand

VOCs were not detected in the Round 1 or Round 2 samples collected from wells US1S, US3S, W3SB, W4S, and US6S. Carbon disulfide was the only VOC detected in both the Round 1 and Round 2 samples collected from well G11S (at concentrations of 0.8J ug/l and 18 ug/l, respectively). The only VOC detected in both the Round 1 and Round 2 samples from well US4S was 1,2-dichloroethene (at concentrations of 35 ug/l and 44 ug/l, respectively).

Vinyl chloride (19 ug/l) was the only VOC detected in the Round 1 sample from well W5S, but was not confirmed in the Round 2 sample from this well (no VOCs were detected in Round 2). Similarly the presence of VOCs in the groundwater in the vicinity of well W6S was not confirmed in the second round of sampling. 1,2-Dichloroethene (2J ug/l) was the only VOC detected in the Round 1 sample from well W6S, however no VOCs were detected in the Round 2 sample from this well.

The VOCs detected in these surficial sand groundwater samples were not detected in the corresponding surface water samples, indicating that these VOCs are being attenuated as the surficial sand groundwater migrates towards, and discharges to Sequoit Creek. Wells located within the surficial sand on the opposite side of the creek relative to the landfill were also not found to contain VOCs in either sampling round, indicating that such groundwater is not being impacted by a release of VOCs from neither the H.O.D. Landfill, nor any other potential source of VOCs (i.e., disposal activities at the Sequoit Acres Industrial Park) .

It is possible that the VOCs in the groundwater samples collected from the surficial sand wells are being impacted by landfill gas contaminants. The compounds detected in the groundwater samples were also detected in the landfill gas and landfill gas has been found to be present in the area. A depletion in the ^{13}C isotope in the groundwater indicates no evidence of leachate mixing with the groundwater in the vicinity of these samples. Baedecker and Back (1979) found that landfill generation of carbon dioxide and methane, via biological decay, results in an enrichment of ^{13}C in landfill leachate due to ^{12}C being preferentially utilized during the biological decay process. The H.O.D. Landfill leachate is enriched with ^{13}C, consistent with the results of Baedecker and Back (1979). (WMII, 1991).

Clay Diamict

VOCs were not detected in the Round 1 or Round 2 samples collected from wells G11D and US3I. Trichloroethene was the only VOC detected in the Round 1 and Round 2 samples from well US6I at concentrations of 2 J ug/l and 1 J ug/l, respectively. The trichloroethene concentrations in the groundwater samples collected from well US6I have declined over time and can be expected to continue to decline further.

Deep Sand and Gravel

VOCs were not detected in the Round 1 or Round 2 samples collected from wells US1D, W3D, US4D, US6D, and W7D. VOCs were only detected in the groundwater samples from the deep sand and gravel well US3D, which is located off-site to the west of the site. The VOCs detected were vinyl chloride (28 ug/l to 35 ug/l) and 1,2-dichloroethene (11 ug/l to 18 ug/l). Acetone (6 J ug/l) and 1,2-dichloroethene (0.5 J ug/l) were the only VOCs detected in the sample from village well VW-4, which is the closest water supply well to well US3D. The concentrations of the compounds detected in wells US3D and VW-4 may indicate that the VOCs in the vicinity of well US3S are being attenuated to nearly undetectable levels in the water pumped from well VW-4. It is also possible that vinyl chloride was not detected in the VW-4 sample due to either dilution (possibly resulting from the extraction of groundwater through a 20 foot screened interval versus a 5 foot screened interval in US3D) or to the volatilization of the chemical constituents (due to the use of the high capacity pumping system for sampling). However, the presence of acetone and the absence of vinyl chloride in the sample from well VW4 could also indicate that there is a different source for the VOCs in the sample from well VW4.

VOCs were detected in the on-site surficial sand wells US4S and W5S, but not in the on-site deep sand and gravel well US4D, indicating that the VOCs in the surficial sand at that location are not migrating through the clay diamict to impact the deep sand and gravel in the vicinity of US4D.

The groundwater inorganic chemistry plotted on a Piper diagram indicates that samples collected from the surficial sand and the deep sand and gravel are enriched in bicarbonates, calcium, and magnesium, with generally lower concentrations of sodium, potassium, sulfate, and chloride. The only exception noted was the sample collected from W6S, which contained higher concentrations of sulfate and chloride. Groundwater samples collected from the intermediate (clay till) wells were generally noted to contain higher concentrations of carbonates than the shallow (surficial sand) or deep (deep sand and gravel aquifer) wells.

The continuity, thickness, and texture of the clay-rich diamict indicates that it serves as confining layer between the surficial sand and the deep sand and gravel. Numerous soil borings have been sampled in the vicinity of the H.O.D. Landfill to define the subsurface conditions. The clay-rich diamict isopach map shows the estimated lateral extent, and thickness, of this unit in the vicinity of the site (Figure 18). Based upon the available data, the clay-rich diamict is continuous beneath the site. The regional cross-section also indicates that the clay-rich diamict is regionally extensive. Beneath the majority of the site, the clay-rich diamict thickness ranges from an estimated 40 ft to over 70 ft, with small areas having estimated thicknesses of greater than 90 ft to less than 30 ft. The geotechnical analyses classify the clay-rich diamict samples as a gravelly, sandy, silty, or lean clay (CL to CL-ML).

The differences in the hydraulic heads in the surficial sand and the deep sand and gravel also indicates that the clay diamict is continuous and provides a resistance to downward vertical flow (i.e., low vertical hydraulic conductivity). Based upon the water level elevations observed at the site, there is approximately a 30 to 35 ft decrease in the hydraulic head between the surficial sand and the deep sand and gravel aquifer.

The USGS pump test evaluation determined that the hydraulic conductivity of the clay diamict was 2.1E-06 cm/s. Slug testing performed in previous studies indicated that this hydraulic conductivity ranged from 7.9E-06 cm/s to 8.0E-06 cm/s. The laboratory permeability test results indicated that the hydraulic conductivity of the clay-rich diamict ranges from 1.50E-08 cm/s to 1.70E-08 cm/s. Each of these results confirm that the hydraulic conductivity of the clay till layer is much lower than the hydraulic conductivity of the deep sand and gravel, or the surficial sand.

Nevertheless, VOCs have been detected in samples from wells screened in the off-site deep sand and gravel. One potential mechanism for the transport of these VOCs to the deep sand and gravel, is via leaking abandoned boreholes and leaking well seals. Patrick Engineering (1989) stated that the exploratory boreholes for the municipal wells may provide a pathway for the VOC migration from the surficial sand to the deep sand and gravel.

The variability in the chloride concentrations in samples obtained from the off-site deep sand and gravel monitoring wells could be explained by just such a mechanism. The chloride concentrations in the on-site deep wells range from 3 mg/l (US4D) to 8 mg/l (US6D). In the off-site deep sand and gravel wells, chlorides were observed at the following concentrations: 22 mg/l (US1S), 144 mg/l (US3D) and 153 mg/l (W3D). This wide variation could indicate that there have been localized releases of chloride-impacted groundwater from the surficial sand to the deep sand and gravel through leaking boreholes/well seals. A general release of chlorides from the surficial sand would result in a generalized chloride impact to the clay diamict and to the deep sand and gravel.

The potential for leaking well seals was demonstrated at well PZ2, which was found to have a leaking well seal, as indicated by water level trends, and was replaced with a double-cased well. Village Well No. 4 (VW-4) was apparently constructed without a double-casing though the surficial sand, as no such casing is reported on the drillers log. The greatest potential for well seal leakage is where the hydraulic head difference is greatest, such as at a pumping well. An intermittently pumped well would allow for periods of leakage into the deep sand and gravel without immediate collection by the extraction pump. VW-4 is also reportedly drilled through the waste of the Cunningham Dump (Patrick, 1989), which has been identified as a potential source of contaminants. The potential exists for contaminants to migrate downward via the borehole annulus, into the well, and into the deep sand and gravel aquifer.

Other potential sources of contamination in the vicinity of the exploratory boreholes include:

- The past discharge of untreated waste by Quaker Industries
- The former Cunningham Dump (located west of Sequoit Creek)
- The former Quaker Dump (located west of Sequoit Creek)
- Fill areas in the Sequoit Acres Industrial Park
- Industries in the Sequoit Acres Industrial Park

6.4 RECOMMENDED REMEDIAL ACTION OBJECTIVES

The Baseline Risk Assessment was developed using the U. S. EPA's "Presumptive Remedy for CERCLA Municipal Landfill Sites", September 1993 (EPA 540-F-93-035) which identifies containment as the presumptive remedy. The response action objectives listed in this Presumptive Remedy Guidance are:

- Preventing direct contact with landfill contents
- Minimizing infiltration and the resulting contaminant leaching to groundwater
- Controlling surface water runoff and erosion
- Containment of the groundwater contaminant plume and preventing further migration from source areas, and
- Controlling and treating landfill gas

Preventing direct contact with waste, minimizing infiltration, controlling leachate generation, and controlling landfill gas are typically addressed by capping the site and by installing leachate and gas collection systems. Each of these components already exist at the site, but require some improvements to enhance their effectiveness. The VOCs found in the surficial sand were not found to be migrating off-site, indicating that active controls may not be needed. Control of the VOCs in the on-site surficial sand can be remediated by improved gas collection, if the landfill gas is the source of these concentrations.

The VOCs found in the off-site deep sand and gravel layer may be present there due to their migration from the surficial sand downward via well or borehole seal leakage (i.e., via potential annular seal leakage in Village of Antioch Well No. 4). As previously discussed, analytical results indicate that contaminants are not migrating off-site within the upper aquifer. A potential source for the lower aquifer impacts via the possible VW-4 annular seal leakage, is contaminants from the Former Cunningham/Quaker Village Dump. VW-4 was apparently installed through the refuse material of the Cunningham Dump. The potential for such leakage will be reduced by the abandonment of VW-4. The abandonment of VW-4 will seal off a potential migration pathway for sources located in the industrial park area, and generally reduce the downward gradient due to the cessation of pumping operations at the well. The remedial action objective for the off-site deep sand and gravel layer is to prevent its exposure to VOC impacted groundwater. This may be accomplished though the abandonment of VW-4, and through the creation of institutional controls to prevent the construction of new wells in the industrial park area.

PMS/dlp
J:\2386\0096\RI_FINAL\RI_TEXT\SECTION6.DOC

7

7.0 REFERENCES

Baedecker, Mary J. and Back, William, *Hydrogeological Processes and Chemical Reactions at a Landfill*, vol. 17, No. 5-Groundwater-September-October 1979.

Battelle, Pacific Northwest Laboratories, 1984. *Chemical Attenuation Rates, Coefficients, and Constants in Leachate Migration,* Volume 1: A Critical Review. EPRI EA-3356, Volume 1.

Bouwer, E.J. and McCarty, 1983. *Transformations of Halogenated Organic Compounds Under Denitrification Conditions.* Applied and Environmental Microbiology 45(4) 1296-1299.

Bouwer, E.J. and McCarty, 1983a. *Transformations of 1- and 2 Carbon Halogenated Aliphatic Organic Compounds Under Methanogenic Conditions.* Applied and Environmental Microbiology 45(4) 1286-1294.

Derek, Lovely R., *Dissimilatory Fe(III) and Mn(IV) Reduction,* Microbiological Reviews, June 1991, p. 259-287, American Society for Microbiology.

Freeze, R. and Cherry, J., 1979. *Groundwater.* Prentice-Hall 604 pp.

Howard, Philip H., *Handbook of Environmental Fate and Exposure Data for Organic Chemicals, volume I and II,* Lewis Publishers, Inc., 1989.

Lindsay, W.L., *Chemical Equilibria in Soils.* John Wiley & Sons.

Lyman, W.J., W. F. Reehl and D. H. Rosenblatt, 1981. *Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds.* McGraw-Hill.

Manahan, S.E., 1984. *Environmental Chemistry.* PWS Publishers, 912 pp.

Montgomery and Welkom, *Groundwater Chemicals Desk Reference,* Lewis Publishers, Inc., 1990.

Olson, R. L. and A. Davis, 1990. *Predicting the Fate and Transport of Organic Compounds in Groundwater parts 1 and 2.* Hazardous Materials Control 3(3): 39-64 and 3(4): 18-37.

Parsons, F., P. R. Wood, and J. DeMarco, 1984. *Transformations of Tetrachloroethene and Trichloroethene in Microcosms and Groundwater.* J. AWWA, February 1984, pp. 56-59.

Robinson, W. D., 1986. *Solid Waste Handbook; A Practical Guide.* John Wiley & Sons

USDA, 1970. *Soil Survey Lake County, Illinois.* U.S. Government Printing Office, Washington, D.C.

U.S. Geological Survey, 1985. *Study and Interpretation of the Chemical Characteristics of Natural Water.* United States Geological Survey Water-Supply Paper 2254.

Willman, H. B., Elwood Atherton, T. C. Buschbach, Charles Collinson, John C. Frye, M. E. Hopkins, Jerry A. Lineback, and Jack A. Simon, 1975. *Handbook of Illinois Stratigraphy.* Illinois State Geological Survey, Bulletin 95, Urbana, Illinois.

Willman, H. B. et.al., Summary of the Geology of the Chicago Area. Illinois State Geological Survey, Urbana, Illinois.

Woller, Dorothy M., and James P. Gibb, 1976. *Public Groundwater Supplies in Lake County.* Illinois State Water Survey, Urbana, Illinois.

WMII Communication, *WMII Comments to Expanded Site Inspection Report for H.O.D.*, June 19, 1991, from Ann L. Straw, WMII Environmental Counsel, to Ms. Sally Jensen, United States Environmental Protection Agency, Region 5.

PMS/dlp
J:\2386\0096\RI_REVIS\RI_TEXT\91.DOC

T
A
B
L
E
S

TABLE 1-1
LIST OF ACRONYMS AND ABBREVIATIONS
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Acronym	Description
1,1-DCA	1,1-dichloroethane
1.2-DCA	1,2-dichloroethane
1,2-DCPA	1,2-dichloropropane
1,2-DCE	1,2-dichloroethene
1,1-DCE	1,1-dichloroethene
APC	Administrative Order by Consent
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society of Testing Materials
ATV	All Terrain Vehicle
BETX	Benzene, Ethylbenzene, Toluene, and Xylene
BGS	Below Ground Surface
CEC	Cation Exchange Capacity
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLP	Contract Laboratory Program
CRQL	Contract Required Quantitation Limit
DCE	1,2-dichloroethene
FS	Feasibility Study
HELP Model	Hydrologic Evaluation of Landfill Performance Model
I.D.	Inner Diameter
MCL	Maximum Contaminant Level
MSL	Mean Sea Level
NCP	National Contingency Plan
NPL	National Priorities List
O.D.	Outer Diameter
PCB	Polychlorinated Biphenyls
PID	Photoionization Detector
PQL	Practical Quantitiation Limit
PSER/TS	Preliminary Site Evaluation Report/Technical Scope

TABLE 1-2

SUMMARY OF MUNICIPAL WELL INFORMATION
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Well No.	Date	Driller	Ground Elevation	Total Depth	Screened Interval	Formation
1	1907	Charles Thorne	780	216	207-216	Sand and Gravel
2	1906/ 1949	C.L. Wertz	780	226/ 231.5*	210-231.5	Sand and Gravel
3	1953	Layne-Western	770	150	120.5-140.5	Sand and Gravel
4	1965	Layne-Western	770	141	109-129	Sand and Gravel
5	1978	Layne-Western	--	131	109-129	Sand and Gravel

* Well was rehabilitated in 1949.

TABLE 1-3
SUMMARY OF PERMITTED SPECIAL WASTES*
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Generator	Waste Name	Annual Authorized Volume	Permit Period
Fox Lake Northwestern Region	Digested liquid domestic sludge	520,000 gallons	Through 9/18/86
Round Lake Sanitary District	Secondary digestor sludge	2,000 gallons/day	8/9/77 through 9/84
Village of Antioch	Aerobic digested domestic waste water sludge	200 cubic yards	11/81 through 9/84
Village of Libertyville	Storm sewer sludge and grit	260 cubic yards	8/83 through 7/86
Travenol Labs	Fat emulsion	182,000 gallons	11/81 through 11/84
Waste Management of Wisconsin	Automotive manufacturing sludge	13,728 cubic yards	3/83 through 3/86
Abbott Laboratories	Activated sludge	7,000,000 gallons	3/83 through 3/86
Abbott Laboratories	Ogen products (outdated pharmaceutical product)	5,500 gallons	5/83 through 5/86
Abbott Laboratories	Spent beer concentrate	5,000,000	3/83 through 3/86
Great Lakes Naval Base	Animal fat	80 cubic yards	3/82 through 1/85
Intermatic	Paint booth waste	2,500 gallons/month	3/75 through 10/79
Spring Grove, Illinois	Waste oils and chlorinated solvents	Uncertain	10/78 through 10/79
Pickard Inc., Antioch Illinois	Water and clay waste	1,200 gallons	11/81 through 12/84
Wells Manufacturing, Woodstock Illinois	Slag	1,040 cubic yards	8/81 through 8/84
Wells Manufacturing, Woodstock, Illinois	Baghouse dust and grinding sludge	1,248 gallons	11/82 through 12/84
OMC Johnson	Water soluble coolant and oil waste	500,000 gallons	11/81 through 11/84
Morton Chemical Company	AMBT wastewater	200,000 gallons	2/82 through 2/85
Morton Chemical Company	Wastewater latex emulsion	1,500,000 gallons	8/82 through 10/85
Morton Chemcial Company	Waste filter cake and latex sludge	100,100 gallons	12/81 through 1/85
Morton Chemical Company	Spent Carbon	9,000 gallons	12/81 through 1/85
Morton Chemical Company	Baghouse dust	8,640 cubic yards	7/83 through 6/85
Quaker Industries	Water soluble oil and stain	10,000 gallons	2/26/80 through 2/26/81
Quaker Industries	Paint, coolants, and paint booth oversprays	90 drums	3/29/77 through 3/29/78

* Based on a review of IEPA files, an entry on this table indicates that IEPA approved these waste types and quantities at the site. Wastes listed on this table may or may not have been actually disposed at the site.

Table 1-4

SUMMARY OF EXPANDED SITE INSPECTION
FIELD ACTIVITIES
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

A.	Soil Borings/Monitoring Wells Drilled (Figure 4 for locations)	
	SB1	US4S*
	SB1A	US4D*
	US1S*	US5D*
	US1D*	US6S*
	US2D*	US6I*
	US3S*	US6D*
	US3I*	US7S*
	US3D*	

*Monitoring Well Installed

B.	Hyrdaulic Conductivity Testing	
	US1S	US4D
	US1D	US5D
	US2D	US6S
	US3S	US6I
	US3I	US6D
	US3D	US7S
	US4S	

C.	Soil Sampling and Analysis (TCL/TAL)	
	US1D (Samples S1 - S8)	US5D (Samples S36 - S40)
	US3D (Samples S9 - S16)	US6D (Samples S41 - S45)
	US2D (Samples S17 - S27)	US7D (Samples S46 - S49)
	US4D (Samples S28 - S35)	

Table 1-4 (continued)

SUMMARY OF EXPANDED SITE INSPECTION
FIELD ACTIVITIES
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

D.	Groundwater Sampling	
	Round 1 Sampling (8/10-12/87) TCL/TAL	
	US1S	US6D
	US2D	US7S
	US3S	G11D
	US4S	G102
	US4D	R103
	US5D	G14S
	US6S	G14D
	US6I	Residential wells RW1-RW8
	Round 2 Sampling (4/19/88) VOCs	
	US1S	US6S
	US1D	US6I
	US3S	US6D
	US4S	US7S
	US4D	G102
	Round 3 Sampling (5/19/88) VOCs	
	US1S	US4D
	US1D	US6D
	US6I	

TABLE 1-5
SUMMARY OF MONITORING WELL CONSTRUCTION DETAILS
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Well	Completion	Coordinates		Ground	TOIC	Total	Well/Screen	Screen	Stratigraphy	Top of Sand Pack		Screen Interval			Screen Interval		
#	Date	North	East	Elev	Elev	Depth	Materials	Length	at Screen	Depth	Elev	Depth			Elevation		
EPA Wells																	
US1S	5/22/87	2115302.72	1053552.35	766.5	768.69	12.41'	stainless	5.7'	silty sand & gravel	3.50	763.00	6.71	to	12.41	759.79	to	754.09
US1D	5/27/87	2115302.79	1053547.83	766.9	768.88	92.41'	stainless	5.7'	f-med Sand	81.00	685.90	92.41	to	86.71	674.49	to	680.19
US2D	6/16/87	2114832.02	1050654.41	768.2	770.73	112.77'	pvc	8.3'	sand & gravel	103.00	665.20	104.47	to	112.77	663.73	to	655.43
US3S	6/2/87	2115488.87	1050515.19	767.1	770.48	22.5'	stainless	5.7'	sand & gravel	13.50	753.60	16.81	to	22.51	750.29	to	744.59
US3I	6/10/87	2115483.04	1050532.52	767.01	769.93	58'	pvc	3'	CL to SC	52.50	714.51	55	to	58	712.01	to	709.01
US3D	6/3/87	2115486.53	1050523.96	767.1	769.72	83'	pvc	5.3'	fine-med sand	73.50	693.60	77.28	to	82.58	689.82	to	684.52
US4S	6/17/87	2115388.68	1050754.78	771.1	773.67	23'	stainless	5.7'	sand & gravel	15.00	756.10	17.17	to	22.87	753.93	to	748.23
US4D	6/23/87	2115377.82	1050754.38	770.5	772.7	103.84'	stainless	5.7	fine-med. silt	94.00	676.50	98.14	to	103.84	672.36	to	666.66
US5D	6/29/87	2116743.35	1050757.09	765.1	767.73	93.14'	stainless	5.7'	sand & gravel	84.00	681.10	87.44	to	93.14	677.66	to	671.96
US6S	7/10/87	2115367.32	1051516.03	767.1	769.9	41.7'	stainless	5.7'	sand & gravel	NA	NA	36	to	41.7	731.1	to	725.4
US6I	7/10/87	2115380.91	1051520.35	767.6	770.21	62.76'	stainless	3.7'	CL	55.00	712.60	59.06	to	62.76	708.54	to	704.84
US6D	7/6/87	2115387.72	1051523.28	767.1	770.09	83.17'	stainless	5.7'	sand & gravel	74.50	692.60	77.47	to	83.17	689.63	to	683.93
US7S	7/16/87	2116603.79	1051803.25	764.4	767.99	32.63'	stainless	5.7'	Interbedded Cl+GP	25.00	739.40	26.93	to	32.63	737.47	to	731.77
TSC Wells																	
G11S	NA	2116538.48	1050747.65	767.6	770.12	NA	NA	NA	fine to coarse sand	NA	NA	NA		NA	NA		NA
G11D	NA	2116541.35	1050747.19	767.1	769.99	NA	NA	NA	organic silty clay	NA	NA	NA		NA	NA		NA
G14S	5/7/74	2115621.98	1053289.24	767.6	770.34	10	NA	NA	clayey sand	NA	NA	NA		NA	NA		NA
G14D	5/7/74	2115619.37	1053288.07	767.7	769.75	34	NA	NA	silty sand	NA	NA	NA		NA	NA		NA
G102	5/8/74	2115417.06	1050750.06	771.1	773.53	25	NA	NA	f-c sand	NA	NA	NA		NA	NA		NA
R103	10/31/85	2115400.27	1051520.55	767.6	769.55	27	pvc	5	f-c sand tr. gravel	17.7	NA	21	to	27	746.6	to	740.6
TSC Leachate Wells																	
LP1	5/19/83	1+80S	13+35W	797.73	N/A	45	PVC	30	Fill and Refuse	4.5	792.8	13	to	43	784.3	to	754.3
LP8	5/20/83	6+50S	5+00W	796.23	N/A	43.5	PVC	30	Fill and Refuse	4	792.93	13	to	43	783.93	to	753.93
LP9	5/20/83	6+50S	10+00W	795.06	N/A	43.5	PVC	30	Fill and Refuse	4	791.06	13	to	43	782.06	to	752.06
LP10	5/23.83	7+50S	14+50W	795.06	N/A	45	PVC	30	Fill and Refuse	4	791.06	13	to	43	782.06	to	752.06
P2A	9/18/84	1+80S	10+00W	795.1	797.6	75	PVC	65	Fill and Refuse	4.5	790.06	6.6	to	71.6	788.5	to	723.5
P3A	9/21/84	1+80S	5+05W	792.4	794.7	75	PVC	65	Fill and Refuse	5	787.4	7.7	to	72.7	784.7	to	719.7
Warzyn Wells																	
W2D	4/20/93	2116648.18	1052499.88	770.7	773.04	88.33'	pvc	5'	f-c sand	79.80	690.90	83.3	to	88.3	687.4	to	692.4
W3SA	4/7/93	2115185.28	1051029.19	763.8	766.54	15.64'	pvc	10.09'	f-c sand	5.00	758.80	5.55	to	15.64	758.25	to	748.16
W3SB	4/7/93	2115189.39	1051027.83	763.7	766.81	29.57'	pvc	5'	sand over. clay	22.55	741.15	24.55	to	29.57	739.1	to	734.13

TABLE 1-5
SUMMARY OF MONITORING WELL CONSTRUCTION DETAILS
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Well #	Completion Date	Coordinates North	Coordinates East	Ground Elev	TOIC Elev	Total Depth	Well/Screen Materials	Screen Length	Stratigraphy at Screen	Top of Sand Pack Depth	Top of Sand Pack Elev	Screen Interval Depth			Screen Interval Elevation		
W3D	5/25/93	2115187.6	1051022.66	763.73	765.93	78'	pvc	5'	f-c sand	70.90	692.83	73.3	to	77.6	690.43	to	686.13
W4S	5/26/93	2115201.97	1050628.33	767.5	769.97	15'	pvc	10'	f-c sand	4.00	763.50	5	to	15	762.5	to	752.5
W5S	4/21/93	2115375.15	1050760.47	771.1	773.49	14.34'	pvc	10.46'	f-c sand	3.90	767.20	5.22	to	14.34	765.88	to	756.76
W6S	4/16/93	2115399.38	1051541.09	764.9	767.41	15'	pvc	9.18'	f-c sand	4.00	760.90	5.82	to	15	759.08	to	749.9
W7D	4/14/93	2116325.98	1053153.28	780.2	782.87	99.72'	pvc	4.3'	f-c sand	93.00	687.20	95.42	to	99.72	684.8	to	680.48
W8D	3/21/93	2115325.82	1052660.77	766.68	768.14	94'	pvc	5'	f-c sand	76.60	690.08	89	to	94	677.68	to	672.68
PELA Piezometers																	
PZ1	8/10/89	2116820.66	1053361.37	786.2	788.48	118.2'	stainless	10'	clay over sand	102.00	684.20	108.2	to	118.2	678.2	to	668
PZ1U	2/28/90	2115026.24	1051398.67	763.9	766.41	27'	pvc	20'	sand	5.50	758.40	7	to	27	756.9	to	736.9
PZ2U	3/1/90	2114903.68	1050856.51	764.1	768.04	16.5'	pvc	10'	sand	5.00	759.10	6.5	to	16.5	757.6	to	747.6
PZ3U	3/5/90	2115540.75	1051908.41	763.4	766.27	37'	pvc	30'	sand	5.00	758.40	7	to	37	756.4	to	726.4
PZ4U	3/6/90	2115619.7	1052359.45	763.3	766.49	27'	pvc	20'	sand & gravel	6.00	757.30	7	to	27	756.3	to	736.3
PZ5U	3/7/90	2115771.83	1053088.12	769.3	771.11	32'	pvc	20'	sand	10.00	759.30	12	to	32	757.3	to	737.3
PZ6U	4/26/90	2115818.07	1052491.73	763.6	766.54	42.5'	pvc	10'	sand & gravel	23.00	740.60	32.5	to	42.5	731.1	to	721.1
PELA Sequoit Creek Piezometers																	
SC-1A	3/4/90	2115370.25	1052636.44	764.7	766.84	13.2	1.25" Galvan.	5	silt/f-med. sand	5.00	759.70	8.2	to	13.2	756.5	to	751.5
SC-1B	3/2/90	2115325.82	1052637.67	766.4	769.34	23.69	1.25" PVC	10	silt/f-med. sand	7.50	758.90	13.69	to	23.69	752.7	to	742.71
SC-1C	2/28/90	2115254.06	1052641.84	762.9	765.44	15.55	1.25" PVC	5	silt/f-med. sand	10.80	752.10	10.55	to	15.55	752.3	to	743.14
SC-1D	2/28/90	2115231.17	1052643.06	762.94	766.39	19.8	1.25" PVC	5	f-v. coarse sand	13.90	749.04	14.8	to	19.8	748.14	to	
SC-2A	3/1/90	2115338.69	1051601.5	763.2	765.09	11.1	1.25" PVC	5	silt/f-coarse sand	5.70	757.50	6.1	to	11.1	757.1	to	752.1
SC-2B	3/1/90	2115316.07	1051603.37	766	767.24	19.1	1.25" PVC	5	f-coarse sand	3.37	762.63	14.1	to	19.1	751.9	to	746.9
SC-2C	2/22/90	2115260.1	1051600.09	763.2	764.51	14.9	1.25" Galvan.	5.9	silt/f-c sand	8.75	754.45	9	to	14.9	754.2	to	748.3
SC-2D	2/23/90	2115241.45	1051600.63	763.4	764.77	13.7	1.25" Galvan.	5	Cl/f-c sand	9.00	754.40	8.7	to	13.7	754.7	to	749.7
SC-3B	3/7/90	2115369.02	1050754.32	769.9	770.6	16.9	1.25" Galvan.	5	f-c sand	8.46	761.44	11.9	to	16.9	758	to	753
SC-3C	3/20/90	2115358.14	1050690.91	767.7	770.26	15.5	1.25" Galvan.	5	f-c sand/gravel	7.00	760.70	10.5	to	15.5	757.2	to	752.2
SC-3D	3/20/90	2115359.75	1050673.05	767.1	769.77	15.5	1.25" Galvan.	5	silt/f-c sand	8.00	759.10	10.5	to	15.5	756.6	to	751.6
SC-4A	3/7/90	2116552.59	1050772.28	768.8	770.22	27.5	1.25 " PVC	10	silty clay	15.00	753.80	17.5	to	27.5	751.3	to	741.3
SC-4B	3/6/90	2116550.92	1050752.8	768.1	770.44	27.89	1.25 " PVC	10	clayey silt	17.44	750.66	17.89	to	27.89	750.2	to	740.21
SC-4C	3/5/90	2116539.91	1050689.83	765.8	768.53	17.3	1.25 " PVC	10	silt/fine sand	3.20	762.60	7.3	to	17.3	758.5	to	748.5
SC-4D	3/19/90	2116551.85	1050676.6	766.3	769.6	22	1.25 " PVC	10	silt/gravel	7.00	759.30	12	to	22	754.3	to	744.3

TABLE 1-5
SUMMARY OF MONITORING WELL CONSTRUCTION DETAILS
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Well #	Completion Date	Coordinates North	East	Ground Elev	TOIC Elev	Total Depth	Well/Screen Materials	Screen Length	Stratigraphy at Screen	Top of Sand Pack Depth	Elev	Screen Interval Depth			Screen Interval Elevation		
Warzyn Gas Probes																	
GP3	4/21/93	2116615.46	1052220.9	770.8	773.51	20	2" PVC	14.82	silty clay	3.6	767.2	5.03	to	19.85	765.77	to	750.95
GP4A	4/15/93	2116248.07	1053013.74	776.4	778.87	26	2" PVC	20.2	silty clay	5	771.4	5.8	to	26	770.6	to	750.4
GP5A	4/22/93	2115682.26	1051583.29	768.4	770.8	16.1	2" PVC	10.1	silty clay	6	762.6	6	to	16.1	762.4	to	752.3
Warzyn Leachate Piezometers																	
LP1	4/27/93	2116410.72	1050909.73	775.6	778.46	20.31	6" PVC	10.44	fill and refuse	7	768.6	9.87	to	20.31	765.73	to	755.29
LP2	4/30/93	2116428.68	1051349.01	785.5	787.8	35	6" PVC	25.3	fill and refuse	8.5	777	9.7	to	35	775.8	to	750.5
LP3	4/28/93	2116082.67	1050918.94	778.1	780.89	22.5	6" PVC	14.5	fill and refuse	9	769.1	11	to	25.5	767.1	to	752.6
LP4	5/4/93	2116110.56	1051338.6	788.9	790.84	39	6" PVC	29.1	fill and refuse	8.6	780.3	9.9	to	39	779	to	749.9
LP5	4/21/93	2116229.99	1051719.62	796.6	800.13	50	6" PVC	39.5	fill and refuse	9	787.6	10.5	to	50	786.1	to	746.6
LP6	4/16/93	2115990.18	1051732.08	794.6	797.32	36.5	6" PVC	26.8	fill and refuse	8	786.6	9.7	to	36.5	784.9	to	758.1
LP7	4/28/93	2116197.77	1052105.4	794.7	797.39	61	6" PVC	51.5	fill and refuse	8.5	786.2	9.5	to	61	785.2	to	733.7
LP8	4/27/93	2116218.62	1052519.39	793.5	796.35	70	6" PVC	60	fill and refuse	9	784.5	10	to	70	783.5	to	723.5
LP9	4/23/93	2116220.42	1052769.86	785.8	789.16	66.5	6" PVC	57.3	fill and refuse	8.5	777.3	9.2	to	66.5	776.6	to	719.3
LP10	4/27/93	2115810.43	1050919.77	781.1	783.92	23	6" PVC	13.5	fill and refuse	8.3	772.8	9.5	to	23	771.6	to	758.1
LP11	4/12/93	2115807.09	1051321.81	787.8	790.61	29.2	6" PVC	21.7	fill and refuse	7.5	780.3	9.3	to	29.2	778.5	to	758.6
LP12	4/8/93	2115515.46	1051138.39	782.6	784.85	22.5	6" PVC	12.5	fill and refuse	8	774.6	10	to	22.5	772.6	to	760.1
LP13	4/13/93	2115448.41	1050899.85	779	781.68	17	6" PVC	7.17	fill and refuse	9	770	9.83	to	17	769.17	to	762
LP14	4/13/93	2115474.47	1051389.52	781.7	784.27	22.5	6" PVC	12.3	fill and refuse	8.9	772.8	10.2	to	22.5	771.5	to	759.2
Kelletts Well Boring, Inc.																	
GWF1	6/23/88	2+63S	17+75W	795	798	42	8" PVC	22	fill and refuse	14	781	20	to	42	773	to	751
GWF2	6/22/88	2+28S	14+86W	796.2	799.2	47	8" PVC	27	fill and refuse	17	779.2	20	to	47	776.2	to	749.2
GWF3	6/22/88	2+32S	11+49W	797.2	800.2	45	8" PVC	25	fill and refuse	17	780.2	20	to	45	777.2	to	752.2
GWF4	6/22/88	2+27S	8+55W	795	798	45	8" PVC	25	fill and refuse	17	778	20	to	45	775	to	750
GWF5	6/22/88	2+11S	5+37W	789.2	792.2	55	8" PVC	35	fill and refuse	17	772.2	20	to	55	769.2	to	734.2
GWF6	6/23/88	3+78S	7+47W	791.2	794.2	41	8" PVC	21	fill and refuse	17	774.2	20	to	41	771.2	to	750.2
GWF7	6/24/88	3+90S	10+70W	795.9	798.9	48	8" PVC	28	fill and refuse	17	778.9	20	to	48	775.9	to	747.9
GWF8	6/24/88	4+46S	14+50W	797.4	800.4	48	8" PVC	28	fill and refuse	17	780.4	20	to	48	777.4	to	749.4
GWF9	6/25/88	4+94S	16+72W	797	800	47	8" PVC	27	fill and refuse	17	780	20	to	47	777	to	750
GWF10	6/25/88	6+87S	17+59W	792.7	795.7	38	8" PVC	18	fill and refuse	17	775.7	20	to	38	772.7	to	754.7
GWF11	6/24/88	6+69S	15+85W	793.6	796.6	40	8" PVC	20	fill and refuse	17	776.6	20	to	40	773.6	to	753.6
GWF12	6/24/88	6+20S	12+93W	792.5	795.5	22	8" PVC	10	fill and refuse	10	782.5	12	to	22	780.5	to	770.5

TABLE 1-5
SUMMARY OF MONITORING WELL CONSTRUCTION DETAILS
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Well	Completion	Coordinates		Ground	TOIC	Total	Well/Screen	Screen	Stratigraphy	Top of Sand Pack		Screen Interval			Screen Interval		
#	Date	North	East	Elev	Elev	Depth	Materials	Length	at Screen	Depth	Elev	Depth			Elevation		
GWF13	6/23/88	5+36S	8+50W	794.7	797.7	45	8" PVC	25	fill and refuse	17	777.7	20	to	45	757.7	to	732.7
GWF14	6/23/88	5+43S	5+75W	792.2	795.2	43	8" PVC	23	fill and refuse	17	775.2	20	to	43	755.2	to	732.2

Notes: Elev = Elevation in Feet MMSL, USGS Datum
TOIC = Top of Inner Well Casing
Sch = Schedule
Screen Length in Feet
Slot Size in Inches
Stratigraphic Abbreviations: S=Sand Grave, F=Fine, M=Medium, C=Coarse
NA = Not Available

TABLE 1-6
SOIL BORING INFORMATION
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Boring #	Completion Date	Completed by	Ground Elev	Total Depth
1	5/24/73	TSC	99.20	50
2	5/24/73	TSC	98.60	50
3	6/15/73	TSC	120.10	80
4	6/13/73	TSC	104.50	30
5	6/13/73	TSC	101.50	20
6	6/13/73	TSC	97.30	25
7	6/13/73	TSC	96.60	30
7-A	8/9/73	TSC	96.60	60
8	6/14/73	TSC	97.00	30
9	6/14/73	TSC	96.00	25
10	8/6/73	TSC	97.80	60
11	8/7/73	TSC	98.50	60
12	8/2/73	TSC	94.88	15
12-A	8/2/73	TSC	94.50	35
12-B	8/3/73	TSC	94.71	20
13	8/2/73	TSC	100.10	55
14	8/3/73	TSC	98.90	60
15	8/9/73	TSC	95.27	55
16	8/9/73	TSC	94.88	40
17	8/9/73	TSC	101.23	20
18	8/9/73	TSC	100.94	25
18-S	8/9/73	TSC	101.33	25
19	8/7/73	TSC	103.57	25
20	8/9/73	TSC	104.00	15
21	8/8/73	TSC	102.86	15
22	8/7/73	TSC	102.46	15
23	5/6/74	TSC		60
24	5/8/74	TSC	766.8*	25
25	5/8/74	TSC	769.7*	25
26	5/7/74	TSC	766.9*	25
27	5/7/74	TSC	767*	50
1001	2/1/80	TSC		80
1002	2/4/80	TSC		80
1003	2/5/80	TSC		80
1004	2/1/80	TSC		80
201	12/2/81	TSC	786.90	80
202	12/3/81	TSC	790.80	80
203	11/30/81	TSC	798.30	80
204	12/3/81	TSC	769.00	80
205	12/8/81	TSC	774.70	80
206	12/4/81	TSC	775.80	80
207	12/7/81	TSC	763.10	80
208	12/11/81	TSC	763.60	80
209	12/9/81	TSC	763.70	80
210	12/10/81	TSC	762.20	80

Notes:
Elev = Elevation in Feet MMSL, USGS Datum
TOIC = Top of Inner Well Casing
Sch = Schedule
Screen Length in Feet
Slot Size in Inches
Stratigraphic Abbreviations: S = Sand Gravel, F = Fine, M = Medium, C = Coarse
NA = Not Available

TABLE 1-6
SOIL BORING INFORMATION
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Boring #	Completion Date	Completed by	Ground Elev	Total Depth
1101	2/2/81	TSC	742.40	30
1101A	2/7/81	TSC	749.40	45
1101C	2/7/81	TSC	746.20	45
1102	2/2/81	TSC	731.00	20
1103	2/2/81	TSC	730.60	20
1104	2/2/81	TSC	733.30	20
1105	2/4/81	TSC	770.00	50
1105A	2/7/81	TSC	767.00	40
1106	2/5/81	TSC	757.50	51
1107	2/6/81	TSC	731.50	30
1107A	2/6/81	TSC	NA	35
1108	2/6/81	TSC	732.60	20
1109	2/6/81	TSC	734.60	20
1110	2/6/81	TSC	763.00	40
1111	2/12/81	TSC	782.60	20
1111A	2/12/81	TSC	778.60	50
1201	2/9/81	TSC	746.00	45
1202	2/9/81	TSC	738.40	45
1203	2/9/81	TSC	744.30	45
1204	2/9/81	TSC	741.40	15
1205	2/13/81	TSC	744.00	35
1206	2/13/81	TSC	752.40	35
1207	2/13/81	TSC	763.00	45
1208	2/13/81	TSC	743.90	45
1209	2/16/81	TSC	756.10	50
1210	2/16/81	TSC	741.50	35
P2A	9/18/84	TSC	795.10	75
P3A	9/21/84	TSC	792.40	75
1402	6/4/81	TSC	748.40	35
101	7/30/80	TSC		30
102	7/31/80	TSC		30
103	7/31/80	TSC		80
105	8/1/80	TSC		30
106	8/6/80	TSC		65
107	8/4/80	TSC		70
108	8/1/80	TSC		20
109	8/1/80	TSC		20
110	8/1/80	TSC		50
111	8/6/80	TSC		80
114	8/8/80	TSC		50
115	8/12/80	TSC		50
2	2/4/80	TSC	784.83	80
3	2/5/80	TSC	783.80	80
4	2/1/80	TSC	789.60	80

Notes:
Elev = Elevation in Feet MMSL, USGS Datum
TOIC = Top of Inner Well Casing
Sch = Schedule
Screen Length in Feet
Slot Size in Inches
Stratigraphic Abbreviations: S = Sand Gravel, F = Fine, M = Medium, C = Coarse
NA = Not Available

TABLE 1-6
SOIL BORING INFORMATION
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Boring #	Completion Date	Completed by	Ground Elev	Total Depth
SB1	4/29/87	U.S. EPA	794.68	50
SB1A	5/20/87	U.S. EPA	794.68	136.5
LB-1 (B-5)	9/12/89	PELA	762.94	90
LB-2 (PELA-2)	10/25/89	PELA	763.35	75.5
LB-2A (PELA-2A)	7/28/89	PELA	768.84	20
LB-3 (PELA-3)	7/27/89	PELA	763.88	23.5
LB-3A (PELA-3A)	7/27/89	PELA	764.52	20
LB-4 (PELA-4)	7/28/89	PELA	763.43	25
LB-4A (PELA-4A)	8/3/89	PELA	763.40	75.5
LB-5 (PELA-5)	8/8/89	PELA	763.78	30
LB-6 (PELA-6)	8/9/89	PELA	764.15	52
LB-7 (B-3)	8/22/89	PELA	771.54	99.5
LB-8 (B-7)	9/1/89	PELA	772.53	30
LB-9 (B-4)	9/8/89	PELA	760.93	80
LB-10 (PELA 10)	10/4/89	PELA	763.17	80.5
PE-3	9/15/89	PELA	768.92	38.5
PE-3A	9/28/89	PELA	768.92	103.5
IB-1	8/14/89	Patrick Engineering, Inc.	769.50	10.5
IB-2	8/14/89	Patrick Engineering, Inc.	768.70	10.5
IB-3	8/14/89	Patrick Engineering, Inc.	767.30	7.5
IB-4	8/14/89	Patrick Engineering, Inc.	768.30	9
IB-5	8/15/89	Patrick Engineering, Inc.	767.60	9
IB-6	8/15/89	Patrick Engineering, Inc.	766.50	9
IB-7A	8/15/89	Patrick Engineering, Inc.	768.60	9
IB-7B	8/16/89	Patrick Engineering, Inc.	768.81	4.5
IB-8	8/16/89	Patrick Engineering, Inc.	768.78	9.5
IB-9	8/16/89	Patrick Engineering, Inc.	767.48	7.5
IB-10	8/16/89	Patrick Engineering, Inc.	773.07	7.5
LB-8	9/1/89	Patrick Engineering, Inc.	772.30	30
PE-3	9/15/89	Patrick Engineering, Inc.	768.90	38.5
PE-3A	9/25/89	Patrick Engineering, Inc.	768.90	NA
VA-5	7/12/90	Raimonde Drilling	774.77	95
VA-1		Raimonde Drilling	772.30	
VA-2		Raimonde Drilling	772.10	
VA-3		Raimonde Drilling	773.60	
VA-4		Raimonde Drilling	773.80	
VA-6		Raimonde Drilling	777.50	
VA-6 (1-6)		Raimonde Drilling	777.70	
C-1	7/24/90	Stratigraphics		35
C-2	7/24/90	Stratigraphics		27
C-3	7/25/90	Stratigraphics		26
C-4	7/25/90	Stratigraphics		20
C-5	7/25/90	Stratigraphics		26

Notes:
Elev = Elevation in Feet MMSL, USGS Datum
TOIC = Top of Inner Well Casing
Sch = Schedule
Screen Length in Feet
Slot Size in Inches
Stratigraphic Abbreviations: S = Sand Gravel, F = Fine, M = Medium, C = Coarse
NA = Not Available

TABLE 1-6
SOIL BORING INFORMATION
H.O.D. LANDFILL
ANTIOCH, ILLINOIS

Boring #	Completion Date	Completed by	Ground Elev	Total Depth
B1	4/27/93	Warzyn	774.7	35
B2	4/27/93	Warzyn	772.2	38
B2A	4/27/93	Warzyn	772.1	17
B3	4/27/93	Warzyn	773.7	50
B4	4/27/93	Warzyn	774.1	49
B5	4/27/93	Warzyn	775.2	49

Notes:
Elev = Elevation in Feet MMSL, USGS Datum
TOIC = Top of Inner Well Casing
Sch = Schedule
Screen Length in Feet
Slot Size in Inches
Stratigraphic Abbreviations: S = Sand Gravel, F = Fine, M = Medium, C = Coarse
NA = Not Available

TABLE 1-7
Summary of VOCs Detected In
Village Well No. 4
H.O.D. Landfill RI/FS

Date	Cis-1,2-Dichloroethene	Chloromethane	Chloroform	Trichloroethene	Vinyl chloride	Trans-1,2-Dichloroethene
1-Feb-84	--	ND	ND	ND	ND-6.7	ND
22-Feb-84	--	ND	ND	<1	--	--
16-Apr-84	--	ND	ND	<1	--	--
9-Mar-89	--	ND	ND	ND	3.6	--
23-Mar-89	0.2	ND	ND	ND	0.4-1.8	ND-<1
24-Mar-89	--	ND	ND	ND -<1	0.8	ND
22-Aug-89	--	ND	ND	ND	ND	--
23-Aug-89	--	ND	ND	ND	0.2	<0.2
24-Aug-89	--	ND	ND	<0.2	ND-0.2	ND-<0.2
28-Aug-89	--	ND	ND	ND-<0.2	ND-0.2	ND-<0.2
13-Sep-89	--	ND	ND	ND-<0.2	ND-0.2	ND-<0.2
14-Sep-89	--	ND	ND	ND	ND	ND
27-Sep-89	--	ND	ND	ND	ND	ND
26-Oct-89	--	ND	ND	ND	ND	ND
9-Nov-89	--	ND	ND	ND	ND	ND
13-Dec-89	ND	ND	ND	ND	ND	ND
16-May-90	ND	ND	ND	ND	ND	ND
7-Jan-92	0.5	ND	ND	ND	ND	ND
7-Apr-92	ND	ND	0.9	ND	ND	ND
4-Jun-92	ND	ND	ND	ND	ND	ND
6-Jul-92	ND	2.2	ND	ND	ND	ND
3-Aug-92	ND	ND	ND	ND	ND	ND
4-Aug-92	ND	ND	ND	ND	ND	ND
16-Sep-92	0.5	ND	ND	ND	ND	ND
21-Oct-92	ND	ND	ND	ND	ND	ND
3-Nov-92	0.8	1.3	ND	ND	ND	ND
11-Jan-93	ND	ND	ND	ND	ND	ND
8-Feb-93	ND	ND	ND	ND	ND	ND
1-Mar-93	0.6	ND	ND	ND	ND	ND
6-Apr-93	ND	ND	ND	ND	ND	ND
4-May-93	ND	ND	ND	ND	ND	ND
31-Mar-94	0.5	ND	ND	ND	ND	ND

Notes:

1. This table presents all reported detects of volatile organic compounds in water samples collected from Village Well No. 4 finished water collected following treatment (i.e., chlorination and treatment with polyphosphates).
2. Sampling was conducted by the Village of Antioch.
3. Results are in ug/L.
4. - = Not analyzed
5. ND = not detected
6. For 1992 and 1993 data, detection limits are 0.2 for trichloroethene, 0.5 ug/L for vinyl chloride, trans- and cis-1,2-dichloroethene, and 1.0 ug/L for chloromethane and chloroform.
7. The compounds chloromethane and chloroform can be produced during chlorination of groundwater and may not be related to an external contaminant source.

TABLE 2-1

Field Parameters
HOD Landfill
Groundwater Sampling

Well August '93	pH	°C Temperature	Specific Conductivity (ohms) (1)	Dissolved Oxygen (mg/l)	Oxidation Reduction (mV)
HD-GWUS1S-01	7.38	10.5	760	5.2 @ 9 °C	204 @ 11.3 °C
HD-GWUS1D-01	7.58	11	694	3.6 @ 10.5 °C	69 @ 12.5 °C
HD-GWUS3S-01	7.34	13.5	1025	4.3 @ 12 °C	224 @ 14 °C
HD-GWUS3I-01	8.12	12.5	626	6.9 @ 12 °C	84 @ 13.5 °C
HD-GWUS3D-01	7.34	14	1153	4.7 @ 14 °C	83 @ 10 °C
HD-GWUS4S-01	7.27	9.5	1144	6.2 @ 9 °C	50 @ 10.5 °C
HD-GWUS4D-01	7.82	12.5	546	3.4 @ 12 °C	40 @ 13.5 °C
HD-GWUS6S-01	7.17	11.5	835	3.5 @ 11 °C	63 @ 13 °C
HD-GWUS6I-01	8.17	12.5	680	5.4 @ 12 °C	65 @ 14 °C
HD-GWUS6D-01	7.68	13	598	3.5 @ 11.5 °C	20 @ 14 °C
*HD-GWW3SB-01	7.27	13.5	1298	8.4 @ 13 °C	91 @ 13 °C
*HD-GWW3D-01	7.47	14	1410	NM	98 @ 13.5 °C
*HD-GWW4S-01	6.92	14	1410	9.6 @ 14 °C	147 @ 14 °C
HD-GWW4S-91	6.91	13	1447	9.5 @ 13 °C	138 @ 13 °C
HD-GWW5S-01	6.79	12.5	1133	5.3 @ 12 °C	76 @ 13 °C
HD-GWW6S-01	6.95	12	2229	6.2 @ 11 °C	91 @ 12.5 °C
HD-GWW7D-01	7.88	12.5	600	3.2 @ 12 °C	65 @ 23.5 °C
HD-GWG11S-01	–	–	–	–	–
HD-GWG11D-01	–	–	–	–	–
HD-GWUS6S-91	7.18	10.5	859	4.8 @ 10 °C	57 @ 12 °C
HD-GWFB01-01	6.70	23	41	5.8 @ 23 °C	25 @ 23.5 °C
HD-GWFB02-01	6.65	20.5	10	10.1 @ 20 °C	8 @ 21.5 °C
HD-GWUS4D-91	7.85	12	NM	3.2 @ 11 °C	67 @ 13 °C
HD-FB03-01	7.85	16	26	9.2 @ 16 °C	76 @ 16 °C
HD-LCLP11-01	6.75	13	3947	4.2 @ 11.5 °C	50 @ 14 °C
HD-LCLP1-01	7.16	10	8714	1.6 @ 10 °C	42 @ 11 °C
HD-LCLP1-91	7.19	10	8714	0.8 @ 10 °C	21 @ 11 °C
HD-LCLP6-01	7.17	19	11931	1.0 @ 19 °C	-50 @ 19 °C
HD-LCFB01-01	6.52	13	13	7.0 @ 12.5 °C	40 @ 13.5 °C
HD-LCLP8-01	7.15	25	12900	1.4 @ 26 °C	82 @ 26.5 °C

HD-LCMHE-01	6.78	16	5121	3.4 @ 16 °C	72 @ 16.5 °C
HD-SWS201-01	7.65	17	595	9.0 @ 17 °C	61 @ 17 °C
HD-SWFB01-01	6.54	19	1	7.0 @ 18 °C	35 @ 19 °C
HD-SWS101-01	8.05	22	500	6.0 @ 22 °C	118 @ 22 °C
HD-SWS301-01	7.79	18.5	597	4.6 @ 18 °C	118 @ 19 °C
HD-SWS301-01	7.77	19	539	8.4 @ 19 °C	110 @ 20 °C
HD-VW03-01	7.45(2)	13	658	NM	NM
HD-VW05-01	7.52	15	750	NM	NM
HD-PW01-01	NR	NR	NR	NM	NM
HD-PW02-01	NS	NS	NS	NS	NS
HD-PW03-01	7.91	15	625	NM	NM
HD-PW04-01	7.59	16	609	NM	NM
HD-PW05-01	8.13(2)	15	625	NM	NM

TABLE 2-1

Field Parameters
H.O.D Landfill
Groundwater Sampling

Well March '94	pH	°C Temperature	Specific Conductivity (ohms)[1]	Dissolved Oxygen (mg/l)	Oxidation Reduction (mV)
HD-GWUS1S-02	7.12	10	786	7.0	243
HD-GWUS1S-92	7.10	11.5	726	6.0	228
HD-GWUS1D-02	7.60	13	658	11	194
HD-GWUS3S-02	7.18	12	1419	5	203
HD-GWUS3I-02	7.86	11	636	7.5	79
HD-GWUS3D-02	7.07	11	1111	6.8	110
HD-GWUS4S-02	7.12	13	1250	7.9	180
HD-GWUS4D-02	7.83	12.5	527	6.4	168
HD-GWUS6S-02	7.04	15	750	2	159
HD-GWUS6I-02	8.76	14.5	506	4.4	139
HD-GWUS6D-02	7.58	12	588	9.5	132
*HD-GWW3SB-02	6.99	14	1256	5.6	194
*HD-GWW3D-02	7.45	11.5	1233	14	192
HD-GWW4S-02	6.99	10	1286		107
HD-GWW5S-02	6.65	11	1389	8	56
HD-GWW6S-02	6.97	11	1833	11	27
HD-GWW6S-92	7.0	11	1840	10	26
HD-GWW7D-02	7.82	12.5	567	7.4	190
HD-GWG11S-02	7.10	9	1691	9.0	107
HD-GWG11D-02	7.79	12	1149	11.8	111
HD-GWFB01-02	8.75	21	234	5	160
HD-GWFB02-02	NR	NR	NR	NR	NR
HD-GWFB03-02	NR	NR	NR	NR	NR
HD-SWFB01-02	8.25	20	22	5.6	105
HD-SWFB02-02	8.03	16	24	12	171
HD-SWPSG2-02	7.55	11	597	15	133
HD-SWPSG1-02	7.95	13	559	>15	198

HD-SWS101-02	8.06	11	549	14.8	187
HD-SWS201-02	7.57	13	592	7.0	223
HD-SWS301-02	7.59	12	568	8	185
HD-SWS401-02	7.70	10.5	577	>15	196
HD-SWS401-92	7.87	10.5	606	>15	197
HD-SWS501-02	8.04	11.5	545	15	208
HD-SWS601-02	8.07	12.5	533	15	209
HD-VW03-02	7.32	12.0	574	NR	NR
HD-VW05-02	7.48	11.5	685	NR	NR
HD-VW04-02	7.61	16.5	602	NR	NR

NOTES:
NM = Parameter not measured
— = *Not enough sample in well for field parameters*
* = Wells sampled on June 1, 1993
mg/l = Milligrams per liter (dissolved oxygen readings)
mV = Millivolts (oxidation reduction potential)
(1) = Conductivities corrected to 25°C
+ = Field Parameters not obtained due to lack of enough sample volume
(2) = *pH meter not stabilizing, confidence in reading is low*
NR = Not recorded
NS = Not sampled
Dissolved oxygen > 15 indicates meter not working

TAB/jrs/DAP
J:\10010202\WP\TBL\98FIELD.WPD

Table 3-1
Landfill Cap Evaluation
Soil Testing Results

H.O.D. Landfill RI/FS
Antioch, Illinois

TEST PIT NUMBER	LAYER	DEPTH (inches)	GRAIN SIZE	ATTERBURG LIMITS LL/PI	MOISTURE CONTENT (%)	NATURAL DENSITY (lbs/cu ft)	LABORATORY PERMEABILITY (cm/sec)	PROCTOR ANALYSIS (lbs/cu ft)
1	D	24-31	CL	34/15	18.7	--	--	--
2	D	34-40	CL	31/14	14.3	--	--	--
3	D	26-36	CL	38/21	19.4	--	--	--
4	E	41-55	CL	33/16	17.6	--	--	--
5	C	17-20	CL	33/16	13.7	--	--	--
6	D	41-65	CL	38/19	18.2	--	--	--
7	B	8-35	CL	46/25	23.8	--	--	--
8	D	56-82	CL	34/16	14.8	--	--	--
9	E	29-84	CL	34/17	33.6	--	--	--
10	D	30-62	CL	33/16	16.1	--	--	--
10-DUP	D	30-62	CL	31/15	15.6	--	--	--
1	--	18-32	--	--	--	115.5	--	--
2	--	25-38	--	--	--	109.3	--	--
3	--	26-40	--	--	16.2	112.7	9.03E-09	--
4	--	30-42	--	--	19.6	--	1.04E-08	--
5	--	15-30	--	--	--	117.7	--	--
6	--	39-53	--	--	--	116.4	--	--
7	--	35-50	--	--	18.6	108.2	3.70E-08	--
8	--	58-70	--	--	--	128.3	--	--
9	--	29-42	--	--	14.5	114.7	3.00E-08	--
10	--	43-55	--	--	--	121.9	--	--
2	--	21-31	--	--	--	--	--	126
3	--	24-34	--	--	--	--	--	126
6	--	16-26	--	--	--	--	--	130
10	--	29-39	--	--	--	--	--	132

Note:-- denotes not applicable

Table 3-2
Boutwell Apparent Vertical Conductivity
H.O.D. Landfill
Antioch, Illinois

BOUTWELL NUMBER	APPARENT VERTICAL CONDUCTIVITY (cm/sec)
1	1.02E-05
2	3.67E-08
3	4.22E-08
4	7.77E-08
5	9.08E-07
6	5.97E-08
7	1.04E-07
8	8.86E-06
9	1.61E-05
10	4.69E-08

CCH/cch/DAP

I:\10010201/technica/geotable/boutsum.xls

TABLE 3-3
Landfill Cap Thickness and Vertical Extent of Refuse
H.O.D. Landfill
Antioch, Illinois

Boring Location	Ground Surface Elevation (ft)	Depth to Refuse (ft)	Refuse Thickness (ft)	Depth to Base Material (ft)	Elevation of Base Material (ft)
LP1	775.6	5.0	18.0	23.0	752.6
LP2	785.5	4.0	36.0	40.0	745.5
LP3	778.1	5.0	23.5	28.5	749.6
LP4	788.9	4.0	36.0	40.0	748.9
LP5	796.6	4.5	46.5	51.0	745.6
LP6	794.6	4.5	35.5	40.0	754.6
LP7	794.7	5.0	57.0	62.0	732.7
LP8	793.5	7.0	63.5	70.5	723.0
LP9	785.8	8.0	60.5	68.5	717.3
LP10	781.1	5.0	23.5	28.5	752.6
LP11	787.8	9.0	24.0	33.0	754.8
LP12	782.6	4.5	21.0	25.5	757.1
LP13	779	5.0	12.0	17.0	762.0
LP14	781.7	4.5	19.0	23.5	758.2
TP1	nm	6.5	--	--	--
TP2	nm	5.8	--	--	--
TP3	nm	7.3	--	--	--
TP4	nm	5.2	--	--	--
TP5	nm	4.1	--	--	--
TP6	nm	5.4	--	--	--
TP7	nm	5.0	--	--	--
TP8	nm	6.8	--	--	--
TP9	nm	7.0	--	--	--
TP10	nm	5.2	--	--	--
B1	774.7	5.0	3.3	8.3	766.4
B2	772.1	4.0	6.0	10.0	762.1
B3	773.7	4.0	5.5	10.5	763.2
B4	774.1	4.0	9.5	13.5	760.6
B5	775.2	5.0	12.0	17.0	758.2
GWF1	795	5.0	37.0+	42+	+
GWF2	796.2	5.0	42.0+	47.0+	+
GWF3	797.2	5.0	40.0 +	45.0+	+
GWF4	795	5.0	40.0+	45.0+	+
GWF5	789.2	5.0	50.0+	55.0+	+
GWF6	791.2	5.0	36.0+	41.0+	+
GWF7	795.9	5.0	43.0+	48.0+	+
GWF8	797.4	5.0	43.0+	48.0+	+
GWF9	797	5.0	43.0+	48.0+	+
GWF10	792.7	5.0	33.0+	38.0+	+
GWF11	793.6	5.0	35.0+	40.0+	+
GWF12	792.5	5.0	17.0+	22.0+	+
GWF13	794.7	5.0	40.0+	45.0+	+
GWF14	792.2	5.0	38.0+	43.0+	+
P1	797.73	4.0	38.0	42.0	755.7
P2A	795.1	4.0	68.5	72.5	722.6
P3A	792.4	5.5	66.5	72.0	720.4
P8	796.23	4.0	37.0	41.0	755.2
P9	796.93	4.0	36.0	40.0	756.9
P10	795.06	4.0	39.0	43.0	752.1

Notes:
+ Base Material not encountered. Thickness of refuse may be greater than actual Thickness represented.
-- Base Material not encountered in Test Pits.
Ground Surface Elevations unavailable for P1, P8, P9 and P10 (Top of PVC Casing elevations used)
nm - Ground Surface Elevation not measured at Test Pit Locations

DAP/jrs/PMS
J:2386/0090/10010201/technica/geotable\refuse.xls

TABLE 3-4

Landfill Gas
Field Screening Results
H.O.D. Landfill
Antioch, Illinois

June 4, 1993

Probe Number	% Methane	% Carbon Dioxide	% Oxygen
LP01	0.0	0.4	20.5
LP06	67.7	32.2	0.1
LP07	65.4	34.4	0.1
LP08	67.6	31.1	0.1
LP11	72.3	26.7	0.1
GP3	0.0	0.0	20.9
GP4A	0.0	0.0	20.8
GP5A	0.0	0.0	20.9

March 30, 1994

Probe Number	% Methane	% LEL	% Oxygen
PZ5U	0.0	0.0	21.0
G14S	0.0	0.0	21.0
G14D	0.0	0.0	21.0
PZ6U	0.0	0.0	21.0
PZ4U	0.0	0.0	21.0
PZ3U	0.0	0.0	21.0
R103	0.0	0.0	21.0
US6S	0.0	0.0	21.0
W6S	0.0	0.0	21.0
W5S	20.0	100.0	E
US4S	0.0	0.0	21.0
G102	20.0	170.0	E
G11S	0.0	0.0	21.0
G11D	0.0	0.0	21.0
GP3	0.0	0.0	21.0
GP4A	0.0	0.0	21.0
GP5A	0.0	0.0	21.0

LEL = Lower Explosion Limit
E = Measurement Error

DAP/jrs/PMS/ACC/DAP
J:10010202\technica\geotable\gasprob.xls

Table 3-5
Monitoring Well/Staff Gauge and Stand Pipe Water Levels
H.O.D. Landfill
Antioch, Illinois

				6/8/93 - 6/9/93		8/18/93-8/19/93 (1)		10/19/93-10/21/93 (1)		12/15/93-12/16/93 (2)		2/17/94 - 2/18/94 (2)		3/28/94		4/22/1994-4/25/1994	
Well Number	Ground Elevation (ft msl)	TOIC Elevation (ft msl)	Total Depth (ft)	Groundwater Level (ft)	Groundwater Elevation (ft msl)	Depth to Water from TOIC	Groundwater Elevation	Depth to Water from TOIC	Groundwater Elevation	Depth to Water from TOIC	Groundwater Elevation	Depth to Water from TOIC	Groundwater Elevation	Depth to Water from TOIC	Groundwater Elevation	Depth to Water from TOIC	Groundwater Elevation
*US1S	766.5	768.69	--	4.3	764.39	6.18	762.51	4.79	763.9	5.17	763.52	4.72	763.97	4.48	764.21	4.97	763.72
+US1D	766.9	768.88	ww	38.24	730.64	38.95	729.93	38.88	730	39.19	729.69	39.86	729.02	38.58	730.3	38.82	730.06
+US2D	768.2	770.73	ww	41.24	729.49	42.19	728.54	41.28	729.45	42	728.73	43.06	727.67	41.18	729.55	41.9	728.83
*US3S	767.1	770.48	25.4	8.39	762.09	8.88	761.6	9.42	761.06	8.61	761.87	8.71	761.77	8.23	762.25	8.51	761.97
-US3I	767.01	769.93	59.95	36.00	733.93	37.5	732.43	37.14	732.79	37.03	732.9	38.21	731.72	36.67	733.26	36.66	733.27
+US3D	767.1	769.72	ww	41.31	728.41	40.57	729.15	39.96	729.76	42.44	727.28	40.22	729.5	40.34	729.38	41.98	727.74
*US4S	771.1	773.67	ww	11.82	761.85	12.25	761.42	11.7	761.97	11.77	761.9	11.85	761.82	11.65	762.02	11.8	761.87
+US4D	770.3	772.7	ww	44.09	728.61	43.4	729.3	43.1	729.6	45.26	727.4	43.42	729.28	43.24	729.46	44.85	727.85
+US5D	765.1	767.73	ww	37.55	730.18	38.12	729.61	37.68	730.05	37.82	729.91	38.35	729.38	37.93	729.8	38.24	729.49
*US6S	767.1	769.9	--	7.45	762.45	8.2	761.8	7.53	762.4	7.68	762.22	7.8	762.1	7.27	762.63	7.67	762.23
-US6I	767.6	770.21	--	32.15	738.06	23.89	746.32	23.72	746.49	23.88	746.33	24.5	745.71	23.57	746.64	23.73	746.48
+US6D	767.1	770.09	ww	40.39	729.7	40.45	729.64	40.39	729.7	41.53	728.56	40.98	729.11	40.26	729.83	41.08	729.01
-US7S	764.4	767.99	35.95	5.54	762.45	6.95	761.04	6.25	761.74	6.39	761.6	6.67	761.32	4.9	763.09	5.5	762.49
													0		0		0
+G11S	767.6	770.12	ww	4.74	765.38	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	NA		6.19	763.93
-G11D	767.1	769.99	ww	9.31	760.68	9.98	760.01	9.31	760.68	9.51	760.48	9.46	760.53	NA		9.03	760.96
*G14S	767.6	770.34	ww	5.19	765.15	Dry	Dry	7.77	Dry	7.05	763.29	7.48	762.86	5.29	765.05	8.35	761.99
-G14D	767.7	769.75	ww	6.65	763.1	8.12	761.63	7.52	762.23	7.06	762.69	7.56	762.19	6.42	763.33	6.97	762.78
*G102	771.1	773.53	ww	11.69	761.84	12.56	760.97	12	761.53	11.62	761.91	12.09	761.44	11.5	762.03	11.64	761.89
*R103	767.6	769.55	ww	7.1	762.45	8.11	761.44	7.43	762.12	7.4	762.15	7.64	761.91	7.24	762.31	7.27	762.28
+W2D	770.7	773.04	90.72	42.3	730.74	43.02	730.02	42.77	730.27	43	730.04	43.66	729.38	42.6	730.44	43.21	729.83
*W3SA	763.8	766.54	–	4.24	762.3	4.9	761.64	4.23	762.31	4.31	762.23	4.52	762.02	4.09	762.45	4.37	762.17
*W3SB	763.7	766.81	–	4.55	762.26	5.15	761.66	4.53	762.28	4.69	762.12	4.8	762.01	4.38	762.43	4.66	762.15
+W3D	763.73	765.93	–	36.66	729.27	35.63	730.3	36.44	729.49	37.71	728.22	36.98	728.95	30.3	735.63	37.22	728.71
*W4S	767.5	769.97	16.72	7.85	762.12	8.34	761.63	7.76	762.21	8.01	761.96	8.05	761.92	7.72	762.25	7.92	762.05
*W5S	771.1	773.49	–	11.65	761.84	12.07	761.42	11.52	761.97	11.52	761.97	11.68	761.81	11.47	762.02	11.59	761.9
*W6S	764.9	767.41	–	4.95	762.46	5.88	761.53	5.06	762.35	5.25	762.16	5.38	762.03	4.76	762.65	5.09	762.32
+W7D	780.2	782.87	102.26	52.06	730.81	52.9	729.97	52.59	730.28	52.88	729.99	53.54	729.33	52.4	730.47	52.98	729.89
+W8D	766.68	768.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	37.92	730.22	38.18	729.96
+PZ1	786.2	788.48	119.5	56.84	731.64	57.8	730.68	57.9	730.58	58.14	730.34	59.04	729.44	58.01	730.47	57.84	730.64
+PZ2	767	766.44	74.26	29.42	737.02	29***	737.44	28.81	737.63	28.61	737.83	28.17	738.27	Abandoned	Abandoned	Abandoned	Abandoned
*PZ1U	763.9	766.41	27.25	3.47	762.94	4.32***	762.09	3.87	762.54	3.97	762.44	4.21	762.2	3.62	762.79	3.98	762.43
*PZ2U	764.1	768.04	19.86	4.89	763.15	5.96	762.08	5.42	762.62	5.53	762.51	5.63	762.41	5.19	762.85	5.53	762.51
*PZ3U	763.4	766.27	39.75	3.4	762.87	4.45	761.82	3.92	762.35	3.98	762.29	4.02	762.25	3.46	762.81	3.7	762.57
*PZ4U	763.3	766.49	30.35	3.42	763.07	4.53	761.96	4.07	762.42	4.05	762.44	4.02	762.47	3.49	763	3.97	762.52
*PZ5U	769.3	771.11	34.59	7.49	763.62	8.79	762.32	8.46	762.65	8.4	762.71	8.38	762.73	7.53	763.58	8.12	762.99
*PZ6U	763.6	766.54	NA	3.5	763.04	4.63	761.91	4.16	762.38	4.26	762.28	4.18	762.36	3.58	762.96	4.06	762.48

Table 3-5
Monitoring Well/Staff Gauge and Stand Pipe Water Levels
H.O.D. Landfill
Antioch, Illinois

Staff Gauge (PSG) and Stand Pipe (SC) Number	Ground Elevation (ft msl)	TOC Elevation (ft msl)	Total Depth (ft)	6/8/93-6/9/93		8/18/93-8/19/93		10/19/93-10/21/93		12/15/93-12/17/93		2/17/1994 - 2/18/1994		3/28/94		4/22/1994-4/25/1994	
				Groundwater Level (ft)	Groundwater Elevation (ft msl)	Groundwater Level (ft)	Groundwater Elevation	Groundwater Level (ft)	Groundwater Elevation	Groundwater Level (ft)	Groundwater Elevation	Groundwater Level (ft)	Groundwater Elevation	Groundwater Level (ft)	Groundwater Elevation	Groundwater Level (ft)	Groundwater Elevation
PSG-1	NA	763.79	NA	1.7/2.98**	762.16/763.44	1.8***	762.26	2.31	762.77	2.28	762.74	Frozen	NA	2.62	763.08	2.1	762.56
SC-1A	764.7	766.84	14.9	4.23/4.11**	762.61/762.73	4.7	762.14	4.28	762.56	4.23	762.61	4.39	762.45	3.56	763.28	4.06	762.78
SC-1B	766.4	769.34	24	6.22/5.16**	763.12/764.18	7.21	762.13	6.58	762.76	6.61	762.73	6.46	762.88	6	763.34	6.66	762.68
SC-1C	762.9	765.44	18	2.57**	762.87	3.25***	762.19	3.17	762.27	2.87	762.57	2.86	762.58	2.3	763.14	2.97	762.47
SC-1D	762.94	766.39	22.35	3.22**	763.17	4.26***	762.13	3.93	762.46	3.83	762.56	3.75	762.64	3.22	763.17	3.91	762.48
PSG-2	NA	762.53	NA	2.1	761.3	2.04	761.24	2.82	762.02	2.37	761.57	2.7	761.9	NM	NA	2.45	761.65
PSG-2A	NA	763.87	NA	NA	NA	NA	NA	2.16	762.03	1.72	761.59	1.99	761.86	1.85	761.72	1.66	761.53
SC-2A	763.2	765.09	--	2.91	762.18	3.59	761.5	3	762.09	2.99	762.1	3.05	762.04	2.6	762.49	2.93	762.16
SC-2B	766	767.24	20	4.8	762.44	5.5	761.74	4.95	762.29	5.28	761.96	5.15	762.09	4.63	762.61	5	762.24
SC-2C	763.2	764.51	15	2.14	762.37	2.69***	761.82	2.21	762.3	2.33	762.18	2.51	762	1.95	762.56	2.37	762.14
SC-2D	763.4	764.77	15	2.4	762.37	2.92***	761.85	2.33	762.44	2.42	762.35	2.65	762.12	2.13	762.64	2.52	762.25
PSG-3A	NA	764.66	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.74	761.4	0.8	761.46
PSG-3	NA	762.86	NA	1.64/2.3**	761.17/761.83	1.56	761.09	1.95	761.48	1.4	760.93	Frozen	NA	**Destroyed**		**2.01**	**761.54**
SC-3B	769.9	770.6	17.25	8.71	761.89	9.19	761.4	8.6	762	8.69	761.9	8.77	761.83	8.57	762.03	8.73	761.87
SC-3C	767.7	770.26	17.08	8.31	761.95	8.75	761.51	8.25	762.01	8.33	761.93	8.42	761.84	8.22	762.04	8.37	761.89
SC-3D	767.1	769.77	13.85	Broken	NA	Broken	NA	Broken	NA	Broken	NA	Broken	NA	5.03	764.74	7.74	762.03
PSG-4	NA	762.45	NA	1.4	760.52	1.8	760.92	2.21	761.33	2.4	761.52	-- --	NA	2.09	761.21	2.29	761.41
SC-4A	768.8	770.22	-- --	9.36	760.86	10.35	759.87	8.93	761.29	9.63	760.59	9.29	760.93	9.09	761.13	9.68	760.54
SC-4B	768.1	770.44	30	9.6	760.84	10.28	760.16	9.16	761.28	9.89	760.55	--	NA	9.34	761.1	9.91	760.53
SC-4C	765.8	768.53	20.17	7.63	760.9	8.31	760.22	7.35	761.18	7.99	760.54	7.62	760.91	7.51	761.02	8.08	760.45
SC-4D	766.3	769.6	24	8.68	760.92	9.42	760.2	8.38	761.2	9.1	760.5	8.7	760.9	8.65	760.95	9.23	760.37
EPA Well Point (S101)	762.5	765.49	8.9	2.25	763.24	2.94***	762.55	2.63	762.86	2.72	762.77	Frozen	NA	2.33	763.16	2.36	763.13
Surface Water Level at																	
EPA Well Point (S101)	762.5	765.49	NA	2.45	763.04	Dry***	765.49	2.34	763.15	2.34	763.15	Frozen	NA	2.08	763.41	2.36	763.13

Notes:

(ft msl) = feet above mean sea level
---- = Measurement Not Collected
NA = Not Applicable
TOIC = Top of Inner Casing
TOC = top of Casing
* = Near surface/surficial sand well/water table well
+ = Deep sand and gravel well

- = Intermediate diamict well
PZ1 = P.E. Lamoreaux wells
W6S = Warzyn Wells
G115/R103 = TSC Wells
** = Measurements obtained on 6/9/93
*** = Measurements obtained on 9/3/93
(1) = Water Levels collected by Western Gulf Coast Laboratories
(2) = Water levels collsected by EMT

SJC/jrs/DAP/SJC/TAB/BER/SJC

Elevations Surveyed by Gentile and Associates, Inc. for Warzyn on June 28 through July 1, 1993

TABLE 3-6
Leachate Elevations
H.O.D. Landfill
Antioch, Illinois

						5/4/93			8/20/93 (a)			10/20/93		
Piezometer Number	**Ground Elevation**	**Depth to Base of Refuse**	**Landfill Base Elevation**	**TOIC Elevation**	**Total Piez. Depth**	**Depth to Leachate**	**Leachate Elevation**	**Refuse Saturated Thickness**	**Depth to Leachate**	**Leachate Elevation**	**Refuse Saturated Thickness**	**Depth to Leachate**	**Leachate Elevation**	**Refuse Saturated Thickness**
LP1	775.6	23.0	752.6	778.46	20.31	12.71	765.75	13.2	11.3	767.19	14.6	11.21	767.25	14.7
LP2	785.5	40.0	745.5	787.8	3.5	20.93	766.87	21.4	18.1	769.8	24.3	18.12	769.7	24.2
LP3	778.1	28.5	749.6	780.89	25.5	15.56	765.33	15.7	16	764.89	15.3	16	764.89	15.3
LP4	788.9	40.0	748.9	790.84	39	19.47	771.37	22.5	17.72	773.12	24.2	18.12	772.72	23.8
LP5	796.6	51.0	745.6	800.13	50	40.3	759.83	14.2	38.9	761.23	15.6	39.08	761.05	15.4
LP6	794.6	40.0	754.6	797.32	36.5	20.65	776.67	22.1	17.68	779.64	25.0	17.24	780.08	25.5
LP7	794.7	62.0	732.7	797.39	61	22.75	774.64	41.9	22.8	774.59	41.9	22.57	774.82	42.1
LP8	793.5	70.5	723.0	796.35	70	44.05	752.3	29.3	42.4	753.95	31.0	42.3	754.05	31.1
LP9	785.8	68.5	717.3	789.16	66.5	26.76	762.4	45.1	26.1	763.06	45.8	25.42	763.74	46.4
LP10	781.1	28.5	752.6	783.92	23	19.25	764.67	12.1	17.85	766.07	13.5	17.81	766.11	13.5
LP11	787.8	33.0	754.8	790.61	29.2	20.54	770.07	15.3	19.8	770.81	16.0	19.49	771.12	16.3
LP12	782.6	25.5	757.1	784.85	22.5	20.56	764.29	7.2	19.9	764.95	7.9	19.97	764.88	7.8
LP13	779.0	17.0	762.0	781.68	17	15.46	766.22	4.2	15.13	766.55	4.5	15.38	766.3	4.3
LP14	781.7	23.5	758.2	784.27	22.5	20.2	764.07	5.9	19.43	764.84	6.6	19.47	764.8	6.6

TABLE 3-6
Leachate Elevations
H.O.D. Landfill
Antioch, Illinois

	12/17/93			2/18/94			3/28/94			4/25/94		
Piezometer Number	Depth to Leachate	Leachate Elevation	Refuse Saturated Thickness	Depth to Leachate	Leachate Elevation	Refuse Saturated Thickness	Depth to Leachate	Leachate Elevation	Refuse Saturated Thickness	Depth to Leachate	Leachate Elevation	Refuse Saturated Thickness
LP1	11.76	766.7	14.1	11.95	767.25	14.7	11.82	766.7	14.1	11.96	766.7	14.1
LP2	18.52	769.3	23.8	18.61	769.7	24.2	18.83	769.3	23.8	19.17	769.3	23.8
LP3	16.36	764.53	14.9	16.45	764.44	14.8	15.96	764.53	14.9	16.24	764.53	14.9
LP4	18.69	772.15	23.3	19.08	771.76	22.9	19.06	772.15	23.3	18.60	772.15	23.3
LP5	39.31	760.82	15.2	39.08	761.05	15.4	39.1	760.82	15.2	36.16	760.82	15.2
LP6	17.95	779.37	24.8	17.95	779.37	24.8	17.7	779.37	24.8	17.58	779.37	24.8
LP7	22.67	774.72	42.0	22.45	774.94	42.2	21.72	774.72	42.0	21.73	774.72	42.0
LP8	42.09	754.26	31.3	42.12	754.23	31.2	41.68	754.26	31.3	41.72	754.26	31.3
LP9	25.09	764.07	46.8	25.10	764.06	46.8	25.02	764.07	46.8	25.95	764.07	46.8
LP10	16.9	767.02	14.4	17.89	766.03	13.4	17.4	767.02	14.4	18.12	767.02	14.4
LP11	20.07	770.54	15.7	20.63	769.98	15.2	20.88	770.54	15.7	20.83	770.54	15.7
LP12	20.17	764.68	7.6	20.02	764.83	7.7	20.04	764.68	7.6	20.18	764.68	7.6
LP13	15.67	766.01	4.0	15.90	765.78	3.8	15.3	766.01	4.0	15.38	765.01	4.0
LP14	19.61	764.66	6.5	19.68	764.59	6.4	19.62	764.66	6.5	19.59*	764.66	6.5

Notes:

Depths and leachate head are in feet.

Elevations in feet mean sea level.

TOIC = Top of Inner Casing.

Elevations surveyed by Gentile and Associates, Inc. for Warzyn on June 28 through July 1, 1993.

(a) = Leachate levels collected by Weston Gulf Coast Laboratories, Inc.

(b) = Leachate levels collected by EMT.

* = Leachate level obtained on 4/22/94.

TABLE 3-7
Sequoit Creek Flow Measurements
H.O.D. Landfill
Antioch, Illinois

June 8, 1993

PSG 1

Station No.	Depth of Water (ft)	Revolutions of Standard Meter	Elapsed Time (sec.)	Velocity[1] (ft/sec.)	Distance Between Stations (ft)	Area of Station[2] (ft^2)	Flow[3] (ft^3/sec.)
1	1.50	0	90	0	1	1.50	None
2	1.68	0	60	0	1	1.68	None
3	1.70	0	60	0	1	1.70	None
4	1.40	0	60	0	1	1.40	None

No flow, the water is full (to the surface) of elodea weed.

PSG2

Station No.	Depth of Water (ft)	Revolutions of Standard Meter	Elapsed Time (sec.)	Velocity[1] (ft/sec.)	Distance Between Stations (ft)	Area of Station[2] (ft^2)	Flow[3] (ft^3/sec.)
1	0.62	4	60	0.34	1	0.62	0.214
2	0.93	3	60	0.31	1	0.93	0.288
3	1.11	0	60	0.00	1	1.11	None
4	1.38	13	60	0.67	1	1.38	0.925
5	1.70	8	60	0.49	1	1.70	0.833
6	1.03	9	60	0.53	1	1.03	0.546
7	1.11	3	60	0.31	1	1.11	0.344
8	1.00	0	60	0.00	1	1.00	None
							3.15

Total discharge is 3.15 ft^3/sec.

TABLE 3-7
Sequoit Creek Flow Measurements
H.O.D. Landfill
Antioch, Illinois

PSG3

June 8, 1993

Station No.	Depth of Water (ft)	Revolutions of Standard Meter	Elapsed Time (sec.)	Velocity (1) (ft/sec.)	Distance Between Stations (ft)	Area of Station (2) (ft^2)	Flow (3) (ft^3/sec.)
1	0.23	0	60	0.00	1	0.23	None
2	0.41	0	60	0.00	1	0.41	None
3	0.51	13	60	0.67	1	0.51	0.343
4	1.30	13	60	0.67	1	1.30	0.871
5	1.48	16	60	0.78	1	1.48	1.15
6	1.51	13	60	0.67	1	1.51	1.01
7	1.45	19	60	0.89	1	1.45	1.29
8	1.21	12	60	0.64	1	1.21	0.774
9	1.21	3	60	0.31	1	1.21	0.375
10	1.05	1	60	0.24	1	1.05	0.252
11	1.00	0	60	0.00	1	1.00	None
12	0.75	0	60	0.00	1	0.75	None
13	0.46	0	60	0.00	1	0.46	None
Total discharge is 6.065 ft ^{3},sec.							6.065

PSG4

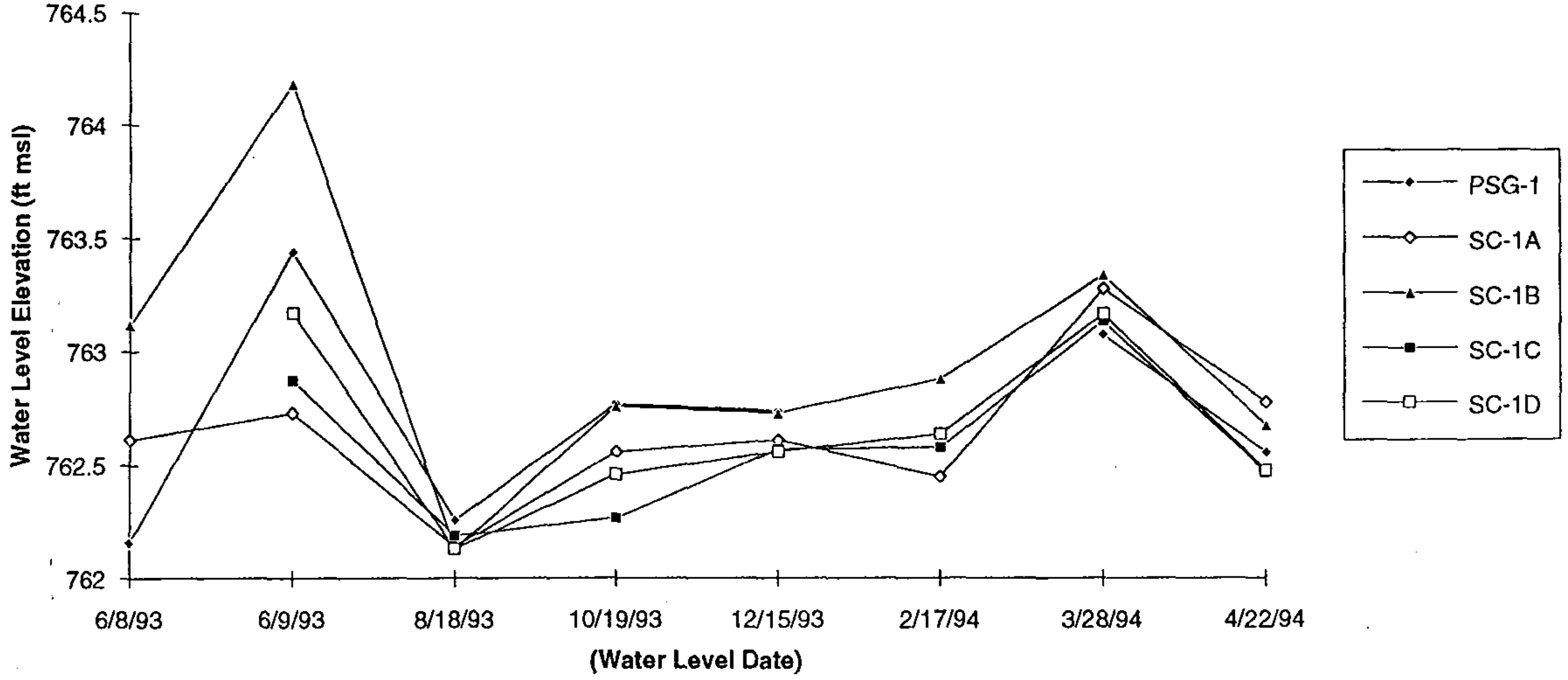
Station No.	Depth of Water (ft)	Revolutions of Standard Meter	Elapsed Time (sec.)	Velocity (1) (ft/sec.)	Distance Between Stations (ft)	Area of Station (2) (ft^2)	Flow (3) (ft^3/sec.)
1	0.50	0	60	0.00	2	1.00	None
2	0.90	0	60	0.00	2	1.80	None
3	1.18	0	60	0.00	2	2.36	None
4	1.28	0	60	0.00	2	2.56	None
5	1.80	1	60	0.24	2	3.60	0.864
6	2.20	7	60	0.45	2	4.40	1.98
7	1.50	9	60	0.53	2	3.00	1.59
8	1.01	3	60	0.31	2	2.02	0.63
9	0.78	0	60	0.00	2	1.56	None
10	0.68	0	60	0.00	2	1.36	None
11	0.45	0	60	0.00	2	0.90	None
(4) Total Discharge is 5.064 ft ^{3}.'sec.							5.064

Notes:

1. Velocity is reported in feet per second (fps) calculated for the Standard Gurley meter by:
   Velocity = 2.18(r) + 0.2 where R = Revolutions/elapsed time (sec.)
2. Area of the station is reported in square feet (ft^3) and calculated by multiplying the depth of water by the distance between stationns.
3. Flow is reported in cubic feet per second (ft^2 /sec.) and calculated by multiplying velocity by the area of the station.
4. Total discharge is the sum of the individual stations flow, reported in ft /sec.
5. The stations in the creek were located in the main channel of the creek. At locations PSG1 and PSG2 the channel from the bank to bank was wider than what is given on this table, but water was between 3 and 5 inches deep with cattails, thus flow measurement could not be made.

Table 3-8

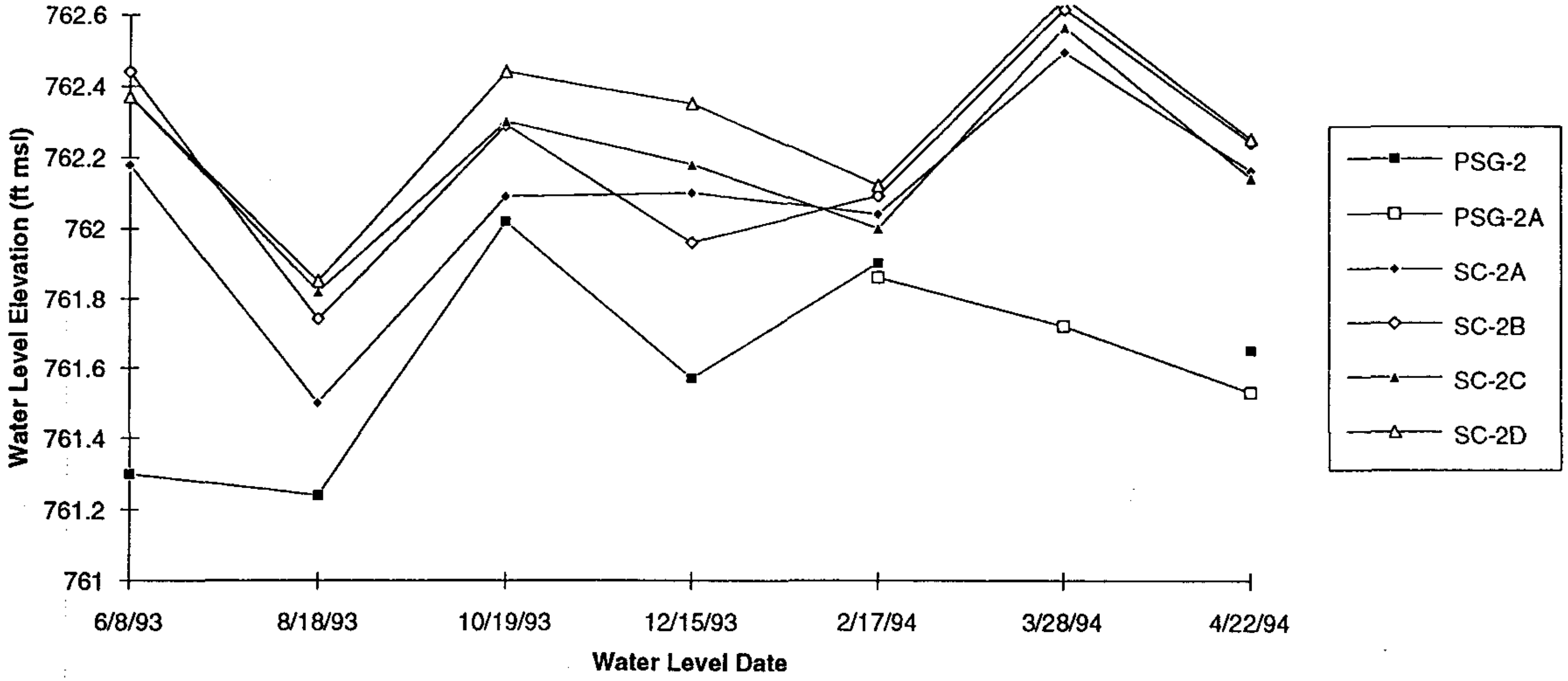
Sequoit Creek Staff Gage PSG1 and Associated Standpipe Water Levels, from June 93 through April 94, HOD Landfill, Antioch, Illinois



Notes
ft msl = feet above mean sea level
J:/10010202/technica/geotable/CHART15.XLC

Table 3-9

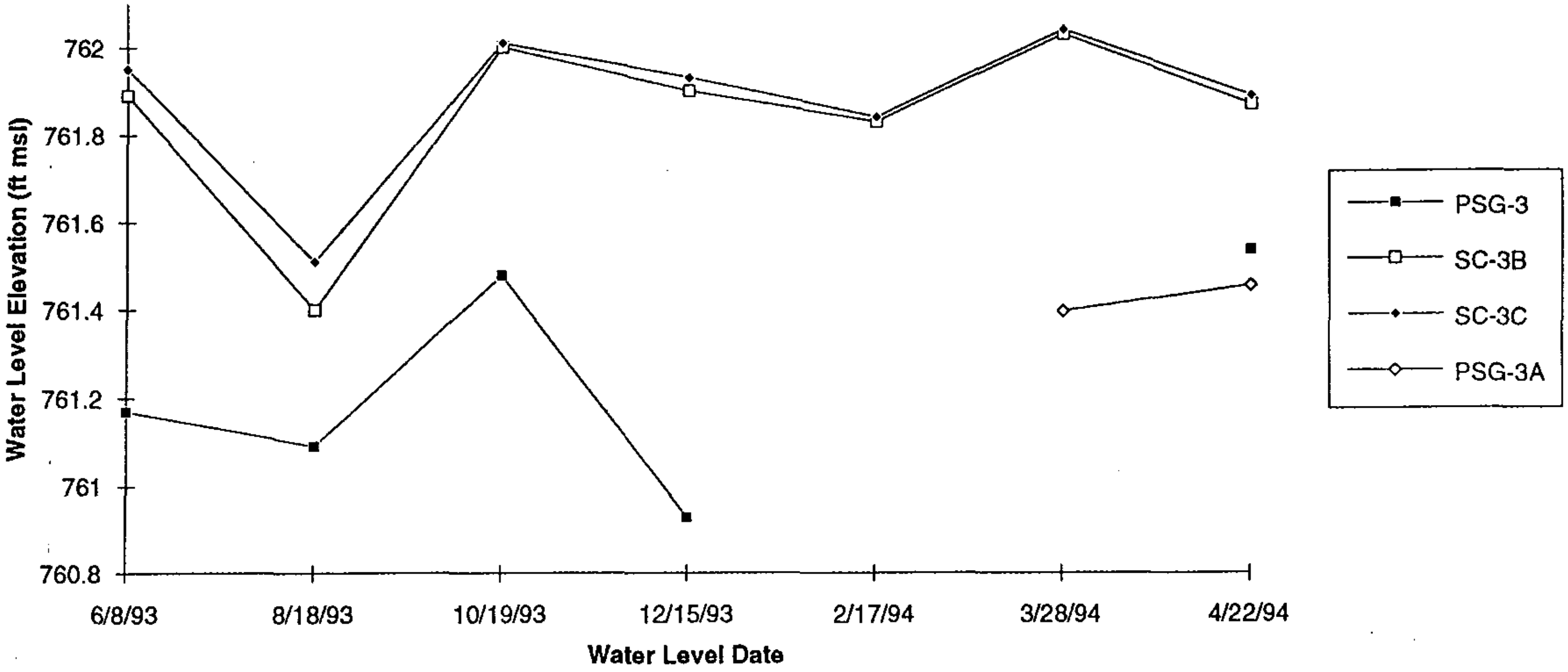
Sequoit Creek Staff Gage PSG2 and Associated Standpipe Water Levels, from June 93 through April 94,HOD Landfill, Antioch, Illinois



ft msl = feet above mean seal level
J:/10010202/technica/geotable/CHART11.XLC

Table 3-10

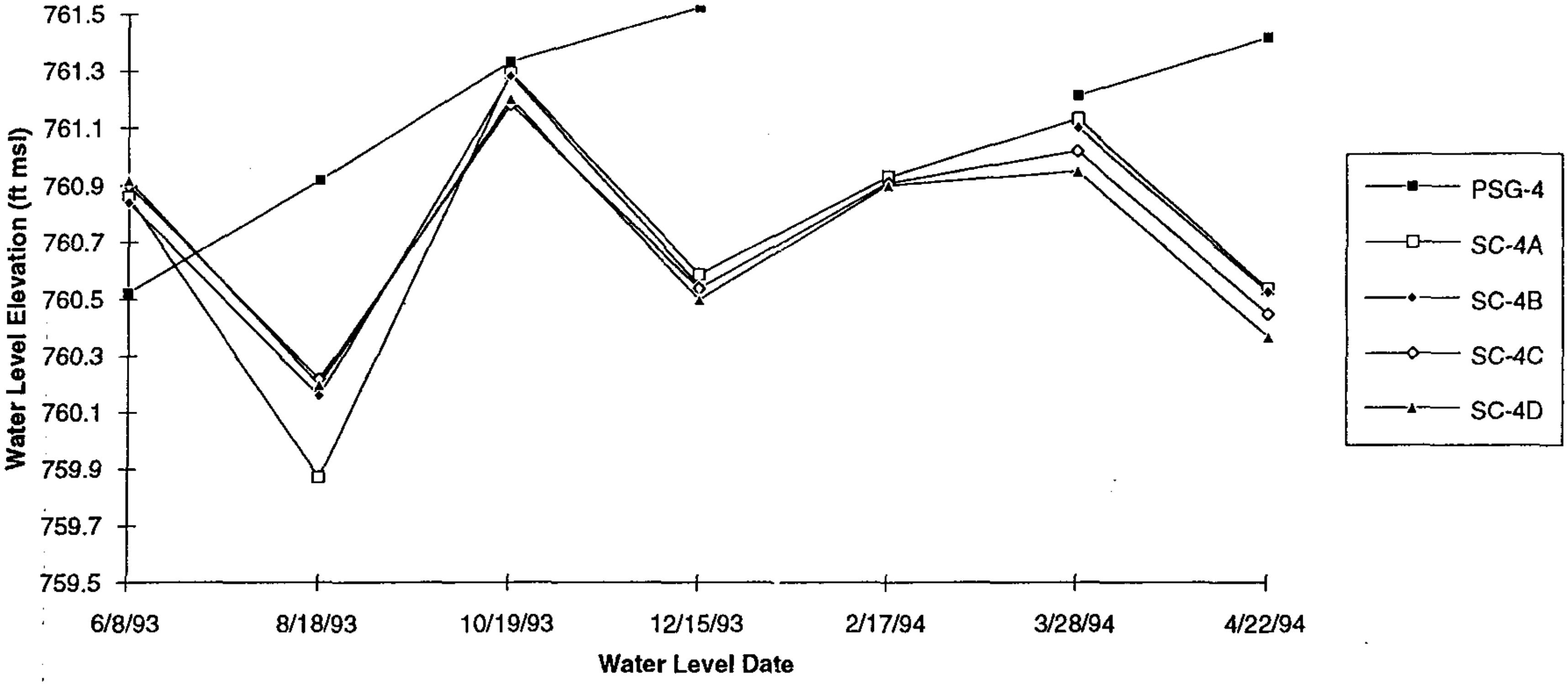
Sequoit Creek Staff Gage PSG3 and Associated Standpipe Water Levels, from June 93 through April 94, HOD Landfill, Antioch, Illinois



ft msl = feet above mean sea level
J:/10010202/technica/geotable/CHART13.XLC

Table 3-11

Sequoit Creek Staff Gage PSG4 and Associated Standpipe Water Levels, from June 93 through April 94, HOD Landfill, Antioch, Illinois



ft msl = feet above mean sea level
J:/10010202/technica/geotable/CHART14.XLC

TABLE 3-12
Geotechnical Laboratory Results
H.O.D. Landfill
Antioch, Illinois

Sample Point	Location	Depth (ft)	GSA (1)	P200 (2)	L.L. (3)	P.I. (4)	Vertical Laboratory Permeability (CM/S)	USCS (5)	Total Organic Carbon (6)	Estimated Total Porosity
SU01	Surface	0-1	20.6/20.1/28.1/31.2	59.3	28	12	–	CL	–	–
SU02	Surface	0-1	4.9/32.4/47.0/15.7	62.7	33	8	–	CL	–	–
SU03	Surface	0-1	3.0/25.5/43.2/28.3	71.5	51	21	–	MH	–	–
SU04	Surface	0-1	0.5/60.5/23.2/15.8	39	26	10	–	SC	–	–
SU04 (D)	Surface	0-1	1.2/62.0/20.6/16.2	36.8	25	9	–	SC	–	–
SU05	Surface	0-1	6.6/33.1/33.5/26.8	60.3	29	12	–	CL	–	–
W2D	Profile	7-9	0.6/10.8/54.8/33.8	88.6	30	11	–	CL	–	–
W2D	Profile	29-31	–	–	–	–	1.50E-08	CL	3.6	0.38
W2D	Profile	32-34	3.3/2.3/33.3/61.1	94.4	38	19	–	CL	–	–
W2D (D)	Profile	32-34	0.1/2.0/33.4/64.5	97.9	38	19	–	CL	–	–
W2D	Screen interval	86-88	15.3/78.0/5.1/1.6	6.7	–	–	–	SP-SM	–	–
W3SB	Profile	18-20	10.4/80.7/5.7/3.2	8.9	–	–	–	SW-SM	–	–
D	Profile	36-38	–	–	–	–	1.70E-08	CL	1.64	0.24
3D	Profile	38-40	5.0/44.0/28.8/22.2	51	18	6	–	CL/ML	–	–
W5S	Screen interval	7-9	18.5/41.4/30.6/9.5	40.1	63	NP	–	SM	11.7	–
W5S	Screen interval	12-14	8.8/70.6/16.5/4.1	20.6	–	–	–	SM	–	–
W6S	Screen interval	12-14	0.0/87.6/9.9/2.5	12.4	–	–	–	SM	–	–
W6S(D)	Screen interval	12-14	0.0/86.9/10.1/3.0	13.1	–	–	–	SM	–	–
W7D	Profile	2-4	0.0/10.5/55.5/34.0	89.5	33	14	–	CL	–	–
W7D(D)	Profile	2-4	0.9/96.9/0.3/1.9	2.2	–	–	–	SP	–	–
W7D	Profile	27-29	1.4/4.1/32.8/61.7	94.5	34	15		CL	–	–
B1	Profile	25-27	30.5/62.8/4.3/2.4	6.7	–	–	–	SP-SM	–	–
B1	Profile	31-33	0.7/7.9/43.7/47.7	91.4	31	15	–	CL	–	–
B2A	Profile	15-17	18.3/73.9/5.7/2.1	7.8	–	–	–	SP-SM	–	–
B2	Profile	34-36	7.9/21.1/38.5/32.5	71	23	9	–	CL	–	–
B3	Profile	22-24	18.2/67.6/10.5/3.7	14.2	–	–	–	SM	–	–
B3	Profile	46-48	0.7/11.2/43.3/44.8	88.1	27	12	–	CL	–	–
B4	Profile	37-39	2.3/70.4/23.5/3.8	27.3	–	–	–	SM	–	–
B4(D)	Profile	37-39	1.1/67.7/27.6/3.6	31.2	–	–	–	SM	–	–
	Profile	47-49	0.9/7.7/52.3/39.1	91.4	25	11	–	CL	–	–
[illegible]	Profile	29-31	17.3/69.5/8.8/4.4	13.2	–	–	–	SM	–	–
B5	Profile	45-47	0.4/8.5/42.4/48.7	91.1	29	13	–	CL	–	–
W8D	Profile	26-28	19.9/66.5/13.6	13.6	–	–	–	SM	–	–
W8D	Profile	58-60	1.3/8.5/90.2	90.2	–	–	–	CL	–	–
W8D	Profile	79-81	32.5/56.0/11.5	11.5	–	–	–	SP-SM	–	–
W8D	Screen Interval	91-93	0.2/89.7/10.1	10.1	–	–	–	SP-SM	–	–

Footnotes:

(1) GSA = Grain Size Analysis, % by weight, e.g.,

gravel/sand/silt/clay	gravel/sand/silt&clay
5/43/20/32	26/68/6

(2) P200 = Percent finer than No. 200 sieve, (silt and clay)

(3) LL= Liquid Limit (%)

(4) PI Plasticity Index

(5) USCS = Unified Soil Classification System

(6) = Total Organic Carbon loss on ignition %

(D) = Duplicate

Notes:

1. -- = Not tested
2. * = Shelby Tube Sample

DAP/jrs/PMS/SJC
J:10010201\geotable\geolab.xls

Table 3-13

Summary of Soil Testing Results
H.O.D. Landfill
Antioch, Illinois

	Sample		Results of Grain Size Analysis				Hydraulic Conductivity	Source of
Boring No.	Depth (ft)	Gravel (%)	Sand (%)	Silt (%)		Clay (%)	(cm/sec)	Test Results
LB1	13.0 to 17.5	46	44	-	10	-	6.3x10^{-3}*	PELA
LB1	20.5 to 25	33	57	-	10	-	4.7x10^{-4}*	PELA
LB1	26.5 to 31	52	36	-	12	-	1.4x10^{-3}*	PELA
LB2	7.0 to 8.5	38	54	-	8	-	5.0x10^{-3}**	PELA
LB2	11.5 to 13	67	27	-	6	-	4.1x10^{-2}**	PELA
LB3	5.5 to 7	43	54	-	3	-	1.2x10^{-2}**	PELA
LB4	10.0 to 11.5	0	92	-	8	-	5.0x10^{-3}**	PELA
LB4A	22.0 to 23.5	57	41	-	2	-	4.4x10^{-2}**	PELA
LB4A	38.5 to 40	68	27	-	5	-	7.3x10^{-2}**	PELA
LB4A	40.0 to 44.5	75	20	-	5	-	1.4x10^{-1}**	PELA
LB4A	54.5 to 56.5	43	54	-	3	-	1.4x10^{-2}**	PELA
LB9	8.5 to 11.5	9	72	-	19	-	7.3x10^{-4}**	PELA
LB9	14.5 to 19	57	35	-	8	-	1.5x10^{-2}*	PELA
LB9	25.0 to 29.5	52	38	-	10	-	3.8x10^{-4}*	PELA
LB9	49.0 to 53.5	50	40	-	10	-	5.9x10^{-3}**	PELA
LB10	10.0 to 14.5	49	46	-	5	-	1.3x10^{-3}*	PELA
LB10	16.0 to 20.5	45	52	-	3	-	1.3x10^{-3}*	PELA
LB10	43.0 to 46	47	44	-	9	-	2.0x10^{-2}**	PELA
LB10	46.0 to 50.5	84	13	-	3	-	7.7x10^{-1}**	PELA
LB2	18.5 to 19.5	0	27	32	-	41	1.1x10^{-8}**	PELA
LB2	64.5 to 65.5	0	47	18	-	35	1.1x10^{-8}**	PELA
LB3	16.0 to 17.5	1	25	45	-	29	1.2x10^{-8}**	PELA
LB4A	68.5 to 70.5	2	43	31	-	24	1.0x10^{-8}**	PELA
GW3I	49.5 to 51	0	10	24	-	66	–	U.S. EPA ESI
GW3I	55.0 to 57.5	0	23	24	-	53	2.3x10^{-8}	U.S. EPA ESI
GW2D	19.0 to 21.5	0	38	44	-	18	1.2x10^{-6}	U.S. EPA ESI
LB10+	56.5 to 58	-	-	-	-	-	1.1x10^{-6}*	PELA
LB10+	58.0 to 59.5	-	-	-	-	-	2.9x10^{-6}*	PELA
LB10+	59.5 to 61	-	-	-	-	-	6.9x10^{-7}*	PELA
LB2	18.5 to 19.5	-	-	-	-	-	1.1x10^{-8}*	PELA
LB2	64.5 to 65.5	-	-	-	-	-	1.1x10^{-8}*	PELA
LB3	16.0 to 17.5	-	-	-	-	-	1.2x10^{-8}*	PELA
LB4A	68.5 to 70.5	-	-	-	-	-	1.0x10^{-8}*	PELA
AL384	6.0 (Clay Sample)	-	-	-	-	-	3.4x10^{-8} (2.7x10^{-8})	GeoServices
AL385	5.0 (Clay Sample)	-	-	-	-	-	1.9x10^{-8} (1.6x10^{-8})	GeoServices
AL386	5.5 (Clay Sample)	0	<1	-	99	-	8.4x10^{-8} (6.0x10^{-8})	GeoServices
AL387	10.5 (Clay Sample)	-	-	-	-	-	9.0x10^{-9} (8.5x10^{-9})	GeoServices
AL388	6.5 (Clay Sample)	-	-	-	-	-	1.6x10^{-8} (1.5x10^{-8})	GeoServices
AL389	8.5 (Silty Sand)	-	-	-	-	-	2.1x10^{-7} (1.5x10^{-7})	GeoServices

Notes:

PELA = P.E. LaMoreaux and Associates
ESI = Expanded Site Inspection Report
Where samples have been analyzed for silt plus clay the grain size percentage is shown in the column between silt and clay.
+ Samples were disturbed and dehydrated. Results may not be representative.
* Constant Head Permeability
** Permeability estimated by Hazen's Formula
GeoServices = GeoServices, Boynton Beach, Florida. GeoServices results presented in parentheses were obtained using Site leachate as the permeant. Other GeoServices results were obtained using groundwater obtained from the Site.

SJC/jrs/DAP
J:\10010202\WP\TBL\92.WPD

Table 3-14

In Situ Hydraulic Conductivity Results
H.O.D. Landfill
Antioch, Illinois

Well No.	Saturated Test Interval (feet msl)	Saturated Thickness (ft)	Hydraulic Conductivity (cm/sec)	Material Screened (USCS)
W3SB	762 - 734.1	27.9	7.10E-02	SP
W4S	761.9 - 752.5	9.4	9.40E-03	SP-GP
W5S	762.3 - 755.6	6.7	2.90E-03	SM
W3D	*	45	3.80E-04	SP
US1S	764.7 - 754.1	10.6	3.60E-04	GM
US3S	761.8 - 744.6	17.2	2.10E-02	GW-GM
US4S	762.3 - 748.2	14.1	2.30E-02	SW-GW
US6S	762.7 - 725.4	37.3	5.20E-02	SP-GW
US3D	*	45	1.60E-04	SP
US6D	*	45	1.10E-03	SP

Notes:

* - Estimated saturated thickness for confined aquifer of 45 feet based upon regional data

(msl) = feet above mean sea level

(cm/sec) = centimeters per second

(USCS) = Unified Soil Classification System

Table 3-15

Summary of Slug Test Analysis
Conducted by U.S. EPA FIT*
H.O.D. Landfill RI/FS

Well No.	Unit Monitored By Well	Conductivity (cm/sec) (Hvorselv Method)	Transmissivity (T) (ft^2/sec) (Cooper Method)	Conductivity (K) (cm/sec) (T=Kb; b = screen length)
US1S	Surficial Sand	4.8×10^{-4}	--	--
US1D	Deep Sand & Gravel	--	3.0×10^{-4}	1.8×10^{-3}
US2D	Deep Sand & Gravel	--	2.1×10^{-3}	1.3×10^{-2}
US3S	Surficial Sand	2.7×10^{-2}	--	--
US3I	Clay Diamict	7.9×10^{-6}	--	--
US3D	Deep Sand & Gravel	--	5.2×10^{-4}	3.1×10^{-3}
US4S	Surficial Sand	5.3×10^{-2}	--	--
US4D	Deep Sand & Gravel	--	1.8×10^{-4}	1.1×10^{-3}
US5D	Deep Sand & Gravel	--	2.6×10^{-3}	1.6×10^{-2}
US6S	Surficial Sand	7.0×10^{-2}	--	--
US6I	Clay Diamict	8.0×10^{-6}	--	--
US6D	Deep Sand & Gravel	--	3.0×10^{-4}	1.8×10^{-3}
US7S	Clay Diamict (Sand Lense)	5.8×10^{-3}	--	--

* Source: Ecology and Environment, Inc. 1989.

TABLE 3-16
Vertical Gradient Calculations
H.O.D. Landfill
Antioch, Illinois

Well	Position of Head Measurement Elevation (ft MSL)	6/8 - 6/9/93 Water Level Elevation (ft MSL)	Vertical Gradient (ft/ft)
G11D	746.80	760.68	
US5D	684.85	730.18	0.49
US4S	745.00	761.85	
US4D	700.00	729.00	0.73
W3SB	734.16	762.26	
W3D	693.23	729.27	0.81
PZ2U	747.60	763.15	
US2D	684.20	730.74	0.51
W3SA	762.30	762.30	
W3SB	734.13	762.26	0.0014*
US3S	726.50	762.09	
US3D	697.20	728.41	1.15
US6S	715.10	762.45	
US6D	694.30	729.70	1.57
US1S	753.40	764.39	
US1D	691.50	730.64	0.55
US6S	718.10	762.45	
US6I	706.10	738.06	2.03
**US6I	706.10	738.06	
US6D	694.30	729.70	0.71
US3S	726.50	762.09	
**US3I	711.10	733.93	1.83
**US3I	711.10	733.93	
US3D	697.20	728.41	0.40

Notes:

1. Position of Head Measurement is the elevation of the top of clay and the bottom of clay.
2. Positive vertical gradients indicate downward flow, negative indicate upward flow.
3. Vertical Gradient =

$$\frac{\text{Shallow Well Head Elevation - Deep Well Head Elevation}}{\text{**Absolute Value of Difference between the elevation of top clay diamict and bottom clay diamict}}$$

5. (ft MSL) = Feet above Mean Sea Level

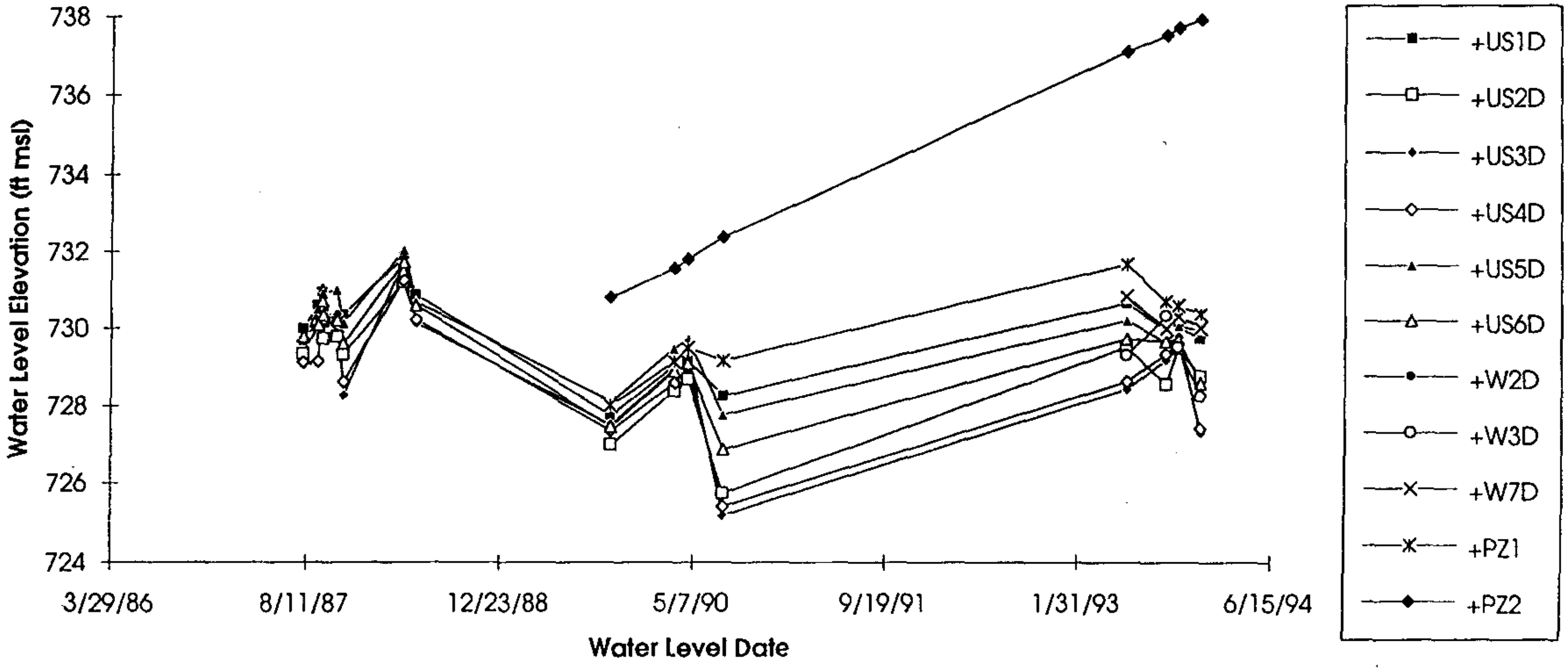
* = Gradient Calculated in Surficial Sand using water table and center of screen elevations

** = Center of screen elevation used for intermediate wells.

SJC/jrs/DAP

J:10010201/geotable/vertgrad.xls

TABLE 3-17

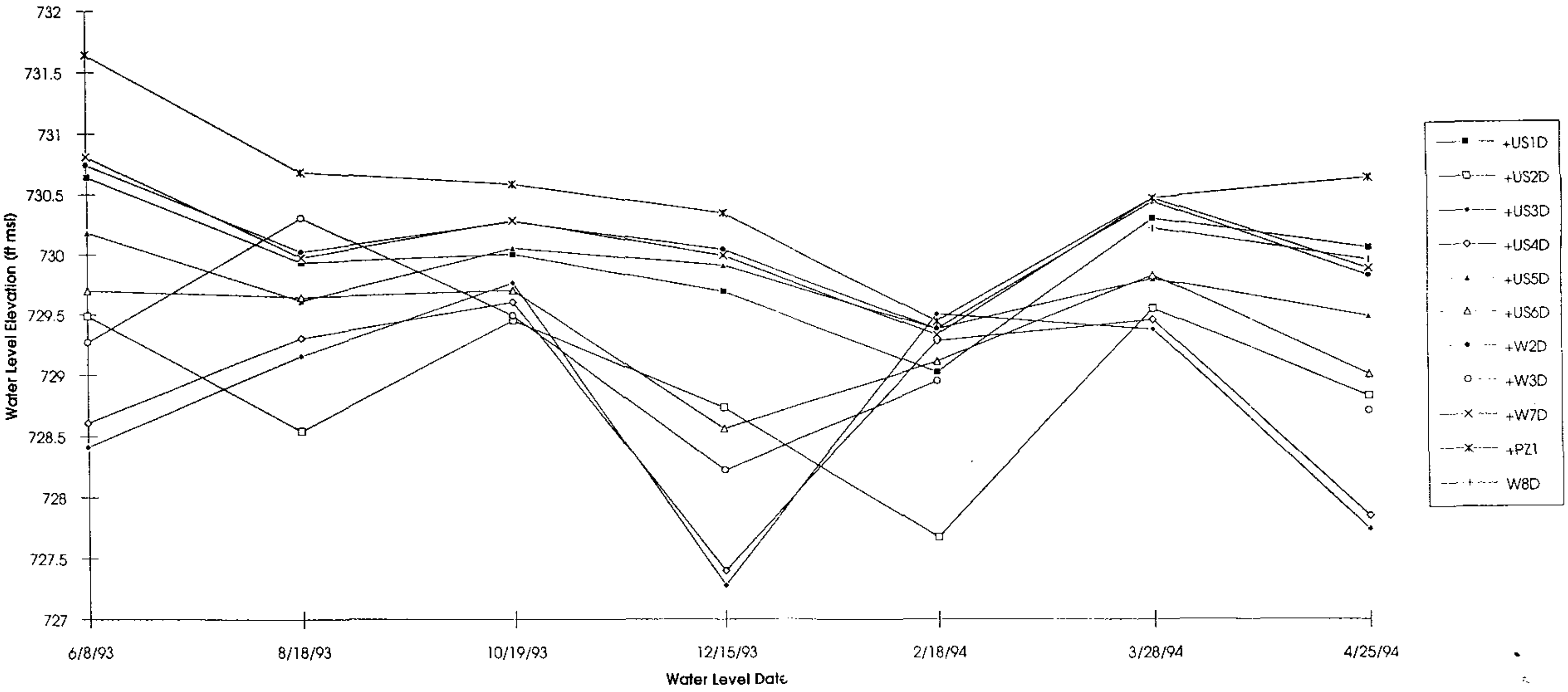


Deep Sand and Gravel Groundwater Elevations, HOD Landfill, Antioch, Illinois

Notes:
ft msl = feet above mean seal level
J:/10010201/Technica/Geotable/CHART4.XLC

TABLE 3-18

Deep Sand and Gravel Groundwater Elevations, HOD Landfill, Antioch, Illinois (June 1993 through April 1994)



Notes:
ft msl = feet above mean sea level
J:\10010202\technica\geotable\CHART7.XLC

Table 4-1

Summary of Analytical Results

Detected VOCs, SVOCs and Pesticides/PCBs

Leachate Samples

H.O.D. Landfill

Antioch, Illinois

	Groundwater Standards			Sample Designation							
Compounds	MCL	Class I	Class II	HD-LCLP01-01	HD-LCLP01-91	HD-LCLP06-01	HD-LCLP08-01	HD-LCLP11-01	HD-LCMHE-01	HD-LCFB01-01	HD-LCTB02-01
Detected VOCs											
Vinyl Chloride	2	2	10						18		
Chloroethane				45	46						
Methylene Chloride	5	5	50	160	180	58			44	1	3
Acetone		700	700	110		2200	19000	1500	140	13	5
1,1-Dichloroethene	7	7	35						5		
1,1-Dichloroethane		700	3500						13		
1,2-Dichloroethene	70	70	200	7				190	70		
1,2-Dichloroethane	5	5	25						22		
2-Butanone				190		3200	12000	3900	120		
1,2-Dichloropropane	5	5	25						28		
Trichloroethene	5	5	25						14		
Benzene	5	5	25	12	13				22		
4-Methyl-2-Pentanone				22	22	160	450		43		
2-Hexanone				14							
Tetrachloroethene	5	5	25	9					9		
Toluene	1000	1000	2500	330	450	210	260	740	62		
Ethylbenzene	700	700	1000	52	46			130			
Xylenes (total)	10000	10000	10000	100	90	170		330	41		
Detected SVOCs											
Phenol		100	100	160	170	83	840	5J	19		
1,4-Dichlorobenzene						5		20			
2-Methylphenol		350	350			16					
4-Methylphenol				730	760	1300	2200	48	5J		
2,4-Dimethylphenol		140	140	12J	11J	4J	20J	3J	6J		
Naphthalene		25	39		34J	6J	26J	16			
Diethylphalate		5600	5600	32J	31J			4J			
Di-n-butylphthalate		700	3500							1J	
bis(2-ethylhexyl)phthalate		6	60					42			
Detected Pesticides/PCBs											
Aroclor-1016		0.5	2.5	4.6	6.3						

Notes:

TICs not reported in Table; TICs results presented in Appendix O-7

Concentrations reported in micrograms per liter (ug/L)

J - Estimated value below detection limit

Samples collected on May 12-13, 1993

TABLE 4-2

Comparison of Results of Leachate Analysis with General Values for Municipal Solid Waste Landfills

	H.O.D. Observed Value (mg/l)	IEPA Values (mg/l)
Aluminum	0.150 - 140	6
Calcium	0.090 - 930	1,200
Iron	7.9 - 380	500
Magnesium	140 - 570	500
Manganese	0.076 - 5.6	20
Potassium	82 - 510	500
Sodium	240 - 1,500	1,500
Chloride	196 - 2,070	3,000
Sulfate	17 - 530	1,000
Alkalinity	1,700 - 4,360	NA
Hardness	768 - 3,460	NA
Total Dissolved Solids	2,430 - 10,200	10,000
Total Organic Carbon	30.5 - 120	6,000
Ammonia	45 - 378	600
Nitrate	ND - 0.06	NA
pH	6.75 - 7.14	5 - 9
Antimony	ND	9
Arsenic	0.0041 - 0.0513	0.1
Chromium	0.0099 - 0.418	0.05
Barium	ND - 1,710	0.01
Beryllium	ND - 0.0125	NA
Cadmium	ND - 0.0679	0.1
Cobalt	0.0081 - 0.185	0.13
Copper	0.034 - 0.755	1
Lead	0.0062 - 1.930	0.5
Mercury	ND - 0.0018	0.01
Nickel	0.0219 - 0.560	1
Selenium	ND	0.05
Silver	ND - 0.0109	0.05
Thalium	ND - 0.0022	0.5
Vanadium	0.0024 - 0.386	0.03
Zinc	ND - 8.280	20
Cyanide	ND - 37.8	0.3

Notes:
NA = Not available
NA = Not detected

(1) = Illinois Environmental Protection Agency LPC - PA2 "Instructions for the Application for a Permit to Develop a Non-Hazardous Landfill, November 1992.

Ranges include duplicate sample results

Table 4-3
Summary of Detected VOCs
Landfill Gas Samples
H.O.D. Landfill
Antioch, Illinois

Compounds	Sample Designation						
	HD-LGLP01-01	HD-LGLP06-01	HD-LGLP07-01	HD-LGLP08-01	HD-LGLP11-01	HD-LGLP11-91	HD-LGTB01-01
Freon 12		6300	1800	2100	9100	8600	
Chloromethane				720			
Freon 114		7200		760	860	940	
Vinyl Chloride		4900	21000	13000	1100	1300	
Chloroethane	47	810					
Freon 11	78	12000	270		310	330	
cis-1,2-DCE	6.3	370	5400	1400	2400	2700	
Carbon Disulfide		690					
Acetone		730	3900	15000		520	
Methylene Chloride	95	220					
1,1-Dichloroethane		140	540				
1,1-Dichloroethene			480				
2-Butanone	21	1800	5200	22000		600	
Benzene	10	420	970	670	630	690	
Trichloroethene		160	2500	590	960	1000	
Toluene	540	11000	66000	53000	20000	21000	
Tetrachloroethene		270	4400	830	2700	2800	
Chlorobenzene		180		4500			
Ethylbenzene	34	3700	11000	9700	3200	3400	
Xylenes (total)	52	7600	30000	24000	7000	7100	
4-Ethyl toluene		520	1300	2600		490	
1,3,5-Trimethylbenzene		200	510	910			
1,2,4-Trimethylbenzene		440	1200	2100		420	

Notes:

Samples collected on June 4,1993

Concentrations reported in parts per billion

Only detected compounds reported

No compounds detected in Trip Blank

Table 4-4
Summary of Analytical Results
Detected VOCs, SVOCs and Pesticides/PCBs
Round 1 and 2 Groundwater Samples
H.O.D. Landfill
Antioch, Illinois

Round I Groundwater Sampling						*Round II Groundwater Samping*					
Sample Designation	**Compounds**					**Sample Designation**	**Compound**				
	Acetone	**Carbon Disulfide**	**Vinyl Chloride**	**1,2-DCE**	**TCE**		**Acetone**	**Carbon Disulfide**	**Vinyl Chloride**	**1,2-DCE**	**TCE**
MCL			2	70	5	**MCL**			2	70	5
Class I Std.	700	700	2	70	5	**Class I Std.**	700	700	2	70	5
Class II Std.	*700*	*3500*	*10*	*200*	*25*	***Class II Std.***	*700*	*3500*	*10*	*200*	*25*
G11S-01		0.8J				G11S-02		18			
G11D-01						G11D-02					
US01S-01						US01S-02					
US01D-01						US01D-02					
US03S-01						US03S-02					
US03I-01						US03I-02					
US03D-01			**28**	11		US03D-02			**35**	18	
US04S-01				35		US04S-02				44	
US04D-01						US04D-02					
US06S-01						US06S-02					
US06I-01					2J	US06I-02					1J
US06D-01						US06D-02					
W3D-01						W3D-02					
W3SB-01						W3SB-02					
W4S-01						W4S-02					
W5S-01			**19**			W5S-02					
W6S-01				2J		W6S-02					
W7D-01						W7D-02					

Notes:

Round I Groundwater Samples collected in May/June 1993

Round II Groundwater Samples collected in March 1994

Concentrations reported in micrograms per liter (ug/L)

J - estimated value below detection limit

SVOCs and Pesticides/PCBs were not detected in groundwater samples and are therefore not reported in the Table

Table 4-5
Summary of Analytical Results
Detected VOCs, SVOCs and Pesticides/PCBs
Private/Village Well Groundwater Samples
H.O.D. Landfill
Antioch, Illinois

	Groundwater Standards			Sample Designation (Round I Sampling)					
Compounds	MCL	Class I	Class II	VW3-01	VW5-01	PW1-01	PW2-01	PW3-01	PW5-01
Detected VOCs									
Carbon Disulfide		700	3500		0.6J				
Detected SVOCs									
2-Methylphenol		350	350		0.5J		0.9J		
4-Chloroaniline				0.7J					

	Groundwater Standards			Sample Designation (Round 2 Sampling)		
Compounds	MCL	Class I	Class II	VW3-02	VW4-02	VW5-02
Detected VOCs						
Acetone		700	700	11J		
cis-1,2-DCE		70	200		6J	
1,2-DCE		70	200	0.7J	0.5J	0.8J
Detected SVOCs						
2-Methylphenol		350	350			0.5J
4-Chloroaniline				0.7J		

Notes:
Concentrations reported in micrograms per liter (ug/L)
1,2-DCE - 1,2-Dichloroethene
J - Estimated value below detection limit
Round 1 Samples collected in June\July 1993
Round 2 Samples collected in March 1994 (Private wells not sampled during Round 2 activities)
Pesticides/PCBs were not detected in Private or Village Well Groundwater samples

J:2386/0096/datatab/CHEMDATA.XLS/private wells/PMS

Table 4-6

Summary of Analytical Results

Detected VOCs, SVOCs and Pesticides/PCBs

Round 1 and 2 Surface Water Samples

H.O.D. Landfill

Antioch, Illinois

	Round 1 Surface Water Samples		
Detected VOCs	SWS101-01	SWS201-01	SWS301-01
2-Hexanone			3J
4-methyl-2-pentanone			2J

	Round 2 Surface Water Samples							
Detected VOCs	SWS101-02	SWS201-02	SWS301-02	SWS401-02	SWS501-02	SWS601-02	SWPSG1-02	SWPSG2-02
2-Hexanone								
4-methyl-2-pentanone								

Notes:
Tentatively Identified Compounds (TICs) not reported in Table
Concentrations reported in micrograms per kilogram (ug/kg)
J - Estimated value below detection limit
SVOCs and Pesticides/PCBs were not detected in Round 1 or 2 surface water samples
VOCs were not detected in samples other than SWS301-01
Round 1 Samples collected in May 1993
Round 2 samples collected in March 1994

Table 4-7
Summary of Analytical Results
Detected VOCs, SVOCs and Pesticides/PCBs
Round 2 Sediment Samples
H.O.D. Landfill
Antioch, Illinois

	Sample Designation (Round 2 Sediment Samples)							
Detected VOCs	SDS101-02	SDS201-02	SDS301-02	SDS401-02	SDS501-02	SDS601-02	SDPSG1-02	SDPSG2-02
Phenanthrene			310J					
Fluoranthene		380J	680J					
Pyrene		370J	580J					
Benzo (a) anthracene			250J					
Chrysene			300J					
bis(2-ethylhexyl)-phthalate		940J	1500J					
Benzo (b) fluoranthene			430J					
Benzo (a) pyrene			290J					

Notes:
Tentatively Identified Compounds (TICs) not reported in Table
Concentrations reported in micrograms per kilogram (ug/kg)
J - Estimated value below detection limit
VOCs and Pesticides/PCBs were not detected in sediment samples
SVOCs were not detected in samples other than SDS201 and SDS301
Samples collected in March 1994

Sediment samples not collected during Round 1 field activities

Table 4-8
Summary of Analytical Results
Detected VOCs, SVOCs and Pesticides/PCBs
Round 1 Surface Soils Samples
H.O.D. Landfill
Antioch, Illinois

	Sample Designation					
Compounds	HD-SU01-01	HD-SU02-01	HD-SU03-01	HD-SU04-01	HD-SU04-91	HD-SU05-01
Detected VOCs						
Methylene Chloride	570	59	48	1200	210	
Acetone	140	17	8J		15	
Carbon Disulfide		6J				
Benzene	7J					
Toluene	55J	3J			2J	
Ethylbenzene	240	12J				
Xylenes	280	37				
Detected SVOCs						
1,4-Dichlorobenzene	130J					
Naphthalene	320J	630				
2-Methylnaphthalene	61J	390J				
Acenaphthene	120J	1000				
Dibenzofuran	59J	620				
Fluorene	68J	500				
Phenanthrene	250J	240J	120J	36J		51J
Anthracene	46J					
Fluoranthene			160J	59J		73J
Pyrene			110J	52J		54J
bis(2-ethylhexyl)-phthalate	160J	320J	280J	3500	3600	9600
Benzo (b) fluoranthene			110J			
Carbazole	130J					
Detected Pesticides/PCBs						
4,4'-DDD	4.3					

Notes:
Tentatively Identified Compounds (TICs) not reported in Table; TICs results presented in Appendix O-12
Concentrations reported in micrograms per kilogram (ug/kg)
J - Estimated value below detection limit
Surface Soils samples not collected during Round 2 RI sampling activities
Samples collected on May 14, 1993

TABLE 4-9
SUMMARY OF HISTORICAL MONITORING WELL VOC DATA
H.O.D. Landfill RI/FS

SAMPLE ID	Date	Trichloroethene	1,2-Dichloroethene (cis/trans)	Vinyl chloride	4-Methyl-2-pentanone	Acetone	Methylene chloride	Benzene	Toluene
US01D	8/11/87					7J			
US01D	4/19/88					2BJ	0.9BJ		
US01D	5/19/88						10		
US01S	8/11/87					6J			
US01S	4/19/88					1BJ	1BJ		
US01S	5/19/88					28JB			
US03D	5/8/90			12.3					
US03S	8/11/87								
US03S	4/19/88					3BJ	2BJ		
US04D	8/10/87					5BJ	5BJ		
US04D	8/10/87						3J		
US04S	8/10/87		71			21.5			
	4/18/88		69			3			
	5/9/90		41.1						
	7/26/90		41.5						
US06S	8/11/87					7J			
	4/18/88					5BJ	3BJ		
US06D	8/11/87					7			
	4/19/88					4BJ	2BJ		
	5/19/88	0.47					4.2		
	5/9/90	0.5							
	7/26/90	0.7							
US06I	8/12/87	7							
	4/18/88	5				5BJ	2BJ		2J
	5/19/88	5.3	1.2J				1.1J		
	8/18/88	5				5	2		2
US07S	8/11/87					5J		8	
	4/18/88						4BJ	2BJ	
G102	4/18/88					5BJ	2BJ		2J
	5/10/90			2.4					

Notes:

1. This table presents historical data for H.O.D Landfill samples collected from monitoring wells. Only wells and sampling rounds with VOC detects are presented in this table. Acetone and methylene chloride are often lab contaminants. Warzyn did not perform data validation for the sampling rounds and has not assessed data quality.
2. All results are in units of ug/L.

J - Indicates and estimated value

B - Compound detected in the associated blank as well as the sample.

TABLE 5-1
Summary of Physical and Chemical Properties of Compounds Detected at H.O.D. Landfill
H.O.D. Landfill RI/FS

COMPOUND	Molecular Weight *(g/mole)*	Water Solubility *(mg/L)*	Density *(g/cc)*	Henry's Law Constant *(atm-m3/mole)*	Koc *(ml/g)*	Log Kow	Vapor Pressure *(mm Hg)*	Retardation Factor *(foc =0.05%)*	Retardation Factor *(foc = 0.1%)*	Retardation Factor *(foc = 0.5%)*	Retardation Factor *(foc = 1.0%)*
olatile Organic Compounds											
hloromethane	50.49	6.50E+03	0.92	2.40E-02	35	0.91	4.31E+03	1.1	1.2	2.1	3.1
inyl chloride	62.50	2.67E+03	1.37	1.07E-02	57	1.38	2.66E+03	1.2	1.3	2.7	4.4
hloroethane	64.52	5.71E+03	0.92	8.48E-03	50	1.43	7.66E+02	1.2	1.3	2.5	4.0
lethylene chloride	84.94	1.30E+04	1.33	2.68E-03	8.8	1.25	4.35E+02	1.0	1.1	1.3	1.5
cetone	58.09	1.00E+06	0.79	3.67E-05	2.2	-0.24	2.31E+02	1.0	1.0	1.1	1.1
arbon disulfide	76.13	2.10E+03	1.26	1.40E-03	54	1.7 - 4.16	2.97E+02	1.2	1.3	2.6	4.2
,1-Dichloroethene	96.95	2.25E+03	1.22	3.01E-02	65	2.13	5.91E+02	1.2	1.4	3.0	4.9
,1-Dichloroethane	98.96	5.50E+03	1.18	4.31E-03	30	1.79	1.82E+02	1.1	1.2	1.9	2.8
,2-Dichloroethene	96.94	6.30E+03	1.26	6.74E-03	39	2.09	2.65E+02	1.1	1.2	2.2	3.3
,2-Dichloroethane	98.96	8.52E+03	1.25	9.77E-04	14	1.48	7.87E+02	1.0	1.1	1.4	1.8
-Butanone	72.10	2.39E+03	0.81	1.05E-05	4.5	0.29	9.06E+01	1.0	1.0	1.1	1.3
2-Dichloropropane	112.99	2.74E+03	1.16	2.07E-03	51	1.99	4.97E+01	1.2	1.3	2.5	4.1
richloroethene	131.40	1.10E+03	1.46	1.03E-03	126	2.42	6.90E+01	1.4	1.8	4.8	8.6
enzene	78.11	1.79E+03	0.88	5.43E-03	83	2.13	9.52E+01	1.2	1.5	3.5	6.0
-Methyl-2-pentanone	100.16	1.70E+04	0.8	1.49E-02	20.5	1.09	6.00E+00	1.1	1.1	1.6	2.2
-Hexanone	100.16	3.50E+04	0.81	1.75E-03	14	1.38	3.80E+00	1.0	1.1	1.4	1.8
etrachloroethene	165.82	1.50E+02	1.62	1.49E-02	364	3.40	1.85E+01	2.1	3.2	12	23
oluene	92.13	5.35E+02	0.87	5.94E-03	300	2.73	2.84E+01	1.9	2.8	10	19
hlorobenzene	112.56	4.88E+02	1.11	3.93E-03	330	2.84	1.17E+01	2.0	3.0	11	21
hylbenzene	106.16	1.61E+02	0.87	8.44E-03	1100	3.15	9.53E+00	4.3	7.6	34	67
otal Xylenes	106.00	4.66E+02	0.9	7.04E-03	330	3.26	1.00E+01	2.0	3.0	11	21
2,4-Trimethylbenzene	120.20	3.00E+01	0.88	2.30E-03	9200	4.30	2.90E-01	29	56	277	553
3,5-Trimethylbenzene	120.20	3.00E+01	0.88	2.30E-03	9200	4.30	2.90E-01	29	56	277	553
Ethyl toluene	120.00	4.70E+02	0.86	3.36E-03	330	3.26	1.00E+01	2.0	3.0	11	21
ichlorofluoromethane (Freon 11)	137.38	1.08E+03	1.49	9.70E-02	159	2.53	8.02E+02	1.5	2.0	6	11
ichlorodifluoromethane (Freon 12)	120.92	2.80E+02	1.49	2.79E+00	58	2.16	4.25E+03	1.2	1.3	2.7	4.5
ichlorotetrafluoroethane (Freon 114)	170.92	2.80E+02	1.53	2.79E+00	58	2.16	4.87E+03	1.2	1.3	2.7	4.5

JAH/jrs/BJC
J:10010201/chemistry/chem.xls

TABLE 5-1

Summary of Physical and Chemical Properties of Compounds Detected at H.O.D. Landfill

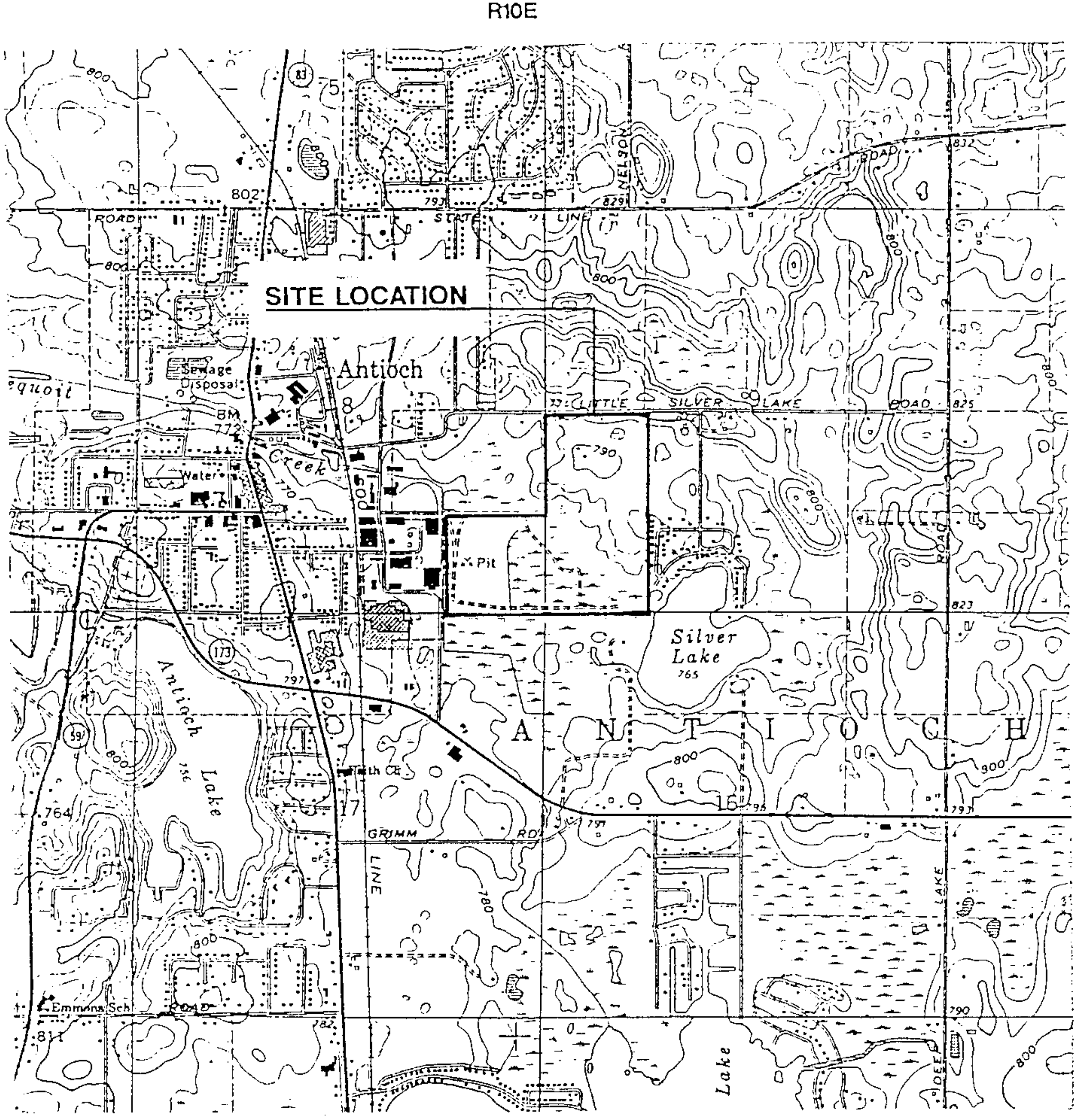
H.O.D. Landfill RI/FS

COMPOUND	Molecular Weight *(g/mole)*	Water Solubility *(mg/L)*	Density *(g/cc)*	Henry's Law Constant *(atm-m3/mole)*	Koc *(ml/g)*	Log Kow	Vapor Pressure *(mm Hg)*	Retardation Factor (f_{oc} =5.0%)	Retardation Factor (f_{oc} = 0.1%)	Retardation Factor (f_{oc} = 0.5%)	Retardation Factor (f_{oc} = 1.0%)
Phenol	94.11	9.30E+04	1.07	3.97E-07	14.2	1.46	3.41E-01	1.0	1.1	1.4	1.9
1,4-Dichlorobenzene	147.00	7.90E+01	1.46	3.10E-03	1700	3.39	4.00E+01	6.1	11.2	52	103
2-Methylphenol	108.14	2.50E+04	1.04	1.23E-06	500	1.93	2.40E-01	2.5	4.0	16	31
4-Methylphenol	108.14	2.30E+04	1.02	7.92E-07	500	1.67	1.20E+01	2.5	4.0	16	31
2,4-Dimethylphenol	122.17	7.86E+03	0.96	6.55E-06	42	2.42	5.90E-02	1.1	1.3	2.3	3.5
Naphthalene	128.18	3.44E+01	0.96	4.60E-04	649	3.36	2.30E+01	2.9	4.9	20	40
4-Chloroaniline	127.57	3.90E+00	1.43	1.07E-05		1.83	2.50E-02				
2-Methylnaphthalene	142.20	2.46E+01	1.01	4.08E-04	712	4.11	5.90E-02	3.1	5.3	22	44
Acenaphthene	154.21	3.47E+00	1.02	1.50E-04	4600	3.92	1.55E-03	15	29	139	277
Dibenzofuran	168.20	1.00E+01	1.09	2.13E-04	820	4.17	2.00E-02	3.5	5.9	26	50
Diethylphthalate	222.24	8.96E+02	1.12	8.46E-07	142	3.00	1.65E+03	1.4	1.9	5.3	9.5
Fluorene	166.22	1.69E+00	1.2	2.14E-04	7300	4.12	7.10E-04	23	45	220	439
Phenanthrene	178.24	1.18E+00	0.98	2.56E-05	14000	4.46	6.80E-04	43	85	421	841
Anthracene	178.24	4.50E-02	1.28	1.40E-03	14000	4.45	1.95E-04	43	85	421	841
Fluoranthene	202.26	2.56E-01	1.25	1.70E-02	38000	5.22	5.00E-06	115	229	1,141	2,281
Pyrene	202.26	1.32E-01	1.27	1.09E-05	38000	4.88	2.50E-06	115	229	1,141	2,281
bis(2-Ethylhexyl)phthalate	390.57	3.00E-01	0.99	1.10E-05	692	4.20	6.20E-08	3.1	5.2	22	43
Benzo(b)fluoranthene	252.32	1.20E-03		1.20E-05	550000	6.57	5.00E-07	1651	3,301	16,501	33,001
Carbazole	167.00	1.69E+00		9.23E-05	7300	3.29	7.10E-04	23	45	220	439
Pesticides/PCBs											
4,4'-DDD	*320.00*	*1.00E-01*		*7.96E-06*	770000	*6.20*	*1.89E-06*	*2311*	*4,621*	*23,101*	*46,201*
PCB	328.00	3.10E-02		1.07E-03	530000	6.04	7.70E-05	1591	3,181	15,901	31,801

DRAWINGS

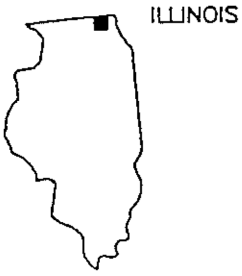
FIGURES

QUAL. CONTROL
Graphic Standards CCM 8-5-93
Lead Professional SJC 9-6-93
Technical Review
Project Manager
Management Review
Other

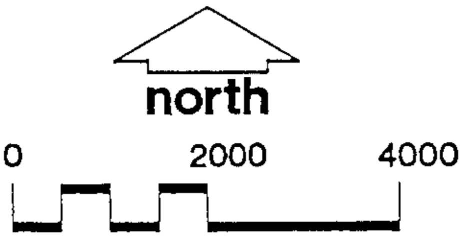


NOTE

BASE MAP DEVELOPED FROM THE ANTIOCH, ILLINOIS 7.5 MINUTE U.S.G.S. TOPOGRAPHIC QUADRANGLE MAP DATED 1960, PHOTOREVISED 1972.



QUADRANGLE LOCATION



SCALE IN FEET

FIGURE

Developed By: SJC	Drawn By: CCM
Approved By: M. Hamper	Date: 9-29-94
Reference:	
Revisions:	

SITE LOCATION MAP

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

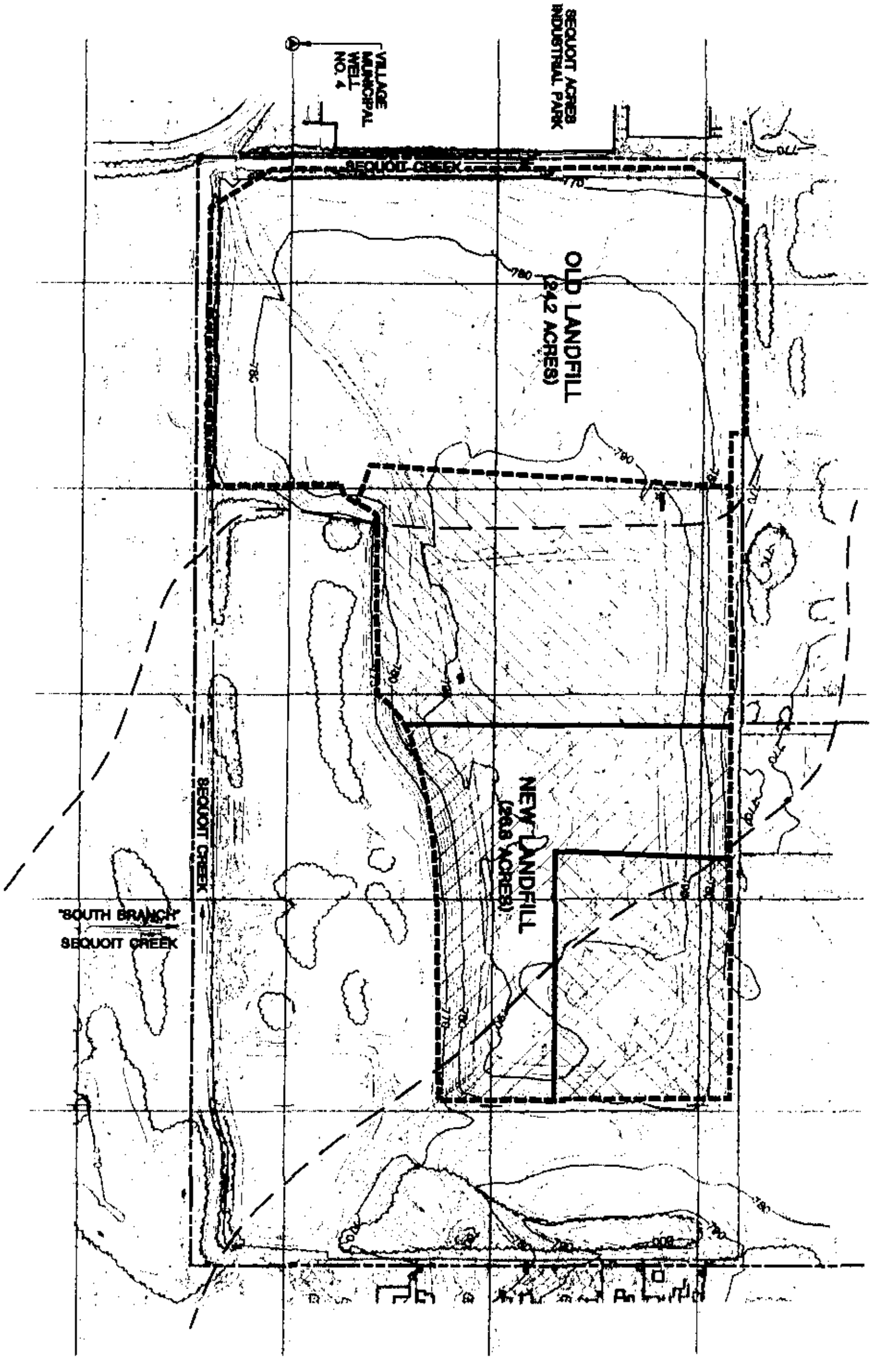
Drawing Number
10010202 A1

WARZYN

WARZYN INC.

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

QUALITY CONTROL	Graphic Standards CCM 6-21-96	Technical Review	Management Review
	Lead Professional	Project Manager	Other



LEGEND

- APPROXIMATE PROPERTY LINE
- APPROXIMATE LIMITS OF LANDFILLED AREA
- 780 TOPOGRAPHIC CONTOUR LINE
- TREES, BRUSH
- ACCESS ROAD
- BUILDING
- SPOT ELEVATION
- FENCE LINE
- APPROXIMATE LIMIT OF SEQUOIT CREEK MARCH PRIOR TO CHANNELIZATION
- APPROXIMATE LOCATION OF AREA OPERATED USING "TRENCH FILL" METHOD
- APPROXIMATE LOCATION OF AREA OPERATED USING "AREA FILL" METHOD
- APPROXIMATE LOCATION OF PORTION OPERATED AS "DEEP TRENCH" AREA

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. TOPOGRAPHY IS BASED IN U.S.G.S. DATUM.
3. GRID BASED ON ILLINOIS STATE PLANE COORDINATE SYSTEM.

north

0 300 600

SCALE IN FEET

FIGURE 2

SITE FEATURES MAP

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT ON ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number 2386.0096 B5

MONTGOMERY WATSON

Developed By SJC
Drawn By CCM
Approved By
Date 1-17-97
Reference 10010202/B5
Revisions

QUALITY CONTROL
Graphic Standards CCM 1-28-94
Lead Professional
Technical Review
Project Manager
Management Review
Other

LEGAL DESCRIPTIONS

PARCEL 1 THAT PART OF THE SOUTHEAST QUARTER OF THE SOUTHEAST QUARTER OF SECTION 8, TOWNSHIP 46 NORTH, RANGE 10, EAST OF THE THIRD PRINCIPAL MERIDIAN, BOUNDED AND DESCRIBED AS FOLLOWS: BEGINNING AT THE NORTHWEST CORNER OF SAID SOUTHEAST QUARTER OF THE SOUTHEAST QUARTER; THENCE SOUTH 0° EAST ON WEST LINE OF SAID SOUTHEAST QUARTER OF SOUTHEAST QUARTER, 1324.35 FEET TO THE SOUTHWEST CORNER THEREOF; THENCE NORTH 89°-25'-07" EAST ON SOUTH LINE OF SAID SOUTHEAST QUARTER OF SOUTHEAST QUARTER; 827.39 FEET, THENCE NORTH 02°-27'-34" EAST, 389.73 FEET; THENCE NORTH 78°-30'-26" WEST, 100.0 FEET; THENCE NORTH 04°-17'-14" EAST, 915.0 FEET TO A POINT ON THE NORTH LINE OF SAID SOUTHEAST QUARTER OF SOUTHEAST QUARTER WHICH IS 814.50 FEET EAST OF THE NORTHWEST CORNER THEREOF; THENCE 89°-35'-37" WEST, ON SAID NORTH LINE, 814.50 FEET TO THE PLACE OF BEGINNING, IN LAKE COUNTY, ILLINOIS.

PARCEL 2 THE SOUTHWEST QUARTER OF THE SOUTHWEST QUARTER OF SECTION 9, TOWNSHIP 46 NORTH, RANGE 10, EAST OF THE THIRD PRINCIPAL MERIDIAN, ALSO THE SOUTHEAST QUARTER OF THE SOUTHEAST QUARTER OF SECTION 8, TOWNSHIP 46 NORTH, RANGE 10, EAST OF THE THIRD PRINCIPAL MERIDIAN, (EXCEPT THAT PART DESCRIBED AS FOLLOWS: BEGINNING AT THE NORTHWEST CORNER OF SAID SOUTHEAST QUARTER OF SOUTHEAST QUARTER; THENCE SOUTH 0° EAST ON WEST LINE OF SAID SOUTHEAST QUARTER OF SOUTHEAST QUARTER, 1324.35 FEET TO THE SOUTHWEST CORNER THEREOF; THENCE NORTH 89°-25'-07" EAST ON SOUTH LINE OF SAID SOUTHEAST QUARTER OF SOUTHEAST QUARTER, 827.39 FEET; THENCE NORTH 02°-27'-34" EAST, 389.73 FEET; THENCE NORTH 78°-30'-26" WEST, 100.0 FEET; THENCE NORTH 04°-17'-14" EAST, 915.0 FEET TO A POINT ON THE NORTH LINE OF SAID SOUTHEAST QUARTER OF SOUTHEAST QUARTER WHICH IS 814.50 FEET EAST OF THE NORTHWEST CORNER THEREOF; THENCE SOUTH 89°-35'-37" WEST, ON SAID NORTH LINE, 814.50 FEET TO THE PLACE OF BEGINNING, IN LAKE COUNTY, ILLINOIS.

PARCEL 3 THE NORTHEAST QUARTER OF THE NORTHWEST QUARTER OF THE SOUTHWEST QUARTER AND OF THE SOUTHEAST QUARTER OF THE NORTHWEST QUARTER OF THE SOUTHWEST QUARTER OF SECTION 9, TOWNSHIP 46 NORTH, RANGE 10, EAST OF THE THIRD PRINCIPAL MERIDIAN, IN LAKE COUNTY, ILLINOIS.

PARCEL 4 THE EAST HALF OF THE NORTHWEST QUARTER OF THE NORTHWEST QUARTER OF THE SOUTHWEST QUARTER AND ALSO THE EAST HALF OF THE SOUTHWEST QUARTER OF THE NORTHWEST QUARTER OF THE SOUTHWEST QUARTER OF SECTION 9, TOWNSHIP 46 NORTH, RANGE 10, EAST OF THE THIRD PRINCIPAL MERIDIAN, IN LAKE COUNTY, ILLINOIS.

PARCEL 5 THE WEST HALF OF THE NORTHWEST QUARTER OF THE NORTHWEST QUARTER OF THE SOUTHWEST QUARTER AND THE WEST HALF OF THE SOUTHWEST QUARTER OF THE NORTHWEST QUARTER OF THE SOUTHWEST QUARTER OF SECTION 9, TOWNSHIP 46 NORTH, RANGE 10, EAST OF THE THIRD PRINCIPAL MERIDIAN, IN LAKE COUNTY, ILLINOIS.

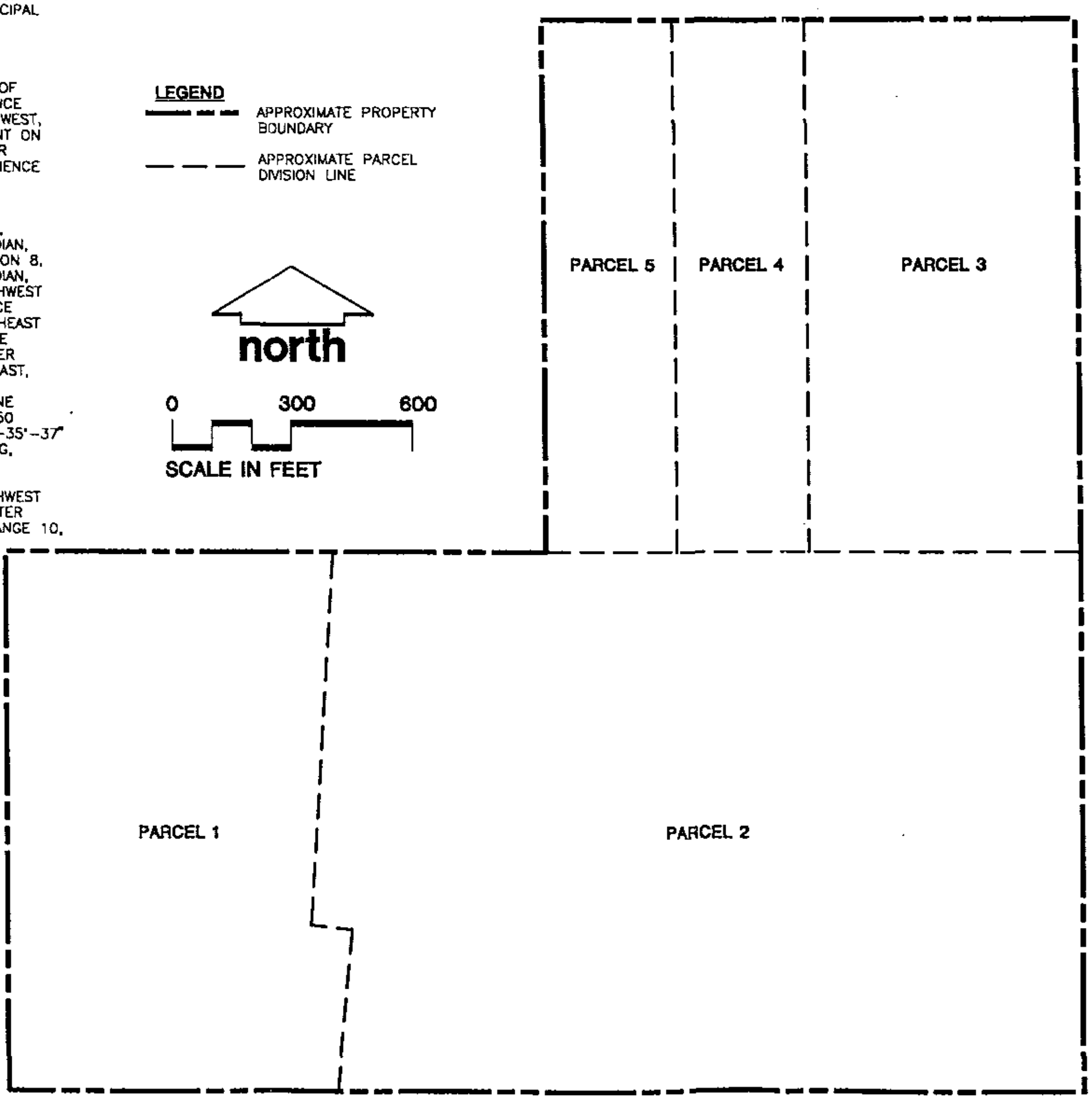


FIGURE 3

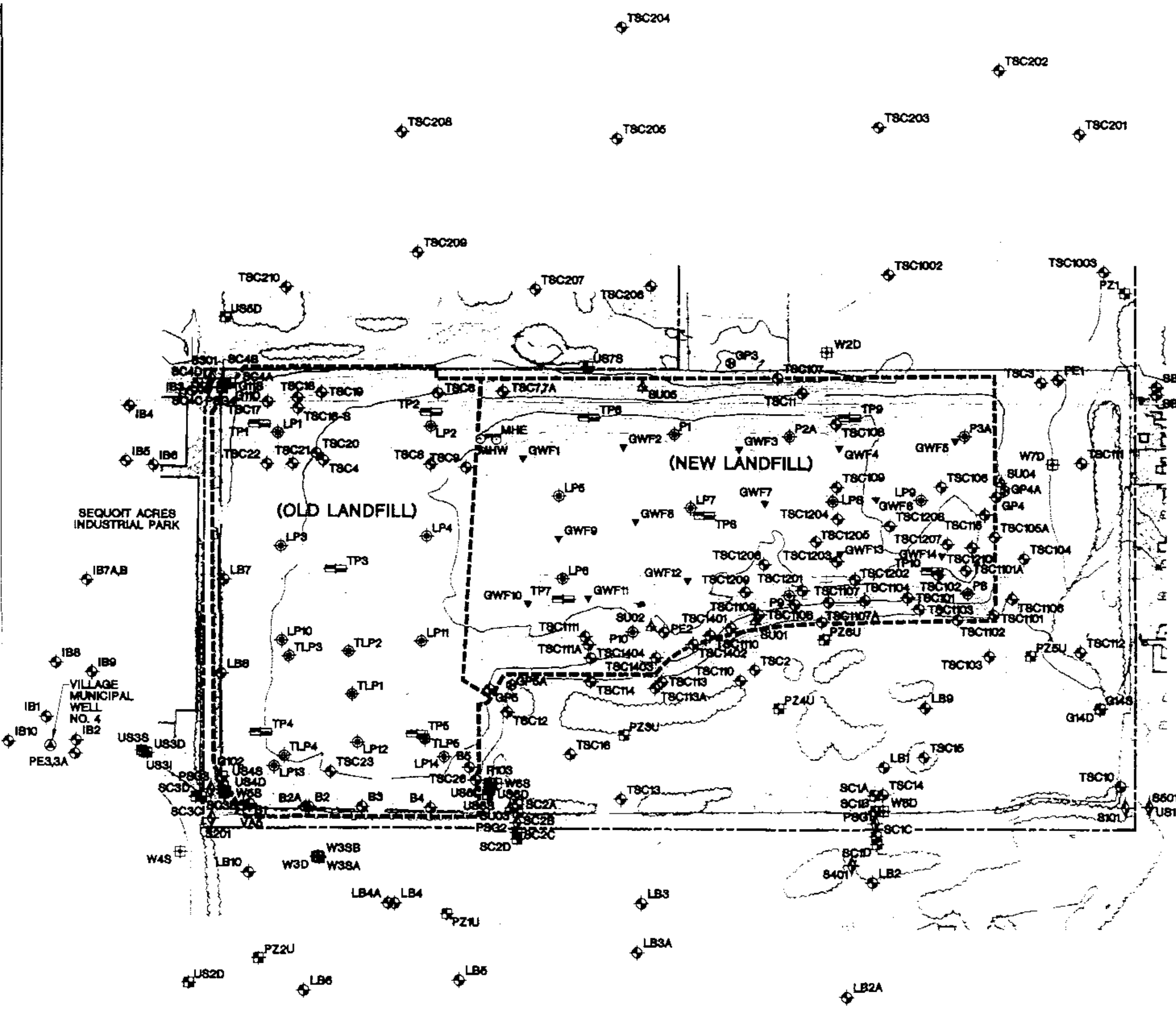
Developed By: SJC
Drawn By: CCM
Approved By: M. Hampen
Date: 9-27-94
Reference:
Revisions:

SITE LEGAL DESCRIPTIONS
REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
10010202 **B8**

WARZYN

ARZYN INC.



LEGEND

	APPROXIMATE PROPERTY LINE
	APPROXIMATE LIMITS OF LANDFILLED AREA
	TOPOGRAPHIC CONTOUR LINE
	TREES, BRUSH
	BUILDING
	FENCE LINE
SC1D	PELA STANDPIPE LOCATION AND NUMBER
R103	TSC MONITORING WELL LOCATION AND NUMBER
PZ1U	PELA PIEZOMETER LOCATION AND NUMBER
US4S	USEPA MONITORING WELL LOCATION AND NUMBER
G11S	TSC MONITORING WELL LOCATION AND NUMBER
S201	SURFACE WATER/SEDIMENT SAMPLING LOCATION AND NUMBER
PSG1	PELA STAFF GAGE LOCATION AND NUMBER
W7D	WARZYN MONITORING WELL LOCATION AND NUMBER
TP3	WARZYN TEST PIT LOCATION AND NUMBER
LP8	WARZYN LEACHATE PIEZOMETER LOCATION AND NUMBER
SU01	WARZYN SURFACE SOIL SAMPLING LOCATION AND NUMBER
GP5A	WARZYN GAS PROBE LOCATION AND NUMBER
B1/GP5	WARZYN SOIL BORING LOCATION AND NUMBER
MHW/ MHE	LEACHATE COLLECTION MANHOLE WEST/ LEACHATE COLLECTION MANHOLE EAST
IB8	INDUSTRIAL PARK SOIL BORING LOCATION AND NUMBER
LB5	PATRICK ENGINEERING SOIL BORING LOCATION AND NUMBER
TSC204	TSC SOIL BORING LOCATION AND NUMBER
GWF1	GAS FLARE LOCATION AND NUMBER
TLP1	TEMPORARY PIEZOMETER LOCATION AND NUMBER
P2A	LEACHATE EXTRACTION WELL LOCATION AND NUMBER

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. LOCATION OF PELA STAFF GAGES PSG1 AND PSG2 ARE APPROXIMATE.
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993.

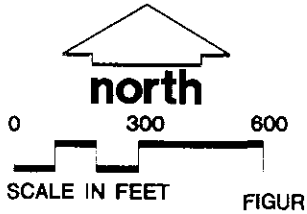


FIGURE 4

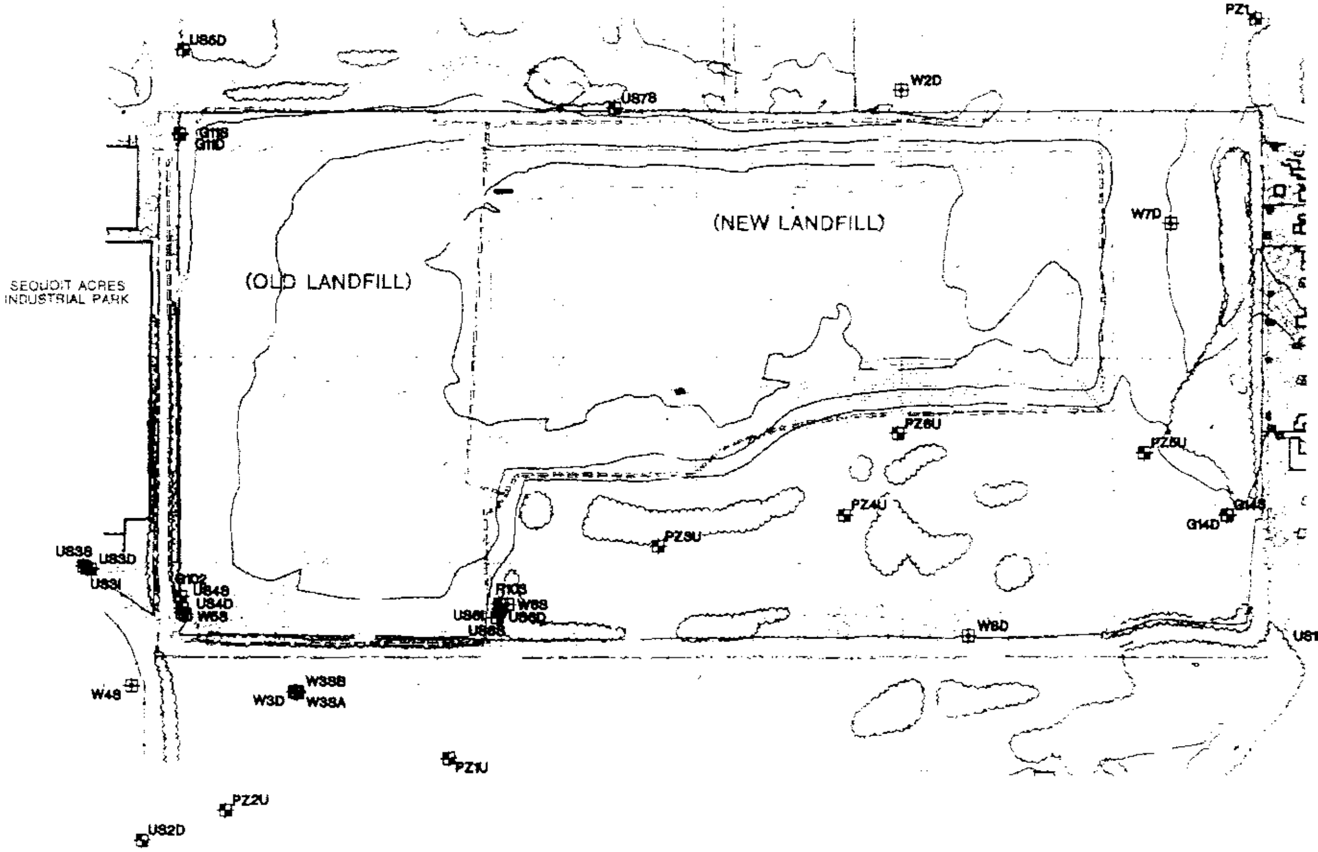
Developed By SJC
Drawn By CCM
Approved By
Date 1.12.97
Reference 10010202/B1
Revisions

MONITORING WELL, SOIL BORING, AND LEACHATE PIEZOMETER LOCATION MAP

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 **B1**

MONTGOMERY WATSON



LEGEND

- - - - APPROXIMATE PROPERTY LINE
APPROXIMATE LIMITS OF LANDFILLED AREA
TOPOGRAPHIC CONTOUR LINE
TREES, BRUSH
BUILDING
FENCE LINE
R103 TSC MONITORING WELL LOCATION AND NUMBER
PZ1U PELA PIEZOMETER LOCATION AND NUMBER
US4S USEPA MONITORING WELL LOCATION AND NUMBER
G11S TSC MONITORING WELL LOCATION AND NUMBER
W7D WARZYN MONITORING WELL LOCATION AND NUMBER

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. LOCATION OF PELA STAFF GAGES PSG1 AND PSG2 ARE APPROXIMATE.
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993.

north

0 300 600
SCALE IN FEET

FIGURE 5

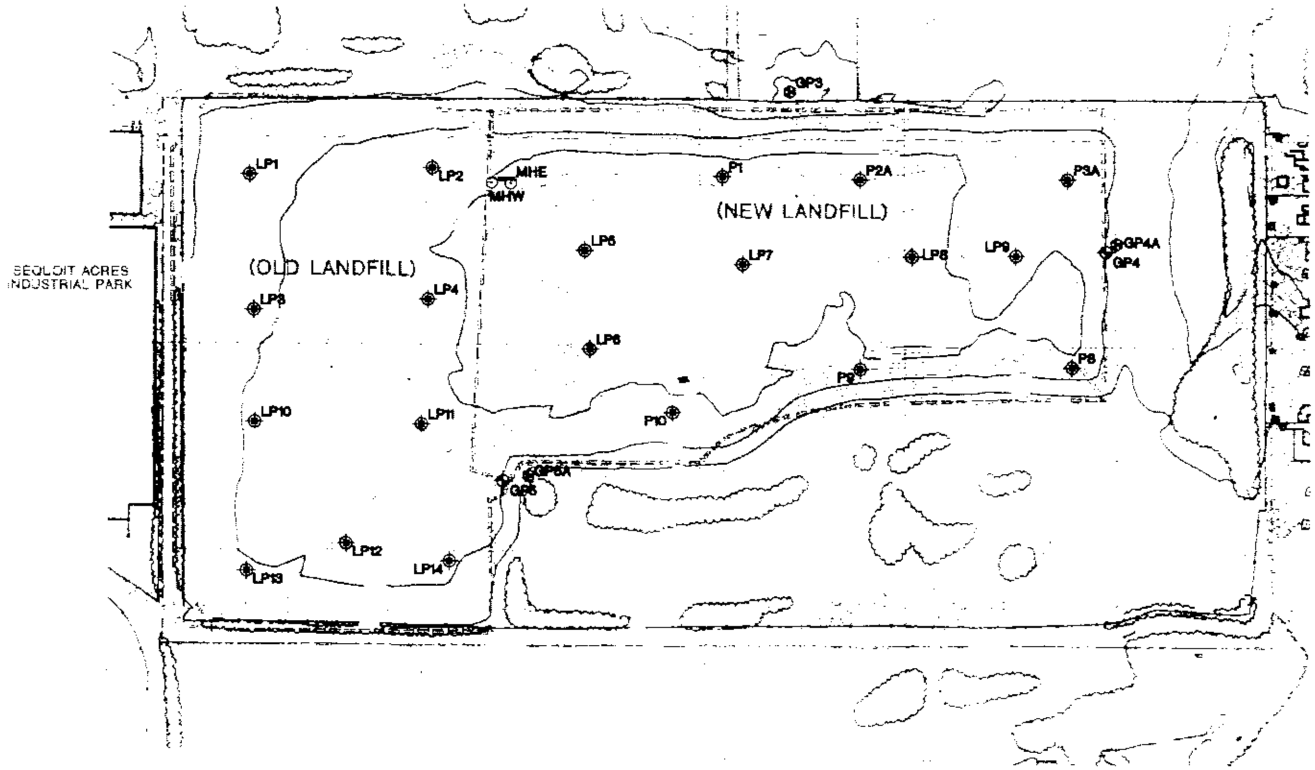
Developed By SJC
Drawn By CCM
Approved By
Date 1/7/97
Reference
Revisions

MONITORING WELL AND PIEZOMETER LOCATION MAP

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 B20

MONTGOMERY WATSON



LEGEND

- - - - APPROXIMATE PROPERTY LINE
- ▭▭▭ APPROXIMATE LIMITS OF LANDFILLED AREA
- —— TOPOGRAPHIC CONTOUR LINE
- ○ TREES, BRUSH
- ▭ BUILDING
- —x FENCE LINE
- ⊕LP6 WARZYN LEACHATE PIEZOMETER LOCATION AND NUMBER
- ⊕GP6A WARZYN GAS PROBE LOCATION AND NUMBER
- ⊙MHW/MHE LEACHATE COLLECTION MANHOLE WEST/ LEACHATE COLLECTION MANHOLE EAST
- ⊕P2A LEACHATE EXTRACTION WELL LOCATION AND NUMBER

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. LOCATION OF PELA STAFF GAGES PSG1 AND PSG2 ARE APPROXIMATE.
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993.

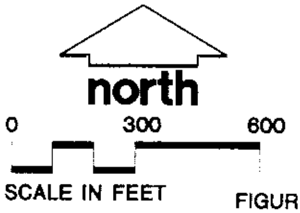


FIGURE 6

Developed By SJC
Drawn By CCM
Approved By
Date 1-17-97
Reference
Revisions

LEACHATE PIEZOMETER AND GAS PROBE LOCATION MAP

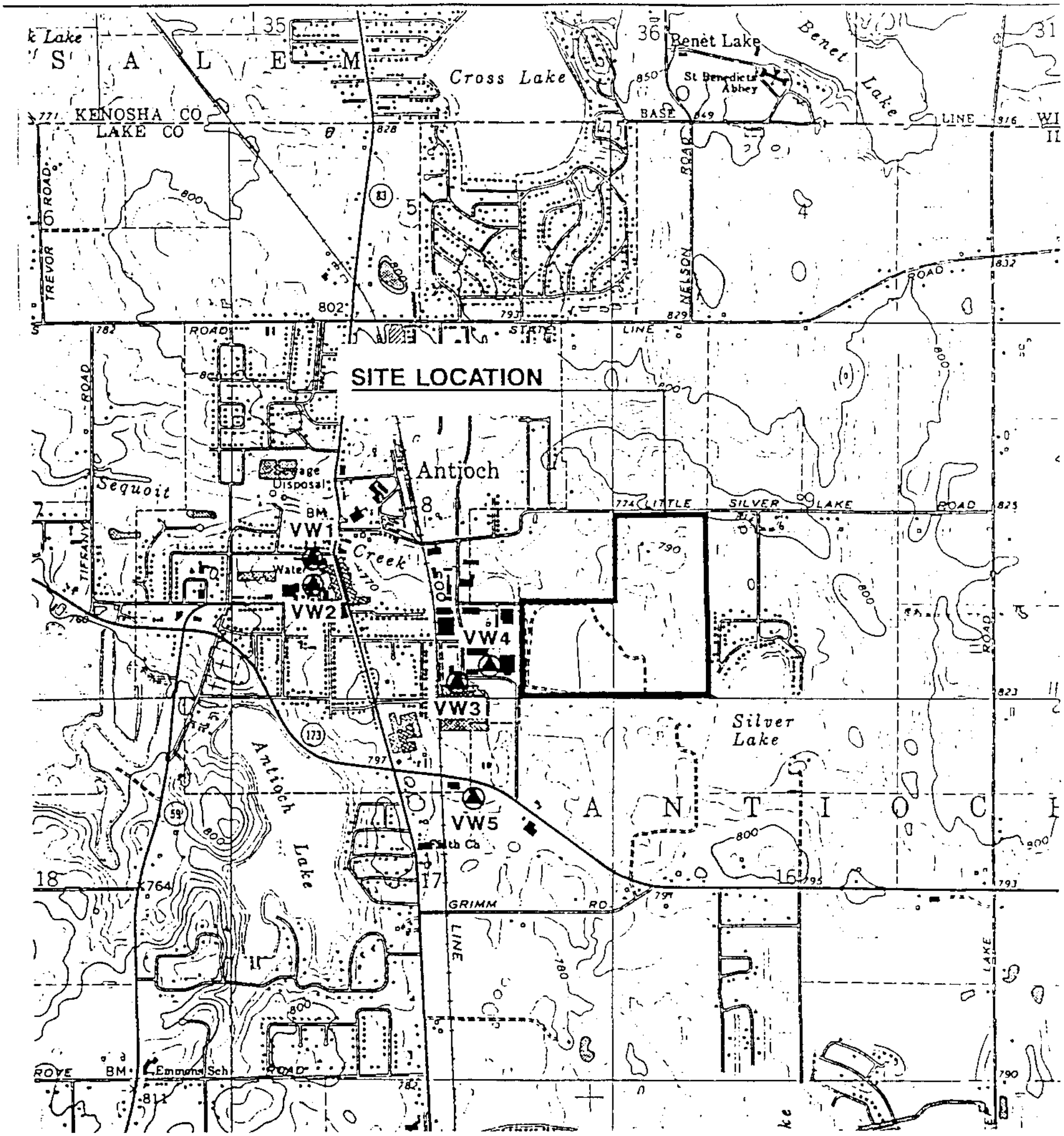
REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096**B21**

MONTGOMERY WATSON

Management Review
Other
Techn Review
Project Manager
Graphic Standards
Lead Professional
QC CONTROL

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.



LEGEND

▲ **VW1** VILLAGE WATER SUPPLY WELL LOCATION AND NUMBER

NOTE

BASE MAP DEVELOPED FROM THE ANTIOCH, ILLINOIS 7.5 MINUTE U.S.G.S. TOPOGRAPHIC QUADRANGLE MAP, DATED 1960, PHOTOREVISED 1972.

north

0 2000 4000

SCALE IN FEET

FIGURE 7

Developed By SJC
Drawn By CCM
Approved By
Date 1-17-97
Reference
Revisions

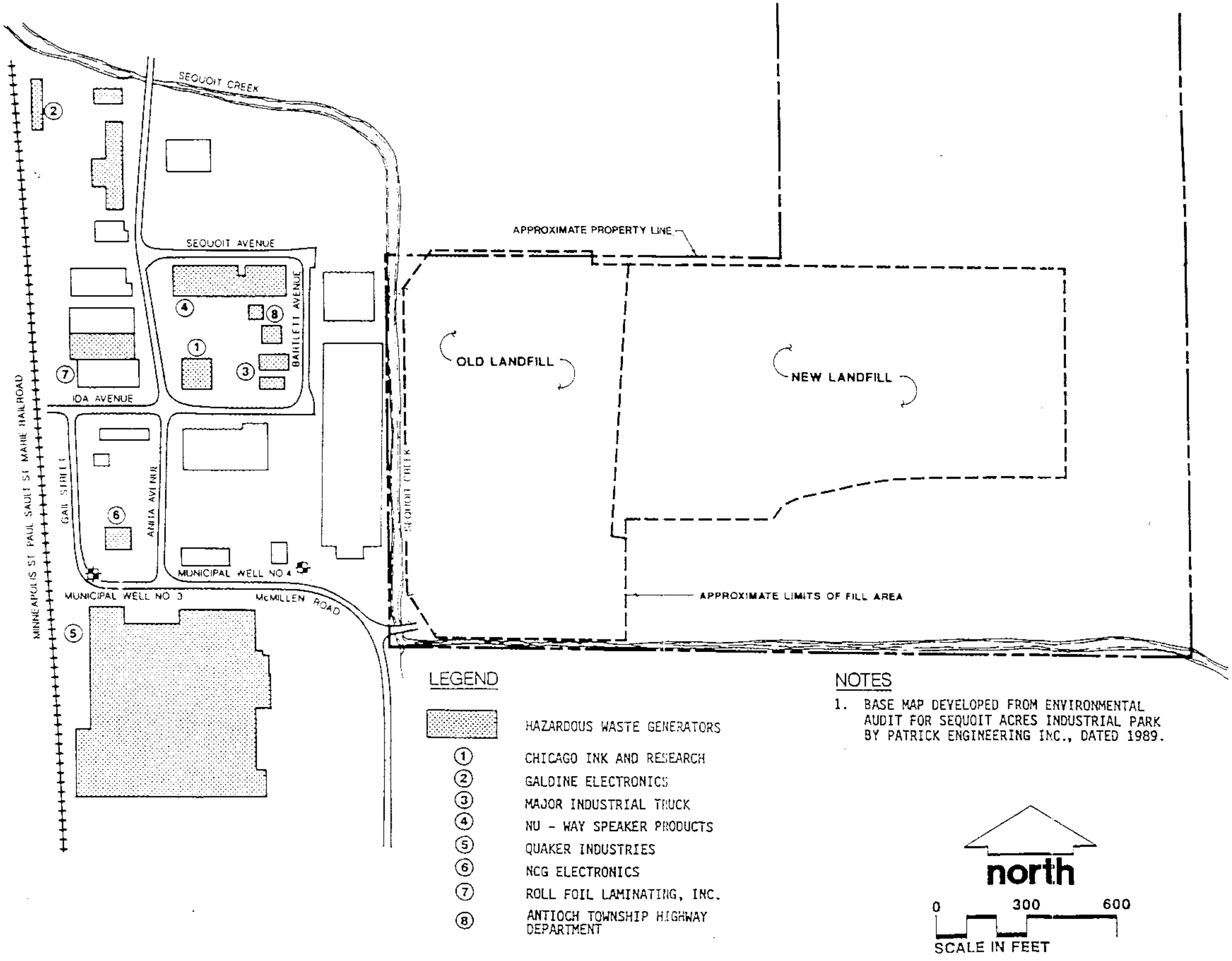
VILLAGE WATER SUPPLY WELL LOCATION MAP

REMEDIAL INVESTIGATION MAP
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 A2

MONTGOMERY WATSON

QUALITY CONTROL
Graphic Standards
Lead Professional
Technical Review
Project Manager
Management Review
Other



NOTES

1. BASE MAP DEVELOPED FROM ENVIRONMENTAL AUDIT FOR SEQUOIT ACRES INDUSTRIAL PARK BY PATRICK ENGINEERING INC., DATED 1989.

Developed By SJC
Drawn By CCM
Approved By
Date 1/17 97
Reference
Revisions

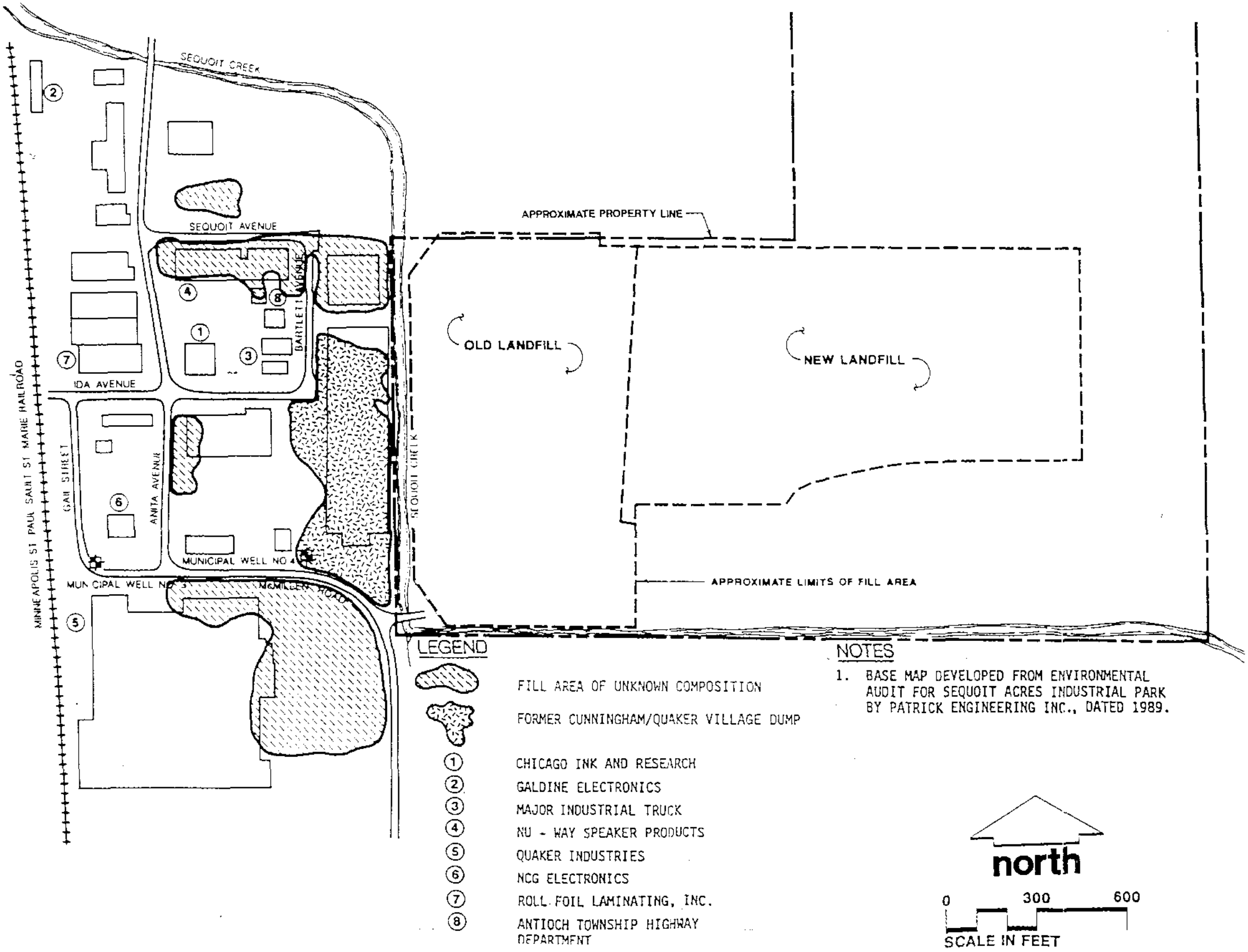
SEQUOIT ACRES INDUSTRIAL PARK MAP

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 **B9**

MONTGOMERY WATSON

FIGURE 8



LEGEND

FILL AREA OF UNKNOWN COMPOSITION

FORMER CUNNINGHAM/QUAKER VILLAGE DUMP

① CHICAGO INK AND RESEARCH
② GALDINE ELECTRONICS
③ MAJOR INDUSTRIAL TRUCK
④ NU - WAY SPEAKER PRODUCTS
⑤ QUAKER INDUSTRIES
⑥ NCG ELECTRONICS
⑦ ROLL FOIL LAMINATING, INC.
⑧ ANTIOCH TOWNSHIP HIGHWAY DEPARTMENT

NOTES

1. BASE MAP DEVELOPED FROM ENVIRONMENTAL AUDIT FOR SEQUOIT ACRES INDUSTRIAL PARK BY PATRICK ENGINEERING INC., DATED 1989.

FIGURE 9

FILLED AREAS IN INDUSTRIAL PARK MAP

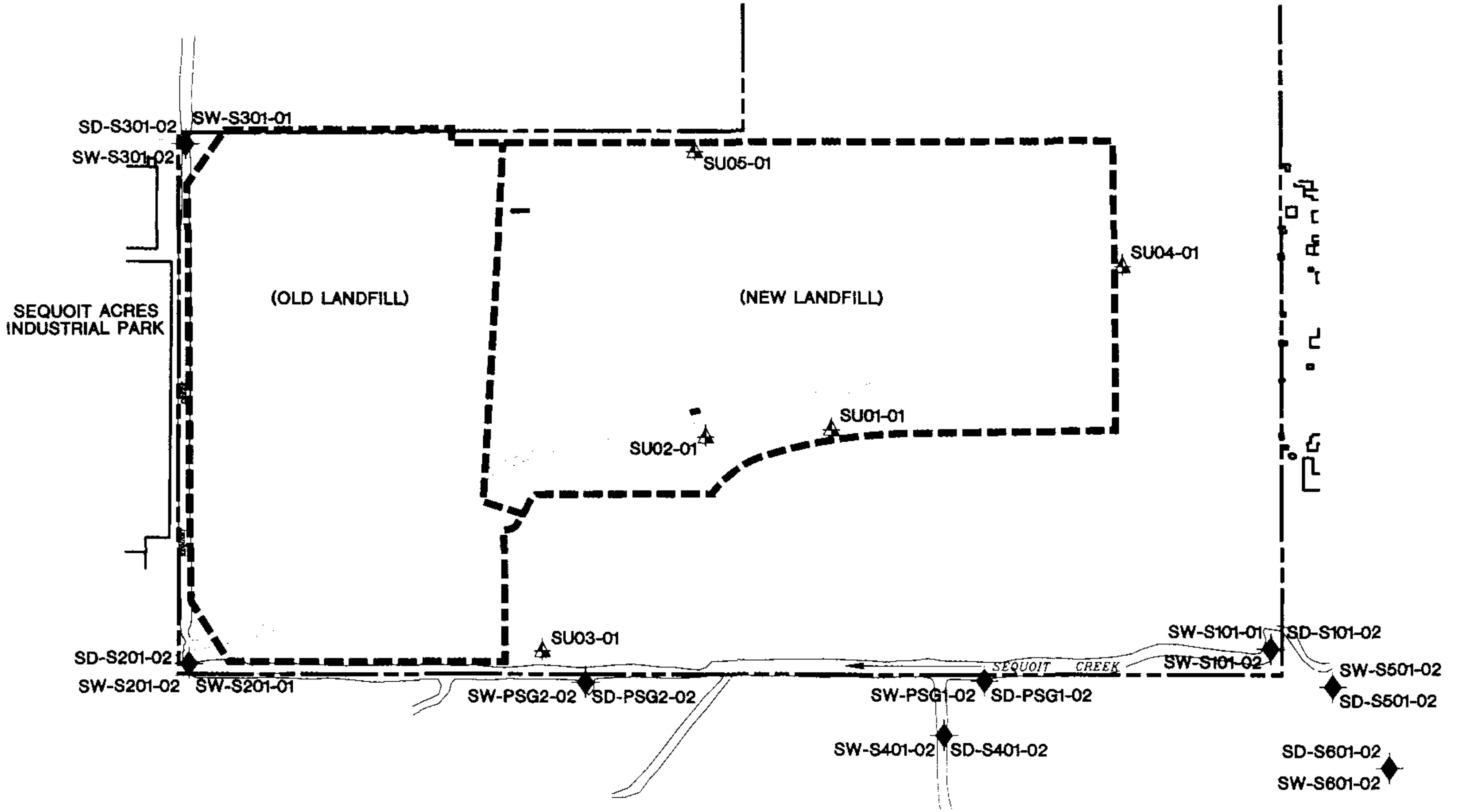
REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Developed By SJC
Drawn By CCM
Approved By
Date 1-17-97
Reference
Revisions

Drawing Number 2386.0096B10

MONTGOMERY WATSON

QUALITY CONTROL
Graphic Standards
Lead Professional
Technical Review
Project Manager
Management Review
Other



LEGEND

— - —	APPROXIMATE PROPERTY LINE
▬ ▬ ▬	APPROXIMATE LIMITS OF LANDFILLED AREA
	ACCESS ROAD
▭	BUILDING
◆ S202	SURFACE WATER/SEDIMENT SAMPLING LOCATION AND NUMBER
△ SU01-01	ROUND I WARZYN SURFACE SOIL SAMPLING LOCATION AND NUMBER

NOTES

1. REFER TO DRAWING 10010201-F2 FOR ADDITIONAL NOTES AND LEGEND.
2. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY.
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY DURING JUNE AND JULY 1993.
4. ROUND I SAMPLES (i.e., SD-S101-01) COLLECTED IN MAY 1993. ROUND II SAMPLES (i.e., SD-S101-02) COLLECTED IN MARCH 1994.

north

0 250 500

SCALE IN FEET

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

QUALITY CONTROL	Graphic Standards CCM 6-21-96	Technical Review	Management Review
	Lead Professional	Project Manager	Other

Developed By SJC
Drawn By CCM
Approved By
Date 1/1/97
Reference 10010207/B11
Revisions

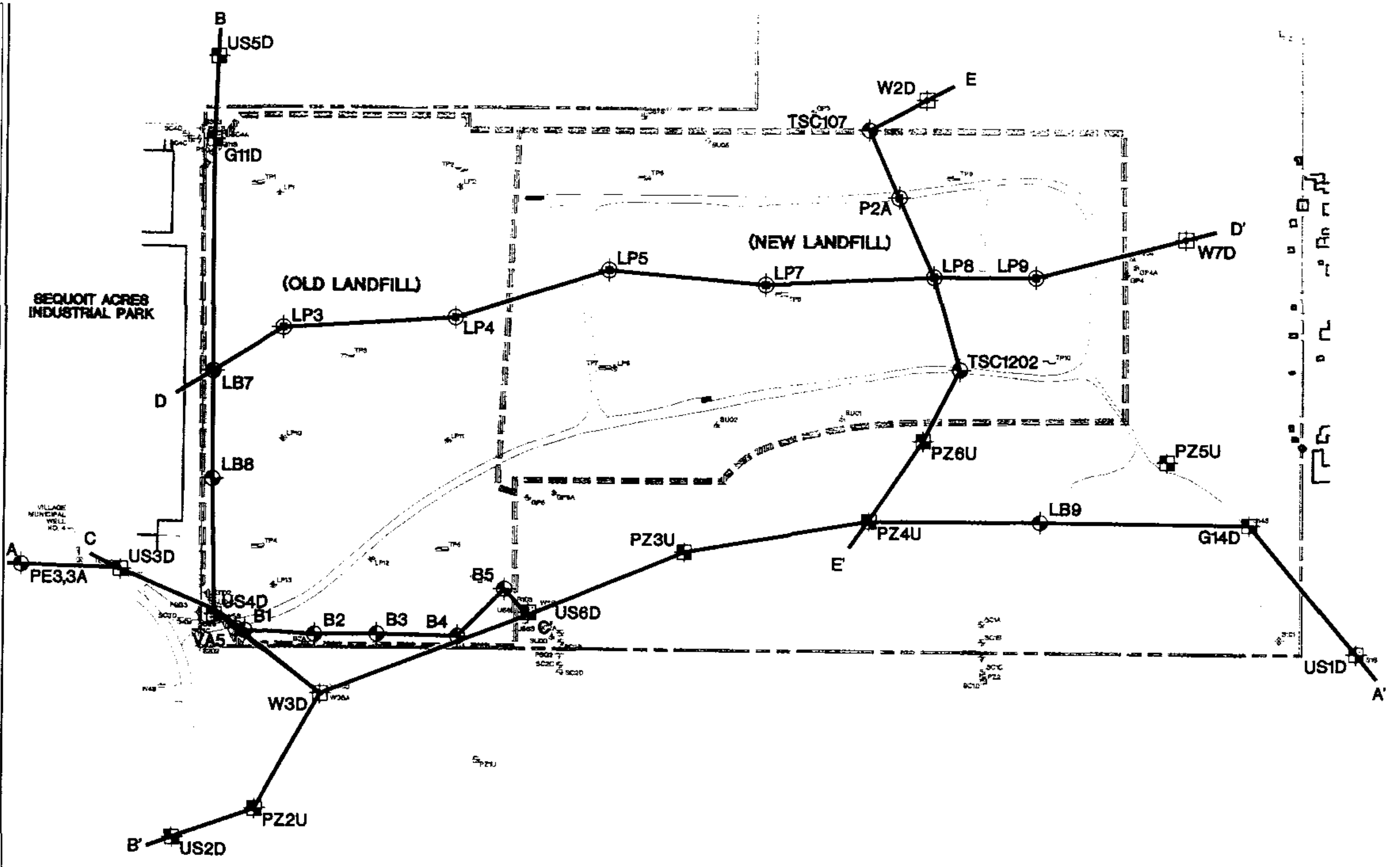
SURFACE WATER/SEDIMENT AND SURFACE SOIL SAMPLING LOCATION MAP (ROUND I & II)

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 **B11**

MONTGOMERY WATSON

FIGURE 10



LEGEND

▬ ▬ ▬	APPROXIMATE PROPERTY LINE
▨ ▨ ▨	APPROXIMATE LIMITS OF LANDFILLED AREA
‐ ‐ ‐	ACCESS ROAD
☐	BUILDING
A ―― A'	LOCATION OF GEOLOGIC CROSS-SECTION

NOTES

1. REFER TO DRAWING 10010201-F2 FOR ADDITIONAL NOTES AND LEGEND.
2. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY.
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED DURING JUNE AND JULY 1993.

north

0 250 500
SCALE IN FEET

FIGURE 11

Developed By SJC
Drawn By CCM
Approved By
Date 1-12-91
Reference
Revisions

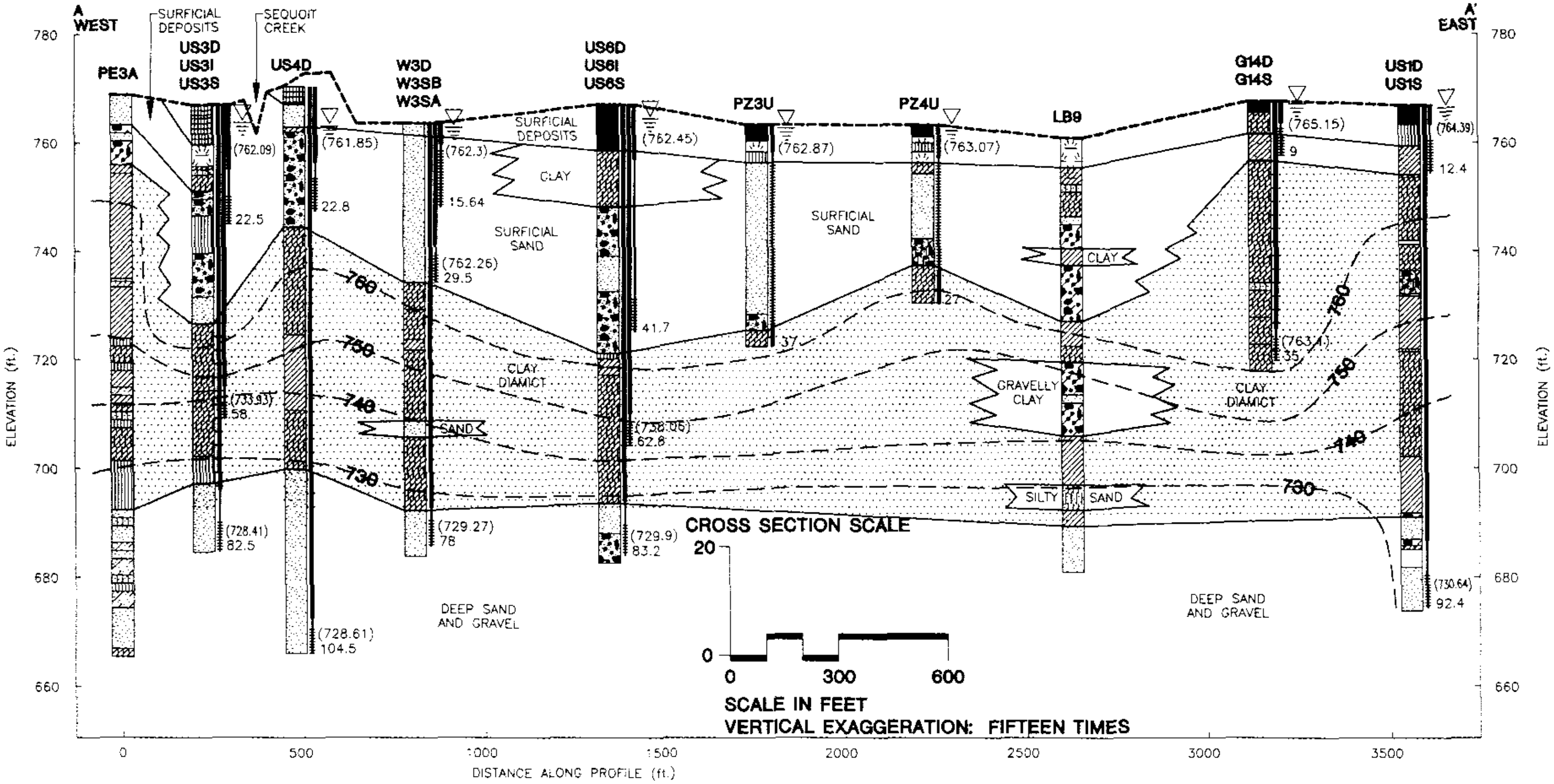
GEOLOGIC CROSS-SECTION LOCATION MAP

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096B12

MONTGOMERY WATSON

QUALITY CONTROL | Graphic Standards | Lead Professional | Technical Review | Project Manager | Management Review | Other



SECTION A-A'

NOTES

1. THE STRATUM LINES ARE BASED ON INTERPOLATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS.
2. FOR THE PURPOSE OF ILLUSTRATING SUBSOIL CONDITIONS ON THE CROSS-SECTIONS, SOME OF THE BORINGS LOGS HAVE BEEN SIMPLIFIED. FOR A DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS AT INDIVIDUAL BORINGS REFER TO SOIL BORING LOGS. (APPENDED TO REPORT)
3. COMPLETE MONITORING WELL INSTALLATION DETAILS ARE APPENDED TO REPORT.
4. HORIZONTAL DISTANCES ARE MEASURED WITH RESPECT TO THE CENTER OF EACH SOIL BORING LOCATION.
5. ELEVATIONS ARE SHOWN IN REFERENCE TO U.S.G.S. DATUM.
6. QUESTIONS MARKS INDICATE THE CORRELATION OR EQUIPOTENTIAL LINES ARE INFERRED.
7. GROUNDWATER ELEVATIONS ARE BASED ON MEASUREMENTS OBTAINED BY WARZYN INC. ON JUNE 8 AND 9, 1993. CONTOURS ARE EXTRAPOLATED BASED ON CALCULATED VERTICAL HYDRAULIC GRADIENTS. SEE TABLE 3-16 OF RI REPORT.

LEGEND

░	SAND
▥	SILTY SAND
▨	CLAYEY SAND
▩	CLAYEY GRAVEL
▩	SAND AND GRAVEL
▩	SAND AND GRAVEL, SOME SILT AND CLAY
▩	SAND AND GRAVEL, SOME CLAY
■	TOPSOIL
▩	PAVEMENT
▦	FILL
▩	REFUSE
▥	SILT
▩	SILTY CLAY
▨	LEAN CLAY
760	GROUNDWATER EQUIPOTENTIAL LINE (CONTOUR INTERVAL = 10 FT.)
(728.41)	GROUNDWATER ELEVATION
82.6	TOTAL DEPTH OF WELL IN FEET BELOW GROUND SURFACE
	BACKFILLED WITH BENTONITE
	2" I.D. RISER
	2" I.D. SLOTTED WELL SCREEN
▽	SURFICIAL SAND WELL WATER LEVELS

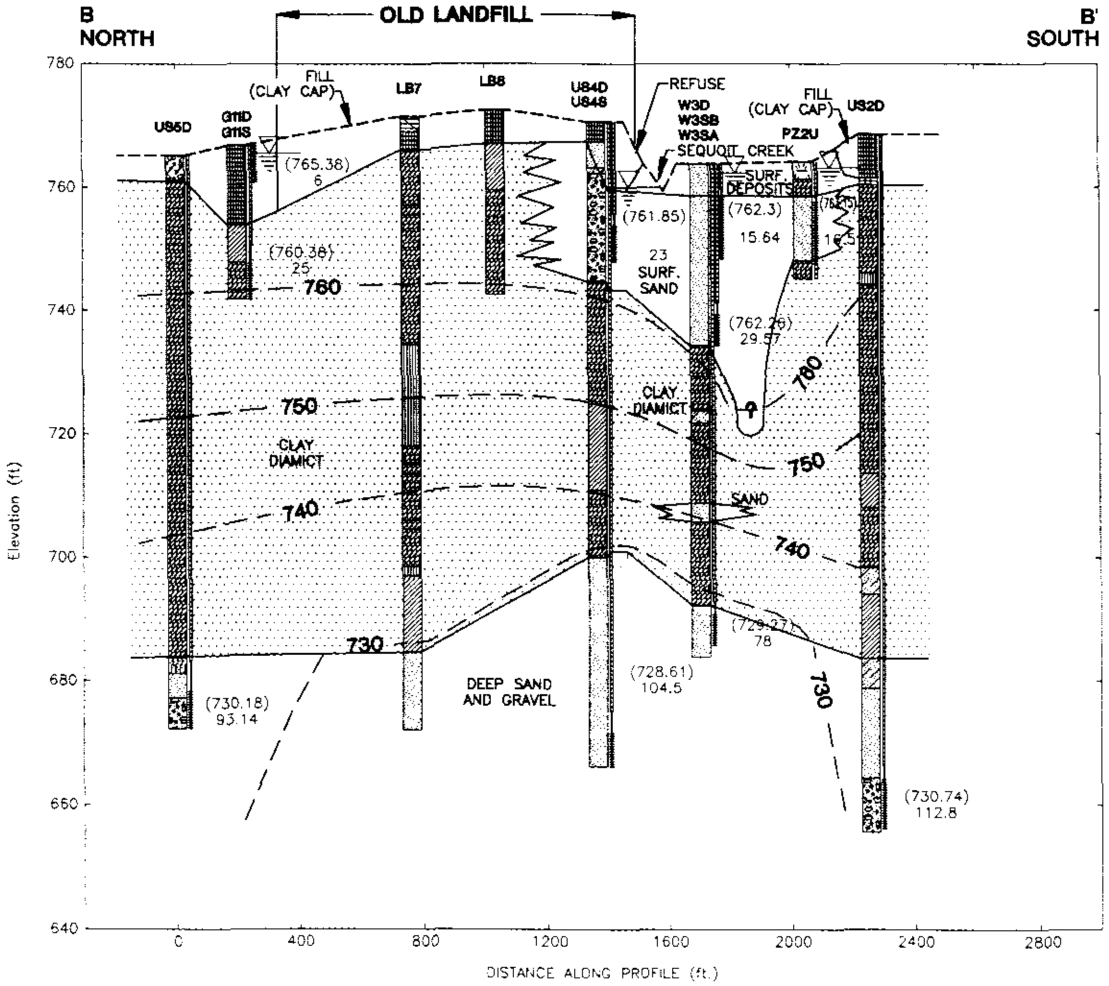
FIGURE 12

Developed By PMS
Drawn By CCM
Approved By
Date 1-17-97
Reference
Revisions

GEOLOGIC CROSS-SECTION A-A'
REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

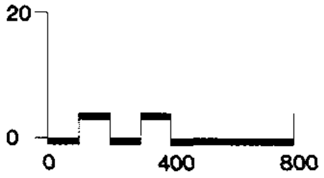
Drawing Number
2386.0096 B22

MONTGOMERY WATSON



SECTION B - B'

CROSS SECTION SCALE



SCALE IN FEET
VERTICAL EXAGGERATION: TWENTY TIMES

LEGEND

░	SAND
▦	SILTY SAND
▨	CLAYEY SAND
▩	CLAYEY GRAVEL
▩	SAND AND GRAVEL
▩	SAND AND GRAVEL, SOME SILT AND CLAY
▩	SAND AND GRAVEL, SOME CLAY
■	TOPSOIL
■	PAVEMENT
▦	FILL OR REFUSE
▥	SILT
▩	SILTY CLAY
▨	LEAN CLAY
760	GROUNDWATER EQUIPOTENTIAL LINE (CONTOUR INTERVAL 10 FT.)
(730.74)	GROUNDWATER ELEVATION
112.8	TOTAL DEPTH OF WELL IN FEET BELOW GROUND SURFACE

BACKFILLED WITH BENTONITE
2" I.D. RISER
2" I.D. SLOTTED WELL SCREEN
▽ SURFICIAL SAND WELL WATER LEVELS

NOTES

1. THE STRATUM LINES ARE BASED ON INTERPOLATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS.
2. FOR THE PURPOSE OF ILLUSTRATING SUBSOIL CONDITIONS ON THE CROSS-SECTIONS, SOME OF THE BORING LOGS HAVE BEEN SIMPLIFIED. FOR A DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS AT INDIVIDUAL BORINGS, REFER TO SOIL BORING LOGS. (APPENDED TO REPORT)
3. COMPLETE MONITORING WELL INSTALLATION DETAILS ARE APPENDED TO REPORT.
4. CROSS-SECTION HAS BEEN EXAGGERATED TWENTY TIMES.
5. HORIZONTAL DISTANCES ARE MEASURED WITH RESPECT TO THE CENTER OF EACH SOIL BORING LOCATION.
6. ELEVATIONS ARE SHOWN IN REFERENCE TO U.S.G.S. DATUM.
7. QUESTION MARKS INDICATE CORRELATION OR EQUIPOTENTIAL LINES ARE INFERRED.
8. GROUNDWATER ELEVATIONS ARE BASED ON MEASUREMENTS OBTAINED BY WARZYN INC. ON JUNE 8 AND 9, 1993. CONTOURS ARE EXTRAPOLATED BASED ON CALCULATED VERTICAL HYDRAULIC GRADIENTS. SEE SECTION 3.7 OF REPORT.

FIGURE 13

Developed By SJC	Drawn By CCM
Approved By	Date 1-17-97
Reference 10010202/B14	
Revisions	

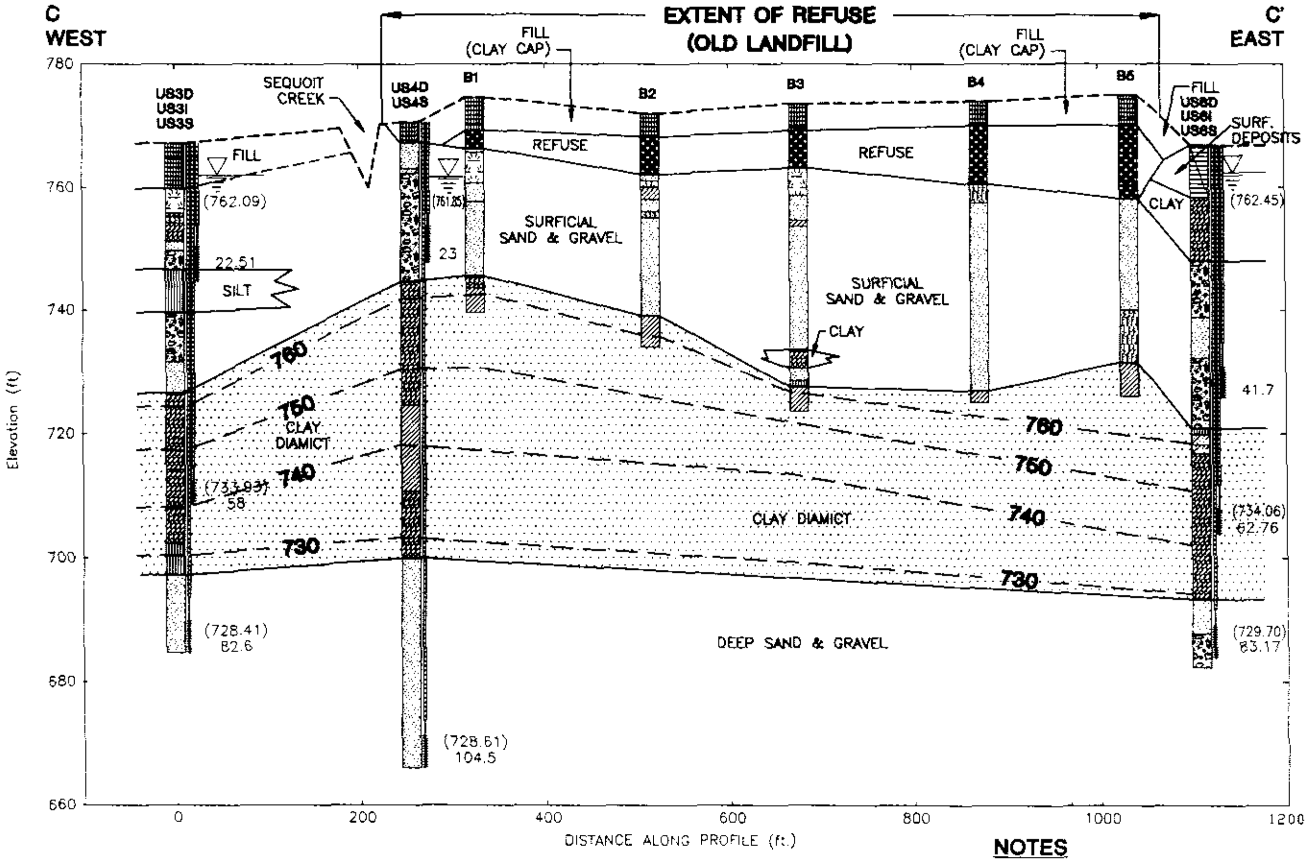
GEOLOGIC CROSS-SECTION B-B'

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096**B14**

MONTGOMERY WATSON

QUALITY CONTROL			
Graphic Standards CCM 6-21-96	Technical Review	Management Review	
Lead Professional	Project Manager	Other	



SECTION C - C'

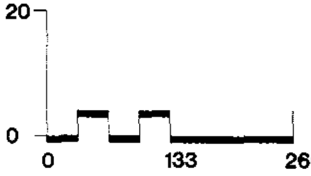
LEGEND

▢	SAND
▥	SILTY SAND
▨	CLAYEY SAND
▩	CLAYEY GRAVEL
▩	SAND AND GRAVEL
▩	SAND AND GRAVEL, SOME SILT AND CLAY
▩	SAND AND GRAVEL, SOME CLAY
■	TOPSOIL
▩	PAVEMENT
▦	FILL
▩	REFUSE
▥	SILT
▨	SILTY CLAY
▨	LEAN CLAY
760	GROUNDWATER EQUIPOTENTIAL LINE (CONTOUR INTERVAL = 10 FT.)
(728.41)	GROUNDWATER ELEVATION
82.6	TOTAL DEPTH OF WELL IN FEET BELOW GROUND SURFACE
	BACKFILLED WITH BENTONITE
	2" I.D. RISER
	2" I.D. SLOTTED WELL SCREEN
▽	SURFICIAL SAND WELL WATER LEVEL

NOTES

1. THE STRATUM LINES ARE BASED ON INTERPOLATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS.
2. FOR THE PURPOSE OF ILLUSTRATING SUBSOIL CONDITIONS ON THE CROSS-SECTIONS, SOME OF THE BORING LOGS HAVE BEEN SIMPLIFIED. FOR A DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS AT INDIVIDUAL BORINGS REFER TO SOIL BORING LOGS. (APPENDED TO REPORT)
3. COMPLETE MONITORING WELL INSTALLATION DETAILS ARE APPENDED TO REPORT.
4. CROSS-SECTION HAS BEEN EXAGGERATED 6.65 TIMES.
5. HORIZONTAL DISTANCES ARE MEASURED WITH RESPECT TO THE CENTER OF EACH SOIL BORING LOCATION.
6. ELEVATIONS ARE SHOWN IN REFERENCE TO U.S.G.S. DATUM.
7. QUESTION MARKS INDICATE THE CORRELATION OR EQUIPOTENTIAL LINES ARE INFERRED.
8. GROUNDWATER ELEVATIONS ARE BASED ON MEASUREMENTS OBTAINED BY WARZYN INC. ON JUNE 8 AND 9, 1993. CONTOURS ARE EXTRAPOLATED BASED ON CALCULATED VERTICAL HYDRAULIC GRADIENTS. SEE TABLE 3-16 OF RI REPORT.

CROSS SECTION SCALE



SCALE IN FEET
VERTICAL EXAGGERATION: 6.65 TIMES

FIGURE 14

Developed By SJC
Drawn By CCM
Approved By Ray Lee
Date 1-17-97
Reference 100102C2/B15
Revisions

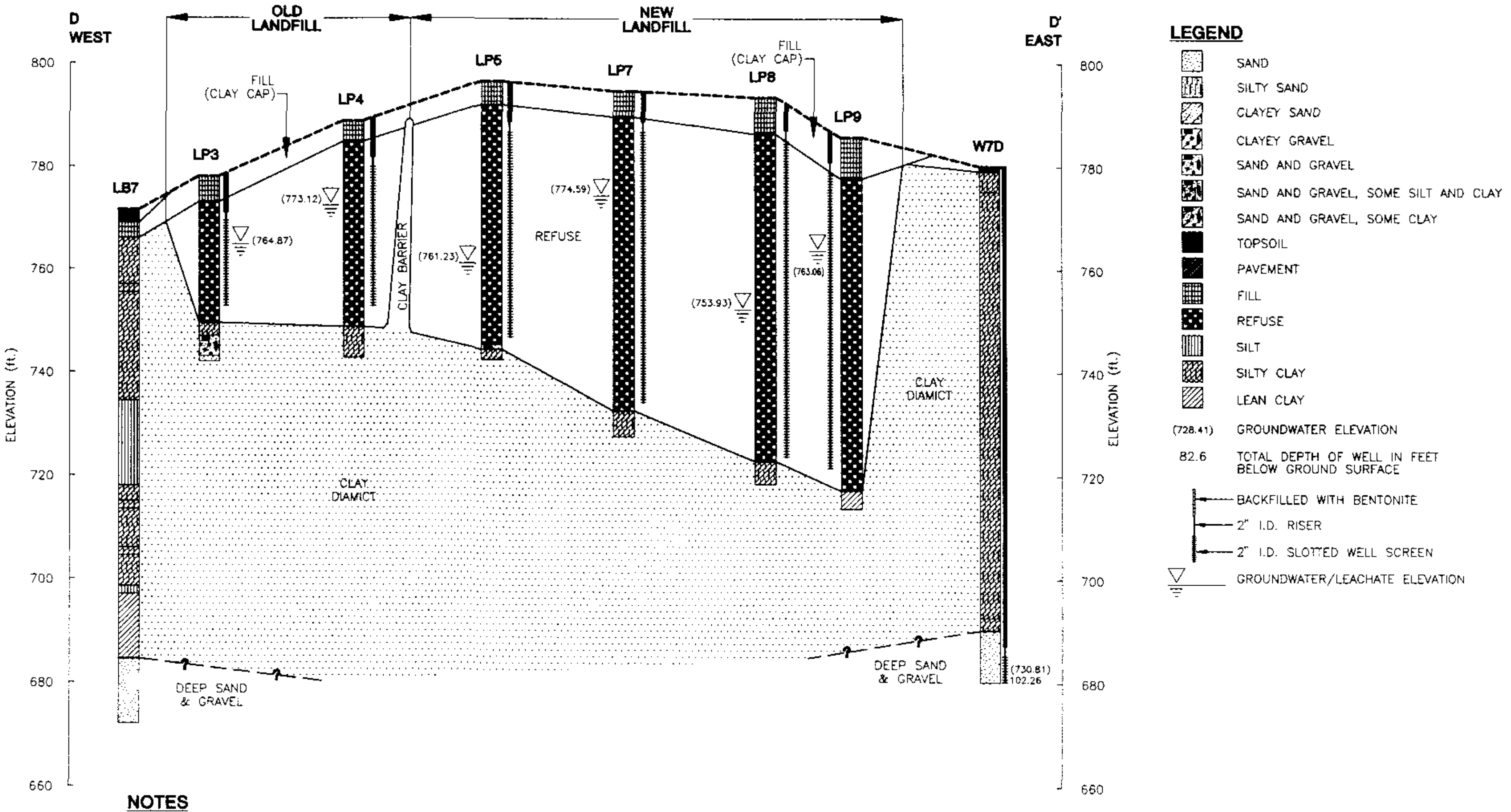
GEOLOGIC CROSS-SECTION C-C'

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096**B15**

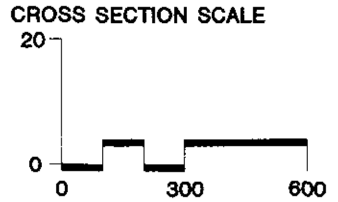
MONTGOMERY WATSON

QUALITY CONTROL
Graphic Standards CCM 6-21-96
Lead Professional
Technical Review
Project Manager
Management Review
Other



NOTES

1. THE STRATUM LINES ARE BASED ON INTERPOLATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS.
2. FOR THE PURPOSE OF ILLUSTRATING SUBSOIL CONDITIONS ON THE CROSS-SECTIONS, SOME OF THE BORINGS LOGS HAVE BEEN SIMPLIFIED. FOR A DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS AT INDIVIDUAL BORINGS REFER TO SOIL BORING LOGS. (APPENDED TO REPORT)
3. COMPLETE MONITORING WELL INSTALLATION DETAILS ARE APPENDED TO REPORT.
4. HORIZONTAL DISTANCES ARE MEASURED WITH RESPECT TO THE CENTER OF EACH SOIL BORING LOCATION.
5. ELEVATIONS ARE SHOWN IN REFERENCE TO U.S.G.S. DATUM.
6. GROUNDWATER ELEVATIONS ARE BASED ON MEASUREMENTS OBTAINED BY WARZYN INC. ON JUNE 8 AND 9, 1993.



SCALE IN FEET
VERTICAL EXAGGERATION: FIFTEEN TIMES

FIGURE 15

QUALITY CONTROL	Graphic Standards	Technical Review	Management Review
	Lead Professional	Project Manager	Other

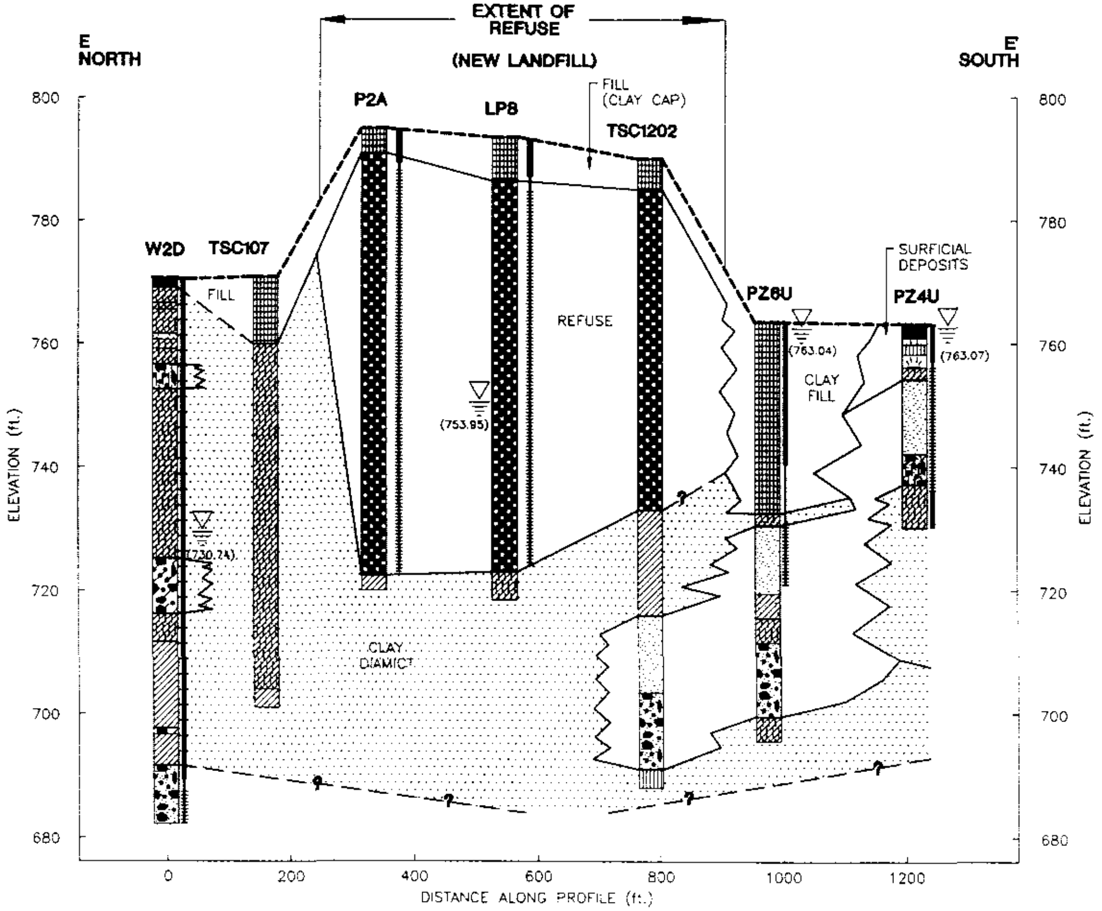
GEOLOGIC CROSS-SECTION D-D'

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Developed By PMS
Drawn By CCM
Approved By
Date 1-17-98
Reference
Revisions

Drawing Number 2386.0096 B23

MONTGOMERY WATSON



LEGEND

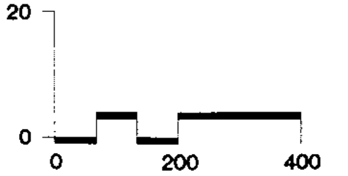
░	SAND
▥	SILTY SAND
▨	CLAYEY SAND
▨	CLAYEY GRAVEL
▩	SAND AND GRAVEL
▩	SAND AND GRAVEL, SOME SILT AND CLAY
▨	SAND AND GRAVEL, SOME CLAY
■	TOPSOIL
■	PAVEMENT
▦	FILL
▩	REFUSE
▥	SILT
▩	SILTY CLAY
▨	LEAN CLAY
(728.41)	GROUNDWATER ELEVATION
82.6	TOTAL DEPTH OF WELL IN FEET BELOW GROUND SURFACE

BACKFILLED WITH BENTONITE
2" I.D. RISER
2" I.D. SLOTTED WELL SCREEN
▽ GROUNDWATER/LEACHATE ELEVATION

NOTES

1. THE STRATUM LINES ARE BASED ON INTERPOLATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS.
2. FOR THE PURPOSE OF ILLUSTRATING SUBSOIL CONDITIONS ON THE CROSS-SECTIONS, SOME OF THE BORINGS LOGS HAVE BEEN SIMPLIFIED. FOR A DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS AT INDIVIDUAL BORINGS REFER TO SOIL BORING LOGS. (APPENDED TO REPORT)
3. COMPLETE MONITORING WELL INSTALLATION DETAILS ARE APPENDED TO REPORT.
4. HORIZONTAL DISTANCES ARE MEASURED WITH RESPECT TO THE CENTER OF EACH SOIL BORING LOCATION.
5. ELEVATIONS ARE SHOWN IN REFERENCE TO U.S.G.S. DATUM.
6. GROUNDWATER ELEVATIONS ARE BASED ON MEASUREMENTS OBTAINED BY WARZYN INC. ON JUNE 8 AND 9, 1993.

CROSS SECTION SCALE



SCALE IN FEET
VERTICAL EXAGGERATION: TEN TIMES

FIGURE 16

Developed By PMS
Drawn By CCM
Approved By
Date 1/7.97
Reference
Revisions

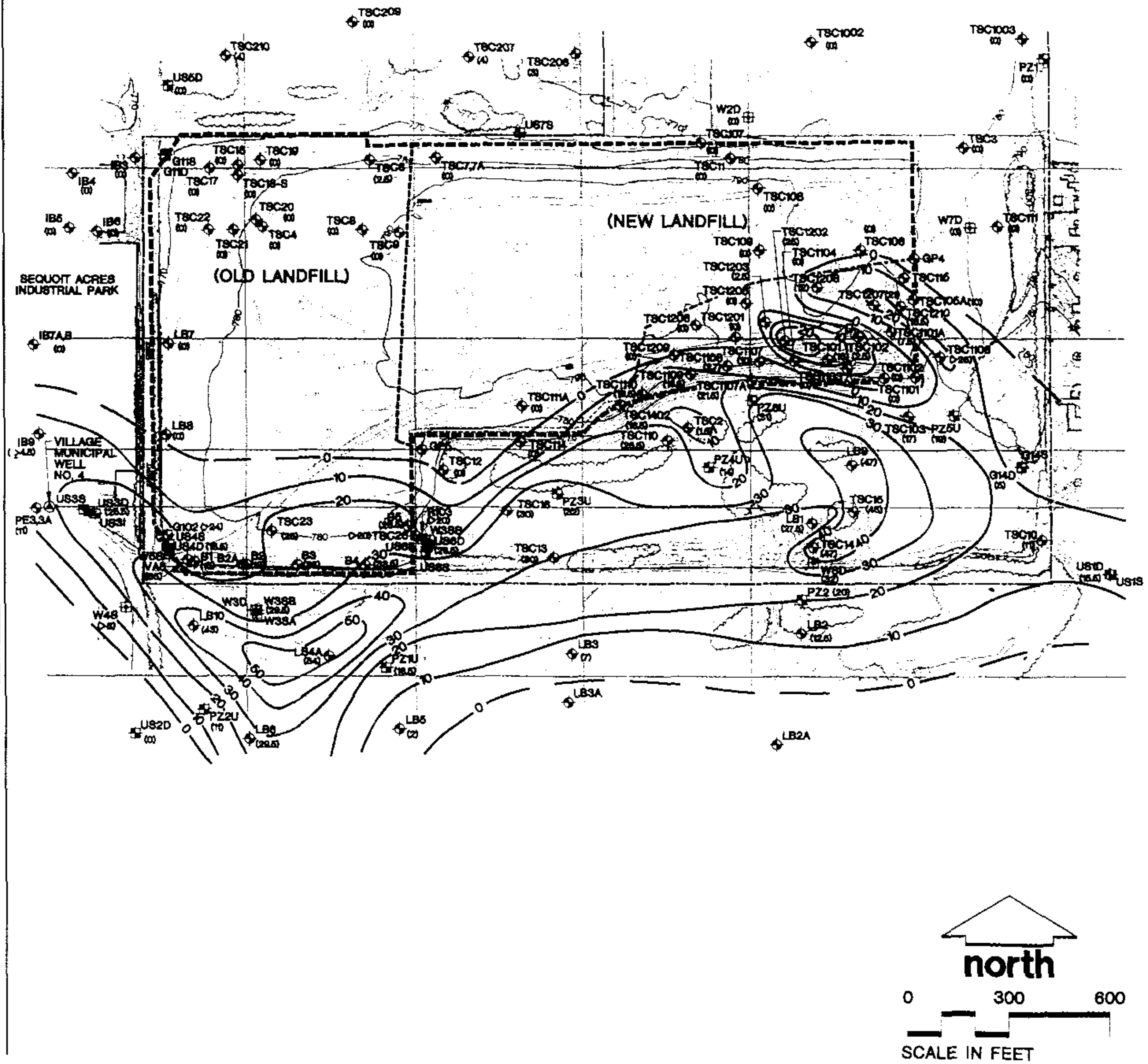
GEOLOGIC CROSS-SECTION E-E'

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 **B24**

MONTGOMERY WATSON

QUALITY CONTROL
Graphic Standards
Lead Professional
Technical Review
Project Manager
Management Review
Other



LEGEND

— — —	APPROXIMATE PROPERTY LINE
■ ■ ■	APPROXIMATE LIMITS OF LANDFILLED AREA
– · – · –	APPROXIMATE EXTENT OF BOTTOM CLAY SEAL
- - - - -	APPROXIMATE EXTENT OF PERIMETER OF CLAY SEAL
—750—	TOPOGRAPHIC CONTOUR LINE
○	TREES, BRUSH
	ACCESS ROAD
▭	BUILDING
	SPOT ELEVATION
———	FENCE LINE
⊕ IB9	PATRICK ENGINEERING SOIL BORING LOCATION AND NUMBER
⊕ VA5	LITIGATION PLAINTIFF SOIL BORING LOCATION AND NUMBER
⊕ TSC	TSC SOIL BORING LOCATION AND NUMBER
⊕ PE3A	PELA SOIL BORING LOCATION AND NUMBER
⊕ LB2	PELA ENGINEERING SOIL BORING LOCATION AND NUMBER
⊕ GP6	WARZYN PERIMETER GAS PROBE LOCATION AND NUMBER
—30—	THICKNESS OF SURFICIAL SAND CONTOUR (CONTOUR INTERVAL 10 FT., DASHED WHERE INFERRED)
(47)	THICKNESS OF SAND IN FEET

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. TOPOGRAPHY IS BASED IN U.S.G.S. DATUM.
3. GRID BASED ON ILLINOIS STATE PLANE COORDINATE SYSTEM.
4. SURFICIAL SAND ISOPACH MAP WAS DEVELOPED FROM LOGS OF SITE SOIL BORINGS, MONITORING WELLS, AND PIEZOMETERS.
5. SURFICIAL SAND MAY CONTAIN DISCONTINUOUS LAYERS AND LENSES OF CLAY AND SILT.
6. SURFICIAL SAND THICKNESSES ARE BASED ON THE THICKNESS OF SAND ENCOUNTERED IN BORINGS. IN THE NEW LANDFILL AREA THE SURFICIAL SAND WAS EXCAVATED AND BOTTOM AND PERIMETER CLAY SEALS PLACED. THEREFORE SURFICIAL SAND THICKNESS SHOWN IN THIS AREA REPRESENTS PRE-DEVELOPMENT CONDITIONS. SEE NOTE 7
7. THE WESTERN PORTION OF THE NEW LANDFILL RECEIVED A FULL DEPTH PERIMETER CLAY SEAL ALONG THE SOUTHERN BOUNDARY. THIS SEAL WAS TIED INTO THE NATURAL UNDERLYING CLAY AND WAS EXTENDED UPWARD AND TIED INTO THE CLAY CAP
8. BOTTOM SEAL IN LANDFILL WAS TO CONSIST OF AT LEAST 10 FEET OF NATURAL CLAY OR 6 FEET OF COMPACTED CLAY. PERIMETER SEAL WAS TO CONSIST OF A 12 FOOT WIDE COMPACTED CLAY WALL EXTENDING FROM THE BOTTOM CLAY SEAL TO THE CLAY CAP. FOR FURTHER DETAILS REFER TO TEXT PORTION OF REPORT.

FIGURE 17

Drawn By CCM
Developed By SJC
Approved By
Date 1-17-97
Reference
Revisions

SURFICIAL SAND ISOPACH MAP

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

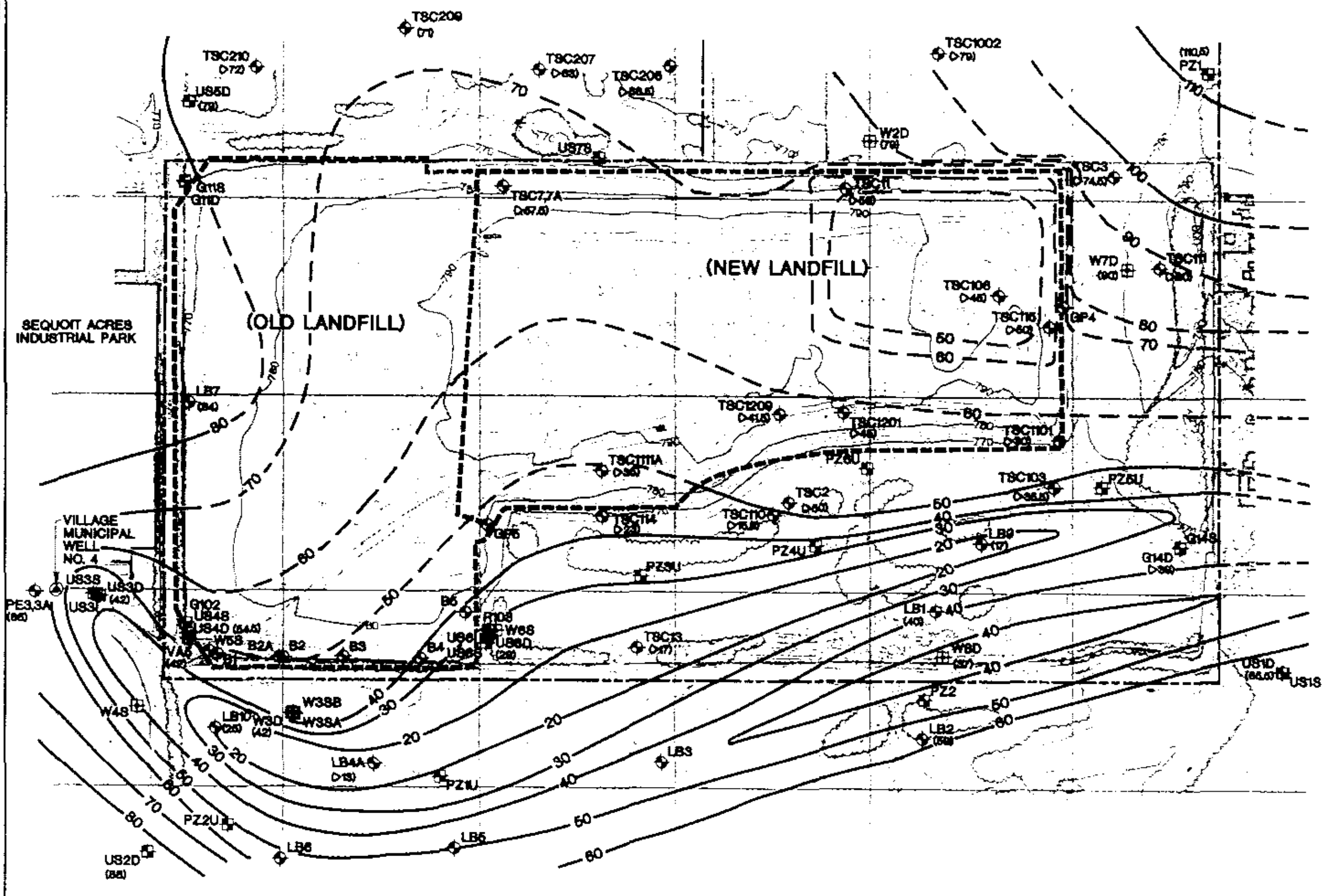
Drawing Number
2386.0096 **B6**

MONTGOMERY WATSON

QUALITY CONTROL
Graphic Standards
Lead Professional
Technical Review
Project Manager
Management Review
Other

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson

QUALITY CONTROL	Graphic Standards CCM 6-21-96	Technical Review	Management Review
	Lead Professional	Project Manager	Other



LEGEND

— - — - —	APPROXIMATE PROPERTY LINE
■ ■ ■ ■	APPROXIMATE LIMITS OF LANDFILLED AREA
- - - 800- - -	TOPOGRAPHIC CONTOUR LINE
	TREES, BRUSH
	ACCESS ROAD
▭	BUILDING
	SPOT ELEVATION
———	FENCE LINE
⊕ W2D (79)	WARZYN MONITORING WELL LOCATION AND NUMBER
◈ VA5	LITIGATION PLAINTIFF SOIL BORING LOCATION AND NUMBER
◈ PE3A	PELA SOIL BORING LOCATION AND NUMBER
◈ LB2	PELA SOIL BORING LOCATION AND NUMBER
—30—	THICKNESS OF CLAY-RICH DIAMICT CONTOUR (CONTOUR INTERVAL 10 FT. DASHED WHERE INFERRED)
(47)	THICKNESS OF CLAY-RICH DIAMICT

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. TOPOGRAPHY IS BASED ON U.S.G.S. DATUM.
3. GRID BASED ON ILLINOIS STATE PLANE COORDINATE SYSTEM.
4. CLAY-RICH DIAMICT ISOPACH MAP WAS DEVELOPED FROM WARZYN'S INTERPRETATION OF LOGS OF SITE SOIL BORINGS AND MONITORING WELLS.
5. CLAY-RICH DIAMICT MAY CONTAIN DISCONTINUOUS LAYERS AND LENSES OF CLAY AND SILT.

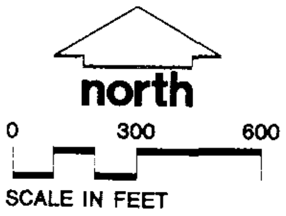


FIGURE 18

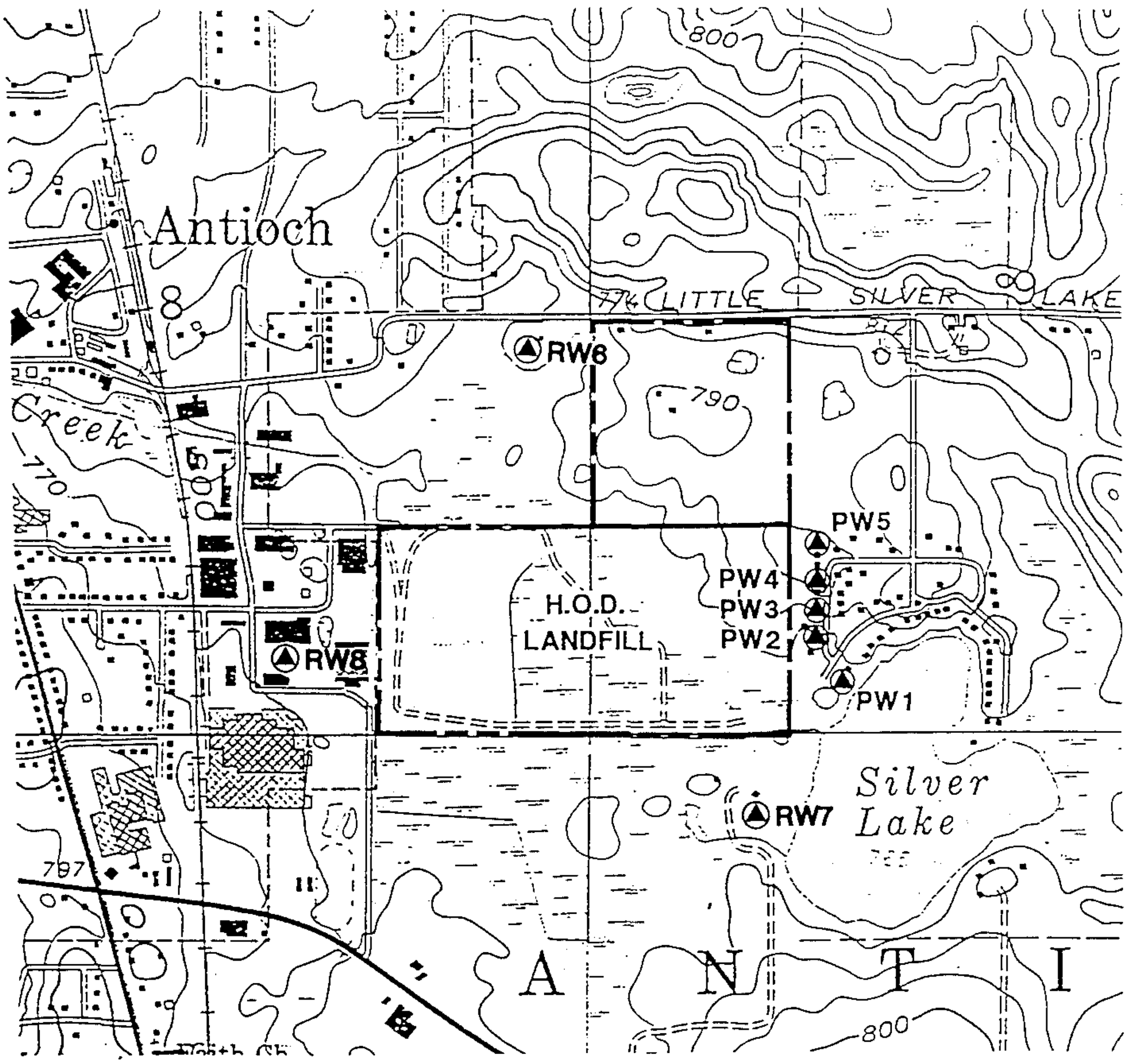
Developed By SJC
Drawn By CCM
Approved By
Date 1-12-97
Reference 10010202/B7
Revisions

CLAY-RICH DIAMICT ISOPACH MAP

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 **B7**

MONTGOMERY WATSON



Management Review ___
Other ___
Tech Review ___
Project Manager ___
Graphic Standards CCM 6-21-96
Lead Professional ___
QUALITY CONTROL

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

LEGEND

▲ **PW1**	PRIVATE WELL SAMPLING LOCATION AND NUMBER
▲ **RW6**	RESIDENTIAL WELL SAMPLED DURING AUGUST 1987 PHASE OF USEPA ESI.

NOTE

1. BASE MAP DEVELOPED FROM THE ANTIOCH, ILLINOIS-WISCONSIN 7.5 MINUTE U.S.G.S. TOPOGRAPHIC QUADRANGLE MAP, DATED 1960, PHOTOREVISED 1972.
2. PW1 THROUGH PW5 CORRESPOND TO RW1 THROUGH RW5 LOCATIONS SAMPLED DURING THE AUGUST 1987 PHASE OF USEPA ESI.

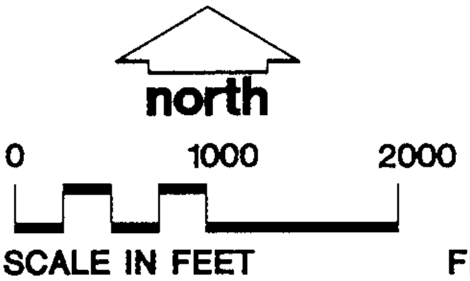


FIGURE 19

Developed By SJC
Drawn By CCM
Approved By
Date 1-17-97
Reference 10010202/A3
Revisions

PRIVATE WATER SUPPLY WELL SAMPLING LOCATIONS

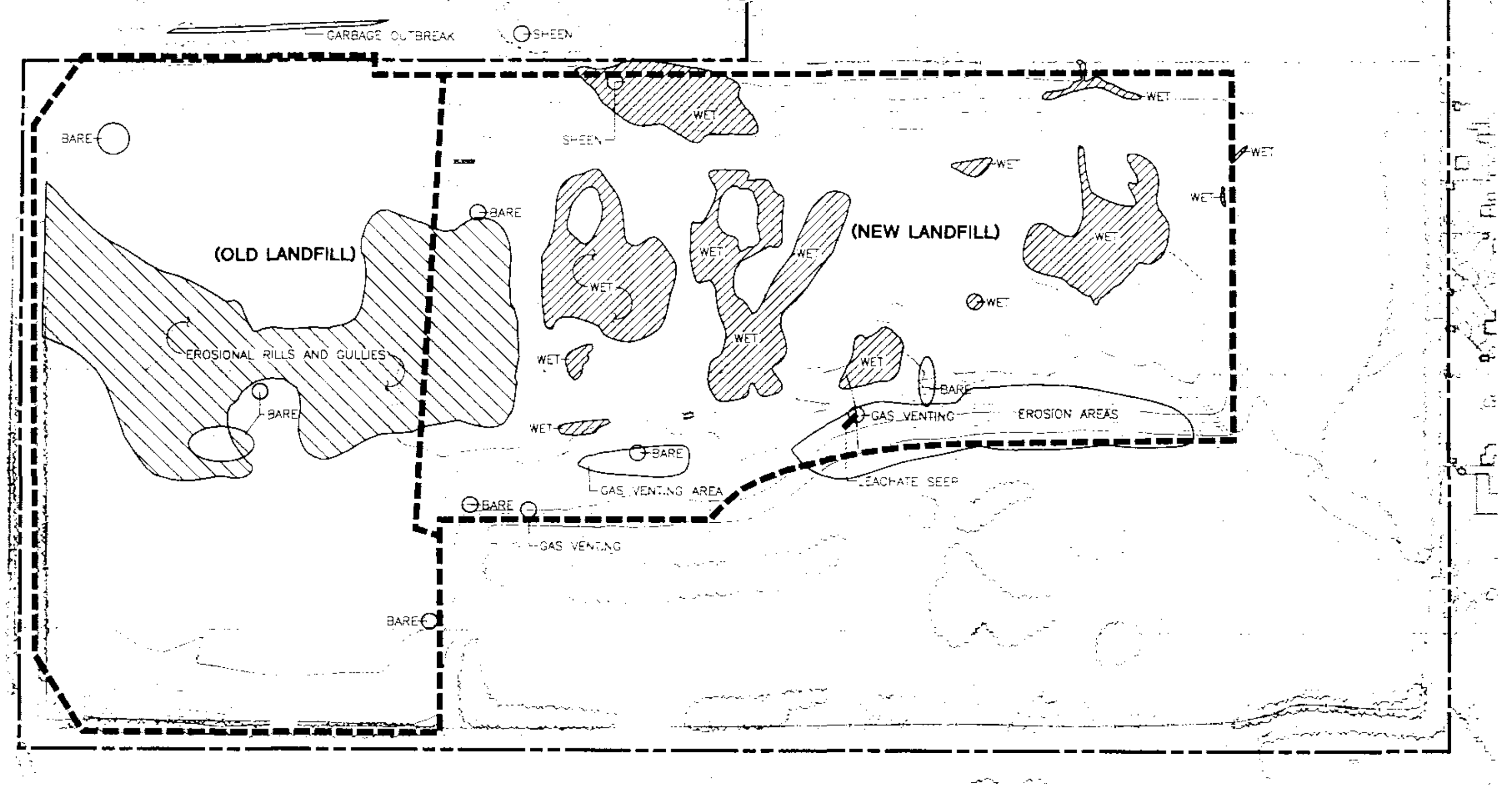
REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 A3

MONTGOMERY WATSON

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson

QUALITY CONTROL		
Graphic Standards	Technical Review	Management Review
Lead Professional	Project Manager	Other



LEGEND

— — —	APPROXIMATE PROPERTY LINE
▬ ▬ ▬	APPROXIMATE LIMITS OF LANDFILLED AREA
- - -	TOPOGRAPHIC CONTOUR LINE
	TREES, BRUSH
	ACCESS ROAD
▭	BUILDING
· · ·	FENCE LINE
○	DOCUMENTED AREAS

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. LANDFILL COVER SURVEY DOCUMENTED BY WARZYN INC. ON MARCH 23 AND 24, 1994.

north

0 200 400
SCALE IN FEET

FIGURE 20

Developed By SJC/CCH
Drawn By CCM
Approved By
Date 1-17-97
Reference
Revisions

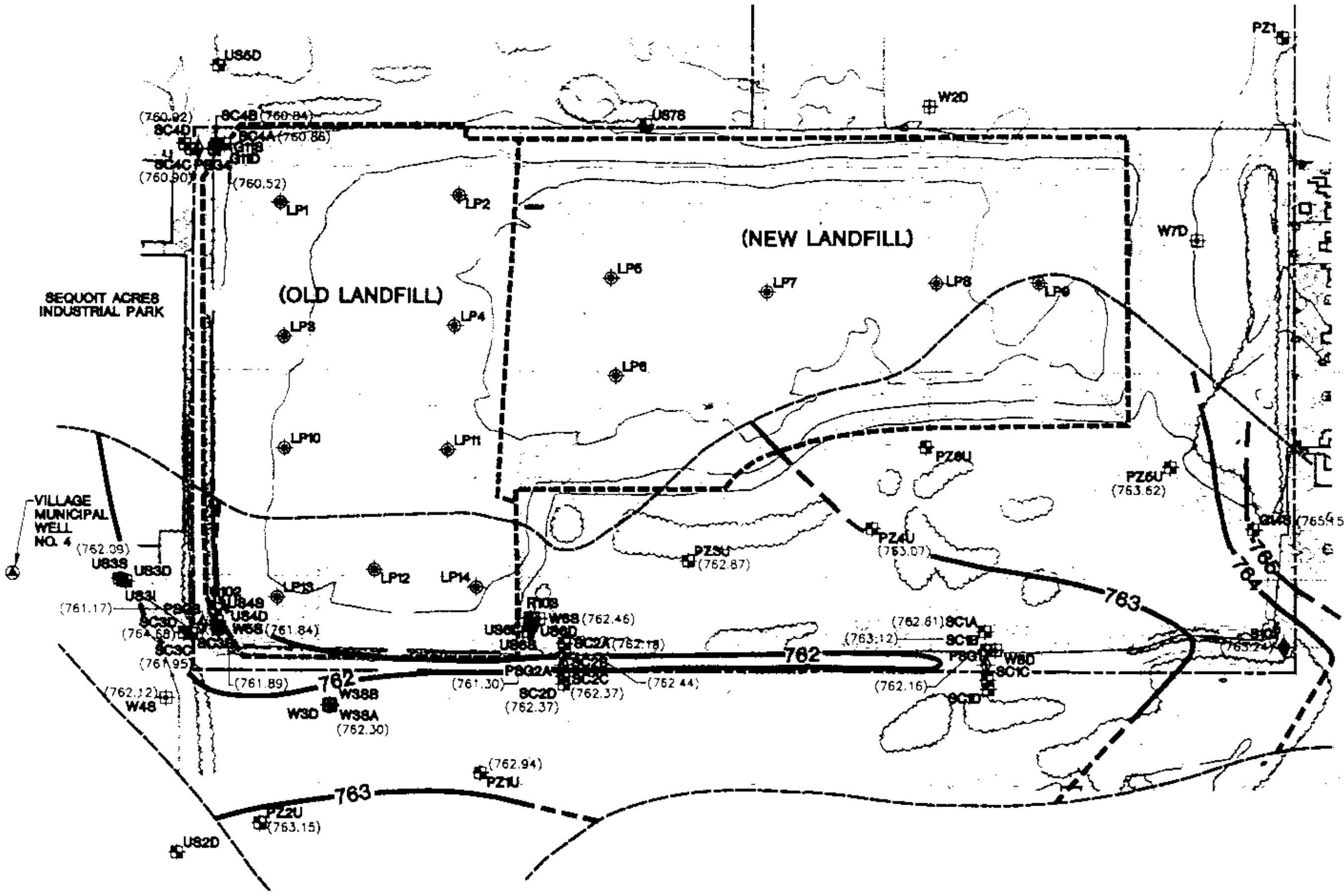
LANDFILL COVER SURVEY MAP
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 **B4**

MONTGOMERY WATSON

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

QUALITY CONTROL		
Graphic Standards	Technical Review	Management Review
Lead Professional	Project Manager	Other



LEGEND

– – – –	APPROXIMATE PROPERTY LINE
■ ■ ■ ■	APPROXIMATE LIMITS OF LANDFILLED AREA
– · –	TOPOGRAPHIC CONTOUR LINE
	TREES, BRUSH
▭	BUILDING
·····×	FENCE LINE
SC1D	PELA STANDPIPE LOCATION AND NUMBER
R103	TSC MONITORING WELL LOCATION AND NUMBER
PZ1U	PELA PIEZOMETER LOCATION AND NUMBER
US4S	USEPA MONITORING WELL LOCATION AND NUMBER
G11S	TSC MONITORING WELL LOCATION AND NUMBER
◇ PSG1	PELA STAFF GAGE LOCATION AND NUMBER
⊞ W7D	WARZYN MONITORING WELL LOCATION AND NUMBER
⊕ LP6	WARZYN LEACHATE PIEZOMETER LOCATION AND NUMBER
◆ S101	SURFACE WATER SAMPLING LOCATION AND NUMBER
——	APPROXIMATE EXTENT OF SURFICIAL SAND
765 ——	WATER TABLE CONTOUR (CONTOUR INTERVAL: 1 FT)
(762.2)	WATER TABLE ELEVATION (FT MEAN SEA LEVEL)

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. LOCATION OF PELA STAFF GAGES PSG1 AND PSG2 ARE APPROXIMATE.

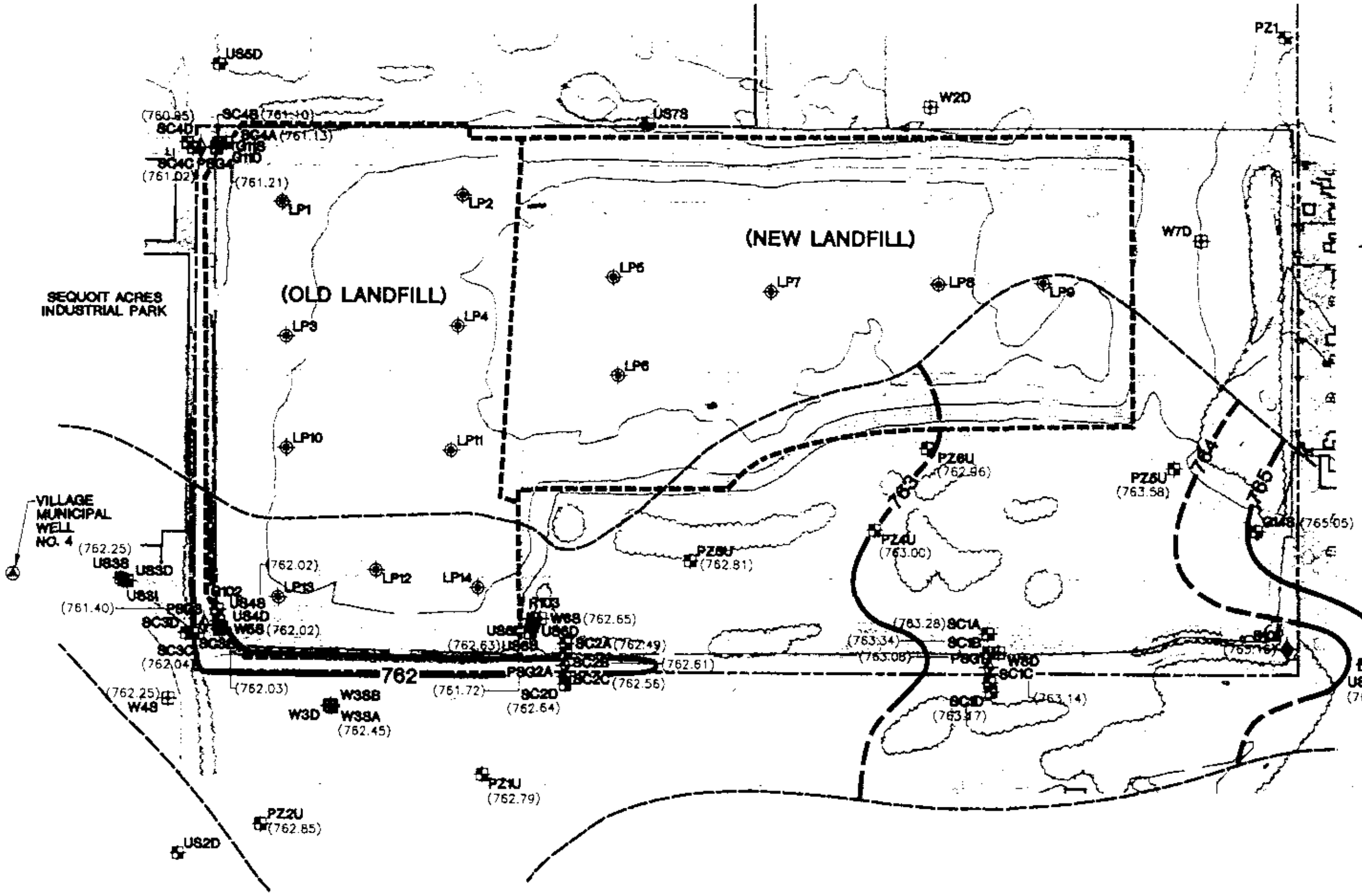
FIGURE 21

SURFICIAL SAND POTENTIOMETRIC SURFACE MAP (JUNE 1993)
REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Developed By SJC	Drawn By CCM
Approved By	Date 1-17-97
Reference	
Revisions	

Drawing Number 2386.0096B16

MONTGOMERY WATSON



LEGEND

— — —	APPROXIMATE PROPERTY LINE
▬ ▬ ▬	APPROXIMATE LIMITS OF LANDFILLED AREA
— · —	TOPOGRAPHIC CONTOUR LINE
◯	TREES, BRUSH
▭	BUILDING
—×—	FENCE LINE
SC1D	PELA STANDPIPE LOCATION AND NUMBER
R103	TSC MONITORING WELL LOCATION AND NUMBER
PZ1U	PELA PIEZOMETER LOCATION AND NUMBER
US4S	USEPA MONITORING WELL LOCATION AND NUMBER
G11S	TSC MONITORING WELL LOCATION AND NUMBER
PSG1	PELA STAFF GAGE LOCATION AND NUMBER
W7D	WARZYN MONITORING WELL LOCATION AND NUMBER
LP8	WARZYN LEACHATE PIEZOMETER LOCATION AND NUMBER
◆ S101	SURFACE WATER SAMPLING LOCATION AND NUMBER
———	APPROXIMATE EXTENT OF SURFICIAL SAND
765 ▬	WATER TABLE CONTOUR (CONTOUR INTERVAL: 1 FT)
(762.2)	WATER TABLE ELEVATION (FT MEAN SEA LEVEL)

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. LOCATION OF PELA STAFF GAGES PSG1 AND PSG2 ARE APPROXIMATE.
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993.

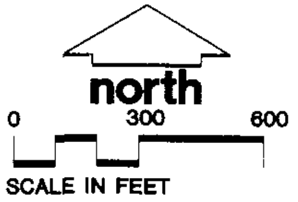


FIGURE 22

SURFICIAL SAND POTENTIOMETRIC SURFACE MAP (MARCH 28, 1994)

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Developed By SJC
Drawn By CCM
Approved By
Date 1.12.9?
Reference
Revisions

Drawing Number
2386.0096 **B2**

MONTGOMERY WATSON

QUALITY CONTROL
Graphic Standards
Lead Professional
Technical Review
Project Manager
Management Review
Other

SOIL LEGEND

A number shows the soil type or a group of undifferentiated soils. A capital letter, A, B, C, D, E, F, or G, shows the slope. W preceding the number shows a wet soil. Most symbols without a slope letter are those of nearly level soils. A final number, 2, after the slope letter indicates an eroded soil.

SYMBOL	NAME
25F	Hennepin loam, 15 to 30 percent slopes
25G	Hennepin loam, 30 to 60 percent slopes
27B	Miami silt loam, 2 to 4 percent slopes
27C	Miami silt loam, 4 to 7 percent slopes
27C2	Miami silt loam, 4 to 7 percent slopes, eroded
27D	Miami silt loam, 7 to 12 percent slopes
27D2	Miami silt loam, 7 to 12 percent slopes, eroded
54	Plainfield sand, slightly acid variant, 1 to 4 percent slopes
57B	Montmorenci silt loam, 2 to 4 percent slopes
57C2	Montmorenci silt loam, 4 to 7 percent slopes, eroded
67	Harpster silty clay loam
93F	Rodman gravelly loam, 15 to 50 percent slopes
W97	Houghton peat, wet
103	Houghton muck
W103	Houghton muck, wet
107	Sawmill silty clay loam
146A	Elliott silt loam, 0 to 2 percent slopes
146B	Elliott silt loam, 2 to 4 percent slopes
153	Pella silty clay loam
189A	Martinton silt loam, 0 to 2 percent slopes
189B	Martinton silt loam, 2 to 4 percent slopes
192A	Del Rey silt loam, 0 to 2 percent slopes
192B	Del Rey silt loam, 2 to 4 percent slopes
194B	Morley silt loam, 2 to 4 percent slopes
194B2	Morley silt loam, 2 to 4 percent slopes, eroded
194C	Morley silt loam, 4 to 7 percent slopes
194C2	Morley silt loam, 4 to 7 percent slopes, eroded
194D	Morley silt loam, 7 to 12 percent slopes
194D2	Morley silt loam, 7 to 12 percent slopes, eroded
194E	Morley silt loam, 12 to 25 percent slopes
194E2	Morley silt loam, 12 to 25 percent slopes, eroded
232	Ashkum silty clay loam
228A	Nappanee silt loam, 0 to 2 percent slopes
228B	Nappanee silt loam, 2 to 4 percent slopes
228C2	Nappanee silt loam, 4 to 7 percent slopes, eroded
298A	Beecher silt loam, 0 to 2 percent slopes
298B	Beecher silt loam, 2 to 4 percent slopes
320A	Frankfort silt loam, 0 to 2 percent slopes
320B	Frankfort silt loam, 2 to 4 percent slopes
323C2	Casco loam, 2 to 10 percent slopes, eroded
325A	Dresden loam, 0 to 2 percent slopes
325B	Dresden loam, 2 to 4 percent slopes
327A	Fox loam, 0 to 2 percent slopes
327B	Fox loam, 2 to 4 percent slopes
327C2	Fox loam, 4 to 7 percent slopes, eroded
327D2	Fox loam, 7 to 12 percent slopes, eroded
330	Peotone silty clay loam
W330	Peotone silty clay loam, wet
365	Aptakisic silt loam
367	Beach sand
370B	Saylesville silt loam, 1 to 4 percent slopes
370C2	Saylesville silt loam, 4 to 7 percent slopes, eroded
442A	Mundelein silt loam, 0 to 2 percent slopes
442B	Mundelein silt loam, 2 to 4 percent slopes
443A	Barrington silt loam, 0 to 2 percent slopes
443B	Barrington silt loam, 2 to 4 percent slopes
465	Montgomery silty clay
490A	Odell silt loam, 0 to 2 percent slopes
490B	Odell silt loam, 2 to 4 percent slopes
495A	Corwin silt loam, 0 to 2 percent slopes
495B	Corwin silt loam, 2 to 4 percent slopes
513	Granby loamy fine sand
531B	Markham silt loam, 1 to 4 percent slopes
531B2	Markham silt loam, 2 to 4 percent slopes, eroded
531C	Markham silt loam, 4 to 7 percent slopes
531C2	Markham silt loam, 4 to 7 percent slopes, eroded
531D2	Markham silt loam, 7 to 12 percent slopes, eroded
696A	Zurich silt loam, 0 to 2 percent slopes
696B	Zurich silt loam, 2 to 4 percent slopes
696C	Zurich silt loam, 4 to 7 percent slopes
696C2	Zurich silt loam, 4 to 7 percent slopes, eroded
696D2	Zurich silt loam, 7 to 15 percent slopes, eroded
697A	Wauconda silt loam, 0 to 2 percent slopes
697B	Wauconda silt loam, 2 to 4 percent slopes
698A	Grays silt loam, 0 to 2 percent slopes
698B	Grays silt loam, 2 to 4 percent slopes
706B	Boyer sandy loam, 1 to 4 percent slopes
706C2	Boyer sandy loam, 4 to 10 percent slopes, eroded
978A	Wauconda and Beecher silt loams, 0 to 2 percent slopes
978B	Wauconda and Beecher silt loams, 2 to 4 percent slopes
979A	Grays and Markham silt loams, 0 to 2 percent slopes
979B	Grays and Markham silt loams, 2 to 4 percent slopes
980B	Zurich and Morley silt loams, 2 to 4 percent slopes
980C2	Zurich and Morley silt loams, 4 to 7 percent slopes, eroded
981A	Wauconda and Frankfort silt loams, 0 to 2 percent slopes
981B	Wauconda and Frankfort silt loams, 2 to 4 percent slopes
982A	Aptakisic and Nappanee silt loams, 0 to 2 percent slopes
982B	Aptakisic and Nappanee silt loams, 2 to 4 percent slopes
983B	Zurich and Nappanee silt loams, 2 to 4 percent slopes
984B	Barrington and Varna silt loams, 2 to 4 percent slopes
999A	Mundelein and Elliott silt loams, 0 to 2 percent slopes
999B	Mundelein and Elliott silt loams, 2 to 4 percent slopes
BA	Borrow area
GP	Gravel pits
MA	Marsh
ML	Made land

NOTES

1. SCS SOILS MAP WAS OBTAINED FROM THE SOIL SURVEY OF LAKE COUNTY, ILLINOIS, DATED SEPTEMBER 1970.

north

0 1000 2000

SCALE IN FEET (APPROX.

FIGURE 23

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson

QUALITY CONTROL | Graphic Standards | Lead Professional | Technical Review | Project Manager | Management Review | Other

Developed By SJC
Drawn By CCM
Approved By
Date 1-17-97
Reference
Revisions

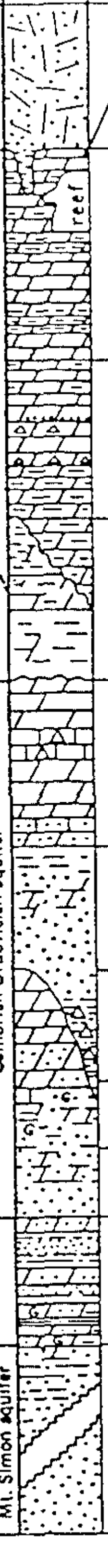
SURFICIAL SOILS MAP

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 **B17**

MONTGOMERY WATSON

Q. CONTROL
Graphic Standards
Lead Professional
Tech Review
Project Manager
Management Review
Other



SYSTEM	SERIES	GROUP OR FORMATION	AQUIFER		THICKNESS (FT)	DESCRIPTION
QUATERNARY	PLEISTOCENE		Sands and Gravels		90-325	Unconsolidated glacial deposits-pebbly clay (till), silt, sand and gravel Alluvial silts and sands along streams
					Fissure Fillings	Shale, sandy, brown to black
SILURIAN	NIAGARAN	Racine	Silurian	Shallow dolomite aquifer	0-180	Dolomite, very pure to argillaceous, silty, cherty; reefs in upper part
		Sugar Run				Dolomite, slightly argillaceous and silty
		Joliet				Dolomite, very pure to shaly and shale, dolomitic; white, light gray, green, pink, maroon
	ALEXANDRIAN	Kankakee			0-90	Dolomite, pure top 1'-2', thin green shale partings, base glauconitic
		Elwood				Dolomite, slightly argillaceous, abundant layered white chert
		Wilhelmi				Dolomite, gray, argillaceous and becomes dolomitic shale at base
ORDOVICIAN	CINCINNATIAN	Maquoketa			100-240	Shale, red; oolites Shale, silty, dolomitic, greenish gray, weak (Upper unit) Dolomite and limestone, white, light gray, interbedded shale (Middle unit) Shale, dolomitic, brown, gray (Lower unit)
	CHAMPLAINIAN	Galena	Galena-Platteville	Cambrian-Ordovician aquifer	270-335	Dolomite, and/or limestone, cherty (Lower part) Dolomite, shale partings, speckled Dolomite and/or limestone, cherty, sandy at base
		Platteville				
		Glenwood	Glenwood-St. Peter		165-300	Sandstone, fine and coarse grained; little dolomite; shale at top Sandstone, fine to medium grained; locally cherty red shale at base
		St. Peter				
CAMBRIAN	CROIXAN	Eminence	Eminence-Potosi		0-100	Dolomite, light colored, sandy, thin sandstones
		Potosi				Dolomite, fine-grained, gray to brown, drusy quartz
		Franconia	Franconia		40-80	Dolomite, sandstone and shale, glauconitic, green to red, micaceous
		Ironton	Ironton-Galesville		100-190	Sandstone, fine to coarse grained, well sorted; upper part dolomitic
		Galesville				
		Eau Claire			385-475	Shale and siltstone, dolomitic, glauconitic; sandstone, dolomitic, glauconitic
		Elmhurst Member	Elmhurst-Mt. Simon	Elmhurst-Mt. Simon aquifer	1200-2000	Sandstone, coarse grained, white, red in lower half; lenses of shale and siltstone, red, micaceous
		Mt. Simon				
PRE-CAMBRIAN						Granitic Rocks

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

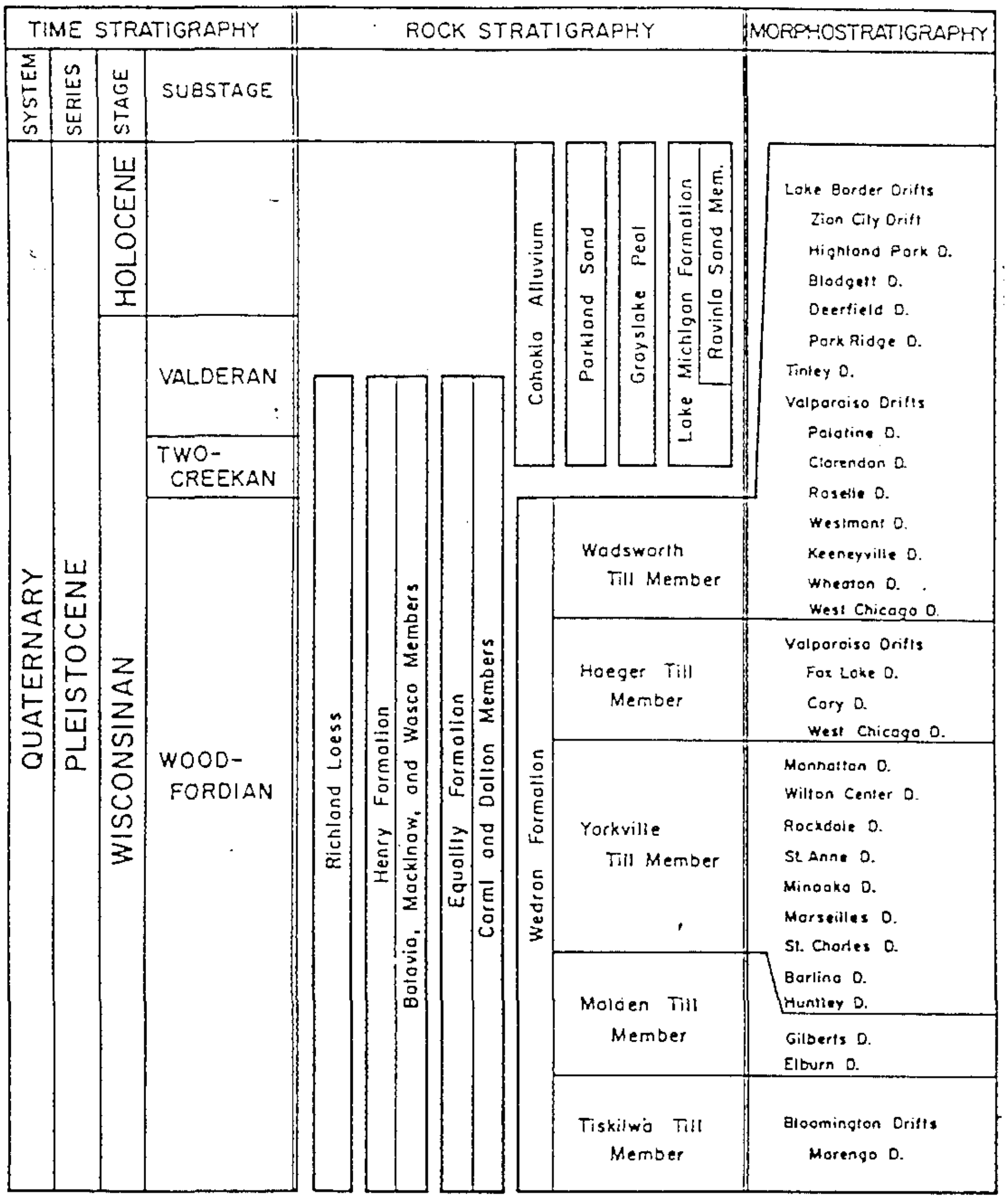
NOTE

STRATIGRAPHIC COLUMN ADAPTED FROM PUBLIC GROUNDWATER SUPPLIES IN LAKE COUNTY, ILLINOIS. STATE WATER SURVEY, URBANA, ILLINOIS BY DOROTHY M. WOLLER AND JAMES P. GIBB, 1976.

FIGURE 24

Developed By SJC	Drawn By CCM	**STRATIGRAPHIC COLUMN FOR NORTHEASTERN ILLINOIS**	Drawing Number 2386.0096 A4
Approved By	Date 1-17-97	REMEDIAL INVESTIGATION H.O.D. LANDFILL WASTE MANAGEMENT OF ILLINOIS, INC. ANTIOCH, ILLINOIS	**MONTGOMERY WATSON**
Reference			
Revisions			

ITY ROL | Graphic Standards | Lead Professional | Te. ıl Review | Pro, . Manager | Management Review | Other



NOTE

STRATIGRAPHIC COLUMN TAKEN FROM SUMMARY OF THE GEOLOGY OF THE CHICAGO AREA. ILLINOIS STATE GEOLOGICAL SURVEY CIRCULAR 460 BY H.B. WILLMAN.

FIGURE 25

Developed By SJC
Drawn By CCM
Approved By Dlfg L Ct
Date 1-17-97
Reference
Revisions

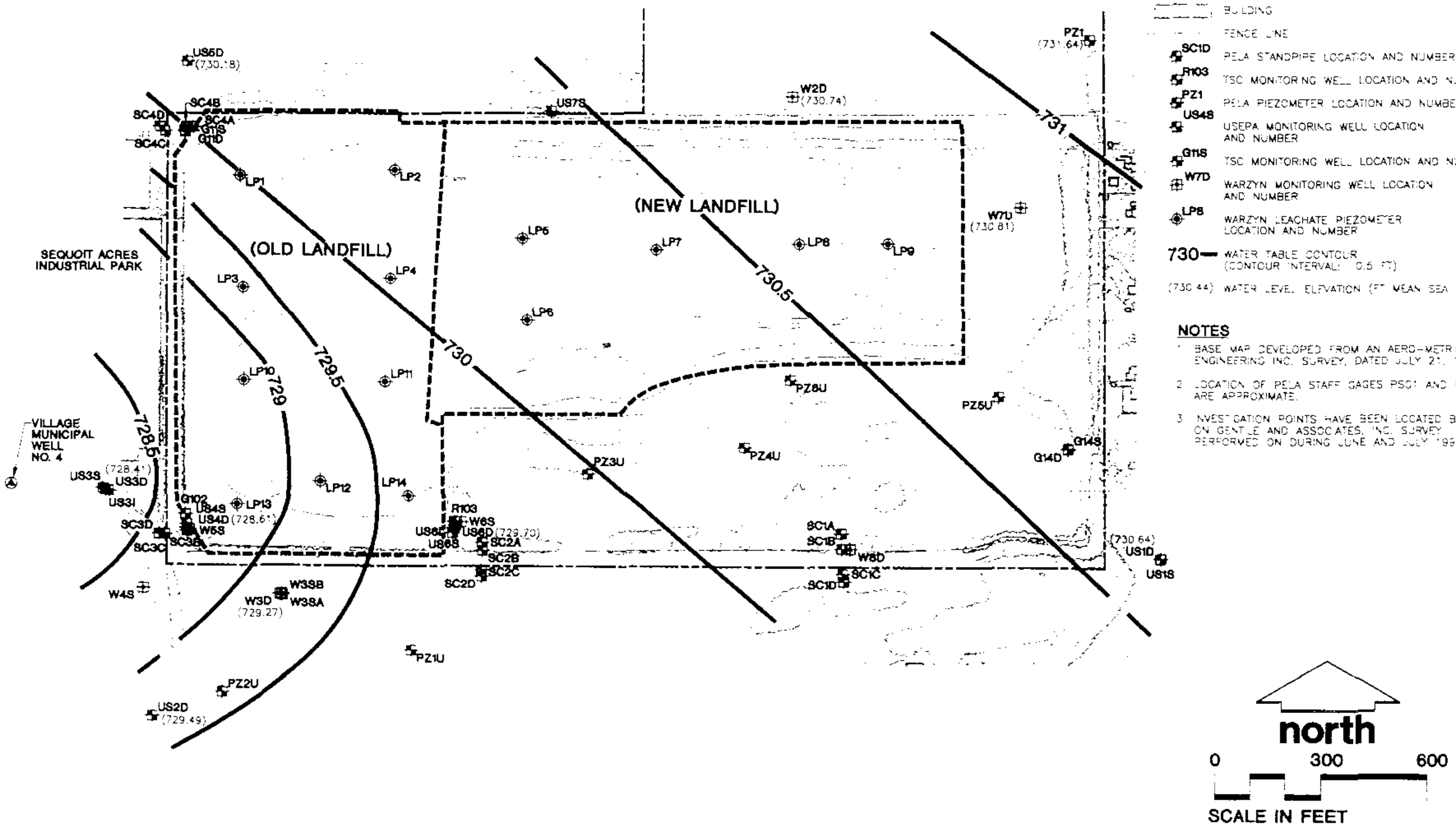
PLEISTOCENE STRATIGRAPHIC COLUMN FOR CHICAGO AREA

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 A5

MONTGOMERY WATSON

QUALITY CONTROL
Graphic Standards
Lead Professional
Technical Review
Project Manager
Management Review
Other



LEGEND

APPROXIMATE PROPERTY LINE
APPROXIMATE LIMITS OF LANDFILLED AREA
TOPOGRAPHIC CONTOUR LINE
TREES, BRUSH
BUILDING
FENCE LINE
SC1D PELA STANDPIPE LOCATION AND NUMBER
R103 TSC MONITORING WELL LOCATION AND NUMBER
PZ1 PELA PIEZOMETER LOCATION AND NUMBER
US4S USEPA MONITORING WELL LOCATION AND NUMBER
G11S TSC MONITORING WELL LOCATION AND NUMBER
W7D WARZYN MONITORING WELL LOCATION AND NUMBER
LP8 WARZYN LEACHATE PIEZOMETER LOCATION AND NUMBER
730 WATER TABLE CONTOUR (CONTOUR INTERVAL: 0.5 FT)
(730.44) WATER LEVEL ELEVATION (FT MEAN SEA LEVEL)

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993
2. LOCATION OF PELA STAFF GAGES PSG1 AND PSG2 ARE APPROXIMATE.
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993

FIGURE 26

Drawn By CCM
Date 1/12/97
Developed By SJC
Approved By
Reference
Revisions

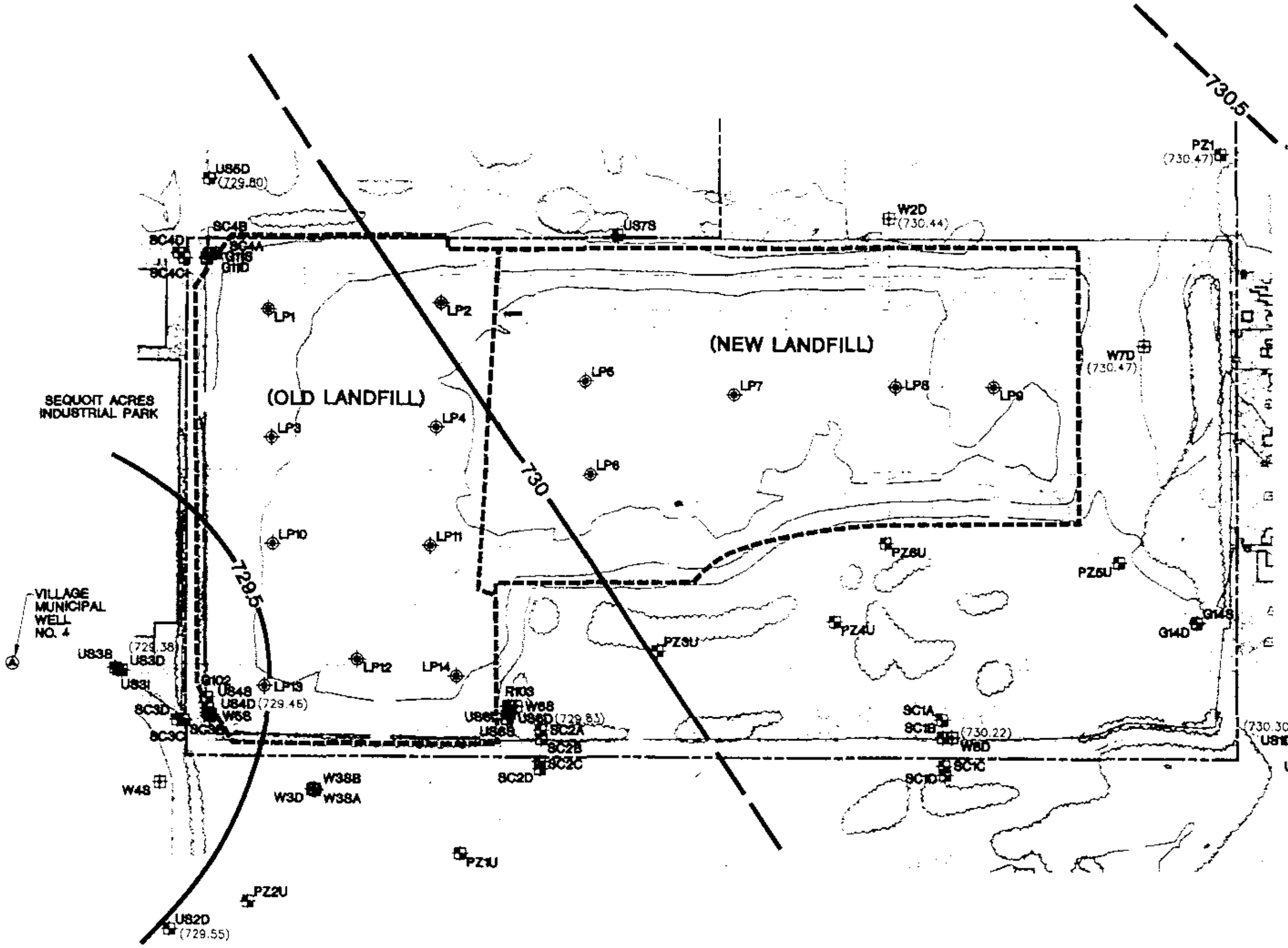
DEEP SAND AND GRAVEL POTENTIOMETRIC SURFACE MAP (JUNE 1993)
REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096B18

MONTGOMERY WATSON

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

QUALITY CONTROL		
Graphic Standards	Technical Review	Management Review
Lead Professional	Project Manager	Other



LEGEND

▬ ▬ ▬	APPROXIMATE PROPERTY LINE
■■■■■	APPROXIMATE LIMITS OF LANDFILLED AREA
— — —	TOPOGRAPHIC CONTOUR LINE
◯	TREES, BRUSH
▭	BUILDING
———	FENCE LINE
⊞ SC1D	PELA STANDPIPE LOCATION AND NUMBER
⊞ R103	TSC MONITORING WELL LOCATION AND NUMBER
⊞ PZ1	PELA PIEZOMETER LOCATION AND NUMBER
⊞ US4S	USEPA MONITORING WELL LOCATION AND NUMBER
⊞ G11S	TSC MONITORING WELL LOCATION AND NUMBER
⊞ W7D	WARZYN MONITORING WELL LOCATION AND NUMBER
⊕ LP6	WARZYN LEACHATE PIEZOMETER LOCATION AND NUMBER
730 ▬	WATER TABLE CONTOUR (CONTOUR INTERVAL: 0.5 FT)
(730.44)	WATER LEVEL ELEVATION (FT MEAN SEA LEVEL)

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. LOCATION OF PELA STAFF GAGES PSG1 AND PSG2 ARE APPROXIMATE.
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993.

north

0 300 600

SCALE IN FEET

FIGURE 27

Developed By SJC
Drawn By CCM
Approved By
Date 1-7-97
Reference
Revisions

DEEP SAND AND GRAVEL POTENTIOMETRIC SURFACE MAP (MARCH 28, 1994)

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 **B3**

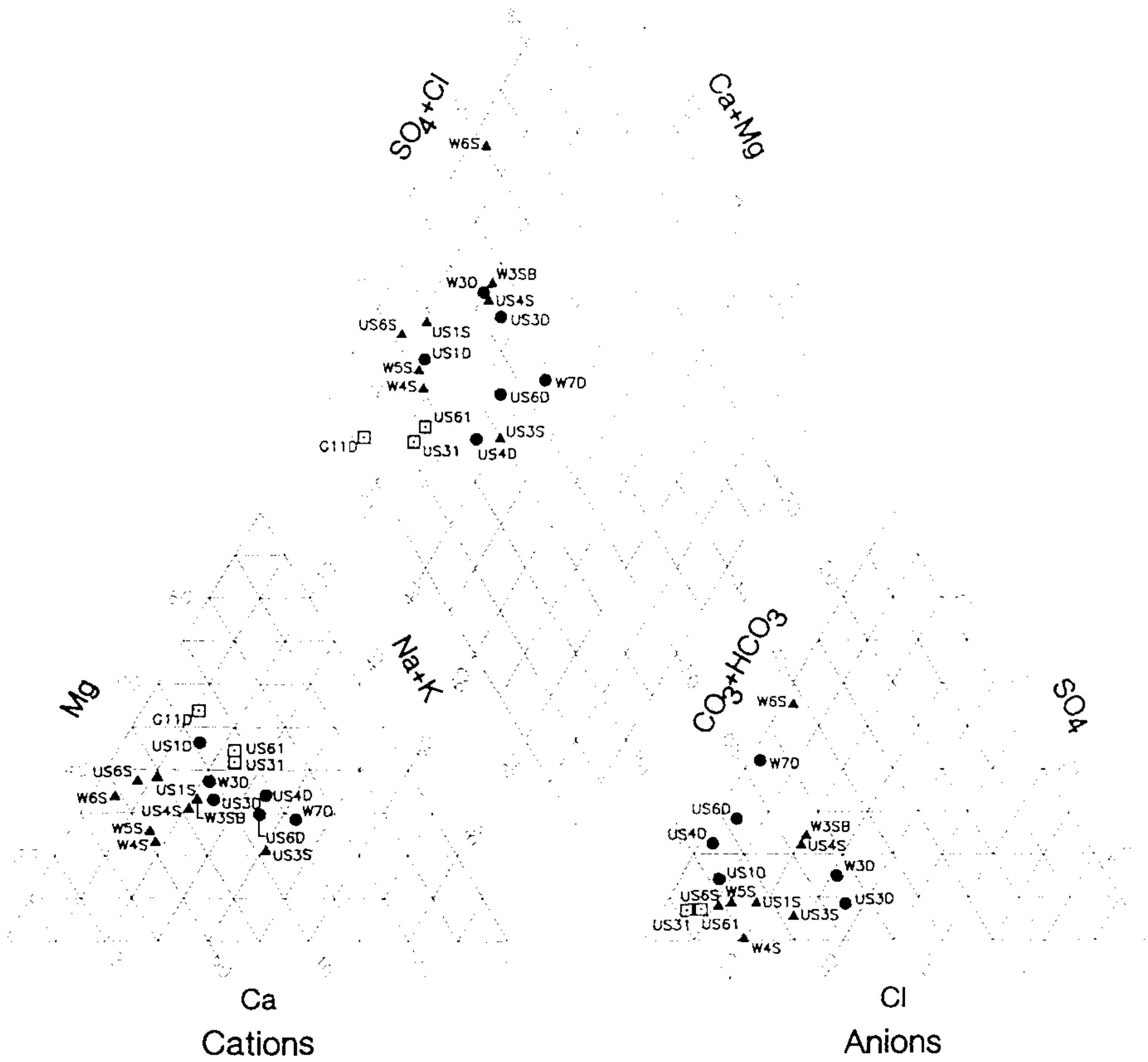
MONTGOMERY WATSON

Management Review ______
Other ______

Tech. Review ______
Project Manager ______

Graphic Standards ______
Lead Professional ______

...TY CONTROL



LEGEND

● US1D	DEEP SAND AND GRAVEL AQUIFER SAMPLES
▲ W4S	SHALLOW SAND AND GRAVEL GROUNDWATER SAMPLES
⊡ US61	INTERMEDIATE CLAY TILL GROUNDWATER SAMPLES

NOTE

PLOTTED CONCENTRATIONS IN MILLIEQUIVALENTS PER LITER (meq/l).

FIGURE 28

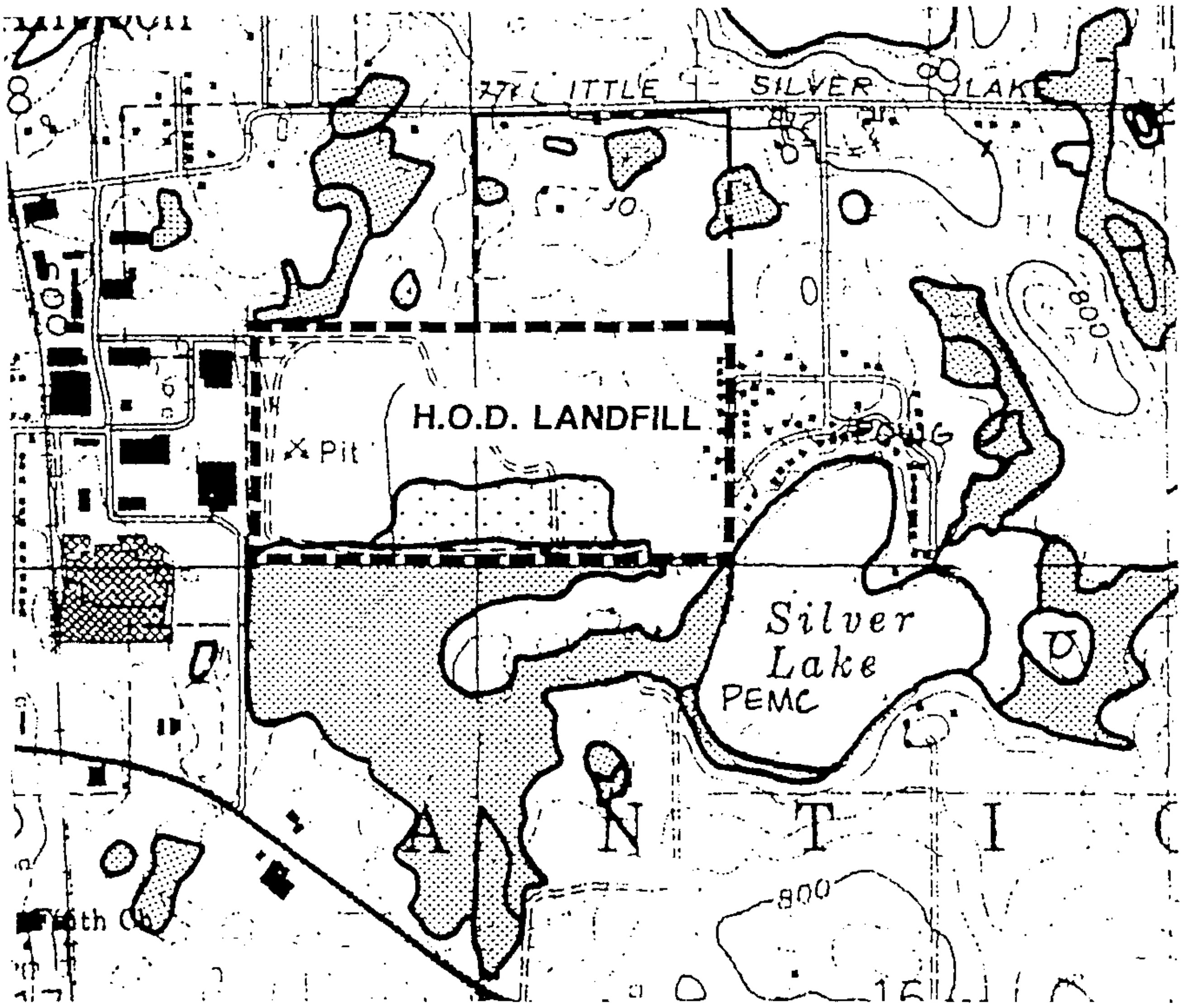
Developed By SJC
Drawn By CCM
Approved By
Date 1-7-97
Reference
Revisions

GROUNDWATER PIPER DIAGRAM

H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number
2386.0096 A6

MONTGOMERY WATSON



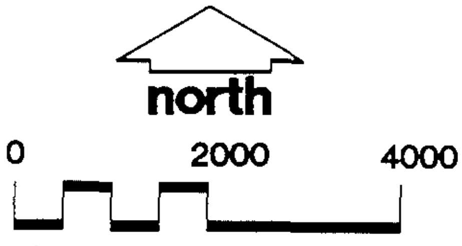
LEGEND

░ SEASONAL WETLAND 1, 2

▒ WETLAND 1, 2

NOTES

1. BASE MAP DEVELOPED FROM THE ANTIOCH, ILLINOIS 7.5 MINUTE U.S.G.S. TOPOGRAPHIC QUADRANGLE MAP, DATED 1960, PHOTOREVISED 1972.
2. WETLAND AREAS IDENTIFIED BY ANALYSIS OF HIGH ALTITUDE AERIAL PHOTOGRAPHY. AREAS HAVE NOT BEEN FIELD VERIFIED.



SCALE IN FEET

FIGURE 29

Developed By PMS
Drawn By CCM
Approved By Rlyht
Date 1-17-97
Reference
Revisions

WETLANDS INVENTORY MAP

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

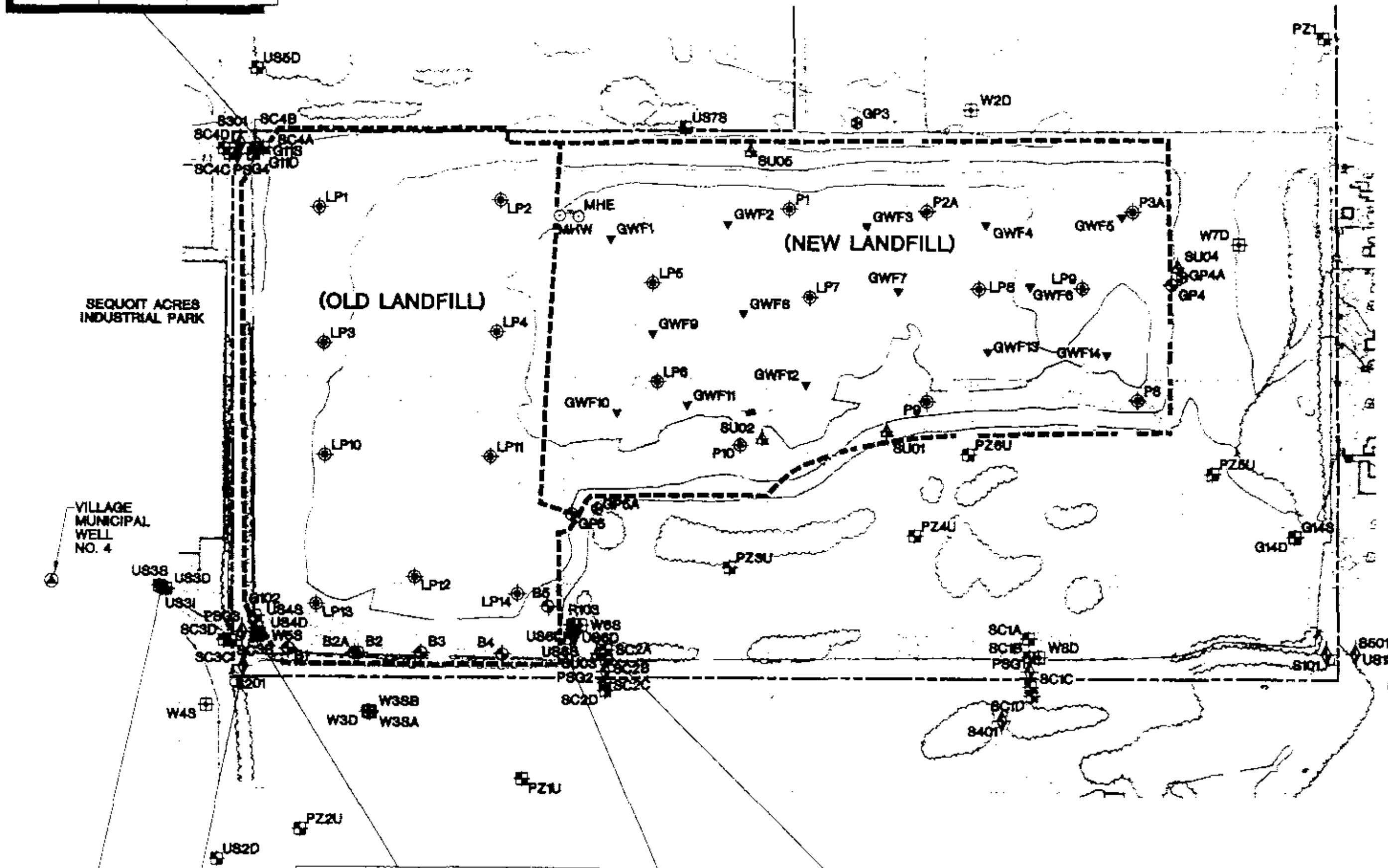
Drawing Number
2386.0096 **A7**

MONTGOMERY WATSON

Q..Y CONTROL
Graphic Standards CCM 12-19-96
Lead Professional
Tech. Review
Project Manager
Management Review
Other

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

G11S	ROUND 1	ROUND 2
CARBON DISULFIDE	0.8	18



W5S	ROUND 1	ROUND 2
VINYL CHLORIDE	19	ND

W6S	ROUND 1	ROUND 2
1,2 DICHLORO-ETHENE	2	ND

US4S	ROUND 1	ROUND 2
1,2 DICHLORO-ETHENE (TOTAL)	35	44

US6I	ROUND 1	ROUND 2
TRICHLOROETHENE	2	1

US3D	ROUND 1	ROUND 2
1,2 DICHLORO-ETHENE	11	18
VINYL CHLORIDE	28	35

LEGEND

━ ━ ━	APPROXIMATE PROPERTY LINE
▬ ▬ ▬	APPROXIMATE LIMITS OF LANDFILLED AREA
- - —	TOPOGRAPHIC CONTOUR LINE
	TREES, BRUSH
	BUILDING
—x—	FENCE LINE
SC1D	PELA STANDPIPE LOCATION AND NUMBER
R103	TSC MONITORING WELL LOCATION AND NUMBER
PZ1U	PELA PIEZOMETER LOCATION AND NUMBER
US4S	USEPA MONITORING WELL LOCATION AND NUMBER
G11S	TSC MONITORING WELL LOCATION AND NUMBER
S201	SURFACE WATER/SEDIMENT SAMPLING LOCATION AND NUMBER
PSG1	PELA STAFF GAGE LOCATION AND NUMBER
W7D	WARZYN MONITORING WELL LOCATION AND NUMBER
LP6	WARZYN LEACHATE PIEZOMETER LOCATION AND NUMBER
SU01	WARZYN SURFACE SOIL SAMPLING LOCATION AND NUMBER
GP5A	WARZYN GAS PROBE LOCATION AND NUMBER
B1/GP5	WARZYN SOIL BORING LOCATION AND NUMBER
○ MHW/ MHE	LEACHATE COLLECTION MANHOLE WEST/ LEACHATE COLLECTION MANHOLE EAST
▼ GWF1	GAS FLARE LOCATION AND NUMBER
P2A	LEACHATE EXTRACTION WELL LOCATION AND NUMBER

NOTES

1. BASE MAP DEVELOPED FROM AN AERO-METRIC ENGINEERING INC. SURVEY, DATED JULY 21, 1993.
2. LOCATION OF PELA STAFF GAGES PSG1 AND PSG2 ARE APPROXIMATE.
3. INVESTIGATION POINTS HAVE BEEN LOCATED BASED ON GENTILE AND ASSOCIATES, INC. SURVEY PERFORMED ON DURING JUNE AND JULY 1993.
4. CONCENTRATIONS IN ug/L.
5. ROUND I AND II GROUNDWATER SAMPLING LOCATIONS ARE LISTED IN SECTIONS 2.9.1 AND 2.10.4, RESPECTIVELY.

north

0 300 600

SCALE IN FEET

FIGURE 30

Drawn By CCM

Date 1/12/97

Developed By SJC

Approved By

Reference 10010202/B19

Revisions

ROUND I/ROUND II GROUNDWATER VOC CONCENTRATIONS (ug/L)

REMEDIAL INVESTIGATION
H.O.D. LANDFILL
WASTE MANAGEMENT OF ILLINOIS, INC.
ANTIOCH, ILLINOIS

Drawing Number 2386.0096**B19**

MONTGOMERY WATSON

QUALITY CONTROL

Graphic Standards CCM

Lead Professional

6-21-96

Technical Review

Project Manager

Management Review

Other

This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.