REMEDIAL INVESTIGATION/FEASIBILITY STUDY VOLNEY LANDFILL, TOWN OF VOLNEY, OSWEGO COUNTY, NEW YORK

Prepared for :

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

50 Wolf Road, Albany, New York 12233

Henry G. Williams, Commissioner

DIVISION OF SOLID AND HAZARDOUS WASTE

Norman H. Nosenchuck, P.E. - Director

URS Company, Inc.
570 Delaware Avenue
Buffalo, New York 14202

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622

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EXECUTIVE SUMMARY

PART I - REMEDIAL INVESTIGATION

The Volney Landfill site is located northwest of the intersection of Howard and Silk Roads in a rural area in the Town of Volney, Oswego County, New York. The 85-acre site, of which 55 acres are inactive landfill on which closure operations have recently been completed, is approximately 2 miles northeast of the City of Fulton and 10 miles southeast of Lake Ontario. The landfill has a relatively flat top, moderately steep side slopes, and rises approximately 50 feet above the surrounding terrain. Bell Creek flows near the site and wetlands extend along the area adjacent to the landfill. A few residences, including a trailer park, are in the vicinity.

From 1969 through 1983, the landfill was operated primarily as a facility for the disposal of residential, commercial and light industrial wastes. However, between 1974 and 1975 the landfill allegedly accepted approximately 8,000 barrels containing the residues of chemical sludges from Pollution Abatement Services, Inc. (PAS), a hazardous waste disposal site in the City of Oswego, New York. Additionally, some of these barrels contained liquid waste which was incorporated into the fill. From the mid-1970's through 1986, leachate collection systems were installed and several methods to treat collected leachate were implemented. During this period, several investigations involving water quality sampling and analyses were conducted. Although early programs were limited in extent, there have been a number of more detailed hydrogeologic investigations of the landfill over the past several years.

The primary purpose of this investigation was to define the existing geologic and hydrologic conditions at the site, identify the extent of contamination and modes of contaminant transport, and evaluate the potential impact of the site upon public health and the environment. Accomplishment of these objectives involved completion of the following:

- review and evaluation of existing data and information concerning the site

- development of Health/Safety and Work/Quality Assurance Plans prior to the initiation of on-site activities

- development of a topographic base map of the site, including all field-data points

- performance of detailed geophysical studies of the site using the techniques of terrain conductivity, electrical resistivity and seismic refraction

- installation of soil borings and groundwater monitoring wells on-site and in the surrounding area, including both overburden and bedrock wells

- performance of slug tests in the monitoring wells to determine hydraulic conductivities

- performance of organic vapor screening tests on soil samples obtained during boring operations to determine the vertical extent of soil contamination

- collection of soil samples from the borings for detailed laboratory analyses on physical properties

- collection of water level measurements in monitoring wells and stream water to determine horizontal flow directions and vertical hydraulic gradients

- collection of groundwater samples from monitoring wells for field measurements and detailed laboratory chemical analyses

- collection of stream water and sediment samples along Bell Creek and Black Creek tributaries for field measurements (stream water only) and detailed laboratory chemical analyses

- collection of one leachate sample on-site for field measurements and detailed laboratory chemical analyses.

The information obtained during the field investigations was used to characterize the geology and hydrology of the Volney Landfill site and to assess contamination on, and originating from, the site, and evaluate potential impacts upon public health and the environment.

The geomorphic setting of the region in which the site is located consists of gently rolling hills and intervening flatlands. The subsurface geology includes gently dipping clastic sedimentary rocks of Lower Paleozic Age, overlain by 4 generalized overburden stratigraphic units, largely composed of glacial deposits, and a layer of artificial fill at the surface. The generalized stratigraphic sequence of overburden units from the top of bedrock to the ground surface includes: lodgement till, glaciolacustrine fine sand and silt, reworked sand and gravel, alluvium and swamp, and artificial fill. The lodgement till unit is a compact, relatively impermeable layer (typically $6.7x10^{-5}$ cm/sec), which continuously underlies the site.

Groundwater flow systems were evaluated in both the horizontal and vertical directions. Underlying the site is a shallow, unconfined aquifer, comprised of various unconsolidated units overlying lodgement till, which has a water table configuration closely related to surface topography. A large portion of this upper flow system is directed eastward from the landfill toward Bell Creek. The southwest portion of the landfill drains into the Black Creek tributaries. Vertical hydraulic gradients were found to be highly variable, which may be attributed to groundwater mounding at the site and recent site capping.

Contamination was assessed using organic vapor readings and detailed laboratory chemical analyses for the Hazardous Substance List (HSL) and other compounds. Above-ambient organic vapor readings, which may indicate soil or groundwater contamination, were detected in soil samples from both shallow and deep borings. Groundwater analyses detected a variety of volatile and semi-volatile HSL compounds, although in general, concentrations at the time this study was conducted were low, and not substantially different from those which have been observed in previously reported investigations of hazardous substances occurring at municipal landfills. No pesticides, PCB's or cyanide were detected. Groundwater contamination has been detected around the perimeter of the site, and appears to have permeated lodgement till and reached the bedrock aquifer. Surface water analyses detected a variety of HSL compounds, although in general, in lesser concentrations and fewer numbers than groundwater samples. Similarly, no pesticides, PCB's or cyanide were detected in any of the surface water samples. Although surface water quality adjacent to and downstream from the landfill indicates that the site may be contributing to the low levels of surface water contamination, the data also suggests a probable contaminant source on Bell Creek upstream from and unrelated to the Volney Landfill. Analyses performed on stream sediments generally found fewer numbers of HSL compounds, but in greater concentrations than detected in groundwater and surface water samples. Additionally, one PCB compound was detected in sediment in a downstream direction from the site. Cyanide was detected in all sediment samples.

The primary potential impact of the Volney Landfill appears to be upon surface water and groundwater related activities at and downgradient from the site, involving both human and aquatic life. Since the site has been capped, the possibility of direct contact with waste materials is minimum. Groundwater contamination at the landfill, which could potentially affect an estimated 25 local residences dependant on private water wells, is generally low-level, although groundwater standards were exceeded in a few of the monitoring wells sampled during this study. The existence of several municipal supply well fields, located approximately 20 miles downstream from the site on the Oswego River, is considered insignificant, since surface water contamination, already at a low level adjacent to the landfill, is lessened considerably by the natural dilution of contaminants with distance within the stream system.

A baseline health risk assessment was performed to determine the present levels of public health risk associated with groundwater contamination in the vicinity of the Volney Landfill. Available analytical data from residential wells near the site does not indicate any present health risk associated with toxic or carcinogenic chemicals. On the other hand, monitoring well data, to the extent which it can be extropolated as an indicator of residential well quality, suggests that there is some potential health risk associated with toxic chemicals (manganese, methyl ethyl ketone and phenol), but a more clearly definable risk related to carcinogenic chemicals (benzene, vinyl chloride and arsenic).

The New York State Department of Environmental Conservation (NYSDEC) designated wetlands located downstream from the site provide a haven for fish, waterfowl and birds migrating through the area. The low levels of surface water contamination observed during this study are not considered a significant threat to the wetland ecosystems. Contaminated stream sediments, however, which are transported and deposited throughout the stream system as a result of flooding events, may pose a significantly greater risk to the wetland ecosystems downgradient from the site.

PART II - FEASIBILITY STUDY

In order to facilitate the evaluation of remedial alternatives, a simplified analytical model of the Volney Landfill was developed. This model provides a water balance of the site, and indicates the relative magnitudes of infiltration into the landfill, seepage through underlying lodgement till, and lateral groundwater flow away from the site. The values generated by this water balance, particularly the rate of lateral groundwater flow, were used to estimate the location, configuration and size of remedial measures.

Based upon the evaluation of public health and environmental impacts at the site, the primary objective of remedial action was determined to be the mitigation of local, shallow groundwater contamination. Objectives not addressed in this study, primarily due to lack of sufficient detailed information, were the evaluation/remediation of bedrock contamination and the cleanup of stream ecosystems at and downstream from the site. Both of these issues, which are related to the potential need for further off-site remedial actions in addition to the source control actions considered in this study, are recommended for further evaluation as part of a supplemental Remedial Investigation/Feasibility Study.

A formal screening process was used to develop a list of final remedial alternatives for detailed evaluation. This screening consisted of the following steps:

(1) A technical screening was performed, using site conditions and project objectives, to identify individual remedial technologies considered appropriate at the Volney Landfill site. A total of eight (8) technologies were so identified.

(2) Using logical relationships between these technologies to limit the way in which they can be combined, a total of 12 preliminary remedial alternatives were developed from this list of appropriate technologies.

(3) These 12 preliminary alternatives were subsequently divided into six (6) categories, reflecting Superfund Amendments and Reauthorization Act (SARA) guidelines and relative levels of risk reduction.

(4) A preliminary alternative screening was performed for the purpose of resolving two (2) specific questions, and thereby further reducing the number of alternatives. The resolution of these questions was as follows:

- On-site leachate treatment was determined to be, under given assumptions, more cost-effective than off-site leachate disposal at a local publicly owned treatment works (POTW). However, because of uncertainty regarding these assumptions, and the need for a treatability study to confirm the feasibility and economics of on-site treatment, both technologies were carried forward.

- A slurry wall, used in conjunction with a perimeter leachate collection drain, was found to be a cost-effective method for minimizing the inflow of clean water from beyond the landfill into the drain. In all alternatives involving leachate collection, a slurry wall was included with the collection drain itself.

(5) Eight (8) final remedial alternatives, falling into six (6) alternative categories, were identified for detailed evaluation pursuant to the preliminary screening process above. These were:

Alt. 1 - No action

Alt. 2 - Excavation and off-site waste disposal (southern section of landfill)

Alt. 3 - Supplementary capping (of landfill side slopes)

Alt. 4a - Leachate collection (gravel drain with slurry wall) and off-site leachate disposal

Alt. 4b - Leachate collection and on-site leachate treatment

Alt. 5a - Supplementary capping, leachate collection and off-site leachate disposal

Alt. 5b - Supplementary capping, leachate collection and on-site leachate treatment

Alt. 6a - Incineration

Each of the final remedial alternatives above was evaluated in detail, using non-cost and cost criteria. The non-cost criteria evaluation utilized a weighted matrix scoring system. Each alternative was scored on a comparative "1 to 5" basis under the following five (5) weighted categories: technical aspects (effectiveness, useful life, operation/maintenance requirements, demonstrated performance, constructability, time to implement/achieve results, worker safety, public safety); institutional aspects; public health aspects;

environmental aspects; and conformance with SARA guidelines. The results were totalled to determine a relative non-cost criteria evaluation (or "quasi-benefit") score for each alternative.

Each alternative was also evaluated for cost. The cost analysis addressed: direct capital (i.e., construction) costs; indirect capital costs (additional studies, engineering services, legal/administrative services, and contingency budget); operation and maintenance (O/M) costs; and replacement costs. All of these component costs were combined, using standard economic formulas, to determine the total present worth of each alternative.

In consideration of the relative benefits (i.e., non-cost criteria evaluation scores) and costs of the remedial alternatives evaluated in this study, Alternative 5b is recommended for implementation at the Volney Landfill site. This alternative includes supplementary capping of the landfill side slopes, installation of a leachate collection system around two portions of the site perimeter, and construction of an on-site leachate treatment facility. The rationale for recommending this alternative, over the others, is as follows:

(1) Because of the potential risk posed by the site to groundwater users in the vicinity, and in consideration of USEPA and NYSDEC agency policy concerning Superfund site remediation, no action (Alternative 1) is not considered an appropriate response at the Volney Landfill.

(2) Alternative 5b is more effective, and much less expensive, than either excavation and off-site waste disposal (Alternative 2) or incineration (Alternative 6).

(3) Alternative 5b has a significantly higher evaluation score than either supplementary capping alone (Alternative 3) or leachate collection alone (Alternatives 4a/4b).

Neither capping nor leachate collection are 100 percent effective at preventing leachate generation or collecting leachate, respectively. In combination, however, they reinforce one another and provide the maximum possible reduction of leachate migration from the site. Furthermore, in consideration of USEPA and NYSDEC policy, as expressed during the evaluation of alternatives in this study, the combination of supplementary capping and leachate collection provides a comprehensive approach which is most consistent with current regulatory policy for Superfund site cleanup.

(4) The on-site leachate treatment included in Alternative 5b is estimated to be somewhat more cost-effective than off-site leachate disposal at a local POTW (Alternative 5a).

Alternative 5b, as recommended, includes the following principal components.

- Supplementary Capping - Supplementary capping will cover approximately 35 acres of the landfill side slopes, extending from the existing PVC membrane cap on the top of the landfill to beyond the limits of refuse. The principal element of the cap will be a 60-mil high density polyethylene (HDPE) liner, which will be placed over the present (recompacted) lodgement till soil cap on the landfill side slopes. Underlying the HDPE liner will be a 6-inch layer of sand; overlying it will be a 24-inch layer of sand and a 12-inch topsoil layer.

- Leachate collection - The leachate collection system will include a gravel-filled leachate collection drain, with accompanying soil-bentonite slurry wall, collection wells and force main, around two portions of the site perimeter where there exists a significant depth of saturated soil overlying lodgement till. The north drain segment is estimated to be approximately 2,020 feet long, and the south drain segment approximately 1,780 feet long. This collection system will discharge via the force main to an on-site leachate treatment facility on the east side of the site.

- <u>On-site leachate treatment</u> - The on-site leachate treatment facility will, pending a treatability study, involve a process train consisting of: flow equalization, biological treatment and carbon adsorption. Major equipment items will include a 150,000-gallon equalization/storage facility, a 50,000-gallon sequenced biological reactor (with manual powdered activated carbon addition), and a filter press. Treated effluent will be discharged to Bell Creek, and sludge filter cake transported to an approved off-site landfill facility.

The total estimated present worth of the recommended remedial alternative is $13,296,000. This includes $9,934,000 in construction costs, indirect capital costs of $2,942,000, and annual O/M costs of approximately $44,000 per year. Prior to design, a leachate treatability study and detailed geotechnical investigation along the proposed collection drain alignment will have to be performed. The total time required to implement this plan, from initiation of design through completion of construction, is estimated to be 30 months.

There are several possible variations of the recommended plan which may bear further consideration. These are:

- Modification or elimination of the north drain and slurry wall segment, and down-scaling of the proposed on-site leachate treatment facility, pending a review of the design, construction and operation of the existing leachate collection system in the northern section of the landfill.

- o Substitution of off-site leachate disposal at a POTW for on-site leachate treatment (i.e., substitution of Alt. 5a for Alt. 5b), if the treatability study and/or negotiations with local treatment facilities should indicate that this is a more cost-effective alternative.

A long-term (30-year) groundwater monitoring program is proposed for the site, which includes sampling and analysis of 11 residential and 16 monitoring wells. Assuming that, after two (2) years of quarterly sampling, the number of monitoring wells can be reduced by half and the sampling frequency reduced to annually, the total estimated present worth of this proposed monitoring program is approximately $270,000.

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

VOLNEY LANDFILL

TOWN OF VOLNEY, OSWEGO COUNTY, NEW YORK

TABLE OF CONTENTS

TABLE OF CONTENTS

(Cont'd.)

TABLE OF CONTENTS

(Cont'd.)

Page No.

TABLE OF CONTENTS

(Cont'd.)

TABLE OF CONTENTS

(Cont'd.)

Page No.

TABLE OF CONTENTS

(Cont'd.)

TABLE OF CONTENTS

(Cont'd.)

Page No.

PART II - FEASIBILITY STUDY

TABLE OF CONTENTS

(Cont'd.)

Page No.

TABLE OF CONTENTS

(Cont'd.)

Page No.

TABLE OF CONTENTS

(Cont'd.)

LIST OF FIGURES

Page No.

LIST OF FIGURES
(Cont'd.)

LIST OF TABLES

LIST OF TABLES

(Cont'd.)

LIST OF TABLES

(Cont'd.)

LIST OF TABLES

APPENDICES

A - Surface Geophysical Study Report

B - Soil Boring Logs

C - Rock Core Logs

D - Monitoring Well Installation Reports

E - Physical Property Results of Soil Samples

F - Hydraulic Conductivity Test Results

G - Environmental Sampling Report

H - Groundwater Analytical Results and Laboratory/Trip Blank Data

I - Stream Water/Leachate Analytical Results

J - Sediment Analytical Results

K - Water Quality Standards and Criteria

L - Calculations

PART I

REMEDIAL INVESTIGATION

PART I - REMEDIAL INVESTIGATION FOR VOLNEY LANDFILL

1.0 INTRODUCTION

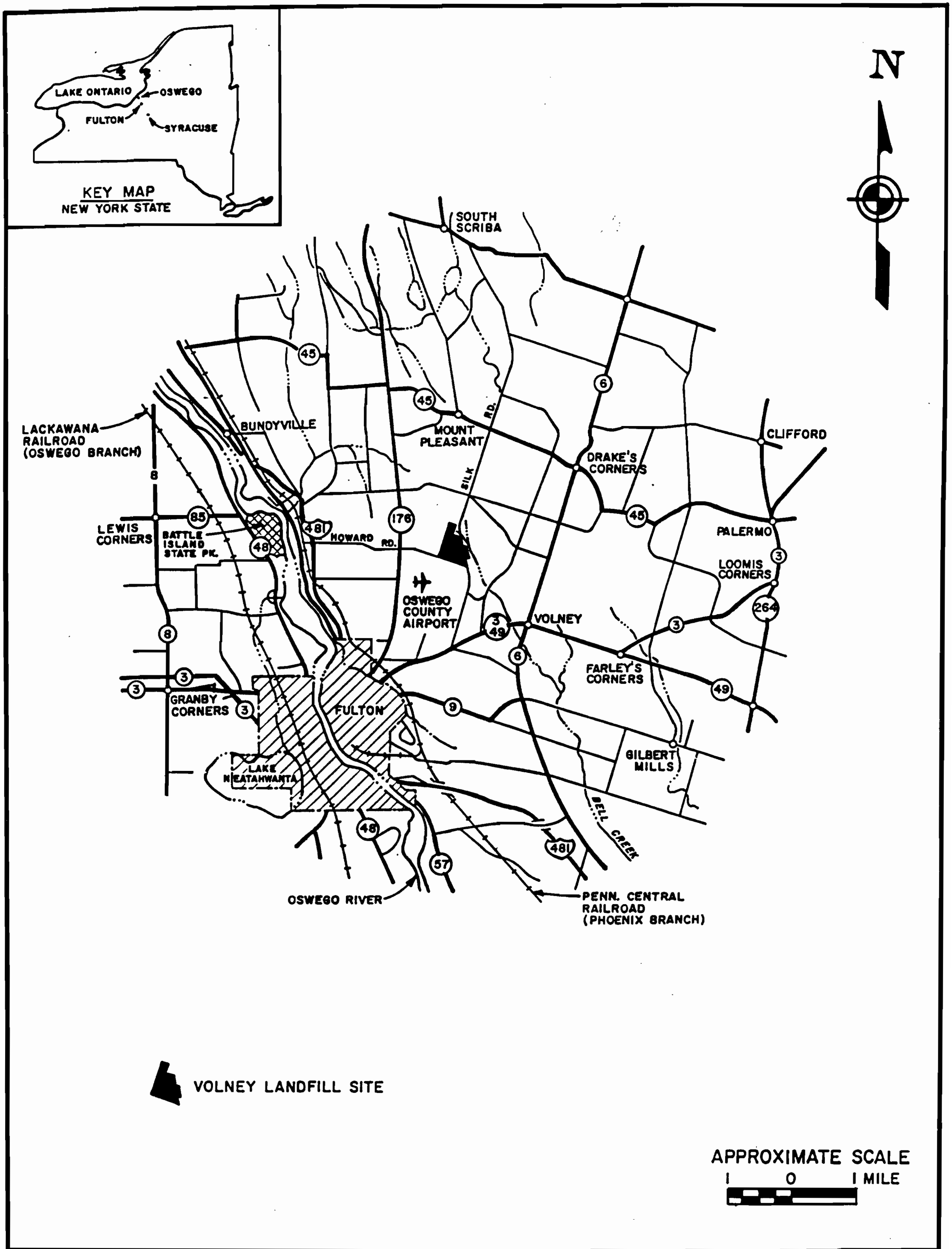
1.1 Site Background

1.1.1 General Description - The Volney Landfill site is located northwest of the intersection of Howard and Silk Roads in the Town of Volney, Oswego County, New York (Figure 1-1). This location is approximately 2 miles northeast of the City of Fulton, 25 miles north-northwest of the City of Syracuse and 10 miles southeast of Lake Ontario. The site is in the northeast corner of the Fulton, New York 7-1/2 minute U.S.G.S. topographic quadrangle.

The site consists of 85 acres, of which 55 acres are inactive landfill on which closure operations have recently (fall 1985) been completed. Average depth of fill is reportedly 45 feet, with a maximum depth of 60 feet in the northern portion of the landfill. A minimum 5-foot separation between waste materials and the water table was reportedly maintained in the northern portion of the site. Operations in the southern portion of the landfill, prior to implementation of Part 360 regulations, required only a 3-foot separation; although in general, at least a five-foot separation was maintained (Barton and Loguidice, 1984). The landfill has a relatively flat top and moderately steep side slopes. It rises approximately 50 feet above the surrounding terrain and forms a locally prominent topographic feature. The site is fenced, with access gates on Silk and Howard Roads.

1.1.2 Site History - The following historical description is based primarily upon information provided in the engineering closure report (Barton and Loguidice, 1984) and a hydrogeologic investigation report (Geraghty and Miller, 1984).

Operations at the Volney Landfill, also known as the Oswego Valley Sanitary Landfill, were initiated in 1969 in a former sand and gravel



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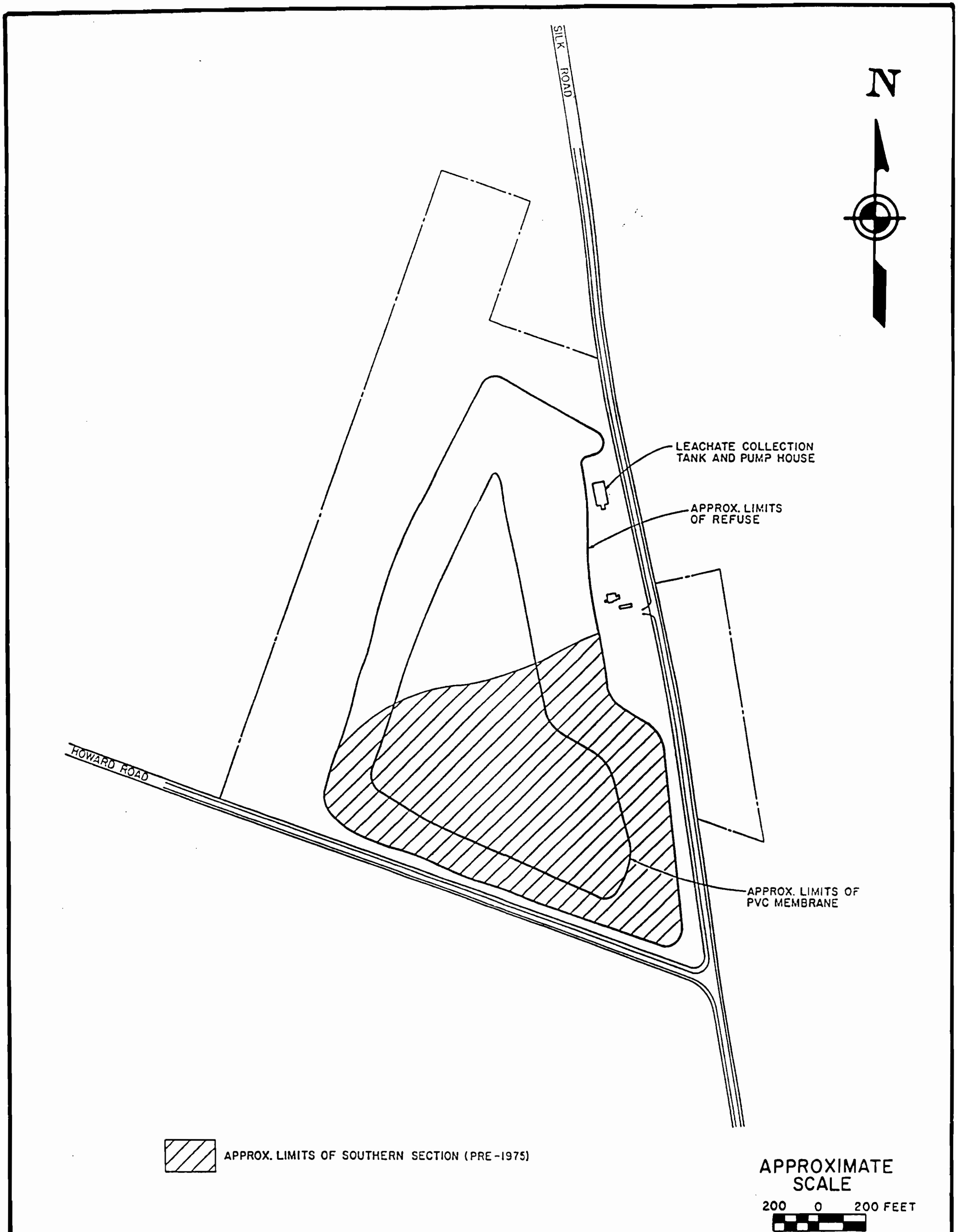
SITE LOCATION MAP

FIGURE 1-1

pit located in the southeast corner of the site, and thereafter progressed generally northward (Figure 1-2). From 1969 until 1974, the landfill was operated by the Oswego Valley Solid Refuse Disposal District Board. The Board consisted of the City of Fulton, the Village of Phoenix, and the Towns of Granby, Schroeppel and Volney. In early 1975, Oswego County purchased the site from the board to use as a county-wide facility for disposal of municipal, commercial and light industrial wastes.

As the landfill expanded in the mid 1970's to the central and northern parts of its present configuration, a leachate collection system was installed. After the County purchased the site, surficial sand and gravel were removed and the underlying glacial till was graded towards a common collection trench in the central portion of the site and connected to a small sump opposite the maintenance building. In the northern portion, a leachate collection drain was installed in 1982 and connected to a second sump. Both these sumps discharge to the leachate collection tank built in 1982 on the east side of the site. The tank has a design capacity of 300,000 gallons and an overflow capacity of 374,000 gallons.

Several methods have been employed to treat collected leachate. A spray irrigation treatment system was designed by Barton, Brown, Clyde & Loguidice in October of 1973 and has been in use infrequently as a backup to the leachate collection system. From about 1979 to 1983 leachate collected first from the sumps and then the collection tank was treated at Armstrong Cork Co. Wastewater Treatment Center in Fulton. Collected leachate was reported to be between 500 and 5,000 gal/day during 1980-1982. After the County was informed that Armstrong would no longer accept leachate for treatment, as a temporary arrangement they enlisted the City of Oswego's Westside Sewage Treatment Plant. Leachate was transported to and treated in Oswego during 1984 and 1985. Reported average daily quantities of leachate treated at the plant were 3,550 gal/day in 1984 and 6,900 gal/day in 1985. The Fulton Wastewater



URS Company, Inc. CONSULTING ENGINEERS NEW YORK NEW JERSEY	SITE LAYOUT MAP	FIGURE 1-2

Treatment Plant has been treating the leachate since 1986; quantities undetermined.

Waste disposal continued at the Volney Landfill until shortly after the opening of the Bristol Hill Landfill, approximately 2 miles to the southeast, in September 1983. Since that time, closure operations have been completed by Oswego County. Closure operations include a system for venting landfill gases and collecting their condensates, installation of an impermeable cap on the landfill top and uppermost side slopes, surface water controls, and a vegetative crop cover. The major construction phases of this closure were completed in the fall of 1985.

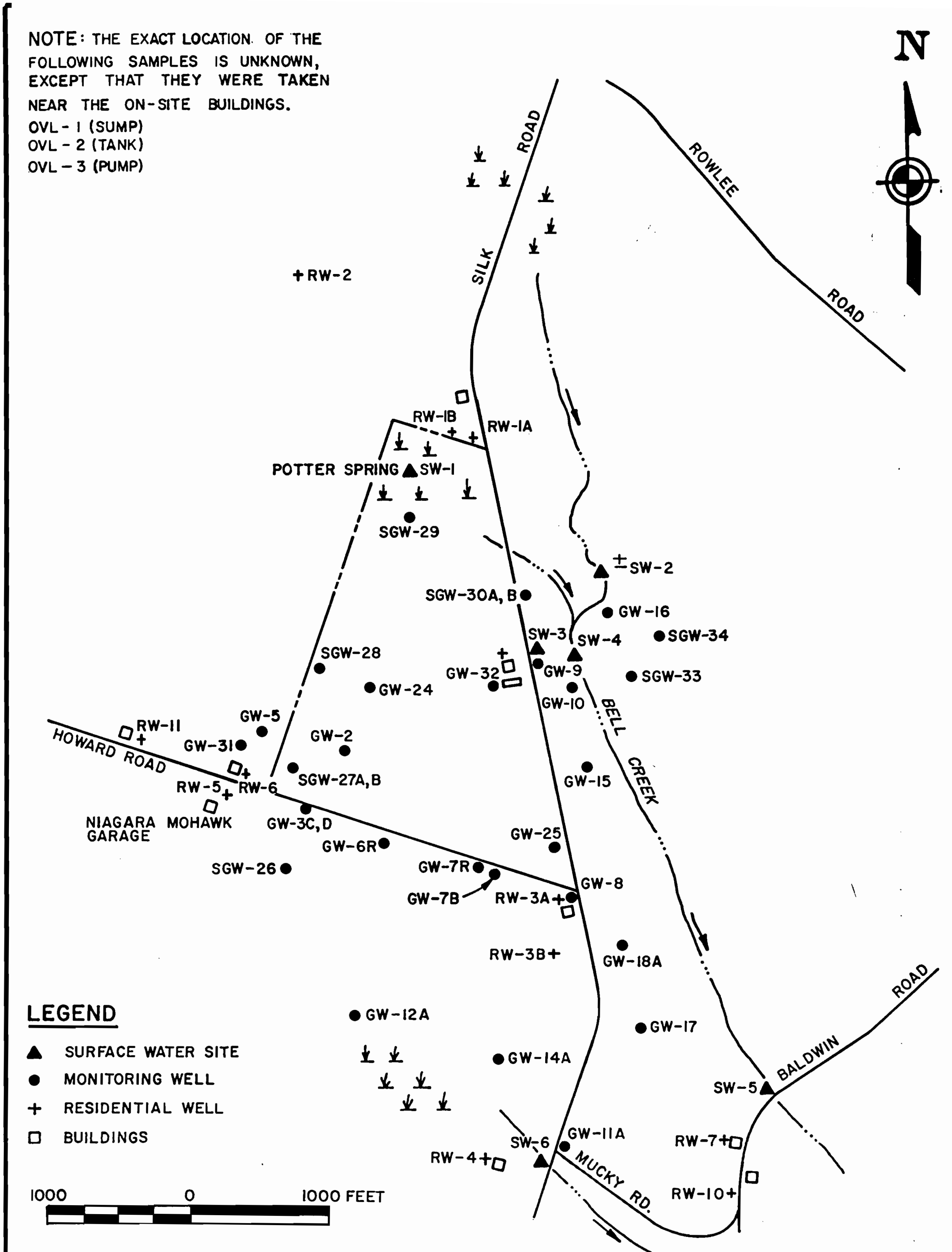
Most of the waste materials disposed of in the landfill from 1969 to 1983 consisted of residential, commercial, institutional and industrial wastes, including wastewater treatment sludges from commercial haulers and county vehicles. However, between March 1974 and January 1975, the landfill accepted approximately 8,000 barrels from Pollution Abatement Services (PAS), a hazardous waste incineration facility located in the City of Oswego. The New York State Department of Environmental Conservation (NYSDEC) had approved the landfill for disposal of discarded barrels from PAS containing the residues of chemical sludges, with the exception of phenols or chlorinated compounds. During this time a minimum of 5,273 barrels were reportedly accepted by the landfill. An unknown number of these barrels apparently contained liquid and not just solid waste. The landfill operator at the time of disposal recalls that approximately 50-200 barrels contained unidentified liquid waste which was incorporated into the everyday fill. Acceptance of barrels from PAS was terminated in January of 1975.

1.1.3 Previous Investigations - Prior to and concurrent with this study, there have been extensive investigations of the Volney Landfill. The County currently is engaged in an extensive quarterly monitoring and reporting program of monitoring and nearby residential wells.

Previous investigation sampling locations are shown on Figure 1-3. After formal approval was given in 1969 to establish the landfill, the New York State Department of Health (NYSDOH) was contacted for assistance in carrying out a water quality sampling and analysis program. Early sampling was limited to bacteriological analysis of nearby residential wells.

In 1973, leachate breakouts were identified along Silk Road entering a tributary to Bell Creek. Samples of leachate and stream water, and a review of previous sampling efforts showed evidence of contamination in the leachate but little, if any, contamination of surface or groundwater. Requests for further investigations into the quality of groundwater around the landfill led to several sampling programs sponsored by various agencies from 1976 to the present. In 1976 the NYSDOH began to analyze groundwater samples in order to characterize the quality of groundwater in more detail. "Bacteriological results were unsatisfactory for [2 nearby] residences while some of the chemical results for the trailer on the landfill site [bedrock well] did not meet recommended standards stated in Part 72 of the New York State Sanitary Code" (Oswego County Health Department, 1976). In 1978 the NYSDOH expanded the analysis to include organics commonly found in leachate-contaminated groundwater.

Six sampling locations, including three private water supplies, were tested in 1979 by the County. Traces of organic compounds in the 3 residential wells were determinated to be the result of chlorination of the well water. Private water supplies with bacteriological contamination were determined to probably be the result of faulty well covers or septic systems. Data extracted from a May 14, 1979 Consent Order between the NYSDEC and Oswego County showed that, "report and sampling data indicates that [3] private water supplies adjacent to the landfill... and the county landfill [trailer] appear to exceed drinking water standards and/or groundwater standards" (NYSDEC, 1980).



SOURCE: GERAGHTY AND MILLER (1986)

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PREVIOUS INVESTIGATION SAMPLING LOCATIONS

FIGURE 1-3

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In 1979, a cooperative study involving the State University Research Center at Oswego (SURCO) and the United States Geological Survey (USGS) was initiated by an Oswego County legislative resolution. The purpose of the study was to assess chemical waste disposal sites in Oswego County including Volney Landfill. The majority of monitoring wells shown on Figure 1-3 were drilled for this study. In 1980 the Oswego County Health Department Commissioner formed an ad hoc committee composed of County and State agencies, consultants and investigators to review test results and propose recommendations for future sampling. An agreement was made to coordinate the NYSDOH- sponsored sampling with the County-sponsored sampling. The NYSDOH assumed the responsibility of sampling the residences and the County the on-site wells and leachate. The NYSDOH withdrew from the sampling program in mid-1982, and their responsibilities were assumed by the County. Additional samples were collected in 1982 under funding from the New York State Department of Environmental Conservation (NYSDEC). Analysis of samples collected between 1980 and 1982 indicated possible landfill contaminant migration to the south/southwest and to the east. Benzene was found in concentrations which exceeded standards in residential wells to the north, west and south of the landfill (Barton and Loguidice, 1980, Oswego County Public Health Department, 1981 a, b). Additional details on compounds detected in the residential wells during this period are provided in the Engineering Closure Report (Barton and Loguidice, 1984).

A program for sampling the monitoring wells and private water supplies, including the landfill trailer well and residential wells, on a quarterly basis was developed in 1983. The March 1984 results of this quarterly sampling program indicated that groundwater contamination was present in at least two, and probably all three, of the monitoring wells (Geraghty and Miller, 1984). Benzene (in exceedence of groundwater standards) and xylenes were present in one of the monitoring wells. Toluene and MEK were found in two of the three monitoring wells; toluene was also found in trace amounts in two of the nine private water supplies. A resampling of the three private wells was conducted in

May 1984, and indicated all previously sampled volatile organic compounds were below the detection limits.

In 1985 a hydrogeologic investigation was conducted which involved the inspection, restoration and/or installation of monitoring wells (Geraghty and Miller, 1985). In addition, it involved the collection of water level measurements and water quality data (selected organics and inorganics) from 10 residential wells, 19 monitoring wells, leachate collection system, and nearby stream water. The January 1985 groundwater samples analyzed during the Geraghty and Miller investigation contained a number of organic compounds in the monitoring wells including chloroform, benzene, toluene, 1,1,1-trichloroethane and MEK. A number of volatile organic compounds were present in the leachate; a lesser number were detected in groundwater samples. MEK, however, was evident in relatively high concentrations in both the leachate and groundwater, indicating the landfill is a source of this volatile organic. Sampling performed at the residential wells indicated that groundwater standards at that time were satisfied for all inorganic compounds; however, standards for benzene were exceeded in 2 of the monitoring wells.

Quarterly sampling from June 1985 through March 1986 was conducted from monitoring wells, residential wells, stream water from Bell Creek and leachate (Geraghty and Miller, 1986). Over a dozen organic compounds were detected in generally low concentrations. MEK was again found in the highest concentration of any of the volatiles (250 ug/l at one location). Results of residential well sampling indicated that concentrations of iron, TDS, and pH occasionally exceeded groundwater standards. Stream water quality was relatively stable and all of the above parameters fell within acceptable limits at the time. Leachate sampling indicated that concentrations of inorganic constituents generally remained constant or decreased. Decreased concentrations were generally apparent among the volatile organic compounds, including toluene, ethyl benzene, 1,2-dichloroethane and MEK.

Tables 1-1 through 1-3 provide a summary of the previous discussion and detail the compounds detected in the quarterly sampling program between March 1984 and March 1986. Table 1-4 summarizes the compounds analyzed during each sampling. Table 1-1 provides the results of sampling in March 1984; Table 1-2 the results from January 1985; and Table 1-3 the maximum concentrations in wells sampled between October 1985 and March 1986. Both residential and test (i.e. monitoring) wells are included on the tables. Neither all wells nor all compounds were sampled and analyzed for at all time periods. Blank values indicate either that the compound was not analyzed during the time period (see Table 1-4) or was not found in concentrations above the detection limits; detection limits varied over time and with each compound. The compounds listed in the tables are on the current Hazardous Substance List (number on list included) or are parameters indicative of landfill leachate. Full details of the quarterly monitoring program are provided in Geraghty and Miller (1986).

Table 1-5 indicates the compounds and parameters from Tables 1-1 through 1-3 which, given current New York State Class GA groundwater regulations, exceed groundwater standards in residential and/or monitoring wells. This table also indicates the compounds/parameters which exceed current non-enforceable guidelines. As indicated by the values on Table 1-5, groundwater contamination at the Volney Landfill has generally been non-uniform and low-level. A number of compounds/parameters contravene current groundwater standards in monitoring wells; residential wells analyzed over this time period, however, have been relatively clean.

1.1.4 <u>Regulatory Status</u> - On March 14, 1979 the NYSDEC entered into a consent order with Oswego County after alleged violations by the County were reported in regards to operations at the Volney Landfill. The County was allegedly in contravention of groundwater quality standards established by the NYSDEC. Corrective actions to be taken by the County on or before June 15, 1979 involved groundwater monitoring studies, evaluation of leachate treatment, evaluation of sludge treatment, and

TABLE 1-1

GROUNDWATER ANALYTICAL SUMMARY (MARCH 1984)

HSL Compound (ug/l)	Residential Wells									Test Wells		
	RW-1A	RW-1B	RW-2	RW-3A	RW-4	RW-5	RW-6	RW-7	RW-10	GW-3C	GW-3D	GW-10
9. 1,1-dichloroethane					67							
13. MEK										1,900	50	
24. Benzene												7.1
31. Toluene			12			12				76		24
35. Xylenes												9.6
37. Phenol										341		14
Zinc	130	40	60	470	60	100	120	100	290	100	160	1,400
Indicator Parameters (mg/l)												
Alkalinity	74	124	150	220	56	182	244	152	48	526	360	353
Ammonia Nitrogen	0.07	0.08	0.2		0.05	0.15	0.11	0.17		0.22	0.11	1.25
COD			2.8	3.6		4.4	3.2		2	980	24.4	56
Hardness	112	132	156	220	72	184	236	168	48	768	428	500
TDS	200	216	248	280	100	268	360	276	100	1,257	676	895
TOC										373	35.5	39
pH (Standard Units)	6.7	7.6	7.6	7.4	8.0	7.4	7.3	7.4	6.5	7.4	7.0	6.7
Specific Conductance (umhos/cm)	300	325	385	445	140	405	510	410	195	1,400	900	1,350

TABLE 1-2

GROUNDWATER ANALYTICAL SUMMARY (JANUARY 1985)

HSL Compound (ug/l)	Residential Wells									
	RW-1A	RW-1B	RW-2	RW-3A	RW-3B	RW-4	RW-5	RW-7	RW-10	RW-11
5. Methylene Chloride										6
Zinc	170	90	90	490	100	100	80	50	210	110
Indicator Parameters (mg/l)										
Alkalinity	56	120	140	200	140	82	170	140	38	250
Ammonia Nitrogen					0.12		0.05	0.10	0.05	0.05
COD	2	3.7	1.2	7.8	5.7	4.1	11.0	1.6	4.1	8.6
Hardness	100	160	180	220	160	96	220	190	92	270
TDS	152	264	308	296	236	176	328	320	168	368
TOC			3.0	9	7	9		4	4	19
pH (Standard Units)	7.1	7.3	7.5	6.6	7.9	8.0	7.3	7.4	7.3	7.4
Specific Conductance (umhos/cm)	190	300	400	400	300	200	400	400	200	450

TABLE 1-2 (Cont'd.)

GROUNDWATER ANALYTICAL SUMMARY (JANUARY 1985)

HSL Compound (ug/1)	Test Wells								
	GW-3C	GW-3D	GW-5	GW-9	GW-10	GW-11A	GW-12A	GW-14A	GW-15
11. Chloroform									
13. MEK	1,100								
14. 1,1,1-Trichloroethane		17			69				
24. Benzene	6			28					
31. Toluene	86			10					
Zinc	30	30	90	120	1,100	650	80	40	680
Indicator Parameters (mg/l)									
Alkalinity	450	390	130	530	300	142	360	200	400
Ammonia Nitrogen	0.12		0.24	0.18	2.54		0.33	0.10	0.56
COD	649	11.4	25.3	47.2	49	25	32.2	41	9.4
Hardness	670	480	130	480	520	208	380	212	400
TDS	971	446	160	620	936	316	967	215	452
TOC	290	37	14	23	18	14	17	21	
pH (Standard Units)	7.3	6.8	7.6	7.3	6.6	7.4	6.9	7.3	6.8
Specific Conductance (umhos/cm)	1,140	750	260	1,019	1,350	420	750	455	650

TABLE 1-2 (Cont'd.)

GROUNDWATER ANALYTICAL SUMMARY (JANUARY 1985)

HSL Compound (ug/1)	Test Wells									
	GW-16	GW-17	GW-18A	SGW-26	SGW-27A	SGW-27B	SGW-28	SGW-29	SGW-30A	SGW-30B
11. Chloroform								6		
13. MEK										
14. 1,1,1-Trichloroethane						12				
24. Benzene										
31. Toluene									17	
Zinc	380	40	140	50	40	130	60	40	160	80
Indicator Parameters (mg/1)										
Alkalinity	270	140	170	150	32	140	200	86	210	100
Ammonia Nitrogen	0.23						0.08			
COD	3.7	12	14	30.6	3.7	12	8.2	14.5	12.2	8.2
Hardness	330	180	210	180	52	170	250	120	240	140
TDS	651	196	268	268	112	320	276	124	340	172
TOC	12	7	6	6	9	4		9	10	5
pH (Standard Units)	7.3	7.8	7.5	7.8	6.9	7.3	7.4	7.4	6.9	8.8
Specific Conductance (umhos/cm)	525	275	350	340	101	380	606	225	600	300

TABLE 1-3

GROUNDWATER ANALYTICAL SUMMARY (OCTOBER 1985 THROUGH MARCH 1986)

HSL Compound (ug/1)	Residential Wells									
	RW-1A	RW-1B	RW-2	RW-3A	RW-3B	RW-4	RW-5	RW-7	RW-10	RW-11
5. Methylene Chloride	6		5	7						
32. Chlorobenzene										10
Zinc	80	30		20	10	30	60		80	70
Indicator Parameters (mg/1)										
Alkalinity	132	118	148	190	156	76	176	136	38	212
Ammonia Nitrogen	0.04		0.04	1.73				0.11		
COD	11	7.0	9.0	7	6.7	8.0	6.4	5.1	9.4	17
Hardness	188	176	172	252	212	92	264	176	72	230
TDS	312	220	240	356	220	172	272	264	172	300
TOC	3	4	4	4	6	17	8	8	4	7
pH (Standard Units)	6.4	8.1	7.9	7.6	7.6	8.1	8.0	8.0	6.7	8.0
Specific Conductance (umhos/cm)	490	335	400	530	320	170	430	400	225	475

TABLE 1-3 (Cont'd.)

GROUNDWATER ANALYTICAL SUMMARY (OCTOBER 1985 THROUGH MARCH 1986)

HSL Compounds (ug/l)	Test Wells											
	GW-3C	GW-3D	GW-5	GW-6	GW-7B	GW-8	GW-9	GW-10	GW-11A	GW-12A	GW-14A	GW-15
3. Vinyl Chloride				8								
4. Chloroethane					8							
5. Methylene Chloride			44					1	5	3	1	
Methyl Chloride					1							
9. 1,1-Dichloroethane	3											
10. Trans-1,2-Dichloro-ethylene	6			1			3					
11. Chloroform								28				
12. 1,2-Dichloroethane							2					
13. MEK	250		23									
14. 1,1,1-Trichloroethane	2											
21. Trichloroethylene							1	1				
24. Benzene	1							5				
31. Toluene	88			1				2				
32. Chlorobenzene							4					
33. Ethyl Benzene							2	4				
Zinc	50	30		60	50	50	570	640	100	30	40	70

TABLE 1-3 (Cont'd.)

GROUNDWATER ANALYTICAL SUMMARY (OCTOBER 1985 THROUGH MARCH 1986)

Indicator Parameters (mg/l)	Test Wells											
	GW-16	GW-17	GW-18A	GW-26	SGW-27A	SGW-27B	SGW-28	SGW-29	SGW-30A	SGW-30B	SGW-33	SGW-34
Alkalinity	304	138	218	158	26	158	178	150	264	114	196	207
Ammonia Nitrogen		0.11	0.21		0.05	0.14			0.19			0.16
COD	4.6	4.3	10	46	41	44	46	10	32	94	29	23
Hardness	403	206	238	202	51	219	223	190	304	140	180	235
TDS	380	224	332	244	76	232	340	236	672	208	276	300
TOC	5	5	6	17	16	16	18	5	13	31	22	15
pH (Standard Units)	8.2	8.2	8.3	8.3	6.4	8.1	8.3	8.3	7.9	8.2	8.2	8.4
Specific Conductance (umhos/cm)	600	305	460	380	105	350	360	275	980	295	400	435

Note: Concentration are maximums found in samplings performed between October 1985 and March 1986.

TABLE 1-4

COMPOUNDS ANALYZED BETWEEN MARCH 1984 AND MARCH 1986
(GERAGHTY AND MILLER, 1986)

Organics	March 1984	January 1985	October 1985 March 1986
Phenol	-		
Chloroform	-	-	-
1,1,1-Trichloroethane	-	-	-
Carbon Tetrachloride	-	-	-
Dichlorobromomethane	-	-	-
Trichloroethylene	-	-	-
Chlorodibromomethane	-	-	-
Bromoform	-	-	-
Tetrachloroethylene	-	-	-
Methylene Chloride	-	-	-
Chlorobenzene	-	-	-
1,1,2,2-Tetrachloroethane	-	-	-
1,1-Dichloroethane	-	-	-
1,2-Dichloroethane	-	-	-
1,1-Dichloroethylene	-	-	-
Trans-1,2-Dichloroethylene	-	-	-
Chloroethane	-	-	-
Vinyl Chloride	-	-	-
Methyl Chloride	-	-	-
Methyl Bromide	-	-	-
1,2-Dichloropropane	-	-	-
Cis-1,3,-Dichloropropene	-	-	-
1,1,2-Trichloroethane	-	-	-
Trans-1,3-Dichloropropene	-	-	-
2-Chloroethyl vinyl ether	-	-	-
Benzene	-	-	-
Toluene	-	-	-
Ethyl Benzene	-	-	-
Xylenes			
Methyl Ethyl Ketone (MEK)		-	-
Inorganics & Indicator Parameters			
Iron	-	-	-
Manganese	-	-	-
Zinc	-	-	-
Calcium			
Magnesium			
Hardness	-	-	-
Alkalinity	-	-	-
pH	-	-	-
Specific Conductance	-	-	-
Chloride	-	-	-

TABLE 1-4 (Cont'd.)

Organics	March 1984	January 1985	October 1985-March 1986
Sulfate	-	-	-
TDS	-	-	-
Total Phosphate (as phosphorous)	-		
Ammonia Nitrogen	-	-	-
Nitrite	-		
Nitrate	-	-	-
Total Coliforms	-		
Fecal Coliforms	-		
TOC	-	-	-
BOD_5	-		
COD	-	-	-

TABLE 1-5

GROUNDWATER COMPOUNDS AND PARAMETERS
FROM PREVIOUS (MARCH 1984 - MARCH 1986) SAMPLING EXCEEDING CURRENT STANDARDS AND GUIDELINES

Substance	Max. Conc. RWs	Max. Conc. MWs	Current Enforceable Limit	Source[1]	Total No. Samples
Benzene	ND	28 ug/l	Not Detectable	703.5	5
Vinyl Chloride	ND	8 ug/l	1 ug/l	MCL	1
Zinc	490[2]	1,400 ug/l	300 ug/l	170.4	9
TDS	<500	1,257 mg/l	500 mg/l	170.4	16
pH	6.4	6.4, 8.8	6.5 to 8.5	170.4	3

Substance	Max. Conc. RWs	Max. Conc. MWs	Current Guidelines	Source	Total No. Samples
Chloroform	ND	28 ug/l	0	CWA	2
Vinyl Chloride	ND	8 ug/l	0	RMCL	1
1,2-Dichloroethane	ND	2 ug/l	0	CWA	1
Trichloroethylene	ND	2 ug/l	0	RMCL	2
Benzene	ND	28 ug/l	0	RMCL	5
TDS	<500	1,257 mg/l	500 mg/l	143.3	16

Notes:
1) Sources for the Limits are detailed in Appendix K:
   703.5 - 6 NYCRR Water Quality Regulations for groundwater
   170.4 - 10 NYCRR Sources of Water Supply
   MCL - USEPA Maximum contaminant levels
   CWA - Clean Water Act Guidelines
   143.3 - 40 CFR USEPA National Secondary Drinking Water Regulations
   RMCL - USEPA Recommended Maximum Contaminant Levels
   RW - Residential Well
   MW - Monitoring Well
2) Iron cased well

development of a closure plan. At this time, the NYSDEC agreed to sample leachate from the landfill for toxic substances and the site was targeted for high priority work as a part of the SURCO/USGS groundwater contamination study.

On December 9, 1983 the County of Oswego received a letter from the NYSDEC which stated that:

> "In accordance with the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) the DEC has determined that the County was responsible for the release or threatened release of hazardous substances at the Volney Landfill."

When there is a release or threat of release of a hazardous substance from a facility, the facility may be scored using the Hazardous Ranking System (HRS) as outlined in Appendix A of 400 CFR 300 for the purpose of placing the facility on the National Priorities List (NPL).

In June of 1983, Engineering-Science, Inc. performed a Phase I Engineering Investigation and Evaluation for the NYSDEC (Engineering - Science, 1983). In the Phase I report, an HRS scoring of 44.42 was presented, which is above the minimum score of 28.5 necessary for inclusion on the NPL. Further evaluation resulted in the modification of the score in July 1984, when the NYSDEC submitted a score of 32.89 to the United States Environmental Protection Agency (USEPA). The revised HRS scoring documents were found to be satisfactory by the USEPA. Consequently the site was proposed for the NPL and, after the public comment period, finalized as a NPL site.

The County of Oswego received notification of the inclusion of the Volney Landfill in the registry of inactive hazardous waste disposal sites in New York State via a letter from the NYSDEC dated December 18, 1984. At the present time, the site is #577 on the NPL.

1.2 Nature and Extent of the Problem

The total volume of waste materials buried at the Volney Landfill is estimated, from the overall dimensions of the site and depth of fill, to be approximately 4 million cubic yards. Within the fill are a reported 8,000 barrels from the PAS site -- some probably containing various hazardous substances. These barrels were reportedly crushed and incorporated into the daily fill area; their location, however, is unknown. Apart from these PAS wastes, there is a strong likelihood that other hazardous substances, typically associated with municipal and industrial refuse, are also present, and probably widely diffused throughout the landfill.

Because the landfill is unlined, and has a leachate collection system only in its newer (northern) section, leachate migration in both horizontal and vertical directions is occurring. Vertical migration, however, is impeded by the occurrence of a relatively impervious lodgement till unit underlying the fill. Relatively low-level contamination of groundwater and surface water in the vicinity of the landfill has been observed; previous sampling of private water supplies and monitoring wells has indicated non-uniform and low-level contravention of drinking water standards to date. Because groundwater is used locally as a source of potable water, its contamination by landfill leachate poses the most serious concern at this site. Surface water contamination is also occurring, though typically at significantly lower concentration levels and with a much less direct potential impact to human health and the environment.

The site has recently been closed. As part of the closure operations, a PVC membrane liner and methane gas collection system were installed over the relatively flat top section of the landfill, and a two-foot soil cap (minimum permeability 10^{-5} cm/sec) with passive gas venting over its much steeper side slopes. As mentioned, a leachate collection system was installed prior to refuse placement in the northern section of the site. Post-closure monitoring of surface water and groundwater is ongoing.

1.3 Remedial Investigation Summary

The purpose of the remedial investigations at the Volney Landfill was to develop data sufficient to characterize the site, identify contaminant transport modes, assess the extent of contamination, evaluate the site's impact upon public health and the environment, and identify/evaluate alternative remedial measures to mitigate these impacts. Field investigations at the site commenced in September 1985 and were completed in November 1986; environmental media were resampled during July 1986. In this section, the field activities employed during the remedial investigations are briefly summarized. Subsequent sections of the report address the methods of investigation associated with these activities. Additional details concerning field investigation activities and methods may be found in the following documents, which were prepared at the outset of the project:

- Health and Safety Plan for the Remedial Investigation and Feasibility Study at the Volney Landfill Site (URS Company, 1985a);
- Work/QA Project Plan for the Remedial Investigation and Feasibility Study at the Volney Landfill Site (URS Company, 1985b).

1.3.1 Surface Geophysical Studies - Surface geophysical studies were conducted at the Volney Landfill using the techniques of terrain conductivity profiling, electrical resistivity sounding and seismic refraction surveying. Terrain conductivity surveying was performed along the perimeter of the site to determine lateral variations in shallow stratigraphy and groundwater. Along the same perimeter, electrical resistivity soundings were taken to determine general variations in subsurface electrical properties with depth and to facilitate interpretation of terrain conductivity data. Seismic refraction surveying was performed along the landfill perimeter and along eight radial lines directed away from the landfill in order to determine overburden stratigraphy and depth to bedrock. Collectively, surface geophysical findings were used to establish the final number and location of monitoring wells at the landfill. The methods and generalized results of the geophysical studies are presented in Section 4.0 of this report. A separate geophysical study report is included in Appendix A.

1.3.2 Soil Boring/Monitoring Well Installations - Soil borings and monitoring wells were installed at the site in order to directly evaluate subsurface conditions, including: overall stratigraphy, soil properties, aquifer parameters, groundwater flow and groundwater quality. A total of 28 borings were drilled at 18 locations, with a stainless steel monitoring well installed in each boring. These included 25 overburden and 3 bedrock wells. Continuous split-spoon samples were taken in the deepest boring at each location. Soil samples from the split-spoons were examined and classified by the supervising geologist in accordance with the Modified Burmister Identification System. After their installation, each of the monitoring wells was developed by pumping or bailing, depending upon the depth of well. The locations of borings and monitoring wells, together with interpretations of subsurface data, are presented in Section 4.0. The raw data produced during drilling operations are included in Appendix B (Soil Boring Logs) and Appendix C (Rock Core Logs). Appendix D provides Monitoring Well Installation Reports.

1.3.3 Organic Vapor Screening of Soil Samples - In order to evaluate vertical soil contamination profiles, split-spoon samples obtained during boring operations were scanned with a photoionization detector. Results of this organic vapor screening are presented in Section 4.0.

1.3.4 Physical Soil Testing - Selected soil samples from the borings were tested for physical properties, including moisture content (35 tests), grain size (33 sieve and 4 hydrometer tests), and Atterberg Limits (2 tests). The results are presented in Appendix E and discussed in Section 4.0.

1.3.5 Hydraulic Conductivity Testing - Slug tests were performed on all but four of the monitoring wells in order to determine the hydraulic conductivity over the screened interval of the aquifer(s). Test results are presented in Appendix F, with a discussion of these results in Section 4.0.

1.3.6 Water Level Measurements - Water level readings were taken in all monitoring wells on April 1, 1986 and November 5-6, 1986 for the purpose of evaluating groundwater hydrology and developing a groundwater contour map. On the latter sampling date, water elevations were also obtained in many of the surrounding wells which had been installed during previous investigations. Water level data are presented and discussed in Section 4.0 of this report.

1.3.7 Environmental Sampling/Analysis - In order to assess the degree and extent of contamination at the Volney Landfill, the following environmental samples were collected in accordance with previously-established and approved QA/QC protocols:

- o Groundwater samples were collected from 25 of the 28 wells installed. (The remaining 3 wells were found to be dry.)
- o Stream Water samples were collected at 7 locations along Bell Creek and Black Creek.
- o Sediment samples were taken from the stream bed surface at each of the 7 stream water sampling stations.
- o One (1) leachate sample was collected from a breakout point on the north side of the landfill.

A complete environmental sampling report, addressing the conditions encountered, methods employed, and measurements taken in the field, is presented in Appendix G.

Chemical analyses of environmental samples were performed for the following parameters:

- o Groundwater, Stream Water and Leachate samples were analyzed for Hazardous Substance List (HSL) compounds, including: volatiles, semi-volatiles, pesticide/PCB's and metals. These samples were also analyzed for total cyanide, total phenols, field measurements including pH, specific conductance and temperature and the following indicator parameters: alkalinity, ammonia nitrogen, chemical oxygen demand (COD), total hardness, total dissolved solids (TDS) and total organic carbon (TOC).
- o Sediment samples were analyzed for the same parameters as above, exclusive of the indicator parameters.

Analytical results are presented in Appendix H (Groundwater Appendix I (Stream Water and Leachate) and Appendix J (Sediment).

1.3.8 Surveying and Mapping - Field surveys were performed to determine the exact locations and elevations of all field data points (e.g., groundwater monitoring wells). Horizontal coordinates are based on the New York State Plane Coordinate System; vertical elevations are based on the USC&GS Mean Sea Level Datum of 1929. A topographic base map of the site was prepared at a scale of 1 inch = 200 feet and a contour interval of 5 feet, using existing aerial photography provided by Air Survey Corporation of Virginia from a May 8, 1985 flight.

1.4 Report Overview

This report has been organized in a format generally consistent with Chapter 9 of the USEPA's Guidance on Remedial Investigations Under CERCLA (USEPA, 1985a) and Guidance on Feasibility Studies Under CERCLA (USEPA, 1985b). Part I of the report (Sections 1.0 through 6.0) presents the remedial investigation phase of the project. Part II (Sections 7.0 through 12.0) addresses the feasibility study. Appendices are bound separately. The following list summarizes the contents of each section of the report:

- o Section 2.0 describes the site features at Volney Landfill, particularly the demography, land use, natural resources and climatology.

- o Section 3.0 identifies and discusses the hazardous substances potentially present at the site. Because the hazardous wastes from the PAS site are buried and inaccessible, and because drilling was not performed through the already-closed landfill itself, this hazardous substances investigation is based upon indirect evidence of known characteristics of waste materials at the PAS site itself and typical occurrence of hazardous substances in municipal landfill leachate, as reported in various studies.

- o Section 4.0 presents the results of a detailed hydrogeologic investigation of the Volney Landfill. It includes a description of field investigation methods, an evaluation of overburden and bedrock geology on a regional and site-specific basis, and an assessment of regional and site-specific hydrology. This section also addresses subsurface contamination of soil and groundwater.

- o Section 5.0 addresses surface water features of the site, including topography and drainage patterns, stream flow characteristics and flood potential, field investigation methods, and levels/extents of contamination observed in surface water and stream sediments near the site.

- o Section 6.0 identifies potential receptors of contamination originating at the Volney Landfill site, and assesses the impact of this contamination upon public health and the environment.

- o Section 7.0, which serves as an introduction to the feasibility stage of the project, summarizes results of the remedial investigation, presents a simplified and generalized hydrogeologic/ contamination model of the site, identifies objectives of remedial action, and sets forth the procedural logic by which alternative remedial actions will be evaluated.

- o Section 8.0 presents a technical screening of individual remedial action technologies, a combination of these technologies into preliminary remedial action alternatives, and a preliminary screening of these alternatives on the basis of environmental/public health and cost factors.

- o Section 9.0 identifies the final remedial action alternatives which are to be evaluated in detail, i.e., those which pass the preliminary alternative screening.

- o Section 10.0 includes a detailed evaluation of these selected remedial alternatives on the basis of technical, institutional, public health, environmental and cost factors.

- o Section 11.0 summarizes the remedial action alternatives, indicating their important relative features and the way they compare to one another in terms of the detailed evaluation criteria described above.

- o Section 12.0 offers a preliminary recommendation of a single remedial action alternative, a conceptual design of the component technologies comprising this alternative, and a discussion of key technical and institutional aspects related to its implementation.

2.0 SITE FEATURES INVESTIGATION

2.1 Demography

The Volney Landfill is located in a rural area of the Town of Volney, Oswego County, New York. A trailer park is located approximately 1,000 feet north of the site on Silk Road; a few houses are located within 100 feet of the site boundaries. The closest population center is the City of Fulton approximately 2 miles away (1980 U.S. Census population 13,312). The population of Oswego County as a whole was 113,901 in the 1980 census. This is approximately a 13% increase over the 1970 census population of 100,897.

2.2 Land Use

Land use in the vicinity of the Volney Landfill includes primarily woodlands and farmlands; zoning is residential. Homes are sparsely located in the area. A residential trailer park, the Kerfien Mobile Home Park, is located approximately 1,000 feet north of the site on Silk Road. The Oswego County Airport is situated southwest of the site. Near the southwest corner of the landfill, Niagara Mohawk Power Corporation operates a facility on Howard Road which is the base for transmission-line construction and maintenance crews. Numerous inactive sand and gravel pits are located in the area, including locations immediately south and east of the site. A major producer of aggregate materials and concrete products, Northern Readymix, is located about one mile south on Silk Road.

2.3 Natural Resources

Bell Creek, which flows in a southerly direction near the site, is the closest natural resource to the Volney Landfill. Most of the creek and additional land area along the reach adjacent to the landfill are NYSDEC designated wetlands. These wetlands provide a haven for fish, waterfowl, and birds which may migrate through the area. The area is also a source of aggregate. Several sand and gravel pits, both active and inactive are nearby; the landfill itself is located directly over an inactive pit.

2.4 Climatology

Climatic data for the site and vicinity was obtained from the National Climatic Data Center (National Oceanic and Atmospheric Administration (NOAA), 1985) for Syracuse over a 30-year period of record. The site is actually located closer to the City of Oswego than to Syracuse. However, given Oswego's proximity to Lake Ontario, and considering that the site is inland, Syracuse climatic data was considered more representative.

Precipitation data for a 30-year period of record (1956-85) is provided in Table 2-1. The mean annual precipitation is 36.79 inches; annual precipitation ranged from a minimum of 27.10 inches in 1964 to 58.17 inches in 1976. The mean monthly precipitation remains under 3.1 inches for most of the year, increasing to above 3.3 inches in June, July and August. Snowfall occurs from October through April, and occasionally in May. Normal, minimum and maximum precipitation for water and snow over a 36 year period of record are also provided in Table 2-1. A maximum monthly rainfall of 12.3 inches was recorded in June of 1972; a 24-hour maximum of 4.27 inches was recorded in August of 1954. A maximum monthly snow accumulation of 72.6 inches was recorded in February of 1958; a 24-hour maximum of 24.5 inches was recorded in January of 1966.

Temperature data for a 30-year period of record at Syracuse are provided in Table 2-2. The mean annual temperature is 47.6^{O}F. The highest recorded temperature was 98^{O}F in June of 1953, and the lowest recorded was -26^{O}F in both January 1966 and February 1979.

Prevailing winds are westerly, as reported in the NOAA Wind-Ceiling-Visibility Data for the Syracuse Airport (NOAA, 1981).

TABLE 2-1

PRECIPITATION DATA FOR SYRACUSE, NY

PRECIPITATION (inches) SYRACUSE, NEW YORK

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1956	2.28	3.90	4.63	3.35	3.03	1.71	3.75	8.41	4.27	1.28	2.38	3.02	42.01
1957	2.19	1.76	2.01	2.60	2.88	4.18	6.13	3.45	2.28	0.93	1.86	2.90	33.17
1958	4.46	5.28	1.31	3.36	3.70	5.24	3.63	2.06	4.89	3.37	3.76	1.73	42.79
1959	4.59	2.22	2.93	2.51	1.97	2.53	2.54	4.48	0.93	7.15	4.34	5.01	41.20
1960	3.11	4.90	2.48	2.94	3.96	1.86	1.03	2.69	2.93	2.77	1.68	1.86	32.21
1961	2.30	4.14	4.22	3.74	2.40	3.68	5.08	1.78	1.21	3.59	2.99	2.45	37.58
1962	2.87	2.96	1.96	3.57	1.05	1.10	2.74	4.63	1.99	3.30	2.22	2.25	30.64
1963	1.85	2.05	2.79	2.22	2.84	2.49	1.21	3.59	0.85	0.21	5.65	2.06	27.81
1964	2.18	1.13	3.83	3.66	2.31	1.41	2.15	3.09	0.75	1.52	2.20	2.87	27.10
1965	2.28	2.82	1.63	3.53	1.61	2.04	1.34	1.95	3.60	2.70	2.97	1.92	28.39
1966	3.98	2.96	2.27	3.05	1.79	2.73	2.09	2.64	4.75	0.90	2.05	3.93	33.14
1967	1.47	1.49	1.34	2.11	3.33	1.56	6.33	5.00	2.73	3.52	4.48	2.66	36.02
1968	2.08	1.10	3.13	2.40	3.46	6.14	3.77	4.17	3.43	5.81	4.07	4.67	44.23
1969	3.37	1.49	1.08	3.95	4.34	3.74	0.90	1.77	1.13	2.30	4.56	3.42	32.05
1970	1.02	1.84	2.45	3.68	2.79	2.93	4.42	4.07	4.33	3.84	3.53	3.33	38.23
1971	1.90	4.07	2.90	2.19	3.40	3.26	6.49	4.01	2.56	1.62	3.52	3.26	39.18
1972	1.10	2.87	2.49	4.03	6.19	12.30	3.45	3.76	4.12	4.36	6.79	3.95	55.41
1973	1.85	1.71	3.45	6.91	5.58	7.07	3.62	2.97	4.57	3.81	6.73	4.38	52.65
1974	2.08	1.70	4.34	3.09	5.78	4.67	9.52	4.60	4.45	1.58	4.95	3.47	50.23
1975	2.54	3.05	2.67	2.01	2.74	4.08	9.32	5.35	8.81	3.69	3.54	4.10	51.90
1976	2.79	2.71	4.62	8.12	7.41	7.42	5.24	6.73	3.27	6.53	1.53	1.80	58.17
1977	1.84	1.62	3.47	3.04	0.75	3.30	4.76	4.93	6.54	4.75	5.31	4.33	44.64
1978	5.77	0.80	3.08	1.87	1.90	3.58	2.78	3.31	3.93	2.68	1.25	4.12	35.07
1979	4.70	2.54	2.73	3.89	3.07	2.33	2.33	3.69	5.25	2.91	3.25	1.84	38.53
1980	1.47	1.38	4.34	3.33	1.34	4.45	2.57	1.33	3.40	2.56	2.64	3.27	32.08
1981	1.34	2.72	1.01	2.04	2.61	1.89	2.68	2.63	5.58	6.66	3.09	2.96	35.21
1982	3.59	1.26	2.63	1.71	2.87	4.64	3.83	2.60	4.22	0.72	4.52	2.55	35.14
1983	1.92	1.07	2.30	6.34	3.33	1.50	2.31	2.80	2.98	1.98	4.30	5.50	36.33
1984	1.30	2.88	2.39	3.16	4.97	2.02	3.66	5.17	2.61	1.95	3.48	4.38	37.97
1985	2.49	1.55	2.61	1.22	3.39	2.80	2.75	1.44	3.88	3.39	5.18	1.80	32.50
Record Mean	2.69	2.51	3.08	3.09	3.02	3.56	3.45	3.32	3.07	3.03	3.00	2.96	36.79

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
PRECIPITATION (inches):													
Water Equivalent													
-Normal	2.61	2.65	3.11	3.34	3.16	3.63	3.76	3.77	3.29	3.14	3.45	3.20	39.11
-Maximum Monthly	5.77	5.38	6.84	8.12	7.41	12.30	9.52	8.41	8.81	8.29	6.79	5.50	12.30
-Year	1978	1951	1955	1976	1976	1972	1974	1956	1975	1955	1972	1983	JUN 1972
-Minimum Monthly	1.02	0.80	1.01	1.22	0.75	1.10	0.90	1.33	0.75	0.21	1.25	1.73	0.21
-Year	1970	1978	1981	1985	1977	1962	1969	1980	1964	1963	1978	1958	OCT 1963
-Maximum in 24 hrs	1.47	1.99	1.34	2.85	3.13	3.88	4.07	4.27	4.14	3.60	2.09	2.18	4.27
-Year	1958	1961	1974	1976	1969	1972	1974	1954	1975	1955	1967	1952	AUG 1954
Snow, Ice pellets													
-Maximum Monthly	72.2	72.6	40.3	16.4	1.2					4.4	25.9	52.5	72.6
-Year	1978	1958	1984	1983	1973					1952	1976	1969	FEB 1958
-Maximum in 24 hrs	24.5	21.4	14.7	7.1	1.2					2.4	12.1	15.6	24.5
-Year	1966	1961	1971	1975	1973					1974	1973	1978	JAN 1966

TABLE 2-2

TEMPERATURE DATA FOR SYRACUSE, NY

AVERAGE TEMPERATURE (deg. F)

SYRACUSE, NEW YORK

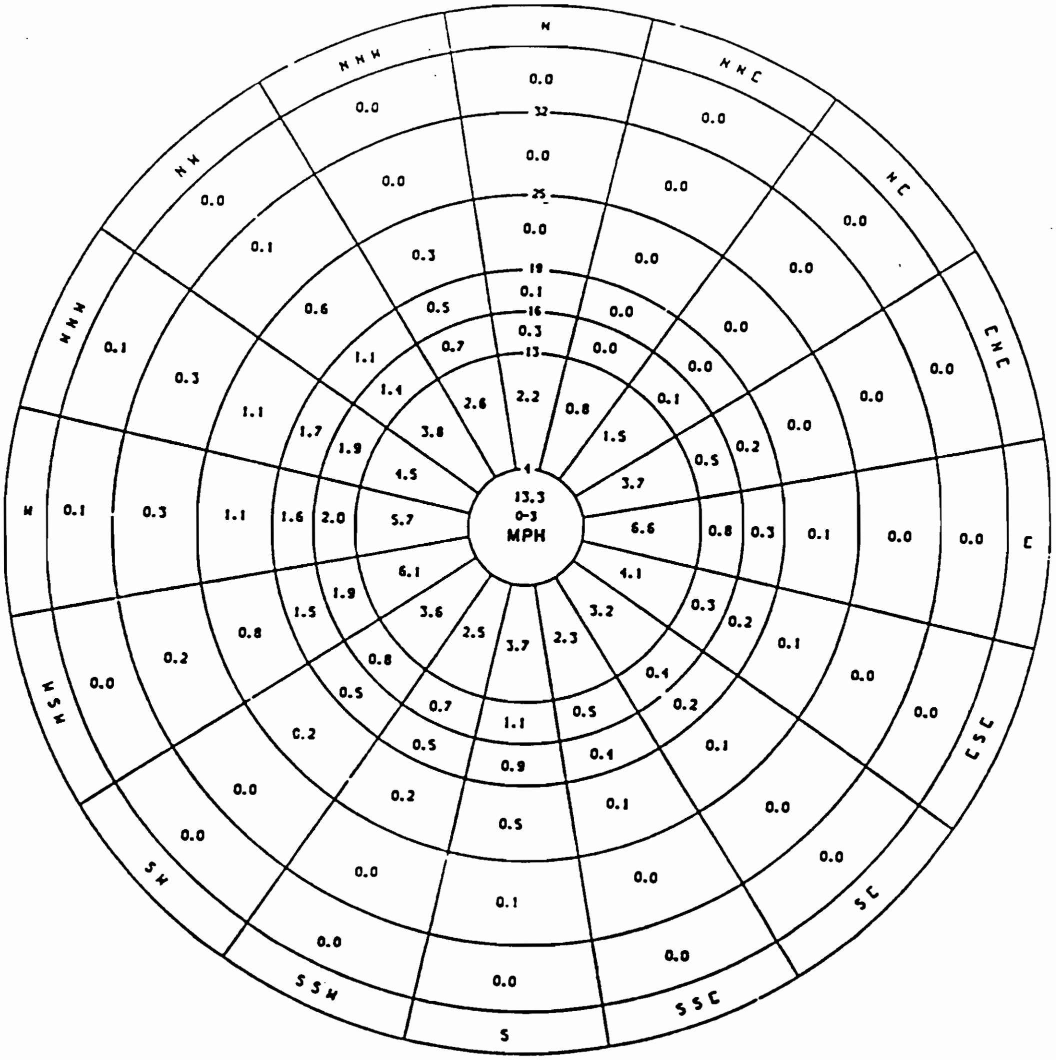
YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1956	22.6	27.0	28.5	42.9	53.4	67.0	68.2	69.2	58.8	52.7	41.2	33.3	47.1
1957	18.8	30.4	35.1	48.4	56.0	70.4	70.4	67.1	62.6	50.1	42.0	34.2	48.8
1958	21.4	19.5	34.3	48.3	54.5	62.5	70.5	69.1	61.9	50.4	41.9	19.4	46.1
1959	21.0	21.8	31.1	47.6	60.0	67.6	73.5	74.1	67.3	52.3	38.6	31.1	48.8
1960	24.7	27.0	24.4	49.5	59.8	66.6	69.4	68.7	63.8	50.0	43.8	23.7	47.6
1961	18.8	25.9	33.2	42.9	55.5	66.6	71.8	70.4	69.5	55.8	40.7	29.1	48.3
1962	24.1	21.5	34.6	47.3	62.3	68.3	69.2	69.1	59.7	51.2	35.5	24.5	47.3
#1963	20.8	18.4	34.2	45.6	54.7	66.6	71.7	66.1	57.2	56.3	44.9	20.8	46.4
1964	25.9	23.7	35.1	46.5	61.6	66.0	73.2	67.5	61.6	49.5	43.6	29.6	48.6
1965	20.5	24.6	30.3	42.3	59.4	63.7	67.5	69.1	62.8	47.9	38.7	32.1	46.6
1966	19.0	23.1	34.4	42.6	51.2	65.7	71.1	70.4	59.5	49.5	42.9	29.2	46.6
1967	30.6	19.2	31.6	44.9	50.2	69.5	67.7	66.6	60.7	51.8	37.6	32.7	46.9
1968	18.5	21.1	33.2	48.1	53.6	64.9	69.9	68.8	64.8	52.5	40.0	27.2	46.9
1969	24.3	23.6	30.4	46.9	55.7	64.5	69.9	71.3	63.8	51.1	40.4	23.8	47.1
1970	16.1	24.1	31.7	47.2	57.5	63.5	69.7	68.0	61.4	52.3	41.7	25.4	46.5
1971	18.5	26.5	31.2	42.8	55.8	67.9	69.0	67.1	65.6	56.6	36.9	33.2	47.6
1972	26.4	22.9	29.4	40.5	58.5	64.5	72.9	69.2	63.5	46.5	37.0	30.8	46.9
1973	28.4	21.4	42.6	46.8	54.3	69.6	72.7	73.5	62.0	53.7	40.7	29.5	49.6
1974	26.0	21.6	32.3	48.8	54.1	65.6	69.1	68.9	59.1	46.5	40.6	30.4	46.9
1975	29.4	28.1	31.7	39.9	62.9	67.1	71.7	68.2	57.1	53.2	46.6	27.6	48.6
1976	18.1	32.5	36.6	48.4	54.2	67.9	66.7	66.0	59.8	46.9	35.8	22.6	46.3
1977	15.7	26.0	40.1	48.2	60.3	62.7	70.8	67.3	62.5	50.6	44.0	27.3	48.0
1978	21.3	17.6	29.4	42.2	58.3	64.8	71.9	71.7	59.9	49.6	40.3	30.6	46.4
1979	22.4	12.9	39.1	45.1	58.6	66.0	71.7	67.9	61.4	50.9	44.5	33.4	47.8
1980	25.6	19.8	32.4	47.8	59.8	63.0	72.5	73.8	63.4	48.8	37.6	22.6	47.3
1981	15.0	33.7	36.4	50.0	59.2	68.0	73.3	70.4	61.6	47.9	39.0	29.0	48.6
1982	14.8	25.1	33.2	43.9	59.4	63.1	70.4	65.3	60.6	50.4	43.9	34.1	47.0
1983	23.4	26.4	35.7	44.3	53.7	66.7	72.0	69.0	62.5	50.3	39.0	22.5	47.1
1984	18.7	32.0	24.5	46.0	52.4	65.4	68.0	68.8	57.7	52.2	38.3	33.5	46.5
1985	22.0	27.3	36.3	47.8	59.5	62.0	69.8	68.9	63.5	51.4	41.2	26.0	48.0
Record													
Mean	23.6	24.1	33.4	45.4	56.9	66.1	71.1	69.2	62.2	51.4	40.2	28.2	47.6
Max	31.4	32.1	41.4	54.7	67.1	76.2	81.1	78.9	71.8	60.4	47.2	35.0	56.4
Min	15.9	16.1	25.4	36.1	46.7	56.0	61.1	59.4	52.5	42.3	33.2	21.4	38.8

 # Indicates a station relocation

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F:													
Normals													
-Daily Maximum	30.6	32.2	41.4	56.2	67.9	77.2	81.6	79.6	72.3	60.9	47.9	35.3	56.9
-Daily Minimum	15.0	15.8	25.2	36.0	46.0	55.4	60.3	58.9	51.8	41.7	33.3	21.3	38.4
-Monthly	22.8	24.0	33.3	46.1	57.0	66.3	71.0	69.3	62.0	51.3	40.6	28.3	47.7
Extremes													
-Record Highest	70	69	85	89	96	98	97	97	97	87	81	70	98
-Year	1967	1981	1977	1962	1977	1953	1962	1965	1953	1963	1950	1966	JUN 1953
-Record Lowest	-26	-26	-16	9	25	35	45	40	28	19	5	-22	-26
-Year	1966	1979	1950	1972	1966	1966	1976	1965	1965	1976	1976	1980	FEB 1979

Wind speeds average 8.4 knots (9.7 mph) for all weather over the ten year period of record (1965-74). Maximum average wind speeds were 10.3 knots (11.8 mph) for February; minimum speeds were 6.9 knots (7.9 mph) for both June and August.

A wind graph provided by NOAA is shown in Figure 2-1 for the Syracuse airport. The concentric circles show wind speed in miles per hour (mph). The individual numbers represent percentages of total observations found in each direction for the given wind speed.



URS Company, Inc. CONSULTING ENGINEERS NEW YORK NEW JERSEY	WIND GRAPH FOR SYRACUSE AIRPORT, NY	FIGURE 2-1

3.0 HAZARDOUS SUBSTANCES INVESTIGATION

3.1 Waste Types

The majority of wastes disposed of at the Volney Landfill are residential, commercial, institutional and industrial wastes, including wastewater treatment sludges. Between March 1974 and January 1975, a minimum of 5,273 (USEPA, 1986a) but approximately 8,000, barrels were accepted from the Pollution Abatement Services (PAS) hazardous waste incineration facility in Oswego, New York. The New York State Department of Environmental Conservation (NYSDEC) had previously approved the landfill for disposal of discarded barrels from PAS containing the residues of chemical sludges, with the exception of barrels containing phenols or chlorinated compounds. As estimated by the landfill operator at that time 50-200 barrels containing liquids from PAS were delivered to the site, rather than the approved sludge residues. These barrels were reportedly crushed and incorporated into the daily fill area.

Because the only reported discrete occurrence of hazardous waste deposition at the Volney Landfill involves the PAS barrels, it is noteworthy to consider the relative proportion and approximate location of these barrels at the site. According to the most recent Hazard Ranking System (HRS) score for the site, developed by the NYSDEC and approved by the USEPA, there are a minimum of 5,273 barrels from PAS corresponding to a volumetric equivalent of approximately 1,320 cubic yards. By comparison, using the average fill depth of 45 feet over the 55-acre area, the total volume of in-place fill material at the Volney Landfill is estimated to be approximately 4,000,000 cubic yards. Therefore, the hazardous wastes from PAS constitute an extremely small portion (less than 0.04 percent) of the total fill volume at the site. Regarding their location, the fact that deposition of PAS wastes occurred during 1974 and early 1975 indicates that they are located in the older, southern section of the landfill (see Figure 1-2). This implies, although not conclusively, that leachate from the area of the landfill containing the PAS barrels is not collected by the leachate collection system, which was constructed during expansion of the landfill to the north.

3.2 Waste Component Characteristics

Because the Volney Landfill has been graded and capped, and hazardous substances at the site are reportedly buried at typical depths of 20 feet (Scrudato, 1981), direct measurement and characterization of wastes are impossible. Therefore, the potential occurrence of hazardous substances within the landfill has been surmised from the following indirect evidence:

(a) the known characteristics of waste materials at the PAS site itself, from which the previously discussed barrels originated; and

(b) the general occurrence of hazardous substances in leachate and groundwater originating from municipal landfills, as studied by a number of recent investigations.

Later in the report, these potentially present hazardous substances are compared with contaminants actually observed in environmental samples from the site.

3.2.1 Characteristics of Waste Materials From the PAS Site - Between March 1974 and January 1975, approximately 8,000 barrels were accepted at the Volney Landfill from the PAS facility in the City of Oswego (USEPA, 1986a). Although the contents of these barrels are generally unknown, most of them reportedly contained residues only of non-phenolic and non-chlorinated chemical sludges. Approximately 50 to 200 of the barrels, however, contained unknown liquids.

In the absence of data concerning the contents of barrels deposited at the Volney Landfill, it is reasonable -- if somewhat speculative -- to surmise that these barrels may have contained wastes which are representative of the PAS main site from which they originated. The following tables indicate the range of waste types encountered at PAS:

- Table 3-1 identifies, on the basis of internal records, chemical compounds which were handled by PAS at the main incinerator site in Oswego and at the various "satellite" sites in Oswego County (Scrudato et al., 1983).

- Table 3-2 summarizes waste types and quantities removed from the PAS site during surficial cleanup of drums and tanks from the site (Camp, Dresser and McKee, 1983).

- Table 3-3 summarizes waste types encountered during removal of buried drums at PAS based on URS construction records.

- Table 3-4 and 3-5 indicate the chemical composition of liquids and sludges removed from buried tanks at the PAS site based on URS construction records.

It should be emphasized that the data presented in Tables 3-1 to 3-5 are strictly applicable to the PAS site only, and are presented here only to indicate the range of hazardous substances which <u>may</u> have been received from PAS at the Volney Landfill. This data demonstrates an extremely wide variety of hazardous substances, including: waste acids and alkalis, PCB-contaminated solids and liquids, halogenated organics, organic resins, solvents and heavy metals. Because of this broad range of chemical compounds which were handled at the PAS main site, it is impossible to designate individual indicator compounds, or groups of compounds, as characteristic of the PAS wastes which may have been received at the Volney Landfill.

3.2.2 <u>Hazardous Substances in Municipal Landfill Leachate</u> - Although the only specific, reported incidence of hazardous waste deposition at

TABLE 3-1

INORGANIC AND ORGANIC CHEMICAL COMPOUNDS HANDLED BY PAS, INC.
AS IDENTIFIED FROM INTERNAL PAS RECORDS (1969-1977)

Inorganic	Organic
Pb (i)	Methylene Chloride (Dichloromethane)
As (i)	Benzene (ss)
Cd (i)	Toluene
Br_2	Xylene (Dimethylbenzene) (i)
S (i)	Chloroform (ss)
Al (i)	Ethyl Alcohol (ss)
Cl_2	MEK (2-Butanone) (v)
Cr (i)	DMF (Dimethylfuran) (i)
Cu (i)	Methanol (oo)
I_2 (i)	Butanol (s)
Fe (i)	Xylenol (1,2-Dimethyl-3-Hydroxybenzene)
Hg (i)	Glycerine (Propanetriol) (oo)
Na ($NaOH+H_2$)	Trichloroethylene (ss)
Zn (i)	Ethylene Glycol (1,2-Ethanediol) (oo)
NH_4OH (s)	Methylchloroform (i)
Ni (i)	DMA (Dimethylaniline) (ss)
Co (i)	Acetaldehyde (Ethanol) (oo)
Si (i)	Pyridine (oo)
NH_4CL (s)	PCB's (i)
	Chlorinated pesticides
	Acrylonitrile (Vinyl Cyanide) (s)
	Bromoform (ss)
	Styrene
	Phenol (s)
	Formaldehyde (Methanol) (s)
	Nitrobenzene (ss)
	Chloronitrobenzene (i)
	2-Thiourea (H_2NCSNH_2) (s)
	Oleic acid (Cis-9-Octadecenoic Acid) (i)
	Allyl Alcohol (2-Propen-1-01) (oo)
	Butyl Carbitol (Diethyleneglycol Monobutyl Ether) (oo)

Notes:

1) Solubilities are given for inorganic compounds in their elemental form only.
   i = (insoluble) ss = (slightly soluble)
   s = (soluble) v = (very soluble)
   oo = (soluble in all proportions)
2) This list may contain chemical compounds handled by PAS at other sites in Oswego County, and not necessarily at the main incinerator site.

TABLE 3-2

SUMMARY OF WASTE TYPES AND QUANTITIES COLLECTED AND DISPOSED OF DURING SURFICIAL CLEANUP OF THE PAS SITE (JUNE-OCTOBER, 1982)

Description	Total Quantity of Waste
Water Reactive Liquid	237.1 gal
Organic Liquid, Low Halogen (<2%) <50 ppm PCB	20,749 gal
Organic Liquid, High Halogen (>2%) <50 ppm PCB	1,426 gal
Aqueous Acids pH <2.0	769 gal
Alkalines pH >12.5	1,819 gal
Solids, >50 ppm PCB	60.75 drums
Solids, <50 ppm PCB	3,662.1 drums
PCB Contaminated Liquid, 50-500 ppm	55 gal
PCB Contaminated Liquid, >500 ppm	144 gal
Lab Packs	3 drums
Empty Drums	2,615 drums
Collection and Handling of Washwater	63,918 gal
Neutral Aqueous <50 ppm PCB, No Cyanide, No Sulfide	165,536 gal
Collection and Handling of Sludges	123.5 drums
Disposal of Salvageable Steel to Smelter	62.42 tons
Disposal of Building Rubble to Landfill	123.42 tons

TABLE 3-3

SUMMARY OF WASTE TYPES AND QUANTITIES COLLECTED AND DISPOSED OF
DURING DRUM EXCAVATION AND REMOVAL AT THE PAS SITE
(DECEMBER 1985 - JULY 1986)

Description	Total Quantity of Waste
Aqueous, low TOC, pH 2-12.5, No CN	84.5 gal
Aqueous, high TOC, pH 2-12.5, No CN	499.9 gal
PCB Liquids, 50-500 ppm PCB	60.4 gal
PCB Liquids, >500 ppm PCB	94.3 gal
PCB Solids, >50 ppm PCB, High F.P.	1,656.7 cf
Organic Solids, <50 ppm PCB, High F.P.	11,239.4 cf
Organic Solids, <50 ppm PCB, Med. F.P.	14,703.9 cf
Organic Solids, <50 ppm PCB, Low F.P.	4,338.1 cf
Bulk Contaminated Soil	14,227.5 cy
Solid, Sulfides	7,948.7 cf

TABLE 3-4

SUMMARY OF TANK LIQUID WASTE ANALYTICAL DATA
FROM TANKS EXCAVATED AND REMOVED AT THE PAS SITE
(FEBRUARY - JULY, 1986)

Tank No.	6	7	9A	10
VOLATILE COMPOUNDS				
Acetone		3,900	920	9,500
Acryloritrile				54
Ethylbenzene		43	23	
Methylene Chloride		310		
Methyl Isobutyl Ketone	160	120	65	140
2-Propanol		46		
Toluene	27		27	
Xylenes		160	65	
PESTICIDES/PCB's				
Alpha-BHC				.003
Gamma - BHC				.001
PCB's				
1242		290 (oil layer)		
1248			3.0-9.93	533
1260		5,200 (oil layer) 800 (mixed)		
METALS/INORGANICS				
Arsenic		4.6		
Cadmium	0.02	0.02-0.77	0.03	
Chromium	0.10		0.05	0.05
Lead	0.09		0.29	
Cyanide	0.75	24	0.6	16.5
Sulfide		53	23	31

Notes:

1) Units are mg/l or mg/kg (ppm).
2) Blanks indicate compounds were below detection limits or analysis was not performed.

TABLE 3-5

SUMMARY OF TANK SLUDGE ANALYTICAL DATA
FROM TANKS EXCAVATED AND REMOVED AT THE PAS SITE
(FEBRUARY - JULY, 1986)

Tank No.	6	7	9A	9B	10
VOLATILE COMPOUNDS					
Benzene	60				
Chlorobenzene	72				
Chloroform	97				
1,2-Dichlorobenzene	25				
1,2-Dichloroethane	73				
Ethylbenzene	2,800				
Methylene Chloride	640				
Methyl Isobutyl Ketone	1,600				
Tetrachloroethylene	450				
Toluene	9,900				
1,1,1-Trichloroethane	46				
Trichloroethylene	1,200				
PCB's					
1242	2-6	47-73	59-280		2,390
1248	3		20-45	358-523	
1254			81-99		534
1260	3	243-1,480	25-50		57
METALS/INORGANICS					
Arsenic	2.9	2.7-14.9	1.6-11	29	8.6
Cadmium	3.3		9.8-40	8	22
Chromium	310	40-52.5	1,600-9,620	560	590
Lead	1,150	130-213	6,800-39,000	1,700	6,000
Mercury	0.24	0.77-1,000	0.93	0.95	1.1
Nickel		23-50		30	49
Chloride	2,600	13,100-13,800	44,600-79,200	18,200	26,400

Notes:

1) Units are ug/g (ppm) for volatiles and PCB's.
2) Units are ug/g (ppm) wet weight for metals.
3) Analyses of volatile compounds for Tank 6 are based on mean values for solidified sludge.
4) Blanks indicate compounds were below detection limits or analysis was not performed.

the Volney Landfill involves the barrels from PAS, it would be incorrect to assume that all hazardous substances detected in environmental samples from the landfill vicinity are attributable to this source. Other municipal, commercial and industrial waste sources undoubtedly influence the composition of leachate and may, in aggregate (and by virtue of their relative volumetric proportions), play a much larger role in the overall character of Volney Landfill leachate. This is true of not only the common indicator parameters (e.g., chloride, iron, COD and specific conductance), but also the hazardous substances present in the leachate.

Municipal landfills, and the leachate produced from municipal landfills, typically contain a significant number of chemical compounds which are designated as being hazardous. Although most investigations have dealt with the more common and non-hazardous indicator parameters, such as those cited above, a number of recent studies have addressed the hazardous substances present in municipal landfill leachates. For example, Sabel and Clark (1983), Sawhney and Kozloski (1984), and Mureebe et al. (1986) have all evaluated the composition of leachate from various municipal landfills in terms of hazardous substance components. Their results are summarized in Table 3-6. As seen from this table, a fairly wide variety of Hazardous Substance List (HSL) compounds were found to be present in the leachate from these landfills. It is reasonable to infer from these results that, at Volney Landfill, a variety of HSL compounds would occur under any circumstances, and that the effect of PAS wastes located on-site would be superimposed upon this occurrence.

TABLE 3-6

HAZARDOUS SUBSTANCES DETECTED IN MUNICIPAL LANDFILL LEACHATE

Compound	No. of Sites Total	No. of Sites Detected	Concentration Range (ug/l) Low	Concentration Range (ug/l) High
Chloromethane	11	5		170 *
Bromomethane	11	2		170 *
Vinyl Chloride	11	3	10	61 *
Chloroethane	12	6	62	170 *
Methylene Chloride	16	13	40	20,000
Acetone	13	9	18	13,000
1,1-Dichloroethane	14	10	.6	6,300
Chloroform	17	5	14.8	1,300
1,2-Dichloroethane	17	6	5.5	11,000
1,1,1-Trichloroethane	12	3	7.6	2,400
1,1,2,2-Tetrachloroethane	5	1		210
1,2-Dichloropropane	12	5	2	81
1,1,2-Trichloroethane	11	1		500
Benzene	18	12	4	540
Toluene	15	14	7.5	6,362
Chlorobenzene	6	2	1.5	60
Ethyl Benzene	14	11	12	820
Total Xylenes	6	6	12	170
1,4-Dichlorobenzene	7	4	7.7	16
1,2-Dichlorobenzene	6	3	10	32
Isophorone	1	1		67
Naphthalene	1	1		10
Diethylphthalate	1	1		76
Methyl Ethyl Ketone	11	7	110	27,000
Arsenic	1	1		18
Cadmium	1	1		15
Chromium	1	1		240
Copper	1	1		27
Lead	1	1		90
Nickel	1	1		390
Selenium	1	1		7
Zinc	1	1		12,000
Cyanide, Total	1	1		100
Phenols, Total	1	1		4,000

Notes:

1) * indicates concentration data not available for all sites.

4.0 HYDROGEOLOGIC INVESTIGATION

4.1 Field Investigation Methods

Remedial investigation activities were previously summarized in Section 1.3 of this report. The following section expands upon this summary by identifying and briefly discussing the methods of investigation associated with these activities. Since further detail concerning investigation methods may be found in the Health and Safety Plan (URS Company, 1985a) and the Work/QA Project Plan (URS Company, 1985b), the discussion below is limited to major features of the investigation methods and/or points of deviation between the actual field methods and those outlined in the prior work plans.

4.1.1 Surface Geophysical Studies - Surface geophysical studies were conducted at the Volney Landfill from September 25 to October 11, 1985 using the techniques of terrain conductivity profiling, electrical resistivity sounding and seismic refraction surveying. Terrain conductivity profiling along the perimeter of site, using Geonics EM-31 and EM-34 Terrain Conductivity Meters, provided information on lateral variations in shallow stratigraphy and groundwater. Electrical resistivity sounding was performed with a Bison Instruments Model 2350 Earth Resistivity Meter along the same perimeter traverse to determine general variations in subsurface electrical properties with depth in order to facilitate interpretation of the terrain conductivity data. This preliminary information was used to evaluate and modify the proposed monitoring well program, and to interpolate subsurface conditions between boreholes. Seismic refraction surveying was performed using a NIMBUS ES-1210 Multichannel Signal Enhancement Seismograph along the landfill perimeter and along eight radial lines directed away from the landfill to determine overburden stratigraphy and depth to bedrock.

The findings of the surface geophysical studies are presented in Appendix A. These geophysical results, along with logs of previously-drilled wells, provided a technical basis for establishing final drilling locations and number of wells. The locations and number of wells were selected to provide adequate soil and groundwater samples in areas of anomalous geophysical readings and to provide a suitable distribution of wells among stratigraphic units.

4.1.2 Soil Boring/Monitoring Well Installations

4.1.2.1. General Description - Drilling operations at the Volney Landfill site commenced on January 10, 1986 and were completed February 8, 1986. Results of the drilling operations are presented in Appendix B (Soil Boring Logs) and Appendix C (Rock Core Logs). Appendix D provides the Monitoring Well Installation Reports.

Drilling was conducted by John Mathes and Associates, Inc. of Columbia, Illinois, and by A.W. Kincaid of Canastoga, New York, under the constant observation of on-site geologists from Dunn Geoscience Corporation. John Mathes and Associates mobilized two CME-55 drilling rigs to the site to conduct the soil drilling and sampling and to drill rock core samples. A.W. Kincaid mobilized one TH-60 drilling rig to the site to install casing prior to drilling the bedrock core borings and to drill one deep, unsampled soil boring into lodgement till (VBW-10D).

Soil boring/monitoring well locations are shown on Figure 4-1. Table 4-1 summarizes boring locations and sampling methods. A total of 28 borings were drilled at 18 locations with a monitoring well installed in each boring. These included 25 overburden (soil) wells and 3 bedrock wells. Of these borings, 19 were drilled within the site boundaries and 9 were outside. Single wells were drilled at 12 locations, while multiple well installations include 2 wells each at 3 locations, 3 wells each at 2 locations and 4 wells at 1 location.

Well designations were assigned as follows. Single wells were given no suffix, with the exception of VBW-17A where "A" refers to alternate. For well pairs, the shallow and deep overburden wells were given the suffixes "S" and "D", respectively. For three-well clusters,

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MONITORING WELL LOCATIONS

FIGURE 4-1

TABLE 4-1

SOIL BORING/MONITORING WELL LOCATIONS AND SAMPLING METHODS

Well[1] No.	Coordinates Northing(Y)	Easting(X)	Ground Elevation (ft)	On-site/ Off-site	Soil/Rock Sampling
VBW-1	1222301.567	555053.224	490.69	Off	Standard
VBW-2	1222839.826	553986.826	486.69	Off	Standard
VBW-3S	1223121.026	553264.158	473.38	On	None
VBW-3I	1223111.627	553267.449	472.98	On	None
VBW-3D	1223119.940	553271.749	473.38	On	Continuous
VBW-3BR	1223128.600	553274.996	473.70	On	Rock Core
VBW-4S	1223390.471	553610.844	483.46	On	None
VBW-4D	1223380.503	553609.651	483.30	On	Standard
VBW-5	1223858.361	553374.502	474.92	On	Standard
VBW-6	1225122.098	554215.090	455.67	On	Standard
VBW-7S	1224833.770	554740.655	453.71	Off	Standard
VBW-7D	1224845.851	554735.574	453.41	Off	None
VBW-8S	1224251.927	554760.454	461.56	On	None
VBW-8D	1224254.833	554769.227	461.20	On	Continuous
VBW-8BR	1224260.409	554762.522	461.08	On	Rock Core
VBW-9S	1223451.872	555028.486	494.32	On	None
VBW-9D	1223443.063	555030.526	494.28	On	Standard
VBW-10S	1222740.764	555146.546	492.48	On	Continuous
VBW-10D	1222757.629	555142.556	494.31	On	None
VBW-10BR	1222724.516	555147.944	492.98	On	Rock Core
VBW-11	1221370.167	555394.770	491.34	Off	Standard
VBW-12	1222524.449	554617.169	495.79	Off	Standard
VBW-13	1223324.919	552608.100	466.98	Off	Standard
VBW-14	1225094.816	554737.981	454.65	Off	Standard
VBW-15	1223644.361	555190.117	449.47	Off	Standard
VBW-16	1222564.786	552579.977	465.52	Off	Standard
VBW-17	1224224.793	555342.157	455.87	Off	Standard
VBW-17A	1224154.898	555234.872	447.60	Off	Standard

Notes:
1) S = Shallow; I = Intermediate; D = Deep; BR = Bedrock; A = Alternate.

the overburden wells were similarly suffixed "S" and "D" and the bedrock well was given the suffix "BR". Four-well cluster VBW-3 was similarly designated, with the addition of the suffix "I" for the intermediate-depth overburden well.

4.1.2.2 Soil Borings and Samples - Soil borings were advanced using 4 1/4-inch inside diameter (I.D.) hollow-stem augers. Two CME-55 drill rigs were used for soil borings, except for boring VBW-10D which was advanced with the TH-60 air rotary rig due to the extremely dense lodgement till encountered.

Split-spoon samples were collected in accordance with the Work/QA Project Plan, with continuous sampling in the deepest overburden boring at each of the three-well and four-well cluster locations of VBW-3, VBW-8 and VBW-10. Thin-wall tube (Shelby tube) samples were not collected because clay soils suitable for this type of sampling were not encountered. Some soils containing clays were encountered in borings VBW-7D and VBW-8D; however, these soils contained significant sand and silt fractions and, as such, were non-cohesive and not suitable for thin-wall tube samples and laboratory permeability tests.

Soil samples were examined and classified by the inspecting geologist upon opening of the split-spoon sampler. Classification was based upon the Modified Burmister Identification System (discussed in Appendix B) and the Unified Soil Classification System (A.S.T.M. Standard D-2487). A log of each sampled boring was prepared during drilling, and is presented in Appendix B.

4.1.2.3 Monitoring Well Installations in Soil - Monitoring wells were installed largely as defined in the Work/QA Project Plan. All overburden wells consist of 2-inch I.D. stainless steel risers and screens. Construction details and materials used for each of the wells are presented in Appendix D. In most cases, soil stratigraphy indicated that a seal of bentonite below the well screen would serve no purpose, so that seal was omitted. In wells with a shallow water table, a bentonite slurry seal was installed above the well screen, rather than a bentonite pellet seal. This modification was made because of the difficulty in working with pellets below the water table.

Wells VBW-9S and VBW-10S were installed in fill materials because a sand and gravel unit was not encountered. Fill materials sampled were wet and were thought to be below the water table. These wells were later found to be dry, however, as was well VBW-9D, screened in glacial till.

4.1.2.4 Monitoring Well Installations in Bedrock - Minor modifications were made to the Work/QA Project Plan for drilling and installation of bedrock monitoring wells. A TH-60 air rotary drill rig was used to install the permanent casing at each bedrock monitoring well. An 8-inch nominal tricone roller bit was used to drill the borings. Temporary 8-inch steel casing in 21-foot sections was advanced with the bit to promote circulation of drilling air and cuttings and to prevent formational collapse. The boring was advanced 5 feet into rock to create a rock socket, with the temporary casing advanced part way into the bedrock.

Four-inch flush joint stainless steel casing with a screw-on teflon bottom cap was lowered to the bottom of the boring. A stainless steel centralizer was attached 2 feet from the bottom of the casing to ensure an even distribution of grout in the socket. A 1-inch tremie pipe was then lowered in the annulus to the bottom of the rock socket and a 30:1 cement/bentonite grout mixture was pumped into the annulus until it reached a point 2 feet from the ground surface. The 8-inch temporary casing was then removed in 21-foot lengths and additional grout was added.

Removal of casing and grout injection continued until all temporary casing was removed and grout was noted at the surface. The tremie pipe was then removed. This procedure was modified during the installation of two wells, VBW-8BR and VBW-10BR. In the case of well

VBW-8BR, grouting began as described above, with the tremie pipe at the bottom of the boring. Grout filled the temporary casing which was then pulled back 21 feet and the top 21-foot segment of temporary casing was removed. At this point the grout pump failed; however, the casing was removed properly, with grout continually added by hand maintaining the proper seal. In the case of well VBW-10BR, grouting and casing removal proceeded as described above until the casing was pulled back above a depth of 20 feet. At this point, which is at the top of till and base of fill, continued grouting did not provide any rise in grout level in the boring because grout was apparently moving laterally through the fill. Cuttings of glacial till were used to fill the annulus between the borehole and the 4-inch stainless steel casing above the depth of 20 feet up to the depth of 1.5 feet, at which depth the protective casing was cemented in place.

After allowing the grout to set around the casing for at least one week, a CME-55 drill rig cored through the bottom teflon plug and at least 5 feet into the bedrock. The recovered core was logged by the on-site geologist. Rock core logs are presented in Appendix C. Monitoring well installation reports are included in Appendix D.

4.1.2.5 Monitoring Well Development - Because of site accessibility limitations and heavy snow cover, monitoring wells were developed by suction lift pumping and/or bailing, rather than the modified air-lift method described in the Work/QA Project Plan.

Fifteen wells were developed by intermittent pumping using an above-ground centrifugal pump, the Water Bug, manufactured by Homelite. Well-dedicated 0.5-inch polyethylene tubing was used with the pump. Nine wells, including the bedrock wells, were developed by removing water with well-dedicated polyvinyl chloride bailers. Two exceptions were wells VBW-5 and VBW-4S, which were developed with the same bailer after thorough rinsing with deionized water. Bailers were utilized when the depth of water in a well exceeded the 20-foot lift capacity of the pump. Both a bailer and the pump were used to develop VBW-5.

The well water volume was calculated prior to development. For wells screened in soil materials, a minimum of 5 well volumes were removed. Development continued until water cleared or the turbidity of the water reached a steady state. For bedrock wells VBW-3BR and VBW-8BR, a minimum of 3 well volumes were removed. Recharge to well VBW-10BR was so slow that less than 2 volumes were removed. Additionally, water removed from well VBW-10BR had an odor of cement grout.

4.1.2.6 Decontamination Procedures - Each drill rig was steam-cleaned upon arrival at the site and before departure from the site. All in-boring equipment, such as hollow-stem augers, 8-inch casing and drill rods were steam-cleaned between each boring. Split-spoon samplers were cleaned with a brush and a non-phosphate detergent solution and rinsed between each sample. All stainless steel well screen and riser pipe were steam-cleaned before installation.

4.1.3 Organic Vapor Screening of Soil Samples - Because of cold and windy field conditions, field screening of split-spoon soil samples was not feasible. Rather, a model TIP photoionization detecter, manufactured by Photovac Incorporated, was used to screen soil samples in the following manner. After opening the split-spoons, soil samples were quickly extracted, placed in jars, covered with aluminum foil and tightly sealed. Jars were not completely filled so that some headspace was left in the jar. Sample jars were placed in the work trailer and allowed to reach room temperature. Soil samples were then scanned with the TIP by inserting the probe through the aluminum foil and recording the reading.

4.1.4 Physical Soil Testing - Selected soil samples obtained from the soil borings were tested for moisture content, grain size and Atterberg Limits. A total of 35 moisture contents, 33 coarse- and fine-grained sieve analyses and 2 Atterberg Limit tests were conducted. Additionally, hydrometer analyses were performed on 4 samples passing the #200 sieve. Tests were conducted in accordance with the Work/QA

Project Plan and A.S.T.M. specifications. Results are presented in Appendix E.

4.1.5 Hydraulic Conductivity Testing - Hydraulic conductivity tests were performed on all but four wells. Wells VBW-9S, VBW-9D and VBW-10S were dry; therefore, no tests were conducted in these wells. Well VBW-10BR was apparently affected by grout intrusion into the bedrock and was not tested.

All tests were slug tests because many of the water table wells contained insufficient water to conduct a reliable bail test. A slug of 1, 2 or 3 gallons of potable water was used, depending upon well capacity and the amount of water needed for a reliable data curve. Data was analyzed using the methods described in the Work/QA Project Plan. Additional details of data acquistion and analyses are presented in Appendix F.

4.1.6 Water Level Measurements - Water level measurements were taken in each well several times during drilling and well development. A complete set of water level readings was made on April 1, 1986, and again on November 5-6, 1986. A model 51453 water level indicator manufactured by Slope Indicator Company was used. This is an electronic device which emits an audible sound when the probe contacts water. Depths to water were taken from the measuring point (MP), to the nearest 0.01 foot. The MP for April readings was the top of riser pipe, and in November the top of casing was used. The probe was thoroughly rinsed with deionized water between wells.

4.1.7 Groundwater Sampling/Analysis - Groundwater sampling was performed using the detailed procedures outlined in the approved Work/QA Project Plan. An environmental sampling report, addressing actual field conditions encountered and methods of operation, is presented in Appendix G. Laboratory analyses were performed by NYTEST Environmental, Inc., a "Technically Acceptable" laboratory under the New York State Superfund Program. Analyses were performed in accordance with the USEPA

Caucus Organics and Inorganics Protocols for the Contract Laboratory Program (CLP) (USEPA, 1985c).

Initially, groundwater samples were collected at the Volney Landfill during the period from February 18 to March 14, 1986. However, due to a laboratory violation of holding times for these samples, it was necessary to resample wells during the period from July 21 to July 30, 1986. The groundwater analytical results which are presented in Appendix H, and discussed in subsequent sections of this report, are based on the latter sampling round.

4.2 Geology

This section discusses the geomorphology, overburden and bedrock geology of the Volney Landfill site. This discussion was developed through a review of work conducted by previous investigators, an interpretation of topographic maps of the area, and field and laboratory investigations conducted specifically for this remedial investigation. Field investigations include surface geophysical surveys, observations made at field exposures, and an extensive test boring program which collected soil and bedrock samples from 21 borings. Laboratory analyses were conducted to measure physical properties of selected soil samples.

Results of the surface geophysical study are discussed in detail in Appendix A. Detailed logs of all sampled soil borings are presented in Appendix B. Rock core boring logs are in Appendix C. Reports of physical soil analyses are in Appendix E. This data is summarized in the following discussions, tables and figures.

4.2.1 Regional Geomorphology - The site is situated in the Lake Ontario section of the Interior Lowlands physiographic province. This is a region of gently rolling hills and intervening flatlands, with elevations that range from 246 feet at Lake Ontario to hilltops between about 400 and 600 feet. The region is underlain by gently dipping clastic sedimentary rocks (sandstones, siltstones and shales) of Lower

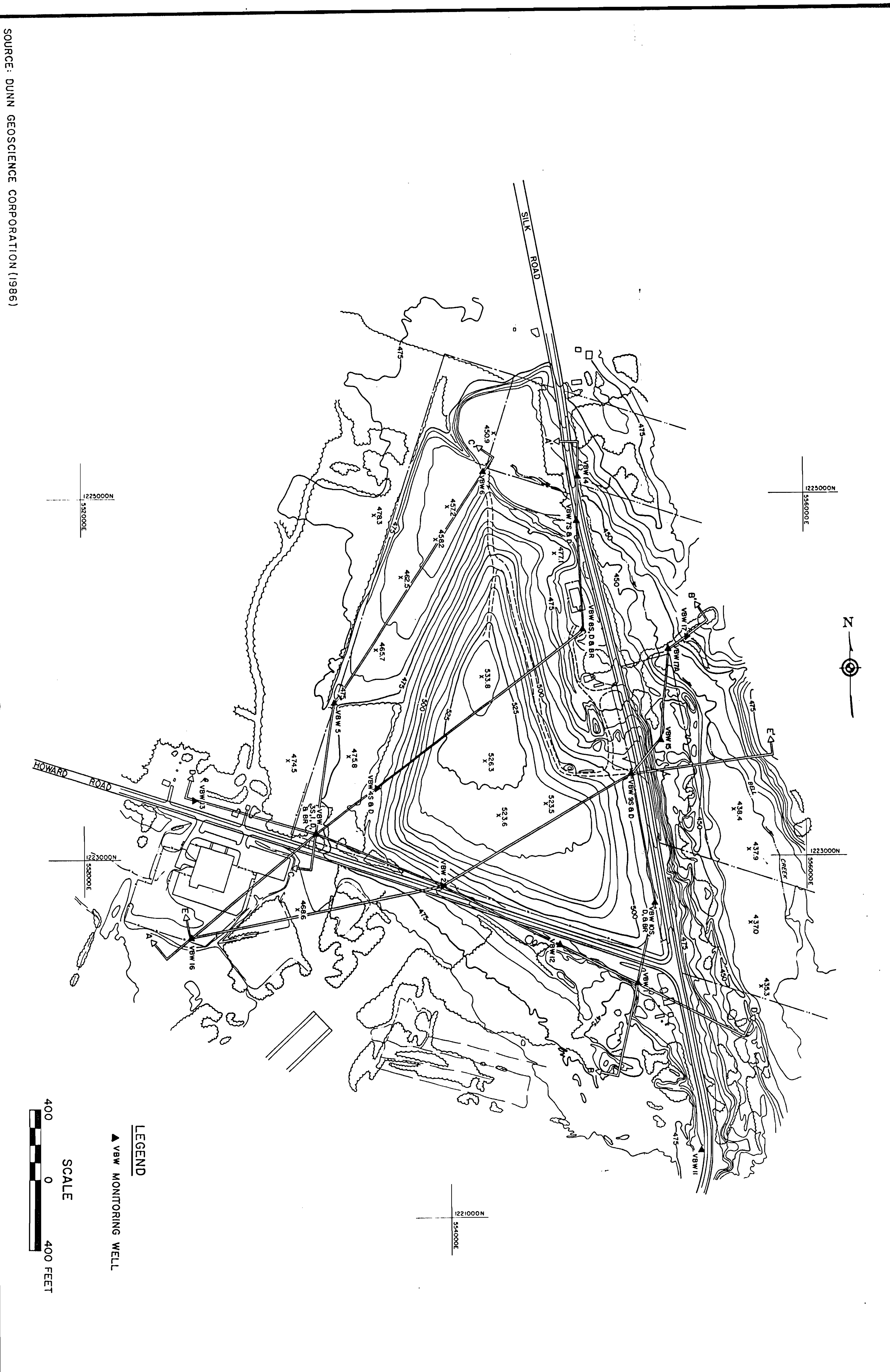
Paleozoic Ages. Bedrock does not typically outcrop due to an overlying mantle of unconsolidated materials, primarily consisting of glacial deposits. Glacial deposits include a nearly ubiquitous mantle of glacial till, which is locally formed into elongated ridges or drumlins, and a variety of glacial meltwater sand and gravel deposits, and fine-grained glacial lake (lacustrine) sediments. Typically, drumlins form the hilltops of the region. In the lower elevations, glacial till is covered with glacial meltwater deposits, glacial lake deposits, alluvium, and swamp deposits (peat and muck).

4.2.2 Soil Geology

4.2.2.1 Soil Borings - A total of 18 soil borings were drilled in which soil samples were collected with a split-spoon sampler. Boring locations are indicated on Figure 4-1. Table 4-1 summarizes boring location and sampling methods. Split-spoon samples were generally taken at standard intervals (i.e., one sample every five feet). Continuous sampling was conducted at multiple-well clusters VBW-3, VBW-8 and VBW-10, to provide additional detail.

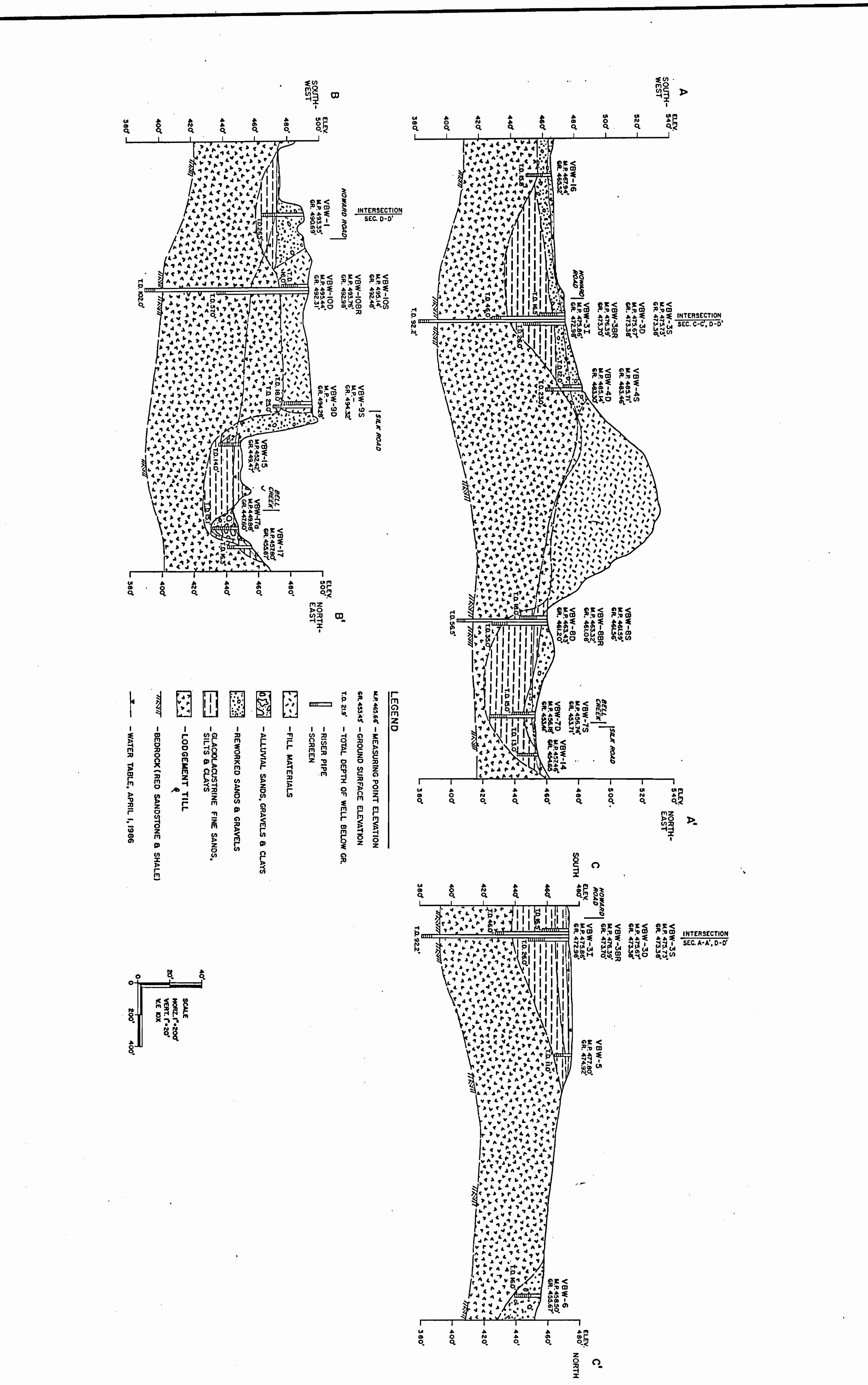
Soil boring logs were prepared during drilling by the on-site geologist. These logs, presented in Appendix B, were used to prepare five interpretive cross-sections of the site's subsurface stratigraphy. Locations of cross-section lines are shown on Figure 4-2. The cross-sections themselves are shown on Figures 4-3 and 4-4.

4.2.2.2 Stratigraphic Sequence - Unconsolidated materials have been grouped into several generalized stratigraphic units. A summary of the depth and elevations of major units encountered during drilling is presented in Table 4-2. A generalized sequence of stratigraphic units is shown on Figure 4-5.



URS Company, Inc. CONSULTING ENGINEERS NEW YORK NEW JERSEY	LOCATION OF GEOLOGIC CROSS-SECTIONS	FIGURE 4-2

C-1457



SOURCE: DUNN GEOSCIENCE CORPORATION (1986)

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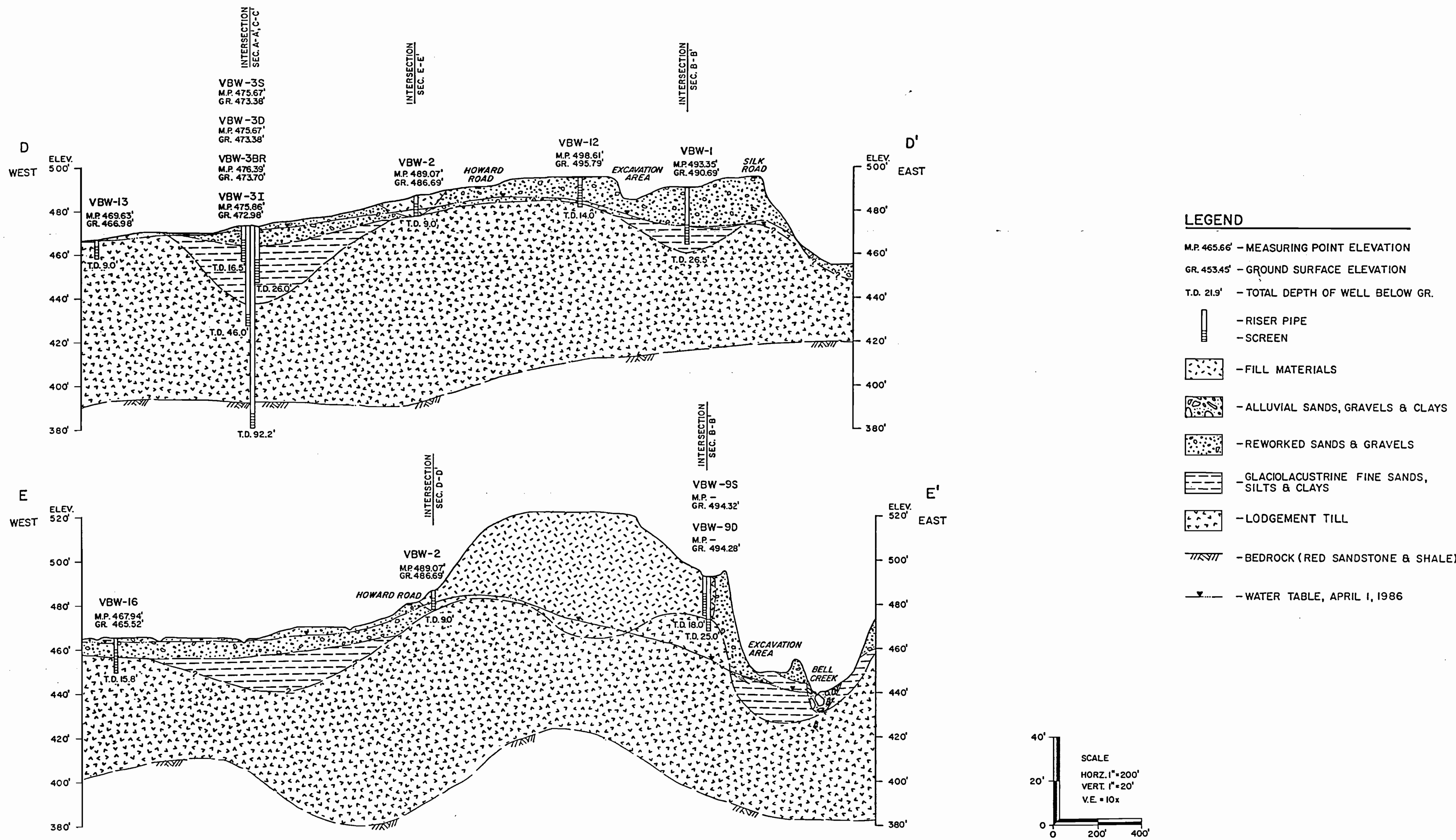
GEOLOGIC CROSS-SECTIONS: A-A', B-B', C-C'

FIGURE 4-3



SOURCE: DUNN GEOSCIENCE CORPORATION (1986)

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GEOLOGIC CROSS-SECTIONS: D–D', E–E'

FIGURE 4-4

TABLE 4-2

DEPTHS AND ELEVATIONS OF STRATIGRAPHIC UNITS

Boring No.	Ground Elevation	Silt, Sand & Gravel Thickness (1)	Lodgement Till		Bedrock	
			Depth	Elevation	Depth	Elevation
VBW-1	490.69	>28.0	--	<462.69	--	--
VBW-2	486.69	--	9.0	477.69	--	--
VBW-3D	473.38	36.0	36.0	437.38	--	--
VBW-3BR	473.70	--	--	--	81.0	392.70
VBW-4S	483.46	--	--	--	--	--
VBW-4D	483.30	15.0	15.0	468.30	--	--
VBW-5	474.92	12.0	12.0	462.92	--	--
VBW-6	455.67	>18.0	--	<437.67	--	--
VBW-7S	453.71	30.0	30.0	423.71	--	--
VBW-8D	461.20	29.0	29.0	432.2	--	--
VBW-8BR	461.08	--	--	--	46.5	414.58
VBW-9D	494.28	--	19.5	474.78	--	--
VBW-10S	482.48	--	18.0	474.48	--	--
VBW-10BR	492.98	--	--	--	91.0	401.98
VBW-11	491.34	>25.0	--	<466.34	--	--
VBW-12	495.79	12.5	12.5	483.29	--	--
VBW-13	466.98	1.0	1.0	465.98	--	--
VBW-14	454.65	15.2	15.2	439.45	--	--
VBW-15	449.47	>16.0	--	<433.47	--	--
VBW-16	465.52	9.1	9.1	456.42	--	--
VBW-17	455.87	8.5	8.5	447.37	--	--
VBW-17A	447.60	>16.0	--	<431.60	--	--

Notes:
1) Unit consists of glaciolacustrine fine sand and silt, reworked sand and gravel, alluvium and fill, all overlying glacial lodgement till.
2) All measurements are in feet.

STRATIGRAPHIC UNIT	LITHOLOGY	DESCRIPTION	THICKNESS (FEET)
ARTIFICIAL FILL		ROAD FILL MATERIALS, LANDFILL DEBRIS	0 TO 60
ALLUVIUM AND SWAMP DEPOSITS		SAND, GRAVEL, SILT, PEAT, MARL, MUCK, CLAY	NOT DISCERN-ABLE IN BORINGS
REWORKED SAND AND GRAVEL		SILTY AND CLEAN SAND AND GRAVEL	4 TO 25
GLACIOLACUSTRINE FINE SAND & SILT		FINE SAND AND SILT	0 TO 34
LODGEMENT FILL		COARSE TO FINE SAND, LITTLE SILT AND CLAY, SOME GRAVEL	16 TO 73
BEDROCK		FINE-GRAINED SANDSTONE WITH INTERBEDS OF CLAY/ SHALE	900

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GENERALIZED SEQUENCE OF SOIL STRATIGRAPHIC UNITS

FIGURE 4-5

Surface exposures of bedrock were not observed anywhere at the site or in the immediate vicinity of the site. Seismic data (Appendix A) and bedrock borings indicates that the depth to bedrock ranges from approximately 30 to 100 feet.

Immediately overlying bedrock is a unit of glacial lodgement till. Lodgement till is a material deposited at the base of an advancing glacier. This unit was found to be areally continuous in the site area.

Overlying the lodgement till unit there occur a variety of discontinuous deposits which formed during regional deglaciation. Glaciolacustrine deposits of fine sand and silt were encountered immediately overlying lodgement till in topographically low areas.

The uppermost deposit of deglaciation is a discontinuous veneer of sand and gravel which, at one time, mantled much of the site area. Former mining operations have removed some of these deposits. This unit is predominantly gravel along the steep slopes immediately east of Silk Road. This surficial sand and gravel unit has previously been mapped as a beach sand and gravel unit and, in the more gravelly area east of Silk Road, as a wave delta sand and gravel unit (Miller, 1980a). These units have been grouped into one hydrogeologic unit during this study, and are referred to as a reworked sand and gravel unit.

An alluvial unit is recognized as the uppermost natural stratigraphic unit in a small area adjacent to Bell Creek in the topographic low east of Silk Road.

Finally, an artificial fill unit consists of the debris and soil-cover materials comprising the landfill proper, as well as minor roadbed fill materials.

4.2.2.3 Descriptions of Soil Strata

4.2.2.3.1 Lodgement Till - The lowermost and oldest unit of the unconsolidated stratigraphic sequence is a compact to very compact glacial lodgement till. The compact nature of the lodgement till is a result of its deposition at the base of an advancing continental ice sheet.

Lodgement till was molded during deposition into elongated ridges or drumlins. Approximately 35 drumlins have been identified within a 3-mile radius of the Volney Landfill. Orientation of the long axes of drumlins indicate the general flow direction of glacial ice over the region was about S25°E.

Drumlins are prominent both to the north and south of the site. In the site area, however, drumlins are somewhat less prominent. This is, in part, due to deposition of post glacial deposits in the topographic lows between drumlins, as evident in the cross-sections (Figures 4-3 and 4-4). Another possible factor is the erosion of drumlin forms by wave erosion during elevated post-glacial lake levels in Glacial Lake Iroquois following deglaciation.

Drilling into the lodgement till was very difficult. Penetration resistance to the driven split-spoon sampler was often over 100 blows per foot of sample. Sampler refusal, defined as 100 blows with less than 6 inches of penetration, was common and hollow-stem auger penetration was difficult. None of the three borings, which were planned for continuous sampling to bedrock (VBW-3, VBW-8 and VBW-10), were able to be sampled through the entire till section.

Lodgement till samples are typically reddish-brown in color. This suggests it was derived from the underlying sedimentary rocks which are similarly colored. Additionally, a relatively high percentage of the pebbles observed in samples were noted to be local lithologies.

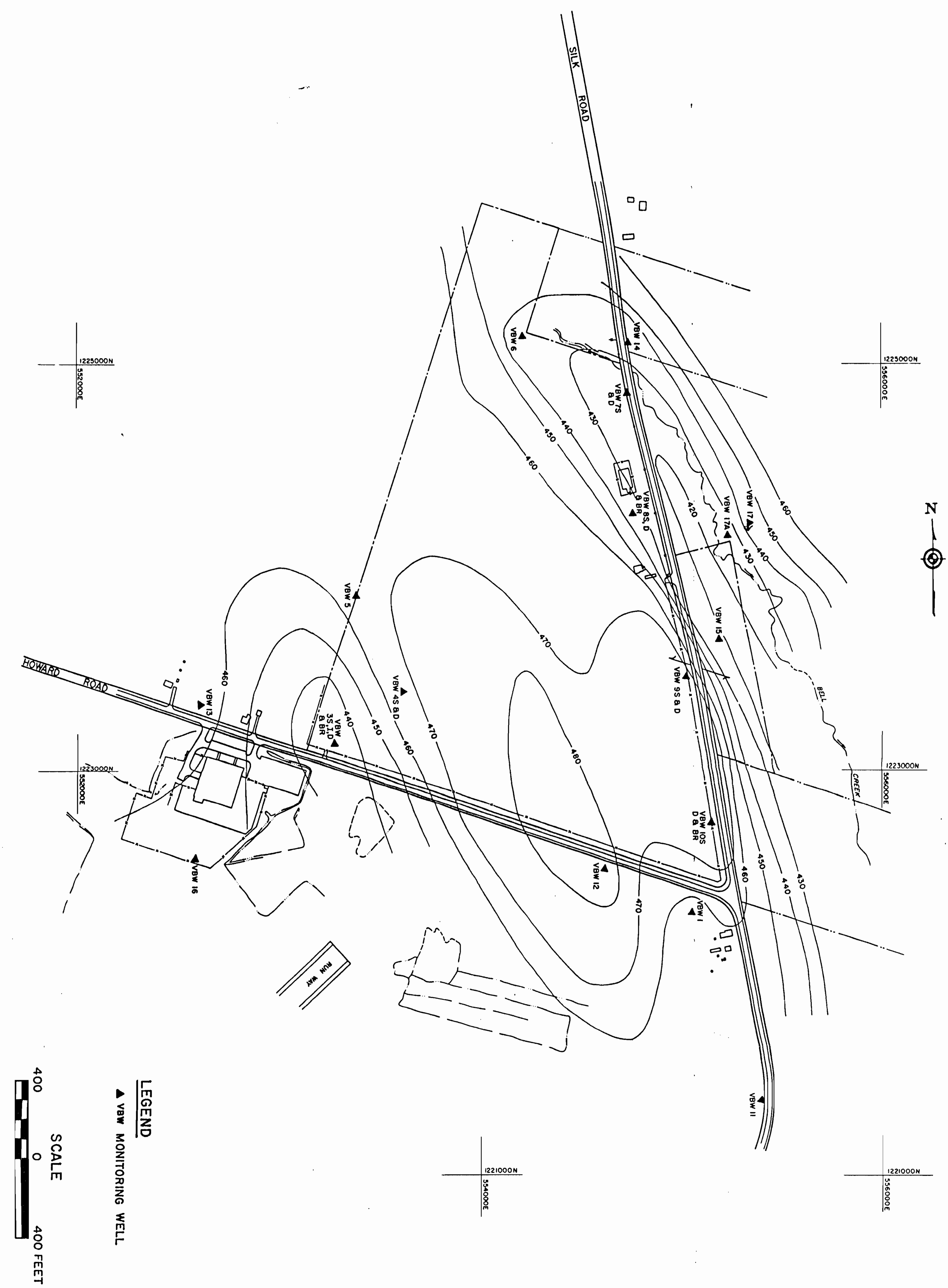
Grain-size analyses were performed on 14 split-spoon samples of lodgement till (Appendix E). Grain-size distribution data and curves for these samples indicate a rather uniform and consistent distribution of grain sizes. Average distributions among the 13 analyses are 29 percent gravel, 54 percent sand, and 17 percent silt and clay. A generalized description of the lodgement till, using the Modified Burmister and Unified Soil Classifications, is Coarse to fine SAND, little Silt and Clay, some coarse to fine(+) Gravel, SM. Note that the sample from VBW-14 is a combined sample of lodgement till and the overlying sand formation.

The thickness of the lodgement till at the three multi-well clusters is 16.5 feet at VBW-8, 45 feet at VBW-3, and 73 feet at VBW-10. Variations of thickness across the site area, as interpreted from seismic refraction data and 13 of the 14 sampled borings drilled into lodgement till, are shown in the cross-sections (Figures 4-3 and 4-4). These sections indicate thickness generally occurs within the ranges indicated by multi-well clusters.

The generalized top-of-till topography is depicted in Figure 4-6. The steep till slope immediately east of Silk Road may have been oversteepened by erosion of glacial meltwaters. Due to the lack of data from under the landfill, it is not clear whether the topographic high of till under the landfill is two coalesced drumlinoid features or whether an unobserved interdrumlin channel occurs between two closely spaced drumlins.

Borings drilled during this study and from previous studies (Scrudato, 1981; Geraghty and Miller, 1984 and 1985) suggest that the lodgement till unit occurs above bedrock throughout the immediate site area. Drilling has not been performed to determine if the lodgement till occurs over bedrock in the valley of Bell Creek east of Silk Road. Surficial mapping by Miller (1980a, 1980b) indicates that the hills east of Bell Creek are till drumlins.

SOURCE: DUNN GEOSCIENCE CORPORATION (1986)



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GENERALIZED LODGEMENT TILL TOPOGRAPHY

FIGURE 4-6

On Howard Road, southwest of the site, till was encountered at the ground surface in boring VBW-13. Mapping by Miller (1980a) indicates an extensive area of till at the surface from VBW-13 westward, extending north and south along the general trend of NY Route 176 (roads are located on Figure 1-1).

4.2.2.3.2 Glaciolacustrine Fine Sand and Silt - Glaciolacustrine deposits, primarily consisting of fine sand and silt, were encountered in three areas during drilling. As shown by the cross-sections (Figures 4-3 and 4-4), these deposits accumulated in the trough areas between drumlins. An extensive area of glaciolacustrine deposits is found along Bell Creek and was encountered in borings VBW-7, VBW-8, VBW-14, VBW-15, VBW-17 and VBW-17A. A second area occurs near the southwest corner of the site. In this area, boring VBW-3 encountered a thick section of glaciolacustrine fine sand from depths of 8 feet to 36 feet. Boring VBW-5 is located near the margin of this glaciolacustrine basin (see section C-C', Figure 4-3). Section E-E' (Figure 4-4) depicts this basin as extending southward from VBW-3, although this is somewhat speculative and based upon regional drumlin orientations. A third glaciolacustrine basin was encountered in boring VBW-1 just southwest of the intersection of Howard and Silk Roads. This third basin is located between the southerly ends of the two drumlins underlying the southern part of the landfill (Figure 4-6).

Glaciolacustrine deposits consist primarily of brown fine sand with variable silt contents. Densities were variable, ranging from loose to compact but generally looser at the top of the section. Some borings in the Bell Creek glaciolacustrine basin (VBW-7, VBW-8 and VBW-17 encountered mixtures of gray fine sand, silt and clay in the lower portions of this unit. Thin layers of sandier or gravelly glaciolacustrine deposits were encountered at the base of this unit in a few borings.

Grain-size analyses were performed on 10 glaciolacustrine samples (Appendix E). Five samples were predominantly silt, ranging from 59.67% to 98.26% silt. Five samples were predominantly fine sand, with variable amounts of silt ranging from 10.56% to 19.94%, and occasionally minor amounts of coarser or finer constituents. Hydrometer analyses performed on 4 of these samples indicate that the silt and clay fractions of these sediments are primarily coarse silt. Atterberg Limit tests were performed on two lacustrine samples from VBW-5 and these samples were found to be non-plastic.

4.2.2.3.3 Reworked Sand and Gravel - The uppermost unconsolidated unit in most areas surrounding the landfill consists of brown sand and gravel ranging from 4 feet to over 25 feet thick. This unit is texturally variable, and ranges from silty sand and silty sand and gravel mixtures west of the landfill, to clean gravels and gravel-sand mixtures east and southeast of the landfill. Grain-size analyses were performed on 8 samples of this unit (Appendix E).

This unit has been extensively quarried in the past. Quarrying of gravels has occurred at the base of the slope along Silk Road. Boring VBW-15 indicates surficial gravel was removed down to the underlying glaciolacustrine fine sands. Remnants of this coarse aggregate material are scattered in the area around VBW-15. Some sections of this gravel are partially cemented with calcium carbonate.

Other areas of quarrying include the area southwest of the intersection of Silk and Howard Roads, the area northwest of the landfill (between VBW-5 and VBW-6), and according to reports (Barton and Loguidice, 1984) the area beneath the southern part of the landfill. In many of these areas, sand and gravel was excavated down to the lodgement till surface.

Areas identified by the seismic refraction and terrain conductivity surveys (Appendix A) as underlain by low-velocity or low-conductivity materials were often underlain by sand and gravel deposits. This is indicated by drilling results and field observations, especially in the area along Silk Road near the intersection with Howard Road.

As stated previously, the uppermost sand and gravel unit is termed reworked sand and gravel in this report. Previous investigators (Miller, 1980 a,b and Scrudato, 1981) have referred to these deposits as a beach sand and gravel unit and a wave delta sand and gravel unit. These two units are laterally continuous and, based on soil textures and water level observations, tend to act as one unit hydrogeologically. Therefore, beach and wave delta designations have been omitted in this study and the less definitive term "reworked" has been used to describe this unit.

4.2.2.3.4 Alluvium and Swamp Deposits - Boring VBW-17A was drilled adjacent to the channel of Bell Creek east of the landfill and encountered alluvial deposits. These are interbedded layers of sand, gravel and silt which formed by fluvial reworking of the glacial sediments and subsequent deposition along the stream banks (see Section B-B', Figure 4-3). One grain-size analysis was performed on the lowermost sample from VBW-17A (Appendix E). It is not certain, however, whether this sample is alluvium or the underlying reworked glacial sand and gravel.

Swamp deposits are mapped at a few areas in the region (Miller, 1980 a,b). These are deposits of peat, marl, muck and clay which accumulate in poorly drained, swampy areas. Minor accumulations of swamp deposits may be present in the upper reaches of Bell Creek, between borings VBW-6 and VBW-17A; however, none were observed directly in the borehole samples.

4.2.2.3.5 Artificial Fill - Artificial fill deposits include roadbed fill materials beneath the pavements of Silk and Howard Roads, and debris-cover fill of the landfill proper. Debris fill was encountered in borings VBW-2, VBW-9 and VBW-10. This indicates that the landfill extends beyond the topographic mound, at least in the southern portion, and may extend very close to Silk and Howard Roads.

4.2.3 Bedrock

4.2.3.1 Lithology and Structure - The New York State geologic map (Fisher et. al., 1970) indicates that bedrock beneath the Volney Landfill consists of the Queenston Formation of Late Ordovician Age and the overlying Medina Group of Silurian Age. These Lower Paleozoic sedimentary rock units are undifferentiated on the state map; largely because outcrops are rare in this area and these rock units are lithologically similar. The Queenston Formation is composed of red shales and siltstones. The Medina Group is primarily red sandstones and shales.

These rock units have a combined thickness of approximately 900 feet and occur in a belt that outcrops from east to west across central New York State. The outcrop belt pinches out against the southwestern margin of the Adirondack Highlands to the east and is largely obscured by glacial deposits along the northern shore of Lake Ontario to the west. These rock formations gently dip beneath younger formations to the south. The underlying Upper Ordovician Lorraine Group rocks outcrop about 4.5 miles north of the site. The overlying and younger Lower Silurian Clinton Group outcrops about 1.5 miles to the south.

Rock units strike generally east-west and dip gently to the south. Two near-orthogonal principal joint sets have been reported (Isachsen and McKendree, 1977). One set ranges in strike from approximately N70°E to N80°E. The second ranges from approximately N25°W to N50°W. Both sets of joints are nearly vertical. A statewide compilation of lineaments and faults identified by analysis of Landsat 1 (ERTS) imagery has identified no major bedrock structural features in the site area.

4.2.3.2 Bedrock Core Samples - Bedrock coring was conducted at borings VBW-3BR, VBW-8BR and VBW-10BR to verify bedrock elevations from seismic data, obtain core samples and create bedrock monitoring wells. The resulting open core holes are approximately 3.0 inches in diameter. Core samples obtained are approximately 1.9 inches in diameter. Bedrock core data is summarized in Table 4-3.

Cores taken from each boring are similar in lithology. They can be summarized as highly-fractured, dark reddish-brown, fine-grained sandstone, featuring clasts or interbeds of dark reddish-brown clay/ shale. Core recoveries and Rock-Quality Designations (RQD) were generally low. Numerous core breaks were encountered along bedding planes or shale partings. Most of the core loss is attributed to deterioration at these interfaces. The core recovered was generally the more durable sandstone fractions; hence, recovered core samples were generally fresh.

4.2.3.3 Bedrock Topography - Depths to the top of bedrock surface in borings VBW-3BR, VBW-8BR and VBW-10BR are respectively, 81.0, 46.5 and 91.0 feet. For borings VBW-3BR and VBW-8BR, these results provide reasonable verification of the depth to bedrock determined by seismic lines which passed nearby. Seismic data near boring VBW-10BR was somewhat ambiguous; therefore, such verification is not applicable.

Data from the bedrock wells and results from the seismic data (Appendix A) were used to prepare a generalized top of bedrock contour map (Figure 4-7). The bedrock surface has a generally low relief with linear trends similar to the regional surficial land forms.

4.3 Groundwater Hydrology

4.3.1 Regional Groundwater Hydrology

4.3.1.1 Bedrock Aquifers - The bedrock units underlying the site include the Silurian Medina Group and the underlying Ordovician

TABLE 4-3
BEDROCK CORE DATA

	VBW-3BR	VBW-8BR	VBW-10BR
Top of Bedrock Elevation (ft)	392.70	414.58	401.98
Lithology	Sandstone	Sandstone	Sandstone
Interval Cored (ft)	387.70-381.50	409.58-404.58	396.98-390.98
Core Penetration (ft)	6.20	5.00	6.0
Recovery (ft)	4.3	3.5	0.6
Percent Recovery	69%	70%	10%
RQD (%)	16%	0%	0%
Strength (S)	2-3	2-3	2-3
Decomposition (D)	1	1	1
Fracturing (F)	3-4	3-4	3-4

ROCK QUALITY PARAMETERS

R.Q.D.	Description of Rock Quality
0-25%	Very Poor
25-50%	Poor
50 - 75%	Fair
75-90%	Good
90-100%	Excellent

Grades of Strength

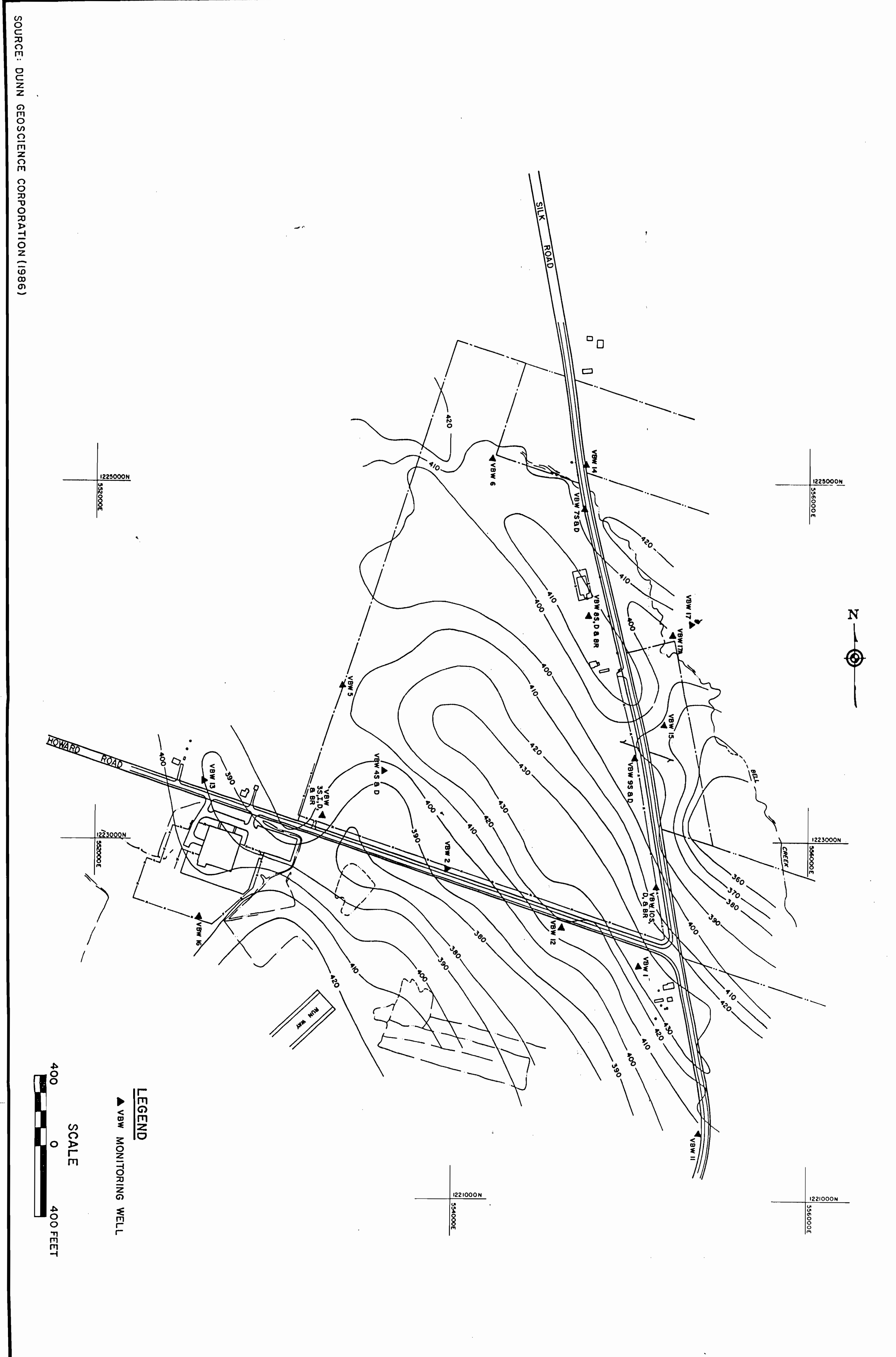
S - 1 Strong (Metallic sound; breaks with difficulty with hammer)
S - 2 Moderately Strong (Dull sound; breaks with moderate hammer blow)
S - 3 Weak (Cuts easily with moderate hammer blow)
S - 4 Very Weak (Breaks with finger pressure)

Grades of Decomposition

D - 1 Fresh Rock
D - 2 Slightly Altered Rock (Joints Stained)
D - 3 Moderately Altered Rock (Matrix somewhat weakened)
D - 4 Highly Altered Rock (Matrix weak)
D - 5 Residual Soil (Soil-like saprolite)

Grades of Fracturing

F - 1 Massive (Fracture spacing greater than 3 feet)
F - 2 Moderately jointed (Fracture spacing 8 inches to 3 feet)
F - 3 Very Jointed (Fracture spacing 4 inches to 8 inches)
F - 4 Extremely Jointed (Fracture spacing 2 inches to 4 inches)
F - 5 Crushed (Fracture spacing less than 2 inches)



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GENERALIZED TOP OF BEDROCK CONTOUR MAP

FIGURE 4-7

Queenston Shale. These red to gray, fine- to coarse-grained sandstones and siltstones produce average well yields of 10 gallons per minute (gpm) in northern Oswego County (Kantrowitz, 1970). Bedrock aquifers in the region generally transmit water through secondary porosity features, such as joints and fractures. To some extent, the sandstones of the Medina Group also transmit water by primary intergranular porosity. Wells tapping bedrock aquifers in Oswego County have average depths of 85 to 90 feet.

4.3.1.2 Unconsolidated Aquifers - Glacial lodgement till and glaciolacustrine fine sand and silts constitute the poorest quality aquifers in the region. The till in Oswego County, which has a sandy composition, yields only 1 to 2 gpm from large diameter dug wells, while glaciolacustrine deposits can be expected to yield an average of 1 to 2 gpm or less (Kantrowitz, 1970).

The best aquifers in the region are sand and gravel units. These deposits, where sufficiently saturated, generally yield 5 to 50 gpm in sandy zones and 50 to 100 gpm in gravelly zones (Kantrowitz, 1970).

4.3.2 Site Groundwater Hydrology

4.3.2.1 Previous Studies - Hydrogeologic studies by Geraghty and Miller (1984; 1985) indicate that groundwater flows radially from beneath the Volney Landfill. Groundwater gradients are steepest toward Bell Creek on the east side of the landfill. Groundwater elevations ranged from a maximum of about 470 to 480 feet above mean sea level (msl) near the southern portion of the landfill, to 430 and 440 feet above msl near Bell Creek. Well levels were generally higher in May 1984 than January 1985, as expected, due to seasonal recharge.

Bedrock water levels indicated groundwater flow in the bedrock in the easterly direction (Geraghty and Miller, 1984; 1985). Available data from well pairs completed in bedrock and at the water table indicated some upward and some downward gradients, although lack of well construction details prevented definitive conclusions.

4.3.2.2. Monitoring Wells - Monitoring well locations are shown on Figure 4-1. Well completion logs (Appendix D) provide details of intervals screened and packed, as well as types of sealing materials. Well data is provided in Table 4-4 which includes water level readings for April 1, 1986 and November 5-6, 1986. During the latter round of measurements, water level readings were also taken from surrounding wells which had been installed during previous investigations (see Figure 1-3 for locations). Table 4-5 summarizes well construction and development data. Of the 28 monitoring wells constructed, 3 are in bedrock, 7 in lodgement till, 6 in glaciolacustrine fine sands and silts, 9 in sand and gravel or alluvium, and 3 in fill materials.

Three of the 28 wells turned out to be dry and could not be used for water level measurements. Wells VBW-9S, VBW-9D and VBW-10S were constructed along the east side of the landfill in fill, lodgement till, and fill, respectively. Split-spoon samples of the fill materials were moist to wet. It was thought that these wells were constructed in or below a water table perched on the lodgement till. Subsequently, however, these wells turned out to be dry, since the water table is well below the lodgement till surface along the higher parts of the eastern landfill margin.

Well VBW-10BR did not recharge adequately for a complete well development (Table 4-5). Well water conductivity and pH data (see Section 4.4) indicate that grout penetrated into the bedrock formation below this well, adversely affecting the well's usefulness for water level readings, hydraulic conductivity tests and water quality analyses. Additional bedrock coring in well VBW-10BR could have produced a well suitable for water level readings and hydraulic conductivity tests; however, the presence of grout in the bedrock formation could have continued to affect water quality analyses.

TABLE 4-4
WELL ELEVATION AND WATER TABLE ELEVATION DATA

Well No.[1]	Ground Elevation	Top of Protective Casing (MP-1)[2]	Top of Riser (MP-2)[3]	Depth of Water Table Below MP-2 (4-1-86)	Elevation of Water Table (4-1-86)	Depth of Water Table Below MP-1 (11-5,6-86)	Elevation of Water Table (11-5,6-86)
VBW-1	490.69	493.53	493.35	20.54	472.81	21.15	472.38
VBW-2	486.69	489.16	489.07	8.62	480.45	8.83	480.33
VBW-3S	473.38	475.82	475.73	4.87	470.86	7.23	468.59
VBW-3I	472.98	475.91	475.86	4.98	470.88	7.42	469.98
VBW-3D	473.38	475.75	475.67	4.74	470.93	7.19	468.56
VBW-3BR	473.70	477.40	476.39	4.58	471.81	8.31	467.60
VBW-4S	483.46	485.78	485.71	9.82	475.89	13.77	472.01
VBW-4D	483.30	485.18	485.14	10.20	474.94	12.02	473.16
VBW-5	474.92	477.86	477.80	4.31	473.94	4.83	473.03
VBW-6	455.67	458.64	458.50	4.76	453.74	6.21	452.43
VBW-7S	453.71	456.91	456.74	5.60	451.14	6.54	450.37
VBW-7D	453.41	456.26	456.18	4.91	451.27	5.83	450.43
VBW-8S	461.56	463.74	463.59	10.88	452.71	12.58	451.16
VBW-8D	461.20	463.53	463.43	10.76	452.67	12.71	450.82
VBW-8BR	461.08	463.56	463.32	10.99	452.33	12.75	450.81
VBW-9S	494.32	496.52	----	Dry	476.32	Dry	Dry
VBW-9D	494.28	497.11	----	Dry	469.28	27.29	469.82
VBW-10S	492.48	495.28	495.14	Dry	475.98	Dry	Dry
VBW-10D	492.31	495.48	495.44	38.94	456.50	41.73	453.75
VBW-10BR	492.98	494.30	493.76	53.31	440.45	39.58	454.72
VBW-11	491.34	493.78	493.63	19.65	474.00	21.54	472.24
VBW-12	495.79	498.70	498.61	14.14	484.47	14.67	484.03
VBW-13	466.98	469.70	469.63	3.54	466.09	3.83	465.87
VBW-14	454.65	457.61	457.46	4.23	453.23	5.0	452.61
VBW-15	449.47	452.59	452.42	7.06	445.36	9.21	443.38
VBW-16	465.52	468.09	467.94	4.70	463.24	6.02	462.07
VBW-17	455.87	457.91	457.80	5.41	452.39	8.79	449.12
VBW-17A	447.60	450.02	449.88	4.53	445.35	4.75	445.27

TABLE 4-4 - (Cont'd.)
WELL ELEVATION AND WATER TABLE ELEVATION DATA

Well No.[1]	Ground Elevation	Top of Protective Casing (MP-1)[2]	Top of Riser (MP-2)[3]	Depth of Water Table Below MP-2 (4-1-86)	Elevation of Water Table (4-1-86)	Depth of Water Table Below MP-1 (11-5,6-86)	Elevation of Water Table (11-5,6-86)
GW-2		484.67				13.63	471.04
GW-3C		476.94				10.00	466.94
GW-3D		476.88				9.46	467.42
GW-5		473.40				3.90	469.50
GW-6R		487.07				7.46	479.61
GW-7R		498.70				14.48	484.22
GW-8R		493.41				34.02	459.39
GW-9		473.48				27.58	445.90
GW-10		458.63				15.81	442.82
GW-15		451.57				12.81	438.76
GW-16		469.94				14.21	455.73
GW-17		466.49				17.58	448.91
GW-18A		466.94				16.96	449.98
GW-24		483.20				3.50	479.70
GW-25		495.60				18.00	477.60
GW-31		472.60				2.35	470.25
SGW-26		470.24				5.02	465.22
SGW-27A		475.44				6.33	469.11
SGW-27B		475.50				6.50	469.00
SGW-28		479.99				7.77	472.22
SGW-29		458.42				6.00	452.42
SGW-30A		457.13				8.00	449.13
SGW-30B		456.37				7.88	448.49
SGW-33		450.91				4.75	446.16
SGW-34		469.74				4.98	464.76

TABLE 4-4 - (Cont'd.)
WELL ELEVATION AND WATER TABLE ELEVATION DATA

Well No.[1]	Ground Elevation	Top of Protective Casing (MP-1)[2]	Top of Riser (MP-2)[3]	Depth of Water Table Below MP-2 (4-1-86)	Elevation of Water Table (4-1-86)	Depth of Water Table Below MP-1 (11-5,6-86)	Elevation of Water Table (11-5,6-86)
Bell Creek							445.12
Potter Stream (ponding water south of VBW-6)							456.23
Potter Stream (stream south of VBW-6)							455.77
Potter Stream (stream north of VBW-6)							452.93

Notes:
1) Refer to Figures 1-3 and 4-1 for well locations.
2) MP-1 = Measuring Point for data collected on 11-5,6-86.
3) MP-2 = Measuring Point for data collected on 4-1-86.
4) All measurements are in feet.

TABLE 4-5

WELL CONSTRUCTION AND DEVELOPMENT DATA

Well No.	Screened Depth (ft)	Stratigraphic Unit Screened	Well Volume (gals)	No. of Volumes Removed	Bailed or Pumped	Comments
VBW-1	16.4-26.5	Sand & Gravel	1.38	7.3	Bail	Highly Turbid
VBW-2	3.5-9.0	Fill	0.51	5.9	Pump	Leachate Odor
VBW-3S	5.7-16.5	Sand & Gravel	2.06	12.1	Pump	Clear
VBW-3I	16.0-26.0	Sand & Gravel	3.89	5.2	Pump	Clear
VBW-3D	41.0-46.0	Lodgement Till	3.73	5.6	Pump	Clear
VBW-3BR	86.0-92.2	Bedrock	57.1	3.1	Bail	Sulfur Odor
VBW-4S	7.0-12.0	Sand & Gravel	0.47	6.4	Bail	Moderately Turbid
VBW-4D	18.0-23.0	Lodgement Till	2.07	5.1	Bail	Slightly Turbid
VBW-5	6.0-11.0	Fine Sand & Silt	9.00	6.0	Both	Slightly Turbid
VBW-6	6.0-16.0	Sand & Gravel	2.13	5.6	Pump	Slightly Turbid
VBW-7S	4.5-15.0	Sand & Gravel	1.94	5.5	Pump	Slightly Turbid
VBW-7D	18.5-29.0	Fine Sand & Silt	4.41	5.2	Pump	Clear
VBW-8S	7.5-18.0	Fine Sand	1.28	5.9	Pump	Leachate Odor
VBW-8D	25.5-35.0	Sand & Gravel	4.10	5.9	Bail	Leachate Odor
VBW-8BR	51.5-56.5	Bedrock	27.19	3.3	Bail	Leachate Odor

TABLE 4-5 (Cont'd.)

WELL CONSTRUCTION AND DEVELOPMENT DATA

Well No.	Screened Depth (ft)	Stratigraphic Unit Screened	Well Volume (gals)	No. of Volumes Removed	Bailed or Pumped	Comments
VBW-9S	8.0-18.0	Fill	---	---	---	Dry
VBW-9D	20.0-25.0	Lodgement Till	---	---	---	Dry
VBW-10S	6.0-16.5	Fill	---	---	---	Dry
VBW-10D	52.0-57.0	Lodgement Till	3.12	5.8	Bail	Leachate Odor
VBW-10BR	96.0-102.0	Bedrock	54.0	1.4	Bail	Very Low Recharge
VBW-11	11.3-23.0	Sand & Gravel	0.89	7.3	Bail	Petroleum Odor
VBW-12	3.9-14.0	Sand & Gravel	0.39	9.6	Pump	Clear
VBW-13	3.3-9.0	Lodgement Till	1.28	7.0	Pump	Slightly Turbid
VBW-14	2.5-13.0	Fine Sand	1.82	5.5	Pump	Clear
VBW-15	3.5-14.0	Sand	1.36	8.1	Pump	Slightly Turbid
VBW-16	5.3-15.8	Sand & Gravel	2.18	7.6	Pump	Clear
VBW-17	11.3-16.3	Lodgement Till	1.70	5.6	Pump	Slightly Turbid
VBW-17A	5.0-15.1	Sand, Gravel & Clay	2.05	5.6	Pump	Slightly Turbid

4.3.2.3 Moisture Content - Laboratory analyses of moisture content were performed on 33 soil samples. Results are summarized by stratigraphic unit in Table 4-6. Glaciolacustrine fine sand and silt samples from below the water table had the highest moisture content. This indicates a relatively high porosity and is consistent with the uniform gradation found in the sieve analysis of these samples (Appendix E). Moisture contents were lowest in the lodgement till probably due to the high degree of compaction which occurred during deposition. Variation of moisture content was greatest for the sand and gravel unit. This is in part due to the relative position of the water table, the larger variety of grain-size distributions and relative densities of these samples. The coarse-grained nature of the sand and gravel, however, makes an accurate measure of moisture content difficult using split-spoon samples, since water can run out of these samples during retrieval from the boring.

4.3.2.4 Hydraulic Conductivity - Hydraulic conductivity test results are presented in Appendix F, a summary of which is in Table 4-7. Table 4-8 lists average hydraulic conductivities for different stratigraphic units, using the most reliable test data.

Hydraulic conductivity values correspond reasonably to stratigraphic units. Values measured in sand and gravel were significantly higher and more variable than the other materials at the site. This reflects the diversity in grain-size distributions in these materials. The lacustrine fine sands and silts were consistently low in hydraulic conductivity. Wells VBW-3I and VBW-15 were screened in coarser-grained lacustrine sediments and were averaged with the sand and gravel.

Wells in lodgement till have low hydraulic conductivities. This is attributed to the high degree of compaction and wide range of grain sizes, including fine-grained particles, in this unit. Well VBW-8D was screened across till and the overlying unit; consequently, it was not included in the averages shown in Table 4-8. Hydraulic

TABLE 4-6

MOISTURE CONTENT DATA

Unit Sampled	Above/Below Water Table	Number of Samples	Moisture Content
Sand and Gravel	Above	3	3.91% to 7.13%
Sand and Gravel	Below	6	8.28% to 18.32%
Fine Sand and Silt	Below	10	17.12% to 25.43%
Lodgement Till	Above	2	0.22% to 3.33%
Lodgement Till	Below	11	5.82% to 9.26%
Till/Sand and Gravel Mixture	Below	1	12.37%

TABLE 4-7

SUMMARY OF HYDRAULIC CONDUCTIVITY TESTS

Well No.	Screened Depth (ft)	Stratigraphic Unit Screened	Saturated Screen Length (ft)	Hydraulic Conductivity (ft/day)	Remarks
VBW-1	16.4-26.5	Sand & Gravel	8.46	14.34	
VBW-2	3.5-9.0	Fill	2.78	1.53	
VBW-3S	5.7-16.5	Sand & Gravel	10.00	11.93	
VBW-3I	16.0-26.0	Sand & Gravel	5.0	26.53	
VBW-3D	41.0-46.0	Lodgement Till	10.00	4.78×10^{-1}	
VBW-3BR	86.0-92.2	Bedrock	6.50	6.06×10^{-1}	
VBW-4S	7.0-12.0	Sand & Gravel	4.48	2.83×10^{-2}	See Note 1
VBW-4D	18.0-23.0	Lodgement Till	5.00	2.13×10^{-2}	
VBW-5	6.0-11.0	Fine Sand & Silt	5.00	6.76×10^{-1}	
VBW-6	6.0-16.0	Sand & Gravel	10.00	1.30	
VBW-7S	4.5-15.0	Sand & Gravel	10.00	1.10×10^{-1}	See Note 2
VBW-7D	18.5-29.0	Fine Sand & Silt	10.00	4.87×10^{-1}	
VBW-8S	7.5-18.0	Fine Sand	9.12	7.68×10^{-1}	
VBW-8D	25.5-35.0	Sand & Gravel	10.00	2.96	
VBW-8BR	51.5-56.5	Bedrock	5.00	5.80×10^{-1}	
VBW-9S	8.0-18.0	Fill	-----	-----	Dry
VBW-9D	20.0-25.0	Lodgement Till	-----	-----	Dry
VBW-10S	6.0-16.5	Fill	-----	-----	Dry
VBW-10D	52.0-57.0	Lodgement Till	5.0	1.24×10^{-1}	
VBW-10BR	96.0-102.0	Bedrock	-----	-----	See Note 3
VBW-11	11.3-23.0	Sand & Gravel	5.50	20.69	
VBW-12	3.9-14.0	Sand & Gravel	2.66	9.08×10^{-1}	See Note 1
VBW-13	3.3-9.0	Lodgement Till	5.00	2.09×10^{-1}	
VBW-14	2.5-13.0	Fine Sand	10.00	8.59×10^{-1}	
VBW-15	3.5-14.0	Sand	10.00	10.29	
VBW-16	5.3-15.8	Sand & Gravel	5.00	1.78	
VBW-17	11.3-16.3	Lodgement Till	5.00	1.00×10^{-1}	
VBW-17A	5.0-15.1	Sand & Clay	10.00	1.19	

Notes:
1) Data base considered invalid.
2) Well construction effects were possible.
3) No test conducted due to possible grout effects.

TABLE 4-8

AVERAGE HYDRAULIC CONDUCTIVITY BY STRATIGRAPHIC UNIT

Stratigraphic Unit	Average Hydraulic Conductivity (ft/day)	Number of Tests	Standard Deviation
Reworked Sand & Gravel	11.01	8	9.43
Fine Sand & Silt	0.70	4	0.16
Lodgement Till	0.19	5	0.18
Bedrock	0.59	2	0.02

conductivities were greater in the bedrock unit than lodgement till due to the fracturing and partings present at the top of the bedrock.

4.3.2.5 Groundwater Flow Patterns - Groundwater elevations, as presented in Table 4-4, were used to evaluate groundwater flow in both horizontal and vertical directions.

Figure 4-8, a groundwater elevation contour map, indicates the horizontal component of groundwater flow in the shallow unconfined aquifer, comprised of various unconsolidated units overlying lodgement till. This map is based upon water level readings obtained on April 1, 1986. The readings taken on November 5-6 indicated a similar contour pattern, though elevations on this latter measurement date were typically several feet lower than in April. The flow directions from this study are also similar to those of previous investigations (Geraghty and Miller, 1984, 1985).

Figure 4-8 indicates that an elongated groundwater high, approaching an elevation of 485 feet above mean sea level, is present at the southern margin of the site, extending north-northwestward. This groundwater high is coincident with a buried drumlin (Figure 4-6) and parallels its trend. This indicates that the water table is closely related to stratigraphy. The groundwater divide identified on Figure 4-8 runs along the crest of the buried drumlin to Howard Road. South of Howard Road, the divide extends eastward between wells VBW-12 and VBW-1. At well VBW-1, the divide shifts southward to parallel Silk Road. Water drains from the landfill into two drainage basins. A large portion of the shallow groundwater drainage from the landfill is directed eastward under Silk Road to Bell Creek. The southwest corner of the landfill drains to the southwest, into the Black Creek tributaries.

Table 4-9 summarizes vertical hydraulic gradients, as determined from water level readings at monitoring well pairs and clusters on April 1, 1986 and November 5-6, 1986. Wells which were dry are not included on the table. These data indicate vertical gradients

URS Company, Inc. CONSULTING ENGINEERS NEW YORK NEW JERSEY	GROUNDWATER ELEVATION CONTOUR MAP	FIGURE 4-8

TABLE 4-9

VERTICAL HYDRAULIC GRADIENTS

Well No.	Water Table Elevation (ft) 4/86	Water Table Elevation (ft) 11/86	Change in Head (ft) 4/86	Change in Head (ft) 11/86	Difference Between Well Screens (ft)	Gradient (1) 4/86	Gradient (1) 11/86
VBW-3S	470.86	468.59	+0.02	-0.99	9.50	+0.002	-0.104
VBW-3I	470.88	467.60	+0.05	+0.96	20.00	+0.003	+0.048
VBW-3D	470.93	468.56	+0.88	+1.42	46.20	+0.019	+0.031
VBW-3BR	471.81	469.98					
VBW-4S	475.89	472.01	-0.95	+1.15	11.00	-0.086	+0.105
VBW-4D	474.94	473.16					
VBW-7S	451.14	450.37	+0.13	+0.06	14.00	+0.009	+0.004
VBW-7D	451.27	450.43					
VBW-8S	452.71	451.16	-0.04	-0.34	17.00	-0.002	-0.020
VBW-8D	452.67	450.82	-0.34	-0.01	21.50	-0.016	-0.001
VBW-8BR	452.33	450.81					
VBW-10D	(2)	453.75		+0.97	44.50	(2)	+0.022
VBW-10BR		454.72					

Note:
1) A (+) gradient indicates upward flow; (-) gradient indicates downward flow.
2) Well VBW-10BR did not recharge adequately.

which are highly variable in both space and time. This pattern is not surprising in light of the following factors: (1) groundwater mounding at the site, induced by the relatively impermeable lodgement till unit underlying more conductive overburden strata, will tend to produce relatively short-term, drainage-related fluctuations in water table elevations and vertical gradients; and (2) recent site capping is undoubtedly producing a long-term change in these vertical flow patterns.

4.4 Subsurface Contamination

Data from two separate investigation techniques have been utilized to evaluate soil and groundwater quality at the Volney Landfill site. These are: (a) field screening of soil samples obtained during drilling using an organic vapor detector; and (b) sampling and chemical analysis of groundwater from monitoring wells. The results are presented and discussed in the following sections.

4.4.1 Soil Screening Results - Split-spoon soil samples taken during drilling were screened for organic vapors, as described in Section 4.1.3. A list of soil samples which had readings above ambient levels (under 1 ppm on the Photovac TIP) is presented in Table 4-10. A depth profile of organic vapors for those borings with more than one above-ambient measurement is presented on Figure 4-9. Above ambient readings of organic vapors may indicate soil or groundwater contamination at the particular sample depth.

Ambient vapor readings were found in shallow wells near the site boundaries just west and north of the limits of fill (VBW-5, VBW-6 and VBW-14). Elevated readings were found in shallow wells off-site increasing from slightly elevated in the east (VBW-17, VBW-17A, VBW-15 and VBW-1) to moderately elevated in the southeast (VBW-11 and VBW-12) and high in the southwest (VBW-16 and VBW-13).

TABLE 4-10

SUMMARY OF ORGANIC VAPOR SCREENING OF SOILS
(Non-Ambient Results)

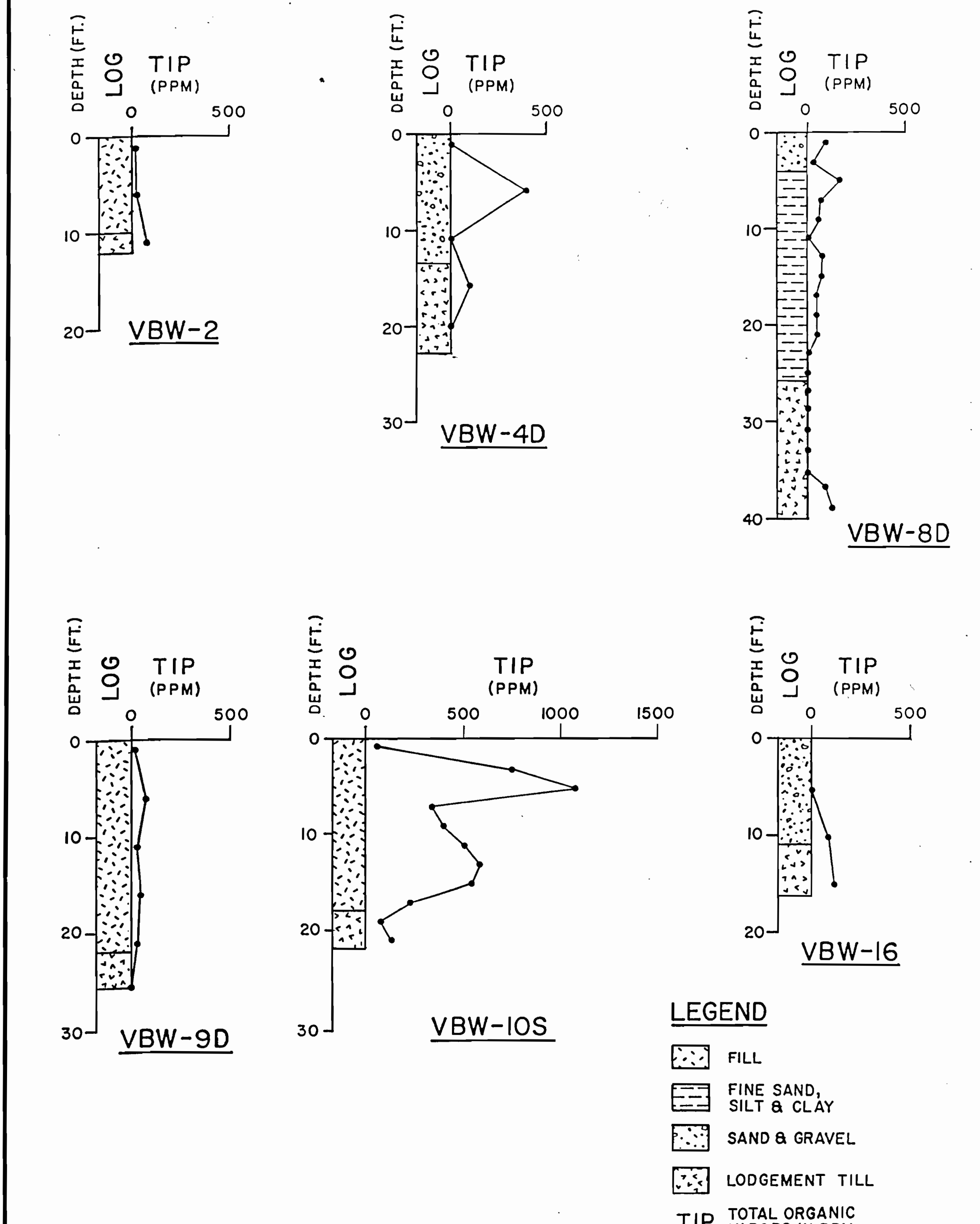
Boring No.	Sample No.	Depth (ft)	Stratigraphic Unit	Photovac TIP Reading[1]
VBW-1	2	9-11	Sand & Gravel	17
VBW-2	1	0-2	Fill	21
	2	5-7	Fill	23
	3	10-12	Lodgement Till	67
VBW-3I	25	48-50	Lodgement Till	35
VBW-4D	2	5-7	Fine Sand	410
	4	15-15.4	Lodgement Till	114
VBW-7S	3	14-16	Sand & Gravel	14
VBW-8D	1	0-2	Sand & Gravel	80
	2	2-4	Sand & Gravel	27
	3	4-6	Fine Sand	152
	4	6-8	Fine Sand	56
	5	8-10	Fine Sand	49
	7	12-14	Fine Sand	65
	8	14-16	Silt & Clay	59
	9	16-18	Silt & Clay	30
	10	18-20	Fine Sand	32
	11	20-22	Fine Sand	42
	16	30-32	Lodgement Till	10
	17	32-34	Lodgement Till	23
	19	36-38	Lodgement Till	90
	20	38-40	Lodgement Till	120
VBW-9	1	0-2	Fill	25
	2	5-7	Fill	83
	3	10-12	Fill	35
	4	15-17	Fill	48
	5	20-22	Fill	27
VBW-10S	1	0-2	Fill	53
	2	2-4	Fill	760
	3	4-6	Fill	1,090
	5	8-10	Fill	349
	6	10-12	Fill	410
	7	12-14	Fill	520
	8	14-16	Fill	610
	9	16-18	Fill	555
	10	18-20	Lodgement Till	240
	11	20-22	Lodgement Till	84
	12	22-24	Lodgement Till	146

TABLE 4-10 (Cont'd.)

Boring No.	Sample No.	Depth (ft)	Stratigraphic Unit	Photovac TIP Reading[1]
VBW-11	5	24-26	Fine Sand	25
VBW-12	1	4-6	Sand & Gravel	22
	3	14-16	Lodgement Till	13
VBW-13	2	5-7	Lodgement Till	30
VBW-15	3	14-16	Fine Sand	17
VBW-16	2	9-11	Sand & Gravel	89
	3	14-16	Lodgement Till	116
VBW-17	3	14-16	Lodgement Till	15
VBW-17A	3	14-16	Sand & Gravel	19

Notes:

1) Readings on Photovac TIP are in parts per million of organic vapors.



SOURCE: DUNN GEOSCIENCE CORPORATION (1986)

URS Company, Inc. CONSULTING ENGINEERS NEW YORK NEW JERSEY	ORGANIC VAPOR SOIL PROFILES	FIGURE 4-9

Wells which were within or near the limits of fill showed moderate and high vapor readings (VBW-2, VBW-4D, VBW-9D and VBW-10S). These readings are not unusual for landfill debris. Well clusters with upward gradients showed ambient to moderately elevated vapor readings (VBW-3 and VBW-7). Well VBW-3I, where the vertical gradient fluctuated between upward and downward, showed moderately elevated readings at depth. Well clusters with downward gradients showed high vapor readings at depth (VBW-4 and VBW-8). These may be an effect of shallow groundwater moving downward through the hollow-stem augers during drilling or actual contamination at depth.

4.4.2 Groundwater Contamination - Groundwater samples were collected and analyzed from 25 of the 28 monitoring wells installed during this investigation. (The remaining three wells, VBW-9S, VBW-9D and VBW-10S, were found to be dry.) The samples were analyzed for the following compounds and parameters:

- Hazardous Substance List (HSL) volatile compounds (35 specific compounds and library search for additional mass spectrometer (MS) peaks)
- HSL semi-volatile compounds (68 specific compounds and library search for additional MS peaks)
- HSL pesticides and PCB's (27 specific compounds)
- HSL metals (13 specific compounds)
- Total cyanide
- Total phenols
- Six (6) leachate indicator parameters: alkalinity, ammonia nitrogen (NH_3), chemical oxygen demand (COD), total calcium hardness, total dissolved solids (TDS) and total organic content (TOC)

In addition, field measurements of pH, specific conductance and temperature were taken while the samples were being collected.

A summary of groundwater analytical results is presented in Table 4-11 (volatile compounds), Table 4-12 (semi-volatile compounds), Table 4-13 (metals, cyanide and total phenols), and Table 4-14 (indicator parameters and field measurements). These summary tables indicate only the compounds which were detected in one or more sample. The compound numbers correspond to the numbers from the complete Hazardous Substance List.

The groundwater analytical data in Tables 4-11 through 4-14 is discussed in the following sections. Results shown on these tables are generally expressed in micrograms per liter (ppb), or milligrams per liter (ppm). Throughout the discussion below, the following descriptive terminology is used:

- o extremely low ppb range = <1 ppb
- o very low ppb range = 1-10 ppb
- o low ppb range = 10-100 ppb
- o medium ppb range = 100-500 ppb
- o high ppb range = 500-1,000 ppb

1 ppm = 1,000 ppb

It should be noted that this terminology refers only to the concentrations at which various compounds were detected, and does not reflect the varying degrees of risk posed by these compounds.

4.4.2.1 General Occurrence of Hazardous Substances in Groundwater - As indicated by Tables 4-11 through 4-13, a variety of HSL compounds were detected in groundwater samples at the Volney Landfill. These included 17 volatile compounds, 14 semi-volatile compounds and 10 metals. Neither pesticides/PCB's, nor cyanide was detected in any of the wells. The following paragraphs expand upon the general occurrence of HSL compounds in groundwater.

Among the detectable volatile compounds, those appearing most frequently (i.e., in more than 3 of the 25 samples analyzed) were

TABLE 4-11

GROUNDWATER ANALYTICAL SUMMARY - VOLATILE COMPOUNDS

Volatile Compounds	VBW-1	VBW-2	VBW-3S	VBW-3I	VBW-3D	VBW-3BR	VBW-4S	VBW-4D	VBW-5	VBW-6	VBW-7S	VBW-7D
3. Vinyl Chloride												
4. Chloroethane		7.3					2.5				2.8	
5. Methylene Chloride	1.3	821.*	6.1	9.0	1.8	81.	2.4*	2.4*	4.5*	4.5*	5.2*	2.2*
6. Acetone						12.	8.1					
9. 1,1-Dichloroethane											2.7	
10. trans-1,2-Dichloroethene	0.39									4.0		
11. Chloroform										70.		
13. 2-Butanone (or MEK)												
14. 1,1,1-Trichloroethane		0.53*		0.55						1.6		
21. Trichloroethene		1.2*							0.72*	3.4		
24. Benzene							2.2					
28. 2-Hexanone		11.										
30. Tetrachloroethene												
31. Toluene							0.45*				0.95*	0.55*
33. Ethyl Benzene		1.4										
34. Styrene												
35. Total Xylenes		15.										
Total HSL Volatiles	1.7	857.	6.1	9.6	1.8	93.	15.6	2.4	5.2	83.5	11.6	2.8
Total Additional Peaks	16.	12.	Ø	Ø	3.	Ø	55.	7.	12.	44.	25.	2.

Notes:

1) All values are in ug/l (ppb).

2) Blank values and unlisted HSL compounds were not detected.

3) * = Compound also detected in laboratory and/or trip blank.

TABLE 4-11 (Cont'd.)

GROUNDWATER ANALYTICAL SUMMARY - VOLATILE COMPOUNDS

Volatile Compounds	VBW-8S	VBW-8D	VBW-8BR	VBW-10D	VBW-10BR	VBW-11	VBW-12	VBW-13	VBW-14	VBW-15	VBW-16	VBW-17	VBW-17A
3. Vinyl Chloride	5.8												
4. Chloroethane	20.												
5. Methylene Chloride	4.6*	4.9*	3.5*		113.*		82.*	54.*	7.1*	3.1*	875.*	2.9*	3.7*
6. Acetone		66.		5.1	2,767.*				2.0				
9. 1,1-Dichloroethane	10.2												
10. trans-1,2-Dichloroethane	4.0												
11. Chloroform													
13. 2-Butanone (or MEK)					54.								
14. 1,1,1-Trichloroethane							0.63*	0.67*					
21. Trichloroethene	1.3						0.93*	0.88*			0.69*		
24. Benzene	3.5				0.52								
28. 2-Hexanone		6.2			5.5								
30. Tetrachloroethene							0.62*						
31. Toluene		3.9			1.7				0.67*			0.89*	
33. Ethyl Benzene		3.4			1.4								
34. Styrene		2.8											
35. Total Xylenes		0.55			1.4								
Total HSL Volatiles	49.4	87.8	3.5	5.1	2,944.5	Ø	84.2	55.5	9.8	3.1	875.7	3.8	3.7
Total Additional Peaks	28.	21.	Ø	Ø	36.	Ø	5.	10.	10.	3.	3.	3.	2.

Notes:
1) All values are in ug/l (ppb).
2) Blank values and unlisted HSL compounds were not detected.
3) * = Compound also detected in laboratory and/or trip blank.

TABLE 4-12

GROUNDWATER ANALYTICAL SUMMARY - SEMI-VOLATILE COMPOUNDS

Semi-Volatile Compounds	VBW-1	VBW-2	VBW-3S	VBW-3I	VBW-3D	VBW-3BR	VBW-4S	VBW-4D	VBW-5	VBW-6	VBW-7S	VBW-7D
37. Phenol		ISV					ISV					
43. Benzyl Alcohol		"					"					
45. 2-Methylphenol		"					"					
47. 4-Methylphenol		"					"					
54. Benzoic Acid		"					"					
68. Dimethyl Phthalate		"	35.			2.7	"					
71. Acenaphthene		"					"					
77. Diethylphthalate	1.0	"	0.4		0.38	0.37	"					
88. Di-n-butylphthalate	1.0	"	1.0	1.3	32.	1.4	"	4.0			63.	
95. bis (2-ethylhexyl)phthalate	59.	"	19.	35.	58.	38.	"	201.	86.	43.	166.	286.
97. Di-n-octyl phthalate	0.2	"	0.2	0.78	1.1	0.68	"	3.0	2.0			
98. Benzo(b)fluoranthene		"					"					
101. Indeno(1,2,3-cd)pyrene		"					"					
102. Dibenz(a,h)anthracene		"			1.1		"					
Total HSL Semi-Volatiles	61.2	"	55.6	37.1	92.6	43.2	"	208.	88.	43.	229.	286.
Total Additional Peaks	95.	"	531.	105.	981.	242.	"	Ø	76.	22.	136.	57.

Notes:
1) All values are in ug/l (ppb).
2) Blank values and unlisted HSL compounds were not detected.
3) ISV = Insufficient Sample Volume.
4) * = Compound also detected in laboratory and/or trip blank.

TABLE 4-12 (Cont'd.)

GROUNDWATER ANALYTICAL SUMMARY - SEMI-VOLATILE COMPOUNDS

Semi-Volatile Compounds	VBW-8S	VBW-8D	VBW-8BR	VBW-10D	VBW-10BR	VBW-11	VBW-12	VBW-13	VBW-14	VBW-15	VBW-16	VBW-17	VBW-17A
37. Phenol					33.	ISV							
43. Benzyl Alcohol					12.*	"							
45. 2-Methylphenol					1.0	"							
47. 4-Methylphenol					26.	"							
54. Benzoic Acid					43.	"							
68. Dimethyl Phthalate						"							
71. Acenaphthene	1.0					"							
77. Diethylphthalate	1.0				0.45	"	0.68	0.3			0.2		
88. Di-n-butylphthalate	2.0			2.3	1.0	"	1.2	1.0		1.0	1.0	4.0	
95. bis (2-ethylhexyl)phthalate	215.	37.	51.	80.	44.	"	178.	118.	134.	39.	45.	122.	134.
97. Di-n-octyl phthalate	40.	1.0	1.0	0.61	2.0	"	0.09	0.2	2.0	1.0		2.0	1.4
98. Benzo(b)fluoranthene					4.0	"							
101. Indeno(1,2,3-cd)pyrene					3.0	"							
102. Dibenz(a,h)anthracene					1.0	"							
Total HSL Semi-Volatiles	259.	38.	52.	82.9	170.4	"	180.	119.5	136.	41.	46.2	128.	135.4
Total Additional Peaks	292.	37.	129.	128.	438.	"	153.	161.	42.	776.	86.	297.	81.

Notes:

1) All values are in ug/l (ppb).
2) Blank values and unlisted HSL compounds were not detected.
3) ISV = Insufficient Sample Volume.
4) * = Compound also detected in laboratory and/or trip blank.

TABLE 4-13

GROUNDWATER ANALYTICAL SUMMARY - METALS, CYANIDE AND TOTAL PHENOLS

Metals, Cyanide and Total Phenols	VBW-1	VBW-2	VBW-3S	VBW-3I	VBW-3D	VBW-3BR	VBW-4S	VBW-4D	VBW-5	VBW-6	VBW-7S	VBW-7D
Antimony		ISV					ISV					
Arsenic	2.	"				85.	"					
Beryllium		"		4.			"	5.			4.	5.
Cadmium		"					"					
Chromium		"					"		15.			
Copper		"					"					
Lead	9.	"					"			11.		3.
Mercury		"			0.2		"			0.3		
Nickel	75.	"		21.		22.	"	61.			71.	
Selenium		"	10.	13.	12.	11.	"	12.			6.	16.
Silver		"					"					
Thallium	7.	"					"		2.	4.	2.	
Zinc	31.	"	23.	15.	19.	4.	"	32.	61.	72.	29.	12.
Total Metals	124.	"	33.	53.	31.2	122.	"	110.	78.	87.3	112.	36.
Cyanide		"					"					
Total Phenols	7.	"	7.		5.		"	13.				

Notes:
1) All values are in ug/l (ppb).
2) Blank values were not detected.
3) ISV = Insufficient Sample Volume.

TABLE 4-13 (Cont'd.)

GROUNDWATER ANALYTICAL SUMMARY - METALS, CYANIDE AND TOTAL PHENOLS

Metals, Cyanide and Total Phenols	VBW-8S	VBW-8D	VBW-8BR	VBW-10D	VBW-10BR	VBW-11	VBW-12	VBW-13	VBW-14	VBW-15	VBW-16	VBW-17	VBW-17A
Antimony						ISV	ISV						
Arsenic		4.	12.			"	"						2.
Beryllium						"	"		5.			5.	5.
Cadmium			4.	5.	5.	"	"						
Chromium					27.	"	"						
Copper						"	"						
Lead	5.	7.	8.		9.	"	"			4.			
Mercury	0.2			0.3		"	"						
Nickel	22.					"	"	38.			22.		
Selenium				3.	3.	"	"	9.		3.		8.	
Silver						"	"						
Thallium	10.	12.	3.	2.	3.	"	"	3.					
Zinc	94.	29.	39.	21.	10.	"	"		29.	24.	4.	6.	17.
Total Metals	131.2	52.	66.	31.3	57.	"	"	50.	34.	31.	26.	19.	24.
Cyanide						"	"						
Total Phenols	10.	6.		9.	130.	"	"	7.					

Notes:
1) All values are in ug/l (ppb).
2) Blank values were not detected.
3) ISV = Insufficient Sample Volume.

TABLE 4-14

GROUNDWATER ANALYTICAL SUMMARY - FIELD MEASUREMENTS AND INDICATOR PARAMETERS

Field Measurements	VBW-1	VBW-2	VBW-3S	VBW-3I	VBW-3D	VBW-3BR	VBW-4S	VBW-4D	VBW-5	VBW-6	VBW-7S	VBW-7D
pH, Standard Units	6.52	7.15	7.28	7.79	8.93	8.57	ISV	7.09	7.81	7.01	7.00	7.69
Specific Conductance (umhos/cm)	1,200.	1,880.	230.	250.	300.	460.	"	1,030.	410.	650.	1,130.	320.
Temperature, °C	15.3	26.6	17.8	15.7	14.5	14.0	"	16.2	16.5	19.4	17.6	18.2
Indicator Parameters												
Alkalinity	639.	ISV	97.	111.	113.	285.	ISV	417.	204.	340.	528.	458.
Ammonia Nitrogen	1.93	"					"				0.31	
COD	19.	"	19.	7.	161.	155.	"	30.		4.	26.	
Total Hardness ($mgCaCO_3/l$)	569.	"	88.	112.	107.	9.	"	372.	228.	437.	863.	156.
TDS	411.	"	75.	140.	150.	230.	"	660.	460.	260.	730.	250.
TOC	240.	52.	74.	17.	18.	33.	"	56.	160.	47.	74.	14.

Notes:
1) All values are in mg/l (ppm).
2) Blank values were not detected.
3) ISV = Insufficient Sample Volume.

TABLE 4-14 (Cont'd.)

Field Measurements	VBW-8S	VBW-8D	VBW-8BR	VBW-10	VBW-10BR	VBW-11	VBW-12	VBW-13	VBW-14	VBW-15	VBW-16	VBW-17	VBW-17A
pH, Standard Units	6.31	7.07	7.42	7.10	12.24	ISV	6.63	7.51	6.75	7.06	7.38	7.76	7.47
Specific Conductance (umhos/cm)	1,840.	1,050.	670.	790.	7,200.	"	1,440.	500.	300.	620.	530.	310.	530.
Temperature, °C	16.6	15.9	17.5	15.9	18.6	"	24.9	20.9	18.4	20.7	20.5	17.1	18.5
Indicator Parameters													
Alkalinity	666.6	398.	131.	196.	1,062.	ISV	ISV	ISV	138.	284.	ISV	135.	172.
Ammonia Nitrogen	15.65				10.22	"	"	"			"		
COD	35.	13.	64.	39.	300.	"	"	"	110.	30.	"	30.	228.
Total Hardness ($mgCaCO_3/l$)	524.	494.	224.	363.	826.	"	"	"	118.	608.	"	165.	215.
TDS	880.	620.	430.	351.	4,930.	"	"	"	140.	390.	"	230.	360.
TOC	150.	54.	15.	36.	83.	"	28.	35.	49.	89.	37.	51.	120.

Notes:
1) All values are in mg/l (ppm).
2) Blank values were not detected.
3) ISV = Insufficient Sample Volume.

methylene chloride (23 occurrences), toluene (7 occurrences), trichloroethene (7 occurrences), acetone (6 occurrences), 1,1,1-trichloroethane (5 occurrences) and chloroethane (4 occurrences). These compounds were generally present in the very low ppb range. Exceptions were methylene chloride, which was present in two well samples (VBW-2 and VBW-16) in the high ppb range, and acetone, which was present in one well sample (VBW-10BR) in the very low ppm range. Compounds recognized as additional MS peaks were also typically in the low ppb range.

The only semi-volatile compounds appearing in more than 3 of the 22 well samples analyzed were the following 4 phthalates: bis(2-ethyl hexyl) phthalate (22 occurrences), di-n-octyl phthalate (18 occurrences), di-n-butylphthalate (15 occurrences) and diethylphthalate (9 occurrences). These compounds generally occurred in the very low ppb range, with the exception of bis(2-ethyl hexyl) phthalate, which occurred in levels up to the medium ppb range in a number of samples. Additional MS peak compounds were typically measured in the low-to-medium ppb range; however, C_6-cycloalkane was detected in the high ppb range in two well samples (VBW-3D and VBW-15).

Of the 13 HSL metals analyzed, all but 3 (antimony, chromium and silver) were detected in at least one groundwater sample. Those appearing in more than 3 of the 21 samples analyzed were: zinc (20 occurrences), selenium (12 occurrences), thallium (10 occurrences), lead (8 occurrences), nickel (8 occurrences), beryllium (7 occurrences), arsenic (4 occurrences) and mercury (4 occurrences). Metals were generally measured within a fairly narrow range of very low to low ppb. Mercury, however, in all samples where it was detected, fell within the extremely low ppb range.

As previously stated, none of the 27 HSL pesticide/PCB compounds were detected in any of the groundwater samples from the site. Likewise, cyanide was not detected in any of the samples. Total phenols were detected in 9 of the 21 samples analyzed, with typical concentrations in the very low to low ppb range. (The maximum total phenol concentration, 130 ppb, was measured in well VBW-10BR.)

4.4.2.2 Other Groundwater Parameters Measured - Statistical analyses of groundwater field measurements and general leachate indicator analyses are summarized on Table 4-15. For each parameter measured, the high, low and mean values are presented. Specific wells in which the high and low values occurred are also indicated. In this table, the abbreviation "ND" stands for "not detected". Since ammonia (NH_3) was only detected in 4 wells, mean values were not calculated for this parameter.

4.4.2.3 Relative Contamination of Wells - As indicated by the previous discussions, there are a variety of compounds present in groundwater at the Volney Landfill site. These compounds vary from well to well making comparison between wells extremely difficult on a compound-specific basis. For this reason, a Relative Contamination Index (RCI) has been developed for each of the wells. This RCI permits comparison between wells on the basis of aggregate compound occurrence. Its value is meaningful only on a comparative basis; the parameter value has no meaning in absolute terms.

In developing an RCI for comparison of groundwater samples, it is useful to consider not only the occurrence and concentration of specific compounds within each sample, but also the relative degree of hazard posed by the compounds. To represent this hazard factor, toxicity and persistence have been used in a manner consistent with the USEPA's National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300). Appendix A of the NCP presents a system, referred to as the Hazard Ranking System (HRS), for ranking uncontrolled hazardous waste sites. Specifically, it includes a matrix by which chemical compounds are scored on the basis of their combined toxicity and persistence. Higher scores indicate compounds which are more toxic and/or less biodegradable, and which therefore pose a greater degree of

TABLE 4-15

STATISTICAL ANALYSES - GROUNDWATER INDICATOR PARAMETERS AND FIELD MEASUREMENTS

Parameter	Unit	High Value (Sample)	Low Value (Sample)	Mean Value
pH	---	12.24 (VBW-10BR)	6.31 (VBW-8S)	7.55
Specific Conductance	umhos/cm	7,200. (VBW-10BR)	230. (VBW-3S)	1,028.
Temperature	°C	26.6 (VBW-2)	14.0 (VBW-3BR)	18.1
Alkalinity	mg/l	1,062. (VBW-10BR)	97. (VBW-3S)	335.
NH_3	mg/l	15.6 (VBW-8S)	ND (15 of 19 wells)	---
COD	mg/l	300. (VBW-10BR)	ND (2 of 19 wells)	67.
Hardness (Ca)	mg/l	863. (VBW-7S)	9. (VBW-3BR)	341.
TDS	mg/l	4,930. (VBW-10BR)	75. (VBW-3S)	616.
TOC	mg/l	240. (VBW-1)	14. (VBW-7D)	67.

Notes:
1) ND = Not Detected.

hazard. For details of this chemical compound scoring system, Appendix A of the National Contingency Plan should be consulted. The system was used to establish a combined toxicity/persistence value for the various compounds present in samples from the Volney Landfill. Results are shown in Table 4-16. Some of the values shown on this table are for compounds which did not appear in groundwater, but were present in stream water, leachate and/or stream sediment samples. On the other hand, Table 4-16 does not include values for several compounds which were observed in groundwater samples, but which are not used in the RCI scoring system for reasons discussed below. As in previous tables, the compound numbers in Table 4-16 correspond to numbers from the full Hazardous Substance List.

Using the groundwater analytical results summarized in Tables 4-11 through 4-13, and the toxicity/persistence factors in Table 4-16, a Relative Contamination Index (RCI) was determined for each of the groundwater monitoring wells at the Volney Landfill site. RCI values were calculated as follows:

- o The following 6 HSL semi-volatile compounds were omitted from the scoring because of their common occurrence as sampling contaminants: dimethyl phthalate, diethylphthalate, di-n-butylphthalate, bis(2-ethyl hexyl) phthalate, di-n-octyl phthalate and butyl benzyl phthalate.
- o In addition, all observed compounds on Tables 4-11 through 4-13 which were also detected in laboratory and/or trip blank samples were omitted from the scoring, since their presence cannot be conclusively associated with the sampled medium.
- o For each of the other detected HSL compounds, the compound's concentration was multiplied by its toxicity/persistence factor.
- o For additional peaks (volatiles and semi-volatiles), the total concentration was multiplied by a representative average toxicity/persistence factor.

TABLE 4-16

TOXICITY/PERSISTENCE VALUES OF CHEMICAL COMPOUNDS

Fraction	Compound	Toxicity/ Persistence Value
VOLATILES	3. Vinyl Chloride	15
	4. Chloroethane	12
	5. Methylene Chloride	15
	6. Acetone	6
	7. Carbon Disulfide	12
	9. 1,1-Dichloroethane	9
	10. trans-1,2-Dichloroethene	9
	11. Chloroform	18
	13. 2-Butanone	9
	14. 1,1,1-Trichloroethane	15
	21. Trichloroethene	12
	24. Benzene	12
	28. 2-Hexanone	6
	29. 4-Methyl-2-pentanone	12
	31. Toluene	9
	33. Ethyl Benzene	9
	34. Styrene	12
	35. Total Xylenes	9
SEMI-VOLATILES	37. Phenol	12
	40. 2-Chlorophenol	15
	45. 2-Methylphenol	12
	47. 4-Methylphenol	12
	54. Benzoic Acid	9
	58. Naphthalene	9
	61. 4-Chloro-3-methylphenol	12
	62. 2-Methylnaphthalene	6
	71. Acenaphthene	12
	74. Dibenzofuran	15
	85. Pentachlorophenol	12

TABLE 4-16 - (Cont'd.)

TOXICITY/PERSISTENCE VALUES OF CHEMICAL COMPOUNDS

Fraction	Compound	Toxicity/ Persistence Value
SEMI-VOLATILES (Cont'd.)	86. Phenanthrene	12
	89. Fluoranthene	18
	91. Pyrene	18
	98. Benzo(b)fluoranthene	15
	101. Indeno (1,2,3-cd)pyrene	18
	102. Dibenz(a,h)anthracene	18
PESTICIDES/PCB'S	128. Aroclor-1248	18
METALS/CYANIDE	All Metals	18
	Cyanide	18

- Products were subtotalled to yield RCI values for each fraction (e.g., volatile, semi-volatile).
- Fraction subtotals were totaled to yield total RCI values for each sample.
- Samples of each fraction were ranked from #1 most contaminated to least contaminated based on their total RCI values.

Results of the above procedure are presented in Table 4-17 and discussed in the following section.

4.4.2.4 Evaluation of Groundwater Contamination - In the following paragraphs, groundwater contamination at the Volney Landfill is evaluated from a number of different standpoints. This evaluation is based upon groundwater and the RCI's as presented in the previous sections. An assessment of groundwater quality in terms of environmental and public health standards is included in Section 6.0 of this report.

Comparing wells on an individual basis, and using the RCI as the measure of a well's overall contamination, the following list identifies the 5 (out of 21) most contaminated wells in descending order: (1) VBW-3BR (open bedrock well); (2) VBW-6 (screened in sand and gravel); (3) VBW-8S (screened in fine sand); (4) VBW-10BR (open bedrock well); and (5) VBW-1 (screened in sand and gravel). Well locations are indicated on Figure 4-1. Wells VBW-6, VBW-8S and VBW-1 are shallow wells screened in relatively permeable materials near the perimeter of the landfill, where leachate contamination is not surprising. More significant, however, is the observed contaminantion in VBW-3BR and VBW-10BR, both open bedrock wells. Previous investigations (Geraghty and Miller, 1985) have concluded that the bedrock unit had not been influenced by landfill leachate. The observed contamination in these wells would appear to indicate otherwise. However, any conclusion drawn from well VBW-10BR should be tempered by consideration of the following factors:

TABLE 4-17

RELATIVE CONTAMINATION INDEX (RCI) VALUES - GROUNDWATER MONITORING WELLS

	VBW-1	VBW-2	VBW-3S	VBW-3I	VBW-3D	VBW-3BR
HSL VOLATILES	24	302	92	143	27	1,287
HSL SEMI-VOLATILES	Ø	--	Ø	Ø	20	Ø
METALS & CYANIDE	2,232	--	594	954	562	2,196
TOTAL RCI	2,256	--	686	1,097	609	3,483
Rank (#1 to #21)	#5		#13	#11	#16	#1

	VBW-4S	VBW-4D	VBW-5	VBW-6	VBW-7S	VBW-7D
HSL VOLATILES	105	Ø	Ø	1,361	58	Ø
HSL SEMI-VOLATILES	--	Ø	Ø	Ø	Ø	Ø
METALS & CYANIDE	--	1,980	1,404	1,566	2,016	648
TOTAL RCI	--	1,980	1,404	2,927	2,074	648
Rank (#1 to #21)		#7	#9	#2	#6	#14

TABLE 4-17 (Cont'd.)

RELATIVE CONTAMINATION INDEX (RCI) VALUES - GROUNDWATER MONITORING WELLS

	VBW-8S	VBW-8D	VBW-8BR	VBW-10D	VBW-10BR	VBW-11
HSL VOLATILES	513	538	Ø	31	566	Ø
HSL SEMI-VOLATILES	12	Ø	Ø	Ø	1,239	--
METALS & CYANIDE	2,362	936	1,188	563	1,026	--
TOTAL RCI	2,887	1,474	1,188	594	2,831	--
Rank (#1 to #21)	#3	#8	#10	#17	#4	

	VBW-12	VBW-13	VBW-14	VBW-15	VBW-16	VBW-17	VBW-17A
HSL VOLATILES	Ø	Ø	12	Ø	Ø	Ø	Ø
HSL SEMI-VOLATILES	Ø	Ø	Ø	Ø	Ø	Ø	Ø
METALS & CYANIDE	---	900	612	558	468	342	432
TOTAL RCI	--	900	624	558	468	342	432
Rank (#1 to #21)		#12	#15	#18	#19	#21	#20

(a) Odors noted during development of this well (Section 4.1.2.5) and the very high pH value of the well sample (Table 4-14) suggest intrusion of grout into the bedrock formation around the well.

(b) Partial sealing of the bedrock formation by grout intrusion is also suggested by the very slow recharge rates observed during well development (Section 4.1.2.5) and sampling (Appendix G). These slow rates reduce the amount of flushing associated with development and purging, and increase the possibility that the sample obtained from this well is not truly representative of the bedrock formation, rather a relic affect of leachate encountered from above during drilling. (Note, however, that the external seal through lodgement till was installed without incident, and is considered to be effective in preventing downhole contaminant migration.)

In order to compare well contamination by major stratigraphic units, the following breakdown is provided: three wells (VBW-3BR, VBW-8BR and VBW-10BR) are open-hole bedrock wells; five wells (VBW-3D, VBW-4D, VBW-10D, VBW-13 and VBW-17) are screened in the lodgement till aquitard; all other wells are screened in the various, more permeable overlying strata. The average RCI values for these major units are: average bedrock RCI = 2,500; average lodgement till RCI = 885; average RCI of combined overlying strata = 1,349. If bedrock well VBW-10BR is omitted from consideration, for reasons discussed above, the average RCI of the two remaining bedrock wells is 2,335. Therefore, even in the absence of VBW-10BR, bedrock contamination at this site is indicated by the available chemical data. This observation warrants further consideration of the site's hydrogeologic features, and particularly the feasibility of vertical leachate migration through lodgement till to bedrock.

Geologic cross-sections of the site (Figures 4-3 and 4-4) indicate that the average thickness of lodgement till underlying the landfill is approximately 60 feet. According to Table 4-8, the average hydraulic conductivity of this lodgement till unit is approximately 0.19 feet/day (6.7 x 10^{-5} centimeters/second). A typical volumetric porosity (n) value for this unit would be 0.20. Vertical hydraulic gradients, as measured at well clusters and reported on Table 4-9, vary greatly with location and time. The maximum downward gradient measured on the two water level reading dates was (-) 0.086. Darcy's Law may be utilized to calculate vertical flow velocity:

$$V = (K/n)\ (dh/dl)$$

Where K = hydraulic conductivity

n = volumetric porosity

dh/dl = hydraulic gradient

The vertical velocity calculated by this equation is approximately 0.082 feet/day. At this velocity, it would require only approximately two years for leachate to penetrate the average lodgement till thickness of 60 feet. Even allowing for lower sustained downward hydraulic gradients at the site (i.e. 0.010), it would appear to be feasible from a hydrogeologic standpoint that leachate from the landfill has had sufficient time (approximately 17 years) to reach bedrock.

Comparison of contamination in wells monitoring groundwater flow from the southern (old) section and northern (new) section of the landfill can also be made, in order to evaluate whether there is any measurable difference in groundwater quality on the two sides of the landfill. For the purpose of this comparison, only overburden wells have been utilized. The following 9 wells have been used to represent flow from the southern section: VBW-1, VBW-3S, VBW-3I, VBW-3D, VBW-4D, VBW-10D, VBW-13, VBW-15 and VBW-16. By comparison, the following 6 wells represent flow from the northern section: VBW-6, VBW-7S, VBW-7D, VBW-8S, VBW-8D and VBW-14. Wells located very near the divide between southern and northern sections of the landfill (VBW-5, VBW-17 and

VBW-17A), where flow directions are more questionable, were not used for this comparison. The average RCI of wells in the south is 1,014; the average RCI of wells in the north is 1,772. On this basis alone, it would appear that levels of groundwater contamination are generally somewhat higher in wells on the north side of the landfill. Although this comparison is statistically inconclusive, it does indicate, at least, that levels of overburden groundwater contamination are not distinctly higher on the side of the landfill (south) where hazardous wastes from the PAS site are reported to have been buried.

Specific spatial patterns of contaminant migration away from the landfill are not evident from the study data. This analytical data supports the general hydrogeologic model of radial (contaminated) groundwater flow away from the site in all directions. It is noteworthy that monitoring well VBW-11, for which only limited analytical data is available, shows no contamination by HSL volatile organic compounds. This well is located southeast of the landfill (Figure 4-1), in the direction which previous investigations (Geraghty and Miller, 1985) have identified as the primary direction of plume migration.

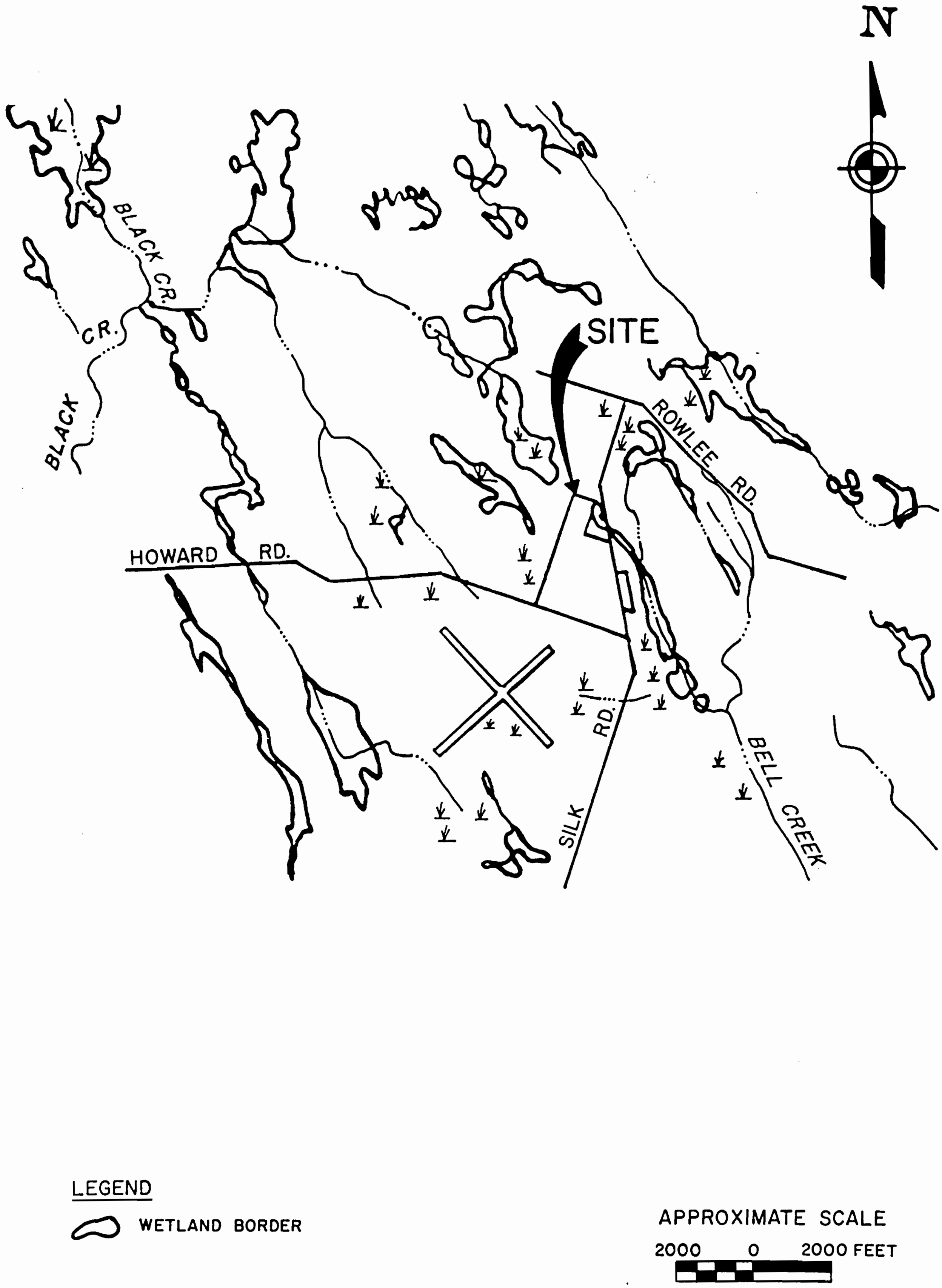
5.0 SURFACE WATER INVESTIGATION

5.1 Surface Water and Drainage Patterns

Surface drainage in the area is generally by low-gradient streams. The site area is drained by Bell Creek and tributaries of Black Creek which eventually drain into the Oswego River, a major regional river that empties into Lake Ontario at Oswego, New York (Figure 5-1). Several ponds, marshes and wetlands are within a mile of the site.

The Volney Landfill site was constructed on a pre-existing topographic high which forms the divide between the headwaters of the north-northwest flowing Black Creek drainage to the west and the south-southeast trending Bell Creek drainage to the east. The development of these two drainage basins is largely controlled by drumlin orientation. On the east side of Silk Road, Bell Creek has a well defined inter-drumlin channel. In the divide area, however, drumlin topography is subdued and a surface mantle of sand and gravel is present. For most of the site area, surface drainage is not well developed and the location of the drainage divide is approximate. Sand and gravel excavation beyond the northwest corner of the landfill appears to have shifted the divide a short distance to the west. Surface drainage was also being affected by landfill closure.

A line of small springs or seeps was observed after snowmelt along the north-south trending cut slope of sand and gravel at the northwest corner of the landfill. These springs were issuing from the sand and gravel at the contact with the underlying lodgement till. Spring water flowed across the excavated surface and past well VBW-6 into the small swampy area at the headwaters of Bell Creek, north of the landfill. These springs, which had not been observed previously, may be the result of excavation opening an avenue of surface discharge for water perched on the lodgement till surface.



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SURFACE WATER MAP

FIGURE 5-1

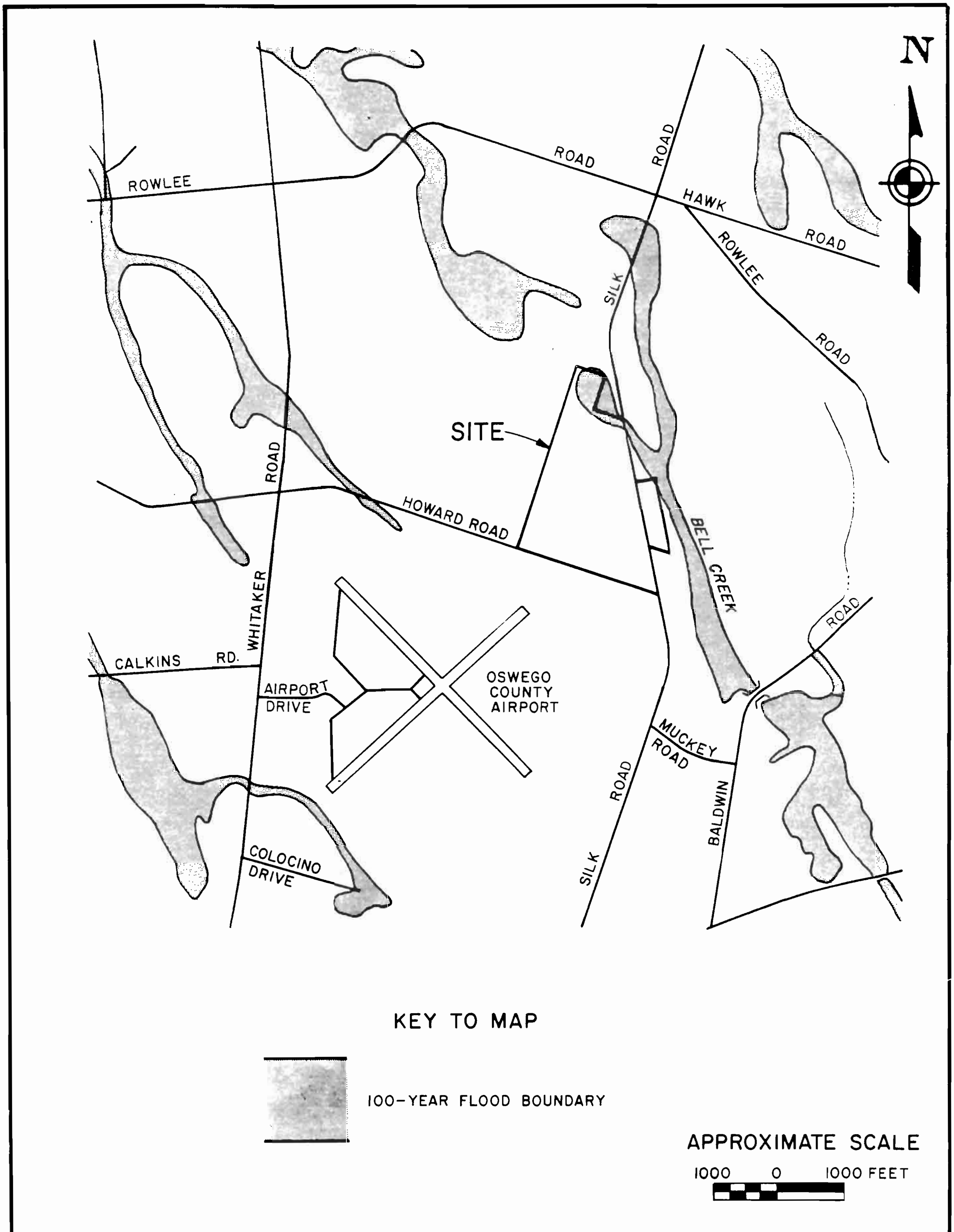
5.2 Flood Potential

A Flood Insurance Study for the Town of Volney was initiated in 1978 and published in 1981 (FEMA, 1981). In the vicinity of the site, Bell Creek and tributaries of Black Creek were studies by approximate methods, as they had been previously identified as areas having minimal flood hazards. Figure 5-2 shows the 100-year flood boundaries for these waterways in the vicinity of the site. A small portion of the 100-year flood boundary for Bell Creek does cross the site boundary in the extreme northeast corner, beyond the limits of landfilling operations.

5.3 Surface Water Contamination

Surface water and stream sediments in the vicinity of the Volney Landfill were sampled and analyzed in accordance with protocols set forth in the Work/QA Project Plan (URS Company, 1985b). A full environmental sampling report is included in Appendix G. The locations of surface water/sediment sampling points are shown on Figure 5-3. At all locations except VLCH-1, both surface water and sediment samples were collected. VSS-1 is located upgradient from Volney Landfill on a tributary of Bell Creek. All other locations are effectively downgradient from the site. The following sampling locations are located along Bell Creek at locations successively farther downstream: VLCH-1 (a leachate breakout point on the north side of the site), VSS-2, VSS-4 and VSS-5. Sampling stations VSS-6 and VSS-7 are located at the headwaters of tributaries to Black Creek, with all other sampling stations in the Bell Creek watershed.

Surface water samples were analyzed for the same compounds and parameters as groundwater samples (refer to Section 4.4.2). A summary of surface water analytical results is presented in Table 5-1 (volatile compounds), Table 5-2 (semi-volatile compounds), Table 5-3 (metals, cyanide and total phenols) and Table 5-4 (indicator parameters and field measurements). As previously, the tables indicate only those compounds which were detected, with compound numbers corresponding to



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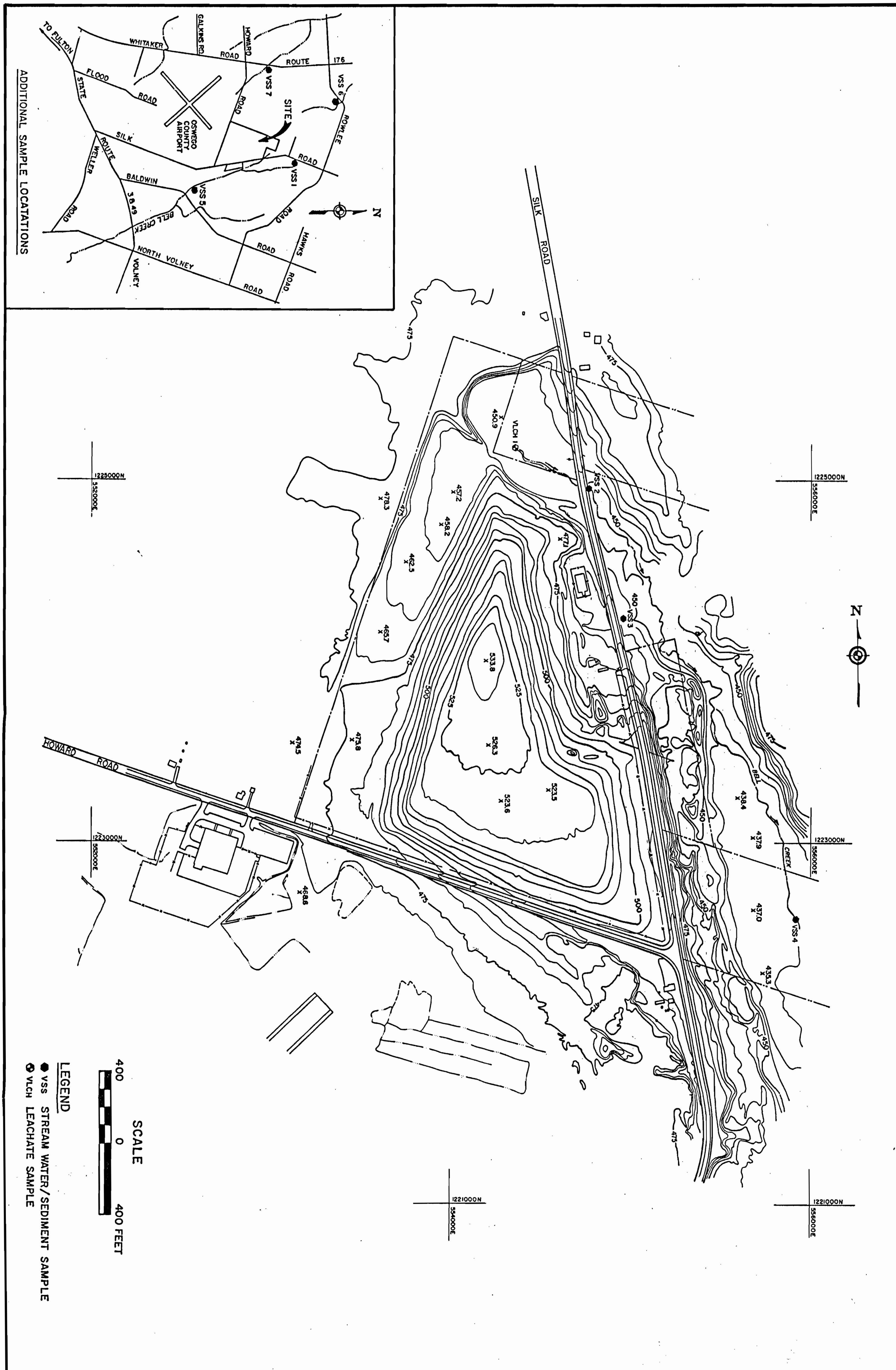
100-YEAR FLOOD BOUNDARY MAP

FIGURE 5-2

A-2207

C-1462



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SURFACE WATER/SEDIMENT SAMPLING LOCATIONS

FIGURE 5-3

TABLE 5-1
SURFACE WATER ANALYTICAL SUMMARY - VOLATILE COMPOUNDS

Volatile Compounds	Stream Water							Leachate
	VSS-1	VSS-2	VSS-3	VSS-4	VSS-5	VSS-6	VSS-7	VLCH-1
5. Methylene Chloride		0.33*	0.60*	3.6*	0.45*		2.6*	0.78*
6. Acetone	2.4							69.*
7. Carbon Disulfide								
11. Chloroform					0.37*	0.48*		
13. 2-Butanone (or MEK)								
14. 1,1,1-Trichloroethane						0.85*	3.4*	1.0*
21. Trichloroethene		1.2*	1.4*	1.5*	0.85*		1.3*	
28. 2-Hexanone								
29. 4-Methyl-2-pentanone								
31. Toluene								
Total HSL Volatiles	2.4	1.5	2.0	5.1	1.7	1.3	7.3	70.8
Total Additional Peaks	14.	Ø	Ø	Ø	11.	Ø	Ø	10.

Notes:
1) All values are in ug/l (ppb).
2) Blank values and unlisted comounds were not detected.
3) * = Compound also detected in laboratory and/or trip blank

TABLE 5-2
SURFACE WATER ANALYTICAL SUMMARY - SEMI-VOLATILE COMPOUNDS

Semi-Volatile Compounds	Surface Water							Leachate
	VSS-1	VSS-2	VSS-3	VSS-4	VSS-5	VSS-6	VSS-7	VLCH-1
40. 2-Chlorophenol								0.67
45. 2-Methylphenol								
47. 4-Methylphenol	0.99							
54. Benzoic Acid	5.8							
58. Naphthalene	0.39			0.41		0.41		
61. 4-Chloro-3-methylphenol								0.53
62. 2-Methylnaphthalene			0.12	0.13				
74. Dibenzofuran				0.08		0.08		
77. Diethylphthalate	0.51			0.76		0.66		
85. Pentachlorophenol						0.30		0.52
86. Phenanthrene								
88. Di-n-butylphthalate	0.77	1.0	0.64	1.1		0.95	1.4	
89. Fluoranthene						0.18		
91. Pyrene								
95. bis(2-ethylhexyl)phthalate	86.	58.	98.	68.	67.	127.	40.	17.
97. Di-n-octyl phthalate	0.18		0.24	0.40		0.53		0.12

TABLE 5-2 (Cont'd)
SURFACE WATER ANALYTICAL SUMMARY - SEMI-VOLATILE COMPOUNDS

	Surface Water							Leachate
Semi-Volatile Compounds	VSS-1	VSS-2	VSS-3	VSS-4	VSS-5	VSS-6	VSS-7	VLCH-1
Total HSL Semi-Volatiles	94.6	59.	99.	70.9	67.	130.1	41.4	18.8
Total Additional Peaks	1,085.	Ø	352.	567.	192.	1,163.	122.	371.

Notes:

1) All values are in ug/l (ppb).
2) Blank values and unlisted HSL compounds were not detected.
3) * = Compound also detected in laboratory and/or trip blank.

TABLE 5-3
SURFACE WATER ANALYTICAL SUMMARY - METALS, CYANIDE AND TOTAL PHENOLS

	Surface Water							Leachate
Metals, Cyanide, Total Phenols	VSS-1	VSS-2	VSS-3	VSS-4	VSS-5	VSS-6	VSS-7	VLCH-1
Antimony								
Arsenic	37.	5.	3.	3.	7.	7.	7.	
Beryllium	5.	3.	3.		4.			
Cadmium	3.							
Chromium								
Copper	15.							10.
Lead	79.	1.	4.	2.	3.	3.		9.
Mercury		0.2		0.4	0.2			
Nickel								
Selenium	2.		3.			2.		15.
Silver								
Thallium	20.		15.	15.	14.			2.
Zinc	385.	6.	30.	6.	8.			4.
Total Metals	546.	15.2	58.	26.4	36.2	12.	7.	40.
Cyanide								
Total Phenols	11.	16.	6.	5.	12.			

Notes:
1) All values are in ug/l (ppb).
2) Blank values and unlisted comounds were not detected.

TABLE 5-4
SURFACE WATER ANALYTICAL SUMMARY - FIELD MEASUREMENTS AND INDICATOR PARAMETERS

	Surface Water							Leachate
Field Measurements	VSS-1	VSS-2	VSS-3	VSS-4	VSS-5	VSS-6	VSS-7	VLCH-1
pH, Standard Units	7.02	7.22	7.53	7.47	7.74	7.46	7.00	8.01
Specific Conductance (uhmos/cm)	420.	250.	490.	390.	430.	310.	360.	220.
Temperature, °C.	26.7	18.6	22.1	19.1	20.9	22.5	22.2	23.9
Indicator Parameters								
Alkalinity	214.	110.	168.	169.	182.	136.	174.	80.
Ammonia Nitrogen	0.92		0.11					0.11
COD	86.		43.	6.	17.	13.	26.	25.
Total Hardness (mg $CaCo_3$)	269.	140.	333.	268.	283.	176.	234.	128.
TDS	220.	100.	140.	250.	270.	190.	390.	360.
TOC	140.	27.	54.	31.	28.	26.	23.	11.

Notes:
1) All values are in mg/l (ppm).
2) Blank values were not detected.

identification numbers from the full Hazardous Substance List. The surface water analytical data is discussed below using the same descriptive terminology as was introduced for discussion of groundwater results (Section 4.4.2).

5.3.1 <u>General Occurrence of Hazardous Substances in Surface Water</u> - Tables 5-1 through 5-4 indicate that a variety of HSL compounds were detected in the 8 surface water samples (including the one leachate breakout sample) near Volney Landfill. Specifically, these detections included 5 volatile compounds, 14 semi-volatiles and 9 metals. Neither pesticide/PCB's nor cyanide, was detected in any of the surface water samples. The general occurrence of HSL compounds in surface water is discussed in the following paragraphs, by compound category.

Among volatile organic compounds, only the following were detected at 3 or more of the 8 surface water sampling stations: methylene chloride (6 occurrences), trichloroethene (5 occurrences), and 1,1,1-trichloroethane (3 occurrences). Each of these three compounds was also found in laboratory and/or trip blanks, however, as indicated in Table 5-1. In general, fewer volatile compounds were present in surface water than in groundwater samples. (This would be expected under normal circumstances, since groundwater flow into adjacent streams and/or surface runoff to the streams generally provides an opportunity for volatilization of contaminants). Volatile compounds in surface water were generally present in the extremely low ppb range, except that acetone was detected in the low ppb range in one sample (VLCH-1). Again, comparing surface water and groundwater results, the concentration of volatile compounds in surface water was typically an order of magnitude lower, which is explainable by a combination of volatilization and dilution as water moves away from the landfill. Compounds recognized as additional MS peaks were typically detected in the very low ppb range.

A total of 5 HSL semi-volatile compounds were detected in 3 or more of the 8 surface water samples. These included bis(2-ethyl hexyl) phthalate (8 occurrences), di-n-butylphthalate (6 occurrences), di-n-octyl phthalate (5 occurrences), diethylphthalate (3 occurrences) and naphthalene (3 occurrences). Discounting the 4 phthalate compounds, which were also widespread in groundwater samples and are suspected sampling contaminants, only naphthalene occurred with any regularity. Because it was not detected in any of the groundwater samples, and its presence was also observed upgradient from the site (at VSS-1), naphthalene may be attributable to sources other than Volney Landfill. In any case, this compound was detected in only the extremely low ppb range. Additional MS peak semi-volatile compounds were typically detected at concentrations in the low to medium ppb range. A notable exception to this is benzene, which was tentatively identified as an additional peak in the analysis of two samples (VSS-1 and VSS-6) in the high ppb range (912 ppb and 942 ppb, respectively). However, benzene as an additional peak was also detected in fairly high concentrations in the laboratory blank samples, rendering its actual occurrence in surface water questionable.

Among the 13 HSL metals analyzed, a total of 7 were detected in 3 or more surface water samples. These included arsenic (7 occurrences), lead (7 occurrences), zinc (6 occurrences), thallium (5 occurrences), beryllium (4 occurrences), selenium (4 occurrences) and mercury (3 occurrences). All of these were also widespread among groundwater samples. Nickel, however, which was found in many of the groundwater samples, did not occur at any of the surface water stations. Metal compounds detected in surface water were generally found in very low ppb concentrations. Exceptions to this were mercury, which occurred in the extremely low ppb range, and several metals (arsenic, lead, zinc) which appeared in the low to medium ppb range at upstream sampling station VSS-1.

No pesticide/PCB or cyanide compounds were detected in any surface water samples. Total phenols were detected in 5 of the 8 samples at concentrations in the very low to low ppb range. These results for pesticides/PCB's, cyanide and total phenols, in terms of general occurrence and typical concentrations, are consistent with the findings related to groundwater at the site.

5.3.2 Other Surface Water Parameters Measured - Table 5-5 presents statistical data concerning surface water indicator parameters and field measurements. This data reveals several interesting aspects of surface water quality at the site. One is that, in terms of several common indicators of leachate and/or impaired water quality (e.g., temperature, alkalinity, COD and TOC), the poorest quality surface water was measured at VSS-1 upstream from the site on a tributary to Bell Creek (see Figure 5-3). This finding, supported by several analyses for HSL compounds, indicates an apparent contamination source upstream from and apparently unrelated to Volney Landfill.

Along Bell Creek itself, there is no apparent trend in surface water parameters other than a slight general decrease in water quality in a downstream direction from VSS-2 to VSS-5. Comparison of groundwater and surface water data (Tables 4-15 and 5-5) reveals that leachate indicators in surface water generally occur at one-third to two-thirds their value in groundwater, a result consistent with the expected dilution of water moving away from the landfill.

5.3.3 Relative Contamination of Surface Water - Relative Contamination Index (RCI) values of surface water and stream sediment samples have been prepared using the same method as described for groundwater samples (section 4.4.2.3). The results are shown in Table 5-6. These results indicate the relative composite level of contamination among surface water samples, based upon an aggregate accounting of the numbers and concentrations of hazardous substances within the samples, and the toxicity/persistence of these substances.

From an overall standpoint, calculated RCI values at the various surface water sampling stations show no spatial trend. As previously noted, on the basis of general leachate indicator parameters, upstream sample VSS-1 appears to be the most highly contaminated of the

TABLE 5-5

STATISTICAL ANALYSES - SURFACE WATER INDICATOR PARAMETERS AND FIELD MEASUREMENTS

Parameter	Unit	High Value (Sample)	Low Value (Sample)	Mean Value
pH	---	8.01 (VLCH-1)	7. (VSS-7)	7.43
Specific Conductance	umhos/cm	490. (VSS-3)	220. (VLCH-1)	359.
Temperature	°C	26.7 (VSS-1)	18.6 (VSS-2)	22.
Alkalinity	mg/l	214. (VSS-1)	80. (VLCH-1)	154.
NH_3	mg/l	0.92 (VSS-1)	ND (5 of 8 stations)	---
COD	mg/l	86. (VSS-1)	ND (1 of 8 stations)	27.
Hardness ($CaCo_3$)	mg/l	333. (VSS-3)	128. (VLCH-1)	229.
TDS	mg/l	390. (VSS-7)	100. (VSS-2)	240.
TOC	mg/l	140. (VSS-1)	11. (VLCH-1)	42.5

Notes:
1) ND = Not Detected.

TABLE 5-6

RELATIVE CONTAMINATION INDEX (RCI) - SURFACE WATER/SEDIMENT SAMPLING STATIONS

SURFACE WATER	VSS-1	VSS-2	VSS-3	VSS-4	VSS-5	VSS-6	VSS-7	VLCH-1
HSL VOLATILES	14.	Ø	Ø	Ø	Ø	Ø	Ø	Ø
HSL SEMI-VOLATILES	68	Ø	1	6	Ø	12	Ø	23
METALS & CYANIDE	9,828	274	1,044	475	652	216	126	720
TOTAL RCI	9,910	274	1,045	481	652	228	126	743
Rank (#1 to #7)	#1	#6	#2	#5	#4	#7	#8	#3

SEDIMENT	VSS-1(S)	VSS-2(S)	VSS-3(S)	VSS-4(S)	VSS-5(S)	VSS-6(S)	VSS-7(S)
HSL VOLATILES	307	254	Ø	Ø	126	Ø	Ø
HSL SEMI-VOLATILES	Ø	Ø	Ø	1,860	Ø	Ø	12,240
PESTICIDES & PCB's	Ø	Ø	1,440	Ø	Ø	Ø	Ø
METALS & CYANIDE	408	1,292	384	835	1,314	4,244	3,191
TOTAL RCI	715	1,546	1,824	2,695	1,440	4,244	15,431
Rank (#1 to #7)	#7	#5	#4	#3	#6	#2	#1

surface water samples, and indicates a probable contaminant source upstream from Volney Landfill.

5.4 Sediment Contamination

Sediment samples were analyzed for Hazardous Substance List (HSL) compounds. The results are presented in Table 5-7 (volatile compounds), Table 5-8 (semi-volatile compounds), and Table 5-9 (metals, cyanide and total phenols).

5.4.1 General Occurrence of Hazardous Substances in Sediments - Hazardous Substance List (HSL) compounds detected in sediment samples include 8 volatiles, 6 semi-volatiles, 1 PCB and 11 metals. Cyanide was also detected in all 7 of the sediment samples. It is noteworthy that the occurrence of one PCB compound (Aroclor-1248) and cyanide were unique to sediment samples; neither PCB's nor cyanide were detected in any of the groundwater or surface water samples from the site. The following paragraphs discuss the occurrence of HSL compounds in greater detail.

Among volatile organic compounds, the following were detected in 3 or more of the 7 sediment samples: methylene chlorine (7 occurrences), trichloroethene (6 occurrences) and acetone (5 occurrences). Each of these compounds was also detected in laboratory and/or trip blanks, however, as indicated in Table 5-7. Volatile organics in sediment samples typically occurred in the very low to low ppb range, except that in several samples acetone and methylene chloride were observed in the medium ppb range. Volatile organic compounds which were tentatively identified as additional MS peaks generally occurred also in the very low to low ppb range, with the exception of one compound in VSS-6 (n-phenyl benzene amine) which occurred in the medium ppb range.

The only semi-volatile HSL compound appearing in 3 or more of the sediment samples was bis(2-ethyl hexyl)phthalate (7 occurrences), which has previously been identified as a probable sampling contaminant.

TABLE 5-7
SEDIMENT ANALYTICAL SUMMARY - VOLATILE COMPOUNDS

Volatile Compounds	Sediment						
	VSS-1	VSS-2	VSS-3	VSS-4	VSS-5	VSS-6	VSS-7
5. Methylene Chloride	20.*	12.*	14.*	29.*	9.8*	148.*	38.*
6. Acetone		100.*	19.*		66.*	127.*	135.*
7. Carbon Disulfide		4.7					
11. Chloroform							
13. 2-Butanone (or MEK)	15.	22.					
14. 1,1,1-Trichloroethane							
21. Trichloroethene	2.9*	1.7*	0.88*		0.66*	16.*	4.0*
28. 2-Hexanone	8.7						
29. 4-Methyl-2-pentanone	10.						
31. Toluene					14.		
Total HSL Volatiles	56.6	140.4	33.9	29.	90.5	291.	177.
Total Additional Peaks	30.	9.	6.	16.	21.	150.	72.

Notes:

1) All volatiles are in ug/l (ppb).
2) Blank values and unlisted compounds were not detected.
3) * = Compound as detected in laboratory and/or trip blank.

TABLE 5-8
SEDIMENT ANALYTICAL SUMMARY - SEMI-VOLATILE COMPOUNDS

Semi-Volatile Compounds	Sediment						
	VSS-1	VSS-2	VSS-3	VSS-4	VSS-5	VSS-6	VSS-7
40. 2-Chlorophenol							
45. 2-Methylphenol				59.			
88. Di-n-butylphthalate				61.			
89. Fluoranthene				64.			380.
91. Pyrene							300.
95. bis(2-ethylhexyl)phthalate	628.	940.	2,100.	7,000.	3,200.	5,800.	12,000.
97. Di-n-octyl phthalate			165.	350.			
Total HSL Semi-Volatiles	628.	940.	2,265.	7,534.	3,200.	5,800.	12,680.
Total Additional Peaks	20,036.	87,715.	734.	23,147.	2,616.	310,097.	29,976.

Notes:
1) All values are in ug/l (ppb).
2) Blank values and unlisted HSL compounds were not detected.
3) * = Compound also detected in laboratory and/or trip blank.

TABLE 5-9
SEDIMENT ANALYTICAL SUMMARY - METALS, CYANIDE AND TOTAL PHENOLS

Metals, Cyanide, Total Phenols	Sediment						
	VSS-1	VSS-2	VSS-3	VSS-4	VSS-5	VSS-6	VSS-7
Antimony							
Arsenic	1.55	2.26	1.64	3.97	3.91	12.3	8.80
Beryllium	3.67	3.07	0.75		3.09	29.9	11.3
Cadmium						2.59	
Chromium	2.54	7.11	2.52	7.47	5.54	14.3	9.54
Copper	4.10	12.8	4.16	7.94	12.2	48.7	23.8
Lead	2.12	10.19	1.89	4.76	8.32	19.5	26.7
Mercury	0.113	0.064	0.100	0.095	0.032		0.22
Nickel					3.26		
Selenium							
Silver	1.98	1.13	0.88				
Thallium			1.64	1.43		9.74	1.47
Zinc	6.08	35.1	7.69	20.2	28.4	98.7	95.4
Total Metals	22.15	71.72	21.27	45.86	64.75	235.73	177.23
Cyanide	0.52	0.04	0.08	0.51	8.24	0.04	0.04

TABLE 5-9 (Cont'd.)

SEDIMENT ANALYTICAL SUMMARY - METALS, CYANIDE AND TOTAL PHENOLS

	Sediment						
Metals, Cyanide, Total Phenols	VSS-1	VSS-2	VSS-3	VSS-4	VSS-5	VSS-6	VSS-7
Total Phenols	0.404	0.853	0.002	0.135	1.563	1.354	0.325
Percent Solids	70.71	61.82	79.25	62.92	61.30	15.39	27.24

Notes:

1) All values are in mg/kg (ppm).
2) Blank values and unlisted HSL compounds were not detected.
3) Metals calculated on a dry weight basis.

This compound occurred in the high ppb to low ppm range in most of the samples, whereas the few other HSL semi-volatiles were typically in the low to medium ppb range. A number of additional semi-volatile compounds, which were tentatively identified by MS peaks, occurred at much higher concentrations than the HSL semi-volatiles themselves. In particular, benzene and an unknown alkane were detected in the low to medium ppm range. As in the case of surface water samples, however, benzene as an additional semi-volatile peak also occurred at high concentrations in the laboratory blank sample, indicating that its presence may be due to laboratory contamination.

A total of 9 HSL metals were detected in 3 or more of the 7 sediment samples: arsenic (7 occurrences), chromium (7 occurrences), copper (7 occurrences), lead (7 occurrences), zinc (7 occurrences), beryllium (6 occurrences), mercury (6 occurrences), thallium (4 occurrences), and silver (3 occurrences). In general, these compounds were also fairly widespread in surface water samples, except for chromium, copper and silver. Metals occurred at much higher concentrations in sediment than in surface water or groundwater, typically in the very low to low ppm range. An exception was mercury, which was typically present in the low to medium ppb range. Because metals have a tendency to accumulate on sediments, the higher observed concentrations in sediment samples is not surprising.

As previously stated, one PCB compound (Aroclor-1248) was detected at one sediment sampling station (VSS-3), where its concentration was 80 ppb. The location of this station (see Figure 5-2) would appear to indicate that the landfill is the source of this contaminant, though without other evidence of its occurrence in the stream system, firm conclusions cannot be drawn. Cyanide was detected in all sediment samples, and occurred over a broad range of concentrations (low ppb to low ppm). The highest concentration of cyanide in stream sediments (8.24 ppm) occurred at VSS-5, the most downstream of the samples (Figure 5-3). The second highest concentration of cyanide (520 ppb) was reported at VSS-1, the most upstream of the samples, and one located at a point upgradient from the landfill. Total phenols were also detected at all stations, with concentrations ranging broadly from the low ppb's to low ppm's. Like cyanide, the maximum total phenol concentration (1.56 ppm) occurred at VSS-5.

5.4.2 Relative Contamination of Sediments - Table 5-6 indicates the Relative Contamination Index (RCI) values of sediment samples from Bell Creek and Black Creek. This statistical parameter was calculated by the same method as previously described (Section 4.4.2.3).

Sediment RCI values are generally higher than surface water values. However, as with surface water, there is no spatial trend of sediment contamination within the stream system, nor any conclusive evidence that contamination is originating from the Volney Landfill.

6.0 PUBLIC HEALTH AND ENVIRONMENTAL CONCERNS

6.1 Overview of Site Contamination

Contamination from the Volney Landfill was considered on a media-specific basis in Section 4.4.2 (groundwater contamination), Section 5.3. (surface water contamination) and Section 5.4 (sediment contamination). The following discussion summarizes these sections and provides an overview of contamination from the landfill. The same descriptive terminology as was introduced for discussion of groundwater results is used (Section 4.4.2).

Groundwater contamination at Volney Landfill may be summarized as follows:

(1) A number of Hazardous Substance List (HSL) organics are present in groundwater at the site. Their detection is generally sporadic from well to well, with no specific compound or group of compounds being truly "characteristic" of the site groundwater. These organic compounds typically occur in the very low ppb range. The type and concentrations of HSL organics occurring in groundwater at Volney are not substantially different from those which have been observed in previously reported investigations of hazardous substances occurring at other municipal landfills.

(2) The occurrence of HSL metals in groundwater was somewhat more consistent, with zinc being the most commonly detected. Metals were generally observed in the very low ppb range to the low ppb range.

(3) No pesticides, PCB's or cyanide were detected in any of the groundwater samples.

(4) Leachate indicator parameters observed in most of the groundwater samples indicate that groundwater contamination by landfill leachate is occurring around the perimeter of the site.

(5) Available data indicates that leachate from the landfill has permeated lodgement till and reached bedrock. Contaminant levels in bedrock generally equal or exceed those in the overburden strata.

(6) Groundwater contamination appears to be no greater from the southern (old) section of the landfill, where hazardous wastes from the PAS site are reported to have been buried.

(7) Except as noted above, groundwater contamination displays no pronounced spatial distribution pattern. However, the location of monitoring wells installed during this study, and the single round of groundwater samples collected from them, are inadequate to permit definition or tracking of a contaminant plume.

Important overall aspects regarding surface water (excluding leachate samples) contamination at the site are as follows:

(1) HSL organic compounds observed in surface water were generally fewer in number and lower in concentration than those observed in groundwater. Typically, organic compounds in surface water samples were measured in the extremely low ppb range.

(2) There appears to be a source of background contamination upstream from the landfill, at station VSS-1 on Bell Creek (Figure 5-3).

(3) The number of HSL metals observed in surface water samples were similar to those in groundwater, as were their concentrations (i.e., extremely low ppb range). An exception was nickel, which was widespread in groundwater but absent from surface water.

(4) No pesticides, PCB's or cyanide were detected in any of the surface water samples.

(5) Leachate indicator parameters reveal contamination of adjacent surface waters, though in an apparently diluted form as compared with groundwater contamination. Upstream sampling station VSS-1 showed the highest overall concentration of leachate indicators.

(6) There was no pronounced spatial trend in observed surface water contamination adjacent to or downstream from the landfill.

Sediment contamination displayed the following major characteristics:

(1) In general, fewer HSL organic compounds were detected in stream sediments than in surface water or groundwater, though at somewhat higher concentrations. HSL organic concentrations in sediments varied broadly, up to the medium ppb range.

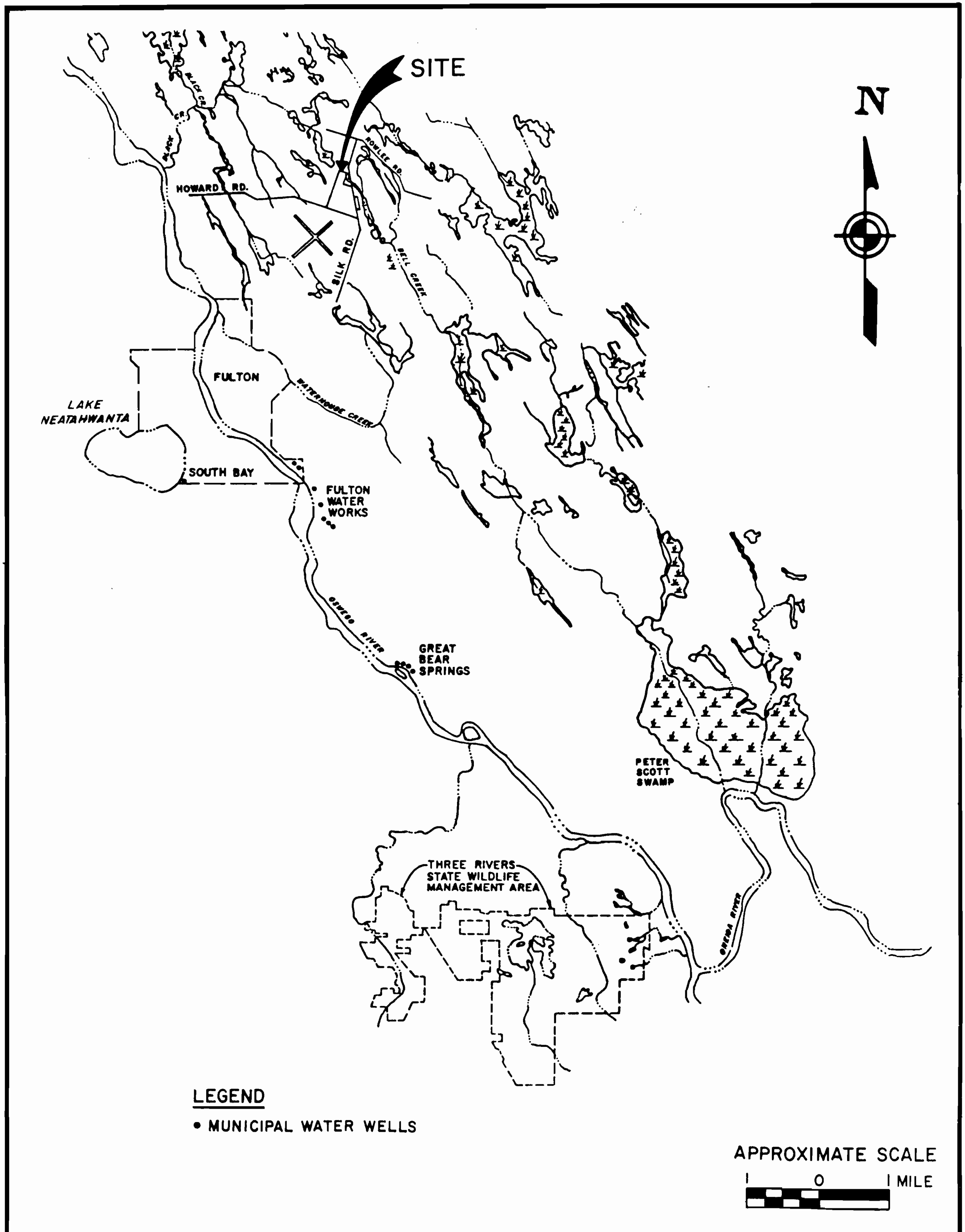
(2) HSL metals occurred at much higher concentrations in stream sediments than in other media (very low to low ppm range).

(3) One PCB compound (Aroclor-1248) was detected at one sediment sampling station (VSS-3) at a concentration of 80 ppb. Cyanide was detected at all stations, and ranged broadly in concentration from the low ppb to low ppm range. As previously stated, no PCB's or cyanide were observed in any of the groundwater or surface water samples.

(4) There was no spatial trend of sediment contamination within the sampled streams. Again, however, sediment contamination observed at VSS-1 indicates a possible background source within the Bell Creek system.

6.2 Potential Receptors

Figure 6-1 indicates potential receptors of contaminated surface water from the Volney Landfill. As shown on this figure, and discussed previously, the site is located on a topographic ridge separating the Black Creek and Bell Creek watersheds. Drainage from the west side of the landfill generally follows a path to one or more of the Black Creek tributaries, from where it flows approximately 4 miles in a curving northwest-to-southwest direction before discharging into the Oswego River at a point approximately 3 (river) miles north, or downstream, of the City of Fulton. Runoff from the east side of the landfill generally drains into Bell Creek, flows approximately 10 miles in a generally southward direction before entering the Oneida River, and then another 3 miles before discharging into the Oswego River at a point approximately 12 (river) miles south, or upstream, of the City of Fulton. There are no known surface water intakes along either of these routes. Figure 6-1 does indicate, however, the location of several municipal supply well fields off Lake Neatahwanta and along the Oswego River in the reach



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POTENTIAL SURFACE WATER RECEPTORS

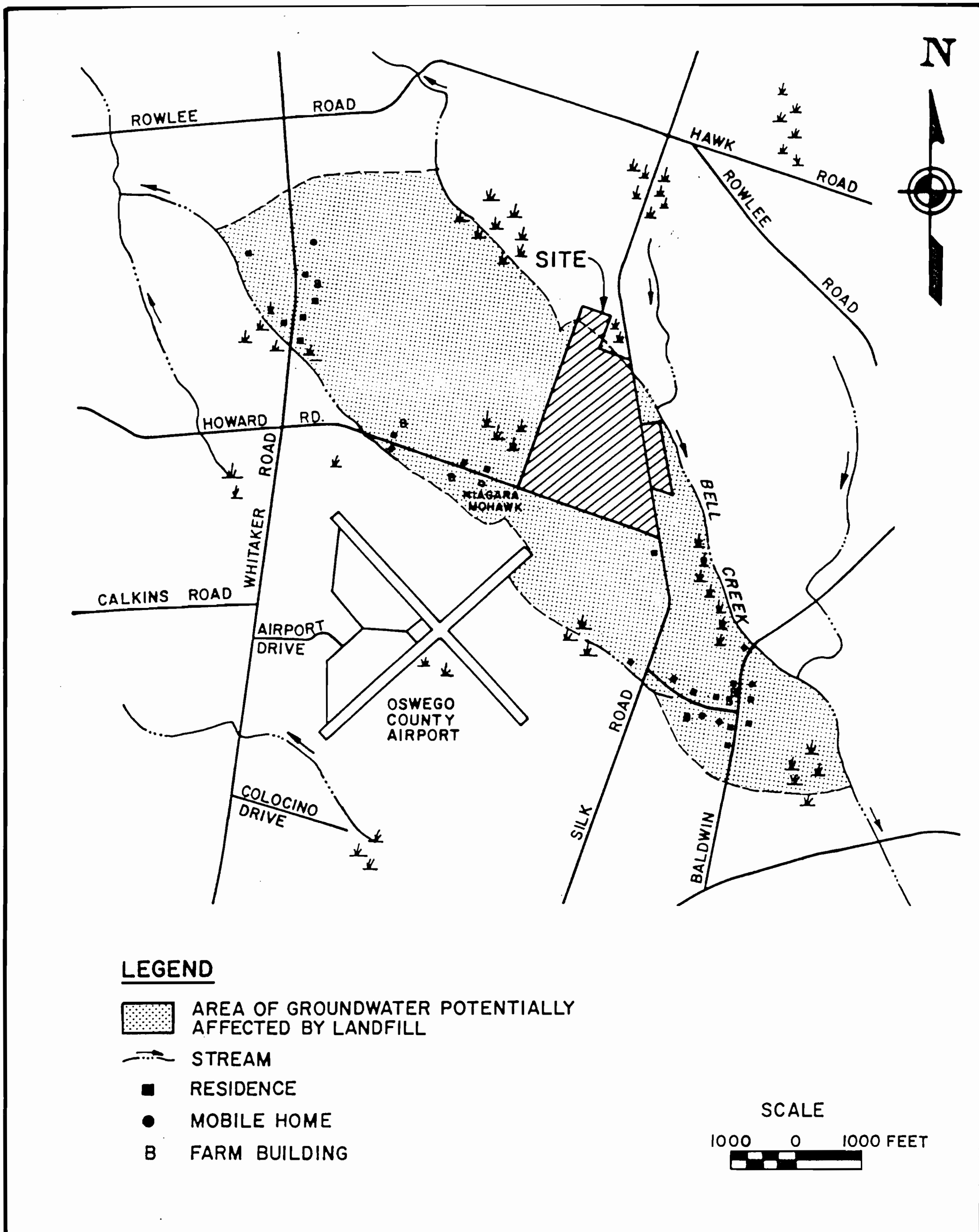
FIGURE 6-1

north (downstream) of its confluence with the Oneida River. These well fields, collectively serving approximately 15,000 people in the City of Fulton (McFarland-Johnson Engineers, 1982), are in direct hydraulic contact with the Oswego River. At least one of them, the Fulton Water Works, has been reported to induce river flow to the wells (Anderson, 1982). Also shown on Figure 6-1, as potential environmental receptors, are a number of state-designated wetlands located downstream from Volney Landfill along Bell Creek and Black Creek tributaries.

Figure 6-2 indicates, by shaded area, potential receptors of contaminated groundwater from the landfill. This area was estimated by assuming that groundwater flow reflects surface topography, and tracing the extreme surface drainage flow paths from the perimeter of the landfill to the nearest perennial streams. All residences within the area are served by individual wells, and are therefore potential receptors of groundwater contamination from the landfill. A total of 25 single-family residences are located within the shaded area of Figure 6-2. (Notes: The assumption of coinciding surface water and groundwater divides is reasonable for shallow groundwater flow, but not necessarily for groundwater flow within bedrock. Also, the shaded area of groundwater influence in Figure 6-2 assumes no interaction between surface water and groundwater downstream from the inception point of perennial streamflow; this assumption is most appropriate for low-production (e.g., individual), and/or deep, drilled wells.)

6.3 Public Health Impacts

The primary potential health impacts of the Volney Landfill are related to human and fish contact with contaminated surface water and groundwater from the site. In the following sections, applicable surface water and groundwater standards/guidelines are identified, then compared with observed levels of contamination at the landfill. Following this, a baseline health risk assessment is presented, which indicates the existing level of risk associated with potable use of groundwater in the vicinity of the site.



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POTENTIAL GROUNDWATER RECEPTORS

FIGURE 6-2

6.3.1 Applicable Water Quality Standards and Criteria - Surface water in the State of New York is given designations by the New York State Department of Environmental Conservation (NYSDEC) according to the the "Best Usage of Waters". Both tributaries of Black Creek near Volney Landfill, as well as Bell Creek, are designated as Class "D". New York State Water Quality Regulations (6 NYCRR, Part 701) identify the best usage of Class D surface water as follows:

> "The waters are suitable for fishing. The water quality shall be suitable for primary and secondary contact recreation even though other factors may limit the use for that purpose. Due to such natural conditions as intermittency of flow, water conditions not conducive to propagation of game fishery or stream bed conditions, the waters will not support fish propagation."

Water quality standards for Class D surface water are included in Appendix K. It should be noted that New York State designated wetlands, including those shown on Figure 6-1, share the same water quality classifications as the surface water to which they are contiguous, in this case Class D.

Groundwater in the vicinity of the Volney Landfill site is designated by NYSDEC as Class "GA". New York State Water Quality Regulations (6 NYCRR, Part 703) identify the best usage of Class GA groundwater as follows:

> "The best usage of Class GA waters is as a source of potable water supply. Class GA waters are fresh ground waters found in the saturated zone of unconsolidated deposits and consolidated rock or bedrock."

According to these regulations, standards applicable to Class GA groundwater shall be the most stringent of those from the following four sources (refer to Appendix K for source standards):

(1) New York State Water Quality Regulations (6 NYCRR, Part 703)

(2) Maximum Contaminant Levels for drinking water promulgated by the New York State Department of Health (10 NYCRR, Subpart 5-1, Public Water Supplies)

(3) Standards for raw water promulgated by the New York State Department of Health (10 NYCRR, Part 170, Sources of Water Supply)

(4) Maximum Contaminant Levels for drinking water promulgated as Primary Drinking Water Regulations by the U.S. Environmental Protection Agency (USEPA) pursuant to the Safe Drinking Water Act (40 CFR, Part 141).

In addition to the preceding enforceable standards for surface water and groundwater, the USEPA has issued water quality guidelines referred to as Secondary Drinking Water Regulations (40 CFR, Part 143). These, along with guidelines pursuant to the Clean Water and Safe Drinking Water Acts which are summarized in the USEPA's Guidance on Feasibility Studies Under CERCLA (USEPA, 1985b), are presented in Appendix K. They include the following:

(1) Secondary Drinking Water Regulations (applicable to groundwater)

(2) Safe Drinking Water Act, Recommended Maximum Contaminant Levels

(3) Safe Drinking Water Act, Secondary Maximum Contaminant Levels (applicable to groundwater).

(4) Clean Water Act, Water Quality Criteria for Human Health -- Fish and Drinking Water (applicable to surface water)

(5) Clean Water Act, Water Quality Criteria for Human Health -- Adjusted for Drinking Water Only (applicable to groundwater)

6.3.2 <u>Observed Versus Allowable Contaminant Concentrations</u> - Table 6-1 summarizes observed versus allowable concentrations of hazardous

TABLE 6-1

OBSERVED VERSUS ALLOWABLE CONTAMINANT CONCENTRATIONS

		Groundwater				Surface Water			Sediment	Leachate
Substance	Detection Limit (ug/l)	Max Conc. (ug/l)	Enforceable Limit	Source(1)	Guideline Limit(2)	Max Conc. (ug/l)	Enforceable Limit(3)	Guideline Limit(2)	Max Conc. (ug/l)	Max Conc. (ug/l)
HSL VOLATILES										
1. Chloromethane	10	ND(4)			0	ND		0	ND	ND
2. Bromomethane	10	ND			0	ND		0	ND	ND
3. Vinyl Chloride	10	5.8	1	MCL	0#	ND		0	ND	ND
4. Chloroethane	10	20.				ND			ND	ND
5. Methylene Chloride	5	875.				3.6			148.	0.78
6. Acetone	10	2,767.				2.4			135.	69.
7. Carbon Disulfide	5	ND				ND			4.7	ND
8. 1,1-Dichloroethene	5	ND	7.0 ug/l	MCL	7.0 ug/l#	ND			ND	ND
9. 1,1-Dichloroethane	5	10.2				ND			ND	ND
10. trans-1,2-Dichloroethene	5	4.0				ND			ND	ND
11. Chloroform	5	70.	100 ug/l	703.5	0	0.48		0	ND	ND
12. 1,2-Dichloroethane	5	ND	5 ug/l	MCL	0	ND		0	ND	ND
13. 2-Butanone (or MEK)	10	54.				ND			22.	ND
14. 1,1,1-Trichloroethane	5	1.6	0.2 mg/l	MCL	19 mg/l	3.4		18.4 mg/l	ND	1.0
15. Carbon Tetrachloride	5	ND	5 ug/l	703.5	0	ND		0	ND	ND
16. Vinyl Acetate	10	ND				ND			ND	ND
17. Bromodichloromethane	5	ND			0	ND		0	ND	ND
18. 1,1,2,2-Tetrachloroethane	5	ND				ND			ND	ND
19. 1,2-Dichloropropane	5	ND				ND			ND	ND
20. trans-1,2-Dichloropropene	5	ND			87 mg/l	ND		87 mg/l	ND	ND
21. Trichloroethene	5	3.4	5 ug/l	MCL	0#	1.5			16.0	ND
22. Dibromochloromethane	5	ND			0	ND		0	ND	ND
23. 1,1,2-Trichloroethane	5	ND			0	ND		0	ND	ND
24. Benzene	5	3.5	NT(5)	703.5	0#	ND		0	ND	ND
25. cis-1,3-Dichloropropene	5	ND			87 mg/l	ND		87 mg/l	ND	ND
26. 2-Chloroethyl Vinyl Ether	10	ND				ND			ND	ND
27. Bromoform	5	ND			0	ND		0	ND	ND
28. 2-Hexanone	10	11.				ND			8.7	ND
29. 4-Methyl-2-pentanone	10	ND				ND			10.	ND
30. Tetrachloroethene	5	0.62			0#	ND			ND	ND
31. Toluene	5	3.9			15 mg/l	ND		14.3 mg/l	14.	ND
32. Chlorobenzene	5	ND			488 ug/l	ND	50 ug/l	488 ug/l	ND	ND
33. Ethyl Benzene	5	3.4			2.4 mg/l	ND		1.4 mg/l	ND	ND
34. Styrene	5	2.8	931 ug/l	703.5		ND			ND	ND
35. Total Xylenes	5	15.				ND				

TABLE 6-1 (Cont'd.)

OBSERVED VERSUS ALLOWABLE CONTAMINANT CONCENTRATIONS

Substance	Detection Limit (ug/l)	Groundwater Max Conc. (ug/l)	Groundwater Enforceable Limit	Groundwater Source (1)	Groundwater Guideline Limit (2)	Surface Water Max Conc. (ug/l)	Surface Water Enforceable Limit (3)	Surface Water Guideline Limit (2)	Sediment Max Conc. (ug/l)	Leachate Max Conc. (ug/l)
HSL SEMI-VOLATILES										
36. N-Nitrosodimethylamine	not analyzed									
37. Phenol	10	33.			3.5 mg/l	ND		3.5 mg/l	ND	ND
38. Aniline	not analyzed									
39. bis(2-Chloroethyl) ether	10	ND	1.0 ug/l	703.5	0	ND		0	ND	ND
40. 2-Chlorophenol	10	ND			0.1 ug/l	ND		0.1 ug/l	ND	0.67
41. 1,3-Dichlorobenzene	10	ND			470 ug/l	ND	50 ug/l	400 ug/l	ND	ND
42. 1,4-Dichlorobenzene	10	ND	0.75 mg/l	MCLG	470 ug/l	ND	50 ug/l	400 ug/l	ND	ND
43. Benzyl Alcohol	10	12.0				ND			ND	ND
44. 1,2-Dichlorobenzene	10	ND			470 ug/l	ND	50 ug/l	400 ug/l	ND	ND
45. 2-Methylphenol	10	1.0				ND			59.	ND
46. bis(2-Chloroisopropyl) ether	10	ND			34.7 ug/l	ND		34.7 ug/l	ND	ND
47. 4-Methylphenol	10	26.0				0.99			ND	ND
48. N-Nitroso-Dipropylamine	10	ND				ND			ND	ND
49. Hexachloroethane	10	ND			0	ND		0	ND	ND
50. Nitrobenzene	10	ND			19.8 mg/l	ND		19.8 mg/l	ND	ND
51. Isophorone	10	ND			5.2 mg/l	ND		5.2 mg/l	ND	ND
52. 2-Nitrophenol	10	ND				ND			ND	ND
53. 2,4-Dimethylphenol	10	ND			400 ug/l	ND		400 ug/l	ND	ND
54. Benzoic Acid	50	43.				5.8			ND	ND
55. bis(2-Chloroethoxy) methane	10	ND			0	ND		0	ND	ND
56. 2,4-Dichlorophenol	10	ND				ND			ND	ND
57. 1,2,4-Trichlorobenzene	10	ND				ND	50 ug/l		ND	ND
58. Naphthalene	10	ND				0.41			ND	ND
59. 4-Chloroaniline	10	ND				ND			ND	ND
60. Hexachlorobutadiene	10	ND			0	ND		0	ND	ND
61. 4-Chloro-3-methylphenol	10	ND			3000 ug/l	ND		3000 ug/l	ND	0.53
62. 2-Methylnaphthalene	10	ND				0.13			ND	ND
63. Hexachlorocyclopentadiene	10	ND			206 ug/l	ND		206 ug/l	ND	ND
64. 2,4,6-Trichlorophenol	10	ND			0	ND		0	ND	ND
65. 2,4,5-Trichlorophenol	50	ND			2600 ug/l	ND		2600 ug/l	ND	ND
66. 2-Chloronaphthalene	10	ND				ND			ND	ND
67. 2-Nitroaniline	50	ND				ND			ND	ND
68. Dimethyl Phthalate	10	35.			350 mg/l	ND		313 mg/l	ND	ND
69. Acenaphthylene	10	ND				ND			ND	ND
70. 3-Nitroaniline	50	ND				ND			ND	ND

C-1474

TABLE 6-1 (Cont'd.)

OBSERVED VERSUS ALLOWABLE CONTAMINANT CONCENTRATIONS

Substance	Detection Limit (ug/l)	Groundwater Max Conc. (ug/l)	Groundwater Enforceable Limit	Groundwater Source (1)	Groundwater Guideline Limit (2)	Surface Water Max Conc. (ug/l)	Surface Water Enforceable Limit (3)	Surface Water Guideline Limit (2)	Sediment Max Conc. (ug/l)	Leachate Max Conc. (ug/l)
71. Acenaphthene	10	1.0			20 ug/l	ND		20 ug/l	ND	ND
72. 2,4-Dinitrophenol	50	ND			70 ug/l	ND		70 ug/l	ND	ND
73. 4-Nitrophenol	50	ND				ND			ND	ND
74. Dibenzofuran	10	ND				0.08			ND	ND
75. 2-4-Dinitrotoluene	10	ND				ND			ND	ND
76. 2,6-Dinitrotoluene	10	ND				ND			ND	ND
77. Diethylphthalate	10	1.0			434 mg/l	0.76		350 mg/l	ND	ND
78. 4-Chlorophenyl Phenyl Ether	10	ND				ND			ND	ND
79. Fluorene	10	ND				ND			ND	ND
80. 4-Nitroaniline	50	ND				ND			ND	ND
81. 4,6-Dinitro-2-methylphenol	50	ND				ND			ND	ND
82. N-nitrosodiphenylamine	10	ND			0	ND		0	ND	ND
83. 4-Bromophenyl Phenyl Ether	10	ND				ND			ND	ND
84. Hexachlorobenzene	10	ND	0.35 ug/l	703.5	0	ND		0	ND	ND
85. Pentachlorophenol	50	ND			1.01 mg/l	ND	1.0 ug/l	1.01 mg/l	ND	0.52
86. Phenanthrene	10	ND				0.30			ND	ND
87. Anthracene	10	ND				ND			ND	ND
88. Di-n-butylphthalate	10	63.	770 ug/l	703.5	44 mg/l	1.4		34 mg/l	61.	ND
89. Fluoranthene	50	ND				0.18			380.	ND
90. Benzidine	50	ND			0	ND	0.1 ug/l	0	ND	ND
91. Pyrene	10	ND				ND			300.	ND
92. Butyl Benzyl Phthalate	10	ND				ND			ND	ND
93. 3,3'-Dichlorobenzidine	20	ND			0	ND		0	ND	ND
94. Benzo(a)anthracene	10	ND				ND			ND	ND
95. bis(2-ethyl hexyl)phthalate	10	286.	4.2 mg/l	703.5	21 mg/l	127.		15 mg/l	12,000.	17.
96. Chyrsene	10	ND				ND			ND	ND
97. Di-n-octyl Phthalate	10	40.	4.2 mg/l	703.5		0.53			350.	0.12
98. Benzo(b)fluoranthene	10	4.0				ND			ND	ND
99. Benzo(k)fluoranthene	10	ND				ND			ND	ND
100. Benzo(a)pyrene	10	ND				ND			ND	ND
101. Indeno(1,2,3-cd)pyrene	10	3.0				ND			ND	ND
102. Dibenz(a,h)anthracene	10	1.1				ND			ND	ND
103. Benzo(g,h,i)perylene	10	ND				ND			ND	ND

TABLE 6-1 (Cont'd.)

OBSERVED VERSUS ALLOWABLE CONTAMINANT CONCENTRATIONS

Substance	Detection Limit (ug/l)	Groundwater				Surface Water			Sediment	Leachate
		Max Conc. (ug/l)	Enforceable Limit	Source (1)	Guideline Limit (2)	Max Conc. (ug/l)	Enforceable Limit (3)	Guideline Limit (2)	Max Conc. (ug/l)	Max Conc. (ug/l)
HSL PESTICIDES/PCB's										
104. alpha-BHC	0.05	ND	NT (5)	703.5		ND	2 ug/l		ND	ND
105. beta-BHC	0.05	ND	NT	703.5		ND	2 ug/l		ND	ND
106. delta-BHC	0.05	ND	NT	703.5		ND	2 ug/l		ND	ND
107. Lindane	0.05	ND	NT	703.5		ND	2 ug/l		ND	ND
108. Heptachlor	0.05	ND	NT	703.5	0	ND	0.001 ug/l	0	ND	ND
113. 4,4'-DDE	0.10	ND	NT			ND	0.001 ug/l		ND	ND
110. Heptachlor Epoxide	0.05	ND	NT	703.5	0	ND	0.001 ug/l	0	ND	ND
111. Endosulfan I	0.05	ND			138 ug/l	ND	0.22 ug/l	74 ug/l	ND	ND
112. Dieldrin	0.10	ND	NT	703.5	0	ND	Aldrin+Dieldrin	0	ND	ND
109. Aldrin	0.05	ND	NT	703.5	0	ND	= 0.001 ug/l	0	ND	ND
114. Endrin	0.10	ND	NT	703.5	1 ug/l	ND	0.002 ug/l	1 ug/l	ND	ND
115. Endosulfan II	0.10	ND			138 ug/l	ND	0.22 ug/l	74 ug/l	ND	ND
116. 4,4'-DDD	0.10	ND				ND	0.001 ug/l		ND	ND
117. Endrin Aldehyde	0.10	ND				ND			ND	ND
118. Endosulfan Sulfate	0.10	ND				ND			ND	ND
119. 4,4'-DDT	0.10	ND	NT	703.5	0	ND	0.001 ug/l	0	ND	ND
120. Endrin Ketone	0.10	ND				ND			ND	ND
121. Methoxychlor	0.5	ND	35 ug/l	703.5		ND			ND	ND
122. Chlordane	0.5	ND	0.1 ug/l	703.5	0	ND		0	ND	ND
123. Toxaphene	1.0	ND	NT	703.5	0	ND	1.6 ug/l	0	ND	ND
124. Aroclor-1016	0.5	ND	0.1 ug/l	703.5	0	ND	0.001 ug/l	0	ND	ND
125. Aroclor-1221	0.5	ND	0.1 ug/l	703.5	0	ND	0.001 ug/l	0	ND	ND
126. Aroclor-1232	0.5	ND	0.1 ug/l	703.5	0	ND	0.001 ug/l	0	ND	ND
127. Aroclor-1242	0.5	ND	0.1 ug/l	703.5	0	ND	0.001 ug/l	0	ND	ND
128. Aroclor-1248	0.5	ND	0.1 ug/l	703.5	0	ND	0.001 ug/l	0	80.0	ND
129. Aroclor-1254	1.0	ND	0.1 ug/l	703.5	0	ND	0.001 ug/l	0	ND	ND
130. Aroclor-1260	1.0	ND	0.1 ug/l	703.5	0	ND	0.001 ug/l	0	ND	ND

TABLE 6-1 (Cont'd.)

OBSERVED VERSUS ALLOWABLE CONTAMINANT CONCENTRATIONS

Substance	Detection Limit (ug/l)	Groundwater Max Conc. (ug/l)	Groundwater Enforceable Limit	Groundwater Source (1)	Groundwater Guideline Limit (2)	Surface Water Max Conc. (ug/l)	Surface Water Enforceable Limit (3)	Surface Water Guideline Limit (2)	Sediment Max Conc. (ug/l)	Leachate Max Conc. (ug/l)
HSL METALS, CYANIDE, TOTAL PHENOLS									(mg/kg)	
Antimony	50	ND			146 ug/l	ND		146 ug/l	ND	ND
Arsenic	2	85.	25 ug/l	703.5	0	37.	360 ug/l	0	12.3	ND
Beryllium	3	5.			0	5.		0	29.9	ND
Cadmium	3	5.	10 ug/l	703.5	10 ug/l	3.	563 ug/l	10 ug/l	2.59	ND
Chromium	9	ND	50 ug/l	703.5	50 ug/l	ND	16 ug/l	50 ug/l	14.3	ND
Copper	10	27.	200 ug/l	170.4	1 mg/l	15.			48.7	10.
Lead	1	11.	25 ug/l	703.5	50 ug/l	79.		50 ug/l	26.7	9.
Mercury	0.03	0.3	2 ug/l	703.5	10 ug/l	0.4		144 ug/l	0.22	ND
Nickel	15	75.			15.4 ug/l	ND		13.4 ug/l	3.26	ND
Selenium	2	16.	10 ug/l	141.11	10 ug/l	3		10 ug/l	ND	15.
Silver	5	ND	50 ug/l	703.5	50 ug/l	ND		50 ug/l	1.98	ND
Thallium	2	12.			17.8 ug/l	20	20 ug/l	13 ug/l	9.74	2.
Zinc	2	94.	300 ug/l	170.4	5 mg/l	385	30 ug/l	5 mg/l	98.7	4.
Cyanide, Total	10	ND	100 ug/l	170.4	200 ug/l	ND	22 ug/l	200 ug/l	8.24	ND
Phenols, Total	2	130.	1 ug/l	703.5		16	1.0 ug/l		1.563	ND
pH		6.31to12.24	6.5to8.5	170.4	6.5to8.5*	7.00to7.74	6.0to9.5			8.01
TDS		4,930. mg/l	500 mg/l		500 mg/l*					

Notes:

1) Sources for the Enforceable Limits are as follows:
   703.5 6 NYCRR Water Quality Regulations, Part 703.5 classes and quality standards for groundwater
   170.4 10 NYCRR Part 170.4 Sources of Water Supply - Standards of raw water quality
   141.11 40 CFR, Part 141 Environmental Protection Agency National Primary Drinking Water Regulations - Subpart B maximum contaminant levels for inorganic chemicals
   MCL - 40 CFR, Part 141 Environmental Protection Agency National Primary Drinking Water Regulations - Maximum contaminant levels for organic chemicals proposed in Federal Register (11/13/85)
2) All Guideline Limits are from the Clean Water Act except as noted by an * which are from : 40 CFR, Part 143.3 Environmental Protection Agency National Secondary Drinking Water Regulations - Secondary Maximum Contaminant Levels or by a # which are from 40 CFR Part 141 Recommended Maximum Contaminant Levels
3) All Surface Water Enforceable Limits are from: 6 NYCRR Water Quality Regulations, Part 701.19 classes and standards for fresh surface waters.
4) ND = not detected.
   ug/l (liquid) = ppb.
   mg/l (liquid) = mg/kg (solid) = ppm.
   ng/l (liquid) = 10^{-3} ppb.
5) NT = not detectable by tests as referenced in 703.4.

C-1474

surface water and groundwater contaminants at the Volney Landfill site. This table lists each of the Hazardous Substance List (HSL) compounds which were analyzed for, its laboratory detection limit, its maximum observed concentration in surface water and groundwater samples, and the corresponding enforceable limits and non-enforceable guidelines regarding these contaminants. Also presented for comparison in Table 6-1 are the maximum observed sediment and leachate (i.e., VLCH-1) concentrations of each contaminant. It should be noted that 2 HSL organic compounds, phenol and benzene, were also tentatively identified as additional mass spectrometer (MS) peaks in the HSL fractions to which they are not formally assigned (i.e., phenol as a volatile and benzene as a semi-volatile).

Tables 6-2 and 6-3 condense the data in Table 6-1 by indicating, for groundwater and surface water, respectively, the specific contaminants/parameters which violated their corresponding enforceable limits or non-enforceable guidelines in one or more samples. The results presented in these tables are discussed separately below.

As indicated by Table 6-2, groundwater contamination at the Volney Landfill is generally non-uniform and low-level. Among the seven compounds/parameters which violated groundwater limits, most did so in only one to a few wells, and at concentrations typically in the very low to low ppb range. This finding is consistent with previous sampling results at the Volney Landfill, as reported in Section 1.1.3.

The data presented in Table 6-3 indicates a generally lower incidence of surface water contaminants, and at generally lower concentration levels, than observed in groundwater, perhaps reflecting the dilution of these contaminants as they flow underground toward the adjacent streams.

The only parameter violating a surface water concentration limit was total phenols, which did so at 5 stations, with a maximum concentration of 16 ppb (exceeding the 1 ppb limit). In addition, a

TABLE 6-2

GROUNDWATER SUBSTANCES AND PARAMETERS EXCEEDING STANDARDS AND GUIDELINES

Substance	Max Conc. (ug/l)	Exceeded Enforceable Limit Conc. (ug/l)	Source	No. Samples/ Total Samples
Vinyl Chloride	5.8	1	MCL	1/24
Benzene	3.5	not detectable	703.5	2/24
Arsenic	85	25	703.5	1/20
Selenium	16	10	141.11	5/20
Total Phenols	13	1	703.5	8/20
pH (Min)	6.31	6.5	170.4	1/22
TDS	880 mg/l	500 mg/l	170.4	4/18

Substance	Max Conc. (ug/l)	Exceeded Guideline Conc. (ug/l)	Source	No. Samples/ Total Samples
Chloroform	70	0	CWA	1/24
Vinyl Chloride	5.8	0	RMCL	1/24
Benzene	3.5	0	RMCL	2/24
Trichloroethene	3.4	0	RMCL	7/24
Tetrachloroethene	0.62	0	RMCL	1/24
Arsenic	85	0	CWA	5/20
Beryllium	5	0	CWA	7/20
Nickel	75	15.4	CWA	8/20
TDS	880 mg/l	500 mg/l	143.3	4/18

Notes:

1) Refer to notes in Table 6-1.
2) VBW-10Br has not been included in the sample count due to the expected interference of grout.

TABLE 6-3

SURFACE WATER SUBSTANCES AND PARAMETERS EXCEEDING STANDARDS AND GUIDELINES

Substance	Max Conc. (ug/l)	Exceeded Enforceable Limit		
		Conc. (ug/l)	Source	No. Samples/ Total Samples
Total Phenols	16	1.0	701.19	5/7

Substance	Max Conc. (ug/l)	Exceeded Guideline		
		Conc. (ug/l)	Source	No. Samples/ Total Samples
Chloroform	0.48	0	CWA	2/7
Arsenic	37	0	CWA	7/7
Beryllium	5	0	CWA	4/7
Lead	79	50	CWA	1/7
Thallium	20	13	CWA	4/7
Mercury	0.4	.144	CWA	3/7

Notes:
1) Table does not include leachate data.
2) Refer to notes in Table 6-1.

number of compounds violated Clean Water Act guidelines, though again usually at low concentrations and only a few stations. Arsenic was the most widespread of these, violating the "zero" guideline in all surface water samples.

The impact of surface water contamination adjacent to the Volney Landfill site is lessened considerably by the natural dilution of contaminants within the stream system. This dilution results from a number of processes, including mechanical dispersion and physical/chemical/biological reductions (e.g., due to adsorption, settlement, volatilization, biological decay, etc.) By (conservatively) ignoring all processes except mechanical dispersion by streamflow, and using the one-dimensional form of the convective-diffusion equation for turbulent flow, an approximate solution for dilution in a downstream direction has been derived (see Appendix L). This equation is:

$$X_m = 100\ D^2 \qquad \text{[Eq. 6-1]}$$

Where, X_m = distance downstream from site (feet)
D = dilution (initial concentration/concentration at X_m)

Based upon this equation, contaminants will be diluted by an order of magnitude (i.e., D = 10) at a distance of approximately 1.9 miles downstream from the site. Total phenols, which were detected only in samples from Bell Creek, will be diluted to concentrations less than surface water limits within 5 miles from the site, and more than 8 miles upstream from the Oswego River.

Based upon the foregoing discussion, it is felt that the primary potential public health impact of the Volney Landfill is through local contamination of groundwater, which is a source of potable water. This impact is evaluated in the following baseline health risk assessment.

6.3.3 Baseline Public Health Evaluation - For reasons discussed previously, the primary potential public health impact at the Volney Landfill is the contamination of groundwater, which is used as a local source of water supply. In order to assess the level of risk associated with this groundwater contamination, a baseline public health evaluation has been performed. This health evaluation provides a quantitative estimate of risk levels under existing conditions, and can be used as a component factor in determining whether remedial action at the site is warranted.

6.3.3.1 Methodology - The basic methodology utilized in this public health evaluation follows that provided in USEPA's "Superfund Public Health Evaluation Manual" (USEPA, 1986b). The evaluation is based on data collected both during this Remedial Investigation, and during previous investigations as reported by Geraghty and Miller (1986).

6.3.3.2 Data Base for Risk Assessment - Tables 6-4 and 6-5 list contaminants detected in selected residential and monitoring wells in the vicinity of Volney Landfill. The residential wells selected for study are those that have been sampled recently and are considered most likely to be effected by contaminants migrating from the site. The selected residential wells are listed in note 1 of Table 6-4 and shown on Figure 1-3. They include all sampled residential wells reported in Geraghty and Miller (1986), within the area of potentially affected groundwater receptors (Figure 6-2), and are located to the southwest and southeast of the landfill. Monitoring wells were selected for study if recent analytical data was available and if they were located in the pathway of groundwater migrating toward the selected residential wells. The selected monitoring wells are listed in note 1 of Table 6-5 and shown on Figures 1-3 and 4-1. Compounds from both residential and monitoring wells were evaluated in terms of possible health effects. Two separate risk assessments were performed, one utilizing data collected from residential wells, and the other using data collected from monitoring wells. The selection of a common set of indicator

TABLE 6-4

CONTAINMENTS DETECTED IN RESIDENTIAL WELLS[1]

Compound	Quantifiable Detections	Maximum Concentration	Mean Concentration[2]	Classification[3]	Toxicity/ Carcino- genicity Data Exists	Selected as Indicator Chemical
VOLATILES						
(31) Toluene	1	12	0.6	T	Yes	Yes
METALS						
Manganese	14	270	52.0	T	Yes	Yes
Zinc	19	490	127.5	T	Yes	Yes

All data reported in ug/l (ppb)

NOTES:

(1) Wells used for assessment include RW-3A, 3B, 4, 5, 6, 7, 10 and 11.

(2) Mean concentration based on total number of samples analyzed for a particular compound. If a compound was not detected in a sample, a score of zero was assigned when determining the mean.

(3) T: Toxic.

TABLE 6-5
CONTAMINANTS DETECTED IN MONITORING WELLS[1]

Compound		Quantifiable Detections Total/Valid	Maximum Concentration Total/Valid	Mean Concentration Total/Valid[2]	Classification[3]	Toxicity/ Carcino-genicity Data Exists	Selected as Indicator Chemical
VOLATILES							
(3)	Vinyl Chloride[4]	2/2	8/8	0.39/0.39	C	Yes	Yes
(4)	Chloroethane	2/2	8/8	0.43/0.43	NR	No	No
(5)	Methylene Chloride	11/3	875/44	56.6/2.0	NR	No	No
(8)	Acetone	4/0	17/0	1.2/0	T	Yes	No
(9)	1,1-Dichloroethane	1/1	3/3	0.09/0.09	T	Yes	Yes
(10)	Trans-1,2-Dichloroethene	2/2	6/6	0.18/0.18	T,C(I)	No	No
(13)	2-Butanone (MEK)	5/5	1,900/1,900	95/95	T	Yes	Yes
(14)	1,1-Trichloroethane	6/2	17/17	0.95/1.2	T	Yes	Yes
(21)	Trichloroethene	4/0	1.2/0	0.11/0	T	Yes	No
(24)	Benzene	1/1	1/1	0.03/0.03	C	Yes	Yes
(28)	2-Hexanone (MBK)	1/1	11/11	0.31/0.31	NR	No	No
(30)	Tetrachloroethene	1/0	0.62/0	0.02/0	C	Yes	No
(31)	Toluene	3/3	88/88	4.7/4.7	T	Yes	Yes
(33)	Ethyl Benzene	1/1	1.4/1.4	0.04/0.04	T	Yes	Yes
(35)	Total Xylene	1/1	15/15	0.43/0.43	T	Yes	Yes
(37)	Phenol	1/1	341/341	9.7/9.7	T	Yes	Yes

TABLE 6-5 - Continued

Compound	Quantifiable Detections Total/Valid	Maximum Concentration Total/Valid	Mean Concentration Total/Valid[2]	Classification[3]	Toxicity/ Carcino-genicity Data Exists	Selected as Indicator Chemical
SEMI VOLATILES						
(68) Dimethyl Phthalate	2/2	35/35	4.2/4.2	NR	No	No
(77) Diethyl Phthalate	7/0	1.0/0	0.37/0	T	Yes	No
(88) Di-n-Butylphthalate	8/0	32/0	4.4/0	T	Yes	No
(95) Bis(2-ethylhexyl)phthalate	8/0	178/0	61.2/0	T	Yes	No
(97) Di-n-octyl phthalate	7/7	1.1/1.1	0.36/0.36	NR	No	No
METALS						
Arsenic	2/2	85/85	9.7/9.7	C	Yes	Yes
Beryllium	1/1	4.0/4.0	0.44/0.44	T,C(I)	Yes	Yes
Lead	1/1	9.0/9.0	1.0/1.0	T	Yes	Yes
Mercury	1/1	0.2/0.2	0.02/0.02	T	Yes	Yes
Nickel	5/5	75/75	19.8/19.8	T,C(I)	Yes	Yes
Selenium	5/5	13.0/13.0	6.1/6.1	T	Yes	Yes
Thallium	2/2	7.0/7.0	1.1/1.1	T	Yes	Yes
Zinc	29/29	650/650	60.4/60.4	T	Yes	Yes
Manganese	24/24	9,900/9,900	1,137/1,137	T	Yes	Yes

All data reported in ug/l (ppb)

TABLE 6-5 - Continued

NOTES:

(1) Wells used for assessment include the following:

- o from Geraghty and Miller, 1986: GW-3C, 3D, 5, 7, 8, 11A, 12A, 14A, 17, 18A, 26, 27A, and 27B
- o from RI/FS: VBW-1, 2, 3S, 3I, 3D, 3BR, 12, 13 and 16

(2) Mean concentration based on total number of samples analyzed for a particular compound. If a compound was not detected in a sample, a score of zero was assigned when determing the mean.

(3) T: Toxic; C: Carcinogenic; C(I): Carcinogenic by Inhalation Only; NR: Not assigned a classification in Superfund Public Health Evaluation Manual.

(4) Vinyl Chloride was not detected in wells listed in Note (1). However, since vinyl chloride was detected at levels exceeding the MCL in other monitoring wells, it was selected as an indicator chemical for this study.

chemicals for both of these separate risk assessments is discussed in the following section.

6.3.3.3 Indicator Chemicals - Indicator chemicals were selected based upon the criteria listed below:

- o The chemical must have been detected in at least one valid analysis since 1984.
- o The chemical must have known toxic or carcinogenic effects.
- o There must be quantitative data available for toxicity or carcinogenicity for the chemical.

During the RI/FS, a number of compounds detected in the monitoring wells were also detected in QA/QC sample blanks. Becaue of uncertainty regarding the source of these compounds, they were not considered "valid" detections and were not used in the quantitative risk assessment. All data collected from monitoring wells reported by Geraghty and Miller (Tables 1-1 through 1-3) were considered valid in the quantitative risk assessment. However, chlorinated compounds detected in residential wells by Geraghty and Miller were not considered valid, since these wells may have been chlorinated.

Chloroethane, methylene chloride, trans-1,2-dichloroethane, and 2-hexanone (methyl butyl ketone) were eliminated from consideration since they were not listed as toxic or carcinogenic substances in the Superfund Public Health Evaluation Manual, or, if listed, no quantitative data was reported for their toxicity or carcinogenicity.

None of the phthalates were selected as chemical indicators since it is believed these compounds may be sampling contaminants.

Based upon the foregoing procedure for selection of indicator chemicals, three (3) compounds detected in residential wells (toluene, manganese and zinc) and 18 compounds detected in monitoring wells

(9 volatiles, 9 metals) were considered in the quantitative risk assessment. These compounds were grouped according to toxicity or carcinogenicity, as presented in Tables 6-6 and 6-7.

6.3.3.4 Exposure Pathways - An exposure pathway is the route a contaminant may take to reach a susceptible receptor. For an exposure pathway to be complete, three factors must be present: (1) a source of contamination, (2) a route of contaminant transport, and (3) a receptor who may be exposed to the contaminants.

6.3.3.4.1 Source of Contamination - Because of the wide variety of chemicals occurring in landfill leachate, and the observed occurrence/pattern of groundwater contamination at the Volney Landfill (Section 4.4.2), it is believed that the landfill is the principal source of most, if not all, of the indicator chemicals selected above for quantitative risk assessment.

6.3.3.4.2 Routes of Transport - As previously discussed, groundwater contamination is the primary potential health risk at the Volney Landfill. Groundwater flow within the unconsolidated overburden deposits is generally radial, away from the landfill. Other investigators (Geraghty and Miller, 1985) have indicated that bedrock flow is toward the east and northeast. The communication between overburden and bedrock aquifers is retarded, though not prevented, by the relatively impermeable lodgement till unit which overlies bedrock. Therefore, groundwater contamination from the landfill travels principally in a horizontal and outward radial direction, but at the same time moves vertically through lodgement till toward bedrock. Residential wells in both overburden (sand and gravel) and bedrock units are potentially affected by this contamination, though the impact upon overburden wells is considerably more direct.

6.3.3.4.3 Receptors - It is currently estimated that 25 residential wells (i.e., approximately 100 people) may be exposed to the contaminants listed in Tables 6-6 and 6-7 (see Section 6.2). Of the

TABLE 6-6

CONTAMINANTS EVALUATED IN RISK ASSESSMENT OF RESIDENTIAL WELLS

A. TOXINS

	Acceptable Intake (ug/kg/d)		Maximum Concentration (Valid Data)	Mean Concentration (Valid Data)	MCL[1]	WQC[2]
	Subchronic	Chronic				
Toluene	430	290	12	0.6	NR	15,000
Manganese	530	220	270	52.0	NR	NR
Zinc	210	210	490	127.5	NR	5,000[3]

All data in ug/l except as noted.

NR = Not reported in Superfund Public Health Evaluation Manual.

NOTES:

(1) MCL - Maximum Contaminant Levels from Safe Drinking Water Act, 40 CFR 141.12.

(2) WQC - EPA Ambient Water Quality Criteria for Protection of Human Health, Adjusted for Drinking Water Only (45 Federal Register 79318-79379, November 28, 1980). The adjusted values are not official EPA water quality standards, but may be appropriate for Superfund sites with contaminated groundwater.

(3) Criteria based on taste and odor effects, not human health effects. Health-based water quality criteria are not available for these chemicals.

TABLE 6-7

CONTAMINANTS EVALUATED IN RISK ASSESSMENT OF MONITORING WELLS

A. TOXINS

	Acceptable Intake (ug/kg/d)		Maximum Concentration (Valid Data)	Mean Concentration (Valid Data)	MCL[1]	WQC[2]
	Subchronic	Chronic				
VOLATILES						
1,1-Dichloroethane	1,200	120	3	0.09	NR	NR
2-Butanone (MEK)	NR	46	1,900	95	NR	NR
1,1,1-Trichloroethane	NR	54	17	1.2	200	19,000
Toluene	430	290	88	4.7	NR	15,000
Ethyl Benzene	970	97	1.4	0.04	NR	2,400
Total Xylenes	100	10	15	0.43	NR	NR
Phenol	10	10	341	9.7	NR	3,500
METALS						
Beryllium	NR	0.5	4.0	0.44	NR	0 (0.0039)
Lead	NR	1.4	9.0	1.0	50	5,200
Manganese	530	220	9,900	1,137	NR	NR
Mercury	2.0	2.0	0.2	0.02	2	10
Nickel	20	10	75	9.8	NR	15.4
Selenium	3.2	3.0	13.0	7.5	10	10.0
Thallium	NR	0.45	7.0	1.1	NR	17.8
Zinc	210	210	650	60.4	NR	5,000[3]

TABLE 6-7 - Continued

CONTAMINANTS EVALUATED IN RISK ASSESSMENT OF MONITORING WELLS

B. CARCINOGENS	Carcinogenic Potency $(ug/kg/d)^{-1}$	Maximum Concentration (Valid Data)	Mean Concentration (Valid Data)	MCL[1]	WQC[2]
VOLATILES					
Vinyl Chloride	2,300	8	0.39	1.0	0 (2.0)
Benzene	52	1	0.03	5.0	0 (0.67)
METALS					
Arsenic	15,000	85	9.7	50	(.025)

All data in ug/l except as noted.

NR = Not reported in Superfund Public Health Evaluation Manual.

NOTES:

(1) MCL are Maximum Contaminant Levels from Safety Drinking Water Act, 40 CFR 141.12.

(2) WQC are EPA Ambient Water Quality Criteria for Protection of Human Health. These adjusted criteria were derived from published EPA water quality criteria (45 Federal Register 79318-79379, November 28, 1980), and were adjusted for drinking water only. The adjusted values are not official EPA Water Quality Criteria, but may be appropriate for Superfund sites with contaminated groundwater. Concentration in parenthesis correspond to midpoint (10^{-6}) of risk range for potential carcinogens only.

(3) Criteria based on taste and odor effects, not human health effects. Health-based water quality criteria are not available for these chemicals.

eight (8) residential wells from which analytical data is used in this health risk assessment (Table 6-4), four (4) are bedrock wells and four (4) are screened in overburden deposits. The major exposure path and subsequent health risk is the ingestion of contaminated drinking water. Although there may be some risk of exposure via inhalation, mainly through showering, this risk is considered much smaller than by ingestion, and has not been considered in this risk assessment.

6.3.3.5 Point Source Concentrations - In order to assess the risk of receptor exposure to contaminants, the concentrations expected at the receptor must be evaluated. In this report, the contaminant concentrations actually measured at residential and monitoring wells were assumed to be representative of concentrations expected for long-term exposure, as discussed below. The organic partition coefficient (K_{oc}) is a measure of the relative sorption potential for organics, and is a significant environmental fate determinant for all exposure pathways. The K_{oc} indicates the tendency of an organic chemical to be adsorbed and is largely independent of soil properties. The normal range of K_{oc} values is from 1 to 10^7, with higher values indicating greater sorption potential. As indicated on Table 6-8, the organic chemicals considered in this risk assessment have relatively low K_{oc} values, indicating faster leaching from the waste source into the aquifer and relatively rapid transport through the aquifer. A combination of low K_{oc} and high soil concentration indicates that significant releases of chemical to groundwater are possible in the future (USEPA, 1986b). Since no information concerning concentrations of organics in soil was obtained during the RI/FS, the impact of these compounds on future groundwater quality is uncertain. However, since the contaminants have been in place for a number of years and since these organics are relatively mobile, the concentrations detected in monitoring and residential wells used for the risk assessment represent a reasonable assumption of the upperbound limit of concentrations expected for long-term exposure.

TABLE 6-8

K_{oc} VALUES OF INDICATOR ORGANICS

Compound	K_{oc} (ml/g)
2-Butanone (MEK)	4.5
Benzene	83
1,1-Dichloroethane	30
Ethyl Benzene	1100
Phenol	14.2
Toluene	300
1,1,1-Trichloroethane	152
Total Xylenes	240
Vinyl Chloride	57

The mobility of metals varies with factors such as soil pH and oxidation potential; however, most heavy metals, because of their higher charge, adsorb more readily to soil than lower charged metals such as sodium or potassium, and are consequently more persistent in the soil matrix. Of the metals considered, arsenic, lead, mercury and zinc are listed as persistent in surface water in Appendix A-2 (Half Lives in Various Media) in the Superfund Public Health Evaluation Manual. Although data on persistence in soil and groundwater is not included in the Appendix, heavy metals are generally considered persistent in these media as well. Since heavy metals are persistent in soils, and therefore would not tend to leach, and since these metals would probably persist in groundwater once present, the levels detected in monitoring wells and residential wells used for the risk assessment represent a conservative assumption for the upperbound limit of concentration expected in groundwater for long-term exposure.

6.3.3.6 Standards and Criteria - For potential groundwater exposure via drinking water, the most appropriate standard comparisons are with Safe Drinking Water Act Maximum Contaminant Levels (MCL's). MCL's are currently available for 24 chemicals (10 inorganics, 6 organic pesticides and 8 volatile organics). Generally, the MCL represents the allowable lifetime exposure to the contaminant for a 70 kilogram (kg) adult who is assumed to ingest two liters of water per day. The only two compounds detected in monitoring wells at concentrations exceeding their MCL values were selenium and vinyl chloride (Table 6-7). However, these exceedences were based on maximum concentrations; neither compound's mean concentration exceeded its MCL values.

Federal ambient water quality criteria are health-based water quality criteria that estimate the ambient surface water concentration which will not result in adverse health effects in humans. Although the criteria are not enforceable, they have been used to develop enforceable state water quality standards. The published criteria have been adjusted for drinking water ingestion only. These values are considered appropriate for evaluation of potential risk at Superfund sites with contaminated groundwater. Criteria for noncarcinogens are based on published Acceptable Daily Intakes (ADI's) and standard intake assumptions. Criteria for carcinogens represent the incremental lifetime cancer risk of 10^{-6} based on published data and extrapolation models. As indicated on Tables 6-7, maximum detected concentrations of arsenic, beryllium, nickel, selenium, benzene and vinyl chloride exceeded the USEPA Ambient Water Quality Criteria (WQC), and mean concentrations of arsenic and beryllium exceeded the WQC in monitoring wells.

As indicated in Table 6-6, neither MCL's nor WQC's were exceeded in any of the residential wells utilized in this health risk assessment.

6.3.3.7 Quantitative Risk Assessment - Health effects are divided into three broad categories: acute and subchronic effects; chronic effects; and carcinogenic risks. These are discussed seprately below.

6.3.3.7.1 Acute and Subchronic Health Effects - For non-carcinogenic chemicals, the estimated acceptable subchronic intake (AIS) has been estimated by USEPA's Environmental Criteria and Assessment Office (ECAO). The AIS is defined as the highest short-term (10- to 90-day) exposure without any expected adverse health effects. Comparing the AIS to the estimated short-term intake level indicates whether health effects would be expected in the exposed population. The individual probability of effects (i.e., risk) resulting from exposures above the AIS cannot be estimated (USEPA, 1985e).

For the purposes of this report, since a risk assessment based on possible chronic effects represents a more conservative estimate of health risk, and since it seems reasonable to assume the concentrations of compounds detected in the wells studied represent long-term concentrations, the health risk assessment for noncarcinogens was based only on chronic effects as discussed in the next section.

6.3.3.7.2 Chronic Effects - Chronic toxic effects (where a threshold limit may exist) may result from long-term repeated ingestion of groundwater contaminants. The criteria used to evaluate the potential for health impacts from chronic ingestion are the acceptable chronic intake (AIC) values (USEPA, 1986e). These values assume a 70-kg adult consuming two liters of water per day throughout a 70-year life-time.

At the Volney Landfill site, 15 noncarcinogenic chemicals (7 organics and 8 metals) have been evaluated. To assess the overall potential for noncarcinogenic effects posed by multiple chemicals, a hazard index approach has been utilized, based on USEPA's "Guidelines for Health Risk Assessment of Chemical Mixtures" (USEPA, 1986f). This approach assumes that multiple subthreshold exposures could result in an adverse effect and that the magnitude of the adverse effect will be proportional to the sum of the ratios of the subthreshold exposures to acceptable exposures. This can be expressed as:

$$\text{Hazard Index} = \frac{E_1}{RL_1} + \frac{E_2}{RL_2} + \ldots + \frac{E_i}{RL_i} \qquad \text{[Eq. 6-2]}$$

where:

E_i = Exposure level (or intake) for the i^{th} toxicant (The exposure level is determined by multiplying the concentration detected by the average consumption of 2 liters of water per day, then dividing by an average body weight of 70 kg. The exposure level in expressed in mg/kg/day).

RL_i = Reference level (or intake) for the i^{th} toxicant (i.e., the AIC value in mg/kg/day).

Any single chemical with an exposure level greater than the reference level will cause the hazard index to exceed unity, and when the index exceeds unity, there may be concern for a potential health risk. For multiple chemical exposures, the hazard index can exceed unity even if no single chemical exceeds its acceptable level. However, the assumption of additivity reflected in the hazard index equation is most properly applied to compounds which induce the same effect by the same mechanism. Consequently, application of the equation to a mixture of compounds that are not expected to induce the same type of effects could overestimate the potential for effects.

For the purposes of this report, only the single chemical exposure level was considered to avoid overestimation of potential health effects by assuming additive effects of all compounds. The quantitative risks are presented in Tables 6-9 and 6-10.

As indicated in Table 6-9, the hazard index did not exceed unity for any of the compounds studied in residential wells. As indicated in Table 6-10, the hazard index exceeded unity for both MEK and Manganese based on the maximum concentration detected in the monitoring wells studied. The hazard index for Phenol, at 0.99, was very close to unity. Based on mean concentrations, no individual chemical's hazard index exceeded unity. It must be emphasized that the hazard index is not a mathematical prediction of incidence or severity of effects, but simply a numerical index to help identify potential exposure problems (USEPA, 1986b).

6.3.3.7.3 Carcinogenic Risk - Contaminants detected in monitoring well samples which were considered as indicator chemicals and which are known or suspected carcinogens include vinyl chloride, benzene and arsenic. None of the indicator chemicals detected in residential wells are know or suspected carcinogens.

Carcinogenic potency is defined as the upper 95% confidence limit of the amount of risk per unit of exposure. Therefore, multiplication of the carcinogenic potency in inverse intake units (kg-day/mg) by the estimated long-term intake in corresponding units (mg/kg-day) will yield an upper-bound carcinogenic risk estimate (USEPA, 1986b).

TABLE 6-9

CHRONIC HAZARD INDICES FOR RESIDENTIAL WELLS

Compound	Chronic Daily Intake (CDI) Max.[1] (mg/kg/d)	Chronic Daily Intake (CDI) Mean[2] (mg/kg/d)	Acceptable Intake for Chronic Exposures (AIC) (mg/kg/d)	Hazard Index Max.	Hazard Index Mean
Toluene	3.5E-04	1.7E-05	2.9E-01	1.2E-03	6.0E-05
Manganese	7.8E-03	1.5E=03	2.2E-01	3.6E-02	6.9E-03
Zinc	1.4E-02	3.7E-03	2.1E-01	6.8E-02	1.8E-02

Notes:

(1) $CDI = \frac{\text{Max. concentration detected in mg/l x 2 liters water ingested per day}}{\text{70 kg (average body weight)}}$

(2) $CDI = \frac{\text{Mean concentration detected in mg/l x 2 liters water ingested per day}}{\text{70 kg (average body weight)}}$

TABLE 6-10

CHRONIC HAZARD INDICES FOR MONITORING WELLS

Compound	Max.[1] (mg/kg/d)	Mean[2] (mg/kg/d)	Acceptable Intake For Chronic Exposures (AIC) (mg/kg/d)	Hazard Index Max.	Hazard Index Mean
VOLATILES					
1,1-Dichloroethane	8.7E-05	2.6E-06	1.2E-01	7.3E-04	2.2E-05
2-Butanone (MEK)	5.5E-02	2.8E-03	4.6E-02	1.2E+00	6.0E-02
1,1,1-Trichloroethane	4.9E-04	3.5E-05	5.4E-02	9.1E-03	6.4E-04
Toluene	2.6E-03	1.4E-04	2.9E-01	8.8E-03	4.7E-04
Ethyl Benzene	4.1E-05	1.2E-06	9.7E-02	4.2E-04	1.2E-05
Total Xylenes	4.4E-04	1.2E-05	1.0E-02	4.4E-02	1.2E-03
Phenol	9.9E-03	2.8E-04	1.0E-02	9.9E-01	2.8E-02
METALS					
Beryllium	1.2E-04	1.3E-05	5.1E-04	2.3E-01	2.6E-02
Lead	2.6E-04	2.9E-05	1.4E-03	1.9E-01	2.1E-02
Manganese	2.9E-01	3.3E-02	2.2E-01	1.3E+00	1.2E-01
Mercury	5.8E-06	5.8E-07	2.0E-03	2.9E-03	2.9E-04
Nickel	2.2E-03	2.8E-04	1.0E-02	2.2E-01	2.8E-02
Selenium	3.8E-04	2.2E-04	3.0E-03	1.3E-01	7.3E-02
Thallium	2.0E-04	3.2E-05	4.5E-04	4.5E-01	7.1E-02
Zinc	1.9E-02	1.8E-03	2.1E-01	9.0E-02	8.3E-03

Notes:

(1) CDI = Max. concentration detected in mg/l x 2 liters H_2O ingested per day - 70 kg (average body weight)

(2) CDI = Mean concentration detected in mg/l x 2 liters H_2O ingested per day - 70 kg (average body weight)

Risk estimates were calculated for the mean, and the maximum concentrations to provide a range of risk estimates. The concentrations detected in the monitoring well samples and used in the calculations are assumed to be the concentrations to which receptors are exposed.

The non-threshold model, which is linear at low doses, has been adopted as the primary basis for risk extrapolation to low levels of dose-response relationship for individual contaminants. Although limited, it is the best of any of the current mathematical extrapolation models. Any risk estimates made with such a model should be regarded as conservative, representing the plausible upper limit for the risk; i.e., the true risk is not likely to be higher than the estimate, but it could be lower (USEPA, 1984).

Uncertainties are associated with the carcinogenic risk estimates for various chemicals. They are introduced because of: (a) the need to extrapolate below the dose range of the experimental (animal test) data; (b) the variability of the receptor population; (c) comparison of animal dose equivalency to human exposure; (d) the fact that selection of appropriate animal studies, the cancer risk estimation used, and the route of exposure in the test animals may be different than the one expected in site-specific circumstances; and (e) the fact that the estimated risk is a probability conditional upon the assumption that an animal carcinogen is also a human carcinogen.

In order to clarify the limitations inherent in using animal test data for cancer risk assessment, the following direct quotation is provided:

> "The risk -- likelihood of developing cancer -- depends on the intensity, route, and duration of exposure to a carcinogen. Individuals may respond differently to similar exposure, depending on host factors such as age, sex, nutritional status, overall health, and inherited characteristics. Only in a few instances, where [there is data from] studies of

long-term human exposures and cancer incidence in restricted environments, can risk be estimated with confidence" (USDHHS, 1983).

To assess the total risk posed by the presence of more than one known or suspected carcinogen, risk estimates calculated for single contaminants are added (USEPA, 1986b). Table 6-11 summarizes carcinogenic risks associated with the three (3) carcinogenic compounds detected in monitoring wells. As previously stated, none of the indicator chemicals detected in residential wells are known or suspected carcinogens.

Risk addition assumes that: (1) individual intakes are small; (2) there are no synergistic or antagonistic chemical interactions; (3) individuals will be exposed to all contaminants detected; and (4) all of the compounds induce carcinogenic effects in humans (USEPA, 1985e).

It must be noted that arsenic contributes 99 percent of the total carcinogenic risk; however, risk based on maximum concentrations for benzene and vinyl chloride still exceed 1×10^{-6}, which represents a commonly referenced mid-range value for acceptable carcinogenic risk.

6.3.3.8 Summary and Conclusions - Under the assumptions of this study, as reviewed below, the principal conclusions regarding public health risks posed by the Volney Landfill are:

(1) Available analytical data from residential wells in the vicinity of the landfill does not indicate any risk associated with toxic or carcinogenic chemicals. It should be noted, however, that arsenic, the carcinogenic chemical of greatest concern in the monitoring well data, was not analyzed for the residential well samples utilized in this study.

TABLE 6-11

CARCINOGENIC RISK FOR MONITORING WELLS

Compound	Chronic Daily Intake: Max.[1] (mg/kg/d)	Chronic Daily Intake: Mean[2] (mg/kg/d)	Carcinogenic Potency $(mg/kg/d)^{-1}$	Carcinogenic Risk: Max.	Carcinogenic Risk: Mean
Vinyl Chloride	2.32E-04	1.13E-05	2.3E+00	5.34E-04	2.60E-05
Benzene	2.90E-05	8.70E-07	5.2E-02	1.51E-06	4.52E-08
Arsenic	2.47E-03	2.81E-04	15.0E+00	3.71E-02	4.22E-03
Total				3.76E-02	4.25E-03

Notes:

(1) $CDI = \frac{\text{Max. concentration detected in mg/l} \times \text{2 liters water ingested per day}}{\text{70 kg (average body weight)}}$

(2) $CDI = \frac{\text{Mean concentration detected in mg/l} \times \text{2 liters water ingested per day}}{\text{70 kg (average body weight)}}$

(2) Monitoring well data suggests that there is some potential for health risk associated with toxic chemicals (manganese, MEK and phenol), but a considerably larger risk related to carcinogenic chemicals (benzene, vinyl chloride and -- especially -- arsenic). However, any risk derived from this monitoring well data assumes, as discussed below, that groundwater of the quality observed in the monitoring wells reaches the residential wells and is subsequently ingested.

(2a) The potential risk from toxic chemicals observed in the monitoring wells is marginal. The hazard index (a numerical index which, when greater than unity, indicates a potential toxic health risk) had the following maximum values: manganese (1.3), MEK (1.2) and phenol (0.99). These values were realized, however, only for the maximum observed concentrations of these chemicals, and under the assumption of chronic exposure to these maximum concentrations.

(2b) The maximum carcinogenic risks for individual compounds derived from monitoring well data were: benzene (1.51×10^{-6}), vinyl chloride (5.34×10^{-4}) and arsenic (3.71×10^{-2}). Again, these values are based upon maximum observed concentrations, and assume long-term exposure to these concentrations. However, even utilizing mean concentrations, the carcinogenic risks associated with vinyl chloride (2.60×10^{-5}) and arsenic (4.22×10^{-3}) are considered to be significant.

The assumptions which form the basis for this health risk assessment are considered to be realistic, though generally conservative. Some of the key assumptions are reviewed and discussed below.

(a) Relationship between residential and monitoring wells - Since groundwater from monitoring wells is not ingested, its quality is a matter of public health concern only to the degree which it reflects the quality, or potential quality, of groundwater in residential wells. The monitoring wells considered in this study were selected from locations in the proximity of residential wells, and in the expected direction of contaminant migration from the Volney Landfill toward these residential wells (see Tables 6-4, 6-5 and Figure 1-3). The 22 monitoring wells, with the exception of VBW-3BR, are screened in overburden deposits. The 8 residential wells, on the other hand, include 4 overburden and 4 bedrock wells. Based upon their locations and intake depths, it appears that the monitoring wells can reasonably -- if somewhat conservatively -- be assumed to represent potential water quality in the residential wells. Nevertheless, separate health risk assessments were performed for each set of wells.

(b) Volney Landfill as a source of arsenic - As stated in Section 6.3.3.4.1, the landfill is assumed to be the principal source of most, if not all, of the indicator parameters selected for use in this risk assessment. This assumption bears special discussion in relationship to arsenic, which contributes 99 percent of the total calculated carcinogenic risk at the site. Arguments can be made for and against the landfill as a source of arsenic. As indicative of its not being a source of arsenic: (1) a 1979 analysis of leachate from the landfill showed no arsenic, using a detection limit of 10 ppb (Engineering-Science, 1983); (2) arsenic has reportedly been detected in several nearby wells which are unaffected by the Volney Landfill, "indicating that levels of this constituent may also occur naturally in the [Medina Sandstone] formation" (Barton and Loguidice, 1984). On the other hand, there are a number of indications that the arsenic concentrations observed are attributable to Volney Landfill leachate, including: (1) among 14 residential wells sampled from July 1976 through September 1983, arsenic was found to exceed groundwater standards in only the landfill trailer (bedrock) well, during 5 of 18 samplings, with a maximum concentration of 240 ppb; (2) arsenic was detected by the United States Geological Survey at relatively high concentrations in two overburden monitoring wells -- an onsite leachate well (39 ppb) and a well located immediately to the east of the landfill across Silk Road (offsite well #10 at 61 ppb). "Arsenic concentrations exceeded the U.S. Public Health Service standard of 50 ug/l at well 10, which is in the path of eastward ground-water flow to Bell Creek" (Anderson and Miller, 1986); (3) arsenic is not an uncommon constituent of municipal landfill leachate (Table 3-6). Considering the above arguments, both pro and con, it would appear reasonable to assume that the arsenic observed during the Remedial Investigation in several monitoring wells, especially VBW-3BR (85 ppb), is at least partially attributable to the landfill.

(c) Carcinogenicity of arsenic - The carcinogenicity of arsenic itself is a matter of some scientific debate. Its evaluation as a carcinogen in this health risk assessment is based solely upon its similar classification in USEPA's "Superfund Public Health Evaluation Manual."

(d) Chronic effects - The treatment of observed well concentrations as chronic exposure levels is explained in Section 6.3.3.5. Although conservative, this assumption appears reasonable on the basis of: (1) the landfill's age; (2) the relatively high mobility of the indicator organic chemicals; and (3) the probable persistence in soils and groundwater of heavy metals such as arsenic.

6.4 Environmental Impacts

Potential environmental impacts of the Volney Landfill are limited in both type and degree. Since the site has been capped, the possibility of direct contact with waste materials is minimum. Likewise, subsurface gas migration away from the site, with its corresponding potential impact upon resident flora and fauna, will presumably be prevented by the gas collection/venting system which was installed with the cap. (It is still too early, however, to evaluate the operation of this system.) On a larger scale, there are no federal parklands, national forests or historical sites within the vicinity of, or threatened by, the landfill. From an overall standpoint, the primary potential impacts of the site are upon the stream channels and wetlands located downgradient from it (Figure 6-1). Considering the relatively low levels of surface water contamination, however, even these impacts are felt to be minor.

The New York State Department of Environmental Conservation (NYSDEC) wetlands shown on Figure 6-1 have been designated primarily upon the basis of resident vegetation. These wetlands also provide a haven for fish, waterfowl and birds migrating through the area. Although the landfill and surrounding wetlands are not known to be the habitat of any endangered or threatened species, nor the sole habitat of any terrestrial or avian fauna, they are within the migrating range of the Osprey (fish hawk), a threatened species protected at Three Rivers State Wildlife Management Area, approximately 10 miles south of the site. Again, however, the low levels of surface water contamination discussed previously are felt to pose no significant risk to the wetland system or its inhabitants. The location of these wetlands is, however, significant from a remedial standpoint, since they could be adversely affected by the implementation of any remedial measures which increase -- even temporarily -- the discharge of contaminants (including sediments) to the stream system.

The above discussion addresses primarily the relatively minor impact of contaminated surface water upon the wetland system. It should be noted, however, that contaminated sediments within the stream system pose another, significantly greater, potential risk to the environment. As summarized in Section 6.1, contaminant levels in sediments are generally higher than in surface water, especially among metals and cyanide. Contaminated sediments, which are transported and deposited throughout the stream system intermittently in response to flooding events, may pose a risk to the wetland ecosystems downgradient from the site. However, the evaluation of such a risk would require an environmental assessment of the stream/wetland system, which is beyond the scope of this study.

PART II

FEASIBILITY STUDY

PART II - FEASIBILITY STUDY FOR VOLNEY LANDFILL

7.0 APPROACH

7.1 Remedial Investigation Summary

Part I of this report, Sections 1 through 6, presents the results of a Remedial Investigation conducted at the Volney Landfill site. One of the objectives of this investigation was to collect data and characterize the site in sufficient detail to allow an identification and evaluation of remedial alternatives, as part of the Feasibility Study. The key findings of the Remedial Investigation, upon which this Feasibility study is based, are as follows:

- Volney Landfill is a recently closed municipal facility in which a number of barrels, some reportedly containing hazardous wastes, have been placed. As part of its closure, the site was graded, capped and seeded, with a gas venting system installed under the PVC membrane portion of the cap.

- The site is located in a sparsely populated rural area. Residents in the vicinity are served by private wells.

- The landfill itself is approximately 55 acres in size, with an average fill depth of approximately 45 feet and a maximum depth of approximately 60 feet.

- The chemical characteristics and exact quantity of hazardous wastes deposited in the landfill are unknown. Judging from their source, however, these wastes could include any of the extremely wide variety of hazardous substances which were handled at the PAS site in the City of Oswego. Because the quantity of these reported hazardous wastes is extremely small compared to that of the other wastes on-site, it is suspected that their manifestation in adjacent surface water and groundwater may be masked by the hazardous components of "typical" municipal landfill leachate.

- The site is underlain by a thick section of unconsolidated deposits, primarily of glacial origin, overlying bedrock. The bedrock unit, occurring at depths ranging from about 30 to 100 feet below ground surface, consists of reddish brown sandstones, siltstones and shales. A basal layer of compact lodgement till, varying in thickness from about 16.5 to 73 feet, appears to be laterally continuous over bedrock throughout the site. Glaciolacustrine deposits occur as layers of fine sand and silt, up to 28 feet thick, directly overlying lodgement till in the topographic basins between drumlins. Reworked sand and gravel, ranging from 4 to 25 feet thick, occurs as a surficial mantle which overlies the lodgement till and glaciolacustrine deposits. This reworked sand and gravel unit was excavated to till prior to the placement of refuse.

- Groundwater flow is radially outward from the landfill. Most groundwater flow is eastward toward Bell Creek; groundwater from the southwest corner and west side of the landfill flows toward and ultimately discharges into the headwater tributaries of Black Creek.

- The reworked sand and gravel unit acts as the primary avenue for groundwater flow in the site area. Lodgement till acts as a partial, though not absolute, hydrologic barrier to groundwater flow between the overlying deposits and bedrock.

- Groundwater analyses indicate low-level contamination of groundwater around the landfill perimeter. Typical concentrations of those hazardous substances detected were in the very low ppb range. Non-hazardous leachate indicator parameters confirm the occurrence of relatively low-level groundwater contamination around the site.

- Available data, though limited, indicate that leachate from the landfill has permeated lodgement till and reached bedrock.

- Stream water adjacent to the landfill is also contaminated, though typically at even lower levels than groundwater. Based upon the results from one sampling station (VSS-1), there appears to be some background source of contamination upstream from the site on Bell Creek.

- Contaminant levels in stream sediments adjacent to the site are typically higher than in surface water, particularly among metals (very low to low part-per-<u>million</u> (ppm) range) and cyanide (low ppb to low ppm range).

- Considering the potential receptors of contamination from the Volney Landfill, it is felt that the primary potential public health impact of the site is through local contamination of groundwater, which is a source of potable water.

- Available analytical data from residential wells in the vicinity of the landfill does not indicate any present risk associated with toxic or carcinogenic chemicals.

- Monitoring well data, to the extent which it can be extropolated as an indicator of residential well quality, suggests that there is some potential for health risk associated with toxic chemicals (manganese, MEK and phenol), but a considerably larger risk related to carcinogenic chemicals (benzene, vinyl chloride and -- especially -- arsenic).

- Potential environmental impacts resulting from surface water contamination at the site are minimal, though contaminated sediments may pose a significantly greater--but presently unquantifiable--risk to the wetlands downgradient from the site.

7.2 Simplified Site Model

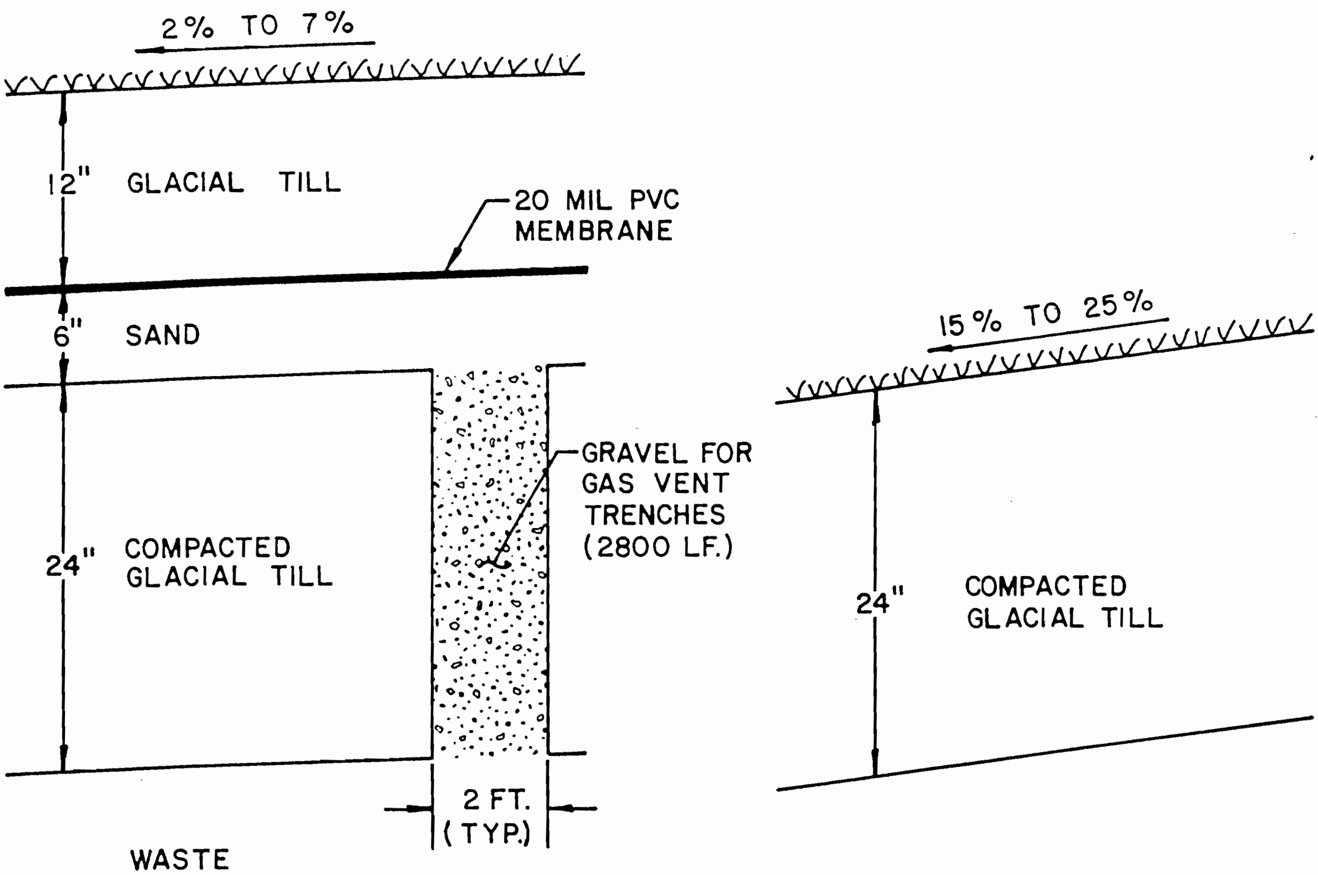
The Volney Landfill site may be generally characterized as highly variable in terms of geologic and hydrogeologic properties. For example, Figures 4-3 and 4-4 (geologic cross sections) indicate abrupt changes in stratigraphy across the site. This high degree of spatial variability is common in glacial geologic environments, particularly those which have been modified by human activities such as landfilling. Due to the presence of the landfill, groundwater mounding will occur beneath the site. Flow has already been determined to be radially away from the landfill. Hydrologic properties will tend to vary considerably with time in response to both seasonal climatic conditions and specific rainfall events. This temporal variation in groundwater hydrologic parameters is demonstrated by the observed change in water table elevations and vertical hydraulic gradients at the site (Table 4-9).

For the purpose of developing and evaluating remedial alternatives, it is useful to develop a conceptual model which "smooths out" the spatial and temporal variations discussed above. Such a model is presented below. Its components include a simplified geometric representation of the landfill, an analysis for prediction of infiltration (I) through the landfill cap, an estimate of average seepage (S) through lodgement till underlying the site, and a water balance to predict lateral flow (Q) away from the site.

7.2.1 Infiltration (I) Analysis - An infiltration analysis was performed using the Hydrologic Evaluation of Landfill Performance (HELP)

Computer Model. This program, which was developed by the United States Army Corps of Engineers Waterways Experiment Station for the United States Environmental Protection Agency (Schroeder, et al., 1983a), is a quasi-two-dimensional hydrologic model of water movement across, into, through and out of landfills. Its solution technique accounts for the effects of surface storage (snow), runoff, infiltration, percolation, evapotranspiration, soil moisture storage and lateral drainage. For further information concerning this model, the above-referenced user's manual may be consulted, or the full program documentation manual (Schroeder, et al., 1983b). The HELP model was applied to the Volney Landfill site using default climatological data for Syracuse, New York, over the 5-year simulation period from 1974 through 1978. (Note that the average annual precipitation over this modeling period was 47.97 inches, or 30 percent greater than the long-term (30-year) annual average of 36.79 inches (Section 2.4). Use of this default climatological data, therefore, provides a conservative estimate of infiltration on an annual basis.) In modeling the landfill, the top and side slopes were separately analyzed, as shown on Figure 7-1.

The top of the landfill is approximately 22 acres in size with slopes ranging from 2 to 7 percent. It is overlain by a soil barrier layer and a synthetic liner. More specifically, a 2-foot layer of compacted glacial till (design permeability = 1 x 10^{-5} cm/sec) overlies refuse. On top of this barrier is a 6-inch sand layer, which was installed to provide a smooth bedding for the membrane liner. The liner consists of a 20-mil polyvinyl chloride (PVC) membrane with glued seams. Overlying the liner is a 12-inch layer of glacial till acting as a protective covering and a zone to support vegetative growth. The upper surface was scarified and seeded with a standard grass seed mixture. Quality control during construction of this cap included nuclear density testing at 100-foot grid intervals and cap thickness evaluation at a 200-foot grid intervals, but no field testing of membrane material or seams. Within the cap on the top section of the landfill, a gas collection system was installed. This system includes approximately 2,800 linear feet of gas collection pipes, installed in 2-foot wide



TOP OF LANDFILL
NOT TO SCALE

LANDFILL SIDE SLOPES
NOT TO SCALE

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EXISTING LANDFILL COVER SECTIONS

FIGURE 7-1

trenches, which were excavated through the underlying soil barrier and backfilled with gravel. Vent pipes from this system are seamed to the membrane liner at points of penetration.

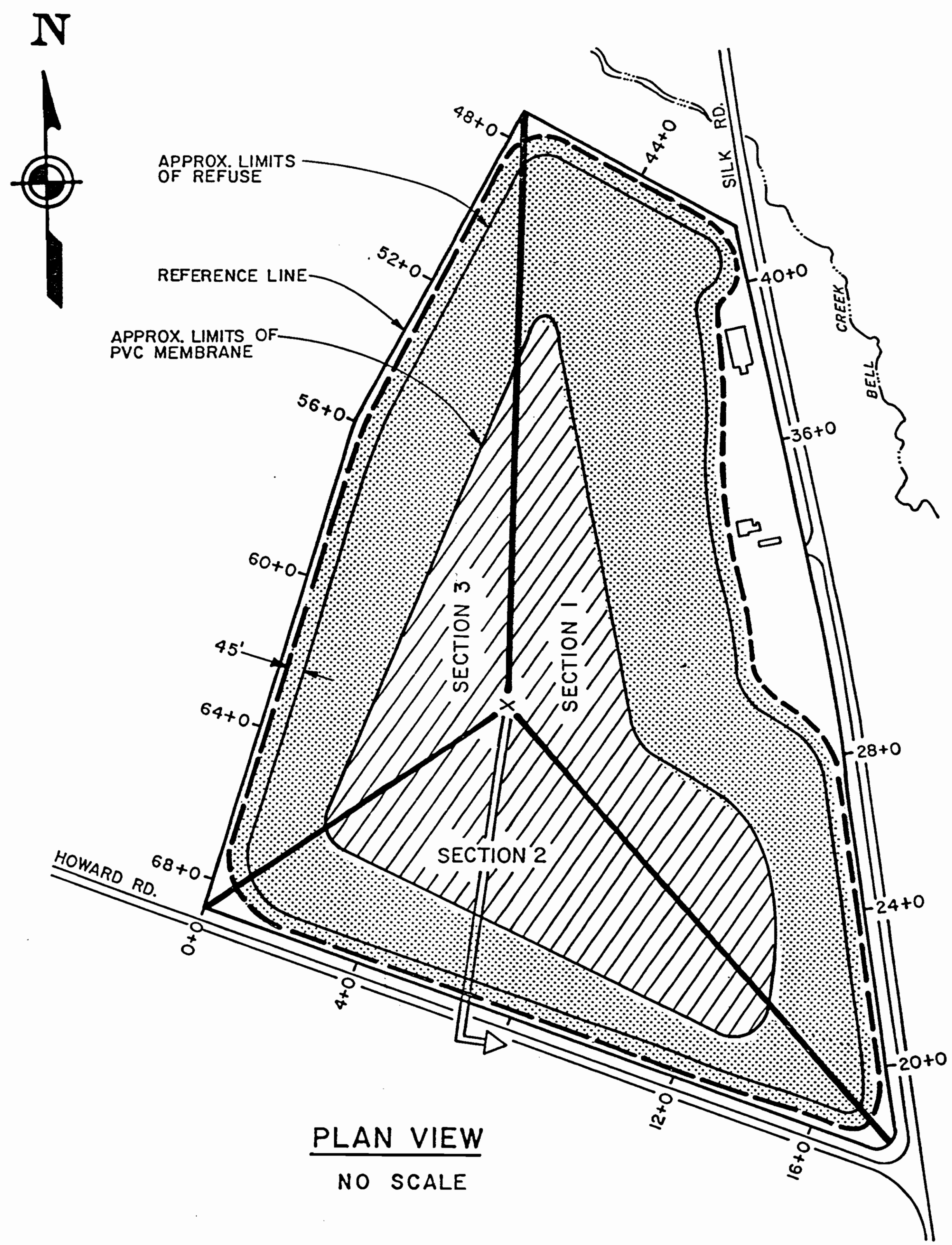
The landfill side slopes, as shown on Figure 7-2, are approximately 35 acres in size with slopes ranging from 15 to 25 percent. The cover on these side slopes includes a minimum 2-foot thickness of compacted glacial till (design permeability = 1×10^{-5} cm/sec), with the upper surface scarified and seeded with a standard grass seed mixture.

Computer model results, indicating the water budget analysis for both sections of the landfill, are presented in Appendix L. These results may be summarized as follows:

	Landfill Top	Landfill Side Slopes
Average Annual Precipitation	47.97 in	47.97 in
Average Annual Runoff	18.03 in	17.08 in
Average Annual Evapotranspiration	28.48 in	24.33 in
Average Annual Infiltration Into Landfill (i)	0.62 in	5.91 in

As indicated by the above figures, the combination membrane and soil barrier on the top surface of the landfill is more effective in preventing infiltration than the solitary soil barrier on the side slopes, despite the much steeper slope of the side slopes. The infiltration rates modeled with the HELP program (0.62 inches per year on the landfill top and 5.91 inches per year on the side slopes) are used hereafter in this report as an indication of existing conditions and as a basis for comparison among remedial alternatives.

7.2.2 Seepage (S) Through Lodgement Till - In Section 4.4.2.4, it was determined that leachate from the Volney Landfill has had sufficient



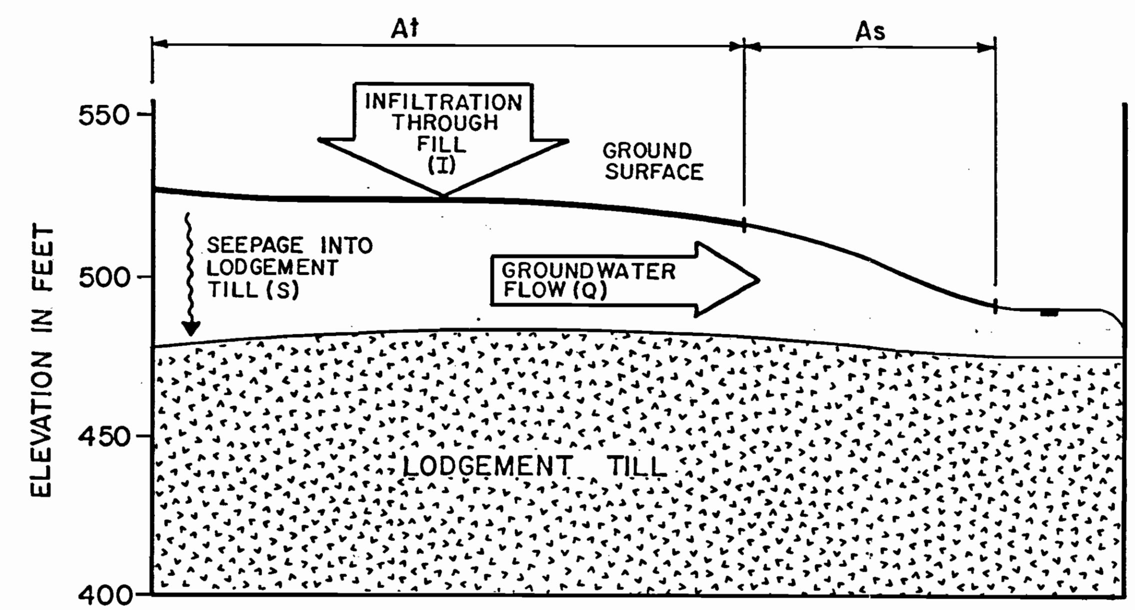
PLAN VIEW

NO SCALE

LEGEND

At = AREA OF LANDFILL TOP

As = AREA OF LANDFILL SIDE SLOPES



TYPICAL CROSS-SECTION

LANDFILL SECTION	1	2	3
I (gpd)	5,510	5,200	5,650
S (gpd)	1,230	1,210	1,070
Q (gpd)	4,280	3,990	4,580

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SIMPLIFIED WATER BALANCE

FIGURE 7-2

C-1463

time to permeate lodgement till and reach bedrock. The calculation supporting this statement was based upon the maximum observed downward hydraulic gradient in the April 1986 water level measurements (-0.086). As indicated by Table 4-9, however, most vertical hydraulic gradients are considerably less than this value. Furthermore, these gradients vary considerably with time and location. For the purpose of estimating long-term average seepage into lodgement till, a value of -0.001 (i.e., downward) has been used for the hydraulic gradient. As indicated by Table 4-8, the average hydraulic conductivity of lodgement till is approximately 0.19 feet/day (6.7 x 10^{-5} centimeters/second). Therefore, using Darcy's equation, the average seepage into lodgement till per unit area may be calculated by the following equation:

$$S = (K)\ (dh/dl)$$

where	S	= seepage per unit area	[L/T]
	K	= hydraulic conductivity	[L/T]
	dh/dl	= vertical hydraulic gradient	[L/T]

Using the above values for K and dh/dl, the average seepage into lodgement till is estimated to be 0.00019 feet/day, or 0.83 inches/year. It should be emphasized that this calculation of seepage is intended only for use in the simplified site model, and that it represents a single, composite average of a parameter which varies widely in space and time, and which has not been measured sufficiently for detailed evaluation.

7.2.3 Lateral Flow (Q) Away From Landfill - Figure 7-2 provides a simplified representation of the site. On this figure, the landfill has been divided into three subareas: Section 1 drains to the north and east toward Bell Creek; Section 2 drains to the south toward Howard Road; Section 3 drains to the west toward the headwater tributaries of Black Creek. Each of these sections has been further broken down into two components, A_t and A_s, representing the portion of each section located on the top of the landfill (i.e., within the PVC membrane) and on its side slopes, respectively. The figure also indicates a stationed reference line around the perimeter of the landfill, which will be discussed later.

Figure 7-2 presents a simplified water balance of the Volney Landfill. Infiltration (I), or inflow to the system, is based upon the analysis presented in Section 7.2.1, and consists of two parts:

$$I_n = i_t A_{nt} + i_s A_{ns}$$

where, I_n = Total infiltration into landfill Section "n" [L3/T]

i_t = Average infiltration rate into top of landfill (Section 7.2.1) [L/T]

A_{nt} = Top area of Section "n" [L^2]

i_s = Average infiltration rate into sideslopes of landfill (Section 7.2.1) [L/T]

A_{ns} = Sideslope area of Section "n" [L^2]

Outflow from the system consists of two parts, seepage into lodgement till (S) plus lateral flow away from the landfill (Q). Seepage is calculated as:

$$S_n = s_n (A_{nt} + A_{ns})$$

where, S_n = Total seepage into lodgement till from landfill Section "n" [L^3/T]

s_n = Average seepage rate (or 0.83 inches/year from Section 7.2.2) [L/T]

Lateral flow is calculated as the difference between infiltration and seepage, or:

$$Q_n = I_n - S_n$$

where, Q_n = Total lateral flow of groundwater from landfill Section "n" $[L^3/T]$

The water balance shown in Figure 7-2, on a rate basis, has been summarized in Table 7-1. As indicated by the values on this table, the total average infiltration into the landfill (approximately 16,400 gallons/day) produces approximately 12,900 gal/day of lateral groundwater outflow and approximately 3,500 gal/day of vertical seepage into lodgement till. The uncertainties concerning vertical seepage, particularly in regard to hydraulic gradients, has been previously discussed. It should further be pointed out that, as the recently completed landfill capping takes effect, vertical seepage will probably decrease as downward hydraulic gradients -- whatever their actual value may be -- decrease in response to lowering of the overburden water table.

The lateral groundwater outflow from the landfill is not uniformly distributed along its perimeter. This can be seen from Figure 7-3, which shows an estimated stratigraphic and groundwater profile around the landfill perimeter. Along some portions of this profile (e.g. stations 17+00 to stations 31+00), the water table elevation is below the lodgement till surface. In these areas, lateral groundwater outflow atop the lodgement till does not occur. In other areas (e.g, stations 31+00 to 51+20 and 60+00 to 9+20), the depth of saturated soil overlying lodgement till is substantial, and lateral groundwater outflow exceeds its average value. In other words, maximum lateral outflow of groundwater from the site can be expected to occur in those locations where the depth of saturated soil overlying lodgement till is greatest.

Along the west side of the landfill from stations 51+20 to 60+00, the water table and lodgement till surface approximately coincide with the ground surface. Under these circumstances, leachate perched atop the lodgement till would be expected to break out as surface flow.

TABLE 7-1

WATER BALANCE SUMMARY

Landfill Section	Section 1	Section 2	Section 3	Total Landfill
A_t (acres)	8.28	8.60	4.99	21.87
A_s (acres)	11.67	10.92	12.32	34.91
I_n (gallons/day)	5,510	5,200	5,650	16,360
S_n (gallons/day)	1,230	1,210	1,070	3,510
Q_n (gallons/day)	4,280	3,990	4,580	12,850

Notes: Precipitation = 47.97 inches/year
i_t = 0.62 inches/year
i_s = 5.91 inches/year
s_n = 0.83 inches/year

In fact, a line of small springs was observed on April 1, 1986 at the northwest corner of the landfill. It would appear that excavation in this area, for the purpose of obtaining cover material, has opened an avenue of surface discharge for groundwater perched on the lodgement till surface, which otherwise would flow off-site as part of the lateral outflow fraction (Q_n).

Finally, it should be pointed out that the water balance presented in this section was performed without taking into account the existing leachate collection system in the newer (northern) section of the landfill. Because information concerning the design, construction and operation of this system is generally very limited or unavailable, its efficiency cannot be evaluated. Regardless of efficiency, however, the system, if presently operational, will reduce the estimated quantity of seepage and lateral groundwater outflow from the north section of the landfill.

7.2.4 Assumptions and Limitations - The simplified site model presented in this section is based upon a number of important assumptions, and is therefore limited to use as a preliminary planning tool. Before final design can proceed on any of the potential remedial measures evaluated using this model, it will be necessary to obtain additional field data, and particularly in the case of groundwater flow analysis, to analyze the system using more sophisticated techniques. Specifically, the following assumptions will have to be addressed and refined:

(a) Spatial averaging of hydrogeologic properties - The spatial averaging of hydrogeologic properties such as hydraulic conductivity (K) and hydraulic gradient (i) is a simplification of the real system which, prior to final design, will have to be refined through the aquisition and assessment of additional field data.

(b) Vertical seepage - Vertical seepage into lodgement till is, in the simplified model, represented as a one-dimensional process.

This representation approximately describes the entry of groundwater, from overburden strata, into the lodgement till unit underlying the landfill, but not the subsequent flow of groundwater through the till. Except for the case of unsaturated flow, discussed subsequently, the actual flow of contaminated groundwater from the site is three-dimensional. Its downward seepage through lodgement till is superimposed upon a horizontal flow component, which is represented on Figure 4-8 by the groundwater contour map. The primary factors determining whether (and where) leachate from various sections of the landfill fully permeates lodgement till, and reaches bedrock, are: (1) the relative vertical and horizontal hydraulic gradients within the till along particular groundwater flow paths; (2) the relative vertical and horizontal hydraulic conductivities of the lodgement till unit; and (3) the relative lengths of flow in vertical and horizontal directions before contaminated groundwater originating at the site "breaks through" to bedrock or reaches a groundwater discharge point, such as an intercepting stream. In general, vertical gradients are less than horizontal gradients, vertical and horizontal conductivities are felt to be similar, and vertical flow distances to bedrock (i.e., lodgement till thicknesses) are less than horizontal flow distances to discharge points. As previously discussed, groundwater analytical data and hydrogeologic properties both suggest, though not conclusively, that leachate from at least some portions of the landfill has permeated lodgement till and reached bedrock.

(c) Unsaturated flow - The simplified site model assumes saturated flow conditions. As indicated by Figure 7-3, there are some portions of the landfill, especially in the southeast corner, where the upper portion of the lodgement till unit is unsaturated. For unsaturated conditions, groundwater flow is essentially vertically downward (i.e., gravity flow). With movement of groundwater in the unsaturated zone, the unsaturated hydraulic conductivity is typically less than under saturated flow conditions. On the other hand, at Volney Landfill, the vertical hydraulic gradient for unsaturated flow (which

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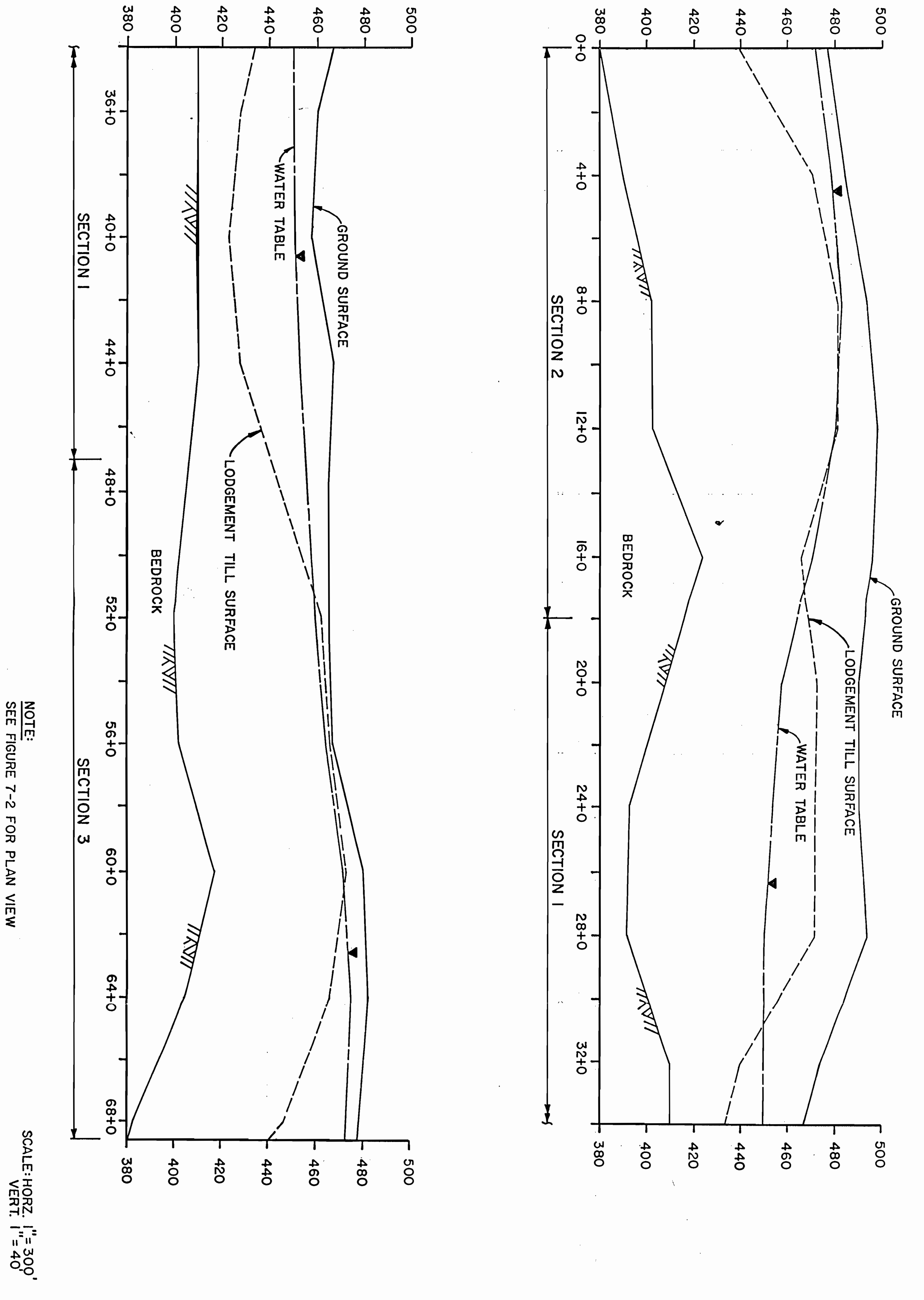

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LANDFILL PERIMETER CROSS-SECTION

FIGURE 7-3

approaches unity) is considerably greater than the vertical gradient used to represent downward flow under saturated conditions. Once downward-flowing leachate does reach the water table, its flow is three-dimensional, as discussed above.

(d) Steady-state - The simplified model in this section assumes steady-state conditions. In reality, hydrogeologic properties -- especially hydraulic gradients -- are expected to vary with time on an event-specific and seasonal basis, and also to undergo long-term variations in response to the recent site capping.

7.3 Objectives of Remedial Action

The overall objective of remedial action(s) at the Volney Landfill is to eliminate or minimize any adverse effects of the site upon public health or the environment. As discussed in Chapter 6, potential public health impacts posed by the landfill are considered to be more significant than environmental impacts. Furthermore, the primary potential public health impact is felt to be localized contamination of groundwater, which is a source of potable water in the area. Therefore, the primary objective of remedial action(s) at Volney Landfill is the mitigation of local groundwater contamination. The various remedial alternatives formulated in the following chapter each address this objective, though in different manners and to different degrees.

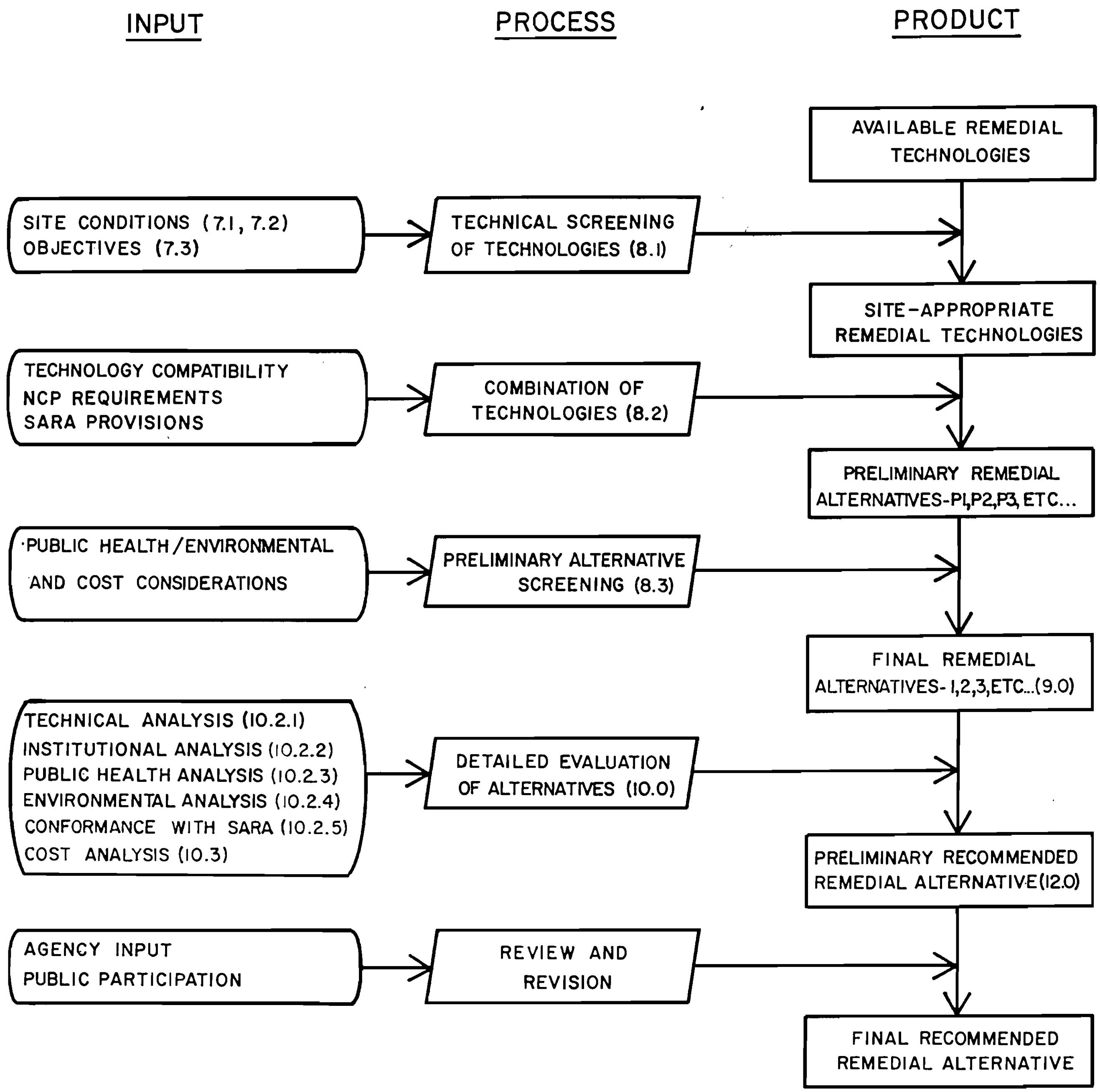
In stating the object of remedial action at the site, it is also important to identify remedial approaches which fall outside of or beyond this objective. First, the remedial actions considered subsequently do not address bedrock contamination. Although groundwater in bedrock underlying the site appears to have been contaminated to some degree, the extent of this contamination cannot be determined from presently available data, nor can restoration concepts (if feasible at all) be evaluated. Although bedrock contamination is not addressed specifically in the following remedial alternatives, further study of its impacts is recommended (Section 12.5). Another remedial concept not addressed in this feasibility study is cleanup of the Bell Creek and/or Black Creek stream system. As discussed in Section 6.4, although surface water contamination appears to be of relatively little significance, a greater risk is posed by contaminated stream sediments. However, without a detailed environmental assessment of the stream system, the degree of this risk, and the correlation between contaminated sediments and the Volney Landfill site, cannot be determined. Even if the risk proved significant, however, and cleanup was warranted, stream remediation would logically be evaluated and performed independently from, and subsequently to, cleanup of the site itself.

7.4 Procedure for Feasibility Study Evaluation

Figure 7-4 indicates the generalized procedure for evaluating remedial alternatives as part of this feasibility study. The procedure is based essentially upon USEPA's Guidance on Feasibility Studies Under CERCLA (USEPA, 1985b), with minor modifications and clarifications as discussed below.

- Technical Screening of Technologies: Available remedial technologies are initially screened on a technical basis. From this screening, a list of individual remedial technologies, appropriate to site conditions and consistent with remedial action objectives, is developed.

- Combination of Technologies: These site-appropriate remedial technologies are next combined into a number of preliminary remedial alternatives. The basis for the various combinations are: (a) the technical and logical interrelationship between separate technologies; (b) Superfund Amendments and Reauthorization Act (SARA) guidelines regarding alternative development, including a preference for remedial actions that utilize permanent solutions and alternative treatment or resource recovery technologies.



NOTE: NUMBERS IN PARENTHESES REFER TO SECTIONS OF THIS REPORT

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A-2211

- Preliminary Alternative Screening: Preliminary remedial alternatives are next screened on the basis of environmental and public health concerns, and cost. This screening is very general, and intended primarily to reduce the number of remedial alternatives which will subsequently be evaluated in detail.

- Detailed Evaluation of Alternatives: Those alternatives passing the preliminary screening are evaluated in detail, using the following criteria: technical merit; institutional aspects; public health impacts; environmental impacts; and cost. These criteria are applied through use of a weighted matrix scoring system, which rates each alternative on a relative, and somewhat judgement-oriented, basis. The end product of this detailed evaluation is an overall benefit "score" for each alternative, along with a comparative cost for its implementation. This "benefit-versus-cost" analysis provides a basis for a preliminary recommendation of a single remedial alternative.

- Review and Revision - It is recognized that agency input and public participation are vital to the decision-making process of a feasibility study. Therefore, utilizing input from these two sources, provision is made for a review and revision process, culminating in a final recommended remedial alternative.

8.0 SCREENING OF REMEDIAL ACTION TECHNOLOGIES

8.1 Technical Screening of Technologies

There is a very wide variety of remedial technologies available for the cleanup of hazardous waste sites. A comprehensive list of these technologies is presented in USEPA's Guidance on Feasibility Studies Under CERCLA (USEPA, 1985b). Not all of these technologies, of course, are applicable to each specific site. At the Volney Landfill, the applicability of remedial technologies is limited, from a technical standpoint, by site conditions and by the site-specific objectives for remedial action which were discussed in the previous chapter. This section provides a technical screening of remedial technologies, culminating in an identification of technologies which are considered appropriate for the Volney Landfill site.

8.1.1 Inappropriate Remedial Technologies - Many of the "universe" of remedial action technologies at hazardous waste sites are inappropriate at the Volney Landfill. Some of the more significant of these are identified below, along with the reason(s) for excluding them.

- In-situ waste treatment: Direct in-situ treatment of wastes at the landfill is impractical because of the relatively small quantity and unknown locations of hazardous wastes within the very large landfill volume. Furthermore, although the nature of these wastes is unknown, the possibility exists that they may be so diverse (see Section 3.0) as to render specific treatment technologies ineffective.

- Encapsulation of wastes: For small waste quantities and/or large sites, a feasible remedial technology is excavation and on-site encapsulation of wastes in a secure landfill cell. However, the Volney Landfill contains a very large quantity of fill materials (estimated 4 million cubic yards). In relation to this in-place volume, the available site area is too small to consider encapsulation, even if other practical shortcomings of this method were overlooked.

- Stormwater diversion: Because of the site location on a topographic high point, stormwater diversion is unnecessary. The minor encroachment of the 100-year flood boundary of Bell Creek in the extreme northeast corner of the site is beyond the limits of landfilling and outside the area of potential remedial measures.

- Supplementary capping--landfill top: The landfill top surface has recently been capped with a membrane liner overlying a 2-foot compacted soil barrier, as shown in Figure 7-1. From the infiltration analysis in Section 7.2.1, average annual infiltration through the top surface is calculated to be 0.62 inches/year, as compared with 5.91 inches/year through the side slope surface. Although the top surface cap is not fully consistent with current USEPA guidelines for remedial action at waste disposal sites (USEPA, 1985d), particularly with regard to depth of cover over the barrier elements, it is considered to be effective enough that supplementary capping, with its corresponding disturbance of the existing gas collection/venting system, is not warranted.

- Recovery of contaminated groundwater plume: Recovery of contaminated groundwater from beyond the site boundaries of the landfill is not evaluated in this report for the following reasons: (a) Although other investigators have described a contaminated plume of groundwater moving toward the southeast, the data from this investigation is insufficient to delineate such a plume, or even to confirm its existence. Rather, the observed pattern of contamination in this study is simply radial in all directions away from the landfill; (b) The abundance of surface water in the area, and the landfill's location in relation to this surface water, suggest a fairly narrow range for plume migration prior to its emergence as surface water; (c) Other remedial technologies considered hereafter serve the same general purpose as plume recovery; and (d) Recovery of contaminated groundwater from the bedrock aquifer, if viewed as a form of plume recovery, is beyond the remedial action objectives at this site.

- Gas migration controls: Control of gas migration from the landfill is assumed to be unnecessary because of the recent design and construction of a gas collection/venting system at the site.

- Recovery of contaminated stream sediments: Recovery of contaminated stream sediments, by mechanical dredging or any other form, is inappropriate in light of the remedial action objectives which were stated in the previous chapter.

- Alternative water supply: Although monitoring well data reveals contamination of groundwater in the landfill vicinity, available analytical data from residential wells does not indicate any present health risk from toxic or carcinogenic chemicals in the groundwater. Further study of residential well water quality is necessary, and is recommended as part of this study (Section 12.5). Until such further study has been completed, however, and in the absence of data from residential wells indicating a health risk associated with groundwater usage, alternative water supply is considered an inappropriate remedial technology.

o Bottom sealing: Bottom sealing of the landfill, by block displacement or other method, is not considered appropriate because of the large size of the site and the lack of geologic data from immediately under the refuse fill.

8.1.2 Site-Appropriate Remedial Technologies - On the basis of specific site conditions and remedial action objectives, the following technologies are considered to be technically appropriate for further evaluation at the Volney Landfill site:

o Excavation and off-site waste disposal: Notwithstanding its practical, environmental and economic shortcomings, the excavation and off-site disposal of hazardous wastes at the Volney Landfill is a technically feasible remedial technology. For the sake of future discussion, and in the absence of information concerning the location of hazardous wastes on site, it has been assumed that application of this technology would require complete excavation of the old (southern) section of the landfill, in which the reported hazardous waste barrels are buried. The total volume of fill material in this section of the landfill has been estimated to be one-half the total site volume, or approximately 2 million cubic yards.

o Supplementary capping--landfill sides: The existing cap on the side slopes of the landfill consists of a 2-foot layer of compacted glacial till, with a design permeability of 1×10^{-5} cm/sec (see Figure 7-1). This cap is insufficient by current USEPA guidelines for remedial action at waste disposal sites (USEPA, 1985d), which call for a combination membrane/soil barrier cap as part of a layered cover system. Regardless of the applicability of these guidelines, and from a purely technical standpoint, the existing side slope cap is deficient in several respects, the most important being that exposure of the soil barrier at the surface of the site (and within the frost zone) will result in its eventual deterioration through the combined processes of root growth, freeze-thaw cracking and dessication cracking. For this reason, supplementary capping of the landfill side slopes has been identified as a technically feasible remedial technology.

o Slurry wall: The primary geologic site feature affecting the feasibility of a slurry wall is the existence of a relatively impermeable geologic unit which can serve as the wall's foundation. At the Volney Landfill, a continuous layer of lodgement till underlies the site. Although the average hydraulic conductivity of this unit (Table 4-8) has been estimated to be a relatively high 0.19 feet/day (6.7 x 10^{-5} cm/sec), it is considerably less permeable than the soil strata overlying it. For this reason, the use of a slurry wall is considered to be technically feasible at the Volney Landfill site. It would be used around portions of the site perimeter, in conjunction with a drain system, to collect leachate migrating outward away from the landfill.

o Leachate collection drain: A leachate collection drain could, from a technical standpoint, be constructed around portions of the landfill perimeter to intercept lateral groundwater flow from the site ("Q" in Section 7.2.3). This drain would rest atop lodgement till and be constructed only along those sections of the landfill perimeter where there exists a saturated thickness of overlying soil. As indicated by Figures 7-2 and 7-3, this technology applies primarily along the southeast boundary of the site (Stations 60+00 to 9+20) and around the north section of the landfill (Station 31+00 to 51+20).

o Off-site leachate disposal: Leachate from the landfill, which is collected by the existing leachate collection system in the newer (northern) section of the site, is presently taken to the City of Fulton municipal wastewater treatment plant. Continued use of this facility, or alternate municipal/private treatment facilities, is a feasible technology for disposal of leachate.

o On-site leachate treatment: A variety of treatment technologies are available for on-site treatment of leachate at the Volney Landfill. Among these, the process train considered to be most feasible includes: flow equalization, batch biological treatment and carbon adsorption. The reasons for this process selection, along with a full discussion of on-site treatment considerations, is presented in the following section of this report.

o <u>Incineration</u>: Although potential logistical problems with on-site incineration are staggering, the technology is technically feasible. In evaluating incineration, it has been assumed, as in the case of excavation and off-site waste disposal, that one-half the total site volume, or approximately 2 million cubic yards, would be incinerated.

8.2 Development of Preliminary Remedial Alternatives

In the previous section, remedial technologies considered appropriate for the Volney Landfill site were identified. If "no action" is added to this list, site-appropriate remedial technologies are as follows:

- No Action
- Excavation and Off-Site Waste Disposal
- Supplementary Capping--Landfill Sides
- Slurry Wall
- Leachate Collection Drain
- Off-Site Leachate Disposal
- On-Site Leachate Treatment
- Incineration

Remedial alternatives consist of one or more individual remedial technologies, grouped so as to provide a unified and coherent response to site problems. From a purely mathematical standpoint, the above eight (8) technologies could be arranged, singly or in various size groups, to form a total of 255 remedial alternatives. Obviously, this number is much too large to work with. It is fortunate, therefore, that logical relationships between these technologies limit the ways in which they can be combined. For example, some technologies are independent of one another, others are dependent, and some are mutually exclusive. The following relationships are used to limit the development of preliminary remedial alternatives:

(a) "No Action" is mutually exclusive of all other technologies.

(b) "Excavation and Off-Site Waste Disposal" will also be treated as mutually exclusive, since this technology would totally remove the targeted source of on-site contamination.

(c) A "Slurry Wall" will only be used in conjunction with a "Leachate Collection Drain," since an impermeable barrier could otherwise create a "bathtub effect" within the site.

(d) A "Leachate Collection Drain" requires the accompanying use of either "Off-Site Leachate Disposal" or "On-Site Leachate Treatment."

(e) "Off-Site Leachate Disposal" and "On-Site Leachate Treatment" are mutually exclusive technologies.

(f) "Incineration" is mutually exclusive of all other technologies.

Using the above "rules" for combining remedial technologies, the total number of possible remedial alternatives is reduced from 255 to 12. These alternatives are identified in Table 8-1. The letter "P" prefacing each of them indicates that the alternatives are preliminary, to be subsequently reduced by the screening techniques discussed below.

The 12 remedial alternatives identified above may be categorized using two criteria. One is the Superfund Amendments and Reauthorization Act of 1986 (SARA) requirement that, as a minimum, the following categories of alternatives be evaluated in detail: no-action, containment and on-site treatment. Another basis for categorizing

TABLE 8-1

PRELIMINARY REMEDIAL ALTERNATIVES

Remedial Technology	Preliminary Remedial Alternatives											
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
No Action	✓											
Excavation and Off-Site Waste Disposal		✓										
Supplementary Capping - Landfill Sides			✓	✓	✓	✓	✓					
Slurry Wall				✓	✓			✓	✓			
Leachate Collection Drain				✓	✓	✓	✓	✓	✓	✓	✓	
Off-Site Leachate Disposal				✓		✓		✓		✓		
On-Site Leachate Treatment					✓		✓		✓		✓	
Incineration												✓

alternatives is the relative level of risk reduction which they provide. Although the alternatives evaluated hereafter actually represent a continuim ranging from lower to higher degrees of risk reduction, they will be simulated by three categories corresponding to lower, intermediate and higher levels of reduction. Based upon this rationale, the preliminary alternatives shown in Table 8-1 may be grouped into the following six (6) categories. Following each category designation and description, in parentheses, are the preliminary remedial alternative numbers from Table 8-1 which fall into that category.

o <u>Category I - No Action</u>: This self-explanatory category consists of a single alternative, which serves as a baseline for comparison with other alternatives. (P1)

o <u>Category II - Excavation and Off-Site Waste Disposal</u>: This category also includes but a single alternative. (P2)

o <u>Category III - Reduction of Leachate Generation</u>: This category includes a single alternative providing reduced leachate generation through supplementary capping of the landfill side slopes. Since no cap can ever be regarded as 100 percent effective, some small volume of leachate will continue to be generated at the site. This leachate, plus that contained within and draining from the existing refuse fill, will continue to discharge from the site. For this reason, plus the ongoing potential for future contamination of individual wells in the site vicinity, Category III is considered to correspond with a relatively low overall degree of risk reduction. (P3)

o <u>Category IV - Leachate Collection</u>: This category includes alternatives which provide for collection of leachate emanating outward from the landfill by a drain installed around portions of the site perimeter. This drain may be installed with or without an accompanying slurry wall, and utilizing off-site leachate disposal or on-site treatment. Because these variations are not intrinsic to the concept of leachate collection, they can be evaluated independently (see following section). Since leachate collection, like supplementary capping, cannot realistically be regarded as 100 percent effective in reducing leachate migration from the site, it too, by itself, is considered to represent a relatively low overall degree of risk reduction. (P8-P11)

- Category V - Reduction of Leachate Generation plus Leachate Collection: This category includes alternatives which provide supplementary capping of the landfill sides in addition to leachate collection along portions of the site perimeter. Although these measures cannot guarantee a zero level of leachate migration from the site, especially in the vertical direction as seepage through lodgement till, they are collectively considered to be very effective at reducing to a minimal amount the lateral flow of leachate away from the site. Therefore, this category is designated as providing an intermediate degree of risk reduction. (P4-P7)

- Category VI - Incineration: This single-alternative category provides destruction of on-site waste materials by incineration of the old (southern) portion of the landfill. Because it would permanently destroy the only discrete hazardous waste specifically reported to have been deposited at the site, but would not affect the generation or migration of leachate from the new (northern) section of the landfill, this category is considered to represent an intermediate level of risk reduction. (P12)

8.3 Preliminary Alternative Screening

The purpose of this section is to screen preliminary remedial alternatives on the basis of public health/environmental and cost considerations, thereby producing a set of final remedial alternatives for detailed evaluation. The six (6) remedial action categories presented in the previous section include all of the 12 preliminary alternatives from Table 8-1. The additional screening process in this section is directed toward the resolution of two (2) specific questions:

(a) What is the optimum method for handling leachate collected at the site, off-site disposal or on-site treatment?

(b) Is the construction of a slurry wall to accompany a perimeter leachate collection drain justified under the site conditions?

The remainder of this section addresses each of these questions in turn, with the results used in the following Chapter to formulate final remedial alternatives for each of the six (6) general alternative categories.

8.3.1 Evaluation of Alternative Technologies for Leachate Disposal - The two alternative technologies for leachate disposal are off-site disposal and on-site treatment. These are evaluated comparatively in the following sections. Regardless of the outcome of this comparative evaluation, both technologies will be carried forward through the evaluation process because, without treatability studies (which have not been performed to date), it is impossible to conclusively establish the feasibility of any on-site treatment process(es), or, alternately, to rule out the need for off-site disposal of leachate.

8.3.1.1 Off-Site Leachate Disposal - The cost for disposing of leachate at a publicly owned or private wastewater treatment facility is highly variable. It depends not only upon the chemical nature of the leachate, but also: the size, design and operating condition of the plant; the regulatory status of the plant regarding acceptance of extraneous waste streams; the owner of the facility generating leachate (e.g., public or private); and, to some extent, the overall political and economic climate at the time of disposal. The degree of this variability may be demonstrated by the following examples:

- Disposal of hazardous leachate is generally feasible only at commercial waste management facilities, and then typically at a premium price. At the PAS Superfund site in the City of Oswego, off-site leachate treatment/disposal cost quotes ranged from $0.15 to $0.75 per gallon, exclusive of transportation (URS Company, 1985c).

- Many publicly owned wastewater treatment works (POTW's) are capable of handling non-hazardous sanitary landfill leachate. Based upon our recent experience, typical leachate treatment/disposal costs charged by POTW's to commercial landfill operators range from approximately $0.01 to $0.05 per gallon, exclusive of transportation.

- Municipal landfill owners are sometimes able to dispose of non-hazardous leachate at local POTW's free of charge. For example, leachate from the Volney Landfill was treated at the City of Oswego's Westside Sewage Treatment Plant during 1984 and 1985 for no charge.

As a basis for comparison with on-site treatment, the following assumptions have been made regarding the cost of off-site leachate disposal:

- A one million gallon (1,000,000) storage facility, will be constructed for temporary leachate holding prior to off-site disposal.

- Leachate transportation cost is $0.01 per gallon.

- Leachate will be disposed of off-site, under a non-gratis arrangement with a local POTW, for $0.05 per gallon.

Under these assumptions, and using a 10 percent discount rate and 30-year operating life, the total estimated present worth of off-site leachate disposal is approximately $3,529,000. Based upon a leachate production rate of 13,000 gallons per day, this equates to approximately $0.079 per gallon. Additional details are presented in Tables 8-5 and 10-6.

8.3.1.2 On-Site Leachate Treatment - This section contains a preliminary assessment of treatment alternatives for leachate and groundwater from the Volney Landfill based upon operating characteristics, demonstrated capabilities and costs. The specific objectives of the preliminary assessment include the following:

- o Selection of best available treatment unit operations based on waste characteristics and selection of treatment process train.
- o Identification of treatment capital costs.
- o Identification of annual operation and maintenance costs.

8.3.1.2.1 Waste Characterization - A detailed summary of groundwater and leachate characteristics is presented in Sections 4.4.2 and 5.3. Analytical data collected for the RI/FS indicates that metals were detected at relatively low levels. The highest levels found in groundwater were arsenic at 85 ug/l, nickel at 75 ug/l and zinc at 94 ug/l. Significantly lower metals concentrations were detected in leachate.

The highest total concentration of volatile compounds (Hazardous Substance List (HSL) and additional mass spectrometer (MS) peaks) found in the on-site groundwater samples was 2,980 ug/l in VBW-10BR; this compares to 81 ug/l found in the on-site leachate sample. The highest total concentration of semi-volatile compounds (HSL and additional MS peaks) in the on-site groundwater samples was 1,074 ug/l in VBW-3D, this compares to 390 ug/l for leachate.

8.3.1.2.2 Treatment Objectives - As currently envisioned, the on-site treatment system will discharge directly to Bell Creek.

Discharge limitations would probably be based on either USEPA Best Attainable Treatment (BAT) standards or New York State Water Quality Standards, whichever is stricter. Final discharge requirements would be based on State review of a State Pollution Discharge Elimination System (SPDES) permit application for the facility; therefore, exact discharge requirements are unknown at this time. For the purpose of this report, selection of a preliminary treatment system was based on optimum organic removal since organics are the major contaminants detected on site. The selection of the preliminary system did not consider metals removal from leachate prior to discharge to surface water since maximum concentrations detected in groundwater would not exceed limits specified by New York State Water Quality Standards for surface water; however, metals removal may be required pending State review of data.

8.3.1.2.3 Assessment of Alternatives Processes - Previous studies have identified unit processes for hazardous waste leachate treatment (Shuckrow et al., 1982 and McArdle et al., 1986). These unit processes are listed in Table 8-2. Only 13 of the 21 processes are considered to be generally applicable technologies for hazardous waste treatment (Shuckrow et al., 1982). The other processes, along with the reasons for considering them non-applicable, are listed below.

Catalysis - commercial practicality has not been demonstrated.

Crystallization - does not respond to changing wastewater characteristics and is a complex operation.

Dialysis/Electrodialysis - not well-suited to mixed constituent wastestream.

Distillation - high capital cost and high energy requirements.

Evaporation - high capital and operating costs.

TABLE 8-2

UNIT PROCESSES FOR HAZARDOUS WASTE LEACHATE TREATMENT

Biological Treatment	Equalization
Carbon Adsorption	Evaporization
Catalysis	Filtration
Chemical Oxidation	Flocculation
Chemical Reduction	Ion Exchange
Chemical Precipitation	Resin Adsorption
Crystallization	Reverse Osmosis
Density Separation	Solvent Extraction
Dialysis/Electrodialysis	Stripping
Distillation	Ultrafiltration
Wet Oxidation	

Resin Adsorption - technology is not as well defined as carbon adsorption.

Solvent Extraction - carbon adsorption is a more effective and economical method of organic removal.

Ultrafiltration - limited to low volume leachate streams with substantial quantities of high molecular weight (7,500-500,000) solutes such as oils.

The remaining processes may be classified into two categories. Category 1 includes processes with the broadest range of applications and most extensive full-scale operating experience. Category 2 includes processes with limited application and less full-scale operating experience. Category 1 and 2 processes are listed below, with the major application for each process.

Category 1. More experience, broad application range

Biological treatment - soluble biodegradable organics and nutrients.

Chemical Precipitation - soluble metals.

Carbon Adsorption - soluble organics, especially toxics and refractories.

Density Separation - wastewater suspended solids, chemical precipitates, oily materials.

Equalization - all organics and inorganics.

Filtration - suspended solids and precipitates.

Flocculation - used in conjunction with solid/liquid separation. Often preceded by precipitation.

Category 2. Less full-scale experience, limited application

Chemical Oxidation - cyanide and organics.

Chemical Reduction - hexavalent chromium.

Ion Exchange - inorganics, especially fluoride and total dissolved solids.

Membranes (RO) - total dissolved solids.

Stripping (air) - ammonia nitrogen, volatile organics.

Wet Oxidation - high strength or toxic organic aqueous streams.

The ability of most of the processes listed above to treat compounds in chemical classifications most often constituting hazardous waste leachate is summarized in Table 8-3 (Shuckrow et al., 1981).

8.3.1.2.4 Selection of Process Train - In most cases, an effective overall treatment plan includes two or more of the process modules listed in Categories 1 and 2.

As indicated on Table 8-3 (Shuckrow et. al., 1981), biological treatment and carbon adsorption are the unit processes best able to handle the wide variety of organic compounds detected in groundwater and leachate at the Volney Landfill.

TABLE 8-3 — TREATMENT PROCESS APPLICABILITY MATRIX

Chemical Classification	Biological Treatment	Carbon Adsorption	Precipitation	Chemical Oxidation		Chemical Reduction	Ion Exchange	Reverse Osmosis	Stripping	Wet Oxidation
				Alkaline Chlorina-tion	Ozonation					
1. Alcohols	E	V		N	G,E	N		V		
2. Aliphatics	V	V		N	P	N		V		
3. Amines	V	V		N	N	N				
4. Aromatics	V	G,E	F	N	F,G	N		V		
5. Ethers	G	V		N		N				
6. Halocarbons	P	G,E		N	F,G	N				
7. Metals	P,F	N,P	E	N		G	E	E	N	
8. Miscellaneous:										
Ammonia	G,E	N	N	N		N	G		G	
Cyanide	F,G	N	N	E	E	N			N	
TDS	N	N	N	N	N	N	E	E	N	N
9. PCB	N	E		N		N				
10. Pesticides	N,P	E		N	E	N		E		
11. Phenols	G	E		N	E	N		V		
12. Phthalates	G	E	G	N		N				
13. Polynucelar Aromatics	N,P	G,E	R	N	G	N				

Key for Symbols:

E - Excellent performance likely
F - Fair performance likely
R - Reported to be removed
V - Variable performance reported for different compounds in the class

G - Good performance likely
P - Poor performance likely
N - Not applicable

A blank indicates that no data are available to judge performance; it does not necessarily indica*e that the process is not applicable.

Note: Use of two symbols indicates differing reports of performance for different compounds in the class.

Other applicable unit processes for organic treatment include stripping and wet oxidation. Wet oxidation is a complex process requiring sophisticated controls, and in addition, process reliability has not been established. Stripping of organics can be accomplished by steam or air. Steam stripping has the disadvantage of high energy requirements, and furthermore, the process produces a contaminated condensate that requires further treatment or disposal. Air stripping is capable of removing low boiling point organics (VOC's); however, air emissions have the potential to adversely affect air quality and human health. Organics released in the gas-phase by either stripping method may be adsorped on carbon, but the addition of carbon adsorption to air stripping generally makes this alternative economically unattractive. For the above reasons, wet oxidation and stripping were not considered as feasible alternatives for leachate treatment at the Volney Landfill.

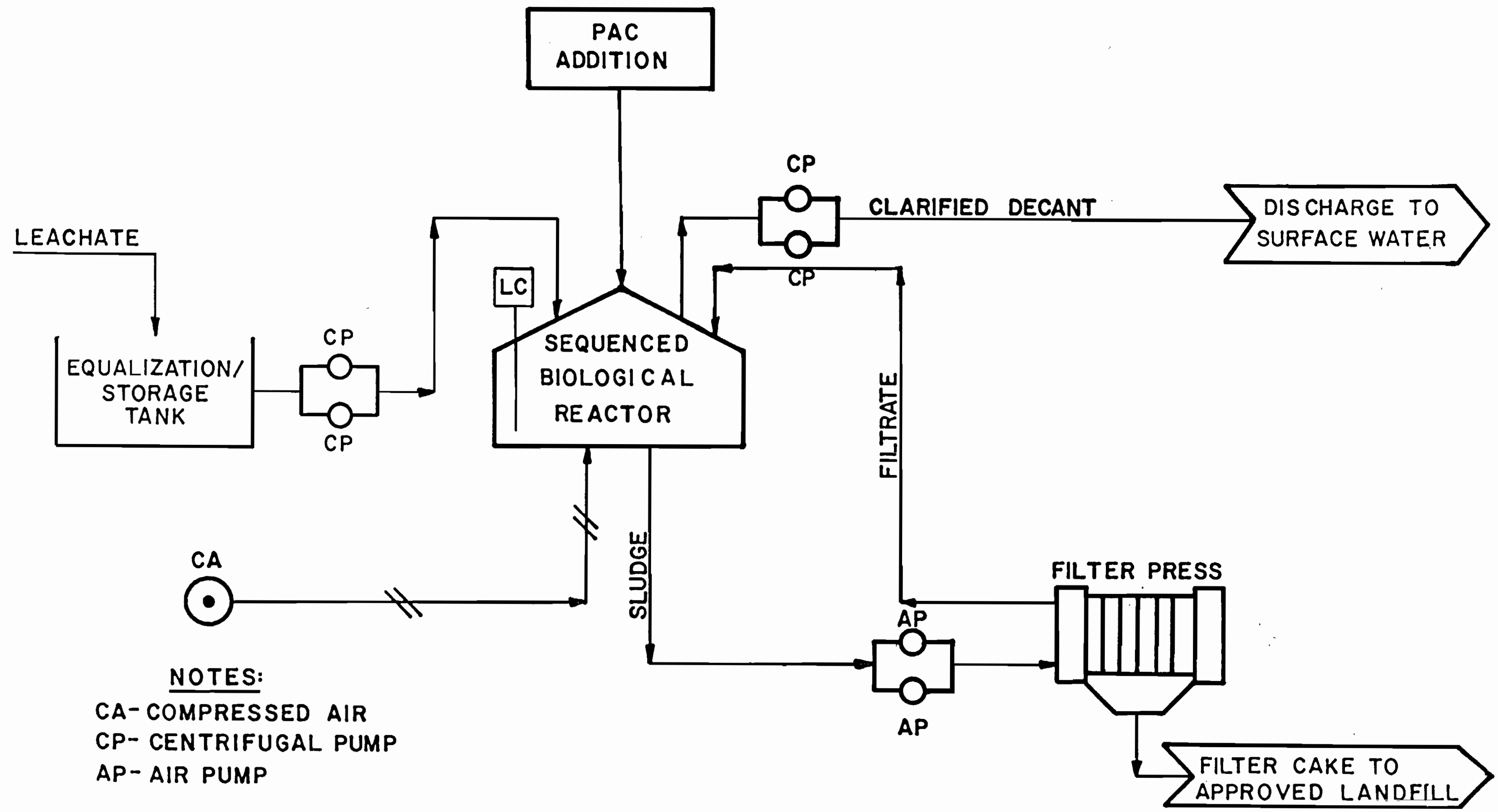
The process train considered to be the most feasible for use at this site includes: flow equalization, biological treatment and carbon adsorption. The objective of flow equalization is to dampen influent flow concentration fluctuations, and thereby improve downstream process performance. Equalization should be considered in planning and design of all leachate treatment facilities since the composition and volume of leachate fluctuate with time. Neutralization could possibly be required to adjust the pH after equalization and prior to biological treatment. Based on available data, equalized leachate would most likely fall within the pH range of 7-8, which is acceptable for biological systems. Therefore, neutralization was not considered for the preliminary system. Since the maximum total organic carbon (TOC) concentration (240 mg/l) detected in groundwater is significantly larger than the total concentrations of VOC's and extractables detected in the groundwater, it is likely that a large fraction of organics may be biodegradable, and therefore amenable to biological treatment. Since leachate flow is expected to be intermittent and the average flow rate is expected to be relatively low, a batch biological reactor is recommended. Carbon adsorption is recommended for remaining refractory organics that are not readily biodegradable. Based on a previous leachate treatability study performed by URS Company for the Pollution Abatement Services (PAS) site in Oswego, New York (URS Company, 1985c), powdered activated carbon (PAC) addition to the biological reactor is recommended as a more cost-effective method than granulated activated carbon (GAC) for adsorping refractory organics. The preliminary leachate treatment system is shown in Figure 8-1.

As part of the design phase for on-site leachate treatment, bench-scale or pilot-scale testing would be required for the following reasons: (1) to determine the effectiveness of selected unit processes, individually and collectively, with actual leachate from the Volney Landfill site; and (2) to establish final design parameters for these processes. Based upon this testing program, certain processes might have to be added, deleted or modified.

8.3.1.2.5 Process Design Criteria - The criteria specified below were used for determining plant operation and maintenance costs.

General Considerations

- o Plant will be operated five (5) days per week, 8-hours per day.
- o Process will operate in batch mode.
- o Process vessels will be located out-of-doors.
- o Reactor influent will be heated by steam supplied by an on-site generator, since biological reaction rates drop off sharply in cold temperatures.



URS URS Company, Inc. CONSULTING ENGINEERS NEW YORK NEW JERSEY

PRELIMINARY LEACHATE TREATMENT SYSTEM

FIGURE 8-1

Operations and Maintenance Considerations

(a) Personnel Requirements - A preliminary estimate of plant operation and maintenance labor requirements is provided below:

Job Function	Average Time Required Per Day (Hr.)
Filter Press Operation	1.0
Powdered Activated Carbon Addition	0.5
Sampling and Jar Tests	1.0
Equipment Checks	1.0
Manifesting and Bookkeeping	0.5
Minor Maintenance	1.0
Cycle Start-up and Shut-down	1.0
TOTAL	6.0

Based on the above estimates, it is anticipated that plant operations will require one person per 8 hour shift.

(b) Operating Sequence

The proposed daily operating procedure would include the following chronological steps:

- Discharge sludge to filter press
- Discharge reactor
- Charge reactor

- o Heat influent if required

- o Add PAC

- o Allow reaction to take place overnight - timer to stop air and agitation after approximately 8 hours of reaction time.

(c) Utilities

The following utilities would be supplied by regional utility companies:

- Potable water
- Electric
- Gas
- Telephone

The following utilities would be supplied by the plant operator:

- Steam generator
- Compressed air

For purposes of estimating capital costs, it has been assumed that service facilities supplied by regional utility companies would be installed prior to treatment plant construction.

Auxiliary Materials

- o Powdered activated carbon manually added to bioreactor.

8.3.1.2.6 Equipment Design Criteria - The design of process equipment is based upon the expected rate of leachate generation and delivery to the system under existing conditions (i.e., without supplementary capping of landfill side slopes). As indicated in Table 7-1, the total average lateral flow of leachate away from the landfill, which represents the maximum amount which could be collected by a perimeter leachate drain, is 12,880 gallons/day (gpd). The ratio of peak daily to average annual percolation from the landfill base is approximately 11 (0.182 inches/day divided by 5.91 inches/year, as determined by computer output in Appendix L). Applying this ratio to the average lateral flow yields a maximum daily flow of approximately 145,000 gallons/day. This very conservative number will be used only for the sizing of equalization/storage facilities, with all other process rates calculated on the basis of average daily flow (approximately 13,000 gallons/day, or 91,000 gallons/7-day week or 18,000 gallons/operating day). The design criteria utilized for process equipment sizing and developing treatment plant capital costs are listed below:

Equalization/Storage

- Initial influent flow rate - 145,000 gallons/day.
- Total capacity of 150,000 gallons, which is sufficient for peak daily flow or 11 days of average daily flow.
- Above-ground vessel constructed of carbon steel.
- Mixer required for mild agitation.
- Mixer horsepower - 0.15 horsepower/1,000 gallons (Ulrich, 1984).

Biological

- o Influent flow to reactor - 125 gpm for 3 hours (125% of average flow per operating day, based on 5-day operating week).

- o Reactor sized at 50,000 gallons, or twice the daily influent flow (URS Company, 1985c).

- o Aerated reactor.

- o Installed spares for charge and discharge pumps and aeration.

- o One batch processed per operating day.

- o Solids pumped from reactor into filter press - filter cake disposed of off site.

- o Discharge flow rate - 125 gpm for 3 hours.

Carbon

- o Manual charge of powdered activated carbon to reactor.

- o PAC added at 3,300 milligrams per liter (mg/l), based on chemical oxygen demand (COD) of 1,550 mg/l.

- o 25 percent of PAC wasted per batch.

8.3.1.2.7 Basis for Cost Estimate - Equipment was sized based on information provided in the previous section, and equipment costs were obtained from Process Plant Construction Estimating Standards (Richardson Engineering Services, 1986), A Guide to Chemical Process

Design and Economics (Ulrich, 1984), current Means' price information (R.S. Means Company, Inc., 1986) and vendor quotations. Data used for sizing equipment is preliminary because a treatability study has not been performed. Consequently, a study estimate of capital costs has been prepared based on knowledge of major equipment and published factors for equipment installation (Peters et al., 1980). The probable accuracy of such an estimate is ±30 percent. The basis for the operation and maintenance cost estimate is summarized in Table 8-4.

8.3.1.2.8 Cost Estimate for On-Site Leachate Treatment - Table 8-5 summarizes the estimated costs for on-site leachate treatment. Additional details concerning this estimate are presented on Table 10-7 and in Appendix L. (Table 8-5 also summarizes the estimated costs for off-site leachate disposal, as discussed in the previous section.) As indicated by this table, the total estimated present worth of on-site leachate treatment is approximately $2,908,000. For a leachate production rate of 13,000 gallons per day, this translates to approximately $0.065 per gallon.

8.3.2 Evaluation of Slurry Wall - As previously discussed, a leachate collection drain could be installed around portions of the landfill perimeter to collect the lateral flow of leachate outward, away from the site. This drain would penetrate overburden soils down to the depth of lodgement till, and would be located only along those portions of the landfill perimeter where there exists a significant depth of saturated soil overlying till. Figures 7-2 and 7-3 indicate that these conditions occur around the north side of the landfill (approximate stations 31+00 to 51+20) and around the southwest corner (approximate stations 60+00 to 9+20). The placement of a collection drain would, unless other measures were implemented, induce a significant amount of backflow from the area outside of the drain. Since this flow would have to be treated, its occurrence would have an economic bearing on total project costs.

TABLE 8-4

OPERATION AND MAINTENANCE FACTORS

Items	Basis
Operating and Maintenance Labor	$20.00/Hour
Maintenance	3% of Capital Costs
Auxiliary Materials and Energy	
- Electric	$0.06/kw-hr
- Steam	$12.00/1,000 lb
- Gas	$5.50/1,000 ft^3
- PAC	$0.70/pound
Purchased Services	
- Water Quality Analysis	Conventional parameters once per week. Hazardous Substance List compounds once per month
Insurance and Taxes	1% of Capital Costs
Maintenance Reserve and Contingency Costs	1% of Capital Costs
Filter Cake Disposal	$4.60/CF

TABLE 8-5

COMPARATIVE COST ESTIMATE

ON-SITE LEACHATE TREATMENT VERSUS OFF-SITE DISPOSAL

ON-SITE LEACHATE TREATMENT

Total Capital Costs ($1,175,000)

Annual Operation/Maintenance Costs ($183,800/yr)

TOTAL PRESENT WORTH $2,908,000

OFF-SITE LEACHATE DISPOSAL

Total Capital Costs ($840,000)

Annual Operation/Maintenance Costs ($285,200/yr)

TOTAL PRESENT WORTH $3,529,000

Note: The above costs are based upon a leachate production rate of approximately 13,000 gallons per day, which assumes existing conditions without supplementary capping of the landfill side slopes. With supplementary capping, it is estimated that the leachate production rate, and all of the above costs, with the exception of the treatability study for on-site leachate treatment, would be reduced by a factor of approximately 80 percent.

One method for preventing, or at least minimizing, this entry of "clean" water into the leachate collection system would be to construct a slurry wall along the outside of the drain. The effect of such a wall in graphically depicted in Figure 8-2. In this figure, the term "Q_{LF}" represents lateral flow of leachate from the landfill. This leachate flow is controlled by the water balance within the landfill, as previously discussed in Section 7.2.3. The term "Q_0" represents flow to the drain which, in the absence of a slurry wall or other preventative measure, would occur from outside the limits of the landfill. Since this outlying area is continuously replenished by precipitation and infiltration, Q_0 represents a flow of essentially clean water to the leachate collection system.

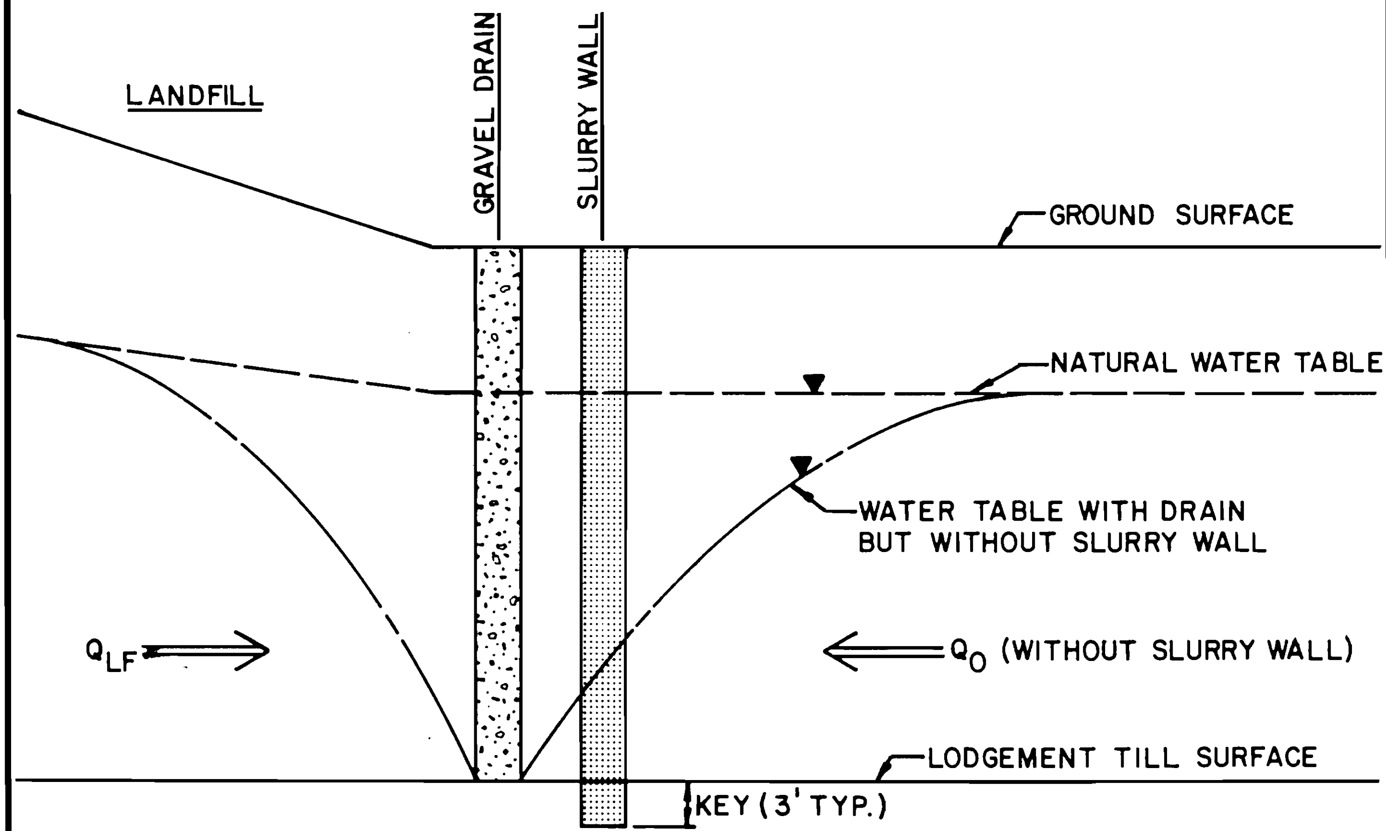
The cost-effectiveness of a slurry wall may be evaluated by: (a) calculating the value of Q_0 which would occur without a wall; (b) determining the cost for treatment of this Q_0 (which represents the "benefit" of the slurry wall); and (c) comparing this benefit with the cost of the wall. For each of the two possible leachate collection drain segments, this cost-effective evaluation of a slurry wall has been performed (Appendix L). Some of the key assumptions in the analysis are:

- o The slurry wall will be capable of preventing 90 percent of Q_0 from reaching the drain, with the remainder attributable to slow seepage through and/or under the wall.

- o The cost of treating Q_0 equals $0.065 per gallon, the unit rate for on-site leachate treatment calculated in the previous section.

- o The present worth of treating Q_0 is calculated using a discount rate of 10 percent and a 30-year operating period.

- o The unit cost for constructing the soil bentonite (SB) slurry wall is $7.00 per square foot.



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SLURRY WALL EFFECT ON LEACHATE COLLECTION

FIGURE 8-2

Table 8-6 summarizes the slurry wall evaluation. As indicated by this table, a slurry wall is justified along both reaches of the leachate collection drain. Along Reach 1, in the northern section of the landfill, the benefit of a wall ($1,886,000 = present worth of leachate treatment) is approximately 3.6 times its cost ($529,000). Along Reach 2, on the southwest side of the site, the wall's benefit ($1,075,000 present worth of leachate treatment) is also equal to approximately 3.6 times its cost ($302,000). Therefore, through the remainder of this report, all alternatives which involve leachate collection will include a slurry wall to accompany the collection drain itself.

TABLE 8-6

SLURRY WALL EVALUATION SUMMARY

	Reach 1 North Side	Reach 2 Southwest Side
Begin Station (±)	31+00	60+00
End Station (±)	51+20	9+20
Length	2,020 ft.	1,780 ft.
Avg. Depth (1)	31 ft.	19 ft.
Avg. Saturated Depth (2)	19 ft.	12 ft.
Avg. Wall Depth (3)	34 ft.	22 ft.
Q_{LF}	5,400 gpd	4,900 gpd
Q_o	9,400 gpd	5,300 gpd
90% x Q_o	8,400 gpd	4,800 gpd
Annual Treatment Cost	$200,000/yr	$114,000/yr
Present Worth of Treatment	$1,886,000	$1,075,000
Slurry Wall Cost	$529,000	$302,000

Notes: (1) From ground surface to lodgement till

(2) From water table to lodgement till

(3) Avg. depth plus 3 feet (key)

9.0 FINAL REMEDIAL ALTERNATIVES

9.1 Summary of Screening Process

In Section 8.1, a list of eight (8) possible site-appropriate remedial technologies for the Volney Landfill was developed through a technical screening process which accounted for site conditions and remedial action objectives. Based upon logical relationships between these technologies, they were combined in Section 8.2 into 12 preliminary remedial action alternatives. These 12 preliminary alternatives were subsequently broken down into six (6) categories, reflecting Superfund Amendments and Reauthorization Act (SARA) guidelines and relative levels of risk reduction. To further reduce the field, a preliminary alternative screening was performed in Section 8.3, with the following results:

- o On-site leachate treatment was estimated to cost approximately $0.065 per gallon, versus off-site disposal, whose cost is highly variable but which was estimated at approximately $0.079 per gallon. Both technologies will be carried forward as alternative leachate disposal methods.

- o A slurry wall was determined to be a cost-effective measure for preventing entry of clean water into a perimeter leachate collection drain, and will be incorporated as part of all alternatives which include leachate collection.

9.2 Final Remedial Alternatives

As a result of the above screening process, a total of eight (8) remedial action alternatives have been developed for detailed comparative evaluation at the Volney Landfill site. These final alternatives are summarized in Table 9-1. They represent a range of conceptual approaches and risk reduction levels. Two (2) of these final alternatives (4b, 5b) include the same technologies as their pair partners

TABLE 9-1

FINAL REMEDIAL ALTERNATIVES

Final Alternative No.	Components	Category - Level of Risk Reduction	Preliminary Alternative No.
1	No Action	I	P1
2	Excavation and Off-Site Waste Disposal	II	P2
3	Supplementary Capping	III - Low	P3
4a	Leachate Collection (Off-Site Disposal)	IV - Low	P8
4b	Leachate Collection (On-Site Treatment)	IV - Low	P9
5a	Supplementary Capping + Leachate Collection (Off-Site Disposal)	V - Intermediate	P4
5b	Supplementary Capping + Leachate Collection (On-Site Treatment)	V - Intermediate	P5
6	Incineration	VI - Intermediate	P12

Notes: 1) Leachate collection includes a partial perimeter drain and slurry wall.
2) Categories and preliminary alternative nos. are as designated in Section 8.2.

(4a,5a), except that on-site leachate treatment is substituted for off-site disposal. Apart from these variations, there are six (6) basic remedial alternatives, corresponding to the six (6) alternative categories introduced in Section 8.3.

9.3 Component Technologies

Before proceeding with an evaluation of final remedial alternatives, the components comprising them are discussed and summarized.

9.3.1 No Action - This alternative is self-explanatory and serves as a basis for comparison with other, action alternatives.

9.3.2 Excavation and Off-Site Waste Disposal - This alternative involves excavation of the old (southern) section of the landfill, with subsequent transportation to and disposal at a secure landfill off-site. Since the location of hazardous wastes on-site is unknown, other than in the old section of the site, it has been assumed that the entire southern section of the landfill (estimated 2 million cubic yards) would have to be excavated. The likelihood of any single commercial landfill having the capacity to accept these wastes is very small. Therefore, the off-site disposal aspect of this alternative is treated generically, with an average transportation distance assumed to be 400 miles. (Note that there are several secure landfill sites in Western New York, approximately 200 miles from the Volney Landfill.)

9.3.3 Supplementary Capping - Supplementary capping of the landfill side slopes involves the approximately 35 acres lying between the limits of the existing PVC membrane liner and a line lying parallel to and approximately 45 feet beyond the existing limits of refuse (Area "A_s" in Figure 7-2). This offset allows the cap to be extended over a perimeter leachate collection drain and/or slurry wall. The supplementary cap will be placed over the existing 2-foot layer of compacted, seeded lodgement till as follows. Existing vegetation will be removed from the surface by scraping, and the resulting loosened surface will be recompacted by rolling. A 6-inch layer of sand will be added to provide support for a 60-mil high density polyethylene (HDPE) liner, textured to reduce the possibility of slippage by the overlying drainage layer. Above the HDPE membrane, a 24-inch layer of sand will be placed, followed by a 12-inch layer of topsoil or suitably amended native soil. The surface will be fine-graded, seeded and mulched using jute net. Figures 9-1 and 9-2 show the relationship between this supplementary cap and other potential on-site remedial measures.

9.3.4 Leachate Collection - Leachate collection involves the installation of a gravel trench drain and accompanying slurry wall around portions of the landfill perimeter where there exists a significant depth of saturated sediments overlying lodgement till. Based upon current estimates, these conditions occur along two sections of the perimeter: (a) around the north side of the site (approximately stations 31+00 to 51+20); and (b) around the southwest corner of the site (approximately stations 60+00 to 9+20). For a plan view identifying these stations, refer to Figure 7-2; for a profile view, refer to Figure 7-3. The gravel drain will consist of a stone-filled trench, four feet wide, lined with filter fabric, and installed by excavation with temporary sheet piling. The drain will be excavated to the top of the lodgement till surface. At its low points (two (2) in the north drain segment and one (1) in the southwest segment), collection wells will be installed, consisting of 14-inch diameter stainless steel wells with stainless steel pumps and controls. These pumps will discharge leachate, via an underground force main, from the collection system to an equalization/storage facility, either for off-site disposal or on-site treatment. The slurry wall accompanying this drain is shown schematically in Figure 8-2. It will be located on the outside of the drain, to minimize the entry of clean water into the collection system from beyond the landfill limits. The slurry wall will be backfilled with soil-bentonite (SB), using soil excavated from the trench. It will be keyed approximately 3 feet into lodgement till. An overview of the leachate collection system, in relation to other potential on-site remedial measures, is shown in Figures 9-1 and 9-2.

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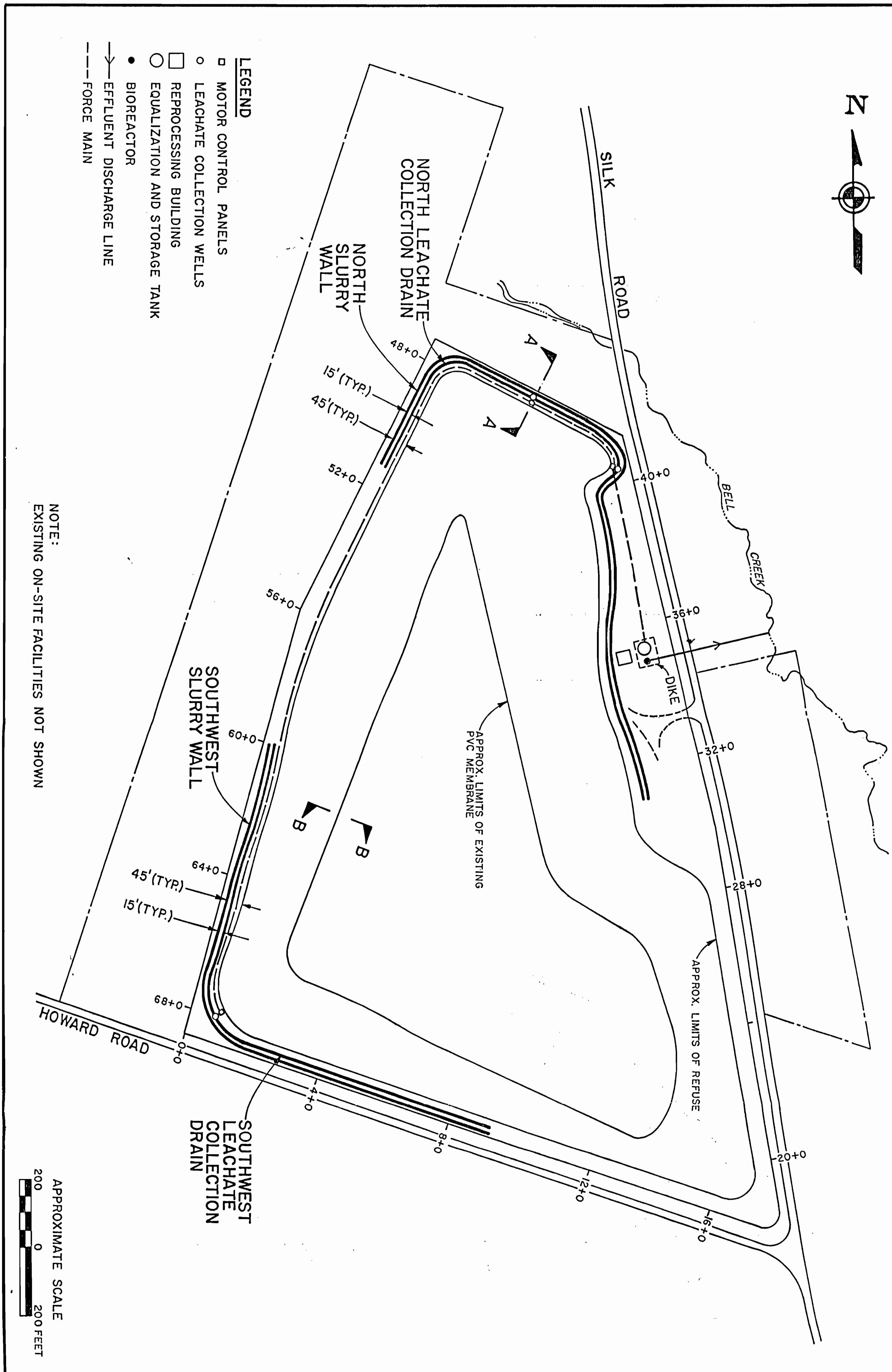
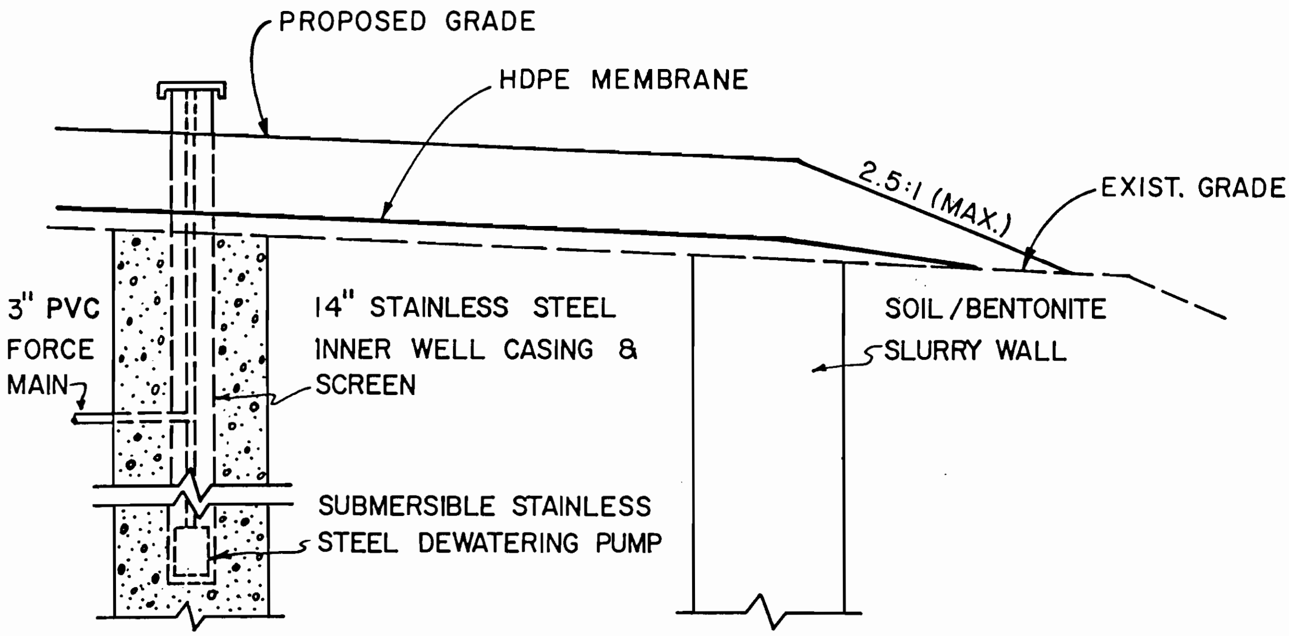
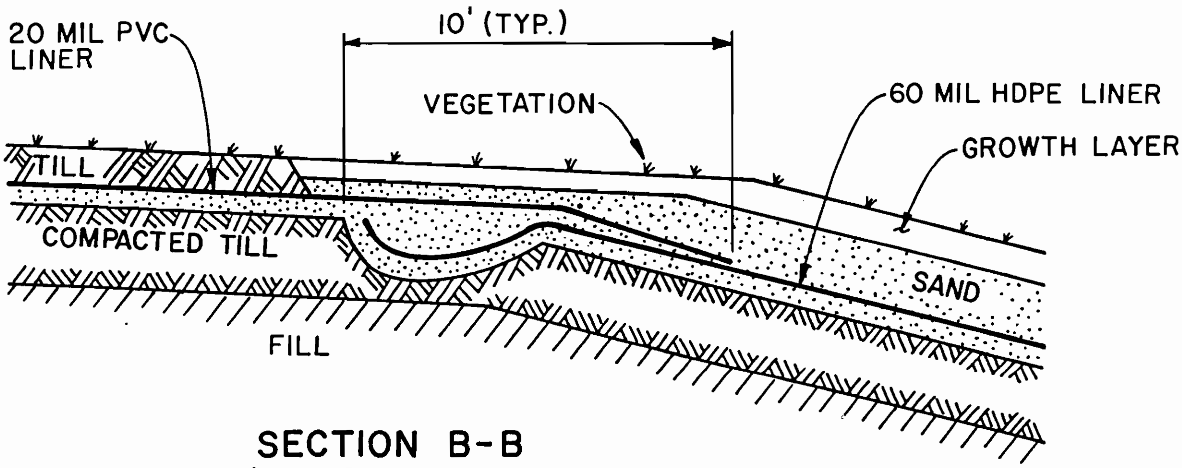


URS Company, Inc. CONSULTING ENGINEERS NEW YORK NEW JERSEY	POSSIBLE ON-SITE REMEDIAL ALTERNATIVE COMPONENTS PLAN VIEW	FIGURE 9-1



SECTION A-A

NOT TO SCALE



SECTION B-B

NOT TO SCALE

URS Company, Inc. CONSULTING ENGINEERS NEW YORK NEW JERSEY	POSSIBLE ON-SITE REMEDIAL ALTERNATIVE COMPONENTS -SECTIONS	FIGURE 9-2

A-2214

9.3.5 Off-Site Leachate Disposal - This measure involves disposal of leachate at a local publicly owned treatment works (POTW). At the present time, leachate from the Volney Landfill is treated at the Fulton Wastewater Treatment Plant. Although the feasibility and cost of using this facility on a long-term basis has not been established, the cost of off-site leachate disposal has been generically estimated at $0.079 per gallon, which includes a transportation cost of $0.01 per gallon. This measure also includes the construction of a 1,000,000-gallon storage tank on-site.

9.3.6 On-Site Leachate Treatment - On-site treatment of leachate was evaluated in Section 8.3.2.2 of this report. Pending a treatability study, the optimum process train for on-site treatment appears to include: flow equalization, biological treatment and carbon adsorption. Major equipment items would include a 150,000-gallon equalization/storage facility, a 50,000-gallon sequenced biological reactor (with manual powdered activated carbon addition), and a filter press. Treated effluent would be discharged to Bell Creek, and sludge filter cake transported to an approved off-site landfill facility. The treatment plant has been conceptually located on Figure 9-2 in the eastern area of the site. Although other locations are possible, the one shown is easily accessible from Silk Road, provides a direct effluent discharge route to Bell Creek, yet does not encroach onto the landfill surface or into the 100-year flood boundary of Bell Creek (as would a location on the east side of Silk Road). Figure 9-1 indicates the planimetric relationship between this leachate treatment plant and other potential on-site remedial measures.

9.3.7 Incineration - This alternative involves excavation and on-site incineration of the old (southern) section of the landfill, encompassing an estimated 2 million cubic yards of waste materials. To accomplish this, a total of ten (10) rotary kiln incinerator units, each 9-feet long, would have to be installed on-site and operated over 5-day, 24-hour work weeks for approximately 5 years.

10.0 DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

10.1 Evaluation Procedure

This section contains a detailed evaluation of the eight (8) final remedial alternatives identified in Section 9.2. The criteria used in this evaluation are generally consistent with USEPA's Guidance on Feasibility Studies Under CERCLA (USEPA, 1985b), with slight modifications as discussed below. Evaluation criteria fall into two broad classifications: non-cost criteria and cost criteria. Separate evaluations are initially performed for each, then combined in the preliminary recommendation of a remedial alternative (Section 12.0).

Non-cost criteria may be further divided into the following five categories: technical, institutional, public health, environmental and conformance with Superfund Amendments and Reauthorization Act of 1986 (SARA) guidelines. The last of these is obviously an addition to criteria in the above-cited reference, and reflects SARA's stated preference for alternatives which employ on-site treatment technologies. Since non-cost criteria are intrinsically judgemental, the non-cost evaluation procedure employed herein should be regarded likewise. Unlike costs, which can be estimated in a determinate manner, the incremental benefits of alternate remedial plans cannot be quantified on an absolute basis. Therefore, the scoring system described below for non-cost criteria should be regarded only as providing a relative basis for comparison of remedial alternatives.

The comparative, non-cost evaluation of remedial alternatives is performed using a weighted matrix scoring system, as demonstrated in Table 10-1. The five non-cost criteria categories are each given a total category weight, with that for technical and public health categories being higher (8) than that for the other three categories (2). The rationale for these category weights is as follows:

TABLE 10-1

SCORING SYSTEM FOR NON-COST EVALUATION OF REMEDIAL ALTERNATIVES

Evaluation Category	Sub-Category	Scoring Factor	Factor Weight	Category Weight
Technical	Performance	Effectiveness	1	8
		Useful Life	1	
	Reliability	O&M Requirements	1	
		Demonstrated Performance	1	
	Implementability	Constructability	1	
		Time to Implement/ Achieve Results	1	
	Safety	Worker Safety	1	
		Public Safety	1	
Institutional	NA	NA	2	2
Public Health	NA	NA	8	8
Environmental	NA	NA	2	2
SARA Conformance	NA	NA	2	2

- Relative technical feasibility of the various alternatives can be evaluated in greater detail, and with a higher degree of reliability, than the other categories, as evidenced by its division into sub-categories and individual scoring factors.

- Public health does not lend itself to the same detailed component evaluation as technical feasibility, but is considered to be equally important in aggregate.

- The other three categories are not considered to be as important at this site and/or cannot be evaluated with the same degree of reliability.

The procedure for scoring remedial alternatives is as follows. For each alternative, every category (or scoring factor, in the case of the technical category) is independently assigned a base score from 1 to 5, with 1 representing the lowest (or worst) score and 5 the highest (or best). The rationale for assigning base scores is presented in the following report sections; as previously stated, they are intended only as a broad and relative comparison between alternatives. Base scores are next multiplied by category (or scoring factor) weights, then totalled to determine a total weighted score for each alternative. These total weighted scores may, in a semi-quantitative sense, be regarded as a relative measure of each alternative's "benefit".

The cost evaluation of remedial alternatives is relatively straightforward. Since the alternatives consist of various groupings of individual remedial components, the component costs are analyzed initially, then combined in an appropriate manner to determine the total alternative costs. The cost evaluation addresses both capital and operation/maintenance costs, converted to present worth for the purpose of direct comparison between alternatives. The analysis is based upon standard economic methods, as presented in USEPA's Remedial Action Costing Procedures Manual (USEPA, 1985g).

It should be noted that long-term environmental monitoring is a necessary component of all remedial alternatives considered in this study. For this reason, and because the cost of monitoring is generally quite small compared with the cost of remedial action, monitoring requirements and costs are not included in the following comparative evaluation of remedial alternatives. Rather, a proposed environmental monitoring program is presented in Section 12.4 of this report, as a component of the recommended alternative.

10.2 Non-Cost Criteria Evaluation

Non-cost criteria are grouped into the five categories shown in Table 10-1. These categories are defined below, then used to assign "base scores" for each of the final remedial alternatives at the Volney Landfill site.

10.2.1 Technical Analysis - There are four technical evaluation sub-categories: performance, reliability, implementability and safety. Each of these, along with the individual scoring factors comprising them, are discussed and applied below.

10.2.1.1 Performance - The technical performance of alternative remedial measures is evaluated on the basis of two properties: effectiveness and useful life.

10.2.1.1.1 Effectiveness - Effectiveness refers to the ability of a remedial alternative to achieve its desired function. The scoring of this category should not reflect the value of the function itself (e.g., its applicability, completeness), but rather the alternative's ability to achieve that function. By proper engineering design, most remedial alternatives -- if technically feasible in the first place -- can be adopted to site conditions in such a manner as to achieve their desired functions. Therefore, the effectiveness of the final remedial alternatives considered in this report, which have already passed through a technical screening process, is generally quite high. There are, however, several points of variation, as described below:

- o <u>Alt. 1 (Base Score = 3)</u>; Since the "no action" alternative has no function, a mid-range score of 3 is assigned to this scoring factor. (Note: This mid-range score of 3 has been assigned to the "no action" alternative under most categories, since the alternative has no specific function and, therefore, cannot be comparatively evaluated on any basis relating to how or when the function is accomplished. Exceptions to this scoring procedure are the public health and environmental categories, under which the functions themselves of various alternatives are evaluated in terms of overall risk reduction levels, and by which standard, "no action" is comparatively less favorable than alternatives which do reduce risk to some degree.)

- o <u>Alt. 2 (Base Score = 5)</u>: Assuming, as was done in developing this alternative, that all hazardous wastes are contained in the old (south) section of the landfill, excavating and removing this entire section is an entirely effective method for ridding the site of these wastes.

- o <u>Alt. 3 (Base Score = 3)</u>: The purpose of supplementary capping is to reduce leachate generation and migration from the site. Although the supplementary cap will reduce most infiltration through the landfill side slopes, some remnant will practically always remain. Furthermore, the supplementary cap will not affect the relatively minor existing infiltration through the landfill top.

- o <u>Alt. 4a (Base Score = 3)</u>: The function of a perimeter leachate drain is to collect leachate migrating laterally outward away from the landfill. Because of the site's irregular stratigraphy, however, it is anticipated that this perimeter collection concept will effectively intercept most, but not all, of the leachate flowing from the landfill.

o Alt. 4b (Base Score = 3): Both off-site leachate disposal and on-site treatment are considered equally able to achieve their desired function, with the function of the latter being dictated by system operating parameters and effluent discharge limitations. Therefore, the effectiveness of alternatives employing off-site disposal or on-site treatment is considered to be identical.

o Alt. 5a (Base Score = 4): With perimeter leachate collection plus supplementary capping, lateral leachate migration from the landfill should be reduced to the maximum practical degree.

o Alt. 5b (Base Score = 4): This alternative is equally effective to Alt. 5a, for reasons stated above.

o Alt. 6 (Base Score = 4): Although incineration of the old (southern) section of the landfill will, under the previously-discussed assumption, involve processing of all known hazardous waste at the landfill, it is considered slightly less effective than excavation and off-site waste disposal (Alt. 2) because of the fact that residual ash -- possibly containing some non-volatile components of the waste materials -- will remain on-site.

10.2.1.1.2 Useful Life - Useful life refers to the period of time over which an alternative can be expected to operate as designed. Most of the technologies comprising the remedial alternatives in this study have, with proper operation and maintenance provisions, almost indefinite service lives. Possible exceptions are supplementary capping and the leachate collection drain. Although the supplementary side slope cap considered for this site includes a double barrier of soil and high-quality (HDPE) membrane liner, some deterioration over time is inevitable. Likewise, the gravel leachate collection drain, though wrapped in filter fabric, will eventually experience some degree of clogging or "blinding". For these reasons, the useful life score of alternatives employing either one of these technologies has been reduced to 4, or set at 3 for alternatives employing both. As before, the useful life of the "no action" alternative (Alt. 1) has been assigned a mid-range score of 3. Useful life base scores, under the above rules, are summarized as follows:

- <u>Alt. 1 (Base Score = 3)</u>
- <u>Alt. 2 (Base Score = 5)</u>
- <u>Alt. 3 (Base Score = 4)</u>
- <u>Alt. 4a (Base Score = 4)</u>
- <u>Alt. 4b (Base Score = 4)</u>
- <u>Alt. 5a (Base Score = 3)</u>
- <u>Alt. 5b (Base Score = 3)</u>
- <u>Alt. 6 (Base Score = 5)</u>

10.2.1.2 <u>Reliability</u> - The reliability of alternative remedial measures is evaluated in terms of their operation/maintenance requirements and demonstrated performance.

10.2.1.2.1 <u>Operation/Maintenance (O/M) Requirements</u> - Operation/maintenance requirements, when treated as a non-cost evaluation criterion, refers to the general level of O/M required for different remedial alternatives. Note that operation/maintenance is also quantified in the cost evaluation of remedial alternatives. Its inclusion here reflects the additional, non-quantifiable consideration that technologies requiring frequent or complex O/M activities are generally less reliable than those requiring little or straightforward O/M.

Among the remedial action technologies under consideration in this study, on-site leachate treatment and incineration have by far the highest level of O/M requirements, as detailed in Sections 8.3.1.2 and 9.3.7. The leachate collection drain, which includes several individual well pump stations and connecting force mains, has a much lower level of required operation and maintenance. Supplementary capping also requires minimum operation and maintenance, for annual vegetative cover upkeep and slope repair. In developing base scores for O/M requirements of the remedial alternatives, it has been assumed that, from the maximum score of 5, one (1) point is deducted for each alternative including on-site leachate treatment, and another for alternatives which include both of the following technologies: leachate collection drain and supplementary capping. Two (2) points are deducted for incineration, which requires 5 years and involves the use of 10 rotary kiln incinerators operating on a full-time, 24-hour basis. As before, a mid-range score of 3 is assigned to the no-action alternative. Resulting base scores for operation and maintenance requirements are as follows:

- Alt. 1 (Base Score = 3)
- Alt. 2 (Base Score = 5)
- Alt. 3 (Base Score = 5)
- Alt. 4a (Base Score = 5)
- Alt. 4b (Base Score = 4)
- Alt. 5a (Base Score = 4)
- Alt. 5b (Base Score = 3)
- Alt. 6 (Base Score = 3)

10.2.1.2.2 Demonstrated Performance - Demonstrated performance of component technologies is another measure of a remedial alternative's overall reliability. Each of the technologies considered herein is proven, under a given set of operating and/or field conditions. However, for two technologies -- on-site leachate treatment and a leachate collection drain -- these conditions have not yet been fully defined. Before on-site treatment can be implemented (or identified with certainty as being feasible), a bench-scale treatability study must be performed. The conceptual layout of the leachate collection drain and accompanying slurry wall is based upon a interpolated geologic profile around the landfill perimeter (Figure 7-3). The design of this system, along with a final confirmation of its feasibility, will require further geotechnical investigation (surface geophysics and interval borings) along this perimeter layout. In light of the above considerations, the scoring for demonstrated performance includes a separate 1-point deduction from the maximum score of 5 for each alternative employing leachate collection or on-site leachate treatment (or a 2-point deduction for alternatives with both). The resulting scores are as follows:

- Alt. 1 (Base Score = 3)
- Alt. 2 (Base Score = 5)
- Alt. 3 (Base Score = 5)
- Alt. 4a (Base Score = 4)
- Alt. 4b (Base Score = 3)
- Alt. 5a (Base Score = 4)
- Alt. 5b (Base Score = 3)
- Alt. 6 (Base Score = 5)

10.2.1.3 Implementability - Implementability of remedial alternatives is reflected by their constructability and time required to both implement and achieve desired results.

10.2.1.3.1 Constructability - Constructability refers to the overall feasibility and ease of constructing or implementing a remedial alternative. From a pure construction standpoint, constructability is primarily a function of on-site conditions. When overall implementation is considered, however, features external to the site (such as the availability of off-site disposal facilities) come into play. The following discussion presents the rationale for assigning base scores under this category:

- Alt. 1 (Base Score = 3): As before, the no-action alternative is assigned a mid-range score.

- Alt. 2 (Base Score = 1): Excavation and removal of the entire south section of the landfill would create staggering problems from both a construction and implementation standpoint. The logistical aspects of excavating and transporting an estimated 2 million cubic yards of fill material, treated as a hazardous waste, are apparent. Furthermore, it is likely that this volume would severely strain the capacities of existing secure landfill facilities throughout the region, if it could be handled at all.

- Alt. 3 (Base Score = 4): Supplementary capping of the landfill sides would require a number of special construction provisions, including the implementation of operating, slope stabilization and erosion control measures on the long, steep side slopes, and the establishment of procedures to prevent damage to the existing membrane liner and gas collection system on the top of the landfill. Although these conditions can be effectively addressed through proper engineering design and construction management, a less-than-perfect base score of 4 is assigned to this alternative to reflect its degree of construction complexity.

o Alt. 4a (Base Score = 4): The perimeter leachate drain, like supplementary capping of the landfill sides, is constructable but not simple. The gravel-fill drain will extend to depths as great as 40 feet, requiring the use of temporary sheeting during construction. Likewise the placement of filter fabric along the drain and installation of collection wells at its low points will require careful, though not extraordinary, planning and construction management. The base score assignment of 4 for constructability of Alt. 4a reflects the same rationale as for Alt. 3.

o Alt. 4b (Base Score = 4): The same base score as for Alt. 4a is assigned to this alternative, since an on-site leachate treatment facility, as compared with off-site disposal, offers no forseeable problems in terms of constructability.

o Alt. 5a (Base Score = 3): The combination of supplementary capping and a leachate collection drain will tend to reinforce any potential construction problems associated with either measure individually.

o Alt. 5b (Base Score = 3): Same as Alt. 5a, with no distinction between on-site leachate treatment and off-site disposal.

o Alt. 6 (Base Score = 1): Like Alt. 2, incineration will require the excavation and on-site handling of approximately 2 million cubic yards of refuse treated as hazardous waste. It will, furthermore, require that this large refuse-handling operation be coordinated over a 5-year period with the operation of a multiple-unit incineration facility. From a constructability and implementation standpoint, this alternative presents major potential problems.

10.2.1.3.2 Time to Implement/Achieve Results - All of the remedial alternatives considered in this study can be implemented within one construction season except Alt. 2 (excavation and off-site waste disposal), which is estimated to require three seasons, and Alt. 6

(incineration), which is estimated to require five years. From a pure implementation time standpoint, therefore, Alt. 2 is assigned a score 2 points less than the others and Alt. 6 is assigned a score 3 points less. In terms of achieving their desired results, on the other hand, all alternatives will become effective immediately after their implementation. (Note that "desired results" are alternative-specific, and not equal in terms of cleanup or risk reduction level. For example, supplementary capping will achieve its desired results -- reduction of on-site leachate generation -- immediately after it is implemented, notwithstanding the fact that existing leachate within the refuse fill, and a reduced amount of new leachate produced at the site, will continue to migrate outward in the absence of a collection drain.) Using the above rationale, base scores for time are assigned as follows:

- Alt. 1 (Base Score = 3)
- Alt. 2 (Base Score = 3)
- Alt. 3 (Base Score = 5)
- Alt. 4a (Base Score = 5)
- Alt. 4b (Base Score = 5)
- Alt. 5a (Base Score = 5)
- Alt. 5b (Base Score = 5)
- Alt. 6 (Base Score - 2)

10.2.1.4 Safety - To distinguish this category from public health, and thereby maintain the independence of the scoring system, safety will be regarded on a short-term basis only, during the actual implementation of remedial measures. Two safety aspects are scored separately: safety to on-site workers and to the general public.

10.2.1.4.1 Worker Safety - All construction operations involve some level of worker risk. This comparative evaluation, however, does not address the risks associated with standard construction procedures, per se, but rather those associated specifically with fire, explosion or possible exposure to hazardous substances. In general, the remedial alternatives under consideration in this study, with the exception of Alt. 2 and Alt. 6, involve a relatively low level of risk to workers during construction. Both Alt. 2 and Alt. 6, on the other hand, require excavation and handling of the entire south section of the landfill; both alternatives pose a very high risk level. Excavation in this waste fill could easily cause landfill fires (if, as is highly possible, there are dry sections within the fill), explosions (from confined methane gas pockets), and exposure to known and/or presently unsuspected hazardous materials within the fill. Among the other alternatives, supplementary capping is considered to have an extremely low risk level, since the work would be performed on the surface of the existing till cap, with no anticipated exposure to buried wastes. Leachate collection (drain and accompanying slurry wall) poses a somewhat higher risk, since it involves excavation. Although workers would be subject to a strict health/safety plan and would not be permitted to enter the trench, excavation adjacent to waste sites always involves some degree of potential for explosion and/or exposure to hazardous substances in solid, liquid or gaseous form. For this reason, each alternative including leachate collection has been assigned a base score one (1) point lower than those which don't (i.e., Alt. 3). Because off-site leachate disposal requires handling and transporting leachate on an ongoing basis, alternatives including off-site disposal have been assigned a worker safety score one (1) point lower than those involving on-site treatment. The "no-action" alternative has again been assigned a mid-range score of 3, while Alt. 2 and Alt. 6 have been assigned scores of 1 for reasons discussed above. In summary, base scores assigned for worker safety are as follows:

- Alt. 1 (Base Score = 3)

- Alt. 2 (Base score = 1)
- Alt. 3 (Base Score = 5)
- Alt. 4a (Base Score = 3)
- Alt. 4b (Base Score = 4)
- Alt. 5a (Base Score = 3)
- Alt. 5b (Base Score = 4)
- Alt. 6 (Base Score = 1)

10.2.1.4.2 Public Safety - In general, the same remedial measures posing a risk to on-site workers also pose a risk to the general public, though at a reduced level due to distance from the site. On a comparative basis, the risk levels are considered to be the same, so the same base scores as for worker safety have been assigned. Again, these are:

- Alt. 1 (Base Score = 3)
- Alt. 2 (Base Score = 1)
- Alt. 3 (Base Score = 5)
- Alt. 4a (Base Score = 3)
- Alt. 4b (Base Score = 4)
- Alt. 5a (Base Score = 3)
- Alt. 5b (Base Score = 4)
- Alt. 6 (Base Score = 1)

10.2.2 Institutional Analysis - The institutional aspects of various remedial alternatives considered in this study may be viewed in several manners:

(a) Compliance with standards - Tables 6-2 and 6-3 indicate the groundwater and surface water parameters, respectively, which were found during this study to exceed current regulatory standards. While each of the eight (8) remedial alternatives, with the exception of "no action", will improve the current situation, its exact impact upon environmental concentrations is impossible to ascertain. For this reason and, more importantly, because the closely related public health aspects of these remedial alternatives are separately and independently evaluated in Section 10.2.3, compliance with standards is not considered from an institutional standpoint in the scoring of alternatives.

(b) Community relations- Public perception of remedial alternatives is an important consideration in the final selection of a remedy. However, since public input is unavailable at this stage of the evaluation process, it will be incorporated subsequently into the final recommendation process.

(c) Permit requirements - The single, fairly narrow, basis on which to comparatively evaluate remedial alternatives from an institutional standpoint is their need for, and anticipated difficulty in obtaining, regulatory permits. Of the remedial technologies considered herein, those with the most important associated permit requirements are excavation and off-site waste disposal, on-site leachate treatment, and incineration. The former of these involves the need for New York State permits for waste hauling and disposal. Considering the volume of material involved, current regulatory status of many commercial disposal facilities, and generally negative political climate regarding off-site waste disposal, it is anticipated that these permits could prove extremely difficult to obtain. The base score below for Alt. 2 reflects this concern. On-site leachate treatment, with effluent discharge to Bell Creek, will require a New York State Pollution Discharge

Elimination System (SPDES) permit. Although there is no reason to anticipate difficulty in obtaining such a permit, uncertainty in the present absence of a treatability study is considered sufficient reason to reduce by one (1) point the score of those alternatives employing on-site treatment. The construction and 5-year operation of a large incinerator facility at the landfill site may generate local opposition, and will require a NYSDEC air quality permit; the base score for Alt. 6 has, therefore, been reduced by 2 points. The resulting base scores for institutional analysis are presented below:

- Alt. 1 (Base Score = 3)
- Alt. 2 (Base Score = 1)
- Alt. 3 (Base Score = 5)
- Alt. 4a (Base Score = 5)
- Alt. 4b (Base Score = 4)
- Alt. 5a (Base Score = 5)
- Alt. 5b (Base Score = 4)
- Alt. 6 (Base Score = 3)

10.2.3 Public Health Analysis - The relative public health benefits provided by remedial alternatives are a very important aspect of their comparative evaluation. Section 8.2 of this report identifies how the remedial alternatives under consideration were grouped into categories on the basis of their anticipated level of risk reduction. Table 9-1 summarizes the final alternatives and their corresponding categories. Because public health and risk reduction are alternate expressions of the same concept, these previously-developed categories are utilized directly in the assignment of public health base scores. Categories providing a relatively low level of risk reduction are assigned a base score of 3; those providing an intermediate level are assigned a score of 4; and categories providing a relatively high level of risk reduction are assigned a base score of 5. An exception to this is Alt. 3 (supplementary capping), which is in the same overall relatively low risk reduction category as Alts. 4a and 4b (leachate collection), but is considered to offer an even lower level of public health protection because it does not actively prevent -- but rather reduces -- the amount of leachate migrating from the site. The score of Alt. 3 has, therefore, been reduced by one (1) point and set at a value of 2. Since Alt. 1 (no action) does not reduce risk at all, it is assigned the minimum score of 1. Excavation and off-site waste disposal (Alt. 2), like the intermediate-level alternatives, will theoretically prevent continued leachate migration from the site, but only from the northern section. Therefore, the public health base score for this alternative is assigned a value of 3. Incineration (Alt. 6) is considered to provide approximately the same level of overall risk reduction as excavation and off-site waste disposal; therefore, it too is assigned a base score of 3.

- <u>Alt. 1 (Base Score = 1)</u>

- <u>Alt. 2 (Base Score = 3)</u>

- <u>Alt. 3 (Base Score = 2)</u>

- <u>Alt. 4a (Base Score = 3)</u>

- <u>Alt. 4b (Base Score = 3)</u>

- <u>Alt. 5a (Base Score = 4)</u>

- <u>Alt. 5b (Base Score = 4)</u>

- <u>Alt. 6 (Base Score = 3)</u>

10.2.4 Environmental Analysis - Since the landfill has been capped, the potential for direct discharge of contaminated surface water and/or sediments to the adjacent stream system has been greatly reduced. Indirectly, the streams -- especially Bell Creek -- are still influenced by lateral leachate flow from the site, a good portion of which, at least, is probably intercepted by these streams. This flow of leachate from the site, therefore, is a logical focus for assessing the relative environmental affects of various remedial alternatives. The relative risk reduction levels previously assigned to alternative categories were developed primarily in terms of how they affected leachate migration from the site. Therefore, these categories are equally applicable to an environmental scoring of alternatives, except for the following distinction. Alternatives which involve on-site leachate treatment are considered slightly less favorable (i.e., one (1) point) from an environmental standpoint than those with off-site disposal, since the discharge of effluent to the stream system offers a slight potential for degradation of water quality, even after treatment, and a larger potential in the event of a treatment process upset.

Environmental base scores are similar to those for public health, except as modified for the reason above. In summary, these environmental base scores are:

- Alt. 1 (Base Score = 1)
- Alt. 2 (Base Score = 3)
- Alt. 3 (Base Score = 2)
- Alt. 4a (Base Score = 3)
- Alt. 4b (Base Score = 2)
- Alt. 5a (Base Score = 4)

- Alt. 5b (Base Score = 3)

- Alt. 6 (Base Score = 3)

10.2.5 Conformance with SARA Guidelines - The Superfund Amendments and Reauthorization Act of 1986 (SARA) establishes a preference for alternatives employing on-site treatment of wastes, and a bias against alternatives utilizing off-site transportation and disposal without treatment. The alternative most in keeping with SARA is Alt. 6 -- incineration, which is assigned the maximum base score of 5 under this category. Although not a direct waste treatment technology, on-site leachate treatment is felt to be more in conformance with SARA guidelines than off-site leachate disposal. Therefore, alternatives which include on-site leachate treatment (4b, 5b) are assigned an above-average base score of 4, while those employing off-site leachate disposal (4a, 5a) are given a below-average score of 2. Alt. 2, which involves large-scale excavation, transportation and disposal of wastes off-site, is given the minimum score of 1 under this category. The other alternatives are assigned a score of 3, representing their neutrality in regards to this category. In summary, the base scores are as follows:

- Alt. 1 (Base Score = 3)

- Alt. 2 (Base Score = 1)

- Alt. 3 (Base Score = 3)

- Alt. 4a (Base Score = 2)

- Alt. 4b (Base Score = 4)

- Alt. 5a (Base Score = 2)

- Alt. 5b (Base Score = 4)

o <u>Alt. 6 (Base Score = 5)</u>

10.2.6 <u>Summary of Non-Cost Evaluation of Remedial Alternatives</u> - Table 10-2 summarizes the evaluation of remedial alternatives by non-cost criteria. Placed in order of increasing scores (i.e., lower to higher effective "benefit"), the eight (8) alternatives compare as follows:

Alt. 1 (Total Weighted Score = 46)
Alt. 2 (Total Weighted Score = 60)
Alt. 6 (Total Weighted Score = 68)
Alt. 3 (Total Weighted Score = 72)
Alt. 4a (Total Weighted Score = 75)
Alt. 4b (Total Weighted Score = 75)
Alt. 5a (Total Weighted Score = 83)
Alt. 5b (Total Weighted Score = 83)

Several aspects of this comparative alternative ranking are obvious, such as:

o With the exception of Alt. 6, total weighted alternative scores generally follow their categories, as indicated in Table 9-1. Category I (Alt. 1), representing no action, has the lowest total score, followed in succession by: Category II (Alt. 2) -- excavation and off-site waste disposal; Category VI (Alt. 6) -- incineration; Category III (Alt. 3) -- supplementary capping; Category IV (Alts. 4a, 4b) -- leachate collection; and Category V (Alts. 5a, 5b) -- supplementary capping plus leachate collection.

o The scores of alternatives utilizing off-site leachate disposal are, within each category, identical to those with on-site leachate treatment.

Further discussion of these remedial alternative scores is presented in Section 12.0, where they are used in conjunction with

TABLE 10-2

SUMMARY SCORING
RESULTS OF NON-COST EVALUATION OF REMEDIAL ALTERNATIVES

Scoring Category or Factor (Weight)[1]		BASE SCORE (WEIGHTED SCORE) Alt. 1	Alt. 2	Alt. 3	Alt. 4a	Alt. 4b	Alt. 5a	Alt. 5b	Alt. 6
Effectiveness	(1)	3 (3)	5 (5)	3 (3)	3 (3)	3 (3)	4 (4)	4 (4)	4 (4)
Useful Life	(1)	3 (3)	5 (5)	4 (4)	4 (4)	4 (4)	3 (3)	3 (3)	5 (5)
O/M Requirements	(1)	3 (3)	5 (5)	5 (5)	5 (5)	4 (4)	4 (4)	3 (3)	3 (3)
Demonstrated Perf.	(1)	3 (3)	5 (5)	5 (5)	4 (4)	3 (3)	4 (4)	3 (3)	5 (5)
Constructability	(1)	3 (3)	1 (1)	4 (4)	4 (4)	4 (4)	3 (3)	3 (3)	1 (1)
Time	(1)	3 (3)	3 (3)	5 (5)	5 (5)	5 (5)	5 (5)	5 (5)	2 (2)
Worker Safety	(1)	3 (3)	1 (1)	5 (5)	3 (3)	4 (4)	3 (3)	4 (4)	1 (1)
Public Safety	(1)	3 (3)	1 (1)	5 (5)	3 (3)	4 (4)	3 (3)	4 (4)	1 (1)
Institutional	(2)	3 (6)	1 (2)	5 (10)	5 (10)	4 (8)	5 (10)	4 (8)	3 (6)
Public Health	(8)	1 (8)	3 (24)	2 (16)	3 (24)	3 (24)	4 (32)	4 (32)	3 (24)
Environmental	(2)	1 (2)	3 (6)	2 (4)	3 (6)	2 (4)	4 (8)	3 (6)	3 (6)
SARA	(2)	3 (6)	1 (2)	3 (6)	2 (4)	4 (8)	2 (4)	4 (8)	5 (10)
Total Weighted Score		(46)	(60)	(72)	(75)	(75)	(83)	(83)	(68)

Notes:
(1) Refer to Table 10-1 for further category breakdowns
Maximum Possible Total Weighted Score = 110

alternative costs to develop a preliminary recommendation for remedial action at the Volney Landfill site.

10.3 Cost Evaluation of Remedial Alternatives

10.3.1 Component Cost Analysis - The eight (8) final remedial alternatives considered in this study (Table 9-1) consist of the following component technologies, in various combinations:

- o Excavation and Off-site Waste Disposal
- o Supplementary Capping of Landfill Side Slopes
- o Leachate Collection Drain and Slurry Wall
- o Off-site Leachate Disposal
- o On-site Leachate Treatment
- o Incineration

A description of these technologies, and the elements which they include, was presented in Section 9.3. Tables 10-3 through 10-8 summarize the estimated costs for implementing each technology at the Volney Landfill site. Appendix L provides additional detail concerning these estimates.

Table 10-9 summarizes the costs of these component technologies, including their total capital costs, annual operation/maintenance costs and total present worth. As can be seen from this table, the costs vary widely, from a total present worth of $2,908,000 for on-site leachate treatment to $796,600,000 for incineration. In the following section, these component costs are combined as necessary to determine the total cost of each remedial alternative.

TABLE 10-3

COST ESTIMATE
EXCAVATION AND OFF-SITE WASTE DISPOSAL

CAPITAL COSTS	
Direct Capital Costs	
Excavation (2,000,000 cubic yards)	$ 8,000,000
Transportation (400 miles)	136,000,000
Disposal (Secure landfill)	300,000,000
TOTAL DIRECT CAPITAL COSTS	$444,000,000
Indirect Capital Costs	
Engineering	$ 1,000,000
Contingency (20%)	88,800,000
Legal/Administrative	2,000,000
TOTAL INDIRECT CAPITAL COSTS	$ 91,800,000
TOTAL CAPITAL COSTS	$535,800,000
OPERATION/MAINTENANCE COSTS	Ø
REPLACEMENT COSTS	Ø
TOTAL PRESENT WORTH	$535,800,000

TABLE 10-4

COST ESTIMATE
SUPPLEMENTARY CAPPING OF LANDFILL SIDE SLOPES

CAPITAL COSTS	
Direct Capital Costs	
Preparation of Existing Surface	$ 24,000
Sand (Placed & compacted/141,200 cubic yards)	1,921,000
HDPE Liner (60-mil, textured/169,400 sq. yards)	1,464,000
Vegetative Layer (Local borrow/56,500 cubic yards)	474,000
Seedbed Prep., Seeding, Mulching (169,400 sq. yards)	311,000
Terracing Fill (24,000 cubic yards)	327,000
Passive Gas Venting (1 vent per acre)	10,000
TOTAL DIRECT CAPITAL COSTS	$4,531,000
Indirect Capital Costs	
Engineering (12%)	$ 544,000
Contingency (20%)	906,000
Legal/Administrative (5%)	227,000
TOTAL INDIRECT CAPITAL COSTS	$1,677,000
TOTAL CAPITAL COSTS	$6,208,000
OPERATION/MAINTENANCE COSTS	
Mowing, Regrading ($6,000/yr)	
PRESENT WORTH OF O/M COSTS	$ 57,000
REPLACEMENT COSTS	Ø
TOTAL PRESENT WORTH	$6,265,000

TABLE 10-5

COST ESTIMATE

LEACHATE COLLECTION DRAIN AND SLURRY WALL

NORTH DRAIN

CAPITAL COSTS	
Direct Capital Costs	
Excavation & Temporary Sheeting (2,020 ft. @ 31 ft. avg. depth)	$1,053,000
Filter Fabric Lining (2,020 ft. @ 31 ft. avg. depth)	63,000
Stone Fill (2,020 ft. @ 31 ft. avg. depth)	74,000
Leachate Collection Wells (2 wells/14-inch stainless steel casing & screen/stainless steel pump & controls)	50,000
Slurry Wall (Soil bentonite/75,500 sq. ft.)	529,000
Force Main (3-inch PVC/900 ft.)	13,400
TOTAL DIRECT CAPITAL COSTS	$1,782,000
Indirect Capital Costs	
Geotechnical Investigation	$ 50,000
Engineering (12%)	214,000
Contingency (20%)	356,000
Legal/Administrative (5%)	89,000
TOTAL INDIRECT CAPITAL COSTS	$ 709,000
TOTAL CAPITAL COSTS	$2,491,000
OPERATION/MAINTENANCE COSTS	
Annual Pump and Motor Maintenance ($640/yr)	
Annual Electricity ($110/yr)	
Total Annual O/M Costs ($750/yr)	
PRESENT WORTH OF O/M COSTS	$ 7,000

TABLE 10-5 (Cont.)

COST ESTIMATE

LEACHATE COLLECTION DRAIN AND SLURRY WALL

NORTH DRAIN

REPLACEMENT COSTS	
Pumps and Controls, after 15 yrs ($14,000)	
PRESENT WORTH OF REPLACEMENT COSTS	$ 3,000
TOTAL PRESENT WORTH: NORTH DRAIN	$2,501,000

SOUTHWEST DRAIN

CAPITAL COSTS	
Direct Capital Costs	
Excavation & Temporary Sheeting (1,780 ft. @ 19 ft. avg. depth)	$ 569,000
Filter Fabric Lining (1,780 ft. @ 19 ft. avg. depth)	34,000
Stone Fill (1,780 ft. @ 19 ft. avg. depth)	40,000
Leachate Collection Well (14-inch stainless steel casing & screen/stainless steel pump & controls)	25,000
Slurry Wall (Soil bentonite/43,100 sq. ft.)	302,000
Force Main (3-inch PVC/2,500 ft.)	37,000
TOTAL DIRECT CAPITAL COSTS	$1,007,000
Indirect Capital Costs	
Geotechnical Investigation	$ 44,000
Engineering (12%)	121,000
Contingency (20%)	201,000
Legal/Administrative (5%)	50,000
TOTAL INDIRECT CAPITAL COSTS	$ 416,000
TOTAL CAPITAL COSTS	$1,423,000

TABLE 10-5 (Cont.)

COST ESTIMATE
LEACHATE COLLECTION DRAIN AND SLURRY WALL

SOUTHWEST DRAIN

OPERATION/MAINTENANCE COSTS		
Annual Pump and Motor Maintenance ($320/yr)		
Annual Electricity ($90/yr)		
Total Annual O/M Costs ($410/yr)		
PRESENT WORTH OF O/M COSTS	$	4,000
REPLACEMENT COSTS		
Pumps and Controls, after 15 yrs ($7,000)		
PRESENT WORTH OF REPLACEMENT COSTS	$	2,000
TOTAL PRESENT WORTH: SOUTHWEST DRAIN		$1,429,000

TABLE 10-5 (Cont.)

COST ESTIMATE
LEACHATE COLLECTION DRAIN AND SLURRY WALL

NORTH AND SOUTHWEST DRAINS

CAPITAL COSTS	
Total Direct Capital Costs ($2,789,000)	
Total Indirect Capital Costs ($1,125,000)	
TOTAL CAPITAL COSTS	$3,914,000
OPERATION/MAINTENANCE COSTS	
Total Annual O/M Costs ($1,160/yr)	
PRESENT WORTH OF O/M COSTS	$ 11,000
REPLACEMENT COSTS	
PRESENT WORTH OF REPLACEMENT COSTS	$ 5,000
TOTAL PRESENT WORTH: NORTH AND SOUTHWEST DRAINS ...	$3,930,000

TABLE 10-6

COST ESTIMATE

OFF-SITE LEACHATE DISPOSAL

CAPITAL COSTS	
Direct Capital Costs	
Storage Tank (Concrete/1,000,000 gallons)	$400,000
Tank Foundation	202,000
Discharge Pumps, Piping, Misc.	11,000
TOTAL DIRECT CAPITAL COSTS	$613,000
Indirect Capital Costs	
Engineering (12%)	$ 73,000
Contingency (20%)	123,000
Legal/Administrative (5%)	31,000
TOTAL INDIRECT CAPITAL COSTS	$227,000
TOTAL CAPITAL COSTS	$840,000
OPERATION/MAINTENANCE COSTS	
Pump Maintenance, Electricity ($500/yr)	
Transportation: 13,000 gpd @ $0.01/gal ($47,450/yr)	
Disposal: 13,000 gpd @ $0.05/gal ($237,250/yr)	
Total Annual O/M Costs ($285,200/yr)	
PRESENT WORTH OF O/M COSTS	$2,689,000
REPLACEMENT COSTS	Ø
TOTAL PRESENT WORTH	$3,529,000

Note: Above costs are based upon a leachate production rate of approximately 13,000 gallons per day, which assumes existing conditions without supplementary capping of landfill side slopes. With supplementary capping, all costs would be reduced by approximately 80 percent.

TABLE 10-7

COST ESTIMATE
ON-SITE LEACHATE TREATMENT

CAPITAL COSTS	
Direct Capital Costs	
Equalization/Storage Tank (150,000 gallons)	$ 126,000
Equalization/Storage Tank Agitator	14,000
Bioreactor (50,000 gallons, including feed pump, aeration, decanter, and control panel, with installed spares)	145,000
Discharge Pumps (2)	5,000
Filter Press	19,000
Feed Pumps (2)	4,000
Air Compressor	3,000
Sludge Tank	3,000
Steam Generator	23,000
Equipment Subtotal	$ 342,000
Installation (40% of equipment costs)	137,000
Instrumentation (10% of equipment costs)	34,000
Piping (50% of equipment costs)	171,000
Electrical (10% of equipment costs)	34,000
Buildings (10% of equipment costs)	34,000
TOTAL DIRECT CAPITAL COSTS	$ 752,000
Indirect Capital Costs	
Treatability Study	$ 70,000
Engineering (12%)	90,000
Startup Services (10%)	75,000
Contingency (20%)	150,000
Legal/Administrative (5%)	38,000
TOTAL INDIRECT CAPITAL COSTS	$ 423,000
TOTAL CAPITAL COSTS	$1,175,000

TABLE 10-7 (Cont.)

COST ESTIMATE
ON-SITE LEACHATE TREATMENT

<u>OPERATION/MAINTENANCE COSTS</u>

Annual Operating Labor: 2,080 hrs/yr ($41,600/yr)
Annual Maintenance Labor & Materials ($32,000/yr)
Annual Steam Usage ($18,200/yr)
Annual Electricity Usage ($5,000/yr)
Annual Gas Usage ($1,600/yr)
Annual PAC Usage ($26,800/yr)
Annual Sludge Disposal ($7,200/yr)
Annual Water Quality Analyses ($30,000/yr)
Insurance and Taxes ($10,700/yr)
Maintenance Reserve & Contingency Costs ($10,700/yr)
Total Annual O/M Costs ($183,800/yr)
PRESENT WORTH OF O/M COSTS $1,733,000

<u>REPLACEMENT COSTS</u> Ø

TOTAL PRESENT WORTH $2,908,000

Note: Above costs are based upon a leachate production rate of approximately 13,000 gallons per day, which assumes existing conditions without supplementary capping of landfill side slopes. With supplementary capping, all costs, with the exception of the treatability study, would be reduced by approximately 80 percent.

TABLE 10-8

COST ESTIMATE

INCINERATION

CAPITAL COSTS	
Direct Capital Costs	
Install ten (10) rotary kiln incinerators, each 9 feet long	$ 200,000,000
TOTAL DIRECT CAPITAL COSTS	$ 200,000,000
Indirect Capital Costs	
Engineering (12%)	24,000,000
Contingency (20%)	40,000,000
Legal and Administrative (5%)	10,000,000
TOTAL INDIRECT CAPITAL COSTS	$ 74,000,000
TOTAL CAPITAL COSTS	$ 274,000,000
OPERATION/MAINTENANCE COSTS	
Fuel ($135,000,000/yr)	
Labor ($ 1,890,000/yr)	
Waste Excavation & Hauling ($980,000/yr)	
TOTAL ANNUAL O/M COSTS ($137,870,000/yr)	
PRESENT WORTH OF O/M COSTS (5 yrs)	$ 522,600,000
REPLACEMENT COSTS	Ø
TOTAL PRESENT WORTH	$ 796,600,000

TABLE 10-9

SUMMARY OF REMEDIAL ALTERNATIVE COMPONENT COSTS

Component Technology	Total Capital Costs ($ x 10^3)	Annual O/M Costs ($ x 10^3)	Total Present Worth ($ x 10^3)
Excavation and Off-Site Waste Disposal	535,800.	Ø	535,800.
Supplementary Capping of Landfill Side Slopes	6,208.	6.0	6,265.
Leachate Collection Drain and Slurry Wall	3,914.	1.2	3,930.
Off-Site Leachate Disposal *	840.	285.2	3,529.
On-Site Leachate Treatment *	1,175.	183.8	2,908.
Incineration	274,000.	137,870.	796,600.

* Costs for off-site leachate disposal and on-site leachate treatment are based upon a leachate production rate of approximately 13,000 gallons per day, which assumes existing conditions without supplementary capping of landfill side slopes. With supplementary capping, costs would be reduced by approximately 80 percent.

Note: Long-term environmental monitoring costs not included.

10.3.2 Summary of Remedial Alternative Costs - Table 10-10 summarizes the total cost of each remedial alternative, including its total capital costs, annual operation/maintenance costs and total present worth. These total costs are determined by summing the component costs of the individual technologies comprising the alternatives (Table 10-9). The following points highlight this evaluation of total remedial alternative costs:

- The "no-action" alternative involves zero cost and, therefore, represents the low end of the estimated cost range.

- Alternative 6 (incineration), with a total present worth of $796,600,000, is the most costly of the alternatives considered.

- Alternative 2 (excavation and off-site waste disposal), is also extremely costly, with an estimated total present worth of $535,800,000.

- All of the other five alternatives fall within the relatively narrow total present worth range of $6,265,000 to $10,901,000.

TABLE 10-10

TOTAL COST OF REMEDIAL ALTERNATIVES

Alternative	Total Capital Costs ($ x 10^3)	Annual O/M Costs ($ x 10^3)	Total Present Worth ($ x 10^3)
1	Ø	Ø	Ø
2	535,800.	Ø	535,800.
3	6,208.	6.0	6,265.
4a	4,754.	286.4	7,459.
4b	5,089.	185.0	6,838.
5a	10,290.	64.2	10,901.
5b	10,412.	44.0	10,832.
6	274,000.	137,870.	796,600.

Note: Each alternative above requires long-term environmental monitoring. Monitoring costs, however, are not included in the above totals.

11.0 SUMMARY OF REMEDIAL ACTION ALTERNATIVES

The eight (8) final remedial alternatives considered at the Volney Landfill site were developed in Section 8.0, listed in Section 9.0 (Table 9-1), evaluated on the basis of non-cost criteria in Section 10.2 (Table 10-2), and evaluated on the basis of cost in Section 10.3 (Table 10-10). The results of the above process are summarized on Table 11-1. This table identifies the component technologies included within each alternative, along with the alternative's non-cost criteria evaluation score and total estimated present worth.

From the information presented on Table 11-1, the following conclusions may be drawn:

(1) No action (Alt. 1) has the lowest score and a zero cost. Because of the potential risk posed by the site to groundwater users in the vicinity (Section 6.3.3), and in consideration of USEPA and NYSDEC agency policy concerning Superfund site remediation, as expressed during the course of this study, no action is not considered an appropriate response at the Volney Landfill.

(2) Excavation and off-site waste disposal (Alt. 2) and incineration (Alt. 6) both have relatively low evaluation scores and extremely high costs. Therefore, neither alternative is considered cost-effective at this site.

(3) Paired alternatives employing off-site leachate disposal versus on-site treatment (4a/4b and 5a/5b) have identical scores. As discussed in Section 8.3.1, on-site treatment is somewhat less expensive than off-site disposal. However, as indicated by the relative present worths of the above paired alternatives, this cost difference is marginal. Furthermore, it is subject to assumptions regarding the on-site treatability of leachate (pending a treatability study) and the final destination/cost of off-site leachate disposal (at a "local" municipal wastewater treatment facility). Hereafter in this report, on-site

TABLE 11-1

SUMMARY OF REMEDIAL ALTERNATIVES

Alternative	Component Technologies	Evaluation Score	Total Present Worth ($\$x10^3$)
1	No Action	46	Ø
2	Excavation and Off-Site Waste Disposal	60	535,800
3	Supplementary Capping	72	6,265
4a	Leachate Collection (Off-Site Disposal)	75	7,459
4b	Leachate Collection (On-Site Treatment)	75	6,838
5a	Supplementary Capping + Leachate Collection (Off-Site Disposal)	83	10,901
5b	Supplementary Capping + Leachate Collection (On-Site Treatment)	83	10,832
6	Incineration	68	796,600

Note: Each alternative above requires long-term environmental monitoring. Monitoring costs, however, are not included in the above totals.

leachate treatment is recommended because of its apparent, slight advantage over off-site leachate disposal. It is understood, however, that, in light of the very close comparative cost-effectiveness of these measures, a final decision regarding which one is most appropriate at the Volney Landfill will require the performance of a leachate treatability study and specific negotiations for long-term leachate disposal with a local municipal treatment facility.

(4) Supplementary capping (Alt. 3) has a slightly lower evaluation score and total present worth than leachate collection (Alts. 4a/4b). Both categories appear to be, within the assumptions and accuracy of this evaluation procedure, approximately equal from a cost-effectiveness standpoint.

(5) The combination of supplementary capping and leachate collection (Alts. 5a/5b) has a significantly higher score than either category alone, and a cost equal to approximately 80 percent of the combined individual costs of its two components. (As previously discussed, supplementary capping will reduce leachate generation and, thereby, reduce the long-term operation/maintenance cost associated with leachate collection.) Although Alts. 5a/5b cannot be quantitatively demonstrated as more cost-effective than either Alt. 3 or Alts. 4a/4b alone, this category does have the following relative benefits:

(a) Neither supplementary capping nor leachate collection are 100 percent effective at preventing leachate generation or collecting leachate, respectively. In combination, however, they reinforce one another and provide the maximum possible reduction of leachate migration from the site.

(b) In consideration of USEPA and NYSDEC policy, as expressed during the evaluation of alternatives in this study, the combination of supplementary capping and leachate collection provides a comprehensive approach which is most consistent with current regulatory policy and rationale for remediation of Superfund sites.

For the above reasons, supplementary capping plus leachate collection is considered an appropriate response at this site. Specifically, Alternative 5b (supplementary capping plus leachate collection with on-site treatment) is recommended for implementation at the Volney Landfill.

12.0 PRELIMINARY RECOMMENDATION OF REMEDIAL ACTION

On the basis of the preceding detailed evaluation of remedial alternatives, a preliminary recommendation of remedial action at the Volney Landfill site is presented in this section. The discussion below includes: a synopsis of the recommended plan; its estimated cost and implementation schedule; special considerations related to its design, construction and permitting requirements; a proposed long-term environmental monitoring program; and recommendations for a supplemental Remedial Investigation/Feasibility Study.

12.1 Remedial Action Synopsis

The recommended remedial action at Volney Landfill consists of a basic plan with several possible variations.

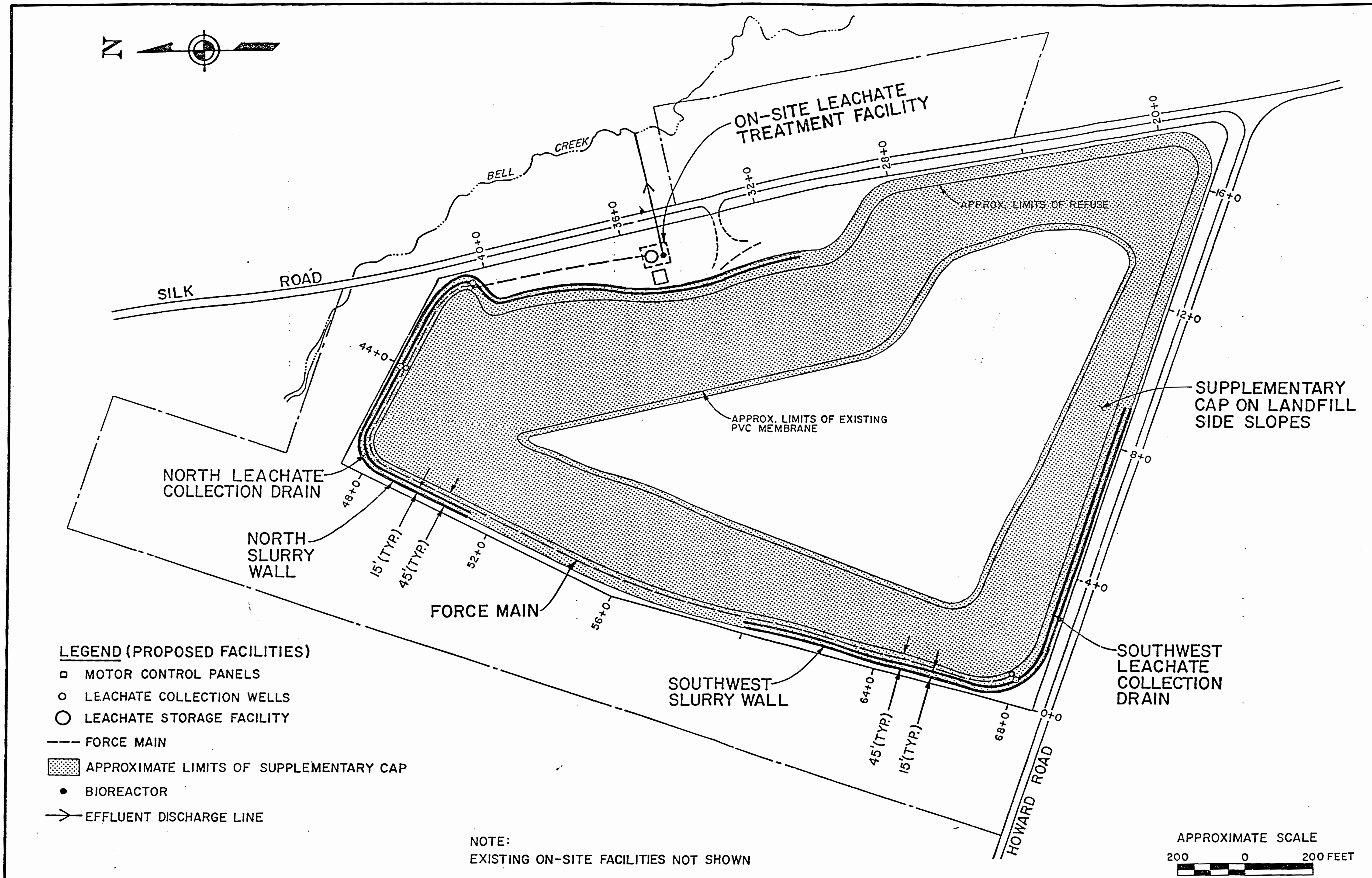
12.1.1 Basic Plan - The basic recommended remedial action plan, identified previously as Alternative 5b, consists of a supplementary cap on the side slopes of the landfill, a leachate collection system around part of the landfill perimeter, and an on-site leachate treatment facility.

Supplementary capping of the landfill side slopes involves approximately 35 acres lying between the limits of the existing PVC membrane liner and a line lying parallel to and approximately 45 feet beyond the existing limits of refuse (Figure 12-1). This offset allows the cap to be extended over the perimeter leachate collection drain and slurry wall. The supplementary cap will be placed over the existing 2-foot layer of compacted, seeded lodgement till as follows. Existing vegetation will be removed from the surface by scraping, and the resulting loosened surface will be recompacted by rolling. A 6-inch layer of sand will be added to provide support for a 60-mil high density polyethylene (HDPE) liner, textured to reduce the possibility of slippage by the overlying drainage layer. Above the HDPE membrane, a 24-inch layer of sand will be placed, followed by a 12-inch layer of topsoil or suitably amended native soil. The surface will be fine-graded, seeded and mulched using jute net. Regrading fill will be incorporated into the final cover design so as to provide 10-foot-wide terraces at vertical elevation changes of approximately 20 feet. (The purpose of these terraces is to reduce erosion and provide access to the landfill side slopes for future maintenance.) A passive gas venting system will also be incorporated into the supplementary cap. Figure 12-1 indicates the approximate limits of the proposed supplementary cap, and Figure 12-2 shows its sectional relationship to the existing PVC membrane on the landfill top, and to the proposed leachate collection drain/slurry wall.

The leachate collection system consists of a perimeter leachate collection drain and slurry wall around the north and southwest sections of the landfill, with an accompanying force main from the two drain segments to a new on-site leachate treatment facility on the east side of the site. From this treatment facility, effluent will be discharged to Bell Creek (Figure 12-1).

The leachate collection drain segments shown on Figure 12-1 lie parallel to and approximately 30 feet outside of the limits of refuse in the north and southwest sections of the site. Although a detailed geotechnical investigation will have to be performed along the drain alignment prior to final design, subsurface conditions have been estimated from the perimeter reference line shown in Figures 7-2 and 7-3. With respect to this reference line, the north drain will extend approximately from stations 31+00 to 51+20, and the southwest drain approximately from stations 60+00 to 9+20. (These are the estimated reaches along which there exists a significant depth of saturated sediments overlying lodgement till.) The drain will extend from the ground surface down to the top of lodgement till. In the north, this corresponds to an average depth of approximately 31 feet and a maximum depth of approximately 39 feet over the 2,020-foot drain length. The southwest drain will have an average depth of approximately 19 feet and a maximum depth of approximately 36 feet over its 1,780-foot length.

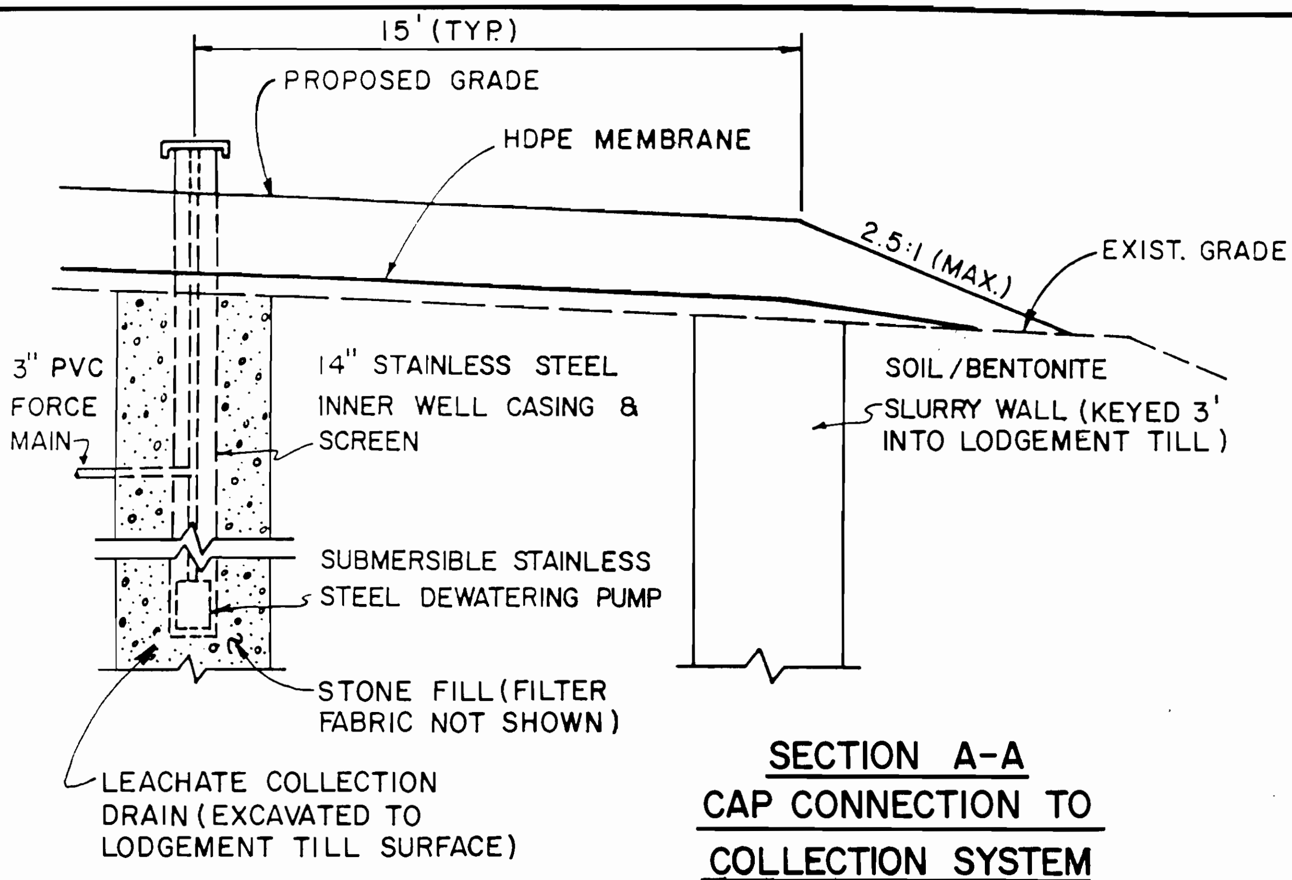
C-1466



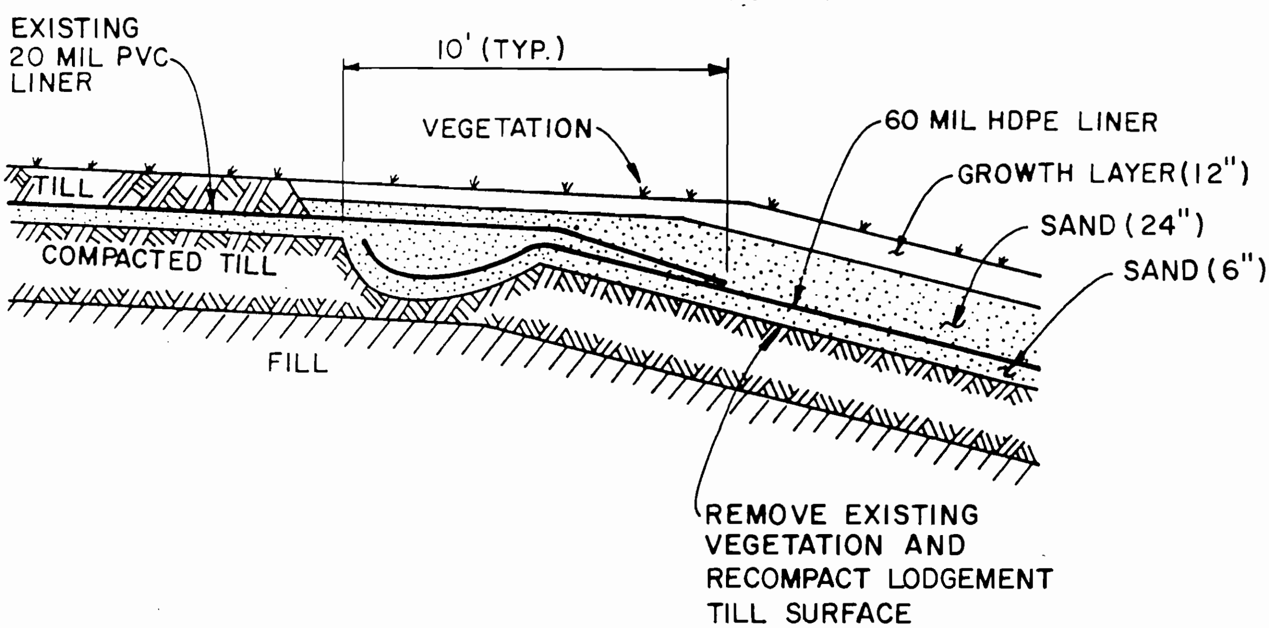
URS | URS Company, Inc. CONSULTING ENGINEERS NEW YORK NEW JERSEY

RECOMMENDED REMEDIAL PLAN-PLAN VIEW

FIGURE 12-1



SECTION A-A
CAP CONNECTION TO COLLECTION SYSTEM
NOT TO SCALE



SECTION B-B
CAP CONNECTION TO EXISTING PVC MEMBRANE
NOT TO SCALE

URS Company, Inc. CONSULTING ENGINEERS NEW YORK NEW JERSEY	RECOMMENDED REMEDIAL PLAN—SECTIONS	FIGURE 12-2

The leachate collection drain will consist of a stone-filled trench, four (4) feet wide, lined with filter fabric, and installed by excavation with temporary sheet piling (or other approved method.) At relative low points along the lodgement till surface, which the drain will follow, collection wells will be installed. These collection wells will consist of 14-inch diameter stainless steel casings and screens, with stainless steel pumps and controls. It is estimated that two (2) collection wells will be required along the north drain segment and one (1) along the southwest drain. From each well, an underground force main will convey leachate to the proposed leachate treatment facility.

Approximately 15 feet outside of the collection drain, a soil bentonite (SB) slurry wall will be constructed, with a key depth approximately three (3) feet into lodgement till. The purpose of this slurry wall is to minimize the entry of clean water from beyond the landfill limits into the leachate collection system.

Based on the evaluation in Section 8.3.1.2 of this report, and pending a treatability study, the optimum process train for on-site leachate treatment consists of: flow equalization, biological treatment and carbon adsorption. Major equipment items will include a 150,000-gallon equalization/storage facility, a 50,000-gallon sequenced biological reactor (with manual powdered activated carbon addition), and a filter press. Treated effluent will be discharged to Bell Creek, and sludge filter cake transported to an approved off-site landfill facility. The proposed treatment plant location is shown on Figure 12-1.

12.1.2 <u>Possible Plan Variations</u> - There are several possible variations of the basic recommended remedial plan, including: (a) modifications to the north segment of the leachate collection drain and equalization/storage facility to reflect the influence of the existing leachate collection system; and (b) consideration of off-site leachate disposal versus on-site treatment. Each of these possible variations is discussed separately below, along with its effects on total project cost and implementation aspects.

o <u>North drain segment and new storage facility</u> - The leachate collection system proposed herein takes no account of the existing system in the new (northern) section of the landfill. There are two primary reasons for this approach. First, since data is presently lacking concerning the design, construction and operation of this existing system, its performance cannot be accurately assessed, nor can its impact upon the proposed new collection system be evaluated. Second, an independent analysis of the proposed drain is more conservative and provides a higher degree of flexibility than one which hinges upon the use of existing facilities. Despite this approach, it is recognized that the existing leachate collection system in the northern section of the landfill will probably influence the design of the north drain and slurry wall segment, and in any case must be evaluated and taken into account during the design phase. As an extreme case, if the existing system is determined to effectively serve the same function as the north drain segment, then this north drain may not be necessary at all. Recognizing this possibility, Table 10-5 provides a separate breakdown for the cost of the north and southwest drains. As indicated by the following figures, the north drain represents approximately 64 percent of the total cost for leachate collection:

	North and Southwest Drains	North Drain Only
Total Capital Costs	$3,914,000	$2,491,000
Total Present Worth	$3,930,000	$2,501,000

Like the existing leachate collection system, and for the same reasons, the existing leachate holding tank was not accounted for in the preliminary sizing of a new equalization/storage tank for the proposed on-site treatment facility. Therefore, the new 150,000-gallon storage tank may be down-scaled if, during design, it is found that the existing tank can be used for supplementary storage. In any case, this existing facility must be further evaluated during the design phase of the project.

o Off-site leachate disposal - As discussed in the previous section of this report, on-site leachate treatment has been recommended over off-site disposal because of its lower estimated cost ($0.065 per gallon versus $0.079 per gallon). This comparative cost estimate, however, is based upon several assumptions, the most important being that the landfill leachate can be treated to stream discharge standards, and that a local POTW can be found for off-site leachate disposal at a disposal cost of $0.05 per gallon. Both of these assumptions must be further evaluated, the former through a treatability study and the latter through specific negotiations with local POTW's. If a leachate treatability study were to demonstrate that on-site treatment is less favorable than presently anticipated, for technical, economic or institutional reasons, then off-site leachate disposal could be substituted.

12.2 Schedule and Costs

The recommended remedial plan includes construction of a supplementary cap, leachate collection drain, slurry wall, force main and on-site leachate treatment facility. Under normal conditions, construction of these measures should require no more than 365 working days, or 12 months. From a weather standpoint, the critical factors in the project are the cap and slurry wall, which cannot be installed under freezing conditions. Even with this limitation, however, the project appears to be constructable within a single year, provided that the contractor's notice to proceed is received in a time frame which will permit full utilization of a construction season. The time required for engineering design, including the performance of a leachate treatability study and detailed geotechnical investigation along the leachate drain alignment, is estimated to be 12 months. Allowing an additional six (6) months between design completion and construction startup, for agency review, public participation and procurement, the total estimated time from design commencement to construction completion is 30 months.

Table 12-1 provides an estimated cost breakdown of the recommended remedial plan and possible plan variations, as discussed previously.

TABLE 12-1

ESTIMATED COST BREAKDOWN OF RECOMMENDED PLAN AND POSSIBLE PLAN VARIATIONS

Basic Plan Component Items	Direct Capital Costs ($\$x10^3$)	Indirect Capital Costs ($\$x10^3$)	Annual O/M Costs ($\$x10^3$)	Total Present Worth ($\$x10^3$)
Supplementary Cap	4,531.	1,677.	6.0	6,265.
Leachate Collection System	2,789.	1,125.	1.2	3,930.
On-Site Leachate Treatment	150.	140.	36.8	637.
Subtotal	7,470.	2,942.	44.0	10,832.
Project Initiation	1,120.	Ø	Ø	1,120.
Temporary Construction Facilities	1,195.	Ø	Ø	1,195.
Job Site Safety	149.	Ø	Ø	149.
TOTAL	9,934.	2,942.	44.0	13,296.
Possible Plan Variations				
Eliminate North Drain	-1,782.	-709.	- 0.8	-2,501.
Use Off-Site Leachate Treatment vs. On-Site	- 27.	- 95.	+20.2	+ 69.

This table separately identifies: direct capital costs (i.e., construction costs); indirect capital costs (additional studies, engineering, legal/administrative and 20-percent contingency); annual operation/maintenance costs; and total present worth. As before, present worth is based upon a 10-percent discount rate and 30-year operating life. Table 12-1 also includes estimated direct capital costs for project initiation (e.g., mobilization, temporary access roads, etc.), temporary construction facilities (e.g., office and decontamination trailers), and job site safety (e.g., provision and maintenance of safety equipment). Although these items were not included in previous cost evaluations, since they are common to all remedial alternatives, they are an important part of the total construction cost estimate. Finally, Table 12-1 identifies separately the estimated impact which each of the two possible plan variations discussed above would have upon total project costs. For example, elimination of the north drain segment would reduce total construction costs by approximately $1,782,000 (18 percent) and total present worth by approximately $2,501,000 (19 percent).

As indicated by Table 12-1, the total present worth of the recommended remedial plan is $13,296,000. This includes an estimated construction cost of $9,934,000, estimated indirect capital costs of $2,942,000, and estimated annual operation and maintenance costs of $44,000 per year.

12.3 Design/Construction/Permitting Considerations

Implementation of the recommended plan involves relatively straightforward design and construction features. There are, however, several considerations which bear special attention, as discussed below.

- Like all construction projects at waste disposal sites, it will be necessary to develop and implement a health/safety plan to protect workers and the general public during construction. Of special importance in this regard is the excavation of a leachate collection drain. Since this drain will be installed immediately outside the limits of refuse and in a trench saturated with leachate, the health/safety plan will have to provide measures to minimize the potential for contact with contaminated substances in solid, liquid and/or gaseous forms. Furthermore, as part of the operation plan, it will be necessary to develop methods for handling water encountered during trench excavation in a safe and environmentally sound manner (e.g. dewatering liquid must be collected and not discharged).

- o The 100-year floodplain of Bell Creek encroaches onto the extreme northeast corner of the site and, at one location, comes close to the north segment of the proposed leachate collection drain. While not a major concern, the design must take the occurrence of this floodplain into account in a manner acceptable from a regulatory standpoint.

- o A New York State Pollution Discharge Elimination System (SPDES) permit will be required for effluent discharge from the proposed on-site leachate treatment facility into Bell Creek.

- o Special provisions will have to be made during construction of the supplemental landfill cap to insure an adequate connection to, with minimum disruption of, the existing PVC membrane cap on the top surface of the landfill.

- o The moderately steep side slopes of the landfill create the possibility of erosion problems both during and after construction of the supplementary cap. For construction, an effective erosion/sediment control plan will have to be designed and implemented. On a longer-term basis, the engineering design must address potential erosion and slope stability problems, especially as they relate to the sand layer overlying the HDPE liner.

- Since the proposed remedial alternative represents a containment approach, it will be necessary according to SARA to inspect and re-evaluate the effectiveness of the plan every 5 years.

12.4 Proposed Groundwater Monitoring Program

A considerable effort has been expended over recent years to sample and analyze groundwater and surface water in the vicinity of the Volney Landfill. Table 12-2 summarizes the most recent recommended monitoring program at the site (Geraghty & Miller, 1986.) The locations of sampling points referred to on this table are shown in Figure 1-3.

In light of the present study's findings, certain modifications to the recommended monitoring program in Table 12-2 are considered to be appropriate. These are summarized in the following sections. It should be noted that the long-term monitoring program proposed herein is directed solely toward evaluating groundwater quality in the immediate vicinity of the landfill. In doing so, it will provide a data base for ongoing assessment of health risks associated with groundwater contamination, and a basis for evaluating the effectiveness of remedial measures to be implemented at the landfill. It will not, however, specifically address the impact of the site upon surface water quality, nor will it attempt to establish the limits of groundwater contamination, originating from the site, in horizontal or vertical directions. These objectives are addressed in Section 12.5 as part of a recommended supplemental Remedial Investigation/Feasibility Study (RI/FS).

12.4.1 Sample Locations - Proposed sample locations are indicated in Table 12-2 for residential wells, leachate sites, monitoring wells and surface water sites. As stated above, surface water monitoring will be

TABLE 12-2

PROPOSED MONITORING PROGRAM BY
GERAGHTY & MILLER FOR THE VOLNEY LANDFILL

SAMPLE LOCATIONS

Residential Wells (annual)

RW-1A	RW-5
RW-1B	RW-6
RW-2	RW-7
RW-3A	RW-10
RW-3B	RW-11
RW-4	

Monitoring Wells (semiannual)

GW-3C	GW-17
GW-3D	SGW-28
GW-5	SGW-29
GW-7R	SGW-30A
GW-9	
GW-12A	
GW-15	

Leachate Sites (semiannual)

OVL-1 (sump)
OVL-2 (tank)
OVL-3 (pump)

Surface Water Sites (semiannual)

SW-1
SW-3
SW-5

ANALYTICAL PARAMETERS

Alkalinity
Ammonia
Chemical Oxygen Demand
Chloride
Coliform (residential wells only)
Hardness
Iron
Manganese
Nitrate
Total Dissolved Solids
Total Organic Carbon
Sulfate
Specific Conductance
Temperature
pH
Zinc
Volatile Organic Compounds & Methyl Ethyl Ketone

WATER LEVEL MEASUREMENTS

All wells and surface water sites (semiannually) deleted from this phase of the program, and addressed as part of a supplemental RI/FS. Also, separate leachate monitoring will not be necessary, since leachate quality will be tested on a regular basis as an operational requirement for the on-site leachate treatment facility. For residential and monitoring well sample locations, reference is made to the baseline health risk assessment (Section 6.3.3), which utilized data from select residential and monitoring wells to evaluate potential health risks associated with contaminated groundwater in the site vicinity. These previously-selected well locations are, with some modifications, considered appropriate for long-term groundwater monitoring.

- Residential wells - All 8 of the residential wells used in the baseline health risk assessment are identified in Table 12-2 as proposed sampling locations. The table also includes 3 additional wells (RW-1A, RW-1B and RW-2) located to the north of the landfill. Although leachate from the site is not, by the assumptions discussed in Section 6.2, expected to reach these 3 residential wells, their inclusion in the monitoring program is conservative, and considered appropriate. Therefore, the proposed long-term groundwater monitoring program includes the 11 residential wells listed in Table 12-2.

- Monitoring wells - Of the 11 proposed monitoring wells in Table 12-2, 6 were used in the baseline health risk assessment, and are felt to be appropriate for inclusion in the long-term groundwater monitoring program. The remaining 5 wells in Table 12-2 include 3 (GW-9, GW-15 and SGW-30A) located to the east of the site, toward Bell Creek, and 2 (SGW-28 and SGW-29) located to the west and northwest of the site. Since these wells are not located in the groundwater flow directions of primary interest, it is felt that their number can be reduced to 1 well located east of the landfill (GW-9) and 1 well located to the west (SGW-28). In addition, monitoring wells GW-11A and GW-14A, from previous investigations, are recommended for inclusion in the monitoring program because of their down-field location in a primary reported direction of groundwater flow from the landfill toward residential wells. Finally, it is recommended that the following wells installed during this RI/FS, and used in the baseline health risk assessment, be included in the long-term groundwater monitoring program: VBW-1, VBW-2, VBW-3S, VBW-3BR, VBW-13 and VBW-16.

12.4.2 Analytical Parameters - Of the Hazardous Substance List (HSL) compounds considered in this study, the ones of greatest concern from a public health standpoint are benzene, methyl ethyl ketone (MEK, or 2-butanone), vinyl chloride, phenol, arsenic and manganese. Because the first 3 of these compounds are volatile organics, it is recommended that the entire volatile organic fraction of the HSL be included in the analytical program. The occurrence of phenolic compounds can be evaluated by analysis for total phenols. Arsenic and manganese should also be included in the program, along with the following additional metals: berylluim, lead, mercury, nickel, selenium, thallium and zinc (refer to Table 6-10). In addition to the above specific compounds, the following general indicators of leachate are recommended for inclusion in the analytical program: alkalinity, ammonia nitrogen, chemical oxygen demand (COD), total calcium hardness, total dissolved solids (TDS) and total organic carbon (TOC). With each sampling, field measurements should also be taken for specific conductance, pH and temperature. These general leachate indicators are the same ones analyzed for during this RI/FS.

12.4.3 Sampling Frequency - To evaluate seasonal fluctuations in groundwater quality, it is recommended that initially -- for a period of two (2) years -- all residential and monitoring wells be sampled and analyzed on a quarterly basis. Thereafter, the program frequency can be substantially reduced, unless the data indicates the need for continued frequent monitoring. From the third year onward, it is recommended, pending review of the initial two (2) years' data, that sampling and analysis be reduced to an annual basis. Further, it is estimated that, after the second year, the number of monitoring wells sampled can selectively be reduced to one-half the number used initially (i.e., from 16 to 8).

12.4.4. Program Summary - Table 12-3 summarizes the proposed long-term groundwater monitoring program at the Volney Landfill site. Sample locations are shown on Figure 1-3 for previous investigations ("GW" and "SGW" wells), and on Figure 4-1 for this Remedial Investigation ("VBW" wells). As indicated by this table, the assumed length of long-term groundwater monitoring is 30 years. The estimated annual cost of the program (sampling plus analysis) is $85,000 per year for the first 2 years and $16,000 per year for years 3 through 30. The total estimated present worth of this program is approximately $270,000. Details concerning these cost estimates may be found in Appendix L.

12.5 Recommended Supplemental RI/FS

The recommended remedial alternative at the Volney Landfill provides containment, or source control, of the hazardous waste located on-site. As discussed in Section 7.3, certain objectives were identified as falling beyond the scope of the present Remedial Investigation/Feasibility Study (RI/FS). These included evaluation of bedrock contamination and assessment of the site's impact upon the stream/wetland system adjacent to and downstream from the landfill. It is recommended that both of these issues be addressed as part of a supplemental RI/FS, which will be directed toward evaluating whether additional, off-site remedial measures are necessary at the Volney Landfill.

o Evaluation of bedrock contamination - The evaluation of possible bedrock contamination from the landfill should be performed as part of a larger study, in which the extent of groundwater contamination from the site in both horizontal and vertical directions is analyzed. Before the scope of such a study can be developed, it will be necessary to perform a residential well survey for the purpose of establishing existing downgradient wells (beyond those in the immediate vicinity of

TABLE 12-3

PROPOSED LONG-TERM GROUNDWATER MONITORING PROGRAM

SAMPLE LOCATIONS

Residential Wells		Monitoring Wells*	
RW-1A	RW-5	GW-3C	VBW-1
RW-1B	RW-6	GW-3D	VBW-2
RW-2	RW-7	GW-5	VBW-3S
RW-3A	RW-10	GW-7R	VBW-3BR
RW-3B	RW-11	GW-9	VPW-13
RW-4		GW-11A	VBW-16
		GW-12A	
		GW-14A	
		GW-17	
		SGW-28	

* Reduce number of monitoring wells from 16 to 8 after 2nd year

ANALYTICAL PARAMETERS

HSL Volatile Organics
Total Phenols
Metals:
- Arsenic
- Beryllium
- Iron
- Lead
- Manganese
- Mercury
- Nickel
- Selenium
- Thallium
- Zinc

Leachate Indicators:
- Alkalinity
- Ammonia Nitrogen
- Chemical Oxygen Demand (COD)
- Hardness (Calcium)
- Total Dissolved Solids (TDS)
- Total Organic Carbon (TOC)
- Specific Conductance**
- pH**
- Temperature**

** Field Measurement

SAMPLING FREQUENCY

Years 1 through 2: Quarterly
Years 3 through 30: Annually

the landfill which were surveyed by previous investigators), which can be used to track, if feasible, the leading edge of a groundwater contaminant plume. It is anticipated that, in addition to existing residential wells, some new bedrock and overburden wells will have to be installed at various locations downgradient from the site. Although the cost of this study cannot be accurately estimated without the residential well survey mentioned above, it is estimated, for preliminary budgetary purposes only, that the study cost will be approximately $300,000. This includes approximately equal allowances for field work (e.g., well installation), laboratory analyses, and hydrogeological evaluation/report preparation.

o Environmental assessment of wetlands - An environmental assessment of the stream/wetland systems along Bell and Black Creeks should be performed in order to assess the Volney Landfill's impact upon these ecosystems. As indicated previously in the report (Section 5.0), surface water contamination levels within these streams are generally low, but sediment contamination occurs at significantly higher levels. The environmental assessment should address the site's specific impact upon these water bodies (as distinguished from possible upstream contaminant sources), and should include a quantitative assessment of risks associated with surface water/sediment contamination. Although the experimental design and cost estimate for this environmental assessment will require coordination with state and local environmental officials, and is beyond the present scope of work, the cost for a similar environmental assessment of the stream system adjacent to the PAS Superfund site in Oswego, New York was approximately $250,000. For preliminary budgetary planning purposes, it is recommended that a cost of $300,000 be allocated for the recommended environmental assessment at Volney Landfill.

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