REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

AT THE

RAMAPO LANDFILL

ROCKLAND COUNTY

NYSDEC SITE NO. 3-44-004

TOWN OF RAMAPO, NEW YORK

SEPTEMBER 1991

PREPARED BY

URS Consultants, Inc.
282 Delaware Avenue
Buffalo, New York 14202

VOLUME 1 OF 4

REMEDIAL INVESTIGATION

AND

FEASIBILITY STUDY

AT THE

RAMAPO LANDFILL

RAMAPO (T), ROCKLAND (C), NEW YORK

SEPTEMBER 1991

Prepared for:

TOWN OF RAMAPO, NEW YORK

SUMMARY
TABLE OF CONTENTS
RAMAPO LANDFILL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

VOLUME I: REMEDIAL INVESTIGATION

VOLUME II: FEASIBILITY STUDY

VOLUMES III AND IV: APPENDICES

RAMAPO LANDFILL

REMEDIAL INVESTIGATION

VOLUME 1

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

VOLUME 1

Page No.

TABLE OF CONTENTS - Continued

VOLUME 1

TABLE OF CONTENTS - Continued

VOLUME 1

RAM 001 0447

TABLE OF CONTENTS - Continued

VOLUME 1

RAM 001 0448

TABLE OF CONTENTS
VOLUME I
LIST OF FIGURES

TABLE OF CONTENTS
VOLUME I

LIST OF TABLES

TABLE OF CONTENTS
VOLUME I

LIST OF TABLES (Continued)

TABLE OF CONTENTS
VOLUME I
LIST OF TABLES (Continued)

TABLE OF CONTENTS
VOLUME I

LIST OF TABLES (Continued)

TABLE OF CONTENTS
(VOLUMES 3 AND 4)
LIST OF APPENDICES

RAM 001 0454

EXECUTIVE SUMMARY

Remedial Investigation

The Ramapo Landfill is an inactive landfill site located on a 96-acre tract in the Town of Ramapo, Rockland County, New York. It lies at the base of the Ramapo Mountains, about 35 miles northwest of New York City, and one mile northeast of Hillburn, New York. A portion of the site is currently being used as a trash compaction facility by the Town of Ramapo. A police pistol range is also found on site.

(Please note that the use of the words onsite and offsite throughout this report are to depict the area within the property lines shown on Plate 1, and are not intended to convey the meanings defined in the National Contingency Plan (NCP).

About 50 acres of the site have been used for landfill activities. The filled portion occurs in two major mounds, or lobes, which slope steeply to the west toward Torne Brook, a Class B stream. Torne Brook is a tributary of the Ramapo River, a Class A stream. The Ramapo River, lies, at its nearest point of approach, 300 feet from the southwest corner of the site. Spring Valley Water Co. wells that supply over 200,000 people are found across the Ramapo River; two of which are within 1,500 feet of the landfill. Two residential wells, supplying a total of approximately 55 residents, are located within 1,200 feet of the site; the closest of which is approximately 400 feet from the limits of fill.

Analytical data was provided to URS by the Spring Valley Water Co. for the three water supply wells in the vicinity of the landfill. The data showed that water from these wells, which draw from the overburden, met both the enforceable Safe Drinking Water Act and NYS Department of Health maximum contaminant levels.

The Ramapo Landfill site was first used as a gravel quarry in the 1950s. The landfill was permitted in 1971 by the Rockland County Department of Health. Filling may have begun as early as the mid-1960s, and was carried on into the early 1980s. Substances allegedly dumped include demolition debris, municipal waste, industrial and sewage sludges, and paint sludge. Excavation and filling progressed generally from west to east; the southern lobe to the northern lobe and back to the southern lobe.

From 1974, when a black sludge was discovered emanating from the landfill, an extensive amount of sampling has been carried out at, and in the vicinity of, this site. Approximately 30 separate sampling events or sampling series have been carried out. These have examined leachate, surface water, groundwater, air, and waste. The earliest studies were undertaken by local and regional water authorities. The site gradually came to the attention of the New York State Department of Health, New York State Department of Environmental Conservation (NYSDEC), and the United States Environmental Protection Agency (USEPA). In 1980 the first Consent Order was entered into between the Town of Ramapo and the NYSDEC.

In 1984-85 a leachate collection system was installed by Hutton Construction Co., Inc. of Ceder Grove, NJ for the Town of Ramapo along the downgradient edge of the landfill. Surface water and groundwater were conducted to an aeration lagoon in the site's southwest corner. The lagoon's discharge was initially to the Ramapo River after aeration in the lagoon. Since November 1, 1990, water has been directly discharged to the Village of Suffern Wastewater Treatment Plant.

Since 1980, four Consent Orders have been entered into between the Town of Ramapo and NYSDEC. In March 1989, URS Consultants, Inc. contracted with the Town of Ramapo to perform a Remedial Investigation (RI) and Feasibility Study (FS) at the site in compliance with the latest Consent Order.

In addition to its environmental sampling effort (for chemical analysis) URS performed the following site work:

- surveyed and mapped site locations where samples were collected
- performed geophysical surveys
- took stream profiles across the Ramapo River and Torne Brook for discharge calculations
- made 31 soil borings
- installed 28 monitoring wells and 10 piezometers
- performed hydraulic conductivity testing in all monitoring wells
- took samples for geotechnical analysis
- performed pressure-testing for bedrock in 10 rock coreholes
- measured groundwater and surface water elevations
- performed a Habitat-Based Assessment of animal and plant life on or near the site.
- performed a community well survey.

Field work was carried out in two phases, the first from April 1989 through May 1990, the second in August-September 1990.

The sandy loams generally characterizing the site are deep, and were formed in glacial till derived mainly from schist and gneiss. Permeability is moderate to moderately high. Vegetative covertypes include oak-tulip forest, hemlock-northern hardwood forest, and a low, herbaceous growth that covers most of the landfill. Woody plants, once covering the site and removed by quarry and landfilling activities, are not colonizing the landfill rapidly. No NYSDEC-regulated wetlands occur within 9 miles downstream of the site. Local streams provide habitat for several species of fish, although data showing that the landfill might be affecting fish life in the stream are lacking.

The dominant surface water feature in the area is the Ramapo River, a class A water body with an average flow of 110 mgd. Torne Brook, which flows as close as 50 feet from the landfill, discharges to the Ramapo River just west of the site. Torne Brook and its tributaries are Class B water bodies. All site drainage enters the Torne Brook-Ramapo River drainage basin.

The Ramapo Landfill is underlain by a sequence of unconsolidated sediments that overlie bedrock of granitic and biotite gneiss. Overburden sediments are the result of recent alluvial deposition from the Ramapo River and Torne Brook and of late Wisconsin glacial deposition.

In addition to the prominent Ramapo fault, which exists east of the site along the base of the Ramapo Mountains, a number of less prominent lineaments have been identified, though not located during field activities; two of these impinge upon the landfill itself. The importance of these lies in their providing a potential pathway for migration of contaminants offsite.

The fill at the site is a heterogeneous mix of materials in a native silt-sand matrix. URS estimates of maximum fill thickness are up to 80 feet in the northern lobe, and 70 feet in the southern lobe. Three units have been identified as underlying the site: an overburden aquifer consisting of loose and dense sands; an intermediate unit within a thin zone of weathered rock; and a bedrock aquifer. Depth to bedrock ranges from zero to greater than 65 feet. Hydraulic conductivities in loose sands of the overburden aquifer were on the order of 10^{-2} cm/sec; and in the dense sands on the order of 10^{-5} cm/sec. Hydraulic conductivity values for the bedrock aquifer ranged from 1.3×10^{-5} cm/sec to 1×10^{-2} cm/sec.

The water table surface closely parallels the surface topography, meaning that shallow groundwater generally flows toward and discharges into, Torne Brook which is a topographic low for the area. Although the intermediate and bedrock aquifers appear to follow the same general pattern as the overburden aquifer, it is likely that they flow beneath Torne Brook, and do not discharge into it. The direction of vertical flow across the site is variable, but is generally downward; upward gradients have been identified near the Ramapo River.

There were no NYSDEC regulated or federal jurisdictional wetlands identified onsite or within the drainage area of the landfill. However, the United States Geological Survey (USGS) identified an area of less than ten acres offsite and east of the Baler Building as a wetland. Therefore, a wetland is assumed to be present.

Media sampled during the RI included surface and subsurface soil, groundwater, surface water, sediments, and air. In assessing the extent of contamination, degree of risk, and implementability of remedial alternatives, Applicable or Relevant and Appropriate Requirements (ARARs) were considered. For the RI, consideration was restricted to chemical-specific ARARs for each media.

Of eleven surficial soil and waste samples analyzed, one--a paint sludge sample taken away from the landfill surface failed the test for the characteristic of ignitability but is not defined as hazardous waste according to testing procedures. This material as well as the surrounding soil was removed by the NYSDEC. Volatiles showed up infrequently and at relatively low concentration in surficial soil; semivolatiles, especially polycyclic aromatic hydrocarbons (PAHs), were detected across the site, and at higher concentrations. Migration of semivolatiles offsite appears to be occurring. Pesticides were not a widespread soil contaminant, nor were PCBs detected in surficial soils. Cadmium, beryllium, and mercury were detected. There are no ARARs for surficial soil.

Contamination of surface soil sample LSMW-10 off the landfill surface appears to be due to erosion of contaminated landfill surficial soils.

Subsurface soil samples were taken above the water table, and all but one were taken from a depth of greater than 4 feet. Organic compounds (1 volatile and 6 semivolatile compounds) were detected in subsurface soils at a single well MW-3. Pesticides and PCBs were not found in the samples. Metals were detected at similar concentrations in all soil borings across the site. There are no ARARs for subsurface soil.

Ten monitoring wells were installed in the overburden aquifer, eight in the intermediate aquifer, and ten in the bedrock aquifer. Twenty-four volatiles were detected in groundwater. (Two of these are suspected laboratory contaminants.) Concentrations of volatiles were relatively low, but higher than background. Naphthalene, a PAH, was detected in groundwater, although the absence of other PAHs in groundwater and their presence in subsurface or surficial soil, is an indication that PAHs are not leaching from soil to groundwater. Two pesticides, neither of which had been detected in onsite soils, were detected in groundwater. Eight metals were found in excess of background metals concentrations. The area of the site showing greatest contamination was the area around MW-8, near the site's southwest corner. This monitoring well is located adjacent to a section of the deep leachate collector which at least periodically is situated above the water table. Among groundwater samples, ARARs were exceeded in all three aquifers only for benzene, iron, manganese, and TOC. Most ARAR exceedances were in MW-8 (all aquifers) and MW-4 (all aquifers).

Vinyl chloride, as well as oil and grease, were detected in samples taken from Torne Brook, upstream of the landfill. Vinyl Chloride was not detected in any other media on or offsite (surficial or subsurface soil, groundwater, sediments, or air), therefore, its presence is felt to be due to upstream contamination. Twelve metals were also detected in upstream samples. Three volatile organic compounds (vinyl chloride, benzene, toluene) and several metals (copper, aluminum, iron, vanadium) were found at slightly elevated levels adjacent to the landfill but not downstream of it. These compounds were also found in some of the groundwater samples. Therefore, there is some evidence of landfill effect upon Torne Brook, adjacent to the landfill, although it is relatively minor.

The Ramapo River showed no signs of present contamination by the landfill, although evidence of past contamination was found at the now-unused, former Outfall 001 near the leachate pond. Recent sampling by the NYSDEC (July, 1991) showed that the landfill was not contributing to contamination of the Ramapo River. Onsite leachate seeps showed relatively high concentrations of several metals, but the seeps appear to be intermittent.

Among surface water samples, ARARs were exceeded in upstream samples for vinyl chloride, mercury, thallium, zinc, TOC, sulfide, and lead. In downstream samples: vinyl chloride, antimony, arsenic, iron, manganese, mercury, nickel, zinc, ammonia, TOC, NO_2-N, TDS, sulfide, copper, and lead. The bulk of downstream samples in which ARARs were exceeded were taken from former Outfall 001. The landfill is therefore not a significant contributor to downstream surface water contamination.

Sediment samples were collected at eight surface water sampling stations and in the leachate holding pond. Upstream of the landfill, sediments showed no organic compounds, but 18 metals were detected. A similar array of compounds was seen in downstream samples, indicating a lack of contribution by the landfill of sediment contamination except to a minor extent in the localized areas of SS-3 and SS-8. Sediment cleanup criteria (TBCs) calculated for these and other samples did not show any exceedances. While many of the sediment contaminants were not found in the groundwater and surface water, many were the same as those found in surficial soils across the site. Erosion may therefore be a contributing factor to the contamination of Torne Brook.

Air monitoring was conducted within piezometers. "Hot spot" monitoring was also carried out for TCL organics, and point source monitoring was carried out for methane and TCL organics. Relatively high methane readings were detected at two piezometers. One relatively high point source reading was also obtained. One ARAR for air samples (one-three hundredth Threshold Limit Values) was exceeded. Ambient Guideline Concentrations (AGCs) were not exceeded.

A baseline health risk assessment (HRA) performed in compliance with guidance provided by the United States Environmental Protection Agency, was prepared to evaluate potential adverse health effects caused by the release of chemicals from the Ramapo Landfill site in the absence of remedial measures. Five basic pathways were evaluated in the baseline HRA which included: 1) ingestion of soil; 2) dermal contact with soil; 3) inhalation of vapors from the landfill; 4) ingestion of groundwater; and 5) inhalation of vapors released from groundwater during showering. These pathways were evaluated for both current and future use conditions.

Human health risks were calculated for both noncarcinogenic chemicals (i.e. chemicals having toxic effects but not expected to cause cancer) and carcinogenic chemicals (i.e. chemicals that could potentially cause cancer). For noncarcinogenic chemicals, both short-term or subchronic and long-term or chronic effects were evaluated. Under current land use conditions, total sitewide risks based on the combination of the basic pathways were determined for adults (trespassers and nearby residents), children (trespassers and nearby residents), and employees working at the site. Under future land use conditions, it was assumed that residential development would occur at the site even though this is contrary to current zoning ordinances. Consequently, total sitewide risks were determined for adults and children living onsite, and workers.

Under present land use conditions, the risk characterization showed that cancer risks for all populations evaluated (i.e. adults, children, and workers) were within the acceptable range (i.e. 1E-06 to 1E-04) established by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The evaluation of non-cancer risks under present conditions showed that the hazard index (a measure of noncancer risk) was below the acceptable level of one for adults, however, the acceptable level was exceeded for workers and children. In accordance with the USEPA guidance, when the hazard index exceeds one there may be concern for potential health effects. For children and workers, essentially all potential noncancer risk results from inhalation of vapors from the landfill. The chemical(s) responsible for this risk are xylenes (total) and chlorobenzene for workers and xylenes (total) alone for children.

The evaluation of risk under present conditions as summarized above, is based upon numerous assumptions, and therefore, involves a considerable degree of uncertainty. Some of this uncertainty is inherent in the risk assessment process itself, and the current limits of scientific knowledge regarding human health risk factors. For example, the extrapolation of animal study data to humans, and from high doses used in experimental studies to the low doses associated with hazardous waste sites results in large uncertainty factors for the published toxicity values used in the risk assessment for xylenes (total) and chlorobenzene. For these two chemicals which are responsible for essentially all risk under current conditions, the uncertainty factors are 100 and 1000, respectively, biased conservatively. Uncertainty is also introduced into the risk assessment by the limits of available data. For example, concentrations of chlorobenzene and xylenes (total) in the air samples are generally low except for one sample (PSR-2) which was taken at an auger drilled into fill within the northern lobe and abandoned. In addition, these concentrations are estimated values because interference was encountered during analysis. Since the concentrations of xylenes (total) and chlorobenzene reported for PSR-2 are solely responsible for driving the hazard indices for workers and children above the acceptable level of one, the potential for human health effects under present conditions is highly uncertain.

In keeping with USEPA's concept of reasonable maximum exposure, very conservative assumptions were utilized to calculate risk. As a result, the general population is almost certainly not exposed to levels estimated in this analysis, and therefore, would experience risks which are smaller than those presented. Because of this conservative approach and the high degree of uncertainty associated with risk calculations (particularly with those that exceeded acceptable levels), this health risk assessment under present conditions should be utilized with discretion and in conjunction with other means of assessment (e.g. ARARs) in determining the need for and/or approach to site remediation.

Under future use conditions, (i.e. a resident residing on the landfill withdrawing groundwater) cancer risks for workers and children were within the NCP acceptable range; however, cancer risk for adults slightly exceeded the acceptable limit of 1E-04. Noncancer risks for all populations exceeded the acceptable value of one. For both cancer and noncancer risks inhalation of vapors from the landfill and ingestion of groundwater were the pathways responsible for all the risk for all receptors.

The primary chemical contributors for inhalation of vapors were benzene for cancer risk and chlorobenzene and xylenes (total) for noncancer risk. As under present conditions, the questionable nature of data from PSR-2 make estimates of risk associated with inhalation of vapors from the landfill highly uncertain. For ingestion of groundwater, arsenic and manganese were the primary chemical contributors to cancer and noncancer risk, respectively.

As under present conditions, the concept of reasonable maximum exposure was utilized to calculate risk. In evaluating future conditions, it was assumed that the landfill will be used for residential development. However, the landfill and surrounding area are zoned for industrial use. Plans for development into the distant future cannot be known with certainty. However, the Town of Ramapo's current and stated intent for future zoning requirements, and the fact that a landfill is unlikely to become an area of residential development, make estimates of risk for adult and children in the future highly hypothetical. Estimated risk to workers in the future may be considered more probable than estimates of potential residential exposure. However, the primary contributor to risk under this scenario is exposure to vapors from the landfill. Uncertainty associated with inhalation of vapors from the landfill has been discussed earlier. The other contributor to risk (although not as high) is ingestion of groundwater. Such potential worker exposure to groundwater could easily be eliminated by continuing to supply workers with an alternate drinking water supply, e.g. bottled water. As with the evaluation of risk under present conditions, the assessment under future conditions should be utilized with discretion when determining the need for and/or approach to site remediation.

1 INTRODUCTION

(Please note that the use of the words onsite and offsite throughout this report are to depict the area within the property lines shown on Plate 1, and are not intended to convey the meanings defined in the National Contingency Plan (NCP).)

In the 1950s and 1960s, prior to landfill operations, portions of the site were excavated as a source of gravel. On May 28, 1971, the Rockland County Department of Health granted a permit to the Town of Ramapo for the operation of a sanitary landfill. There is evidence, however, of clearing and possible filling at the site prior to this time. Early operations at the landfill occurred in the northern half of the site. Operations in the 1980s concentrated on the southern lobe, but the northern lobe was expanded. Landfilling was completed by 1984.

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). Given the results of analytical testing of onsite leachate, groundwater, and nearby surface waters, as described under Section 1.2.4 of this report, HRS scoring was conducted in 1982.

The Hazard Ranking System (HRS) score developed for the site was 44.73 which was above the minimum score of 28.5 necessary for inclusion on the NPL. Consequently, the site was proposed and listed as a NPL site. As of April 1991, the site was #326 on the NPL (out of 1,089 sites). The site has been identified and classified as Classification Code 2 by the New York State Department of Environmental Conservation (NYSDEC): significant threat to the public health or environment - action required.

In July 1983, a Remedial Action Master Plan (RAMP) was performed for the site by NUS Corp. under contract to the United States Environmental Protection Agency (USEPA). The RAMP was intended to be the basis of a scoping decision made by the lead federal agency to request funding for remedial actions.

Four Consent Orders concerning the Ramapo Landfill have been entered into between the Town of Ramapo and the NYSDEC. These orders are dated June 4, 1980, May 20, 1983, February 8, 1985, and February 1, 1988. The 1980 Order required the Town of Ramapo, as Respondent: (a) to determine the extent of leachate movement and the feasibility of leachate collection, (b) to construct a surface water and groundwater diversion system, (c) to construct a leachate collection system, (d) to construct a system capable of transporting or treating the collected leachate, (e) to phase out operation of the landfill pursuant to conditions stated in the Order, and (f) to meet other related requirements specified in the Order and in the schedule of compliance that was part of the Order.

A Modified Order on Consent was signed in 1983 requiring the Town of Ramapo to comply with a modified Schedule of Compliance, which required construction of a leachate collection system, maintenance of an interim surface water diversion system, construction of an Initial Treatment System and monitoring of the effluent from that System, a subsurface investigation program, the phase-out of the existing site for refuse disposal and submission of a closure plan. The 1983 Order included a description and a schematic drawing of the Initial Treatment System.

The 1985 Order included a new schedule of compliance which, among other provisions, required that the Initial Treatment System be completed on or before June 30, 1985, and which also required construction of a final treatment system by October 31, 1986.

In August 1986, a hearing was conducted in the matter of an application by the Town for a State Pollutant Discharge Elimination System (SPDES) permit. As a result of this hearing, it was stated that the position of the NYSDEC staff was that the Town had missed dates in the Orders on Consent but had not been grossly negligent or willful. The SPDES permit was therefore approved.

On February 1, 1988, the Town entered into its fourth and current (Title 3 1986 Environmental Quality Bond Act) Consent Order with the NYSDEC. The goal of this Order is to develop and implement a remedial investigation, feasibility study and remedial program for the site, subject to the approval of the NYSDEC. The ongoing study of the Ramapo Landfill site, described herein, is being conducted to satisfy this Consent Order.

1.1 Purpose of Report

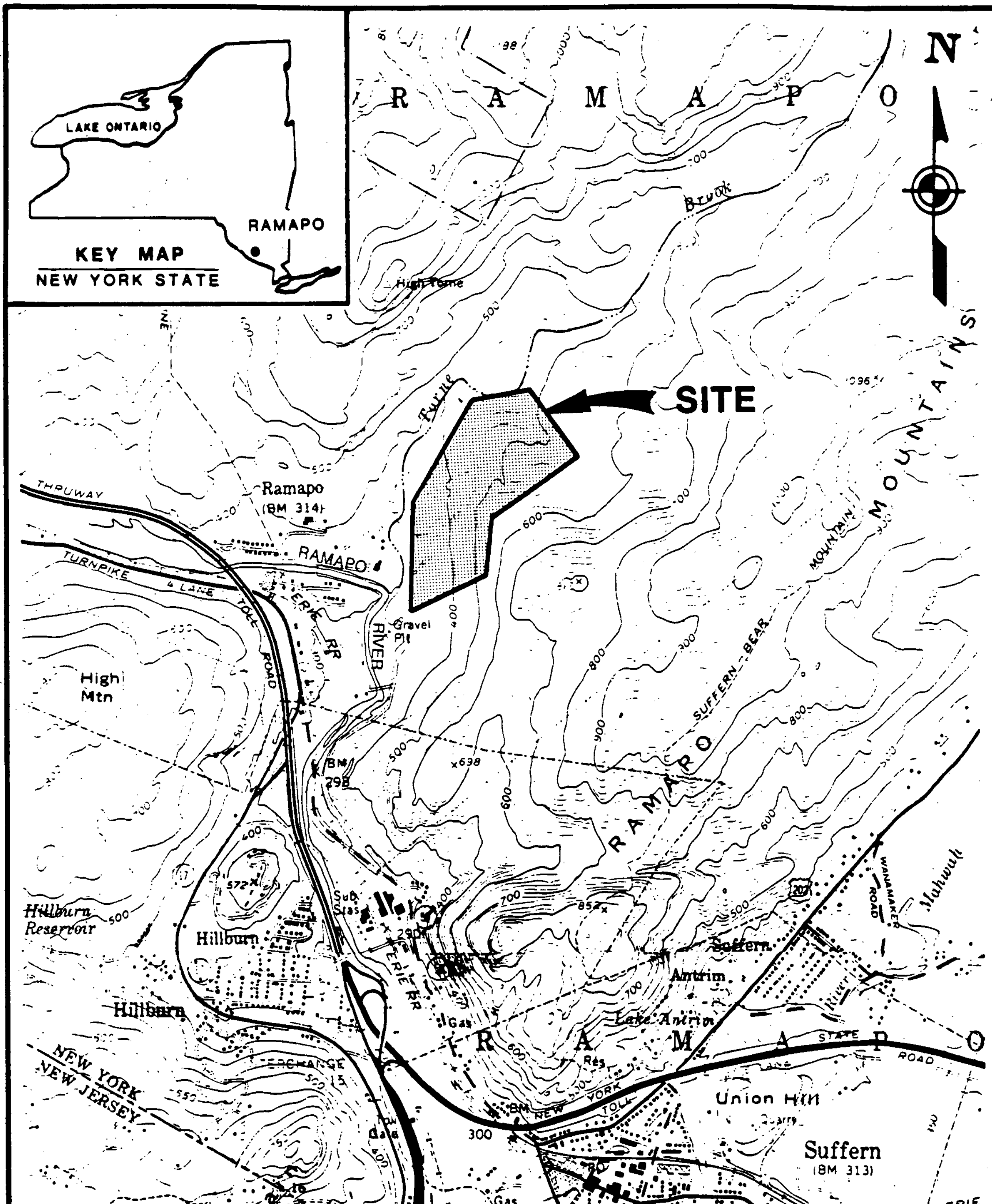
The purpose of the Remedial Investigation Report is to present, summarize, and provide interpretation and conclusions on data gathered during the Remedial Investigation (RI) activities at the Ramapo Landfill, Town of Ramapo, County of Rockland, New York. Activities were performed in two phases. First phase activities were performed from April 1989 through May 1990 and included: preliminary literature reviews, site entry air monitoring, a soil-gas survey, geophysical surveys, historical photography interpretation, fracture trace analyses, stream-surface-subsurface soil and waste investigations, installation of monitoring wells and piezometers, stream water and groundwater sampling, chemical analysis of samples, hydraulic conductivity tests, geotechnical analysis on selected soils, stream velocity profiles, and preparation for a Habitat Based Assessment. A report presenting the results of the first phase of investigation was provided to the public information repositories for public comment in July 1990. The scope of work for the planned second phase of field activities was also provided at that time. Following the comment period, the second phase of field activities began in August 1990 and continued through September, 1990. The second phase activities included: installation of additional monitoring wells and piezometers, collection and chemical analysis of samples from groundwater, stream water, stream sediments, air, and the leachate pond, hydraulic conductivity tests, geotechnical analysis of surficial soils, and a terrain conductivity survey (conducted in June 1990). Results from the second phase were provided to the public information repositories in December 1990 as Appendices to the RI/FS report.

This Remedial Investigation and the associated Appendices present the results of both investigation phases. This information provides for the characterization of physical, geological, hydrogeological, chemical, and environmental factors at the Ramapo Landfill. The data and interpretations provided herein are presented to define the nature and extent of contamination and its effect on human health and the environment, and to provide adequate characterization of the site for the Feasibility Study.

1.2 Site Background

1.2.1 Site Description

The Ramapo Landfill is located on a 96-acre tract in the Town of Ramapo, Rockland County, New York, about 35 miles northwest of New York City, and 1 mile northeast of the Village of Hillburn, New York. The site location is shown on Figure 1-1 and a site plan on Figure 1-2. The site is situated at the western base of the Ramapo Mountains off Torne Valley Road east of the New York State Thruway, NYS Route 17, and NYS Route 59. Utility corridors lie on three sides of the site, high voltage power transmission lines to the east and west, and a high-pressure gas line to the south. A power substation is located just to the north of the site.



USGS 7.5 MINUTE SERIES
RAMSEY AND SLOATSBURG
QUADRANGLES (1955)

Ramapo Landfill

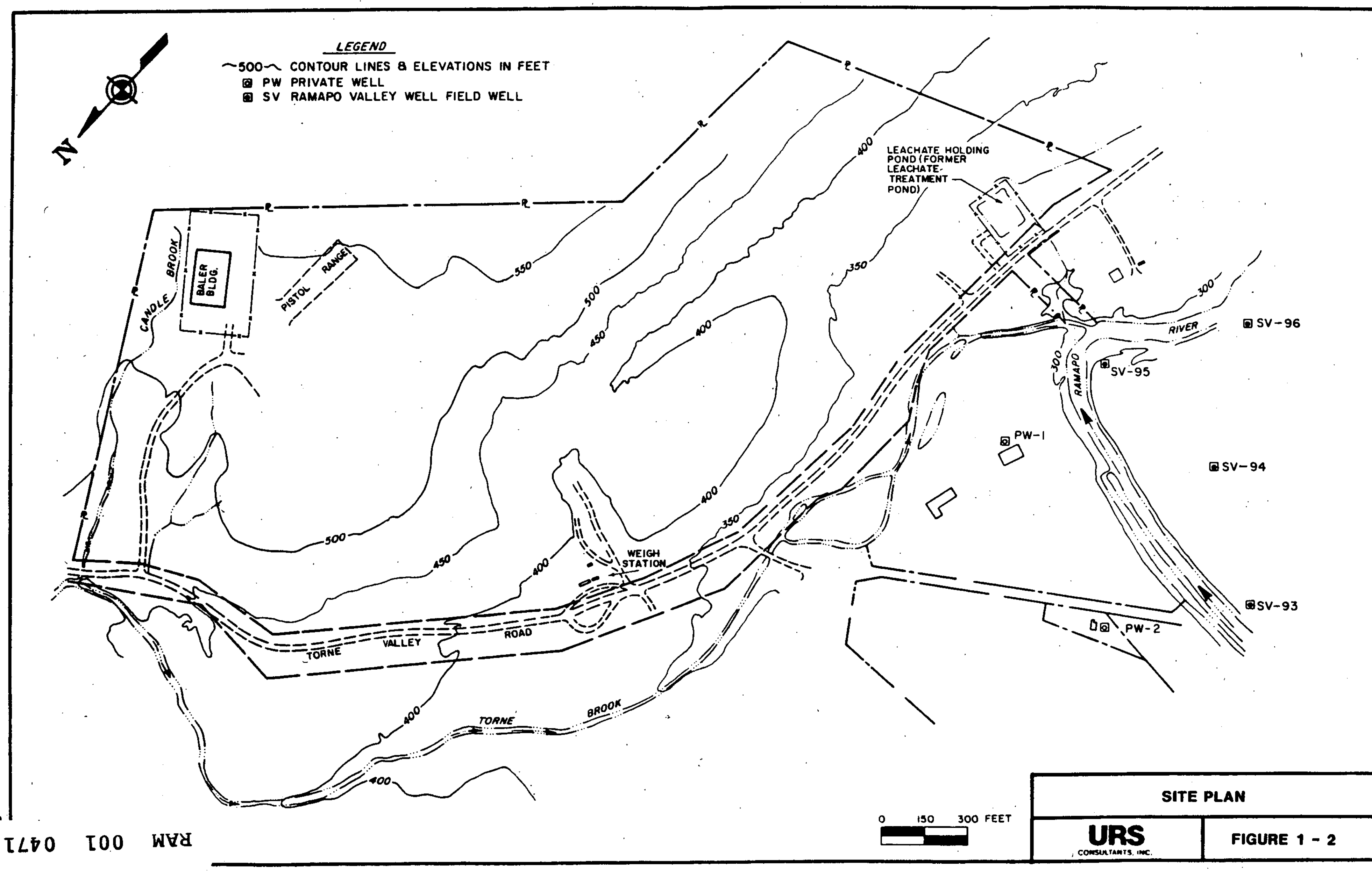
0 1000 2000FT
SCALE

A-2936-C

URS CONSULTANTS, INC.

SITE LOCATION

FIGURE 1-1



SITE PLAN

URS CONSULTANTS, INC.

FIGURE 1 - 2

RAM 001 0471

The site is currently being used as a compaction and transfer facility by the Town of Ramapo. Trash and debris are weighed at a weigh station/guard house along Torne Valley Road and compacted at a baler facility in the eastern corner of the site, and transferred to the Al Turi Landfill in Goshen, New York. A pistol range utilized by the Town of Ramapo Police Department is also located near the eastern corner of the site. A leachate collection system diverts surface and subsurface leachate from the landfill to a pond in the southwestern corner of the site. The Town routinely maintains this system. Prior to November 1, 1990, this pond was used for leachate treatment. Since this date, however, the Town has been discharging the collected water to the Suffern Wastewater Treatment facility twelve hours a day. For the remaining twelve hours, the pond is used as a holding basin.

Approximately 50 acres of the site are covered with fill material. The landfilled portion of the site is mounded into two major lobes (northern and southern), and slopes steeply toward the west with grades ranging from less than one percent to greater than 30 percent. Vegetative cover, although generally thick, varies from young trees to a mix of grasses and underbrush to bare ground. Areas along the site boundaries consist of mature hardwood forest.

The dominant surface water features in the vicinity of the site are the Ramapo River, Torne Brook, and Candle Brook. The Ramapo River, located approximately 300 feet from the southwest corner of the site, is a NYSDEC Class "A" waters and may be used as a source of water supply for drinking, culinary, or food processing purposes. Torne Brook, which flows near the western boundary of the site, and Candle Brook, a tributary of Torne Brook, are NYSDEC Class "B" waters suitable for primary contact recreation and any other use except as a source of water supply for drinking, culinary, or food processing purposes. These surface water features are shown on Figure 1-2.

Groundwater is withdrawn from the area south and west of the site for residential use. Two private wells, identified as PW-1 and PW-2 on Figure 1-2, are located within 1,200 feet of the landfill and supply over 50 people. Four production wells from the Ramapo Valley well field, which is operated by the Spring Valley Water Company and identified as SV-93 through SV-96 on Figure 1-2, are located within 1,500 feet of the landfill. These wells supply over 200,000 people.

1.2.2 History of Landfill Operations

Prior to landfill operations in the 1950s and 1960s, portions of the site were excavated as a source of gravel. Five to fifteen feet of gravel was reportedly removed near the access road per discussions with the former landfill operator. From the 1965 aerial photo obtained from the U.S. Department of Agriculture (USDA), an estimated 25% of the site had been disturbed by clearing, excavation (by trenching), and possibly filling of excavated areas in the northern portion of the site. This photo substantiates allegations of dumping prior to the initiation of permitted landfilling activity by the Town of Ramapo. Paint sludges from an automobile manufacturer were found offsite and also reportedly dumped during this time period.

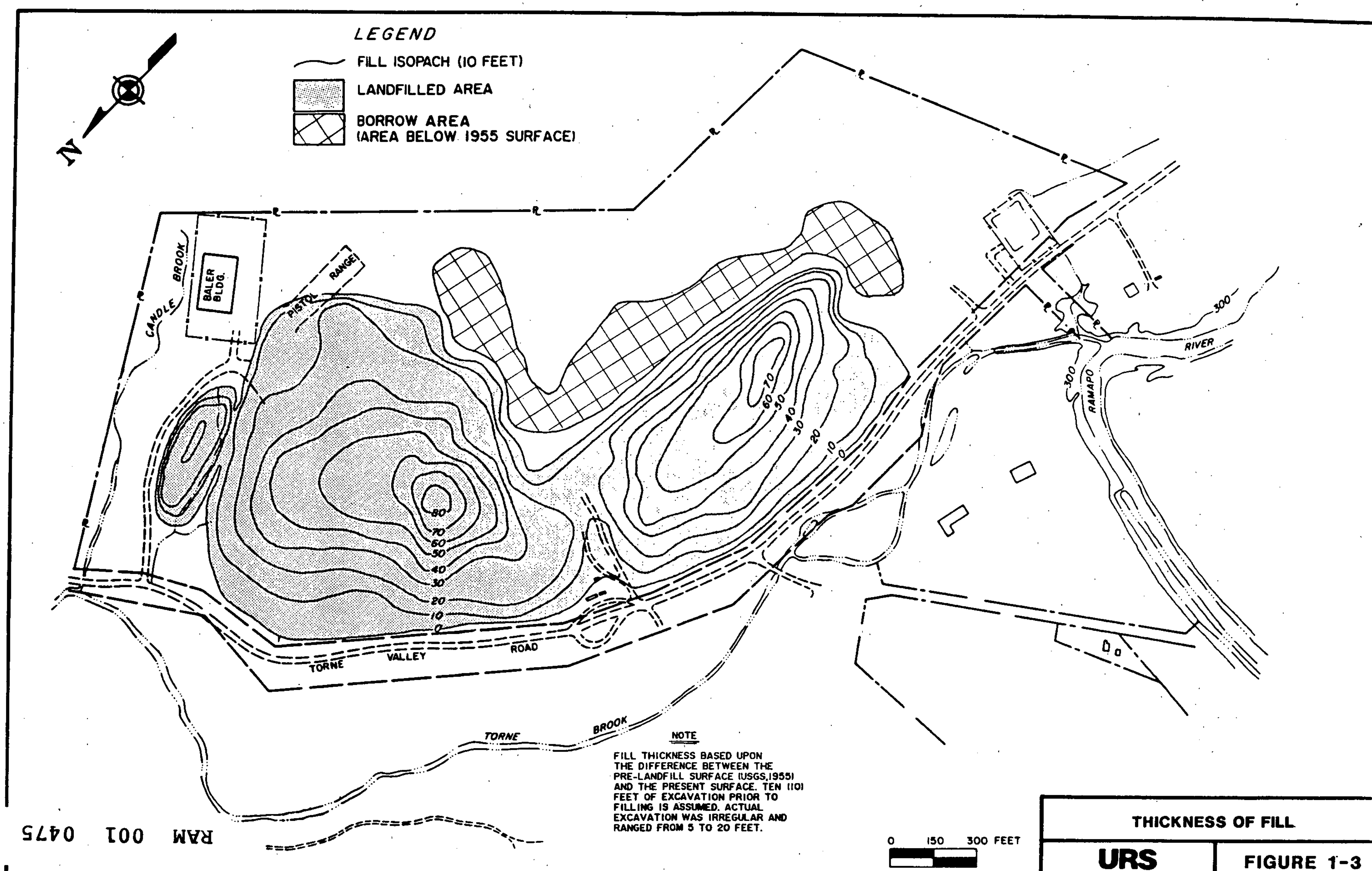
On May 28, 1971, the Rockland County Department of Health granted a permit to the Town of Ramapo for the operation of a sanitary landfill. At that time, the site was owned by the Ramapo Land Company and the contract-operator was the Torne Mountain Sand and Gravel Co., Inc. Early operations at the landfill occurred in the northern half of the site and included the irregular excavation of soft, porous (non-gravel) material preferentially to "hard pan" areas which were not excavated. The base of the landfill is, therefore, likely to be very irregular with excavations below the natural ground surface ranging from five to twenty feet deep. Material below the northern half (lobe) of the landfill is described as being "hard pan" with a high fine (clay-silt) content. Near the southern edge of the lobe, just northeast of the weigh station, bedrock was encountered and reportedly was exposed partially under the southern lobe.

In June of 1976, a contract was awarded to Sorgine Construction Services of New York, Inc., for operation and maintenance of the landfill until June 1981. The contract was terminated by the Town of Ramapo on August 23, 1979, when the Town began to operate the landfill directly. Landfilling was completed by 1984. During this time period, landfilling activity was concentrated on the southern lobe, but the northern lobe was expanded upon. Excavation continued into the upslope side of the site, while other areas were apparently covered and graded. The pattern and thickness of fill as based on URS estimates is shown in Figure 1-3.

Both landfill lobes consist of mixed refuse. Substances alleged to have been dumped onsite include: industrial sludges and other wastes from a pharmaceutical company; 55-gallon drums containing sludges from a cosmetic company; sewage sludges; and general municipal refuse (NUS, 1983). Additional materials which were reportedly dumped at the site include asbestos, construction and demolition debris, yard debris, paint sludge, and liquid wastes from a paper company. The toxicity and characteristics of landfilled materials is unknown but assumed to be highly variable.

1.2.3 Lateral Fill Progression

The history of lateral fill progression at the Ramapo Landfill was compiled using a series of aerial photographs taken between 1952 and 1987. Changes in site characteristics with each successive photograph are detailed below. Due to the non-definitive nature of these sources of information and the fairly long time span between some of the photographs, the following evaluations should be regarded as general. Figures 1-4 through 1-6 illustrate site changes over time.



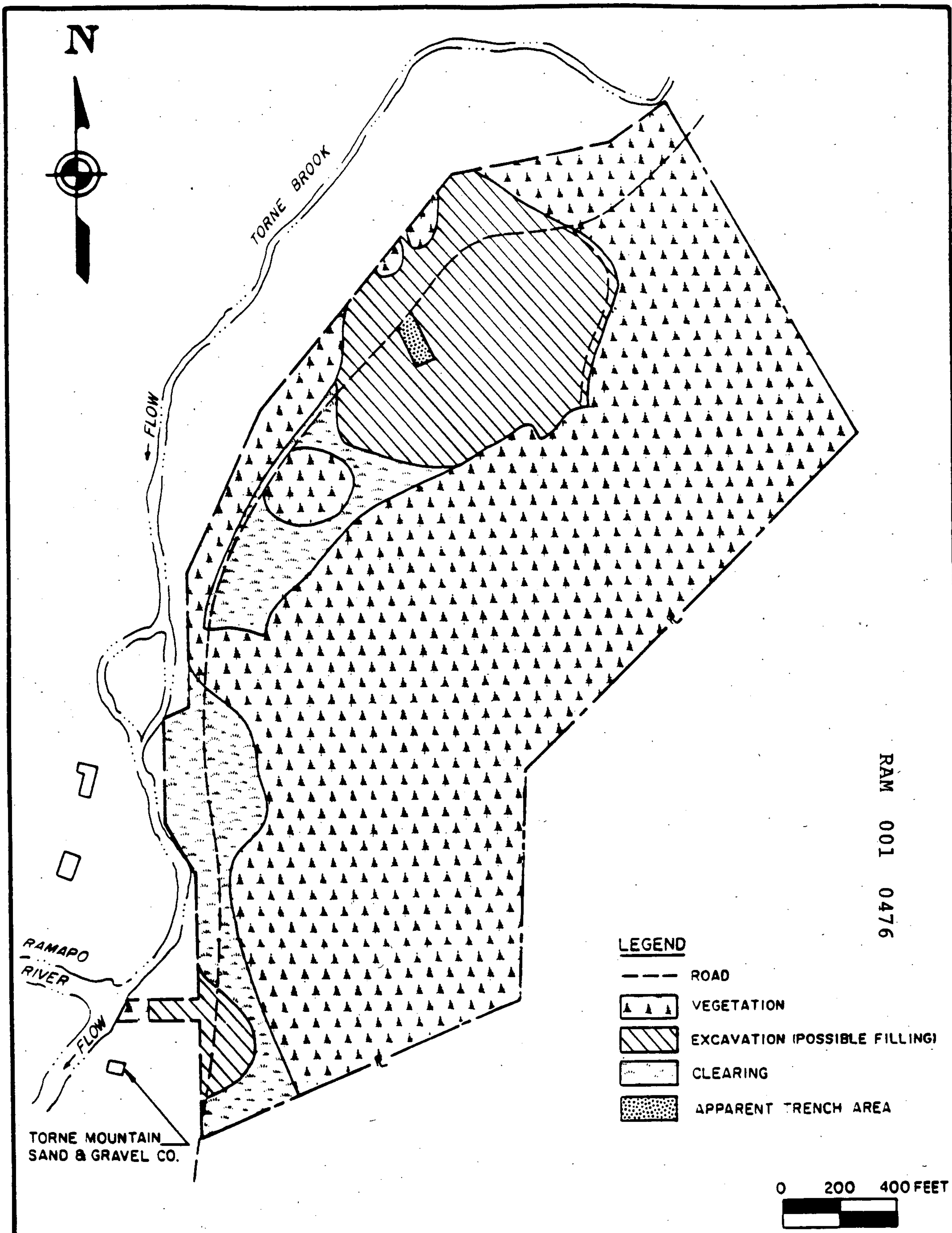
NOTE

FILL THICKNESS BASED UPON THE DIFFERENCE BETWEEN THE PRE-LANDFILL SURFACE (USGS,1955) AND THE PRESENT SURFACE. TEN (10) FEET OF EXCAVATION PRIOR TO FILLING IS ASSUMED. ACTUAL EXCAVATION WAS IRREGULAR AND RANGED FROM 5 TO 20 FEET.

THICKNESS OF FILL

URS CONSULTANTS, INC

FIGURE 1-3



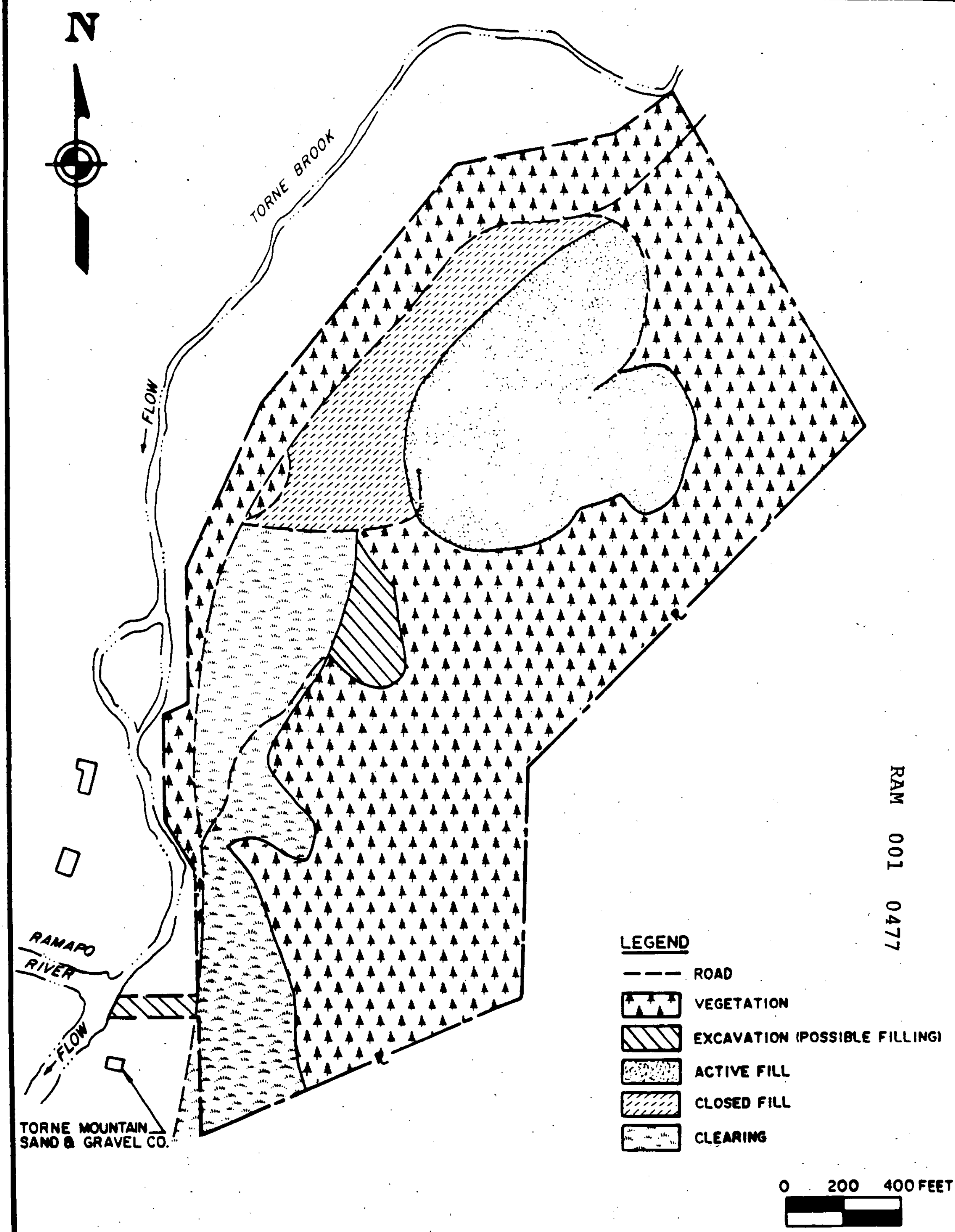
RAM 001 0476

URS CONSULTANTS, INC.

RAMAPO LANDFILL
FILL PROGRESSION 1965

FIGURE 1-4

A-3169



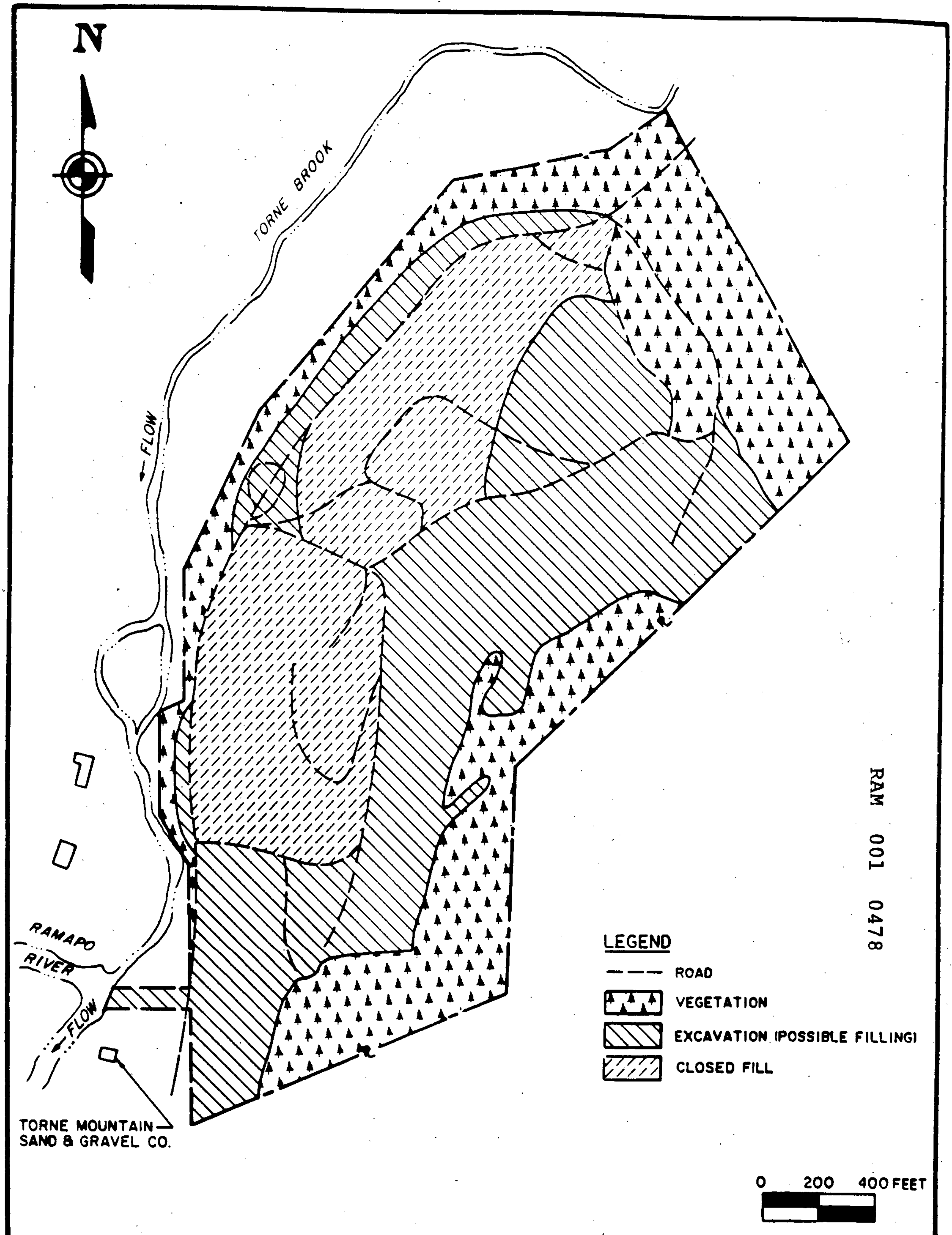
RAM 001 0477

URS CONSULTANTS, INC.

RAMAPO LANDFILL
FILL PROGRESSION 1974

FIGURE 1-5

A-3170



RAM 001 0478

A-3171

URS CONSULTANTS, INC.

RAMAPO LANDFILL
FILL PROGRESSION 1983

FIGURE 1-6

1952 - At this time the landfill site is undisturbed. Residential properties are present along the western bank of Torne Brook directly west of the site boundary. Most of the site is heavily wooded with a small clearing located in the southwest corner of the property. Access to the site area has apparently been established from the south along the Ramapo River.

1965 - A large portion of the western edge of the site along the access road has been cleared of vegetation. An estimated 25% of the site has been disturbed by clearing and possible filling which occurred prior to the start of municipal operations by the Town of Ramapo (Figure 1-4). The northwest portion of the site as well as the adjacent property north of the site have been highly disturbed by apparent excavation. There is evidence of trenching in this area as displayed by the arrangement of similar-sized large objects within what appears to be a trench and along the access road north of this trench. Evidence of additional trenches which may have been covered is apparent just north of the open trench. The southwest corner of the site and adjacent property have been moderately disturbed, and the presence of a small building is assumed to be related to operations of the Torne Mountain Sand and Gravel Company.

The New York State Thruway has been constructed approximately 2,000 feet west of the site. Additionally, there appears to be an automobile junkyard between the Erie Railroad and the Ramapo River approximately 1,000 feet west of the southwest corner of the site.

1974 - By 1974, the site access road has been improved and further clearing has occurred along the west side of the site (Figure 1-5). An estimated 40% of the site has been disturbed by clearing and filling by this time. The northwest portion of the site has apparently been filled, covered, and graded, and filling has progressed to the north-central sections of the site, which appear active. Filling appears to be followed closely by grading, as little of the active fill area appears to be disturbed. The eastern portion of the active fill area appears to be cut into the hillside and followed by filling in lifts. Additional activity is evident in the central section of the site, with apparent clearing, excavation, and possibly filling.

The property north of the site appears to be graded and partially vegetated relating to construction of an electrical substation. Further, local changes include removal of the automobile junkyard west of the site, and expansion of the sand and gravel operation adjacent to the southwest corner of the site.

1983 - By this time, excavation and filling has extended to the eastern property line in the northern portion of the site and south through the central portion of the site. An estimated 75% of the site has been disturbed by excavation and filling by this time (Figure 1-6). The west-central section of the site along the access road has apparently been filled, covered, and graded, and appears as a large mound with sparse vegetation. The northwestern section of filling also appears mounded and is covered, roughly graded, and partially vegetated. Numerous roadways cross the northern fill area apparently as access to the active north-central area.

1984 - The active fill area in the northern portion of the site has been extended eastward to the eastern property line and through the central portion of the site. The northern fill area has apparently received additional cover and grading.

1987 - A baler building and police weapons firing (pistol) range have been constructed in the northeast corner of the site. The north and south fill areas appear roughly graded and partially vegetated. Vegetation has also covered portions of the cleared areas along the access road which appears to have been paved with asphalt.

Portions of the northeast and central areas of the landfill are uncovered and possibly active. A number of cylindrical and square objects which appear to be concrete culverts are staged along the access road to the northeast fill area and near the site scalehouse.

Changes to the southernmost portion of the site during this period cannot be determined since photos covering this portion of the site were not available.

1.2.4 Previous Investigations

A number of investigations have been performed both on and in the vicinity of the landfill for a variety of purposes over the past two decades. Some of this data is too voluminous to characterize and represent here. In particular, these include the weekly analysis of leachate for the Town's SPDES permit, and the monthly sample which the Spring Valley Water Company has historically taken from former Outfall 001. Table 1-1 provides a summary of previous sampling and analyses performed. Contained within Appendix M are the analytical data sheets from most of these investigations. Data from the long-term studies, e.g. the SPDES sampling are not included since the analyses are of limited scope and the results are indicative of current conditions (i.e. former Outfall 001 is no longer in use).

With the exception of a few of the previous investigations, information on the sampling and laboratory analysis of historical samples is unknown. As such, it is not known whether appropriate QA/QC procedures were followed, and if resulting data was adequately reviewed so as to assure its accuracy. Therefore, the following data is presented for informational purposes only and is not summarized or compared against data collected during this RI.

TABLE 1-1
SUMMARY OF PREVIOUS SAMPLING AND ANALYSIS

Date	Matrix	Activity
1974	Leachate	Water company discovered a black sludge emanating from landfill
May 31, 1974	Surface Water (Torne Brook)	Weekly sampling of Torne Brook at 3 locations initiated by Spring Valley Water Supply Co.
June 26, 1974	Leachate	Passaic Valley Water Commission analyzed discharge to Torne Brook
June 1974 to October 1978	Leachate and Surface Water (Torne Brook and Ramapo River)	NYSDOH and NJDOH analyzed samples taken of leachate, Torne Brook and Ramapo River (6/18/74; 11/24/76; 10/20/77; 2/13/78; 6/29/78; 8/15/ & 16/78; 10/30 & 31/78)
September 11, 1975	Surface Water (Ramapo River)	Town of Ramapo sampled upstream, opposite and downstream of site
October 17, 1975	Leachate	Hackensack Water Co. analysis of leachate
1975	Leachate and Surface Water (Ramapo River)	Hackensack Water Co. analyzed leachate and upstream, opposite and downstream of the site in Ramapo River
March 9, 1976	Surface Water (Torne Brook and Ramapo River)	Rockland County Department of Health sampled Torne Brook upstream of site and 1,000 ft. from confluence with River; sampled River upstream and downstream of Torne Brook
August 26, 1976	Groundwater	NYSDOH sample at weigh station
November 24, 1976	Surface Water (Torne Brook)	Leggette Brashears, and Graham, Inc. (for Spring Valley Water Co.) samples taken 50 ft below holding pond outlet and 10 ft below confluence of leachate and Torne Brook

TABLE 1-1 (Continued)

Date	Matrix	Activity
May 1978	Surface Water (Torne Brook and Ramapo River)	Leggette Brashears, and Graham, Inc. (for Spring Valley Water Co.) sampled Torne Brook at 8 locations, Ramapo River at 3 locations and analyzed for only specific conductance
June 21 and July 11, 1978	Surface Water (Ramapo River)	Leggette Brashears, and Graham, Inc. (for Spring Valley Water Co.) sample taken both dates from Ramapo River 1350 ft. downstream from mouth of Brook
September 6, 1978	Leachate	Unknown laboratory analysis of leachate
March 21, 1979	Groundwater	NYSDOH sampled wells 1, 2A, 3, 4A
March 21, 1979	Groundwater	Unknown lab analyzed wells 1, 2, 2A, 3, 4, 4A
March 21, 1979	Groundwater	Hackensack Water Co. analyzed wells 1, 2, 2A, 3, 4, 4A
March 21, 1979	Groundwater	Fred C. Hart Assoc. sampled B-129 through B-136
April 1 and 11, 1980	Groundwater	Leonard Jackson Assoc. analyzed the majority of the 25 monitoring wells for specific conductance
May 29, 1980	Air	EPA Region II Field Investigation Team explosimeter survey
July, 1980	Offsite Soil and Drum Contents	RCHD collected soil and liquid drum contents from Ramapo Landfill Co. property
October 11, 1980	Waste	EPA sampled a sludge-like material from an unknown location on or near landfill
October 11, 1980	Leachate	EPA sampled at the leachate inflow and outflow

TABLE 1-1 (Continued)

Date	Matrix	Activity
February and March, 1981	Groundwater	NYSDEC performed extensive sampling and analysis of monitoring wells (2/4/81; 2/18/81; 3/11/81)
March 11, 1981	Groundwater	Hackensack Water Co. analyzed samples from monitoring wells 3, 5, 5A, 8A, 18
1982	Surface water (Torne Brook at confluence with Ramapo River)	NYSDOH analyzed samples taken by NYSDEC for the program: Routine Toxics Surveillance Network Near Problem Landfills (6/1/82; 6/29/82; 7/27/82; 8/24/82; 9/20/82; 10/19/82)
Late 1982 and March 15, 1983	Leachate, Groundwater	NYTL analyzed 2 leachate and 2 groundwater samples
October 28, 1983	Waste	Sample obtained during the course of excavating trench
1983	Leachate	Analysis for NPDES permit
1984 - 1985	Leachate	Town of Ramapo sampled leachate monthly in collectors
1986 - Present	Leachate	Weekly analysis of leachate by Envirotest Laboratories, Inc. for the Town of Ramapo
February 5, 1987	Groundwater, surface water, sediments	NUS Corp. collected samples during their investigation on Ramapo Land Co. property
March 16, 1988	Groundwater	All wells analyzed for indicator parameters; 3 wells in depth analysis for Town of Ramapo
July 25, 1988	Groundwater	Dunn Geoscience sampled monitoring well DGC-6S which was installed at the proposed Torne Valley Balefill site, north of the Ramapo Landfill

TABLE 1-1 (Continued)

Date	Matrix	Activity
March 22, 1988 July 12, 1988	Spring Valley Water Co. wells SV-94, SV-95, SV-96	Spring Valley Water Co. has their water supply wells sampled and analyzed every 3 years for SDWA parameters
July 12, 1991	Torne Brook and Ramapo River	NYSDEC sampling

On May 28, 1971, the Rockland County Department of Health granted a permit to the Town of Ramapo for the operation of a sanitary landfill. As early as 1974, the Spring Valley Water Supply Company, operator of the Ramapo Valley well field, discovered a black sludge emanating from the landfill. Following this discovery, numerous investigations of the various media on and in the vicinity of the site commenced which continue to this date (Table 1-1). These will be discussed separately under the headings of air, waste, soil, groundwater, water supply wells, and surface water and sediments (which includes leachate, Torne Brook, and the Ramapo River). Most of the following discussion is from the Remedial Action Master Plan by NUS (1983). Remaining information is from documents obtained from the NYSDOH, NYSDEC, and the Town of Ramapo files. Water quality data for the Spring Valley Water Co. water supply wells was provided to URS by the Spring Valley Water Co., and is presented under the heading "Water Supply Wells".

1.2.4.1 Air

An explosimeter survey was conducted at the site on May 29, 1980 by the USEPA Region II Field Investigation Team. No detectable levels of contaminants were found. Chemical detecting tubes and an air pump were used to test for phenol and toluene at the north end of the site (upwind), the south end of the site, and the inflow end of a collection basin culvert. These tests showed no detectable contaminant levels.

On February 5, 1987, NUS Corp., during the course of their investigation on the adjacent Torne Mountain Sand and Gravel site, used an HNu in the breathing zone to measure ambient air quality and within monitoring wells 8A, 10, and 4. No air readings above background were detected in the breathing zone. A reading of 13 ppm was measured in well 8A.

RAM 001 0486

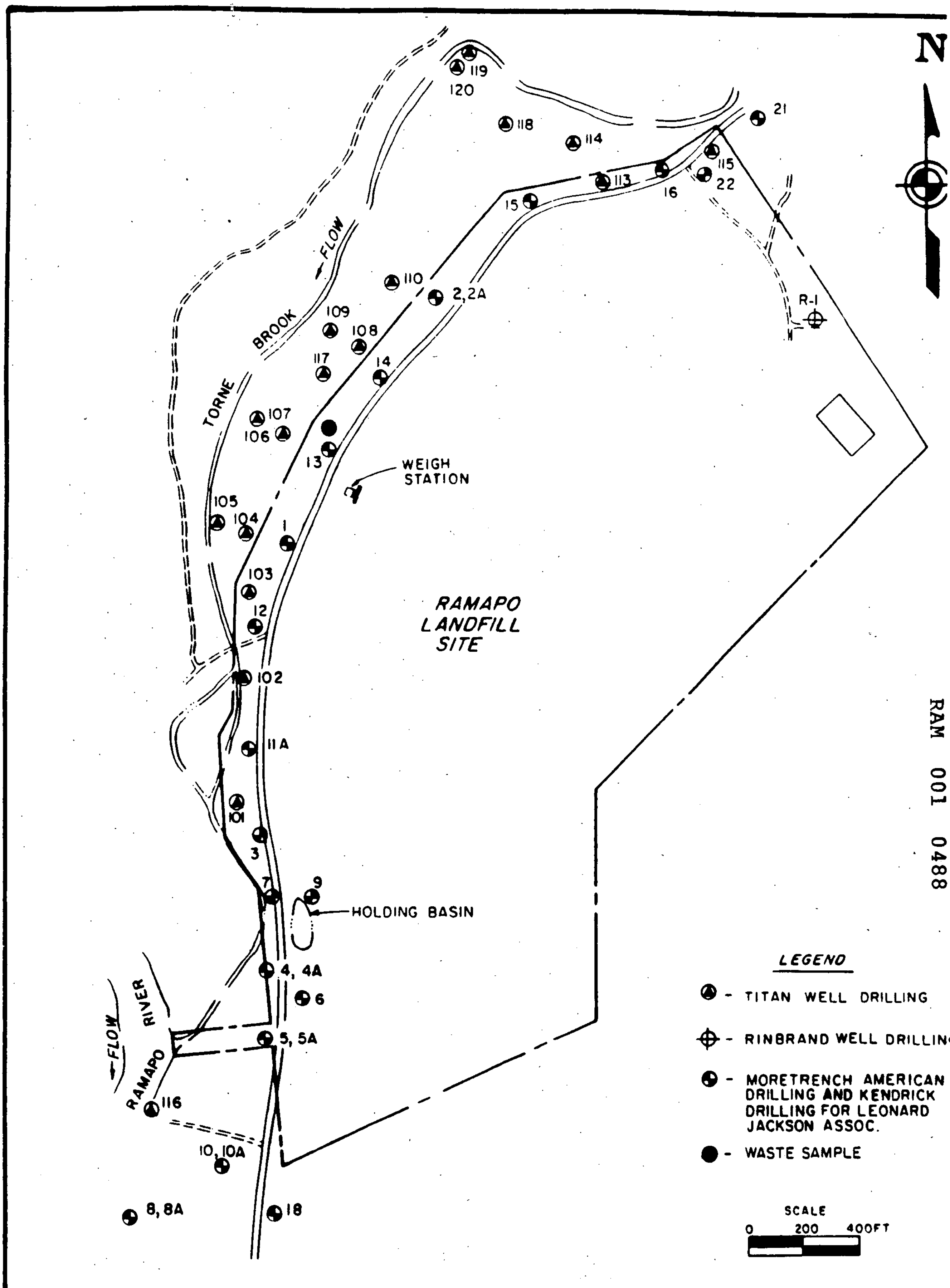
1.2.4.2 Waste

The USEPA took a sample of a sludge-like material from an unknown location on or near the landfill, on October 11, 1980. The sample was analyzed for priority pollutants. Results showed the presence of volatiles and semi-volatiles ranging in concentration from none detected (ND) to 340 ppb; and metals from ND to 40 ppm. Compounds detected at relatively high concentrations were: fluoranthene (250 ppb), phenanthrene (340 ppb), pyrene (160 ppb), copper (40 ppm), and zinc (32 ppm).

On October 28, 1983, during the course of excavating a trench for the leachate collection system, a blue-green rubbery substance was discovered in the vicinity of the weigh station outside the area of the active landfill. The location of this waste sample is shown on Figure 1-7. Results of an aromatic hydrocarbons analysis showed the presence of benzene (13 ppm); ethylbenzene (68 ppm); toluene (88 ppm); and total xylenes (260 ppm). Another portion of the sample was used for an EP Toxicity Extraction which showed a concentration of barium of 0.8 ppm, cadmium of 0.04 ppm, lead of 129 ppm, and mercury of 0.0005 ppm. Maximum concentrations of these contaminants characteristic of hazardous waste are 100 ppm, 1.0 ppm, 5.0 ppm, and 0.2 ppm, respectively. These results led the laboratory (Sanitary Science and Laboratories, Inc.) to state that: "The presence of the aromatic hydrocarbons and the concentration of lead in the EP Toxicity Extract indicate that the material tested is a hazardous waste". The Town requested guidance from the NYSDEC as to what to do with the substances found. When no guidance was received, the area was backfilled.

1.2.4.3 Soil

No soil samples had been collected onsite prior to the URS remedial investigation.



RAM 001 0488

A-3204

URS CONSULTANTS, INC.

PREVIOUS INVESTIGATIONS
WELL LOCATIONS

FIGURE 1-7

The offsite area between the landfill and the Ramapo River is property owned by the Ramapo Land Co. This area had been historically used by the previous landfill operator as a staging and storage area. It was the subject of an investigation in 1980 by the Rockland County Health Department following allegations that hazardous waste was being buried in this area. Another investigation was performed in 1987-1988 by NUS Corp. from which a report entitled "Final Draft Site Inspection Report Torne Mountain Sand and Gravel aka Ramapo Land Company" was written. This 1988 report discusses results from both of these investigations.

The following discussion is summarized from the 1988 NUS report. In 1980, liquid from above-ground drums, and soils were sent to the NYSDOH for analysis.

Results of the 1988 investigation are detailed under the sections Groundwater, Surface Water, and Sediments which were the media analyzed. These samples were to be analyzed by the NYSDOH for volatile halogenated organics, hydrocarbon scan, PCBs, and metals; however, there turned out to be insufficient samples for the analysis. Reported results showed that copper (1 ppm), lead (320 ppm), and zinc (15 ppm) were detected in the drum samples. Cadmium (15 ppb), chromium (57 ppb), iron (56,600 ppb), and manganese (3,940 ppb) were also detected. [Whether these were results for soil or waste was not specified.] Additionally, it was reported that kerosene was detected in a raw water sample. The site operator backhoed this site in 1980 in the presence of NYSDEC and only wood pallets were observed to be buried. The approximately 50 drums were then removed. Apparently an underground storage tank was observed onsite. All onsite tanks appeared to be unused and empty.

1.2.4.4 Groundwater

In 1979, the initial subsurface investigation of the landfill was carried out. It included the drilling of six test boring/monitoring wells

RAM 001 0489

at four locations (MW 1-4A) for Leonard Jackson Assoc. (LJA) (for the Town of Ramapo). A second stage of drilling was performed in 1980 again for LJA (for the Town). During this time twenty test borings/monitoring wells were installed at sixteen locations (MW 5-21). Locations of monitoring wells are shown on Figure 1-7. These wells have been sampled and analyzed periodically by the NYSDOH, the NYSDEC, and consulting firms. The NYSDOH analyzed well samples taken on August 26, 1976 (from a previously installed well located in the vicinity of the weigh station), and March 21, 1979. The 1976 sample was analyzed only for indicator parameters. (color, NH_3, NO_2, NO_3 + NO_2, chloride, hardness, alkalinity, pH, COD, sodium, turbidity). The 1979 samples taken from wells 1, 2A, 3, and 4A were analyzed for metals, (iron, manganese, arsenic, cadmium, chromium, lead, mercury, selenium), phenols, TOC, benzene, toluene, and xylene. All metals except for arsenic, iron and manganese were below the detection limit: phenols ranged from 3 to 700 ppb; TOC from 5 to 98 ppm; benzene was listed at greater than 200 ppb; toluene at greater than 50 ppb; and xylene at greater than 800 ppb.

The NUS report stated that an unnamed laboratory analyzed groundwater samples taken from wells 1, 2, 2A, 3, 4 and 4A on March 21, 1979. Results showed metals in concentrations ranging from ND to 69.6 ppm. Values for indicator parameters were reported. A few volatiles were reported at low concentrations above the detection limit.

The Hackensack Water Co. analyzed groundwater samples taken from the same wells on March 21, 1979. Results showed metal concentrations varying from 1 ppb to 46.6 ppm and values for a number of indicator parameters. Volatiles were reported as non-detected.

Fred C. Hart Associates sampled eight monitoring wells on March 21, 1979, and analyzed for the majority of the priority pollutants. Benzene, ethylbenzene, and toluene were detected at concentrations of 15, 18, and

1,629 ppb respectively. Metals concentrations ranged between 27 and 640 ppb.

Leonard Jackson Associates conducted a specific conductance survey on April 1 and April 11, 1980. The majority of wells were tested on April 1; some on April 11. Results showed that specific conductance ranged between 103 and 4,800 umho/cm with an average of 935 umho/cm.

The NYSDEC conducted an extensive sampling program during February and March 1981. Various wells were analyzed for metals, indicator parameters, phenol, toluene, and two xylene isomers. Two of the samples contained toluene (up to 2.47 ppm), xylene isomers (up to 0.55 ppm), and phenol (up to 0.91 ppm). Metals detected ranged in concentrations from ND to 228 ppm. The March 11 samples from Well #5 exhibited on acidic pH of 2.6.

The Hackensack Water Co. analyzed samples for the Spring Valley Water Co. on March 11, 1981 from monitoring wells 3, 5, 5A, 8A, and 18, for ten volatile organics. All are reported as being non-detected (detection limit not listed).

New York Testing Laboratories, Inc. (NYTL) analyzed samples from wells 3 and 16 in late 1982. Benzene at 19 ppb, phenol up to 39 ppb, and metals up to 295 ppb were detected.

As part of their investigation into the Torne Mountain Sand and Gravel aka Ramapo Land Company site located south of the Ramapo Landfill, NUS sampled three monitoring wells (also two surface water and sediment locations) on February 5, 1987. Sample GW-1 was obtained from LJA MW-8A and sample GW-2 from LJA MW-10 both of which were on Ramapo Land Company property. Sample GW-3 was obtained from LJA MW-4A on the Ramapo Landfill considered to be upgradient from the other two samples. Results, which were summarized in their report (NUS, 1988) showed no volatiles detected, 2 phthalates detected at 1 ppb each in GW-1 and GW-2, no pesticides/PCBs detected, and eighteen out of the twenty-two metals analyzed for were detected. (Results for silver were apparently rejected during a data audit for not passing EPA QA/QC requirements.)

Of the metals detected, there did not appear to be a pattern of increasing or decreasing concentrations across the Ramapo Land Co. site with the exception of mercury, which was only detected in GW-1, and sodium, all metals were detected at similar (less than three times as per previous agency guidance) concentrations in all three monitoring wells. (The sodium concentration in GW-3 was 7.5 times greater than that detected in GW-2.) As it is apparent that this data has been reviewed against EPA QA/QC criteria, the following comparison with 1987 New York State Ambient Water Quality Standards for groundwater has been included. Four metals exceeded 1987 ARARs: cadmium at 11 ug/l in GW-1 and at 15 ug/l GW-2 (ARAR 10 ug/l); iron at 56,600, 50,000, and 54,700 ug/l, respectively in all three samples (ARAR 300 ug/l); lead at 140 ug/l in GW-1 and at 230 ug/l in GW-2 (ARAR 25 ug/l); and manganese at 1,790, 3,940, and 1,630 ug/l, respectively in all three samples (ARAR 300 ug/l).

As part of its preliminary hydrogeologic/engineering evaluation of the Proposed Torne Valley Balefill located north of the Ramapo Landfill site, Dunn Geoscience Corporation sampled and analyzed a monitoring well in the unconsolidated deposits (sand) in 1988. Results of the analysis showed methylene chloride (5.2 ppb), which was considered a laboratory contaminant and benzene (2.6 ppb below the detection limit of 5.0 ppb which was considered to be low enough to represent a laboratory artifact (Dunn Geoscience, 1988)). Metals ranged in concentration from ND for most of metals, to 7.55 ppm for iron.

1.2.4.5 Water Supply Wells

Samples from each of the Spring Valley Water Company's water supply wells are obtained and analyzed for Safe Drinking Water Act (SDWA) parameters every three years. Results of the March 22, 1988 analysis of wells SV-95 and SV-96, and the July 12, 1988 analysis of well SV-94, were provided to URS. (For well locations, see Figure 1-2.) The analytical data sheets are presented in Appendix M.

In summary, of the 60 volatile organics analyzed for in each well, none were detected. Pesticides and herbicides were not detected either. Of the eighteen metals analyzed, nine were detected (aluminum, calcium, copper, iron, magnesium, manganese, potassium, sodium, zinc). A comparison between the SDWA primary maximum contaminant levels (MCLs) of 1988, and the NYSDOH public water supplies MCLs and the data showed that of the metals detected, none had a primary MCL associated with it. (Primary MCLs are enforceable standards for public drinking water systems.) In reviewing the secondary MCLs, manganese at 210 ppb in SV-95 exceeded the MCL of 50 ppb. (Secondary MCLs are federally non-enforceable regulations and control contaminants in drinking water that affect the aesthetic qualities relating to the public acceptance of drinking water.)

Indicator parameters were also analyzed; ten of which have either primary or secondary MCLs associated with them. Sample results from the water supply wells did not come close to exceeding the MCL values for the indicator parameters.

Water from the three Spring Valley Water Co. water supply wells in the vicinity of the landfill met the SDWA primary MCLs, and with the exception of manganese in SV-95, met the secondary MCLs as well. The Ramapo landfill, therefore, is not having a deleterious effect on those water supply wells.

1.2.4.6 Surface Water and Sediments

Previous investigations of surface water at and in the vicinity of the site include those on leachate, Torne Brook, and the Ramapo River.

The New Jersey Department of Health (NJDOH), the New York State Department of Health (NYSDOH), the Hackensack Water Co., the Passaic Valley Water Commission, an unknown laboratory, the USEPA, and NYTL all sampled or analyzed leachate emanating from the site during the time period 1974 to 1983. Samples were taken at varying locations across the landfill during this time. Many of the analyses performed were for indicator parameters and metals. COD (up to 5,000 ppm), iron (up to 360 ppm), and zinc (up to 11 ppm) were among the contaminants detected. Analyses for organics were generally limited to "volatile suspended matter" and "total volatile solids". Results for individual organic compounds showed levels of total phenols up to 25 ppb, benzene up to 0.7 ppb, and phenol up to 1,070 ppb, among others. In 1983, an analysis was performed for an NPDES permit. The sample contained organics (phenol) up to 80 ppb including benzene at 19 ppb, and metals up to 50 ppm (iron). (This excludes di-octyl phthalate detected at 700 ppb.) Reported indicator parameters were as follows: BOD (2,751 ppb), COD (4,426 ppb), TOC (400 ppb), and TSS (240 ppb).

In 1984 and 1985 a leachate collection system was constructed under a Consent Order by the NYSDEC. Prior to completion of the leachate collection system and aeration ponds, the Town of Ramapo sampled leachate in the piping system. Analyses were performed for the entire list of priority pollutants over an eighteen month period. [Due to the volume of data gathered, analytical results are not presented in this report.] Following completion of the system in 1986, weekly analysis of the leachate commenced. It was carried out by Envirotest Laboratories, Inc. of Newburgh, New York for the Town of Ramapo SPDES permit. Due to the volume of data gathered, analytical results are not presented in this report.] The discussion of leachate at the site is taken from the "Landfill Leachate Treatability Studies and Facilities Design Report" prepared by Malcolm Pirnie, Inc. in June 1987 and presented in Section 1.2.5.

During 1975 and 1976, the Town of Ramapo, the Hackensack Water Co., and the Rockland County DOH each took 3-4 water samples of Torne Brook and the Ramapo River, upstream, adjacent to, and downstream of the site, and analyzed for six indicator parameters (pH, dissolved oxygen, BOD, suspended solids, coliform, and fecal coliform). Results indicated that the landfill was raising the level of total coliforms in both Torne Brook and the Ramapo River. An analysis of Torne Brook 50 feet below the holding pond by the NYSDOH in 1976 reported levels below detection limits for most compounds analyzed.

Leggette, Brashears, and Graham, Inc., sampled Torne Brook and the Ramapo River on November 24, 1976; June 21, 1978; and July 11, 1978 for the Spring Valley Water Co. Samples taken downstream of the landfill were analyzed for metals; the highest concentration detected was 1.0 ppm of barium in Torne Brook. Other metals detected include arsenic, cadmium, hexavalent chromium, copper, iron, lead, manganese, mercury, silver, and zinc. Leggette, Brashears, and Graham, Inc., also performed a specific conductance survey of Torne Brook and the Ramapo River in May of 1978. Results indicate that leachate from the landfill raised the specific conductance of Torne Brook but not the Ramapo River (NUS, 1983).

On June 29, 1978 the NJDOH sampled both Torne Brook and the Ramapo River upstream and downstream of the landfill. Results indicated that the site was adversely affecting Torne Brook (in particular increased COD, TKN, NH_3 and iron values), and to a lesser extent the Ramapo River.

In 1982, the NYSDOH analyzed samples taken from Torne Brook at its confluence with the Ramapo River for the report "Routine Toxics

Surveillance Network Near Problem Landfills". Samples were taken on six separate occasions and analyzed for priority pollutants. Two volatiles were detected at up to 2 ppb (benzene and tetrachloroethane), and silver up to 20 ppb.

As part of their investigation into the Torne Mountain Sand and Gravel aka Ramapo Land Company site located south of the Ramapo Landfill, NUS sampled two surface water and sediment samples on February 5, 1987. Samples SW-1 and SED-1 were taken at the confluence of Torne Brook and the Ramapo River near former outfall 001, and samples SW-2 and SED-2 were taken approximately 1,000 feet downstream in the Ramapo River. Results, which are summarized in their report (NUS, 1983) showed no volatiles, the presence of ten semi-volatiles up to a concentration of 280 ppb (pentachlorophenol) in both sediment samples; only one semi-volatile (di-n-butylphthalate) at 1 ppb in the surface water; no pesticides/PCBs; and many metals. Eight metals were detected in the surface water samples at generally higher concentrations in SW-1 than SW-2. Eighteen metals were detected in the sediment samples at generally higher concentrations in SED-2 that SED-1. As it is apparent that this data has been reviewed against EPA QA/QC criteria, the following comparison with 1987 New York State Ambient Water Quality Standard for surface water has been included. Of the eight metals detected in the surface water, iron at 2,800 ppb (ARAR is 300 ppb) and manganese at 310 ppb (ARAR's 300 ppb) in SW-1 exceeded ARARs.

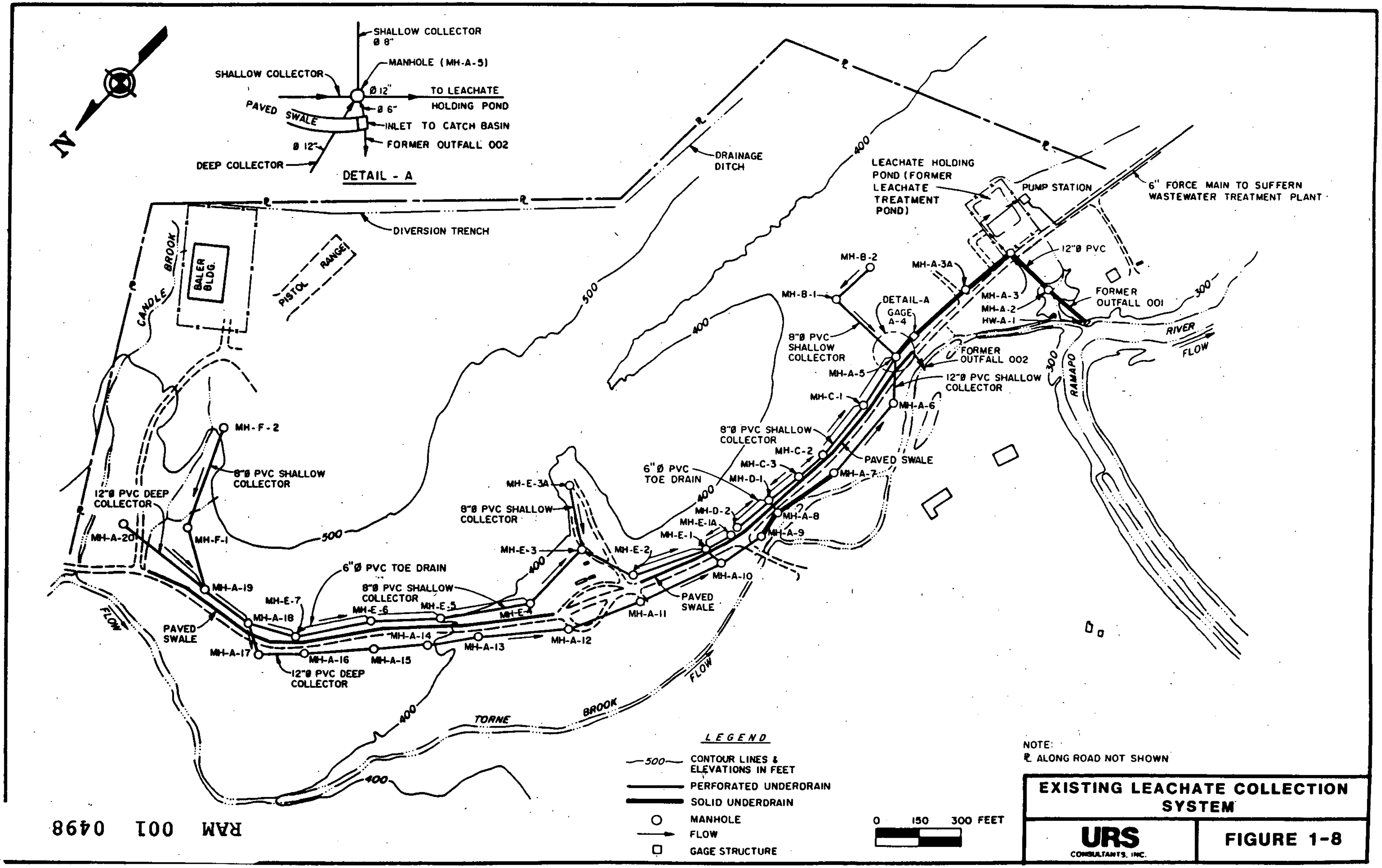
On July 12, 1991, the NYSDEC sampled Torne Brook approximately 100 feet upstream from the power line right-of-way that heads east of the Orange and Rockland County Utilities Substation, and three locations on the Ramapo River. The three samples were collected roughly 150-feet upstream of the former Outfall 001, at the confluence with the former outfall, and roughly 150 feet downstream. Samples were analyzed for Target Analyte metals, cyanide, total organic carbon (TOC), and ammonia.

The maority of the twenty-three metals analyzed for were detected in at least one of the samples. There is no apparent increase in concentrations between upstream and downstream samples. The maximum concentrations of aluminum, barium, copper, and potassium were detected in the two upstream samples. Maximum concentrations of calcium, iron, lead, magnesium, manganese, sodium, vanadium, and zinc were detected in the two downstream samples. However, there was no significant difference between the downstream maximum concentrations and those upstream, (e.g., upstream calcium concentration 27,385.4 ppb, downstream 28,355.9 ppb; upstream iron concentration 110 ppb, downstream 140 ppb.) Neither cyanide or ammonia were detected in any of the four samples. TOC was detected at 3.7 ppm in all three of the Ramapo River samples, and at 1.3 ppm in Torne Brook. The results indicate that the landfill is not having an impact on the Ramapo River.

1.2.5 Leachate Collection and Treatment System

In 1984 and 1985 a leachate collection system was constructed under a Consent Order between the Town of Ramapo and the NYSDEC. The majority of the following discussion has been taken from the Landfill Leachate Treatability Studies and Facilities Design Report prepared by Malcolm Pirnie, Inc. (1987), in conjunction with information provided by the Town and has been included for both informational and historical purposes.

The existing leachate collection system consists of four main conduits located along the northern and western boundaries of the site as shown on Figure 1-8. Three conduits are located in the subsurface using perforated drain pipes. A 6" toe drain was installed just beneath the ground surface at the toe of the landfill, using 2,933 linear feet of perforated pipe. An 8" shallow underdrain was installed at a depth eight to ten feet below grade using 4,023 linear feet of perforated pipe on the upslope side of Torne Valley Road. A 12" deep underdrain was installed between ten and twenty-five feet deep using 4,259 linear feet of both



EXISTING LEACHATE COLLECTION SYSTEM

FIGURE 1-8

RAM 001 0498

perforated and non-perforated pipe. The fourth conduit consists of a concrete surface water collector at the base of the landfill which enters a stormwater catch basin located in the southwestern part of the site near MH-A-5. The catch basin was constructed and is maintained to prevent silt and other debris from entering the leachate collection system. This conduit handles surface seeps from the landfill and surface runoff during storm events. The four collectors tie together near MH-A-5 (see Detail A on Figure 1-8). A 6" force main connects to the leachate holding pond, while a 48" pipe leads to Torne Brook (Former Outfall 002). This 48" pipe is designed to convey overflow during heavy water runoff from the concrete collector.

The previous onsite treatment system used a wet-well pumping station with four submersible pumps to lift the leachate up to a distribution chamber. From the distribution chamber the influent flowed directly into a 500,000-gallon aerated lagoon. The lagoon is a clay-lined structure, baffled to create an aeration/mixing zone and a quiescent zone for settling. Aeration was supplied by two 15-HP submerged aerators. Effluent left the lagoon via an unbaffled overflow weir mounted on a small concrete chamber. Floating material was prevented from leaving in the effluent by the concrete chamber walls.

The effluent continued to flow by gravity to the post aeration basin where the treated leachate was aerated once again before discharge to the Ramapo River. The treatment system was designed based on the following data:

LEACHATE INFLUENT DESIGN DATA FOR SYSTEM

Parameter	Design Value
Flow	200,000-500,000 GPD
BOD	2,751 mg/l
COD	4,420 mg/l
Dissolved Solids	3875 mg/l
Suspended Solids	240 mg/l
Chlorides	726 mg/l
Iron, Total	50.7 mg/l
Manganese	12.5 mg/l
Zinc	1.36 mg/l
Ammonia	265 mg/l
pH	7.28

Leachate effluent after 10 days of detention time:

BOD	70 - 80 % reduction
COD	70 - 80 % reduction
Dissolved Oxygen	2.0 mg/l

The mechanical equipment consists of two 140 gpm pumps, two 350-gpm pumps, two aerators with a capacity of 115 lbs O_2/hour and two aerators with a capacity of 3.5 lbs O_2/hour.

Flows to the treatment system were pumped directly from the existing pump station wet well by the submersible pumps. Flow would vary with the size and number of pumps on line at any one time. The pump station was designed to have the 140-gpm pump run as needed, with the 350- gpm pump as standby for high flow conditions. Pumps may be run either automatically or manually by the selection of certain pumps to be "off" or in "auto" at the pump control panel. Plant flows and instantaneous loading were therefore determined by the number of pumps running at any particular time. The flow of leachate from the landfill, along with some surface runoff collected during storm events, was measured by a Parshall flume (flow metering device).

Effective November 1, 1990, leachate is no longer treated at the site. Leachate from the pond is being discharged to the Village of Suffern Wastewater Treatment Plant approximately 1.8 miles south of the site. The 6" force main is approximately 7,900 feet long and was installed primarily along the shoulders of Torne Valley Road and Rt. 59. A pump station is located south of the holding pond and contains two submersible dual-speed pumps, with a maximum capacity of 280 gpm.

Leachate from the pond, whose capacity was increased to 750,000 gallons by raising the weir elevation, is pumped through the force main as long as necessary between 8 p.m. and 8 a.m. seven days a week. The low speed rate for each pump is 145 gpm, which is sufficient for emptying the holding pond daily in 6-9 hours. The maximum rate, combined with the augmented storage capacity provides for disposing of storm flows from the concrete gutter. The present contract with the Village of Suffern anticipates an average daily flow of 80,000 gpd, for a maximum yearly flow of 29,200,000 gallons. The contract runs for five years, renewable for an additional 5 years.

Table 1-2 is a summary of the available data for Ramapo Landfill raw leachate from January 1984 to 1987 from the Malcolm Pirnie report (1987). The concentrations of parameters in the raw leachate are highly variable, primarily due to high flows during wet weather periods. The discharge levels for each parameter (except pH) are stated as mass loadings, or pounds per day (lb/d). Mass loadings were calculated using the concentration of the analyte, multiplied by the leachate flow for that day, and by the appropriate conversion factor. Table 1-3 presents a summary of the lagoon effluent for 1985 to 1987, and a comparison between

TABLE 1-2

SUMMARY OF RAW LEACHATE ANALYSIS (MALCOLM PIRNIE, INC. 1987)

			BOD_5		TSS		NH_3		Fe		Mn	
Date	Flow x1000 gpd	pH	mg/l	lb/d	mg/l	lb/d	mg/l	lb/d	mg/l	lb/d	mg/l	lb/d
1984 Avg.	82.6	7.3	80.6	54.3	73.0	49.3	19.7	13.5	18.56	12.60	3.78	2.62
1985 Avg.	83.4	7.0	15.5	10.3	15.6	11.0	19.0	12.9	7.23	5.49	4.46	3.04
1986 Avg.	104.0		7.9	6.6			21.5	20.3	5.96	4.67	3.82	3.76
1987 Avg.	40.4		60.0	20.2	20.0	6.7	34.0	11.5	5.00	1.68	3.00	1.01
Average	84.0	7.2	46.8	33.4	51.8	34.7	20.6	14.3	12.22	8.90	3.91	2.83
Max.	120.0	7.7	332.0	221.5	378.0	252.2	34.0	22.2	44.60	29.76	6.19	4.65
Min.	40.4	6.5	4.4	2.1	9.0	5.2	11.0	7.8	3.20	1.39	0.01	0.00
No. Samples	19	15	21	19	16	16	21	19	21	19	21	19

TABLE 1-3

LAGOON EFFLUENT ANALYSIS (Malcolm Pirnie, Inc., 1987)

			BOD_5		TSS		NH_3		Fe		Mn	
Date	**Flow x1000 gpd**	**pH SU**	**mg/l**	**lb/d**	**mg/l**	**lb/d**	**mg/l**	**lb/d**	**mg/l**	**lb/d**	**mg/l**	**lb/d**
1985 Avg.	17.2	7.9	5.4	0.6	22.0	1.1	7.2	1.3	1.73	0.27	0.57	0.07
1986 Avg.	109.8 (86.0)	7.8	6.3	5.5 (4.7)	29.8	25.4 (21.1)	12.1	11.6 (8.9)	2.22	2.40 (1.68)	0.71	0.75 (0.52)
1987 Avg.	105.8 (50.7)	7.8	8.6	7.1 (3.7)	10.8	9.9 (4.8)	29.4	19.9 (10.6)	2.14	1.96 (0.92)	1.04	0.77 (0.45)
Winter Avg.	108.2 (74.7)	7.8	5.6	4.9 (3.6)	18.5	21.4 (14.0)	18.7	13.9 (10.1)	2.40	2.36 (1.52)	0.87	0.75 (0.50)
Summer Avg.	49.5	7.9	8.0	3.4	38.4	21.6	4.4	2.1	1.48	0.64	0.46	0.21
Grand Avg.	86.5 (65.0)	7.8	6.5	4.4 (3.5)	25.1	21.5 (16.4)	13.6	9.8 (7.2)	2.09	1.78 (1.22)	0.73	0.57 (0.40)
Maximum	375.0 (334.6)	8.3	30.0	25.6 (25.6)	88.0	97.0 (62.7)	39.0	82.3 (44.6)	5.20	14.07 (7.81)	1.70	3.75 (1.65)
Minimum	3.5	7.4	1.0	0.1	6.0	0.5	0.0	0.0	0.01	0.00	0.01	0.00
No. Sample	71	59	66	66	48	47	64		67	67	67	67

* Parenthesis indicate flow corrected data.

the two tables was attempted by Malcolm Pirnie, Inc. as follows. (Because sampling data for raw leachate does not coincide with effluent sampling on a day-to-day basis, comparison of influent and effluent quantities and concentrations were made on an average or seasonal basis.)

Comparing the data in Tables 1-2 and 1-3 revealed the average removal efficiencies for iron (Fe) and manganese (Mn) to be 67 and 82 percent, respectively. Ammonia (NH_3) removals varied considerably because of the sensitivity of nitrification to environmental influences, but were in the range of 50 to 90% in the summer and 0 to 25% in the winter. Suspended solids (TSS) concentrations in the raw leachate were found to be generally quite low. Suspended solids found in the effluent were probably due to the growth of biological solids in the aerated lagoon. Since the leachate treatment pond was designed as a once-through system without provision for solids removal, a certain amount of these solids invariably escaped in the effluent, contributing to the higher than desired suspended solids concentrations in the effluent.

1.3 Report Organization

This RI Report has been organized in a format consistent with Chapter 3 of USEPA's Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (USEPA, 1988) and is part of a four volume set. The RI Report is Volume 1; the FS Report will be Volume 2; Appendices are contained within Volumes 3 and 4.

2. SUMMARY OF REMEDIAL INVESTIGATION FIELD ACTIVITIES

In carrying out field activities at the Ramapo Landfill site, all applicable project plans were followed except where deviations were necessitated by site conditions. All deviations from protocol or the sampling program were approved in advance by the Town of Ramapo and the NYSDEC Project Manager. Applicable documents include the Work Plan (URS, 1989), Field Sampling Plan (FSP - URS, 1989), Quality Assurance Project Plan (QAPP - URS, 1989), and Site - Specific Health and Safety Plan (HASP - URS, 1989). The field work for the first phase of this project was performed from April 1989 through May 1990. The second phase of field activities was performed from July 1990 through September 1990 but also includes the terrain conductivity survey performed in June 1990. The following discussions pertain to both phases of investigation.

(Please note that the use of the words onsite and offsite throughout this report are to depict the area within the property lines shown on Plate 1, and are not intended to convey the meanings defined in the National Contingency Plan (NCP).)

2.1 Surveying and Mapping

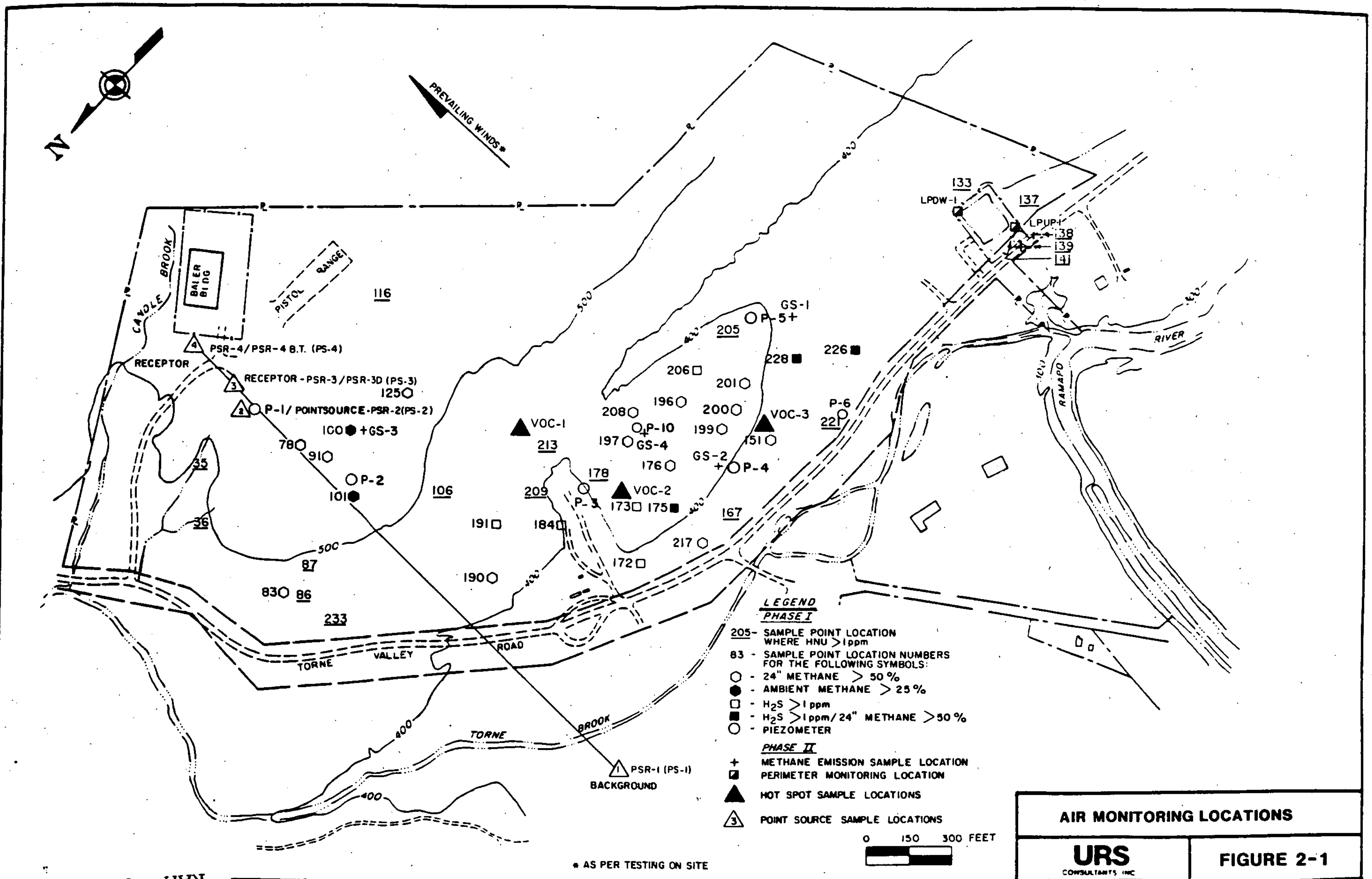
A topographic base map (Scale 1 inch = 100 feet, contour interval = 10 feet) of the Ramapo Landfill was prepared from a 1984 aerial photo supplied by the Town of Ramapo. The topographic base map at this and smaller scales was used during the site investigation, data analysis phase, and subsequent evaluations of remedial alternatives.

Field surveys were conducted to locate soil gas survey sampling locations, and to establish exact locations and elevations of monitoring wells, geophysical stations, and environmental sampling points. Vertical and horizontal benchmark control was provided by the Town of Ramapo. Vertical control is based on the National Geodetic Vertical Datum of 1929, and horizontal control is assumed. All surveying was performed by URS under the supervision of a New York State licensed surveyor, Earle C. Newman. Property lines were taken from a map of a boundary survey prepared for the Town of Ramapo by A.R. Sparaco, Jr., PLS, dated October 20, 1982. As shown on all URS maps and exhibits, property line locations are approximate, being shown for reference only, and not intended to be used for conveyance of property.

2.2 Air/Soil Gas Survey

In September 1989, prior to intrusive activities at the Ramapo Landfill, air and soil gas screening was performed to determine the level of personal protection necessary for onsite activities and to aid in determining potential sampling locations. A total of 240 air and soil gas monitoring locations were surveyed with a spacing of roughly 100 feet between survey stations. Each soil gas sampling location was established at the time of sampling with the aid of an Electronic Distance Meter and the local horizontal survey benchmarks. Soil gas survey data and sampling locations are given in Appendix A.1. At each soil gas survey station three 1/4-inch diameter holes were made, two to depths of 24 inches and one to a depth of 8 inches. Organic vapor concentrations were recorded in the 8-inch and in one 24-inch hole using a photoionization detection unit (PID). The remaining 24-inch hole was monitored for explosive gases and hydrogen sulfide using an Explosive Gas Indicator (EGI). Above-ambient air readings were also noted if present on either instrument. Above-ambient readings are presented on Figure 2-1.

An air monitoring program was carried out during the second phase of field activities. The primary objectives of the program were to determine the type and concentration of airborne contaminants emanating from the Ramapo Landfill, to define the dispersion of the these contaminants, and to determine the production of landfill gases. To accomplish these



AIR MONITORING LOCATIONS

FIGURE 2-1

objectives, three air monitoring activities were conducted, the full results of which are presented in Section 4.5.

1) Point Source Monitoring

Point source monitoring consisted of background, point source, and receptor areas. A transect was made of the northern lobe intersecting the point source (Piezometer 1) and the receptor area (Baler Building). By connecting these points and extending the line beyond the western perimeter of the landfill, the background location was established. Sample locations are identified on Figure 2-1 as PSR-1 through PSR-4 (Point Source Receptor). Samples at these locations were collected in tedlar bags and analyzed for volatile organics and methane.

2) Hotspot Monitoring

Three areas on the surface of the landfill registered high PID readings during the soil gas survey. A sample was taken at each of these locations on the surface of the landfill (identified as VOC-1, VOC-2, and VOC-3 on Figure 2-1) by Tenax adsorbent tube, and analyzed for volatile organics.

3) Methane Quality

Samples from four locations identified as GS-1, GS-2, GS-3, and GS-4, were collected in tedlar bags and analyzed for methane, nitrogen, carbon dioxide, oxygen and hydrocarbons. The samples were taken within piezometers or pre-existing vents. These results will be combined with results of the PSR samples to aid in the determination of the quality of gas emanating from the landfill.

In addition to the above activities, independent eight-hour air samples were collected upwind and downwind of the leachate pond concurrent with sampling of the pond itself (water and sediment). These two air samples were analyzed for volatile organics.

2.3 Surface Geophysical Survey

The purposes of the seismic geophysical surveys were to provide information about the subsurface stratigraphy, depth to bedrock, and to identify any bedrock troughs or buried valleys. A total of 5,600 feet of seismic refraction line and 1,070 feet of seismic reflection line were completed by Hager-Richter Geoscience, of Windham, New Hampshire. Field operations were supervised by URS personnel. Results of the survey are explained in Section 3.7.3. The complete geophysical study report is included in Appendix B.1.

At the request of the NYSDEC, an EM-31 terrain conductivity survey was performed in the vicinity of the Baler Building and MW-5 cluster in order to delineate the limits of fill and to locate buried metallic objects. Operation of the Geonics model EM-31 electromagnetic terrain conductivity meters was done by geophysicists from Weston Geophysical of Westboro, Massachusetts. Surveying and supervision was performed by URS personnel. Results of the survey are contained within Section 3.7.3. The complete terrain conductivity survey report is included as Appendix B.2.

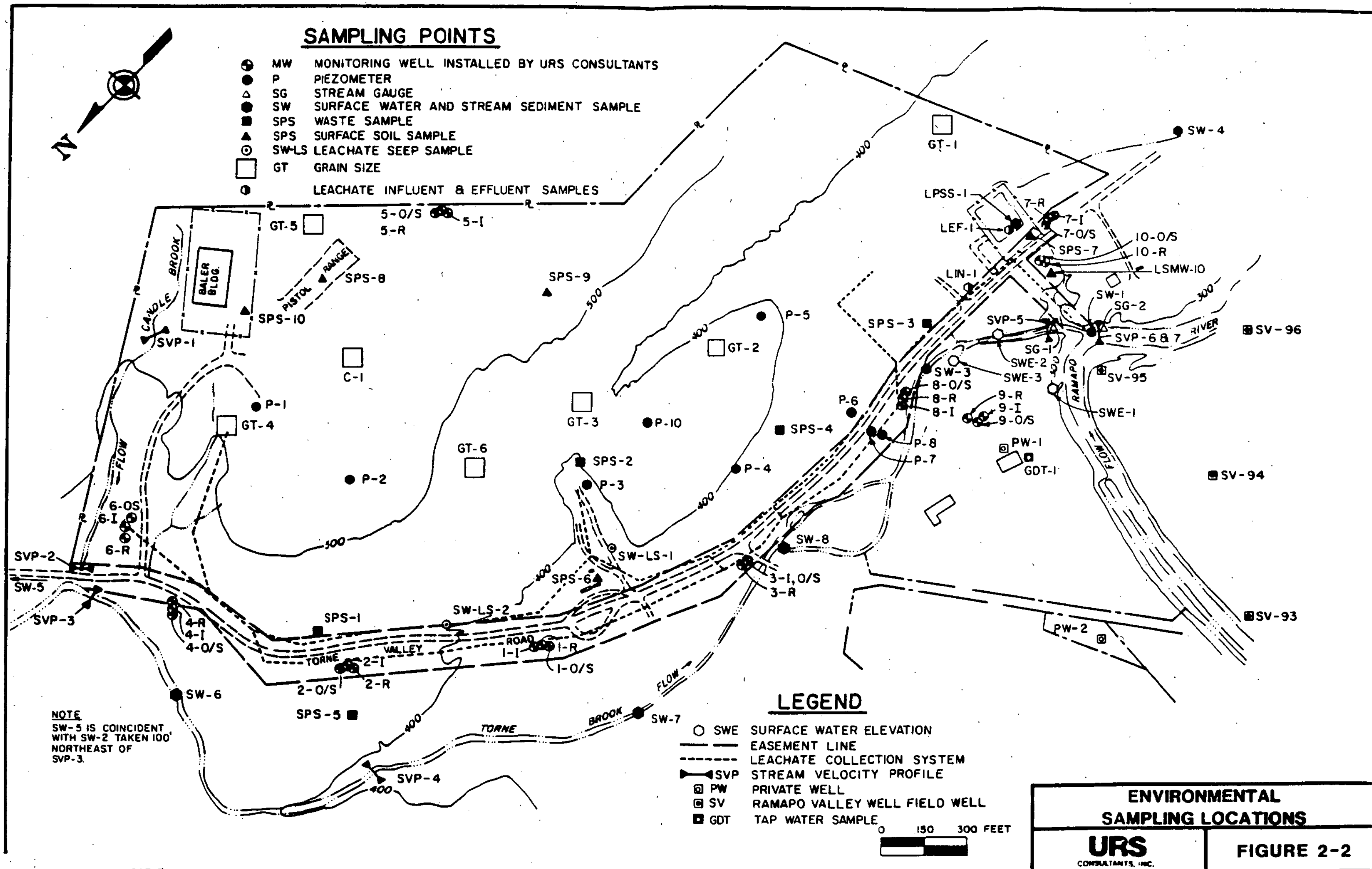
2.4 Subsurface Drilling Program/Monitoring Well and Piezometer Installation

Soil borings and monitoring wells were constructed at the site to directly evaluate subsurface conditions. Conditions evaluated included: stratigraphy, physical soil properties, soil quality, aquifer parameters, and groundwater flow and quality. Final location of all monitoring wells and piezometers was discussed with Town and NYSDEC personnel prior to their selection.

Twenty-one borings were made at eight locations on or near the Ramapo Landfill during the first phase. Twenty borings were completed as stainless-steel monitoring wells, and one was completed as a PVC piezometer. Four additional piezometers were installed. Seven wells were completed in the shallow overburden (OS), six were completed at the bedrock/overburden interface (I), and seven were completed in bedrock (R). Eight boring attempts made unsuccessful by the presence of large boulders, were abandoned at a shallow depth and grouted. Well locations are shown on Figure 2-2. Figure 2-2 has been enlarged and presented as Plate 1 found at the end of this report.

During the second phase, eight additional monitoring wells and six additional piezometers were installed. Three wells were completed in the shallow overburden, two at the bedrock/overburden interface, and three in bedrock. Monitoring well cluster GW-9 and well pair GW-10 were located offsite on adjacent properties. Two boring attempts made unsuccessful by the presence of large cobbles and boulders, were abandoned at a shallow depth in the vicinity of GW-9 and grouted.

All borings and monitoring wells were installed in accordance with the procedures specified in the FSP and QAPP except where field conditions dictated a different approach. To enable the advancement of boreholes through boulder and cobble-rich dense sands and gravels, all boreholes, with the exception of GW-7OS, were advanced with 4-1/4-inch I.D. hollow-stem augers instead of the 6-1/4-inch I.D. hollow-stem augers specified in the Work Plan (URS, 1989). GW-7OS was advanced with 6-1/4-inch I.D. hollow-stem augers to completion depth. Because of the change in auger size, the final reamed size of all rock holes was reduced from 5 inches to 4 inches in diameter. At two locations (GW-8R and GW-1R), core holes were not reamed due to loss of circulation of drilling water during rock coring. At these locations, wells were installed in the NX-core holes. In addition, bentonite seals below the water table were installed as a bentonite slurry through a tremie pipe from the top of sandpack to ground



ENVIRONMENTAL SAMPLING LOCATIONS

FIGURE 2-2

surface. After sufficient time for slurry settling, (24 hours) the slurry was supplemented by at least 6 inches of pelletized or rough-cut bentonite before cement grout was added.

Due to the high methane levels encountered during the completion of P-1 piezometers P-2, P-3, P-4, P-5 and P-10 were not completed as planned. An existing PVC well in the vicinity of proposed piezometer P-2 was used as a substitute for this piezometer. Piezometers P-3, P-4, P-5, and P-6 were completed as 1-1/4-inch steel well points driven by hand with an 80-pound drive hammer. Piezometer P-10 was completed as a 1-1/4-inch gas piezometer driven by hand with an 80-pound drive hammer. It was completed within the fill as a part of the overall air monitoring program.

The dual piezometers (P-7 and P-8) were installed in boreholes advanced with an ODEX casing advancement system. The piezometer installation and material specifications were in accordance with protocols outlined in the Scope of Work for the Second Phase (July 1990), with the exception of the following items. Galvanized risers and stainless-steel screens were used in place of PVC to ensure the structural stability of the wells due to the presence of cobbles and boulders in the substratum. Due to the unavailability of 6 inch casing, 8 inch casing was used for borehole advancement. This larger borehole necessitated the use of a 10-inch flush-mount protective casing. Proposed dual piezometer P-9 on an adjoining property was not installed due to an access delay caused by the property owner. The access delay conflicted with the driller contractor's schedule for the ODEX drill rig, and the rig was demobilized offsite prior to an access agreement with the property owner.

Continuous split-spoon samples were taken down to the maximum depth of drilling at each location. Continuous sampling at each dual piezometer location was not performed due to the time-consuming and cumbersome process involved when split-spoon sampling with an ODEX system. Soil at piezometer P-8 was sampled to a depth of 20 feet, the approximate depth of the nearby deep leachate collector, per an agreement with NYSDEC personnel. All other materials classification during dual piezometer borehole advancement was done by examination of drill cuttings. Soil samples from the split-spoons were examined and classified by the field geologist in accordance with the procedures found in the FSP and QAPP. After installation, each of the monitoring wells was developed by pumping or bailing, depending upon the depth of the well. A peristaltic pump was used on the first-round wells, and both a peristaltic and centrifugal pump were used on the second round wells. The wells were considered developed when the groundwater indicator parameters, such as pH, specific conductance, and temperature had stabilized and, if possible, turbidity readings of less than 50 NTUs were achieved. Monitoring well GW-6I, installed during the second phase, exhibited turbidity values of over 50 NTUs even after extracting 385 gallons over a three day period. This was due to the presence of mica flecks in the weathered bedrock zone. This material would settle out of solution very rapidly, unlike a silt, therefore this well was considered developed with the approval of the NYSDEC with the recommendation that during sampling care would be taken to obtain a clear sample, particularly those waters that would be analyzed for metals and for volatile organic compounds.

The raw data produced during drilling operations are included as Appendix C (soil boring logs and piezometer details) and Appendix D (monitoring well and piezometer installation reports). Appendix E contains the well development reports. Appendix G includes piezometer and well locations and elevations surveyed after installation during the second phase.

2.5 Hydrogeological Testing

Hydrogeological testing of the water-bearing formations at the Ramapo Landfill consisted of slug tests, packer tests, and physical soil testing. Slug testing for determining hydraulic conductivity was performed by first raising the water level with a stainless-steel slug and electronically monitoring the return of the water level to a static level over time, and second by removing the slug and monitoring return of the water level to a static level. In addition, selected bedrock boreholes were pressure-tested with a dual packer system by pumping water under pressure into the bedrock formation and measuring water loss. The results of slug and packer tests are given in Appendix H and are discussed in Section 3.7.4. Laboratory sieve and hydrometer grain-size analyses were performed on selected soil samples according to ASTM Method D 422 during both phases of field investigations. The laboratory reports may be found in Appendix I.

2.6 Stream Hydrology Studies

Stream hydrology was investigated to aid in the assessment of the effect of the Ramapo Landfill site on the Ramapo River and on Torne Brook and its tributaries. This study included the installation of two stream staff gauges and the determination of several stream velocity profiles and corresponding discharges.

Two (Stevens) stream staff gauges were installed, one at the Ramapo River and one at Torne Brook. The gauges were mounted on non-treated lumber and secured to the shore so that a portion of the staffs were immersed in water at all times. The gauges were referenced to the USGS Vertical Geodetic Datum of 1929.

Cross-sectional profiles and stream velocities were determined at two locations on Candle Brook, three locations on Torne Brook, and at two nearly identical locations on the Ramapo River. Section locations are shown on Figure 2-2. Discharge calculations are given in Appendix P.1. Results are discussed in Section 3.6.

2.7 Community Well Survey

A survey of community water wells downgradient from the Ramapo Landfill was completed to determine the depth and usage of groundwater in the area. Six wells were found within 1,500 feet of the landfill. Results are discussed in Section 3.6.

2.8 Ecological Study

The ecological study was done according to the NYSDEC's "Division Technical and Administrative Guidance Memorandum: Habitat-Based Assessment Guidance Document for Conducting Environmental Risk Assessments at Hazardous Waste Sites" (Draft, December 28, 1989). The method consists of the following measures:

- Site Description - identification of plant covertypes within a one-half mile radius of the site, and of special resources within a two mile radius, or nine miles downstream of the site.

- Resource Characterization - a description of fish and wildlife likely to inhabit the area, the quality of habitat provided, and evident stress caused by the landfill on local fauna and flora.

- Hazard Threshold and ARAR Identification - identification of significant habitats, rare, endangered, or threatened species, and New York State Water Quality Standards and Guidance Values. ARARs will be provided within the section on analytical results (Section 4).

The potential impacts of the landfill on the terrestrial and aquatic species in the vicinity are identified in Section 6.9 following the health risk assessment.

2.9 Environmental Sampling

The purpose of the environmental sampling program is to produce a data base adequate to characterize the site, to assess its current impact upon public health and the environment, and to provide a basis for assessment of future impacts. URS attempted to take the two phases of samples six months apart so as to be representative of more than one season.

All first-phase laboratory analyses were performed by NYSDEC Contract Laboratory Program (CLP) laboratories, and following the latest CLP protocols. Samples were analyzed for NYS Superfund CLP Target Compound List/Target Analyte List parameters. All quality assurance/quality control (QA/QC) procedures specified in the QAPP were followed. All data were subjected to rigorous review by URS before acceptance or rejection. Data validation, reduction, and determination of useability were performed in accordance with USEPA Standard Operating Procedure (SOP) No. HW-3 CLP Organic Data Review. The inorganic data validation processes were performed in accordance with USEPA SOP No. 788 for Inorganic Analysis including Revisions 2/89 and 6/89. The Data Useability Reports which summarize the data reviews for each round of data are included as Appendix J. Environmental sample descriptions are given in Appendix K. Sample locations are shown on Figure 2-2 and on Plate 1. Parameters analyzed by the laboratory for each media are presented, along with a summary of results, in Section 4.

For the second phase, the NYS Analytical Services Protocols (ASP), which superseded the CLP, were utilized. In addition, USEPA Method 524.2 was used, at the request of the NYSDEC, in order to achieve lower detection limits for volatile organics for groundwater and surface water samples.. Six TCL/TAL volatiles not ordinarily determined by this method were then analyzed by ASP.

(a) **Soils:** As mentioned in Section 2.4, continuous split-spoon samples were taken over the depth of overburden at all borings or boring clusters. After classification by the field geologist, a representative, discrete sample was taken from each split-spoon for volatile analysis. Then a composite sample was taken from each split-spoon and submitted for the remaining chemical analyses (semi-volatiles, pesticides/PCBs, inorganics). Samples not analyzed were held for reference purposes.

Ten surface or near-surface samples were taken with a bucket auger or hand trowel during the first phase, some being strictly soil and others containing waste material. Again, care was taken to bottle the portion of the sample sent for volatiles analysis first (quickly). SPS-6 was resampled during the second phase, since organic results from the first phase were rejected due to holding time violations by the laboratory. The results of the soil investigation are presented in Section 4.1.

(b) **Groundwater:** Groundwater samples from 20 wells were collected during the first phase: GW-40S was resampled during the second phase due to holding time violations by the laboratory. All first-phase and second-phase wells were sampled during the second phase in accordance with the FSP. Prior to sampling, at least three well volumes of water were recovered (purged) from each well to ensure that only fresh groundwater was sampled. Each groundwater sample was collected in the sample containers supplied by the laboratories. Field preservation was completed on the appropriate portion of each sample. Samples were labeled with sample identification codes, analyses to be performed, field preservation method, date and time collected, and field sampler's initials. Groundwater sample identification codes were used per the Work Plan. All groundwater samples were inventoried upon recovery, and chain of custody initiated. Samples were sealed upon collection, packed in coolers, and shipped to the appropriate laboratories within 24 hours of collection. Groundwater analytical results are discussed in Section 4.2. Well purging and development logs are given in Appendix F and Appendix E, respectively.

In addition, a water sample (identified as GDT-1) was taken on an adjacent property from the pump house supplying potable water to approximately fifty residents.

(c) **Surface Water and Sediments:** Surface water and stream sediment samples were collected during the first phase at two locations in Torne Brook, one location in the Ramapo River, and one in a small swale draining the southern portion of the site. During the second phase, re-samples were taken where results had been rejected during the first-phase data audit due to holding time violations by the laboratory. In addition, three new locations along Torne Brook were sampled and analyzed. Results are presented in Section 4.3.

(d) **Leachate Seeps:** During the first phase, two leachate seeps on the landfill were located, sampled, and samples were sent for analysis. During the second phase of drilling, a leachate seep was identified offsite in the vicinity of MW-10. Soil sample LSMW-10 was taken at this location and sent for analysis. Results are presented in Section 4.3.

(e) **Leachate Pond:** Samples were taken during the second phase in conjunction with an eight-hour air study at the leachate pond. These samples included an influent water sample from the discharge pipe leading to the pond from the landfill; an effluent water sample from the pond near the opening to the overflow pipe; and a sediment sample from the sides of the pond.

3. PHYSICAL CHARACTERISTICS OF THE STUDY AREA

3.1 Surface Features

The Ramapo Landfill is located within the Ramapo Mountains in the valley of Torne Brook near its confluence with the Ramapo River. The site is situated at the base of the southeastern ridge forming this asymmetrical valley. Elevations at the landfill range from 580 to 310 feet above mean sea level (amsl). To the northwest, High Torne Peak rises steeply to an elevation of over 1,100 feet within 2,000 feet of the landfill. The ridge directly above the landfill is much less steep, rising to an elevation of over 1,000 feet at a distance of nearly a mile from the landfill.

(Please note that the use of the words onsite and offsite throughout this report are to depict the area within the property lines shown on Plate 1, and are not intended to convey the meanings defined in the National Contingency Plan (NCP).)

3.2 Climate

Information on climate for the area was obtained from the National Oceanic and Atmospheric Administration for Stewart Air Force Base in Newburgh, New York (NOAA, 1990). Newburgh is located approximately thirty miles north of the site and is the nearest reporting weather station. Precipitation, temperature, and wind data were available for this location for the period 1942-1969.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total Annual
Precipitation (in)	2.7	2.7	3.1	3.5	3.9	3.4	3.6	3.7	3.3	3.2	3.7	3.4	40.2
Temperature (°F)	26	28	37	48	58	68	73	72	64	54	42	29	---

The mean annual precipitation is 40.2 inches. Recorded temperatures range from extremes of -20° F to 102° F. Prevailing winds are from the west and the west-southwest at a mean speed of less than 10 mph. The above table shows a breakdown of the mean monthly precipitation and temperature.

3.3 Demography and Land Use

The Ramapo Landfill is situated on a 96 acre parcel, owned by and located within the Town of Ramapo, Rockland County, New York, approximately 35 miles northwest of New York City and one mile northeast of the Village of Hillburn, New York. The landfill is located along the west slope of the Ramapo Mountains approximately 2,500 feet south of the Harriman Section of Palisades Interstate Park. At the present time the landfill property is used for the operation of a municipal waste transfer station and a police weapons firing (pistol) range. Utilities such as electricity, gas, and telephone pass through corridors surrounding the landfill property. An active electrical sub-station constructed in 1972-1973 is located adjacent to the north side of the site with 365,000 volt transmission lines running along the east and west sides of the site to within 400 feet of the landfill property. Torne Brook was re-routed within the confines of the substation upstream of the site for construction of this substation for Orange and Rockland Utilities. Additionally, a high-pressure gas pipeline is located approximately 500 feet south of the site.

The land surrounding the site is rugged, heavily wooded, and sparsely populated. Torne Brook and the Ramapo River are located immediately west of the landfill. The nearest residential property is located less than 500 feet west of the site along the west bank of Torne Brook. The intervening land is wooded. The nearest suburban development is the Village of Hillburn, with a 1980 census population of nearly 1000. Commercial properties are located less than 2,000 feet west of the site along the west bank of the Ramapo River. The intervening land slopes west to the Ramapo River floodplain. The Spring Valley Water Company draws large volumes of water from commercial wells located within the Ramapo River Valley. The closest of these is approximately 500 feet west of the landfill. Spring Valley water usage is addressed in Section 3.6.

As identified on the U.S. Geological Survey topographic maps for the region, many hiking trails have been established throughout the Ramapo Mountains. One of these, the Suffern-Bear Mountain Trail, passes within one mile of the landfill.

The nearest agricultural land may be found along the east side of the Ramapo Mountains approximately 1.5 miles east of the landfill site.

Cultural resources identified in the vicinity of the site include the property of Torne Brook Farm, which was added to the National Register of Historic Places in May 1988.

Also, the site has been identified as lying within a "potentially significant archaeologically significant area" as denoted on the New York State Archaeological Site Location map (communications with R. Bean, NYSDEC Division of Regulatory Affairs - Region 3, and B. Fulleur, NYS Office of Parks, Recreation, and Historic Preservation, November 1990). The exact locations of important archaeological sites (e.g. former Native American encampments) are not revealed to the public in order to safeguard them from vandalism and the like. The records are maintained by the NYS Office of Parks, Recreation, and Historic Preservation. It will be necessary to know this information during the design phase of the project if any offsite remedial action activity is proposed which could affect such an area (e.g. excavations).

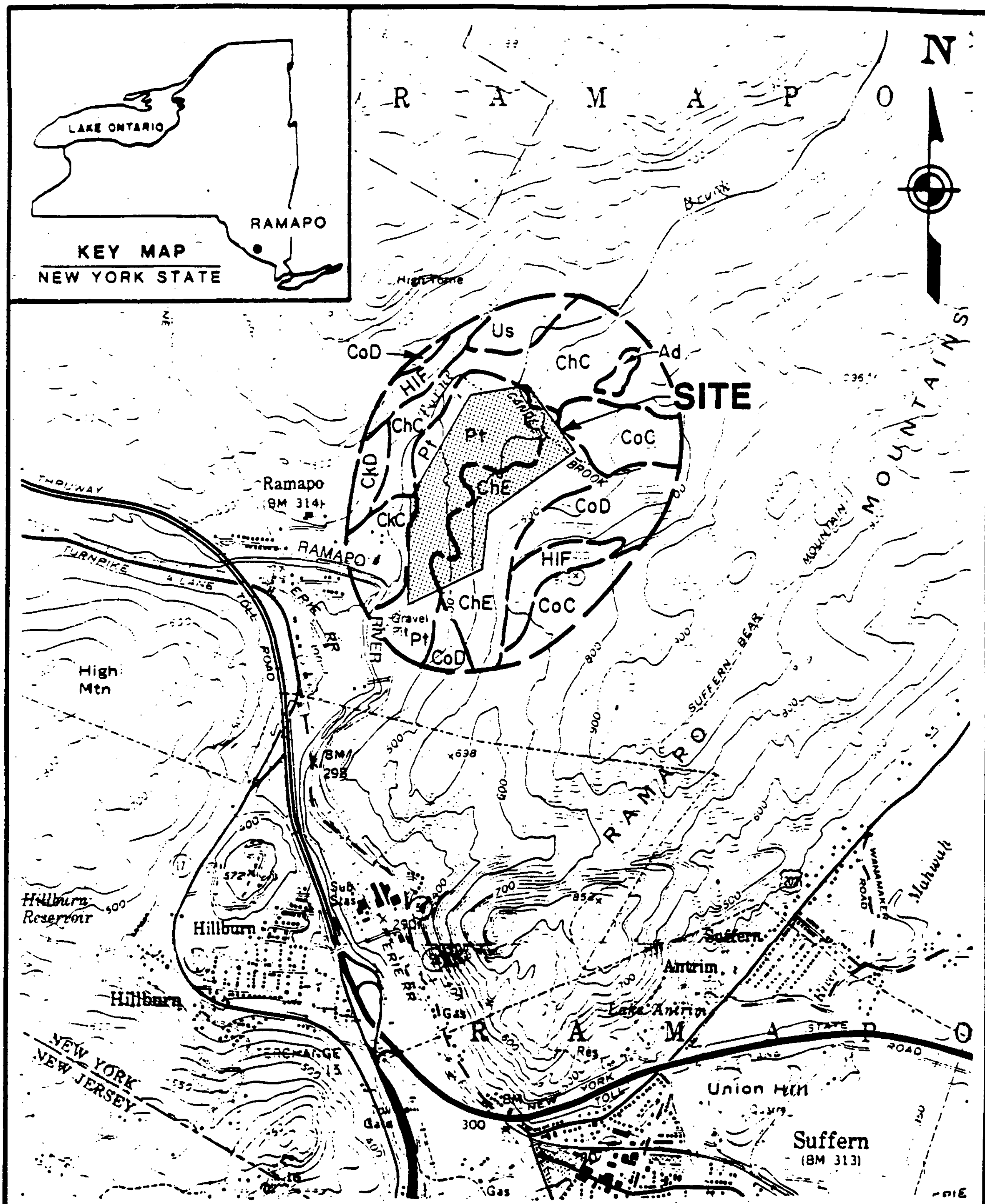
3.4 Soils

According to information taken from the Environmental Impact Statement (EIS) for the site prepared by Leonard Jackson Associates (1978), the group of soils that dominates the landfill is the Charlton Series. This consists of deep soils formed in glacial till derived mainly from schist and gneiss. The Charlton Series is generally a fine, sandy loam of varying color, and listed as very friable and strongly acidic. Charlton soils are found on till-covered uplands, with slopes generally ranging from 2 to 35 percent. Runoff is medium to rapid. Internal drainage is medium, and permeability is moderate or moderately high.

The EIS report also states that a small segment of Leicester Series soils exists within the fill area in poorly drained and low-lying areas. Leicester soils are formed in glacial till mainly from schist, gneiss, and granitic rocks. They are poorly drained, runoff is slow, and permeability is moderate or moderately high.

The current Soil Conservation Service (SCS) maps (USDA, 1990), however, follow a revision made in the Rockland County soils classifications in 1986. The SCS soils are shown on Figure 3-1. The fill area is mapped as a gravel pit/mining area (Pt). The soils surrounding the landfill are of the Charlton series (ChC, ChE, CkC, CkD, CoC, CoD), and the Leicester series is not shown. Other series shown on Figure 3-1 are Alden (Ad), Hollis (HiF), and Udorthents (Us).

The southeastern portion of the site has been used in the past as a gravel pit.



USGS 7.5 MINUTE SERIES
RAMSEY AND SLOATSBURG
QUADRANGLES (1955)

0 1000 2000FT
SCALE

URS CONSULTANTS, INC.	SCS SOILS IN VICINITY OF LANDFILL	FIGURE 3-1

A-3913

3.5 Ecology

3.5.1 Covertypes

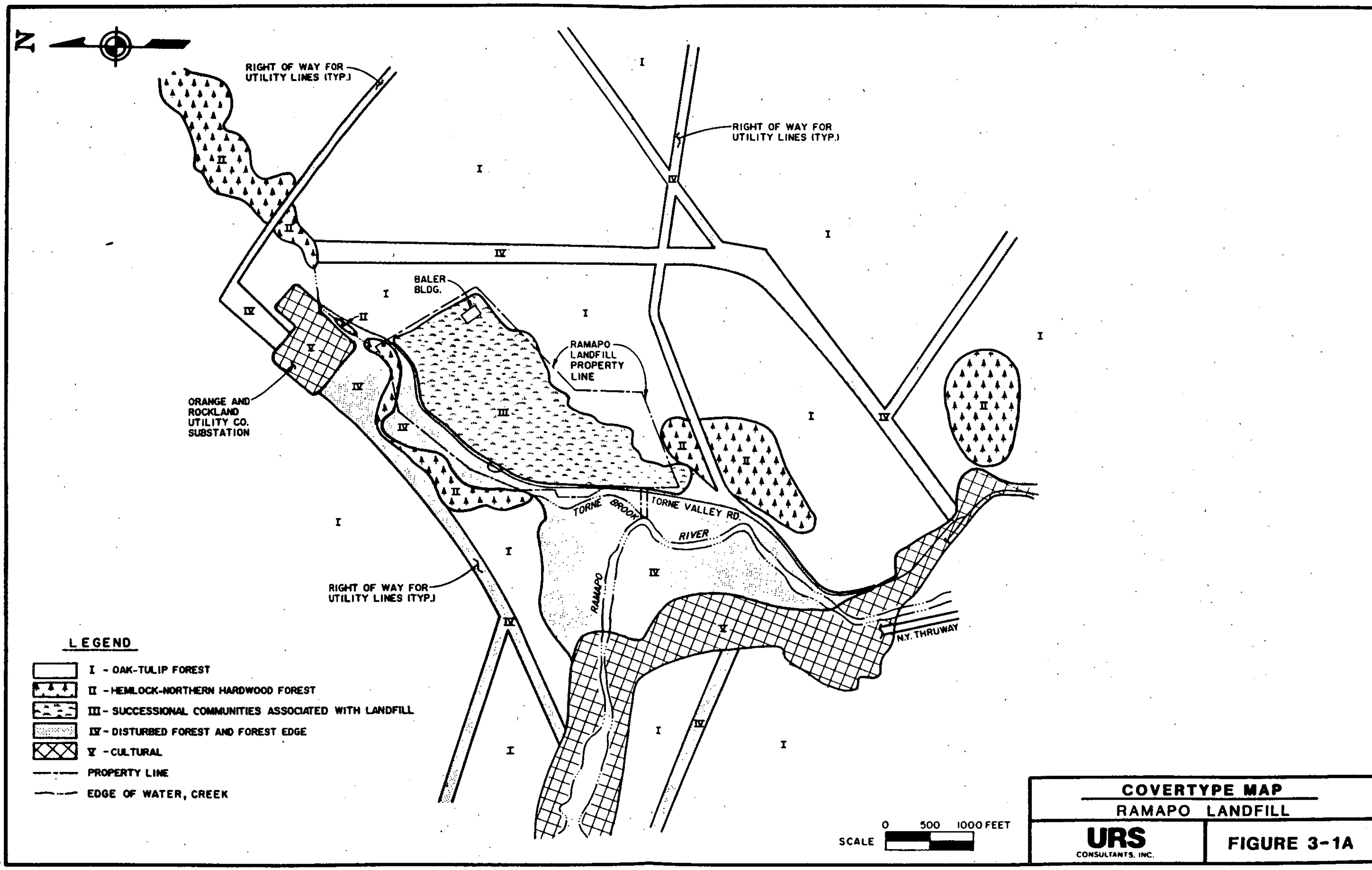
The plant communities on the site and within a one-half mile radius of it may be divided into five categories. These are based as closely as possible upon the community types listed in: "Natural and Cultural Ecological Communities of New York State" (NYSDEC, 1988). The community types are described in the following paragraphs, and their ranges are shown on Figure 3-1A. Field identification of the indicator species was made May 21, 1990, by URS personnel. All species identified in the field check are listed in Appendix N.

I: **Oak-Tulip forest** - This community occupies most of the undeveloped land surrounding the landfill. It is a mature community, with a sparse undergrowth of shade-tolerant species. This forest is dominated by red oak, red and sugar maples, white oak, tulip tree, and shagbark hickory. Understory species include maple-leaf viburnum, flowering dogwood, witch-hazel, and mountain laurel. Ground cover includes geranium, hay-scented fern, Christmas fern, sensitive fern, and cinnamon fern.

This community type is apparently secure globally, but may be of limited acreage in New York State, and in danger of extirpation (NYSDEC, 1988).

The soil is acidic, moderately well drained, and overlies unconsolidated glacial deposits.

II: **Hemlock - Northern Hardwood Forest.** This community grows on the poorly drained, acidic, lowland soils along Torne Brook, and on lower portions of some west-facing slopes in the area. Hemlock alone dominates over part of the range, with red maple, white oak, and red oak as co-



COVERTYPE MAP
RAMAPO LANDFILL
FIGURE 3-1A

dominants elsewhere. Beneath stands of pure hemlock, undergrowth is sparse. Where the canopy is varied, there is an understory which includes dogwood and sassafras.

This forest type is apparently secure throughout New York State and the world (NYSDEC, 1988).

III: Successional Communities Associated with the Landfill - Herbaceous growth and low-growing shrubs cover most of the landfill surface, except in a few isolated areas where invasive woody plants have become established, and a small, unvegetated area in the northwestern portion of the site, where activity continues next to the baler building. Herbaceous plants range from those adapted to dryer soils (goldenrod, white clover, cinquefoil, birdsfoot trefoil) to those favoring wet soils (Phragmites spp.). Hydrophytic species often occur in small, distinctly defined outcrops, within areas of mesophytic species. Herbaceous growth over most of the landfill is thick and tall by the end of the growing season. Shrubs and woody perennial vines include virginia creeper, raspberry, rose, grape vine, poison ivy, and elderberry. Larger woody species include eastern cottonwood, black willow, smaller willow species, black locust, ailanthus, and red mulberry.

Woody plants do not appear to be colonizing the landfill rapidly. The stands of trees are isolated and relatively distinct, without bordering areas of significant sapling growth. The slower growing hardwood species (tulip tree, shagbark hickory, downy juneberry) are beginning to establish themselves on the eastern border of the landfill.

IV: Disturbed Forest and Forest Edge - The banks of the Ramapo River and the edges of forest adjacent to clearings and developed areas are still dominated by oak and maple, but also contain invasive species. These include willow and cottonwood, as well as vines, smaller trees, shrubs, and ground cover. The principal agent of this disturbance is clearing of land, allowing light to enter the forest beneath the canopy and fostering the growth of species normally not able to survive in a mature canopied woodland. Power line rights-of-way are kept free of taller trees, and are therefore non-successional shrublands dominated by shrub willows, downy juneberry, smaller shrubs and herbs, Phragmites, raspberry, and rose.

V: Cultural Areas - These occur in the southwestern portion of the area delineated for covertype identification. All are actively maintained: lawns, roadsides, roads, parking lots, buildings, etc. Small, wooded areas may be found within this community, but they are less effective as habitat than the surrounding forest because of their isolation. This group of communities does not support the diverse flora/fauna that the surrounding forest does.

3.5.2 Special Resources

According to documents supplied by the New York State Natural Heritage Program, the landfill is in the historical range of a sub-species of the Eastern Woodrat, Neotoma floridana magister, listed by NYSDEC as endangered in New York State. The Natural Heritage Program ranking indicates that it is apparently secure globally, but that it is in danger of extirpation within New York State. The ranking also indicates that there is a question as to the quality of the taxonomic entity. Southeastern New York State is the northernmost part of its historical range, which extends in a band west of the Appalachian Mountains into Tennessee and Alabama (Hall and Kelson, 1959). No reliable sightings of this animal have been made in New York State in two years (Peter Nye, 1990).

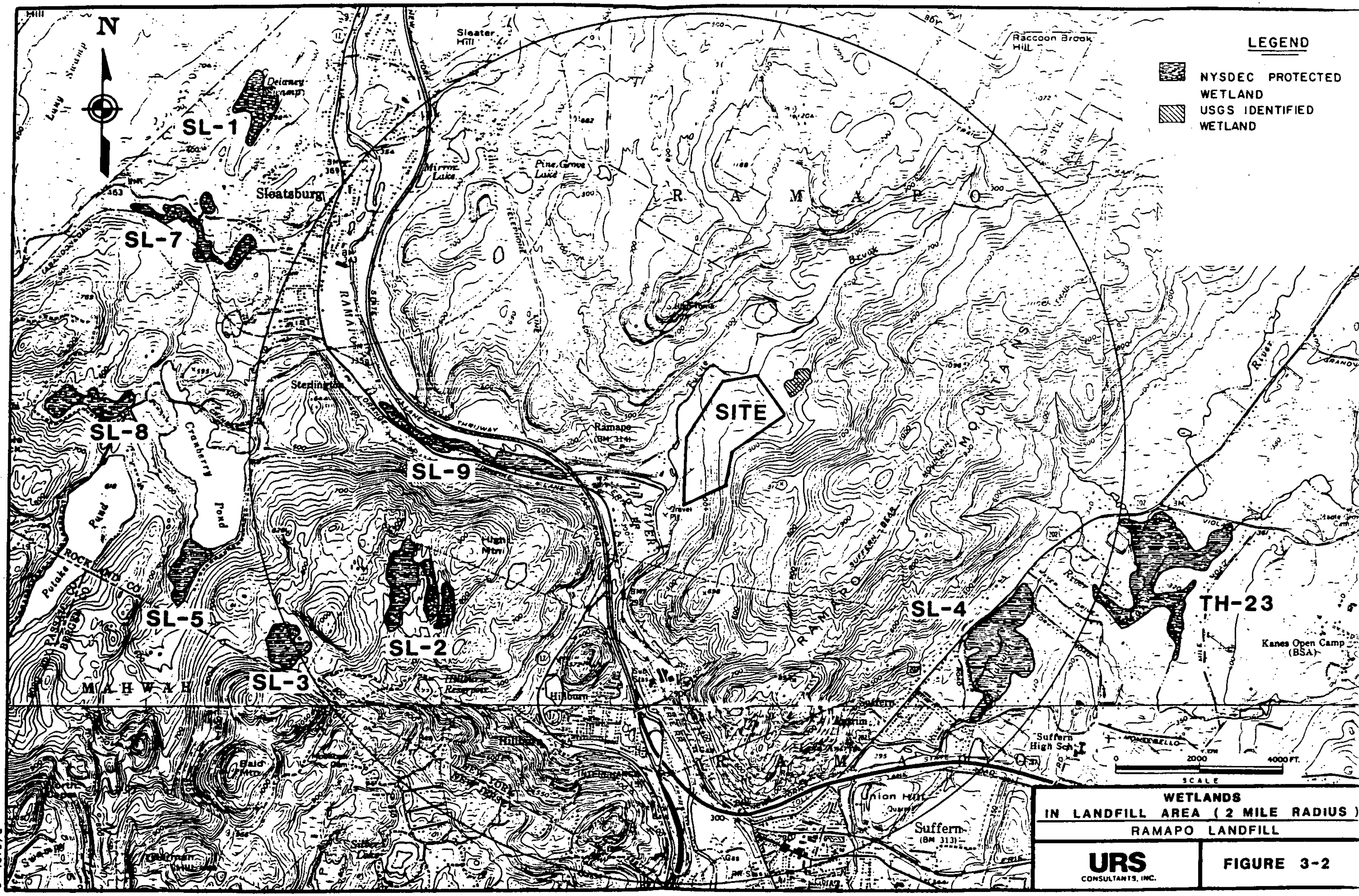
The Eastern Woodrat is primarily herbivorous, preferring green leaves to seeds and nuts. Its habitat is within rocky outcrops or boulder fields. For this reason, it is unlikely to occur on or in the immediate vicinity of the landfill (Peter Nye, 1990). No other NYSDEC rare, threatened, or endangered species or critical habitats are known to occur within a two-mile radius of the landfill, or within nine miles downstream of the landfill.

According to the US Fish and Wildlife Service, there are no federally listed or proposed endangered or threatened species within the project impact area (letter from R. Nunes, USEPA to K. McCue, NYSDEC, September 9, 1991).

No NYSDEC-regulated wetlands occur within nine miles downstream of the site, though several occur within a two-mile radius, either upstream of the site or on a different watershed. These wetlands and their NYSDEC classifications, shown on Figure 3-2, are presented below (where a Class I is the highest classification):

Designation	Class
SL-2	II
SL-3	III
SL-4	I
SL-9	III
TH-23	II

In response to an NYSDEC request for a wetlands assessment at the Ramapo Landfill site according to the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (USACE, USEPA, USFWS, USDA-SCS, January, 1989), URS has taken data gathered during the Habitat-Based Assessment for this site, and, utilizing the data, performed a desktop evaluation according to the methods prescribed in this manual. The evaluation was performed over the area presented in Figure 3-1 of the RI report, which depicts soils encountered on the site and adjacent areas.



WETLANDS IN LANDFILL AREA (2 MILE RADIUS)

RAMAPO LANDFILL

URS CONSULTANTS, INC.

FIGURE 3-2

In the Habitat-Based Assessment, the Ramapo Landfill site was apportioned into five ecological communities corresponding to classifications found in Ecological Communities of New York State (NYSDEC, 1990). These were (1) oak-tulip forest; (2) hemlock-northern hardwood forest; (3) successional communities (old field); (4) disturbed forest and forest edge; and (5) cultural.

Each of the first three ecological communities was evaluated according to the methodology prescribed in the Federal Manual. Community 4, being a combination of communities 1 and 3, was not separately evaluated, nor--due to the virtual impossibility of making a desktop evaluation of such an area--was the cultural community evaluated. Delineation of ecological communities is shown on Figure 3-1A.

While the dominant plants of each ecological community encountered in the study area do include potentially hydrophytic species, the vegetation criterion was clearly met only for ecological community 3, namely the successional communities, where greater than 50 percent of dominant species were potentially hydrophytic. Despite the occurrence of hydric soil in a small area of community 1, neither the vegetation nor the hydrology criterion was clearly met where this soil unit occurred. The hydrology criterion was not met in any ecological community examined.

In summary, the wetlands assessment performed according to the Federal Manual has shown that, since all three criteria were met in no single ecological community on or near the Ramapo Landfill site, no jurisdictional wetlands exist in the area assessed. Data forms for Routine Onsite Wetlands Determination may be found for ecological communities 1 through 3 in Appendix N.

The USGS has identified a wetland near the headwaters of Candlebrook, off the property and east of the Baler Building, as shown on Figure 3-2 (USGS, 1982). Sheet 6 of the USGS report identifies the area, which is less than 10 acres in size, as "water and wetlands". As the USGS may have had more site-specific information to identify such a wetland, we will consider there to be a wetland onsite until a complete wetland delineation is performed.

3.5.3 Resource Characterization

The quality of the area surrounding the landfill as wildlife habitat is such that there may be few, if any, animal or bird species common to southeastern New York State which do not occur there (Scott Smith, 1990). One exception may be beaver, which could find adequate habitat upstream or north of the site, but would be very unlikely to be encountered on the site or downstream of it due to the proximity of human activity.

The quality of terrestrial habitat on and around this site has been estimated based upon three factors:

A. Much of the forest surrounding the landfill is mature and has been allowed to grow without significant disturbance for 50 to 100 years. A portion of the forest upgradient of the landfill had been logged through the mid 1980s, to a limited extent. The oak, hickory, tulip tree, sycamore, and juneberry provide food for a wide variety of birds and mammals. Mature forests support a wider variety of birds and animals than younger woodlots common near human habitation.

B. The forests surrounding the landfill are extensive. The landfill is at the southern tip of a large area of relatively undeveloped land. This area is contiguous with Harriman State Park, which itself contains 46,000 acres of mostly undeveloped land. The effect of this is to allow the presence of species which are unable to co-exist with man, or which have large habitat requirements.

C. There is a lack of human activity within the area. Few roads exist in the undeveloped area north of the landfill.

The disturbed communities (Types III and IV) add to the value of this area as habitat. The variety and lower height of many invasive species provides quality winter food for deer, rabbit, and many bird species. Animals and birds seen on the landfill by URS personnel during the RI/FS field work include deer, rabbit, duck, turkey, Canada goose, mink, raccoon, opossum, and various species of snakes and songbirds.

Streams in the area provide habitat for several fish species. These include some game fish, although neither Torne Brook nor the Ramapo River are classified by NYSDEC as trout streams. As stated previously, the Ramapo River and Torne Brook are classified as Class A and B waters, respectively. Information on fish present in the Ramapo River and Torne Brook has been obtained from stream surveys conducted by the NYSDEC Division of Fish and Wildlife. Surveys in the Ramapo River were conducted in 1936 both upstream and downstream of the confluence with Torne Brook, and in 1983 and 1988 upstream (in slightly different locations). Additionally, a visual survey of Torne Brook was performed in 1936. All surveys were performed in July.

The NYSDEC surveys include data on water characteristics (pH, alkalinity, etc.), stream size and characteristics (flow, degree of cover, etc.), and fish captured (the quantity, size and species). The number of each species of fish captured in each survey is summarized in Table 3-1.

Since no comparative surveys were performed in the Ramapo River downstream of Torne Brook in either 1983 or 1988 no effect of the landfill on fish populations may be inferred. However, the data may be used as indicators, at least, of the type of fish likely to inhabit the river near the landfill, which could be affected by contaminant loadings to the river.

TABLE 3-1

SUMMARY OF RAMAPO RIVER FISH SURVEYS

Scientific Name	Common Name	Downstream 1936	Upstream 1936	Upstream 1983	Upstream 1988
Amblopites rupestris	rockbass	3	1	8	
Catostomus commersoni	white sucker	1	13	3	2
Erimyzon oblongus	creek chub sucker	1			
Etheostoma olmstedi (Boleosom nigrum olmstedi)	tesselated darter	8		1	4
Exoglossum maxilingua	cutlip minnow	3	2	3	15
Lepomis auritus	redbreast sunfish	1		8	
Lepomis gibbosus (Eupomotis gibbosus)	pumpkinseed		2		
Lepomis macrochirus	bluegill			2	1
Micropterus dolomieui	smallmouth bass	6			7
Micropterus salmoides (Aplites salmoides)	largemouth bass	1	2		
Notropis amoenus	comely shiner	2			
Notropis cornutus	common shiner	19	3	22	11
Rhinichthys atratula (Rhinichthys a.atronasus)	blacknose dace	35			
Rhinichthys cataractae	longnose dace				1
Salmo trutta	brown trout			1	
Semotilus corporalis (Leucosomus corporalis)	fallfish	17	10	29	4
Crayfish spp.	crayfish	2	1		

In accordance with the descriptions contained in "Natural and Cultural Ecological Communities of New York State" (NYSDEC, 1988) the Ramapo River is best described as a "mid-reach stream". This stream type has a well defined pattern of alternating pool, riffle and run sections, and primarily lateral erosion. Seven of the 16 species characteristic of this community type have been found in one or more of the fish surveys reported here.

The 1936 visual survey of Torne Brook had no formal fish count, but a few blacknose dace were noted, and it was observed that the stream appeared able to support trout. The cooler water, steeper gradient and presence of blacknose dace indicate that this is a "rocky headwater stream" (NYSDEC, 1988).

3.5.4 <u>Effect of the Landfill on Past and Present Ecology</u>

The vegetation surrounding the landfill, including that found in areas downhill and downgradient of the site, appears lush and healthy. No stressed vegetation was apparent in these areas during the field identification.

The construction of the landfill destroyed the existing vegetation on the site and in immediately adjacent areas. Several large, standing dead trees exist south of the fill area, probably killed by physical damage during landfilling activities. In these areas, as noted in Section 3.5.1, regrowth varies from short herbaceous plants to colonies of invasive woody trees.

Birds, fish, and animals of the area are potential bioaccumulators of any persistent chemicals that may be present in the fill. Deer tracks were observed near ponded water on the landfill surface; a duck was seen swimming in onsite water. At least one rabbit warren exists in the small gully between the northern and southern fill areas. Canada geese and goslings were seen at the edge of the leachate pond on Torne Valley Road. Songbirds may be assumed to be eating the many berries produced by the vines and shrubs on the landfill cover. At this time, however, effects of any contaminants on the fauna of the area have not been documented.

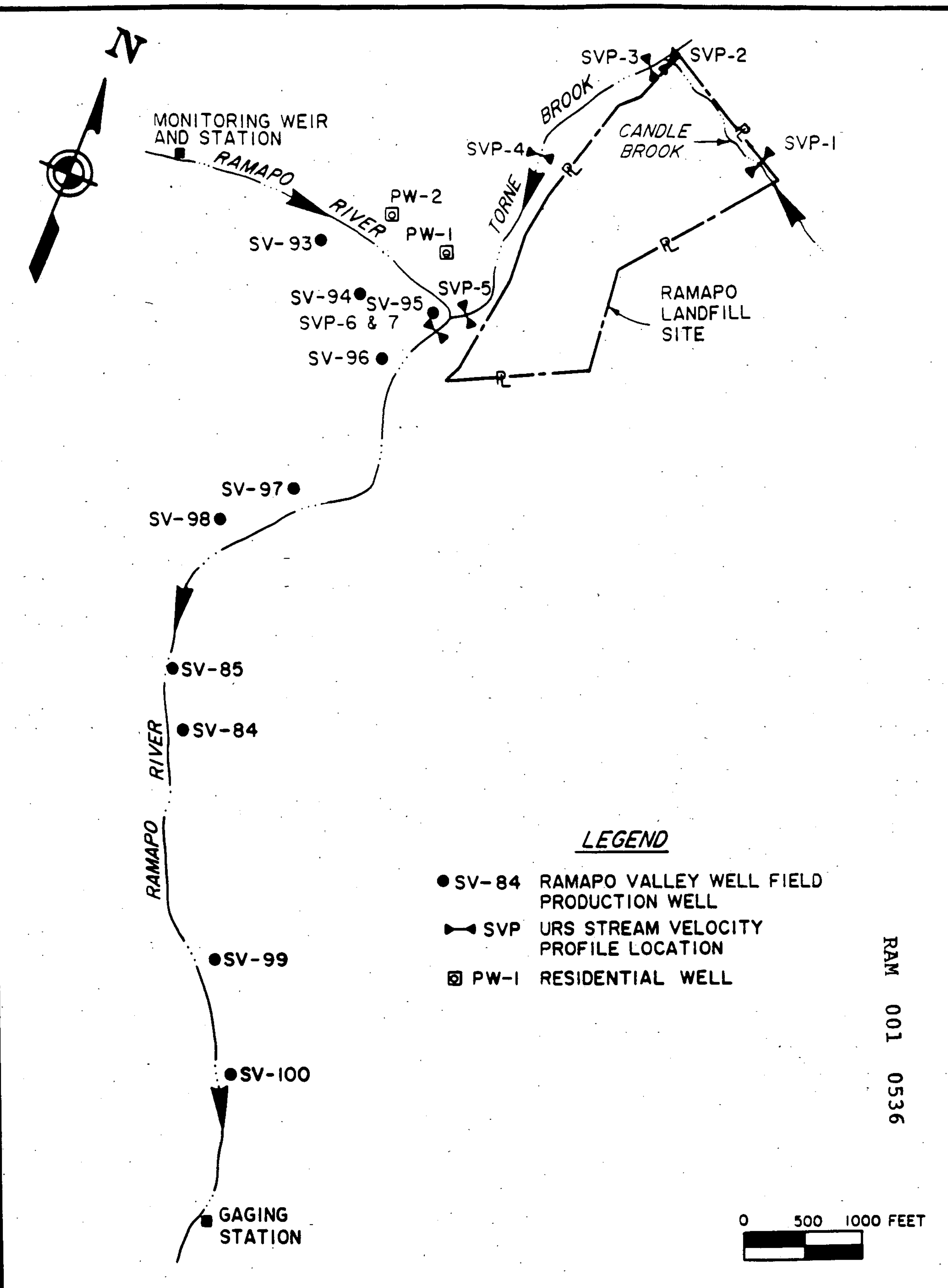
3.6 Surface Water Hydrology and Water Usage

3.6.1 Ramapo River

The dominant surface water feature in the vicinity of the landfill is the Ramapo River (Figure 3-3). The river originates near Harriman, New York and drains an area of about 95 square miles in New York State before it enters New Jersey. The river flows generally to the south through the Ramapo River Valley, passing within 400 feet of the landfill proper. The average daily flow is 110 million gallons per day (mgd). The maximum recorded flow was 6,300 mgd (April 1984). The minimum recorded flow was 4 mgd.

Stream profiles were taken by URS across the Ramapo River on two days in October 1989. Profile locations are shown on Figure 3-3, and actual profiles on Figure 3-4. Water depths in the River are shown as relative from the top of water surface and were not surveyed at the SVP locations. Similarly, River widths were measured but not surveyed. At locations SVP-6 and SVP-7 (which were taken at almost identical locations just downstream of the site) the river is approximately 60 feet wide. On October 25, 1989, discharge was calculated at 543.18 cfs (350 mgd), and at 316.43 cfs (200 mgd) five days later, on October 30, 1989. [Note that the difference in river profiles between locations SVP-6 and SVP-7 is due to the presence of boulders along the river bed.]

The elevation of the Ramapo River was surveyed at SG-2 (near the confluence with Torne Brook) and at a point upstream (SWE-1). Locations are shown on Figure 2-2. [All measured water levels are presented in



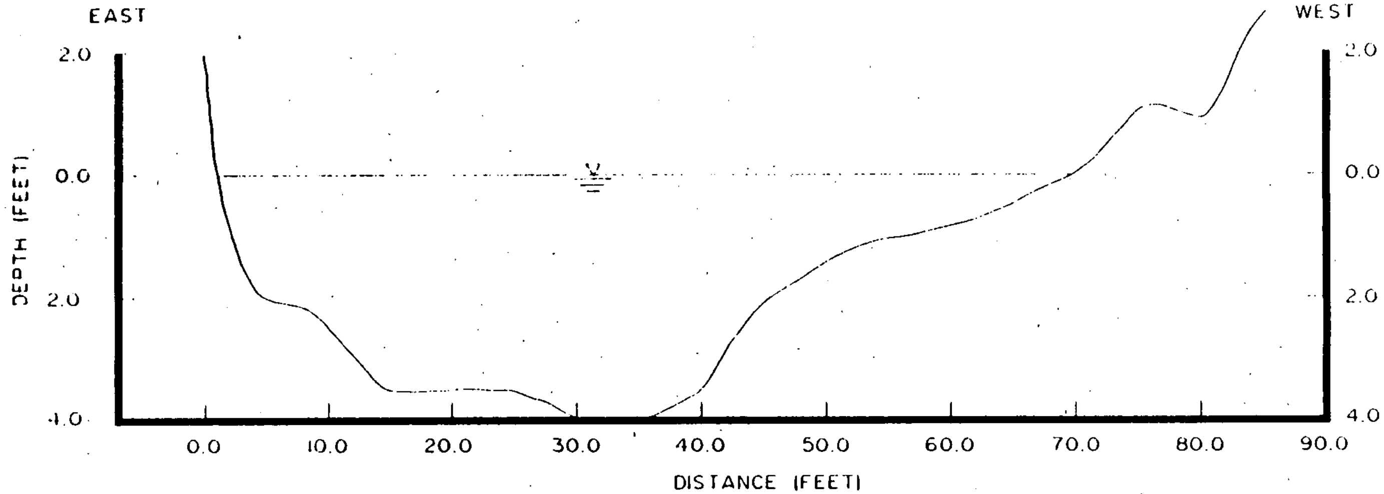
RAM 001 0536

A-3191

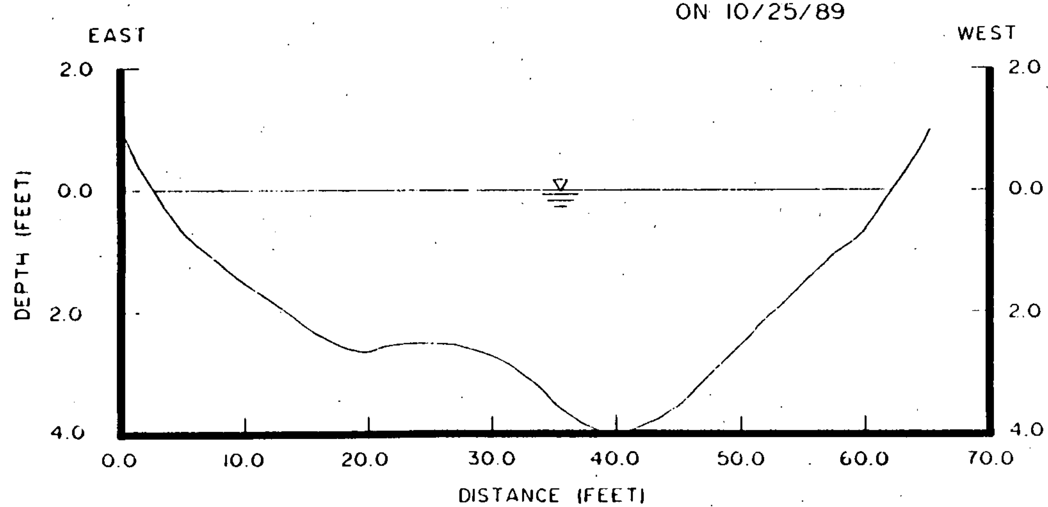
URS CONSULTANTS, INC.

MAP OF SURFACE WATER FEATURES

FIGURE 3-3



LOCATION 6 - RAMAPO RIVER
Q = 543.18 FT^3/SEC
ON 10/25/89



LOCATION 7 - RAMAPO RIVER
Q = 316.43 FT^3/SEC
ON 10/30/89

NOTE: ALL PROFILES LOOKING DOWNSTREAM,
LOCATIONS WERE NOT SURVEYD.

RAMAPO RIVER PROFILES

URS | **FIGURE 3-4**

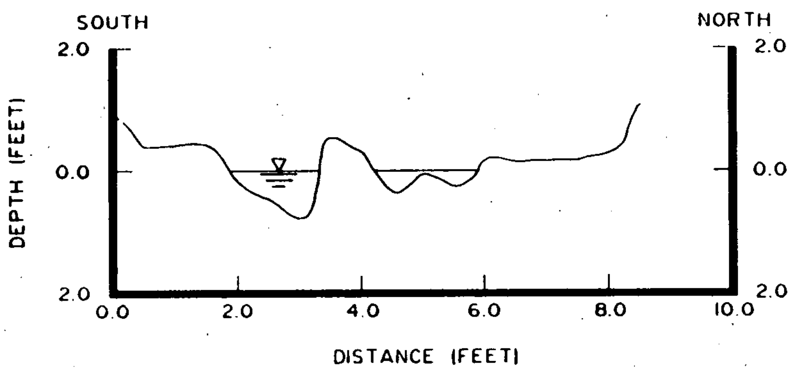
RAM 001 0537

Appendix G.2.] On October 25, 1989 the River elevation was 293.99 feet, and on October 30, 1989 293.20 feet. In general, there was little change in the river level between October 1989 and May 1990 adjacent to the site, varying between 292.81 feet and 294.03 feet.

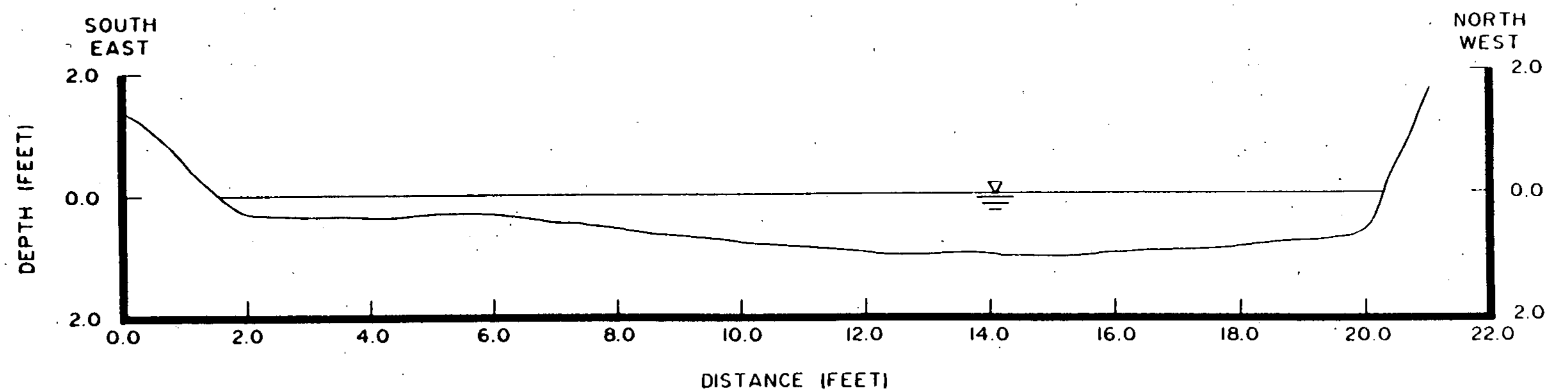
The Ramapo River is a NYSDEC "Class A" water body, meaning that its best usage is as a source of water supply for drinking, culinary, or food processing purposes, and any other usages. It should be noted, however, that two sewage disposal facilities discharge into the Ramapo River upstream from the site. The Village of Sloatsburg operates a plant for about two dozen homes and discharges treated sewage approximately one mile upstream. In addition, the Orange County Sewer District, which serves a number of Orange County municipalities, discharges at Harriman within fifteen miles upstream from the site.

3.6.2 Torne Brook

Torne Brook, an elongated dendritic stream, originates in the Ramapo Mountains approximately 2.5 miles upstream of the site. At several locations it flows within fifty feet of the limits of fill before discharging into the Ramapo River just west of the site. It has a drainage area of about 2.6 square miles. Backwaters from the Ramapo River flood into the mouth of Torne Brook at high flows. Three stream profiles were developed across Torne Brook from field measurements (not surveyed) in October 1989. SVP-3 and SVP-4 are located near the northern portion of the landfill (Figures 3-5 and 3-6). Profiles across these locations show the brook to be approximately twenty feet wide, and generally one foot deep or less. Discharge across SVP-3 was calculated at 7.24 cfs (5 mgd), and across SVP-4, was 11.69 cfs (8 mgd). At SVP-5, just upstream of the discharge to the Ramapo River, Torne Brook is narrower (approximately 13 feet wide) and deeper (about two feet deep). Discharge was calculated at 16.05 cfs at SVP-5. The 100-year floodplain for Torne Brook, as shown in



LOCATION 1 - CANDLE BROOK
Q = 0.9 FT^3/SEC
ON 10/24/89



LOCATION 3 - TORNE BROOK
Q = 7.24 FT^3/SEC
ON 10/24/89

NOTE: ALL PROFILES LOOKING DOWNSTREAM, LOCATIONS WERE NOT SURVEYED.

CANDLE BROOK AND TORNE BROOK PROFILES	
URS CONSULTANTS	FIGURE 3-5

RAM 001 0539

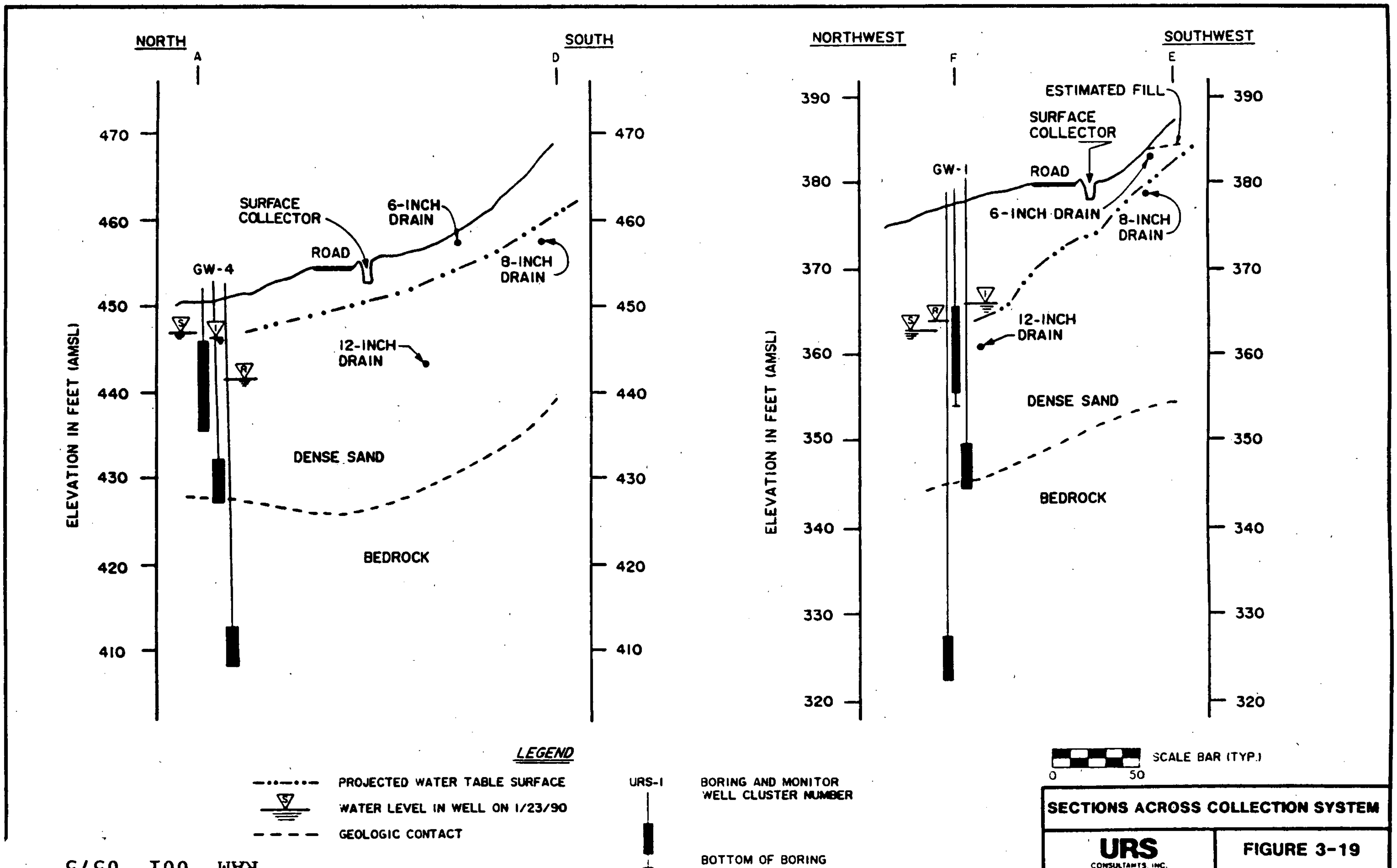
sections of subsurface collector may be periodically above the water table. Such a condition would provide a pathway for collected leachate to discharge into the overburden rather than to flow to the leachate holding pond. This was further evidenced by the presence of dry sections in the collectors (MH-A-6, MH-C-2) on 9/11/90 detailed in Appendix G.2.

Sections and profiles through the collectors are provided on Figures 3-19, 3-20, and 3-21. As shown on Figures 3-20 and 3-21, there are several locations where the collectors appear to be above the water table. Such a condition is of particular concern for the deep collector in the areas of perforated pipe located between MH A-9 and MH A-10, and between MH A-6 and MH A-7. This condition will have to be investigated more fully through periodic water level monitoring in the manholes and the monitoring wells. The water levels should be confirmed and the seasonal fluctuations of the water tables defined. If indeed leachate is discharging from the collection system to the overburden, a modification of the system may be warranted.

3.8 <u>Water Balance</u>

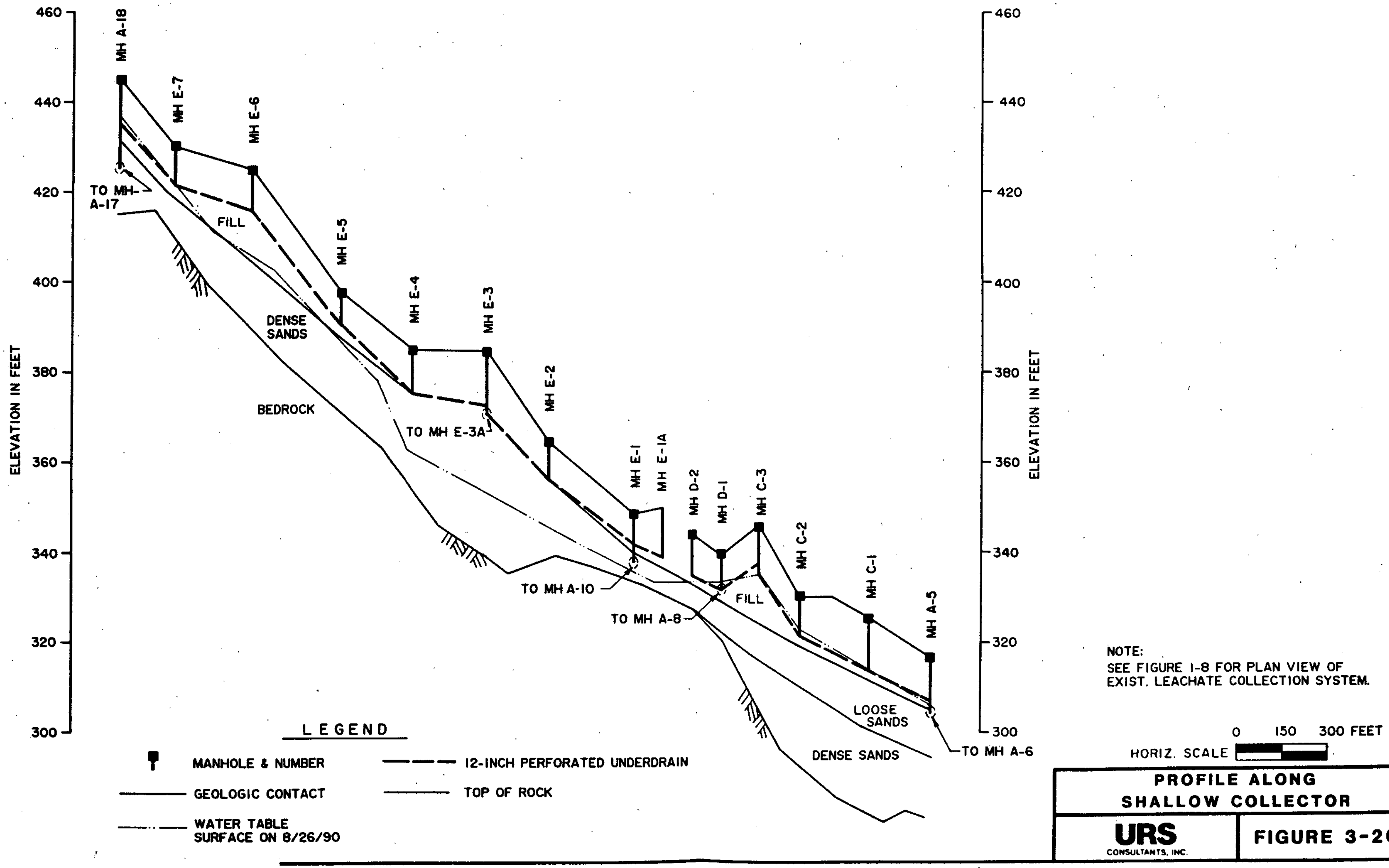
The groundwater regime of shallow aquifers is controlled by local climatic conditions (precipitation, evapotranspiration) and geomorphological features (soil type, vegetative cover, and ground surface slope). These factors affect the amount of infiltration that enters the groundwater system. The objective of the water balance analysis was to establish an infiltration rate considered to be representative of existing conditions at the Ramapo Landfill site. Once water infiltrates the landfill it adds to the amount of leachate generated by the landfill. The water balance analysis is based upon the methods developed by Thornthwaite and Mather (1955) and Fenn et. al., (1975).

Precipitation figures for the water balance analysis were taken from historical rainfall data for the area as presented in Section 3.2.



SECTIONS ACROSS COLLECTION SYSTEM

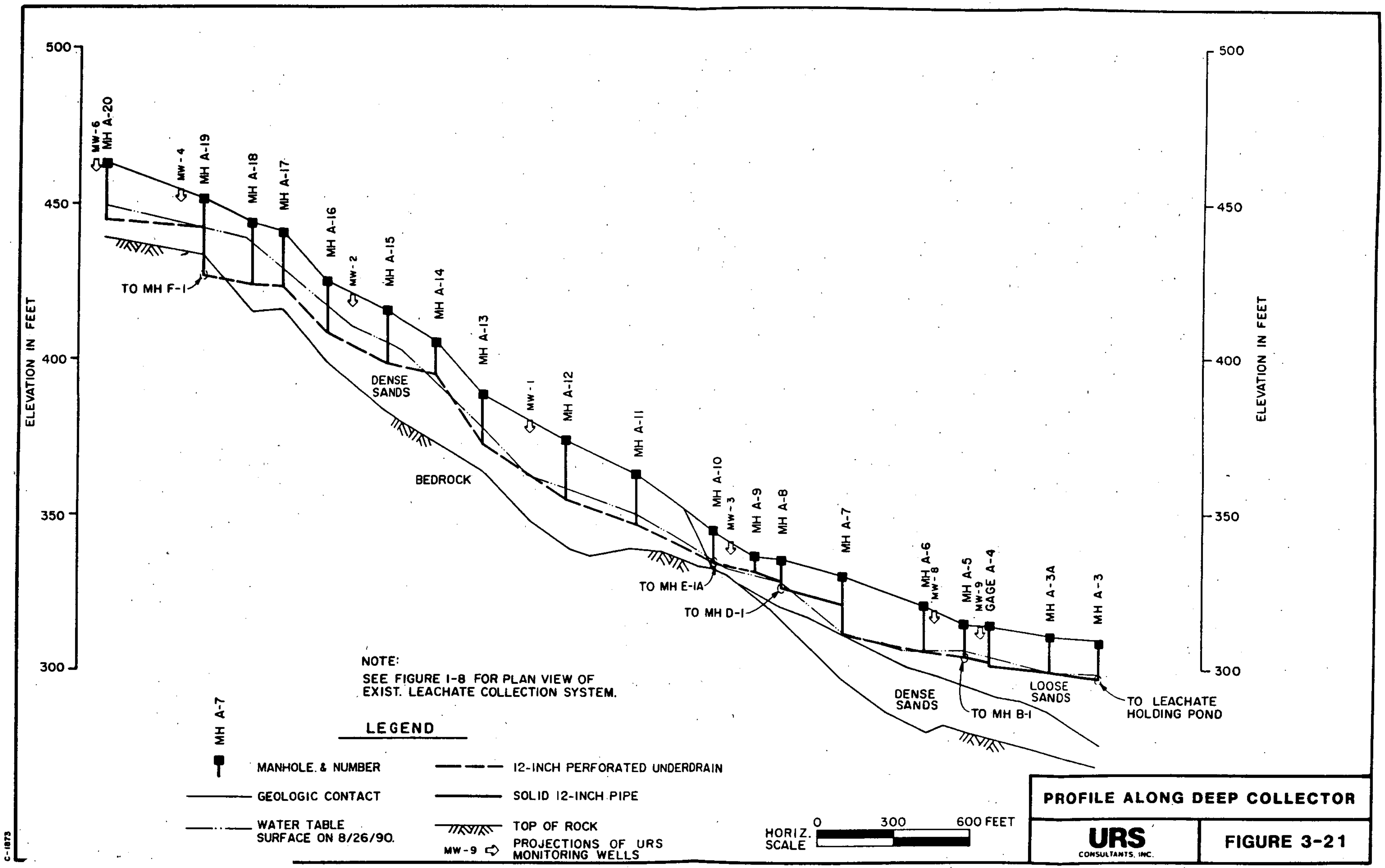
FIGURE 3-19



PROFILE ALONG SHALLOW COLLECTOR

URS CONSULTANTS, INC.

FIGURE 3-20



PROFILE ALONG DEEP COLLECTOR

FIGURE 3-21

RAM 001 0577

Surface runoff was assumed to be 50% as suggested by a LJA report (1978). This value is acceptable given the large slopes at the site. Using the difference between precipitation and runoff, infiltration was calculated by the water balance method. Table 3-7 summarizes the results of the water balance analysis.

To determine infiltration to the landfill under capped conditions, version II of the Hydrologic Evaluation of Landfill Performance (HELP) model developed by the US Waterways Experiment Station for the USEPA (Schroeder et al, 1983) was used. Discussions on the HELP model runs are presented in the Feasibility Study where they are incorporated into the remedial design.

TABLE 3-7

WATER BALANCE SUMMARY

Annual Precipitation:	40.2 inches
Surface Runoff:	20.1 inches (50 percent)
Evapotranspiration:	16.9 inches (42 percent)
Infiltration:	3.2 inches (8 percent)

4. ENVIRONMENTAL QUALITY

This section presents analytical data from the sampling performed during the RI at the Ramapo Landfill site. This data is used to describe the nature and extent of contamination at the site on a media-specific basis. The media sampled during the investigation were soil, groundwater, surface water, sediments, and air. URS attempted to take the two phases of samples six months apart so as to be representative of more than one season. Please note that all tables in Chapter 4 have been included at the end of the chapter.

(Please note that the use of the words onsite and offsite throughout this report are to depict the area within the property lines shown on Plate 1, and are not intended to convey the meanings defined in the National Contingency Plan (NCP).)

In addition to analytical data, Applicable or Relevant and Appropriate Requirements (ARARs) and To-Be-Considered Material (TBCs) are also presented. ARARs for the Ramapo Landfill were compiled in cooperation with the NYSDEC, NYS Department of Health, and the USEPA. In assessing the extent of contamination, potential environmental and public health risks, and the feasibility and implementability of remedial alternatives, three categories of ARARs are normally considered. These categories are chemical-specific, location-specific, and action-specific ARARs. Chemical-specific ARARs are health- or risk-based numerical values for specific chemicals developed and promulgated by Federal and State agencies. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. Chemical-specific ARARs are presented for each media in the following sections. Since location-specific and action-specific ARARs pertain to remedial activities, they will be presented in the Feasibility Study.

4.1 Surficial and Subsurface Soil

Surficial soil, including waste and subsurface soil samples, was taken as part of the RI at the Ramapo Landfill. The rationale for establishing each of the sampling locations may be found in Appendix I, entitled Environmental Sample Descriptions. Samples were taken as composites (excluding the portions to be analyzed for volatiles) at locations considered representative of generalized areas (i.e. background, northern lobe, southern lobe, between lobes, etc.) across the site and vicinity. Due to the diversity of sample locations and results, surficial soil and waste samples are discussed independently, rather than being grouped together. Sample locations are shown on Figure 2-2 and Plate 1 located at the end of the report.

During the first phase of the investigation, five waste samples (SPS-1 through SPS-5), five surficial soil samples (SPS-6 through SPS-10), and seven soil boring samples (GW-1-SB through GW-5-SB, GW-7-SB, and GW-8-SB) were sent to the laboratory for analysis. All samples were analyzed for TCL volatiles, semivolatiles, pesticides/PCBs, metals, cyanide, total phenols, and several miscellaneous inorganic parameters. Additionally, the five waste samples were analyzed for the RCRA hazardous waste characteristics of ignitability, corrosivity, reactivity, and EP Toxicity. Results are presented in Tables 4-1, 4-2, and 4-3, for the waste, surficial soil, and subsurface soil samples, respectively.

During the second phase, SPS-6 was resampled and analyzed for volatiles and semivolatiles because those fractions had been rejected during the first phase data audit due to laboratory holding time violations. Results for SPS-6 re-sample are presented in Table 4-4. No additional onsite surficial or subsurface soils were sampled during the second phase.

At the request of NYSDEC a surficial soil sample was taken offsite in the vicinity of monitoring well GW-10, where a leachate seep was observed. This soil sample was labeled LSMW-10 and located in an offsite area between the landfill and the Ramapo River, on property owned by the Ramapo Land Co. This area had been historically used by the previous landfill operator as a staging and storage area. It was the subject of an investigation in 1980 by the Rockland County Health Department following allegations that hazardous waste was being buried in this area. Another investigation was performed in 1987-1988 by NUS Corp. from which the report entitled "Final Draft Site Inspection Report Torne Mountain Sand and Gravel aka Ramapo Land Company" was written. This report discusses results from both of these investigations which have been summarized in Section 1.2.4 of this RI. Results indicated the presence of metals in soil and liquid from above-ground drums, and kerosene in a raw water sample. (It is not known if other matrices were analyzed for.) Metals detected included cadmium, chromium, copper, iron, lead, manganese, and zinc. The maximum concentration reported was for lead at 320 ppm. The historical use of this area will be considered in evaluating the presence of contaminants in Sample LSMW-10 attributable to the landfill.

Results for LSMW-10, which was analyzed for volatiles, semi-volatiles, pesticides/PCB, and metals are presented in Table 4-4.

4.1.1 Results of Surficial Soil Sampling

SPS-9 is considered to be the background surficial soil sample representative of natural conditions in the vicinity of the site. No organic compounds were detected in this sample. Eighteen of the 23 metals analyzed for were detected. They ranged in concentration from 0.55 ppm (selenium) to 21,300 ppm (iron). Results of the remaining soil samples will be compared to this background soil sample in order to determine what, if any, contaminants the landfill may be contributing to surrounding soil.

SPS-1 was obtained near Torne Valley Road downslope of the northern lobe in an area where high HNu readings had been observed during the soil gas study. No organics were detected in this sample, however. Metals detected were within one order of magnitude of those detected in SPS-9, with the exception of cadmium (at 1.2 ppm) and calcium (at 10,000 ppm).

SPS-2 was also located in an area of high HNu readings in between the northern and southern lobes. No volatiles were detected. Eleven semivolatiles were detected up to 440 ppb (fluoranthene). No pesticides or PCBs were detected. Metals detected were within one order of magnitude of those detected in SPS-9 with the exception of beryllium (at 0.24 ppm).

SPS-3 was located near Torne Valley Road downslope of the southern lobe and adjacent to the location of the former holding basin. One volatile, 1,1,2,2-tetrachloroethane, was detected in this sample at a concentration of 2 ppb. Twelve semivolatiles were detected at concentrations up to concentration of 160 ppb (fluoranthene). One pesticide, heptachlor epoxide, was detected at 26 ppb. Metals detected were all at concentrations approximately the same as those detected in SPS-9.

SPS-4 was taken on the sideslope of the southern lobe in an area of high HNu readings. Five volatiles were detected in this sample at concentrations up to 730 ppb (chlorobenzene). Fourteen semivolatiles were detected at concentrations up to 1,100 ppb (naphthalene). Many of the semivolatiles detected were dissimilar to those found elsewhere on the site, which may indicate a separate source area on the landfill. No pesticides or PCBs were detected. Metals detected were within an order of magnitude of those detected in SPS-9, with the exception of cadmium (measured at 9,390 ppm).

SPS-5 was a sample of paint sludge located offsite across Torne Valley Road. A number of paint sludge areas were seen offsite in the vicinity of the landfill. Three volatiles were detected at concentrations up to 110,000 ppb (total xylenes). Four semi-volatiles were detected at concentrations up to 16,000 ppb (naphthalene). One pesticide, heptachlor, was detected at 4 ppb. Of the nineteen metals detected, eight (antimony, barium, cadmium, chromium, copper, lead, selenium, zinc) were at concentrations greater than an order of magnitude of those detected in SPS-9. The results of the RCRA hazardous waste characteristics testing the sample from SPS-5 failed the test for the characteristic of ignitability; that is, the flash point was less than 140°F. The NYSDEC decided to remove the paint sludge at SPS-5 as well as from additional areas offsite where paint sludge had been found. The removal was undertaken in the Fall of 1990, when approximately 36 cy of soil and paint sludge were excavated and disposed of in Clarkstown Landfill by the NYSDEC. As the paint sludge found at SPS-5 has already been removed from the surface in the vicinity of the site, contaminants only detected in this sample are not further considered in the remainder of the RI or the FS. In particular, data from this sample was not used in the Health Risk Assessment to evaluate exposure concentrations for exposure pathways relating to surficial soil.

SPS-6 and the SPS-6 resamples were obtained in the vicinity of the weigh station. No volatile organics were detected. Eleven semivolatiles were detected at concentrations up to 160 ppb [bis(2-ethylhexyl) phthalate]. Three pesticides were also detected in SPS-6 (resample), gamma-chlorodane concentrations reaching 20 ppb. Metals detected were almost all on the same order of magnitude as those detected in SPS-9, with the exception of cadmium (at 1.7 ppm) and calcium (at 9,580 ppm). The value for pH at this location was anomalously high (8.28).

SPS-7 was obtained in the vicinity of the leachate holding pond. No organics were detected in this sample. With the exception of cadmium (measured at 0.84 ppm), all metals were within one order of magnitude of those detected in SPS-9.

SPS-8 was obtained in the vicinity of the pistol range. No organics were detected in this sample. All metals detected were at concentrations approximately the same as those measured in SPS-9.

SPS-10 was obtained within the fenced area surrounding the Baler Building. No volatiles were detected in this sample. Thirteen semivolatiles were detected at concentrations up to 320 ppb [bis (2-ethylhexyl)phthalate]. No pesticides or PCBs were detected. Metals detected were within an order of magnitude of those detected in SPS-9. The value of pH at this location was anomalously high (8.55).

During the installation of offsite monitoring well MW-10, a leachate seep was observed. LSMW-10 is a sample of the surficial soil in this area. (This sample was collected instead of a leachate sample because there was insufficient leachate to allow the collection of a liquid sample.) No volatiles were detected in this sample. Ten semivolatiles were detected at concentrations up to 130 ppb (fluoranthene). One pesticide, gamma-chlordane, was detected (at 4.5 ppb). Four metals (beryllium, cadmium, calcium, and mercury) were detected at concentrations greater than an order of magnitude above those detected in SPS-9.

4.1.2 Summary of Surficial Soil Data

Volatiles were not determined to be a widespread contaminant in the surficial soil and waste samples. They were detected only in SPS-3 and SPS-4, and at concentrations less than 1 ppm.

Semivolatiles were detected across the site. The most frequently detected semivolatile compounds, which was be generally grouped as polycyclic aromatic hydrocarbons (PAHs), were detected in samples from SPS-2, -3, -4, -6, -10, and LSMW-10 (high concentration 130 ppb). Their presence in LSMW-10 indicates that contaminants have migrated offsite through either surface water runoff, or erosion. The non-PAH semivolatiles detected in SPS-4 may indicate the presence of a separate source in this area resulting from the landfill.

Pesticides were not determined to be widespread across the site. Heptachlor epoxide was detected in SPS-3; dieldrin, alpha- and gamma-chlordane in SPS-6; and gamma-chlordane in LSMW-10, at a maximum concentration of 26 ppb.

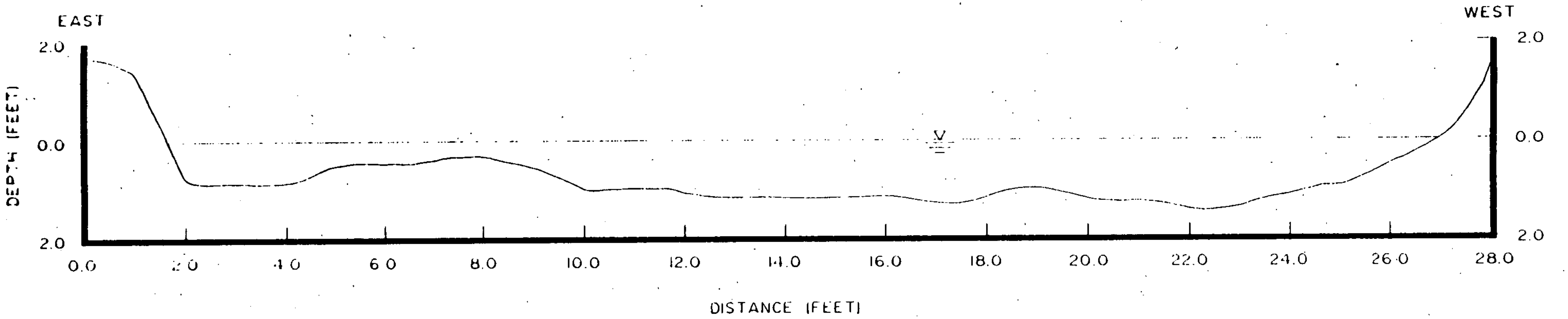
No PCBs were detected in surficial soil at the site.

Several metals considered attributable to the landfill were detected in samples across the site. Cadmium was detected in five samples, calcium in three and beryllium in two. Mercury was also detected in LSMW-10 but was not detected in any other soil samples (surficial or subsurface) onsite.

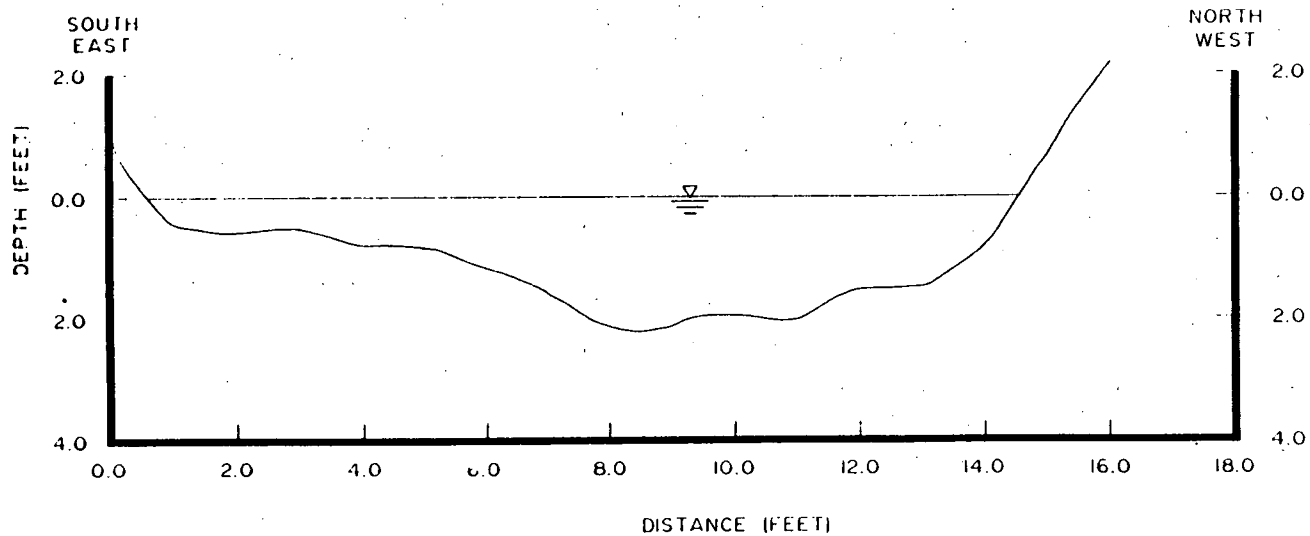
Upward vertical gradients prevail in the area where sample LSMW-10 was taken near monitoring wells MW-100/S and MW-10R. PAHs and the pesticide detected in LSMW-10 were not detected in either MW-100/S or MW-10R. Metals concentrations in LSMW-10 were significantly higher in LSMW-10 than in MW-100/S or MW-10R. This implies that contaminants in surficial soils in this area are not being transported via groundwater. Similarly, the leachate pond is not contributing to contamination of this area as leachate pond water (samples LIN and LEF) and sediment (sample LPSS-1) did not show contamination at these levels. Samples which showed contaminants at levels generally similar to those in LSMW-10 were SPS-6, SS-3, and SS-4. Therefore, it is assumed that contaminated surficial soils from the landfill are contributing to contamination in this area.

4.1.3 Results of Subsurface Soil Sampling

Seven subsurface soil samples were taken from the monitoring well borings installed during the first phase. MW-5-SB may be considered to be



LOCATION 4 - TORNE BROOK
Q = 11.69 FT^3/SEC
ON 10/24/89



LOCATION 5 - TORNE BROOK
Q = 16.05 FT^3/SEC
ON 10/24/89

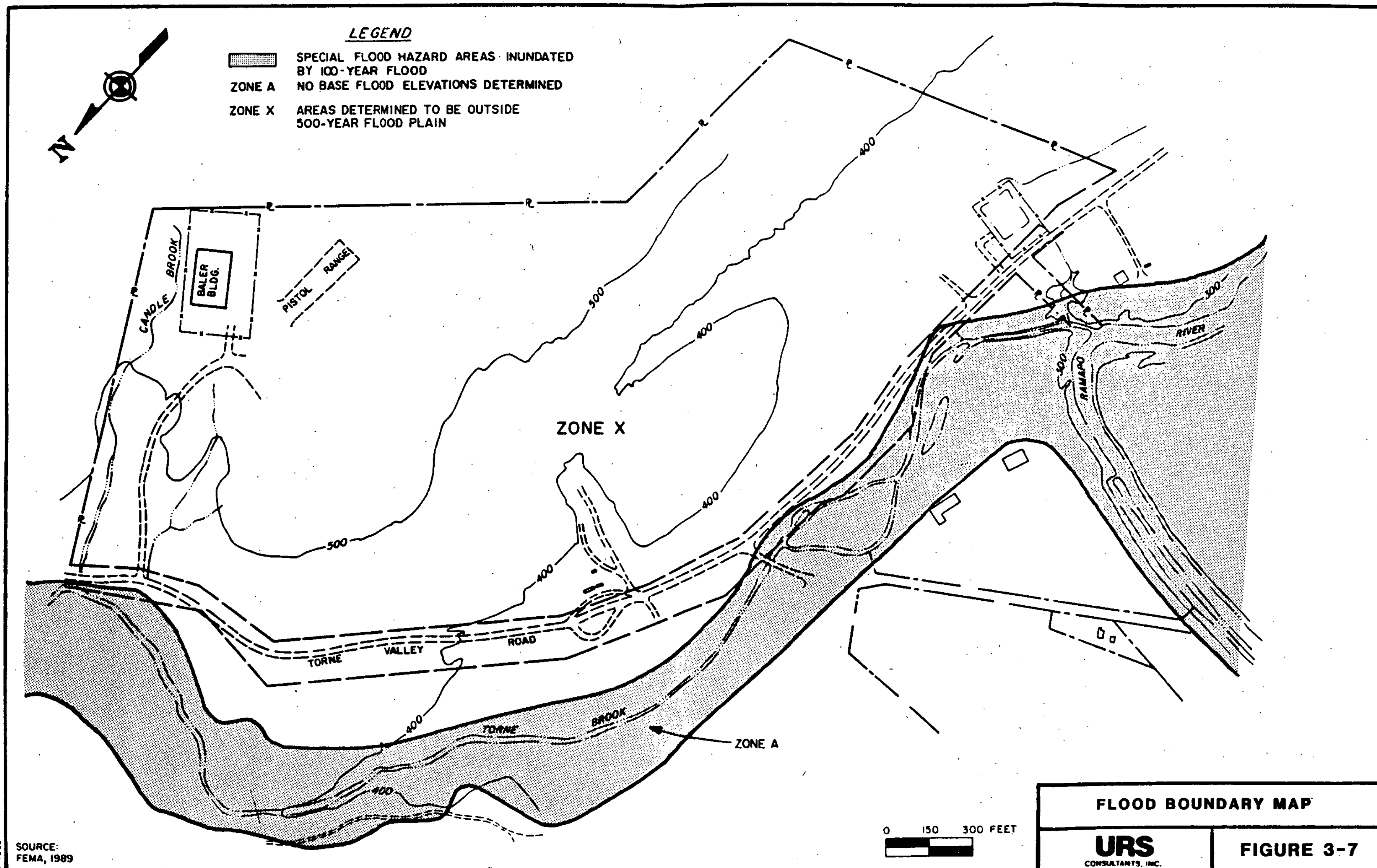
RAM 001 0540

NOTE: ALL PROFILES LOOKING DOWNSTREAM, LOCATIONS WERE NOT SURVEYED.

TORNE BROOK PROFILES

URS CONSULTANTS

FIGURE 3-6



SOURCE:
FEMA, 1989

FLOOD BOUNDARY MAP

URS CONSULTANTS, INC.

FIGURE 3-7

C-1082

RAM 001 0541

Figure 3-7, is taken from the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map for the Town of Ramapo (FEMA, 1989).

The elevation of Torne Brook was surveyed at SG-1, within 200 feet of its confluence with the Ramapo River, and at two additional locations further upstream (SWE-2, SWE-3). Locations are shown on Figure 2-2. All water level measurements are presented in Appendix G.2. On October 25, 1989 the stream elevation at SG-1 was 296.15 feet, and on October 30, 1989, 296.05 feet. In general there was little change in the water level between October 1989 and May 1990, stream elevation varying between 295.87 feet and 296.67 feet.

Torne Brook and its tributaries are NYSDEC "Class B" waters meaning that best usage is for primary contact recreation (i.e. swimming) and any other uses except as a water supply for drinking, culinary, or food processing purposes.

3.6.3 Site Drainage

Drainage at the site follows the topography, which steeply slopes toward Torne Brook and the Ramapo River. Candle Brook traverses the northern end of the site and flows into Torne Brook. A profile across Candle Brook (SVP-1) showed it to be narrow and shallow (less than one foot wide and one foot deep). The discharge at SVP-1 was only 0.9 cfs. SVP-2 was located at a culvert beneath Torne Valley Road near Candle Brook's confluence with Torne Brook. A profile across this area was not developed. Discharge calculations indicated that flow was less than 1 cfs at SVP-2.

Two additional swales drain the area around the landfill. The first nearly parallels Candle Brook in the northern portion of the landfill and the second conveys surface water away from Torne Brook in the southern portion of the site.

Upgradient diversion trenches have been constructed along portions of the southern property lines. These trenches, which are properly maintained (cleared of vegetation), help to convey surface water runoff from upslope areas away from the landfill.

A surface water collector has been installed along the downgradient edge of the site. The system comprises a concrete surface collector which runs from a point near the northern edge of the site, and follows along the access road, to a catch basin inlet. The collector is connected to the leachate holding pond by a six-inch force main. A 48-inch pipe, whose purpose is the conveyance of overflow during periods of heavy water runoff, from the concrete collector, leads to Torne Brook. The holding pond is directly discharged to the Suffern Wastewater Treatment Plant.

3.6.4 Water Usage

Ten production (water supply) wells operated by the Spring Valley Water Supply Co. and serving a population of over 200,000 (referred to as the Ramapo Valley well field) are located along the Ramapo River both upstream and downstream of the site. The wells, which range in depth from 71 to 127 feet, are completed in the Ramapo Valley Aquifer (Leggette, Brashears, and Graham, Inc., 1982). Well SV-94 is located west of the landfill across the Ramapo River, and is the furthest inland. The screened interval is in gravel between 62.5 and 99 feet. The well screen terminates at the top of bedrock. It is a 14 inch double cased well whose capacity is reportedly 900 gpm. The closest of these wells to the site (SV-95 on Figure 3-3) lies approximately 500 feet west of the site on the west bank of the Ramapo River. The screened interval is between depths 59 and 89 feet, approximately one foot above top of bedrock. It is a 14 inch double cased well whose capacity is reportedly 500 gpm (Leggette, Brashears & Graham, Inc., 1982). SV-96, the next production well downstream, also is 14 inches, double cased, and has a 500-gpm capacity. Its screened interval is between a 55.5 and 84 foot depth, at an unknown height above the top of bedrock. These wells were drilled in 1978 and pumps were set in 1980 even though the Spring Valley Water Company was one of the first to note, in 1979, that contaminants appeared to be migrating from the landfill (see Section 1.2.4).

The average supply capacity of the Ramapo Valley well field is considered to be 8 to 10 mgd with a maximum capacity of 14 mgd. The Well Field is subject to conditions of its permit, which require partial or complete shutdown of the wells under certain conditions of low river flow. Partial shutdown is mandated when flow in the river at the gaging station located between the NYS Thruway and the Village of Suffern is between 8 and 10 mgd. When the flow falls below 8 mgd, pumping from the well field must cease.

Torne Brook Estate, a residential apartment complex of 25 units, has a water well 450 feet from the landfill that supplies about 50 people. A smaller apartment complex of 2 units maintains a water well about 1,200 feet from the landfill. This well presently supplies 5 residents. These wells are designated as PW-1 and PW-2, respectively, on Figure 3-3. Both these wells are located between the landfill and the Ramapo River on the western side of Torne Brook.

3.7 Geology and Hydrogeology

Information presented in this section was obtained from a review of available geologic reports, including USGS topographic and geologic maps of the area, and data gathered during first and second field and laboratory investigations of the site. Field investigations included surface geophysical surveys, a soil boring program that characterized soil and fill material at 31 boring locations, installation of 28 monitoring wells and 10 piezometers, and hydraulic testing of water-bearing formations. Geotechnical laboratory analyses were conducted on selected subsurface and surficial soil samples. Table 3-2 summarizes the results

TABLE 3-2
SUMMARY OF GRAIN SIZE ANALYSIS

ID #: Depth	Total % Gravel	% Sand Coarse	% Sand Medium	% Sand Fine	Total % Sand	% Fines Silt	% Fines Clay	Total % Fines
C-1* 0-6"	17	16	13	25	54	24	5	29
GW-1 14.0-18.0'	25	13	19	22	54	17	4	21
GW-2 9.5-12.5'	19	15	17	21	53	23	5	28
GW-4 2.0-4.0'	13	12	14	29	55	28	4	32
GW-5 4.0-6.0'	10	12	15	28	55	28	7	35
GW-5 30.0-32.0'	34	14	11	19	44	19	3	22
GW-7 16.0-22.0'	45	14	17	17	48	6	1	7
GW-7 44.0-46.0'	29	15	12	18	45	24	2	26
GW-8 20.0-22.0'	8	37	43	10	90	1	1	2
GW-8 28.0-32.0'	28	11	19	21	51	17	4	21

* Sample C-1 is a sample of surface cover from the northeastern portion of the landfill.

TABLE 3-2 (Continued)

SUMMARY OF GRAIN SIZE ANALYSIS

ID #: Depth	Total % Gravel	Total % Sand	Total % Fines
GT-1 Surficial	29.4	57.2	13.4
GT-2 Surficial	10.2	34.9	54.9
GT-3 Surficial	11.8	59.4	28.8
GT-4 Surficial	5.4	54.9	39.7
GT-5 Surficial	20.3	49.6	30.1
GT-6 Surficial	6.9	51.3	41.8

of the geotechnical testing. In-situ hydraulic conductivity testing (slug testing) was conducted at each well. Pressure testing of bedrock was completed in ten rock coreholes.

Results of the geophysical investigations are presented in detail in Appendix B. Detailed logs of all sampled soil borings from this and previous studies appear in Appendices C and L, respectively. Geotechnical testing data may be found in Appendix I.

3.7.1 Regional Geology

The Ramapo Landfill is underlain by a sequence of unconsolidated sediments which overlie bedrock of granitic and biotite gneiss. Overburden sediments have resulted from the combined forces of recent alluvial deposition from the Ramapo River and Torne Brook and glacier-related deposition (from the Late Wisconsin Ice Sheet). The glacially-derived sediments of Late Wisconsin age (Perlmutter, 1959) include sandy ablation tills, kame sands, and gravels (Moore, et al, 1982). In areas adjacent to the Ramapo River and Torne Brook, these deposits lie under a cover of glacial outwash and recent alluvial sediments. The outwash and alluvium of the Ramapo River Valley make up the Ramapo Valley Fill Aquifer, from which most the community water is drawn.

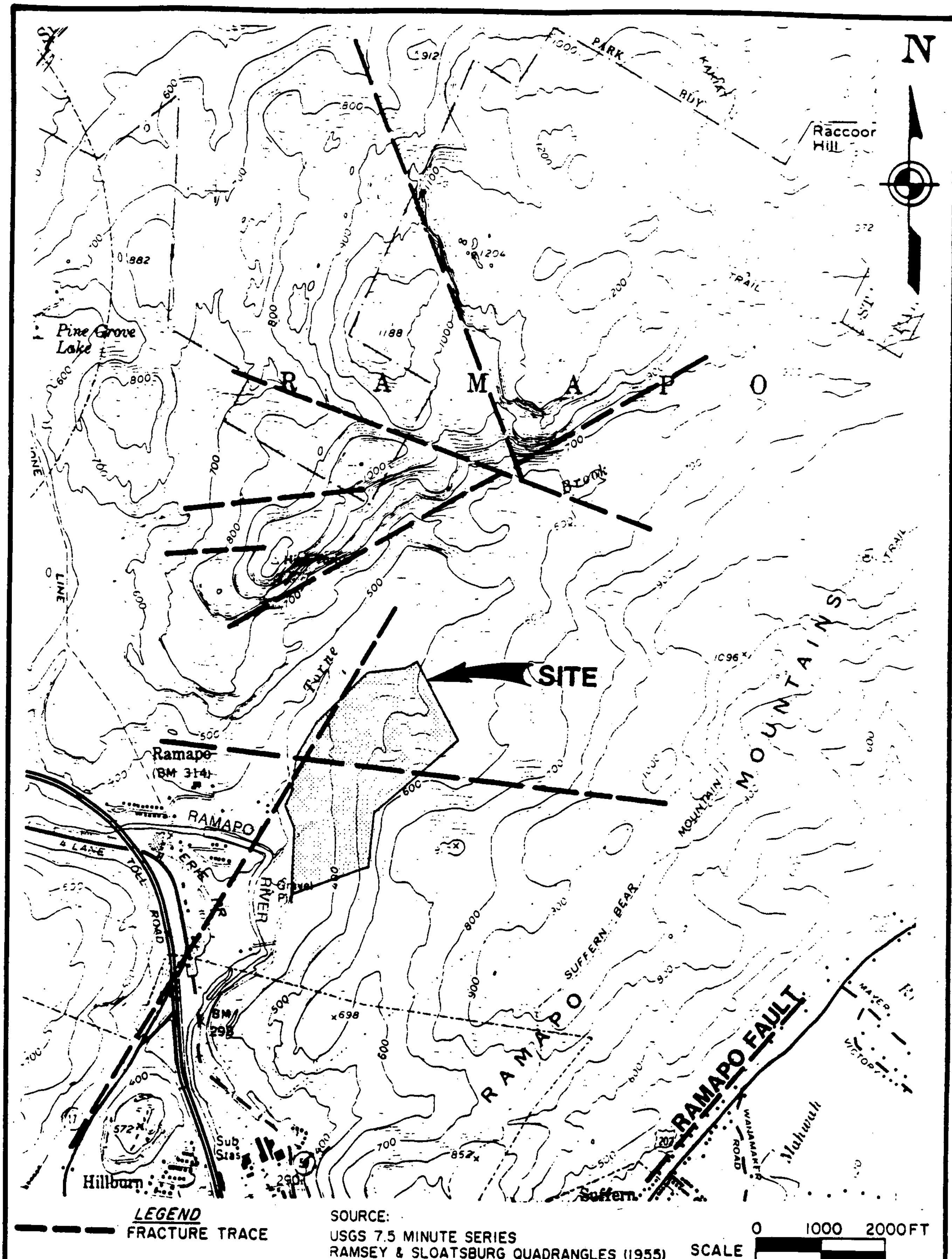
The bedrock geology of the area is structurally complex. Faults of Proterozoic, Paleozoic, and Mesozoic age cut through the fractured Proterozoic metamorphic rock of the area. The area is subject to low-level seismic activity centered around the Ramapo Fault, located 1.25 miles southeast of the site (Ratcliffe 1980, Isachsen and McKendree 1977).

3.7.2 Fracture Trace Analysis

A fracture trace analysis was performed to supplement subsurface information for the Ramapo Landfill RI/FS. Remote sensing techniques were employed for this task, using a series of black and white and color aerial photographs at various scales ordered from the USDA, USGS and the National Archives and Records Administration. Regional geologic and topographic maps, as well as available published information, were also used to identify known or potential fault or fracture traces. Fracture traces are found as linear features (lineaments) identified by geomorphic or tonal variations on aerial photographs. These features may represent geomorphology, although, they may also be representative of surficial expressions of subsurface structural features. Structural features such as offset or displacement along geomorphic features, or anomalous stream characteristics such as deflections, were also used as possible indicators of subsurface structures. It must be noted that analysis of possible fractures in this manner is by no means definitive.

Fault systems (including the Ramapo fault which is approximately 1.25 miles southeast of the site) have been identified within the Ramapo area through detailed geologic mapping (Ratcliffe 1980, Isachsen and McKendree 1977). The Ramapo fault strikes northeast and dips steeply southeast. Additional major faulting is found sub-parallel to the Ramapo fault. Previous studies indicate that this faulting was produced by a southeast-to-northwest compression during the Greenville and Taconic orogenies (mountain building events) which produced primarily reverse faulting. Minor faults and lineaments are also found at secondary orientations to the major faults in the region. A pattern of low-level seismic activity has been documented through a 30-kilometer wide zone roughly centered on the Ramapo fault. This activity is reportedly believed to be controlled by reactivation of the northeast-striking, southeast-dipping faults. Many faults in the region are found intruded during the Mesozoic Era by igneous dikes of lamprophyre, andesite, or rhyoidacite (Ratcliffe 1980).

In conducting the fracture trace analysis, a number of lineaments were identified in the vicinity of the Ramapo Landfill (Figure 3-8). Most



A-3200

URS CONSULTANTS, INC.

FRACTURE TRACE MAP

FIGURE 3-8

RAM 001 0549

obvious is the Ramapo fault. Many additional lineaments are found in the area, some of which trend northeast similar to the Ramapo fault, and others of which assume secondary orientations. Most of these appear as composite lineaments, displaying both geomorphic and tonal variations. Some appear to be erosional features, possibly structural drainage controls such as fractures or faults. Others show slight offsets in topographic or geomorphic alignment, the magnitude of which is difficult to measure, indicating possible displacements along fracture surfaces.

Two lineaments have been observed within the immediate area of the landfill. The lineaments are based on features presented on air photos which extend a distance beyond the fill boundaries. The fracture trace analysis was done using a series of air photos taken from 1952, prior to landfilling, to 1987. Features noted on the early photos were also transposed onto the report map. These features may not appear or may not appear as pronounced on later photos due to landfill activities but the subsurface structural feature we suggest <u>may</u> be present did not disappear due to surface activity. This is not an exact science and is merely an attempt to identify <u>possible</u> subsurface pathways. Regardless of whether or not the lineaments identified are fractures, we know from drilling at the site that many fractures are present and they transmit water.

One lineament lies adjacent to the west side of the landfill and trends northeast, similar to the Ramapo fault. This lineament may represent faulting or other subsurface structures controlling deflections in Torne Brook. The second lineament trends east-west and appears to cross through the central portion of the landfill. This lineament exhibits offset along geomorphic features, which may also represent faulting. As a potential fault this may represent a pathway for contaminant migration offsite or to depth within the subsurface. Several drilling locations were chosen in an attempt to intersect these features on site. Although no definite evidence of faulting was observed, rock cores at locations MW-1, -3, and -5 revealed highly fractured zones.

Additionally, results of the seismic refraction survey indicate shape change in bedrock surface elevations in the area of borings MW-1 and 3 further suggesting possible faulting. A detailed discussion of these findings is included in the following section.

3.7.3 Site Stratigraphy

A sequence of unconsolidated sediments ranging in thickness from 8 to 12 feet overlying granitic and biotite gneiss, was encountered in boreholes drilled at the Ramapo Landfill site. Figure 3-9 is a generalized geologic/hydrogeologic column for the site. Principal units of the section include loose sands, dense sands, and both weathered and competent bedrock. Cross-section locations are shown on Figure 3-10. Geologic cross-sections are shown on Figures 3-11, 3-12, and 3-13. The units described below are defined on the basis of composition, with emphasis given to hydrologic properties. The units are described from youngest to oldest (i.e. shallowest to deepest).

(a) Fill: The fill encountered in borings at the Ramapo Landfill is a heterogeneous mix of materials in a matrix that appears to be native silts and sands. Fill material in P-1 includes paper, plastic, metal fragments, wood chips, and other municipal trash. Additionally, although not observed, the presence of industrial waste within the landfill is probable. The fill appears to be confined to an approximately 50-acre area east of Torne Valley Road. The fill surface may be topographically divided into north and south lobes, separated by a deep valley. Maximum fill thicknesses have been estimated by URS at 70 feet in the southern lobe and 80 feet in the northern lobe (see Figure 1-3); and by Velzy Associates (1986) as 80 feet in the southern lobe and 90 feet in the northern lobe. The northern lobe makes up roughly 5/8 of the filled area onsite. The southern and eastern boundaries of fill within the northern lobe were delineated during the Phase II EM-31 terrain conductivity survey (Appendix B.2).

HYDROGEOLOGIC UNIT	LITHOLOGIC UNIT	STRATIGRAPHIC PROFILE	MATERIAL DESCRIPTION	HYDROGEOLOGIC PROPERTIES	GENETIC ORIGIN
—	FILL		MATRIX RANGES FROM CLAYEY SILT TO SILTY SAND: CONTAINS FILL MATERIAL INCLUDING; PAPER, PLASTIC, METAL FRAGMENTS, WOOD CHIPS, AND OTHER MUNICIPAL GARBAGE.	LOW TO HIGH HYDRAULIC CONDUCTIVITY	MAN EMPLACED
SHALLOW AQUIFER	LOOSE SANDS		GREY TO BROWN; VERY LOOSE TO LOOSE; SAND, FINE TO COARSE, WITH SOME GRAVEL AND SILT, TRACE CLAY; OR SANDY GRAVEL, WITH SOME SILT. UNIFIED SOIL CLASSIFICATIONS INCLUDE SP, SM, SW, AND GW. CONTAINS FEW COBBLES.	HIGH HORIZONTAL HYDRAULIC CONDUCTIVITY $K = 10^{-2}$ cm/s (SLUG TESTS) PART OF RAMAPO VALLEY FILL AQUIFER	ALLUVIUM AND GLACIAL OUTWASH ASSOCIATED WITH THE RAMAPO RIVER AND TORNE BROOK VALLEY
	DENSE SANDS		GREY TO BROWN; MEDIUM DENSE TO VERY DENSE, FINE TO MEDIUM SILTY SAND WITH SOME GRAVEL AND TRACE CLAY; OR GRAVELLY SAND WITH SOME SILT AND TRACE CLAY. UNIFIED SOIL CLASSIFICATIONS INCLUDE SM, SW AND GW. CONTAINS ABUNDANT BOULDERS AND COBBLES.	MEDIUM HIGH HORIZONTAL CONDUCTIVITY $K = 10^{-4}$ TO 10^{-5} cm/s (SLUG TESTS)	STRATIFIED ICE CONTACT DEPOSITS; ABLATION TILL; INCLUDES SOME COLLUVIAL DEPOSITS
INTERMEDIATE AQUIFER	WEATHERED BEDROCK		OXIDIZED GRANITIC GNEISS THAT IS FRACTURED BOTH HORIZONTALLY AND VERTICALLY. CONTAINS SOME SILT IN FRACTURES	HYDRAULICALLY SIMILAR TO DENSE SANDS ABOVE $K = 10^{-4}$ TO 10^{-5} cm/s (SLUG TESTS)	NEAR SURFACE CHEMICAL DECOMPOSITION
BEDROCK AQUIFER	BEDROCK		GRANITIC AND BIOTITE GNEISS; QUARTZ, FELDSPAR, HORNBLENDE, BIOTITE, AND OCCASIONAL GARNET. DARK MINERAL FRACTION RANGES FROM 30%-70%, WELL FOLIATED, VARIABLY FRACTURED	FLOW ALONG FRACTURES. COMPETENT ZONES PROVIDE LOCAL BARRIERS TO VERTICAL GROUND WATER FLOW. $K = 10^{-2}$ TO 10^{-5} cm/s (SLUG TESTS) $K = 10^{-2}$ TO 10^{-9} cm/s (PRESSURE TESTS)	METAMORPHIC BEDROCK. (METAMORPHOSED SANDSTONES)

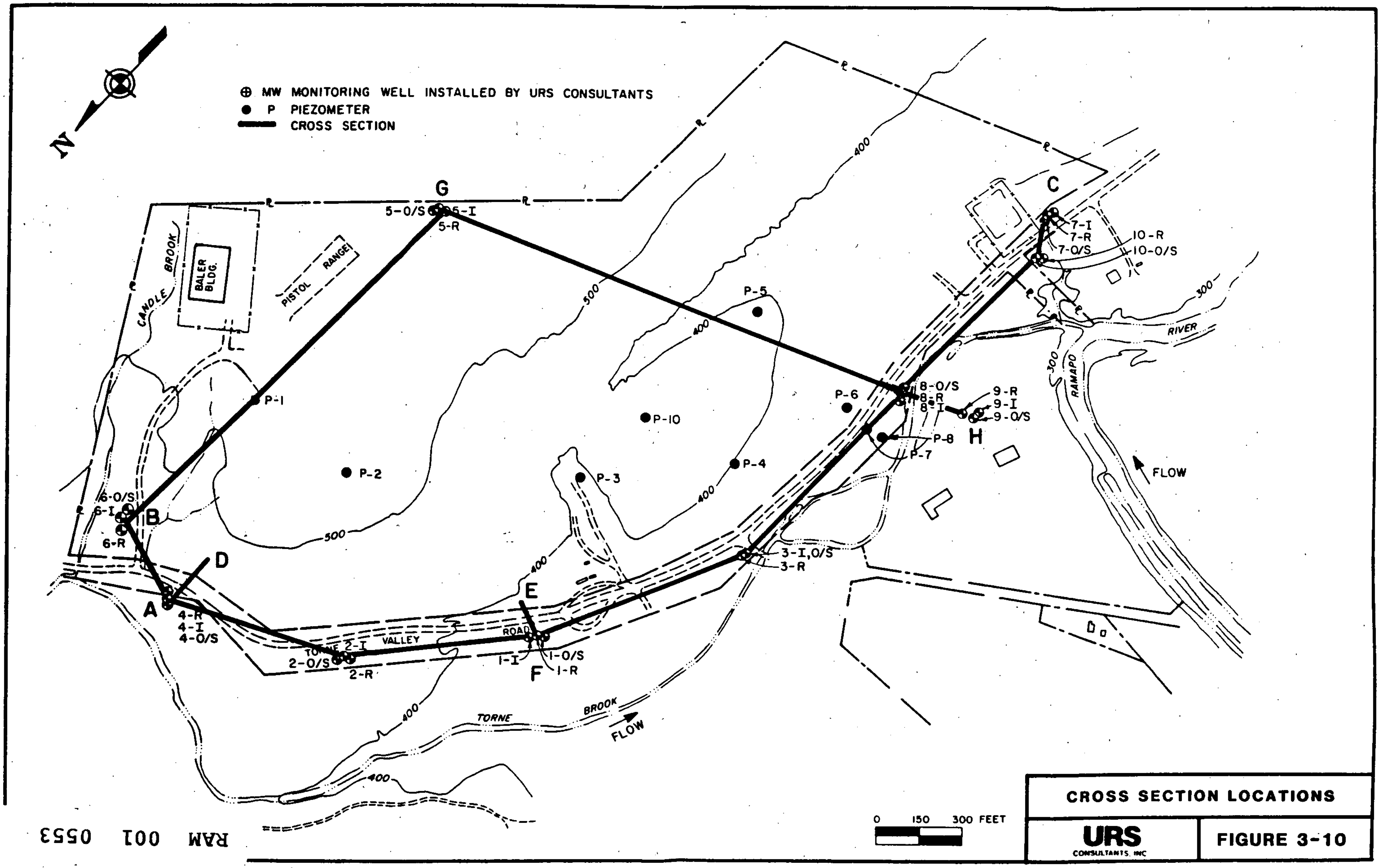
RAM 001 0552

AC-3791-10 3/29/90

URS CONSULTANTS

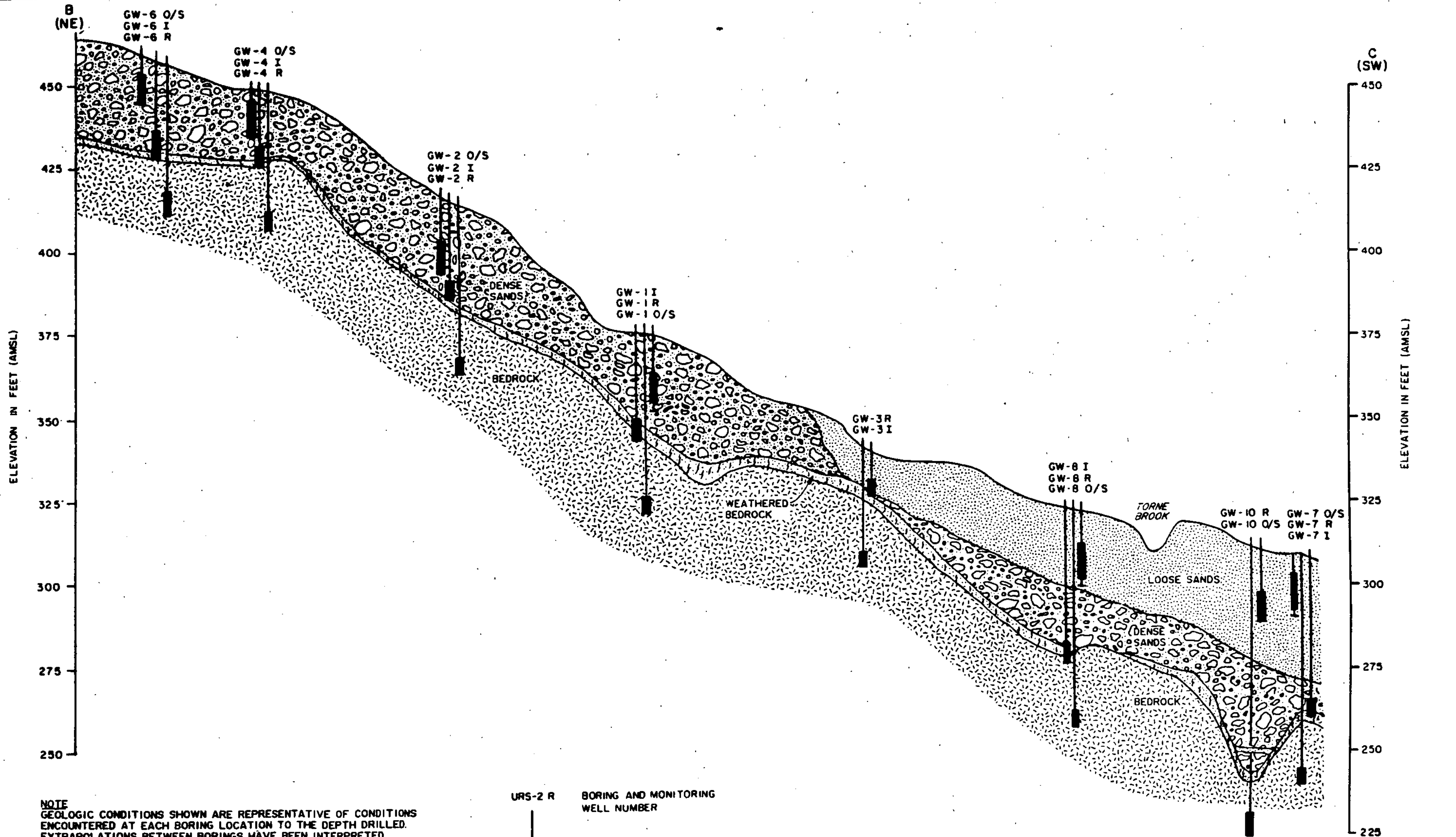
GENERALIZED GEOLOGIC
HYDROGEOLOGIC COLUMN

FIGURE 3-9



CROSS SECTION LOCATIONS

FIGURE 3-10



NOTE
GEOLOGIC CONDITIONS SHOWN ARE REPRESENTATIVE OF CONDITIONS ENCOUNTERED AT EACH BORING LOCATION TO THE DEPTH DRILLED. EXTRAPOLATIONS BETWEEN BORINGS HAVE BEEN INTERPRETED USING STANDARD ACCEPTED GEOLOGIC PRACTICES AND PRINCIPALS. ACTUAL CONDITIONS MAY VARY BETWEEN BORINGS FROM THOSE SHOWN. BEDROCK DEPTHS BETWEEN BORINGS HAVE BEEN INTERPRETED WITH THE AID OF GEOPHYSICAL SURVEYS.

URS-2 R — BORING AND MONITORING WELL NUMBER

SCREENED INTERVAL OF MONITORING WELL

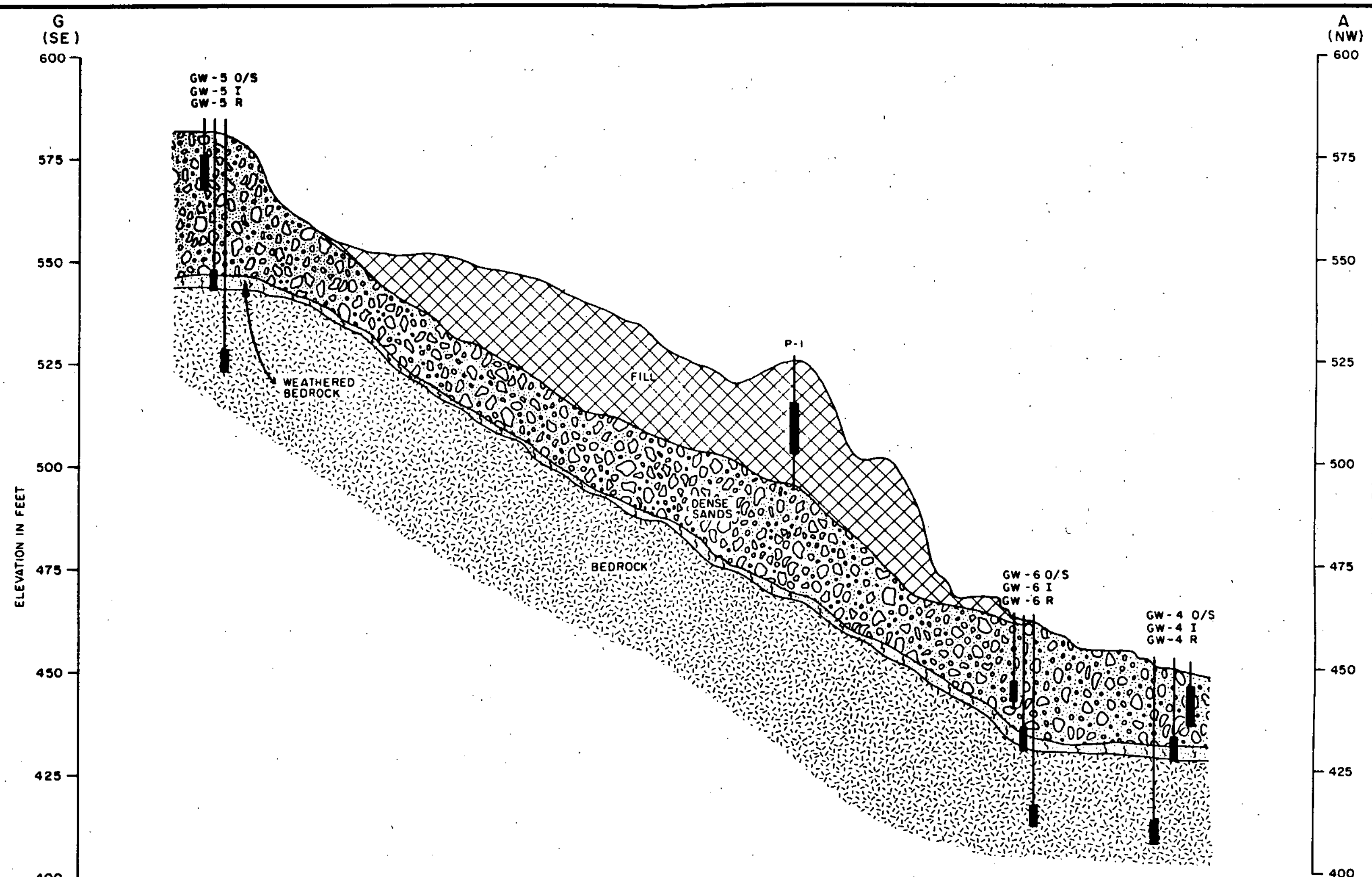
BOTTOM OF BORING

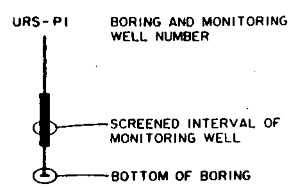
HORZ. SCALE 0 300 600 FT.

GEOLOGIC CROSS SECTION B-C

URS CONSULTANTS, INC.

FIGURE 3-11





NOTE
GEOLOGIC CONDITIONS SHOWN ARE REPRESENTATIVE OF CONDITIONS ENCOUNTERED AT EACH BORING LOCATION TO THE DEPTH DRILLED. EXTRAPOLATIONS BETWEEN BORINGS HAVE BEEN INTERPRETED USING STANDARD ACCEPTED GEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY BETWEEN BORINGS FROM THOSE SHOWN. BEDROCK DEPTHS BETWEEN BORINGS HAVE BEEN INTERPRETED WITH THE AID OF GEOPHYSICAL SURVEYS.

HORIZ. SCALE 0 100 200 FEET

GEOLOGIC CROSS SECTION G-A

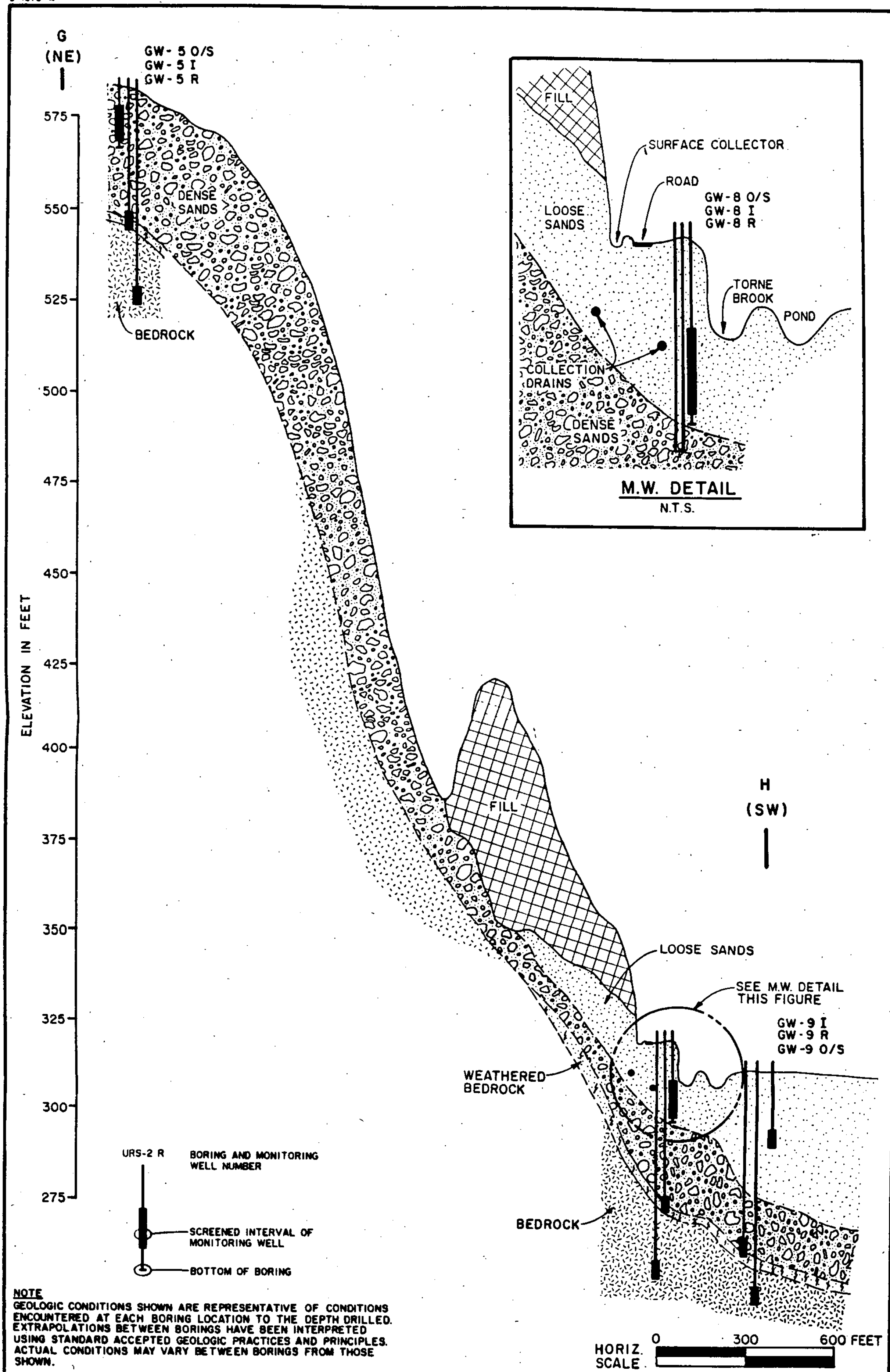
URS CONSULTANTS, INC.

FIGURE 3-12

1007

RAM 001 0555

C-1875-A



NOTE
GEOLOGIC CONDITIONS SHOWN ARE REPRESENTATIVE OF CONDITIONS ENCOUNTERED AT EACH BORING LOCATION TO THE DEPTH DRILLED. EXTRAPOLATIONS BETWEEN BORINGS HAVE BEEN INTERPRETED USING STANDARD ACCEPTED GEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY BETWEEN BORINGS FROM THOSE SHOWN.

URS CONSULTANTS, INC.

GEOLOGIC CROSS SECTION G - H

FIGURE 3-13

RAM 001 0556

(b) Shallow Aquifer - The highly permeable sediments of the shallow aquifer may be divided into two basic units: a grey to brown, very loose to loose sand or sandy gravel with some silt, and a medium-dense to very dense silty sand or gravelly sand with abundant boulders and cobbles. Samples submitted for geotechnical analysis (Table 3-2) indicate that these materials are compositionally similar. However, significant differences in the compaction of these two materials make them distinguishable and hydrologically dissimilar. The loose sands overlie the dense sands, thinning away from the Ramapo River and Torne Brook, and do not appear at all in borings greater than 1,500 feet away from the Ramapo River. The loose sand unit is likely the alluvium and glacial outwash that makes up the Ramapo Valley Fill Aquifer. Dense sands in the upper aquifer are likely a heterogeneous mix of ablation till, stratified ice contact deposits, and colluvium.

(c) Intermediate Aquifer - A thin weathered rock zone was encountered above bedrock at all boring locations. This weathered zone ranged in thickness from a few inches to nearly five feet. This material is highly oxidized and fractured, both vertically and horizontally.

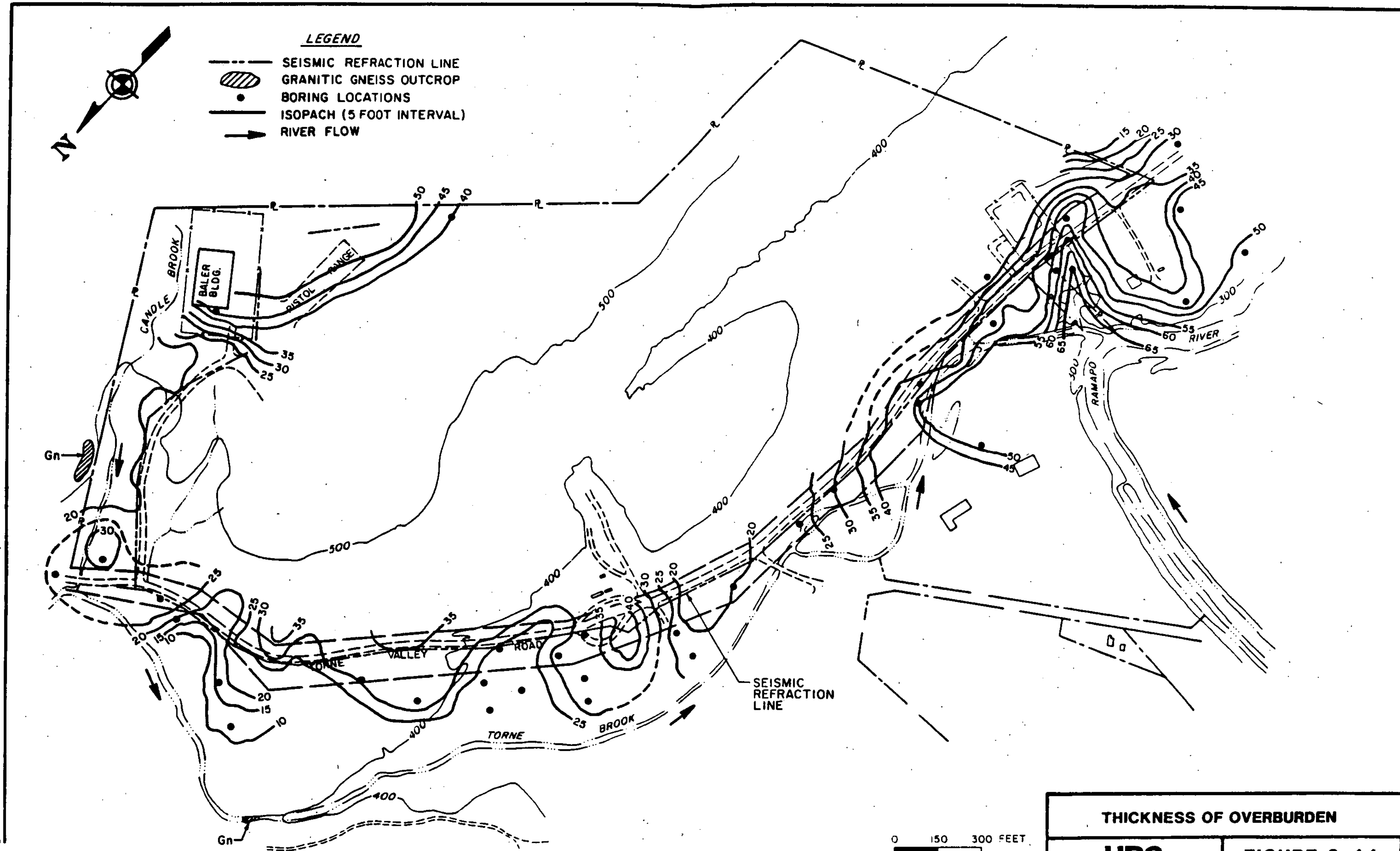
(d) Bedrock Aquifer - The bedrock in the vicinity of the Ramapo Landfill is dominantly granitic and biotite gneiss. The mineralogy and degree of foliation of bedrock observed in borings at the site varied only to a relatively minor extent. All bedrock cores observed contained fractures, many of which were stained or contained sediment. This may indicate weathering and water flow.

The main thrust of the rock-coring program was to confirm the nature of and depth to bedrock, and to identify preferential contaminant pathways in the form of faults, highly fractured zones, or buried valleys. Although no definite evidence of faulting was observed at the ground surface, such as offsets of linear features, several of the rock cores drilled revealed highly fractured zones which may be a result of faulting.

Boring GW-3 was drilled in the vicinity of the intersection of two distinct fracture traces as identified from aerial photography. At this location, a 2-foot thick highly fractured and weathered zone was discovered beneath 17 feet of competent bedrock. At boring GW-9, also in the vicinity of this intersection, 4 feet of highly fractured and weathered rock was encountered beneath 5 feet of competent bedrock.

Many of the fractures in bedrock appear to be roughly horizontal. At two locations (GW-5 and GW-1), distinctly oblique fractures were noted. Zones of very broken rock were observed at four locations. It should be noted, however, that monitoring wells, which are vertically oriented, would be expected to encounter more horizontal and oblique fractures than vertical ones in bedrock.

Compilation of boring and geophysical data reveals an irregular relationship between the surface and the top of bedrock. An isopach map depicting the thickness of the overburden (depth to bedrock) is shown in Figure 3-14. Although the bedrock surface generally slopes southwestward with the topography, the depth to bedrock ranges from zero to greater than 65 feet. The overburden generally thickens near the Ramapo River and two additional bedrock "troughs" are apparent. A shallow "trough" occurs in the vicinity of the Ramapo Landfill weigh station between boring locations GW-1 and GW-3. A deeper, broader "trough" is apparent from geophysical and boring information in the northeastern corner of the site. A depth to bedrock of 68 feet was logged at GW-10R, near the Ramapo River (Figure 3-12). After reviewing selected boring logs from previous investigations, it is believed that this is most likely a localized channel, perhaps a buried portion of an ancestral, preglacial equivalent of the Ramapo River.



THICKNESS OF OVERBURDEN

URS CONSULTANTS, INC.

FIGURE 3-14

3.7.4 Hydraulic Conductivity

The hydraulic conductivity of each of the various hydrogeologic units was estimated by conducting variable-head slug tests on each monitoring well. Field data was used to calculate values of hydraulic conductivity by using both the time-lag and variable-head methods (Hvorslev, 1951). Only the variable-head method was used on the Phase II well data. The results of this analysis are presented in Table 3-3. In addition, selected bedrock boreholes were pressure tested at various depths. This data was also reduced to yield values of hydraulic conductivity and the results are given in Table 3-4.

The ranges of hydraulic conductivities measured were generally similar within the individual units defined. The hydraulic conductivity of the loose sands is 2-3 orders of magnitude greater than the hydraulic conductivity of the dense sands and weathered bedrock. The hydraulic conductivity values for the bedrock aquifer ranged from 1.3×10^{-5} cm/sec to 1×10^{-2} cm/sec (combining both slug and packer tests).

Properties of each unit are summarized below:

(a) Loose Sands - This unit is the most permeable of the materials investigated at the Ramapo Landfill site. The hydraulic conductivity of the loose sand is on the order of 1×10^{-2} cm/sec. Porosities of similar sands have been found to range from 20-35 percent (Fetter, 1980).

(b) Dense Sands - Measurements of hydraulic conductivity of the dense sands ranged from 5.1×10^{-5} to 1.4×10^{-4} cm/sec. The porosity of similar compact sandy fill ranges from 10-20 percent (Fetter, 1980).

(c) Weathered Bedrock - Measurements of hydraulic conductivity of the intermediate layer ranged from 4.0×10^{-5} to 1.5×10^{-3} cm/sec.

TABLE 3-3
HYDRAULIC CONDUCTIVITY RESULTS FROM SLUG TESTING

Well Number	Screened Interval (Feet Below Surface)	Unit	Hydraulic Conductivity (cm/s)		
			Time Lag	Variable Head	Average
1-OS	12.0 - 22.0	Dense sand	6.2×10^{-5}	4.0×10^{-5}	5.1×10^{-5}
2-OS	10.4 - 20.4	Dense sand	2.8×10^{-4}	1.2×10^{-4}	2.0×10^{-4}
3-OS/I	7.8 - 12.8	Loose sand	*	*	1.0×10^{-2}
4-OS	4.5 - 14.5	Dense sand	1.7×10^{-3}	2.7×10^{-4}	9.9×10^{-4}
5-OS	6.0 - 16.0	Dense sand	+	+	+
6-OS	13.3 - 18.3	Dense sand	*	1.4×10^{-4}	1.4×10^{-4}
7-OS	6.0 - 16.0	Loose sand	*	*	1.0×10^{-2}
8-OS	10.0 - 20.0	Loose sand	*	*	1.0×10^{-2}
9-OS	5.7 - 15.7	Loose sand	*	1.5×10^{-2}	1.5×10^{-2}
10-OS	7.9 - 17.9	Loose sand	*	1.0×10^{-3}	1.0×10^{-3}
1-I	25.5 - 30.5	Weth RX/dense sand	3.0×10^{-4}	1.8×10^{-4}	2.9×10^{-4}
2-I	22.3 - 27.3	Weth RX/dense sand	3.7×10^{-5}	4.2×10^{-5}	4.0×10^{-5}
4-I	18.0 - 23.0	Weth RX/dense sand	1.1×10^{-4}	9.2×10^{-5}	1.0×10^{-4}
5-I	35.0 - 40.0	Weth RX/dense sand	4.2×10^{-5}	3.8×10^{-5}	4.0×10^{-5}
6-I	24.5 - 29.5	Dense sand	2.4×10^{-3}	6.9×10^{-4}	1.7×10^{-3}
7-I	41.7 - 46.7	Weth RX/dense sand	6.6×10^{-4}	2.0×10^{-4}	4.3×10^{-4}
8-I	44.6 - 49.6	Weth RX/dense sand	2.6×10^{-3}	2.0×10^{-3}	2.3×10^{-3}
9-I	36.7 - 41.7	Weth RX/dense sand	1.4×10^{-3}	1.6×10^{-3}	1.5×10^{-3}

TABLE 3-3 (Continued)

Well Number	Screened Interval (Feet Below Surface)	Unit	Hydraulic Conductivity (cm/s)		
			Time Lag	Variable Head	Average
1-R	47.0 - 52.0	Bedrock	2.5×10^{-4}	1.4×10^{-4}	1.9×10^{-4}
2-R	46.9 - 51.9	Bedrock	*	*	1.0×10^{-2}
3-R	31.5 - 36.5	Bedrock	++	++	++
4-R	38.3 - 43.3	Bedrock	1.9×10^{-4}	1.7×10^{-4}	1.8×10^{-4}
5-R	55.0 - 60.0	Bedrock	8.2×10^{-5}	8.6×10^{-5}	8.4×10^{-5}
6-R	44.2 - 49.2	Bedrock	5.6×10^{-4}	**	5.6×10^{-4}
7-R	62.3 - 67.3	Bedrock	2.5×10^{-4}	1.4×10^{-4}	2.0×10^{-4}
8-R	61.0 - 66.0	Bedrock	2.8×10^{-4}	1.9×10^{-4}	2.4×10^{-4}
9-R	56.5 - 61.5	Bedrock	1.6×10^{-3}	1.6×10^{-3}	1.6×10^{-3}
10-R	82.4 - 87.4	Bedrock	1.3×10^{-4}	5.0×10^{-5}	8.9×10^{-5}

* Recovery too fast for proper data reduction. A value of 10^{-2} or greater is assumed.
\+ Test rejected
++ Data not taken
* Screened in the unsaturated zone
** Erroneous readings

TABLE 3-4

HYDRAULIC CONDUCTIVITY VALUES
GENERATED FROM BEDROCK PACKER TESTS

Well Number	Inverval Tested (ft. below surface)	Hydraulic Conductivity (cm/sec)
URS 2R	41.3 - 34.3	1.3×10^{-5}
URS 2R	48.3 - 41.3	*
URS 3R	26 - 19	5.4×10^{-5}
URS 3R	26 - 19	6.5×10^{-5}
URS 3R	33 - 26	*
URS 5R	49.5 - 42.5	2.0×10^{-5}
URS 5R	56.5 - 49.5	7.2×10^{-5}
URS 6R	30.0 - 33.3	*
URS 6R	33.3 - 38.3	4.7×10^{-5}
URS 6R	38.3 - 43.3	7.7×10^{-5}
URS 6R	43.3 - 49.3	9.3×10^{-6}
URS 7R	57.8 - 50.8	1.4×10^{-4}
URS 7R	63.6 - 56.8	*
URS 9R	52.4 - 57.9	3.2×10^{-5}
URS 9R	57.9 - 62.4	5.7×10^{-6}
URS 10R	68.4 - 72.1	*
URS 10R	72.1 - 76.4	*
URS 10R	76.4 - 82.1	2.2×10^{-6}
URS 10R	82.1 - 87.9	1.3×10^{-5}

* Indicates that no water was lost to the formation during the test. Hydraulic conductvity of these intervals may range from the limit of sensitivity of the method used (10^{-7} cm/sec) to that of unfractured metamorphic rock (10^{-9} cm/sec as suggested on page 158 by Freeze and Cherry, 1979).

Weathered metamorphic rocks may have porosities in the range of 30-60 percent (Stewart, 1964).

(d) <u>Bedrock</u> - Hydraulic conductivity values for the bedrock aquifer obtained from slug test data ranged from 8.9×10^{-5} to 1×10^{-2} cm/sec. Values calculated from pressure test data were on the order of 10^{-5} cm/sec. The range of hydraulic conductivity values may be attributed to variations in the fracturing of the rock.

The primary porosity of unfractured plutonic and metamorphic rock is extremely low (less than 2 percent; Fetter, 1980) and results in primary hydraulic conductivity on the order of 10^{-9} cm/sec (Freeze and Cherry, 1979). Secondary porosity in these rocks, in the form of fractures, increases porosity from 2 to 5 percent or more (Davis, 1969), and may increase hydraulic conductivity many orders of magnitude. At shallow depths, sheet fractures form in plutonic and metamorphic rocks in a near-horizontal plane due to the removal of overburden by erosion (Le Grand, 1949). Many of the fractures observed in the bedrock at the Ramapo Landfill are possibly of this origin.

These fractures are further enhanced by vertical or oblique faults and joint patterns. Joint or fault traces are often expressed in the surface topography as shallow troughs or valleys and are associated with zones of high hydraulic conductivity.

Packer test data from rock wells GW-2R, 3R, 7R and 9R indicate a significant decrease in hydraulic conductivity with depth within several yards of the top of the bedrock surface (Table 3-4). This is noted in particular with packer tests at borings GW-3 and GW-7 where although fractured throughout the entire cored interval hydraulic conductivity drop from 10^{-5} cm/sec within the upper test interval to essentially impermeable within the deeper test interval.

3.7.5 Groundwater Flow Patterns

Water elevations were obtained during both phases of the field investigations in the URS monitoring wells, historical monitoring wells (where possible), piezometers, Torne Brook, the Ramapo River, and manholes along the leachate collection system (second phase only). All recorded measurements are presented in Appendix G.2. Water levels from the January 23, 1990, and the August 26, 1990, measurements are considered to be representative of the two phases of field investigations. The data is presented in Table 3-5, in feet (msl), and form the basis of the following discussion.

Groundwater contours for the water table surface, as measured on January 23, 1990, are presented on Figure 3-15. The water table surface closely parallels the surface topography, and shallow groundwater generally flows towards Torne Brook which is a topographic low between the landfill and lands between the Brook and the River. The flow direction in the intermediate and bedrock aquifers is likely very similar to that of the water table aquifer but in all probability, flows beneath Torne Brook to the River.

With the addition of five piezometers, a monitoring well pair, and two monitoring well clusters (one of which is on the opposite side of Torne Brook from the landfill) during the second phase, the contours shown on Figure 3-16 were developed from measurements taken on August 26, 1990. It appears as if Torne Brook is acting as the discharge area for the water table aquifer (overburden).

Three water level readings were obtained in Torne Brook and two in the Ramapo River (during the second phase). Levels in the brook at SWE-2 were similar to water levels in the overburden (LJ-4), showing the strong interconnection in this area between the two. The horizontal gradient across the site decreases from very steep near the westernmost portion of

TABLE 3-5

WATER LEVEL INFORMATION (Feet)
OVERBURDEN AND SURFACE WATER

Location	1/23/90	8/26/90
MW-1	363.08	362.66
MW-2	410.51	410.88
MW-3	334.29	333.17
MW-4	446.82	446.04
MW-5	573.30	571.75
MW-6	----	449.52
MW-7	298.24	299.15
MW-8	306.08	306.15
MW-9	----	301.80 (8/30/90)
MW-10	----	293.08
P-1	504.15	505.12
P-2	510.39	515.44
P-3	391.83	391.70
P-4	385.17	386.52
P-5	dry	390.90
P-6	----	321.57
P-7	----	307.96
P-8	----	307.85
Torne Brook		
SG-1	296.15	295.67 (9/11/90)
SWE-2		298.42 (9/11/90)
SWE-3		302.51 (9/11/90)
Ramapo River		
SG-2	293.40	292.32 (9/11/90)
SWE-1	----	292.47 (9/11/90)

TABLE 3-5 (Continued)

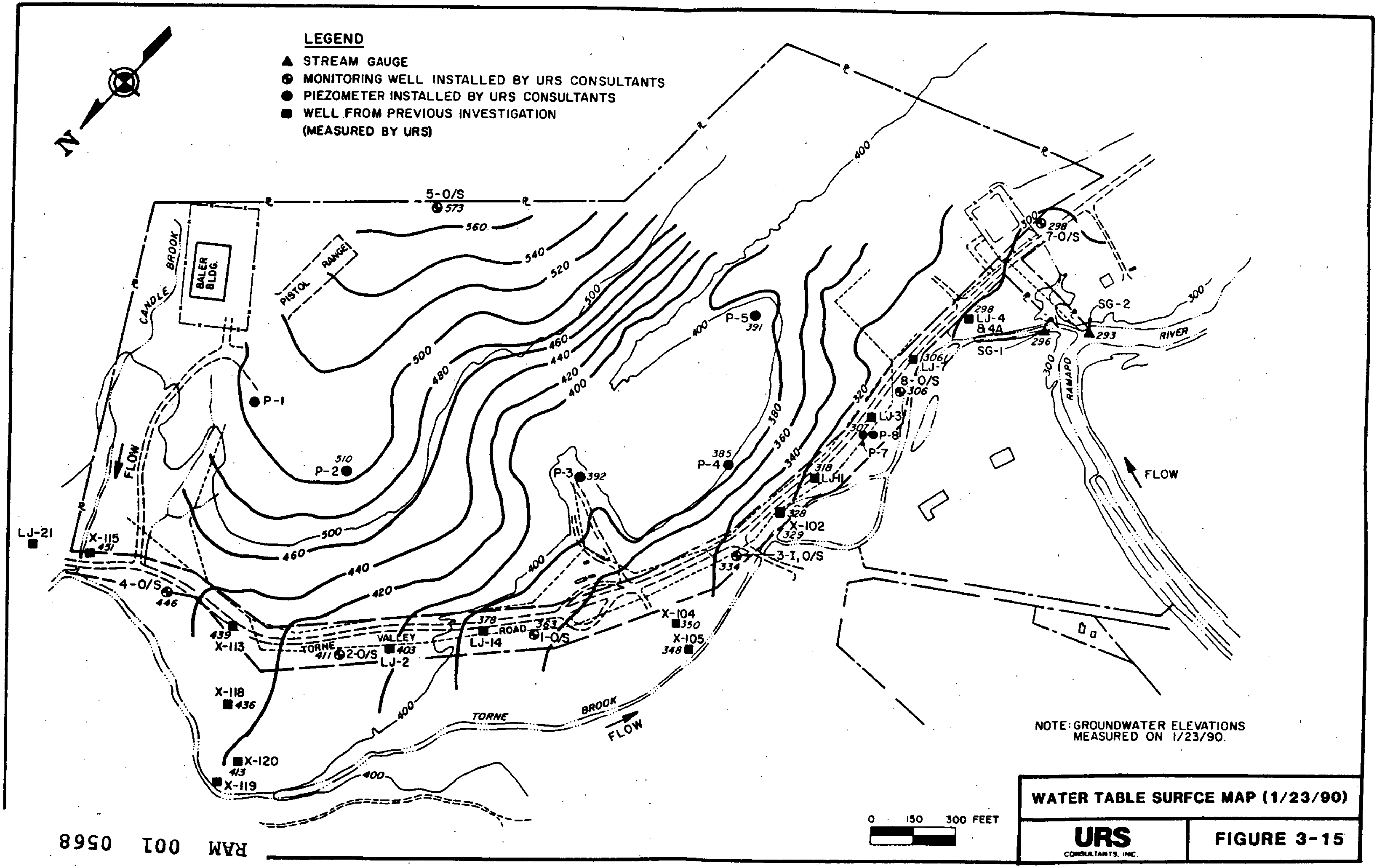
WATER LEVEL INFORMATION (Feet)

INTERMEDIATE

Location	1/23/90	8/26/90
MW-1	365.97	363.62
MW-2	407.44	409.26
MW-4	446.18	445.38
MW-5	570.43	569.96
MW-6	----	449.98
MW-7	295.80	296.36
MW-8	306.57	305.72
MW-9	----	297.68 (8/30/90)
P-7	----	308.07
P-8	----	307.93

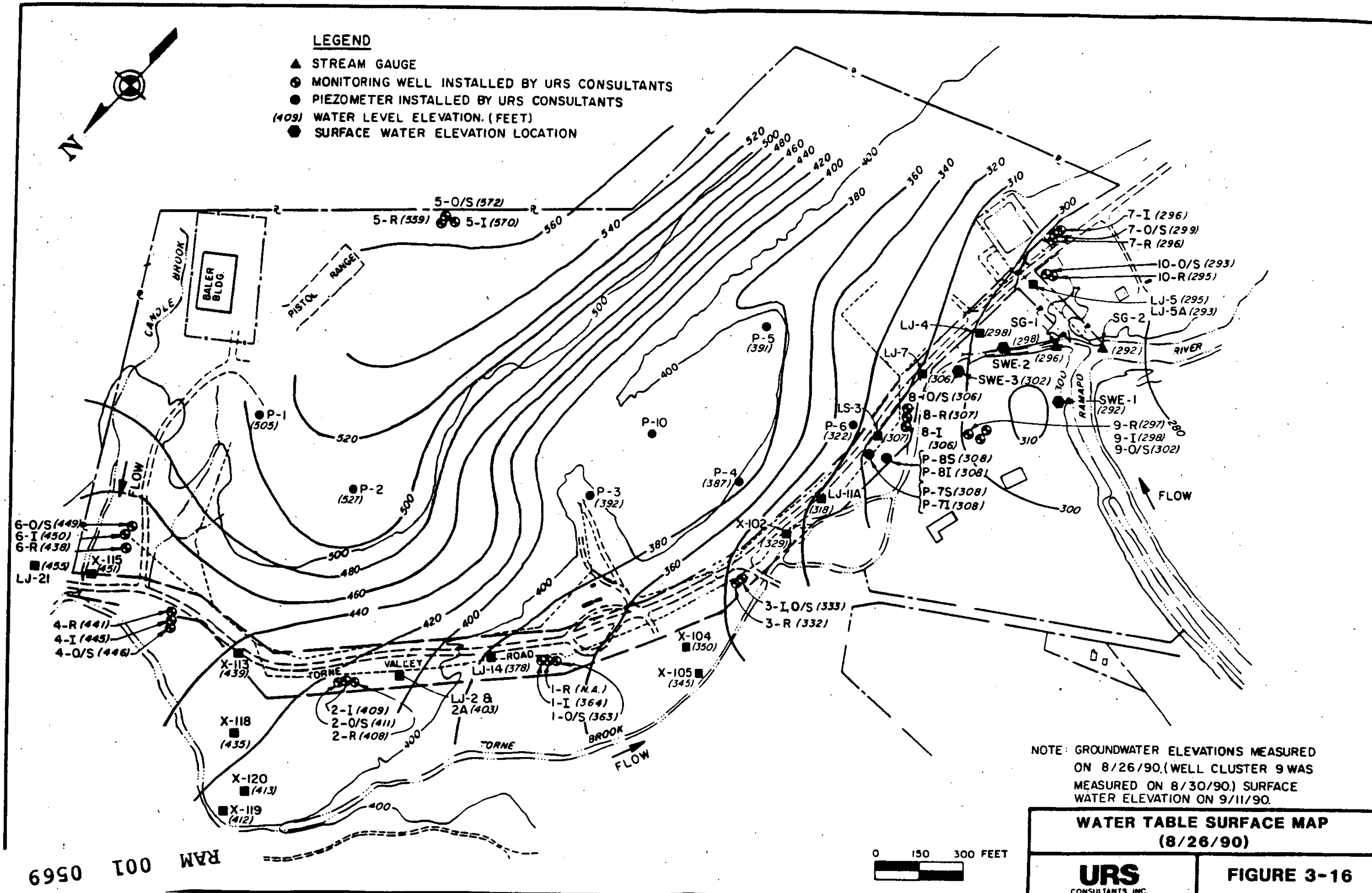
BEDROCK

Location	1/23/90	8/26/90
MW-1	364.12	Not measured
MW-2	407.92	407.89
MW-3	332.85	332.37
MW-4	441.34	440.75
MW-5	559.42	559.01
MW-6	----	438.15
MW-7	294.55	295.61
MW-8	305.53	307.27
MW-9	----	296.99 (8/30/90)
MW-10	----	294.73



WATER TABLE SURFCE MAP (1/23/90)

FIGURE 3-15



WATER TABLE SURFACE MAP (8/26/90)

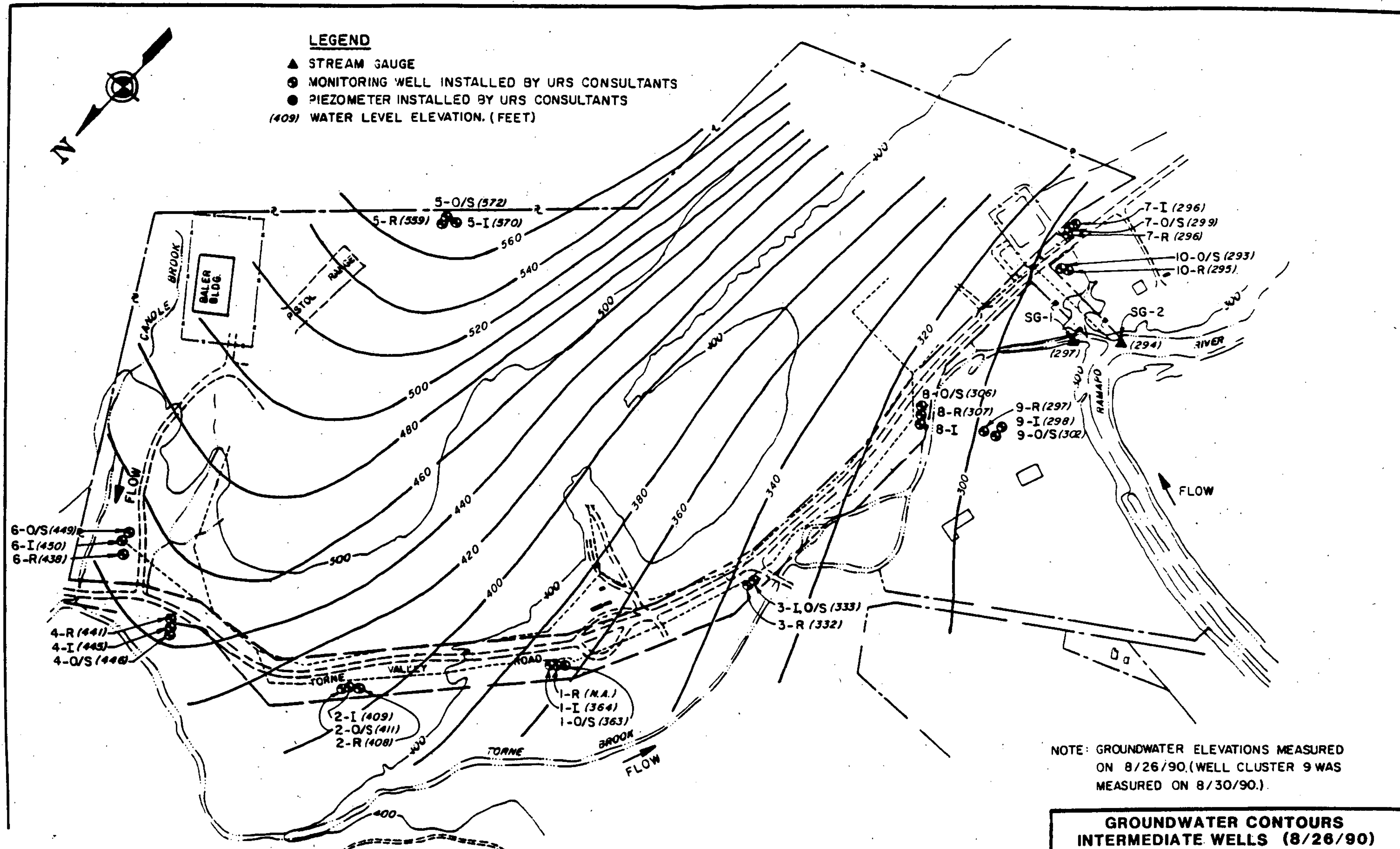
FIGURE 3-16

the site (gradient = 0.4), to gentler across the southern mound (gradient = 0.13), to negligible (gradient = 0.02) between the southwestern edge of the site and the Ramapo River.

Groundwater contour maps were developed for the intermediate and bedrock aquifers (Figures 3-17 and 3-18, respectively). Contours generally follow the same pattern as the overburden aquifer. It appears, based on monitoring well data, that these two units flow beneath Torne Brook and do not discharge to it.

Table 3-6 summarizes the vertical hydraulic gradients, as determined from water level readings at well clusters. This data indicates that the direction of the vertical flow varies across the site but is generally downward. Wells at GW-3, GW-4, GW-5, and GW-7 exhibit downward gradients between the shallow aquifer and intermediate layer, and intermediate layer and bedrock aquifer. These wells, with the exception of GW-3, are all located at least 100 feet from the existing leachate collection drains, and are likely representative of the area's natural vertical flow. The remaining onsite well clusters are located within 25 feet of the leachate collection drains, and exhibit both upward and downward gradients at each cluster. At these locations, the leachate collection system may be affecting the normal vertical flow pattern. Water levels in P-7 and P-8 piezometer pairs showed upward gradients. Offsite monitoring well pair GW-10, which was installed during the second phase, showed upward flow both during installation and upon measuring water levels. Monitoring cluster GW-9, which is offsite and across Torne Brook, showed downward flow from the overburden to the intermediate and then to the bedrock aquifer.

On August 26, 1990, during the second phase of field activities, water level measurements were taken in many of the manholes near GW-8. Based on these measurements, and on information provided to URS on the shallow and deep leachate collection systems, it has been determined that



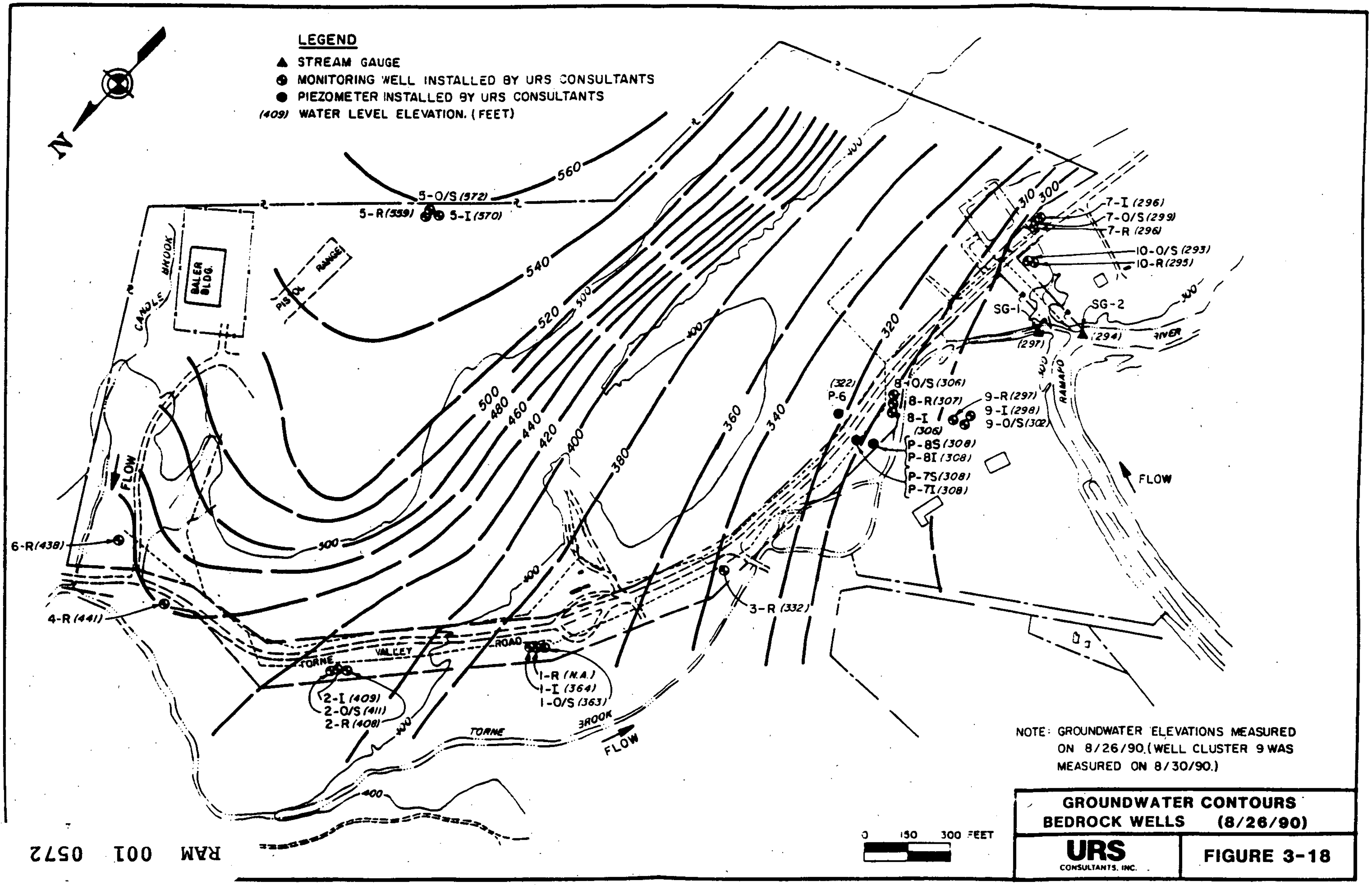
NOTE: GROUNDWATER ELEVATIONS MEASURED ON 8/26/90.(WELL CLUSTER 9 WAS MEASURED ON 8/30/90.)

GROUNDWATER CONTOURS INTERMEDIATE WELLS (8/26/90)

URS CONSULTANTS, INC.

FIGURE 3-17

RAM 001 0571



NOTE: GROUNDWATER ELEVATIONS MEASURED ON 8/26/90. (WELL CLUSTER 9 WAS MEASURED ON 8/30/90.)

GROUNDWATER CONTOURS
BEDROCK WELLS (8/26/90)

URS CONSULTANTS, INC.

FIGURE 3-18

TABLE 3-6
VERTICAL HYDRAULIC GRADIENTS

Location	1/23/90	8/26/90
1OS		+
1I	+	
1R	-	NT
2OS		
2I	-	-
2R	+	-
3OS/I		
3R	-	-
4OS		
4I	-	-
4R	-	-
5OS		
5I	-	-
5R	-	-
6OS		
6I		+
6R		-
7OS		
7I	-	-
7R	-	-
8OS		
8I	+	-
8R	-	+
9OS		
9I		-
9R		- (8/30/90)
10OS		
10R		+
P-7S		+
P-7I		
P-8S		+
P-8I		

(+) denotes upward gradient
(-) denotes downward gradient
NT Water level measurement in MW-1R could not be taken due to the presence of an obstruction.

RAM 001 0573

representative of background conditions. The remaining samples were taken downgradient of the two landfill lobes. All samples were taken above the water table and all but MW-4-SB (collected at a depth of 1 to 4 feet) were taken at a depth of greater than four feet. Samples were analyzed for TCL volatiles, semivolatiles, pesticides/PCBs, metals, cyanide, total phenols, and several miscellaneous indicator parameters. Results are presented in Table 4-3.

Methylene chloride, acetone, and toluene, which are common laboratory contaminants, were the only volatiles detected. Semivolatiles (six) were detected only in MW-3-SB, including some PAHs, which were found at concentrations up to 75 ppb (fluoranthene). Neither pesticides nor PCBs were detected in the borings, although it must be noted that four of the seven sample results for pesticides and PCBs had to be rejected due to holding time violations by the laboratory. Metals were detected at similar concentrations in all soil borings across the site, with the exception of a few metals detected at low levels in only one boring. Antimony, for example, was detected only in MW-8-SB; beryllium only in MW-2-SB; cadmium only in MW-7-SB; selenium only in MW-4-SB; and thallium only in MW-8-SB.

4.1.4 Summary of Subsurface Soil Data

The only organic compounds detected in subsurface soil downgradient of the site were at MW-3-SB, which was sampled at a depth of 6-10 feet. One volatile and six semivolatiles were detected at this location. No pesticides or PCBs were detected in any subsurface soil. Metals were generally found to be at similar concentrations across the site.

4.1.5 Soil ARARs

There are no New York State ARARs for soil. Federal TBCs for soil include the Toxic Substance Control Act (TSCA) regulations (for PCBs). No

PCBs were detected in soil at the site. Five waste samples were analyzed for RCRA hazardous waste characteristics and EP Toxicity parameters, for which there are regulatory levels. A comparison between the EP Toxicity Criteria and levels detected at the site is presented in Table 4-5. No measurements exceeded the EP Toxicity Criteria. As part of RCRA testing, the samples were also analyzed for the characteristics of ignitability, corrosivity, and reactivity. SPS-5, an offsite paint sludge, was determined to be ignitable. SPS-5, the soil around it, and additional areas where paint sludge was found in surficial soils in the vicinity of the site were removed by the NYSDEC separately from the Ramapo Landfill remedial program in the fall of 1990, and disposed of in the Clarkstown Landfill, Ramapo County.

4.2 Groundwater

During the two phases of field activities, ten monitoring wells were installed in the overburden aquifer, eight in the intermediate aquifer, and ten in the bedrock aquifer. Sample results from the first phase are presented in Table 4-6 for the shallow wells (overburden), in Table 4-7 for the intermediate wells, and in Table 4-8 for the deep wells (bedrock aquifer). Samples from the first phase were analyzed for TCL volatiles, semivolatiles, pesticides/PCBs, metals, cyanide, total phenols, and indicator parameters. Sample results from the second phase are presented in Tables 4-9, 4-10, and 4-11, respectively, for the three aquifers. In addition, during the second phase, water from the pump house of the adjacent property owner was sampled and labelled GDT-1. The pump house draws groundwater from the residential well (PW-1) and supplies it to the residents of Torne Brook Farm. Samples from the second phase were analyzed for TCL volatiles, semivolatiles, pesticides/PCB, and metals. Several indicator parameters were analyzed in some of the second phase samples.

All sampling and laboratory protocols were carried out in accordance with the work plans for the two phases of work with, the following exceptions.

Laboratory results for semivolatiles from MW-4-OS were rejected during the first phase due to holding time violations by the laboratory. This well was resampled during the second phase, but the data were again rejected due to non-compliance by the laboratory with the specified protocols (NYSDEC ASP). Therefore no data exists for semivolatiles in MW-4-OS.

As requested by the NYSDEC in order to achieve lower detection limits, groundwater samples collected during the second phase were sent to two different laboratories. Aqueous volatile analysis was performed by York Laboratories, of Monroe, CT according to Method 524.2 [Energy & Environmental Engineering, Inc. (E^3I) of East Cambridge, Mass. had been unable to do this analysis]. York Laboratory was requested to analyze for the additional TCL compounds, those that are not part of the Method 524.2 compound list. Results for analysis of aqueous volatile samples are presented in the second-phase tables. The remaining analyses were performed by E^3I according to NYSDEC ASP - September 1989. A number of the samples required reextraction of the semivolatiles fraction as required by NYSDEC ASP, due to analytical deviations. These are shown on the tables with the suffix - RE.

And finally, groundwater samples collected on an adjacent property by URS in MW-90S, MW-9I, and MW-9R were split with the USEPA. The USEPA sent the split samples for analysis to Gulf South Environmental Lab, of New Orleans, Louisiana, for organics analysis, and to DATACHEM of Salt Lake City, Utah, for inorganics analysis. Results are presented in Table 4-12 and identified in the text as MW-90S split, MW-9I split and MW-9R split.

4.2.1 Results of Groundwater Sampling

MW-5 monitoring well cluster is located on the upgradient edge of the landfill, near the property line. It is beyond the limits of fill as determined during the EM-31 terrain conductivity survey performed during this remedial investigation. The MW-5 cluster has a well in each of the overburden, intermediate, and bedrock layers. These wells are considered to be background and representative of natural conditions in the vicinity of the site.

Overburden Aquifer

Benzene at 2 ppb during the first round was the only organic compound detected in the two samplings of MW-5 O/S. While it is not suggested that benzene is ubitiquous to the area it should be noted that benzene at 2.6 ppb was detected in a Dunn Geoscience well drilled at a location north of the landfill (see RI Section 1.2.4.4). As stated in the Dunn report, this was considered to be low enough to represent a laboratory artifact (Dunn Geoscience, 1988). Fifteen of the twenty-three metals were detected in the first round samples; fourteen in the second round. Concentrations were generally higher in the first round; and cobalt was not detected in the second round.

In the remaining overburden wells, all of which are considered to be downgradient, organics were detected at low concentrations (i.e., ≤ 3 ppb), except for acetone which was detected at 21 ppb. Seven volatiles were detected between the two rounds of sampling (chloromethane, benzene, chlorobenzene, acetone, toluene, p-isopropyltoluene, 1,4-dichlorobenzene). One semivolatile was detected (bis(2-ethylhexyl)phthalate). No pesticides or PCBs were detected in the overburden groundwater. MW-8 O/S had the greatest frequency of detections with five compounds detected.

Sixteen out of twenty-three metals were detected between the two rounds of sampling. During the first round, MW-1 O/S had the majority of maximum concentrations of all overburden wells followed by MW-8 O/S. During the second round, MW-7 O/S had the majority of maximum concentrations followed by MW-2 O/S. Concentrations of a number of metals were substantially higher in the downgradient samples than in the upgradient samples (arsenic, barium, calcium, chromium, copper, iron, manganese, nickel, potassium, sodium). Concentrations of metals were generally higher in samples taken from the overburden than in samples from the intermediate and bedrock.

Miscellaneous inorganic indicator parameters were analyzed for in the groundwater samples with detectable results. It is not known, however, whether values detected were above background because there was insufficient well volume in GW-5OS to sample and analyze for these parameters.

Analysis of split samples from GW-9OS (samples split with the USEPA) led to similar results as the URS sample. The only organic compound detected was bis(2-ethylhexyl)phthalate at 12 ppb. Several additional metals (barium, mercury, potassium, vanadium and zinc) were not reported in the USEPA split samples, but were detected in the URS samples.

Sample GDT-1, which was potable water from PW-1, showed the presence of tetrachloroethane at 0.6 ppb, and twelve of the twenty-three metals. All metals detected were below the NYS standards and guidelines for a drinking water source (class GA) which include the NYSDOH standards.

Intermediate Aquifer

Six organic compounds were detected in the two samplings of MW-5I. Methylene chloride, toluene, bromochloromethane, and alpha-BHC were all detected at < 1 ppb; tetrachloroethene was detected at 2.3 ppb; and bis(2-ethyl hexyl)phthalate was detected at 9 ppb. Sixteen of the twenty-three metals were detected in the second round samples; the same as those detected in the upgradient overburden wells. Twelve metals were detected in the first round samples at generally lower concentrations than in the second round samples.

Many organics were detected in the downgradient intermediate layer samples including 27 volatiles, 3 semivolatiles, and 1 pesticide. The majority of the organics were detected during the second round in wells MW-6I and MW-8I. Eighteen of the twenty-three metals were detected. The majority of maximum concentrations were detected in MW-8I during the second round. During the first round, maximum concentrations were found in samples MW-1I, MW-4I, and MW-8I almost equally.

The concentrations of several miscellaneous inorganic water quality parameters (ammonia, TKN, alkalinity, acidity, total phosphorus, TOC, TSS, and TDS) exceeded the concentrations of the background well by at least one order of magnitude. Most of the exceedances occurred in well MW-8I.

No VOCs were detected in the split samples of MW-9I analyzed by the USEPA. Two semivolatile organic compounds, pyrene and bis(2-ethylhexyl)phthalate, were detected in the split samples. Pyrene was detected at 3 ppb. No pesticides/PCBs were detected. Several metals (arsenic, barium, cadmium, cobalt, copper, mercury, potassium, vanadium, and zinc) were detected in the URS split sample but not in the USEPA split sample.

Bedrock Aquifer

Two organics, 2-butanone at 7 ppb, and bis(2-ethylhexyl)phthalate at 3 ppb, were detected in the two samplings of the upgradient bedrock well. Twelve metals were detected during the first round; eleven during the second round. With the exceptions of aluminum and chromium, concentrations of metals were generally the lowest in the upgradient bedrock wells as compared to the downgradient bedrock wells.

Twenty-one organics were detected in the downgradient bedrock monitoring wells. These included 16 volatiles, 4 semivolatiles, and 1 pesticide. The majority of these detections were in MW-4R, MW-8R, and MW-9R, although half of the detections were at very low concentrations, (i.e., $\leq$ 1 ppb). Thirteen metals were detected during the first round; sixteen during the second round. Maximum concentrations of metals were detected most frequently in MW-4R during the first round; and MW-8R during the second round. Elevated concentrations of at least a single metal appeared to be present in every bedrock monitoring well except MW-5R and MW-7R.

No VOCs were detected in the USEPA split samples. Lindane (gamma-BHC) was the only pesticide detected (0.055 ppb, in MW-7R). This pesticide was also detected in the USEPA split sample (MW-9R), at a concentration of 0.11 ppb. A review of the metals results from the USEPA split sample shows similar concentrations to those detected in the URS sample. The only exceptions are that aluminum and lead were detected in the split sample at 37.2 ppb and 4.6 ppb, respectively, and were not detected in URS's sample. Aluminum was detected in the background sample at 159 ppb during the second round; lead was not detected in the background sample.

The following miscellaneous inorganic parameters exceeded the background sample by one order of magnitude: TKN, nitrate/nitrite-N, oil and grease, and TOC.

4.2.2 Summary of Groundwater Data

In general, the overburden contained the highest concentrations of metals, while the intermediate layer contained the highest concentrations of organics. The greatest frequency of detections of compounds, both organics and metals, occurred in the cluster at MW-8. These monitoring wells are present in an area where the deep leachate collector has been identified to be periodically allowing leachate to exfiltrate to the subsurface. This area is followed by the area around MW-4 and MW-6 for greatest frequency of detections. This is also an area where the leachate collector has been determined to be periodically above the water table.

Organic compounds detected in MW-8 O/S were not detected in MW-9 O/S or GDT-1. Metals detected in MW-9 O/S were at lower concentrations than in MW-8 O/S. Except for benzene detected at 0.2 ppb, no organics were detected in MW-9I, whereas, quite a few were detected in MW-8I. Metals detected in MW-9I were at lower concentrations than in MW-8I. This indicates that groundwater in the overburden and intermediate layers east of Torne Brook is not flowing beneath Torne Brook to the lands west. Rather, it is either flowing downgradient to the bedrock layer, where downward vertical gradient prevail, or discharging to Torne Brook. Volatile organics and metals detected in MW-8R were for the most part present in MW-9R, indicating that contaminants are migrating through this layer. Though, as indicated in the next section on groundwater ARARs, they are not doing so in concentrations detrimental to the environment.

4.2.3 Groundwater ARARs

New York State lists ARARs for groundwater within the NYSDEC's Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values (dated September, 1990). This current version for the most part includes NYS Department of Health standards as well. In addition, the USEPA Primary Drinking Water Standards were also considered as ARARs for the site, and USEPA Directive #9355.4-02 which proposes an action level in onsite groundwater of 15 ppb for lead. Table 4-13 presents the comparison between ARARs and compounds detected in the upgradient samples (MW-5) and the downstream samples (all other URS groundwater monitoring wells and GDT-1). The three aquifers of interest, namely, overburden, intermediate, and bedrock, are detailed separately.

As shown in Table 4-14, which summarizes the ARAR exceedances, benzene, iron, manganese, and TOC exceeded ARARs in all three aquifers; all these compounds also exceeded ARARs in at least one of the upgradient wells (MW-50/S, -5I, or -5R). The majority of ARAR exceedances were in MW-8 (all aquifers), followed by MW-4 (all aquifers). While MW-8 was the most contaminated area with regards to ARAR exceedances, concentrations of organics and metals detected in MW-9 O/S, MW-9I, MW-9R across Torne Brook, exceeded ARARs for only sodium and gamma-BHC, in addition to benzene, iron, manganese, and TOC which were also exceeded upgradient. This supports the conclusion that contaminants are not migrating past Torne Brook in either the overburden, intermediate layer, or bedrock at concentrations detrimental to the environment.

4.3 Surface Water

First phase surface water samples were collected at the following locations:

SW-1: Ramapo River at the location of former Outfall 1
SW-2: Torne Brook upstream from the landfill
SW-3: Torne Brook adjacent to the landfill
SW-4: Drainage swale from the landfill on an adjacent property
SW-LS-1: Leachate seep between northern and southern lobes
SW-LS-2: Leachate seep downslope from the northern lobe.

Results for the first-phase analyses are presented in Table 4-15. Samples for the first phase were analyzed for TCL volatiles, semi-volatiles, pesticides/PCBs, metals, cyanide, total phenols, and indicator parameters. Surface water samples collected during the second phase consisted of new samples and resampling from the first-phase investigation due to laboratory holding time violations. No leachate seeps were observed on the landfill during the second-phase sampling. Second-phase sampling included:

SW-1: resample from same location as above and analysis for pesticides/PCBs
SW-3: resample from same location as above and analysis for semivolatiles and pesticides/PCBs
SW-4: resample from same location as above and analysis for semivolatiles and pesticides/PCBs
SW-5: same location as SW-2 above
SW-6: Torne Brook adjacent to landfill
SW-7: Torne Brook adjacent to landfill
SW-8: Torne Brook adjacent to landfill
LIN: Leachate influent to the holding basin from a manhole
LEF: Leachate within the holding basin.

Results for the second-phase analyses are presented in Table 4-16. Samples for the second phase were analyzed for TCL volatiles, semi-volatiles, pesticides/PCBs, metals, cyanide, total phenols, and a reduced list of indicator parameters.

4.3.1 Results of Surface Water Sampling

Samples SW-2 and SW-5 were taken along Torne Brook approximately 100 feet upstream from the confluence of Candlebrook and Torne Brook, and are considered to be background and representative of upstream conditions. There are approximately 350 to 400 feet between the confluence of Candlebrook and Torne Brook, and the entrance of the Orange and Rockland County Utilities substation, which is approximately a 20-acre facility. The land intervening between the landfill and the substation is relatively pristine and wooded. Results from the two phases of sampling (SW-2 first-phase and SW-5 second- phase) are similar. Only one organic compound, vinyl chloride, was detected in either sample and that was at a concentration of 1.9 ppb in SW-5. Vinyl chloride was also detected in the next surface water sample downstream, SW-6. It was not, however, detected in any other media either on or off the site (surficial or subsurface soil, groundwater, sediments, air) in either sampling round. Therefore, the presence of vinyl chloride in Torne Brook is not attributable to the landfill, but rather due to an upstream source.

Seven of the 23 metals analyzed for were detected at similar concentrations in both samples (barium, calcium, iron, magnesium, manganese, potassium, and sodium) up to a concentration of 4,570 ppb (calcium). Metals detected in only one of the two samples included aluminum, thallium, and zinc detected in SW-2, and lead and mercury detected in SW-5. Additionally, oil and grease was detected in SW-5 at 1.1 ppm, but was not found in any other second-phase surface water sample, indicating an upstream source such as runoff from Torne Valley Pond. The remaining surface water samples were compared to the upstream samples in order to determine what, if any, contaminants the landfill might be contributing.

Effective November 1, 1990, leachate from the holding pond is now pumped directly to the Suffern Wastewater Treatment Plant and not discharged to the Ramapo River. However, sample SW-1 in the Ramapo River was taken on October 25, 1989, when former Outfall 001 was still in use. No organic compounds were detected in SW-1. Fifteen out of 23 metals analyzed for were detected, up to a concentration of 110,000 ppb (calcium). Of the metals detected, four were at concentrations similar to those detected in either SW-2 or SW-5 (aluminum, lead, mercury, and thallium). Six metals were at more than an order of magnitude greater than those in the background samples (calcium, iron, magnesium, manganese, potassium, and sodium). Four metals were detected in SW-1 but not in the background (upstream) samples (antimony, arsenic, copper, and nickel). Additionally, oil and grease was found at 2 ppm.

Sample SW-3 was taken in Torne Brook, approximately 600 feet from its confluence with the Ramapo River. No organics were detected in SW-3. Seven metals were detected, all at concentrations similar to those detected in the upstream samples.

Sample SW-4 was taken in a drainage swale which leading from the southern end of the landfill site to an adjacent property. No organics were detected in this sample. Eleven metals were detected at concentrations similar to those in the upstream samples.

Samples SW-6, SW-7, and SW-8 were all taken in Torne Brook adjacent to the landfill. A few volatiles were detected in these samples (vinyl chloride, benzene, toluene) at low concentrations (0.08 to 0.7 ppb). No semivolatiles, pesticides, or PCBs were detected. Eleven metals (aluminum, barium, calcium, iron, lead, magnesium, manganese, mercury, potassium, sodium, and zinc) were detected at similar concentrations to those of the background samples, with the exceptions of iron and aluminum in SW-8, which were nearly an order of magnitude higher. Additionally, vanadium was detected in SW-8, and copper in SW-6 and SW-8, but not in the upstream samples.

The leachate seep samples taken during the first phase showed the presence of chlorobenzene at 1 ppb in SW-LS-2. No other organic compounds were detected. (It should be noted that pesticides and PCBs data had to be rejected due to holding time violations by the laboratory and could not be re-sampled.) Twenty-one of the 23 metals analyzed for were detected in SW-LS-2, and thirteen out of twenty-three were detected in SW-LS-1. With the exception of aluminum, barium, and zinc in SW-LS-1, and mercury in SW-LS-2, all metals detected were more than an order of magnitude greater than those detected in the upstream surface water samples.

Analysis of the leachate collected from a manhole located upstream of the discharge to the holding pond (LIN) showed the presence of many volatiles at low concentrations (0.2 to 3.4 ppb). All but three of these were not TCL compounds, but were those which are additionally analyzed under Method 524.2. Only one semivolatile (benzoic acid at 0.8 ppb) was detected. No pesticides or PCBs were detected. Sixteen metals were detected at concentrations generally an order of magnitude greater than those for upstream surface water.

Analysis of the leachate effluent from the holding pond (LEF) did not show any volatiles or pesticides/PCBs. Semivolatiles were detected at low concentrations, including benzoic acid at 1.0 ppb, fluoranthene at 0.2 ppb, and di-n-octylphthalate at 1.0 ppb. Metals detected in the holding pond were at similar or lower concentrations as those detected in the leachate influent.

4.3.2 Summary of Surface Water Data

Samples taken in Torne Brook upstream of the landfill and considered to be background demonstrated the presence of vinyl chloride and oil and grease. However, as vinyl chloride was not detected in any other media during this remedial investigation, its presence is not considered to be attributable to the landfill, but rather an upstream source. Twelve metals were detected in one or both of the upstream samples. In comparing the remaining surface water samples to the upstream samples, the following may be surmised: the landfill has had a relatively minor impact on surface water in Torne Brook. Three volatiles (vinyl chloride, benzene, toluene) were detected at low concentrations (0.08 to 0.7 ppb) in samples taken adjacent to the northern lobe of the landfill. Copper was also detected at a concentration of 3.1 ppb. Samples taken adjacent to the southern lobe of the landfill (in SW-8) showed aluminum, copper, iron, and vanadium at concentrations above background. The presence of these metals is localized, however, since the next downstream sample (SW-3) did not show elevated levels.

The sample taken in the Ramapo River at former Outfall 001 indicated that the landfill was not contributing any organics to the river but that ten metals and oil and grease were being contributed. As this outfall is no longer used for discharge to the Ramapo River, this should no longer be a problem.

The sample taken in the drainage swale south of the landfill (on an adjacent property) showed that the landfill was having no effect on surface water in this area.

Leachate seep samples taken during the first phase showed a considerable number of metals detected at high concentrations. Only one organic compound was detected, chlorobenzene at 1 ppb. Leachate seeps were not observed onsite during the second-phase sampling, and this is therefore considered to be an intermittent occurrence.

Analysis of the leachate entering the holding pond showed the presence of organic compounds (volatiles and semivolatiles) at low levels (all $\leq$3.4 ppb). Metals detected were generally higher than the most contaminated surface water sample and were at similar concentrations as those found in leachate seep SW-LS-1. This indicates that the leachate collection system, which includes a surface water collector, is performing adequately in containing most of contaminated surface water runoff from the landfill. Once the leachate enters the treatment basin, now a holding pond, volatilization of some compounds is taking place as evidenced by the absence of volatiles in sample LEF. Semivolatiles and metals were detected in sample LEF, indicating that the treatment basin was having little effect on these compounds. This was further confirmed by the presence of metals at elevated concentrations in sample SW-1 at the former Outfall 001, which was the discharge for the treatment pond. As leachate in the holding pond is now directly pumped to the Suffern Wastewater Treatment Plant, further migration of contaminants to the Ramapo River should no longer be of occurring.

Results of the July 12, 1991 NYSDEC surface water sampling of Torne Brook and the Ramapo River indicated that the landfill was not impacting the Ramapo River. Results of the NYSDEC samples are presented in Appendix M and discussed in more detail in Section 1.2.4.6.

4.3.3 Surface Water ARARs

New York State provides ARARs for surface water according to stream classification. Torne Brook is classified as a Class B stream, its best usage being for primary contact recreation and any other uses except as a source of water supply for drinking, culinary, or food processing purposes. The Ramapo River is a Class A stream whose best usage is as a source of water for drinking, culinary, or food processing purposes, and any other purposes. ARARs are listed within the NYSDEC's Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values (dated September 1990). Since Torne Brook discharges into the Ramapo River adjacent to the site, Class "A" ARAR values were used in the comparison between compounds detected and acceptable concentrations. In addition, Clean Water Act Water Quality Criteria were used in the comparison. From both New York State TOGS 1.1.1

and the Clean Water Act, human and aquatic standards and guidelines were considered. In cases where more than one ARAR was listed, the more stringent of the two was considered to determine compliance with ARARs. Table 4-17 presents the comparison between ARARs and compounds detected in the upstream samples (SW-2 and SW-5) and the downstream samples in either Torne Brook or the Ramapo River (SW-1, SW-3, SW-6, SW-7, SW-8). As shown in Table 4-18, which summarizes the ARAR exceedances, a number of parameters exceeded ARARs in the upstream samples: vinyl chloride, mercury, thallium, zinc, TOC, sulfide, and lead. Parameters which exceeded ARARs in the downstream samples included: vinyl chloride, antimony, arsenic, iron, manganese, mercury, nickel, zinc, ammonia, TOC, NO2-N, TDS, sulfide, copper, lead, and cyanide.

The majority of these exceedances were in SW-1, where former Outfall 001 discharged into the Ramapo River. As this outfall is no longer used for discharge of leachate, ARAR exceedances in this area should no longer occur. The only locations (other than at SW-1) where surface water ARARs were exceeded in downstream samples and not upstream samples were at SW-8 (iron) and SW-6 (copper). It may be concluded therefore that the landfill is not a significant contributor to surface water ARAR exceedances in Torne Brook or the Ramapo River.

4.4 Sediments

Composite sediment samples were collected at surface water sample locations SW-1 through SW-8 and labeled SS-1 through SS-8, and in the leachate holding pond (LPSS-1). Results for the first-phase analyses are presented in Table 4-19. Samples were analyzed for TCL volatiles, semi-volatiles, pesticides/PCBs, and metals. Results for the second-phase analyses are presented in Table 4-20. The semivolatiles and pesticides/PCBs results from the first phase were rejected during the data audit due to holding time violations by the laboratory. These were resampled during the second phase and analyzed for these fractions. New sample locations were analyzed for TCL volatiles, semi-volatiles, pesticides/PCBs, metals and several indicator parameters. Results are shown in Table 4-20.

4.4.1 Results of Sediment Sampling

Samples SS-2 and SS-5, which were taken along Torne Brook approximately 100 feet upstream of the northernmost corner of the landfill, are considered to be background and representative of upstream conditions. No organic compounds were detected in the upstream samples. Eighteen of the 23 metals analyzed for were detected at similar concentrations in each sample with the exception of cadmium which was only detected in SS-5, and nickel, which was only detected in SS-2.

No volatiles were detected in any of the sediment samples except for LPSS-1, where 2-butanone was detected at 10 ppb.

The following semivolatiles were detected in either SS-3 or SS-4: 4-methylphenol, benzoic acid, phenanthrene, fluoranthene, pyrene, benzo(a) anthracene, chrysene, bis(2-ethylhexyl)phthalate, benzo(b) fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene up to concentrations of 420 ppb (benzoic acid). Additionally, bis(2-ethyl hexyl)phthalate was detected in LPSS-1.

Three pesticides (dieldrin, alpha-chlordane, gamma-chlordane) were detected in LPSS-1 at concentrations of up to 16 ppb; gamma-chlordane was also detected in SS-4 at 12 ppb.

Nineteen metals were detected in the downstream samples at concentrations similar to those in the upstream samples. It does not appear as if metals concentrations were increasing along Torne Brook, or that they were concentrated in SS-1 in the Ramapo River. The only areas of high concentrations (an order of magnitude over background) were in SS-

1 for manganese, SS-3 for calcium and thallium, SS-4 for antimony and manganese, and SS-8 for calcium. Concentrations of metals in the holding pond sediment were generally higher than those found in the stream sediments, although not a full order of magnitude greater.

4.4.2 Summary of Sediment Data

Samples taken in Torne Brook upstream of the landfill and considered to be background showed no organic compounds and 18 metals. Similar concentrations of these metals were generally found in the downstream sediment samples indicating that the landfill is not contributing to sediment contamination except to a minor extent in two localized areas (SS-3 and SS-8). Semivolatiles were also detected in SS-3. Many of the contaminants detected were found to be present in the surficial soil samples across the site and not in the groundwater. This indicates that erosion of the landfill is contributing to contamination of Torne Brook.

In addition, contaminants were detected in sample SS-4, which was taken in a drainage swale from the southern portion of the landfill on an adjacent property. Similar contaminants (mainly PAHs) were detected in SS-4 as in the surficial soil samples, indicating that erosion probably contributed to the presence of this offsite contamination.

Results of analysis of the sediment sample taken in the leachate holding pond showed the presence of pesticides and above background of metals. Pesticides detected were the same as those detected in surficial soil sample SPS-6, indicating that soils from erosion of the landfill are entering the leachate collection system and ending up in the leachate holding pond. Metals detected were generally similar to those detected in the various media onsite.

4.4.3 Sediment TBCs

Sediment cleanup criteria have been developed in accordance with documents provided by the NYSDEC Division of Fish and Wildlife, mainly the document "Clean-up Criteria for Aquatic Sediments", dated December 1989. This document details the methodology for determining acceptable levels of non-polar (i.e., relatively insoluble in water) or non-ionic organic compounds in aquatic sediments. Sediments with contaminants in excess of the criteria would be predicted to contain interstitial (pore) water in excess of surface water ARARs. The document is based upon a briefing document presented by the USEPA to its Science Advisory Board in February 1989. Synopses of preliminary methods for determining cleanup criteria for other classes of compounds (i.e. polar organics and metals), based upon other papers and sources, are also presented in the NYSDEC document. Phenolic compounds, although polar, are conservatively grouped with non-polar compounds for the purposes of this method because of their importance, and because they do not readily ionize at near-neutral pH.

The cleanup criteria for non-polar organics are developed based upon the degree to which the chemicals are released from the sediment into the interstitial (pore) water of the sediment. This can best be predicted by the fraction of organic carbon (OC) in the sediment, and the octanol/water partition coefficient, Kow, for the particular chemical. The octanol/water partition coefficient is defined as the ratio of a chemical's concentration in the octanol phase to its concentration in the aqueous phase of a two-phase octanol/water system. Values of Kow represent the tendency of the chemical to partition itself between an organic phase (e.g, sediment, as represented by the octanol) and an aqueous phase of a two-phase sediment/water system. The organic phase, in this case the stream sediment, is modeled by the amount of organic carbon present in the sediment. Given this parameter and the Kow for a contaminant, it is possible to predict the concentration of the contaminant that will result in water at equilibrium with sediment containing that contaminant. Such water is the pore water in the sediment.

The cleanup criteria is the concentration of the chemical in the sediment, which, for its Kow and the sediment OC, causes the pore water to exceed the appropriate Ambient Water Quality Standard/Guidance Value (AWQS/GV) for that chemical. For this site, the AWQS/GVs are the NYS Surface Water Standards for Class A waters (TOGS 1.1.1, 1990).

The calculations may be made as follows:

$$\text{Sediment Criterion, SC (ug/gOC)} = (\text{AWQS/GV}) * 10^{\log Kow} * \frac{1\ \text{Kg}}{1000\ \text{g OC}}$$

Where:

AWQS/GV: The Ambient Water Quality Standard/Guidance Value, used as the basis for the sediment criterion for the specific non-polar organic chemical (ug/l),

Log Kow: The log (base 10) of the octanol-water partition coefficient for the given chemical (unitless),

OC: The fraction of organic carbon in the soil, expressed as a decimal.

$\frac{1\ \text{Kg}}{1000\ \text{g OC}}$: Unit conversion factor

This equation yields the permissible concentration (SC) of the given chemical per gram organic carbon in the sediment. To obtain the criterion for the sediment in question, multiply the sediment criterion obtained above by the number of grams per kilogram of organic carbon in the sediment:

$$\text{Site-Specific sediment criterion, (ug/Kg)} = SC * OC * \frac{1000\ g}{1\ Kg}.$$

Twelve chemicals for which sediment criteria might be developed were detected in two out of the eight second phase samples sediment samples. One polar and eleven non-polar organic compounds were detected in SS-4; three of the non-polar organic compounds were also detected in SS-3. Sample SS-4 was taken from a drainage swale and not from a surface water body capable of sustaining aquatic life or providing potable water. Therefore, the use of this method is not applicable to results from SS-4. Details of the calculations performed are presented in Appendix P.2. Results are shown in Table 4-21.

Comparison of the sediment cleanup criteria with the analytical results in Table 4-21 shows that no contaminants exceed the sediment cleanup criteria. Both human health and aquatic toxicity based criterions were used in calculating sediment cleanup criteria. This indicates that the landfill is not predicted to cause accumulation of chemicals in aquatic animals to levels that would exceed a human health tolerance, action level, or cancer risk dose (human health based criterion), or would be predicted to cause toxicity to benthic or epibenthic life (aquatic based criterion) (NYSDEC Division of Fish and Wildlife, 1989).

4.5 Air

An air monitoring study was conducted during the second phase of field activities to determine the production and quality of landfill gases (specifically methane), the type and concentration of airborne contaminants present, and the potential for exposure to personnel (through dispersion), of the existing contaminants.

The air monitoring study focused upon "hot spots" outlined in the pre-RI soil gas survey to determine methane quality and TCL organic gas emissions as well as the potential for exposure to workers, and others, downwind from the prevailing westerly winds at the Baler Building and outdoor pistol range. Complete soil gas survey results are presented in Appendix A.1. The study comprises three tasks: (1) Monitoring for methane quality within piezometers; (2) "Hot Spot" monitoring for TCL organics; and (3) point source monitoring for methane and TCL organics. All monitoring point locations are shown on Figure 2-1.

4.5.1 Point Source Monitoring

The Point Source Monitoring locations are identified with the prefix PS and PSR. These samples were collected using Tedlar bag and Tenax tubes, respectively, on August 4, 1990. The PS data are tabulated in Table 4-22 and the PSR data are tabulated in Table 4-24. The PS series illustrates methane concentrations and the PSR series illustrates TCL volatiles concentrations. This point source sampling has been conducted along the line of prevailing winds towards the occupied Baler Building and the pistol range. Background samples PS-1 and PSR-1 have been established by projecting a line upwind beyond the western perimeter of the landfill. All samples were collected at the breathing zone height.

The data shows the highest reading of 59.69 mole % (596,900 ppm) of methane at the PS-2 location. This is the furthest westerly onsite sample location from the Baler Building and pistol range. The other two breathing zone samples (PS-3 and PS-4) show very slight and none detectable results, respectively, moving downwind toward the occupied areas respectively. The background sample concentration is only 0.11 mole% or 1,100 ppm actually exceeding the value of sample PS-3, which is directly downwind of the highest value at PS-2. Indications are that methane concentrations are being dispersed prior to reaching the two occupied areas.

Sample locations GS-3, GS-4, and PS-2 exhibited methane and CO_2 concentrations typical of a mature landfill gas with low and non-detectable levels of other compounds tested. By comparison, background sample PS-1, and samples PS-3 and PS-4 which are not on the landfill surface, exhibited concentrations typical of atmospheric conditions. GS-1 and GS-2 anomously exhibited concentrations typical of atmospheric conditions which may be due to sampling methods or the existence of numerous openings in the landfill near the monitoring sites.

4.5.2 "Hot Spot" TCL Organics

Three samples in Table 4-23 identified with the VOC prefix were collected at the surface of the landfill by Tenax adsorbent tubes to determine point source concentrations of, and potential exposure to, TCL volatiles. Results are reported for the detected compounds and compared to Threshold Limit Values (TLV).

4.5.3 Methane Quality

The four samples identified in Table 4-22 with the GS prefix were obtained within piezometers or pre-existing vents with one-liter Tedlar bags on July 24 and August 8, 1990. These samples were collected at "hot spots" identified during the pre-RI soil gas survey. Each GS series sample location corresponds to an elevated combustible-gas meter reading from the pre-RI soil gas survey where a piezometer was installed, or, in the case of GW-3, a pre-existing vent. Sample results for GS-1 and GS-2 showed no methane detected and 0.01 mole % (100 ppm), respectively. Levels at GS-3 and GS-4 are significantly higher, with results of 59.38 and 57.06 mole % (593,800 and 570,600 ppm). Combustible gas meter readings at these two locations had revealed readings of none detected and 100% of the lower explosive limit (LEL) during the pre-RI monitoring.

Sample locations GS-3, GS-4, and PS-2 exhibited methane and CO_2 concentrations typical of a mature landfill gas with low and non-detectable levels of other compounds tested. By comparison, background sample PS-1, and samples PS-3 and PS-4, which are not on the landfill surface, exhibited concentrations typical of atmospheric conditions. GS-1 and GS-2 anomously exhibited concentrations typical of atmospheric conditions which may be due to sampling methods or the existence of numerous openings in the landfill near the monitoring sites.

4.5.4 <u>Air ARARs</u>

ARARs for air at the landfill include the Threshold Limit Values (TLV) established by the American Conference of Governmental Analytical Industrial Hygienists (ACGIH). TLVs refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all occupational workers may be repeatedly exposed (40 hours per week) without adverse health effects. Since TLVs are guidelines for occupational exposure to chemicals, they have been modified according to NYSDEC Region III protocols to be one three-hundredth of the established TLV value. One three-hundredth of the TLV values are presented on Tables 4-23 and 4-24 for volatile compounds.

All three VOC samples exhibit values significantly below one three hundredth of their respective TLV. Among the PSR samples PSR-2 showed total xylenes at 7.7 mg/m^3, which exceeded one three-hundredth TLV (1.45 mg/m^3). All other volatiles were below ARARs. PSR-1, -3, and -4 data are well below the ARAR limit of one three-hundredth of the TLV value.

Ambient Guideline Concentrations (AGCs) are also considered as ARARs for the site. The AGCs found in the NYSDEC Division of Air Resources Air Guide-1 were compared against the contaminant emissions calculated for the landfill. The NYSDEC screening model for baseline air emissions from municipal landfills was used to calculate the contaminant emissions at the request of the NYSDEC. Calculations are presented in Appendix P.4. The maximum concentrations of contaminants detected in air samples from the landfill were considered as being representative of landfill in gas emissions. These were compared against the AGCs as shown on Table 4-25. There were no exceedances. As described by the NYSDEC, the screening model is very conservative, and if no exceedances are found using worst-case emission rates, as was done, then emissions of VOC's to offsite receptors are not of concern.

TABLE 4-I

PHASE I ANALYTICAL RESULTS FOR WASTES
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SPS-1	SPS-2	SPS-3	SPS-4	SPS-5
COLLECTION DATE		10/16/89	10/16/89	10/15/89	10/15/89	10/16/89
Parameter ug/kg (ppb)	Class					
Chloromethane	VOC					
Bromomethane	VOC					
Vinyl Chloride	VOC					
Chloroethane	VOC					
Methylene Chloride	VOC					
Acetone	VOC	R			R	
Carbon Disulfide	VOC					
1,1-Dichloroethene	VOC					
1,1-Dichloroethane	VOC					
1,2-Dichloroethene (total)	VOC					
Chloroform	VOC					
1,2-Dichloroethane	VOC					
2-Butanone (or MEK)	VOC				190	
1,1,1-Trichloroethane	VOC					
Carbon Tetrachloride	VOC					
Vinyl Acetate	VOC					
Bromodichloromethane	VOC					
1,2-Dichloropropane	VOC					
Cis-1,3-dichloropropene	VOC					
Trichloroethene	VOC					
Dibromochloromethane	VOC					
1,1,2-Trichloroethane	VOC					
Benzene	VOC				42	
Trans-1,3-dichloropropene	VOC					
Bromoform	VOC					
4-Methyl-2-pentanone	VOC					
2-Hexanone	VOC					
Tetrachloroethene	VOC					
1,1,2,2-Tetrachloroethane	VOC			2 J		
Toluene	VOC					1100 J
Chlorobenzene	VOC				730	
Ethylbenzene	VOC				260	7100
Styrene	VOC					
Total Xylenes	VOC				570	110000 E

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).
R - Compound rejected because it was detected in the associated method blank at similar concentrations.
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.
E - Compound concentration exceeded the linear calibrated range.

TABLE 4-I

PHASE I ANALYTICAL RESULTS FOR WASTES
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER			SPS-1	SPS-2	SPS-3	SPS-4	SPS-5
COLLECTION DATE			10/16/89	10/16/89	10/15/89	10/15/89	10/16/89
Parameter	ug/kg (ppb)	Class					
Phenol		SEMI					
Bis(2-chloroethyl)ether		SEMI					
2-Chlorophenol		SEMI					
1,3-Dichlorobenzene		SEMI					
1,4-Dichlorobenzene		SEMI				370 J	
Benzyl Alcohol		SEMI					6000 J
1,2-Dichlorobenzene		SEMI				94 J	
2-Methylphenol		SEMI					
Bis(2-chloroisopropyl) ether		SEMI					
4-Methylphenol		SEMI					
N-Nitroso-di-n-propylamine		SEMI					
Hexachloroethane		SEMI					
Nitrobenzene		SEMI					
Isophorone		SEMI					
2-Nitrophenol		SEMI					
2,4-Dimethylphenol		SEMI					
Benzoic Acid		SEMI					
Bis(2-chloroethoxy) methane		SEMI					
2,4-Dichlorophenol		SEMI					
1,2,4-Trichlorobenzene		SEMI					
Naphthalene		SEMI				1100	16000 J
4-Chloroaniline		SEMI					
Hexachlorobutadiene		SEMI					
4-Chloro-3-methylphenol		SEMI					
2-Methylnaphthalene		SEMI				200 J	4800 J
Hexachlorocyclopentadiene		SEMI					
2,4,6-Trichlorophenol		SEMI					
2,4,5-Trichlorophenol		SEMI					
2-Chloronaphthalene		SEMI					
2-Nitroaniline		SEMI					
Dimethyl Phthalate		SEMI					

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-I

PHASE I ANALYTICAL RESULTS FOR WASTES
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SPS-1	SPS-2	SPS-3	SPS-4	SPS-5
COLLECTION DATE		10/16/89	10/16/89	10/15/89	10/15/89	10/16/89
Parameter ug/kg (ppb)	Class					
Acenaphthylene	SEMI					
2,6-Dinitrotoluene	SEMI					
3-Nitroaniline	SEMI					
Acenaphthene	SEMI				190 J	
2,4-Dinitrophenol	SEMI					
4-Nitrophenol	SEMI					
Dibenzofuran	SEMI				150 J	
2,4-Dinitrotoluene	SEMI					
Diethylphthalate	SEMI					
4-Chlorophenyl-phenylether	SEMI					
Fluorene	SEMI				170 J	
4-Nitroaniline	SEMI					
4,6-Dinitro-2-methylphenol	SEMI					
N-nitrosodiphenylamine (1)	SEMI				110 J	
4-Bromophenyl Phenyl Ether	SEMI					
Hexachlorobenzene	SEMI					
Pentachlorophenol	SEMI					
Phenanthrene	SEMI		230 J	81 J	390 J	
Anthracene	SEMI		43 J			
Di-n-butylphthalate	SEMI					
Fluoranthene	SEMI		440	160 J	130 J	
Pyrene	SEMI		310 J	130 J	130 J	
Butylbenzylphthalate	SEMI			130 J		
3,3'-Dichlorobenzidine	SEMI					
Benzo(a)anthracene	SEMI		200 J	84 J		
Chrysene	SEMI		230 J	99 J		
bis(2-ethyl hexyl)phthalate	SEMI			48 J	480 J	4200 J
Di-n-octyl Phthalate	SEMI					
Benzo(b)fluoranthene	SEMI		170 J	84 J	77 J	
Benzo(k)fluoranthene	SEMI		180 J	71 J	72 J	
Benzo(a)pyrene	SEMI		160 J	77 J		
Indeno(1,2,3-cd)Pyrene	SEMI		140 J	61 J		
Dibenz(a,h)anthracene	SEMI					
Benzo(g,h,i)perylene	SEMI		130 J	52 J		

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-I

PHASE I ANALYTICAL RESULTS FOR WASTES
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SPS-1	SPS-2	SPS-3	SPS-4	SPS-5
COLLECTION DATE		10/16/89	10/16/89	10/15/89	10/15/89	10/16/89
Parameter ug/kg (ppb)	Class					
Acenaphthylene	SEMI					
2,6-Dinitrotoluene	SEMI					
3-Nitroaniline	SEMI					
Acenaphthene	SEMI				190 J	
2,4-Dinitrophenol	SEMI					
4-Nitrophenol	SEMI					
Dibenzofuran	SEMI				150 J	
2,4-Dinitrotoluene	SEMI					
Diethylphthalate	SEMI					
4-Chlorophenyl-phenylether	SEMI					
Fluorene	SEMI				170 J	
4-Nitroaniline	SEMI					
4,6-Dinitro-2-methylphenol	SEMI					
N-nitrosodiphenylamine (1)	SEMI				110 J	
4-Bromophenyl Phenyl Ether	SEMI					
Hexachlorobenzene	SEMI					
Pentachlorophenol	SEMI					
Phenanthrene	SEMI		230 J	81 J	390 J	
Anthracene	SEMI		43 J			
Di-n-butylphthalate	SEMI					
Fluoranthene	SEMI		440	160 J	130 J	
Pyrene	SEMI		310 J	130 J	130 J	
Butylbenzylphthalate	SEMI			130 J		
3,3'-Dichlorobenzidine	SEMI					
Benzo(a)anthracene	SEMI		200 J	84 J		
Chrysene	SEMI		230 J	99 J		
bis(2-ethyl hexyl)phthalate	SEMI			48 J	480 J	4200 J
Di-n-octyl Phthalate	SEMI					
Benzo(b)fluoranthene	SEMI		170 J	84 J	77 J	
Benzo(k)fluoranthene	SEMI		180 J	71 J	72 J	
Benzo(a)pyrene	SEMI		160 J	77 J		
Indeno(1,2,3-cd)Pyrene	SEMI		140 J	61 J		
Dibenz(a,h)anthracene	SEMI					
Benzo(g,h,i)perylene	SEMI		130 J	52 J		

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-1

PHASE I ANALYTICAL RESULTS FOR WASTES
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		SPS-1	SPS-2	SPS-3	SPS-4	SPS-5
COLLECTION DATE		10/16/89	10/16/89	10/15/89	10/15/89	10/16/89
Parameter ug/kg (ppb)	Class					
alpha-BHC	PST					
beta-BHC	PST					
delta-BHC	PST					
gamma-BHC (Lindane)	PST					
Heptachlor	PST					4 J
Aldrin	PST					
Heptachlor Epoxide	PST			26 J		
Endosulfan I	PST					
Dieldrin	PST					
4,4'-DDE	PST					
Endrin	PST					
Endosulfan II	PST					
4,4'-DDD	PST					
Endosulfan Sulfate	PST					
4,4'-DDT	PST					
Methyoxychlor	PST					
Endrin Ketone	PST					
alpha-Chlordane	PST					
gamma-Chlordane	PST					
Toxaphene	PST					
Aroclor-1016	PCB					
Aroclor-1221	PCB					
Aroclor-1232	PCB					
Aroclor-1242	PCB					
Aroclor-1248	PCB					
Aroclor-1254	PCB					
Aroclor-1260	PCB					

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-1

PHASE I ANALYTICAL RESULTS FOR WASTES
RAMAPO LANDFILL
(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			SPS-1	SPS-2	SPS-3	SPS-4	SPS-5
COLLECTION DATE			10/16/89	10/16/89	10/15/89	10/15/89	10/16/89
Parameter	Units	Class					
Aluminum	mg/kg	MET	7850	8560	11200	4610	6440
Antimony	mg/kg	MET		4.8			97.9
Arsenic	mg/kg	MET	2.0	1.2	0.93	1.2	7.3
Barium	mg/kg	MET	37.2	27.4	41.7	122	11300
Beryllium	mg/kg	MET		0.24			
Cadmium	mg/kg	MET	1.2				16.3
Calcium	mg/kg	MET	10000	2490	2600	9390	3130
Chromium	mg/kg	MET	15.9	16.5	15.7	12.6	1510
Cobalt	mg/kg	MET	6.9	7.4	9.6	4.0	5.1
Copper	mg/kg	MET	12.7	17.7	16.2	48.3	401
Iron	mg/kg	MET	18600	18000	22400	25300	20100
Lead	mg/kg	MET	7.8	5.3	11.9	7.3	9630
Magnesium	mg/kg	MET	4710	2610	3270	1500	2440
Manganese	mg/kg	MET	250	164	322	101	193
Mercury	mg/kg	MET					
Nickel	mg/kg	MET	17.6	11.1	12.2	19.8	68.7
Potassium	mg/kg	MET	1150	858	1200	828	142
Selenium	mg/kg	MET	0.22			0.65	5.4
Silver	mg/kg	MET					
Sodium	mg/kg	MET	189	275	232	857	145
Thallium	mg/kg	MET					
Vanadium	mg/kg	MET	23.9	33.7	33.1	14.6	6.5
Zinc	mg/kg	MET	45.7	26.2	35.8	76.6	2230
Total Cyanide	mg/kg	MET					
Total Phenols	mg/kg	MISC				3.56	6.41
Arsenic	ug/L	EP TOX					
Barium	ug/L	EP TOX	322	417	433	1170	1900
Cadmium	ug/L	EP TOX					9.0
Chromium	ug/L	EP TOX					46.1
Lead	ug/L	EP TOX					320
Mercury	ug/L	EP TOX					
Selenium	ug/L	EP TOX	64.0				
Silver	ug/L	EP TOX					
Endrin	mg/L	EP TOX					
Lindane	mg/L	EP TOX					
Methoxychlor	mg/L	EP TOX					
Toxaphene	mg/L	EP TOX					
2,4-D	mg/L	EP TOX		0.13 J			
2,4,5-TP	mg/L	EP TOX		0.01 J		0.3 J	
Ignitability		MISC					IGNITABLE
Corrosivity		MISC					
Reactivity		MISC					
% Chlorine	ppm	MISC	193			344	
Heat of Combustion	Btu/lb	MISC	74.0	81.0	37.0	727	6555
% Sulfur	ppm	MISC	330			563	106

NOTE: Only detected results are reported.

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-2

PHASE I ANALYTICAL RESULTS FOR SURFACE SOIL
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SPS-6	SPS-7	SPS-8	SPS-9	SPS-10
COLLECTION DATE		10/27/89	10/17/89	10/17/89	10/17/89	10/17/89
Parameter ug/kg (ppb)	Class					
Chloromethane	VOC					
Bromomethane	VOC					
Vinyl Chloride	VOC					
Chloroethane	VOC					
Methylene Chloride	VOC	R				
Acetone	VOC				R	
Carbon Disulfide	VOC					
1,1-Dichloroethene	VOC					
1,1-Dichloroethane	VOC					
1,2-Dichloroethene (total)	VOC					
Chloroform	VOC					
1,2-Dichloroethane	VOC					
2-Butanone (or MEK)	VOC					
1,1,1-Trichloroethane	VOC					
Carbon Tetrachloride	VOC					
Vinyl Acetate	VOC					
Bromodichloromethane	VOC					
1,2-Dichloropropane	VOC					
Cis-1,3-dichloropropene	VOC					
Trichloroethene	VOC					
Dibromochloromethane	VOC					
1,1,2-Trichloroethane	VOC					
Benzene	VOC					
Trans-1,3-dichloropropene	VOC					
Bromoform	VOC					
4-Methyl-2-pentanone	VOC					
2-Hexanone	VOC					
Tetrachloroethene	VOC					
1,1,2,2-Tetrachloroethane	VOC					
Toluene	VOC					
Chlorobenzene	VOC					
Ethylbenzene	VOC					
Styrene	VOC					
Total Xylenes	VOC					

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

R - Compound rejected because it was detected in the associated method blank at similar concentrations.

TABLE 4-2

PHASE I ANALYTICAL RESULTS FOR SURFACE SOIL
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SPS-6	SPS-7	SPS-8	SPS-9	SPS-10
COLLECTION DATE		10/16/89	10/16/89	10/15/89	10/15/89	10/16/89
Parameter ug/kg (ppb)	Class					
Phenol	SEMI	R				
Bis(2-chloroethyl)ether	SEMI	R				
2-Chlorophenol	SEMI	R				
1,3-Dichlorobenzene	SEMI	R				
1,4-Dichlorobenzene	SEMI	R				
Benzyl Alcohol	SEMI	R				
1,2-Dichlorobenzene	SEMI	R				
2-Methylphenol	SEMI	R				
Bis(2-chloroisopropyl) ether	SEMI	R				
4-Methylphenol	SEMI	R				
N-Nitroso-di-n-propylamine	SEMI	R				
Hexachloroethane	SEMI	R				
Nitrobenzene	SEMI	R				
Isophorone	SEMI	R				
2-Nitrophenol	SEMI	R				
2,4-Dimethylphenol	SEMI	R				
Benzoic Acid	SEMI	R				210 J
Bis(2-chloroethoxy) methane	SEMI	R				
2,4-Dichlorophenol	SEMI	R				
1,2,4-Trichlorobenzene	SEMI	R				
Naphthalene	SEMI	R				
4-Chloroaniline	SEMI	R				
Hexachlorobutadiene	SEMI	R				
4-Chloro-3-methylphenol	SEMI	R				
2-Methylnaphthalene	SEMI	R				
Hexachlorocyclopentadiene	SEMI	R				
2,4,6-Trichlorophenol	SEMI	R				
2,4,5-Trichlorophenol	SEMI	R				
2-Chloronaphthalene	SEMI	R				
2-Nitroaniline	SEMI	R				
Dimethyl Phthalate	SEMI	R				

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.
R - Entire semivolatile fraction has been rejected due to holding time violations.

TABLE 4-2

PHASE I ANALYTICAL RESULTS FOR SURFACE SOIL
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SPS-6	SPS-7	SPS-8	SPS-9	SPS-10
COLLECTION DATE		10/27/89	10/17/89	10/17/89	10/17/89	10/17/89
Parameter ug/kg (ppb)	Class					
Acenaphthylene	SEMI	R				
2,6-Dinitrotoluene	SEMI	R				
3-Nitroaniline	SEMI	R				
Acenaphthene	SEMI	R				
2,4-Dinitrophenol	SEMI	R				
4-Nitrophenol	SEMI	R				
Dibenzofuran	SEMI	R				
2,4-Dinitrotoluene	SEMI	R				
Diethylphthalate	SEMI	R				
4-Chlorophenyl-phenylether	SEMI	R				
Fluorene	SEMI	R				
4-Nitroaniline	SEMI	R				
4,6-Dinitro-2-methylphenol	SEMI	R				
N-nitrosodiphenylamine (1)	SEMI	R				
4-Bromophenyl Phenyl Ether	SEMI	R				
Hexachlorobenzene	SEMI	R				
Pentachlorophenol	SEMI	R				
Phenanthrene	SEMI	R				
Anthracene	SEMI	R				
Di-n-butylphthalate	SEMI	R				
Fluoranthene	SEMI	R				64 J
Pyrene	SEMI	R				73 J
Butylbenzylphthalate	SEMI	R				160 J
3,3'-Dichlorobenzidine	SEMI	R				
Benzo(a)anthracene	SEMI	R				42 J
Chrysene	SEMI	R				64 J
bis(2-ethyl hexyl)phthalate	SEMI	R				320 J
Di-n-octyl Phthalate	SEMI	R				43 J
Benzo(b)fluoranthene	SEMI	R				73 J
Benzo(k)fluoranthene	SEMI	R				61 J
Benzo(a)pyrene	SEMI	R				62 J
Indeno(1,2,3-cd)Pyrene	SEMI	R				93 J
Dibenz(a,h)anthracene	SEMI	R				
Benzo(g,h,i)perylene	SEMI	R				100 J

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.
R - Entire semivolatile fraction has been rejected due to holding time violations.

TABLE 4-2

PHASE I ANALYTICAL RESULTS FOR SURFACE SOIL
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		SPS-6	SPS-7	SPS-8	SPS-9	SPS-10
COLLECTION DATE		10/27/89	10/17/89	10/17/89	10/17/89	10/17/89
Parameter ug/kg (ppb)	Class					
alpha-BHC	PST	R				
beta-BHC	PST	R				
delta-BHC	PST	R				
gamma-BHC (Lindane)	PST	R				
Heptachlor	PST	R				
Aldrin	PST	R				
Heptachlor Epoxide	PST	R				
Endosulfan I	PST	R				
Dieldrin	PST	R				
4,4'-DDE	PST	R				
Endrin	PST	R				
Endosulfan II	PST	R				
4,4'-DDD	PST	R				
Endosulfan Sulfate	PST	R				
4,4'-DDT	PST	R				
Methyoxychlor	PST	R				
Endrin Ketone	PST	R				
alpha-Chlordane	PST	R				
gamma-Chlordane	PST	R				
Toxaphene	PST	R				
Aroclor-1016	PCB	R				
Aroclor-1221	PCB	R				
Aroclor-1232	PCB	R				
Aroclor-1242	PCB	R				
Aroclor-1248	PCB	R				
Aroclor-1254	PCB	R				
Aroclor-1260	PCB	R				

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

R - The entire pesticide/PCB fraction has been rejected due to holding time violations.

TABLE 4-2

PHASE I ANALYTICAL RESULTS FOR SURFACE SOIL
RAMAPO LANDFILL
(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			SPS-6	SPS-7	SPS-8	SPS-9	SPS-10
COLLECTION DATE			10/27/89	10/17/89	10/17/89	10/17/89	10/17/89
Parameter	Units	Class					
Aluminum	mg/kg	MET	6420	9450	11600	16900	7040
Antimony	mg/kg	MET	7.3			4.7	
Arsenic	mg/kg	MET	1.8	1.3	2.3	2.2	1.1
Barium	mg/kg	MET	31.0	46.4	44.0	35.8	40.8
Beryllium	mg/kg	MET					
Cadmium	mg/kg	MET	1.7	0.84			
Calcium	mg/kg	MET	9580	2500	3590	805	3780
Chromium	mg/kg	MET	20.1	15.9	16.8	22.7	13.8
Cobalt	mg/kg	MET	5.7	8.5	8.6	6.6	9.2
Copper	mg/kg	MET	19.1	15.5	18.5	8.6	17.0
Iron	mg/kg	MET	47000	19400	20900	21300	17200
Lead	mg/kg	MET	15.9	5.6	5.8	8.8	10.3
Magnesium	mg/kg	MET	3330	3530	3160	2000	3450
Manganese	mg/kg	MET	335	294	295	88.1	166
Mercury	mg/kg	MET					
Nickel	mg/kg	MET	15.6	12.2	15.2	10.9	11.2
Potassium	mg/kg	MET	888	1290	1070	511	1430
Selenium	mg/kg	MET				0.51	
Silver	mg/kg	MET					
Sodium	mg/kg	MET	272	161	190	113	559
Thallium	mg/kg	MET					
Vanadium	mg/kg	MET	24.6	23.9	28.5	40.8	25.8
Zinc	mg/kg	MET	47.1	35.2	30.6	27.3	44.2
Total Cyanide	mg/kg	MET					
Total Phenols	mg/kg	MISC					
Ammonia-Nitrogen	mg/kg	MISC	47.6	27.3	27.9	107	19.0
NO3-Nitrogen	mg/kg	MISC	3.77	1.09	0.28	3.30	1.39
Total Kjeldahl Nitrogen	mg/kg	MISC	693	280	388	585	245
Moisture	%	MISC	15.5	10.2	14.5	15.9	15.7
pH	SU	MISC	8.28	7.65	6.98	5.43	8.55
TOC	mg/kg	MISC	34,200	10,000	7,320	18,500	6,650

NOTE: Only detected results are reported.

TABLE 4-3

PHASE I ANALYTICAL RESULTS FOR SUBSURFACE SOIL
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		MW-1-SB	MW-2-SB	MW-3-SB	MW-4-SB	MW-5-SB	MW-7-SB	MW-8-SB
COLLECTION DATE		11/15/89	12/17/89	11/16/89	11/30/89	12/5/89	10/16/89	11/7/89
DEPTH		11-13'	7-9'	6-10'	1-4'	4-6'	4-8'	8-12'
Parameter ug/kg (ppb)	Class							
Chloromethane	VOC							
Bromomethane	VOC							
Vinyl Chloride	VOC							
Chloroethane	VOC							
Methylene Chloride	VOC		R	R		R		
Acetone	VOC	13	18	28	R	16	R	R
Carbon Disulfide	VOC							
1,1-Dichloroethene	VOC							
1,1-Dichloroethane	VOC							
1,2-Dichloroethene (total)	VOC							
Chloroform	VOC							
1,2-Dichloroethane	VOC							
2-Butanone (or MEK)	VOC							
1,1,1-Trichloroethane	VOC							
Carbon Tetrachloride	VOC							
Vinyl Acetate	VOC							
Bromodichloromethane	VOC							
1,2-Dichloropropane	VOC							
Cis-1,3-dichloropropene	VOC							
Trichloroethene	VOC							
Dibromochloromethane	VOC							
1,1,2-Trichloroethane	VOC							
Benzene	VOC							
Trans-1,3-dichloropropene	VOC							
Bromoform	VOC							
4-Methyl-2-pentanone	VOC							
2-Hexanone	VOC							
Tetrachloroethene	VOC							
1,1,2,2-Tetrachloroethane	VOC							
Toluene	VOC			2 J				
Chlorobenzene	VOC							
Ethylbenzene	VOC							
Styrene	VOC							
Total Xylenes	VOC							

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

R - Compound rejected because it was detected in the associated method blank at similar concentrations.
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-3

PHASE I ANALYTICAL RESULTS FOR SUBSURFACE SOIL
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		MW-1-SB	MW-2-SB	MW-3-SB	MW-4-SB	MW-5-SB	MW-7-SB	MW-8-SB
COLLECTION DATE		11/15/89	12/17/89	11/16/89	11/30/89	12/5/89	10/16/89	11/7/89
DEPTH		11-13'	7-9'	6-10'	1-4'	4-6'	4-8'	8-12'
Parameter ug/kg (ppb)	Class							
Phenol	SEMI						R	
Bis(2-chloroethyl)ether	SEMI						R	
2-Chlorophenol	SEMI						R	
1,3-Dichlorobenzene	SEMI						R	
1,4-Dichlorobenzene	SEMI						R	
Benzyl Alcohol	SEMI						R	
1,2-Dichlorobenzene	SEMI						R	
2-Methylphenol	SEMI						R	
Bis(2-chloroisopropyl) ether	SEMI						R	
4-Methylphenol	SEMI						R	
N-Nitroso-di-n-propylamine	SEMI						R	
Hexachloroethane	SEMI						R	
Nitrobenzene	SEMI						R	
Isophorone	SEMI						R	
2-Nitrophenol	SEMI						R	
2,4-Dimethylphenol	SEMI						R	
Benzoic Acid	SEMI						R	
Bis(2-chloroethoxy) methane	SEMI						R	
2,4-Dichlorophenol	SEMI						R	
1,2,4-Trichlorobenzene	SEMI						R	
Naphthalene	SEMI						R	
4-Chloroaniline	SEMI						R	
Hexachlorobutadiene	SEMI						R	
4-Chloro-3-methylphenol	SEMI						R	
2-Methylnaphthalene	SEMI						R	
Hexachlorocyclopentadiene	SEMI						R	
2,4,6-Trichlorophenol	SEMI						R	
2,4,5-Trichlorophenol	SEMI						R	
2-Chloronaphthalene	SEMI						R	
2-Nitroaniline	SEMI						R	
Dimethyl Phthalate	SEMI						R	

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

R - The entire semivolatile fraction has been rejected due to holding time violations.

TABLE 4-3

PHASE I ANALYTICAL RESULTS FOR SUBSURFACE SOIL
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		MW-1-SB	MW-2-SB	MW-3-SB	MW-4-SB	MW-5-SB	MW-7-SB	MW-8-SB
COLLECTION DATE		11/15/89	12/17/89	11/16/89	11/30/89	12/5/89	10/16/89	11/7/89
DEPTH		11-13'	7-9'	6-10'	1-4'	4-6'	4-8'	8-12'
Parameter ug/kg (ppb)	Class							
Acenaphthylene	SEMI						R	
2,6-Dinitrotoluene	SEMI						R	
3-Nitroaniline	SEMI						R	
Acenaphthene	SEMI						R	
2,4-Dinitrophenol	SEMI						R	
4-Nitrophenol	SEMI						R	
Dibenzofuran	SEMI						R	
2,4-Dinitrotoluene	SEMI						R	
Diethylphthalate	SEMI						R	
4-Chlorophenyl-phenylether	SEMI						R	
Fluorene	SEMI						R	
4-Nitroaniline	SEMI						R	
4,6-Dinitro-2-methylphenol	SEMI						R	
N-nitrosodiphenylamine (1)	SEMI						R	
4-Bromophenyl Phenyl Ether	SEMI						R	
Hexachlorobenzene	SEMI						R	
Pentachlorophenol	SEMI						R	
Phenanthrene	SEMI			40 J			R	
Anthracene	SEMI						R	
Di-n-butylphthalate	SEMI						R	
Fluoranthene	SEMI			75 J			R	
Pyrene	SEMI			72 J			R	
Butylbenzylphthalate	SEMI						R	
3,3'-Dichlorobenzidine	SEMI						R	
Benzo(a)anthracene	SEMI			42 J			R	
Chrysene	SEMI			43 J			R	
bis(2-ethyl hexyl)phthalate	SEMI			43 J			R	
Di-n-octyl Phthalate	SEMI						R	
Benzo(b)fluoranthene	SEMI						R	
Benzo(k)fluoranthene	SEMI						R	
Benzo(a)pyrene	SEMI						R	
Indeno(1,2,3-cd)Pyrene	SEMI						R	
Dibenz(a,h)anthracene	SEMI						R	
Benzo(g,h,i)perylene	SEMI						R	

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

R - The entire semivolatile fraction has been rejected due to holding time violations.
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-3

PHASE I ANALYTICAL RESULTS FOR SUBSURFACE SOIL
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		MW-1-SB	MW-2-SB	MW-3-SB	MW-4-SB	MW-5-SB	MW-7-SB	MW-8-SB
COLLECTION DATE		11/15/89	12/17/89	11/16/89	11/30/89	12/5/89	10/16/89	11/7/89
DEPTH		11-13'	7-9'	6-10'	1-4'	4-6'	4-8'	8-12'
Parameter ug/kg (ppb)	Class							
alpha-BHC	PST	R		R	R	R		
beta-BHC	PST	R		R	R	R		
delta-BHC	PST	R		R	R	R		
gamma-BHC (Lindane)	PST	R		R	R	R		
Heptachlor	PST	R		R	R	R		
Aldrin	PST	R		R	R	R		
Heptachlor Epoxide	PST	R		R	R	R		
Endosulfan I	PST	R		R	R	R		
Dieldrin	PST	R		R	R	R		
4,4'-DDE	PST	R		R	R	R		
Endrin	PST	R		R	R	R		
Endosulfan II	PST	R		R	R	R		
4,4'-DDD	PST	R		R	R	R		
Endosulfan Sulfate	PST	R		R	R	R		
4,4'-DDT	PST	R		R	R	R		
Methyoxychlor	PST	R		R	R	R		
Endrin Ketone	PST	R		R	R	R		
alpha-Chlordane	PST	R		R	R	R		
gamma-Chlordane	PST	R		R	R	R		
Toxaphene	PST	R		R	R	R		
Aroclor-1016	PCB	R		R	R	R		
Aroclor-1221	PCB	R		R	R	R		
Aroclor-1232	PCB	R		R	R	R		
Aroclor-1242	PCB	R		R	R	R		
Aroclor-1248	PCB	R		R	R	R		
Aroclor-1254	PCB	R		R	R	R		
Aroclor-1260	PCB	R		R	R	R		

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

R - The entire pesticide/PCB fraction has been rejected due to holding time violations.

TABLE 4-3

PHASE I ANALYTICAL RESULTS FOR SUBSURFACE SOIL
RAMAPO LANDFILL
(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			MW-1-SB	MW-2-SB	MW-3-SB	MW-4-SB	MW-5-SB	MW-7-SB	MW-8-SB
COLLECTION DATE			11/15/89	12/17/89	11/16/89	11/30/89	12/5/89	10/16/89	11/7/89
DEPTH			11-13'	7-9'	6-10'	1-4'	4-6'	4-8'	8-12'
Parameter	Units	Class							
Aluminum	mg/kg	MET	6040	6650	11600	9100	10900	8120	6100
Antimony	mg/kg	MET							5.2
Arsenic	mg/kg	MET	1.3	1.7	2.9	2.8	1.4	1.3	1.2
Barium	mg/kg	MET	39.8	26.9	42.5	34.3	39.7	50.7	39.4
Beryllium	mg/kg	MET		0.23					
Cadmium	mg/kg	MET						0.93	
Calcium	mg/kg	MET	3240	15100	4240	1830	1960	1840	1150
Chromium	mg/kg	MET	17.2	14.7	31.8	19.6	23.5	19.4	11.1
Cobalt	mg/kg	MET	9.4	6.6	8.00	7.9	9.3	7.6	4.7
Copper	mg/kg	MET	25.9	17.0	16.3	10.3	16.7	16.6	16.0
Iron	mg/kg	MET	17100	17600	21900	32000	21600	16900	16000
Lead	mg/kg	MET	1.5	3.2	11.2	5.3	2.1	8.9	2.7
Magnesium	mg/kg	MET	3100	5170	2810	2620	3220	3260	2670
Manganese	mg/kg	MET	299	305	382	155	228	289	243
Mercury	mg/kg	MET							
Nickel	mg/kg	MET	10.3	11.6	13.3	10.7	12.2	14.2	12.3
Potassium	mg/kg	MET	1410	1110	946	991	1430	1050	866
Selenium	mg/kg	MET				0.51			
Silver	mg/kg	MET							
Sodium	mg/kg	MET	240	171	209	115	166	133	70.4
Thallium	mg/kg	MET							1.5
Vanadium	mg/kg	MET	23.0	24.8	26.0	34.5	35.7	23.9	15.1
Zinc	mg/kg	MET	17.7	27.0	35.3	26.4	22.0	29.0	22.9
Total Cyanide	mg/kg	MET							
Total Phenols	mg/kg	MISC			0.37				
Ammonia-Nitrogen	mg/kg	MISC	3.97	2.75	37.6	6.72	1.5	22.7	5.9
NO3-Nitrogen	mg/kg	MISC	0.6	2.39	0.3	0.065	0.08	0.605	0.9
Total Kjeldahl Nitrogen	mg/kg	MISC	39.3	11.8	366	61.5	10.7	106	78.0
Moisture	%	MISC	7.98	2.65	19.0	16.3	6.42	7.38	6.84
pH	SU	MISC	7.52	8.13	7.64	6.36	6.79	7.41	7.73
TOC	mg/kg	MISC	4900	1140	16000	13700	675	10400	2080

NOTE: Only detected results are reported.

PHASE II

TABLE 4-4

ANALYTICAL RESULTS FOR SURFICIAL SOIL
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SPS-6	LSMW-10
COLLECTION DATE		09/24/90	8/24/90
Parameter	Class		
Chloromethane	VOC		
Bromomethane	VOC		
Vinyl Chloride	VOC		
Chloroethane	VOC		
Methylene Chloride	VOC	R	R
Acetone	VOC		R
Carbon Disulfide	VOC		
1,1-Dichloroethene	VOC		
1,1-Dichloroethane	VOC		
1,2-Dichloroethene (total)	VOC		
Chloroform	VOC		
1,2-Dichloroethane	VOC		
2-Butanone (or MEK)	VOC		
1,1,1-Trichloroethane	VOC		
Carbon Tetrachloride	VOC		
Vinyl Acetate	VOC		
Bromodichloromethane	VOC		
1,2-Dichloropropane	VOC		
Cis-1,3-dichloropropene	VOC		
Trichloroethene	VOC		
Dibromochloromethane	VOC		
1,1,2-Trichloroethane	VOC		
Benzene	VOC		
Trans-1,3-dichloropropene	VOC		
Bromoform	VOC		
4-Methyl-2-pentanone	VOC		
2-Hexanone	VOC		
Tetrachloroethene	VOC		
1,1,2,2-Tetrachloroethane	VOC		
Toluene	VOC		
Chlorobenzene	VOC		
Ethylbenzene	VOC		
Styrene	VOC		
Total Xylenes	VOC		

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

R – Compound rejected due to being detected in associated method blank.

PHASE II

TABLE 4-4

ANALYTICAL RESULTS FOR SURFICIAL SOIL
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SPS-6	LSMW-10
COLLECTION DATE		09/24/90	8/24/90
Parameter	Class		
Phenol	SEMI		
Bis(2-chloroethyl)ether	SEMI		
2-Chlorophenol	SEMI		
1,3-Dichlorobenzene	SEMI		
1,4-Dichlorobenzene	SEMI		
Benzyl Alcohol	SEMI		
1,2-Dichlorobenzene	SEMI		
2-Methylphenol	SEMI		
Bis(2-chloroisopropyl) ether	SEMI		
4-Methylphenol	SEMI		
N-Nitroso-di-n-propylamine	SEMI		
Hexachloroethane	SEMI		
Nitrobenzene	SEMI		
Isophorone	SEMI		
2-Nitrophenol	SEMI		
2,4-Dimethylphenol	SEMI		
Benzoic Acid	SEMI		
Bis(2-chloroethoxy) methane	SEMI		
2,4-Dichlorophenol	SEMI		
1,2,4-Trichlorobenzene	SEMI		
Naphthalene	SEMI		
4-Chloroaniline	SEMI		
Hexachlorobutadiene	SEMI		
4-Chloro-3-methylphenol	SEMI		
2-Methylnaphthalene	SEMI		
Hexachlorocyclopentadiene	SEMI		
2,4,6-Trichlorophenol	SEMI		
2,4,5-Trichlorophenol	SEMI		
2-Chloronaphthalene	SEMI		
2-Nitroaniline	SEMI		
Dimethyl Phthalate	SEMI		

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

PHASE II

TABLE 4-4

ANALYTICAL RESULTS FOR SURFICIAL SOIL
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SPS-6	LSMW-10
COLLECTION DATE		09/24/90	8/24/90
Parameter	Class		
Acenaphthylene	SEMI		
2,6-Dinitrotoluene	SEMI		
3-Nitroaniline	SEMI		
Acenaphthene	SEMI		
2,4-Dinitrophenol	SEMI		
4-Nitrophenol	SEMI		
Dibenzofuran	SEMI		
2,4-Dinitrotoluene	SEMI		
Diethylphthalate	SEMI		
4-Chlorophenyl-phenylether	SEMI		
Fluorene	SEMI		
4-Nitroaniline	SEMI		
4,6-Dinitro-2-methylphenol	SEMI		
N-nitrosodiphenylamine (1)	SEMI		
4-Bromophenyl Phenyl Ether	SEMI		
Hexachlorobenzene	SEMI		
Pentachlorophenol	SEMI		
Phenanthrene	SEMI	90 J	66 J
Anthracene	SEMI		
Di-n-butylphthalate	SEMI		
Fluoranthene	SEMI	150 J	130 J
Pyrene	SEMI	130 J	110 J
Butylbenzylphthalate	SEMI	100 J	
3,3'-Dichlorobenzidine	SEMI		
Benzo(a)anthracene	SEMI	79 J	64 J
Chrysene	SEMI	81 J	77 J
bis(2-ethyl hexyl)phthalate	SEMI	160 J	45 J
Di-n-octyl Phthalate	SEMI		
Benzo(b)fluoranthene	SEMI	140 J	64 J
Benzo(k)fluoranthene	SEMI	91 J	72 J
Benzo(a)pyrene	SEMI	92 J	63 J
Indeno(1,2,3-cd)Pyrene	SEMI		45 J
Dibenz(a,h)anthracene	SEMI		
Benzo(g,h,i)perylene	SEMI	48 J	

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).
J - Meets identification criteria but the value is
less than the sample quantitation limit and greater than zero.

PHASE II

TABLE 4-4

ANALYTICAL RESULTS FOR SURFICIAL SOIL
RAMAPO LANDFILL
(PESTICIDES AND PCBs)

WELL AND SAMPLE ID NUMBER		SPS-6	LSMW-10
COLLECTION DATE		09/24/90	8/24/90
Parameter	Class		
alpha-BHC	PST		
beta-BHC	PST		
delta-BHC	PST		
gamma-BHC (Lindane)	PST		
Heptachlor	PST		
Aldrin	PST		
Heptachlor Epoxide	PST		
Endosulfan I	PST		
Dieldrin	PST	3.4 J *	
4,4'-DDE	PST		
Endrin	PST		
Endosulfan II	PST		
4,4'-DDD	PST		
Endosulfan Sulfate	PST		
4,4'-DDT	PST		
Methyoxychlor	PST		
Endrin Ketone	PST		
alpha-Chlordane	PST	16 D	
gamma-Chlordane	PST	20 D	4.5 J
Toxaphene	PST		
Aroclor-1016	PCB		
Aroclor-1221	PCB		
Aroclor-1232	PCB		
Aroclor-1242	PCB		
Aroclor-1248	PCB		
Aroclor-1254	PCB		
Aroclor-1260	PCB		

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

J – Meets identification criteria but the value is less than the sample quantitation limit but greater than zero.
* – This value only was quantified outside analysis holding time.
D – Compound result calculated from dilution.

PHASE II

TABLE 4-4

ANALYTICAL RESULTS FOR SURFICIAL SOIL

RAMAPO LANDFILL

(METALS AND MISCELLANEOUS PARAMETERS)

		WELL AND SAMPLE ID NUMBER	SPS-6	LSMW 10
		COLLECTION DATE	09/24/90	8/08/90
Parameter	Units	Class		
Aluminum	mg/kg	MET	NA	15800
Antimony	mg/kg	MET	NA	
Arsenic	mg/kg	MET	NA	3.3
Barium	mg/kg	MET	NA	71.6
Beryllium	mg/kg	MET	NA	0.45 B
Cadmium	mg/kg	MET	NA	3.7
Calcium	mg/kg	MET	NA	2630
Chromium	mg/kg	MET	NA	19.5
Cobalt	mg/kg	MET	NA	10.2 B
Copper	mg/kg	MET	NA	30
Iron	mg/kg	MET	NA	20100
Lead	mg/kg	MET	NA	26.3
Magnesium	mg/kg	MET	NA	3400
Manganese	mg/kg	MET	NA	571
Mercury	mg/kg	MET	NA	0.21
Nickel	mg/kg	MET	NA	19.3
Potassium	mg/kg	MET	NA	1150 B
Selenium	mg/kg	MET	NA	0.72 BW
Silver	mg/kg	MET	NA	
Sodium	mg/kg	MET	NA	207 B
Thallium	mg/kg	MET	NA	
Vanadium	mg/kg	MET	NA	33.8
Zinc	mg/kg	MET	NA	73.9

Only detected results are reported. B – Less than quantitation limit but greater than or equal to instrument detection limit.

NA – Not Analyzed

TABLE 4-5

COMPARISON BETWEEN ANALYTICAL RESULTS FOR WASTES AND EP TOXICITY LIMITS

Parameter	SPS-1	SPS-2	SPS-3	SPS-4	SPS-5	EP Toxicity Limit
Arsenic						5.0
Barium	0.322	0.417	0.433	1.170	1.900	100.0
Cadmium					0.009	1.0
Chromium					0.0461	5.0
Lead					0.320	5.0
Mercury						0.2
Selenium	0.640					1.0
Silver						5.0
Endrin						0.02
Lindane						0.4
Methoxychlor						10.0
Toxaphene						0.5
2,4-D		0.13				10.0
2,4,5-TP		0.01		0.3		1.0

Note: All concentrations are in mg/l (ppm).

TABLE 4-6

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-OS	GW-2-OS	GW-3-OS	GW-4-OS	GW-5-OS	GW-7-OS	GW-8-OS
COLLECTION DATE		1/25/90	1/24/90	1/26/90	1/25/90	1/27/90	1/27/90	1/26/90
Parameter ug/L (ppb)	Class							
Chloromethane	VOC						3 J	
Bromomethane	VOC							
Vinyl Chloride	VOC							
Chloroethane	VOC							
Methylene Chloride	VOC		R				R	
Acetone	VOC	R	R			R	R	
Carbon Disulfide	VOC							
1,1-Dichloroethene	VOC							
1,1-Dichloroethane	VOC							
1,2-Dichloroethene (total)	VOC							
Chloroform	VOC							
1,2-Dichloroethane	VOC							
2-Butanone (or MEK)	VOC							
1,1,1-Trichloroethane	VOC							
Carbon Tetrachloride	VOC							
Vinyl Acetate	VOC							
Bromodichloromethane	VOC							
1,2-Dichloropropane	VOC							
Cis-1,3-dichloropropene	VOC							
Trichloroethene	VOC							
Dibromochloromethane	VOC							
1,1,2-Trichloroethane	VOC							
Benzene	VOC					2 J		2 J
Trans-1,3-dichloropropene	VOC							
Bromoform	VOC							
4-Methyl-2-pentanone	VOC							
2-Hexanone	VOC							
Tetrachloroethene	VOC							
1,1,2,2-Tetrachloroethane	VOC							
Toluene	VOC							
Chlorobenzene	VOC							1 J
Ethylbenzene	VOC							
Styrene	VOC							
Total Xylenes	VOC							

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).
R - Compound rejected because it was detected in the associated method blank at similar conditions.
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.
B - The compound is detected in the associated method blank as well as the sample.

TABLE 4-6

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-OS	GW-2-OS	GW-3-OS	GW-4-OS	GW-4-OS	GW-5-OS	GW-7-OS	GW-8-OS
COLLECTION DATE		1/25/90	1/24/90	1/26/90	1/25/90	9/24/90	1/27/90	1/27/90	1/26/90
Parameter ug/L (ppb)	Class								
Phenol	SEMI				R				
Bis(2-chloroethyl)ether	SEMI				R				
2-Chlorophenol	SEMI				R				
1,3-Dichlorobenzene	SEMI				R				
1,4-Dichlorobenzene	SEMI				R				
Benzyl Alcohol	SEMI				R				
1,2-Dichlorobenzene	SEMI				R				
2-Methylphenol	SEMI				R				
Bis(2-chloroisopropyl) ether	SEMI				R				
4-Methylphenol	SEMI				R				
N-Nitroso-di-n-propylamine	SEMI				R				
Hexachloroethane	SEMI				R				
Nitrobenzene	SEMI				R				
Isophorone	SEMI				R				
2-Nitrophenol	SEMI				R				
2,4-Dimethylphenol	SEMI				R				
Benzoic Acid	SEMI				R				
Bis(2-chloroethoxy) methane	SEMI				R				
2,4-Dichlorophenol	SEMI				R				
1,2,4-Trichlorobenzene	SEMI				R				
Naphthalene	SEMI				R				
4-Chloroaniline	SEMI				R				
Hexachlorobutadiene	SEMI				R				
4-Chloro-3-methylphenol	SEMI				R				
2-Methylnaphthalene	SEMI				R				
Hexachlorocyclopentadiene	SEMI				R				
2,4,6-Trichlorophenol	SEMI				R				
2,4,5-Trichlorophenol	SEMI				R				
2-Chloronaphthalene	SEMI				R				
2-Nitroaniline	SEMI				R				
Dimethyl Phthalate	SEMI				R				

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

R - The entire semivolatile fraction has been rejected due to holding time violations.

TABLE 4-6

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-OS	GW-2-OS	GW-3-OS	GW-4-OS	GW-4-OS	GW-5-OS	GW-7-OS	GW-8-OS
COLLECTION DATE		1/25/90	1/24/90	1/26/90	1/25/90	1/25/90	1/27/90	1/27/90	1/26/90
Parameter ug/L (ppb)	Class								
Acenaphthylene	SEMI				R				
2,6-Dinitrotoluene	SEMI				R				
3-Nitroaniline	SEMI				R				
Acenaphthene	SEMI				R				
2,4-Dinitrophenol	SEMI				R				
4-Nitrophenol	SEMI				R				
Dibenzofuran	SEMI				R				
2,4-Dinitrotoluene	SEMI				R				
Diethylphthalate	SEMI				R				
4-Chlorophenyl-phenylether	SEMI				R				
Fluorene	SEMI				R				
4-Nitroaniline	SEMI				R				
4,6-Dinitro-2-methylphenol	SEMI				R				
N-nitrosodiphenylamine (1)	SEMI				R				
4-Bromophenyl Phenyl Ether	SEMI				R				
Hexachlorobenzene	SEMI				R				
Pentachlorophenol	SEMI				R				
Phenanthrene	SEMI				R				
Anthracene	SEMI				R				
Di-n-butylphthalate	SEMI				R				
Fluoranthene	SEMI				R				
Pyrene	SEMI				R				
Butylbenzylphthalate	SEMI				R				
3,3'-Dichlorobenzidine	SEMI				R				
Benzo(a)anthracene	SEMI				R				
Chrysene	SEMI				R				
bis(2-ethyl hexyl)phthalate	SEMI	3 J	3 J		R				
Di-n-octyl Phthalate	SEMI				R				
Benzo(b)fluoranthene	SEMI				R				
Benzo(k)fluoranthene	SEMI				R				
Benzo(a)pyrene	SEMI				R				
Indeno(1,2,3-cd)Pyrene	SEMI				R				
Dibenz(a,h)anthracene	SEMI				R				
Benzo(g,h,i)perylene	SEMI				R				

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

R - The entire semivolatile fraction has been rejected due to holding time violations.
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-6

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		GW-1-OS	GW-2-OS	GW-3-OS	GW-4-OS	GW-5-OS	GW-7-OS	GW-8-OS
COLLECTION DATE		1/25/90	1/24/90	1/26/90	1/25/90	1/27/90	1/27/90	1/26/90
Parameter ug/L (ppb)	Class							
alpha-BHC	PST							
beta-BHC	PST							
delta-BHC	PST							
gamma-BHC (Lindane)	PST							
Heptachlor	PST							
Aldrin	PST							
Heptachlor Epoxide	PST							
Endosulfan I	PST							
Dieldrin	PST							
4,4'-DDE	PST							
Endrin	PST							
Endosulfan II	PST							
4,4'-DDD	PST							
Endosulfan Sulfate	PST							
4,4'-DDT	PST							
Methyoxychlor	PST							
Endrin Ketone	PST							
alpha-Chlordane	PST							
gamma-Chlordane	PST							
Toxaphene	PST							
Aroclor-1016	PCB							
Aroclor-1221	PCB							
Aroclor-1232	PCB							
Aroclor-1242	PCB							
Aroclor-1248	PCB							
Aroclor-1254	PCB							
Aroclor-1260	PCB							

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

TABLE 4-6

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			GW-1-OS	GW-2-OS	GW-3-OS	GW-4-OS	GW-5-OS	GW-7-OS	GW-8-OS
COLLECTION DATE			1/25/90	1/24/90	1/26/90	1/25/90	1/27/90	1/27/90	1/26/90
Parameter	Units	Class							
Aluminum	ug/L	MET	18900	321	3060	2800	17200	679	1960
Antimony	ug/L	MET							
Arsenic	ug/L	MET				2.8			26.1
Barium	ug/L	MET	197	20.0	133	54.0	98.0	32.0	441
Beryllium	ug/L	MET							
Cadmium	ug/L	MET							
Calcium	ug/L	MET	88200	87200	64300	72000	13400	40100	69100
Chromium	ug/L	MET	153	180	587	139	90.0	33.5	34.8
Cobalt	ug/L	MET	17.8				12.3		
Copper	ug/L	MET	78.3	5.6	18.0	28.1	37.7	6.1	9.6
Iron	ug/L	MET	45000	912	6830	15600	27000	981	229000
Lead	ug/L	MET	11.8	2.5	4.6	5.2	3.9	2.3	3.3
Magnesium	ug/L	MET	30800	17800	20500	25800	9180	13800	19500
Manganese	ug/L	MET	3790	298	8700	4210	981	1240	2830
Mercury	ug/L	MET							
Nickel	ug/L	MET	98.7	61.8	331	87.9	51.2	28.9	30.0
Potassium	ug/L	MET	8120	1050	3190	2230	4450	7180	22400
Selenium	ug/L	MET							
Silver	ug/L	MET							
Sodium	ug/L	MET	57700	14200	47100	35800	13300	61800	102000
Thallium	ug/L	MET							
Vanadium	ug/L	MET	51.6		7.8	6.8	41.5		
Zinc	ug/L	MET	79.3	8.2	17.7	29.8	63.3	21.0	11.3
Total Cyanide	ug/L	MET							
Total Phenols	mg/L	MISC					NA		
Bicarbonate, as CaCO3		MISC	NA	NA	NA	NA	NA	NA	NA
BOD	mg/L	MISC	NA		3.0	5.0	NA	20.0	7.0
COD	mg/L	MISC	25.3	11.5	29.5		NA	51.4	140
Hardness, as CaCO3		MISC	NA	NA	NA	NA	NA	NA	NA
Ammonia-Nitrogen	mg/L	MISC					NA	4.48	59.6
Total Kjeldahl Nitrogen	mg/L	MISC			0.33	0.17	NA	8.95	61.0
Alkalinity, as CaCO3	mg/L	MISC	244	332	332	164	NA	364	1048
Acidity, as CaCO3	mg/L	MISC	303	278	297	141	NA	305	563
NO3/NO2-N	mg/L	MISC		0.46	0.28		NA		0.29
Total Phosphorus	mg/L	MISC	0.43	0.79		0.48	NA	0.26	0.44
Oil & Grease	mg/L	MISC					NA		
TOC	mg/L	MISC	3.52	1.6	77.4	1.39	NA	14.4	51.1
TSS	mg/L	MISC	5000	2300	580	770	NA	4400	1400
TDS	mg/L	MISC	570	370	340	500	NA	960	1500
Sulfate	mg/L	MISC	63.2	80.9		62.5	NA	42.7	
Sulfide	mg/L	MISC					NA		
pH	SU	MISC	7.08	7.60	6.80	7.15	7.00	7.00	6.74
Specific Conductance	umhos	MISC	800	490	750	840	160	1180	2000

NOTE: Only detected results are reported. NA - Not Analyzed

RAM 001 0638

TABLE 4-7

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM INTERMEDIATE WELLS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-I	GW-2-I	GW-4-I	GW-5-I	GW-7-I	GW-8-I
COLLECTION DATE		1/25/90	1/26-27/90	1/25/90	1/27/90	1/25/90	1/26/90
Parameter ug/L (ppb)	Class						
Chloromethane	VOC						3 J
Bromomethane	VOC						
Vinyl Chloride	VOC						
Chloroethane	VOC						
Methylene Chloride	VOC	R				R	
Acetone	VOC		R	R	R		
Carbon Disulfide	VOC						
1,1-Dichloroethene	VOC						
1,1-Dichloroethane	VOC			3 J			
1,2-Dichloroethene (total)	VOC						
Chloroform	VOC						
1,2-Dichloroethane	VOC						
2-Butanone (or MEK)	VOC						
1,1,1-Trichloroethane	VOC						
Carbon Tetrachloride	VOC						
Vinyl Acetate	VOC						
Bromodichloromethane	VOC						
1,2-Dichloropropane	VOC						
Cis-1,3-dichloropropene	VOC						
Trichloroethene	VOC						
Dibromochloromethane	VOC						
1,1,2-Trichloroethane	VOC						
Benzene	VOC			2 J			2 J
Trans-1,3-dichloropropene	VOC						
Bromoform	VOC						
4-Methyl-2-pentanone	VOC	4 J					
2-Hexanone	VOC	2 J					
Tetrachloroethene	VOC						
1,1,2,2-Tetrachloroethane	VOC	2 J					
Toluene	VOC						1 J
Chlorobenzene	VOC						3 J
Ethylbenzene	VOC						
Styrene	VOC						
Total Xylenes	VOC						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

R - The entire semivolatile fraction has been rejected due to holding time violations.
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-7

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM INTERMEDIATE WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-I	GW-2-I	GW-4-I	GW-5-I	GW-7-I	GW-8-I
COLLECTION DATE		1/25/90	1/26-27/90	1/25/90	1/27/90	1/25/90	1/26/90
Parameter ug/L (ppb)	Class						
Phenol	SEMI						
Bis(2-chloroethyl)ether	SEMI						
2-Chlorophenol	SEMI						
1,3-Dichlorobenzene	SEMI						
1,4-Dichlorobenzene	SEMI						
Benzyl Alcohol	SEMI						
1,2-Dichlorobenzene	SEMI						
2-Methylphenol	SEMI						
Bis(2-chloroisopropyl) ether	SEMI						
4-Methylphenol	SEMI						
N-Nitroso-di-n-propylamine	SEMI						
Hexachloroethane	SEMI						
Nitrobenzene	SEMI						
Isophorone	SEMI						
2-Nitrophenol	SEMI						
2,4-Dimethylphenol	SEMI						
Benzoic Acid	SEMI						
Bis(2-chloroethoxy) methane	SEMI						
2,4-Dichlorophenol	SEMI						
1,2,4-Trichlorobenzene	SEMI						
Naphthalene	SEMI						
4-Chloroaniline	SEMI						
Hexachlorobutadiene	SEMI						
4-Chloro-3-methylphenol	SEMI						
2-Methylnaphthalene	SEMI						
Hexachlorocyclopentadiene	SEMI						
2,4,6-Trichlorophenol	SEMI						
2,4,5-Trichlorophenol	SEMI						
2-Chloronaphthalene	SEMI						
2-Nitroaniline	SEMI						
Dimethyl Phthalate	SEMI						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

TABLE 4-7

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM INTERMEDIATE WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-I	GW-2-I	GW-4-I	GW-5-I	GW-7-I	GW-8-I
COLLECTION DATE		1/25/90	1/26-27/90	1/25/90	1/27/90	1/25/90	1/26/90
Parameter ug/L (ppb)	Class						
Acenaphthylene	SEMI						
2,6-Dinitrotoluene	SEMI						
3-Nitroaniline	SEMI						
Acenaphthene	SEMI						
2,4-Dinitrophenol	SEMI						
4-Nitrophenol	SEMI						
Dibenzofuran	SEMI						
2,4-Dinitrotoluene	SEMI						
Diethylphthalate	SEMI			5 J			
4-Chlorophenyl-phenylether	SEMI						
Fluorene	SEMI						
4-Nitroaniline	SEMI						
4,6-Dinitro-2-methylphenol	SEMI						
N-nitrosodiphenylamine (1)	SEMI						
4-Bromophenyl Phenyl Ether	SEMI						
Hexachlorobenzene	SEMI						
Pentachlorophenol	SEMI						
Phenanthrene	SEMI						
Anthracene	SEMI						
Di-n-butylphthalate	SEMI						
Fluoranthene	SEMI						
Pyrene	SEMI						
Butylbenzylphthalate	SEMI						
3,3'-Dichlorobenzidine	SEMI						
Benzo(a)anthracene	SEMI						
Chrysene	SEMI						
bis(2-ethyl hexyl)phthalate	SEMI	3 J	7 J	3 J	9 J	30	5 J
Di-n-octyl Phthalate	SEMI						
Benzo(b)fluoranthene	SEMI						
Benzo(k)fluoranthene	SEMI						
Benzo(a)pyrene	SEMI						
Indeno(1,2,3-cd)Pyrene	SEMI						
Dibenz(a,h)anthracene	SEMI						
Benzo(g,h,i)perylene	SEMI						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-7

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM INTERMEDIATE WELLS
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		GW-1-I	GW-2-I	GW-4-I	GW-5-I	GW-7-I	GW-8-I
COLLECTION DATE		1/25/90	1/26-27/90	1/25/90	1/27/90	1/25/90	1/26/90
Parameter ug/L (ppb)	Class						
alpha-BHC	PST				0.24		
beta-BHC	PST						
delta-BHC	PST			1.9			
gamma-BHC (Lindane)	PST						
Heptachlor	PST						
Aldrin	PST						
Heptachlor Epoxide	PST						
Endosulfan I	PST						
Dieldrin	PST						
4,4'-DDE	PST						
Endrin	PST						
Endosulfan II	PST						
4,4'-DDD	PST						
Endosulfan Sulfate	PST						
4,4'-DDT	PST						
Methyoxychlor	PST						
Endrin Ketone	PST						
alpha-Chlordane	PST						
gamma-Chlordane	PST						
Toxaphene	PST						
Aroclor-1016	PCB						
Aroclor-1221	PCB						
Aroclor-1232	PCB						
Aroclor-1242	PCB						
Aroclor-1248	PCB						
Aroclor-1254	PCB						
Aroclor-1260	PCB						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

TABLE 4-7

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM INTERMEDIATE WELLS
RAMAPO LANDFILL
(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			GW-1-I	GW-2-I	GW-4-I	GW-5-I	GW-7-I	GW-8-I
COLLECTION DATE			1/25/90	1/26-27/90	1/25/90	1/27/90	1/25/90	1/26/90
Parameter	Units	Class						
Aluminum	ug/L	MET	1460	313	1470	453	722	619
Antimony	ug/L	MET						
Arsenic	ug/L	MET						
Barium	ug/L	MET	44.0	11.0	44.0		16.0	155
Beryllium	ug/L	MET						
Cadmium	ug/L	MET						
Calcium	ug/L	MET	107000	22100	104000	9210	27900	108000
Chromium	ug/L	MET	280	20.6	135	143	106	215
Cobalt	ug/L	MET						
Copper	ug/L	MET	9.6		10.0	4.7	4.8	5.1
Iron	ug/L	MET	5300	406	12600	973	1400	15700
Lead	ug/L	MET	3.5	1.4	3.4	2.1	2.9	1.4
Magnesium	ug/L	MET	33000	5690	37600	5410	9990	30100
Manganese	ug/L	MET	1490	82.1	3500	34.4	834	4230
Mercury	ug/L	MET						
Nickel	ug/L	MET	162	28.9	68.3	68.8	79.2	119
Potassium	ug/L	MET	3050	6620	3770	713	2810	34200
Selenium	ug/L	MET						
Silver	ug/L	MET						
Sodium	ug/L	MET	43700	44800	64500	5420	54700	166000
Thallium	ug/L	MET						
Vanadium	ug/L	MET			5.3			
Zinc	ug/L	MET	18.2	7.1	22.8	4.9	22.6	14.7
Total Cyanide	ug/L	MET						
Total Phenols	mg/L	MISC						
Bicarbonate, as CaCO3		MISC	NA	NA	NA	NA	NA	NA
BOD	mg/L	MISC	5.0	NA	25.0	19.0	7.0	14.0
COD	mg/L	MISC	28.7	69.1	36.5	17.7	34.2	94.4
Hardness, as CaCO3		MISC	NA	NA	NA	NA	NA	NA
Ammonia-Nitrogen	mg/L	MISC						26.8
Total Kjeldahl Nitrogen	mg/L	MISC			0.38		0.22	28.3
Alkalinity, as CaCO3	mg/L	MISC	364	140	356	48.0	172	772
Acidity, as CaCO3	mg/L	MISC	339	118	299	23.2	149	622
NO3/NO2-N	mg/L	MISC				0.42		
Total Phosphorus	mg/L	MISC	0.37	0.44	0.29		0.26	
Oil & Grease	mg/L	MISC	3.0	NA				2.1
TOC	mg/L	MISC	9.02	NA	4.7	2.21	3.54	74.8
TSS	mg/L	MISC	560	NA	140	30.0	50.0	40.0
TDS	mg/L	MISC	620	NA	620	60.0	450	1200
Sulfate	mg/L	MISC	62.8	NA	45.5	13.3	37.9	
Sulfide	mg/L	MISC						
pH	SU	MISC	7.17	7.70	7.05	7.30	6.80	7.30
Specific Conductance	umhos	MISC	930	450	1050	125	620	1850

NOTE: Only detected results are reported. NA - Not Analyzed

TABLE 4-8

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM DEEP WELLS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-R	GW-2-R	GW-3-R	GW-4-R	GW-5-R	GW-7-R	GW-8-R
COLLECTION DATE		1/25/90	1/24/90	1/26/90	1/25/90	1/27/90	1/25/90	1/26/90
Parameter ug/L (ppb)	Class							
Chloromethane	VOC							
Bromomethane	VOC							
Vinyl Chloride	VOC							
Chloroethane	VOC							
Methylene Chloride	VOC	R						
Acetone	VOC	R						R
Carbon Disulfide	VOC				2 J			
1,1-Dichloroethene	VOC							
1,1-Dichloroethane	VOC				5			
1,2-Dichloroethene (total)	VOC							
Chloroform	VOC							
1,2-Dichloroethane	VOC							
2-Butanone (or MEK)	VOC					7 J		
1,1,1-Trichloroethane	VOC							
Carbon Tetrachloride	VOC							
Vinyl Acetate	VOC							
Bromodichloromethane	VOC							
1,2-Dichloropropane	VOC							
Cis-1,3-dichloropropene	VOC							
Trichloroethene	VOC							
Dibromochloromethane	VOC							
1,1,2-Trichloroethane	VOC							
Benzene	VOC				1 J			3 J
Trans-1,3-dichloropropene	VOC							
Bromoform	VOC							
4-Methyl-2-pentanone	VOC	3 J						
2-Hexanone	VOC							
Tetrachloroethene	VOC							
1,1,2,2-Tetrachloroethane	VOC							
Toluene	VOC							
Chlorobenzene	VOC							
Ethylbenzene	VOC							
Styrene	VOC							
Total Xylenes	VOC							

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

R - Compound rejected because it was detected in the associated method blank at similar conditions.
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-8

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM DEEP WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-R	GW-2-R	GW-3-R	GW-4-R	GW-5-R	GW-7-R	GW-8-R
COLLECTION DATE		1/25/90	1/24/90	1/26/90	1/25/90	1/27/90	1/25/90	1/26/90
Parameter ug/L (ppb)	Class							
Phenol	SEMI			R				
Bis(2-chloroethyl)ether	SEMI			R				
2-Chlorophenol	SEMI			R				
1,3-Dichlorobenzene	SEMI			R				
1,4-Dichlorobenzene	SEMI			R				
Benzyl Alcohol	SEMI			R				
1,2-Dichlorobenzene	SEMI			R				
2-Methylphenol	SEMI			R				
Bis(2-chloroisopropyl) ether	SEMI			R				
4-Methylphenol	SEMI			R				
N-Nitroso-di-n-propylamine	SEMI			R				
Hexachloroethane	SEMI			R				
Nitrobenzene	SEMI			R				
Isophorone	SEMI			R				
2-Nitrophenol	SEMI			R				
2,4-Dimethylphenol	SEMI			R				
Benzoic Acid	SEMI			R				
Bis(2-chloroethoxy) methane	SEMI			R				
2,4-Dichlorophenol	SEMI			R				
1,2,4-Trichlorobenzene	SEMI			R				
Naphthalene	SEMI			R				
4-Chloroaniline	SEMI			R				
Hexachlorobutadiene	SEMI			R				
4-Chloro-3-methylphenol	SEMI			R				
2-Methylnaphthalene	SEMI			R				
Hexachlorocyclopentadiene	SEMI			R				
2,4,6-Trichlorophenol	SEMI			R				
2,4,5-Trichlorophenol	SEMI			R				
2-Chloronaphthalene	SEMI			R				
2-Nitroaniline	SEMI			R				
Dimethyl Phthalate	SEMI			R				

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

R - The entire semivolatile fraction has been rejected due to holding time violations.

TABLE 4-8

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM DEEP WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-R	GW-2-R	GW-3-R	GW-4-R	GW-5-R	GW-7-R	GW-8-R
COLLECTION DATE		1/25/90	1/24/90	1/26/90	1/25/90	1/27/90	1/25/90	1/26/90
Parameter ug/L (ppb)	Class							
Acenaphthylene	SEMI			R				
2,6-Dinitrotoluene	SEMI			R				
3-Nitroaniline	SEMI			R				
Acenaphthene	SEMI			R				
2,4-Dinitrophenol	SEMI			R				
4-Nitrophenol	SEMI			R				
Dibenzofuran	SEMI			R				
2,4-Dinitrotoluene	SEMI			R				
Diethylphthalate	SEMI			R	3 J			
4-Chlorophenyl-phenylether	SEMI			R				
Fluorene	SEMI			R				
4-Nitroaniline	SEMI			R				
4,6-Dinitro-2-methylphenol	SEMI			R				
N-nitrosodiphenylamine (1)	SEMI			R				
4-Bromophenyl Phenyl Ether	SEMI			R				
Hexachlorobenzene	SEMI			R				
Pentachlorophenol	SEMI			R				
Phenanthrene	SEMI			R				
Anthracene	SEMI			R				
Di-n-butylphthalate	SEMI			R				
Fluoranthene	SEMI			R				
Pyrene	SEMI			R				
Butylbenzylphthalate	SEMI			R				
3,3'-Dichlorobenzidine	SEMI			R				
Benzo(a)anthracene	SEMI			R				
Chrysene	SEMI			R				
bis(2-ethyl hexyl)phthalate	SEMI		2 J	R		3 J	27	2 J
Di-n-octyl Phthalate	SEMI			R				
Benzo(b)fluoranthene	SEMI			R				
Benzo(k)fluoranthene	SEMI			R				
Benzo(a)pyrene	SEMI			R				
Indeno(1,2,3-cd)Pyrene	SEMI			R				
Dibenz(a,h)anthracene	SEMI			R				
Benzo(g,h,i)perylene	SEMI			R				

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.
R - The entire semivolatile fraction has been rejected due to holding time violations.

TABLE 4-8

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM DEEP WELLS
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		GW-1-R	GW-2-R	GW-3-R	GW-4-R	GW-5-R	GW-7-R	GW-8-R
COLLECTION DATE		1/25/90	1/24/90	1/26/90	1/25/90	1/27/90	1/25/90	1/26/90
Parameter ug/L (ppb)	Class							
alpha-BHC	PST							
beta-BHC	PST							
delta-BHC	PST							
gamma-BHC (Lindane)	PST						0.055	
Heptachlor	PST							
Aldrin	PST							
Heptachlor Epoxide	PST							
Endosulfan I	PST							
Dieldrin	PST							
4,4'-DDE	PST							
Endrin	PST							
Endosulfan II	PST							
4,4'-DDD	PST							
Endosulfan Sulfate	PST							
4,4'-DDT	PST							
Methyoxychlor	PST							
Endrin Ketone	PST							
alpha-Chlordane	PST							
gamma-Chlordane	PST							
Toxaphene	PST							
Aroclor-1016	PCB							
Aroclor-1221	PCB							
Aroclor-1232	PCB							
Aroclor-1242	PCB							
Aroclor-1248	PCB							
Aroclor-1254	PCB							
Aroclor-1260	PCB							

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

TABLE 4-8

PHASE I ANALYTICAL RESULTS FOR GROUNDWATER FROM DEEP WELLS
RAMAPO LANDFILL
(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			GW-1-R	GW-2-R	GW-3-R	GW-4-R	GW-5-R	GW-7-R	GW-8-R
COLLECTION DATE			1/25/90	1/24/90	1/26/90	1/25/90	1/27/90	1/25/90	1/26/90
Parameter	Units	Class							
Aluminum	ug/L	MET	715	426		765	485	154	138
Antimony	ug/L	MET							
Arsenic	ug/L	MET							
Barium	ug/L	MET	15.0	9.0	47.0	14.0	8.0	28.0	14.0
Beryllium	ug/L	MET							
Cadmium	ug/L	MET							
Calcium	ug/L	MET	88500	52100	80100	74700	13900	74300	187000
Chromium	ug/L	MET	39.7	16.1	28.0	35.5	27.4	16.2	20.0
Cobalt	ug/L	MET							
Copper	ug/L	MET	9.1	7.4		8.0	3.2	3.1	
Iron	ug/L	MET	1180	409	1930	8230	658		1360
Lead	ug/L	MET	2.3	3.9		3.0		1.2	3.0
Magnesium	ug/L	MET	16800	10200	24000	23700	5010	19100	42700
Manganese	ug/L	MET	144	197	7230	1730	22.3	51.9	872
Mercury	ug/L	MET							
Nickel	ug/L	MET	27.4		18.2	27.9	14.2	14.7	
Potassium	ug/L	MET	2160	1250	2360	1870	898	3170	3170
Selenium	ug/L	MET							
Silver	ug/L	MET							
Sodium	ug/L	MET	15300	11400	90900	20400	5640	21800	25900
Thallium	ug/L	MET							
Vanadium	ug/L	MET							
Zinc	ug/L	MET	10.8	20.7	11.9	33.7	6.9	9.9	7.7
Total Cyanide	ug/L	MET							
Total Phenols	mg/L	MISC							
Bicarbonate, as CaCO3		MISC	NA	NA	NA	NA	NA	NA	NA
BOD	mg/L	MISC	NA	16.0	15.0	19.0	18.0	4.0	9.0
COD	mg/L	MISC	18.6	20.1	44.4	45.0	51.0	11.0	32.5
Hardness, as CaCO3		MISC	NA	NA	NA	NA	NA	NA	NA
Ammonia-Nitrogen	mg/L	MISC							0.89
Total Kjeldahl Nitrogen	mg/L	MISC				0.88			1.85
Alkalinity, as CaCO3	mg/L	MISC	248	148	348	256	52.0	164	444
Acidity, as CaCO3	mg/L	MISC	219	117	376	245	39.0	162	380
NO3/NO2-N	mg/L	MISC	0.61					0.62	
Total Phosphorus	mg/L	MISC	0.34	0.5		0.28	0.29		
Oil & Grease	mg/L	MISC	6.7			5.2			
TOC	mg/L	MISC			95.1	8.38	4.08		10.5
TSS	mg/L	MISC	20	10	20	60	20		10
TDS	mg/L	MISC	410	200	480	400	80	400	800
Sulfate	mg/L	MISC	34.7	22	14.5	19.8	19.8	30.3	39.9
Sulfide	mg/L	MISC							
pH	SU	MISC	7.48	7.70	7.40	7.30	7.80	8.00	7.30
Specific Conductance	umhos	MISC	650	325	950	625	120	700	1450

NOTE: Only detected results are reported. NA - Not Analyzed

RAM 001 0648

PHASE II

TABLE 4-9

ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-OS	GW-1-OS-RE	GW-2-OS	GW-3-OS/I	GW-3-OS/I-RE	GW-4-OS	GW-4-OS-RE	GW-5-OS	GW-6-OS	GW-6-OS-RE
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/15/90
Parameter ug/L (ppb)	Class										
Chloromethane	VOC		NA			NA		NA			NA
Bromomethane	VOC		NA			NA		NA			NA
Vinyl Chloride	VOC		NA			NA		NA			NA
Chloroethane	VOC		NA			NA		NA			NA
Methylene Chloride	VOC		NA			NA		NA			NA
Acetone	VOC		NA			NA		NA		21	NA
Carbon Disulfide	VOC		NA			NA		NA			NA
1,1-Dichloroethene	VOC		NA			NA		NA			NA
1,1-Dichloroethane	VOC		NA			NA		NA			NA
1,2-Dichloroethene (total)	VOC		NA			NA		NA			NA
Chloroform	VOC		NA			NA		NA			NA
1,2-Dichloroethane	VOC		NA			NA		NA			NA
2-Butanone (or MEK)	VOC		NA			NA		NA			NA
1,1,1-Trichloroethane	VOC		NA			NA		NA			NA
Carbon Tetrachloride	VOC		NA			NA		NA			NA
Vinyl Acetate	VOC		NA			NA		NA			NA
Bromodichloromethane	VOC		NA			NA		NA			NA
1,2-Dichloropropane	VOC		NA			NA		NA			NA
Cis-1,3-dichloropropene	VOC		NA			NA		NA			NA
Trichloroethene	VOC		NA			NA		NA			NA
Dibromochloromethane	VOC		NA			NA		NA			NA
1,1,2-Trichloroethane	VOC		NA			NA		NA			NA
Benzene	VOC		NA			NA	0.30 J	NA			NA
Trans-1,3-dichloropropene	VOC		NA			NA		NA			NA
Bromoform	VOC		NA			NA		NA			NA
4-Methyl-2-pentanone	VOC		NA			NA		NA			NA
2-Hexanone	VOC		NA			NA		NA			NA
Tetrachloroethene	VOC		NA			NA		NA			NA
1,1,2,2-Tetrachloroethane	VOC		NA			NA		NA			NA
Toluene	VOC		NA			NA		NA		0.70 J	NA
Chlorobenzene	VOC		NA			NA		NA			NA
Ethylbenzene	VOC		NA			NA		NA			NA
Styrene	VOC		NA			NA		NA			NA
Total Xylenes	VOC		NA			NA		NA			NA

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

NA – Not analyzed.
J – Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

PHASE II

TABLE 4-9

ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-OS	GW-1-OS-RE	GW-2-OS	GW-3-OS/I	GW-3-OS/I-RE	GW-4-OS	GW-4-OS-RE	GW-5-OS	GW-6-OS	GW-6-OS-RE
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/15/90
Parameter ug/L (ppb)	Class										
Dichlorodifluoromethane	VOC		NA			NA		NA			NA
trans-1,2-Dichloroethene	VOC		NA			NA		NA			NA
2,2-Dichloropropane	VOC		NA			NA		NA			NA
cis-1,2-Dichloroethene	VOC		NA			NA		NA			NA
Bromochloromethane	VOC		NA			NA		NA			NA
1,1-Dichloropropene	VOC		NA			NA		NA			NA
Dibromomethane	VOC		NA			NA		NA			NA
1,3-Dichloropropane	VOC		NA			NA		NA			NA
meta and/or para-Xylene	VOC		NA			NA		NA			NA
ortho-Xylene	VOC		NA			NA		NA			NA
Isopropylbenzene	VOC		NA			NA		NA			NA
Bromobenzene	VOC		NA			NA		NA			NA
1,1,2,2-Tetrachloroethane	VOC		NA			NA		NA			NA
1,2,3-Trichloropropane	VOC		NA			NA		NA			NA
Propylbenzene	VOC		NA			NA		NA			NA
2-Chlorotoluene	VOC		NA			NA		NA			NA
4-Chlorotoluene	VOC		NA			NA		NA			NA
1,3,5-Trimethylbenzene	VOC		NA			NA		NA			NA
tert-Butylbenzene	VOC		NA			NA		NA			NA
1,2,4-Trimethylbenzene	VOC		NA			NA		NA			NA
sec-Butylbenzene	VOC		NA			NA		NA			NA
1,3-Dichlorobenzene	VOC		NA			NA		NA			NA
p-Isopropyltoluene	VOC		NA			NA		NA		1.2	NA
1,4-Dichlorobenzene	VOC		NA			NA		NA			NA
1,2-Dichlorobenzene	VOC		NA			NA		NA			NA
Butylbenzene	VOC		NA			NA		NA			NA
1,2-Dibromo-3-chloropropane	VOC		NA			NA		NA			NA
1,2,4-Trichlorobenzene	VOC		NA			NA		NA			NA
Hexachlorobutadiene	VOC		NA			NA		NA			NA
Naphthalene	VOC		NA			NA		NA			NA
1,2,3-Trichlorobenzene	VOC		NA			NA		NA			NA

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).
NA – Not Analyzed

PHASE II

TABLE 4-9

ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-7-OS	GW-8-OS	GW-9-OS	GW-10-OS	GW-10-OS-RE	GDT-1
COLLECTION DATE		09/11/90	09/12/90	09/14/90	09/12/90	09/12/90	09/14/90
Parameter ug/L (ppb)	Class						
Chloromethane	VOC					NA	
Bromomethane	VOC					NA	
Vinyl Chloride	VOC					NA	
Chloroethane	VOC					NA	
Methylene Chloride	VOC					NA	
Acetone	VOC					NA	
Carbon Disulfide	VOC					NA	
1,1-Dichloroethene	VOC					NA	
1,1-Dichloroethane	VOC					NA	
1,2-Dichloroethene (total)	VOC					NA	
Chloroform	VOC					NA	
1,2-Dichloroethane	VOC					NA	
2-Butanone (or MEK)	VOC					NA	
1,1,1-Trichloroethane	VOC					NA	
Carbon Tetrachloride	VOC					NA	
Vinyl Acetate	VOC					NA	
Bromodichloromethane	VOC					NA	
1,2-Dichloropropane	VOC					NA	
Cis-1,3-dichloropropene	VOC					NA	
Trichloroethene	VOC					NA	
Dibromochloromethane	VOC					NA	
1,1,2-Trichloroethane	VOC					NA	
Benzene	VOC		0.30 J			NA	
Trans-1,3-dichloropropene	VOC					NA	
Bromoform	VOC					NA	
4-Methyl-2-pentanone	VOC					NA	
2-Hexanone	VOC					NA	
Tetrachloroethene	VOC					NA	0.60 J
1,1,2,2-Tetrachloroethane	VOC					NA	
Toluene	VOC					NA	R
Chlorobenzene	VOC		1.2			NA	
Ethylbenzene	VOC					NA	
Styrene	VOC					NA	
Total Xylenes	VOC					NA	

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

NA - Not analyzed.
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.
R - Analyte rejected due to blank contamination.

PHASE II

TABLE 4-9

ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-7-OS	GW-8-OS	GW-9-OS	GW-10-OS	GW-10-OS-RE	GDT-1
COLLECTION DATE		09/11/90	09/12/90	09/14/90	09/12/90	09/12/90	09/14/90
Parameter ug/L (ppb)	Class						
Dichlorodifluoromethane	VOC					NA	
trans-1,2-Dichloroethene	VOC					NA	
2,2-Dichloropropane	VOC					NA	
cis-1,2-Dichloroethene	VOC					NA	
Bromochloromethane	VOC					NA	
1,1-Dichloropropene	VOC					NA	
Dibromomethane	VOC					NA	
1,3-Dichloropropane	VOC					NA	
meta and/or para-Xylene	VOC					NA	
ortho-Xylene	VOC					NA	
Isopropylbenzene	VOC					NA	
Bromobenzene	VOC					NA	
1,1,2,2-Tetrachloroethane	VOC					NA	
1,2,3-Trichloropropane	VOC					NA	
Propylbenzene	VOC					NA	
2-Chlorotoluene	VOC					NA	
4-Chlorotoluene	VOC					NA	
1,3,5-Trimethylbenzene	VOC					NA	
tert-Butylbenzene	VOC					NA	
1,2,4-Trimethylbenzene	VOC					NA	
sec-Butylbenzene	VOC					NA	
1,3-Dichlorobenzene	VOC					NA	
p-Isopropyltoluene	VOC					NA	
1,4-Dichlorobenzene	VOC		1.1			NA	
1,2-Dichlorobenzene	VOC					NA	
Butylbenzene	VOC					NA	
1,2-Dibromo-3-chloropropane	VOC					NA	
1,2,4-Trichlorobenzene	VOC					NA	
Hexachlorobutadiene	VOC					NA	
Naphthalene	VOC					NA	
1,2,3-Trichlorobenzene	VOC					NA	

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).
NA – Not Analyzed

PHASE II

TABLE 4-9

ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-OS	GW-1-OS-RE	GW-2-OS	GW-3-OS/I	GW-3-OS/I-RE	GW-4-OS	GW-4-OS-RE	GW-5-OS	GW-6-OS	GW-6-OS-RE
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/15/90
Parameter ug/L (ppb)	Class										
Phenol	SEMI										
Bis(2-chloroethyl)ether	SEMI										
2-Chlorophenol	SEMI										
1,3-Dichlorobenzene	SEMI										
1,4-Dichlorobenzene	SEMI										
Benzyl Alcohol	SEMI										
1,2-Dichlorobenzene	SEMI										
2-Methylphenol	SEMI										
Bis(2-chloroisopropyl) ether	SEMI										
4-Methylphenol	SEMI										
N-Nitroso-di-n-propylamine	SEMI										
Hexachloroethane	SEMI										
Nitrobenzene	SEMI										
Isophorone	SEMI										
2-Nitrophenol	SEMI										
2,4-Dimethylphenol	SEMI										
Benzoic Acid	SEMI										
Bis(2-chloroethoxy) methane	SEMI										
2,4-Dichlorophenol	SEMI										
1,2,4-Trichlorobenzene	SEMI										
Naphthalene	SEMI										
4-Chloroaniline	SEMI										
Hexachlorobutadiene	SEMI										
4-Chloro-3-methylphenol	SEMI										
2-Methylnaphthalene	SEMI										
Hexachlorocyclopentadiene	SEMI										
2,4,6-Trichlorophenol	SEMI										
2,4,5-Trichlorophenol	SEMI										
2-Chloronaphthalene	SEMI										
2-Nitroaniline	SEMI										
Dimethyl Phthalate	SEMI										

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

RE - This sample required reextraction/reanalysis.

PHASE II

TABLE 4-9

ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-OS	GW-1-OS-RE	GW-2-OS	GW-3-OS/I	GW-3-OS/I-RE	GW-4-OS	GW-4-OS-RE	GW-5-OS	GW-6-OS	GW-6-OS-RE
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/15/90
Parameter ug/L (ppb)	Class										
Acenaphthylene	SEMI										
2,6-Dinitrotoluene	SEMI										
3-Nitroaniline	SEMI										
Acenaphthene	SEMI										
2,4-Dinitrophenol	SEMI										
4-Nitrophenol	SEMI										
Dibenzofuran	SEMI										
2,4-Dinitrotoluene	SEMI										
Diethylphthalate	SEMI										
4-Chlorophenyl-phenylether	SEMI										
Fluorene	SEMI										
4-Nitroaniline	SEMI										
4,6-Dinitro-2-methylphenol	SEMI										
N-nitrosodiphenylamine (1)	SEMI										
4-Bromophenyl Phenyl Ether	SEMI										
Hexachlorobenzene	SEMI										
Pentachlorophenol	SEMI										
Phenanthrene	SEMI										
Anthracene	SEMI										
Di-n-butylphthalate	SEMI										
Fluoranthene	SEMI										
Pyrene	SEMI										
Butylbenzylphthalate	SEMI										
3,3'-Dichlorobenzidine	SEMI										
Benzo(a)anthracene	SEMI										
Chrysene	SEMI										
bis(2-ethyl hexyl)phthalate	SEMI					2 J					
Di-n-octyl Phthalate	SEMI										
Benzo(b)fluoranthene	SEMI										
Benzo(k)fluoranthene	SEMI										
Benzo(a)pyrene	SEMI										
Indeno(1,2,3-cd)Pyrene	SEMI										
Dibenz(a,h)anthracene	SEMI										
Benzo(g,h,i)perylene	SEMI										

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.
RE - This sample required reextraction/reanalysis.

PHASE II

TABLE 4-9

ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-7-OS	GW-8-OS	GW-9-OS	GW-10-OS	GW-10-OS-RE	GDT-1
COLLECTION DATE		09/11/90	09/12/90	09/14/90	09/12/90	09/12/90	09/14/90
Parameter ug/L (ppb)	Class						
Phenol	SEMI						
Bis(2-chloroethyl)ether	SEMI						
2-Chlorophenol	SEMI						
1,3-Dichlorobenzene	SEMI						
1,4-Dichlorobenzene	SEMI						
Benzyl Alcohol	SEMI						
1,2-Dichlorobenzene	SEMI						
2-Methylphenol	SEMI						
Bis(2-chloroisopropyl) ether	SEMI						
4-Methylphenol	SEMI						
N-Nitroso-di-n-propylamine	SEMI						
Hexachloroethane	SEMI						
Nitrobenzene	SEMI						
Isophorone	SEMI						
2-Nitrophenol	SEMI						
2,4-Dimethylphenol	SEMI						
Benzoic Acid	SEMI						
Bis(2-chloroethoxy) methane	SEMI						
2,4-Dichlorophenol	SEMI						
1,2,4-Trichlorobenzene	SEMI						
Naphthalene	SEMI						
4-Chloroaniline	SEMI						
Hexachlorobutadiene	SEMI						
4-Chloro-3-methylphenol	SEMI						
2-Methylnaphthalene	SEMI						
Hexachlorocyclopentadiene	SEMI						
2,4,6-Trichlorophenol	SEMI						
2,4,5-Trichlorophenol	SEMI						
2-Chloronaphthalene	SEMI						
2-Nitroaniline	SEMI						
Dimethyl Phthalate	SEMI						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

RE - This sample required reextraction/reanalysis.

PHASE II

TABLE 4-9

ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-7-OS	GW-8-OS	GW-9-OS	GW-10-OS	GW-10-OS-RE	GDT-1
COLLECTION DATE		09/11/90	09/12/90	09/14/90	09/12/90	09/12/90	09/14/90
Parameter ug/L (ppb)	Class						
Acenaphthylene	SEMI						
2,6-Dinitrotoluene	SEMI						
3-Nitroaniline	SEMI						
Acenaphthene	SEMI						
2,4-Dinitrophenol	SEMI						
4-Nitrophenol	SEMI						
Dibenzofuran	SEMI						
2,4-Dinitrotoluene	SEMI						
Diethylphthalate	SEMI						
4-Chlorophenyl-phenylether	SEMI						
Fluorene	SEMI						
4-Nitroaniline	SEMI						
4,6-Dinitro-2-methylphenol	SEMI						
N-nitrosodiphenylamine (1)	SEMI						
4-Bromophenyl Phenyl Ether	SEMI						
Hexachlorobenzene	SEMI						
Pentachlorophenol	SEMI						
Phenanthrene	SEMI						
Anthracene	SEMI						
Di-n-butylphthalate	SEMI						
Fluoranthene	SEMI						
Pyrene	SEMI						
Butylbenzylphthalate	SEMI						
3,3'-Dichlorobenzidine	SEMI						
Benzo(a)anthracene	SEMI						
Chrysene	SEMI						
bis(2-ethyl hexyl)phthalate	SEMI						
Di-n-octyl Phthalate	SEMI						
Benzo(b)fluoranthene	SEMI						
Benzo(k)fluoranthene	SEMI						
Benzo(a)pyrene	SEMI						
Indeno(1,2,3-cd)Pyrene	SEMI						
Dibenz(a,h)anthracene	SEMI						
Benzo(g,h,i)perylene	SEMI						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

RE - This sample required reextraction/reanalysis.

PHASE II

TABLE 4-9

ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		GW-1-OS	GW-1-OS-RE	GW-2-OS	GW-3-OS/I	GW-3-OS/I-RE	GW-4-OS	GW-4-OS-RE	GW-5-OS	GW-6-OS	GW-6-OS-RE
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/15/90
Parameter ug/L (ppb)	Class										
alpha-BHC	PST		NA			NA		NA			NA
beta-BHC	PST		NA			NA		NA			NA
delta-BHC	PST		NA			NA		NA			NA
gamma-BHC (Lindane)	PST		NA			NA		NA			NA
Heptachlor	PST		NA			NA		NA			NA
Aldrin	PST		NA			NA		NA			NA
Heptachlor Epoxide	PST		NA			NA		NA			NA
Endosulfan I	PST		NA			NA		NA			NA
Dieldrin	PST		NA			NA		NA			NA
4,4'-DDE	PST		NA			NA		NA			NA
Endrin	PST		NA			NA		NA			NA
Endosulfan II	PST		NA			NA		NA			NA
4,4'-DDD	PST		NA			NA		NA			NA
Endosulfan Sulfate	PST		NA			NA		NA			NA
4,4'-DDT	PST		NA			NA		NA			NA
Methyoxychlor	PST		NA			NA		NA			NA
Endrin Ketone	PST		NA			NA		NA			NA
alpha-Chlordane	PST		NA			NA		NA			NA
gamma-Chlordane	PST		NA			NA		NA			NA
Toxaphene	PST		NA			NA		NA			NA
Aroclor-1016	PCB		NA			NA		NA			NA
Aroclor-1221	PCB		NA			NA		NA			NA
Aroclor-1232	PCB		NA			NA		NA			NA
Aroclor-1242	PCB		NA			NA		NA			NA
Aroclor-1248	PCB		NA			NA		NA			NA
Aroclor-1254	PCB		NA			NA		NA			NA
Aroclor-1260	PCB		NA			NA		NA			NA

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

NA - Not Analyzed

PHASE II

TABLE 4-9

ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		GW-7-OS	GW-8-OS	GW-9-OS	GW-10-OS	GW-10-OS-RE	GDT-1
COLLECTION DATE		09/11/90	09/12/90	09/14/90	09/12/90	09/12/90	09/14/90
Parameter ug/L (ppb)	Class						
alpha-BHC	PST					NA	
beta-BHC	PST					NA	
delta-BHC	PST					NA	
gamma-BHC (Lindane)	PST					NA	
Heptachlor	PST					NA	
Aldrin	PST					NA	
Heptachlor Epoxide	PST					NA	
Endosulfan I	PST					NA	
Dieldrin	PST					NA	
4,4'-DDE	PST					NA	
Endrin	PST					NA	
Endosulfan II	PST					NA	
4,4'-DDD	PST					NA	
Endosulfan Sulfate	PST					NA	
4,4'-DDT	PST					NA	
Methyoxychlor	PST					NA	
Endrin Ketone	PST					NA	
alpha-Chlordane	PST					NA	
gamma-Chlordane	PST					NA	
Toxaphene	PST					NA	
Aroclor-1016	PCB					NA	
Aroclor-1221	PCB					NA	
Aroclor-1232	PCB					NA	
Aroclor-1242	PCB					NA	
Aroclor-1248	PCB					NA	
Aroclor-1254	PCB					NA	
Aroclor-1260	PCB					NA	

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

NA - Not Analyzed

PHASE II

TABLE 4-9

ANALYTICAL RESULTS FOR GROUNDWATER FROM SHALLOW WELLS
RAMAPO LANDFILL
(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			GW-1-OS	GW-2-OS	GW-3-OS	GW-4-OS	GW-5-OS	GW-6-OS	GW-7-OS	GW-8-OS	GW-9-OS	GW-10-OS	GDT-1
COLLECTION DATE			9/15/90	9/15/90	9/15/90	9/15/90	9/15/90	9/15/90	9/15/90	9/15/90	9/15/90	9/15/90	9/15/90
Parameter	Units	Class											
Aluminum	ug/L	MET	7130	19000	1620	3640	7220	2950	16100	2260	165 B	1730	122 B
Antimony	ug/L	MET											
Arsenic	ug/L	MET	2.4 B	4.9 B				2.5 B	4.3 B	20.5			
Barium	ug/L	MET	100 B	139 B	61 B	58 B	33 B	110 B	230.0	122 B	3 B	50 B	3 B
Beryllium	ug/L	MET											
Cadmium	ug/L	MET											
Calcium	ug/L	MET	78800	132000	87000	81400	8420	97800	77600	31500	7300	37000	9260
Chromium	ug/L	MET	57.3	141	1290	40.1	35.6	36.5	40.1	16.7	6.8 B	24.5	
Cobalt	ug/L	MET	12.2 B	42.3 B	11 B			25.3 B	21.9 B	10.5 B		24.7 B	
Copper	ug/L	MET	32	59.4	17.9 B	17.3 B	2.7 B	12.7 B	62.3	13.7 B		4.7 B	47.4
Iron	ug/L	MET	17500	41800	9750	12400	11200	10600	24500	43800	249	8320	64 B
Lead	ug/L	MET	6.2	34.1	5 B	7.2 *	5.8 *	9.6 *	8.8	5.1 B	3.8 B*	2.2 B	9.2 *
Magnesium	ug/L	MET	24200	31400	25300	28600	5000 B	31500	29000	10200	1920 B	11400	2670 B
Manganese	ug/L	MET	3700	4770	18100	5020	530	6770	3260	2750	14.6 B	31200	
Mercury	ug/L	MET					0.2 BN	0.63 N			0.5 N		0.29 N
Nickel	ug/L	MET	36.6 B	99.4	79.7	23 B		35 B	30.7 B	28.1 B		26.9 B	17
Potassium	ug/L	MET	4660 B	4820 B	3280 B	3170 B	2370 B	10300	31200	16100	717 B	2340 B	1070 B
Selenium	ug/L	MET											
Silver	ug/L	MET											
Sodium	ug/L	MET	52900	14900	62300	56900	5280	23900	84100	58400	2250 B	32900	4360 B
Thallium	ug/L	MET											
Vanadium	ug/L	MET	21.8 B	40 B	7.1 B	10 B	15.4 B	11.1 B	28.5 B		5.9 B		
Zinc	ug/L	MET	34.9	107	11.5 B	20.5	26.9	18.5 B	52.4	30.7	5 B	16.2 B	11.7 B
Total Cyanide	ug/L	MET					NA						
Total Phenols	mg/L	MISC					NA						
BOD	mg/L	MISC	NA	NA	NA	NA	NA	3.0	NA	NA			
COD	mg/L	MISC	NA	NA	NA	NA	NA	68.6	NA	NA			
Chloride	mg/L	MISC	NA	NA	NA	NA	NA	106	NA	NA		55.8	
Ammonia-Nitrogen	mg/L	MISC	NA	NA	NA	NA	NA	0.65	NA	NA		1.32	
Total Kjeldahl Nitrogen	mg/L	MISC	NA	NA	NA	NA	NA	1.35	NA	NA		0.99	
NO3 - Nitrogen	mg/L	MISC	NA	NA	NA	NA	NA		NA	NA	0.62		0.61
Total Phosphorus	mg/L	MISC	NA	NA	NA	NA	NA	0.52	NA	NA			
Oil & Grease	mg/L	MISC	NA	NA	NA	NA	NA		NA	NA			
TOC	mg/L	MISC	NA	NA	NA	NA	NA	20.82	NA	NA		3.38	
TSS	mg/L	MISC	NA	NA	NA	NA	NA	375	NA	NA	2	15	
TDS	mg/L	MISC	NA	NA	NA	NA	NA	625	NA	NA	65	298	50
Sulfate	mg/L	MISC	NA	NA	NA	NA	NA		NA	NA	9.4	11.3	9.6
Sulfide	mg/L	MISC	NA	NA	NA	NA	NA		NA	NA			
pH	SU	MISC	7.33	8.04	6.67	7.23	6.41	6.43	6.66	7.06	7.2	6.37	
Specific Conductance	umhos	MISC	700	530	1100	1100	105	700	1050	1800	90	510	
Temperature	deg. C	MISC	18	17	18	19	16	22	17	18	20	17	

Only detected results are reported.
NA - Not Analyzed

N - Spike sample % recovery out of control limits.
* - Duplicate analysis not within control limits.

B - Less than quantitation limit but greater than or equal to instrument detection limit.

PHASE II

TABLE 4-10

ANALYTICAL RESULTS FOR GROUNDWATER FROM INTERMEDIATE WELLS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-I	GW-1-I-RE	GW-2-I	GW-4-I	GW-4-I-RE	GW-5-I	GW-6-I	GW-7-I	GW-8-I	GW-9-I
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/11/90	09/12/90	09/14/90
Parameter ug/L (ppb)	Class										
Chloromethane	VOC		NA	2.3		NA					
Bromomethane	VOC		NA			NA					
Vinyl Chloride	VOC		NA			NA					
Chloroethane	VOC		NA			NA					
Methylene Chloride	VOC		NA			NA	0.60 J				
Acetone	VOC		NA	28		NA					
Carbon Disulfide	VOC		NA			NA					
1,1-Dichloroethene	VOC		NA			NA					
1,1-Dichloroethane	VOC	0.50 J	NA		2.8	NA					
1,2-Dichloroethene (total)	VOC		NA			NA					
Chloroform	VOC		NA			NA		R			
1,2-Dichloroethane	VOC		NA		0.20 J	NA					
2-Butanone (or MEK)	VOC		NA			NA					
1,1,1-Trichloroethane	VOC		NA			NA	R	R			
Carbon Tetrachloride	VOC		NA			NA					
Vinyl Acetate	VOC		NA			NA					
Bromodichloromethane	VOC		NA			NA					
1,2-Dichloropropane	VOC		NA			NA					
Cis-1,3-dichloropropene	VOC		NA			NA					
Trichloroethene	VOC		NA			NA		0.20 J			
Dibromochloromethane	VOC		NA			NA					
1,1,2-Trichloroethane	VOC		NA			NA					
Benzene	VOC	0.30 J	NA		1.0	NA		0.20 J	0.30 J	2.9	0.20 J
Trans-1,3-dichloropropene	VOC		NA			NA					
Bromoform	VOC		NA			NA					
4-Methyl-2-pentanone	VOC		NA			NA					
2-Hexanone	VOC		NA			NA					
Tetrachloroethene	VOC		NA			NA	2.3	0.60 J			
1,1,2,2-Tetrachloroethane	VOC		NA			NA					
Toluene	VOC	0.30 J	NA			NA	0.40 J	0.30 J		0.60 J	
Chlorobenzene	VOC		NA			NA				16	
Ethylbenzene	VOC		NA			NA					
Styrene	VOC		NA			NA		0.60 J			
Total Xylenes	VOC		NA			NA					

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.
R - Analyte rejected due to blank contamination.
NA - Not Analyzed

PHASE II

TABLE 4-10

ANALYTICAL RESULTS FOR GROUNDWATER FROM INTERMEDIATE WELLS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-I	GW-1-I-RE	GW-2-I	GW-4-I	GW-4-I-RE	GW-5-I	GW-6-I	GW-7-I	GW-8-I	GW-9-I
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/11/90	09/12/90	09/14/90
Parameter ug/L (ppb)	Class										
Dichlorodifluoromethane	VOC		NA			NA					
trans-1,2-Dichloroethene	VOC		NA			NA					
2,2-Dichloropropane	VOC		NA			NA					
cis-1,2-Dichloroethene	VOC	0.30 J	NA		0.10 J	NA		0.10 J			
Bromochloromethane	VOC		NA			NA	0.80 J				
1,1-Dichloropropene	VOC		NA			NA					
Dibromomethane	VOC		NA			NA					
1,3-Dichloropropane	VOC		NA			NA					
meta and/or para-Xylene	VOC		NA			NA		1.30			
ortho-Xylene	VOC		NA			NA		0.40 J		0.70 J	
Isopropylbenzene	VOC		NA		0.50 J	NA		0.40 J		3.7	
Bromobenzene	VOC		NA			NA					
1,1,2,2-Tetrachloroethane	VOC		NA			NA					
1,2,3-Trichloropropane	VOC		NA			NA					
Propylbenzene	VOC		NA			NA		0.40 J		0.80 J	
2-Chlorotoluene	VOC		NA			NA					
4-Chlorotoluene	VOC		NA			NA					
1,3,5-Trimethylbenzene	VOC		NA		1.9	NA		1.9		1.8	
tert-Butylbenzene	VOC		NA			NA		0.40 J		1.5	
1,2,4-Trimethylbenzene	VOC		NA		0.80 J	NA				1.4	
sec-Butylbenzene	VOC		NA			NA					
1,3-Dichlorobenzene	VOC		NA			NA					
p-Isopropyltoluene	VOC		NA			NA		1.2		1.7	
1,4-Dichlorobenzene	VOC		NA			NA					
1,2-Dichlorobenzene	VOC		NA			NA				1.2	
Butylbenzene	VOC		NA			NA					
1,2-Dibromo-3-chloropropane	VOC		NA			NA					
1,2,4-Trichlorobenzene	VOC		NA			NA					
Hexachlorobutadiene	VOC		NA			NA					
Naphthalene	VOC		NA			NA				4.2	
1,2,3-Trichlorobenzene	VOC		NA			NA					

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.
NA - Not Analyzed

PHASE II

TABLE 4-10

ANALYTICAL RESULTS FOR GROUNDWATER FROM INTERMEDIATE WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-I	GW-1-I-RE	GW-2-I	GW-4-I	GW-4-I-RE	GW-5-I	GW-6-I	GW-7-I	GW-8-I	GW-9-I
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/11/90	09/12/90	09/14/90
Parameter ug/L (ppb)	Class										
Phenol	SEMI										
Bis(2-chloroethyl)ether	SEMI										
2-Chlorophenol	SEMI										
1,3-Dichlorobenzene	SEMI										
1,4-Dichlorobenzene	SEMI										
Benzyl Alcohol	SEMI										
1,2-Dichlorobenzene	SEMI										
2-Methylphenol	SEMI										
Bis(2-chloroisopropyl) ether	SEMI										
4-Methylphenol	SEMI										
N-Nitroso-di-n-propylamine	SEMI										
Hexachloroethane	SEMI										
Nitrobenzene	SEMI										
Isophorone	SEMI										
2-Nitrophenol	SEMI										
2,4-Dimethylphenol	SEMI										
Benzoic Acid	SEMI										
Bis(2-chloroethoxy) methane	SEMI										
2,4-Dichlorophenol	SEMI										
1,2,4-Trichlorobenzene	SEMI										
Naphthalene	SEMI									3 J	
4-Chloroaniline	SEMI										
Hexachlorobutadiene	SEMI										
4-Chloro-3-methylphenol	SEMI										
2-Methylnaphthalene	SEMI										
Hexachlorocyclopentadiene	SEMI										
2,4,6-Trichlorophenol	SEMI										
2,4,5-Trichlorophenol	SEMI										
2-Chloronaphthalene	SEMI										
2-Nitroaniline	SEMI										
Dimethyl Phthalate	SEMI										

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).
RE – This sample required reextraction/reanalysis.

J – Meets identification criteria, but the value is less than the sample quantitation limit and greater than zero.

PHASE II

TABLE 4-10

ANALYTICAL RESULTS FOR GROUNDWATER FROM INTERMEDIATE WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-I	GW-1-I-RE	GW-2-I	GW-4-I	GW-4-I-RE	GW-5-I	GW-6-I	GW-7-I	GW-8-I	GW-9-I
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/11/90	09/12/90	09/14/90
Parameter ug/L (ppb)	Class										
Acenaphthylene	SEMI										
2,6-Dinitrotoluene	SEMI										
3-Nitroaniline	SEMI										
Acenaphthene	SEMI										
2,4-Dinitrophenol	SEMI										
4-Nitrophenol	SEMI										
Dibenzofuran	SEMI										
2,4-Dinitrotoluene	SEMI										
Diethylphthalate	SEMI				4 J	5 J					
4-Chlorophenyl-phenylether	SEMI										
Fluorene	SEMI										
4-Nitroaniline	SEMI										
4,6-Dinitro-2-methylphenol	SEMI										
N-nitrosodiphenylamine (1)	SEMI										
4-Bromophenyl Phenyl Ether	SEMI										
Hexachlorobenzene	SEMI										
Pentachlorophenol	SEMI										
Phenanthrene	SEMI										
Anthracene	SEMI										
Di-n-butylphthalate	SEMI										
Fluoranthene	SEMI										
Pyrene	SEMI										
Butylbenzylphthalate	SEMI										
3,3'-Dichlorobenzidine	SEMI										
Benzo(a)anthracene	SEMI										
Chrysene	SEMI										
bis(2-ethyl hexyl)phthalate	SEMI	2 J*							2 J		
Di-n-octyl Phthalate	SEMI										
Benzo(b)fluoranthene	SEMI										
Benzo(k)fluoranthene	SEMI										
Benzo(a)pyrene	SEMI										
Indeno(1,2,3-cd)Pyrene	SEMI										
Dibenz(a,h)anthracene	SEMI										
Benzo(g,h,i)perylene	SEMI										

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).
RE - This sample required reextraction/reanalysis.

J - Meets identification criteria, but the value is less than the sample quantitation limit and greater than zero.
* - This value was quantified with AP surrogates exceeding QC limits.

RAM 001 0663

PHASE II

TABLE 4-10

ANALYTICAL RESULTS FOR GROUNWATER FROM INTERMEDIATE WELLS
RAMAPO LANFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		GW-1-I	GW-1-I-RE	GW-2-I	GW-4-I	GW-4-I-RE	GW-5-I	GW-6-I	GW-7-I	GW-8-I	GW-9-I
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/11/90	09/12/90	09/14/90
Parameter ug/L (ppb)	Class										
alpha-BHC	PST		NA			NA					
beta-BHC	PST		NA			NA					
delta-BHC	PST		NA			NA					
gamma-BHC (Lindane)	PST		NA			NA					
Heptachlor	PST		NA			NA					
Aldrin	PST		NA			NA					
Heptachlor Epoxide	PST		NA			NA					
Endosulfan I	PST		NA			NA					
Dieldrin	PST		NA			NA					
4,4'-DDE	PST		NA			NA					
Endrin	PST		NA			NA					
Endosulfan II	PST		NA			NA					
4,4'-DDD	PST		NA			NA					
Endosulfan Sulfate	PST		NA			NA					
4,4'-DDT	PST		NA			NA					
Methyoxychlor	PST		NA			NA					
Endrin Ketone	PST		NA			NA					
alpha-Chlordane	PST		NA			NA					
gamma-Chlordane	PST		NA			NA					
Toxaphene	PST		NA			NA					
Aroclor-1016	PCB		NA			NA					
Aroclor-1221	PCB		NA			NA					
Aroclor-1232	PCB		NA			NA					
Aroclor-1242	PCB		NA			NA					
Aroclor-1248	PCB		NA			NA					
Aroclor-1254	PCB		NA			NA					
Aroclor-1260	PCB		NA			NA					

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

NA - Not Analyzed

PHASE II

TABLE 4-10

ANALYTICAL RESULTS FOR GROUNDWATER FROM INTERMEDIATE WELLS

RAMAPO LANDFILL

(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			GW-1-I	GW-2-I	GW-4-I	GW-5-I	GW-6-I	GW-7-I	GW-8-I	GW-9-I
COLLECTION DATE			9/13/90	9/13/90	9/14/90	9/15/90	9/15/90	9/11/90	9/12/90	9/14/90
Parameter	Units	Class								
Aluminum	ug/L	MET		189 B	5160	16400	273	986	2550	
Antimony	ug/L	MET								
Arsenic	ug/L	MET							11 B	
Barium	ug/L	MET	43 B	8 B	76 B	90 B	6 B	26 B	559	
Beryllium	ug/L	MET								
Cadmium	ug/L	MET			4.9 B					
Calcium	ug/L	MET	111000	13800	113000	10200	11500	41900	112000	7860
Chromium	ug/L	MET	11.1	24.3	70.6	48.8	28.7	13.1	32.5	8.1 B
Cobalt	ug/L	MET	9.8 B			12.8 B		12.4 B	36.2 B	
Copper	ug/L	MET		5.1 B	20.9 B	37.8	5.9 B	5.8 B	11.4 B	3.2 B
Iron	ug/L	MET	7180	532	24500	23300	486	3000	30500	145
Lead	ug/L	MET	2.7 B	4.2 B	5.3 B*	9 *		2.2 B	3 B	
Magnesium	ug/L	MET	33500	4130 B	41300	10400	3020 B	18700	71300	1920 B
Manganese	ug/L	MET	1530	50.5	4500	276	33.1	631	1110	377
Mercury	ug/L	MET			0.2 BN	0.6 N	2.3 N		0.28 N	
Nickel	ug/L	MET	19 B	17.6 B	44.4	35 B	22 B	21.5 B	153	
Potassium	ug/L	MET	2640 B	4770 B	4780 B	4210 B	1170 B	1970 B	196000	807 B
Selenium	ug/L	MET								
Silver	ug/L	MET								
Sodium	ug/L	MET	47400	54600	75300	6170	4380 B	52900	643000	4460 B
Thallium	ug/L	MET								
Vanadium	ug/L	MET			15.2 B	35.2 B			19.5 B	
Zinc	ug/L	MET	7.9 B	9.9 B	17.8 B	43.7	8.5 B	15 B	23.9	3.7 B
Total Cyanide	ug/L	MET								
Total Phenols	mg/L	MISC								
Bicarbonate, as CaCO3		MISC	NA	NA	NA	NA	NA	NA	NA	NA
BOD	mg/L	MISC	NA	NA	NA	NA	3	NA	NA	
COD	mg/L	MISC	NA	NA	NA	NA		NA	NA	
Chloride	mg/L	MISC	NA	NA	NA	NA		NA	NA	
Hardness, as CaCO3		MISC	NA	NA	NA	NA	NA	NA	NA	NA
Ammonia-Nitrogen	mg/L	MISC	NA	NA	NA	NA		NA	NA	
Total Kjeldahl Nitrogen	mg/L	MISC	NA	NA	NA	NA	0.1	NA	NA	
Alkalinity, as CaCO3	mg/L	MISC	NA	NA	NA	NA	NA	NA	NA	NA
Acidity, as CaCO3	mg/L	MISC	NA	NA	NA	NA	NA	NA	NA	NA
NO3/NO2-N	mg/L	MISC	NA	NA	NA	NA		NA	NA	
Total Phosphorus	mg/L	MISC	NA	NA	NA	NA		NA	NA	
Oil & Grease	mg/L	MISC	NA	NA	NA	7.3	NA	NA	NA	
TOC	mg/L	MISC	NA	NA	NA	NA		NA	NA	
TSS	mg/L	MISC	NA	NA	NA	NA	4.4	NA	NA	
TDS	mg/L	MISC	NA	NA	NA	NA	112	NA	NA	68
Sulfate	mg/L	MISC	NA	NA	NA	NA	14.3	NA	NA	10.7
Sulfide	mg/L	MISC	NA	NA	NA	NA		NA	NA	
pH	SU	MISC	7.56	9.24	7.48	7.58	7.3	7.12	7.47	7.26
Specific Conductance	umhos	MISC	1220	580	1350	110	135	650	5800	120
Temperature	Deg. C	MISC	16	21	19	17	17	16	19	19

Only detected results are reported. N - Spike sample % recovery out of control limits. B - Less than quantitation limit but greater than or equal instrument detection limit.

NA - Not Analyzed * - Duplicate analysis not within control limits.

RAM 001 0665

PHASE II

TABLE 4-11

ANALYTICAL RESULTS FOR GROUNDWATER FROM DEEP WELLS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-R	GW-2-R	GW-3-R	GW-3-R-RE	GW-4-R	GW-4-R-RE	GW-5-R	GW-6-R	GW-7-R	GW-8-R	GW-9-R	GW-10-R
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/11/90	09/12/90	09/14/90	09/14/90
Parameter ug/L (ppb)	Class												
Chloromethane	VOC				NA		NA						
Bromomethane	VOC				NA		NA						
Vinyl Chloride	VOC				NA		NA						
Chloroethane	VOC				NA		NA						
Methylene Chloride	VOC				NA		NA						
Acetone	VOC				NA		NA				35	23	
Carbon Disulfide	VOC				NA		NA						
1,1-Dichloroethene	VOC				NA		NA						
1,1-Dichloroethane	VOC	0.80 J			NA	2.1	NA				1.0		
1,2-Dichloroethene (total)	VOC				NA		NA						
Chloroform	VOC				NA		NA						
1,2-Dichloroethane	VOC				NA	0.10 J	NA						
2-Butanone (or MEK)	VOC				NA		NA						
1,1,1-Trichloroethane	VOC				NA		NA						
Carbon Tetrachloride	VOC				NA		NA						
Vinyl Acetate	VOC				NA		NA						
Bromodichloromethane	VOC				NA		NA						
1,2-Dichloropropane	VOC				NA		NA						
Cis-1,3-dichloropropene	VOC				NA		NA						
Trichloroethene	VOC				NA		NA						
Dibromochloromethane	VOC				NA		NA						
1,1,2-Trichloroethane	VOC				NA		NA						
Benzene	VOC				NA	1.0	NA				0.40 J	0.90 J	
Trans-1,3-dichloropropene	VOC				NA		NA						
Bromoform	VOC				NA		NA						
4-Methyl-2-pentanone	VOC				NA		NA						
2-Hexanone	VOC				NA		NA						
Tetrachloroethene	VOC				NA		NA						
1,1,2,2-Tetrachloroethane	VOC				NA		NA						
Toluene	VOC				NA		NA		0.30 J				
Chlorobenzene	VOC				NA		NA				1.8	2.0	
Ethylbenzene	VOC				NA		NA						
Styrene	VOC				NA		NA						
Total Xylenes	VOC				NA		NA						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

NA - Not analyzed.
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

PHASE II

TABLE 4-11

ANALYTICAL RESULTS FOR GROUNDWATER FROM DEEP WELLS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-R	GW-2-R	GW-3-R	GW-3-R-RE	GW-4-R	GW-4-R-RE	GW-5-R	GW-6-R	GW-7-R	GW-8-R	GW-9-R	GW-10-R
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/11/90	09/12/90	09/14/90	09/14/90
Parameter ug/L (ppb)	Class												
Dichlorodifluoromethane	VOC				NA	0.20 J	NA						
trans-1,2-Dichloroethene	VOC				NA		NA						
2,2-Dichloropropane	VOC				NA		NA						
cis-1,2-Dichloroethene	VOC				NA	0.10 J	NA				0.90 J		
Bromochloromethane	VOC				NA		NA						
1,1-Dichloropropene	VOC				NA		NA						
Dibromomethane	VOC				NA		NA						
1,3-Dichloropropane	VOC				NA		NA						
meta and/or para-Xylene	VOC				NA		NA						
ortho-Xylene	VOC				NA		NA						
Isopropylbenzene	VOC				NA	0.50 J	NA				0.50 J	1.0	
Bromobenzene	VOC				NA		NA						
1,1,2,2-Tetrachloroethane	VOC				NA		NA						
1,2,3-Trichloropropane	VOC				NA		NA						
Propylbenzene	VOC				NA		NA					0.50 J	
2-Chlorotoluene	VOC				NA		NA						
4-Chlorotoluene	VOC				NA		NA						
1,3,5-Trimethylbenzene	VOC				NA		NA					1.9	
tert-Butylbenzene	VOC				NA		NA						
1,2,4-Trimethylbenzene	VOC				NA		NA						
sec-Butylbenzene	VOC				NA		NA						
1,3-Dichlorobenzene	VOC				NA		NA						
p-Isopropyltoluene	VOC				NA		NA					1.2	
1,4-Dichlorobenzene	VOC				NA		NA						
1,2-Dichlorobenzene	VOC				NA		NA					0.90 J	
Butylbenzene	VOC				NA		NA						
1,2-Dibromo-3-chloropropane	VOC				NA		NA						
1,2,4-Trichlorobenzene	VOC				NA		NA						
Hexachlorobutadiene	VOC				NA		NA						
Naphthalene	VOC				NA		NA				0.80 J	0.30 J	
1,2,3-Trichlorobenzene	VOC				NA		NA						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

PHASE II

TABLE 4-11

ANALYTICAL RESULTS FOR GROUNDWATER FROM DEEP WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-R	GW-2-R	GW-3-R	GW-3-R-RE	GW-4-R	GW-4-R-RE	GW-5-R	GW-6-R	GW-7-R	GW-8-R	GW-9-R	GW-10-R
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/11/90	09/12/90	09/14/90	09/14/90
Parameter ug/L (ppb)	Class												
Phenol	SEMI												
Bis(2-chloroethyl)ether	SEMI												
2-Chlorophenol	SEMI												
1,3-Dichlorobenzene	SEMI												
1,4-Dichlorobenzene	SEMI												
Benzyl Alcohol	SEMI												
1,2-Dichlorobenzene	SEMI												
2-Methylphenol	SEMI												
Bis(2-chloroisopropyl) ether	SEMI												
4-Methylphenol	SEMI												
N-Nitroso-di-n-propylamine	SEMI												
Hexachloroethane	SEMI												
Nitrobenzene	SEMI												
Isophorone	SEMI												
2-Nitrophenol	SEMI												
2,4-Dimethylphenol	SEMI												
Benzoic Acid	SEMI												
Bis(2-chloroethoxy) methane	SEMI												
2,4-Dichlorophenol	SEMI												
1,2,4-Trichlorobenzene	SEMI												
Naphthalene	SEMI												
4-Chloroaniline	SEMI												
Hexachlorobutadiene	SEMI												
4-Chloro-3-methylphenol	SEMI												
2-Methylnaphthalene	SEMI												
Hexachlorocyclopentadiene	SEMI												
2,4,6-Trichlorophenol	SEMI												
2,4,5-Trichlorophenol	SEMI												
2-Chloronaphthalene	SEMI												
2-Nitroaniline	SEMI												
Dimethyl Phthalate	SEMI												

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

RE - This sample required reextraction/reanalysis.

PHASE II

TABLE 4-11

ANALYTICAL RESULTS FOR GROUNDWATER FROM DEEP WELLS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-1-R	GW-2-R	GW-3-R	GW-3-R-RE	GW-4-R	GW-4-R-RE	GW-5-R	GW-6-R	GW-7-R	GW-8-R	GW-9-R	GW-10-R
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/11/90	09/12/90	09/14/90	09/14/90
Parameter ug/L (ppb)	Class												
Acenaphthylene	SEMI												
2,6-Dinitrotoluene	SEMI												
3-Nitroaniline	SEMI												
Acenaphthene	SEMI												
2,4-Dinitrophenol	SEMI												
4-Nitrophenol	SEMI												
Dibenzofuran	SEMI												
2,4-Dinitrotoluene	SEMI												
Diethylphthalate	SEMI					2 J					2 J		
4-Chlorophenyl-phenylether	SEMI												
Fluorene	SEMI												
4-Nitroaniline	SEMI												
4,6-Dinitro-2-methylphenol	SEMI												
N-nitrosodiphenylamine (1)	SEMI												
4-Bromophenyl Phenyl Ether	SEMI												
Hexachlorobenzene	SEMI												
Pentachlorophenol	SEMI												
Phenanthrene	SEMI												
Anthracene	SEMI												
Di-n-butylphthalate	SEMI												
Fluoranthene	SEMI												
Pyrene	SEMI												
Butylbenzylphthalate	SEMI										2 J		
3,3'-Dichlorobenzidine	SEMI												
Benzo(a)anthracene	SEMI												
Chrysene	SEMI												
bis(2-ethyl hexyl)phthalate	SEMI										9 J		
Di-n-octyl Phthalate	SEMI										130		
Benzo(b)fluoranthene	SEMI												
Benzo(k)fluoranthene	SEMI												
Benzo(a)pyrene	SEMI												
Indeno(1,2,3-cd)Pyrene	SEMI												
Dibenz(a,h)anthracene	SEMI												
Benzo(g,h,i)perylene	SEMI												

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.
RE - This sample required reextraction/reanalysis.

PHASE II

TABLE 4-11

ANALYTICAL RESULTS FOR GROUNDWATER FROM DEEP WELLS
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		GW-1-R	GW-2-R	GW-3-R	GW-3-R-RE	GW-4-R	GW-4-R-RE	GW-5-R	GW-6-R	GW-7-R	GW-8-R	GW-9-R	GW-10-R
COLLECTION DATE		09/13/90	09/13/90	09/13/90	09/13/90	09/14/90	09/14/90	09/15/90	09/15/90	09/11/90	09/12/90	09/14/90	09/12/90
Parameter ug/L (ppb)	Class												
alpha-BHC	PST				NA		NA						
beta-BHC	PST				NA		NA						
delta-BHC	PST				NA		NA						
gamma-BHC (Lindane)	PST				NA		NA						
Heptachlor	PST				NA		NA						
Aldrin	PST				NA		NA						
Heptachlor Epoxide	PST				NA		NA						
Endosulfan I	PST				NA		NA						
Dieldrin	PST				NA		NA						
4,4'-DDE	PST				NA		NA						
Endrin	PST				NA		NA						
Endosulfan II	PST				NA		NA						
4,4'-DDD	PST				NA		NA						
Endosulfan Sulfate	PST				NA		NA						
4,4'-DDT	PST				NA		NA						
Methyoxychlor	PST				NA		NA						
Endrin Ketone	PST				NA		NA						
alpha-Chlordane	PST				NA		NA						
gamma-Chlordane	PST				NA		NA						
Toxaphene	PST				NA		NA						
Aroclor-1016	PCB				NA		NA						
Aroclor-1221	PCB				NA		NA						
Aroclor-1232	PCB				NA		NA						
Aroclor-1242	PCB				NA		NA						
Aroclor-1248	PCB				NA		NA						
Aroclor-1254	PCB				NA		NA						
Aroclor-1260	PCB				NA		NA						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

PHASE II

TABLE 4-11

ANALYTICAL RESULTS FOR GROUNDWATER FROM DEEP WELLS
RAMAPO LANDFILL
(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			GW-1-R	GW-2-R	GW-3-R	GW-4-R	GW-5-R	GW-6-R	GW-7-R	GW-8-R	GW-9-R	GW-10-R
COLLECTION DATE			9/13/90	9/13/90	9/13/90	9/14/90	9/15/90	9/15/90	9/11/90	9/12/90	9/14/90	9/14/90
Parameter	Units	Class										
Aluminum	ug/L	MET	1520	463	223	321	159 B	420	1270	1020		2700
Antimony	ug/L	MET										
Arsenic	ug/L	MET									3.1 BW	
Barium	ug/L	MET	22 B	9 B	53 B	10 B	4 B	10 B	25 B	19 B	100 B	24 B
Beryllium	ug/L	MET										
Cadmium	ug/L	MET										
Calcium	ug/L	MET	95600	53400	99400	66300	14600	17800	64900	219000	79700	64000
Chromium	ug/L	MET	17.5	5.5 B	11.4	13.1	29.3	31.1	16.8	23.1	8.8	26.9
Cobalt	ug/L	MET			19.5 B					13.2 B	10.9 B	
Copper	ug/L	MET	14.8 B	5.4 B	3.8 B		3.4 B	10.3 B	7.7 B	39.3		11.4 B
Iron	ug/L	MET	2650	602	1370	5290	368	683	1940	2940	20200	4390
Lead	ug/L	MET	3 B	3 B	2.3 B	11.4 *		6.4 *	1.7 B	4.5 BW		2.2 B
Magnesium	ug/L	MET	18300	10600	30800	21100	5030	4220 B	22100	51100	25800	11500
Manganese	ug/L	MET	98.5	135	12400	1520	9.3 B	14.3 B	102	181	3270	110
Mercury	ug/L	MET					0.47 N			2		
Nickel	ug/L	MET			22.2 B			19.4 B	25.5 B	30.1 B	22 B	20.6 B
Potassium	ug/L	MET	2320 B	1260 B	2360 B	1490 B	1070 B	1220 B	2900 B	10500	18600	2510 B
Selenium	ug/L	MET										
Silver	ug/L	MET										
Sodium	ug/L	MET	15000	7210	82100	15300	5270	5370	21500	39600	147000	10700
Thallium	ug/L	MET										
Vanadium	ug/L	MET										6.1 B
Zinc	ug/L	MET	15.3 B	10.6 B	16 B	6.2 B		13.4 B	13.8 B	53.7	5.4 B	25.7
Total Cyanide	ug/L	MET										
Total Phenols	mg/L	MISC										
Bicarbonate, as CaCO3		MISC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BOD	mg/L	MISC	NA	NA	NA		NA	3.0	NA	NA	27	
COD	mg/L	MISC	NA	NA	NA		NA		NA	NA	97	
Chloride	mg/L	MISC	NA	NA	NA			6.1	NA	NA	204	26.5
Hardness, as CaCO3		MISC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ammonia-Nitrogen	mg/L	MISC	NA	NA	NA		NA		NA	NA	26.4	
Total Kjeldahl Nitrogen	mg/L	MISC	NA	NA	NA		NA		NA	NA	25.8	0.12
NO3/NO2-N	mg/L	MISC	NA	NA	NA	0.61	NA		NA	NA		
Total Phosphorus	mg/L	MISC	NA	NA	NA		NA		NA	NA		
Oil & Grease	mg/L	MISC	NA	NA	NA	NA	NA	2	NA	NA		5.65
TOC	mg/L	MISC	NA	NA	NA	NA	NA	2.3	NA	NA	24.81	4.67
TSS	mg/L	MISC	NA	NA	NA		NA	7	NA	NA	42	40
TDS	mg/L	MISC	NA	NA	NA	50	NA	125	NA	NA	775	252
Sulfate	mg/L	MISC	NA	NA	NA	9.6	NA	15.4	NA	NA	9.6	18.2
Sulfide	mg/L	MISC	NA	NA	NA		NA		NA	NA		
pH	SU	MISC	8.02	8.87	6.78	7.61	7.42	7.20	7.06	7.7	7.32	8.41
Specific Conductance	umhos	MISC	680	400	1100	550	140	151	600	1500	40 L	450
Temperature	Deg C	MISC	17	19	18	19	16	17	18	18	18	18

Only detected results are reported. N – Spike sample % recovery out of control limits L – Erroneous reading due to low battery on conductivity meter.
NA – Not Analyzed * – Duplicate analysis not within control limits. B – Less than quantitation limit but greater than or equal to instrument detection limit.

TABLE 4-12

USEPA ANALYTICAL RESULTS FOR GW-9
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-9-OS	GW-9-I	GW-9-R
COLLECTION DATE		09/14/90	09/14/90	09/14/90
Parameter ug/L (ppb)	Class			
Chloromethane	VOC			
Bromomethane	VOC			
Vinyl Chloride	VOC			
Chloroethane	VOC			
Methylene Chloride	VOC			
Acetone	VOC			
Carbon Disulfide	VOC			
1,1-Dichloroethene	VOC			
1,1-Dichloroethane	VOC			
1,2-Dichloroethene (total)	VOC			
Chloroform	VOC			
1,2-Dichloroethane	VOC			
2-Butanone (or MEK)	VOC			
1,1,1-Trichloroethane	VOC			
Carbon Tetrachloride	VOC			
Vinyl Acetate	VOC			
Bromodichloromethane	VOC			
1,2-Dichloropropane	VOC			
Cis-1,3-dichloropropene	VOC			
Trichloroethene	VOC			
Dibromochloromethane	VOC			
1,1,2-Trichloroethane	VOC			
Benzene	VOC			
Trans-1,3-dichloropropene	VOC			
Bromoform	VOC			
4-Methyl-2-pentanone	VOC			
2-Hexanone	VOC			
Tetrachloroethene	VOC			
1,1,2,2-Tetrachloroethane	VOC			
Toluene	VOC			
Chlorobenzene	VOC			
Ethylbenzene	VOC			
Styrene	VOC			
Total Xylenes	VOC			

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

TABLE 4-12

USEPA ANALYTICAL RESULTS FOR GW-9
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-9-OS	GW-9-I	GW-9-R
COLLECTION DATE		09/14/90	09/14/90	09/14/90
Parameter ug/L (ppb)	Class			
Phenol	SEMI			
Bis(2-chloroethyl)ether	SEMI			
2-Chlorophenol	SEMI			
1,3-Dichlorobenzene	SEMI			
1,4-Dichlorobenzene	SEMI			
Benzyl Alcohol	SEMI			
1,2-Dichlorobenzene	SEMI			
2-Methylphenol	SEMI			
Bis(2-chloroisopropyl) ether	SEMI			
4-Methylphenol	SEMI			
N-Nitroso-di-n-propylamine	SEMI			
Hexachloroethane	SEMI			
Nitrobenzene	SEMI			
Isophorone	SEMI			
2-Nitrophenol	SEMI			
2,4-Dimethylphenol	SEMI			
Benzoic Acid	SEMI			
Bis(2-chloroethoxy) methane	SEMI			
2,4-Dichlorophenol	SEMI			
1,2,4-Trichlorobenzene	SEMI			
Naphthalene	SEMI			
4-Chloroaniline	SEMI			
Hexachlorobutadiene	SEMI			
4-Chloro-3-methylphenol	SEMI			
2-Methylnaphthalene	SEMI			
Hexachlorocyclopentadiene	SEMI			
2,4,6-Trichlorophenol	SEMI			
2,4,5-Trichlorophenol	SEMI			
2-Chloronaphthalene	SEMI			
2-Nitroaniline	SEMI			
Dimethyl Phthalate	SEMI			

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

PHASE II

TABLE 4-12

USEPA ANALYTICAL RESULTS FOR GW-9
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		GW-9-OS	GW-9-I	GW-9-R
COLLECTION DATE		09/14/90	09/14/90	09/14/90
Parameter ug/L (ppb)	Class			
Acenaphthylene	SEMI			
2,6-Dinitrotoluene	SEMI			
3-Nitroaniline	SEMI			
Acenaphthene	SEMI			
2,4-Dinitrophenol	SEMI			
4-Nitrophenol	SEMI			
Dibenzofuran	SEMI			
2,4-Dinitrotoluene	SEMI			
Diethylphthalate	SEMI			
4-Chlorophenyl-phenylether	SEMI			
Fluorene	SEMI			
4-Nitroaniline	SEMI			
4,6-Dinitro-2-methylphenol	SEMI			
N-nitrosodiphenylamine (1)	SEMI			
4-Bromophenyl Phenyl Ether	SEMI			
Hexachlorobenzene	SEMI			
Pentachlorophenol	SEMI			
Phenanthrene	SEMI			
Anthracene	SEMI			
Di-n-butylphthalate	SEMI			
Fluoranthene	SEMI			
Pyrene	SEMI		3 J	
Butylbenzylphthalate	SEMI			
3,3'-Dichlorobenzidine	SEMI			
Benzo(a)anthracene	SEMI			
Chrysene	SEMI			
bis(2-ethyl hexyl)phthalate	SEMI	12 J	7 J	4 J
Di-n-octyl Phthalate	SEMI			
Benzo(b)fluoranthene	SEMI			
Benzo(k)fluoranthene	SEMI			
Benzo(a)pyrene	SEMI			
Indeno(1,2,3-cd)Pyrene	SEMI			
Dibenz(a,h)anthracene	SEMI			
Benzo(g,h,i)perylene	SEMI			

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

PHASE II

TABLE 4-12

USEPA ANALYTICAL RESULTS FOR GW-9
RAMAPO LANDFILL
(PESTICIDES AND PCBs)

WELL AND SAMPLE ID NUMBER			GW-9-OS	GW-9-I	GW-9-R
COLLECTION DATE			09/14/90	09/14/90	09/14/90
Parameter	ug/L (ppb)	Class			
alpha-BHC		PST			
beta-BHC		PST			
delta-BHC		PST			
gamma-BHC (Lindane)		PST			0.11
Heptachlor		PST			
Aldrin		PST			
Heptachlor Epoxide		PST			
Endosulfan I		PST			
Dieldrin		PST			
4,4'-DDE		PST			
Endrin		PST			
Endosulfan II		PST			
4,4'-DDD		PST			
Endosulfan Sulfate		PST			
4,4'-DDT		PST			
Methyoxychlor		PST			
Endrin Ketone		PST			
alpha-Chlordane		PST			
gamma-Chlordane		PST			
Toxaphene		PST			
Aroclor-1016		PCB			
Aroclor-1221		PCB			
Aroclor-1232		PCB			
Aroclor-1242		PCB			
Aroclor-1248		PCB			
Aroclor-1254		PCB			
Aroclor-1260		PCB			

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

PHASE II

TABLE 4-12

USEPA ANALYTICAL RESULTS FOR GW-9
RAMAPO LANDFILL
(METALS)

WELL AND SAMPLE ID NUMBER			GW-9-OS	GW-9-I	GW-9-R
COLLECTION DATE			9/14/90	9/14/90	9/14/90
Parameter	Units	Class			
Aluminum	ug/L	MET	143 B	45.8 B	37.2 B
Antimony	ug/L	MET			
Arsenic	ug/L	MET			4.3 B
Barium	ug/L	MET			117 B
Beryllium	ug/L	MET			
Cadmium	ug/L	MET			
Calcium	ug/L	MET	8260 E J	8430 E J	84900 E J
Chromium	ug/L	MET	7.3 B	20.5	10.6
Cobalt	ug/L	MET			13.0 B
Copper	ug/L	MET			
Iron	ug/L	MET	345	203	22700
Lead	ug/L	MET	2.4 B	2.7 B	4.6
Magnesium	ug/L	MET	2130 B	2030 B	27900 J
Manganese	ug/L	MET	21.0 E	360 E J	3590 E J
Mercury	ug/L	MET			
Nickel	ug/L	MET		17.2 B	35.3 B
Potassium	ug/L	MET			19100
Selenium	ug/L	MET			
Silver	ug/L	MET			
Sodium	ug/L	MET	2400 B E	4670 B E	154000 E J
Thallium	ug/L	MET			
Vanadium	ug/L	MET			
Zinc	ug/L	MET			
Total Cyanide	ug/L	MET			

Only detected results are reported.

E -Estimated value due to interference..

B - Less than quantitation limit but greater than or than or equal to instrument detection limit.

J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero.

TABLE 4-13

COMPARISON OF GROUNDWATER FROM THE OVERBURDEN TO ARARS

Parameter	Upgradient Max. Conc. (ppb) Detected	Downgradient Max. Conc. (ppb) Detected	Downgradient Location of Max. Concentration	ARAR Value[a] (ppb)
Benzene	2	2	GW-8	ND
Acetone		21	GW-6	50[c]
Toluene		0.7	GW-6	5[b]
Tetrachloroethene		0.6	GDT-1	5
Chlorobenzene		1	GW-8	5
p-Isopropyltoluene		1.2	GW-6	5[b]
1,4-Dichlorobenzene		1.1	GW-8	4.7[+]
Bis(2-ethylhexyl)phthalate		3	GW-1/GW-2	50
Aluminum	17,200	19,000	GW-2	---
Arsenic		26.1	GW-8	25
Barium	98	441	GW-8	1,000
Calcium	13,400	132,000	GW-2	---
Chromium	90	1,290	GW-3	50
Cobalt	12	42.3	GW-2	---
Copper	38	78.3	GW-1	200
Iron	27,000	229,000	GW-8	300
Lead	5.8	34.1	GW-2	15[f]
Magnesium	9,180	31,500	GW-6	35,000
Manganese	981	31,200	GW-10	300
Mercury	0.2	0.63	GW-6	2
Nickel	51.2	331	GW-3	---
Potassium	4,450	31,200	GW-7	---
Sodium	13,300	102,000	GW-8	20,000
Vanadium	42	51.6	GW-1	---
Zinc	63	107	GW-2	300

TABLE 4-13 (Continued)

Parameter	Upgradient Max. Conc. (ppm) Detected	Downgradient Max. Conc. (ppm) Detected	Downgradient Location of Max. Concentration	ARAR Value[a] (ppm)
BOD	NA	20	GW-7	---
COD	NA	140	GW-8	---
Ammonia-N	NA	59.6	GW-8	---
TKN	NA	61	GW-8	---
Alkalinity	NA	1,048	GW-8	---
Acidity	NA	563	GW-8	---
NO_3/NO_2-N	NA	0.62	GW-9	10[e]
Total Phosphorus	NA	0.79	GW-2	---
TOC	NA	77.4	GW-3	0.1
TSS	NA	5,000	GW-1	---
TDS	NA	1,500	GW-8	---
Sulfate	NA	80.9	GW-2	250

a - The values were obtained from New York State DEC Water Quality Standards and Guidelines dated September 1990.

b - The values were obtained from Chapter I - New York State Sanitary Code, Subpart 5-1, Principle Organic Contaminants.

c - The values were obtained from Chapter I - New York State Sanitary Code, Subpart 5-1, Unspecified Organic Contaminants.

d - The values were obtained from USEPA Drinking Water Standards

e - This values is for NO_3-N only. Analytical results are given as NO_3/NO_2-N

f - USEPA proposed action level

\+ - This value applies to the sum of 1,4 and 1,2-dichlorobenzene

NA - This well could not be sampled due to insufficient sample volume.

ND - Not detected

RAM 001 0678

TABLE 4-13 (Continued)

COMPARISON OF GROUNDWATER FROM THE INTERMEDIATE AQUIFER TO ARARS

Parameter	Upgradient Max. Conc. (ppb) Detected	Downgradient Max. Conc. (ppb) Detected	Downgradient Location of Max. Conc.	ARAR Value[a] (ppb)
1,1-Dichloroethane		3	GW-4	5
Chloromethane		3	GW-8	5[b]
1,2-Dichloroethane		0.2	GW-4	5
Trichloroethene		0.2	GW-6	5
Tetrachloroethene	2.3	0.6	GW-6	5
cis-1,2-Dichloroethene		0.3	GW-1	5[b]
Acetone		28	GW-2	50[c]
Toluene	0.4	1	GW-8	5[b]
Benzene		2.9	GW-8	ND
Styrene		0.6	GW-6	5
Chlorobenzene		16	GW-8	5
Isoporopylbenzene		3.7	GW-8	5[b]
1,3,4-Trimethylbenzene		1.9	GW-4/GW-6	5[b]
1,2,4-Trimethylbenzene		1.4	GW-8	5[b]
m&p-Xylene		1.3	GW-6	5
o-Xylene		0.7	GW-8	5
Propylbenzene		0.8	GW-8	5[b]
tert-butylbenzene		1.5	GW-8	5[b]
p-Isopropyltoluene		1.7	GW-8	5[b]
1,2-Dichlorobenzene		1.2	GW-8	4.7[+]
Diethylphthalate		5	GW-4	50
Bis(2-ethylhexyl)phthalate		30	GW-7	50
Naphthalene		4.2	GW-8	10
pyrene		3	GW-9 split	50

RAM 001 0679

TABLE 4-13 (Continued)

Parameter	Upgradient Max. Conc. (ppb) Detected	Downgradient Max. Conc. (ppb) Detected	Downgradient Location of Max. Conc.	ARAR Value[a] (ppb)
alpha-BHC	0.24		GW-5	ND
delta-BHC		1.9	GW-4	ND
Aluminum	16,400	5,160	GW-4	--
Arsenic		11	GW-8	25
Barium	90	559	GW-8	1,000
Cadmium		4.9	GW-4	10
Calcium	10,200	113,000	GW-4	--
Chromium	143	280	GW-1	50
Cobalt	12.8	36.2	GW-8	--
Copper	37.8	20.9	GW-4	200
Iron	23,300	30,500	GW-8	300
Lead	9	5.3	GW-4	15[f]
Magnesium	10,400	71,400	GW-8	35,000
Manganese	276	4,500	GW-4	300
Mercury	0.6	2.3	GW-6	2
Nickel	69	162	GW-1	--
Potassium	4,210	196,000	GW-8	--
Sodium	6,170	643,000	GW-8	--
Vanadium	35.2	19.5	GW-8	--
Zinc	43.7	23.9	GW-8	300

RAM 001 0680

TABLE 4-13 (Continued)

COMPARISON OF GROUNDWATER FROM THE INTERMEDIATE AQUIFER TO ARARS

Parameter	Upgradient Conc. (ppm) Detected	Downgradient Max. (ppm) Detected	Downgradient Location of Max Conc.	ARAR Value[a] (ppm)
BOD	19	25	GW-4	--
COD	17.7	94.4	GW-8	--
Total Kjeldahl Nitrogen		28.3	GW-8	--
Alkalanity	48	772	GW-8	---
Acidity	23.2	622	GW-8	--
Total Phosphorus		0.44	GW-2	--
Oil & Grease	7.3	3	GW-1	--
TOC	2.21	74.8	GW-8	0.1
TSS	30	560	GW-1	--
TDS	60	1,200	GW-8	--
Sulfate	13.3	62.8	GW-1	250

a - The values were obtained from New York State DEC Water Quality Standards and Guidelines dated September 1990.

b - The values were obtained from Chapter I - New York State Sanitary Code, Subpart 5-1, Principle Organic Contaminants.

c - The values were obtained from Chapter I - New York State Sanitary Code, Subpart 5-1, Unspecified Organic Contaminants.

d - The values were obtained from USEPA Drinking Water Standards

e - This values is for NO_3-N only. Analytical results are given as NO_3/NO_2-N

f - USEPA proposed action level

+ - This value applies to the sum of 1,4 and 1,2-dichlorobenzene

NA - This well could not be sampled due to insufficient sample volume.

ND - Not detected

RAM 001 0681

TABLE 4-13 (Continued)

COMPARISON OF GROUNDWATER FROM THE BEDROCK AQUIFER TO ARARs

Parameter	Upgradient Max. Conc. (ppb) Detected	Downgradient Max. Conc. (ppb) Detected	Downgradient Location of Max. Concentration	ARAR Value[a] (ppb)
Carbon Disulfide		2	GW-4	---
Acetone		35	GW-8	50[c]
1,1-Dichloroethane		5	GW-4	5
1,2-Dichloroethane		0.1	GW-4	5
2-Butanone	7		GW-5	---
Benzene		3	GW-8	ND
4-methyl-2-pentanone		3	GW-1	---
Toluene		0.3	GW-6	5[b]
Chlorobenzene		2	GW-9	5
Dichlorodifluoro-methane		0.2	GW-4	5[b]
cis-1,2-dichloroethene		0.9	GW-8	5[b]
isopropylbenzene		1.0	GW-9	5[b]
propylbenzene		0.5	GW-9	5[b]
1,3,5-trimethylbenzene		1.9	GW-9	5[b]
p-isopropyltoluene		1.2	GW-9	5[b]
1,2-dichlorobenzene		0.9	GW-9	4.7[+]
Naphthalene		0.8	GW-8	10
Diethylphthalate		3	GW-4	50
Butylbenzylphthalate		2	GW-8	50
Bis(2-ethylhexyl) phthalate	3	27	GW-7	50
Di-n-octylphthalate		130	GW-8	50
gamma-BHC		0.11	GW-9 split	ND
Aluminum	485	2700	GW-10	---
Arsenic		4.9	GW-9 split	25
Barium	8	117	GW-9 split	1,000

TABLE 4-13 (Continued)

Parameter	Upgradient Max. Conc. (ppb) Detected	Downgradient Max. Conc. (ppb) Detected	Downgradient Location of Max. Concentration	ARAR Value[a] (ppb)
Calcium	14,600	219,000	GW-8	---
Chromium	29.3	39.7	GW-1	50
Cobalt		19.5	GW-3	---
Copper	3.4	39.3	GW-8	200
Iron	683	22,700	GW-9 split	300
Lead		11.4	GW-4	15[f]
Magnesium	5030	51,100	GW-8	35,000
Manganese	22.3	12,400	GW-3	300
Mercury	0.47	2	GW-8	2
Nickel	14.2	35.3	GW-9 split	---
Potassium	1070	19,100	GW-9 split	---
Sodium	5640	154,000	GW-9 split	20,000
Vanadium		6.1	GW-10	---
Zinc	6.9	53.7	GW-8	300

RAM 001 0683

TABLE 4-13 (Continued)

Parameter	Upgradient Max. Conc. (ppm) Detected	Downgradient Max. Conc. (ppm) Detected	Downgradient Location of Max. Concentration	ARAR Value[a] (ppm)
BOD	18	27	GW-9	
COD	51	97	GW-9	
Ammonia - N		26.4	GW-9	
TKN		25.8	GW-9	
Alkalinity	52	444	GW-8	
Acidity	39	380	GW-8	
NO3/NO2-N		0.62	GW-7	
Total Phosphorus	0.29	0.34	GW-1	10
Oil & Grease		6.7	GW-1	
TOC	4.08	95.1	GW-3	0.1
TSS	20	60	GW-4	
TDS	80	800	GW-8	
Sulfate	19.8	39.9	GW-8	250
pH	7.8	8.87	GW-2	
Spec. Conductance	140	1500	GW-8	

a - The values were obtained from New York State DEC Water Quality Standards and Guidelines dated September 1990.

b - The values were obtained from Chapter I - New York State Sanitary Code, Subpart 5-1, Principle Organic Contaminants.

c - The values were obtained from Chapter I - New York State Sanitary Code, Subpart 5-1, Unspecified Organic Contaminants.

d - The values were obtained from USEPA Drinking Water Standards

e - This values is for NO_3-N only. Analytical results are given as NO_3/NO_2-N

f - USEPA proposed action level

+ - This value applies to the sum of 1,4 and 1,2-dichlorobenzene

NA - This well could not be sampled due to insufficient sample volume.

ND - Not detected

RAM 001 0684

TABLE 4-14

SUMMARY OF GROUNDWATER ARARS EXCEEDANCES

OVERBURDEN

Parameter	Location of Exceedance
Arsenic	GW-8
Chromium	GW-1, GW-2, GW-3, GW-4, GW-5
Iron	GW-1, GW-2, GW-3, GW-4, GW-5, GW-6, GW-7, GW-8, GW-9 split
Lead	GW-2
Manganese	GW-1, GW-2, GW-3, GW-4, GW-5, GW-6, GW-7, GW-8, GW-10
Sodium	GW-1, GW-3, GW-4, GW-6, GW-7, GW-8
TOC	GW-1 through GW-10, not analyzed in GW-5
Benzene	GW-5, GW-8, GW-4

INTERMEDIATE

Parameter	Location of Exceedance
Benzene	GW-1, GW-4, GW-6, GW-7, GW-8, GW-9
Chlorobenzene	GW-8
alpha-BHC	GW-5
delta-BHC	GW-4
Chromium	GW-1, GW-4, GW-5, GW-7, GW-8
Iron	GW-1 through GW-8
Magnesium	GW-4, GW-8
Manganese	GW-1, GW-4, GW-7, GW-8, GW-9
Mercury	GW-6
TOC	GW-1, GW-4, GW-5, GW-7, GW-8

BEDROCK

Parameter	Location of Exceedance
1,1-Dichloroethane	GW-4
Benzene	GW-4, GW-8, GW-9
Di-n-octyl phthalate	GW-8
gamma-BHC	GW-7, GW-9 split
Iron	All wells
Magnesium	GW-8
Manganese	GW-3, GW-4, GW-8, GW-9, GW-9 split
Mercury	GW-8
Sodium	GW-3, GW-4, GW-7, GW-8, GW-9
TOC	GW-3, GW-4, GW-5, GW-8, GW-9, GW-10

TABLE 4-15

PHASE I ANALYTICAL RESULTS FOR SURFACE WATER AND LEACHATE SEEPS
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SW-1	SW-2	SW-3	SW-4	SW-LS-1	SW-LS-2
COLLECTION DATE		10/25/89	10/26/89	10/26/89	10/26/89	10/23/89	10/23/89
Parameter ug/L (ppb)	Class						
Chloromethane	VOC						
Bromomethane	VOC						
Vinyl Chloride	VOC						
Chloroethane	VOC						
Methylene Chloride	VOC		R				
Acetone	VOC						
Carbon Disulfide	VOC						
1,1-Dichloroethene	VOC						
1,1-Dichloroethane	VOC						
1,2-Dichloroethene (total)	VOC						
Chloroform	VOC						
1,2-Dichloroethane	VOC						
2-Butanone (or MEK)	VOC						
1,1,1-Trichloroethane	VOC						
Carbon Tetrachloride	VOC						
Vinyl Acetate	VOC						
Bromodichloromethane	VOC						
1,2-Dichloropropane	VOC						
Cis-1,3-dichloropropene	VOC						
Trichloroethene	VOC						
Dibromochloromethane	VOC						
1,1,2-Trichloroethane	VOC						
Benzene	VOC						
Trans-1,3-dichloropropene	VOC						
Bromoform	VOC						
4-Methyl-2-pentanone	VOC						
2-Hexanone	VOC						
Tetrachloroethene	VOC						
1,1,2,2-Tetrachloroethane	VOC						
Toluene	VOC						
Chlorobenzene	VOC						1 J
Ethylbenzene	VOC						
Styrene	VOC						
Total Xylenes	VOC						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

R - Compound rejected because it was detected in the associated method blank at similar concentrations.

TABLE 4-15

PHASE I ANALYTICAL RESULTS FOR SURFACE WATER AND LEACHATE SEEPS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SW-1	SW-2	SW-3	SW-4	SW-LS-1	SW-LS-2
COLLECTION DATE		10/25/89	10/26/89	10/26/89	10/26/89	10/23/89	10/23/89
Parameter ug/L (ppb)	Class						
Phenol	SEMI		R	R	R		
Bis(2-chloroethyl)ether	SEMI		R	R	R		
2-Chlorophenol	SEMI		R	R	R		
1,3-Dichlorobenzene	SEMI		R	R	R		
1,4-Dichlorobenzene	SEMI		R	R	R		
Benzyl Alcohol	SEMI		R	R	R		
1,2-Dichlorobenzene	SEMI		R	R	R		
2-Methylphenol	SEMI		R	R	R		
Bis(2-chloroisopropyl) ether	SEMI		R	R	R		
4-Methylphenol	SEMI		R	R	R		
N-Nitroso-di-n-propylamine	SEMI		R	R	R		
Hexachloroethane	SEMI		R	R	R		
Nitrobenzene	SEMI		R	R	R		
Isophorone	SEMI		R	R	R		
2-Nitrophenol	SEMI		R	R	R		
2,4-Dimethylphenol	SEMI		R	R	R		
Benzoic Acid	SEMI		R	R	R		
Bis(2-chloroethoxy) methane	SEMI		R	R	R		
2,4-Dichlorophenol	SEMI		R	R	R		
1,2,4-Trichlorobenzene	SEMI		R	R	R		
Naphthalene	SEMI		R	R	R		
4-Chloroaniline	SEMI		R	R	R		
Hexachlorobutadiene	SEMI		R	R	R		
4-Chloro-3-methylphenol	SEMI		R	R	R		
2-Methylnaphthalene	SEMI		R	R	R		
Hexachlorocyclopentadiene	SEMI		R	R	R		
2,4,6-Trichlorophenol	SEMI		R	R	R		
2,4,5-Trichlorophenol	SEMI		R	R	R		
2-Chloronaphthalene	SEMI		R	R	R		
2-Nitroaniline	SEMI		R	R	R		
Dimethyl Phthalate	SEMI		R	R	R		

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

R - The entire semivolatile fraction has been rejected due to holding time violations.

TABLE 4-15

PHASE I ANALYTICAL RESULTS FOR SURFACE WATER AND LEACHATE SEEPS
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SW-1	SW-2	SW-3	SW-4	SW-LS-1	SW-LS-2
COLLECTION DATE		10/25/89	10/26/89	10/26/89	10/26/89	10/23/89	10/23/89
Parameter ug/L (ppb)	Class						
Acenaphthylene	SEMI		R	R	R		
2,6-Dinitrotoluene	SEMI		R	R	R		
3-Nitroaniline	SEMI		R	R	R		
Acenaphthene	SEMI		R	R	R		
2,4-Dinitrophenol	SEMI		R	R	R		
4-Nitrophenol	SEMI		R	R	R		
Dibenzofuran	SEMI		R	R	R		
2,4-Dinitrotoluene	SEMI		R	R	R		
Diethylphthalate	SEMI		R	R	R		
4-Chlorophenyl-phenylether	SEMI		R	R	R		
Fluorene	SEMI		R	R	R		
4-Nitroaniline	SEMI		R	R	R		
4,6-Dinitro-2-methylphenol	SEMI		R	R	R		
N-nitrosodiphenylamine (1)	SEMI		R	R	R		
4-Bromophenyl Phenyl Ether	SEMI		R	R	R		
Hexachlorobenzene	SEMI		R	R	R		
Pentachlorophenol	SEMI		R	R	R		
Phenanthrene	SEMI		R	R	R		
Anthracene	SEMI		R	R	R		
Di-n-butylphthalate	SEMI		R	R	R		
Fluoranthene	SEMI		R	R	R		
Pyrene	SEMI		R	R	R		
Butylbenzylphthalate	SEMI		R	R	R		
3,3'-Dichlorobenzidine	SEMI		R	R	R		
Benzo(a)anthracene	SEMI		R	R	R		
Chrysene	SEMI		R	R	R		
bis(2-ethyl hexyl)phthalate	SEMI		R	R	R		
Di-n-octyl Phthalate	SEMI		R	R	R		
Benzo(b)fluoranthene	SEMI		R	R	R		
Benzo(k)fluoranthene	SEMI		R	R	R		
Benzo(a)pyrene	SEMI		R	R	R		
Indeno(1,2,3-cd)Pyrene	SEMI		R	R	R		
Dibenz(a,h)anthracene	SEMI		R	R	R		
Benzo(g,h,i)perylene	SEMI		R	R	R		

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

R - The entire semivolatile fraction has been rejected due to holding time violations.

TABLE 4-15

PHASE I ANALYTICAL RESULTS FOR SURFACE WATER AND LEACHATE SEEPS
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		SW-1	SW-2	SW-3	SW-4	SW-LS-1	SW-LS-2
COLLECTION DATE		10/25/89	10/26/89	10/26/89	10/26/89	10/23/89	10/23/89
Parameter ug/L (ppb)	Class						
alpha-BHC	PST	R	R	R	R	R	R
beta-BHC	PST	R	R	R	R	R	R
delta-BHC	PST	R	R	R	R	R	R
gamma-BHC (Lindane)	PST	R	R	R	R	R	R
Heptachlor	PST	R	R	R	R	R	R
Aldrin	PST	R	R	R	R	R	R
Heptachlor Epoxide	PST	R	R	R	R	R	R
Endosulfan I	PST	R	R	R	R	R	R
Dieldrin	PST	R	R	R	R	R	R
4,4'-DDE	PST	R	R	R	R	R	R
Endrin	PST	R	R	R	R	R	R
Endosulfan II	PST	R	R	R	R	R	R
4,4'-DDD	PST	R	R	R	R	R	R
Endosulfan Sulfate	PST	R	R	R	R	R	R
4,4'-DDT	PST	R	R	R	R	R	R
Methyoxychlor	PST	R	R	R	R	R	R
Endrin Ketone	PST	R	R	R	R	R	R
alpha-Chlordane	PST	R	R	R	R	R	R
gamma-Chlordane	PST	R	R	R	R	R	R
Toxaphene	PST	R	R	R	R	R	R
Aroclor-1016	PCB	R	R	R	R	R	R
Aroclor-1221	PCB	R	R	R	R	R	R
Aroclor-1232	PCB	R	R	R	R	R	R
Aroclor-1242	PCB	R	R	R	R	R	R
Aroclor-1248	PCB	R	R	R	R	R	R
Aroclor-1254	PCB	R	R	R	R	R	R
Aroclor-1260	PCB	R	R	R	R	R	R

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

R - The entire pesticide/PCB fraction has been rejected due to holding time violations.

TABLE 4-15

PHASE I ANALYTICAL RESULTS FOR SURFACE WATER AND LEACHATE SEEPS
RAMAPO LANDFILL
(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			SW-1	SW-2	SW-3	SW-4	SW-LS-1	SW-LS-2
COLLECTION DATE			10/25/89	10/26/89	10/26/89	10/26/89	10/23/89	10/23/89
Parameter	Units	Class						
Aluminum	ug/L	TAL	131	120		251	201	358000
Antimony	ug/L	TAL	37.8					
Arsenic	ug/L	TAL	1.9				1.2	4.8
Barium	ug/L	TAL	83.0	14.0	15.0	11.0	72.0	5780.0
Beryllium	ug/L	TAL						10
Cadmium	ug/L	TAL						149
Calcium	ug/L	TAL	110000	3190	4160	3720	154000	1368000
Chromium	ug/L	TAL						564
Cobalt	ug/L	TAL					11	508
Copper	ug/L	TAL	6.4				5.7	705
Iron	ug/L	TAL	2630	93.0		74.0	2240.0	2739000
Lead	ug/L	TAL	1.4			1.4		918
Magnesium	ug/L	TAL	33100	853	1090	1120	45400	741000
Manganese	ug/L	TAL	1120	19.5	6.9	17.2	674	78300
Mercury	ug/L	TAL	1.2					1.5
Nickel	ug/L	TAL	25.2					850
Potassium	ug/L	TAL	42100	432	467	425	65900	96500
Selenium	ug/L	TAL					1.6	1.2
Silver	ug/L	TAL						47.4
Sodium	ug/L	TAL	109000	2700	2700	2790	128000	80500
Thallium	ug/L	TAL		5.3		5.2		
Vanadium	ug/L	TAL						780
Zinc	ug/L	TAL	20.8	35.7	54.9	47.9	23.7	4010
Total Cyanide	ug/L	TAL	33				37.8	35.8
Total Phenols	mg/L	MISC	0.018	0.007	0.007		0.024	0.042
Bicarbonate, as CaCO3	mg/L	MISC	4.0	4.0	8.0	4.0	NA	NA
BOD	mg/L	MISC	NA				NA	NA
COD	mg/L	MISC	75.7				NA	NA
Hardness, as CaCO3	mg/L	MISC	477	12.4	13.8	13.9	NA	NA
Ammonia-Nitrogen	mg/L	MISC	21.9	0.11	0.10	0.09	NA	NA
Total Kjeldahl Nitrogen	mg/L	MISC	23.8	0.35	0.31	0.24	NA	NA
Alkalinity, as CaCO3	mg/L	MISC	4.0	4.0	8.0	4.0	NA	NA
Acidity, as CaCO3	mg/L	MISC	NA	2.0	6.0	8.0	NA	NA
NO3-N	mg/L	MISC	6.96				NA	NA
NO2-N	mg/L	MISC	2.38			0.019	NA	NA
Total Phosphorus	mg/L	MISC					NA	NA
Oil & Grease	mg/L	MISC	2				NA	NA
TOC	mg/L	MISC	21.3				NA	NA
TSS	mg/L	MISC	4	3	3	4	NA	NA
TDS	mg/L	MISC	873	32	53	56	NA	NA
Sulfate	mg/L	MISC	74.6	57.1	19.5	20.9	NA	NA
Sulfide	mg/L	MISC	2	1.4			NA	NA
pH	SU	MISC	7.28	6.93	7.28	6.96	NA	NA
Specific Conductance	umhos	MISC	1840	738	754	781	NA	NA
Temp	C	MISC	13	11	11	12.5	NA	NA

NOTE: Only detected results are reported. NA - Not Analyzed

PHASE II

TABLE 4-16

ANALYTICAL RESULTS FOR SURFACE WATER
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SW-1	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	LIN	LEF
COLLECTION DATE		07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	08/08/90	08/08/90
Parameter ug/L (ppb)	Class									
Chloromethane	VOC	NA	NA	NA						
Bromomethane	VOC	NA	NA	NA						
Vinyl Chloride	VOC	NA	NA	NA	1.9	0.7 J				
Chloroethane	VOC	NA	NA	NA						
Methylene Chloride	VOC	NA	NA	NA						
Acetone	VOC	NA	NA	NA						
Carbon Disulfide	VOC	NA	NA	NA						
1,1-Dichloroethene	VOC	NA	NA	NA						
1,1-Dichloroethane	VOC	NA	NA	NA						
1,2-Dichloroethene (total)	VOC	NA	NA	NA						
Chloroform	VOC	NA	NA	NA						
1,2-Dichloroethane	VOC	NA	NA	NA						
2-Butanone (or MEK)	VOC	NA	NA	NA						
1,1,1-Trichloroethane	VOC	NA	NA	NA						
Carbon Tetrachloride	VOC	NA	NA	NA						
Vinyl Acetate	VOC	NA	NA	NA						
Bromodichloromethane	VOC	NA	NA	NA						
1,2-Dichloropropane	VOC	NA	NA	NA						
Cis-1,3-dichloropropene	VOC	NA	NA	NA						
Trichloroethene	VOC	NA	NA	NA						
Dibromochloromethane	VOC	NA	NA	NA						
1,1,2-Trichloroethane	VOC	NA	NA	NA						
Benzene	VOC	NA	NA	NA			0.08 J		0.70 J	
Trans-1,3-dichloropropene	VOC	NA	NA	NA						
Bromoform	VOC	NA	NA	NA						
4-Methyl-2-pentanone	VOC	NA	NA	NA						
2-Hexanone	VOC	NA	NA	NA						
Tetrachloroethene	VOC	NA	NA	NA						
1,1,2,2-Tetrachloroethane	VOC	NA	NA	NA						
Toluene	VOC	NA	NA	NA		0.08 J	0.2 J		R	
Chlorobenzene	VOC	NA	NA	NA					2.0	
Ethylbenzene	VOC	NA	NA	NA					2.2	
Styrene	VOC	NA	NA	NA						
Total Xylenes	VOC	NA	NA	NA						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

NA - Not analyzed.
J - Meets identification criteria but the value is less than the sample quantitation limit and greater than zero
B - The compound is detected in the associated method blank as well as in the sample
R - Analyte rejected due to blank contamination.

PHASE II

TABLE 4-16

ANALYTICAL RESULTS FOR SURFACE WATER
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SW-1	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	LIN	LEF
COLLECTION DATE		07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	08/08/90	08/08/90
Parameter ug/L (ppb)	Class									
Dichlorodifluoromethane	VOC	NA	NA	NA						
trans-1,2-Dichloroethene	VOC	NA	NA	NA						
2,2-Dichloropropane	VOC	NA	NA	NA						
cis-1,2-Dichloroethene	VOC	NA	NA	NA					0.20 J	
Bromochloromethane	VOC	NA	NA	NA						
1,1-Dichloropropene	VOC	NA	NA	NA						
Dibromomethane	VOC	NA	NA	NA						
1,3-Dichloropropane	VOC	NA	NA	NA						
meta and/or para-Xylene	VOC	NA	NA	NA					3.4	
ortho-Xylene	VOC	NA	NA	NA					1.6	
Isopropylbenzene	VOC	NA	NA	NA					0.60 J	
Bromobenzene	VOC	NA	NA	NA						
1,1,2,2-Tetrachloroethane	VOC	NA	NA	NA						
1,2,3-Trichloropropane	VOC	NA	NA	NA					1.9	
Propylbenzene	VOC	NA	NA	NA					0.50 J	
2-Chlorotoluene	VOC	NA	NA	NA					0.20 J	
4-Chlorotoluene	VOC	NA	NA	NA					0.80 J	
1,3,5-Trimethylbenzene	VOC	NA	NA	NA					1.8	
tert-Butylbenzene	VOC	NA	NA	NA					0.50 J	
1,2,4-Trimethylbenzene	VOC	NA	NA	NA					1.0	
sec-Butylbenzene	VOC	NA	NA	NA					0.50 J	
1,3-Dichlorobenzenep	VOC	NA	NA	NA						
p-Isopropyltoluene	VOC	NA	NA	NA					1.2	
1,4-Dichlorobenzene	VOC	NA	NA	NA					R	R
1,2-Dichlorobenzene	VOC	NA	NA	NA					0.90 J	
Butylbenzene	VOC	NA	NA	NA					0.60 J	
1,2-Dibromo-3-chloropropane	VOC	NA	NA	NA						
1,2,4-Trichlorobenzene	VOC	NA	NA	NA						
Hexachlorobutadiene	VOC	NA	NA	NA						
Naphthalene	VOC	NA	NA	NA					0.50 J	
1,2,3-Trichlorobenzene	VOC	NA	NA	NA						

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

J - Meets identification criteria, but the value is less than the sample quantitation limit and greater than zero.
B - The compound was detected in the associated method blank as well as in the sample.
R - Analyte rejected due to blank contamination.

PHASE II

TABLE 4-16

ANALYTICAL RESULTS FOR SURFACE WATER
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SW-1	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	LIN	LEF
COLLECTION DATE		07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	08/08/90	08/08/90
Parameter ug/L (ppb)	Class									
Phenol	SEMI	NA								
Bis(2-chloroethyl)ether	SEMI	NA								
2-Chlorophenol	SEMI	NA								
1,3-Dichlorobenzene	SEMI	NA								
1,4-Dichlorobenzene	SEMI	NA								
Benzyl Alcohol	SEMI	NA								
1,2-Dichlorobenzene	SEMI	NA								
2-Methylphenol	SEMI	NA								
Bis(2-chloroisopropyl) ether	SEMI	NA								
4-Methylphenol	SEMI	NA								
N-Nitroso-di-n-propylamine	SEMI	NA								
Hexachloroethane	SEMI	NA								
Nitrobenzene	SEMI	NA								
Isophorone	SEMI	NA								
2-Nitrophenol	SEMI	NA								
2,4-Dimethylphenol	SEMI	NA								
Benzoic Acid	SEMI	NA							0.8 J	1.0 J
Bis(2-chloroethoxy) methane	SEMI	NA								
2,4-Dichlorophenol	SEMI	NA								
1,2,4-Trichlorobenzene	SEMI	NA								
Naphthalene	SEMI	NA								
4-Chloroaniline	SEMI	NA								
Hexachlorobutadiene	SEMI	NA								
4-Chloro-3-methylphenol	SEMI	NA								
2-Methylnaphthalene	SEMI	NA								
Hexachlorocyclopentadiene	SEMI	NA								
2,4,6-Trichlorophenol	SEMI	NA								
2,4,5-Trichlorophenol	SEMI	NA								
2-Chloronaphthalene	SEMI	NA								
2-Nitroaniline	SEMI	NA								
Dimethyl Phthalate	SEMI	NA								

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

J – Meets identification criteria, but the value is less than the sample quantitation limit and greater than zero.

PHASE II

TABLE 4-16

ANALYTICAL RESULTS FOR SURFACE WATER
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SW-1	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	LIN	LEF
COLLECTION DATE		07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	08/08/90	08/08/90
Parameter ug/L (ppb)	Class									
Acenaphthylene	SEMI	NA								
2,6-Dinitrotoluene	SEMI	NA								
3-Nitroaniline	SEMI	NA								
Acenaphthene	SEMI	NA								
2,4-Dinitrophenol	SEMI	NA								
4-Nitrophenol	SEMI	NA								
Dibenzofuran	SEMI	NA								
2,4-Dinitrotoluene	SEMI	NA								
Diethylphthalate	SEMI	NA							R	R
4-Chlorophenyl-phenylether	SEMI	NA								
Fluorene	SEMI	NA								
4-Nitroaniline	SEMI	NA								
4,6-Dinitro-2-methylphenol	SEMI	NA								
N-nitrosodiphenylamine (1)	SEMI	NA								
4-Bromophenyl Phenyl Ether	SEMI	NA								
Hexachlorobenzene	SEMI	NA								
Pentachlorophenol	SEMI	NA								
Phenanthrene	SEMI	NA								
Anthracene	SEMI	NA								
Di-n-butylphthalate	SEMI	NA							R	R
Fluoranthene	SEMI	NA								0.2 J
Pyrene	SEMI	NA								
Butylbenzylphthalate	SEMI	NA								
3,3'-Dichlorobenzidine	SEMI	NA								
Benzo(a)anthracene	SEMI	NA								
Chrysene	SEMI	NA								
bis(2-ethyl hexyl)phthalate	SEMI	NA							R	R
Di-n-octyl Phthalate	SEMI	NA								1.0 J
Benzo(b)fluoranthene	SEMI	NA								
Benzo(k)fluoranthene	SEMI	NA								
Benzo(a)pyrene	SEMI	NA								
Indeno(1,2,3-cd)Pyrene	SEMI	NA								
Dibenz(a,h)anthracene	SEMI	NA								
Benzo(g,h,i)perylene	SEMI	NA								

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

J - Meets identification criteria, but the value is less than the sample quantitation limit and greater than zero.
B - The compound was detected in the associated method blank as well as in the sample.
R - Analyte rejected due to blank contamination.

PHASE II

TABLE 4-16

ANALYTICAL RESULTS FOR SURFACE WATER
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		SW-1	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	LIN	LEF
COLLECTION DATE		07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	08/08/90	08/08/90
Parameter ug/L (ppb)	Class									
alpha-BHC	PST									
beta-BHC	PST									
delta-BHC	PST									
gamma-BHC (Lindane)	PST									
Heptachlor	PST									
Aldrin	PST									
Heptachlor Epoxide	PST									
Endosulfan I	PST									
Dieldrin	PST									
4,4'-DDE	PST									
Endrin	PST									
Endosulfan II	PST									
4,4'-DDD	PST									
Endosulfan Sulfate	PST									
4,4'-DDT	PST									
Methyoxychlor	PST									
Endrin Ketone	PST									
alpha-Chlordane	PST									
gamma-Chlordane	PST									
Toxaphene	PST									
Aroclor-1016	PCB									
Aroclor-1221	PCB									
Aroclor-1232	PCB									
Aroclor-1242	PCB									
Aroclor-1248	PCB									
Aroclor-1254	PCB									
Aroclor-1260	PCB									

NOTE: Only detected results are reported.
All results are reported in ug/L (ppb).

PHASE II

TABLE 4-16

ANALYTICAL RESULTS FOR SURFACE WATER
RAMAPO LANDFILL
(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			SW-1	SW-3	SW-4	SW-5	SW-6	SW-7	SW-8	LIN	LEF
COLLECTION DATE			7/20/90	7/20/90	7/20/90	7/20/90	7/20/90	7/20/90	7/20/90	8/08/90	8/08/90
Parameter	Units	Class									
Aluminum	ug/L	MET	NA	NA	NA				995 N*	156 B	158 B
Antimony	ug/L	MET	NA	NA	NA						
Arsenic	ug/L	MET	NA	NA	NA					2.3 B	
Barium	ug/L	MET	NA	NA	NA	12 B	11 B	9 B	22 B	123 B	88 B
Beryllium	ug/L	MET	NA	NA	NA						
Cadmium	ug/L	MET	NA	NA	NA					4.5 B	
Calcium	ug/L	MET	NA	NA	NA	4570 B	4830 B	4850 B	6060	109000	97900
Chromium	ug/L	MET	NA	NA	NA						
Cobalt	ug/L	MET	NA	NA	NA					9.2 B	
Copper	ug/L	MET	NA	NA	NA		3.1 B		4.3 B	9.7 B	10.9 B
Iron	ug/L	MET	NA	NA	NA	163 N*	177 N*	138 N*	1290 N*	7820	2840
Lead	ug/L	MET	NA	NA	NA	1.8 B	1.6 B	1.7 B	2.8 B	2.6 B	3.2 B
Magnesium	ug/L	MET	NA	NA	NA	1100 B	1230 B	1180 B	1540 B	34300	30700
Manganese	ug/L	MET	NA	NA	NA	44.5 N*	31.9 N*	9.7 BN*	153 N*	1930	923
Mercury	ug/L	MET	NA	NA	NA	0.36	0.25	0.25	0.25		
Nickel	ug/L	MET	NA	NA	NA					23.5 B	20.7 B
Potassium	ug/L	MET	NA	NA	NA	259 B	344 B	489 B	378 B	39700	35200
Selenium	ug/L	MET	NA	NA	NA						
Silver	ug/L	MET	NA	NA	NA						
Sodium	ug/L	MET	NA	NA	NA	2740 B	3490 B	3160 B	3690 B	115000	102000
Thallium	ug/L	MET	NA	NA	NA					2.6 B	
Vanadium	ug/L	MET	NA	NA	NA				5.4 B		
Zinc	ug/L	MET	NA	NA	NA		3.9 B*		26.1 *	19.3 B	13.3 B
Total Cyanide	ug/L	MET	NA	NA	NA					10.8	39.2
Total Phenols	mg/L	MISC	NA	NA	NA						
BOD	mg/L	MISC	NA	NA	NA					7	13
COD	mg/L	MISC	NA	NA	NA					67.8	
Chloride	mg/L	MISC	NA	NA	NA					176	137
Ammonia-Nitrogen	mg/L	MISC	NA	NA	NA					24.3	11.2
Total Kjeldahl Nitrogen	mg/L	MISC	NA	NA	NA	0.15	0.19	0.11	0.17	28.1	15.2
NO3-N	mg/L	MISC	NA	NA	NA					3.69	8
Total Phosphorus	mg/L	MISC	NA	NA	NA						
Oil & Grease	mg/L	MISC	NA	NA	NA	1.1					
TOC	mg/L	MISC	NA	NA	NA	1.64	0.98	1	1.12	27.6	20.6
TSS	mg/L	MISC	NA	NA	NA	4	5	5	2	20	14
TDS	mg/L	MISC	NA	NA	NA	26	28	30	40	914	736
Sulfate	mg/L	MISC	NA	NA	NA	9.4	10.7	11.7	11.2	48.1	50.7
Sulfide	mg/L	MISC	NA	NA	NA						
pH	SU	MISC	6.69	7.41	5.56	7.52	6.86	7.11	7.05	7.55	6.83
Specific Conductance	umhos	MISC	1240	1050	65	75	50	85	65	2400	1790
Temp	C	MISC	20	22	21	21	21	21	21	22	20

Only detected results are reported.
NA – Not Analyzed

N – Spike sample % recovery out of control limits.
* – Duplicate analysis not within control limits.

B – Less than quantitation limit but greater than or equal to instrument detection limit.

TABLE 4-17

SURFACE WATER ARARs

Parameter	Upstream Max. Conc. Detected (ug/l)	Downstream Max. Conc. Detected (ug/l)	Downstream Location of Max. Conc.	Human ARAR/ Source (ug/l)	Aquatic ARAR/ Source (ug/l)
Vinyl chloride	1.9	0.7	SW-6	0.3 A	
Benzene		0.08	SW-6	0.7 B	6 A
Toluene		0.2	SW-7	5 A	
Aluminum	120	995	SW-8		
Antimony		37.8	SW-1	3 A	1,600 B
Arsenic		1.9	SW-1	0.0022 B	
Barium	14	83.0	SW-1	1,000 A&B	
Calcium	4,570	110,000	SW-1		
Copper		6.4	SW-1	200 A	(*) A
Iron	163	2,630	SW-1	300 A	300 A
Lead	1.8	2.8	SW-8	50 A&B	(*) A
Magnesium	1,100	33,100	SW-1	35,000 A	
Manganese	44.5	1,120	SW-1	300 A	
Mercury	0.36	1.2	SW-1	0.14 B	0.012 B
Nickel		25.2	SW-1	1.3 E-7 B	(*) A
Potassium	432	42,100	SW-1		
Sodium	2,740	109,000	SW-1		
Thallium	5.3			4 A	8 A
Vanadium		5.4	SW-8		14 A
Zinc	35.7	54.9	SW-3	300 A	30 A
Total Cyanide		33	SW-1	100 A	5.2 B
Total phenols	7	18	SW-1	1 A	
Ammonia-Nitrogen	110	21,900	SW-1	2,000 A	(*) A
TOC	1,640	21,300	SW-1	100 A	

TABLE 4-17 (Continued)

Parameter	Upstream Max. Conc. Detected (ug/l)	Downstream Max. Conc. Detected (ug/l)	Downstream Location of Max. Conc.	Human ARAR/ Source (ug/l)	Aquatic ARAR/ Source (ug/l)
NO3-N		6,960	SW-1	10,000 A&B	
NO2-N		2,380	SW-1	100 A	
TDS	32,000	873,000	SW-1	500,000 A	
Sulfate	57,100	74,600	SW-1	250,000 A	
Sulfide	1,400	2,000	SW-1	50 A	2 A
pH Min.	6.93	6.69	SW-1	6.5 A	
pH Max.	7.52	7.41	SW-3	8.5 A	

Sources:

A - NYSDEC TOGS 1.1.1 dated September 1990
B - Clean Water Act

Notes:

* - ARAR value must be calculated see next page.

TABLE 4-17 (Continued)

CALCULATED SURFACE WATER ARARs

		SW-1		SW-2		SW-3		SW-5		SW-6		SW-7		SW-8	
Parameter	Units	Conc.	Calcu-lated ARAR	Conc.	Calcu-lated ARAR	Conc.	Calcu-lated ARAR	Conc.	Calcu-lated ARAR	Conc.	Calcu-lated ARAR	Conc.	Calcu-lated ARAR	Conc.	Calcu-lated ARAR
Hardness	ppm	477		12.4		13.8		5.67		6.06		6.03		7.60	
pH	SU	7.28		6.93		7.28		7.52		6.86		7.11		7.05	
Temp	deg C	13.0		11.0		11.0		21		21		21		21	
Ammonia	ppm	21.9	4	0.11	5	0.10	4	NA		NA		NA		NA	
Copper	ppb	6.4	44.9	ND		ND		ND		3.1	1.1	ND		ND	
Lead	ppb	1.4	23.3	ND		ND		1.8	0.08	1.6	0.09	1.7	0.09	2.8	0.12
Nickel	ppb	25.2	313	ND		ND		ND		ND		ND		ND	

TABLE 4-18

SUMMARY OF SURFACE WATER ARAR EXCEEDANCES

Parameter	Location of Exceedance
Vinyl chloride	SW-5, SW-6
Antimony	SW-1
Arsenic	SW-1
Iron	SW-1, SW-8
Manganese	SW-1
Mercury	SW-1, SW-5, SW-6, SW-7, SW-8
Nickel	SW-1
Thallium	SW-2
Zinc	SW-2, SW-3, SW-4
Ammonia	SW-1
TOC	SW-1, SW-5, SW-6, SW-7, SW-8
NO2-N	SW-1
TDS	SW-1
Sulfide	SW-1, SW-2
Copper	SW-6
Lead	SW-5, SW-6, SW-7, SW-8
Cyanide	SW-1

TABLE 4-19

PHASE I ANALYTICAL RESULTS FOR STREAM SEDIMENT
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SS-1	SS-2	SS-3	SS-4
COLLECTION DATE		10/25/89	10/26/89	10/26/89	10/26/89
Parameter ug/kg (ppb)	Class				
Chloromethane	VOC				
Bromomethane	VOC				
Vinyl Chloride	VOC				
Chloroethane	VOC				
Methylene Chloride	VOC				
Acetone	VOC	R	R		
Carbon Disulfide	VOC				
1,1-Dichloroethene	VOC				
1,1-Dichloroethane	VOC				
1,2-Dichloroethene (total)	VOC				
Chloroform	VOC				
1,2-Dichloroethane	VOC				
2-Butanone (or MEK)	VOC				
1,1,1-Trichloroethane	VOC				
Carbon Tetrachloride	VOC				
Vinyl Acetate	VOC				
Bromodichloromethane	VOC				
1,2-Dichloropropane	VOC				
Cis-1,3-dichloropropene	VOC				
Trichloroethene	VOC				
Dibromochloromethane	VOC				
1,1,2-Trichloroethane	VOC				
Benzene	VOC				
Trans-1,3-dichloropropene	VOC				
Bromoform	VOC				
4-Methyl-2-pentanone	VOC				
2-Hexanone	VOC				
Tetrachloroethene	VOC				
1,1,2,2-Tetrachloroethane	VOC				
Toluene	VOC				
Chlorobenzene	VOC				
Ethylbenzene	VOC				
Styrene	VOC				
Total Xylenes	VOC				

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

R - Compound rejected because it was detected in the associated method blank at similar concentrations.

TABLE 4-19

PHASE I ANALYTICAL RESULTS FOR STREAM SEDIMENT
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SS-1	SS-2	SS-3	SS-4
COLLECTION DATE		10/25/89	10/26/89	10/26/89	10/26/89
Parameter ug/kg (ppb)	Class				
Phenol	SEMI	R	R	R	R
Bis(2-chloroethyl)ether	SEMI	R	R	R	R
2-Chlorophenol	SEMI	R	R	R	R
1,3-Dichlorobenzene	SEMI	R	R	R	R
1,4-Dichlorobenzene	SEMI	R	R	R	R
Benzyl Alcohol	SEMI	R	R	R	R
1,2-Dichlorobenzene	SEMI	R	R	R	R
2-Methylphenol	SEMI	R	R	R	R
Bis(2-chloroisopropyl) ether	SEMI	R	R	R	R
4-Methylphenol	SEMI	R	R	R	R
N-Nitroso-di-n-propylamine	SEMI	R	R	R	R
Hexachloroethane	SEMI	R	R	R	R
Nitrobenzene	SEMI	R	R	R	R
Isophorone	SEMI	R	R	R	R
2-Nitrophenol	SEMI	R	R	R	R
2,4-Dimethylphenol	SEMI	R	R	R	R
Benzoic Acid	SEMI	R	R	R	R
Bis(2-chloroethoxy) methane	SEMI	R	R	R	R
2,4-Dichlorophenol	SEMI	R	R	R	R
1,2,4-Trichlorobenzene	SEMI	R	R	R	R
Naphthalene	SEMI	R	R	R	R
4-Chloroaniline	SEMI	R	R	R	R
Hexachlorobutadiene	SEMI	R	R	R	R
4-Chloro-3-methylphenol	SEMI	R	R	R	R
2-Methylnaphthalene	SEMI	R	R	R	R
Hexachlorocyclopentadiene	SEMI	R	R	R	R
2,4,6-Trichlorophenol	SEMI	R	R	R	R
2,4,5-Trichlorophenol	SEMI	R	R	R	R
2-Chloronaphthalene	SEMI	R	R	R	R
2-Nitroaniline	SEMI	R	R	R	R
Dimethyl Phthalate	SEMI	R	R	R	R

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

R - The entire semivolatile fraction has been rejectd due to holding time violations.

TABLE 4-19

PHASE I ANALYTICAL RESULTS FOR STREAM SEDIMENT
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SS-1	SS-2	SS-3	SS-4
COLLECTION DATE		10/25/89	10/26/89	10/26/89	10/26/89
Parameter ug/kg (ppb)	Class				
Acenaphthylene	SEMI	R	R	R	R
2,6-Dinitrotoluene	SEMI	R	R	R	R
3-Nitroaniline	SEMI	R	R	R	R
Acenaphthene	SEMI	R	R	R	R
2,4-Dinitrophenol	SEMI	R	R	R	R
4-Nitrophenol	SEMI	R	R	R	R
Dibenzofuran	SEMI	R	R	R	R
2,4-Dinitrotoluene	SEMI	R	R	R	R
Diethylphthalate	SEMI	R	R	R	R
4-Chlorophenyl-phenylether	SEMI	R	R	R	R
Fluorene	SEMI	R	R	R	R
4-Nitroaniline	SEMI	R	R	R	R
4,6-Dinitro-2-methylphenol	SEMI	R	R	R	R
N-nitrosodiphenylamine (1)	SEMI	R	R	R	R
4-Bromophenyl Phenyl Ether	SEMI	R	R	R	R
Hexachlorobenzene	SEMI	R	R	R	R
Pentachlorophenol	SEMI	R	R	R	R
Phenanthrene	SEMI	R	R	R	R
Anthracene	SEMI	R	R	R	R
Di-n-butylphthalate	SEMI	R	R	R	R
Fluoranthene	SEMI	R	R	R	R
Pyrene	SEMI	R	R	R	R
Butylbenzylphthalate	SEMI	R	R	R	R
3,3'-Dichlorobenzidine	SEMI	R	R	R	R
Benzo(a)anthracene	SEMI	R	R	R	R
Chrysene	SEMI	R	R	R	R
bis(2-ethyl hexyl)phthalate	SEMI	R	R	R	R
Di-n-octyl Phthalate	SEMI	R	R	R	R
Benzo(b)fluoranthene	SEMI	R	R	R	R
Benzo(k)fluoranthene	SEMI	R	R	R	R
Benzo(a)pyrene	SEMI	R	R	R	R
Indeno(1,2,3-cd)Pyrene	SEMI	R	R	R	R
Dibenz(a,h)anthracene	SEMI	R	R	R	R
Benzo(g,h,i)perylene	SEMI	R	R	R	R

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

R - The entire semivolatile fraction has been rejected due to holding time violations.

TABLE 4-19

PHASE I ANALYTICAL RESULTS FOR STREAM SEDIMENT
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		SS-1	SS-2	SS-3	SS-4
COLLECTION DATE		10/25/89	10/26/89	10/26/89	10/26/89
Parameter ug/kg (ppb)	Class				
alpha-BHC	PST	R	R	R	R
beta-BHC	PST	R	R	R	R
delta-BHC	PST	R	R	R	R
gamma-BHC (Lindane)	PST	R	R	R	R
Heptachlor	PST	R	R	R	R
Aldrin	PST	R	R	R	R
Heptachlor Epoxide	PST	R	R	R	R
Endosulfan I	PST	R	R	R	R
Dieldrin	PST	R	R	R	R
4,4'-DDE	PST	R	R	R	R
Endrin	PST	R	R	R	R
Endosulfan II	PST	R	R	R	R
4,4'-DDD	PST	R	R	R	R
Endosulfan Sulfate	PST	R	R	R	R
4,4'-DDT	PST	R	R	R	R
Methyoxychlor	PST	R	R	R	R
Endrin Ketone	PST	R	R	R	R
alpha-Chlordane	PST	R	R	R	R
gamma-Chlordane	PST	R	R	R	R
Toxaphene	PST	R	R	R	R
Aroclor-1016	PCB	R	R	R	R
Aroclor-1221	PCB	R	R	R	R
Aroclor-1232	PCB	R	R	R	R
Aroclor-1242	PCB	R	R	R	R
Aroclor-1248	PCB	R	R	R	R
Aroclor-1254	PCB	R	R	R	R
Aroclor-1260	PCB	R	R	R	R

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

R - The entire pesticide/PCB fraction has been rejected due to holding time violations.

TABLE 4-19

PHASE I ANALYTICAL RESULTS FOR STREAM SEDIMENT
RAMAPO LANDFILL
(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			SS-1	SS-2	SS-3	SS-4
COLLECTION DATE			10/25/89	10/26/89	10/26/89	10/26/89
Parameter	Units	Class				
Aluminum	mg/kg	MET	4160	4270	5580	7800
Antimony	mg/kg	MET				9.5
Arsenic	mg/kg	MET	1.3	0.79	1.5	0.84
Barium	mg/kg	MET	60.9	19.9	26.2	72.3
Beryllium	mg/kg	MET		0.38		0.52
Cadmium	mg/kg	MET				1.3
Calcium	mg/kg	MET	12200	773	10200	1100
Chromium	mg/kg	MET	10.1	5.9	11.6	9.9
Cobalt	mg/kg	MET	5.3	2.1	3.8	11.2
Copper	mg/kg	MET	9.4	3.8	11.7	24.6
Iron	mg/kg	MET	17000	9510	14300	23200
Lead	mg/kg	MET	22.2	4.5	4.4	16.4
Magnesium	mg/kg	MET	2440	1680	5960	2690
Manganese	mg/kg	MET	1410	86.7	348	2970
Mercury	mg/kg	MET				
Nickel	mg/kg	MET	9.8	9.0	7.9	32.4
Potassium	mg/kg	MET	882	448	859	958
Selenium	mg/kg	MET				
Silver	mg/kg	MET				
Sodium	mg/kg	MET	143	65.1	214	73.1
Thallium	mg/kg	MET			0.65	
Vanadium	mg/kg	MET	19.7	10.4	20.5	23.9
Zinc	mg/kg	MET	29.2	33.5	26.0	43.4
Total Cyanide	mg/kg	MET				
Total Phenols	mg/kg	MISC				

NOTE: Only detected results are reported.

PHASE II

TABLE 4-20

ANALYTICAL RESULTS FOR STREAM SEDIMENT
RAMAPO LANDFILL
(VOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SS-1	SS-3	SS-4	SS-4-RE	SS-5	SS-6	SS-7	SS-8	LPSS-1
COLLECTION DATE		07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	08/08/90
Parameter	Class									
Chloromethane	VOC	NA	NA	NA	NA					
Bromomethane	VOC	NA	NA	NA	NA					
Vinyl Chloride	VOC	NA	NA	NA	NA					
Chloroethane	VOC	NA	NA	NA	NA					
Methylene Chloride	VOC	NA	NA	NA	NA	R	R	R	R	
Acetone	VOC	NA	NA	NA	NA					R
Carbon Disulfide	VOC	NA	NA	NA	NA					
1,1-Dichloroethene	VOC	NA	NA	NA	NA					
1,1-Dichloroethane	VOC	NA	NA	NA	NA					
1,2-Dichloroethene (total)	VOC	NA	NA	NA	NA					
Chloroform	VOC	NA	NA	NA	NA					
1,2-Dichloroethane	VOC	NA	NA	NA	NA					
2-Butanone (or MEK)	VOC	NA	NA	NA	NA					40
1,1,1-Trichloroethane	VOC	NA	NA	NA	NA					
Carbon Tetrachloride	VOC	NA	NA	NA	NA					
Vinyl Acetate	VOC	NA	NA	NA	NA					
Bromodichloromethane	VOC	NA	NA	NA	NA					
1,2-Dichloropropane	VOC	NA	NA	NA	NA					
Cis-1,3-dichloropropene	VOC	NA	NA	NA	NA					
Trichloroethene	VOC	NA	NA	NA	NA					
Dibromochloromethane	VOC	NA	NA	NA	NA					
1,1,2-Trichloroethane	VOC	NA	NA	NA	NA					
Benzene	VOC	NA	NA	NA	NA					
Trans-1,3-dichloropropene	VOC	NA	NA	NA	NA					
Bromoform	VOC	NA	NA	NA	NA					
4-Methyl-2-pentanone	VOC	NA	NA	NA	NA					
2-Hexanone	VOC	NA	NA	NA	NA					
Tetrachloroethene	VOC	NA	NA	NA	NA					
1,1,2,2-Tetrachloroethane	VOC	NA	NA	NA	NA					
Toluene	VOC	NA	NA	NA	NA					
Chlorobenzene	VOC	NA	NA	NA	NA					
Ethylbenzene	VOC	NA	NA	NA	NA					
Styrene	VOC	NA	NA	NA	NA					
Total Xylenes	VOC	NA	NA	NA	NA					

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

NA – Not analyzed.
R – Analyte rejected due to blank contamination.

PHASE II

TABLE 4-20

ANALYTICAL RESULTS FOR STREAM SEDIMENT
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SS-1	SS-3	SS-4	SS-4-RE	SS-5	SS-6	SS-7	SS-8	LPSS-1
COLLECTION DATE		07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	08/08/90
Parameter	Class									
Phenol	SEMI									
Bis(2-chloroethyl)ether	SEMI									
2-Chlorophenol	SEMI									
1,3-Dichlorobenzene	SEMI									
1,4-Dichlorobenzene	SEMI									
Benzyl Alcohol	SEMI									
1,2-Dichlorobenzene	SEMI									
2-Methylphenol	SEMI									
Bis(2-chloroisopropyl) ether	SEMI									
4-Methylphenol	SEMI			150 J	190 J					
N-Nitroso-di-n-propylamine	SEMI									
Hexachloroethane	SEMI									
Nitrobenzene	SEMI									
Isophorone	SEMI									
2-Nitrophenol	SEMI									
2,4-Dimethylphenol	SEMI									
Benzoic Acid	SEMI			310 J	420 J					
Bis(2-chloroethoxy) methane	SEMI									
2,4-Dichlorophenol	SEMI									
1,2,4-Trichlorobenzene	SEMI									
Naphthalene	SEMI									
4-Chloroaniline	SEMI									
Hexachlorobutadiene	SEMI									
4-Chloro-3-methylphenol	SEMI									
2-Methylnaphthalene	SEMI									
Hexachlorocyclopentadiene	SEMI									
2,4,6-Trichlorophenol	SEMI									
2,4,5-Trichlorophenol	SEMI									
2-Chloronaphthalene	SEMI									
2-Nitroaniline	SEMI									
Dimethyl Phthalate	SEMI									

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

J – Indicates the result is less than the sample quantitation limit but greater than zero.
RE – This sample required reextraction/reanalysis.

PHASE II

TABLE 4-20

ANALYTICAL RESULTS FOR STREAM SEDIMENT
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SS-1	SS-3	SS-4	SS-4-RE	SS-5	SS-6	SS-7	SS-8	LPSS-1
COLLECTION DATE		07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	08/08/90
Parameter	Class									
Phenol	SEMI									
Bis(2-chloroethyl)ether	SEMI									
2-Chlorophenol	SEMI									
1,3-Dichlorobenzene	SEMI									
1,4-Dichlorobenzene	SEMI									
Benzyl Alcohol	SEMI									
1,2-Dichlorobenzene	SEMI									
2-Methylphenol	SEMI									
Bis(2-chloroisopropyl) ether	SEMI									
4-Methylphenol	SEMI			150 J	190 J					
N-Nitroso-di-n-propylamine	SEMI									
Hexachloroethane	SEMI									
Nitrobenzene	SEMI									
Isophorone	SEMI									
2-Nitrophenol	SEMI									
2,4-Dimethylphenol	SEMI									
Benzoic Acid	SEMI			310 J	420 J					
Bis(2-chloroethoxy) methane	SEMI									
2,4-Dichlorophenol	SEMI									
1,2,4-Trichlorobenzene	SEMI									
Naphthalene	SEMI									
4-Chloroaniline	SEMI									
Hexachlorobutadiene	SEMI									
4-Chloro-3-methylphenol	SEMI									
2-Methylnaphthalene	SEMI									
Hexachlorocyclopentadiene	SEMI									
2,4,6-Trichlorophenol	SEMI									
2,4,5-Trichlorophenol	SEMI									
2-Chloronaphthalene	SEMI									
2-Nitroaniline	SEMI									
Dimethyl Phthalate	SEMI									

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

J - Indicates the result is less than the sample quantitation limit but greater than zero.
RE - This sample required reextraction/reanalysis.

PHASE II

TABLE 4-20

ANALYTICAL RESULTS FOR STREAM SEDIMENT
RAMAPO LANDFILL
(SEMIVOLATILE ORGANIC COMPOUNDS)

WELL AND SAMPLE ID NUMBER		SS-1	SS-3	SS-4	SS-4-RE	SS-5	SS-6	SS-7	SS-8	LPSS-1
COLLECTION DATE		07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	08/08/90
Parameter	Class									
Acenaphthylene	SEMI									
2,6-Dinitrotoluene	SEMI									
3-Nitroaniline	SEMI									
Acenaphthene	SEMI									
2,4-Dinitrophenol	SEMI									
4-Nitrophenol	SEMI									
Dibenzofuran	SEMI									
2,4-Dinitrotoluene	SEMI									
Diethylphthalate	SEMI									
4-Chlorophenyl-phenylether	SEMI									
Fluorene	SEMI									
4-Nitroaniline	SEMI									
4,6-Dinitro-2-methylphenol	SEMI									
N-nitrosodiphenylamine (1)	SEMI									
4-Bromophenyl Phenyl Ether	SEMI									
Hexachlorobenzene	SEMI									
Pentachlorophenol	SEMI									
Phenanthrene	SEMI			75 J	72 J					
Anthracene	SEMI									
Di-n-butylphthalate	SEMI									
Fluoranthene	SEMI		40 J	140 J	130 J					
Pyrene	SEMI		46 J	160 J	130 J					
Butylbenzylphthalate	SEMI									
3,3'-Dichlorobenzidine	SEMI									
Benzo(a)anthracene	SEMI			65 J	56 J					
Chrysene	SEMI			83 J	79 J					
bis(2-ethyl hexyl)phthalate	SEMI		45 J	100 J	120 J					550 J
Di-n-octyl Phthalate	SEMI									
Benzo(b)fluoranthene	SEMI			150 J	120 J					
Benzo(k)fluoranthene	SEMI			63 J	71 J					
Benzo(a)pyrene	SEMI			59 J	70 J					
Indeno(1,2,3-cd)Pyrene	SEMI									
Dibenz(a,h)anthracene	SEMI									
Benzo(g,h,i)perylene	SEMI									

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

J – Indicates the result is less than the sample quantitation limit but greater than zero.
RE – This sample required reextraction/reanalysis.

PHASE II

TABLE 4-20

ANALYTICAL RESULTS FOR STREAM SEDIMENT
RAMAPO LANDFILL
(PESTICIDES AND PCBS)

WELL AND SAMPLE ID NUMBER		SS-1	SS-3	SS-4	SS-4-RE	SS-5	SS-6	SS-7	SS-8	LPSS-1
COLLECTION DATE		07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	07/20/90	08/08/90
Parameter	Class									
alpha-BHC	PST				NA					
beta-BHC	PST				NA					
delta-BHC	PST				NA					
gamma-BHC (Lindane)	PST				NA					
Heptachlor	PST				NA					
Aldrin	PST				NA					
Heptachlor Epoxide	PST				NA					
Endosulfan I	PST				NA					
Dieldrin	PST				NA					1.8 J
4,4'-DDE	PST				NA					
Endrin	PST				NA					
Endosulfan II	PST				NA					
4,4'-DDD	PST				NA					
Endosulfan Sulfate	PST				NA					
4,4'-DDT	PST				NA					
Methyoxychlor	PST				NA					
Endrin Ketone	PST				NA					
alpha-Chlordane	PST				NA					16 J
gamma-Chlordane	PST			12	NA					11 J
Toxaphene	PST				NA					
Aroclor-1016	PCB				NA					
Aroclor-1221	PCB				NA					
Aroclor-1232	PCB				NA					
Aroclor-1242	PCB				NA					
Aroclor-1248	PCB				NA					
Aroclor-1254	PCB				NA					
Aroclor-1260	PCB				NA					

NOTE: Only detected results are reported.
All results are reported in ug/kg (ppb).

J – Indicates the result is less than the sample quantitation value but greater than zero.
NA – Not analyzed.

PHASE II

TABLE 4-20

ANALYTICAL RESULTS FOR STREAM SEDIMENT

RAMAPO LANDFILL

(METALS AND MISCELLANEOUS PARAMETERS)

WELL AND SAMPLE ID NUMBER			SS-1	SS-3	SS-4	SS-5	SS-6	SS-7	SS-8	LPSS-1
COLLECTION DATE			7/20/90	7/20/90	7/20/90	7/20/90	7/20/90	7/20/90	7/20/90	8/08/90
Parameter	Units	Class								
Aluminum	mg/kg	MET	NA	NA	NA	4660 *	6470 *	6010 *	4050 *	14700
Antimony	mg/kg	MET	NA	NA	NA					
Arsenic	mg/kg	MET	NA	NA	NA	1.2 B	0.88 B	0.7 B	0.79 B	13.3
Barium	mg/kg	MET	NA	NA	NA	30.1 B	35.2 B	37.6 B	29.1 B	310
Beryllium	mg/kg	MET	NA	NA	NA	0.99 B	1.2	0.82 B	0.27 B	
Cadmium	mg/kg	MET	NA	NA	NA	3.4 *	4.3 *	2 *	1.3 *	14.6
Calcium	mg/kg	MET	NA	NA	NA	1660 *	924 B*	1480 *	13300 *	58900
Chromium	mg/kg	MET	NA	NA	NA	7	9.8	13	9.5	21
Cobalt	mg/kg	MET	NA	NA	NA	3.9 B	4.3 B	6.1 B	3.7 B	17.1 B
Copper	mg/kg	MET	NA	NA	NA	4.5 B	5.5	5.3 B	7	32.3
Iron	mg/kg	MET	NA	NA	NA	14800 E*	25000 E*	25400 E*	10600 E*	95000
Lead	mg/kg	MET	NA	NA	NA	6 N*	4.8 N*	5.5 N*	3.7 N*	9
Magnesium	mg/kg	MET	NA	NA	NA	1260 *	2500 *	2290 *	8590 *	5430
Manganese	mg/kg	MET	NA	NA	NA	203	493	554	191	3800
Mercury	mg/kg	MET	NA	NA	NA					
Nickel	mg/kg	MET	NA	NA	NA		10.6	6.8 B	7.6 B	20.4
Potassium	mg/kg	MET	NA	NA	NA	515 B	619 B	716 B	421 B	2140 B
Selenium	mg/kg	MET	NA	NA	NA					
Silver	mg/kg	MET	NA	NA	NA					
Sodium	mg/kg	MET	NA	NA	NA	114 B	39.3 B	94.4 B	81.2 B	735 B
Thallium	mg/kg	MET	NA	NA	NA					
Vanadium	mg/kg	MET	NA	NA	NA	9.9 B	15.6	12.9	11.9	41.1
Zinc	mg/kg	MET	NA	NA	NA	53.6 E	82.9 E	71.6 E	29.8 E	135
Total Cyanide	mg/kg	MET	NA	NA	NA	NA	NA	NA	NA	NA
Total Phenols	mg/kg	MISC	NA	NA	NA	NA	NA	NA	NA	NA
Organic Carbon	Percent	MISC	0.8	1.5	3.3	1	0.3	0.3	0.46	NA
pH	SU	MISC	6.69	7.41	5.56	7.52	6.86	7.11	7.05	NA
Specific Conductanc	umhos	MISC	1240	1050	65	75	50	85	65	NA
Temperature	Deg C	MISC	20	22	21	21	21	21	21	NA

Only detected results are reported.

NA – Not Analyzed

N – Spike sample % recovery out of control limits.

E – Estimated value due to interference.

* – Duplicate analysis not within control limits.

B – Less than quantitation limit but greater than or equal to instrument det

TABLE 4-21
SEDIMENT CLEANUP CRITERIA

Compound	AWQS/GV ug/l	Log Kow	H or A*	Sediment Cleanup Criteria SS-3 (ug/Kg)	Ramapo Analytical Results SS-3 (ug/kg)
4-Methylphenol	none	1.94	none	N/A	ND
Benzoic Acid	none	1.87	none	N/A	ND
Phenanthrene	50 none	4.46	H A	21,600	ND
Fluoranthrene	50 none	5.33	H A	160,000	40
Pyrene	50 none	4.88	H A	56,900	46
Benz(a)anthracene	0.002 none	5.61	H A	12	ND
Chrysene	0.002 none	5.61	H A	12	ND
Benzo(b)fluoranthrene	0.002 none	6.57	H A	110	ND
Bis(2-ethylhexyl)-phthalate	4 0.6	5.3	H A	12,000 1,800	45
Benzo(k)fluoranthrene	0.002 none	6.84	H A	210	ND
Benzo(a)pyrene	0.002 0.0012	6.04	H A	33 20	ND
Gamma-chlordane	0.02** 0.002**	2.68	H A	0.18 0.018	ND

* H: Human health based
A: Aquatic organism health based
**: AWQS/GV for chlordane

Soil OC
SS-3 1.50%

RAM 001 0712

TABLE 4-22

Phase II
Landfill Gas Summary
Ramapo Landfill

Parameter	Units	GS-1	GS-2	GS-3	GS-4	PS-1	PS-2	PS-3	PS-4
Nitrogen	mole %	91.35	85.44	1.96	2.29	85.08	3.4	85.06	91.22
Carbon Dioxide	mole %	0.06	0.06	38.38	40.4	0.37	36.49	0.45	0.16
Methane	mole %	ND	0.01	59.38	57.06	0.11	59.69	0.07	ND
Ethane	mole %	0.02	ND	0.02	ND	0.04	0.02	0.02	0.02
Propane	mole %	ND	ND	ND	ND	ND	ND	ND	ND
Isobutane	mole %	ND	0.02	ND	ND	ND	ND	ND	ND
Normal Butane	mole %	ND	0.03	ND	0.01	ND	ND	ND	ND
Isopentane	mole %	ND	ND	ND	ND	ND	ND	ND	ND
Normal Pentane	mole %	ND	ND	ND	ND	ND	ND	ND	ND
Hexanes	mole %	ND	0.01	ND	0.01	0.01	0.01	ND	ND
Oxygen	mole %	8.57	14.43	0.26	0.23	14.39	0.39	14.4	8.6

ND - None Detected
Mole % - an expression of the number of moles of compound per 100 moles.

TABLE 4-23

Phase II
Air Monitoring Program
VOA Analytical Summary
Ramapo Landfill

Parameter	Units	TLV/300	VOC-1	VOC-2	VOC-3	LPDW-1	LPUP-1	LPTB-1
2 - Butanone	mg/m^3	1.97	0.0054	0.0079	0.003	0.0031	ND	ND
1,1,1 - Trichloroethane	mg/m^3	6.37	ND	0.0008	ND	0.0011	0.0013	ND
Carbon Tetrachloride	mg/m^3	0.10	ND	0.0002 J	ND	0.0007	ND	ND
Benzene	mg/m^3	0.10	0.0007	0.0006	0.0003 J	0.0008	0.001	ND
Chlorobenzene	mg/m^3	1.15	ND	0.0005	ND	ND	ND	ND
Ethylbenzene	mg/m^3	1.45	ND	0.0026	0.0008	ND	0.0009	ND
Tetrachloroethylene	mg/m^3	1.13	ND	ND	ND	ND	ND	ND
Styrene	mg/m^3	0.71	ND	ND	0.0005	ND	ND	ND
Toluene	mg/m^3	1.26	0.0079	0.0016	0.0061	0.0017	0.0038	ND
Xylene (Total)	mg/m^3	1.45	ND	0.011	0.007	0.0025	0.0058	ND
Methylene Chloride	mg/m^3	0.58	0.0018 B	0.001 B	0.0013 B	0.0023 B	0.001 B	0.0028 B
Acetone	mg/m^3	5.93	0.015 B	0.013 B	0.016 B	0.011 B	0.011 B	0.0061 B

NOTE: Samples were analyzed for the complete TCL Volatiles list.
ND - None Detected
TLV - Threshold Limit Value as a Time Weighted Average; American Conference of Industrial Hygienists, 1990 - 1991.
J - Indicates the result is less than the sample quanititation limit but greater than zero.
B - Analyte detected in the associated method blank.

TABLE 4-24

Phase II
Air Monitoring Program
VOA Analytical Summary
Ramapo Landfill

Parameter	Units	TLV/300	PSR-1	PSR-2	PSR-3	PSR-3D	PSR-4	PSR-4BT	PSR-TB
2 - Butanone	mg/m^3	1.97	ND	ND	0.0091	0.0075	0.011	0.018	ND
1,1,1 - Trichloroethane	mg/m^3	6.37	ND	ND	0.001	0.0007	0.0011	ND	ND
Carbon Tetrachloride	mg/m^3	0.10	ND	ND	ND	ND	0.0004	ND	ND
Benzene	mg/m^3	0.10	ND	0.029 E	0.0005	ND	0.0006	ND	ND
Chlorobenzene	mg/m^3	1.15	ND	0.37 E	0.0007	ND	ND	ND	ND
Ethylbenzene	mg/m^3	1.45	ND	1.20 E	0.0049	0.0012	0.0009	0.0011	ND
Tetrachloroethylene	mg/m^3	1.13	ND	0.0041	ND	ND	ND	ND	ND
Styrene	mg/m^3	0.71	ND	ND	ND	ND	ND	0.0008	ND
Toluene	mg/m^3	1.26	0.0004 J	0.27 E	0.0011	0.0007	0.0014	0.0013	0.0004 J
Xylene (Total)	mg/m^3	1.45	ND	7.70 E	0.016	0.0046	0.012	0.016	ND
Methylene Chloride	mg/m^3	0.58	0.001 B	0.002 B	0.0006 B	0.0013 B	0.0008 B	0.003 B	0.0034 B
Acetone	mg/m^3	5.93	0.01 B	0.0057 B	0.012 B	0.010 B	0.011 B	0.018 B	0.012 B

NOTE: Samples were analyzed for the complete TCL Volatiles list.
ND - None Detected
TLV - Threshold Limit Value as a Time Weighted Average; American Conference of Industrial Hygienists, 1990 - 1991.
J - Indicates the result is less than the sample quanititation limit but greater than zero.
E - Estimated value due to interference.
B - Analyte detected in the associated method blank.

RAM 001 0715

TABLE 4-25

Phase II
Gas Emissions vs. AGCs
Ramapo Landfill

Parameter	Highest Avg. Conc.	Highest Max. Conc.	AGC
	µg/m^3	µg/m^3	µg/m^3
2 - Butanone	2.81E-04	5.55E-04	no AGC
1,1,1 - Trichloroethane	1.85E-05	3.39E-05	1.00E+03
Carbon Tetrachloride	3.08E-06	1.23E-05	7.00E-02
Benzene	1.85E-04	8.95E-04	1.20E-01
Chlorobenzene	2.29E-03	1.14E-02	2.00E+01
Ethylbenzene	7.45E-03	3.70E-02	1.00E+03
Tetrachloroethylene	2.47E-05	1.26E-04	7.50E-02
Styrene	6.17E-06	2.47E-05	5.10E+02
Toluene	1.69E-03	8.33E-03	2.00E+03
Xylene (Total)	4.78E-02	2.38E-01	3.00E+02
Methylene Chloride	4.63E-05	9.25E-05	no AGC
Acetone	4.15E-04	5.55E-04	1.40E+04

RAM 001 0716

5. GROUNDWATER FLOW AND CONTAMINANT TRANSPORT

5.1 Groundwater Flow Modeling

The three-dimensional groundwater flow model developed was used to represent existing conditions at site, to evaluate remedial technologies associated with groundwater containment and collection, and to aid in the contaminant transport calculations which were done by hand. In evaluating remedial technologies, all uncertainties and sensitivities inherent in looking at one remedial technology would therefore be applied to all technologies. The model was based on URS field observations and measurements and information gathered during the Remedial Investigation. As part of our field investigations, URS concentrated on obtaining information on the landfill site, the Torne Brook Farm property, and the existing leachate collection system. Most of the site is situated within a small aquifer tributary to Torne Brook as defined in "The Geohydrology of the Valley - Fill Aquifer in the Ramapo and Mohawk River Area, Rockland County, New York" (USGS, 1982). Hydrogeologic data obtained for the purposes of the remedial investigation should not and was not extrapolated beyond this small aquifer into the Ramapo River Aquifer, in which the Spring Valley Water Co. water supply wells are located.

The model was calibrated to water levels measured on August 26, 1990, a day for which the monitored values were available for all wells, piezometers and manholes. On this day, the potentiometric surfaces measured were similar to those measured on other days, and therefore were representative of average conditions. Stream surface water elevations used were measured on September 11, 1990. It is not anticipated that the surface water elevations in Torne Brook and the Ramapo River, which are approximately two feet and four feet deep, respectively, would greatly vary in this time span. The following is a summary of the groundwater flow modeling effort. Full details are provided in Appendix P.3.

(Please note that the use of the words onsite and offsite throughout this report are to depict the area within the property lines shown on Plate 1, and are not intended to convey the meanings defined in the National Contingency Plan (NCP).)

5.1.1 Approach

The 3-D computer model used in this study was the Modular Three-Dimensional Finite-Difference Groundwater Flow Model, prepared by the US Geological Survey (McDonald and Harbaugh, 1984). The latest version (2.0) of the program was used (MODFLOW/EM). Groundwater flow within the aquifer is simulated using a block-centered finite-difference approach. Layers can be simulated as confined, unconfined or a combination of both. Flow from external stresses, such as recharge through infiltration, withdrawal from wells, flow into drains, flow through riverbeds and evapotranspiration can be simulated. The model can be used for either 2-D or 3-D simulations and is capable of analyzing both steady state and transient flow.

In this case 3-D steady state conditions were used for the calibration of the model. The process of calibration was conducted utilizing an inverse problem program, for which MODFLOW is a pre-processor.

5.1.2 Hydrogeology

Four hydrogeologic units were identified in Section 3.7.3 of the RI. They include:

- Fill - mostly municipal waste
- Shallow aquifer - dense to loose sands
- Intermediate aquifer - weathered bedrock
- Bedrock aquifer - fractured bedrock.

The fill, the shallow aquifer and the weathered bedrock were combined into one unit - the upper aquifer for modeling purposes. The bedrock was considered to be a separate aquifer. For the purposes of the model, separating the geology into two hydrogeologic units was adequate. The model has the capability to include anisotrophic conditions. Therefore the horizontal and vertical hydraulic conductivity values were modified across the extent of the model, as necessary, to account for existing variations in conductivity at the site.

Upper Aquifer

The upper aquifer is made up of dense sands in the northern portion of the site and loose sands in the southern portion, adjacent to the Ramapo River. Hydraulic conductivity values obtained from slug tests for dense sands varied between 10^{-3} cm/s and 10^{-5} cm/s. The conductivity of loose sands is about 10^{-2} cm/s. (Values were obtained from slug tests.)

The thickness of the undisturbed portion of the upper aquifer in the modeled area is about 20 to 30 ft in the northern portion of the site and increases to about 50 ft approaching the Ramapo River. However, between Torne Valley Rd. to the northwest and the natural boundary of the aquifer to the southeast, the sandy material of the upper aquifer was largely removed and replaced with waste. In those areas, especially between piezometers P-3 and P-5 and in the vicinity of the piezometer P-2, the thickness of the waste layer reaches 70-80 ft. The hydraulic conductivity of the waste layer is not known, as no slug tests were conducted in that area. Fill in general, however, is considered fairly permeable. The US Army Corps of Engineers HELP model recommends the value of 2×10^{-4} cm/sec to be used as a hydraulic conductivity of municipal waste.

There is a large variation in water levels measured within the upper aquifer. They range from 515 ft in piezometer P-2 to 293.5 ft in stream gauge SG-2 on the Ramapo River. Very steep water level gradients are present across the site, in some areas reaching 0.33 ft/ft.

Bedrock Aquifer

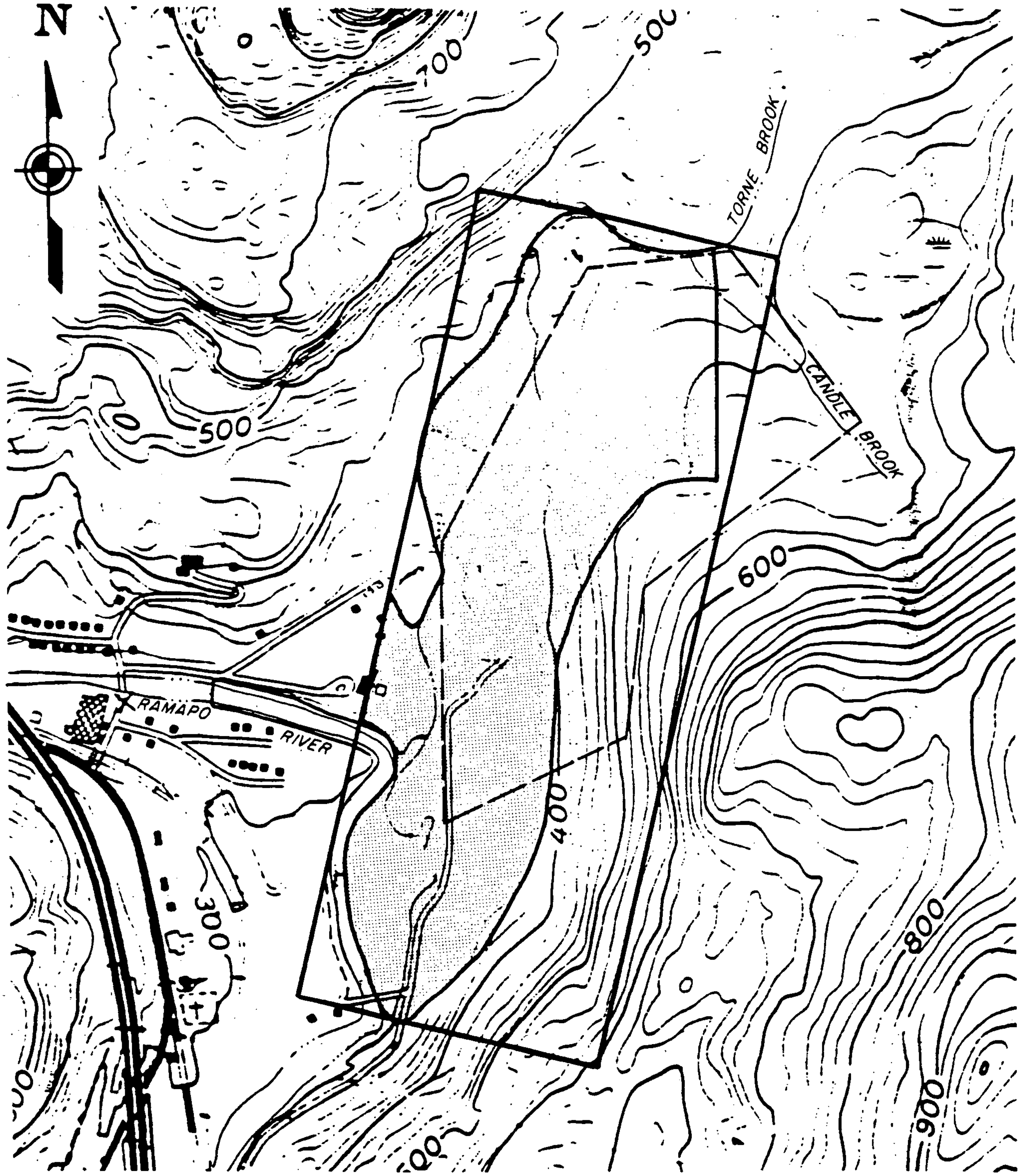
A number of wells were drilled into the bedrock aquifer. Hydraulic conductivity tests show a wide variation of values ranging from 10^{-2} cm/s to 10^{-6} cm/s. Flow through bedrock differs from the flow in the upper aquifer which is typical of porous media. Flow through bedrock in the vicinity of Ramapo Landfill is more typical of flow in a fractured media. The bedrock was included in the model because of its significant importance in the overall water budget. The thickness of the fractured bedrock was assumed as being 25 ft as based on the boring logs.

A large variation in the hydraulic heads occurs across the site within the bedrock aquifer. They range from 440.75 ft in MW-4 to 295.61 ft in MW-7.

Using the hydrogeologic information above, a three-dimensional groundwater flow model was developed as described below.

5.1.3 Areal Extent

The areal extent of the model was determined based on the availability of information pertaining to the hydrogeologic conditions of the site and vicinity. The modeled area was situated between Torne Brook, the natural aquifer boundaries, and the Ramapo River as shown on Figure 5-1. Also, an area west of Torne Brook in the vicinity of well MW-9 was included.



LEGEND

MODELED AREA

LIMITS OF LANDFILL

LIMITS OF THE FINITE DIFFERENCE GRID

RAM 001 0721

0 500 1000 FEET

SCALE

A-3678A

URS CONSULTANTS, INC.

AREAL EXTENT OF THE GROUNDWATER FLOW MODEL

FIGURE 5-1

5.1.4 Existing Leachate Collection System

The existing leachate collection system is described in Section 1.2.5 of the RI. It consists of a toe drain, an above-ground surface water collector, a shallow subsurface collector and a deep subsurface collector. As discussed in Section 3.7.5 of the RI, portions of the collection system are periodically above the water table making it difficult to estimate quantities collected within these four collectors. The Town has contracted for 80,000 gallons per day (gpd) to be treated at the Village of Suffern Wastewater Plant based on flow rates from their historical records. This equates to approximately 55 gallons per minute (gpm). This rate includes all the surface water and subsurface water collected in the system. Remediation efforts will be compared to this rate. The existing leachate collection system located along the downgradient boundary of the landfill was modeled using the MODFLOW drain package. The conductance of drainage pipes was determined during the calibration process.

5.1.5 Torne Brook

In its upper reach adjacent to the site, Torne Brook was assumed to constitute a water divide for the Torne Valley aquifer, therefore, it was modeled as a constant head boundary (Dunn Geoscience Corp. 1988). However, in its lower reach close to the Ramapo River it was modeled using the MODFLOW river package. This was considered to more accurately reflect the nature of the lower reach since in that area the influence of the Ramapo River becomes more pronounced. Also, since remedial action simulations will likely model withdrawal wells in its immediate area, it will ensure that the Torne Brook will not become an infinite source of water for those wells.

5.1.6 Ramapo River

The Ramapo River was assumed to form a constant head boundary along the southwestern edge of the modeled area. This assumption is justified by the fact that the River, having the lowest water surface elevation in the modeled region, serves only as a receptor of water. This condition can be accurately simulated by the constant head boundary because it excludes the possibility of the constant head cells becoming an excessive source of water.

5.1.7 Infiltration for Existing Conditions

An average infiltration for the aquifer tributary to the Ramapo River (primary aquifer) was assumed as 0.003 ft/day ("Evaluation of Ramapo Valley Well Field Management Techniques by RVAM Simulation", LBG Inc. July 1982).

The infiltration to the section of aquifer tributary to the Torne Brook (secondary aquifer) was unknown at the beginning of simulation and constituted one of the calibrated parameters. This approach was chosen due to the high variability of the site's geomorphology (variable slopes, cover types, presence of gullies) that would make a before-hand assessment difficult.

The values resulting from the calibration process discussed in Appendix P.3 are generally in agreement with the field measurements.

5.1.8 General Flow Regime

- The calibrated model is considered to be representative of generalized conditions at the site, and not a detailed investigation into the complex hydrogeology of a site with over a 200-foot drop in head, spanning two aquifers.

- Upper Aquifer (Layer 1)

  Across the modeled area, lateral flow is generally concurrent with the slope of the terrain toward Torne Brook. Torne Brook is a topographic low between the landfill and the land between the brook and the Ramapo River, and was estimated to discharge at approximately 16 cfs near its mouth. Much of the flow in the overburden is intercepted by the leachate collection system along Torne Valley Rd.

  In the southern portion of the modeled area, flow is directed towards the Ramapo River.

- Bedrock Aquifer (Layer 2)

  In the bedrock aquifer, flow is directed from the mountains towards the Ramapo River. It is not influenced by Torne Brook or the leachate collection system.

- Vertical Flow

  The very low vertical conductance obtained from the calibration process suggests that the two aquifers are not hydraulically connected. However, since the fractured bedrock was modeled as a porous media, vertical flow has to be regarded as an areal average. In reality it takes place through sparsely distributed fractures in the bedrock and its real velocity is much greater than the one suggested by the average flow. This is of significant importance in considering the migration of contaminants offsite, for which the real flow velocity will have to be obtained by considering the effective porosity of the fractured bedrock. This was done for contaminant transport calculations.

  Throughout most of the site, the hydraulic heads in the upper aquifer are greater than in the bedrock aquifer. This creates downward flow by which the contaminated leachate from the waste layer can potentially enter the bedrock aquifer. Small areas of the upward flow occur in the vicinity of URS MW-8 and MW-10 and were re-created by the model.

The summary of the parameters resulting from the calibration process and the hydrogeology of the site is presented below.

	Layer 1 (Upper Aquifer)			Layer 2 (Bedrock Aquifer)
	Primary	Secondary	Waste	
Kh [CM/S]	1E-3 - 3E-3	0.3E-4 - 1E-4	1.4E-5 - 1E-4	1.6E-5 -2E-5
Kv [CM/S]	1E-4 - 3E-4	0.3E-5 - 1E-5	1.4E-6 - 1E-5	7E-7 - 12E-7
Saturated Thickness [ft]	10-30	10-30	up to 60	25
Recharge [in/yr]	13.1	4.4	22-44	NA

The parameters are considered to be representative of steady state conditions at the site and used to define existing conditions.

5.1.9 <u>Infiltration For Capped Conditions</u>

In order to evaluate the influence of capping the site with either a NYS Part 360 cap or soil cap on the regional flow patterns and leachate quantities, an infiltration analysis was performed using the USACOE HELP computer model.

The HELP model was applied to the site using default climatological data for the 5-year simulation period from 1975 to 1979. Edison, New

Jersey weather station was used, being the closest location to Ramapo for which a set of default climatological data was available.

The model allows for four types of layers: vertical percolation (topsoil, wastes), lateral drainage (sand), barrier soil (clay) and barrier soil with liner (such as HDPE). Soil parameters can be either user-generated or program-generated (default).

The Part 360 cap was modeled as follows:

Layer Description	Thickness	Layer Type for Modeling Purposes
Topsoil	6"	Vertical percolation
Fill	24"	Vertical percolation or lateral drainage
Sand	12"	Lateral drainage (optional)
Clay	18"	Barrier soil

Also, the potential impact of a gas venting layer consisting of 12 inches of sand was investigated.

Input parameters required for defining the layers include: thickness, hydraulic conductivity, porosity, field capacity, wilting point and initial water content. As specific details of a cap design are not finalized, default values for topsoil, fill, drainage, and barrier layers as suggested by the model documentations were used.

The following values were obtained based on the HELP simulations for Part 360 capped conditions:

	Inches/Year	% of Yearly Rainfall
Runoff	0.5-8.4	1-16%
Evapotranspiration	31.3-33.9	60-65%
Lateral Drainage	6.3-18.8	12-36%
Infiltration	3.1-3.7	6-7%

The results indicate, that the amount of rainwater infiltrating through the cap and reaching the groundwater will be reduced to 3.1-3.7 inches per year from the approximate 50 inches/yr which precipitates. This equates to approximately 11 gallons/minute over the entire landfill area. The infiltration for existing conditions, based on the results of the calibrated groundwater model, displays a very high spacial variability. Throughout most of the site existing infiltration ranges from 4.4 inches per year in the areas of dense sands to 13.1 inches per year in the areas of loose sands. In several locations, however, it reaches 22 to 44 inches per year. This is due primarily to two factors: high permeabilities of refuse in the unvegetated portions of the landfill and the accumulation of offsite surface water runoff in the flatter areas. Locations of high infiltration areas are: the northern and southern lobes and the gully east of the southern lobe.

For a soil cap, which consists of the same HDPE membrane over the northern and southern lobes, and soil covering the sideslopes of the landfill, the following was estimated. Infiltration through the sideslopes would be similar to existing conditions, as a general fill material would be used, and the grading plan for the most part would remain the same. Infiltration through the HDPE would be equivalent to the Part 360 cap on the lobes. Approximately 18.5 gallons/minute would infiltrate to the groundwater over the entire landfill area.

5.1.10 Simulation 1 - Existing Conditions

The purpose of this simulation was to establish the regional flow pattern and point out the problem areas. The results indicate that most of the offsite flow is intercepted by the deep collector within the overburden aquifer. However, portions of the deep collector are periodically exposed above the water surface. In the vicinity of wells MW-8, MW-3, MW-4 and MW-6 the water is draining from the deep collector and flowing underneath to Torne Brook. The estimated leachate collection rate in the deep collector is 29 gpm. The estimated amount of surface water collected in the shallow subsurface collector and the surface water collector is therefore 26 gpm.

This calibrated model was used as the baseline for comparisons between potential remedial technologies. Remedial technologies selected in the Feasibility Study (FS) were super imposed on the groundwater flow system to evaluate their impact and effectiveness for long term conditions as detailed in the FS.

5.2 Contaminant Transport

In order to evaluate the potential for offsite migration of contaminants from the Ramapo Landfill to the potential receptor identified as PW-1, a contaminant transport analysis was performed. The analytical calculations were based on the field observations and measurements gathered during the Remedial Investigation and the results of the groundwater flow model discussed previously.

5.2.1 Approach

The calculations follow a step-by-step approach in attempting to trace the propagation of contaminants from the onsite fill to PW-1. First, the groundwater contour maps generated by the flow model were analyzed in order to determine the pathways by which the contaminants can reach PW-1. Second, the propagation of contaminants along those pathways is traced using analytical methods of calculation. Also, the effects of pumping in well PW-1 are estimated based on the constant discharge, transient, unconfined case.

The results of the groundwater flow model provided a basis for the contaminant transport model. Simulation 1 was used as representative of existing conditions to determine the groundwater flow patterns in the area.

5.2.2 Calculation of Contaminant Concentrations

The potential migration pathways were determined in the previous section based on the results of the groundwater flow model and the analysis of the operation of well PW-1. The contaminant concentration along these pathways was described using the analytical techniques and utilizing the aquifer parameters obtained both from the calibrated groundwater model and the RI field investigation.

- Bedrock aquifer directly underneath the landfill
  As determined earlier, there is a potential for leachate from the Ramapo Landfill to enter the underlying bedrock aquifer. The vertical velocity was estimated at 1.2E-5 ft/day. The contaminant concentration within the leachate was conservatively assumed to be equal to that directly in the landfill. The accumulation of the pollutant in the bedrock aquifer was modeled utilizing a 1-Dimensional steady-state mass balance approach, with the contaminated leachate treated as a distributed source over the length of 1500 ft. The results indicate the concentration of the contaminant in the groundwater within the bedrock aquifer at the downgradient end

of the landfill of about 12% of the leachate concentration within the landfill.

o Bedrock aquifer from the downgradient end of the landfill to PW-1

In this area, contaminant propagation was modeled utilizing a 1-Dimensional transient convective-dispersive equation (Bear, 1979). The downgradient end of the landfill was assumed as a starting point and PW-1 500 ft to the west was the ending point of the simulation. The properties of the aquifer were assumed after the field investigation findings for two wells in the immediate vicinity: URS MW-8 and URS MW-9. The average hydraulic conductivity of the bedrock based on the slug and pressure tests is 8E-4 cm/s, and the hydraulic gradient determined from monitoring levels in MW-8 and MW-9 is 0.025 ft/ft. The porosity of the fractured bedrock was assumed as 5% which is an average value for fractured crystalline rock as given in "Groundwater and Wells" (Driscoll, 1987). Those parameters give an average effective velocity of the groundwater flow of 1.15 ft/day. Different values of the hydrodynamic dispersivity were used ranging from 1 meter to 100 meters (Freeze & Cherry, 1979). The initial concentration of the contaminant at the starting point was assumed as 12% of the concentration in the landfill as discussed in the previous section.

The results of the model indicate that the concentration of contaminant at the ending point (directly underneath PW-1) reaches the steady-state concentration equal to that of the starting point (downgradient edge of the landfill) after 2 - 10 years, depending on the value of the hydrodynamic dispersivity used. Since the landfill has been operational for a much longer period of time, it can be assumed that steady-state conditions are present and that the concentration of contaminant in the bedrock beneath PW-1 is equal to about 12% of the concentration of the contaminant in the landfill.

- Assessment of the contamination of well PW-1

  The steady-state withdrawal rates in well PW-1 are sufficient to cause upward flow. The influence of the nonsteady pumping was also investigated.

  The hydrogeology in the immediate vicinity of PW-1 was based on the boring log from MW-9, about 100 ft from PW-1 as both of these are located within the Ramapo Valley aquifer. The thickness of the saturated zone in the upper aquifer is about 32 ft. Since the formation consists of both dense and loose sands, the average hydraulic conductivity of 10 ft/day was used based on the groundwater model. The effective porosity was assumed as 30% (Bear, 1979).

  Using the formula for the drawdown in a pumping well screened in an unconfined aquifer, the vertical gradients were evaluated for different pumping conditions (Bear, 1979). It was determined that upward flow from the bedrock will start for pumping cycles of 15 gpm which continue for over 67 minutes. (A cycle was assumed to last as long as it takes to fill up a 1000 gallon tank, e.g., for a cycle of 20 gpm over 50 minutes, the contribution of the bedrock water will create a contaminant concentration in the well water of about 6E-5 of the concentration in the landfill reduction of 5 orders of magnitude.)

5.2.3 Summary

Based on the results of the contaminant transport calculations, the following conclusions can be made:

- Downward gradients prevail across the site and the contaminated groundwater from the landfill is infiltrating into the lower (bedrock) aquifer. Therefore, the bedrock aquifer underneath the landfill provides the potential for contaminant migration. As there is no barrier restricting groundwater movement within the bedrock aquifer, the contamination may migrate towards residential well PW-1 and the Ramapo River. It is estimated that at the present time, groundwater within the bedrock aquifer beneath well PW-1 contains a contaminant concentration of about 12% of that directly within the landfill.

- Estimated withdrawal rates in well PW-1 are too small to cause significant upward flow from the bedrock aquifer. It was estimated that, depending on the withdrawal rates assumed, the concentration of contaminants in PW-1 can vary from zero to 6E-5 times the concentration of contaminants within the waste area. Therefore, it is questionable whether well PW-1 is actually being impacted by the contaminants in the bedrock aquifer.

6. BASELINE RISK ASSESSMENT

6.1. Introduction

6.1.1 Objectives and Scope

The public health risk assessment presented in this chapter is an analysis of the potential adverse health effects caused by the release of contaminants from the Ramapo Landfill site in the absence of remedial measures. As such, it may be classified as a no-action, or "baseline" health risk assessment (HRA). This baseline HRA addresses both current and reasonably foreseeable future uses of the Ramapo Landfill site.

The following baseline risk assessment must be regarded as an integral part of the RI and FS for the Ramapo Landfill site. It utilizes data and information provided by site characterization activities of the RI, and in turn generates an assessment of human health risk which serves as one of the principal criteria for determining whether, and to what degree, remedial action may be required at the site as discussed in the FS.

This baseline HRA for the Ramapo site follows the general format and procedures set forth in USEPA's Risk Assessment Guidance for Superfund (RAGS) (EPA 540/1-89-002). In particular, the HRA will include the following five major steps:

1. Selection of Potential Chemicals of Concern
2. Exposure Assessment
3. Toxicity Assessment
4. Risk Characterization
5. Uncertainty Analysis

Each of these steps is presented sequentially in Sections 6.2 through 6.6. Please note that all tables in Chapter 6 have been included at the end of the chapter.

6.1.2 Site Background

The Ramapo Landfill was operated as a sanitary landfill from approximately 1971 to 1984. Although landfilling operations have ceased, the site is currently being used as a compaction facility by the Town of Ramapo. Trash and debris is weighed at a weigh station/guard house along Torne Valley Road and compacted at the Baler Building, located in the northeastern corner of the site. In general, the compaction facilities operate 40 hours per week. The site is patrolled for security reasons during off hours. In addition, a leachate collection system diverts surface and subsurface leachate from the landfill to a pond in the southwestern corner of the site. This pond is used as a holding basin prior to discharge to the Suffern Wastewater Treatment facility.

(Please note that the use of the words onsite and offsite throughout this report are to depict the area within the property lines shown on Plate 1, and are not intended to convey the meanings defined in the National Contingency Plan (NCP).)

The land surrounding the site is rugged, heavily wooded, and sparsely populated. There is no residential development in the proximity of the site along the north, south, or east boundaries. However, there are residences located near the western boundary. The closest residence is located within 500 feet of the site along the west bank of Torne Brook. The land between the residences and the landfill is heavily wooded and the residents must cross Torne Brook to access the site. (A road leads from the residences to the landfill.)

The landfill and surrounding area are zoned for industrial use. The Town of Ramapo expects to operate the compaction facilities into the near future. Planned development of the site into the distant future, whether industrial or residential, is unknown. However, the Town of Ramapo has stated that it has no plans to modify industrial zoning in the areas adjacent to the landfill.

The Ramapo River, a New York State Class A stream, is located approximately 300 feet from the southwest corner of the site. Torne Brook, a Class B stream, is located along the site's western boundary, and discharges into the Ramapo River near the southwest corner of the site. It is reported that the Ramapo River is used, without authorization, for recreation (at "Flat Rock" off Torne Valley Road, approximately one quarter mile downstream of the site).

Groundwater is used by residents in areas south and west of the site. Two private wells (identified as PW-1 and PW-2 on Figure 1-2) are located within 1,200 feet of the landfill across Torne Brook. These wells supply approximately 55 people. Four production wells from the Ramapo Valley Well Field are located within 1,500 feet of the landfill, across the Ramapo River. These wells and a series of others operated by the Spring Valley Water Company supply over 200,000 people.

6.2 Identification of Chemicals of Potential Concern

6.2.1 Nature and Extent of Contamination

The nature and extent of contamination at the Ramapo Landfill site was discussed in Chapter 4 (entitled Environmental Quality) of the RI report. This section, which is based upon Chapter 4, includes a summary discussion of each environmental medium evaluated in the baseline risk assessment.

Groundwater well clusters GW-1 through GW-4, and GW-6 through GW-8, were installed and sampled along the downgradient edge of the landfill to determine the nature and extent of groundwater contamination migrating off site. A background well cluster GW-5 was installed in an upgradient undisturbed area along the eastern boundary of the site. Samples from well cluster GW-9 and the pump house located on an adjacent property were taken to assess the impact of onsite contamination on private well PW-1 which is used by residents of Torne Brook Estates. Two rounds of groundwater samples were taken. The first-round samples were analyzed for TCL parameters. Second-round samples were also analyzed for TCL parameters but the volatile organics were analyzed according to Method 524.2 in order to achieve lower detection limits (at the request of the NYSDEC). This method includes analysis for some volatiles not ordinarily included on the TCL, therefore additional organic contaminants were detected at low concentrations. However, the only organic compound detected at GDT-1 from the private water supply system was tetrachloroethene, at 0.6 ppb.

Surficial soil/waste samples were collected from areas of suspected contamination, such as where there were high HNu readings from the soil gas survey or where there was an indication of past waste storage or disposal activities at the site (i.e. leachate holding basin). Samples were also taken in areas of current activity such as the pistol range, weigh station and the Baler Building. One background sample, SPS-9, was collected in an undisturbed (forested area where no landfill activities have taken place) near the eastern boundary of the site.

An air monitoring study was conducted during the second phase of field activities to determine the type, concentration, and dispersion of airborne contaminants present at the landfill. The air monitoring study included monitoring of "hot spots" outlined in the pre-RI soil gas survey. Point source monitoring consisting of background, point source (Piezometer

1), and receptor area (Baler Building) locations downwind of prevailing westerly winds.

The analytical data generated during the RI have been audited, and the results validated in accordance with procedures outlined in the site work plans. Data Usability Reports for both rounds of analysis are presented in Appendix J.

6.2.2 Chemicals of Potential Concern Used for Quantitative Assessment

Data presented in Chapter 4 of this RI were used to compute averages (arithmetic mean) and to identify maximum concentrations of contaminants in each medium for both onsite and background sources. These values were utilized in accordance with other criteria discussed below to select contaminants (chemicals of potential concern) for inclusion in the baseline health risk assessment. These average and maximum concentrations were subsequently employed to determine exposure point concentrations for use in the exposure assessment (Appendix Q).

6.2.2.1 Groundwater

A list of organic and inorganic chemicals detected in the three groundwater aquifers at the Ramapo Landfill site, as well as their frequency of detection, sample quantitation limit ranges, and onsite and background concentrations are presented in Table 6-1. The average concentrations (used for background concentration and onsite concentration for inorganics only) were calculated using detected concentrations and one-half the sample quantitation limit for samples in which the chemicals were not detected. Sample quantitation limits are detection limits that have been adjusted to account for preparation or analytical method (e.g. dilution, or use of a smaller sample aliquot) if required.

The chemicals listed in Table 6-1 were evaluated and chemicals of potential concern (CPCs) were selected based upon the following criteria:

1) The chemical was detected in at least one sample during either sampling round; and

2) The maximum concentration in the onsite (downgradient) wells must be one order of magnitude greater than the mean concentration in the upgradient (background) groundwater samples for organic chemicals; and

3) The mean concentration in the onsite samples must be one order of magnitude greater than the mean concentration detected in the upgradient groundwater samples for inorganic chemicals.

Background concentration and onsite concentration were compared within each of the aquifers (i.e., shallow, intermediate, and bedrock). In comparing these values, a nondetect value in background was conservatively assumed equal to zero i.e. any chemical detected on site but not detected in background was considered a CPC. By comparing background and onsite concentrations within each aquifer, more chemicals were selected as CPCs than if concentrations from all aquifers had been averaged together prior to the comparison. This conservative approach was utilized so as not to unduly eliminate chemicals attributable to the site. In addition, comparison of background and onsite concentrations for organics was more conservative than for metals since maximum rather than average onsite concentrations were utilized for comparison. This more conservative approach was used because the TCL organic compounds are not naturally occurring in the environment and are not normally expected to be present.

Based upon the above-referenced criteria, groundwater CPCs were selected as presented in Table 6-2. Although chromium (trivalent), aluminum, barium, calcium, copper, iron, nickel, potassium and zinc do not meet the criteria established above, they have also been selected as CPCs at the request of the NYSDEC and USEPA.

6.2.2.2 Soil/Waste

A list of organic and inorganic chemicals detected in surficial soil/waste samples at the Ramapo Landfill is presented in Table 6-3. Also included in this table are sample quantitation limit ranges, sample frequency, onsite concentrations (maximum concentration for organic compounds and average concentration for inorganic chemicals) and the concentrations in the background sample SPS-9.

The chemicals listed in Table 6-3 were evaluated and CPCs were selected based upon the following criteria:

1) The chemical was detected in at least one sample during either sampling round; and

2) The maximum concentration in the onsite surficial soil samples exceeds the background (SPS-9) concentration by one order of magnitude for organic chemicals; [Since no organics were detected in the background soil samples, all organics detected in soil are included in the baseline HRA] and

3) The mean concentration in the surficial soil samples exceeds the background (SPS-9) concentration by one order of magnitude for inorganic chemicals.

Based upon the above-referenced criteria, Table 6-4 presents the soil CPCs.

6.2.2.3 Air

During air monitoring, an upwind background sampling point was established at PSR-1. However, a true background for air quality analysis based on one sampling event is extremely hypothetical, since air quality is subject to many dynamic forces (e.g., windspeed and direction, temperature inversions, localized wind currents, etc.). Consequently, comparison of onsite samples with background samples was not used as a criterion for CPC selection for air, and all compounds detected in air were used in the baseline health risk assessment as shown in Table 6-5.

6.3 Exposure Assessment

The purpose of this exposure assessment is to estimate the type and magnitude of potential human exposures to chemical compounds present at the Ramapo Landfill site. Ultimately, this purpose is achieved by estimating an exposure dose for each pathway and each onsite contaminant. The process includes: first, identification of potential human exposure pathways under existing and future-use scenarios; second, estimation of contaminant concentrations at the point of potential human exposure; and third, application of assumptions and exposure parameters to estimate an exposure dose for each selected pathway.

6.3.1 Exposure Pathways

An exposure pathway is the mechanism by which an individual or population is exposed to contaminants at or originating from a site. Each pathway includes a source or mechanism of release from a source, an exposure point, and an exposure route (e.g., ingestion). If the exposure point differs from the source, a transport/exposure medium is also necessary.

At the Ramapo site, exposure pathways have been developed for current (existing) and potential future land use scenarios. It should be noted that, as a baseline health risk assessment, this entire evaluation addresses potential human health risks under current conditions, i.e., in the absence of remedial measures. The current and future risks calculated in the following sections are predicated upon the assumption that site conditions remain as they are into the foreseeable future.

6.3.1.1 <u>Current Land Use</u>

Potential human exposure pathways under the current (existing) land use scenario are classified as residential, recreational (trespass), or industrial/commercial. (The site is not open for public recreational use, therefore, a recreational user would be a trespassser.) Tables 6-6 through 6-8 show exposure pathways under each of these classifications that have been identified and will be evaluated as part of the baseline HRA under the current land use scenario. These exposure pathways are discussed in more detail below.

a. <u>Soil/Waste</u> - Persons accessing to the site by trespassing could be exposed to surficial soil/waste at any point on the site. Both short-term (child) and long-term (adult) exposure have been evaluated under this trespass scenario. Under the trespass scenario, it was assumed that children age 6-11 would be subject to short-term exposure. Younger children were not evaluated because the likelihood of such children trespassing on site is considered minimal. Since the site is still utilized for trash compaction, employees may also be exposed to contaminants in onsite soil/waste under the current industrial land use scenario. All exposures would result from direct contact with the soil/waste, and subsequent incidental ingestion and dermal absorption of contaminants.

b. <u>Groundwater</u> - Local residents are currently utilizing downgradient wells in the overburden for drinking water. Therefore, under the current residential land-use scenario these residents may be exposed to groundwater contamination via ingestion.

c. <u>Air (Outdoor)</u> - Persons trespassing on the site for recreational purposes could be exposed to contaminants volatilizing from the landfill at any point on the site. Both short-term (child) and long-term exposure have been evaluated under this recreational trespass scenario. Employees currently working on the site could also, during normal operating hours, be exposed to contaminants volatilizing from the landfill, under the current industrial use scenario.

d. <u>Air (Indoor)</u> - Under the current residential land-use scenario, nearby residents using groundwater could be exposed to contaminants volatilizing from groundwater during showering. All exposures to air would be via inhalation.

e. <u>Surface Water</u> - Concern has been raised regarding potential exposure to contaminants in surface water at a recreation area, i.e. Flat Rock, located downstream of the site in the Ramapo River. However, data collected during the RI indicate that this exposure pathway is not significant when compared to other pathways utilized for the quantitative assessment of risk. This exposure pathway is discussed qualitatively in Section 6.6 - Uncertainty Analysis.

6.3.1.2 **<u>Future Land Use</u>**

Tables 6-9 and 6-10 show residential and industrial/commercial exposure pathways for an unremediated site under the future land use scenario. The basis for selection of these routes is discussed below.

a. Soil - Persons living on site in the future would generally be exposed to site soil contamination at a greater frequency than those persons using the site under the recreational trespass scenario. Both short-term (child) and long-term (adult) exposure were evaluated under the future-use scenario. Under the future land use scenario, younger children (0-6 years) who were not considered in the current use scenario, since they would not be likely tresspassers, were utilized to assess risk in order to generate a more conservative assessment. Residents could be exposed to contaminants at the surface or in the subsurface after earthmoving operations associated with residential construction or usage. However, since subsurface samples were collected from the perimeter of the landfill rather than directly on site during the RI, only surface soil samples, which include wastes, were utilized to evaluate the future land use scenario. Worker exposure to soil contamination in the future is expected to remain the same as at the present since exposure frequency is expected to remain the same.

b. Groundwater - Under the future land use scenario, both residents living on site and employees working on site would be potentially exposed to groundwater contamination via ingestion. The concentrations of contaminants in groundwater utilized for the future-use scenario are significantly greater than for the present-use scenario since it is assumed that contamination is not attenuated by transport downgradient to offsite receptors.

c. Air (Outdoor) - Persons living on site in the future-use scenario would generally be expected to be exposed to contaminants volatilizing from the landfill with greater frequency than those using the site under the recreational trespass scenario. However, exposure frequency for employees working on site is expected to remain the same.

d. Air (Indoor) - Indoor exposure to contaminants volatilizing from groundwater used for showering is an exposure pathway under the future land use as well as the current land use scenario. However, exposure concentrations will be significantly higher since onsite concentrations in groundwater are significantly higher than the concentrations modeled for downgradient receptors under the present-use scenario. While the future use assessment considers children ages 0-6, the shower exposure considered only 2 years (age 4-6). This was done since it is considered unlikely that children ages 0-4 will be taking showers.

6.3.2 Exposure Concentrations

In order to quantify health effects, it is necessary to establish the concentration of each potential chemical of concern at the point(s) where it comes into contact with a human receptor (i.e., along a completed exposure pathway). In this study, exposure concentrations were derived from monitoring data, modeling data, or a combination of both monitoring and modeling data. The methods for determining the exposure concentration utilized for each medium are summarized below. [A more detailed description of exposure point concentration determination is included in Appendix Q.]

a. Soil/Waste - Exposure concentrations for soil/waste are based solely on monitoring data. In general, because of the uncertainty associated with estimation of exposure concentrations, the exposure concentration in soil is the upper confidence limit (i.e. the 95 percent upper confidence limit) on the arithmetic average for all surficial soil samples except SPS-5 and SPS-9. SPS-9 was not used since this sample is a background sample. SPS-5 was not used since this sample was taken from a waste pile that was removed during the course of this RI. For chemicals where the upper confidence limit on the arithmetic average was higher than the maximum concentration (because one-half the sample quantitation limit was used for non-detected values) the maximum concentration was used as the exposure concentration.

b. <u>Groundwater</u> - Exposure concentrations at the nearest private well (PW-1) were analytically modeled and utilized to evaluate risk under the current land-use scenario. Evaluation of water level measurements indicates that groundwater flow in the upper (overburden) aquifer is intercepted by Torne Brook, and that consequently it will not impact private wells which are all separated from the landfill by Torne Brook. Therefore, the modeled pathway for transport of groundwater from the landfill to the nearest receptor consisted of the following elements: 1) vertical migration of contamination from the overburden to the upper fractured zone of bedrock; 2) horizontal transport of contamination in fractured bedrock to the point of exposure (beneath PW-1); and 3) vertical contaminant migration upward from the bedrock, resulting from pumping of water from the overburden. Based on this pathway, modeled exposure concentrations at PW-1 are approximately 0.01 percent of the chemical concentrations in onsite groundwater. Chemical concentrations on site were estimated as the 95th percent upper confidence limit on the arithmetic average for all groundwater samples or the maximum concentration where the upper confidence limit on the arithmetic average exceeded the maximum concentration. For the future-use scenario the onsite concentrations were utilized as exposure concentrations. A more detailed description of the groundwater model is presented in Appendix P.3.

c. <u>Air (outdoor)</u> - Exposure concentrations utilized to evaluate exposure to chemicals volatilizing from the landfill are based on monitoring data. The exposure concentration used is the 95th percent upper confidence limit on the arithmetic average of all air samples (except background) collected during the RI.

d. <u>Air (indoor)</u> - The exposure concentrations utilized for chemicals volatilizing during showering were modeled based on groundwater concentrations. The transfer of chemicals from groundwater to air was modeled by utilizing compound-specific parameters (i.e. diffusion

RAM 001 0745

coefficients in air and water and Henry's law constants) and values for volume of water used during showering, and the volume of the shower determined from the literature. A more detailed description of the shower model is presented in Appendix Q.

6.3.3 Estimation of Chemical Intakes

The exposure dose, or intake, is defined as the mass of a substance given to an organism and in contact with an exchange boundary (e.g., lungs) per unit body weight per unit time. Units for exposure intake are typically milligrams per kilogram-day (mg/kg-day). Exposure dose is calculated by dividing the total amount of chemical exposure (mg) by body weight (kg) and exposure time (days). The total amount of chemical exposure is based upon chemical concentration in the environmental medium of concern, relative absorption factor of the chemical, and a number of intake variables expressing the frequency, duration, and magnitude of exposure. These intake variables are selected conservatively, so that, in combination, they produce an estimate of the reasonable maximum exposure for each particular exposure pathway. The following discussion indicates, for current and future land use, how exposure dose has been calculated for each exposure pathway at the Ramapo Landfill site. Note that for many exposure pathways an average daily exposure dose has been calculated for both chronic (lifetime) and subchronic (childhood) exposure. Chronic exposure dose is used to quantify carcinogenic health effects, whereas both chronic and subchronic doses are considered in evaluating noncarcinogenic health effects.

Intake equations for each major exposure pathway are presented below. The numerical values for the variables used in each intake equation and the intakes calculated for each exposure pathway are presented in Tables 6-11 through 6-20. For the purpose of clarity, separate tables were developed for noncarcinogenic (non-cancer-causing) and carcinogenic (cancer-causing) chemicals. Therefore, two tables are presented for each exposure pathway. The list of chemicals included in each of these two categories and the method used to determine the chemical classification is presented in Section 6.4.

1. <u>Ingestion of Soil</u>

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

Where:

CS = Chemical Concentration in Soil (i.e., the 95th percent upper confidence limit on the arithmetic average for surface soil samples - mg/kg).

IR = Ingestion Rate (mg of soil/day)

CF = Conversion Factor (10^{-6} kg/mg)

FI = Fraction Ingested from Contaminated Source (unitless)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT = Averaging Time (period over which exposure is averaged - days)

Excluding concentration, all variable values except exposure frequency and a child's body weight are derived from <u>Risk Assessment Guidance for Superfund (RAGS)</u> (USEPA, December 1989). The child's body weight was obtained from the Exposure Factors Handbook (USEPA, July 1989). Exposure frequency is based on direction provided by USEPA Region II in telephone conference of March 5, 1991. (Variable values originally specified by URS were reviewed by USEPA. The USEPA disagreed with some of the proposed values therefore, some of the values were changed to those specified by the USEPA and subsequently utilized throughout the HRA.) The numerical values for variables used to calculate intake for ingestion of carcinogenic and noncarcinogenic chemicals in soil are presented in Tables 6-11 and 6-12, respectively.

2. Dermal Contact with Soil

Equation:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

Where:

CS = Chemical Concentration in Soil (i.e., 95th percent upper confidence limit on arithmetic average for surface soil samples - mg/kg)
CF = Conversion Factor (10^{-6} kg/mg)
SA = Skin Surface Area Available for Contact (cm^2/event)
AF = Soil to Skin Adherence Factor (mg/cm^2)
ABS = Absorption Factor (unitless)
EF = Exposure Frequency (events/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Average time (period over which exposure is averaged - days)

RAM 001 0748

Excluding concentration, all variable values except a child's body weight, exposure frequency, and absorption factor were derived from RAGS. Exposure frequency and a child's body weight were determined in the same manner as for soil ingestion. The absorption factor is based on Assessment of Health Risk from Exposure to Contaminated Soil (Hawley, 1985). All numerical values for variables used to calculate intake for carcinogenic and noncarcinogenic chemicals in soil via dermal contact are presented in Tables 6-13 and 6-14, respectively.

3. Ingestion of Groundwater

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Where:

CW = Chemical Concentration in Water (the 95th percent confidence limit on the average for future use or a modeled concentration for present use - mg/liter)

IR = Ingestion Rate (liters/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT = Average time (period over which exposure is averaged - days)

Excluding concentrations, all variable values except a child's body weight and ingestion rate were derived from RAGS. Values for a child's body weight and ingestion rate were obtained from the Exposure Factors Handbook (USEPA, July 1989). Numerical values for all variables used to calculate intake from groundwater ingestion for carcinogenic and noncarcinogenic chemicals are presented in Tables 6-15 and 6-16, respectively.

4. <u>Inhalation of Vapor-Phase Chemicals (Outdoors on or near Landfill)</u>

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

Where:

CA = Contaminant Concentration in Air (i.e., 95th percent upper confidence limit on arithmetic average for air samples - mg/m^3)
IR = Inhalation Rate (m^3/hr)
ET = Exposure Time (hours/days)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Average time (period over which exposure is averaged - days)

For this pathway, values for exposure time and exposure frequency were provided by USEPA Region II in a March 5, 1991 telephone conference. The body weight and inhalation rate for a child were derived from the <u>Exposure Factors Handbook</u> (USEPA, July 1989). All other variable values, excluding concentration, are presented in RAGS. Numerical values for variables used to calculate intake of carcinogenic and noncarcinogenic chemicals via inhalation of vapors from the landfill are presented in Tables 6-17 and 6-18, respectively.

5. <u>Inhalation of Vapor-Phase Chemicals (Indoors while Showering)</u>

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

Where:

CA = Contaminant Concentration in Air (i.e., modeled concentration based on groundwater concentration - mg/m^3)
IR = Inhalation Rate (m^3/hour)
ET = Exposure Time (hours/days)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Average time (period over which exposure is averaged - days)

For this pathway, variable values for inhalation rate, exposure time, exposure duration, adult body weight and averaging time are as presented in RAGS. The child's body weight was derived from the <u>Exposure Factors Handbook</u> (USEPA, July 1989). Values for exposure frequency are based on professional judgement and reflect the concept of reasonable maximum exposure (RME). Numerical values for variables used to calculate intake of carcinogenic and noncarcinogenic chemicals via inhalation of vapors volatilizing while showering are presented in Tables 6-19 and 6-20, respectively.

6.4 Toxicity Assessment

The chemicals of potential concern identified from media collected at the Ramapo Landfill site may be categorized by their relative health risks. Risks are divided into carcinogenic and noncarcinogenic effects, with noncarcinogenic chemicals further subdivided into chronic and subchronic categories. USEPA has defined toxicity constants to be used in evaluating these risks.

Toxicity data (with the exception of PAHs) for this risk assessment was collected following the hierarchy described by USEPA. First, Integrated Risk Information System (IRIS) was consulted through an on-line computer linkage. Second, when information was not available on IRIS the Health Effects Assessment Summary Tables (HEAST) for the fourth quarter FY 1990 were consulted. Third, a list of compounds for which information was missing was sent via telefax to USEPA Environmental Criteria and Assessment Office (ECAO). Toxicity data for PAHs were derived from the Superfund Public Health Evaluation Manual (SPHEM) [USEPA, 1986]. This is an interim recommendation of ECAO and was utilized because of the number of PAHs detected in onsite media. PAHs are discussed further in Section 6.6. Only those values from IRIS, HEAST, or SPHEM are used in this risk assessment. Tables 6-21 and 6-22 identify from which of these sources each coefficient was taken, and the date of verification by USEPA.

For evaluating carcinogenic risk from exposure to contaminants, a slope factor (SF) has been established. The SF is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. SFs are developed for oral intake and inhalation routes of exposure.

For evaluating noncarcinogenic effects from exposure to contaminants, the toxicity constants used are the reference dose (RfD) and reference concentration (RfC). Specific values are developed for chronic and subchronic RfDs and RfCs.

Chronic RfDs are derived from the No-Observed-Adverse-Effect-Level (NOAEL) for the critical toxic effect and modified by application of uncertainty factors reflecting the type of study on which the values are based. RfDs are used to estimate risk from oral or dermal routes of exposure.

Chronic RfCs are derived in a similar fashion but are based upon studies of inhalation exposure. For this reason, calculation of RfCs is more complex, and therefore RFCs are available for fewer chemicals.

Subchronic values for RfD and RfC are derived in the same fashion as the chronic values when suitable less-than-lifetime studies are available. As of the date of this report subchronic values have not undergone intra-agency verification and are not yet available on IRIS, the primary EPA source of toxicological information for Superfund.

Since toxicity information is limited for many chemicals used in the HRA, uncertainty factors are published for noncarcinogenic chemicals. These uncertainty factors generally range between 10 and 1,000. A high uncertainty factor indicates low strength of evidence for the toxicity value and further indicates that the toxicity value might change if additional data become available. A low uncertainty factor indicates that there is a high degree of confidence in the value and that a change is less likely should more data become available. Uncertainty factors associated with noncarcinogenic chemicals of greatest concern for the baseline HRA are discussed further in Sections 6.5.3 and 6.5.4.

6.4.1 Carcinogenic Effects

Table 6-21 summarizes toxicity information for the potentially carcinogenic chemical compounds which were detected in one or more of the environmental media at the Ramapo Landfill. For each of these compounds, the following information is provided:

a. Weight of evidence for carcinogenicity expresses the degree of confidence relating to exposure to a given chemical and the likelihood that the chemical causes cancer in humans. This weight of evidence is based upon the following USEPA classification system:

Group A--Human Carcinogen

This category indicates that there is sufficient evidence from epidemiological studies to support a causal association between an agent and cancer in humans.

Group B--Probable Human Carcinogen

This category generally indicates that there is at least limited evidence from epidemiological studies of carcinogenicity to humans (Group B1) or that, in the absence of positive data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2).

Group C--Possible Human Carcinogen

This category indicates that there is limited evidence of carcinogenicity in animals in the absence of positive human data.

Group D--Not Classified

This category indicates that there were no data to evaluate or that the evidence for carcinogenicity in humans and in animals was inadequate.

Group E--No Evidence of Carcinogenicity to Humans

This category indicates that there is no evidence of carcinogenicity in at least two adequate animal tests in different species or in both epidemiological and animal studies.

b. Slope factor, or cancer potency factor, represents a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. This slope factor allows the calculation of incremental lifetime cancer risk associated with exposure to the chemical at a known or estimated dosage. Table 6-21 provides separate slope factors, where applicable and available, for oral and inhalation routes of exposure. [In the absence of published slope factors for dermal routes of exposure, the oral slope factor has been applied in this risk assessment to estimate cancer risk associated with dermally absorbed chemical doses.]

c. References, including source(s) and date(s), are provided to indicate the basis for identified slope factors.

d. Tumor site, i.e., type of cancer upon which the slope factor and weight of evidence are based.

6.4.2 Noncarcinogenic Effects

Unlike carcinogens, noncarcinogenic compounds are thought to have threshold dosage levels below which adverse effects are not expected. This section provides information concerning these threshold levels.

Table 6-22 summarizes toxicity information for the noncarcinogenic chemicals which were detected at the Ramapo Landfill site. [Note that some chemicals (e.g., arsenic) have both carcinogenic and noncarcinogenic effects, and are therefore listed in both Table 6-21 and Table 6-22.] For each of the Table 6-22 chemicals the following information is provided separately for oral and inhalation routes of exposure where appropriate:

a. Toxicity Value, expressed in mg/kg-day for noncarcinogenic chemicals, generally identifies the threshold dosage level below which adverse health effects are not expected. The most common and preferred, criterion for expressing potency is the reference dose (RfD), which is an estimate of the average daily exposure level below which significant, adverse noncarcinogenic health effects are not expected.

b. Source(s) of dose-response data.

c. Date(s) of source information.

d. Critical Effect expresses the end point of adverse response (e.g., liver damage) associated with the exposure to noncarcinogenic chemicals. Although noncarcinogenic health effects for all chemicals are initially added, regardless of critical effect, this identification is necessary to indicate the degree of conservatism involved with this assumption and, if necessary, to subsequently revise it.

6.4.3 Chemicals for Which No Values Are Available

The following chemicals, although identified as being detected in the Ramapo Landfill site samples, were not used in any of the risk calculations due to the lack of published toxicity values. These chemicals include 4 carcinogens: butylbenzylphthalate, lead, nickel, 1,1-dichloroethane, and 15 noncarcinogens: tert-butylbenzene, cobalt, cymene(p-isopropyltoluene), dibenzofuran, lead, delta-BHC, propylbenzene, sodium, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, aluminum, calcium, copper, iron, and potassium.

The remaining chemicals for which some toxicity information is available were included in pathway-specific risk calculations only when relevant toxicity information was available for that pathway. Consequently, only chemicals with toxicity values (noncarcinogens) or slope factors (carcinogens) shown in Table 6-21 or 6-22 are shown in subsequent tables for risk calculation. For example, of 62 noncarcinogenic chemicals, 50 have given chronic RfD values but only 19 have been assigned chronic RfCs. Therefore, many more chemicals have been included in risk calculation for pathways involving oral or dermal exposure than exposure via inhalation.

In general, more information is available for each listed carcinogen. This is because the level of data required to classify a compound as a human carcinogen is usually sufficient to also calculate a slope factor. Of 31 carcinogens there, 26 have oral SFs and 24 have inhalation SFs.

6.4.4 Toxicity Profiles

For each contaminant a toxicity profile has been prepared that summarizes physical and chemical as well as toxicological information. Various sources were consulted for this information, and citations are given where appropriate. These profiles are presented in Appendix Q.

6.5 Risk Characterization

6.5.1 Method of Analysis

Health risk is a function of both human exposure and chemical toxicity. Following from this principle, the risk characterization for the Ramapo Landfill site is the process by which the toxicity, or dose-response, assessment (Section 6.4) is integrated with the exposure assessment (Section 6.3) to estimate present and potential threats to human health posed by contamination at the site. Health risks are identified for both current and future land-use scenarios. The following sections describe, respectively, the carcinogenic and noncarcinogenic (chronic and subchronic) risks posed by the Ramapo Landfill site under current conditions, i.e., in the absence of remedial measures.

6.5.1.1 Carcinogenic Risk

Carcinogenic risk is expressed as the incremental lifetime cancer risk that could be experienced by an individual or population exposed to contaminants at the Ramapo Landfill site under the exposure scenarios, and at the exposure doses, that have been postulated for the site. This incremental lifetime cancer risk corresponds to the upper 95th percentile confidence limit of the probability (when based on animal data), or to the maximum likely estimate (when based on human data), of developing cancer over a 70-year lifetime from exposure to hazardous substances present at the Ramapo Landfill site. It is computed by the following equation:

$$\text{Cancer Risk} = \text{Exposure Level (mg/kg-day)} \times \text{Slope Factor} \; [(\text{mg/kg-day})^{-1}]$$

As indicated by the above equation, incremental lifetime cancer risk is dimensionless. A risk of 1.0 E-06 for example, indicates that an individual would incur an additional risk of 0.000001 (or 1 in one million) due to his/her exposure to contaminants at a given site. Alternately, out of a population of one million persons so exposed, this risk would indicate that one person, on average, would contract cancer due to such exposure.

6.5.1.2 Noncarcinogenic Risk

Noncarcinogenic risk evaluation is based on a threshold response theory. The process involves a comparison of an exposure level (or dose) to the estimated threshold response level. The term used to make this comparison is the "Hazard Index," which is defined as:

$$\text{Hazard Index} = \frac{\text{Exposure Level (Intake or Absorbed Dose) (mg/kg/day)}}{\text{Toxicity Value (mg/kg/day)}}$$

In the above equation, reference dose (RfD) or reference concentration (RfC) are the most common (and the preferred) toxicity values for determining noncarcinogenic effects.

As previously discussed, different noncarcinogenic chemicals may produce different forms of human response, or end points. Therefore, summing the Hazard Indices of all noncarcinogenic chemicals within a pathway is not theoretically correct. It is, however, conservative, and for this reason has been employed as an <u>initial</u> step in the assessment of potential noncarcinogenic health effects at the Ramapo site. If the Hazard Index calculated in this manner produces a value less than the acceptable upper limit of one, distinction between end points is not required. If, however, the total Hazard Index exceeds this acceptable limit, further evaluation of the Hazard Index based on the health effects may be required.

Noncarcinogenic effects have been evaluated separately for chronic (lifetime) and subchronic (short-term) exposure. Whereas the chronic risk evaluation assumes a 30-year exposure to Ramapo Landfill contaminants, the subchronic evaluation assumes a shorter duration (5-year), but higher dose, exposure which might be experienced by children trespassing or living on site. As discussed in Section 6.3, an older child, aged 6 to 11 years, was used to evaluate subchronic exposure under current land use conditions; and a younger child, aged 0 to 6 years, was used for future use conditions.

6.5.1.3 <u>Risk Calculation for Individual Pathways</u>

Using the methodology described above, risks (incremental lifetime carcinogenic risk for carcinogens and hazard indices for noncarcinogens) have been calculated for each of the individual pathways described in Section 6.3, and presented in Tables 6-23 through 6-42. Under the current land-use scenario, six recreational (adult and child trespasser), four residential (adult and child), and three industrial/commercial pathways were identified. These pathways are summarized in Table 6-43. Under the future land-use scenario, ten residential (adult and child) and four industrial/commercial pathways were identified. These pathways are summarized in Table 6-44.

Risk calculations are based on the equations presented above, with input to these equations from Section 6.4 (toxicity values) and Section 6.3 (exposure doses or intake). The resulting calculations are presented in table format, which may be summarized as follows:

- Tables 6-23 through 6-27 indicate cancer risks associated with exposure under the current land-use conditions.
- Tables 6-28 through 6-32 indicate cancer risks associated with exposure under future land-use conditions.
- Tables 6-33 through 6-37 indicate chronic and subchronic health effects under current land-use conditions.
- Tables 6-38 through 6-42 indicate chronic and subchronic health effects under future land-use conditions.

6.5.1.4 Combination of Risks Across Pathways

As shown on Table 6-43, five basic exposure pathways were considered under the current land-use scenario. However, because five different types of receptors were identified, a total of thirteen exposure pathways were evaluated. Since it is possible that individuals living near the site could also trespass on site, risks associated with exposure pathways for residents and trespassers were combined. Consequently, combined total risk was determined for only three receptors, i.e., adults (residents and trespassers), children (residents and trespassers), and workers. Total risk (carcinogenic and chronic noncarcinogenic for adults, and carcinogenic and subchronic noncarcinogenic for children) was determined by adding the risks from each of the five basic exposure pathways. However, since groundwater is not currently being used on site, only three of the five basic exposure pathways (ingestion of groundwater and inhalation of vapor from showering not being applicable) were utilized to determine total risk (carcinogenic and chronic noncarcinogenic) for workers.

Under the future land-use scenarios, only residential and worker exposure was considered, i.e. the trespass scenario was not considered valid. Therefore, total risk (carcinogenic and chronic noncarcinogenic for adult residents and carcinogenic and subchronic for child residents) has been calculated by adding risk from all five basic pathways. Four of the basic exposure pathways were utilized to calculate risk for onsite workers since onsite groundwater use was considered reasonable under future conditions. [Only inhalation of vapors from showering was not used to calculate total risk to workers since it was considered unlikely that future industrial or commercial facilities that use groundwater from the site would have shower facilities.]

Calculations of combined total risk are presented in tabular form and may be summarized as follows:

- Tables 6-45 through 6-47 summarize the total incremental lifetime carcinogenic risks associated with exposure to Ramapo Landfill site contaminants under current land-use conditions for workers, adults (trespassers and residents), and children ages 6-11 (trespassers and residents), respectively.

- Tables 6-48 through 6-50 summarize carcinogenic risks under future land-use conditions for workers, adults, and children ages 0-6, respectively.

- Table 6-51 and 6-52 summarize chronic Hazard Indices under current conditions for workers and adults, respectively.

- Table 6-53 and 6-54 summarize chronic Hazard Indices under future conditions for workers and adults, respectively.

- Tables 6-55 and 6-56 summarize subchronic (child) Hazard Indices for the current (ages 6-11) and future (ages 0-6) land use scenarios, respectively.

6.5.2 Carcinogenic Risk - Results and Discussion

6.5.2.1 Current Land Use

The total cancer risk associated with exposure to contaminants from the Ramapo Landfill site, under current land-use conditions, is presented in Tables 6-45 through 6-47 for workers, adults (residents and trespassers), and children ages 6-11 (residents and trespassers), respectively. The following items of discussion refer to the values presented in these tables.

a. Acceptable risk - USEPA has, through its National Oil and Hazardous Substances Pollution Contingency Plan (NCP), established acceptable exposure levels for known or suspected carcinogens that are to be used to establish remedial action objectives. These acceptable exposure levels are concentration levels that represent an excess upper-bound lifetime cancer risk of 1.0E - 06 to 1.0E - 04.

b. Total sitewide risk - As indicated in Tables 6-23 through 6-27, cancer risks for adults, children, and workers all fall within the acceptable risk range established by the NCP.

c. Major contributing pathways - The exposure pathways which contribute most to the total site cancer risk for all three receptors (adults, children, and workers) studied are dermal contact with soil, ingestion of soil, and inhalation of vapors from the landfill. For adults, soil ingestion contributed most (approximately 62%) to the total cancer risk. For workers and children, inhalation of vapors from the landfill contributed most (approximately 63% and 41%, respectively) to the total cancer risk.

d. Insignificant exposure pathways - Risks associated with ingestion of groundwater and inhalation of vapors while showering are insignificant for all receptors under the current use scenario.

e. Dermal contact with soil - As shown in Table 6-26, most of the risk associated with dermal contact is due to the presence of PAHs in surface soil. In determining cancer risk via dermal contact, a slope factor published in the Superfund Public Health Evaluation Manual for benzo(a) pyrene was used for all PAHs. Therefore, there is a high degree of uncertainty associated with this assessment of risk via dermal contact since slope factors are not available for each compound, and since the slope factor used is not from one of the primary sources, currently specified in RAGs. The estimate of risk from dermal contact is consequently regarded as a conservative estimate.

f. Ingestion of soil - As shown in Table 6-25, PAHs are also the major contributor to cancer risk for ingestion of soil. Therefore, the estimate of risk associated with this pathway is fraught with the same uncertainty as dermal contact, and may be considered conservative.

g. Inhalation of airborne (vapor-phase) carcinogenic chemicals volatilizing from the landfill - As shown in Table 6-27, benzene is the major contributor to the cancer risk associated with this pathway. This is significant since benzene is classified as a known human carcinogen (USEPA weight of evidence group A) by the USEPA.

h. Background levels - Background samples were compared to onsite samples for groundwater and soil/waste as a method of screening chemicals to be used in the risk assessment. No carcinogenic chemicals detected in groundwater were eliminated by this screening procedure. One chemical detected in soil waste with a reported slope factor, i.e. arsenic (a slope factor not being reported for lead), was eliminated by this screening procedure. As shown in Table 6-3, the average onsite concentration of arsenic in soil was less than the background concentration. Therefore, it is very reasonable to assume that arsenic in onsite soil is not attributable to the site, but more likely indicative of naturally occurring levels in the area of the site. Therefore, although there is some uncertainty associated with carcinogenic risk via soil ingestion and dermal contact because arsenic was excluded from the risk calculation, this uncertainty is considered low based on current data concerning background levels.

6.5.2.2 Future Land Use

The total cancer risk associated with exposure to contaminants from the Ramapo Landfill site under future conditions is presented in Tables 6-48 through 6-50 for workers, adults (residents), and children, respectively. The following items of discussion refer to values presented in these tables.

a. Total sitewide risk - As indicated, the cancer risks for children and workers are within the NCP acceptable range (1.0 E-06 - 1.0E-04) for carcinogenic risk. However, the cancer risk for adults slightly exceeds the upper limit of 1.0E-04.

b. Major contributing pathways - The exposure pathways contributing the most to the cancer risk for all three receptors (adults, children, and workers) are ingestion of groundwater and inhalation of vapors from the landfill.

c. Lesser contributing pathways - Although not insignificant, ingestion of soil, dermal contact with soil, and inhalation of vapors during showering have only a minor impact on total risk. The risk associated with all of these pathways combined is only 10-20 percent of the total cancer risk under the future-use scenario.

d. Ingestion of groundwater - As shown on Table 6-28, over 95 percent of the cancer risk associated with ingestion of groundwater is attributable to arsenic. This is significant because arsenic is classified as a known human carcinogen (USEPA weight of evidence group A).

e. Inhalation of Airborne (vapor-phase) carcinogens - As shown in Table 6-32, benzene (a group A carcinogen) is the major contributor to the cancer risk associated with inhalation of vapors from the landfill.

f. Soil ingestion and dermal contact with soil - As shown in Tables 6-30 and 6-31, most of the cancer risk associated with exposure to soil (via ingestion or dermal contact) is attributable to PAHs. As discussed under the current land-use scenario (Section 6.5.2.1e and f) there is uncertainty associated with risk attributable to these pathways since the slope factor for benzo(a)pyrene was utilized for all carcinogenic PAHs detected in soil/waste.

g. Inhalation of airborne (vapor-phase) chemicals volatilizing in shower - As shown in Table 6-29 , carcinogenic risk associated with exposure to chemicals volatilizing in the shower is attributable mainly to benzene, 1,2-dichloroethane, and chloromethane. Benzene is the most significant contributor since it is considered a human carcinogen (group A) by the USEPA. Chloromethane is a possible human carcinogen (group C) and 1,2 dichloroethane is a probable human carcinogen (group B).

h. Background levels - As discussed under the current land use scenario (Section 6.5.2.1 h), arsenic was the only carcinogenic chemical detected in onsite media that was eliminated from the risk assessment since it is not considered attributable to the site. Under the future-use scenario, exclusion of arsenic is considered to produce less uncertainty than under the present-use scenario, since soil ingestion and dermal contact with soil are only minor contributors to the total cancer risk.

6.5.3 Chronic Health Effects - Results and Discussions

6.5.3.1 Current Land Use

The total chronic Hazard Index associated with lifetime exposure to Ramapo Landfill site contaminants, under current land use conditions, is presented in Tables 6-51 and 6-52. The following discussion addresses the magnitude of the non-cancer risk limit, or Hazard Index; major factors contributing to the Hazard Index; and the primary health effects at the site.

a. Acceptable Hazard Index - The total site chronic Hazard Index is a measure of whether or not long-term exposure to site contaminants poses a concern for potential noncarcinogenic health effects. According to USEPA, such a potential exists when the Hazard Index exceeds unity (1.0).

b. Total Sitewide Hazard Index - As shown in Tables 6-51 and 6-52, the total chronic Hazard Indices are 7.0 and 0.3 for the worker and adult (resident and trespasser), respectively.

c. Major Contributing Pathway(s) - For both the worker and adult trespasser/resident, the major contributing pathway is the inhalation of airborne chemicals volatilizing from the landfill.

d. Inhalation From Landfill - For both the worker and adult trespasser the primary chemicals contributing to the Hazard Index are xylene (total), and chlorobenzene, as shown in Table 6-37. In combination, these two chemicals contribute to greater than 99 percent of the Hazard Index.

e. Critical Health Effects - Xylene (total) is the primary contributor to the chronic Hazard Index. The critical health effects of concern for xylene involve the central nervous system. The health effects are based on human data (exposure is 7.5 hrs/day for 5 days). The uncertainty factor used for computation of the toxicity value for xylene is 100. The other major contributory chemical to the inhalation pathway is chlorobenzene, which affects the liver and kidney. Toxicity information is based on rat studies. An uncertainty factor of 1,000 was used to calculate the toxicity value for chlorobenzene. Technically, chemicals inducing different effects should be segregated. However, this approach was not used since only two chemicals were responsible for driving the Hazard Index above one, and because utilizing either of these chemicals alone would cause the Hazard Index to exceed unity for the worker.

6.5.3.2 Future Land Use

Tables 6-53 and 6-54 summarize the total chronic Hazard Index associated with lifetime exposure to Ramapo Landfill site contaminants, under future land-use conditions. The magnitude of the non-cancer risk limit, or Hazard Index, major factors driving the Hazard Index, and the primary health effects at the site are discussed below.

a. Total Sitewide Hazard Index - The total chronic hazard index for the worker is 8, as shown in Table 6-53, and 20 for the adult resident, as shown in Table 6-54.

b. Major Contributing Pathway(s) - The major pathways contributing to the chronic Hazard Index for the worker and adult resident are the inhalation of airborne chemicals volatilizing from the landfill and the ingestion of chemicals from drinking water. The individual chronic Hazard Indices for inhalation of vapors from the landfill and ingestion of groundwater for the worker are 7 and 1, respectively.

c. Inhalation From Landfill - Two chemicals, i.e., xylene (total) and chlorobenzene, are the primary contributors to the chronic Hazard Index for workers and adult residents, as shown in Table 6-42. The health effects of these two chemicals are discussed in Section 6.5.3.1e.

d. Ingestion of Drinking Water - Chronic Hazard Indices for workers and adult residents are presented in Table 6-38. As shown in this table, manganese contributes over 90% of the chronic Hazard Index for workers. Di-n-octylphthalate, mercury, vanadium, and arsenic are minor contributors. Manganese is the chemical contributing most (83%) to the chronic Hazard Index for the adult resident as well. Arsenic is the primary minor contributor.

e. Critical Health Effects - Manganese is the primary contributor to the worker chronic Hazard Index. Manganese has no reported health effects via the oral route based upon human data. The toxicity value is based on an uncertainty factor of 1.0. Four other chemicals (arsenic, vanadium, di-n-octylphthalate and mercury) also contribute to the worker chronic Hazard Index. The ingestion of arsenic orally results in keratosis and hyperpigmentation (skin conditions). Based upon human data the toxicity value is based on an uncertainty factor of 1.0. No health effects were observed from the ingestion of vanadium based upon rat studies. The toxicity value is based on an uncertainty factor of 100. The effect of concern for di-n-octylpthalate based upon rat studies is increased kidney and liver weight. The toxicity value is based on an uncertainty factor of 1,000. The ingestion of mercury affects the kidney based on studies performed on rats. The toxicity value is based on an uncertainty factor of 1,000. Since only one chemical is a responsible for driving the Hazard Index for groundwater ingestion, and only two chemicals drive the Hazard Index for inhalation of vapor from the landfill, segregation by critical effect was not used in computing the total Hazard Index for these pathways.

6.5.4 Subchronic Health Effects - Results and Discussions

6.5.4.1 - Current Land Use

The total subchronic Hazard Index associated with short-term exposure to Ramapo Landfill site contaminants, under current land-use scenarios, is presented in Table 6-55. The following discussion addresses the magnitude of the noncancer index, major factors driving the Hazard Index, and the contributing health effects at the site.

a. Acceptable Hazard Index - The acceptable value for the subchronic Hazard Index according to the USEPA is 1.0.

b. Total Sitewide Hazard Index - As shown in Table 6-55, the total sitewide subchronic Hazard Index is 6.0, which exceeds the USEPA acceptable value of 1.0.

c. Major Contributing Pathway(s) - Inhalation of airborne chemicals volatilizing from the landfill is the major contributing pathway to the subchronic Hazard Index value. The subchronic Hazard Index for this pathway alone is 6.0.

d. Inhalation From Landfill - As indicated in Table 6-37, xylene (total) is the primary contributor to the calculated Hazard Index for this pathway. The contribution of chlorobenzene is significant but much less than xylene. These two organic chemicals together account for nearly 100% of the chronic index.

e. Critical Health Effects - Critical effects associated with subchronic exposure to xylene and chlorobenzene are the same as for chronic exposure and are discussed in Section 6.5.3.1e. As discussed, the Hazard Index was not recalculated based on critical effect because only two chemicals significantly contributed.

6.5.4.2 Future Land Use

Table 6-56 summarizes the total subchronic Hazard Index associated with short-term exposure to Ramapo Landfill site contaminants under the future land-use scenario. The following discussion addresses the magnitude of the noncancer index, major factors driving the Hazard Index, and contributory health effects at the site.

a. Total Sitewide Hazard Index - The total sitewide subchronic Hazard Index, as shown in Table 6-56, is 50.0.

b. Major Contributing Pathway(s) - Inhalation of airborne chemicals volatilizing from the landfill and ingestion of chemicals from drinking water are the primary contributors to the total subchronic Hazard Index. Inhalation of chemicals from the landfill is most significant. This pathway is responsible for over 90% of the total chronic index.

c. Inhalation From Landfill - As indicated in Table 6-42, xylene (total) is the primary contributor (over 90%) to the calculated Hazard Index. Chlorobenzene is the only other significant chemical. Together these two organic chemicals account for nearly 100% of the total chronic hazard index.

d. Ingestion of Drinking Water - Manganese and arsenic are the primary contributors to the total subchronic Hazard Index, as shown in Table 6-38. Combined these two chemicals account for over 90% of the total chronic Hazard Index.

e. Critical Health Effects - Health effects associated with subchronic exposure to xylene, chlorobenzene, manganese, and arsenic are the same as for chronic exposure and are discussed in Section 6.5.3.2. As with chronic exposure, sub-chronic Hazard Indices were not recalculated because so few chemicals dominated the calculation.

6.6 Uncertainty Analysis

The estimates of carcinogenic risk and noncarcinogenic health effects (chronic/subchronic) in this baseline HRA are based upon numerous assumptions, and, therefore involve a considerable degree of uncertainty. Some of this uncertainty is inherent in the risk assessment process itself, and the current limits of scientific knowledge regarding human health risk factors. For example, the necessary extrapolation of animal study data to humans introduces a large uncertainty factor into the process, as does extrapolation from the high doses used in these studies to the low doses associated with most hazardous waste sites such as the Ramapo Landfill site. Likewise, estimating human exposure and human intake is largely judgmental, and involves extrapolation of human behavioral patterns (often unknown even at present) into the relatively distant (up to 70 years) future. The exposure assessment for this study is based upon reasonable maximum exposures, meaning that the general population is almost certainly not exposed to site contaminants at the levels used in this analysis, and, therefore would not experience the calculated risks.

Due to these types of uncertainties, which are discussed in greater detail below, the results of the baseline HRA for the Ramapo Landfill site should not be taken as a characterization of absolute risk, or as a fully probabilistic estimate of this risk. Rather, they are intended to identify the types and relative levels of risk associated with various potential exposure routes at the Ramapo Landfill site, so that remedial efforts can focus upon these aspects of the site which are of greatest concern from a human health standpoint.

The discussion of uncertainty is broken down into three categories as follows:

- o Uncertainty concerning exposure
- o Uncertainty concerning toxicity information
- o Uncertainty concerning risk characterization

Each of these categories is discussed below.

6.6.1 Uncertainty Concerning Exposure

a. Monitoring Data - During the RI, no subsurface soil samples were taken within the boundaries of the landfill. Under the future residential use scenario, it is possible that contaminants in the subsurface could reach receptors after earthmoving operations associated with residential construction. Since no subsurface data were available, analytical results from surface soil samples were used to evaluate both present and future risks. Consequently, future exposure to soil contaminants could be either overestimated or underestimated.

b. Exposure Models

1. Groundwater Model - The results of groundwater modeling indicate that transport of contamination in the overburden to receptors across Torne Brook is highly unlikely. However, contamination is likely to be transported in the underlying bedrock aquifer to the receptors. Since existing downgradient wells withdraw from the overburden, these wells will not be contaminated by groundwater flowing horizontally from the landfill in the overburden. The impact of the landfill on existing potable wells, therefore, is dependent on vertical flow upward from the

bedrock aquifer to the point of withdrawal. This upward flow is almost exclusively dependent on the rate of withdrawal from the existing wells. Since no data are available for well pumps used for water supply, generally conservative assumptions were utilized to approximate withdrawal rates from the potable wells. Under the assumption made regarding withdrawal rates, the concentrations of organic contaminants in the potable water supply are estimated to be below detection limits after being transported from the landfill. This is in general agreement with analytical results in sample GDT-1 from PW-1, since only one organic compound (i.e., tetrachloroethene at 0.06 ppb) was detected. However, since concentrations at the receptor are expected to be below detection limits, assumptions regarding withdrawal rate cannot be verified using precise monitoring data, and therefore the risk from using water from downgradient wells may be over- or underestimated.

2. <u>Shower Model</u> - Estimation of exposure concentrations while showering are based on methodology presented in McKone (McKone, 1987). The showering model conservatively assumes that all volatilized chemicals are contained within the limited volume of the shower, and thus the exposure concentrations in the shower tend to mean overestimation of risk. However, the model does not take into account other possible indoor exposures to contaminants via inhalation, (i.e., from toilets, dishwashers, washing machines, and cooking, or possible dermal exposure while showering or washing), which may lead to underestimation of potential risk from indoor exposure. These inherent assumptions in the shower model produce uncertainty regarding actual exposure concentrations. However, the results of the model used in the baseline HRA are in general agreement with the McKone model, that estimates that the intake from chemicals volatilizing from water will be up to 6 times greater than intake resulting from ingestion of groundwater.

c. <u>Values for Intake Variables</u> - The exposure frequency utilized to evaluate exposure to onsite soil (via ingestion or dermal contact) under the trespass scenario is an estimate based largely on professional judgement and consequently introduces uncertainty into the calculation of intake from soil. Actual exposure frequency would more accurately be determined by evaluating data on behavioral patterns of nearby residents or landfill employees. However, these data are unavailable. Therefore, exposure frequency values recommended by the USEPA for evaluating onsite trespass were utilized in the exposure assessment. These values may be considered to be conservative values that would not underestimate exposure to onsite soil contamination.

d. Exposure Pathways - Public concern has been expressed regarding potential exposure to surface water contaminated by the landfill. Of particular concern is an area reportedly used for recreation, located approximately one-quarter of a mile downstream of the site in the Ramapo River, (i.e., "Flat Rock"). Exposure at this point would result from dermal contact with chemicals in the river during recreational activities (i.e., swimming, fishing, etc.) or from ingestion of chemicals in the water while swimming. As reported in Section 4.3.2, analytical results from surface water samples taken from Torne Brook indicate that the landfill is having little impact on Torne Brook. Three volatiles were detected in low concentrations (0.08 to 0.2 ppb). Four metals, (i.e., copper, aluminum, iron, and vanadium), were also detected above background, although concentrations of these metals decreased significantly downstream before the confluence with the Ramapo River. Flow studies conducted during the RI showed that the flow rate in the Ramapo River is well over an order of magnitude greater that the discharge rate of Torne Brook into the Ramapo River. Consequently, the concentration of contaminants attributable to the landfill and discharging to Torne Brook will be greatly reduced in the Ramapo River. Also, water from the onsite leachate pond is now directly discharged to the Village of Suffern Wastewater Treatment Plant as opposed to the Ramapo River, so this source will have no impact on surface water at Flat Rock. Since only limited surface water sampling was performed during the RI, there is some uncertainty regarding potential exposure to surface water at "Flat Rock". However, based on current data, the risk from exposure to surface water at "Flat Rock" is expected to be much less than risk associated with the other pathways quantitatively evaluated in the baseline risk assessment, and therefore this pathway was not evaluated quantitatively.

6.6.2 Uncertainty Concerning Toxicity Information

a. Surrogate Values - Dose-response information is not available for many chemicals found on site at the Ramapo Landfill. For PAHs, surrogate values have been used to quantify risk as discussed below.

1. Carcinogenic PAHs - All carcinogenic PAHs were assumed to have the same slope factor as benzo(a)pyrene. This slope factor was derived from the Superfund Public Health Evaluation Manual (USEPA, 1986). [This is an ECAO interim recommendation.]

2. Noncarcinogenic PAHs - All noncarcinogenic PAHs were assumed to have the same reference dose value as naphthalene. This reference dose value was derived from the Superfund Public Health Evaluation Manual (USEPA, 1986).

Although these surrogate values may be considered conservative and may oversimplify the toxic properties and interactions of PAHs, the quantity of PAHs detected at the site and the potential risk associated with PAHs seems to justify this conservative approach.

b. Compounds With No Values - There are many chemicals for which dose-response data are undetermined or inadequate, and for which no surrogate value is available. The risk associated with these chemicals cannot be quantified.

c. Chromium Toxicity Values - The literature lists toxicity values for trivalent chromium and hexavalent chromium, whereas the samples were analyzed for total chromium (as per the NYSDEC TCL/TAL). The toxicity value used for the HRA was trivalent chromium (III). The use of the less stable hexavalent chromium (VI) was determined to be unwarranted as there is no history or evidence of any disposal of chromium (VI) at the landfill. (A calculation for chromium (VI) was performed, however, and is presented in the summary text rather than in the tables.)

6.6.3 Uncertainty Concerning Risk Characterization

a. Combination of Pathways - In order to determine total sitewide risk, the risks from individual exposure pathways have been combined using the method described in Section 6.5.1.4. This method essentially involves the addition of risks associated with pathways which are not mutually exclusive. From a probability standpoint, it essentially involves compounding (by multiplication) the probability of exposure via each pathway. The net probability of an individual being exposed through all non-exclusive pathways is considered to be very low. Alternately stated, this combination of pathways tends to produce a very conservative sitewide total risk estimate.

b. Summation of Hazard Indices - In order to determine total sitewide values for chronic and subchronic Hazard Index, the index values for individual chemical compounds were first calculated individually, and then totalled. The resulting sitewide total Hazard Index value is conservative, since different chemicals typically affect different human organs, and therefore produce different noncarcinogenic effects. Addition of their individual index values does not account for these different effects, and typically produces a conservatively high total Hazard Index.

6.7 Summary

This baseline HRA, performed in compliance with guidance provided by the USEPA, has been prepared to evaluate potentially adverse health effects caused by the release of contaminants from the Ramapo Landfill site in the absence of remedial measures. The risk assessment includes five major steps which have been summarized below.

6.7.1 Chemicals of Potential Concern

The initial step in the risk assessment was the selection of chemicals of potential concern (CPCs), i.e. chemicals to be used to evaluate potential risk. Sample results were utilized to select chemicals of potential concern in the baseline HRA for each environmental medium, i.e., soil/waste, groundwater, and air. For soil/waste and groundwater, the concentrations of chemicals detected in each medium were compared to background concentrations in background samples (i.e. SPS-9 for soil and MW-5 for groundwater). Organic compounds were considered CPCs if the maximum onsite concentration exceeded background concentration and inorganic chemicals were considered CPCs if the average onsite concentration exceeded background concentration. In accordance with this methodology, all organic compounds detected in soil and groundwater were selected as CPCs. Three metals were selected as CPCs in soil and eight metals were selected as CPCs in groundwater, using this criteria. At the request of the NYSDEC and USEPA, chromium (III), aluminum, barium, calcium, copper, iron, nickel, potassium and zinc were also selected as CPCs, increasing the number of metals as groundwater CPCs to 17. Because background determination is difficult in air sampling, all chemicals detected in air were selected as CPCs.

6.7.2 Exposure Assessment

In the exposure assessment, intakes or exposure doses were calculated for each of the five basic exposure pathways evaluated in the risk assessment. These five basic exposure pathways included: 1) ingestion of soil; 2) dermal contact with soil; 3) inhalation of vapors from the landfill; 4) ingestion of groundwater; and 5) inhalation of vapors during showering.

The exposure pathways were evaluated under both current and potential future land-use conditions. Under the current land-use scenario, five potential receptors were identified, namely adult and child (ages 6-11) trespassers, adult and child residents, and employees (workers) at the landfill. Exposure intakes (doses) were calculated for each receptor for all exposure pathways considered applicable at the site as shown in Table 6-43. Under the future land-use scenario, three receptors were identified, namely adult and child (ages 0-6) residents, and workers. Exposure intakes were calculated for all relevant pathways as shown in Table 6-44.

For the first three pathways identified above, exposure dose is based on the concentration of contaminants occurring on site. Exposure concentrations for soil and air used to evaluate these pathways were determined by using statistical methods to calculate the upper-bound onsite average concentration. This upper-bound average, or the maximum concentration when applicable, was subsequently used to calculate intake. Under current land-use conditions, groundwater concentrations utilized to estimate intakes from ingestion and inhalation via showering were modeled, since the nearest potential receptors are approximately 1,200 feet from the site. Under the future-use conditions, residential development at the site was assumed so that exposure concentrations are based solely on monitoring data.

Intakes were calculated utilizing equations presented in the Risk Assessment Guidance for Superfund (RAGS). Variables used in the equations were primarily obtained from RAGS or other commonly used USEPA documents.

6.7.3 Toxicity Assessment

Toxicity data were collected, according to the hierarchy prescribed by the USEPA, from IRIS and the Health Effects Summary Tables (HEAST). These data included slope factors, weight-of-evidence category, tumor site for cancer-causing chemicals of potential concern, toxicity values (RfDs or RfCs), and critical effects for non-cancer-causing (toxic) chemicals of potential concern. Toxicity data were not available for a number of chemicals of potential concern from the sources listed above. These chemicals were therefore excluded from the subsequent risk characterization, i.e. calculation of risk.

6.7.4 Risk Characterization

Risks were determined by integrating toxicity data with estimates of exposure intake or dose. Cancer risk was computed for each pathway by multiplying the exposure level (intake or absorbed dose) and the slope factor. The non-cancer risk or Hazard Index was computed for each pathway by dividing the exposure level by the appropriate toxicity value (reference dose).

Under the current and future-use scenarios, overall cancer risks were determined for adults, children and workers. Total risks under the current-use scenario are based on the combination of risks for adult or child trespassers and residents.

Combined chronic Hazard Indices to evaluate long-term noncancer risk were calculated for adults and workers, and combined subchronic Hazard

Indices to evaluate short-term noncancer risk were calculated for children under both the current and future land-use scenarios.

Results of the risk characterization are summarized below:

a. <u>Cancer Risk - (Current land use)</u> - The cancer risks for adults, children, and workers (4E-06, 1E-05 and 3E-05, respectively) were within the acceptable risk range of (1E-06 to 1E-04) established by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Three pathways were primarily responsible for the cancer risk. These pathways included ingestion and dermal contact with soil and inhalation of vapors from the landfill. The primary contaminants responsible for soil-related risks were PAHs. For inhalation of vapors, benzene was the primary contributor.

b. <u>Cancer Risk (Future land use)</u> - Cancer risks for children and workers (7E-05 and 1E-04, respectively) were within the NCP acceptable range. However, cancer risk for adults (2E-04) exceeded the upper limit of 1E-04. Ingestion of groundwater and inhalation of vapors from the landfill were the major contributors to sitewide risk for all receptors. Arsenic and benzene were the chemicals responsible for the most risk from groundwater ingestion and inhalation of landfill vapors, respectively.

c. <u>Chronic Health Effects (Current land use)</u> - The total site Hazard Index exceeded one, the level of concern for noncarcinogenic health effects, for the workers, but not for adult residents and trespassers. Inhalation of airborne chemicals' volatilizing from the landfill was the major contributing pathway to the total Hazard Index. Two chemicals, i.e. xylenes (total) and chlorobenzene, accounted for greater than 99 percent of the noncarcinogenic risk associated with exposure to the vapors from the landfill.

d. <u>Chronic Health Effects (Future land use)</u> - The total chronic Hazard Indices for the worker and adult were 8 and 20, respectively, thus indicating potential adverse noncarcinogenic health effects. Under the future-use scenario, ingestion of groundwater and inhalation of vapors from the landfill contributed most to the total noncarcinogenic risk. The primary chemical contributors were xylenes (total) and chlorobenzene for inhalation of vapors, and manganese for ingestion of groundwater.

e. <u>Subchronic Health Effects (Current land use)</u> - The subchronic Hazard Index of 6 exceeded the accepted level of one. The major contributing pathways and the chemicals of greatest concern for these pathways were the same as for chronic exposure based on current land use.

f. <u>Subchronic Health Effects (Future land use)</u> - The total sitewide subchronic Hazard Index was 50, exceeding the acceptable value of one. Major contributing pathways were the same as for chronic exposure under future land-use conditions. Primary chemical contributors were xylenes (total) and chlorobenzene for inhalation of vapors from the landfill, and manganese and arsenic for ingestion of groundwater.

g. <u>Addition of Chromium to HRA</u> - The addition of chromium (III) caused no change in the total risks posed by the landfill. The use of chromium (VI) had no significant change in the risks posed by the landfill. It did increase the chronic hazard index for ingestion of drinking water in three of the five pathways: Table 6-52 from 2E-04 to 3E-04; Table 6-53 from 1E+00 to 2E+00; and Table 6-55 from 1.8E-04 to 2E-04. As there are no values reported in the HEAST tables for oral slope factors of chromium (VI), the cancer risk associated with ingestion of groundwater can not be calculated.

6.7.5 Uncertainty Analysis

Uncertainty is an inherent part of the baseline HRA since numerous assumptions and judgements are utilized and because the current scientific knowledge regarding human health risk factors is limited. For example, in the baseline HRA for Ramapo, exposure to soil contamination is more accurately quantified since concentration at the points of exposure were based directly on the results of soil sampling. For groundwater-related pathways, exposure concentrations were based on modeling. Conservative assumptions were generally utilized to estimate these concentrations, so that the likelihood of underestimating risk is small. However, the assumptions cannot be verified, thus greater uncertainty is associated with the modeled exposure concentrations.

The Ramapo baseline HRA was also impacted by the lack of toxicity data available for certain chemicals. [Toxicity values were simply not published.] Therefore, risks associated with these chemicals could not be quantified. However, as with PAHs, surrogate values were used to quantify risk. For PAHs, it was assumed that all carcinogenic PAHs were as potent as benzo(a)pyrene, and all noncarcinogenic PAHs were as potent as naphthalene. Although the surrogate value method may be considered simplistic, this approach was utilized because of the number of PAHs detected on site.

Although uncertainty is inherent in the risk analysis, the baseline HRA is based upon the concept of reasonable maximum exposure, meaning that the general population is almost certainly not exposed at levels used in this analysis, and therefore, would experience risks which are smaller than those estimated herein.

6.8 Fugitive Dust Assessment

In performing a risk assessment for fugitive dust, two analyses should be considered, namely an Unpaved Road Analysis, and a Wind Erosion Analysis.

The Unpaved Road Analysis is used to estimate fugitive dust releases associated with vehicles traveling on contaminated, unpaved roads. Since the route of travel around the landfill is Torne Valley Road - a paved and maintained road, and vehicular travel across unpaved roads on the landfill is minimal, fugitive dust releases resulting from vehicular travel are not a concern.

The Wind Erosion Analysis depends on a variety of factors including: soil particle size distribution, the extent of vegetation, prevailing winds in relation to potential receptors, the presence of obstructions, and the frequency of disturbance of the contaminated soils. In accordance with EPA methodology, only soil particles that are small enough to be suspended and transported over significant distances by wind, and inhaled should be considered (USEPA Superfund Exposure Assessment Manual [USEPA, Office of Remedial Response, 1988]). In reviewing the summary of grain size analysis presented in Table 3-2, it is anticipated that very little surficial soil would be small enough to satisfy these three criteria and be considered a potential source of emissions. Further, the majority of the site is unused, well vegetated, and surrounded by trees, thus the disturbance and wind erosion of surficial soil is expected to be minimal. Prevailing winds at the site are from the west. The nearest residences (potential receptors) are located to the west of the site, and therefore, exposure to fugitive dust would be infrequent. For these reasons it was determined that fugitive dust emissions are not expected to pose a health risk.

6.9 Site Impacts to Terrestrial and Aquatic Species

Results of the HRA showed that there are three pathways which pose a potential health risk to humans: 1) dermal contact with soil, 2) ingestion of soil, and 3) inhalation of vapors from the landfill surface. The major contributors to the risk posed by these pathways are PAHs, benzene, xylenes (total), and chlorobenzene. It may be assumed, though it has not been quantified in this assessment, that these same pathways and chemicals pose the same potential for health risk to terrestrial species living in the vicinity of the landfill. Such species are identified in Section 3.5 on the ecology of the area.

In looking at the potential impact to aquatic life in the vicinity of the landfill, both surface water and sediment ARARs and TBCs were reviewed. Results of the sediment cleanup criteria (TBCs) calculations showed that although two PAHs were detected in sediment samples from Torne Brook, they were not at levels which would be predicted to: 1) cause accumulation of the chemicals in aquatic animals to levels that would exceed a human health tolerance, action level, or cancer risk (human health residue - based criterion); or 2) cause toxicity to benthic or epibenthic life (aquatic toxicity - based criterion). Therefore, sediments do not pose a risk to aquatic life. In reviewing the surface water ARAR exceedances, eight out of seventeen exceeded the aquatic (as opposed to the human health) ARAR. Those contaminants exceeding ARARs were inorganics - metals and indicator parameters. Their effect on aquatic life has not been quantified.

TABLE 6-1

ONSITE GROUNDWATER CONTAMINATION LEVELS
RAMAPO LANDFILL SITE

PARAMETER	TYPE	SQL RANGE (PPB)	WELL FREQUENCY # DETECTS	# WELLS	ONSITE CONCENTRATION (PPB) * SHALLOW AQUIFER	INTERMEDIATE AQUIFER	BEDROCK AQUIFER	BACKGROUND CONCENTRATION ** (PPB) SHALLOW AQUIFER	INTERMEDIATE AQUIFER	BEDROCK AQUIFER
Benzene	VOC	1-5	14	43	2.0	2.9	3.0	1.0	ND	ND
Tetrachloroethene	VOC	1-5	2	43	0.6	0.6	ND	ND	2.3	ND
Trichloroethene	VOC	1-5	1	43	ND	0.2	ND	ND	ND	ND
1,4-Dichlorobenzene	VOC	1.0	1	26	1.1	ND	ND	ND	ND	ND
Isopropylbenzene	VOC	1.0	6	26	ND	3.7	1.0	ND	ND	ND
Total Xylene	VOC	1-5	3	43	ND	2.0	ND	ND	ND	ND
Dichlorodifluoromethane	VOC	1.0	1	26	ND	ND	0.2	ND	ND	ND
Acetone	VOC	1-10	4	43	21	28	35	ND	0.4	ND
Toluene	VOC	1-5	5	43	0.7	1.0	ND	ND	ND	ND
1,1-Dichloroethane	VOC	1-5	4	43	ND	3.0	5.0	ND	ND	ND
1,2-Dichloroethane	VOC	1-5	2	43	ND	0.2	0.1	ND	ND	ND
p-Isopropyltoluene	VOC	1.0	4	26	1.2	1.7	1.2	ND	ND	ND
cis-1,2-Dichloroethene	VOC	1-5	5	43	ND	0.3	0.9	ND	ND	ND
1,2,4-Trimethylbenzene	VOC	1.0	2	26	ND	1.4	ND	ND	ND	ND
Carbon Disulfide	VOC	1-5	1	43	ND	ND	2.0	ND	ND	ND
Propylbenzene	VOC	1.0	3	26	ND	0.8	0.5	ND	ND	ND
Chloromethane	VOC	1-10	2	43	ND	3.0	ND	ND	ND	ND
Chlorobenzene	VOC	1-5	5	43	1.0	16	2.0	ND	ND	ND

TABLE 6-1 (Continued)

			WELL FREQUENCY		ONSITE CONCENTRATION (PPB) *			BACKGROUND CONCENTRATION ** (PPB)		
PARAMETER	TYPE	SQL RANGE (PPB)	# DETECTS	# WELLS	SHALLOW AQUIFER	INTERMEDIATE AQUIFER	BEDROCK AQUIFER	SHALLOW AQUIFER	INTERMEDIATE AQUIFER	BEDROCK AQUIFER
Styrene	VOC	1-5	1	43	ND	0.6	ND	ND	ND	ND
1,2-Dichlorobenzene	VOC	1.0	2	26	ND	1.2	0.9	ND	ND	ND
1,3,5-Trimethylbenzene	VOC	1.0	4	26	ND	1.9	1.9	ND	ND	ND
4-Methyl-2-Pentanone	VOC	1-10	1	43	ND	ND	3.0	ND	ND	ND
tert-Butylbenzene	VOC	1.0	2	26	ND	1.5	ND	ND	ND	ND
Naphthalene	SEMI	1.0	3	26	ND	4.2	0.8	ND	ND	ND
Diethylphthalate	SEMI	10.0	5	43	ND	5.0	2.0	ND	ND	ND
Butylbenzylphthalate	SEMI	10.0	1	43	ND	ND	27	ND	ND	ND
Bis(2-ethylhexyl)phthalate	SEMI	10.0	14	43	3.0	30	9	ND	7.0	4.0
Pyrene	SEMI	10.0	1	43	ND	3.0	ND	ND	ND	ND
Di-n-octylphthalate	SEMI	10.0	1	43	ND	ND	130	ND	ND	ND
delta-BHC	PEST	0.05	1	43	ND	1.9	ND	ND	ND	ND
gamma-BHC	PEST	0.05	1	43	ND	ND	0.055	ND	ND	ND
Arsenic	MCP	4.4-8.8	9	43	9.1	5.5	4.9	ND	ND	ND
Cadmium	MCP	8.0	1	43	ND	2.7	ND	ND	ND	ND
Chromium	MCP	8.0	42	43	174	79	20.6	63	95.9	28.4
Cobalt	MCP	18-24	3	43	23	24	22.9	19	18.9	ND
Iron	MCP	100	42	43	29,207	8,479	3,548	19,100	12,136	513
Lead	MCP	6-10	39	43	7.6	2.9	3.5	5	5.6	ND

TABLE 6-1 (Continued)

PARAMETER	TYPE	SQL RANGE (PPB)	WELL FREQUENCY # DETECTS	# WELLS	ONSITE CONCENTRATION (PPB) * SHALLOW AQUIFER	INTERMEDIATE AQUIFER	BEDROCK AQUIFER	BACKGROUND CONCENTRATION ** (PPB) SHALLOW AQUIFER	INTERMEDIATE AQUIFER	BEDROCK AQUIFER
Sodium	MCP	5,000	43	43	44,469	104,645	35,299	9,290	5,795	5,505
Vanadium	MCP	10	14	43	21	22	23.7	28	30	ND
Aluminum	MCP	200	39	43	5,152	1,112	689	12,210	8,426	322
Barium	MCP	200	42	43	110	91	27	66	95	6
Calcium	MCP	5,000	43	43	66,285	65,005	87,787	10,910	9,705	14,250
Copper	MCP	25	36	43	27	8.9	11.4	20	21	3.3
Nickel	MCP	40	36	43	65	63	22	36	52	17.1
Potassium	MCP	5,00	43	43	7,614	21,882	4,765	3,410	2,462	984
Zinc	MCP	20	43	43	30	14.3	17	45	24.3	8.4

Average concentrations are calculated by using one-half the sample quantitation limit (SQL).

<u>Notes</u>:

ND - Not Detected
SQL - Sample Quantitation Limit
* - Values reported for metals are average concentrations. Values reported for organics are maximum concentrations.
** - All values are averaged value for two rounds of sampling.

TABLE 6-2

GROUNDWATER CHEMICALS OF POTENTIAL CONCERN

Benzene	Propylbenzene	Pyrene
Tetrachloroethene	Chloromethane	Arsenic
Trichloroethene	Chlorobenzene	Cadmium
1,4-Dichlorobenzene	Styrene	Manganese
Isopropylbenzene	1,2-Dichlorobenzene	Cobalt
Total Xylene	1,3,5-Trimethylbenzene	Lead
Dichlorodifluoromethane	tert-Butylbenzene	Sodium
1,1-Dichloroethane	Naphthalene	Vanadium
1,2-Dichloroethane	Diethylphthalate	Mercury
p-Isopropyltoluene	Butylbenzylphthalate	Chromium (III)
cis-1,2-Dichloroethene	Bis(2-ethylhexyl)phthalate	Aluminum
1,2,4-Trimethylbenzene	Di-n-octylphthalate	Barium
Carbon Disulfide	delta-BHC	Calcium
Toluene	gamma-BHC	Copper
Acetone	4-Methyl-2-pentanone	Iron
Nickel	Potassium	Zinc

TABLE 6-3

ONSITE SURFICIAL SOIL CONTAMINATION LEVELS

			SAMPLE FREQUENCY			
PARAMETER	TYPE	SQL RANGE (PPB)	# DETECTS	# SAMPLES	ONSITE (PPB)*	BACKGROUND CONC. (PPB)
1,4-Dichlorobenzene	SEMI	380-420	1	9	370	ND
1,2-Dichlorobenzene	SEMI	370-420	1	9	94	ND
Benzoic Acid	SEMI	1800-3500	1	9	210	ND
Naphthalene	SEMI	370-420	1	9	1100	ND
2-Methylnaphthalene	SEMI	370-420	1	9	200	ND
Acenaphthene	SEMI	370-420	1	9	190	ND
Dibenzofuran	SEMI	370-420	1	9	150	ND
Fluorene	SEMI	370-420	1	9	170	ND
N-nitrosodiphenylamine	SEMI	370-420	1	9	110	ND
Phenanthrene	SEMI	380-390	3	9	390	ND
Anthracene	SEMI	370-420	1	9	43	ND
Fluoranthene	SEMI	380-390	4	9	440	ND
Pyrene	SEMI	380-390	4	9	310	ND
Butylbenzylphthalate	SEMI	380-420	2	9	160	ND
Benzo(a)anthracene	SEMI	380-390	3	9	200	ND
Chrysene	SEMI	380-390	3	9	230	ND
Bis(2-ethylhexyl)phthalate	SEMI	380-390	3	9	480	ND
Di-n-octylphthalate	SEMI	380-420	1	9	43	ND

TABLE 6-3 (Continued)

			SAMPLE FREQUENCY			
PARAMETER	TYPE	SQL RANGE (PPB)	# DETECTS	# SAMPLES	ONSITE (PPB)*	BACKGROUND CONC. (PPB)
Benzo(k)fluoranthene	SEMI	380-390	4	9	180	ND
Benzo(a)pyrene	SEMI	380-390	3	9	160	ND
Indeno(1,2,3-cd)pyrene	SEMI	380-390	3	9	140	ND
Benzo(g,h,i)perylene	SEMI	380-420	3	9	130	ND
2-Butanone	VOC	11-13	3	9	190	ND
Benzene	VOC	5-6	1	9	42	ND
1,2,2,2-Tetrachloroethane	VOC	5-6	1	9	2	ND
Chlorobenzene	VOC	5-6	1	9	730	ND
Ethylbenzene	VOC	5-6	1	9	260	ND
Total xylenes	VOC	5-6	1	9	570	ND
Dieldrin	PEST	18-94	1	9	3.4	ND
Chlordane	PEST	9-470	1	9	20	ND
Heptachlor Epoxide	PEST	9-47	1	9	26	ND
Beryllium	MCP	340-900	1	9	243	ND
Cadmium	MCP	1360-7400	4	9	1336	ND
Total phenols	MCP	560-600	1	9	650	ND
Aluminum	MCP	40,000	9	9	9,170,00	16,900,000
Antimony	MCP	4,200-10,900	2	9	2,894	4,700
Arsenic	MCP	2,000	9	9	1,681	2,200
Barium	MCP	40,000	9	9	51,344	35,800
Calcium	MCP	1,000,000	9	9	5,173,333	805,000

TABLE 6-3 (Continued)

			SAMPLE FREQUENCY			
PARAMETER	TYPE	SQL RANGE (PPB)	# DETECTS	# SAMPLES	ONSITE (PPB)*	BACKGROUND CONC. (PPB)
Calcium	MCP	1,000,000	9	9	5,173,333	805,000
Chromium	MCP	2,000	9	9	16,311	22,700
Cobalt	MCP	10,000	9	9	7,789	6,600
Copper	MCP	5,000	9	9	21,667	8,600
Iron	MCP	20,000	9	9	23,211,111	21,300,000
Lead	MCP	1,000	9	9	10,689	8,800
Magnesium	MCP	1,000,000	9	9	3,217,778	2,000,000
Manganese	MCP	3,000	9	9	277,556	88,100
Mercury	MCP	100-270	1	9	78.9	ND
Nickel	MCP	8,000	9	9	14,911	10,900
Potassium	MCP	1,000,000	9	9	1,096,000	511,000
Selenium	MCP	190-210	3	9	184	510
Sodium	MCP	1,000,000	9	9	326,889	113,000
Vanadium	MCP	10,000	9	9	26,878	40,800
Zinc	MCP	4,00	9	9	46,144	27,300

Notes:

ND - Not detected.
* - Values for organics are maximum concentration. Values for inorganics are average concentrations. Average concentrations were calculated using one-half the sample quantitation limit (SQL) for samples where an analyte was undetected.

TABLE 6-4

SOIL/WASTE CHEMICALS OF POTENTIAL CONCERN

1,4-Dichlorobenzene	Benzo(g,h,i)perylene
1,2-Dichlorobenzene	2-Butanone
Benzoic Acid	Benzene
Naphthalene	1,1,2,2-Tetrachloroethane
2-Methylenaphthalene	Chlorobenzene
Acenaphthene	Ethylbenzene
Fluorene	Total Xylenes
N-nitrosodiphenylamine	Dieldrin
Phenanthrene	Chlordane
Anthracene	Heptachlor Epoxide
Fluoranthene	Beryllium
Pyrene	Cadmium
Butylbenzylphthalate	Mercury
Benzo(a)anthracene	Total Phenols
Chrysene	
Bis(2-ethylhexyl)phthalate	
Di-n-octylphthalate	
Benzo(b)fluoranthene	
Benzo(k)fluoranthene	
Benzo(a)pyrene	
Indeno(1,2,3-cd)pyrene	
Dibenzofuran	

TABLE 6-5

AIR CHEMICALS OF POTENTIAL CONCERN

2-Butanone	Tetrachloroethene
1,1,1-Trichloroethane	Styrene
Carbon Tetrachloride	Toluene
Benzene	Total Xylenes
Chlorobenzene	Methylene Chloride
Ethylbenzene	Acetone

Table 6-6
Potential Exposure Pathways: Current Land Use (Residential)

EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE(S)
Groundwater	Nearby residents using groundwater in downgradient wells as potable source.	Ingestion
Air	Nearby residents using groundwater for showering exposed to chemicals volatilized during showering.	Inhalation

Table 6-7

Potential Exposure Pathways: Current Land Use (Recreational or Trespasser)

EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE(S)
Soil/Waste	Persons walking or playing onsite exposed to surficial soil contaminants on a sitewide basis.	Ingestion Dermal
Air	Persons walking or playing onsite exposed to chemicals volatilizing from the landfill.	Inhalation

Table 6-8

Potential Exposure Pathways: Current Land Use (Industrial/Commercial)

EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE(S)
Soil/Waste	Employees working onsite exposed to surficial soil contaminants on a sitewide basis.	Ingestion Dermal
Air	Employees working onsite exposed to chemicals volatilizing from the landfill.	Inhalation

Table 6-9

Potential Exposure Pathways: Future Land Use (Residential)

EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE(S)
Soil/Waste	Persons living onsite could be exposed to full depth of soil contamination.	Ingestion Dermal
Groundwater	Persons living onsite with private wells could be exposed to groundwater contamination.	Ingestion
Air	Persons living onsite and working or playing onsite could be exposed to contaminants volatilizing from the landfill.	Inhalation
Air	Persons using groundwater to supply private residences could be exposed to contaminants volatilized during showering.	Inhalation

Table 6-10

Potential Exposure Pathways: Future Land Use (Commercial/Industrial)

EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE(S)
Soil/Waste	Employees working onsite could be exposed to the full depth of soil contamination.	Ingestion Dermal
Groundwater	Employees working onsite and using private wells as a potable source could be exposed to groundwater contamination.	Ingestion
Air	Employees working onsite could be exposed to contaminants volatilizing from the landfill.	Inhalation

RAM 001 0799

TABLE 6-11

INGESTION OF CARCINOGENIC CHEMICALS IN SOILS

PARAMETER	CHEMICAL CONCENTRATION IN SOIL (mg/kg)	INTAKE (mg/kg-day)					
		CURRENT USE			FUTURE USE		
		ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
1,4-Dichlorobenzene	2.50E-01	4.20E-08	5.37E-08	1.05E-07	1.53E-07	2.39E-07	1.05E-07
N-nitrosodiphenylamine	1.10E-01	1.85E-08	2.36E-08	4.61E-08	6.73E-08	1.05E-07	4.61E-08
Butylbenzylphthalate	1.60E-01	2.68E-08	3.43E-08	6.71E-08	9.80E-08	1.52E-07	6.71E-08
Benzo(a)anthracene	2.00E-01	3.35E-08	4.29E-08	8.39E-08	1.22E-07	1.90E-07	8.39E-08
Chrysene	2.26E-01	3.79E-08	4.85E-08	9.48E-08	1.38E-07	2.15E-07	9.48E-08
Bis(2-ethylhexyl)phthalate	2.85E-01	4.78E-08	6.11E-08	1.20E-07	1.75E-07	2.72E-07	1.20E-07
Benzo(b)fluoranthene	1.67E-01	2.79E-08	3.57E-08	6.98E-08	1.02E-07	1.59E-07	6.98E-08
Benzo(k)fluoranthene	1.63E-01	2.73E-08	3.49E-08	6.82E-08	9.96E-08	1.55E-07	6.82E-08
Benzo(a)pyrene	1.60E-01	2.68E-08	3.43E-08	6.71E-08	9.80E-08	1.52E-07	6.71E-08
Indeno(1,2,3-cd)pyrene	1.40E-01	2.35E-08	3.00E-08	5.87E-08	8.57E-08	1.33E-07	5.87E-08
Benzene	1.53E-02	2.57E-09	3.28E-09	6.42E-09	9.37E-09	1.46E-08	6.42E-09
1,1,2,2-Tetrachloroethane	2.00E-03	3.35E-10	4.29E-10	8.39E-10	1.22E-09	1.90E-09	8.39E-10
Dieldrin	3.40E-03	5.70E-10	7.29E-10	1.43E-09	2.08E-09	3.24E-09	1.43E-09
Chlordane	2.00E-02	3.35E-09	4.29E-09	8.39E-09	1.22E-08	1.90E-08	8.39E-09
Heptachlor Epoxide	1.75E-02	2.94E-09	3.75E-09	7.34E-09	1.07E-08	1.67E-08	7.34E-09
Beryllium	2.40E-01	4.03E-08	5.15E-08	1.01E-07	1.47E-07	2.29E-07	1.01E-07
Cadmium	1.70E+00	2.85E-07	3.65E-07	7.13E-07	1.04E-06	1.62E-06	7.13E-07

PARAMETERS	CURRENT USE			FUTURE USE		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
INGESTION RATE (mg soil/day):	100	100	100	100	200	100
CONVERSION FACTOR (kg/mg)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
FRACTION INGESTED FROM CONTAMINATED SOURCE (unitless)	1	1	1	1	1	1
EXPOSURE FREQUENCY (days/year):	100	274	250	365	365	250
EXPOSURE DURATION (years):	30	5	30	30	5	30
BODY WEIGHT (kg):	70	25	70	70	15	70
AVERAGING TIME (days):	25550	25550	25550	25550	25550	25550

TABLE 6-12

INGESTION OF NONCARCINOGENIC CHEMICALS IN SOILS

CHEMICAL	CHEMICAL CONCENTRATION IN SOIL (mg/kg)	INTAKE (mg/kg-day)					
		CURRENT USE			FUTURE USE		
		ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
1,2-Dichlorobenzene	9.40E-02	3.68E-08	2.82E-07	9.20E-08	1.34E-07	1.25E-06	9.20E-08
Benzoic Acid	2.10E-01	8.22E-08	6.31E-07	2.05E-07	3.00E-07	2.80E-06	2.05E-07
Naphthalene	4.82E-01	1.89E-07	1.45E-06	4.72E-07	6.89E-07	6.43E-06	4.72E-07
2-Methylnaphthalene	2.00E-01	7.81E-08	5.99E-07	1.95E-07	2.85E-07	2.66E-06	1.95E-07
Acenaphthene	1.90E-01	7.44E-08	5.71E-07	1.86E-07	2.71E-07	2.53E-06	1.86E-07
Dibenzofuran	1.50E-01	5.87E-08	4.50E-07	1.47E-07	2.14E-07	2.00E-06	1.47E-07
Fluorene	1.70E-01	6.65E-08	5.10E-07	1.66E-07	2.43E-07	2.27E-06	1.66E-07
Phenanthrene	2.41E-01	9.45E-08	7.25E-07	2.36E-07	3.45E-07	3.22E-06	2.36E-07
Anthracene	4.30E-02	1.68E-08	1.29E-07	4.21E-08	6.14E-08	5.73E-07	4.21E-08
Fluoranthene	2.48E-01	9.71E-08	7.45E-07	2.43E-07	3.54E-07	3.31E-06	2.43E-07
Pyrene	1.60E-01	6.26E-08	4.80E-07	1.57E-07	2.29E-07	2.13E-06	1.57E-07
Di-n-octylphthalate	4.30E-02	1.68E-08	1.29E-07	4.21E-08	6.14E-08	5.73E-07	4.21E-08
Benzo(g,h,i)perylene	1.30E-01	5.09E-08	3.90E-07	1.27E-07	1.86E-07	1.73E-06	1.27E-07
2-Butanone	6.43E-02	2.52E-08	1.93E-07	6.29E-08	9.19E-08	8.57E-07	6.29E-08
Chlorobenzene	2.34E-01	9.16E-08	7.02E-07	2.29E-07	3.34E-07	3.12E-06	2.29E-07
Ethylbenzene	8.46E-02	3.31E-08	2.54E-07	8.28E-08	1.21E-07	1.13E-06	8.28E-08
Total xylenes	1.83E-01	7.17E-08	5.50E-07	1.79E-07	2.62E-07	2.44E-06	1.79E-07
Total phenols	1.33E+00	5.19E-07	3.98E-06	1.30E-06	1.90E-06	1.77E-05	1.30E-06
1,4-Dichlorobenzene	2.50E-01	9.80E-08	7.52E-07	2.45E-07	3.58E-07	3.34E-06	2.45E-07
Butylbenzylphalate	1.60E-01	6.26E-08	4.80E-07	1.57E-07	2.29E-07	2.13E-06	1.57E-07
Bis(2-ethylhexyl)phthalate	2.85E-01	1.12E-07	8.56E-07	2.79E-07	4.07E-07	3.80E-06	2.79E-07
Dieldrin	3.40E-03	1.33E-09	1.02E-08	3.33E-09	4.86E-09	4.53E-08	3.33E-09
Beryllium	2.40E-01	9.39E-08	7.21E-07	2.35E-07	3.43E-07	3.20E-06	2.35E-07
Cadmium	1.70E+00	6.65E-07	5.10E-06	1.66E-06	2.43E-06	2.27E-05	1.66E-06
Mercury	7.88E-02	3.08E-08	2.37E-07	7.71E-08	1.13E-07	1.05E-06	7.71E-08

VARIABLE	CURRENT USE			FUTURE USE		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
INGESTION RATE (mg soil/day):	100	100	100	100	200	100
CONVERSION FACTOR (kg/mg)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
FRACTION INGESTED FROM CONTAMINATED SOURCE (unitless)	1	1	1	1	1	1
EXPOSURE FREQUENCY (days/year):	100	274	250	365	365	250
EXPOSURE DURATION (years):	30	5	30	30	5	30
BODY WEIGHT (kg):	70	25	70	70	15	70
AVERAGING TIME (days):	10950	1825	10950	10950	1825	10950

TABLE 6-13

DERMAL CONTACT WITH CARCINOGENIC CHEMICALS IN SOIL

CHEMICAL	CHEMICAL CONCENTRATION IN SOIL (mg/kg)	ABSORBED DOSE (mg/kg-day)					
		CURRENT USE			FUTURE USE		
		ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
1,4-Dichlorobenzene	2.50E-01	8.99E-09	6.97E-08	8.55E-08	3.28E-08	9.84E-08	8.55E-08
N-nitrosodiphenylamine	1.10E-01	3.95E-09	3.06E-08	3.76E-08	1.44E-08	4.32E-08	3.76E-08
Butylbenzylphthalate	1.60E-01	5.74E-09	4.45E-08	5.46E-08	2.10E-08	6.28E-08	5.46E-08
Benzo(a)anthracene	2.00E-01	7.18E-09	5.56E-08	6.83E-08	2.62E-08	7.85E-08	6.83E-08
Chrysene	2.26E-01	8.11E-09	6.29E-08	7.72E-08	2.96E-08	8.88E-08	7.72E-08
Bis(2-ethylhexyl)phthalate	2.85E-01	1.02E-08	7.93E-08	9.73E-08	3.74E-08	1.12E-07	9.73E-08
Benzo(b)fluoranthene	1.67E-01	5.98E-09	4.63E-08	5.69E-08	2.18E-08	6.54E-08	5.69E-08
Benzo(k)fluoranthene	1.63E-01	5.84E-09	4.53E-08	5.56E-08	2.13E-08	6.39E-08	5.56E-08
Benzo(a)pyrene	1.60E-01	5.74E-09	4.45E-08	5.46E-08	2.10E-08	6.28E-08	5.46E-08
Indeno(1,2,3-cd)pyrene	1.40E-01	5.03E-09	3.90E-08	4.78E-08	1.83E-08	5.50E-08	4.78E-08
Benzene	1.53E-02	5.50E-10	4.26E-09	5.23E-09	2.01E-09	6.01E-09	5.23E-09
1,1,2,2-Tetrachloroethane	2.00E-03	7.18E-11	5.56E-10	6.83E-10	2.62E-10	7.85E-10	6.83E-10
Dieldrin	3.40E-03	1.22E-10	9.46E-10	1.16E-09	4.46E-10	1.34E-09	1.16E-09
Chlordane	2.00E-02	7.18E-10	5.56E-09	6.83E-09	2.62E-09	7.85E-09	6.83E-09
Heptachlor Epoxide	1.75E-02	6.27E-10	4.86E-09	5.97E-09	2.29E-09	6.86E-09	5.97E-09
Beryllium	2.40E-01	8.62E-09	6.68E-08	8.20E-08	3.14E-08	9.43E-08	8.20E-08
Cadmium	1.70E+00	6.10E-08	4.73E-07	5.81E-07	2.23E-07	6.68E-07	5.81E-07
Mercury	1.33E+00	4.76E-08	3.69E-07	4.53E-07	1.74E-07	5.21E-07	4.53E-07

VARIABLE	CURRENT USE			FUTURE USE		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
CONVERSION FACTOR (kg/mg)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2/event):	820	4970	3120	820	3160	3120
SOIL TO SKIN ADHERENCE FACTOR (mg/cm^2)	1.45	1.45	1.45	1.45	1.45	1.45
ABSORPTION FACTOR (unitless)	0.018	0.018	0.018	0.018	0.018	0.018
EXPOSURE FREQUENCY (days/year):	100	274	250	365	365	250
EXPOSURE DURATION (years):	30	5	30	30	5	30
BODY WEIGHT (kg):	70	25	70	70	15	70
AVERAGING TIME (days):	25550	25550	25550	25550	25550	25550

TABLE 6-14

DERMAL CONTACT WITH NONCARCINOGENIC CHEMICALS IN SOILS

CHEMICAL	CHEMICAL CONCENTRATION IN SOIL (mg/kg)	ABSORBED DOSE (mg/kg-day)					
		CURRENT USE			FUTURE USE		
		ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
1,2-Dichlorobenzene	9.40E-02	7.87E-09	3.66E-07	7.49E-08	2.87E-08	5.17E-07	7.49E-08
Benzoic Acid	2.10E-01	1.76E-08	8.18E-07	1.67E-07	6.42E-08	1.15E-06	1.67E-07
Naphthalene	4.82E-01	4.04E-08	1.88E-06	3.84E-07	1.47E-07	2.65E-06	3.84E-07
2-Methylnaphthalene	2.00E-01	1.67E-08	7.78E-07	1.59E-07	6.10E-08	1.10E-06	1.59E-07
Acenaphthene	1.90E-01	1.59E-08	7.40E-07	1.51E-07	5.81E-08	1.04E-06	1.51E-07
Dibenzofuran	1.50E-01	1.26E-08	5.84E-07	1.20E-07	4.59E-08	8.25E-07	1.20E-07
Fluorene	1.70E-01	1.42E-08	6.62E-07	1.35E-07	5.20E-08	9.35E-07	1.35E-07
Phenanthrene	2.41E-01	2.02E-08	9.40E-07	1.92E-07	7.38E-08	1.33E-06	1.92E-07
Anthracene	4.30E-02	3.60E-09	1.67E-07	3.43E-08	1.31E-08	2.36E-07	3.43E-08
Fluoranthene	2.48E-01	2.08E-08	9.66E-07	1.98E-07	7.59E-08	1.36E-06	1.98E-07
Pyrene	2.05E-01	1.72E-08	7.98E-07	1.63E-07	6.26E-08	1.13E-06	1.63E-07
Di-n-octylphthalate	2.85E-01	2.39E-08	1.11E-06	2.27E-07	8.72E-08	1.57E-06	2.27E-07
Benzo(g,h,i)perylene	1.30E-01	1.09E-08	5.06E-07	1.04E-07	3.97E-08	7.15E-07	1.04E-07
2-Butanone	6.43E-02	5.39E-09	2.50E-07	5.12E-08	1.97E-08	3.54E-07	5.12E-08
Chlorobenzene	2.34E-01	1.96E-08	9.11E-07	1.86E-07	7.15E-08	1.29E-06	1.86E-07
Ethylbenzene	8.46E-02	7.09E-09	3.29E-07	6.74E-08	2.59E-08	4.65E-07	6.74E-08
Total xylenes	1.83E-01	1.53E-08	7.13E-07	1.46E-07	5.60E-08	1.01E-06	1.46E-07
Total phenols	1.33E+00	1.11E-07	5.17E-06	1.06E-06	4.06E-07	7.29E-06	1.06E-06
1,4-Dichlorobenzene	2.50E-01	2.10E-08	9.76E-07	2.00E-07	7.66E-08	1.38E-06	2.00E-07
Butylbenzylphthalate	1.60E-01	1.34E-08	6.23E-07	1.27E-07	4.89E-08	8.80E-07	1.27E-07
Bis(2-ethylhexyl)phthalate	2.85E-01	2.39E-08	1.11E-06	2.27E-07	8.72E-08	1.57E-06	2.27E-07
Dieldrin	3.40E-03	2.85E-10	1.32E-08	2.71E-09	1.04E-09	1.87E-08	2.71E-09
Beryllium	2.40E-01	2.01E-08	9.35E-07	1.91E-07	7.34E-08	1.32E-06	1.91E-07
Cadmium	1.70E+00	1.42E-07	6.62E-06	1.35E-06	5.20E-07	9.35E-06	1.35E-06
Mercury	7.88E-03	6.60E-10	3.07E-08	6.28E-09	2.41E-09	4.33E-08	6.28E-09

VARIABLE	CURRENT USE			FUTURE USE		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
CONVERSION FACTOR (kg/mg)	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06
SKIN SURFACE AREA AVAILABLE FOR CONTACT (cm^2/event):	820	4970	3120	820	3160	3120
SOIL TO SKIN ADHERENCE FACTOR (mg/cm^2)	1.45	1.45	1.45	1.45	1.45	1.45
ABSORPTION FACTOR (unitless)	0.018	0.018	0.018	0.018	0.018	0.018
EXPOSURE FREQUENCY (days/year):	100	274	250	365	365	250
EXPOSURE DURATION (years):	30	5	30	30	5	30
BODY WEIGHT (kg):	70	25	70	70	15	70
AVERAGING TIME (days):	10950	1825	10950	10950	1825	10950

TABLE 6-15

INGESTION OF CARCINOGENIC CHEMICALS IN DRINKING WATER

CHEMICAL	CHEMICAL CONCENTRATION IN WATER (mg/l)	INTAKE(mg/kg-day) CURRENT USE		CHEMICAL CONCENTRATION IN WATER (mg/l)	INTAKE(mg/kg-day) FUTURE USE		
		ADULT	CHILD		ADULT	CHILD	WORKER
Benzene	1.54E-07	1.89E-09	4.40E-10	1.54E-03	1.89E-05	5.87E-06	1.29E-05
Tetrachloroethene	6.00E-08	7.35E-10	1.71E-10	6.00E-04	7.35E-06	2.29E-06	5.03E-06
Trichloroethene	2.00E-08	2.45E-10	5.71E-11	2.00E-04	2.45E-06	7.62E-07	1.68E-06
1,4-Dichlorobenzene	5.62E-08	6.89E-10	1.61E-10	5.62E-04	6.89E-06	2.14E-06	4.72E-06
1,1-Dichloroethane	1.74E-07	2.13E-09	4.96E-10	1.74E-03	2.13E-05	6.62E-06	1.46E-05
1,2-Dichloroethane	2.00E-08	2.45E-10	5.71E-11	2.00E-04	2.45E-06	7.62E-07	1.68E-06
Chloromethane	2.72E-07	3.33E-09	7.77E-10	2.72E-03	3.33E-05	1.04E-05	2.28E-05
Styrene	6.00E-08	7.35E-10	1.71E-10	6.00E-04	7.35E-06	2.29E-06	5.03E-06
Butylbenzylphthalate	5.05E-07	6.18E-09	1.44E-09	5.05E-03	6.18E-05	1.92E-05	4.23E-05
Bis(2-ethylhexyl)phthalate	7.05E-07	8.64E-09	2.02E-09	7.05E-03	8.64E-05	2.69E-05	5.91E-05
gamma-BHC	2.72E-09	3.33E-11	7.77E-12	2.72E-05	3.33E-07	1.04E-07	2.28E-07
Arsenic	4.63E-07	5.67E-09	1.32E-09	4.63E-03	5.67E-05	1.76E-05	3.88E-05
Cadmium	4.06E-07	4.97E-09	1.16E-09	4.06E-03	4.97E-05	1.55E-05	3.40E-05
Lead	6.10E-07	7.47E-09	1.74E-09	4.19E-04	5.14E-06	1.60E-06	3.52E-06

VARIABLE	CURRENT USE			FUTURE USE		
	ADULT	CHILD		ADULT	CHILD	WORKER
INGESTION RATE (liters/day)	2	1		2	0.8	2
EXPOSURE FREQUENCY (days/year)	365	365		365	365	250
EXPOSURE DURATION (years)	30	5		30	5	30
BODY WEIGHT (kg)	70	25		70	15	70
AVERAGING TIME (days)	25550	25550		25550	25550	25550

TABLE 6-16

INGESTION OF NONCARCINOGENIC CHEMICALS IN DRINKING WATER

CHEMICAL	CHEMICAL CONCENTRATION IN WATER (mg/l)	INTAKE(mg/kg-day) CURRENT USE		CHEMICAL CONCENTRATION IN WATER (mg/l)	INTAKE(mg/kg-day) FUTURE USE		
		ADULT	CHILD		ADULT	CHILD	WORKER
Isopropylbenzene	8.50E-08	2.43E-09	2.72E-09	8.50E-04	2.43E-05	4.54E-05	1.66E-05
Total Xylenes	1.57E-07	4.50E-09	5.04E-09	1.57E-03	4.50E-05	8.40E-05	3.08E-05
Dichlorodifluoromethane	2.00E-08	5.71E-10	6.40E-10	2.00E-04	5.71E-06	1.07E-05	3.91E-06
Acetone	6.68E-07	1.91E-08	2.14E-08	6.68E-03	1.91E-04	3.56E-04	1.31E-04
Toluene	1.00E-07	2.86E-09	3.20E-09	1.00E-03	2.86E-05	5.33E-05	1.96E-05
p-Isopropyltoluene	6.98E-08	2.00E-09	2.24E-09	6.98E-04	2.00E-05	3.73E-05	1.37E-05
cis-1,2-Dichloroethene	9.00E-08	2.57E-09	2.88E-09	9.00E-04	2.57E-05	4.80E-05	1.76E-05
1,2,4-Trimethylbenzene	6.08E-08	1.74E-09	1.94E-09	6.08E-04	1.74E-05	3.24E-05	1.19E-05
Carbon Disulfide	1.53E-07	4.37E-09	4.90E-09	1.53E-03	4.37E-05	8.16E-05	2.99E-05
Propylbenzene	5.29E-08	1.51E-09	1.69E-09	5.29E-04	1.51E-05	2.82E-05	1.03E-05
Chlorobenzene	2.33E-07	6.67E-09	7.47E-09	2.33E-03	6.67E-05	1.24E-04	4.57E-05
1,2-Dichlorobenzene	5.94E-08	1.70E-09	1.90E-09	5.94E-04	1.70E-05	3.17E-05	1.16E-05
1,3,5-Trimethylbenzene	8.81E-08	2.52E-09	2.82E-09	8.81E-04	2.52E-05	4.70E-05	1.72E-05
4-Methyl-2-Pentanone	3.00E-07	8.57E-09	9.60E-09	3.00E-03	8.57E-05	1.60E-04	5.87E-05
tert-Butylbenzene	6.01E-08	1.72E-09	1.92E-09	6.01E-04	1.72E-05	3.20E-05	1.18E-05
Naphthalene	8.90E-08	2.54E-09	2.85E-09	8.90E-04	2.54E-05	4.75E-05	1.74E-05
Diethylphthalate	4.97E-07	1.42E-08	1.59E-08	4.97E-03	1.42E-04	2.65E-04	9.73E-05
Di-n-octylphthalate	1.28E-06	3.66E-08	4.10E-08	1.28E-02	3.66E-04	6.83E-04	2.51E-04
Pyrene	3.00E-07	8.57E-09	9.60E-09	3.00E-03	8.57E-05	1.60E-04	5.87E-05

VARIABLE	CURRENT USE			FUTURE USE		
	ADULT	CHILD		ADULT	CHILD	WORKER
INGESTION RATE (liters/day)	2	1		2	0.8	2
EXPOSURE FREQUENCY (days/year)	365	365		365	365	250
EXPOSURE DURATION (years)	30	5		30	5	30
BODY WEIGHT (kg)	70	25		70	15	70
AVERAGING TIME (days)	10950	1825		10950	1825	10950

TABLE 6-16 (continued)

INGESTION OF NONCARCINOGENIC CHEMICALS IN DRINKING WATER

CHEMICAL	CHEMICAL CONCENTRATION IN WATER (mg/l)	INTAKE(mg/kg-day) CURRENT USE		CHEMICAL CONCENTRATION IN WATER (mg/l)	INTAKE(mg/kg-day) FUTURE USE		
		ADULT	CHILD		ADULT	CHILD	WORKER
Manganese	4.78E-04	1.37E-05	1.53E-05	4.78E+00	1.37E-01	2.55E-01	9.36E-02
Mercury	4.19E-08	1.20E-09	1.34E-09	4.19E-04	1.20E-05	2.24E-05	8.21E-06
Sodium	8.33E-03	2.38E-04	2.67E-04	8.33E+01	2.38E+00	4.44E+00	1.63E+00
Vanadium	1.14E-06	3.25E-08	3.64E-08	1.14E-02	3.25E-04	6.07E-04	2.23E-04
Tetrachloroethene	6.00E-08	1.71E-09	1.92E-09	6.00E-04	1.71E-05	3.20E-05	1.17E-05
1,4-Dichlorobenzene	5.62E-08	1.61E-09	1.80E-09	5.62E-04	1.61E-05	3.00E-05	1.10E-05
1,1-Dichloroethane	1.74E-07	4.96E-09	5.56E-09	1.74E-03	4.96E-05	9.26E-05	3.40E-05
Styrene	6.00E-08	1.71E-09	1.92E-09	6.00E-04	1.71E-05	3.20E-05	1.17E-05
Butylbenzylphthalate	5.05E-07	1.44E-08	1.62E-08	5.05E-03	1.44E-04	2.69E-04	9.88E-05
Bis(2-ethylhexyl)phthalate	7.05E-07	2.02E-08	2.26E-08	7.05E-03	2.02E-04	3.76E-04	1.38E-04
delta-BHC	1.42E-08	4.06E-10	4.55E-10	1.42E-04	4.06E-06	7.58E-06	2.78E-06
gamma-BHC	2.72E-09	7.77E-11	8.70E-11	2.72E-05	7.77E-07	1.45E-06	5.32E-07
Arsenic	4.63E-07	1.32E-08	1.48E-08	4.63E-03	1.32E-04	2.47E-04	9.06E-05
Cadmium	4.06E-07	1.16E-08	1.30E-08	4.06E-03	1.16E-04	2.16E-04	7.94E-05
Lead	6.10E-07	1.74E-08	1.95E-08	6.10E-03	1.74E-04	3.25E-04	1.19E-04
Cobalt	1.60E-06	4.58E-08	5.13E-08	1.60E-02	4.58E-04	8.56E-04	3.14E-04
Chromium (III)	1.48E-05	4.23E-07	4.74E-07	1.48E-01	4.23E-03	7.89E-03	2.90E-03
Barium	1.01E-05	2.90E-03	4.06E-03	1.01E-01	2.90E-07	5.41E-07	1.99E-07
Nickel	6.16E-06	1.76E-03	2.47E-03	6.16E-02	1.76E-07	3.29E-07	1.21E-07
Zinc	2.61E-06	7.45E-04	1.04E-03	2.61E-02	7.45E-08	1.39E-07	5.10E-08

VARIABLE	CURRENT USE			FUTURE USE		
	ADULT	CHILD		ADULT	CHILD	WORKER
INGESTION RATE (liters/day)	2	1		2	0.8	2
EXPOSURE FREQUENCY (days/year)	365	365		365	365	250
EXPOSURE DURATION (years)	30	5		30	5	30
BODY WEIGHT (kg)	70	25		70	15	70
AVERAGING TIME (days)	10950	1825		10950	1825	10950

RAM 001 0806

TABLE 6–17

INHALATION OF AIRBORNE (VAPOR PHASE) CARCINOGENIC CHEMICALS VOLATILIZING FROM THE LANDFILL

CHEMICAL	CHEMICAL CONCENTRATION IN AIR (mg/m^3)	INTAKE (mg/kg-day)					
		CURRENT USE			FUTURE USE		
		ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
Benzene	1.22E-02	2.56E-05	1.36E-04	5.12E-04	1.49E-03	9.30E-04	5.12E-04
Tetrachloroethene	1.79E-03	3.75E-06	2.00E-05	7.51E-05	2.19E-04	1.36E-04	7.51E-05
Styrene	3.23E-04	6.77E-07	3.60E-06	1.35E-05	3.96E-05	2.46E-05	1.35E-05
Methylene Chloride	1.86E-03	3.90E-06	2.07E-05	7.80E-05	2.28E-04	1.42E-04	7.80E-05
Carbon Tetrachloride	4.04E-04	8.47E-07	4.51E-06	1.69E-05	4.95E-05	3.08E-05	1.69E-05

VARIABLE	CURRENT USE			FUTURE USE		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
INHALATION RATE (m^3/hr):	1.25	1.30	1.25	1.25	1.00	1.25
EXPOSURE TIME (hours/day):	1	4	8	16	16	8
EXPOSURE FREQUENCY (days/year):	100	274	250	365	365	250
EXPOSURE DURATION (years):	30	5	30	30	5	30
BODY WEIGHT (kg):	70	25	70	70	15	70
AVERAGING TIME (days):	25550	25550	25550	25550	25550	25550

TABLE 6-18

INHALATION OF AIRBORNE (VAPOR PHASE) NONCARCINOGENIC CHEMICALS VOLATILIZING FROM THE LANDFILL

CHEMICAL	CHEMICAL CONCENTRATION IN AIR (mg/m^3)	INTAKE (mg/kg-day)					
		CURRENT USE			FUTURE USE		
		ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
2-Butanone	6.60E-03	3.23E-05	1.03E-03	6.46E-04	1.89E-03	7.04E-03	6.46E-04
1,1,1-Trichloroethane	1.02E-03	5.00E-06	1.59E-04	9.99E-05	2.92E-04	1.09E-03	9.99E-05
Carbon Tetrachloride	4.04E-04	1.98E-06	6.31E-05	3.96E-05	1.16E-04	4.31E-04	3.96E-05
Chlorobenzene	1.51E-01	7.41E-04	2.36E-02	1.48E-02	4.32E-02	1.61E-01	1.48E-02
Ethylbenzene	4.91E-01	2.40E-03	7.67E-02	4.81E-02	1.40E-01	5.24E-01	4.81E-02
Toluene	1.13E-01	5.51E-04	1.76E-02	1.10E-02	3.22E-02	1.20E-01	1.10E-02
Xylene (Total)	3.15E+00	1.54E-02	4.92E-01	3.08E-01	9.00E-01	3.36E+00	3.08E-01
Acetone	1.43E-02	7.00E-05	2.24E-03	1.40E-03	4.09E-03	1.53E-02	1.40E-03
Tetrachloroethene	1.79E-03	8.77E-06	2.80E-04	1.75E-04	5.12E-04	1.91E-03	1.75E-04
Styrene	3.23E-04	1.58E-06	5.04E-05	3.16E-05	9.22E-05	3.44E-04	3.16E-05
Methylene Chloride	1.86E-03	9.12E-06	2.91E-04	1.82E-04	5.32E-04	1.99E-03	1.82E-04

VARIABLE	CURRENT USE			FUTURE USE		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ADULT	CHILD	WORKER
INHALATION RATE (m^3/hr):	1.25	1.30	1.25	1.25	1.00	1.25
EXPOSURE TIME (hours/day):	1	4	8	16	16	8
EXPOSURE FREQUENCY (days/year):	100	274	250	365	365	250
EXPOSURE DURATION (years):	30	5	30	30	5	30
BODY WEIGHT (kg):	70	25	70	70	15	70
AVERAGING TIME (days):	10950	1825	10950	10950	1825	10950

TABLE 6–19

INHALATION OF AIRBORNE (VAPOR PHASE) CARCINOGENIC CHEMICALS VOLATILIZING IN THE SHOWER

CHEMICAL	CURRENT USE			FUTURE USE		
	CHEMICAL CONCENTRATION IN AIR (mg/m^3)	INTAKE(mg/kg-day)		CHEMICAL CONCENTRATION IN AIR (mg/m^3)	INTAKE(mg/kg-day)	
		ADULT	CHILD		ADULT	CHILD
Benzene	1.31E-05	9.65E-09	4.50E-09	1.31E-01	9.65E-05	2.50E-05
Tetrachloroethene	4.41E-06	3.24E-09	1.51E-09	4.41E-02	3.24E-05	8.40E-06
Trichloroethene	1.71E-06	1.25E-09	5.85E-10	1.71E-02	1.25E-05	3.25E-06
1,4-Dichlorobenzene	4.00E-06	2.94E-09	1.37E-09	4.00E-02	2.94E-05	7.62E-06
1,1-Dichloroethane	1.68E-05	1.24E-08	5.77E-09	1.68E-01	1.24E-04	3.21E-05
1,2-Dichloroethane	1.68E-06	1.24E-09	5.77E-10	1.68E-02	1.24E-05	3.20E-06
Chloromethane	2.55E-05	1.87E-08	8.73E-09	2.55E-01	1.87E-04	4.85E-05
Styrene	4.31E-06	3.17E-09	1.48E-09	4.31E-02	3.17E-05	8.21E-06

VARIABLE	CURRENT USE		FUTURE USE	
	ADULT	CHILD	ADULT	CHILD
INHALATION RATE (m^3/hr)	0.6	0.6	0.6	0.6
EXPOSURE TIME (hours/day)	0.2	0.2	0.2	0.2
EXPOSURE FREQUENCY (days/year)	365	365	365	365
EXPOSURE DURATION (years)	30	5	30	2
BODY WEIGHT (kg)	70	25	70	18
AVERAGING TIME (days)	25550	25550	25550	25550

TABLE 6-20

INHALATION OF AIRBORNE (VAPOR PHASE) NONCARCINOGENIC CHEMICALS VOLATILIZING IN THE SHOWER

CHEMICAL	CURRENT USE			FUTURE USE		
	CHEMICAL CONCENTRATION IN AIR (mg/m^3)	INTAKE(mg/kg-day)		CHEMICAL CONCENTRATION IN AIR (mg/m^3)	INTAKE(mg/kg-day)	
		ADULT	CHILD		ADULT	CHILD
Tetrachloroethene	4.41E-06	7.56E-09	2.12E-08	4.41E-02	7.56E-05	2.94E-04
1,4-Dichlorobenzene	4.00E-06	6.86E-09	1.92E-08	4.00E-02	6.86E-05	2.67E-04
Isopropylbenzene	5.91E-06	1.01E-08	2.84E-08	5.91E-02	1.01E-04	3.94E-04
Total Xylene	1.12E-05	1.91E-08	5.36E-08	1.12E-01	1.91E-04	7.44E-04
Dichlorodifluoromethane	1.82E-06	3.12E-09	8.74E-09	1.82E-02	3.12E-05	1.21E-04
Acetone	3.02E-05	5.17E-08	1.45E-07	3.02E-01	5.17E-04	2.01E-03
Toluene	7.85E-06	1.35E-08	3.77E-08	7.85E-02	1.35E-04	5.24E-04
1,1-Dichloroethane	1.68E-05	2.89E-08	8.08E-08	1.68E-01	2.89E-04	1.12E-03
p-Isopropyltoluene	4.42E-06	7.58E-09	2.12E-08	4.42E-02	7.58E-05	2.95E-04
cis-1,2-Dichloroethene	6.85E-06	1.17E-08	3.29E-08	6.85E-02	1.17E-04	4.57E-04
1,2,4-Trimethylbenzene	3.85E-06	6.60E-09	1.85E-08	3.85E-02	6.60E-05	2.57E-04
Carbon Disulfide	1.51E-05	2.59E-08	5.29E-06	1.51E-01	2.59E-04	1.01E-03
Propylbenzene	3.35E-06	5.75E-09	1.61E-08	3.35E-02	5.75E-05	2.24E-04
Chlorobenzene	1.86E-05	3.18E-08	8.91E-08	1.86E-01	3.18E-04	1.24E-03
Styrene	4.31E-06	7.39E-09	2.07E-08	4.31E-02	7.39E-05	2.87E-04
1,2-Dichlorobenzene	4.26E-06	7.31E-09	2.05E-08	4.26E-02	7.31E-05	2.84E-04
1,3,5-Trimethylbenzene	5.59E-06	9.58E-09	2.68E-08	5.59E-02	9.58E-05	3.72E-04
4-Methyl-2-Pentanone	1.13E-05	1.94E-08	5.45E-08	1.13E-01	1.94E-04	7.56E-04
tert-Butylbenzene	3.62E-06	6.21E-09	1.74E-08	3.62E-02	6.21E-05	2.42E-04

VARIABLE	ADULT	CHILD		ADULT	CHILD
INHALATION RATE (m^3/hr)	0.6	0.6		0.6	0.6
EXPOSURE TIME (hours/day)	0.2	0.2		0.2	0.2
EXPOSURE FREQUENCY (days/year)	365	365		365	365
EXPOSURE DURATION (years)	30	5		30	2
BODY WEIGHT (kg)	70	25		70	18
AVERAGING TIME (days)	10950	1825		10950	730

TABLE 6-21

TOXICITY VALUES: POTENTIAL CARCINOGENIC EFFECTS

CHEMICAL	SLOPE FACTORS (mg/kg-day)^-1		WEIGHT-OF-EVIDENCE		TUMOR SITE		REFERENCE / SOURCE		DATE
	INHALATION	ORAL	INHALATION	ORAL	INHALATION	ORAL	INHALATION	ORAL	RECORDED INHAL/ORAL
alpha-BHC	6.30E+00	6.30E+00	B2	B2	NA	Liver	IRIS	IRIS	4-91
Arsenic	5.00E+01**	1.75E+00 (a)	A	A	Respiratory	Skin	IRIS	HEAST	2-91/4-FY90
Benzene	2.90E-02	2.90E-02	A	A	Leukemia	Leukemia	IRIS	IRIS	1-91
Benzo(a)anthracene (b)	6.10E+00	1.15E+01	B2	B2	Respiratory	Stomach	SPHEM	SPHEM	1986
Benzo(a)pyrene	6.10E+00	1.15E+01	B2	B2	Respiratory	Stomach	SPHEM	SPHEM	1986
Benzo(b)fluoranthene (b)	6.10E+00	1.15E+01	B2	B2	Respiratory	Stomach	SPHEM	SPHEM	1986
Benzo(k)fluoranthene (b)	6.10E+00	1.15E+01	B2	B2	Respiratory	Stomach	SPHEM	SPHEM	1986
Beryllium	8.40E+00	4.30E+00	B2	B2	Lung	Total Tumors	IRIS	IRIS	1-91
Bis(2-ethylhexyl)phthalate	ND	1.40E-02	B2	B2	NA	Liver	IRIS	IRIS	5-90
Butylbenzylphthalate	NA	NA	NA	C	NA	NA	HEAST	IRIS	4-FY90/2-89
Cadmium	6.10E+00	ND	B1	ND	Respiratory	NA	IRIS	HEAST	3-91/4-FY90
Chloromethane	6.30E-03	1.30E-02	C	C	Kidney	Kidney	HEAST	HEAST	4-FY90
Chrysene (b)	6.10E+00	1.15E+01	B2	B2	Respiratory	Stomach	SPHEM	SPHEM	1986
1,4-Dichlorobenzene	ND	2.40E-02	C	C	NA	Liver	IRIS	IRIS	12-90
1,1-Dichloroethane	ND	ND	C	C	NA	Blood	IRIS	IRIS	1-90
1,2-Dichloroethane	9.10E-02	9.10E-02	B2	B2	CS	CS	IRIS	IRIS	1-91
Dieldrin	1.60E+01	1.60E+01	B2	B2	Liver	Liver	IRIS	IRIS	1-91
alpha-Chlordane *	1.30E+00	1.30E+00	B2	B2	Liver	Liver	IRIS	IRIS	1-91
gamma-Chlordane *	1.30E+00	1.30E+00	B2	B2	Liver	Liver	IRIS	IRIS	1-91
Heptachlor Epoxide	9.10E+00	9.10E+00	B2	B2	Liver	Liver	IRIS	IRIS	1-91
Indeno(1,2,3-cd)pyrene (b)	6.10E+00	1.15E+01	B2	B2	Respiratory	Stomach	SPHEM	SPHEM	1986
Lead	NA	NA	B2	B2	NA	NA	IRIS	IRIS	2-89
Lindane (gamma-BHC)	ND	1.30E+00	B2-C	B2-C	NA	Liver	HEAST	HEAST	4-FY90
Methylene Chloride	4.70E-07	7.50E-03	B2	B2	Lung,Liver	Liver	IRIS	IRIS	1-91
Nickel	8.40E-01	ND	A	ND	Respiratory	NA	IRIS	HEAST	8-91/4-FY90
N-Nitrosodiphenylamine	ND	4.90E-03	B2	B2	NA	Bladder	HEAST	IRIS	4-FY90/3-88
Styrene	2.00E-03	3.00E-02	B2	B2	Blood	Respiratory	HEAST	HEAST	4-FY90
Tetrachloroethene	5.20E-07	5.10E-02	B2	B2	Leukemia,Liver	Liver	HEAST	HEAST	4-FY90
1,1,2,2-Tetrachloroethane	2.00E-01	2.00E-01	C	C	Liver	Liver	IRIS	IRIS	1-91
Trichloroethene	1.70E-02	1.10E-02	B2	B2	Lung	Liver	HEAST	HEAST	4-FY90
Carbon Tetrachloride	1.30E-01	1.30E-01	B2	B2	Liver	Liver	IRIS	IRIS	1-91

Notes:

* - Slope factors are obtained for the chemical chlordane.

** - An absorption factor of 30% is used to calculate unit risk from the slope factor.

CS - Effects circulatory system.

BW - Effects body weight.

NA - Not applicable.

ă - Calculated from oral unit risk of $5E-5[\mu g/L]^{-1}$ (HEAST 3-FY90).

b - Toxicity values for Benzo(a)pyrene were used for all carcinogenic PAHs when data were otherwise unavailable.

ND - Not determined.

IRIS - Integrated Risk Information System. Date indicates last update by EPA. Access to IRIS was March, April 1991.

HEAST - Health Effects Summary Tables. Date indicates quarter and fiscal year for which table was published.

SPHEM - Superfund Public Health Evaluation Manual, USEPA 1986.

TABLE 6-22

TOXICITY VALUES: POTENTIAL NONCARCINOGENIC EFFECTS

CHEMICAL	TOXICITY VALUES (mg/kg-day)				CRITICAL EFFECT				REF/SOURCE				DATE RECORDED
	SUBCHRONIC		CHRONIC		SUBCHRONIC		CHRONIC		SUBCHRONIC		CHRONIC		
	INHALATION Rfc	ORAL Rfd	INHALATION Rfc	ORAL Rfd	INHALATION Rfc	ORAL Rfd	INHALATION Rfc	ORAL Rfd	INHALATION Rfc	ORAL Rfd	INHALATION Rfc	ORAL Rfd	Inhal/Oral
Acenaphthene	ND	6.00E-01	ND	6.00E-02	NA	Hepatotoxicity	NA	Hepatotoxicity	HEAST	HEAST	HEAST	IRIS	4-FY90/FY91
Acetone	ND	1.00E+00	ND	1.00E-01	NA	Liver, Kidney	NA	Liver, Kidney	HEAST	HEAST	HEAST	IRIS	4-FY90/12-90
Aluminum	Data inadequate for quantitative risk assessment (HEAST)												
Anthracene	ND	3.00E+00	ND	3.00E-01		Decreased BW		Decreased BW	HEAST	HEAST	HEAST	IRIS	4-FY90/FY91
Arsenic (d)	ND	1.00E-03	ND	1.00E-03	NA	Skin	NA	Skin	HEAST	HEAST	HEAST	HEAST	4-FY90
Barium	1.00E-03	7.00E-02	1.00E-04	5.00E-02	Fetotoxicity	Increased BP	Fetotoxicity	Increased BP	HEAST	IRIS	HEAST	HEAST	4-FY90/8-91
Benzo(g,h,i)perylene (c)		4.00E-02		4.00E-03		Decreased BW		Decreased BW	HEAST	HEAST	HEAST	HEAST	4-FY90
Benzoic Acid	ND	4.00E+00	ND	4.00E+00	NA	Malaise	NA	Malaise	HEAST	HEAST	HEAST	IRIS	4-FY90/1-91
Beryllium	ND	5.00E-03	ND	5.00E-03	NA	None observed	NA	None observed	HEAST	HEAST	HEAST	IRIS	4-FY90/9-90
Bis(2-ethylhexyl)phthalate (d)	ND	2.00E-02	ND	2.00E-02	NA	Liver	NA	Liver	HEAST	HEAST	HEAST	IRIS	4-FY90/9-89
2-Butanone (MEK)	9.00E-01	5.00E-01	9.00E-02	5.00E-02	CNS	Fetotoxicity	CNS	Fetotoxicity	HEAST	HEAST	HEAST	IRIS	4-FY90/6-90
tert-Butylbenzene	ND	ND	ND	4.00E-01					ECAO	ECAO	ECAO	ECAO	4-91
Butylbenzylphthalate	ND	2.00E+00	ND	2.00E-01	NA	BW, Testes, Liver, Kidney	NA	BW, Testes, Liver, Kidney	HEAST	HEAST	HEAST	IRIS	4-FY90/9-89
Cadmium	ND	ND	ND	5.00E-04 (c)	Cancer	NA	Cancer	Kidney	HEAST	HEAST	HEAST	IRIS	4-FY90/10-89
Calcium													
Carbon Disulfide	2.85E-03(a)	1.00E-01	2.85E-03 (a)	1.00E-01	NA	Fetal toxicity	NA	Fetal toxicity	ECAO	HEAST	HEAST	IRIS	4-FY90/9-90
Chromium(III)	5.71E-06	1.00E+01	5.71E-07	1.00E+00	Respiratory	ND	Respiratory	ND	HEAST	HEAST	HEAST	IRIS	FY91
Chlorobenzene	5.00E-02	2.00E-01	5.00E-03	2.00E-02	Liver, Kidney	Liver, Kidney	Liver, Kidney	Liver, Kidney	HEAST	HEAST	HEAST	IRIS	4-FY90/3-91
Cobalt	ND	ND	1.00E-06	1.00E-05	ND	ND	Respiratory	Heart, Blood	ECAO	ECAO	ECAO	ECAO	4-91
Copper	ND	ND	ND	ND	NA	Local GI irritation	NA	Local GI irritation	HEAST	HEAST	HEAST	HEAST	4-FY90
Cumene (Isopropylbenzene)	2.57E-02 (a)	4.00E-01	2.57E-03 (a)	4.00E-02	CNS, Nose	Kidney	CNS, Nose	Kidney	HEAST	HEAST	HEAST	IRIS	4-FY90/4-91
Cymene (p-Isopropyltoluene)	ND	4.00E-01	ND	4.00E-01					ECAO	ECAO	ECAO	ECAO	4-91
Dibenzofuran	Data inadequate for quantitative risk assessment (HEAST)												
1,2-Dichlorobenzene	4.00E-01	9.00E-01	4.00E-02	9.00E-02	BW	Liver	BW	Liver	HEAST	HEAST	HEAST	IRIS	4-FY90/3-91
1,4-Dichlorobenzene	2.00E-01 (a)	ND	2.00E-01 (a)	ND	Liver, Kidney	NA	Liver, Kidney	NA	HEAST	HEAST	HEAST	HEAST	4-FY90
Dichlorodiflouromethane	5.00E-01	9.00E-01	5.00E-02	2.00E-01	Lung, Liver	None	Lung, Liver	Body weight	HEAST	HEAST	HEAST	IRIS	4-FY90/8-90
1,1-Dichloroethane	1.00E+00	1.00E+00	1.00E-01	1.00E-01	Kidney	None	Kidney	None	HEAST	HEAST	HEAST	HEAST	4-FY90
cis-1,2-Dichloroethene	ND	1.00E-01	ND	1.00E+02	NA	Blood	NA	Blood	HEAST	HEAST	HEAST	IRIS	4-FY90/1-89
Dieldrin	ND	5.00E-05	ND	5.00E-05	NA	Liver lesions	NA	Liver lesions	HEAST	HEAST	HEAST	IRIS	4-FY90/9-90
Diethylphthalate	ND	8.00E+00	ND	8.00E-01	NA	Body weight	NA	Body weight	HEAST	HEAST	HEAST	IRIS	4-FY90/9-87
Di-n-octylphthalate	ND	2.00E-02	ND	2.00E-02	NA	Kidney, Liver	NA	Kidney, Liver	HEAST	HEAST	HEAST	HEAST	4-FY90
Ethylbenzene	2.86E-01	1.00E+00	2.86E-01	1.00E-01	Fetal toxicity	Kidney, Liver	NA	Kidney, Liver	HEAST	HEAST	IRIS	IRIS	4-FY90/FY91
Fluoranthene	ND	4.00E-01	ND	4.00E-02	NA	Liver	NA	Liver	HEAST	HEAST	HEAST	IRIS	FY91
Fluorene	ND	4.00E-01	ND	4.00E-02	NA	Liver	NA	Liver	HEAST	HEAST	HEAST	IRIS	FY91
Iron	Data inadequate for quantitative risk assessment (HEAST)												
Lead (d)	ND	ND	ND	ND	NA	NA	CNS	CNS	HEAST	HEAST	HEAST	IRIS	4-FY90/2-91
Lindane (gamma-BHC)	ND	3.00E-03	ND	3.00E-04	NA	Liver, Kidney	NA	Liver, Kidney	HEAST	HEAST	HEAST	IRIS	4-FY90/3-88

TABLE 6-22 (continued)

TOXICITY VALUES: POTENTIAL NONCARCINOGENIC EFFECTS

CHEMICAL	TOXICITY VALUES (mg/kg-day)				CRITICAL EFFECT				REF/SOURCE				DATE RECORDED
	SUBCHRONIC		CHRONIC		SUBCHRONIC		CHRONIC		SUBCHRONIC		CHRONIC		
	INHALATION Rfc	ORAL Rfd	INHALATION Rfc	ORAL Rfd	INHALATION Rfc	ORAL Rfd	INHALATION Rfc	ORAL Rfd	INHALATION Rfc	ORAL Rfd	INHALATION Rfc	ORAL Rfd	Inhal/Oral
delta-BHC	Data inadequate for quantitative risk assessment (HEAST)												
Manganese	1.14E-04 (a)	1.00E-01	1.14E-04** (a)	1.00E-01	Respiratory,CNS	No effect	Respiratory,CNS	No effect	HEAST	HEAST	IRIS	IRIS	4-FY90/12-90
Mercury	8.57E-05 (a)	3.00E-04	8.57E-05 (a)	3.00E-04	CNS	Kidney	CNS	Kidney	HEAST	HEAST	HEAST	HEAST	4-FY90
Methylene Chloride (d)	8.57E-01 (a)	6.00E-02	8.57E-01 (a)	6.00E-02	NA	Liver	NA	Liver	HEAST	HEAST	HEAST	IRIS	4-FY90/3-88
2-Methylnaphthalene (c)		4.00E-02		4.00E-03		Decreased BW		Decreased BW	HEAST	HEAST	HEAST	HEAST	4-FY90
4-Methyl-2-Pentanone	2.00E-01	5.00E-01	2.00E-02	5.00E-02	Liver,Kidney	Liver,Kidney	Liver,Kidney	Liver,Kidney	HEAST	HEAST	HEAST	IRIS	4-FY90/3-91
Naphthalene	ND	4.00E-02	ND	4.00E-03	NA	Decreased BW	NA	Decreased BW	HEAST	HEAST	HEAST	HEAST	4-FY90
Nickel (d)	ND	2.00E-02	ND	2.00E-02	Cancer	Decreased BW	Cancer	Decreased BW	HEAST	HEAST	HEAST	HEAST	4-FY90
Phenanthrene (c)		4.00E-02		4.00E-03		Decreased BW		Decreased BW	HEAST	HEAST	HEAST	HEAST	4-FY90
Phenols(Total) *	ND	6.00E-01 (b)	ND	6.00E-01 (b)	NA	Reduced Fetal BW	NA	Reduced Fetal BW	HEAST	HEAST	IRIS	IRIS	4-FY90/3-91
Potassium													
Propylbenzene	ND	4.00E-01	ND	4.00E-01					ECAO	ECAO	ECAO	ECAO	4-91
Pyrene	ND	3.00E-01	ND	3.00E-02	NA	Kidney	NA	Kidney	HEAST	HEAST	HEAST	HEAST	4-FY90
Sodium													
Styrene	ND	2.00E+00	ND	2.00E-01	NA	Blood,Liver	NA	Blood,Liver	HEAST	HEAST	HEAST	IRIS	4-FY90/9-90
Tetrachloroethene	ND	1.00E-01	ND	1.00E-02	NA	Liver	NA	Liver	HEAST	HEAST	HEAST	IRIS	4-FY90/3-88
Toluene	5.71E-01 (a)	2.00E+00	5.71E-01 (a)	2.00E-01	CNS,Eyes,Nose	Liver,Kidney	CNS,Eyes,Nose	Liver,Kidney	HEAST	HEAST	HEAST	IRIS	4-FY90/8-90
1,1,1-Trichloroethane	3.00E+00	9.00E-01	3.00E-01	9.00E-02	Liver	Liver	Liver	Liver	HEAST	HEAST	HEAST	IRIS	4-FY90/9-90
1,2,4-Trimethylbenzene	Data inadequate for quantitative risk assessment (HEAST)												
1,3,5-Trimethylbenzene	Data inadequate for quantitative risk assessment (HEAST)												
Vanadium	ND	7.00E-03	ND	7.00E-03	NA	None observed	NA	None observed	HEAST	HEAST	HEAST	HEAST	4-FY90
Xylenes, Total	8.57E-02	4.00E+00	8.57E-02	2.00E+00	CNS,Nose,Throat	None	CNS,Nose,Throat	BW & hyperactivity	HEAST	HEAST	IRIS	IRIS	4-FY90/FY91
Zinc	ND	2.00E-01	ND	2.00E-01	NA	Anemia	NA	Anemia	HEAST	HEAST	HEAST	HEAST	4-FY90
Carbon Tetrachloride (d)	ND	7.00E-03	ND	7.00E-04	NA	Liver Lesions	NA	Liver Lesions	HEAST	HEAST	HEAST	IRIS	4-FY90/3-91
Chlordane (d)	NA	6.00E-05	ND	6.00E-05	NA	Liver	NA	Liver	HEAST	HEAST	HEAST	IRIS	4-FY90/7-89

* - Phenol toxicity values are used.
** - Calculated by analogy to antimony by correcting for differences in molecular weight.
a - Converted from inhalation Rfc (mg/m^3).
b - Developmental effects have been used as the basis of calculation.
c - Toxicity values based on Oral Rfd for naphthalene (HEAST 4-FY90).
d - Refer to Table 6-21 for carcinogenic effects.
e - Rfd is based on water.

BW - Body Weight
BP - Blood Pressure
CNS - Central Nervous System.
GI - Gastro-Intestinal
ND - Not Determined.
NA - Not Applicable.

IRIS - Integrated Risk Information System. Date indicates when last updated by EPA. Access to IRIS was March, April and August 1991.
HEAST - Health Effects Summary Tables. Date indicates quarter and fiscal year for which table was published.

TABLE 6-23

INGESTION OF CARCINOGENIC CHEMICALS IN DRINKING WATER
CANCER RISK – CURRENT USE

CHEMICAL	INTAKE (mg/kg-day)		SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK (unitless)	
	ADULT	CHILD	ORAL	ADULT	CHILD
Benzene	1.89E-09	3.52E-10	2.90E-02	5.47E-11	1.02E-11
Tetrachloroethene	7.35E-10	1.37E-10	5.10E-02	3.75E-11	6.99E-12
Trichloroethene	2.45E-10	4.57E-11	1.10E-02	2.69E-12	5.03E-13
1,4-Dichlorobenzene	6.89E-10	1.29E-10	2.40E-02	1.65E-11	3.09E-12
1,1-Dichloroethane	2.13E-09	3.97E-10	ND	ND	ND
1,2-Dichloroethane	2.45E-10	4.57E-11	9.10E-02	2.23E-11	4.16E-12
Chloromethane	3.33E-09	6.21E-10	1.30E-02	4.33E-11	8.08E-12
Styrene	6.18E-09	1.15E-09	3.00E-03	1.85E-11	3.46E-12
Butylbenzylphthalate	8.64E-09	1.61E-09	NA	NA	NA
Bis(2-ethylhexyl)phthalate	3.33E-11	6.21E-12	1.40E-02	4.66E-13	8.70E-14
gamma-BHC	4.97E-09	9.27E-10	1.30E+00	6.46E-09	1.21E-09
Arsenic	7.47E-09	1.39E-09	1.75E+00	1.31E-08	2.44E-09
Cadmium	5.67E-09	1.06E-09	ND	ND	ND
Lead	5.86E-06	1.09E-06	NA	NA	NA
			TOTAL CANCER RISK:	1.97E-08	3.68E-09

TABLE 6–24

INHALATION OF AIRBORNE (VAPOR PHASE) CARCINOGENIC CHEMICALS VOLATILIZING IN THE SHOWER CANCER RISK – CURRENT USE

CHEMICAL	INTAKE (mg/kg-day)		SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK (unitless)	
	ADULT	CHILD	INHALATION	ADULT	CHILD
Benzene	9.65E-09	4.50E-09	2.90E-02	2.80E-10	1.31E-10
Tetrachloroethene	3.24E-09	1.51E-09	5.20E-07	1.68E-15	7.86E-16
Trichloroethene	1.25E-09	5.85E-10	1.70E-02	2.13E-11	9.95E-12
1,2-Dichloroethane	1.24E-09	5.77E-10	9.10E-02	1.12E-10	5.25E-11
Chloromethane	1.87E-08	8.73E-09	6.30E-03	1.18E-10	5.50E-11
Styrene	3.17E-09	1.48E-09	2.00E-03	6.33E-12	2.95E-12
			TOTAL CANCER RISK:	5.38E-10	2.51E-10

TABLE 6-25

INGESTION OF CARCINOGENIC CHEMICALS IN SOILS
CANCER RISK – CURRENT USE

CHEMICAL	INTAKE (mg/kg-day)			SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK (unitless)		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ORAL	ADULT TRESPASSER	CHILD TRESPASSER	WORKER
1,4-Dichlorobenzene	4.20E-08	5.37E-08	1.05E-07	2.40E-02	1.01E-09	1.29E-09	2.52E-09
N-nitrosodiphenylamine	1.85E-08	2.36E-08	4.61E-08	4.90E-03	9.04E-11	1.16E-10	2.26E-10
Benzo(a)anthracene	3.35E-08	4.29E-08	8.39E-08	1.15E+01	3.86E-07	4.93E-07	9.64E-07
Chrysene	3.79E-08	4.85E-08	9.48E-08	1.15E+01	4.36E-07	5.57E-07	1.09E-06
Bis(2-ethylhexyl)phthalate	4.78E-08	6.11E-08	1.20E-07	1.40E-02	6.69E-10	8.56E-10	1.67E-09
Benzo(b)fluoranthene	2.79E-08	3.57E-08	6.98E-08	1.15E+01	3.21E-07	4.11E-07	8.03E-07
Benzo(k)fluoranthene	2.73E-08	3.49E-08	6.82E-08	1.15E+01	3.14E-07	4.01E-07	7.85E-07
Benzo(a)pyrene	2.68E-08	3.43E-08	6.71E-08	1.15E+01	3.09E-07	3.95E-07	7.72E-07
Indeno(1,2,3-cd)pyrene	2.35E-08	3.00E-08	5.87E-08	1.15E+01	2.70E-07	3.45E-07	6.75E-07
Benzene	2.57E-09	3.28E-09	6.42E-09	2.90E-02	7.45E-11	9.52E-11	1.86E-10
1,1,2,2-Tetrachloroethane	3.35E-10	4.29E-10	8.39E-10	2.00E-01	6.71E-11	8.58E-11	1.68E-10
Dieldrin	5.70E-10	7.29E-10	1.43E-09	1.60E+01	9.12E-09	1.17E-08	2.28E-08
Chlordane	3.35E-09	4.29E-09	8.39E-09	1.30E+00	4.36E-09	5.58E-09	1.09E-08
Heptachlor Epoxide	2.93E-09	3.75E-09	7.33E-09	9.10E+00	2.67E-08	3.41E-08	6.67E-08
Beryllium	4.03E-08	5.15E-08	1.01E-07	4.30E+00	1.73E-07	2.21E-07	4.33E-07
			TOTAL CANCER RISK:		2.25E-06	2.88E-06	5.63E-06

TABLE 6–26

DERMAL CONTACT WITH CARCINOGENIC CHEMICALS IN SOIL
CANCER RISK – CURRENT USE

CHEMICAL	ABSORBED DOSE (mg/kg-day)			SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK (unitless)		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	ABSORBED	ADULT TRESPASSER	CHILD TRESPASSER	WORKER
1,4-Dichlorobenzene	8.99E-09	6.97E-08	8.55E-08	2.40E-02	2.16E-10	1.67E-09	2.05E-09
N-nitrosodiphenylamine	3.95E-09	3.06E-08	3.76E-08	4.90E-03	1.93E-11	1.50E-10	1.84E-10
Butylbenzylphthalate	5.74E-09	4.45E-08	5.46E-08	NA	NA	NA	NA
Benzo(a)anthracene	7.18E-09	5.56E-08	6.83E-08	1.15E+01	8.26E-08	6.40E-07	7.85E-07
Chrysene	8.11E-09	6.29E-08	7.72E-08	1.15E+01	9.33E-08	7.23E-07	8.87E-07
Bis(2-ethylhexyl)phthalate	1.02E-08	7.93E-08	9.73E-08	1.40E-02	1.43E-10	1.11E-09	1.36E-09
Benzo(b)fluoranthene	5.98E-09	4.63E-08	5.69E-08	1.15E+01	6.88E-08	5.33E-07	6.54E-07
Benzo(k)fluoranthene	5.84E-09	4.53E-08	5.56E-08	1.15E+01	6.72E-08	5.21E-07	6.39E-07
Benzo(a)pyrene	5.74E-09	4.45E-08	5.46E-08	1.15E+01	6.61E-08	5.12E-07	6.28E-07
Indeno(1,2,3-cd)pyrene	5.03E-09	3.90E-08	4.78E-08	1.15E+01	5.78E-08	4.48E-07	5.50E-07
Benzene	5.50E-10	4.26E-09	5.23E-09	2.90E-02	1.59E-11	1.24E-10	1.52E-10
1,1,2,2-Tetrachloroethane	7.18E-11	5.56E-10	6.83E-10	2.00E-01	1.44E-11	1.11E-10	1.37E-10
Dieldrin	1.22E-10	9.46E-10	1.16E-09	1.60E+01	1.95E-09	1.51E-08	1.86E-08
Chlordane	7.18E-10	5.56E-09	6.83E-09	1.30E+00	9.33E-10	7.23E-09	8.88E-09
Heptachlor Epoxide	6.27E-10	4.86E-09	5.97E-09	9.10E+00	5.71E-09	4.42E-08	5.43E-08
Beryllium	8.62E-09	6.68E-08	8.20E-08	4.30E+00	3.70E-08	2.87E-07	3.52E-07
Cadmium	6.10E-08	4.73E-07	5.81E-07	ND	ND	ND	ND
				TOTAL CANCER RISK:	4.82E-07	3.73E-06	4.58E-06

TABLE 6-27

INHALATION OF AIRBORNE (VAPOR PHASE) CARCINOGENIC CHEMICALS VOLATILIZING FROM THE LANDFILL CANCER RISK – CURRENT USE

CHEMICAL	INTAKE (mg/kg-day)			SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK (unitless)		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	INHALATION	ADULT TRESPASSER	CHILD TRESPASSER	WORKER
Benzene	2.57E-05	1.36E-04	5.13E-04	2.90E-02	7.44E-07	3.96E-06	1.49E-05
Tetrachloroethene	3.76E-06	2.00E-05	7.52E-05	5.20E-07	1.96E-12	1.04E-11	3.91E-11
Styrene	6.76E-07	3.60E-06	1.35E-05	2.00E-03	1.35E-09	7.20E-09	2.71E-08
Methylene Chloride	3.91E-06	2.08E-05	7.81E-05	4.70E-07	1.84E-12	9.77E-12	3.67E-11
Carbon Tetrachloride	8.48E-07	4.51E-06	1.70E-05	1.30E-01	1.10E-07	5.86E-07	2.20E-06
			TOTAL CANCER RISK		8.55E-07	4.55E-06	1.71E-05

TABLE 6-28

INGESTION OF CARCINOGENIC CHEMICALS IN DRINKING WATER
CANCER RISK – FUTURE USE

CHEMICAL	INTAKE (mg/kg-day)			SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK (unitless)		
	ADULT	CHILD	WORKER	ORAL	ADULT	CHILD	WORKER
Benzene	1.89E-05	5.87E-06	1.29E-05	2.90E-02	5.47E-07	1.70E-07	3.75E-07
Tetrachloroethene	7.35E-06	2.29E-06	5.03E-06	5.10E-02	3.75E-07	1.17E-07	2.57E-07
Trichloroethene	2.45E-06	7.62E-07	1.68E-06	1.10E-02	2.69E-08	8.38E-09	1.85E-08
1,4-Dichlorobenzene	6.89E-06	2.14E-06	4.72E-06	2.40E-02	1.65E-07	5.14E-08	1.13E-07
1,2-Dichloroethane	2.45E-06	7.62E-07	1.68E-06	9.10E-02	2.23E-07	6.93E-08	1.53E-07
Chloromethane	3.33E-05	1.04E-05	2.28E-05	1.30E-02	4.33E-07	1.35E-07	2.96E-07
Styrene	7.35E-06	2.29E-06	5.03E-06	3.00E-03	2.20E-08	6.87E-09	1.51E-08
Bis(2-ethylhexyl)phthalate	8.64E-05	2.69E-05	5.91E-05	1.40E-02	1.21E-06	3.77E-07	8.28E-07
gamma-BHC	3.33E-07	1.04E-07	2.28E-07	1.30E+00	4.33E-07	1.35E-07	2.96E-07
Arsenic	5.67E-05	1.76E-05	3.88E-05	1.75E+00	9.92E-05	3.08E-05	6.80E-05
				TOTAL CANCER RISK:	1.03E-04	3.19E-05	7.03E-05

TABLE 6-29

INHALATION OF AIRBORNE (VAPOR PHASE) CARCINOGENIC CHEMICALS VOLATILIZING IN THE SHOWER CANCER RISK – FUTURE USE

CHEMICAL	INTAKE (mg/kg-day)		SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK (unitless)	
	ADULT	CHILD	INHALATION	ADULT	CHILD
Benzene	9.65E-05	2.50E-05	2.90E-02	2.80E-06	7.25E-07
Tetrachloroethene	3.24E-05	8.40E-06	5.20E-07	1.68E-11	4.37E-12
Trichloroethene	1.25E-05	3.25E-06	1.70E-02	2.13E-07	5.53E-08
1,2-Dichloroethane	1.24E-05	3.20E-06	9.10E-02	1.12E-06	2.91E-07
Chloromethane	1.87E-04	4.85E-05	6.30E-03	1.18E-06	3.06E-07
Styrene	3.17E-05	8.21E-06	2.00E-03	6.33E-08	1.64E-08
			TOTAL CANCER RISK:	5.38E-06	1.39E-06

TABLE 6-30

INGESTION OF CARCINOGENIC CHEMICALS IN SOILS
CANCER RISK - FUTURE USE

CHEMICAL	INTAKE (mg/kg-day)			SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK (unitless)		
	ADULT	CHILD	WORKER	ORAL	ADULT	CHILD	WORKER
1,4-Dichlorobenzene	1.53E-07	2.39E-07	1.05E-07	2.40E-02	3.68E-09	5.74E-09	2.52E-09
N-nitrosodiphenylamine	6.73E-08	1.05E-07	4.61E-08	4.90E-03	3.30E-10	5.15E-10	2.26E-10
Benzo(a)anthracene	1.22E-07	1.90E-07	8.39E-08	1.15E+01	1.41E-06	2.19E-06	9.64E-07
Chrysene	1.38E-07	2.15E-07	9.48E-08	1.15E+01	1.59E-06	2.47E-06	1.09E-06
Bis(2-ethylhexyl)phthalate	1.75E-07	2.72E-07	1.20E-07	1.40E-02	2.44E-09	3.81E-09	1.67E-09
Benzo(b)fluoranthene	1.02E-07	1.59E-07	6.98E-08	1.15E+01	1.17E-06	1.83E-06	8.03E-07
Benzo(k)fluoranthene	9.96E-08	1.55E-07	6.82E-08	1.15E+01	1.15E-06	1.78E-06	7.85E-07
Benzo(a)pyrene	9.80E-08	1.52E-07	6.71E-08	1.15E+01	1.13E-06	1.75E-06	7.72E-07
Indeno(1,2,3-cd)pyrene	8.57E-08	1.33E-07	5.87E-08	1.15E+01	9.86E-07	1.53E-06	6.75E-07
Benzene	9.37E-09	1.46E-08	6.42E-09	2.90E-02	2.72E-10	4.23E-10	1.86E-10
1,1,2,2-Tetrachloroethane	1.22E-09	1.90E-09	8.39E-10	2.00E-01	2.45E-10	3.80E-10	1.68E-10
Dieldrin	2.08E-09	3.24E-09	1.43E-09	1.60E+01	3.33E-08	5.18E-08	2.28E-08
Chlordane	1.22E-08	1.90E-08	8.39E-09	1.30E+00	1.59E-08	2.47E-08	1.09E-08
Heptachlor Epoxide	1.07E-08	1.67E-08	7.33E-09	9.10E+00	9.73E-08	1.52E-07	6.67E-08
Beryllium	1.47E-07	2.29E-07	1.01E-07	4.30E+00	6.32E-07	9.85E-07	4.33E-07
			TOTAL CANCER RISK:		8.22E-06	1.28E-05	5.63E-06

TABLE 6-31

DERMAL CONTACT WITH CARCINOGENIC CHEMICALS IN SOIL
CANCER RISK - FUTURE USE

CHEMICAL	ABSORBED DOSE (mg/kg-day)			SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK (unitless)		
	ADULT	CHILD	WORKER	ABSORBED	ADULT	CHILD	WORKER
1,4-Dichlorobenzene	3.28E-08	9.84E-08	8.55E-08	2.40E-02	7.88E-10	2.36E-09	2.05E-09
N-nitrosodiphenylamine	1.44E-08	4.32E-08	3.76E-08	4.90E-03	7.06E-11	2.12E-10	1.84E-10
Benzo(a)anthracene	2.62E-08	7.85E-08	6.83E-08	1.15E+01	3.01E-07	9.03E-07	7.85E-07
Chrysene	2.96E-08	8.88E-08	7.72E-08	1.15E+01	3.41E-07	1.02E-06	8.87E-07
Bis(2-ethylhexyl)phthalate	3.74E-08	1.12E-07	9.73E-08	1.40E-02	5.23E-10	1.57E-09	1.36E-09
Benzo(b)fluoranthene	2.18E-08	6.54E-08	5.69E-08	1.15E+01	2.51E-07	7.52E-07	6.54E-07
Benzo(k)fluoranthene	2.13E-08	6.39E-08	5.56E-08	1.15E+01	2.45E-07	7.35E-07	6.39E-07
Benzo(a)pyrene	2.10E-08	6.28E-08	5.46E-08	1.15E+01	2.41E-07	7.22E-07	6.28E-07
Indeno(1,2,3-cd)pyrene	1.83E-08	5.50E-08	4.78E-08	1.15E+01	2.11E-07	6.33E-07	5.50E-07
Benzene	2.01E-09	6.01E-09	5.23E-09	2.90E-02	5.82E-11	1.74E-10	1.52E-10
1,1,2,2-Tetrachloroethane	2.62E-10	7.85E-10	6.83E-10	2.00E-01	5.24E-11	1.57E-10	1.37E-10
Dieldrin	4.46E-10	1.34E-09	1.16E-09	1.60E+01	7.13E-09	2.14E-08	1.86E-08
Chlordane	2.62E-09	7.85E-09	6.83E-09	1.30E+00	3.41E-09	1.02E-08	8.88E-09
Heptachlor Epoxide	2.29E-09	6.86E-09	5.97E-09	9.10E+00	2.08E-08	6.24E-08	5.43E-08
Beryllium	3.14E-08	9.43E-08	8.20E-08	4.30E+00	1.35E-07	4.05E-07	3.52E-07
			TOTAL CANCER RISK:		1.76E-06	5.27E-06	4.58E-06

TABLE 6-32

INHALATION OF AIRBORNE (VAPOR PHASE) CARCINOGENIC CHEMICALS
VOLATILIZING FROM THE LANDFILL
CANCER RISK - FUTURE USE

CHEMICAL	INTAKE (mg/kg-day)			SLOPE FACTOR (mg/kg-day)^-1	CANCER RISK (unitless)		
	ADULT	CHILD	WORKER	INHALATION	ADULT	CHILD	WORKER
Benzene	1.50E-03	9.30E-04	5.13E-04	2.90E-02	4.34E-05	2.70E-05	1.49E-05
Tetrachloroethene	2.20E-04	1.36E-04	7.52E-05	5.20E-07	1.14E-10	7.07E-11	3.91E-11
Styrene	3.95E-05	2.46E-05	1.35E-05	2.00E-03	7.90E-08	4.92E-08	2.71E-08
Methylene Chloride	2.28E-04	1.42E-04	7.81E-05	4.70E-07	1.07E-10	6.67E-11	3.67E-11
Carbon Tetrachloride	4.95E-05	3.08E-05	1.70E-05	1.30E-01	6.44E-06	4.00E-06	2.20E-06
				TOTAL CANCER RISK:	5.00E-05	3.10E-05	1.71E-05

TABLE 6-33

INGESTION OF NONCARCINOGENIC CHEMICALS IN DRINKING WATER
HAZARD INDICES - CURRENT USE

CHEMICAL	INTAKE (mg/kg-day)		TOXICITY VALUES - ORAL (mg/kg-day)		HAZARD QUOTIENT (unitless)	
	ADULT	CHILD	SUBCHRONIC	CHRONIC	ADULT	CHILD
Isopropylbenzene	2.43E-09	2.72E-09	4.00E-01	4.00E-02	6.07E-08	6.80E-09
Total Xylene	4.50E-09	5.04E-09	4.00E+00	2.00E+00	2.25E-09	1.26E-09
Dichlorodifluoromethane	5.71E-10	6.40E-10	9.00E-01	2.00E-01	2.86E-09	7.11E-10
Acetone	1.91E-08	2.14E-08	1.00E+00	1.00E-01	1.91E-07	2.14E-08
Toluene	2.86E-09	3.20E-09	2.00E+00	2.00E-01	1.43E-08	1.60E-09
cis-1,2-Dichloroethene	2.57E-09	2.88E-09	1.00E-01	1.00E+02	2.57E-11	2.88E-08
Carbon Disulfide	4.37E-09	4.90E-09	1.00E-01	1.00E-01	4.37E-08	4.90E-08
Chlorobenzene	6.67E-09	7.47E-09	2.00E-01	2.00E-02	3.33E-07	3.73E-08
1,2-Dichlorobenzene	1.70E-09	1.90E-09	9.00E-01	9.00E-02	1.89E-08	2.11E-09
4-Methyl-2-Pentanone	8.57E-09	9.60E-09	5.00E-01	5.00E-02	1.71E-07	1.92E-08
Naphthalene	2.54E-09	2.85E-09	4.00E-02	4.00E-03	6.36E-07	7.12E-08
Diethylphthalate	1.42E-08	1.59E-08	8.00E+00	8.00E-01	1.78E-08	1.99E-09
Di-n-octylphthalate	3.66E-08	4.10E-08	2.00E-02	2.00E-02	1.83E-06	2.05E-06
Pyrene	8.57E-09	9.60E-09	3.00E-01	3.00E-02	2.86E-07	3.20E-08
Manganese	1.37E-05	1.53E-05	1.00E-01	1.00E-01	1.37E-04	1.53E-04
Mercury	1.20E-09	1.34E-09	3.00E-04	3.00E-04	3.99E-06	4.47E-06
Vanadium	3.25E-08	3.64E-08	7.00E-03	7.00E-03	4.64E-06	5.20E-06
Tetrachloroethene	1.71E-09	1.92E-09	1.00E-01	1.00E-02	1.71E-07	1.92E-08
1,1-Dichloroethane	4.96E-09	5.56E-09	1.00E+00	1.00E-01	4.96E-08	5.56E-09
Styrene	1.71E-09	1.92E-09	2.00E+00	2.00E-01	8.57E-09	9.60E-10
Butylbenzylphthalate	1.44E-08	1.62E-08	2.00E+00	2.00E-01	7.21E-08	8.08E-09
Bis(2-ethylhexyl)phthalate	2.02E-08	2.26E-08	2.00E-02	2.00E-02	1.01E-06	1.13E-06
gamma-BHC	7.77E-11	8.70E-11	3.00E-03	3.00E-04	2.59E-07	2.90E-08
Arsenic	1.32E-08	1.48E-08	1.00E-03	1.00E-03	1.32E-05	1.48E-05
Chromium(III)	4.23E-07	4.74E-07	1.00E+01	1.00E+00	4.23E-07	4.74E-08
Barium	2.90E-07	4.06E-07	7.00E-02	5.00E-02	5.80E-06	5.80E-06
Nickel	1.76E-07	2.47E-07	2.00E-02	2.00E-02	8.80E-06	1.24E-05
Zinc	7.45E-08	1.04E-07	2.00E-01	2.00E-01	3.73E-07	5.20E-07
			TOTAL HAZARD INDEX		1.79E-04	2.00E-04

RAM 001 0824

TABLE 6-34

INHALATION OF AIRBORNE (VAPOR PHASE) NONCARCINOGENIC CHEMICALS VOLATILIZING IN THE SHOWER HAZARD INDICES – CURRENT USE

CHEMICAL	INTAKE (mg/kg-day)		TOXICITY VALUES - INHALATION (mg/kg-day)		HAZARD QUOTIENT (unitless)	
	ADULT	CHILD	SUBCHRONIC	CHRONIC	ADULT	CHILD
Tetrachloroethene	7.56E-09	2.12E-08	ND	ND	ND	ND
1,4-Dichlorobenzene	6.86E-09	1.92E-08	2.00E-01	2.00E-01	3.43E-08	9.60E-08
Isopropylbenzene	1.01E-08	2.84E-08	2.57E-02	2.57E-02	3.94E-07	1.10E-06
Total Xylenes	1.91E-08	5.36E-08	8.57E-02	8.57E-02	2.23E-07	6.25E-07
Dichlorodifluoromethane	3.12E-09	8.74E-09	5.00E-01	5.00E-02	6.24E-08	1.75E-08
Acetone	5.17E-08	1.45E-07	ND	ND	ND	ND
Toluene	1.35E-08	3.77E-08	5.71E-01	5.71E-01	2.36E-08	6.60E-08
1,1-Dichloroethane	2.89E-08	8.08E-08	1.00E+00	1.00E-01	2.89E-07	8.08E-08
p-Isopropyltoluene	7.58E-09	2.12E-08	NI	NI	NI	NI
cis-1,2-Dichloroethene	1.17E-08	3.29E-08	ND	ND	ND	ND
1,2,4-Trimethylbenzene	6.60E-09	1.85E-08	NI	NI	NI	NI
Carbon Disulfide	2.59E-08	5.29E-06	ND	ND	ND	ND
Propylbenzene	5.75E-09	1.61E-08	NI	NI	NI	NI
Chlorobenzene	3.18E-08	8.91E-08	5.00E-02	5.00E-03	6.36E-06	1.78E-06
Styrene	7.39E-09	2.07E-08	ND	ND	ND	ND
1,2-Dichlorobenzene	7.31E-09	2.05E-08	4.00E-01	4.00E-02	1.83E-07	5.11E-08
1,3,5-Trimethylbenzene	9.58E-09	2.68E-08	NI	NI	NI	NI
4-Methyl-2-Pentanone	1.94E-08	5.45E-08	2.00E-01	2.00E-02	9.72E-07	2.72E-07
tert-Butylbenzene	6.21E-09	1.74E-08	NI	NI	NI	NI
			TOTAL HAZARD INDEX:		8.54E-06	4.09E-06

TABLE 6-35

INGESTION OF NONCARCINOGENIC CHEMICALS IN SOILS
HAZARD INDICES - CURRENT USE

CHEMICAL	INTAKE (mg/kg-day)			TOXICITY VALUES - ORAL (mg/kg-day)		HAZARD QUOTIENT (unitless)		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	SUBCHRONIC	CHRONIC	ADULT TRESPASSER	CHILD TRESPASSER	WORKER
1,2-Dichlorobenzene	3.68E-08	2.82E-07	9.20E-08	9.00E-01	9.00E-02	4.09E-07	3.14E-07	1.02E-06
Benzoic Acid	8.22E-08	6.31E-07	2.05E-07	4.00E+00	4.00E+00	2.05E-08	1.58E-07	5.14E-08
Naphthalene	1.89E-07	1.45E-06	4.72E-07	4.00E-02	4.00E-03	4.72E-05	3.62E-05	1.18E-04
2-Methylnaphthalene	7.81E-08	5.99E-07	1.95E-07	4.00E-02	4.00E-03	1.95E-05	1.50E-05	4.88E-05
Acenaphthene	7.44E-08	5.71E-07	1.86E-07	6.00E-01	6.00E-02	1.24E-06	9.51E-07	3.10E-06
Fluorene	6.65E-08	5.10E-07	1.66E-07	4.00E-01	4.00E-02	1.66E-06	1.28E-06	4.16E-06
Phenanthrene	9.45E-08	7.25E-07	2.36E-07	4.00E-02	4.00E-03	2.36E-05	1.81E-05	5.91E-05
Anthracene	1.68E-08	1.29E-07	4.21E-08	3.00E+00	3.00E-01	5.61E-08	4.30E-08	1.40E-07
Fluoranthene	9.71E-08	7.45E-07	2.43E-07	4.00E-01	4.00E-02	2.43E-06	1.86E-06	6.07E-06
Pyrene	8.02E-08	6.15E-07	2.00E-07	3.00E-01	3.00E-02	2.67E-06	2.05E-06	6.68E-06
Di-n-octylphthalate	1.68E-08	1.29E-07	4.21E-08	2.00E-02	2.00E-02	8.41E-07	6.46E-06	2.10E-06
Benzo(g,h,i)perylene	5.09E-08	3.90E-07	1.27E-07	4.00E-02	4.00E-03	1.27E-05	9.76E-06	3.18E-05
2-Butanone	2.52E-08	1.93E-07	6.29E-08	5.00E-01	5.00E-02	5.03E-07	3.86E-07	1.26E-06
Chlorobenzene	9.16E-08	7.02E-07	2.29E-07	2.00E-01	2.00E-02	4.58E-06	3.51E-06	1.14E-05
Ethylbenzene	3.31E-08	2.54E-07	8.28E-08	1.00E+00	1.00E-01	3.31E-07	2.54E-07	8.28E-07
Total xylenes	7.17E-08	5.50E-07	1.79E-07	4.00E+00	2.00E+00	3.58E-08	1.37E-07	8.96E-08
Total phenols	5.19E-07	3.98E-06	1.30E-06	6.00E-01	6.00E-01	8.65E-07	6.64E-06	2.16E-06
Butylbenzylphalate	6.26E-08	4.80E-07	1.57E-07	2.00E+00	2.00E-01	3.13E-07	2.40E-07	7.83E-07
Bis(2-ethylhexyl)phthalate	1.12E-07	8.56E-07	2.79E-07	2.00E-02	2.00E-02	5.58E-06	4.28E-05	1.39E-05
Dieldrin	1.33E-09	1.02E-08	3.33E-09	5.00E-05	5.00E-05	2.66E-05	2.04E-04	6.65E-05
Beryllium	9.39E-08	7.21E-07	2.35E-07	5.00E-03	5.00E-03	1.88E-05	1.44E-04	4.70E-05
Cadmium	6.65E-07	5.10E-06	1.66E-06	ND	5.00E-04	1.33E-03	ND	3.33E-03
Mercury	3.08E-08	2.37E-07	7.71E-08	3.00E-04	3.00E-04	1.03E-04	7.90E-04	2.57E-04
			TOTAL HAZARD INDEX:			1.60E-03	1.28E-03	4.01E-03

TABLE 6-36

DERMAL CONTACT WITH NONCARCINOGENIC CHEMICALS IN SOIL
HAZARD INDICES – CURRENT USE

CHEMICAL	ABSORBED DOSE (mg/kg-day)			TOXICITY VALUES – ABSORBED (mg/kg-day)		HAZARD QUOTIENT (unitless)		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	SUBCHRONIC	CHRONIC	ADULT TRESPASSER	CHILD TRESPASSER	WORKER
1,2-Dichlorobenzene	7.87E-09	3.66E-07	7.49E-08	9.00E-01	9.00E-02	8.75E-08	4.07E-07	8.32E-07
Benzoic Acid	1.76E-08	8.18E-07	1.67E-07	4.00E+00	4.00E+00	4.40E-09	2.04E-07	4.18E-08
Naphthalene	4.04E-08	1.88E-06	3.84E-07	4.00E-02	4.00E-03	1.01E-05	4.70E-05	9.61E-05
2-Methylnaphthalene	1.67E-08	7.78E-07	1.59E-07	4.00E-02	4.00E-03	4.18E-06	1.94E-05	3.98E-05
Acenaphthene	1.59E-08	7.40E-07	1.51E-07	6.00E-01	6.00E-02	2.65E-07	1.23E-06	2.52E-06
Fluorene	1.42E-08	6.62E-07	1.35E-07	4.00E-01	4.00E-02	3.56E-07	1.66E-06	3.39E-06
Phenanthrene	2.02E-08	9.40E-07	1.92E-07	4.00E-02	4.00E-03	5.06E-06	2.35E-05	4.81E-05
Anthracene	3.60E-09	1.67E-07	3.43E-08	3.00E+00	3.00E-01	1.20E-08	5.57E-08	1.14E-07
Fluoranthene	2.08E-08	9.66E-07	1.98E-07	4.00E-01	4.00E-02	5.20E-07	2.42E-06	4.94E-06
Pyrene	1.72E-08	7.98E-07	1.63E-07	3.00E-01	3.00E-02	5.72E-07	2.66E-06	5.44E-06
Di-n-octylphthalate	3.60E-09	1.67E-07	3.43E-08	2.00E-02	2.00E-02	1.80E-07	8.37E-06	1.71E-06
Benzo(g,h,i)perylene	1.09E-08	5.06E-07	1.04E-07	4.00E-02	4.00E-03	2.72E-06	1.27E-05	2.59E-05
2-Butanone	5.39E-09	2.50E-07	5.12E-08	5.00E-01	5.00E-02	1.08E-07	5.01E-07	1.02E-06
Chlorobenzene	1.96E-08	9.11E-07	1.86E-07	2.00E-01	2.00E-02	9.80E-07	4.56E-06	9.32E-06
Ethylbenzene	7.09E-09	3.29E-07	6.74E-08	1.00E+00	1.00E-01	7.09E-08	3.29E-07	6.74E-07
Total xylenes	1.53E-08	7.13E-07	1.46E-07	4.00E+00	2.00E+00	7.67E-09	1.78E-07	7.29E-08
Total phenols	1.11E-07	5.17E-06	1.06E-06	6.00E-01	6.00E-01	1.85E-07	8.61E-06	1.76E-06
Butylbenzylphalate	1.34E-08	6.23E-07	1.27E-07	2.00E+00	2.00E-01	6.70E-08	3.12E-07	6.37E-07
Bis(2-ethylhexyl)phthalate	2.39E-08	1.11E-06	2.27E-07	2.00E-02	2.00E-02	1.19E-06	5.55E-05	1.14E-05
Dieldrin	2.85E-10	1.32E-08	2.71E-09	5.00E-05	5.00E-05	5.70E-06	2.65E-04	5.42E-05
Beryllium	2.01E-08	9.35E-07	1.91E-07	5.00E-03	5.00E-03	4.02E-06	1.87E-04	3.82E-05
Cadmium	1.42E-07	6.62E-06	1.35E-06	ND	5.00E-04	2.85E-04	ND	2.71E-03
Mercury	6.60E-09	3.07E-07	6.28E-08	3.00E-04	3.00E-04	2.20E-05	2.20E-05	2.09E-04
				TOTAL HAZARD INDEX:		3.43E-04	6.63E-04	3.26E-03

TABLE 6-37

INHALATION OF AIRBORNE (VAPOR PHASE) NONCARCINOGENIC CHEMICALS VOLATILIZING FROM THE LANDFILL HAZARD INDICES – CURRENT USE

CHEMICAL	INTAKE (mg/kg-day)			TOXICITY VALUES - INHALATION (mg/kg-day)		HAZARD QUOTIENT (unitless)		
	ADULT TRESPASSER	CHILD TRESPASSER	WORKER	SUBCHRONIC	CHRONIC	ADULT TRESPASSER	CHILD TRESPASSER	WORKER
2-Butanone	3.23E-05	1.03E-03	6.46E-04	9.00E-01	9.00E-02	3.59E-04	1.15E-03	7.18E-03
1,1,1-Trichloroethane	5.00E-06	1.59E-04	9.99E-05	3.00E+00	3.00E-01	1.67E-05	5.32E-05	3.33E-04
Chlorobenzene	7.41E-04	2.36E-02	1.48E-02	5.00E-02	5.00E-03	1.48E-01	4.73E-01	2.96E+00
Toluene	5.51E-04	1.76E-02	1.10E-02	5.71E-01	5.71E-01	9.64E-04	3.08E-02	1.93E-02
Xylene (Total)	1.54E-02	4.92E-01	3.08E-01	8.57E-02	8.57E-02	1.80E-01	5.74E+00	3.59E+00
Methylene Chloride	9.12E-06	2.91E-04	1.82E-04	8.57E-01	8.57E-01	1.06E-05	3.39E-04	2.13E-04
				TOTAL HAZARD INDEX:		3.29E-01	6.24E+00	6.58E+00

TABLE 6-38

INGESTION OF NONCARCINOGENIC CHEMICALS IN DRINKING WATER
HAZARD INDICES - FUTURE USE

CHEMICAL	INTAKE (mg/kg-day)			TOXICITY VALUES - ORAL (mg/kg-day)		HAZARD QUOTIENT (unitless)		
	ADULT	CHILD	WORKER	SUBCHRONIC	CHRONIC	ADULT	CHILD	WORKER
Isopropylbenzene	2.43E-05	4.54E-05	1.66E-05	4.00E-01	4.00E-02	6.07E-04	1.14E-04	4.16E-0
Total Xylene	4.50E-05	8.40E-05	3.08E-05	4.00E+00	2.00E+00	2.25E-05	2.10E-05	1.54E-0
Dichlorodifluoromethane	5.71E-06	1.07E-05	3.91E-06	9.00E-01	2.00E-01	2.86E-05	1.19E-05	1.96E-0
Acetone	1.91E-04	3.56E-04	1.31E-04	1.00E+00	1.00E-01	1.91E-03	3.56E-04	1.31E-0
Toluene	2.86E-05	5.33E-05	1.96E-05	2.00E+00	2.00E-01	1.43E-04	2.67E-05	9.78E-0
cis-1,2-Dichloroethene	2.57E-05	4.80E-05	1.76E-05	1.00E-01	1.00E+02	2.57E-07	4.80E-04	1.76E-0
Carbon Disulfide	4.37E-05	8.16E-05	2.99E-05	1.00E-01	1.00E-01	4.37E-04	8.16E-04	2.99E-0
Chlorobenzene	6.67E-05	1.24E-04	4.57E-05	2.00E-01	2.00E-02	3.33E-03	6.20E-04	2.28E-0
1,2-Dichlorobenzene	1.70E-05	3.17E-05	1.16E-05	9.00E-01	9.00E-02	1.89E-04	3.52E-05	1.29E-0
4-Methyl-2-Pentanone	8.57E-05	1.60E-04	5.87E-05	5.00E-01	5.00E-02	1.71E-03	3.20E-04	1.17E-0
Naphthalene	2.54E-05	4.75E-05	1.74E-05	4.00E-02	4.00E-03	6.36E-03	1.19E-03	4.35E-0
Diethylphthalate	1.42E-04	2.65E-04	9.73E-05	8.00E+00	8.00E-01	1.78E-04	3.31E-05	1.22E-0
Di-n-octylphthalate	3.66E-04	6.83E-04	2.51E-04	2.00E-02	2.00E-02	1.83E-02	3.42E-02	1.25E-0
Pyrene	8.57E-05	1.60E-04	5.87E-05	3.00E-01	3.00E-02	2.86E-03	5.33E-04	1.96E-0
Manganese	1.37E-01	2.55E-01	9.36E-02	1.00E-01	1.00E-01	1.37E+00	2.55E+00	9.36E-0
Mercury	1.20E-05	2.24E-05	8.21E-06	3.00E-04	3.00E-04	3.99E-02	7.47E-02	2.74E-0
Vanadium	3.25E-04	6.07E-04	2.23E-04	7.00E-03	7.00E-03	4.64E-02	8.67E-02	3.18E-0
Tetrachloroethene	1.71E-05	3.20E-05	1.17E-05	1.00E-01	1.00E-02	1.71E-03	3.20E-04	1.17E-0
1,1-Dichloroethane	4.96E-05	9.26E-05	3.40E-05	1.00E+00	1.00E-01	4.96E-04	9.26E-05	3.40E-0
Styrene	1.71E-05	3.20E-05	1.17E-05	2.00E+00	2.00E-01	8.57E-05	1.60E-05	5.87E-0
Butylbenzylphthalate	1.44E-04	2.69E-04	9.88E-05	2.00E+00	2.00E-01	7.21E-04	1.35E-04	4.94E-0
Bis(2-ethylhexyl)phthalate	2.02E-04	3.76E-04	1.38E-04	2.00E-02	2.00E-02	1.01E-02	1.88E-02	6.90E-0
gamma-BHC	7.77E-07	1.45E-06	5.32E-07	3.00E-03	3.00E-04	2.59E-03	4.83E-04	1.77E-0
Arsenic	1.32E-04	2.47E-04	9.06E-05	1.00E-03	1.00E-03	1.32E-01	2.47E-01	9.06E-02
Chromium(III)	4.23E-03	7.89E-03	2.90E-03	1.00E+01	1.00E+00	4.23E-03	7.89E-04	2.90E-03
Barium	2.90E-03	5.41E-03	1.99E-03	7.00E-02	5.00E-02	5.80E-02	7.73E-02	3.98E-02
Nickel	1.76E-03	3.29E-03	1.21E-03	2.00E-02	2.00E-02	8.80E-02	1.65E-03	6.05E-02
Zinc	7.45E-04	1.39E-03	5.10E-04	2.00E-01	2.00E-01	3.73E-03	6.95E-03	2.55E-03
				TOTAL HAZARD INDEX		1.79E+00	3.10E+00	1.23E+00

RAM 001 0829

TABLE 6-39

INHALATION OF AIRBORNE (VAPOR PHASE) NONCARCINOGENIC CHEMICALS VOLATILIZING IN THE SHOWER HAZARD INDICES – FUTURE USE

CHEMICAL	INTAKE (mg/kg-day)		TOXICITY VALUES – INHALATION (mg/kg-day)		HAZARD QUOTIENT (unitless)	
	ADULT	CHILD	SUBCHRONIC	CHRONIC	ADULT	CHILD
1,4-Dichlorobenzene	6.90E-05	2.67E-04	2.00E-01	2.00E-01	3.43E-04	1.34E-03
Isopropylbenzene	1.01E-04	3.94E-04	2.57E-02	2.57E-02	3.94E-03	1.53E-02
Total Xylene	1.91E-04	7.44E-04	8.57E-02	8.57E-02	2.23E-03	8.68E-03
Dichlorodifluoromethane	3.10E-05	1.21E-04	5.00E-01	5.00E-02	6.24E-04	2.42E-04
Toluene	1.35E-04	5.24E-04	5.71E-01	5.71E-01	2.36E-04	9.18E-04
1,1-Dichloroethane	2.89E-04	1.12E-03	1.00E+00	1.00E-01	2.89E-03	1.12E-03
Chlorobenzene	3.18E-04	1.24E-03	5.00E-02	5.00E-03	6.36E-02	2.48E-02
1,2-Dichlorobenzene	7.31E-05	2.84E-04	4.00E-01	4.00E-02	1.83E-03	7.10E-04
4-Methyl-2-Pentanone	1.94E-04	7.56E-04	2.00E-01	2.00E-02	9.72E-03	3.78E-03
			TOTAL HAZARD INDEX:		8.54E-02	5.69E-02

TABLE 6-40

INGESTION OF NONCARCINOGENIC CHEMICALS IN SOILS
HAZARD INDICES - FUTURE USE

CHEMICAL	INTAKE (mg/kg-day)			TOXICITY VALUES - ORAL (mg/kg-day)		HAZARD QUOTIENT (unitless)		
	ADULT	CHILD	WORKER	SUBCHRONIC	CHRONIC	ADULT	CHILD	WORKER
1,2-Dichlorobenzene	1.34E-07	1.25E-06	9.20E-08	9.00E-01	9.00E-02	1.49E-06	1.39E-06	1.02E-06
Benzoic Acid	3.00E-07	2.80E-06	2.05E-07	4.00E+00	4.00E+00	7.50E-08	7.00E-07	5.14E-08
Naphthalene	6.89E-07	6.43E-06	4.72E-07	4.00E-02	4.00E-03	1.72E-04	1.61E-04	1.18E-04
2-Methylnaphthalene	2.85E-07	2.66E-06	1.95E-07	4.00E-02	4.00E-03	7.13E-05	6.65E-05	4.88E-05
Acenaphthene	2.71E-07	2.53E-06	1.86E-07	6.00E-01	6.00E-02	4.52E-06	4.22E-06	3.10E-06
Fluorene	2.43E-07	2.27E-06	1.66E-07	4.00E-01	4.00E-02	6.07E-06	5.68E-06	4.16E-06
Phenanthrene	3.45E-07	3.22E-06	2.36E-07	4.00E-02	4.00E-03	8.62E-05	8.05E-05	5.91E-05
Anthracene	6.14E-08	5.73E-07	4.21E-08	3.00E+00	3.00E-01	2.05E-07	1.91E-07	1.40E-07
Fluoranthene	3.54E-07	3.31E-06	2.43E-07	4.00E-01	4.00E-02	8.86E-06	8.28E-06	6.07E-06
Pyrene	2.93E-07	2.13E-06	2.00E-07	3.00E-01	3.00E-02	9.76E-06	7.10E-06	6.68E-06
Di-n-octylphthalate	6.14E-08	5.73E-07	4.21E-08	2.00E-02	2.00E-02	3.07E-06	2.87E-05	2.10E-06
Benzo(g,h,i)perylene	1.86E-07	1.73E-06	1.27E-07	4.00E-02	4.00E-03	4.64E-05	4.33E-05	3.18E-05
2-Butanone	9.19E-08	8.57E-07	6.29E-08	5.00E-01	5.00E-02	1.84E-06	1.71E-06	1.26E-06
Chlorobenzene	3.34E-07	3.12E-06	2.29E-07	2.00E-01	2.00E-02	1.67E-05	1.56E-05	1.14E-05
Ethylbenzene	1.21E-07	1.13E-06	8.28E-08	1.00E+00	1.00E-01	1.21E-06	1.13E-06	8.28E-07
Total xylenes	2.62E-07	2.44E-06	1.79E-07	4.00E+00	2.00E+00	1.31E-07	6.10E-07	8.96E-08
Total phenols	1.90E-06	1.77E-05	1.30E-06	6.00E-01	6.00E-01	3.16E-06	2.95E-05	2.16E-06
Butylbenzylphalate	2.29E-07	2.13E-06	1.57E-07	2.00E+00	2.00E-01	1.14E-06	1.07E-06	7.83E-07
Bis(2-ethylhexyl)phthalate	4.07E-07	3.80E-06	2.79E-07	2.00E-02	2.00E-02	2.04E-05	1.90E-04	1.39E-05
Dieldrin	4.86E-09	4.53E-08	3.33E-09	5.00E-05	5.00E-05	9.71E-05	9.06E-04	6.65E-05
Beryllium	3.43E-07	3.20E-06	2.35E-07	5.00E-03	5.00E-03	6.86E-05	6.40E-04	4.70E-05
Cadmium	2.43E-06	2.27E-05	1.66E-06	ND	5.00E-04	4.86E-03	ND	3.33E-03
Mercury	2.41E-08	1.05E-06	6.28E-08	3.00E-04	3.00E-04	8.03E-05	3.50E-03	2.09E-04
			TOTAL HAZARD INDEX:			5.56E-03	5.69E-03	3.96E-03

TABLE 6-41

DERMAL CONTACT WITH NONCARCINOGENIC CHEMICALS IN SOIL HAZARD INDICES – FUTURE USE

CHEMICAL	ABSORBED DOSE (mg/kg-day)			TOXICITY VALUES - ABSORBED (mg/kg-day)		HAZARD QUOTIENT (unitless)		
	ADULT	CHILD	WORKER	SUBCHRONIC	CHRONIC	ADULT	CHILD	WORKER
1,2-Dichlorobenzene	2.87E-08	5.17E-07	7.49E-08	9.00E-01	9.00E-02	3.19E-07	5.74E-07	8.32E-07
Benzoic Acid	6.42E-08	1.15E-06	1.67E-07	4.00E+00	4.00E+00	1.61E-08	2.88E-07	4.18E-08
Naphthalene	1.47E-07	2.65E-06	3.84E-07	4.00E-02	4.00E-03	3.69E-05	6.63E-05	9.61E-05
2-Methylnaphthalene	6.10E-08	1.10E-06	1.59E-07	4.00E-02	4.00E-03	1.53E-05	2.75E-05	3.98E-05
Acenaphthene	5.81E-08	1.04E-06	1.51E-07	6.00E-01	6.00E-02	9.68E-07	1.73E-06	2.52E-06
Fluorene	5.20E-08	9.35E-07	1.35E-07	4.00E-01	4.00E-02	1.30E-06	2.34E-06	3.39E-06
Phenanthrene	7.38E-08	1.33E-06	1.92E-07	4.00E-02	4.00E-03	1.85E-05	3.33E-05	4.81E-05
Anthracene	1.31E-08	2.36E-07	3.43E-08	3.00E+00	3.00E-01	4.38E-08	7.87E-08	1.14E-07
Fluoranthene	7.59E-08	1.36E-06	1.98E-07	4.00E-01	4.00E-02	1.90E-06	3.40E-06	4.94E-06
Pyrene	6.26E-08	1.13E-06	1.63E-07	3.00E-01	3.00E-02	2.09E-06	3.77E-06	5.44E-06
Di-n-octylphthalate	8.72E-08	1.57E-06	2.27E-07	2.00E-02	2.00E-02	4.36E-06	7.85E-05	1.14E-05
Benzo(g,h,i)perylene	3.97E-08	7.15E-07	1.04E-07	4.00E-02	4.00E-03	9.94E-06	1.79E-05	2.59E-05
2-Butanone	1.97E-08	3.54E-07	5.12E-08	5.00E-01	5.00E-01	5.00E-02	7.08E-07	1.02E-07
Chlorobenzene	7.15E-08	1.29E-06	1.86E-07	2.00E-01	2.00E-02	3.58E-06	6.45E-06	9.32E-06
Ethylbenzene	2.59E-08	4.65E-07	6.74E-08	1.00E+00	1.00E+00	1.00E-01	4.65E-07	6.74E-08
Total xylenes	5.60E-08	1.01E-06	1.46E-07	4.00E+00	2.00E+00	2.80E-08	2.53E-07	7.29E-08
Total phenols	4.06E-07	7.29E-06	1.06E-06	6.00E-01	6.00E-01	6.76E-07	1.22E-05	1.76E-06
Butylbenzylphalate	4.89E-08	8.80E-07	1.27E-07	2.00E+00	2.00E-01	2.45E-07	4.40E-07	6.37E-07
Bis(2-ethylhexyl)phthalate	8.72E-08	1.57E-06	2.27E-07	2.00E-02	2.00E-02	4.36E-06	7.85E-05	1.14E-05
Dieldrin	1.04E-09	1.87E-08	2.71E-09	5.00E-05	5.00E-05	2.08E-05	3.74E-04	5.42E-05
Beryllium	7.34E-08	1.32E-06	1.91E-07	5.00E-03	5.00E-03	1.47E-05	2.64E-04	3.82E-05
Cadmium	5.20E-07	9.35E-06	1.35E-06	ND	5.00E-04	1.04E-03	ND	2.71E-03
Mercury	2.41E-08	4.33E-08	6.28E-08	3.00E-04	3.00E-04	8.03E-05	1.44E-04	2.09E-04
			TOTAL HAZARD INDEX:			1.51E-01	1.12E-03	3.27E-03

TABLE 6-42

INHALATION OF AIRBORNE (VAPOR PHASE) NONCARCINOGENIC CHEMICALS
VOLATILIZING FROM THE LANDFILL
HAZARD INDICES – FUTURE USE

CHEMICAL	INTAKE (mg/kg-day)			TOXICITY VALUES – INHALATION (mg/kg-day)		HAZARD QUOTIENT (unitless)		
	ADULT	CHILD	WORKER	SUBCHRONIC	CHRONIC	ADULT	CHILD	WORKER
2-Butanone	1.89E-03	7.04E-03	6.46E-04	9.00E-01	9.00E-02	2.10E-02	7.82E-03	7.18E-03
1,1,1-Trichloroethane	2.92E-04	1.09E-03	9.99E-05	3.00E+00	3.00E-01	9.73E-04	3.63E-04	3.33E-04
Chlorobenzene	4.32E-02	1.61E-01	1.48E-02	5.00E-02	5.00E-03	8.65E+00	3.22E+00	2.96E+00
Toluene	3.22E-02	1.20E-01	1.10E-02	5.71E-01	5.71E-01	5.63E-02	2.10E-01	1.93E-02
Xylene (Total)	9.00E-01	3.36E+00	3.08E-01	8.57E-02	8.57E-02	1.05E+01	3.92E+01	3.59E+00
Methylene Chloride	5.32E-04	1.99E-03	1.82E-04	8.57E-01	8.57E-01	6.21E-04	2.32E-03	2.13E-04
			TOTAL HAZARD INDEX:			1.92E+01	4.26E+01	6.58E+00

TABLE 6-43

EXPOSURE PATHWAYS EVALUATED FOR CURRENT LAND USE

EXPOSURE PATHWAY	RECEPTORS				
	ADULT RESIDENT	CHILD RESIDENT	ADULT TRESPASSER	CHILD TRESPASSER	WORKER
Ingestion of Soil			X	X	X
Dermal Contact with Soil			X	X	X
Inhalation of Vapors from Landfill			X	X	X
Ingestion of Groundwater	X	X			
Inhalation of Vapors During Showering	X	X			

TABLE 6-44

EXPOSURE PATHWAYS EVALUATED FOR FUTURE LAND USE

EXPOSURE PATHWAY	RECEPTORS			
	ADULT	CHILD 0-6 YRS.	CHILD 6-11 YRS.	WORKER
Ingestion of Soil	X	X		X
Dermal Contact with Soil	X	X		X
Inhalation of Vapors from Landfill	X	X		X
Ingestion of Groundwater	X	X		X
Inhalation of Vapors During Showering	X		X	

RAM 001 0834

TABLE 6-45

CANCER RISK FOR MULTIPLE PATHWAYS
CURRENT USE
WORKER

TOTAL PATHWAY CANCER RISK					TOTAL EXPOSURE CANCER RISK
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
-	-	5E-06	6E-06	2E-05	3E-05

TABLE 6-46

CANCER RISK FOR MULTIPLE PATHWAYS
CURRENT USE
ADULT TRESPASSER AND RESIDENT

TOTAL PATHWAY CANCER RISK					TOTAL EXPOSURE CANCER RISK
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
5E-10	2E-08	5E-07	2E-06	9E-07	4E-06

TABLE 6-47

CANCER RISK FOR MULTIPLE PATHWAYS
CURRENT USE
CHILD TRESPASSER AND RESIDENT

TOTAL PATHWAY CANCER RISK					TOTAL EXPOSURE CANCER RISK
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
3E-10	4E-09	4E-06	3E-06	5E-06	1E-05

TABLE 6–48

CANCER RISK FOR MULTIPLE PATHWAYS
FUTURE USE
WORKER

TOTAL PATHWAY CANCER RISK					TOTAL EXPOSURE CANCER RISK
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
-	7E-05	5E-06	6E-06	2E-05	1E-04

TABLE 6–49

CANCER RISK FOR MULTIPLE PATHWAYS
FUTURE USE
ADULT RESIDENT

TOTAL PATHWAY CANCER RISK					TOTAL EXPOSURE CANCER RISK
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
5E-06	1E-04	2E-06	8E-06	5E-05	2E-04

TABLE 6–50

CANCER RISK FOR MULTIPLE PATHWAYS
FUTURE USE
CHILD RESIDENT

TOTAL PATHWAY CANCER RISK					TOTAL EXPOSURE CANCER RISK
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
1E-06	3E-05	5E-06	1E-05	3E-05	8E-05

TABLE 6-51

CHRONIC HAZARD INDEX FOR MULTIPLE PATHWAYS
CURRENT USE
WORKER

TOTAL PATHWAY CHRONIC HAZARD INDICES					TOTAL CHRONIC HAZARD INDEX
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
-	-	3E-03	4E-03	7E+00	7E+00

TABLE 6-52

CHRONIC HAZARD INDEX FOR MULTIPLE PATHWAYS
CURRENT USE
ADULT TRESPASSER AND RESIDENT

TOTAL PATHWAY CHRONIC HAZARD INDICES					TOTAL CHRONIC HAZARD INDEX
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
9E-06	2E-04	4E-04	2E-03	3E-01	3E-01

TABLE 6-53

CHRONIC HAZARD INDEX FOR MULTIPLE PATHWAYS
FUTURE USE
WORKER

TOTAL PATHWAY CHRONIC HAZARD INDICES					TOTAL CHRONIC HAZARD INDEX
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
-	1E+00	3E-03	4E-03	7E+00	8E+00

RAM 001 0837

TABLE 6-54

CHRONIC HAZARD INDEX FOR MULTIPLE PATHWAYS
FUTURE USE
ADULT RESIDENT

TOTAL PATHWAY CHRONIC HAZARD INDICES					TOTAL CHRONIC HAZARD INDEX
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
9E-02	2E+00	2E-01	6E-03	2E+01	2E+01

TABLE 6-55

SUBCHRONIC HAZARD INDEX FOR MULTIPLE PATHWAYS
CURRENT USE
CHILD TRESPASSER AND RESIDENT

TOTAL PATHWAY SUBCHRONIC HAZARD INDICES					TOTAL SUBCHRONIC HAZARD INDEX
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
4E-06	2E-04	7E-04	1E-03	6E+00	6E+00

TABLE 6-56

SUBCHRONIC HAZARD INDEX FOR MULTIPLE PATHWAYS
FUTURE USE
CHILD RESIDENT

TOTAL PATHWAY SUBCHRONIC HAZARD INDICES					TOTAL SUBCHRONIC HAZARD INDEX
INHALATION FROM SHOWER	INGESTION OF DRINKING WATER	DERMAL CONTACT WITH SOIL	INGESTION OF SOIL	INHALATION FROM LANDFILL	
6E-02	3E+00	1E-03	6E-03	4E+01	5E+01

RAM 001 0838

REFERENCES

Bear, J., Hydraulics of Groundwater, McGraw-Hill Book Company, 1979.

Clark, J.W., W. Viessman Jr., M.J. Hammer. Water Supply and Pollution Control, Third Edition. 1977.

Davis, S.N. and DeWiest, R.J.M., Hydrogeology, John Wiley and Sons, Inc., New York, New York, 1966.

Davis, S.N., Porosity and Permeability of Natural Materials in Flow Through Porous Media, ed. R.J.M. DeWeist, Academic Press, New York, pp-54-89, 1969.

Doherty, J. MODINV Suite of Software for MODFLOW Pre-Processing, Post-Processing and Parameter Optimization. Australian Centre for Tropical Freshwater Research, James Cook University, Townsville, Queensland, Australia, 1990.

Driscoll, F., G. Groundwater and Wells, Second Edition, Johnson Filtration Systems, Inc., St. Paul, Minnesota, 1987.

Dunn Geoscience Corp., Preliminary Hydrogeologic/Engineering Evaluation of Proposed Torne Valley Balefill, prepared for Town of Ramapo, September, 1988.

Dunn Geoscience Corp. Preliminary Hydrogeologic/Engineering Evaluation of Proposed Torne Valley Balefill. Prepared for the Town of Ramapo, 1988.

Earth Manual, A Water Resources Technical Publication, U.S. Dept. of Interior, Bureau of Reclamation, 1974.

FEMA, Flood Insurance Rate Map for the Town of Ramapo, Rockland County, NY, Community-Panel Number 365340 0025 C, revised February 2, 1989.

Fenn, D.G., K.J. Hanley and T.V. Degeare, Use of the Water Balance Method for Predicting Leachate Generation from Solid Waste Disposal Sites. EPA Report No. 530/SW-168. U.S. Environmental Protection Agency, Office of Solid Waste Management Programs, 1975.

Fetter, C. W., Applied Hydrogeology, Charles E. Merrill Publishing Co., Columbus, Ohio, 1980.

Freeze, R.A., and J.A. Cherry, Groundwater. Prentice-Hall, Englewood Cliffs, New Jersey, 1979.

Freeze, R.A., J.A. Cherry Groundwater, Prentice-Hall, Inc., New Jersey, 1979.

Hall and Kelson, Mammals of North America. The Ronald Press Company, 1959.

Hawley, J.K., Assessment of Health Risk From Exposure to Contaminated Soil, Risk Analysis, Vol. 5, No. 4, 1985.

Hvorslev, M.J., Time Lag and Soil Permeability In Ground Water Observations, U.S. Army Corps of Engineers Experiment Station. Bull No. 36, Mississippi, April 1951.

Isachen, Y.W., and McKendree, W.G., Preliminary brittle structure map of New York: New York State Museum and Science Service No. 31C, 1:250,000, 1977.

Lambe, T.W., and Whitman R.V., Soil Mechanics, John Wiley and Sons, New York, New York, 1969.

Le Grand, H.E., Sheet Structure, a major factor in the occurrence of groundwater in the granites of Georgia; Economic Geology, v. 44, pp 110-118, 1949.

Leggette, Brashears & Graham, Inc., Completion Report Ramapo Valley Well Field, prepared for the Spring Valley Water Co., Inc., 1982.

Leonard Jackson Associates, Draft Environmental Impact Statement for the Town of Ramapo Sanitary Landfill, prepared for the NYSDEC, 1978.

LBG, Inc. Evaluation of Ramapo Valley Well Field Management Techniques by RVAM Simulation. Prepared for Spring Valley Water Company, Inc., Wilton, Connecticut, 1982.

Malcolm Pirnie, Inc., "Landfill Leachate Treatment Facility Upgrade", prepared for the Town of Ramapo, New York, June 1987.

McDonald, M.G., and A.U Harbaugh. A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model. U.S. Department of the Interior, U.S. Geological Survey, Reston, Virginia, 1984.

Moore, R.B., D.H. Cadwell, W.G. Stelz and J.L. Belli. Geohydrology of the Valley-Fill Aquifer in the Ramapo and Mahwah Rivers Area, Rockland County, New York. Open-File Report 82-114, Department of the Interior, U.S. Geological Survey, Albany, New York, 1982.

NOAA, AWS Climatological Brief, NY/Newburg-Stewart 1942-1969; Revised Uniform Summary Surface Water, NY/Stewart/14714 4209 through 6912, 1990.

NUS Corp., Remedial Action Master Plan Ramapo Landfill Site, prepared for USEPA, July, 1983.

NUS Corp., Final Draft Site Inspection Report Torne Mountain Sand and Gravel aka Ramapo Landfill Company, prepared for the USEPA, Many 1988.

NYSDEC, Division Technical and Administrative Guidance Memorandum: "Habitat Based Assessment Guidance Document for Conducting Environmental Risk Assessments at Hazardous Waste Sites". December 28, 1989. Draft.

NYSDEC, "Natural and Cultural Ecological Communities of New York State" preliminary draft # 4, October 20, 1988.

NYSDEC, Division of Fish and Wildlife "Clean-up Criteria for Aquatic Sediments", December, 1989.

Perlmutter, N.M., Geology and Groundwater Resources of Rockland County, New York: New York State Water Power and Control Commission Bulletin, GW-42, 133p, 1959.

Peter Nye, NYSDEC Endangered Species Unit, Region 3. Personal Communication. May 31, 1990.

Petrides, George A., A Field Guide to Eastern Trees; Peterson Field Guide Series; Eastern United States and Canada, Hougton Mifflin Co., 1988.

Ratcliffe N.M., Brittle Faults (Ramapo Fault) and Phyllonic Ductile Shear Zones in the Basement Rocks of the Ramapo Seismic Zones New York and New Jersey, and their Relationship to Current Seismicity, in Field Studies of New Jersey Geology and Guide to Field Trips: 52nd Annual Meeting of the New York State Geological Association, Rutgers University, Newark, New Jersey, pg 278-311, 1980.

Schroeder, P.R., J.M. Morgan, T.M. Walski, and A.C. Gibson, The Hydrologic Evaluation of Landfill Performance (HELP), Volume I, User's Guide for Version I, prepared for USEPA, August 1983.

Schroeder, P.R., J.M. Morgan, R.M. Walski, and A.C. Gibson. The Hydrologic Evaluation of Landfill Performance (HELP) Model, Volume I, User's Guider for Version I, prepared for USEPA, 1983, EPA/530-SW-84-009; and Version II guidance documents received with HELP Version II, 1988.

Scott Smith, NYSDEC Wildlife Biologist, Region 3. Personal Communication, May 23, 1990.

Stewart, J.W., Infiltration and Permeability of Weathered Crystalline Rocks, Georgia Nuclear Laboratory, Davson County, Georgia. U.S. Geological Survey Bulletin 1133-D, 1964.

Thornwaite, C.W. and J.R. Mather. The Water Balance, Drexel Institute of Technology, Centerton, New Jersey, 1955.

URS Consultants, Inc., Citizen Participation Plan for the Remedial Investigation/Feasibility Study at the Ramapo Landfill, August, 1989.

URS Consultants, Inc., Health and Safety Plan for the Remedial Investigation/Feasibility Study at the Ramapo Landfill, August, 1989.

URS Consultants, Inc., Work Plan; Quality Assurance Project Plan; and Field Sampling Plan for the Remedial Investigation/Feasibility at the Ramapo Landfill, August, 1989.

USACE, USEPA, USFWS, USDA-SCS, Federal Manual for Identifying and Delineating Jurisdictional Wetlands, an Interagency Cooperative Publication, January 10, 1989.

USDA, Soil Survey of Rockland County, New York, prepared by the Soil Conservation Service, issued October, 1990.

USDA-ASCS Salt Lake City, UT, Telephone (801) 524-5856; USGS-EROS Data Center, Sioux Falls, SD, Telephone (605) 594-6151; National Archives and Records Administration; VA, Telephone (703) 756-6700.

USEPA, Exposure Factors Handbook, EPA/600/8-89/043, July, 1989.

USEPA, Health Effects Assessment Summary Tables, Fourth Quarter FY-1990, OERR 9200 6-303 (90-4), September 1990.

USEPA, Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, EPA/540/G-89/004, October, 1988.

USEPA, Risk Assessment Guidance for Superfund, EPA/540/1-89-002, December 1989.

USEPA, Superfund Public Health Evaluation Manual, EPA/540/1-86-060, 1986.

USEPA Office of Remedial Response, Superfund Exposure Assessment Manual, EPA/540/1-88-001, April, 1988.

USGS, Geohydrology of the Valley-Fill Aquifer in the Ramapo and Mahwah River Area, Rockland County, New York. U.S. Geological Survey Open-file Report 82-114, 1982.

Velzy Associates, Landfill Gas Recovery, Preliminary Site Evaluation Report, Torne Valley Landfill, Town of Ramapo, prepared for National Gas & Electric Corp. of America, 1986.

NOTES

1) SW-5 IS COINCIDENT WITH SW-2 TAKEN 100' NORTHEAST OF SVP-3
2) PROPERTY LINES SHOWN ARE APPROXIMATE, FOR REFERENCE ONLY, AND SHOULD NOT BE USED FOR CONVEYANCE OF REAL PROPERTY. PROPERTY LINES WERE INTERPOL[illegible] PREPARED FOR THE TOWN OF RAMAPO BY [illegible] LIC. No. 46565, DATED OCTOBE[illegible]

NO.	DATE	DESCRIPTION	NO.	DATE	DESCRIPTION
	1-91	ADDED PHASE II SAMPLING			
	6-90	PHASE I SAMPLING			

REVISIONS

DESIGNED BY : B.J.K.
DRAWN BY : S.E.L.
CHECKED BY : A.M.M.
PROJ. ENGR. : J.A.L.

URS CONSULTANTS, INC.

JOB No. 35207

RAMAPO LANDFILL

ENVIRONMENTAL SAMPLING LOCATIONS

Scale: 1"=100' | Date: 2/28/91 | PLATE 1

RAM 001 0845