United States Environmental Protection Agency

Office of Emergency and Remedial Response

PB93-963801
EPA/ROD/R02-92/169
March 1992

EPA

Superfund Record of Decision:

Ramapo Landfill, NY

NOTICE

The appendices listed in the index that are not found in this document have been removed at the request of the issuing agency. They contain material which supplement, but adds no further applicable information to the content of the document. All supplemental material is, however, contained in the administrative record for this site.

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA/ROD/R02-92/169	2.	3. Recipient's Accession No.
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15. Supplementary Notes

PB93-963801

16. Abstract (Limit: 200 words)

The 60-acre former landfill site is located on a 96-acre tract in the Town of Ramapo, Rockland County, New York, about 35 miles northwest of New York City. Utility corridors lie on three sides of the site, including high-voltage power transmission lines. A high-pressure gas line is to the south; a pistol range, northeast; and a power substation, north of the site. Surface water bodies in the site area include the Ramapo River, Torne Brook, and Candle Brook. The Ramapo River may be used as a drinking water source, and Torne Brook is suitable for primary contact recreation. The landfill consists of two major lobes that are steeply sloped toward the Ramapo River and Torne Brook. Groundwater is withdrawn from the area south and west of the site for residential use. Ten water supply wells, operated by the Spring Valley Water Supply Company and serving a population of over 200,000, are located along the Ramapo River both upstream and downstream of the site. Several of these wells are located within 1,500 feet of the landfill; the closest lies approximately 500 feet west of the site. Prior to landfill operations in the 1950's and 1960's, portions of the site were excavated as a gravel source, and in 1971, the Rockland County Department of Health granted a permit to the Town of Ramapo for the operation of the sanitary

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Ramapo Landfill, NY
First Remedial Action - Final
Contaminated Media: soil, gw, sw
Key Contaminants: VOCs (benzene), other organics, metals (arsenic, chromium, lead)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 64
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

Abstract (Continued)

landfill. Until 1984, municipal waste was accepted in the landfill, and construction and demolition debris was accepted at the site until 1989. An offsite leachate collection system, constructed in 1984, currently discharges an average flow of 80,000 gallons per day to the Village of Suffern Wastewater Treatment Plant. 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/guardhouse, compacted at a baler facility in the northeastern corner ofthe site, and transferred to the Al Turi Landfill in Goshen, New York. This ROD represents the entire remedial action for the site by controlling source of contamination and the generation of leachate, and treatment of contaminated ground water. The primary contaminants of concern affecting soil, ground water, and surface water are VOCs, including benzene; other organics; and metals, including arsenic, chromium, and lead.

The selected remedial action for this site includes installing a multi-media cap over the 60-acre landfill; improving the existing leachate collection system; diverting surface water drainage; and relocating and/or raising Torne Valley Road to allow for filling rather than excavating the landfill side slopes in order to achieve stable slopes; installing ground water extraction wells to supplement the existing leachate collection system and off-site treatment at the Suffern Wastewater Treatment Plant; long-term monitoring of ground water, surface water and perimeter air monitoring and venting or control, as required. If necessary, an alternate water supply would be provided. This contingency alternative requires the development of rapid implementation plans and preliminary design of the alternate water system. The estimated present worth cost for this remedial action is $21,410,000 to $28,050,000, which includes an annual O&M cost of $319,800 to $678,600 for 30 years. The higher cost estimate reflects the implementation of optional components of the selected remedy, including an alternate water supply, ground water pretreatment and treatment of landfill gases.

PERFORMANCE STANDARDS OR GOALS: Chemical-specific goals for leachate and shallow ground water clean-up are based on the more stringent New York State Water Quality Criteria standards for VOCs (benzene); other organics; and metals (arsenic, chromium, lead). Surface water standards are based on human and aquatic ARARs, whichever is more stringent.

ROD FACT SHEET

SITE

Name:	Ramapo Landfill
Location:	Town of Ramapo
HRS Score:	44.73

ROD

Date Signed:	March 31, 1992
Remedy:	Landfill Cap/Leachate & GW Collection/Off-site Treatment
Capital Cost:	$18,390,000 - $21,640,000
O & M Cost:	$319,800 - $678,600
Present Worth Cost:	$21,410,000 - $28,050,000

LEAD

NYSDEC

Primary Contact:	Robert Nunes (212) 264-2723
Secondary Contact:	Joel Singerman (212) 264-1132
Main PRPs:	Town of Ramapo

WASTE

Type:	Volatiles, Semi-Volatiles, Inorganics
Medium:	Soil, groundwater, surface water
Origin:	Municipal and hazardous wastes
Est. Quantity:	Municipal Landfill Size: 60 acres

RECORD OF DECISION

Ramapo Landfill Site
Town of Ramapo
Rockland County, New York

United States Environmental Protection Agency
Region II
New York. New York

DECLARATION FOR THE RECORD OF DECISION

Site Name and Location

Ramapo Landfill, Town of Ramapo, Rockland County, New York

Statement of Basis and Purpose

This decision document presents the selected remedial action for the Ramapo Landfill site (the "Site"), located in the Town of Ramapo, Rockland County, New York, which was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §§ 9601-9675, as amended, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300. This decision document explains the factual and legal basis for selecting the remedy for the Site. The information supporting this remedial action decision is contained in the administrative record for the Site. The administrative record index is attached (Appendix III).

The New York State Department of Environmental Conservation (NYSDEC) concurs with the selected remedy. (See Appendix IV.) NYSDEC will also concur with the contingent remedy, should the confirmatory studies determine that the contingent remedy is appropriate.

Assessment of the Site

Actual or threatened releases of hazardous substances from the Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present a significant and substantial endangerment to public health, welfare, or the environment.

Description of the Selected Remedy

This operable unit represents the entire remedial action for the Site. It addresses the principal threats to human health and the environment at the Site by controlling the source of contamination and the generation of contaminated leachate, as well as by treating contaminated groundwater.

The major components of the selected remedy include:

- Installation of a cap on the tops of the landfill using a multi-media system, including layers of fill material, a gas-venting system and an impermeable membrane. The landfill side slopes will be capped using a multi-media system without an impermeable membrane, if confirmatory studies demonstrate that this approach meets remedial action objectives. Should the confirmatory studies indicate that the overall remedy's effectiveness would be significantly reduced by not including an impermeable barrier in the multi-media cap on the sideslopes, then an impermeable barrier would be included in the cap on some or all of the side slopes of the landfill;

- Installation of groundwater extraction wells to supplement the existing leachate collection system;

- Collection and diversion of leachate seeps to the leachate collection system for off-site treatment;

- Installation of a perimeter drain around the sections of the cap containing the impermeable membrane to collect and divert surface water run-off;

- If groundwater pretreatment is needed (pursuant to the requirements of the off-site treatment facility), construction of a pretreatment facility which would be tied into the existing leachate collection and discharge system;

- Performance of air monitoring prior to, during, and following construction at the Site to ensure that air emissions resulting from the cap construction meet applicable or relevant and appropriate requirements. Perimeter air monitoring in the groundwater monitoring wells, piezometers, and additional gas monitoring wells to be installed between the landfill and the Baler Building will be performed. Landfill gas emissions will be controlled, if necessary;

- Imposition of property deed restrictions which will include measures to prevent the installation of drinking water wells at the site, and restrict activities which could affect the integrity of the cap;

- Performance of a maintenance and sampling program upon completion of closure activities. The monitoring program will provide data to evaluate the effectiveness of the remedial effort. Additional monitoring points will be established as needed to detect any future movement of site contaminants toward drinking water sources off-site;

- Development of a contingency plan for rapid implementation of additional measures to protect nearby residents and users of groundwater if those measures are determined to be necessary.

Declaration

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. In keeping with the statutory preference for treatment as a principal element of the remedy, the contaminated leachate and groundwater will be collected and treated. The landfill material, however, cannot be excavated and treated effectively, because of the size of the landfill and because there are no on-site "hot spots" that represent the major sources of contamination.

A review of the Site will be conducted no later than five years after commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment, because this remedy will result in hazardous substances remaining on-site above health-based levels.

Constantine Sidamon-Eristoff — 3/31/93
Regional Administrator — Date

DECISION SUMMARY
RAMAPO LANDFILL SITE

TOWN OF RAMAPO
ROCKLAND COUNTY, NEW YORK

United States Environmental Protection Agency
Region II
New York, New York
March 1992

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ATTACHMENTS

SITE NAME, LOCATION AND DESCRIPTION

The Site 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 and a Site plan is depicted in Figure 2. The Site is situated at the western base of the Ramapo Mountains off Torne Valley Road east of the New York State Thruway, Route 17, and 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 north of the Site.

Approximately 50 acres of the Site are covered with fill material. The landfill 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. Figure 3 depicts the location and depth of the landfill lobes. Both landfill lobes consist of mixed refuse. Substances reportedly disposed of in the landfill portion of the Site include industrial sludge and other wastes from a pharmaceutical company, sewage sludge, municipal refuse, asbestos, construction and demolition debris, yard debris, paint sludge, and liquid wastes from a paper company. 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.

An on-site leachate collection system consists of 4 main conduits located along the northern and western boundaries of the Site as shown in Figure 4. Three conduits are located in the subsurface using perforated drain pipes. A 6-inch toe drain was installed just beneath the ground surface at the toe of the landfill, using 2,933 feet of perforated pipe. An 8-inch shallow underdrain was installed at a depth 8 to 10 feet below grade using 4,023 linear feet of perforated pipe on the upslope side of Torne Valley Road. A 12-inch deep underdrain was installed between 10 and 25 feet deep using 4,259 linear feet of both perforated and nonperforated 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 4 collectors tie together near MH-A-5 (see Detail A on Figure 4). A 6-inch force main connects to the leachate holding pond, while a 48-inch pipe leads to Torne Brook (Former Outfall 002). This 48-inch pipe is designed to convey overflow during heavy-water runoff from the concrete collector.

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, compacted at a baler facility in the northeastern 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 in the northeastern area of the Site.

The main surface waters in the vicinity of the Site are the Ramapo River, Torne Brook, and Candle Brook (see Figure 2). The Ramapo River, located approximately 300 feet from the southwest corner of the Site, is a NYSDEC Class "A" waters, which 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. Figure 5 depicts the 100-year and 500-year floodplain boundary for Torne Brook.

There are no NYSDEC-regulated or federal jurisdictional wetlands preliminarily identified on-site. However, the United States Geological Survey (USGS) has identified an area of less than ten acres near the headwaters of Candle Brook and located east of the Baler Building as a wetland (see Figure 6). No NYSDEC-regulated wetlands occur within 9 miles downstream of the Site, though several occur within a 2-mile radius, either upstream of the Site or on a different watershed. All wetlands on or adjacent to the Site will be definitively delineated as one of the remedial design activities for the Site.

Groundwater is withdrawn from the area south and west of the Site for residential use. Ten water supply wells, operated by the Spring Valley Water Supply Company and serving a population of over 200,000, are located along the Ramapo River both upstream and downstream of the Site. Four of these wells, SV-93, SV-94, SV-95, and SV-96 (see Figure 2), are located within 1,500 feet of the landfill. The closest of these wells lies approximately 500 feet west of the Site on the west bank of the Ramapo River. Torne Brook Estate, a residential apartment complex of 25 units, has a water well, PW-1, 450 feet from the landfill. A 2-unit apartment building maintains a water well, PW-2, about 1,200 feet from the landfill.

SITE HISTORY AND ENFORCEMENT ACTIVITIES

Site History

Prior to landfill operations in the 1950s and 1960s, portions of the Site were excavated as a source of gravel.

In 1971, the Rockland County Department of Health granted a permit to the Town of Ramapo for the operation of the 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.

In 1976, a contract was awarded to Carmine Franco of Sorgine Construction Services of New York, Inc., for operation and maintenance of the landfill. The contract was terminated by the Town of Ramapo in 1979, when the Town began operating the landfill directly. Municipal waste was accepted in the landfill until 1984. The Town of Ramapo continued to accept construction and demolition debris at the Site until 1989.

In September 1983, the Ramapo Landfill site was placed on the Superfund National Priorities List.

The leachate collection and treatment system was constructed along the downgradient edge of the landfill in 1984 and 1985. Surface water and groundwater were conducted to a wastewater treatment pond in the Site's southwest corner. The pond's discharge was initially to the Ramapo River after aeration and settling in the pond.

From April 1989 through May 1990, the first phase (Phase I) of Remedial Investigation field work was carried out. From August to September 1990 the second phase (Phase II) of field work was conducted.

As of November 1, 1990, leachate is no longer treated at the Site and discharged to the Ramapo River. Leachate from the pond is being discharged to the Village of Suffern Wastewater Treatment Plant, approximately 1.8 miles south of the Site, via a sewer line of approximately 7,900 feet in length running along the shoulders of Torne Valley Road and Route 59. The present contract with the Village of Suffern anticipates an average daily flow of 80,000 gallons per day, for a maximum yearly flow of 29,200,000 gallons. The contract runs for 5 years, and is renewable for an additional 5 years.

Enforcement Activities

On June 4, 1980, the first of four Orders on Consent concerning the Ramapo Landfill was entered into between the Town of Ramapo and the NYSDEC. The first order required the Town of Ramapo, as Respondent, to: (a) determine the extent of leachate movement and the feasibility of leachate collection; (b) construct a surface-water and groundwater-diversion system; (c) construct a leachate-collection system; (d) construct a system capable of transporting or treating the collected leachate; (e) phase out operation of the landfill, and (f) meet other related requirements and schedule of compliance specified in the Order.

On May 20, 1983, a Modified Order on Consent was signed, 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 with effluent monitoring, a subsurface investigation program, the phase-out of the existing site for refuse disposal and submission of a closure plan.

On February 8, 1985, an Order on Consent was signed which required that the Initial Treatment System be completed by June 30, 1985 and construction of a Final Treatment System by October 31, 1986.

On February 1, 1988, the Town entered into its fourth and current (Title 3 1986 Environmental Quality Bond Act) Order on Consent (Index No. W3-0083-8707) with NYSDEC. This Order requires that a remedial investigation and feasibility study (RI/FS) and remedial program be developed and implemented for the Site, subject to approval from NYSDEC.

HIGHLIGHTS OF COMMUNITY PARTICIPATION

On September 20, 1989, the Town of Ramapo and NYSDEC conducted a public meeting at the Town of Ramapo Town Hall, Ramapo, New York, to inform local officials and interested citizens about the Superfund process, to review current and planned remedial activities at the Site, and to respond to any questions from area residents and other attendees.

The RI report, FS report, and the Proposed Plan for the Site were released to the public for comment on February 18, 1992. These documents were made available to the public in the administrative record file at the EPA Docket Room in Region II, New York and the information repositories at NYSDEC, Albany, New York, the Finkelstein Public Library, Spring Valley, New York, and the Suffern Free Public Library, Suffern, New York. The public comment period on these documents was held from February 19, 1992 to March 19, 1992.

During the public comment period, a public meeting was held in the Ramapo Town Hall, Ramapo, New York on March 3, 1992, to present the RI/FS reports and the Proposed Plan, answer questions, and accept both oral and written comments. At this meeting, representatives from the EPA, NYSDEC, and the New York State Department of Health (NYSDOH) answered questions about problems at the Site and the remedial alternatives under consideration. Responses to the comments received during the public comment period are included in the Responsiveness Summary (see Appendix V).

SCOPE AND ROLE OF OPERABLE UNIT

This response action applies a comprehensive approach and, therefore, only one operable unit is required to remediate the site.

Remedial action objectives are specific goals to protect human health and the environment; they specify the contaminant(s) of concern, the exposure route(s), receptor(s), and acceptable contaminant level(s) for each exposure route. These objectives are based on available information and standards such as applicable or relevant and appropriate requirements (ARARs) and risk-based levels established in the risk assessment.

The following remedial action objectives were established: 1) prevent inhalation of vapors from the landfill; 2) prevent human and animal contact with contaminated soil from the landfill surface; 3) prevent erosion of contaminated surface soil through surface-water runoff; 4) minimize the infiltration of rainfall or snow melt into the landfill, thus reducing the quantity of water percolating through the landfill materials and leaching out contaminants; and 5) reduce the movement and toxicity of the contaminated landfill leachate into groundwater, and subsequent downgradient migration of contaminants.

NYSDEC is the lead agency for this project; EPA is the support agency.

SUMMARY OF SITE CHARACTERISTICS

RI field work was carried out in two phases: Phase I from April 1989 through May 1990; Phase II from August to September 1990. Media sampled during the RI included surface and subsurface soil, waste samples, groundwater, surface water, sediments, and air. All RI Phase I and II sampling locations, excluding air monitoring points, are depicted in Figure 7.

Volatile compounds were detected in 3 waste sample locations, SPS-3, SPS-4, and SPS-5, at concentrations ranging from 2 micrograms per kilogram (ug/kg) to 110 milligrams per kilogram (mg/kg) (total xylenes at SPS-5). No volatile compounds were detected in any of the surface soil samples including the background sample, SPS-9. Semi-volatile compounds, including polycyclic aromatic hydrocarbons (PAHs), were detected in waste samples and surface soil samples at concentrations ranging from 42 ug/kg to 16 mg/kg (naphthalene at SPS-5). No semi-volatile compounds were detected in the background sample. Antimony, barium, beryllium, cadmium, calcium, chromium, copper, lead, selenium, and zinc were detected in surface soil and waste samples at concentrations exceeding background by an order of magnitude. Acetone was detected in 4 subsurface soil samples, MW-1-SB, MW-2-SB, MW-3-SB, and MW-5-SB, at concentrations ranging from 13 to 28 ug/kg. Six semi-volatile compounds, acetone, and toluene were detected in one monitoring well boring (MW-3-SB).

All five waste samples, (waste samples include landfill material and one paint sludge sample), were analyzed for RCRA hazardous waste characteristics and extraction procedure (EP) toxicity parameters, for which there are regulatory levels. A comparison between the EP Toxicity Criteria and levels detected from the samples is presented in Table 1. 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. Test results indicated that none of the waste samples were classified as a RCRA characteristic waste.

During the installation of monitoring well MW-10, a leachate seep was observed. LSMW-10 is a sample of the surface soil in this area. No volatiles were detected in this sample.

Ten semi-volatiles were detected at concentrations up to 130 ug/kg (flouranthene). One pesticide, gamma-chlordane, was detected at 4.5 ug/kg. Four inorganic compounds, beryllium, cadmium, calcium, and mercury, were detected at concentrations greater than an order of magnitude above background.

NYSDEC Water Quality Standards and Guidelines and/or EPA Primary Drinking Water Standards are currently being contravened in groundwater monitoring wells installed in the overburden, intermediate layer, and bedrock aquifers. Standards were exceeded for arsenic, chromium, iron, lead, magnesium, manganese, mercury, sodium, benzene, chlorobenzene, di-n-octyl phthalate, and total organic carbon. Maximum groundwater concentrations of contaminants are compared with drinking water standards on Table 2. A summary of the number of data which exceeded state and federal drinking water standards is given in Table 3. No federal or state drinking water standards were exceeded in samples taken from the nearby public or private water supply wells.

Phase I and Phase II surface water samples were collected on Torne Brook, on the Ramapo River near the confluence of Torne Brook, a drainage swale on an adjacent property, and from 2 leachate seeps emanating from the landfill. New York State surface water standards were exceeded for vinyl chloride, antimony, arsenic, iron, manganese, mercury, nickel, zinc, ammonia, sulfide, copper, and lead. The highest frequency of the detections above the standards occurred at SW-1, near the confluence of Torne Brook and the Ramapo River, when leachate from the treatment pond was still being discharged to the Ramapo River. Maximum surface water concentrations of contaminants are compared with surface water standards on Table 4. Table 5 includes a summary of the number of data which exceeded state and federal surface water standards.

On July 12, 1991, NYSDEC sampled Torne Brook upgradient from the site, and at 3 locations on the Ramapo River. The 3 samples were collected roughly 150-feet upstream of the former Outfall 001, at the confluence with the former outfall, and roughly 150 feet downstream. The samples were analyzed for Target Analyte metals, cyanide, total organic carbon and ammonia. Analytical results indicated that no standards were exceeded for ammonia or any of the inorganic compounds previously noted as contravening standards.

No volatile or pesticide compounds were detected in any of the sediment samples collected in Torne Brook or the Ramapo River. Three semi-volatile compounds were detected in a sediment sample collected in Torne Brook, SS-3, at concentrations below NYSDEC sediment cleanup criteria. (See Table 6.) Inorganic compounds detected in sediments which exceeded background concentrations by at least an order of magnitude included manganese at SS-1, calcium and thallium at SS-3, antimony and manganese at SS-4, and calcium at SS-8.

An air monitoring study was conducted during the second phase of field activities to determine methane quality and Target Compound List (TCL) organic gas emissions. Air monitoring locations are depicted in Figure 8. The highest airborne concentration of a volatile organic compound (VOC) detected on-site was recorded at a piezometer, P-2, located in the northern lobe, west of the Baler Building. The results from the sample collected indicated a total xylenes concentration of 7.7 milligrams per cubic meter, which exceeded the NYSDEC Ambient Guideline Concentration (AGC) for this compound. AGCs assume continuous exposure, however, and ordinarily are compared to annual averages of air sample results. TCL organic emissions and AGCs are presented in Table 7. No other air sampling data exceeded NYSDEC AGCs.

SUMMARY OF SITE RISKS

A Baseline Risk Assessment was conducted to evaluate the potential risks to human health and the environment associated with the Ramapo Landfill Site in its current state. The Baseline Risk Assessment focused on contaminants in the soil, groundwater, and air which are likely to pose significant risks to human health and the environment. A list of the contaminants of potential concern in groundwater, soil, and air is found in Table 8.

The Baseline Risk Assessment identified several potential exposure pathways by which the public may be exposed to contaminant releases at the Site under current and future land-use conditions. Five exposure scenarios were evaluated under current and future land-use conditions. These pathways included: ingestion of soil; dermal contact with soil; inhalation of vapors from the landfill; ingestion of groundwater; and inhalation of vapors during showering. These exposure pathways were evaluated separately for adults and children and are listed in Table 9. Under the current land-use scenario, five potential receptors were identified, namely, adult and child (ages 6-11) trespassers, adult and child residents living downgradient and off-site, and employees (workers) at the landfill. Under the future land-use scenario, three receptors were identified, namely adult and child (ages 0-6) residents living on-site, and workers. The reasonable maximum exposure scenario was evaluated.

Under current EPA guidelines, the likelihood of carcinogenic (cancer causing) and noncarcinogenic effects due to exposure to site chemicals are considered separately. It was assumed that the toxic effects of the site-related chemicals would be additive. Thus, carcinogenic and noncarcinogenic risks associated with exposures to individual compounds of concern were summed to indicate the potential risks associated with mixtures of potential carcinogens and noncarcinogens, respectively.

Noncarcinogenic risks were assessed using a hazard index (HI) approach, based on a comparison of expected contaminant intakes and safe levels of intake (Reference Doses). Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects. RfDs, which are expressed in units of mg/kg-day, are estimates of daily exposure levels for humans which are thought to be safe over a lifetime (including sensitive individuals). Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) are compared with the RfD to derive the hazard quotient for the contaminant in the particular medium. The reference doses for the compounds of concern at the Ramapo Landfill site are presented in Table 10.

The hazard index is obtained by adding the hazard quotients for all compounds across all media. A hazard index greater than 1 indicates that the potential exists for noncarcinogenic health effects to occur as a result of site-related exposures. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media.

Under current land-use conditions, the total site HI exceeded one for workers and child trespassers. Under future land-use conditions, the HIs exceeded 1 for all scenarios evaluated. Primary chemical contributors to noncarcinogenic health risks were xylenes (total) and chlorobenzene for inhalation of vapors from the landfill, and manganese and arsenic for ingestion of groundwater. A summary of the noncarcinogenic risks associated with the chemicals evaluated across various exposure pathways is found in Table 11.

Potential carcinogenic risks were evaluated using the cancer slope factors developed by EPA for the contaminants of concern. Cancer slope factors (SFs) have been developed by EPA's Carcinogenic Risk Assessment Verification Endeavor for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. SFs, which are expressed in units of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to generate an upper-bound estimate of the excess lifetime cancer risk associated with exposure to the compound at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes the underestimation of the risk highly unlikely. The SF for the compounds of concern are presented in Table 12.

For known or suspected carcinogens, EPA considers excess upper bound individual lifetime cancer risks of between 10^{-4} to 10^{-6} to be acceptable. This level indicates that an individual has not greater than a one in ten thousand to one in a million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year period under specific exposure conditions at the Site. Under current land-use conditions, the risk characterization showed that cancer risks for all receptors evaluated (i.e., adults, children, and workers) were less than or within the acceptable cancer risk range of 10^{-4} to 10^{-6}. Under future land-use conditions, cancer risks for children and workers were within the NCP acceptable range. However, the sum of future cancer risks for all exposure pathways assessed for adults (2×10^{-4}) were marginally outside the range. Arsenic and benzene were the chemicals responsible for the highest carcinogenic risks from groundwater ingestion and inhalation of vapors, respectively. A summary of the carcinogenic risks for the chemicals evaluated across various exposure pathways is found on Table 13.

The calculations were based on the contaminants detected in soils, on-site monitoring wells, and air. It was assumed that in the future, on-site monitoring wells would be used for residential purposes. Risk estimates were developed by taking into account various conservative assumptions about the likelihood of a person being exposed to the various contaminated media.

Uncertainties

The procedures and inputs used to assess risks in this evaluation, as in all such assessments, are subject to a wide variety of uncertainties. In general, the main sources of uncertainty include:

- environmental chemistry sampling and analysis
- environmental parameter measurement
- fate and transport modeling
- exposure parameter estimation
- toxicological data

Uncertainty in environmental sampling arises in part from the potentially uneven distribution of chemicals in the media sampled. Consequently, there is significant uncertainty as to the actual levels present. Environmental chemistry analysis error can stem from several sources including the errors inherent in the analytical methods and characteristics of the matrix being sampled.

Uncertainties in the exposure assessment are related to estimates of how often an individual would actually come in contact with the chemicals of concern, the period of time over which such exposure would occur, and in the models used to estimate the concentrations of the chemicals of concern at the point of exposure.

Uncertainties in toxicological data occur in extrapolating both from animals to humans and from high to low doses of exposure, as well as from the difficulties in assessing the toxicity of a mixture of chemicals. These uncertainties are addressed by making conservative assumptions concerning risk and exposure parameters throughout the assessment. As a result, the Risk Assessment provides upper bound estimates of the risks to populations near the Landfill, and is highly unlikely to underestimate actual risks related to the Site.

More specific information concerning public health risks, including a quantitative evaluation of the degree of risk associated with various exposure pathways, is presented in the RI Report.

Environmental Assessment

The environmental assessment evaluated exposure risks to aquatic life. Comparison of the results obtained from sediment samples with NYSDEC sediment cleanup criteria indicate that no contaminant concentrations found exceed the cleanup criteria. Therefore, sediments are not expected to pose a risk to aquatic life. In reviewing the surface water contaminant concentrations, aquatic surface water standards were exceeded for copper, iron, lead, mercury, sulfide, and zinc.

The ecological studies also indicated that there are no federally listed threatened or endangered species identified at the Site. 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. However, because the species' habitat is within rock outcrops or boulder fields, it is unlikely to occur on or in the immediate vicinity of the landfill. No other NYSDEC rare, threatened, or endangered species or critical habitats are known to occur within a 2-mile radius of the landfill, or within 9 miles downstream of the landfill.

In summary, actual or threatened releases of hazardous substances from this Site, if not addressed by the preferred alternative or one of the other active measures considered, may present a current or potential threat to public health, welfare or the environment.

DESCRIPTION OF REMEDIAL ALTERNATIVES

CERCLA requires that each selected site remedy be protective of human health and the environment, be cost-effective, comply with other statutory laws, and utilize permanent solutions, alternative treatment technologies and resource recovery alternatives to the maximum extent practicable. In addition, the statute includes a preference for the use of treatment as a principal element for the reduction of toxicity, mobility, or volume of the hazardous substances.

This Record of Decision evaluates in detail, 5 remedial alternatives for addressing the contamination associated with the Ramapo Landfill site. The time to implement reflects only the time required to construct or implement the remedy and does not include the time required to design the remedy, negotiate with the responsible parties, or procure contracts for design and construction.

These alternatives are:

Alternative 1: No Further Action with Monitoring

Capital Cost: $0
Operation and Maintenance (O & M) Cost: $345,700
Present Worth Cost: $3,260,000
Time to Implement: 3 months

The Superfund program requires that the "no-action" alternative be considered as a baseline for comparison with the other alternatives. However, since leachate collection and off-site treatment of collected leachate and surface water are part of the ongoing operations at the Site, the requirement for a "no-action" alternative is not relevant for this Site. Therefore, a no further action alternative was considered.

The no further action alternative does not include any additional physical remedial measures that address contamination at the Site. However, this alternative does include maintaining the existing leachate collection system and continuing to send the collected groundwater and surface water to the Suffern Wastewater Treatment Plant at a rate of approximately 80 thousand gallons per day. It includes further long-term monitoring of on-site monitoring wells and nearby residential wells for target compound list (TCL) compounds, surface water in Torne Brook and the Ramapo River for TCL compounds, and air for VOCs and landfill gases.

In addition, the no further action alternative would include the development and implementation of a public awareness and education program to enhance the community's knowledge of the conditions existing at the Site. This alternative would require the involvement of local government, and several health departments and environmental agencies.

Because this alternative would result in contaminants remaining on-site above health-based levels, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions may be implemented to remove or treat the wastes.

Alternative 2: Limited Action (with Option for Alternate Water Supply)

Capital Cost: $190,000 - $710,000
O & M Cost: $345,700
Present Worth Cost: $3,380,000 - $3,970,000
Time to Implement: 6 months

To date, results obtained from sampling of nearby private wells indicate that the wells are not being adversely impacted by the landfill. Therefore, no provision for an alternate water supply is warranted at this time. However, should future groundwater monitoring data indicate that drinking water standards are being contravened in nearby wells, then an alternate water supply may be deemed necessary. This alternative includes the development, during the remedial design, of a contingency plan for the rapid implementation of an alternate water supply, if shown to be needed. The contingency plan would include the preliminary design for the alternate water supply. If drinking water standards are significantly exceeded for site-related parameters in residential wells, or in the same aquifer in the closest monitoring wells to the residental wells, and detected concentations are confirmed by subsequent sampling, residents would immediately be provided with bottled water and/or an acceptable point-of-use treatment system, as an interim measure until an alternate water supply could be constructed.

Posting and fencing of the landfill would be included in order to reduce the frequency of trespassers on the landfill property. This alternative would also include deed restrictions with respect to the future use of the Site, and the prohibition of on-site groundwater extraction for potable use. The existing leachate collection system would be maintained, and the collected groundwater and surface water would continue to be sent to the Suffern Wastewater Treatment Plant. Similar to Alternative 1, this alternative would also include long-term monitoring of groundwater, surface water in Torne Brook and the Ramapo River, and air.

The higher end of the capital cost range ($710,000) and present-worth cost range ($3,970,000) for this alternative reflect the additional cost for the alternate water supply which is considered an optional item.

As in Alternative 1, this alternative would include a public awareness and education program.

Because this alternative would result in contaminants remaining on-site above health-based levels, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions may be implemented to remove or treat the wastes.

Alternative 3: Installation of Groundwater Extraction Wells

Capital Cost: $1,040,000 - $3,300,000
O & M Cost: $547,300 - $1,156,000[1]
Present Worth Cost: $6,206,000 - $14,210,000
Time to Implement: 6 months

Alternative 3 includes the installation of groundwater extraction wells to supplement the existing leachate collection system and restore contaminated groundwater aquifers. Groundwater extraction wells would be installed in areas where the groundwater table may be below the reach of the existing leachate collection system. Portions of the existing deep leachate collector would be plugged or grouted and new solid piping would be laid in areas where the withdrawal wells are to be added, to avoid leakage of the existing system. Collected leachate, groundwater and surface water would be sent to a publicly owned treatment works (POTW) for off-site treatment. The off-site treatment

[1]The O&M costs for Alternatives 3, 4, and 5 assume continued treatment of leachate and treatment of groundwater at the Suffern Wastewater Treatment plant. The Town of Ramapo, however, is pursuing arrangements for treatment of leachate and groundwater at the Rockland County Sewer District No. 1 publicly-owned treatment works.

facility could be the Suffern Wastewater Treatment Plant, which is currently receiving wastewater discharged from the Site, or an alternate POTW. The selected POTW must be in compliance with all federal and state permit requirements. In addition, the wastewater discharged from the Site would have to meet all federal, state, local, and pretreatment requirements for the specific POTW.

If deemed necessary by future groundwater monitoring data, an alternate water supply would be provided for nearby users as discussed in Alternative 2. This alternative includes the development, during Remedial Design, of a contingency plan for rapid implementation of an alternate water supply, if shown to be needed. The contingency plan would include the preliminary design for the alternate water supply, to the extent that public water could be provided to nearby users within one year of determination of its need based on monitoring results. As an interim measure, if drinking water standards are significantly exceeded for site-related parameters in residential wells, or in the same aquifer in the closest monitoring wells to the residents, and detected concentations are confirmed by subsequent sampling, residents would immediately be provided with bottled water and/or an acceptable point-of-use treatment system.

It is estimated that the proposed improvements to the leachate collection system would increase the amount of groundwater collected and sent for treatment. Long-term monitoring of groundwater and surface water would be included under this alternative. Air monitoring for VOCs and landfill gases would be included, along with deed restrictions with respect to the future use of the Site, and the prohibition of on-site groundwater extraction for potable use. Posting and fencing of the landfill would be included in order to reduce the frequency of trespassers on the landfill property.

The higher end of the capital cost range ($3,300,000) and present-worth cost range ($14,210,000) for this alternative reflect the additional costs for the alternate water supply and groundwater pretreatment, which are optional items.

Because this alternative would result in contaminants remaining on-site above health-based levels, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions may be implemented to remove or treat the wastes.

Alternative 4: Landfill Cap; Installation of Groundwater Extraction Wells

OPTION A:

Capital Cost: $26,170,000 - $29,310,000
O & M Cost: $319,600 - $622,600
Present Worth Cost: $29,190,000 - $35,760,000
Time to Implement: 2 years

OPTION B:

Capital Cost: $21,870,000 -$25,010,000
O & M Cost: $319,600 - $622,600
Present Worth Cost: $24,890,000 -$30,880,000
Time to Implement: 2 years

Alternative 4 would involve the installation of a multi-media cap complying with New York State Part 360 Solid Waste Regulations over the entire 60 acres of the landfill, improvements to the existing leachate collection system, a surface water drainage and diversion system, and relocating and/or raising of Torne Valley Road to allow for filling rather than excavating the landfill side slopes in order to achieve stable slopes. With a cap, there would be less infiltration into the landfill, and therefore, less potential for off-site migration of contaminated groundwater. Option A costs reflect estimated costs for a multi-media cap that meets all requirements of the New York State Part 360 Solid Waste Regulations. Option B costs reflect estimated costs for a multi-media cap which is identical to that in Option A, except that it would require a 12-inch thick fill layer above the impermeable barrier as opposed to a 30-inch thick fill layer as required in Part 360. Both fill layers would be covered by a 6-inch thick layer of topsoil. The reduced fill layer in Option B would provide equivalent protection for the impermeable membrane, provided that the impermeable membrane not be damaged by frost or root action. The selection of the Option B cap would require approval from the NYSDEC for a variance of the Part 360 regulations.

The installation of groundwater extraction wells to supplement the existing leachate collection system would be implemented as described in Alternative 3. However, with the addition of a cap over the landfill, surface water would no longer have to be collected and sent for treatment. Collected leachate and groundwater would be sent to a POTW for off-site treatment. The off-site treatment facility could be the Suffern Wastewater Treatment Plant, which is currently receiving wastewater discharged from the Site, or an alternate POTW. The selected POTW must be in compliance with all federal and state permit requirements. In addition, the wastewater discharged from the Site would have to meet all federal, state, local, and POTW-specific pretreatment requirements.

Long-term monitoring of groundwater and surface water would be included under this alternative. Air monitoring for VOCs and landfill gases would be included, and landfill gases would be vented to the atmosphere or controlled, as needed. This alternative also includes deed restrictions with respect to the future use of the Site, and the prohibition of on-site groundwater extraction for potable use. Posting and fencing of the landfill would be included in order to reduce the frequency of trespassers on the landfill property. Contaminated off-site soils resulting from leachate seeps would be removed and consolidated within the capped area.

If deemed necessary by future groundwater monitoring data, an alternate water supply would be provided for nearby users as discussed in Alternative 2. This alternative includes the development, during the remedial design, of a contingency plan for the rapid implementation of an alternate water supply, if shown to be needed. The contingency plan would include the preliminary design for the alternate water supply. If drinking water standards are significantly exceeded for site-related parameters in residential wells, or in the same aquifer in the closest monitoring wells to the residental wells, and detected concentations are confirmed by subsequent sampling, residents would immediately be provided with bottled water and/or an acceptable point-of-use treatment system, as an interim measure until an alternate water supply could be constructed.

The higher end of the capital cost range ($29,310,000 for Option A and $25,010,000 for Option B) and present-worth cost range ($35,760,000 for Option A and $30,880,000 for Option B) reflect additional costs for the optional items which include an alternate water supply, groundwater pretreatment, and treatment of landfill gases.

Because this alternative would result in contaminants remaining on-site above health-based levels, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions may be implemented to remove or treat the wastes.

Alternative 5: Landfill Cap with Soil Cover on Side Slopes; Installation of Groundwater Extraction Wells

Capital Cost: $18,390,000 - $21,640,000
O & M Cost: $319,800 - $678,600
Present Worth Cost: $21,410,000 - $28,050,000
Time to Implement: 2 years

Alternative 5 includes a landfill cap and improvements to the existing leachate collection system. The landfill cap would be similar to the cap described in Alternative 4, Option B, except for the absence of an impermeable membrane on the side slopes of the landfill. While, the exclusion of the impermeable membrane from the cap on the side slopes would result in an increase in the quantity of leachate generated, most of the leachate is expected to be collected by the existing leachate collection system and a proposed groundwater extraction well network. The side slopes, where the existing slopes are greater than 20 percent, are estimated to represent about 25 of the 60 acres. As New York State Part 360 Solid Waste Regulations require an impermeable membrane under the entire capped surface, this alternative would require approval from the NYSDEC for a variance from New York State Part 360 regulations. This approval would be contingent upon the ability of this alternative to collect leachate before it infiltrates into the groundwater aquifers or migrates off-site. As in Alternative 4, Option B, this alternative would also require a variance from New York State Part 360 regulations for the selection of a fill layer of less than 30 inches in thickness overlying the impermeable barrier. Also as in Alternative 4, contaminated off-site soils resulting from leachate seeps would be removed and consolidated within the capped area. Also, landfill gases would be vented to the atmosphere or controlled, as needed.

The installation of groundwater extraction wells to supplement the existing leachate collection system would be implemented as described in Alternative 3. However, with the addition of a cap over the landfill, surface water would no longer have to be collected and sent for treatment. Surface water runoff on the tops of the landfill lobes where the impermeable membrane is present would be collected by a perimeter drain and diverted so as to prevent infiltration from these areas. Collected leachate and groundwater, and leachate seeps, if they occur, would be sent to a POTW for off-site treatment. The off-site treatment facility could be the Suffern Wastewater Treatment Plant, which is currently receiving wastewater discharged from the Site, or an alternate POTW. The selected POTW must be in compliance with all federal and state permit requirements. In addition, the wastewater discharged from the Site would have to meet all federal, state, local, and POTW-specific pretreatment requirements.

With a cap, there would be less infiltration into the landfill, and therefore, less potential for off-site migration of contaminated groundwater. Long-term monitoring of groundwater and surface water as discussed in Alternative 2 would be included, along with deed restrictions with respect to future use of the Site, and the prohibition of on-site groundwater extraction for potable use. Posting and fencing of the landfill would be included in order to reduce the frequency of trespassers on the landfill property.

If deemed necessary by future groundwater monitoring data, an alternate water supply would be provided for nearby users as discussed in Alternative 2. This alternative includes the development, during the remedial design, of a contingency plan for the rapid implementation of an alternate water supply, if shown to be needed. The contingency plan would include the preliminary design for the alternate water supply. If drinking water standards are significantly exceeded for site-related parameters in residential wells, or in the same aquifer in the closest monitoring wells to the residental wells, and detected concentations are confirmed by subsequent sampling, residents would immediately be provided with bottled water and/or an acceptable point-of-use treatment system, as an interim measure until an alternate water supply could be constructed.

The higher end of the capital cost range ($21,640,000) and present-worth cost range ($28,050,000) for this alternative reflect additional costs for the optional items which include an alternate water supply, groundwater pretreatment, treatment of landfill gases.

Because this alternative would result in contaminants remaining on-site above health-based levels, CERCLA requires that the Site be reviewed every five years. If justified by the review, remedial actions may be implemented to remove or treat the wastes.

SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

During the detailed evaluation of remedial alternatives, each alternative was assessed utilizing nine evaluation criteria as set forth in the NCP and OSWER Directive 9355.3-01. These criteria were developed to address the requirements of Section 121 of CERCLA to ensure all important considerations are factored into remedy selection decisions.

The following "threshold" criteria are the most important, and must be satisfied by any alternative in order to be eligible for selection:

1. Overall protection of human health and the environment addresses whether or not a remedy provides adequate protection and describes how risks posed through each exposure pathway (based on a reasonable maximum exposure scenario) are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

2. Compliance with ARARs addresses whether or not a remedy would meet all of the applicable or relevant and appropriate requirements of federal and state environmental statutes and requirements or provide grounds for invoking a waiver.

The following "primary balancing" criteria are used to make comparisons and to identify the major trade-offs between alternatives:

3. Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup goals have been met. It also addresses the magnitude and effectiveness of the measures that may be required to manage the risk posed by treatment residuals and/or untreated wastes.

4. Reduction of toxicity, mobility, or volume through treatment is the anticipated performance of a remedial technology, with respect to these parameters, that a remedy may employ.

5. Short-term effectiveness addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation periods until cleanup goals are achieved.

6. Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed.

7. Cost includes estimated capital and operation and maintenance costs, and the present worth costs.

The following "modifying" criteria are considered fully after the formal public comment period on the Proposed Plan is complete:

8. State acceptance indicates whether, based on its review of the RI/FS and the Proposed Plan, the State supports, opposes, and/or has identified any reservations with the preferred alternative.

9. Community acceptance refers to the public's general response to the alternatives described in the Proposed Plan and the RI/FS reports. Factors of community acceptance to be discussed include support, reservation, and opposition by the community.

A comparative analysis of the remedial alternatives based upon the evaluation criteria noted above follows.

Overall Protection of Human Health and the Environment

The no further action alternative, Alternative 1, would be the least protective of human health and the environment. Although it does provide for leachate collection and off-site transport of collected leachate and surface water, it does not address any of the remedial action objectives established for the Site. Alternative 2 would be more effective than Alternative 1 in protecting human health and the environment, since fencing and posting implemented under Alternative 2 would limit access to the Site by trespassers and children and would provide for an alternate water supply to nearby users, if needed. Alternative 3 would be more effective than Alternatives 1 and 2, since it would include extraction and off-site treatment of contaminated groundwater. Alternatives 1, 2, and 3, however, do not include any provision for a landfill cap and therefore do not reduce the generation of leachate, prevent human and animal contact with contaminated soil from the landfill surface, prevent erosion of contaminated surface soil, nor provide a means of treating landfill gas emissions. Hence, Alternatives 1, 2, and 3 provide limited protection of human health and the environment.

Alternative 4 is most protective of human health and the environment. Ingestion of contaminated groundwater would be prevented by groundwater collection and off-site treatment. The combination of the leachate collection system, off-site groundwater extraction wells, and a multi-media cap would mitigate groundwater contamination. The multi-media cap would reduce the amount of infiltration into the landfill, as well as the water level within the landfill. This would lower the potential for downward migration of contaminants through the bedrock aquifer and for off-site migration of contaminated groundwater. A cap in compliance with New York State Part 360 Solid Waste Regulations would reduce infiltration to an overall 1.2 percent of precipitation. Alternative 4 Option B would be equally protective as Alternative 4 Option A, provided that the synthetic material selected for the impermeable membrane would not be damaged by frost or root action.

Alternative 5 is more protective than Alternatives 1, 2, and 3, and may provide a comparable degree of protection as Alternative 4. With the soil cap in Alternative 5, which would not include a cap with an impermeable barrier over 25 of the 60 acres, infiltration would be reduced to an overall 7 percent of precipitation. Although this infiltration rate is about 6 times greater than the infiltration rate associated with Alternative 4, most of the leachate generated by infiltration of precipitation would occur under the side slopes, and would likely be collected. This is because of the relative proximity of the side slopes to the existing leachate collection system and to the proposed groundwater extraction well network.

With a properly engineered soil cover, Alternative 5 should be as effective as Alternative 4 in controlling landfill gas emissions, since both cap designs include a gas venting system that can be retrofitted, if necessary, with gas treatment. Potential difficulties with gas venting on the soil cap side slopes (e.g., from clogging) could be circumvented with a more frequent placement of vent standpipes.

Direct contact with the waste would be equally mitigated by the caps proposed in Alternatives 4 and 5.

Compliance with ARARs

A New York State Part 360 landfill cap is an action-specific ARAR for landfill closure[2]. Alternatives 1, 2, and 3 would not meet this ARAR, since they do not include any provisions for a landfill cap. Alternative 4 Option A would meet this ARAR, since it includes a cap which would be constructed according to New York State Part 360 regulations. Alternative 4 Option B would meet this ARAR only with a variance for a reduced amount of fill material covering the impermeable layer. The concept of a variance is approvable, if an appropriate synthetic impermeable barrier were used and all other requirements of New York State Part 360 *Solid Waste Regulations* for landfill closure were met. Alternative 5 would only meet this ARAR with a variance for a reduced amount of fill material covering the impermeable layer, and for the elimination of the impermeable layer on the steep side slopes of the landfill.

Alternatives 4 would be the most effective in reducing groundwater contaminant concentrations below maximum contaminant levels (MCLs) because of the lower infiltration rate of precipitation associated with capping the entire landfill including the side slopes. Alternative 5 may be nearly as effective as Alternative 4 in reducing groundwater contaminant migration, if leachate and contaminated groundwater are effectively captured by the improved leachate collection system and the proposed groundwater extraction

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2 Installing a cap will reduce infiltration of precipitation through the landfill, thereby reducing the generation of contaminated groundwater which might exceed ARARs.

wells. Alternative 3 would provide for improvements to the leachate collection system and off-site treatment of leachate and extracted groundwater. However, Alternative 3 would not include a Site cap, and, therefore, would not be in compliance with the New York State landfill closure regulations. Alternatives 1 and 2 provide no measures for containing wastes in the landfill, nor for addressing contaminated groundwater.

Under all alternatives, collected leachate and groundwater would be sent to a POTW for off-site treatment. The selected POTW must be in compliance with all federal and state permit requirements. In addition, the collected leachate and groundwater would have to meet all federal, state, local, and pretreatment requirements for the specific POTW.

Long-Term Effectiveness and Permanence

Alternative 1 does not include any additional permanent measures for containing, controlling, or eliminating any of the on-site contamination, or reducing the potential of exposure to the contaminated landfill materials.

Alternatives 2 and 3 would provide limited protection including posting, fencing, deed restrictions, and, if needed, an alternate water supply for nearby users. Alternative 3 would also provide for improvements to the existing leachate collection system. However, these alternatives include no further measures to control or remediate Site contamination.

The closure caps proposed in Alternatives 4 and 5 represent a permanent measure that could be maintained at regular intervals to ensure their structural integrity and impermeability. Alternative 5 may require additional monitoring and maintenance to ensure integrity of the cap, and to prevent leachate seeps.

Reduction in Toxicity, Mobility, or Volume Through Treatment

None of the alternatives proposed reduce the toxicity or volume of waste present in the landfill.

All of the alternatives include off-site treatment of collected leachate and groundwater. The installation of extraction wells, included with Alternatives 3 through 5, to supplement the Site's existing leachate collection system would further reduce the toxicity, mobility, and volume of contaminated groundwater than would Alternatives 1 and 2. The addition of the proposed caps in Alternatives 4 and 5 would further reduce the toxicity, mobility, and volume of contaminants by limiting or reducing infiltration of precipitation through the landfill. The soil cap in Alternative 5 would not be as effective as the cap in Alternative 4, designed in compliance with New York State Part 360 Solid Waste Regulations, in limiting generation of leachate.

Short-Term Effectiveness

Since no construction is required to implement Alternative 1, the no further action alternative, there would be no associated short-term impacts to the community, workers, or the environment. However, while no increases in risks result in the short-term, no protection against the principal Site threats would be achieved.

Alternative 2 would have the least short-term impact of the remaining alternatives, as it involves the smallest construction effort on-site in potentially contaminated areas. Alternative 3 would have the second lowest short-term impact, with limited construction activities in potentially contaminated areas. However, these alternatives would provide little protection against the principal Site threats.

Alternatives 4 and 5 contain multiple components, which increase the construction effort as well as the time required for implementation. Both alternatives include caps, which would involve clearing, grubbing, and re-grading of the landfill. Potential hazards to the surrounding community, and environment may include airborne dust and particulate emissions and an increase in noise levels. These impacts would be mitigated in part through the employment of proper construction techniques and operational procedures. Risks to on-site workers due to inhalation of contaminants adsorbed to fugitive dust would be minimized through the use of personal protection equipment. Once the surface soils are covered, the short-term impacts to the community, workers, and the environment would no longer be present.

Implementability

Alternative 1, the no further action alternative, would be the easiest of the alternatives to implement because it requires only additional monitoring of groundwater and surface water.

Alternative 2 is the second easiest alternative to implement. The construction of water supply lines and the installation of a fence would be easily implemented. Alternative 3 is the third easiest alternative to implement. The installation of extraction wells and the improvements to the leachate collection system, are not expected to be difficult to implement.

Alternatives 4 and 5 involve capping the landfill, as well as improvements to the leachate collection system. Construction methods for capping are well established, although some technical problems, particularly for large construction projects such as this, may be encountered. The potential for design and construction problems would be reduced under Alternative 5, since the soil cap would not require the installation of a synthetic impermeable barrier on steep side slopes. Stress situations such as bridging over subsidence and friction between the synthetic impermeable barrier and other cover components, especially on side slopes, may require special laboratory tests to ensure the design meets required performance standards. The synthetic liner specified in Alternatives 4 and 5 requires a special handling during installation to ensure integrity.

All of the alternatives would involve some degree of institutional management. Alternative 1 would require administrative coordination of the groundwater monitoring program and the 5-year Site status reviews, along with the development of the public education program. Alternative 2 would require a similar effort for those activities, and also for maintenance of the security fence and for installation of a water supply line to nearby residents.

In addition to the above activities, administrative requirements for Alternative 3 would include operation and maintenance of the improved leachate collection system and a pretreatment facility, if needed. Collected leachate and surface water discharged from the Site would have to be in compliance with the receiving POTW's pretreatment requirements.

Administrative requirements for Alternatives 4 and 5 include the management of the groundwater-monitoring program, improved leachate collection system, and alternate water supply and pretreatment facility, if needed. In addition, the structural integrity and impermeability of the closure cap must be maintained through a program of periodic surveillance and necessary repairs. Because of the relatively large area of the landfill, this effort and its associated cost may be fairly substantial.

Most services and materials required for implementation of all of these potential remedial alternatives are readily available. Standard construction equipment and practices can be employed for the fence installation of Alternatives 2 through 5 and the extensive construction activities of Alternatives 4 and 5. Most of the materials and equipment required for these alternatives may be obtained locally.

Because the work would be taking place on a Superfund site, all on-site personnel must have approved health and safety training. Many companies are available to provide this training to contractors. The engineering and design services required for implementation of Alternatives 3 through 5 would be available from many vendors.

Cost

Present-worth cost estimates consider a 10% discount rate and a 30-year operational period. The present-worth costs are as follows:

Alternative 1	$3,260,000
Alternative 2	$3,380,000 - $3,970,000
Alternative 3	$6,206,000 - $14,210,000
Alternative 4, Option A	$29,190,000 - $35,760,000
Alternative 4, Option B	$24,890,000 - $30,880,000

Alternative 5	$21,410,000 - $28,050,000

The higher range for the present-worth cost in Alternative 2 reflects the additional costs for the alternate water supply which is considered an optional item. The higher range of capital costs and present-worth costs in Alternatives 3, 4, and 5 reflect additional costs for the optional items which include an alternate water supply, groundwater pretreatment, and treatment of landfill gases. Table 14 presents capital costs and annual O&M costs, as well as present-worth cost estimates for all the alternatives.

State Acceptance

NYSDEC concurs with the selected remedy. NYSDEC will also concur with the contingent remedy, should the confirmatory studies determine that the contingent remedy is appropriate. See Appendix IV.

Community Acceptance

The community's comments and concerns received during the public comment period are identified and addressed in the Responsiveness Summary which is attached as Appendix V to this document.

SELECTED REMEDY

Based upon consideration of the requirements of CERCLA, the detailed analysis of the alternatives, and public comments, both NYSDEC and EPA have determined that Alternative 5 is the appropriate remedy, with Alternative 4, Option B as a contingent remedy for the Site.

While, the exclusion of the impermeable membrane from the landfill cap on the side slopes, as discussed in Alternative 5, would result in an increase in the quantity of leachate generated, most of the leachate is expected to be collected by the existing leachate collection system and a proposed groundwater extraction well network. Therefore, the selection of Alternative 5 is contingent upon its ability to adequately collect leachate before it infiltrates into the groundwater aquifers or migrates off-site. Confirmatory studies will be performed during the remedial design phase to determine whether Alternative 5 will attain a standard of performance equivalent to Alternative 4, Option B in reducing migration of contaminated groundwater, preventing leachate outbreaks, and restoring contaminated aquifers. Should the confirmatory studies indicate that Alternative 5 would not meet these objectives, then Alternative 4, Option B would be implemented at the Site, or in those Site areas where needed. Confirmatory studies may include additional groundwater flow modelling and pump tests to determine the hydraulic relationship between the upper and lower aquifers.

The selected alternative, Alternative 5, is expected to achieve substantial risk reduction through source control and a leachate and groundwater collection system.

The major components of the selected remedy are as follows:

- Installation of a cap on the tops of the landfill using a multi-media system, including layers of fill material, a gas-venting system and an impermeable membrane. The landfill side slopes will be capped using a multi-media system without an impermeable membrane, if confirmatory studies demonstrate that this approach meets remedial action objectives. Should the confirmatory studies indicate that the overall remedy's effectiveness would be significantly reduced by not including an impermeable barrier in the multi-media cap on the sideslopes, then an impermeable barrier would be included in the cap on some or all of the side slopes of the landfill;

- Regrading and compacting of the landfill mound to provide a stable foundation for the placement of the cap prior to its construction;

- Contaminated off-site soils resulting from leachate seeps would be removed and consolidated within the capped area.

- Installation of groundwater extraction wells to supplement the existing leachate collection system;

- Collection and diversion of leachate seeps to the leachate collection system for off-site treatment;

- Installation of a perimeter drain around the sections of the cap containing the impermeable membrane to collect and divert surface water runoff;

- If groundwater pretreatment is needed (pursuant to the requirements of the POTW), construction of a pretreatment facility which would be tied into the existing leachate collection and discharge system;

- Performance of air monitoring prior to, during, and following construction at the Site to ensure that air emissions resulting from the cap construction meet applicable or relevant and appropriate requirements. Perimeter air monitoring in the groundwater monitoring wells, piezometers, and additional gas monitoring wells to be installed between the landfill and the Baler Building will be performed. The gas monitoring wells will be monitored quarterly for explosive gas concentrations.

- Performance of air dispersion modeling to estimate ambient air concentrations of contaminants. Landfill gas emissions will be controlled, if necessary.

- Imposition of property deed restrictions by the appropriate State or local authorities. The deed restrictions will include measures to prevent the installation of drinking water wells at the site, and restrict activities which could affect the integrity of the cap.

- Performance of a maintenance and sampling program upon completion of closure activities. The monitoring program will fulfill the requirements of 6 NYCRR Part 360 for post-closure landfill monitoring in addition to monitoring parameters of concern found at the Site. Additional wells will be added where needed to detect any movement of site-related contaminants toward nearby private wells, including production wells of the Spring Valley Water Company.

- Development of a contingency plan for rapid implementation of measures to protect nearby residents and users of groundwater if those measures are determined to be necessary.

- Samples will be collected on a quarterly basis for site-related parameters from nearby residential wells and from new and selected existing monitoring wells. If increases are noted through this monitoring program at or immediately upgradient of the residences, the State and EPA will make a determination as to the need for appropriate action (i.e., extension of a public water line) to remedy the situation.

- Development and implementation of a dust control plan. The plan will contain all possible sources of fugitive dust emissions including intrusive field activities such as excavation or regrading of waste. Normal dust suppression techniques for handling of soils and road materials will be addressed in the plan. The plan should also include how each of these potential dust sources will be controlled by addressing the control methods that will be conducted.

- Spring Valley Water Company (SVWC) production well Nos. 93, 94, 95, and 96 will be monitored quarterly for the site parameter list, if site parameters are not already being monitored by SVWC. After one year, if the monitoring program does not show trends suggesting an impact from site-related contaminants, the monitoring schedule for these wells can be adjusted to conform with the minimum monitoring requirements specified under Chapter 10, Subpart 5-1 of the New York State Sanitary Code.

- Delineation and evaluation of any wetlands on or adjacent to the Site or impacted by the Site consistent with the <u>Federal Manual for Identifying and</u>

Delineating Jurisdictional Wetlands (1989);

- Performance of a Stage 1A cultural resources survey, as early as possible during Remedial Design, on-site and in off-site areas where there is a potential impact to cultural resources.

The purpose of this response action is to reduce the present risk to human health and the environment due to contaminants leaching from the landfill mound. The capping of the landfill will minimize the infiltration of rainfall and snowmelt into the landfill, thereby reducing the potential for contaminants leaching from the landfill and negatively impacting the wetlands habitat and groundwater quality. Capping will prevent direct contact exposure to contaminated soils, and as such will result in risks which are less than EPA's target levels of 10^{-6} and 1 for carcinogenic risks and the noncarcinogenic hazard index, respectively.

Pumping and treating the groundwater will contain the groundwater contamination within the Site boundary and will ensure that groundwater beyond the Site boundary meets applicable or relevant and appropriate state and federal standards for groundwater. The extracted leachate and groundwater will be discharged to a POTW for off-site treatment.

The response action also reduces the movement and toxicity of the contaminated landfill leachate into groundwater, and subsequent downgradient migration of contaminants.

STATUTORY DETERMINATIONS

Under its legal authorities, EPA's primary responsibilities at Superfund sites is to undertake remedial actions that achieve protection of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences. These specify that when complete, the selected remedial action for this site must comply with applicable or relevant and appropriate environmental standards established under federal and state environmental laws unless a statutory waiver is justified. The selected remedy also must be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes, as available. The following sections discuss how the selected remedy meets these statutory requirements. The contingent remedy will also meet these requirements.

Protection of Human Health and the Environment

Alternative 5 and Alternative 4, Option B are fully responsive to this criterion and to the identified remedial response objectives. Capping the landfill protects human health and the environment by reducing the mobility of contaminated materials, in that the leaching of contaminants into the aquifers will be significantly reduced. In addition, capping the landfill will eliminate threats posed to adults, children, trespassers, and wildlife who come in contact with the Site. The extraction and treatment of contaminants in groundwater will prevent the off-site groundwater from being contaminated above drinking water standards, thereby ensuring that the community continues to have a potable supply of drinking water.

Compliance with ARARs

The selected remedy would require approval from the NYSDEC for a variance from New York State Part 360 Solid Waste Regulations for the elimination of the impermeable layer on the side slopes of the landfill. NYSDEC approval of this variance is contingent upon the results of the confirmatory studies to determine the effectiveness of Alternative 5.

Both cap designs in the selected and contingent remedies specify a 12-inch fill layer overlying the impermeable barrier. The selection of a 12-inch fill layer would require approval from NYSDEC for a variance from New York State Part 360 Solid Waste Regulations in order to meet frost protection requirements. NYSDEC considers this variance to be approvable at this site, providing that a synthetic membrane meeting appropriate performance standards is used as an impermeable barrier.

Attainment of chemical-specific ARARs for groundwater will be hastened due to reduced leaching following construction of the cap and the extraction and treatment of leachate and groundwater. The source of surface water contamination (leachate seeps) will be eliminated. Action- and location-specific ARARs will be complied with during implementation.

Action-specific ARARs:

- New York State Solid Waste Management Facilities 6 NYCRR Part 360
- National Emissions Standards for Hazardous Air Pollutants (NESHAPs)
- 6 NYCRR Part 257 Air Quality Standards
- 6 NYCRR Part 212 Air Emission Standards
- 6 NYCRR Part 373 Fugitive Dusts
- 40 CFR 50 Air Quality Standards
- SPDES - Discharge

- Resource Conservation and Recovery Act (RCRA)

Chemical-specific ARARs:

- SDWA MCLs
- 6 NYCRR Part 703.5 Groundwater Quality Regulations
- 6 NYCRR Part 702 Surface Water Standards
- 10 NYCRR Part 5 State Sanitary Code

Location-specific ARARs:

- Clean Water Act Section 404, 33 USC 1344
- Fish and Wildlife Coordination Act, 16 USC 661
- National Historic Preservation Act, 16 USC 470
- New York State Freshwater Wetlands Law ECL, Article 24, 71 in Title 23
- New York State Freshwater Wetlands Permit Requirements and Classification, 6 NYCRR 663 and 664
- New York State Endangered and Threatened Species of Fish and Wildlife Requirements, 6 NYCRR 182

Other Criteria, Advisories, or Guidance To Be Considered:

- Executive Order 11990 (Protection of Wetlands)
- Executive Order 11988 (Floodplain Management)
- EPA Statement of Policy on Floodplains and Wetlands Assessments for CERCLA Actions
- New York Guidelines for Soil Erosion and Sediment Control
- New York State Sediment Criteria, December 1989
- New York State Air Cleanup Criteria, January 1990

- SDWA Proposed Maximum Contaminant Levels (PMCLs) and Maximum Contaminant Level Goals (MCLGs)
- Sole Source Aquifer (SSA) Petition under review for the Ramapo River Watershed
- NYSDEC Technical and Operational Guidance Series 1.1.1, November 1991

Cost-Effectiveness

The selected remedy and the contingent remedy provide overall effectiveness proportional to their costs. The total capital and present worth cost ranges for the selected remedy are estimated to be $18,960,000 - $22,210,000, and $19,890,000 - $26,423,000, respectively. For the contingent remedy, the corresponding cost ranges are $22,440,000 - $25,580,000 and $23,230,000 - $29,230,000, respectively.

Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected remedy and contingent remedy utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. The selected remedy and the contingent remedy represent the best balance of trade-offs among the alternatives with respect to the evaluation criteria.

The extraction and subsequent treatment of groundwater will permanently and significantly reduce the toxicity, mobility, and volume of contaminants in the groundwater. Confirmatory studies will be performed to demonstrate that the selected remedy meets all remedial action objectives. If the confirmatory studies indicate that the selected remedy is not effective in meeting remedial action objectives, then the contingency remedy will be implemented, where needed.

The selected remedy and contingent remedy will require construction of a landfill cap. No technological problems should arise since the technologies and materials needed for capping the landfill are readily available. With the construction of the landfill cap, the direct contact risk to the landfill surface will be eliminated.

Preference for Treatment as a Principal Element

The statutory preference for remedies that employ treatment as a principal element cannot be satisfied for the landfill itself, since treatment of the landfill material is not practicable. The size of the landfill and the fact that there are no identified on-site hot spots that represent the major sources of contamination preclude a remedy in which contaminants could be excavated and treated effectively. However, the selected remedy and the contingent remedy call for the treatment of contaminated groundwater at the Site and, hence, satisfy the preference for treatment for this portion of the remedy.

DOCUMENTATION OF SIGNIFICANT CHANGES

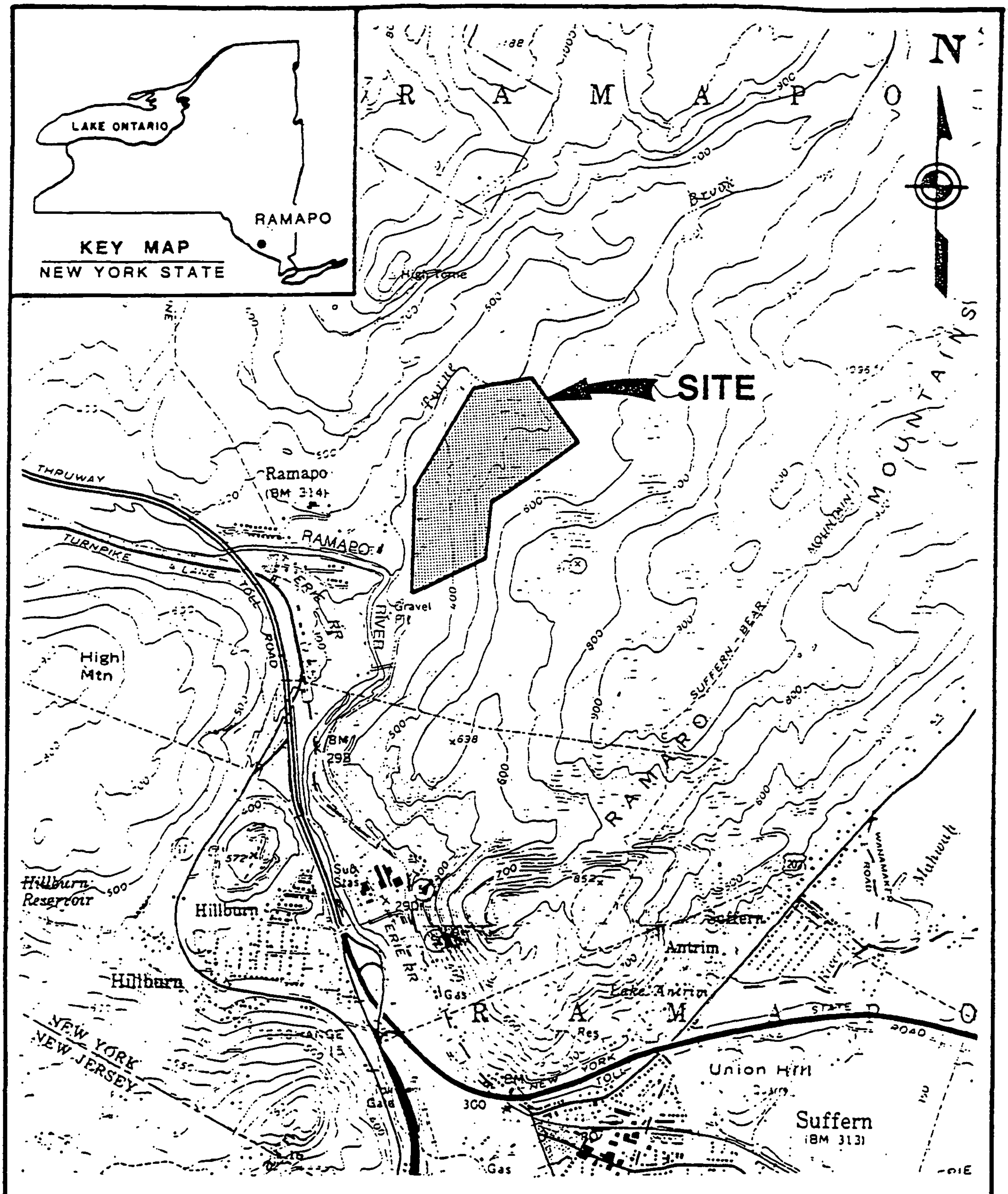
There are no significant changes from the preferred alternative presented in the Proposed Plan, other than a modification of the capital, O&M, and present worth costs associated with Alternatives 3 - 5.

In the Proposed Plan, the O&M costs associated with Alternatives 1 and 2 reflected continued treatment of the leachate from the landfill at the Suffern Wastewater Treatment plant, while Alternatives 3 - 5 reflected O&M costs associated with treatment of the leachate and groundwater at an alternative facility. The costs in ROD, however, reflect treatment of the leachate and groundwater for all of the alternatives at the Suffern Wastewater Treatment plant. The Town of Ramapo, however, is pursuing arrangements for treatment at the Rockland County Sewer District No. 1 POTW.

APPENDIX I

FIGURES

Figures

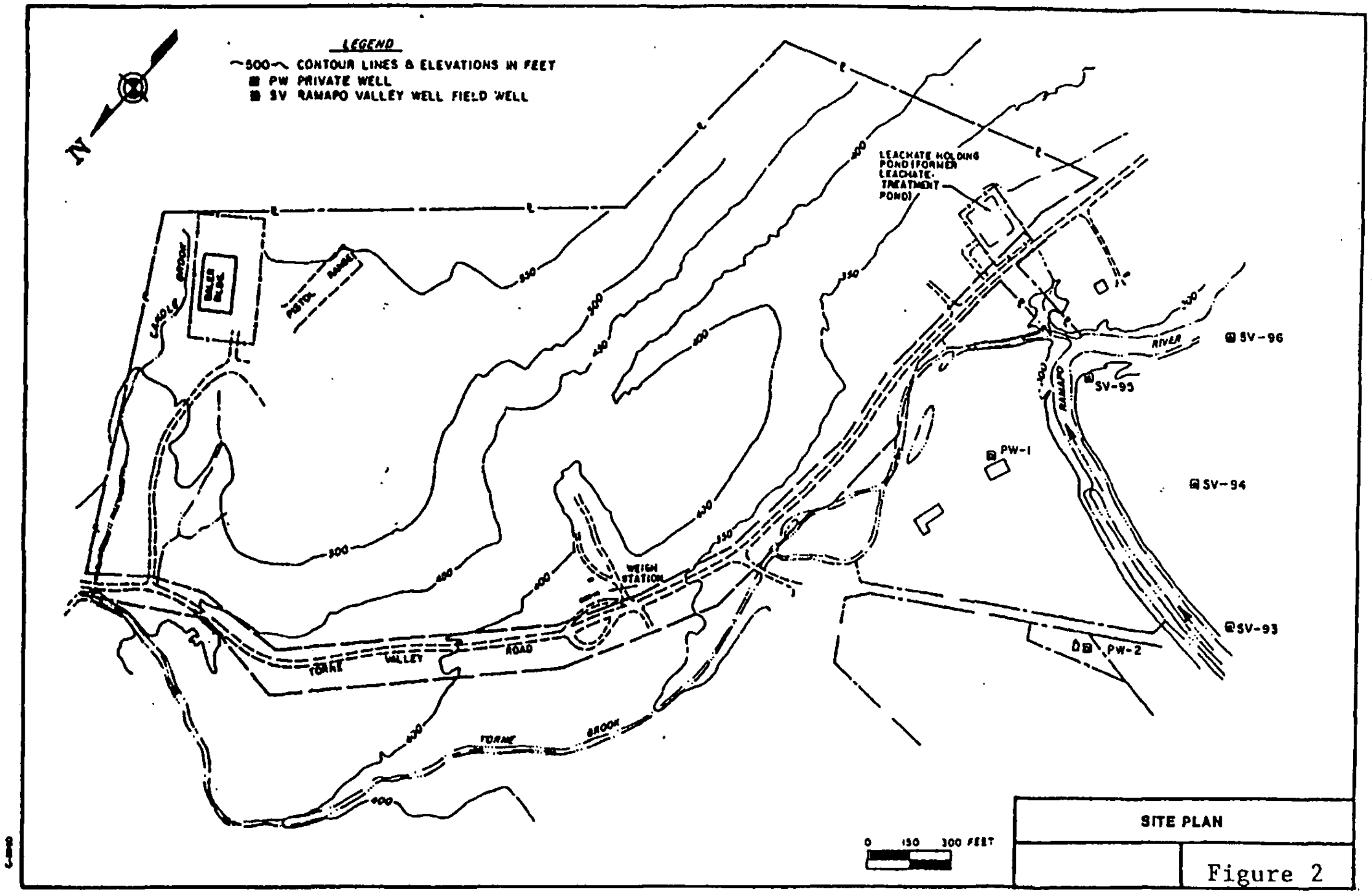


USGS 7.5 MINUTE SERIES
RAMSEY AND SLOATSBURG
QUADRANGLES (1955)

SCALE 0 1000 2000FT

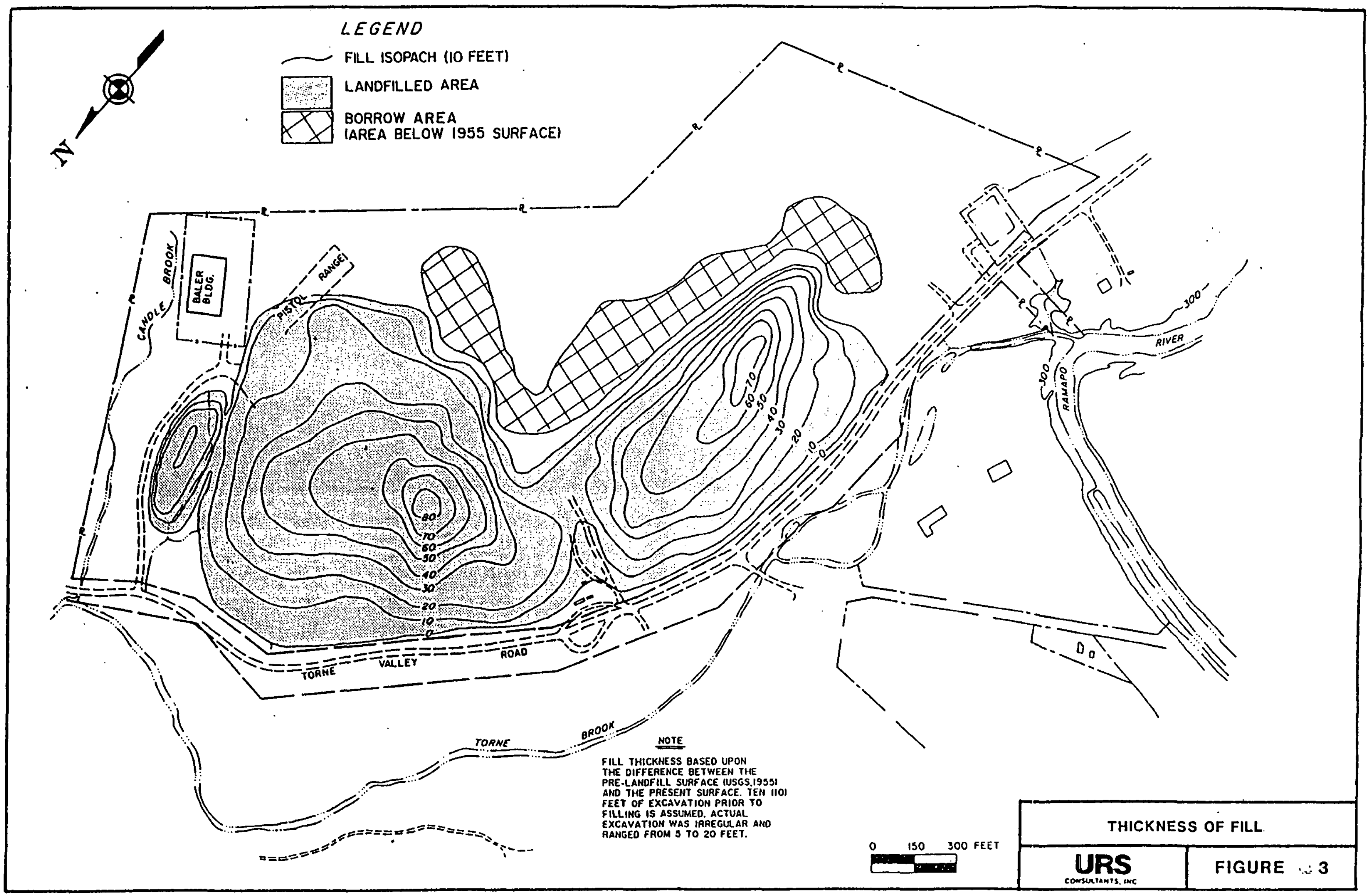
URS CONSULTANTS, INC.	SITE LOCATION	FIGURE 1

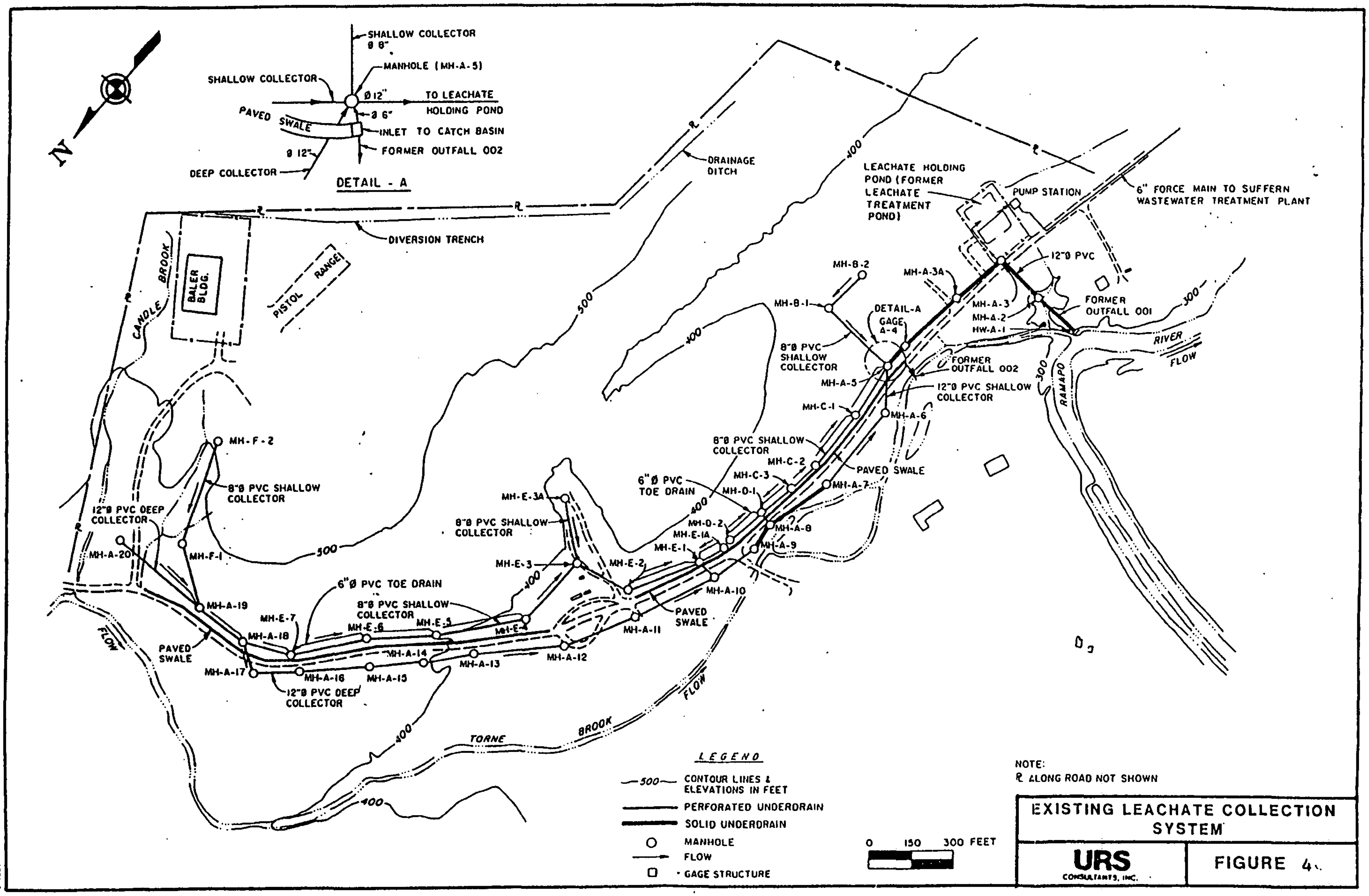
A-2936-C



SITE PLAN

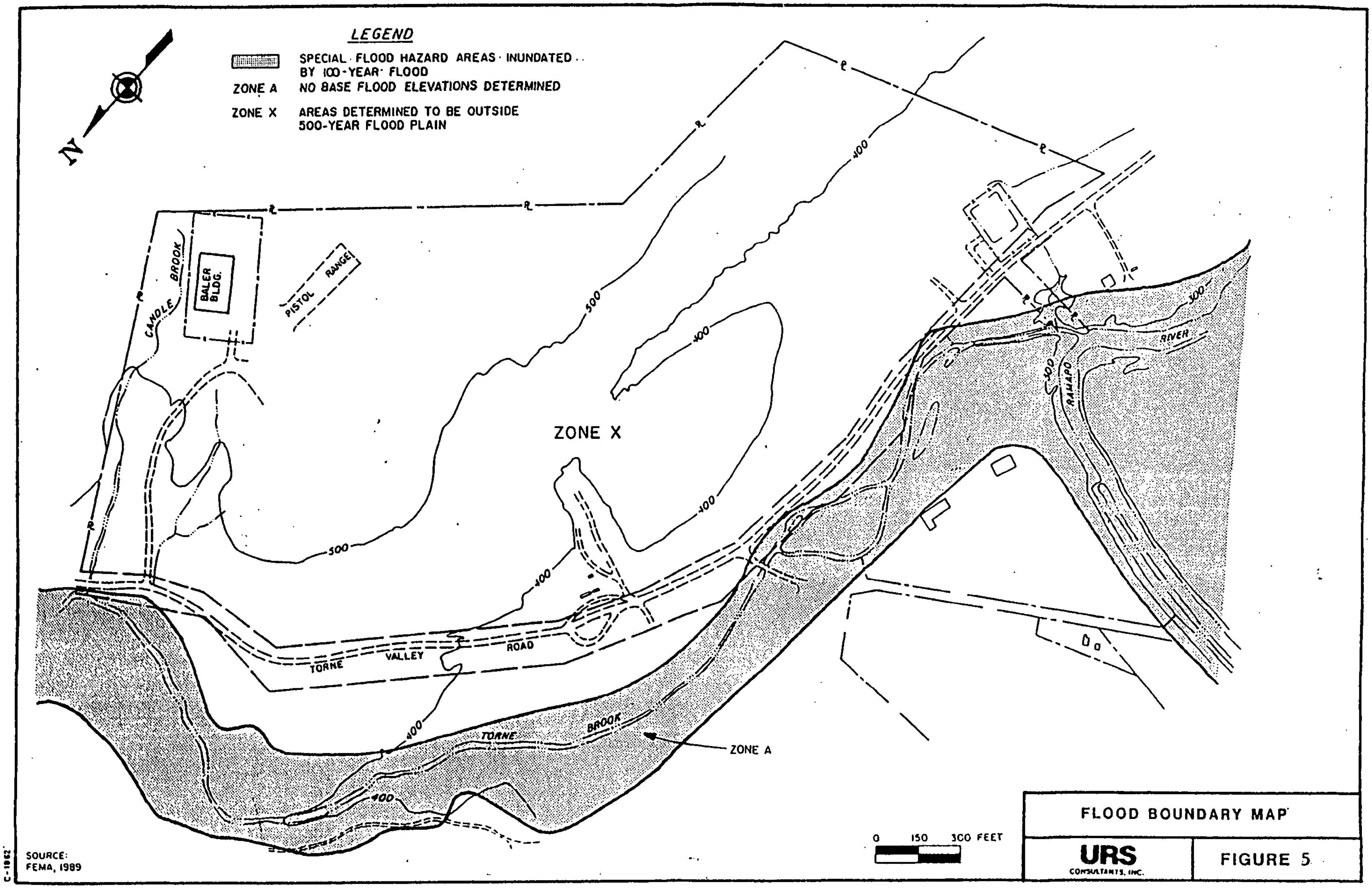
Figure 2

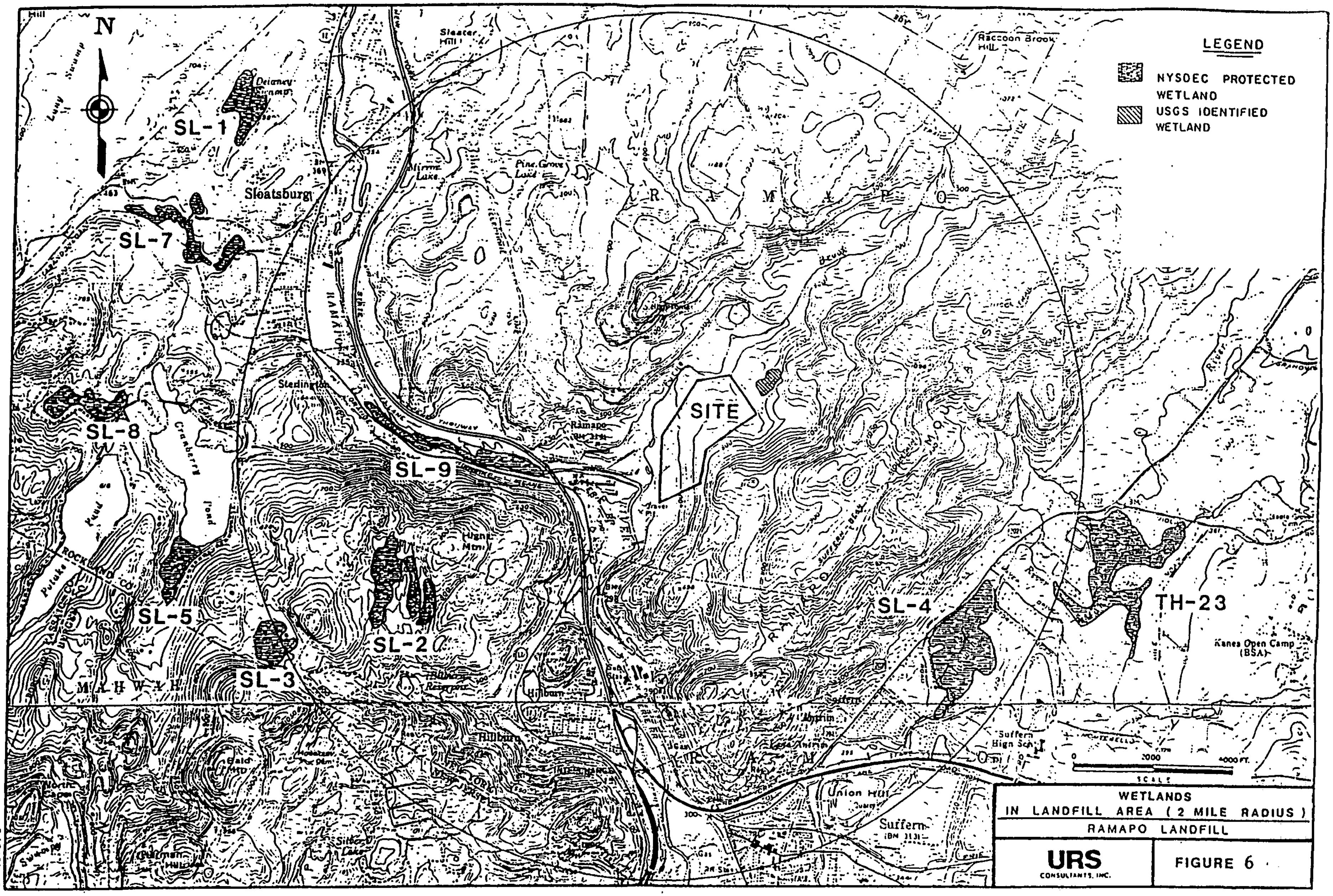

LEGEND
FILL ISOPACH (10 FEET)
LANDFILLED AREA
BORROW AREA
(AREA BELOW 1955 SURFACE)
N
CANDLE BROOK
BALER BLDG.
PISTOL RANGE
80
70
60
50
40
30
20
10
0
TORNE VALLEY ROAD
TORNE BROOK
RAMAPO RIVER
300
NOTE
FILL THICKNESS BASED UPON THE DIFFERENCE BETWEEN THE PRE-LANDFILL SURFACE (USGS,1955) AND THE PRESENT SURFACE. TEN (10) FEET OF EXCAVATION PRIOR TO FILLING IS ASSUMED. ACTUAL EXCAVATION WAS IRREGULAR AND RANGED FROM 5 TO 20 FEET.
0 150 300 FEET
THICKNESS OF FILL
URS
CONSULTANTS, INC
FIGURE 3



EXISTING LEACHATE COLLECTION SYSTEM

FIGURE 4


LEGEND
SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR FLOOD
ZONE A NO BASE FLOOD ELEVATIONS DETERMINED
ZONE X AREAS DETERMINED TO BE OUTSIDE 500-YEAR FLOOD PLAIN
N
BALER BLDG.
CANDLE BROOK
PISTOL RANGE
ZONE X
500
400
300
TORNE VALLEY ROAD
TORNE BROOK
RAMAPO RIVER
ZONE A
0 150 300 FEET
SOURCE: FEMA, 1989
C-1862
FLOOD BOUNDARY MAP
URS CONSULTANTS, INC.
FIGURE 5

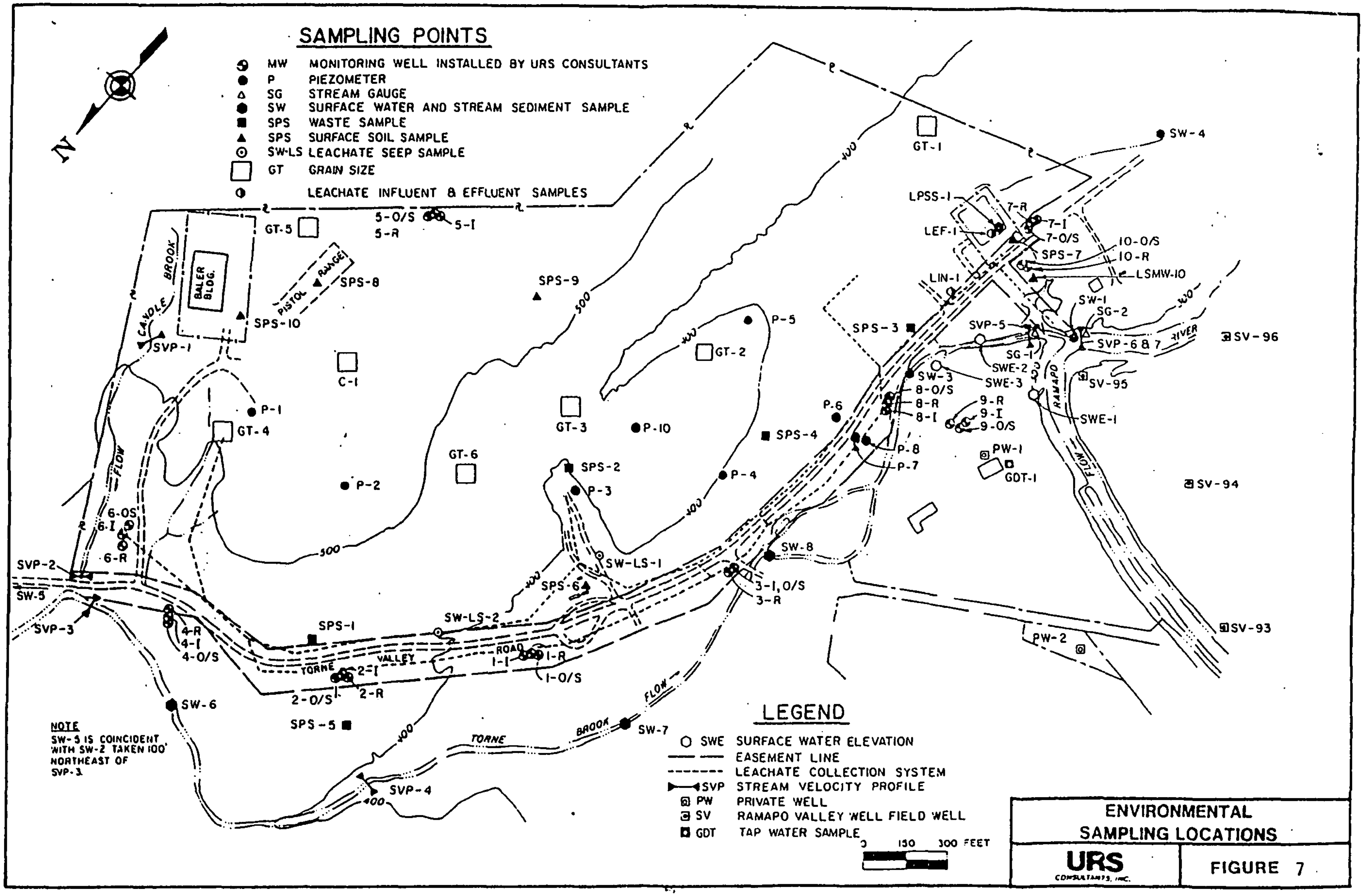


WETLANDS
IN LANDFILL AREA (2 MILE RADIUS)
RAMAPO LANDFILL

URS CONSULTANTS, INC.

FIGURE 6

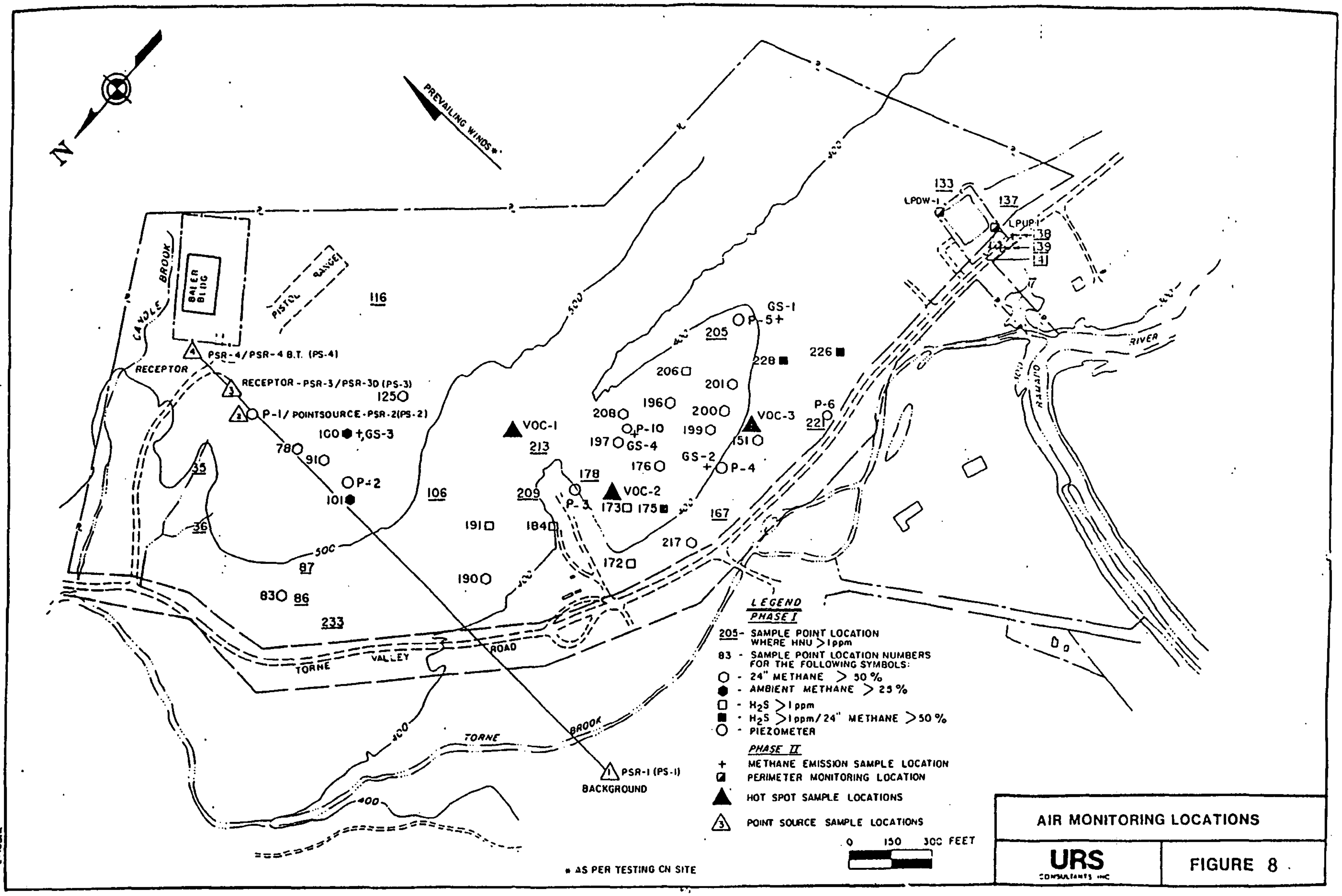
C-1879/a



ENVIRONMENTAL SAMPLING LOCATIONS

URS CONSULTANTS, INC.

FIGURE 7



AIR MONITORING LOCATIONS

FIGURE 8

APPENDIX II

TABLES

Tables

TABLE 1

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 2

COMPARISON OF MAXIMUM DOWNGRADIENT GROUNDWATER DATA TO ARARS

Parameter	Overburden Max. Conc. (ppb)	Overburden Location of Max. Conc.	Intermediate Max. Conc. (ppb)	Intermediate Location of Max. Conc.	Bedrock Max. Conc. (ppb)	Bedrock Location Max. Conc.	ARAR Value[a] (ppb)
Carbon Disulfide					2	GW-4	—
Benzene	2	GW-8	2.9	GW-8	3	GW-8	ND
1,1-Dichloroethane			3	GW-4	5	GW-4	5
Chloromethane			3	GW-8			5[b]
1,2-Dichloroethane			0.2	GW-4	0.1	GW-4	5
4-methyl-2-pentanone					3	GW-1	—
Dichlorodifluoromethane					0.2	GW-4	5[b]
Trichloroethane			0.2	GW-6			5
Acetone	21	GW-6	28	GW-2	35	GW-8	50[c]
Toluene	0.7	GW-6	1	GW-8	0.3	GW-6	5[b]
Tetrachloroethene	0.6	GDT-1	0.6	GW-6			5
cis-1,2-Dichloroethene			0.3	GW-1	0.9	GW-8	5[b]
Styrene			0.6	GW-6			5
Chlorobenzene	1	GW-8	16	GW-8	2	GW-9	5
p-Isopropyltoluene	1.2	GW-6	1.7	GW-8	1.2	GW-9	5[b]
Isopropylbenzene			3.7	GW-8	1.0	GW-9	5[b]
1,3,4-Trimethylbenzene			1.9	GW-4 GW-6			5[b]
1,2,4-Trimethylbenzene			1.4	GW-8			5[b]
1,3,5 trimethylbenzene					1.9	GW-9	5[b]
m&p-Xylene			1.3	GW-6			5
o-Xylene			0.7	GW-8			5
Propylbenzene			0.8	GW-8	0.5	GW-9	5[b]
tert-butylbenzene			1.5	GW-8			5[b]
1-2,Dichlorobenzene			1.2	GW-8	0.9	GW-9	4.7[+]
Diethylphthalate			5	GW-4	3	GW-4	50
1,4-Dichlorobenzene	1.1	GW-8					4.7[+]
Butylbenzylphthalate					2	GW-8	50
Bis(2-ethylhexyl) phthalate	3	GW-1/GW-2	30	GW-7	27	GW-7	50
Di-n-octylphthalate					130	GW-8	50
gamma-BHC					0.11	GW-9 split	ND
Naphthalene			4.2	GW-8	0.8	GW-8	10
pyrene			3	GW-9 split			50
delta-BHC			1.9	GW-4			ND
Aluminum	19,000	GW-2	5,160	GW-4	2700	GW-10	—
Arsenic	26.1	GW-8	11	GW-8	4.9	GW-9 split	25
Barium	441	GW-8	559	GW-8	117	GW-9 split	1,000
Cadmium			4.9	GW-4			10
Calcium	132,000	GW-2	113,000	GW-4	219,000	GW-8	—

TABLE 2 (Continued)

Parameter	Overburden Max. Conc. (ppb)	Overburden Location of Max. Conc.	Intermediate Max. Conc. (ppb)	Intermediate Location of Max. Conc.	Bedrock Max. Conc. (ppb)	Bedrock Location Max. Conc.	ARAR Value[a] (ppb)
Chromium	1,290	GW-3	280	GW-1	39.7	GW-1	50
Cobalt	42.3	GW-2	36.2	GW-8	19.5	GW-3	—
Copper	78.3	GW-1	20.9	GW-4	39.3	GW-8	200
Iron	229,000	GW-8	30,500	GW-8	22,700	GW-9 split	300
Lead	34.1	GW-2	5.3	GW-4	11.4	GW-4	15[f]
Magnesium	31,500	GW-6	71,400	GW-8	51,100	GW-8	35,000
Manganese	31,200	GW-10	4,500	GW-4	12,400	GW-3	300
Mercury	0.63	GW-6	2.3	GW-6	2	GW-8	2
Nickel	331	GW-3	162	GW-1	35.3	GW-9 split	—
Potassium	31,200	GW-7	196,000	GW-8	19,100	GW-9 split	—
Sodium	102,000	GW-8	643,000	GW-8	154,000	GW-9 Split	20,000
Vanadium	51.6	GW-1	19.5	GW-8	6.1	GW-10	—
Zinc	107	GW-2	23.9	GW-8	53.7	GW-8	300
BOD	20	GW-7	25	GW-4	27	GW-9	—
COD	140	GW-8	94.4	GW-8	97	GW-9	—
Total Kjeldahl Nitrogen			28.3	GW-8			
Ammonia-N	59.6	GW-8			26.4	GW-9	—
TKN	61	GW-8			25.8	GW-9	—
Alkalinity	1,048	GW-8	772	GW-8	444	GW-8	—
Acidity	563	GW-8	622	GW-8	380	GW-8	—
NO_3/NO_2-N	0.62	GW-9			0.62	GW-7	10[e]
Total Phosphorus	0.79	GW-2	0.44	GW-2	0.34	GW-1	—
Oil & Grease			3	GW-1	6.7	GW-1	
TOC	77.4	GW-3	74.8	GW-8	95.1	GW-3	0.1
TSS	5,000	GW-1	560	GW-1	60	GW-4	—
TDS	1,500	GW-8	1,200	GW-8	800	GW-8	—
pH					8.87	GW-2	
Spec. Conductance					1500	GW-8	
Sulfate	80.9	GW-2	62.8	GW-1	39.9	GW-8	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

Shaded values exceed ARARs

TABLE 3

LOCATIONS OF GROUNDWATER DATA EXCEEDING ARARS

OVERBURDEN

Parameter	Location
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 through 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

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

1,1-Dichloroethane	GW-4
Benzene	GW-4, GW-8, GW-9
Di-n-octyl phthalate	GW-8
gamma-BHC	GW-7
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

COMPARISON OF MAXIMUM SURFACE WATER CONCENTRATIONS TO 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	
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 Table 4a.

Table 4a

Calculated Surface Water ARARs

		SW-1		SW-2		SW-3		SW-5		SW-6		SW-7		SW-8	
Parameter	Units	Conc.	Calculated ARAR	Conc.	Calculated ARAR	Conc.	Calculate d ARAR	Conc.	Calculated ARAR	Conc.	Calculated ARAR	Conc.	Calculated ARAR	Conc.	Calculated 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 5

LOCATIONS OF SURFACE WATER DATA EXCEEDING ARARS

Parameter	Location
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 6
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

Sediment Cleanup Criteria (ug/kg) = AWQS/GV (ug/L) * $10^{\log Kow}$ * TOC

TABLE 7

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	PSR-1	PSR-2	PSR-3	PSR-3D	PSR-4	PSR-4BT	PSR-TB
2 - Butanone	mg/m^3	1.97	0.0054	0.0079	0.003	0.0031	ND	ND	ND	ND	0.0091	0.0075	0.011	0.018	ND
1,1,1 - Trichloroethane	mg/m^3	6.37	ND	0.0008	ND	0.0011	0.0013	ND	ND	ND	0.001	0.0007	0.0011	ND	ND
Carbon Tetrachloride	mg/m^3	0.10	ND	0.0002 J	ND	0.0007	ND	ND	ND	ND	ND	ND	0.0004	ND	ND
Benzene	mg/m^3	0.10	0.0007	0.0006	0.0003 J	0.0008	0.001	ND	ND	0.029 E	0.0005	ND	0.0006	ND	ND
Chlorobenzene	mg/m^3	1.15	ND	0.0005	ND	ND	ND	ND	ND	0.37 E	0.0007	ND	ND	ND	ND
Ethylbenzene	mg/m^3	1.45	ND	0.0026	0.0008	ND	0.0009	ND	ND	1.20 E	0.0049	0.0012	0.0009	0.0011	ND
Tetrachloroethylene	mg/m^3	1.13	ND	ND	ND	ND	ND	ND	ND	0.0041	ND	ND	ND	ND	ND
Styrene	mg/m^3	0.71	ND	ND	0.0005	ND	ND	ND	ND	ND	ND	ND	ND	0.0008	ND
Toluene	mg/m^3	1.26	0.0079	0.0016	0.0061	0.0017	0.0038	ND	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	0.011	0.007	0.0025	0.0058	ND	ND	7.70 E	0.016	0.0046	0.012	0.016	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	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	0.015 B	0.013 B	0.016 B	0.011 B	0.011 B	0.0061 B	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 quantitation limit but greater than zero.

E - Estimated value due to interference.

B - Analyte detected in the associated method blank.

Table 8

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

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	

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 9

Potential Exposure Pathways

CURRENT LAND USE	RECEPTOR	EXPOSURE ROUTE	EXPOSURE MEDIUM
Trespasser/ Recreational	Adult	Ingestion	Soil/Waste
	Child (6-11yrs)		
	Adult	Dermal	Soil/Waste
	Child (6-11yrs)		
	Adult	Inhalation	Air
	Child (6-11yrs)		
Off-site Residential	Adult	Ingestion	Groundwater
	Child (0-6yrs)		
	Adult	Inhalation	Air
	Child (0-6yrs)		
Industrial/ Commercial	Adult	Ingestion	Soil/Waste
	Adult	Dermal	Soil/Waste
FUTURE LAND USE			
On-site Residential	Adult	Ingestion	Soil/Waste
	Child (0-6yrs)		
	Adult	Dermal	Soil/Waste
	Child (0-6yrs)		
	Adult	Ingestion	Groundwater
	Child (0-6yrs)		
	Adult	Inhalation	Groundwater
	Child (0-6yrs)		
	Adult	Inhalation	Air
	Child (0-6yrs)		
Industrial/ Commercial	Adult	Ingestion	Soil/Waste
	Adult	Dermal	Soil/Waste
	Adult	Ingestion	Groundwater
	Adult	Inhalation	Air

TABLE 10

TOXICITY VALUES: POTENTIAL NONCARCINOGENIC EFFECTS

CHEMICAL	TOXICITY VALUES (mg/kg-day)				REF/SOURCE				DATE RECORDED
	SUBCHRONIC		CHRONIC		SUBCHRONIC		CHRONIC		
	INHALATION Rfc	ORAL RfJ	INHALATION Rfc	ORAL RfJ	INHALATION Rfc	ORAL Rfd	INHALATION Rfc	ORAL Rfd	Inhal/Oral
Acenaphthene	ND	6.00E-01	ND	6.00E-02	HEAST	HEAST	HEAST	IRIS	4-FY90/FY91
Acetone	ND	1.00E+00	ND	1.00E-01	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	HEAST	HEAST	HEAST	IRIS	4-FY90/FY91
Arsenic (d)	ND	1.00E-03	ND	1.00E-03	HEAST	HEAST	HEAST	HEAST	4-FY90
Barium	1.00E-03	7.00E-02	1.00E-04	5.00E-02	HEAST	IRIS	HEAST	HEAST	4-FY90/8-91
Benzo(g,h,i)perylene (c)		4.00E-02		4.00E-03	HEAST	HEAST	HEAST	HEAST	4-FY90
Benzoic Acid	ND	4.00E+00	ND	4.00E+00	HEAST	HEAST	HEAST	IRIS	4-FY90/1-91
Beryllium	ND	5.00E-03	ND	5.00E-03	HEAST	HEAST	HEAST	IRIS	4-FY90/9-90
Bis(2-ethylhexyl)phthalate (d	ND	2.00E-02	ND	2.00E-02	HEAST	HEAST	HEAST	IRIS	4-FY90/9-89
2-Butanone (MEK)	9.00E-01	5.00E-01	9.00E-02	5.00E-02	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	HEAST	HEAST	HEAST	IRIS	4-FY90/9-89
Cadmium	ND	ND	ND	5.00E-04 (c)	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	ECAO	HEAST	HEAST	IRIS	4-FY90/9-90
Chromium(III)	5.71E-06	1.00E+01	5.71E-07	1.00E+00	HEAST	HEAST	HEAST	IRIS	FY91
Chlorobenzene	5.00E-02	2.00E-01	5.00E-03	2.00E-02	HEAST	HEAST	HEAST	IRIS	4-FY90/3-91
Cobalt	ND	ND	1.00E-06	1.00E-05	ECAO	ECAO	ECAO	ECAO	4-91
Copper	ND	ND	ND	ND	HEAST	HEAST	HEAST	HEAST	4-FY90
Cumene (Isopropylbenzene)	2.57E-02 (a)	4.00E-01	2.57E-03 (a)	4.00E-02	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	HEAST	HEAST	HEAST	IRIS	4-FY90/3-91
1,4-Dichlorobenzene	2.00E-01 (a)	ND	2.00E-01 (a)	ND	HEAST	HEAST	HEAST	HEAST	4-FY90
Dichlorodiflouromethane	5.00E-01	9.00E-01	5.00E-02	2.00E-01	HEAST	HEAST	HEAST	IRIS	4-FY90/8-90
1,1-Dichloroethane	1.00E+00	1.00E+00	1.00E-01	1.00E-01	HEAST	HEAST	HEAST	HEAST	4-FY90
cis-1,2-Dichloroethene	ND	1.00E-01	ND	1.00E-02	HEAST	HEAST	HEAST	IRIS	4-FY90/1-89
Dieldrin	ND	5.00E-05	ND	5.00E-05	HEAST	HEAST	HEAST	IRIS	4-FY90/9-90
Diethylphthalate	ND	8.00E+00	ND	8.00E-01	HEAST	HEAST	HEAST	IRIS	4-FY90/9-87
Di-n-octylphthalate	ND	2.00E-02	ND	2.00E-02	HEAST	HEAST	HEAST	HEAST	4-FY90
Ethylbenzene	2.86E-01	1.00E+00	2.86E-01	1.00E-01	HEAST	HEAST	IRIS	IRIS	4-FY90/FY91
Fluoranthene	ND	4.00E-01	ND	4.00E-02	HEAST	HEAST	HEAST	IRIS	FY91
Fluorene	ND	4.00E-01	ND	4.00E-02	HEAST	HEAST	HEAST	IRIS	FY91
Iron	Data inadequate for quantitative risk assessment (HEA								
Lead (d)	ND	ND	ND	ND	HEAST	HEAST	HEAST	IRIS	4-FY90/2-91
Lindane (gamma-BHC)	ND	3.00E-03	ND	3.00E-04	HEAST	HEAST	HEAST	IRIS	4-FY90/3-88
delta-BHC	Data inadequate for quantitative risk assessment (HEAST)								
Manganese	1.14E-04 (a)	1.00E-01	1.14E-04** (a)	1.00E-01	HEAST	HEAST	IRIS	IRIS	4-FY90/12-90
Mercury	8.57E-05 (a)	3.00E-04	8.57E-05 (a)	3.00E-04	HEAST	HEAST	HEAST	HEAST	4-FY90
Methylene Chloride (d)	8.57E-01 (a)	6.00E-02	8.57E-01 (a)	6.00E-02	HEAST	HEAST	HEAST	IRIS	4-FY90/3-88
2-Methylnaphthalene (c)		4.00E-02		4.00E-03	HEAST	HEAST	HEAST	HEAST	4-FY90
4-Methyl-2-Pentanone	2.00E-01	5.00E-01	2.00E-02	5.00E-02	HEAST	HEAST	HEAST	IRIS	4-FY90/3-91
Naphthalene	ND	4.00E-02	ND	4.00E-03	HEAST	HEAST	HEAST	HEAST	4-FY90
Nickel (d)	ND	2.00E-02	ND	2.00E-02	HEAST	HEAST	HEAST	HEAST	4-FY90
Phenanthrene (c)		4.00E-02		4.00E-03	HEAST	HEAST	HEAST	HEAST	4-FY90
Phenols(Total) *	ND	6.00E-01 (b)	ND	6.00E-01 (b)	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	HEAST	HEAST	HEAST	HEAST	4-FY90
Sodium									
Styrene	ND	2.00E+00	ND	2.00E-01	HEAST	HEAST	HEAST	IRIS	4-FY90/9-90
Tetrachloroethene	ND	1.00E-01	ND	1.00E-02	HEAST	HEAST	HEAST	IRIS	4-FY90/3-88
Toluene	5.71E-01 (a)	2.00E+00	5.71E-01 (a)	2.00E-01	HEAST	HEAST	HEAST	IRIS	4-FY90/8-90
1,1,1-Trichloroethane	3.00E+00	9.00E-01	3.00E-01	9.00E-02	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	HEAST	HEAST	HEAST	HEAST	4-FY90
Xylenes, Total	8.57E-02	4.00E+00	8.57E-02	2.00E+00	HEAST	HEAST	IRIS	IRIS	4-FY90/FY91
Zinc	ND	2.00E-01	ND	2.00E-01	HEAST	HEAST	HEAST	HEAST	4-FY90
Carbon Tetrachloride (d)	ND	7.00E-03	ND	7.00E-04	HEAST	HEAST	HEAST	IRIS	4-FY90/3-91
Chlordane (d)	NA	6.00E-05	ND	6.00E-05	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 RfJ for naphthalene (HEAST 4-FY90).

d - Refer to Table 6-21 for carcinogenic effects.

e - RfJ is based on water.

Table 11
Summary of Noncancer Risks

CURRENT LAND USE	RECEPTOR	EXPOSURE ROUTE	EXPOSURE MEDIUM	HAZARD QUOTIENT
Trespasser/ Recreational	Adult	Ingestion	Soil/Waste	<0.01
	Child (6-11yrs)			<0.01
	Adult	Dermal	Soil/Waste	<0.01
	Child (6-11yrs)			<0.01
	Adult	Inhalation	Air	0.329
	Child (6-11yrs)			6.24
Off-site Residential	Adult	Ingestion	Groundwater	<0.01
	Child (0-6yrs)			<0.01
	Adult	Inhalation	Groundwater	<0.01
	Child (0-6yrs)			<0.01
Industrial/ Commercial	Adult	Ingestion	Soil/Waste	<0.01
	Adult	Dermal	Soil/Waste	<0.01
	Adult	Inhalation	Air	6.58
FUTURE LAND USE				
On-site Residential	Adult	Ingestion	Soil/Waste	<0.01
	Child (0-6yrs)			<0.01
	Adult	Dermal	Soil/Waste	0.151
	Child (0-6yrs)			<0.01
	Adult	Ingestion	Groundwater	1.79
	Child (0-6yrs)			3.10
	Adult	Inhalation	Groundwater	0.085
	Child (0-6yrs)			0.057
	Adult	Inhalation	Air	19.2
	Child (0-6yrs)			42.6
Industrial/ Commercial	Adult	Ingestion	Soil/Waste	<0.01
	Adult	Dermal	Soil/Waste	<0.01
	Adult	Ingestion	Groundwater	1.23
	Adult	Inhalation	Air	6.58

NONCANCER RISK SUMMARY

CURRENT LAND USE		
Trespasser/ Recreational	Adult	0.3
	Child	6
Off-site Residential	Adult	<0.01
	Child	<0.01
Industrial/ Commercial	Adult	7
FUTURE LAND USE		
On-site Residential	Adult	20
	Child	50
Industrial	Adult	8

TABLE 12

TOXICITY VALUES: POTENTIAL CARCINOGENIC EFFECTS

CHEMICAL	SLOPE FACTORS (mg/kg-day)^-1		WEIGHT-OF-EVIDENCE		TUMOR SITE		REFERENCE / SOURCE		DATE RECORDED
	INHALATION	ORAL	INHALATION	ORAL	INHALATION	ORAL	INHALATION	ORAL	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.

a - Calculated from oral unit risk of 5E-5[μg/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 13

Summary of Cancer Risks

CURRENT LAND USE	RECEPTOR	EXPOSURE ROUTE	EXPOSURE MEDIUM	CANCER RISK
Trespasser/ Recreational	Adult	Ingestion	Soil/Waste	2.25E-6
	Child (6-11yrs)			2.88E-6
	Adult	Dermal	Soil/Waste	4.82E-7
	Child (6-11yrs)			3.73E-6
	Adult	Inhalation	Air	8.55E-7
	Child (6-11yrs)			4.55E-6
Off-site Residential	Adult	Ingestion	Groundwater	1.97E-8
	Child (0-6yrs)			3.68E-9
	Adult	Inhalation	Groundwater	5.38E-10
	Child (0-6yrs)			2.51E-10
Industrial/ Commercial	Adult	Ingestion	Soil/Waste	5.63E-6
	Adult	Dermal	Soil/Waste	4.58E-6
	Adult	Inhalation	Air	1.71E-5
FUTURE LAND USE				
On-site Residential	Adult	Ingestion	Soil/Waste	8.22E-6
	Child (0-6yrs)			1.28E-5
	Adult	Dermal	Soil/Waste	1.76E-6
	Child (0-6yrs)			5.27E-6
	Adult	Ingestion	Groundwater	1.03E-4
	Child (0-6yrs)			3.19E-5
	Adult	Inhalation	Groundwater	5.38E-6
	Child (0-6yrs)			1.39E-6
	Adult	Inhalation	Air	5.00E-5
	Child (0-6yrs)			3.10E-5
Industrial/ Commercial	Adult	Ingestion	Soil/Waste	5.63E-6
	Adult	Dermal	Soil/Waste	4.58E-6
	Adult	Ingestion	Groundwater	7.03E-5
	Adult	Inhalation	Air	1.71E-5

CANCER RISK SUMMARY

CURRENT LAND USE		
Trespasser/ Recreational	Adult	4E-6
	Child	1E-5
Off-site Residential	Adult	2E-8
	Child	4E-9
Industrial/ Commercial	Adult	3E-5
FUTURE LAND USE		
On-site Residential	Adult	2E-4
	Child	8E-5
Industrial	Adult	1E-4

TABLE 14

SUMMARY OF CAPITAL, OPERATION AND MAINTENANCE, AND PRESENT WORTH COSTS FOR ALL REMEDIAL ALTERNATIVES ASSOCIATED WITH THE RAMAPO LANDFILL SITE

ALTERNATIVE		CAPITAL COST	OPERATION AND MAINTENANCE COST	PRESENT WORTH COST
Alternative 1:	No Further Action with Monitoring	$0	$345,700	$3,260,000
Alternative 2:	Limited Action (with Option for Alternate Water Supply)	$190,000 - $710,000	$345,700	$3,380,000 - $3,970,000
Alternative 3:	Installation of Groundwater Extraction Wells	$1,040,000 - $3,300,000	$547,300 - $1,156,000	$6,206,000 - $14,210,000
Alternative 4A:	Landfill Cap; Installation of Groundwater Extraction Wells	$26,170,000 - $29,310,000	$319,600 - $622,600	$29,190,000 - $35,760,000
Alternative 4B:	Landfill Cap; Installation of Groundwater Extraction Wells	$21,870,000 -$25,010,000	$319,600 - $622,600	$24,890,000 - $30,880,000
Alternative 5:	Landfill Cap with Soil Cover on Side Slopes; Installation of Groundwater Extraction Wells	$18,390,000 - $21,640,000	$319,800 - $678,600	$21,410,000 - $28,050,000