FEASIBILITY STUDY REPORT
FOR
HERTEL LANDFILL SITE
PLATTEKILL, NEW YORK
VOLUME 1
EPA WORK ASSIGNMENT NO. 003-2LH7
JULY, 1991

REGION II

ALTERNATIVE REMEDIAL CONTRACTING STRATEGY (ARCS)
FOR
HAZARDOUS WASTE REMEDIAL SERVICES

EPA Contract No. 68-S9-2001

TAMS CONSULTANTS, Inc.

and

TRC ENVIRONMENTAL CONSULTANTS, Inc.

EXECUTIVE SUMMARY

A Feasibility Study (FS) for the Hertel Landfill site, located in Plattekill, New York (National Priority List No. 810, August 1990) is being conducted for the U.S. Environmental Protection Agency - Region II by TAMS Consultants, Inc. and TRC Environmental Consultants, Inc. The purpose of this FS is to evaluate a range of remedial alternatives which will provide a basis for the selection of an alternative that is protective of human health and the environment. The FS is based on an earlier Remedial Investigation (RI) which investigated the nature and extent of contamination at the site and characterized environmental impact and potential health risks posed by the site.

The Hertel Landfill site operated as an active landfill between the mid 1960's and the late 1970's, receiving municipal wastes and other wastes, including paint wastes, oily wastes, printing wastes fibrous materials, drums, engine blocks and farm equipment, as evidenced by their presence at or near the surface of the site.

The extent of the landfill area and contamination associated with the presence of the landfill was identified and described in the Remedial Investigation Report (TAMS/TRC, July 1991). The investigation indicated that the landfill covers approximately 13 acres of the 80-acre site, consists primarily of household refuse with some metal debris, and varies in thickness to over 16.5 feet. Other distinct areas of waste disposal include surficial paint wastes, and oily wastes.

The samples collected and analyzed from the environmental media at the site provided an overview of contaminant types and distribution. Volatile organic compounds, base/neutral/acid extractable compounds, and metals

(inorganics) were the primary contaminants detected at the site and were distributed as follows:

- The volatile organic compounds (VOCs) were distributed in samples of soil, ground water, sediment, seep water and surface water adjacent to the fill. The most commonly occurring VOCs identified at the site were aromatic hydrocarbons which were present in samples of ground water, subsurface soil, seep water and seep sediment, but not present in surface water samples. Other VOCs, including chlorinated hydrocarbons, were detected in samples of subsurface or surface soils, ground water, seep water, seep sediment, surface water and sediment samples. In most cases, the VOCs were not observed in sediment or surface water samples from downgradient of the site. VOCs exceeded Federal or New York standards for ground water and surface water. No VOCs exceeded New York State Sediment Criteria Guidance.

- The base/neutral/acid extractable (BNA) compounds were identified in all the media sampled on site. Polynuclear aromatic hydrocarbons (PAHs), a subset of the BNA compounds, were present in samples from surface and subsurface soils, on-site ground water, seep water and seep sediment. PAHs were not detected in on-site surface water or sediment. Phenols and phenolic compounds were detected in on-site subsurface soil, ground water and surface water samples. Phenols were not detected in off-site surface water and were detected in only one downgradient sediment sample. Phthalate esters were present all sampled media, including background samples of soil, sediment and ground water. Other BNA compounds are present in samples from on-site soil, ground water, seep water, seep sediment and wetland sediment, but were not detected in downgradient surface water or sediment samples. BNAs exceeded Federal or New York standards for ground water and surface water. For one seep sediment sample, three PAHs exceeded the New York State Sediment Criteria Guidance.

- Metals and other inorganics are widespread in nature and their presence must be compared with natural background in order to determine if landfill impacts are present. Aluminum, arsenic, barium, calcium, copper, chloride, cadmium, chromium, iron, potassium, magnesium, manganese, lead, mercury, sodium, zinc and cyanide all appeared at elevated concentrations in one or more samples from the various media sampled. Calcium, chloride, potassium, magnesium, manganese and sodium, all considered leachate indicator parameters, were noted at above-background concentrations in off-site surface water samples, although the concentrations decreased with distance from the landfill. Inorganics were also detected at elevated levels in downgradient sediment samples. Dissolved arsenic, iron, magnesium, manganese and sodium (as detected in filtered ground water samples) exceeded New York ground water standards. Ten metals exceeded the New York Sediment Criteria Guidance.

A health and environmental risk assessment was conducted to quantitatively and qualitatively assess the potential impacts of the landfill on human and ecological health. For the human health component of the risk assessment, both current and future land use scenarios were considered. The primary cancer and non-cancer risks were associated with the future use of the site as a residential area. The routes of exposure of most concern included dermal contact with soil, ingestion of ground water and ingestion of soil. The chemicals of primary concern include PAHs, arsenic, and chromium in soil and ground water, and manganese in ground water.

The feasibility study process uses the information on the nature and extent of contamination and associated health and environmental risks developed during the RI to develop and evaluate potential remedial alternatives and their overall protection of human health and the environment. The initial step in the Feasibility Study was the identification and screening of soil/waste and ground water remedial technologies on the basis of technical implementability. Because the majority of the surface water/sediment contaminants were attributable to leachate seeps, which would be addressed in the remediation of the soil/waste and ground water, remediation of the surface water/sediment as a separate matrix was not considered. Technology process options were then evaluated on the basis of effectiveness, implementability and cost, and representative process options to be used in the development of remedial alternatives were selected. Nine remedial alternatives, combining remedial technologies applicable to the soil/waste and ground water, were developed based on guidelines for alternative development specified in the National Contingency Plan. An initial screening of the nine alternatives on the basis of effectiveness, implementability and cost resulted in the elimination of four alternatives (referred to as Alternatives 3, 5, 6, and 7) from further consideration.

Five alternatives were retained for detailed analysis and were evaluated on the basis of the following seven criteria:

Short-term effectiveness;
Long-term effectiveness and permanence;
Implementability;
Reduction of toxicity, mobility or volume through treatment;
Compliance with ARARs;
Overall protection of human health and the environment; and
Cost

The five alternatives retained for detailed analyses are summarized in Table ES-1. The results of the detailed analyses, by alternative, are presented in Tables ES-2 through ES-8.

TABLE ES-1
HERTEL LANDFILL FEASIBILITY STUDY

REMEDIAL ALTERNATIVES
ALTERNATIVE DESCRIPTIONS

Alternative 1:	No action	No remedial activities conducted; continued ground water monitoring.
Alternative 2:	Site use restrictions, capping	Site use restrictions and ground water use restrictions; capping of the landfill area (12.2 acres) to limit exposure to contaminants and infiltration of precipitation.
Alternative 2A:	Site use restrictions, capping and slurry wall construction	Site use restrictions and ground water use restrictions; capping of the landfill area (12.2 acres) to limit exposure to contaminants and infiltration of precipitation, slurry wall (1800 feet in length, 40 feet deep) to minimize ground water flow through landfilled waste materials.
Alternative 4:	Site use restrictions, capping; Ground water extraction with on-site physical treatment	Site use restrictions and ground water use restrictions; capping of the landfill area (12.2 acres) to limit exposure to contaminants and infiltration of precipitation, ground water extraction (approximately 14,000 gallons per day) with treatment using chemical precipitation for inorganic removal and carbon adsorption for organic removal.
Alternative 4A:	Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	Site use restrictions and ground water use restrictions; capping of the landfill area (12.2 acres) to limit exposure to contaminants and infiltration of precipitation, ground water extraction (approximately 14,000 gallons per day) with treatment using membrane microfiltration for inorganic removal and UV oxidation for organic treatment.

TABLE ES-2
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
SHORT-TERM EFFECTIVENESS

Alternative 1:	No action	No remedial activities conducted: therefore no short-term risks other than existing baseline risks result. Remedial response objectives not achieved
Alternative 2:	Site use restrictions, capping	Non-cancer risks to on-site workers exceed acceptable levels; personal protective equipment required Effective in limiting soil exposure risks within a short time frame: no protection against contaminated ground water migration
Alternative 2A:	Site use restrictions, capping and slurry wall construction	Non-cancer risks to on-site workers exceed acceptable levels; personal protective equipment required Effective in limiting soil exposure risks and continued contamination of ground water to a limited time frame
Alternative 4:	Site use restrictions, capping: Ground water extraction with on-site physical treatment	Non-cancer risks to on-site workers exceed acceptable levels; personal protective equipment required Effective in limiting soil exposure risks and migration of contaminated ground water to a limited time frame
Alternative 4A:	Site use restrictions, capping: Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	Non-cancer risks to on-site workers exceed acceptable levels; personal protective equipment required Effective in limiting soil exposure risks and migration of contaminated ground water to a limited time frame

TABLE ES-3
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 1:	No action	Baseline risks remain unchanged
Alternative 2:	Site use restrictions, capping	Surface and subsurface soil/waste contaminants are untreated but contained; Long-term monitoring of containment area and ground water required; Potential long-term risks associated with contaminated ground water migration not addressed
Alternative 2A:	Site use restrictions, capping and slurry wall construction	Surface and subsurface soil/waste contaminants are untreated but contained; Long-term contact between ground water and waste materials minimized or eliminated, thereby limiting potential for contaminated ground water migration; Long-term monitoring of containment area and ground water required
Alternative 4:	Site use restrictions, capping; Ground water extraction with on-site physical treatment	Surface and subsurface soil/waste contaminants are untreated but contained; Contaminated ground water migration minimized through pumping and on-site treatment; Long-term monitoring of containment areas and ground water required; may not be effective in maintaining cleanup levels in ground water once pump and treat operations are discontinued
Alternative 4A:	Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	Surface and subsurface soil/waste contaminants are untreated but contained; Contaminated ground water migration minimized through pumping and on-site treatment; Long-term monitoring of containment areas and ground water required; may not be effective in maintaining cleanup levels in ground water once pump and treat operations are discontinued

TABLE ES-4
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
IMPLEMENTABILITY

ALTER-NATIVE	DESCRIPTION OF ALTERNATIVE	TECHNICAL FEASIBILITY	ADMINISTRATIVE FEASIBILITY	AVAILABILITY OF SERVICES AND MATERIALS
1:	No action	Installation of additional monitoring wells is feasible	No inter-agency coordination required	Suppliers of services and equipment readily available
2:	Site use restrictions, capping	Construction easily implemented; Cap could inhibit future remedial activites in capped area or could enhance activities such as ground water extraction	Requires compliance with wetlands protection regulations	Suppliers of services and equipment readily available
2A:	Site use restrictions, capping and slurry wall construction	Construction fairly easily implemented, although presence of boulders and slopes could complicate slurry wall construction; Cap could inhibit future remedial activites in capped area	Requires compliance with wetlands protection regulations	Suppliers of services and equipment readily available
4:	Site use restrictions, capping; Ground water extraction with on-site physical treatment	Construction easily implemented; Ground water treatment technologies easily implemented; Cap could inhibit future remedial activites in capped area	Requires compliance with wetlands protection regulations and authorization to discharge treated ground water to surface water	Suppliers of services and equipment readily available
4A:	Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	Construction easily implemented; Technical problems possible with ground water treatment system; Cap could inhibit future remedial activities in capped area	Requires compliance with wetlands protection regulations and authorization to discharge treated ground water to surface water	Suppliers of services and equipment for ground water treatment system limited

TABLE ES-5
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
REDUCTION OF TOXICITY (T), MOBILITY (M) OR VOLUME (V) THROUGH TREATMENT

Alternative 1:	No action	No reductions in T, M or V: Site conditions remain unchanged
Alternative 2:	Site use restrictions, capping	No reduction in T or V; M of ground water contamination is decreased through containment and prevention of leachate production; ground water table remains within waste materials
Alternative 2A:	Site use restrictions, capping and slurry wall construction	No reduction in T or V; M of ground water contamination is decreased through prevention of leachate production and minimization of contact between waste materials and ground water table
Alternative 4:	Site use restrictions, capping; Ground water extraction with on-site physical treatment	T of ground water reduced through treatment; M of ground water reduced through pumping; No reduction of T or V of soil/waste; M of soil/waste is decreased through containment; Permanence of ground water T reductions not well-defined since ground water table resumes contact with wastes upon discontinuation of pump and treat system
Alternative 4A:	Site use restrictions, capping; Ground water extraction with on-site innovative treatment	T of ground water reduced through treatment; M of ground water reduced through pumping; No reduction of T or V of soil/waste; M of soil/waste is decreased through containment; Permanence of ground water T reductions not well-defined since ground water table resumes contact with wastes upon discontinuation of pump and treat system

TABLE ES-6
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
COMPLIANCE WITH ARARs

NUMBER AND DESCRIPTION OF ALTERNATIVE	CHEMICAL-SPECIFIC	LOCATION-SPECIFIC	ACTION-SPECIFIC
1: No action	ARARs not attained for sediment, ground water or surface water; No applicable soil ARARs	Not applicable	Not applicable
2: Site use restrictions, capping	ARARs not attained for sediment or ground water; No applicable soil ARARs; Cap designed to prevent leachate seeps, thereby reducing surface water contaminant levels	Construction activities to comply with wetlands requirements	Cap design and surface water drainage design to comply with landfill closure requirements
2A: Site use restrictions, capping and slurry wall construction	ARARs not attained for sediment or ground water although minimization of contact between the ground water table and soil/waste may result in reduced ground water contaminant levels; No applicable soil ARARs; Cap designed to prevent leachate seeps, thereby reducing surface water contaminant levels	Construction activities to comply with wetlands requirements	Cap design and surface water drainage design to comply with landfill closure requirements
4: Site use restrictions, capping; Ground water extraction with on-site physical treatment	ARARs not attained for sediment; No applicable soil ARARs; Ground water treatment to attain ARARs; Maintenance of ARARs in ground water following discontinuation of pump and treat operations is not guaranteed; Cap designed to prevent leachate seeps, thereby reducing surface water contaminant levels	Construction activities to comply with wetlands requirements	Cap design, surface water drainage design and ground water discharge standards to comply with landfill closure requirements and NPDES requirements
4A: Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	ARARs not attained for sediment; No applicable soil ARARs; Ground water treatment expected to attain ARARs although innovative technologies not well proven; Maintenance of ARARs in ground water following discontinuation of pump and treat operations is not guaranteed; Cap designed to prevent leachate seeps, thereby reducing water contaminant levels	Construction activities to comply with wetlands requirements	Cap design, surface water drainage design and ground water discharge standards to comply with landfill closure requirements and NPDES requirements

TABLE ES-7
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 1:	No action	Baseline risks remain unchanged; Least protective alternative
Alternative 2:	Site use restrictions, capping	Provides soil/waste contaminant containment but risks associated with ground water contaminant migration not addressed; Effective in the short-term; Does not attain chemical-specific ARARs
Alternative 2A:	Site use restrictions, capping and slurry wall construction	Provides soil/waste contaminant containment; Long-term risks associated with ground water contaminant migration minimized through elimination of contact between the soil/waste and ground water table; Effective in the short-term; Does not attain chemical-specific ARARs
Alternative 4:	Site use restrictions, capping; Ground water extraction with on-site physical treatment	Provides soil/waste contaminant containment and treatment of contaminated ground water; Good short-term effectiveness; Long-term maintenance of ground water ARARs following discontinuation of pump and treat system may not be possible
Alternative 4A:	Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	Provides soil/waste contaminant containment and treatment of contaminated ground water; Short-term effectiveness dependent on effectiveness of innovative ground water treatment methods; Long-term maintenance of ground water ARARs following discontinuation of pump and treat system may not be possible

TABLE ES-8
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
COST

	Alternative	Duration	TOTAL CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH * - O&M COST	TOTAL ** PRESENT WORTH
1	No action	30 yrs - G.W. mon. (1)	$ 58,000	$ 132,000	$ 2,033,000	$ 2,509,000
2	Site use restrictions, capping	30 yrs - G.W. mon. (1) 30 yrs - cap maint.	3,482,000	163,000	2,503,000	7,182,000
2A	Site use restrictions, capping and slurry wall construction	30 yrs - G.W. mon. (1) 30 yrs - cap maint. 30 yrs - slurry wall maint.	8,406,000	171,000	2,626,000	13,238,000
4	Site use restrictions, capping; Ground water extraction with on-site physical treatment	17 yrs - G.W. mon. (1) 30 yrs - cap maint. 12 yrs - G.W. extr. & trtmt	3,989,000	316,000	3,322,000	8,774,000
4A	Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	17 yrs - G.W. mon. (1) 30 yrs - cap maint. 12 yrs - G.W. extr. & trtmt	3,955,000	267,000	2,884,000	8,207,000

* Based on 5% discount rate
** Includes 20% contingency on all components
(1) Includes 4 rounds of samples per year

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APPENDICES

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1.0 INTRODUCTION

TAMS Consultants, Inc. (TAMS) and TRC Environmental Consultants, Inc. (TRC) are conducting a Remedial Investigation/Feasibility Study (RI/FS) of the Hertel Landfill Site, located in Plattekill, New York. The investigation of the site, which was ranked 810 on the National Priority List (NPL) as of August 1990, is being conducted in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). The study is being performed for the U.S. Environmental Protection Agency (USEPA) - Region II under the Alternate Remedial Contracting Strategies (ARCS) program (Contract No. 68-S9-2001, WA No. 003-2LH7).

The purpose of the RI conducted at the Hertel Landfill site was to investigate physical characteristics of the site, identify potential sources of contamination, determine the nature and extent of contamination, and characterize risk and environmental impact. The findings of that investigation were described and evaluated in the Remedial Investigation (RI) Report for the Hertel Landfill Site, Plattekill, New York, dated July 1991. Detailed background information was also provided in the RI Report. Other pertinent reports prepared by TAMS and TRC and others on the Hertel Landfill site prior to conducting the FS include:

- Final RI/FS Work Plan for the Hertel Landfill Site, September, 1989
- Final RI/FS Field Operations Plan (FOP) for the Hertel Landfill Site, October 1989
- Site Analysis, Hertel Landfill, 1990

The purpose of the Feasibility Study, presented herein, is to identify and evaluate alternatives for mitigating contamination and controlling its effects on public health or the environment. By evaluating remedial solutions

selected from the range of technologies available for site cleanup, a response can be formulated which is technically feasible, protects public health and the environment, is cost-effective, and is consistent with applicable or relevant and appropriate environmental standards. The Feasibility Study process was formulated by the U.S. EPA to properly implement CERCLA. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300) establishes the framework for performing the Feasibility Study. Further definition of the FS process is provided in Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, Interim Final, October 1988).

Figure 1-1 provides a summary of the approach being used in this investigation to formulate an appropriate remedial response for the Hertel Landfill site. The FS report incorporates this approach into the following report format:

Section	Description of Contents
1	Introduction/Background Information
2	Assessment of Applicable or Relevant and Appropriate Requirements (ARARS)
3	Identification and Screening of Technologies
4	Development and Screening of Alternatives
5	Detailed Analysis of Alternatives
6	References

1.1 Site Description

The Hertel Landfill site is located in the town of Plattekill, Ulster County, New York, just south of US Route 44/NY Route 55, as shown in Figure 1-2. The site covers approximately 80 acres, of which the landfill and associated surficial waste materials occupy approximately 13.2 acres. A site map showing disposal areas is provided in Figure 1-3.

The topography of the site is generally flat with a variable gentle slope to the east. A topographic map of the landfill area is presented in Figure 1-4. The landfill area is covered with rocky soil and wastes with patches of grass and small shrubs. Abundant vegetation covers the remainder of the site.

Wetlands border the site to the north, south and east, and cover approximately 13 percent of the total area of the site. A small unnamed stream (NYSDEC stream classification number H-128-6-2-1-2) crosses the southern and eastern area of the site and flows in a northeasterly direction, bordering the east side of the fill area.

There are no permanent structures located on the site. A locked gate exists across the unpaved main access road near Routes 44/55; however, there is no perimeter fence.

The area surrounding the site (including the site) is zoned residential, although a small industry is located to the west, adjacent to the site. Private residences are located to the north and east along Routes 44/55 and along connector roads which intersect Routes 44/55. These residences receive their potable water from private wells.

1.2 Site History

The Hertel Landfill was established in 1963 as a municipal waste landfill. It operated until March 1977, when the revocation of the landfill permit by the Ulster County Department of Health and the passage of a Town of Plattekill ordinance prohibiting the disposal of out-of-town garbage resulted in the permanent closing of the site. No landfilling operations or other activities are currently performed under the present proprietor, Environmental Landfills, Inc. (ELI), of New Windsor, New York.

Initial environmental investigations began at the site in 1981, when five ground water monitoring wells were installed by Wehran Engineering, Inc. under the direction of the State of New York. Sampling and analysis of ground water from two downgradient pairs of deep/shallow wells identified the presence of organic and inorganic contaminants.

Previous investigations also identified a number of suspected waste disposal areas at the site including the following:

- Disposal Area #1 - engine block and oil waste materials
- Disposal Area #2 - trailer wreckage and scattered drums
- Disposal Area #3 - oil stain area and sanitary waste
- Disposal Area #4 - farm equipment debris
- Disposal Area #5 - printing waste
- Disposal Area #6 - fibrous material piles
- Disposal Area #7 - paint waste and municipal landfill
- Disposal Area #8 - possible rubber waste

These areas are indicated in Figure 1-3.

RI investigations were conducted by TAMS/TRC at the site between September 1989 and October 1990. The scope of these investigations included geophysical surveys, soil gas screening, test pit excavation, soil borings, and monitoring well installation. Environmental samples collected and submitted for chemical analyses included surface water, sediment, ground water, surface soil and subsurface soil samples. Also included in these samples were leachate seep water and sediment samples. Environmental sampling was conducted off-site as well as on-site. Hydraulic testing, ecological sampling, sampling of private wells in the vicinity of the site and geological characterization activities were also conducted. A complete description of sampling activities and analytical results is presented in the Remedial Investigation (RI) Report for the Hertel Landfill Site (TAMS/TRC, July 1991).

1.3 Nature and Extent of Contamination

The samples collected and analyzed during the RI investigations provided an overview of contaminant types and distribution. No significant "hot spot" areas were identified in association with the suspected disposal areas, with the possible exception of the detection of elevated soil gas readings in the paint waste area (Disposal Area #7) and a floating hydrocarbon product in a monitoring well located within Disposal Area #3, the oil stain and sanitary waste area. The existence of suspected Disposal Area #8 was not verified by the field investigations.

Volatile organic compounds, base/neutral/acid extractable compounds and metals (inorganics) were the primary contaminants detected at the site and were distributed as discussed in the following sections.

1.3.1 Volatile Organic Compounds (VOCs)

The volatile organic compounds (VOCs) were distributed in samples of soil, ground water, sediment, seep water and surface water collected adjacent to the fill. The most commonly occurring VOCs identified at the site were aromatic hydrocarbons (such as toluene, ethylbenzene and xylenes) which were present in ground water at concentrations ranging to 64 ppb, in subsurface soil at concentrations ranging to 310 ppb, in leachate sediment at concentrations ranging to 970 ppb and in leachate seep water at concentrations ranging to 8 ppb. Aromatic VOCs were not detected in non-leachate surface water samples, however. Other VOCs, such as carbon disulfide and chloroform, were also detected in various media at the site. In most cases, VOCs were not observed in sediment or surface water samples collected downgradient of the site.

1.3.2 Base/Neutral/Acid Extractable Compounds (BNAs)

The base/neutral/acid extractable (BNA) compounds were identified in all the media sampled on site. Polynuclear aromatic hydrocarbons (PAHs), including naphthalene, phenanthrene and pyrene, were present in surface soils at concentrations ranging to 3,100 ppb, in subsurface soils at concentrations ranging to 1,100 ppb, in leachate sediment samples at concentrations ranging to 1,500 ppb and in leachate seep samples at concentrations ranging to 4 ppb. Naphthalene was also detected in ground water samples at concentrations ranging to 39 ppb. PAHs were not detected in on-site surface water or sediment.

Phenols and phenolic compounds, such as 4-methylphenol, were detected in on-site subsurface soil at concentrations ranging to 340 ppb, and in ground water and surface water samples at concentrations ranging to 110 ppb. Phenols were not detected in off-site surface water and were detected in only one downgradient sediment sample. Phthalate esters, including bis(2-ethylhexyl)phthalate, were present in all sampled media, including background samples of soil, sediment and ground water. Other BNA compounds are present in samples from on-site soil, ground water, seep water, seep sediment and wetland sediment, but were not detected in downgradient surface water or sediment samples.

1.3.3 Metals and Inorganics

Metals and other inorganics are widespread in nature and their presence must be compared with natural background levels in order to determine if landfill impacts are present. Aluminum, arsenic, barium, calcium, copper, chloride, cadmium, chromium, iron, potassium, magnesium, manganese, lead, mercury, sodium, zinc and cyanide all appeared at elevated concentrations in

one or more samples from the various media sampled. The maximum concentrations of barium (4,490 ppm), cadmium (113 ppm), copper (319 ppm), lead (1,170 ppm), mercury (1.6 ppm) and zinc (615 ppm) detected in surface or subsurface soils exceeded the maximum on-site background levels detected for these metals. Calcium, chloride, potassium, magnesium, manganese and sodium, all considered leachate indicator parameters, were noted at above-background concentrations in off-site surface water samples, although the concentrations generally decreased with distance from the landfill. Inorganics were also detected at elevated levels in downgradient sediment samples.

1.4 Contaminant Fate and Transport

Potential routes of migration, contaminant persistence and observed contaminant migration were considered in evaluating the fate and transport of the site contaminants identified during the RI investigations.

Potential routes of contaminant migration at the Hertel Landfill site consist of the following:

- Migration of contaminated surface soils off-site due to overland runoff, airborne dust, and physical tracking off-site.
- Migration of surface soil contaminants via leaching through subsurface soils and subsequent ground water migration, or through volatilization into the ambient air.
- Migration of waste and subsurface soil contaminants via leaching into the ground water and subsequent ground water migration.
- Migration of contaminated ground water through overburden and bedrock materials or through discharge of shallow ground water to wetland areas and surface waters.
- Migration of contaminated leachate seep and stream/wetland sediments through leaching, erosion, surface water transport and redeposition mechanisms.

The presence of the various contaminant types was evaluated with respect to the existing migration pathways to provide an understanding of contaminant persistence and potential migration. VOCs, which are subject to volatilization and biodegradation by naturally occurring bacteria, were rather widespread in their detection at the site. The most commonly occurring VOCs were the aromatic hydrocarbons. Volatilization, biodegradation and adsorption are the major removal mechanisms for these compounds. The individual aromatic hydrocarbon-benzene compounds vary in their degree of mobility. Other VOCs were present at the site, but do not show a readily discernable pattern of occurrence. Potential migration of these contaminants appears to be mainly via ground water migration, with shallow contamination discharging to seep locations and surface water/wetland areas. Sediments at seep locations also exhibit VOCs.

BNAs were identified in all media sampled at the site. PAHs, detected in surface and subsurface soils, and leachate seep sediment but absent from surface water samples and most ground water samples, are persistent and readily adsorbed to organic carbon in soils. Phenols and phenolic compounds are generally more soluble in water than other BNA compounds and do not tend to adsorb to soils. Phenolic compounds were detected in several ground water samples but were typically absent from soil, sediment and surface water samples. Phthalate compounds were detected in all media sampled at the site, although they were predominantly detected in sediment and soil samples. They generally exhibit low solubility and would not be particularly amenable to water transport. Other BNA compounds detected appeared to represent isolated occurrences and were mainly detected in soils, sediment, ground water and leachate seep water samples.

Pesticides were detected in sediment and soil samples, and PCBs were detected in subsurface soil samples from test pits. Both pesticides and PCBs have an affinity for organics in soils which tends to render them immobile and persistent.

Inorganics have an affinity for soils which reduce their mobility in soils, although pH extremes may render them mobile. The concentrations of metals at the site generally exceed site background levels in all media sampled. However, elevated levels were generally not detected in filtered ground water samples.

1.5 Baseline Risk Assessment

A baseline health and environmental risk assessment was conducted to quantitatively and qualitatively assess the potential impacts of the landfill on human health and ecological health. For the human health component of the risk assessment, both current and future land use scenarios were considered. These scenarios included a current/recreational use scenario, a future/ construction use scenario, and a future/residential use scenario. The routes of exposure of most concern included dermal contact with soil, ingestion of ground water and ingestion of soil. The chemicals of primary concern include PAHs, arsenic and chromium in soil and ground water, and manganese in ground water.

The primary cancer and non-cancer risks were associated with the future use of the site as a residential area, due mainly to the evaluation of ground water ingestion under this scenario. Arsenic and manganese in the ground water primarily contributed to the overall risk associated with ground water ingestion, while the presence of arsenic, chromium and carcinogenic PAH compounds contributed to the risks posed by dermal contact and ingestion with

on-site soils. The evaluation of the current/recreational use scenario identified cancer and non-cancer risks exceeding acceptable risk ranges, mainly due to dermal contact with arsenic and PAH compounds in the soil, for children and adult receptors.

There were no federal threatened or endangered species located on-site. The benthic macroinvertebrate study conducted on-site was inconclusive; the potential exists for site contaminants to produce adverse effects to aquatic organisms. Additionally, there is some indication that the potential exists for elevated inorganics (selenium, cadmium, and mercury) in soil to produce adverse environmental effects.

2.0 FURTHER IDENTIFICATION OF POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Potential Applicable or Relevant and Appropriate Requirements (ARARs) were initially identified in the Final RI/FS Work Plan (TAMS, September 1989). Contaminant-specific ARARs were then used to evaluate site-specific contaminant levels in the RI Report (TAMS/TRC, July 1991). This section provides an overview of potentially applicable chemical-specific, location-specific and action-specific ARARs and To-Be-Considered guidance (TBCs), both on the federal and state levels, which will be used in this report to evaluate remedial alternatives. A comprehensive and conservative approach has been used in developing these lists of ARARs/TBCs, which reflect the types, quantities and extent of contaminants detected at the Hertel Landfill site, locational considerations, and the types of remedial actions likely to be required to mitigate the public health and environmental threats posed by a potential release of contaminants.

Applicable requirements are those clean-up standards, standards of control, or other substantive environmental protection requirements, criteria or limitations promulgated under federal or state law which specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are those federal and state requirements that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. To-be-considered (TBC) material are non-promulgated advisories or guidance issued by federal or state agencies that, although not legally binding, can be used in determining the level of clean-up for protection of health or the environment (USEPA, 1988a).

2.1.1 Potential Federal Chemical-Specific ARARs/TBCs

Potential federal chemical-specific ARARs and TBC criteria are presented in Table 2-1. Because ground water contamination has been detected upgradient of private potable well locations, drinking water criteria such as Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) have been included in the ARARs matrix. For surface waters, Ambient Water Quality Criteria (AWQC), promulgated under the Clean Water Act, represent potential ARARs. The Clean Air Act establishes maximum concentrations for particulates and fugitive dust emissions and could be applicable to remedial alternatives which impact ambient air.

2.1.2 Potential New York Chemical-Specific ARARs/TBCs

Potential New York State chemical-specific ARARs and TBC criteria are presented in Table 2-2. Potential chemical-specific ARARs for ground water remediation include New York MCLs (10 NYCRR 5) and New York Ground Water Quality Standards (6 NYCRR 703). Surface water criteria include New York Surface Water Quality Standards (6 NYCRR 701). Air criteria include New York Ambient Air Quality Standards (6 NYCRR 256 and 257).

2.2 Potential Location-Specific ARARs/TBCs

An area's location is a fundamental determinant of its impact on human health and the environment. Location-specific ARARs are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because they are in a specific location (USEPA, 1988a). Some examples of these unique locations include floodplains, wetlands, coastal areas, historic places and sensitive ecosystems or habitats.

The Hertel Landfill site includes wetlands within the boundaries of the site. No floodplain has been delineated in association with the unnamed stream which flows along the eastern portion of the site (personal communication, Town of Plattekill). The federal- or state-protected status of flora and fauna at the site was evaluated during the RI; certain state-protected species (13 plants/animal) were identified.

2.2.1 Potential Federal Location-Specific ARARs/TBCs

Based on a review of locational features, it appears that federally promulgated location-specific ARARs and TBC criteria designed to protect landmarks, historical and archeological sites, floodplains and coastal areas are not applicable to the Hertel Landfill site. However, federal requirements for the protection of wetlands, wildlife species, farmlands and cultural sites may be applicable to the evaluation of remedial alternatives. The potential federal location-specific ARARs for the site are presented in Table 2-3.

Wetlands regulations, including Executive Order 11990 and Wetlands Construction and Management Procedures (40 CFR 6, Appendix A) and Section 404 of the Clean Water Act, may apply to any remedial action which impacts the stream or wetlands at the Hertel Landfill site. The National Wetland Inventory map for the Clintondale topographic map has not yet been prepared. During the RI, however, on-site wetlands were identified and mapped on the basis of U.S. Army Corps of Engineers guidelines and methodology. The Fish and Wildlife Coordination Act (16 USC 661 et seq.) would require appropriate actions to protect wildlife if modifications to the stream are proposed. The Farmland Protection Policy Act would require evaluation of potential impacts on significant/important farmlands. A cultural resources survey would be

required to determine if an area of cultural value would be impacted by the remedial actions.

2.2.2 Potential State Location-Specific ARARs/TBCs

The State of New York has promulgated regulations for the protection of wetlands and wildlife. The potential state location-specific ARARs and TBCs are presented in Table 2-4. The New York Freshwater Wetlands Law (ECL Article 24.71 in Title 23) and New York State Freshwater Wetlands Permit Requirements and Classification (6 NYCRR 663 and 664) may apply to alternatives which could impact wetlands or surface water at the site. The Endangered and Threatened Species of Fish and Wildlife Requirements (6 NYCRR 182) may apply to activities which impact areas inhabited by endangered species. A red-shouldered hawk, listed as a threatened species under the New York State Environmental Conservation Law, was identified during the environmental survey of the site, as well as thirteen plant species listed in the DEC 193.3 Protected Native Plants list, pursuant to Section 9-1503 of the Environmental Conservation Law.

2.3 Potential Action-Specific ARARs/TBCs

Based on the identification of contaminants in various on-site media, remediation activities may be required and numerous state and federal requirements would apply to the implementation of these activities. Potential action-specific ARARs/TBCs cannot be well-defined until remedial alternatives are developed and response actions defined. A discussion of potential action-specific ARARs/TBCs pertaining to such general response actions as no action, institutional controls, diversion, containment, ground water collection, treatment, decontamination and disposal is provided in the following sections.

2.3.1 Potential Federal Action-Specific ARARs/TBCs

Numerous federally promulgated action-specific ARARs and TBC criteria could potentially affect the implementation of remedial measures. The primary regulatory requirements potentially applicable to the Hertel Landfill site appear in Table 2-5.

The primary federal administrative requirements which will guide remediation are those established under CERCLA and SARA. The revised NCP (40 CFR Part 300) incorporates SARA Title III requirements that alternatives satisfy ARARs, and utilize technologies that will provide a permanent reduction in the toxicity, volume and mobility of contamination, to the extent practicable.

Additional potential federal requirements include those pertaining to worker health and safety, as established under the Occupational Safety and Health Act (OSHA). ARARs associated with treatment, storage and disposal actions include RCRA requirements governing administrative (e.g., permitting) and substantive (design) issues. RCRA requirements include Subtitle C (Hazardous Waste Management) requirements and Subtitle D (Solid Waste Management requirements). The applicability of Subtitle C requirements is dependent on the following criteria:

- If a listed or characteristic waste (as defined under RCRA) was treated, stored or disposed of after the RCRA effective date (11/19/80), Subtitle C requirements apply.
- If the remedial activity applied to the site constitutes treatment, storage or disposal, as defined by RCRA, Subtitle C requirements apply.

The federal Clean Air Act (CAA) and Clean Water Act (CWA) are also potentially applicable to the evaluation of remedial activities which result in discharges to water bodies or ambient air.

2.3.2 Potential State Action-Specific ARARs/TBCs

New York State has promulgated regulations similar to those of the federal government. Potential state action-specific ARARs are presented in Table 2-6. New York Hazardous Waste (6 NYCRR 370-372) and Solid Waste Management Facility (6 NYCRR 360) regulations establish performance standards and design requirements for storage, containment, treatment, and disposal options. The New York Pollutant Discharge Elimination System (6 NYCRR 750-757) and Air Pollution Control Regulations (6 NYCRR 200-221) are potentially applicable to remedial activities which would result in discharges to water bodies or ambient air.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

The overall technology screening and identification process was outlined previously in Figure 1-1. A discussion of the specific activities involved is presented below.

In order to identify and screen potential remedial technologies, an initial identification of remedial action objectives and cleanup criteria is required. Regulatory criteria and risk-based levels are considered in evaluating cleanup criteria.

Once remedial action objectives are developed, general response actions are identified which satisfy the objectives. An initial evaluation is made of the areas and volumes of media to which the general response actions will be applied.

The general response actions are then used to develop a list of potential remedial technologies for each environmental matrix to be remediated. An initial screening of the technologies is conducted based on the technical implementability of the various technologies. Specific site characteristics or waste characteristics typically limit the applicability of certain technologies and these characteristics are considered in determining which technologies are not appropriate for further consideration.

For those technologies which pass the initial screening, the associated technology process options are evaluated in greater detail to allow the selection of one process option to represent each technology type. The representative process option provides a basis for developing performance specifications which are used in evaluating that technology type; however, the specific process actually used to implement the remedial action may not be selected until the remedial design phase. To select a representative process, each process option is evaluated on the basis of effectiveness,

implementability, and cost, with the greatest focus on effectiveness factors. Innovative technologies are either carried through the screening as a selected process option (if there is a reasonable belief that they offer potential for better treatment performance or implementability, few or lesser adverse impacts than other available approaches, or lower costs than demonstrated technologies) or are "represented" by another process option of the same technology type.

3.1 Remedial Action Objectives and Cleanup Criteria

Remedial response objectives are developed in order to set goals for protecting human health and the environment early in the alternative development process. The goals should be as specific as possible but should not unduly limit the range of alternatives that can be developed. For the Hertel Landfill FS, the results of the RI have been used to define specific contaminants of interest and allowable exposures based on the baseline risk assessment and ARARs/TBCs. Remedial response objectives have been developed for the various media at the site, specifically the ground water, soils and surface water/sediment, as presented below.

Ground Water

For ground water, the overall contaminants of interest include VOCs (benzene, chlorobenzene, ethylbenzene, toluene, xylenes and others), BNAs (naphthalene, phthalate esters and phenols) and metals (arsenic, iron and manganese). These contaminants are associated with three general areas of ground water contamination identified at the Hertel Landfill site. New York MCLs were exceeded for several organic compounds in the vicinity of monitoring wells MW-6S and MW-7S, in the central portion of the landfill. The New York

MCL for toluene was exceeded in well MW-13S (31 ppb), located to the north of the general landfill area within Disposal Area #1, the suspected engine block/oil waste disposal area. A third area of ground water contamination is indicated by the presence of contaminants in leachate seeps along the eastern toe of the landfill and in one surface water sample collected from the northern end of the landfill, also impacted by a leachate seep.

The major area of ground water contamination appears to be centered around the locations of monitoring wells MW-6S and MW-7S, with a floating hydrocarbon layer detected in well MW-6S. See Figure 3-1 for monitoring well locations. Contaminants detected in ground water samples from these wells include benzene, toluene, chlorobenzene, ethylbenzene and various phenolic compounds. Leachate indicator parameters were also detected at the highest concentrations in samples collected from wells MW-6S and MW-7S. Leachate indicator parameters were detected at lesser concentrations in monitoring wells located at the toe of the landfill and at even lower concentrations in wells located adjacent to the landfill. Samples collected from both the deep overburden wells and from bedrock well MW-6D also exhibited leachate indicator parameters. Bedrock monitoring well MW-6D was the only bedrock well to exhibit Target Compound List organic contaminants when sampled. Two BNA compounds, phenol and di-n-octylphthalate, were detected in MW-6D during the June 1990 sampling round at levels exceeding New York MCLs. During the August 1990 sampling round, however, these compounds were not detected.

A second potential area of ground water contamination was identified at the location of monitoring well MW-13S. During the two rounds of ground water sampling, toluene was detected at levels of 33 and 31 ppb respectively, levels which exceed the New York MCL for this compound.

The third area of ground water contamination, as indicated by the water quality of leachate seep samples, exhibited low levels of several volatile organics and semivolatile organics, and elevated levels of inorganics which were typically not detected at elevated levels in other surface water/sediment samples (see surface water/sediment discussion below). The ground water table is found within the waste material along the eastern toe of the landfill, where most of the seeps are located. In the areas where elevated inorganics are detected in the leachate seeps, ground water samples from shallow monitoring wells did not exhibit similar inorganics levels. Therefore, while the analytical results for seep samples are considered to be indicative of the ground water quality at these locations, inorganic contaminants may be concentrated near the water table as a result of leachate production.

Potential exposure pathways to ground water contaminants include human ingestion and potential exposure due to discharge of shallow ground water to surface water bodies. A summary of specific ground water contaminants which exceed current ARARs/TBCs is presented in Table 3-1. Also included in the table are leachate seep contaminant levels which exceed current ARARs/TBCs, as well as risk-based cleanup levels for those contaminants for which calculated risks exceed acceptable risk levels. Based on this evaluation, the remedial action objective for ground water is as follows:

> Prevent exposure to VOCs, BNAs, and inorganics at levels exceeding acceptable risk-based cleanup levels or ARARs/TBCs, as indicated in Table 3-1, due to ground water ingestion.

Soils

For soils, the contaminants of interest include arsenic, chromium and other metals. These contaminants were detected over the entire landfill area, with no predictive pattern of distribution observed. It should be noted that

the maximum level of arsenic detected in surface soils (SS-22: 109 ppm) was detected at an upgradient background sample location. This level of detection provided the basis for the identification of risk in association with the presence of arsenic in surface soils at the Hertel Landfill site. Its presence at such an elevated level in a background sample, however, is not easily explained and confirmation sampling would be recommended prior to further evaluation of potential remedial options in this area.

The potential exposure pathways to surface and subsurface soil under current and future scenarios include inhalation, dermal contact and ingestion. A summary of specific soil contaminants which exceed current ARARs/TBCs is presented in Table 3-2. Because no federal or New York chemical-specific ARARs/TBCs have been developed for soil contaminants, New Jersey Department of Environmental Protection (NJDEP) Soil Action Levels are provided as a basis of comparison. For those contaminants for which calculated risks exceed acceptable risk levels, risk-based cleanup levels are presented. Based on this information, the remedial action objective for soils is as follows:

> Prevent exposures to inorganics at levels exceeding acceptable risk-based cleanup levels or ARARs/TBCs, as indicated in Table 3-2, and prevent migration of contaminants that could result in ground water contamination in excess of acceptable risk-based levels or ARARs.

Surface Water and Sediments

For surface water and sediments, the contaminants of interest include inorganic analytes. Elevated levels of PAHs were detected in leachate seep sediment samples and in an off-site stream/wetland sediment sample (SED-20), located near the point where the stream crosses under US 44/55. The off-site PAH contamination is not thought to be attributable to on-site contaminants,

due to the lack of detected contamination at sediment sample locations between the site and the SED-20 location. At the SED-20 location, the identified contaminants may be attributable to the presence of the adjacent roadway.

The potential exposure pathways to surface water/sediment contaminants include dermal contact and ingestion. Allowable contaminant levels based on ARARs/TBCs for surface water are summarized in Table 3-3. Because exposures to surface water (dermal contact or ingestion) did not contribute significantly to total pathway risk calculations, risk-based cleanup levels were not calculated. A similar comparison of risk-based levels and ARARs for sediment contaminants was previously presented in Table 3-2. In both tables, leachate seep/sediment sample results are tabulated separately from surface water/stream sediment sample results. Based on this information, the remedial action objective for surface water and sediments is as follows:

> Prevent exposure to inorganics in sediments and surface water at levels exceeding acceptable risk-based cleanup levels or ARARs/TBCs, as indicated in Tables 3-2 and 3-3 respectively, and prevent releases of contaminants from sediments into surface water that could result in excessive contaminant levels in surface water.

3.2 General Response Actions

General response actions are those remedial actions which will satisfy the remedial objectives. General response actions for the contaminated media at the Hertel Landfill site were formulated based on the results of the environmental investigation and risk assessment.

Ground water, soils, surface water and sediment were evaluated in determining appropriate general response actions. For each of these media, an initial determination has been made of the areas or volumes to which the general response actions may be applied, as described below. In determining these volumes/areas of media, consideration has been given to site conditions,

the nature and extent of contamination, acceptable exposure levels and potential exposure routes.

Ground Water

In order to provide a preliminary estimate of the volume of ground water potentially requiring treatment, an examination of the extent of ground water contamination at levels exceeding MCLs was made. Initially the area surrounding monitoring wells MW-6S and MW-7S is considered (see Figure 3-1). MCLs are exceeded for several volatile compounds in wells MW-6S and MW-7S (6/90 & 8/90). Monitoring well MW-5S exhibited ethylbenzene at a level (6 ppb) slightly exceeding the NY MCL during the August 1990 round of ground water sampling. All other shallow wells surrounding MW-6S and MW-7S exhibited no volatile organic contaminants at levels exceeding MCLs, except at MW-13S, as described previously. Ground water elevations in well MW-6S ranged from 620.09 to 622.34 ft above the National Geodetic Vertical Datum (NGVD) and in well MW-7S they ranged from 628.28 to 628.57 ft NGVD. The depth to bedrock from the ground water table at these two well locations ranged from approximately 20 to 27 feet. Depth to bedrock increases to the east and decreases to the west. Assuming an average total saturated depth to bedrock of 25 feet, an average depth from the water table to the base of the fill material of 5 feet, an areal extent of contamination of 5 acres, a waste material porosity of 52%, and an approximate underlying formation porosity of 30%, the total volume of contaminated ground water in the general area of wells MW-6S and MW-7S is estimated to be approximately 14 million gallons.

To estimate the volume of contaminated ground water associated with the detection of toluene in monitoring well MW-13S, it is assumed that contamination extends in an approximate 150-foot radius around the well (half

the distance to the nearest monitoring well), with a total contaminated depth from the water table to the bedrock of 30 feet. Assuming a formation porosity of 30%, the volume of contaminated water in the area of well MW-13S is estimated to be approximately 5 million gallons. Due to the lack of monitoring wells located to the north, east and west of well MW-13S, additional investigations would be required to verify the accuracy of this estimate.

The volume of near-surface ground water contaminated with inorganics, as exhibited by the leachate seep samples, can be estimated by assuming a contaminated depth of 2 to 4 feet (based on test pit observations), an areal extent of 2 acres (based on the presence of leachate seeps along the northern and eastern toes of the landfill area) and porosities ranging from 30% to 52%. The estimated contaminated water volume ranges from approximately 0.4 to 1 million gallons. For calculation purposes, a volume of 0.8 million gallons will be used.

Based on this analysis, the total volume of contaminated ground water is estimated to be approximately 20 million gallons.

Soils/Wastes

Surface soil and subsurface soil samples collected from the Hertel Landfill site have exhibited various contaminants in various locations across the landfill area. Based on soil boring logs, cover material does not appear to be continuous across the site at a significant depth. At MW-5S and MW-6S, surface soil depths were recorded at eight inches and nine inches respectively. At MW-7S, a mixture of soil and debris was recorded to a depth of four feet. Test pit subsurface soil samples were collected from soil materials within the landfill materials or from soil materials at the base of

the waste materials. Due to the mixed nature of soil and waste, the soil/waste matrix has been considered as a single separate environmental media at the site. The total volume of the soil/waste matrix is considered to consist of the landfill area of 12.2 acres, extending to an average depth of 15 feet (assuming an average waste depth of 12 feet based on test pits and soil borings, and 3 additional feet of contaminated soil beneath the base of the waste). In addition, a 1 acre area of surface debris located to the north of the landfill area is considered to be contaminated to a depth of 2 feet from the surface. For remedial purposes, the total volume of the soil/waste matrix based on these assumptions is estimated to be approximately 300,000 cubic yards.

As discussed in Section 3.1, a significant level of arsenic was detected at one background surface soil sample location. However, no resampling of this area was conducted to confirm this analysis and, if accurate, no surrounding information is available to evaluate the vertical or horizontal extent of the contamination in this area. Therefore, no separate volume has been calculated for this potential area of contamination. Additional confirmation sampling would be required to evaluate the potential remediation of this area. If the area of contamination proved to be relatively small in area and volume, its remediation could be addressed within the remediation of the soil/waste matrix.

Surface Water/Sediment

Surface water and sediment samples collected from the adjacent stream and on-site wetlands for the most part exhibit no significant levels of organic contaminants. Elevated levels of typical leachate indicator parameters and inorganics detected in the samples indicate the impacts of the presence of the

landfill on the surface water/sediment. Leachate seep water and sediment samples exhibited low levels of organics and elevated inorganics. The leachate seeps are generally located within the landfill area and, therefore, the impacted sediment samples are located within the soil/waste matrix and have been addressed in the soil/waste matrix discussion presented above. The ground water table is found within the waste material along the eastern toe of the landfill where most of the seeps are located. Therefore, the seeps are considered to be indicative of the near-surface ground water quality at these locations and were addressed in the ground water discussion presented above. Based on the general lack of contamination attributable to the Hertel Landfill site within surface water/sediment samples other than the leachate seep samples, separate volumes associated with surface water and sediment sample contamination have not been calculated and general response actions have not been developed for these media.

A listing of medium-specific general response actions developed for the media discussed above is provided in Table 3-4.

3.3 Identification and Screening of Technologies and Process Options

The general response actions are developed further through the identification and screening of remedial technologies which could potentially meet the remedial action objectives and cleanup criteria. Following a screening of the remedial technologies on the basis of technical implementability, the process options associated with each technology are screened based on effectiveness, implementability and cost. Representative process options are chosen for inclusion in the comprehensive remedial alternatives developed for the site.

3.3.1 Technology Screening

The technology screening was performed to evaluate technologies for the remediation of the soil/waste matrix and ground water. Tables 3-5 and 3-6 present the screening results for these two media of concern. Each table includes brief descriptions of the individual technologies or process options, and comments on their applicability to the site. The technologies or technology options which do not pass the screening process on the basis of technical implementability are shaded in the figures and will not be retained for further consideration.

3.3.2 Process Option Screening

Upon identification of those technologies which are technically implementable based on the site and waste characteristics, the process options are further evaluated to allow the selection of a representative process option for each technology type. The process options are evaluated on the basis of effectiveness, implementability, and cost. Process option evaluations are presented in Tables 3-7 and 3-8 for each of the soil/waste and ground water matrices. The selected process options are indicated with an asterisk in Tables 3-7 and 3-8, and are summarized in Table 3-9.

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4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

The technologies and process options developed in Section 3 are combined to form a range of remedial alternatives which address site cleanup to varying degrees and meet the criteria set forth in the NCP for the types of remedial alternatives which must be considered. These criteria include the following:

- For alternatives which provide control of the source of contamination, the range of alternatives should include the following:
  - A range of alternatives in which treatment that reduces the toxicity, mobility, or volume of the hazardous substances is a principal element. This range should include an alternative that removes or destroys hazardous substances to the maximum extent feasible, eliminating or minimizing the need for long-term management.
  - One or more alternatives that involve little or no treatment, but provide protection of human health and the environment primarily by preventing or controlling exposure to hazardous substances through engineering controls and/or institutional control.
- For ground water response actions, a limited number of remedial alternatives should be developed that attain site-specific remediation levels within different restoration time periods utilizing one or more different technologies.
- The development of one or more innovative treatment technologies for further consideration.
- The no action alternative.

For the alternatives which are developed, general descriptions of the alternatives are provided. The alternatives then undergo an initial screening process. These activities are described further in Section 4.2.1.

4.1 Development of Alternatives

Remedial response objectives, as presented in Section 3.1, are used as a guide in the development of remedial alternatives. It is at this point in the Feasibility Study that medium-specific actions are combined to form sitewide

remedial alternatives. Table 4-1 summarizes the alternatives which have been developed for the Hertel Landfill site. Table 4-2 presents the technologies which passed the screening process and depicts the way the technologies have been combined into remedial alternatives which meet the NCP criteria for the types of alternatives to be considered.

4.2 Screening of Alternatives

For each of the alternatives presented in Table 4-2, a description of the alternative and an evaluation of the alternative based on effectiveness, implementability and cost criteria are presented. Following this individual screening and analysis, a comparative analysis of the alternatives is performed based on the three screening criteria, and the alternatives to be retained for detailed analysis are selected.

4.2.1 Introduction

The alternative descriptions presented below include such information as the location of excavation or containment areas and the volumes of soil, waste and ground water to be collected, excavated or treated. The thought process used in the development of alternatives is also described. Process options which passed the process screening but are represented by another process option in the alternative are noted.

A preliminary screening of alternatives is performed subsequent to alternative description. The objective of alternative screening is to narrow the list of potential alternatives that will be evaluated in detail, by evaluating and comparing them on the basis of effectiveness, implementability and cost. This screening aids in streamlining the feasibility study process while ensuring that the most promising alternatives are being considered. The

range of treatment alternatives initially developed is retained, where practicable, through the screening process, with comparisons typically focusing on similar alternatives, the most promising of which is carried forward for further analysis.

The effectiveness screening evaluates the effectiveness of each alternative in protecting human health and the environment through reduction of toxicity, mobility or volume. Both long- and short-term effectiveness is considered. Evaluation on the basis of implementability takes into consideration the technical and administrative feasibility of constructing, operating and maintaining a remedial action alternative. The final evaluation criterion, cost, involves the estimation of both capital and operation and maintenance (O&M) costs associated with each alternative. Because of the level of refinement of alternative development, cost estimates may not be as accurate as those developed during the detailed analysis of alternatives. However, estimates are comparative in terms of relative accuracy to allow cost decisions to be made at this point.

4.2.2 Common Major Elements

Several of the alternatives described in the following sections have common major elements which do not change in scope from one alternative to another. These elements are initially described below and are then referenced in the individual alternative descriptions which follow. The major elements common to several alternatives include:

- Ground water monitoring
- Ground water extraction

Ground Water Monitoring

Ground water monitoring would involve the continued monitoring of ground water quality at the site and downgradient of the site. The purpose of this monitoring program would be to identify changes in on-site ground water quality or off-site migration of contamination, and to predict potential impacts to surrounding private potable wells. Both the deep overburden and bedrock ground water quality would be monitored on a quarterly basis. Wells to be sampled would include select existing wells and additional wells to be installed. The installation of additional monitoring wells would be required to further refine ground water flow directions and provide additional downgradient water quality information. For the purposes of the initial screening, it is assumed that twelve wells will be monitored (five bedrock and seven overburden wells), of which four bedrock wells and two overburden wells will be new wells.

Also included in the ground water monitoring program is the sampling and analysis of downgradient private potable wells. It is assumed that fifteen wells will be sampled on an annual basis to confirm that private well water quality is not impacted by contaminant migration.

Ground Water Extraction

Ground water extraction would involve the extraction of contaminated ground water using extraction wells. French drains, another ground water extraction process option, could also provide a means of extraction for contaminated shallow ground water, if necessary. The purpose of a ground water extraction system would be to depress the water table to a level below the bottom of the fill materials, in order to minimize contact between the fill material and the ground water, and thereby minimize leachate production.

The extracted ground water would then, in most cases, be treated on-site and discharged to surface water. Due to the relatively impermeable subsurface conditions identified during remedial investigation well development and sampling, a preliminary evaluation indicates that approximately 22 extraction wells will be required to capture the contamination. The estimated total pumping rate for these wells is approximately 14,000 gallons per day. Based on an assumed ground water treatment period equivalent to the time required to remove three pore volumes of water from the contaminated ground water area (see Section 3.2), and the estimated total contaminated ground water volume of 20 million gallons, it is estimated that the ground water extraction and treatment system would require operation over a 12-year period.

4.2.3 Alternative 1 - No Action

4.2.3.1 Description

The no action alternative would involve no remedial response activities at the Hertel Landfill site, although it would include continued ground water monitoring. No removal or treatment of currently impacted ground water or soil/waste materials would be conducted. Consideration of the no action alternative is required by the NCP.

4.2.3.2 Evaluation

Effectiveness

The no action alternative would provide no reduction in toxicity, mobility or volume of contamination. It would also provide no direct protection of human health or the environment, although continued ground water monitoring would allow for the identification of off-site contaminant migration and potential subsequent response actions.

Implementability

The no action alternative with continued ground water monitoring would require the installation of additional monitoring wells and periodic sampling activities. Overall, it would be relatively easy to implement.

Cost

The only cost associated with the no action alternative would be that associated with monitoring well installation and continued ground water sampling. The cost of the no action alternative is initially estimated at a present worth value of $2,500,000, assuming a 30-year monitoring period.

4.2.4 Alternative 2 - Site Use Restrictions and Capping

4.2.4.1 Description

This alternative was developed as an alternative which would meet the NCP's requirement for consideration of an alternative which utilizes containment with little or no treatment. The alternative consists of the institution of site use restrictions, including fencing and deed restrictions limiting future site development and on-site potable well installation. It also includes capping of the soil/waste matrix (landfill area) with a multi-layer cap to minimize infiltration, leachate production and any infiltration-induced migration of leachate.

A multi-layer cap, designed to meet the requirements of current New York solid waste landfill closure regulations, would be constructed over an area encompassing the areal extent of the existing landfill, as previously indicated in Figure 3-1. The total cap area would be approximately 12.2 acres. The cap would not encompass the one acre area identified as exhibiting surface debris only; the surface debris would be moved to within the area to be capped prior to cap construction.

Process options which passed the screening and which are represented by the chosen process options are presented below:

Medium	Chosen Option	Other Options Which Passed Screening
Soil/Waste	Deed/access restrictions	None
	Multi-layer cap	Clay cap; synthetic cap; asphalt cap; concrete cap
Ground Water	Deed restrictions	Alternate water supply
	Multi-layer cap	Clay cap; synthetic cap; asphalt cap; concrete cap

4.2.4.2 Evaluation

Effectiveness

Alternative 2 would provide no reduction in toxicity or volume of contamination but it would limit the mobility of contaminant migration to some extent by eliminating infiltration as a leachate source. Exposure to potential risks posed by the site would be limited by ground water use restrictions and site use restrictions. Short-term effectiveness would be impacted by the required disruption of surface vegetation and soils during cap construction. Verification of long-term effectiveness would require continued ground water monitoring.

Implementability

Alternative 2 would be relatively easy to implement. It would require removal of all surface vegetation in the general landfill area, grading, and construction of a multi-layer cap. Overall implementability would be good.

Cost

The main cost factors associated with Alternative 2 would be the cap construction cost and the long-term ground water monitoring cost. The cost of the capping alternative is initially estimated at a present worth value of $7,000,000.

4.2.5 Alternate 2A - Site Use Restrictions, Capping, Slurry Wall

4.2.5.1 Description

This alternative was developed as a slight variation of Alternative 2, and therefore is referred to as Alternative 2A. Like Alternative 2, it is a containment alternative involving no treatment. The only difference between Alternative 2 and Alternative 2A is the inclusion of a slurry wall as an additional containment measure. The slurry wall would be constructed upgradient of the landfill area to act as a barrier to ground water flow through the in-place waste materials. In conjunction with the leachate minimization provided by the multi-layer cap, the slurry wall would minimize contact between waste materials and the ground water, and thereby minimize the potential for contaminant migration off-site.

The only additional process option incorporated into Alternative 2A is the slurry wall. Because no other process options passed the screening, the slurry wall does not represent any other process options.

4.2.5.2 Evaluation

Effectiveness

The effectiveness of Alternative 2A would be similar to the effectiveness of Alternative 2, with the added benefit of minimizing ground water flow through the waste materials. The presence of an upgradient slurry wall would

lower the water table within the downgradient portions of the landfill. Therefore, the alternative would minimize leachate generation due to infiltration through the presence of a cap, and by limiting ground water flow through the waste materials.

Implementability

Alternative 2A would be more difficult to implement than Alternative 2. The construction of a slurry wall would be complicated by the presence of subsurface boulders and by the sloping surface of the upgradient side of the landfill. Flat areas are preferred for slurry preparation and backfill mixing. The presence of boulders near the bottom of a slurry wall may lead to variations in trench depth and reduced slurry wall efficiency which, in turn, could lead to piping failure.

Cost

The cost of Alternative 2A would be identical to the cost of Alternative 2, with the added cost of slurry wall construction. The cost of the capping/slurry wall alternative is initially estimated at a present worth value of $15,000,000.

4.2.6 Alternative 3 - Excavation of Contaminated Soil and Waste Materials with Off-Site Disposal and Ground Water Collection with Off-Site Treatment

4.2.6.1 Description

This alternative was developed to meet the NCP's requirement for consideration of an alternative which minimizes the need for long-term management. The alternative consists of excavation of the contaminated soil/waste matrix within the general landfill area and transportation of the

materials off-site for disposal at a licensed disposal facility. Contaminated ground water is also extracted and transported off-site for treatment at a licensed wastewater treatment facility. The long-term management associated with an on-site ground water treatment system is eliminated in this alternative, as compared to other alternatives which include ground water treatment.

Excavation and off-site transportation of the soil/waste matrix would require the handling of an estimated 300,000 cubic yards of material. Following excavation, the site would require grading and seeding to allow for revegetation of the excavated area. An off-site disposal site would have to be identified which would have sufficient capacity to receive the soil/waste materials.

Contaminated ground water would be extracted via ground water extraction wells as previously described in Section 4.2.2. As ground water would be extracted, it would temporarily be stored on-site for subsequent off-site transport to a commercial treatment facility. The identification of a facility licensed to accept the contaminated ground water for treatment would be required. Aqueous waste treatment facilities capable of treating organic and inorganic wastes which are located in the State of New York include CECOS International, Chemical Waste Management of New York and Frontier Chemical Waste Process, Inc. (Environmental Information, Ltd., 1990). All of these facilities are located in the Niagara Falls/Model City area of New York. For the purposes of this evaluation it is assumed that extracted ground water will be sent to CECOS International, where treatment processes include chemical precipitation, oxidation, devolatilization, carbon adsorption and advanced biological treatment.

Process options which passed the screening and which are represented by the chosen process options are presented below:

Medium	Chosen Option	Other Options Which Passed Screening
Soil/Waste	Off-site Landfill	On-site Landfill
Ground Water	Extraction wells	Well points, french drains
	Commercial treatment facility	None

4.2.6.2 Evaluation

Effectiveness

Alternative 3 would be effective in terms of reducing the volume of contaminated soil/waste matrix materials on-site but would provide no reduction in the toxicity of these materials. Mobility would be reduced by the containment features of the off-site disposal facility. Contaminated ground water would also be removed from the site, and a reduction in toxicity would be achieved at a commercial wastewater treatment facility. Long-term effectiveness would be good, based on the complete removal of contaminated soil/waste materials from the site and the treatment of contaminated ground water. In the short-term, additional exposures to waste materials would be realized during the excavation and off-site transport process.

Implementability

The administrative feasibility of identifying a permitted landfill with sufficient capacity to readily accept the estimated 300,000 cubic yards of soil/waste materials is very low. Additionally, the technical feasibility of transporting an estimated 14,000 gallons of contaminated ground water off-site daily over a period of twelve years is also very low.

Cost

Transportation and disposal/treatment costs for both the soil/waste matrix and the contaminated ground water are extremely high. The cost for the off-site landfill/off-site ground water treatment alternative is initially estimated at a present worth value of $190,000,000.

4.2.7 Alternative 4 - Site Use Restrictions, Capping, Ground Water Extraction with On-Site Physical Treatment

4.2.7.1 Description

This alternative was developed as one of several alternatives which provide a range in terms of the extent of reduction in toxicity, mobility or volume of hazardous substances offered by the alternative. It consists of the institution of site use restrictions, including fencing and deed restrictions, and capping of the soil/waste matrix (landfill area) with a multi-layer cap to minimize infiltration, leachate production and any infiltration-induced migration of leachate. In these respects, Alternative 4 is identical to Alternative 2. However, Alternative 4 combines these containment features with a ground water extraction and on-site physical treatment system.

As with Alterative 2, a multi-layer cap, designed to meet the requirements of current New York solid waste landfill closure regulations, would be constructed over the 12.2 acre area extent of the existing landfill.

The ground water extraction system would consist of extraction wells, as described in Section 4.2.2. Upon extraction, however, the ground water would be treated on-site using physical treatment systems. Carbon adsorption is the chosen treatment process for organic contaminants, while chemical precipitation is the chosen treatment process for the inorganics. Following on-site treatment, the effluent would be discharged to surface water.

Process options which passed the screening and which are represented by the chosen process options are presented below:

Medium	Chosen Option	Other Options Which Passed Screening
Soil/Waste	Deed/access restrictions	None
	Multi-layer cap	Clay cap; synthetic cap; asphalt cap; concrete cap
Ground Water	Deed restrictions	Alternate water supply
	Multi-layer cap	Clay cap; synthetic cap; asphalt cap; concrete cap
	Extraction wells	Well points; french drains
	Physical treatment:	
	Organic - carbon adsorption	Air stripping; resin adsorption
	Inorganics - precipitation	Ion exchange; membrane micro-filtration
	On-site discharge - Surface water	Injection wells; water infiltration galleries

4.2.7.2 Evaluation

Effectiveness

The effectiveness of Alternative 4 would be similar to that of Alternative 2, the capping and site use restriction alternative, with the added benefit of ground water extraction and treatment. By extracting ground water, an additional element of hydraulic control would be provided. Ground water would be treated on-site using conventional treatment methodologies, and discharged to the surface water on-site. The long-term effectiveness of the ground water extraction and treatment system, which would be operated over an estimated twelve year period, would be expected to be good.

Implementability

Alternative 4 would be fairly easy to implement, although the administrative feasibility of discharging to surface water may pose problems. The capping and ground water treatment technologies are commonly used and should pose no significant barriers to implementation.

Cost

The cost for Alternative 4 is similar to that of Alternative 2, with the added cost of ground water extraction and treatment. The cost of the capping/site use restriction/physical ground water treatment alternative is initially estimated at a present worth value of $8,200,000.

4.2.8 Alternative 4A - Site Use Restrictions, Capping, Ground Water Extraction with On-Site Innovative Treatment

4.2.8.1 Description

This alternative was developed as a slight variation of Alternative 4, and therefore is referred to as Alternative 4A. Like Alternative 4, it is a containment alternative which includes ground water extraction and treatment. The only difference between Alternative 4 and Alternative 4A is the type of ground water treatment considered. While Alternative 4 includes traditional physical treatment methods, Alternative 4A involves more innovative water treatment methods. Organic contaminants would be treated using UV oxidation, while inorganic contaminants would be treated using a membrane microfiltration process.

UV oxidation consists of a reactor module in which influent is exposed to UV radiation, ozone and hydrogen peroxide to oxidize organic compounds. The process is successful in treating organic constituents, especially halogenated organics. The inorganic treatment system consists of membrane

microfiltration. The microfiltration system uses an automatic pressure filter and Tyvek filter material to filter solid particles from liquid wastes.

The membrane microfiltration inorganic treatment method is a comparable process option to the chemical precipitation treatment method included in Alternative 4. Therefore, the only additional process option incorporated into Alternative 4A is the organic treatment method, UV oxidation. Because no other process options passed the screening for chemical treatment methods, the UV oxidation treatment process does not represent any other process options.

4.2.8.2 Evaluation

Effectiveness

The effectiveness of Alternative 4A in comparison to Alternative 4 is difficult to gauge due to the innovative nature of the ground water treatment systems employed. UV oxidation has been proven in initial testing in the treatment of organics. Membrane microfiltration has not been tested to the same degree as UV oxidation. However, based on the residual contamination exhibited in filtered ground water samples as compared to unfiltered samples, it is expected that the membrane microfiltration unit would be effective in the removal of inorganics from the ground water, although all ARARs may not be achieved. Treatability studies would be required to further define the effectiveness of these treatment methods.

Implementability

Due to the innovative nature of the ground water treatment systems, implementation would be somewhat more difficult than implementation of Alternative 4, which uses conventional treatment methods. Treatability studies would be required prior to final design of the treatment units. As

with Alternative 4, the administrative feasibility of discharging treated ground water to the surface water may pose a problem.

Cost

The cost for Alternative 4A is similar to that of Alternative 4, with the only difference being the cost of the ground water treatment system used. The innovative nature of the treatment system complicates the cost estimation process, since treatment costs are not yet well-established. The cost of the capping/site use restriction/innovative ground water treatment alternative is initially estimated at a present worth value of $7,900,000.

4.2.9 Alternative 5 - Excavation and On-Site Incineration of Soils and Wastes, with Ground Water Extraction and On-Site Physical Treatment

4.2.9.1 Description

This alternative was developed as another of several alternatives which provide a range in terms of the extent of reduction in toxicity, mobility or volume of hazardous substances offered by the alternative. It includes excavation of the contaminated soil/waste matrix within the general landfill area, and subsequent on-site incineration of these materials. A rotary kiln incinerator is the chosen incineration process option. Contaminated ground water is also extracted and treated on-site using carbon adsorption for organics removal and precipitation for inorganics removal.

Excavation and on-site incineration of the soil/waste matrix would require the handling of an estimated 300,000 cubic yards of material. Assuming 240,000 cubic yards of the total consist of waste materials at a typical in-place density for municipal landfills of 800 lb/cu.yd. (Tchobanoglous, et.al., 1977), and the remaining 60,000 cubic yards consist of soils at an average density of 100 lb/cu.ft., the total tonnage of materials requiring

incineration would be 177,000 tons. Based on this estimated tonnage, a large incinerator (greater than 40,000,000 Btu/hr) would be most cost effective to use (Cudahy, 1989). There are several vendors which supply large rotary kiln incinerators.

Following excavation and incineration, the incinerator residue would require testing and handling in accordance with federal and New York State regulations. For the purposes of the evaluation of this alternative, it is assumed that the ash would be disposed of at a hazardous waste landfill. The excavation area would subsequently require grading and seeding to allow for revegetation.

Ground water extraction and on-site treatment would be as described for Alternative 4.

Process options which passed the screening and which are represented by the chosen process options are presented below:

Medium	Chosen Option	Other Options Which Passed Screening
Soil/Waste	Rotary kiln incinerator	Fluidized bed; infrared incinerator
Ground Water	Extraction wells	Well points, french drains
	Physical treatment:	
	Organic - carbon adsorption	Air stripping; resin adsorption
	Inorganics - precipitation	Ion exchange; membrane micro-filtration
	On-site discharge - Surface water	Infiltration galleries, injection wells

4.2.9.2 Evaluation

Effectiveness

Alternative 5 would be effective in that the source of ground water and surface water contamination would be removed and treated. Soil and waste materials would be excavated and treated on-site in an incinerator. Organic contaminants would be destroyed in the incineration process. Inorganics would remain in the ash residue, which would be transported off-site for disposal at a licensed land disposal facility. Short-term effectiveness would be limited by the site disruption which would occur during excavation and by the air emissions associated with incineration activities. The long-term effectiveness of the ground water extraction and treatment system, which would operate over an estimated twelve year period, would be expected to be good.

Implementability

The technical implementability of this alternative would depend on the commercial availability of the required incineration system, while the administrative implementability would be dependent on the ability of the system to meet the substantive requirements applicable to incinerators. Mobile incinerators are available from vendors but the public opposition to such a remedial response could be expected to be significant.

Cost

The cost for Alternative 5 would be high, due to the high cost of mobilizing and operating an on-site incinerator and due to the costs associated with off-site disposal of the ash residues. The cost of the on-site incineration/physical ground water treatment alternative is initially estimated at a present worth value of $120,000,000.

4.2.10 Alternative 6 - Excavation and Off-Site Treatment of Soils and Wastes, Ground Water Extraction and On-Site Biological Treatment

4.2.10.1 Description

This alternative was developed as another of several alternatives which provide a range in terms of the extent of reduction in toxicity, mobility or volume of hazardous substances offered by the alternative. It includes excavation of the contaminated soil/waste matrix within the general landfill area, and subsequent off-site treatment of these materials. The specific type of treatment offered would be dependent upon the vendor selected to provide the treatment; however, the vendor would be required to meet certain performance standards and comply with regulations such as land ban regulations in meeting these standards. For the purposes of evaluating this alternative, an off-site rotary kiln incinerator is used as a representative potential treatment option. Contaminated ground water is also extracted and treated on-site using a biological treatment system for treatment of organic contaminants and precipitation for treatment of inorganics.

Excavation and off-site treatment of the soil/waste matrix would require the handling of an estimated 300,000 cubic yards of material. Following excavation and off-site transport, the excavation area would require grading and seeding to allow for revegetation. Based on the assumed incineration treatment method, the soil/waste materials would be transported to a licensed incineration facility. The nearest licensed hazardous waste incinerators include Rollins Environmental Services Inc., located in Bridgeport, New Jersey and Ross Incineration Services Inc., located in Grafton, Ohio. The incinerator residue would require testing and handling in accordance with federal and state regulations and would be handled by the operator of the incinerator.

Ground water extraction would be as described in Section 4.2.2. Treatment would be accomplished using a biological treatment system, a bioreactor, for treatment of organics. For treatment of inorganics, chemical precipitation is the chosen treatment method.

Process options which passed the screening and which are represented by the chosen process options are presented below:

Medium	Chosen Option	Other Options Which Passed Screening
Soil/Waste	Off-site treatment	Various
Ground Water	Extraction wells	Well points, french drains
	Organics - Bioreactor	None
	Inorganics - Precipitation	Ion exchange; membrane micro-filtration
	On-site discharge - Surface water	Infiltration galleries; injection wells

4.2.10.2 Evaluation

Effectiveness

The effectiveness of this alternative would be dependent upon the off-site treatment method employed. For the purposes of this evaluation, it has been assumed that off-site incineration will be the proposed treatment method. The effectiveness of this alternative would be comparable to that of Alternative 5, since the same soil/waste treatment methods are used.

Implementability

Alternative 6 would not have the difficulties associated with on-site incineration, as described for Alternative 5, but would have difficulties

associated with its implementation due to the required off-site transport of excavated materials and availability of off-site incineration facilities.

Cost

The cost for Alternative 6 would be high, due to the high cost of transportation and off-site incineration of the soil/waste materials. The cost of the off-site soil/waste treatment/physical ground water treatment alternative is initially estimated at a present worth value of $510,000,000.

4.2.11 Alternative 7 - In Situ Vitrification with Ground Water Extraction and On-Site Innovative Treatment

4.2.11.1 Description

This alternative was developed as an alternative which employs innovative treatment technologies. It consists of in situ vitrification of the soil/waste matrix and ground water extraction with on-site treatment. The ground water treatment methods employed include UV oxidation for treatment of organics and membrane microfiltration for treatment of inorganics.

In situ vitrification is a process where an electrical network is used to melt the soil/waste materials at temperatures of 1600° to 2000° C. Organic pollutants are pyrolized while inorganics are immobilized within the vitrified mass, which forms a glasslike monolith upon cooling. The ground water extraction system was previously described in Section 4.2.2. The proposed ground water treatment system was previously described in Section 4.2.8 for Alternative 4A.

Process options which passed the screening and which are represented by the chosen process options are presented below:

Medium	Chosen Option	Other Options Which Passed Screening
Soil/Waste	In situ vitrification	None
Ground Water	Extraction wells	Well points, french drains
	Organics - UV oxidation	None
	Inorganics - Membrane microfiltration	Ion exchange; precipitation
	On-site discharge - Surface water	Infiltration galleries; injection wells

4.2.11.2 Evaluation

Effectiveness

The innovative nature of Alternative 7 complicates the evaluation of the effectiveness of the alternative. The effectiveness of in situ vitrification as applied to a municipal waste landfill has not been previously proven. As described for Alternative 4A, while UV oxidation has been tested successfully in treating organic-contaminated ground water, membrane microfiltration is not as fully developed. The long-term effectiveness of in situ vitrification, if effective in its application, is expected to be good, due to the glasslike monolith that is formed by the process.

Implementability

The implementability of this alternative is limited by the limited availability of vendors which provide the treatment systems. The administrative feasibility could also be limited by the unproven nature of these treatment methodologies. Treatability studies would be required to confirm the effectiveness of these methodologies prior to final design and implementation.

Cost

The cost for Alternative 7 would be expected to be high, mainly due to the mobilization and operation expenses of the in situ vitrification system. The cost of the on-site soil/waste treatment/physical ground water treatment alternative is initially estimated at a present worth value of $110,000,000.

4.3 Selection of Alternatives for Detailed Analysis

A comparative analysis of the individual alternative screenings based on the three evaluation criteria is conducted to allow the elimination of certain alternatives from the detailed analysis process.

4.3.1 Effectiveness

With respect to long-term effectiveness, those alternatives which involve reductions in the toxicity, mobility or volume of contamination and contaminant sources will provide the greatest protection. With respect to short-term effectiveness, those alternatives which are protective during the construction and implementation period are most effective.

For the remedial alternatives developed, those alternatives which provide the greatest long-term effectiveness, due to removal/treatment of contaminated soils and waste materials, typically provide the least amount of short-term protectiveness, due to the required disruption of the waste materials. Alternatives 5, 6, and 7 provide the greatest long-term effectiveness with Alternatives 5 and 6 having similar short-term potential adverse impacts associated with their implementation. Alternative 3 provides long-term effectiveness with respect to the Hertel Landfill site, but since it involves no reduction in soil/waste toxicity, it may not be protective of the environment at the off-site disposal area. Alternatives 2 and 4 are similar

in the degree of short-term effectiveness provided, with less short-term impacts than those expected for soil/waste excavation alternatives. Alternatives 4 and 4A provide a reduction in ground water contamination but do not address remediation of the soil/waste matrix. Alternatives 2 and 2A do not provide an active ground water remediation system, but their containment features could result in a long-term reduction in mobility of contamination. Alternative 1, the no action alternative, provides no treatment or containment of contamination. However, through continued ground water monitoring, potential migration of contamination to off-site private wells could be identified prior to impacting human health.

4.3.2 Implementability

Implementability is a measure of the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Alternative 1 is the most implementable alternative from a construction standpoint. Alternatives 2 and 4 are also fairly readily implemented. The administrative feasibility of Alternatives 3 and 6 is limited by the lack of available off-site disposal/treatment sites with sufficient capacity to accept the entire volume of materials to be excavated from the Hertel Landfill site. Alternative 5 is technically feasible; the administrative feasibility is not as great as for the containment alternatives, but it is feasible. The technical feasibility of Alternative 7 is questionable due to the unproven nature of in situ vitrification with respect to municipal waste materials. The implementability constraints could provide the basis for elimination of Alternatives 3, 6 and 7 from further consideration.

4.3.3 Cost

Preliminary remedial costs for the individual alternatives are summarized in Table 4-3. Alternative 1 is the lowest cost alternative. Alternatives 2, 4 and 4A are comparative in terms of cost. Alternative 2A is slightly higher in cost. Alternatives 5 and 7 are an order of magnitude higher in cost than Alternatives 1, 2 and 4 but they provide treatment of the contamination source that the other alternatives do not. Alternatives 3 and 6 are significantly greater in cost than the other alternatives evaluated, which could provide the basis for elimination of these alternative from further consideration.

4.3.4 Selection of Alternatives for Further Consideration

As described in the previous sections, Alternative 3 may be considered for elimination from further analysis on the basis of implementability and cost. Because Alternative 3 provides a level of effectiveness similar to Alternative 4 in terms of soil/waste containment and ground water treatment, it will not be retained for further consideration.

Alternatives 5, 6, and 7 (excavation & onsite incineration, excavation and off-site treatment, in-situ vitrification, respectively) will be deleted from further analysis in consideration of the following factors:

a) In accordance with the NCP, containment technologies are generally deemed appropriate for waste that poses a relatively low long-term threat or where treatment of the waste is impracticable (e.g., mixed waste of widely varying composition, as is generally found at municipal landfill sites).

b) Similarly, areas of highly toxic and/or mobile material that constitute a principal threat and would justify treatment, have not been identified on this site.

c) The costs of construction and the long-term costs to operate and maintain these alternatives are grossly excessive when compared to their overall effectiveness.

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5.0 DETAILED ANALYSIS OF ALTERNATIVES

Based on the initial screening of alternatives presented in Section 4, three alternatives are retained for further consideration. These alternatives are summarized in Table 5-1.

5.1 Introduction

In this section, the assembled remedial alternatives are described and evaluated in detail. The descriptions are presented by first discussing work components common to several alternatives, then describing each alternative completely. Detailed analyses are then presented. Per the requirements of the NCP, the detailed analyses are divided into seven evaluation categories, including the following:

- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility and Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost
- Compliance with ARARs
- Overall Protection of Human Health and the Environment

Detailed cost estimates for the remedial alternatives are presented in Appendix A.

The two remaining evaluation criteria required by the NCP, Support Agency Acceptance and Community Acceptance, are applied after completion of the FS.

Following individual analyses of the alternatives, a comparative analysis against the seven evaluation criteria is performed.

5.2 Common Elements and Considerations

Prior to the presentation of the specific alternative descriptions, a discussion of certain work elements common to a number of the alternatives, as

well as a discussion of certain considerations which may affect alternative implementation or assessment, is presented.

Mobilization

Prior to any major site work, equipment must be mobilized and the locations of on-site operations established. It is anticipated that, at a minimum, an office trailer will be necessary for control of site operations. Access to the site will be closely monitored; warning signs will be posted and temporary fencing will separate the area where greater health and safety precautions are necessary (the "hot" zone). The office trailer will be situated near the existing site access road. Heavy equipment will be stored in a restricted area.

Equipment Decontamination

Equipment decontamination facilities will be required during remedial construction activities. Provision of such facilities will require construction of a decon pit and collection of decon wastes. After completion of remedial activities, the residual wastewaters will require analysis and disposal at a permitted facilty.

Clearing

For alternatives which require construction activities in the landfill area itself, clearing of existing vegetation will be required. Additionally, some degree of clearing will be required in areas where additional monitoring wells or ground water extraction wells are proposed.

Run-On/Run-Off Controls

For a number of the alternatives considered, run-on/run-off controls will be required to prevent run-on from entering areas where remedial activities are being conducted and to likewise control run-off from remediated areas. Run-on/run-off controls will consist of ditching around the remedial areas and, for alternatives which potentially could result in significant erosion during construction activities, sedimentation control may be required to protect the on-site wetland areas. Sedimentation control could consist of sedimentation basins, interceptor dikes/berms, diversion channels or slope control. For the purposes of cost analyses, construction of a sedimentation basin has been assumed. In accordance with New York landfill closure regulations, drainage control structures associated with capping alternatives would be designed to protect the final cover from, at a minimum, the peak discharge of a 24-hour, 25-year frequency storm.

Access Road Reconstruction

Due to the flooding which currently occurs on the unpaved access road to the site, reconstruction and drainage improvements would be required prior to the implementation of any remedial alternatives requiring regular access to the site. Additional attention to road improvements would be required for those alternatives which require site access by heavy equipment.

Short-Term Risk Estimation for Common Work Elements

Short-term risks to remedial workers associated with incidental ingestion of soil, dermal contact with soil and inhalation of fugitive dusts were quantified in relation to road improvements, and clearing of vegetation from the landfill area. Fugitive dusts were assumed to originate from wind

erosion, vehicular activity over unpaved roads and, in some instances, loading and dumping activities (EPA, 1985). These risks were estimated for workers without the use of personal protective equipment. Use of personal protective equipment would minimize short-term risks.

For potential carcinogens, risks are estimated as probabilities. The compound-specific potency factors for carcinogens are generally estimated through the use of mathematical extrapolation models (e.g., the linearized multistage model). These models estimate the largest possible linear slope, within a 95% confidence interval, at low extrapolated doses. Thus, the potency factor is characterized as a 95% upperbound estimate, such that the true risk is not likely to exceed the upperbound estimate and may be lower.

The evaluation of risk from noncarcinogenic health hazards is based on the use of RfDs (EPA, 1991; EPA, 1989). RfDs are estimates of daily exposure to the population (including sensitive subpopulations) that are likely to be without appreciable risk of deleterious effects for the defined exposure period. The RfD is calculated by dividing the NOAEL or LOAEL derived from animal or human studies by an uncertainty factor, which is multiplied by a modifying factor. RfDs incorporate uncertainty factors which serve as a conservative downward adjustment of the numerical value and reflect scientific judgment regarding the data used to estimate the RfD. For example, a factor of 10 is used to account for variations in human sensitivity (i.e., to protect sensitive subpopulations) when the data stems from human studies involving average, healthy subjects. An additional factor of 10 may also be used for each of the following:

- extrapolation from chronic animal studies to humans,
- extrapolation from a lowest observable adverse effect level (LOAEL) to a no observed adverse effect level (NOAEL), and

- extrapolation from subchronic to chronic studies.

Finally, based on the level of certainty of the study and database, an additional modifying factor (between zero and ten) may be used.

The results of the quantitative risk analysis are presented in two basic forms. In the case of human health effects associated with exposure to potential carcinogens, risk estimates are expressed as the lifetime probability of additional cancer risk associated with the given exposure. In numerical terms, these are presented in scientific notation in this report. Thus, a lifetime risk of 1E-04 means a lifetime incremental risk of one in ten thousand; a lifetime risk of 1E-06 means an incremental lifetime risk of one in one million and so on.

In the cases of exposure to non-carcinogens, the Hazard Index Ratio is used. The fundamental principles used to construct the RfD utilized in calculating the Hazard Index Ratio are predicated on long term or chronic (usually measured in years) exposures and health effects.

Cancer and non-cancer health risks are discussed for scenarios associated with each remedial alternative. In each case, daily doses of the compounds of concern have been calculated for each exposure pathway modeled, and these doses were used to calculate cancer risk levels and hazard index ratios. Dose equations, assumptions and estimates are presented in Appendix B. Cancer risk levels are the lifetime probability of excess cancer due to the exposure pathways emanating from use of the site. Cancer risk levels are derived by multiplying exposure dose by the appropriate cancer slope factor for each compound and exposure route. Non-cancer health risk is quantitated by the hazard index ratio which is the ratio of the exposure dose to the RfD (both in mg/kg/day). The calculated level of cancer risk can be compared to the acceptable total site risk range (1E-04 to 1E-06) for evaluating the need for

remediation, as stated in the "National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule" (EPA, 40 CFR Part 300, March 8), and in the Superfund Human Health Evaluation Manual (1E-04 to 1E-07) (EPA, 1989a). Regarding non-carcinogenic health hazards the Superfund Human Health Evaluation Manual (EPA, 1989) states that:

> "When the total hazard index for an exposed individual or group of individuals exceeds unity, there may be concern for potential non-cancer health effects."

Thus, the cancer risk and hazard index ratios that constitute a concern are >1E-04 and >1E+00, respectively.

Appendix B contains cancer risk and hazard index ratios for all scenarios, pathways and contaminants of concern. Tables 5-2 and 5-3 summarize cancer risk levels and hazard index ratios estimated for common remediation activities including road improvements and clearing of vegetation from the site. These activities will be incorporated into all proposed alternatives, and thus risks associated with these activities are included in the total risk associated with each remedial alternative.

Exposure of remedial workers to contaminants during road construction/ improvement and vegetation clearing is associated with a total cancer risk of 2E-06, which is within the target (acceptable) risk range (Table 5-2).

These site preparation activities are also associated with a total hazard index ratio of 10 (Table 5-3), which is an order of magnitude above the target HI value. Inhalation of airborne chemicals absorbed to fugitive dust is responsible for most of this risk.

Exposure equations, fugitive dust modeling and dose calculations used in evaluating these risks are presented in Appendix B.

Ground Water Monitoring

Quarterly ground water monitoring will be conducted for 5 years (i.e., 20 rounds of samples) subsequent to completion of ground water remediation for remedial alternatives which include ground water treatment (Alternatives 4 and 4A). Long-term (30 year) ground water monitoring is also included in the no action alternative (Alternative 1) and in capping alternatives which include no ground water treatment (Alternatives 2 and 2A). The monitoring system will consist of existing monitoring wells and six new wells to be installed. The proposed locations of additional ground water monitoring wells are provided in Figure 5-1. Of the six proposed wells, two are deep overburden wells and four are bedrock wells. The proposed wells have been located to provide a more comprehensive definition of water quality within the deep overburden and shallow bedrock. These wells, along with existing wells MW-1D, MW-2D, MW-10S, MW-11S, MW-W1D and MW-W2D, will comprise the ground water monitoring network. Also included in the ground water monitoring plan are annual sampling and analysis of private potable wells near the site. For costing purposes, sampling of fifteen private wells has been assumed.

Ground Water Extraction/Discharge

A ground water extraction/discharge system is proposed for several of the alternatives under consideration. The extraction of ground water will allow for the collection of contaminated ground water, and potentially floating product, for subsequent treatment and discharge. Discharge will be to surface water.

In arriving at the proposed extraction system configuration, the primary objectives were: 1) to capture and extract ground water from the entire areal extent of the landfill, especially from areas where contaminant levels

exceeding MCLs have been detected, 2) to depress the water table below the fill (by at least 6 feet in the central portion) so that the fill becomes effectively isolated from the saturated zone, and 3) to eliminate the breakout of leachate at the toe (eastern side) of the landfill. The extraction of ground water from the bedrock aquifer was not a design objective, since ARARs were not exceeded in bedrock well samples. Ground water extraction could result in upward migration of ground water from the bedrock towards the extraction wells.

The proposed ground water extraction well locations are provided in Figure 5-2. Further ground water studies would be conducted during the design stage, should an alternative involving ground water extraction be chosen for remediation of the site. Final design details (number of extraction wells, well locations, etc.) would be determined at that time.

A preliminary configuration of the proposed wellfield, as presented in Figure 5-2, was determined using an analytical computer model (THWELLS, Version 2.0) based on the Theis equation for uniform, non-steady flow in a homogeneous, isotropic confined aquifer of uniform thickness and infinite in areal extent. The assumed hydraulic parameters were as follows:

- Each well will penetrate 15 feet into the saturated zone, to allow for the extraction of shallow, contaminated ground water;
- The average hydraulic conductivity equals 1.2 feet per day, based on the hydraulic conductivities calculated for shallow wells located adjacent to and within the landfill area; and
- Specific yield equals 0.2 (dimensionless).

In determining the well spacing, it was considered desirable, if possible, to use an individual well pumping rate of less than 500 gallons/day, to allow for poor well performance in zones of low hydraulic conductivity.

Using the model, it was determined that, within the landfill, a wellfield consisting of 21 extraction wells, spaced 100 feet apart and each pumping 325 to 350 gallons/day, would provide adequate capture of the contaminated ground water, isolate the fill materials from the water table, and mitigate the leachate breakout. In the area of contamination around well MW-13S, using an average hydraulic conductivity of 12.5 ft/day, it was determined that one well, located midway between the adjacent wetlands and extracting approximately 700 gallons/day, would provide capture for the contaminated ground water in that area. A more detailed discussion of the THWELLS model, including the model's input and output, is provided in Appendix C.

The estimated total withdrawal rate for the proposed extraction system, based on the computer model, is approximately 8,000 gallons/day (5.6 gallons per minute or gpm). A total extraction rate of 10 gpm (14,400 gallons/day) will be used as a basis for the design of the ground water treatment system. The amount of time required to remove a volume of water equal to the contaminant plume volume based on the 10 gpm extraction rate is approximately 3.8 years. A ground water remediation period of twelve years will allow for the removal of three pore volumes.

Ejector-type pumps have been included in the cost estimates for the ground water extraction system. The pumps fill by gravity and discharge using compressed air. With a minimal number of moving parts, ejector pumps are suitable for pumping at very low flow rates and can adapt to variable flow rates as well. Ejector pumps operate pneumatically; therefore, use of electricity in the immediate landfill area may be minimized. Ejector pumps are also designed specifically for the extraction of floating product phases.

Compliance with Wetlands Requirements

The New York Department of Environmental Conservation Freshwater Wetlands Permit Requirements Regulations (6 NYCRR Part 663) identify the guidelines and procedural requirements applicable to various activities conducted in or adjacent to freshwater wetlands. The regulations identify activities which require permits prior to implementation as well as the relative compatibility of the activities with wetlands and their adjacent areas. While CERCLA Section 121(e) states that no federal, state or local permits are required for any removal or remediation activities conducted entirely on-site, remedies must meet the substantive requirements of the law. A wetland evaluation will be performed prior to initiation of Remedial Design so that a complete assessment of potential wetland impacts can be made.

Activities which are part of the following remedial alternatives and which may be impacted by the Wetlands Permit Requirements include the following:

- Draining and altering water levels;
- Constructing, expanding or substantially modifying drainage ditches;
- Clear-cutting trees and vegetation other than trees;
- Grading;
- Constructing roads;
- Drilling a well;
- Constructing a building; and
- Installing utility service.

Requirements vary depending on whether the activity is conducted within the wetland area or within an adjacent area, defined as within 100 feet, measured horizontally, of the boundary of the wetland. Activities which require a permit and are identified in the regulations as being compatible or usually incompatible must meet three test conditions for a permit to be issued. These include: (i) the activity would be compatible with preservation, protection and conservation of the wetland and its benefits; and (ii) would result in no more than insubstantial degradation to, or loss of, any part of the wetland,

and (iii) would be compatible with the public health and welfare. Activities which require a permit and are identified in the regulations as being incompatible must meet certain standards based on the class of wetland affected before a permit will be issued. As stated earlier, remedial activities at the Hertel Landfill site must meet the substantive requirements of the wetlands regulations.

5.3 Individual Analysis of Alternatives

In Section 4.2, preliminary descriptions of alternatives, documentation of the logic behind alternative selection, and a discussion of acceptable process options were presented. Prior to conducting a detailed analysis of remaining alternatives, the various elements of the alternatives, implementation of the elements, the way the elements would be combined to form a complete alternative, the time frame required to achieve cleanup and the common elements included in each alternative are described. Following the alternative description, the alternatives are evaluated against each of the nine evaluation criteria described in Section 5.1.

5.3.1 Alternative 1 - No Action with Continued Ground Water Monitoring

5.3.1.1 Description

The no action alternative involves no remedial actions to reduce toxicity, mobility or volume of contamination at the Hertel Landfill site. The site would remain in its present condition, with no additional barriers to access. The alternative does include the installation of additional monitoring wells and continued ground water monitoring, to identify off-site migration of ground water contamination, should it occur. A description of the ground water monitoring network was provided in Section 5.2.

5.3.1.2 Criteria Assessment

Short-Term Effectiveness - The short-term impacts of the no action alternative would be unchanged from the current risks posed by the Hertel Landfill site. No elevated short-term risks would result from the implementation of this alternative; however, the potential for human and environmental exposure would not be reduced either. A discussion of the risks posed by current environmental conditions at the site is presented in Section 1.5. Based on the current/recreational use scenario, cancer and non-cancer risks exceeding acceptable risk ranges were identified based on dermal contact with arsenic (based on the arsenic concentration detected in a background sample) and PAH compounds in the soil, for children and adult receptors. Remedial action objectives would not be achieved.

Long-Term Effectiveness and Permanence - The no action alternative would provide no reduction in risk and does not utilize controls to treat or manage contamination or contaminant sources. A discussion of the risks posed by current environmental conditions at the site is presented in Section 1.5. In addition to the risks posed by the site under the present use scenario, risks would be exceeded for future site development scenarios. Long-term (30-year) ground water monitoring is included in the no action alternative to provide an indication of potential ground water contaminant migration off-site towards private wells. While long-term monitoring is likely to identify any off-site migration, it provides no remedial action should migration be identified. The selection of the no action alternative would require review should continued monitoring identify migration towards off-site potable wells or should development of the site be proposed. The NCP [300.430(f)(4)(ii)] requires that, if a remedial alternative is selected which results in hazardous

substances remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less than once every five years after initiation of the alternative (i.e., six reviews in a 30 year period; therefore, at a minimum, a five-year review would be required if the no action alternative were implemented.)

Implementability - The no action alternative is the most easily implemented alternative. The technical feasibility of this alternative is limited only by the difficulties in installing deep monitoring wells which were encountered during the remedial investigations. To address these difficulties, tubex drilling, which performed satisfactorily in the RI, is the proposed method of well installation. Tubex drilling services and well construction/monitoring materials are readily available. Once the wells are installed, continued ground water monitoring is easily implemented and future remedial action, if required, would not be hampered by other on-site remedial activities. No administrative feasibility problems would be expected if this alternative were selected.

Reduction of Toxicity, Mobility or Volume Through Treatment - The no action alternative does not include any treatment methods other than naturally occurring degradation processes such as in situ biological degradation and volatilization of organic contaminants. Considering the length of time in which the landfill, the source of contamination, has been in-place at the site, the short-term risks associated with providing no treatment of the source are not expected to pose imminent hazards to human health or the environment above those identified in the baseline risk assessment. However,

long-term risks may be associated with the lack of containment/treatment provided by the no action alternative.

Compliance with ARARs - The no action alternative does not attain all chemical-specific ARARs for contaminants detected in the ground water, surface water or sediment (no federal or state chemical-specific ARARs for soils are available). It should be noted, however, that ARARs may be waived under certain circumstances called out in the NCP, including situations where compliance with the requirement will result in greater risk to human health or the environment than other alternatives, where compliance is technically unpracticable from an engineering perspective or where the alternative will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, through use of another method or approach.

Overall Protection of Human Health and the Environment - The no action alternative may not provide long-term protection of human health and the environment, because it does not address potential risks through the elimination, reduction, or control through treatment, engineering or institutional controls of the source of identified contamination. Risks associated with dermal contact with soils based on the current recreational use of the site are not addressed. Similarly, potential future risks associated with ground water ingestion are not addressed. However, through continued ground water monitoring, the alternative provides the opportunity to review the no action decision, should monitoring ever identify ground water contaminant migration, and allows for a future review of the additional potential risks to human health and the environment associated with the identified migration. A review of the remedial decision is required at a

minimum of every five years under the NCP's requirements for sites where contaminants remain following remediation. Should the site ever be developed for an alternative use, protection of human health and the environment may not be provided.

Cost - The only cost associated with the no action alternative would be the cost of monitoring well installation and continued monitoring of ground water quality. Due to the lack of treatment afforded by the no action alternative, a 30-year monitoring period has been assumed. The cost estimate includes $52,000 in direct capital costs, $6,000 in indirect capital costs and $132,000 in annual operation and maintenance costs ($2,033,000 present value). The total present worth value of this alternative, including contingency, is estimated at $2,509,000. A detailed cost estimate is presented in Appendix A.

5.3.2 Alternative 2 - Site Use Restrictions and Capping

5.3.2.1 Description

Alternative 2 consists of the institution of site use restrictions and capping of the landfill area. It includes the following common work elements described in Section 5.2: Mobilization, Equipment Decontamination, Clearing, Run-on/Run-off Controls, Access Road Reconstruction, Ground Water Monitoring, and Compliance with Wetlands Requirements.

Site use restrictions would include deed restrictions limiting future site development and use, restrictions on the installation of potable wells on-site, and access restrictions in the form of secure fencing around the landfill portion of the site and posting of warning signs.

Capping of the site would initially require clearing of the landfill area and grading and filling of the area to provide an evenly graded surface. It

is estimated that 80,000 cubic yards of fill will need to be brought to the site in order to accomplish this. By providing a consistently sloped base for cap construction, the final cap would subsequently promote runoff. The existing topography is approximately at an average 8% slope across the landfill area, with individual areas ranging as steep as a 33% slope. The landfill area would be surface-graded to an average 5% to 8% slope during cap construction activities. Figure 5-3 indicates the landfill area to be capped under this alternative.

The cap itself would be designed in accordance with the closure requirements set forth in 6 NYCRR Part 360 for Solid Waste Management Facilities. The final cap would consist of a gas venting layer (bounded on its upper and lower surfaces by a filter layer), a low permeability barrier soil cover or geomembrane cover, a barrier protection layer, and topsoil. Following construction of the cap, the surface would be stabilized by planting a vegetative cover. Figure 5-4 provides a cross-section of the final cap design assumed in preparing a cost estimate for this alternative. Evaluation of landfill gas properties would be required during the remedial design stage to determine if a passive gas venting system, as indicated in Figure 5-4, would be adequate or if treatment of the off-gases would be required.

5.3.2.2 Criteria Assessment

Short-Term Effectiveness - Implementation of this alternative would result in disruptions of surface and near-surface soil and waste materials. Tables 5-4 and 5-5 summarize cancer risk levels and hazard index ratios estimated for remediation associated with Alternative 2. The tables present these risks on a chemical-by-chemical basis so that the major factors which drive the risk can be readily ascertained.

Exposure of remedial workers to contaminants while conducting activities associated with remediating the site is associated with a total cancer risk of 1E-05 (including site preparation activities) which is within the acceptable (target) cancer risk range (Tables 5-2 and 5-4).

Site remediation under Alternative 2 is associated with a total hazard index ratio of 20 (Tables 5-3 and 5-5), which is above the target HI value. Inhalation of airborne chemicals adsorbed to fugitive dusts is responsible for most of this risk.

Personal protective equipment and dust control measures could be implemented to minimize the potential for airborne contaminants to impact remedial workers and the surrounding community, respectively. Likewise, surface run-off controls could minimize the impacts of surface water run-off to wetlands and the stream during implementation. The time required to complete construction of the final cap is estimated at four months.

Implementation of site use restrictions would have no short-term adverse impacts to the adjacent community or the environment. Fence construction activities would take place outside of the contaminated limits and would not be expected to pose a risk to construction workers. Construction of the fence could be conducted within the period that cap construction was conducted.

Long-Term Effectiveness - Alternative 2 would not treat the sources of contamination at the site, although it would provide containment through the elimination of exposure to surface soil contaminants and minimization of the infiltration of precipitation through the waste materials. Site use restrictions would limit the accessibility of the site and also limit exposure to identified on-site risks. Long-term residual risks associated with Alternative 2 were addressed in relation to future recreational use of the

site following completion of proposed remedial measures. Potential receptor populations and exposure routes include children playing in or near surface water resulting in incidental ingestion and dermal contact with sediments.

Exposure of children to contaminants while playing on-site is associated with a total cancer risk of 2E-05 (Table 5-6), which is within the target risk range. Similarly, the HI value associated with future recreational use of the site is 0.1, which is also less than the target HI value of 1 (Table 5-7). An additional potential future use exposure includes ingestion of ground water from potable private wells downgradient from the site. Results obtained from the field investigations indicate no current impacts on private wells. However, because this alternative does not address ground water flow through waste material, there is a potential for future impacts.

Future activities which could compromise the integrity of the cap would not be allowed through the implementation of deed restrictions. The NCP requires that the lead agency shall review such an action no less than once every five years after initiation of the alternative (see Section 5.3.1.2). Therefore, a five-year review would be required if Alternative 2 were implemented in order to confirm the continued protectiveness of the alternative.

Long-term management, in the form of maintenance of the cap, drainage control system and ground water monitoring system, would be required. The technologies involved in capping a site are not extremely complicated and the maintenance of such a system following installation should not be difficult. Similarly, replacement, should the cap fail or be damaged, would not be expected to pose risks greater than those of initial installation and should not be difficult to repair.

Implementability - The technical feasibility of cap and fence construction is good. Current site conditions provide minimal obstacles to cap construction, with the exception of the presence of large boulders on-site. Capping technologies are well-developed and fairly reliable, as long as the cap is maintained and site uses are restricted to limit potential damage to the cap system. Due to the relative simplicity of the cap's design, reliability is expected to be good. Certain future remedial actions, such as excavation and disposal/treatment, could not be implemented without compromising the integrity of the cap. However, the presence of the cap does not preclude the use of other remedial technologies and could enhance the implementation of certain technologies, such as ground water extraction. Equipment and supplies necessary to construct a cap and fence are available, although some lead time would be required to identify supply sources, due to the significant volumes of capping materials required.

Administrative feasibility of cap and fence construction is good, although the administrative feasibility of instituting site use restrictions requires the proper authority and coordination within state and local agencies. Site use restrictions have been included in recommended remedial action decisions at other CERCLA sites in New York.

Reduction of Toxicity, Mobility and Volume Through Treatment - Alternative 2 provides no treatment nor associated reduction in contaminant toxicity. The provision of an impermeable cap will limit the infiltration of precipitation and the subsequent volume of leachate production, however, and will therefore limit the mobility of contaminant migration to a certain degree. However, the presence of the water table within the fill materials is not mitigated by this

alternative, thereby providing a continued potential source of ground water contamination.

Compliance with ARARs - Alternative 2 does not attain all chemical-specific ARARs for contaminants detected in the ground water, surface water, or sediment (no federal or state chemical-specific ARARs for soils are available). As described in Section 5.3.1.2, ARARs may be waived under certain circumstances. By designing the final cap system to meet New York Solid Waste Management Facility closure regulations, the alternative will comply with action-specific ARARs. Access road reconstruction, final cap construction or other remedial activities, as previously identified in Section 5.2, conducted within 100 feet of the boundary of a wetland will also have to be conducted in compliance with New York Freshwater Wetlands Regulations.

Overall Protection of Human Health and the Environment - This alternative provides short-term and long-term protection of human health and the environment through the utilization of engineering and institutional controls to limit leachate production and site accessibility. However, it does not address potential risks associated with the possible off-site migration of existing ground water contamination through either ground water treatment or volume reduction. Through continued ground water monitoring, it does provide the opportunity to review the decision, should monitoring ever identify off-site ground water contaminant migration, and allows for a future review of the additional potential risks to human health and the environment associated with the identified migration. Such a review is required at a minimum of every five years under the NCP's requirements for sites where contaminants remain following remediation.

Cost - The cost associated with Alternative 2 includes site clearing, grading, cap construction and maintenance, and long-term monitoring costs. These costs include $3,054,000 in direct capital costs, $427,000 in indirect capital costs and $163,000 in annual operation and maintenance costs ($2,503,000 net present value). The present worth value of this alternative, including contingency, is estimated at $7,182,000. A detailed cost estimate is presented in Appendix A.

5.3.3 Alternative 2A - Site Use Restrictions, Capping, Slurry Wall

5.3.3.1 Description

For Alternative 2A, site use restrictions and capping would be as described for Alternative 2 in Section 5.3.2. Therefore, the description presented herein addresses the only component not evaluated previously, the slurry wall. A slurry wall would be constructed upgradient of the landfill area to act as a barrier to ground water flow through the in-place waste materials. Figure 5-5 presents the proposed site layout for this alternative. Implementation of the following common elements, as described in Section 5.2, would also be required: Mobilization, Equipment Decontamination, Clearing, Run-on/Run-off Controls, Access Road Reconstruction, Ground Water Monitoring, and Compliance with Wetlands Requirements.

The impact of an upgradient slurry wall on the hydrogeology of a disposal site is presented in Figure 5-6. To determine the downgradient impacts of a slurry wall on the water table within the waste materials at the Hertel Landfill site, a numerical computer simulation was run using MODFLOW, the USGS three-dimensional finite difference flow model (McDonald and Harbaugh, 1988). The model was run as a one-layer simulation, and the aquifer parameters used were the same as those used in the analytical extraction wellfield model (Section 5.2). First, constant-head boundaries were placed upgradient and

downgradient from the landfill area to establish flow through the modeled site, and the model was roughly calibrated to the ground water contours for May 22, 1990 (Figure 3-6, RI Report, TAMS/TRC, 1991). Then, the nodes encompassing the proposed wall location were designated zero flux boundaries, and the model was rerun. The resulting nodal hydraulic heads were compared to the pre-wall head values to evaluate the wall's effectiveness in depressing the water table below the fill. The model indicated that the wall's effect would be to lower the water table at least 6 feet in the central portion of the landfill (beneath the base of the fill material), and that the wall would eliminate the leachate breakout at the toe of the landfill. It should be noted that, in simulating one layer only, the model did not account for potential upward ground water flow from the bedrock into the overlying materials.

The slurry wall design is dependent on site characteristics. Where low permeability is required, a soil/bentonite wall is preferred over a cement/ bentonite wall; however, soil/bentonite walls are typically limited to areas where the maximum slope along the trench line is on the order of 2% or less. Due to the existing slopes at the Hertel Landfill site, it is assumed that a cement/bentonite wall will be required.

The width of the wall is designed based on the hydraulic head across the trench. Generally, for a soil bentonite wall, the trench should "have a width of 0.5 to 0.75 feet per 10 feet of hydrostatic head on the wall" (Case, 1982). Because a cement/bentonite wall has greater strength, a wall of lesser thickness will stand up to the same hydrostatic pressure. For the purposes of this evaluation, it is assumed that the slurry wall will be approximately 1800 feet long, located as indicated in Figure 5-5. The wall will be keyed into the underlying bedrock, with an average depth of 40 feet, and the width of the wall will be 3 feet, based on an assumed maximum hydrostatic offset of 40 feet.

To monitor the effectiveness of the slurry wall system upon completion, the installation of observation wells will be required. Proposed observation well locations are provided in Figure 5-5. For the purposes of this evaluation, the installation of 8 observation wells has been assumed. These wells, along with existing monitoring wells in the fill area, will be monitored to confirm the effectiveness of the slurry wall in maintaining the ground water table at a level below the base of the fill material. If hydrostatic pressures upgradient of the slurry wall become excessive, drainage systems may be required to redirect the ground water around the slurry wall. In addition, in the potential event that the wall does not provide the desired water table depression within the landfill, it may be necessary to install extraction wells, either within or outside the walled area, to aid in this process.

5.3.3.2 Criteria Assessment

The following criteria assessments address, for the most part, only the evaluation of the slurry wall component of Alternative 2A; the remaining components were addressed during the assessment of Alternative 2, as presented in Section 5.3.2.

Short-Term Effectiveness - The construction of a slurry wall is not expected to result in significant impacts to the adjacent community or to remedial workers, since the slurry wall is located outside of the boundaries of the landfill area. Short-term risks associated with this alternative are similar to Alternative 2. Potential environmental impacts could result from the on-site construction activities. Run-off control measures would be required to protect wetlands and surface waters during construction.

According to Miller (1979), soil/bentonite slurry walls are normally installed at rates of 25 to 100 linear feet per day. For the purposes of this evaluation, it is assumed that the wall will be constructed at the rate of 50 linear feet per day. Therefore, the time required to construct the slurry wall would be approximately 3 months, allowing for mobilization and demobilization periods. Assuming materials excavated during slurry wall construction could be used in grading the area of the cap installation and cap construction following completion of the slurry wall construction, the total construction time frame would be approximately 7 months.

Long-Term Effectiveness - As with Alternative 2, the construction of a slurry wall would not treat the sources of contamination at the site, although it would provide containment through the elimination of exposure to surface soil contaminants, and minimization of leachate production through the elimination of infiltration and ground water flow through in-place waste materials.

Long-term residual risks associated with this alternative are similar to Alternative 2. However, impacts on potable wells will be restricted to those stemming from ground water remaining under the cap following installation of the slurry wall. No new interaction of ground water with waste material would be expected.

The slurry wall is relatively maintenance-free but monitoring of ground water levels both upgradient and downgradient of the wall would be required to provide an indication of the wall's integrity. In uncontaminated environments, as is the case with an upgradient wall location, slurry walls have shown to be effective in the long-term. Per the requirements of the NCP (see Section 5.3.2), a five-year review would be required if Alternative 2A were

implemented, in order to confirm the continued protectiveness of the alternative.

Implementability - The technical and administrative feasibility of slurry wall construction is good. Slurry wall technologies are well-developed but construction at the site may be complicated by the presence of subsurface boulders and by the sloping surface of the upgradient side of the landfill. The presence of boulders near the bottom of a slurry wall may lead to variations in trench depth and reduced slurry wall efficiency. The proposed depth of the wall may also result in special construction equipment requirements. The presence of a slurry wall would have little effect on future remedial activities.

Reduction of Toxicity, Mobility and Volume Through Treatment - The construction of a slurry wall will provide no treatment nor associated reduction in contaminant toxicity. However, the slurry wall will lower the ground water table below the waste material, thus eliminating ground water/waste contact, and thereby preventing the flow of upgradient, uncontaminated ground water through the fill material. While existing ground water contaminants will not be treated, the potential for future generation of ground water contamination will be reduced.

Compliance with ARARs - The construction of a slurry wall will minimize migration of ground water through the landfill but will not attain all chemical-specific ARARs for contaminants currently detected in the ground water. As described in Section 5.3.1.2, ARARs may be waived under certain circumstances. Site disruption associated with slurry wall construction and

other activities previously identified in Section 5.2 will have to be conducted in compliance with location-specific wetlands requirements. The alternative will comply with action-specific ARARs.

Overall Protection of Human Health and the Environment - The addition of a slurry wall to the original components of Alternative 2 provides an additional degree of long-term protection of human health and the environment through the utilization of engineering controls (a slurry wall) to limit leachate production and ground water contamination. The slurry wall helps to prevent future contamination of ground water, but does not address the potential risks associated with existing ground water contamination through either ground water treatment or volume reduction. As with Alternative 2, a five-year review of the decision would be required under the NCP, should this alternative be chosen.

Cost - The cost associated with Alternative 2A is the same as Alternative 2, with the additional costs associated with slurry wall construction. The total costs for Alternative 2A include $7,246,000 in direct capital costs, $1,159,000 in indirect capital costs and $171,000 in annual operation and maintenance costs ($2,626,000 net present value). The present worth value of this alternative, including contingency, is estimated at $13,238,000. A detailed cost estimate is presented in Appendix A.

5.3.4 Alternative 4 - Site Use Restrictions, Capping and Ground Water Extraction with On-Site Physical Treatment

5.3.4.1 Description

For Alternative 4, site use restrictions and capping would be as described for Alternative 2 in Section 5.3.2. Therefore, the description presented

herein addresses the proposed on-site physical ground water treatment system. Figure 5-7 presents the proposed site layout for this alternative. Implementation of the following common elements, as described in Section 5.2, would also be required: Mobilization, Equipment Decontamination, Clearing, Run-on/Run-off Controls, Access Road Reconstruction, Ground Water Monitoring, Ground Water Extraction/Discharge, and Compliance with Wetlands Requirements.

Ground water would be extracted via ground water extraction wells, as described in Section 5.2, at an estimated combined rate of approximately 10 gallons per minute (14,400 gallons per day). The extracted ground water would be pumped to an on-site treatment system consisting of a chemical precipitation system for inorganic removal and carbon adsorption for organics removal. The treatment systems would be operated to reduce contaminant levels in extracted ground water in accordance with federal and state discharge requirements prior to discharge to surface water.

The chemical precipitation treatment scheme will consist of a filtration unit to remove gross solids prior to treatment, a flow equalization tank, and the chemical reaction/precipitation system. The precipitation system will include the following:

- Reaction tank including mixers and pH control instrumentation;
- Chemical feed system, including a storage tank, mixers, level instrumentation and metering equipment;
- Clarifier;
- pH adjustment tank;
- Filter; and
- Solidification/stabilization system.

A schematic of the system is provided in Figure 5-8.

The proposed precipitation process involves the initial removal of entrained solids through filtration, thereby resulting in reduced reagent costs and smaller equipment sizing for the remainder of the treatment train.

A flow equalization tank is also provided prior to treatment. From the equalization tank, the ground water enters the reaction tank, where a reagent is added to adjust the pH of the wastestream to the level required to precipitate the optimal quantity of inorganic contaminants. Single-stage batch precipitation is expected to be suitable for treatment of the influent ground water stream.

The selection of an applicable precipitation reagent is dependent upon the pH, pollutant loading, and waste/reagent compatibility. For the purposes of this assessment, hydroxide precipitation is assumed. Hydroxide precipitation is a proven method for removing most of the metals identified at elevated concentrations in the ground water at the Hertel Landfill site, including arsenic, chromium (trivalent), copper, iron, lead, manganese, and zinc. Complexing/chelating agents, such as soda ash (Na_2Co_3), can improve the efficiency of the liquid/solid separation and can be effective in the removal of other inorganics such as magnesium. Determination of the final treatment scheme and appropriate reagents will require additional wastestream characterization and treatability study testing.

A clarifier follows the reaction tank. In the clarifier, flow is decreased to a point where solids with a specific gravity greater than that of the liquid settle to the bottom. The supernatant/liquid is drawn off and discharged to a pH adjustment tank for neutralization. The solids are discharged to a holding tank for subsequent dewatering. Dewatering is accomplished using mechanical dewatering equipment such as a belt filter. Once dewatered the sludge may require stabilization/solidification prior to off-site landfill disposal. The use of binding media such as cement-based compounds, lime-based pozzolanic materials or organic polymers can result in a filter cake which passes TCLP limits, potentially allowing for its disposal as

a non-hazardous waste. Based on published sludge generation rates (Palmer, et.al., 1988) and the maximum concentration of iron in filtered ground water samples, a maximum sludge generation rate of 8,200 lb per year is estimated (i.e., 1 lb/hr).

The carbon adsorption unit will consist of two active adsorption columns operated in series. Additional columns will be temporarily stored on-site to allow replacement of spent columns as needed. A schematic of the treatment unit is presented in Figure 5-9. The first column will provide the major portion of the treatment with the second column acting as a polishing column. Based on a design flow rate of 10 gallons per minute (gpm), an assumed carbon usage of 0.5 lb carbon per 1,000 gallons treated (Stenzel, M.H., and Gupta, U.S., 1985), and a typical application rate of 2 to 10 gpm per square foot, it is estimated that a system consisting of two drum-sized columns will be appropriate. Each column will contain approximately 6.5 cubic feet of carbon. Water will be delivered directly from the chemical precipitation system to the top of the first carbon column, and effluent will be collected in a 1,000-gallon equalization tank prior to discharge to the surface water. Based on the assumed carbon usage rate, one of the drums will require replacement every 25 days, or approximately once a month. The system will be operated in a cyclic fashion, with the first adsorber drum replaced, the second adsorber drum replacing the first adsorber drum, and a new adsorber drum replacing the second adsorber drum, as indicated below:

Typical Cycle Schedule

Day	Column A	Column B	Column C
0-25	1st Adsorber	2nd Adsorber	(Replaced)
26-50	(Replaced)	1st Adsorber	2nd Adsorber
51-75	2nd Adsorber	(Replaced)	1st Adsorber

The use of drum-sized adsorbers allows for the replacement of spent drums as needed. The maintenance of a three month supply of replacement drums allows for spent drum pickup and replacement at 90-day intervals, in accordance with RCRA requirements for maximum temporary hazardous waste storage periods.

The major operation and maintenance activities will be the disposal of the filter cake and sludge, and the replacement of spent carbon. Stabilized sludge will be sent off-site for disposal as a non-hazardous waste, provided TCLP requirements are met. The spent carbon will be removed through the pickup and removal of the spent drummed columns and replacement with new columns. Service contracts with carbon suppliers can be arranged to perform this service, which is expected to be required once every three months.

5.3.4.2 Criteria Assessment

The following criteria assessment addresses only the evaluation of the ground water extraction and treatment components of Alternative 4; the remaining components (capping and site use restrictions) were addressed during the assessment of Alternative 2, as presented in Section 5.3.2.2.

Short-Term Effectiveness - In the short-term, installation of ground water extraction wells could result in potentially added risks to on-site construction workers. Short-term risks to remediation workers involved in road improvements, clearing of vegetation and installation of a cap are described under Alternative 2 (Tables 5-2 through 5-7). Additional short-term risks associated with installation of twenty-two extraction wells were estimated for remedial workers in the absence of any personal protective equipment.

Tables 5-8 and 5-9 summarize cancer risk levels and hazard index ratios estimated for installation of extraction wells under Alternative 4. Exposure of remedial workers to contaminants is associated with a total cancer risk of 5E-05 (including site preparation, capping and extraction well installation), which is within the acceptable risk range.

Site remediation under this alternative is associated with a total HI of 30, which is above the target HI value of 1. The primary contribution to this risk is inhalation of contaminants absorbed to fugitive dusts (Tables 5-3, 5-5 and 5-9). The use of personal protective equipment is likely to minimize these risks. No significant added risks to the adjacent community or the environment are anticipated as a result of extraction well or treatment system installation. Protection against contaminated ground water migration would be provided upon initiation of extraction and control of ground water gradients.

For Alternative 4, the time required to meet remedial response objectives will depend on the time required to meet ground water quality standards through the operation of a pump and treat system. For the purposes of this evaluation, it has been assumed that the treatment of three pore volumes of ground water will provide adequate treatment. At the assumed extraction rate of 14,400 gallons per day, ground water treatment would continue for a period of 12 years.

Long-Term Effectiveness and Permanence - Chemical precipitation and carbon adsorption are effective methods for the removal of metals and organics in contaminated ground water. Precipitation is a proven method for removing most of the metals identified at the Hertel Landfill site. Through stabilization, the filter cake treatment residual may pass TCLP limits thus allowing for its disposal as a non-hazardous waste. Spent carbon will be transported off-site

for disposal, and, therefore, may present minimal off-site residual contamination.

Ground water monitoring will be continued for five years after the completion of ground water treatment at the site. The potential for additional ground water contamination to occur following discontinuation of the pumping system operation, and subsequent waste/ground water contact exists and would require monitoring. Because waste materials would remain in-place under this alternative, a five-year review of the action would be required (see Section 5.3.1.2).

Residual risks associated with long-term future use of the site are not expected to be significant based on restricted future use of the site. That is, implementation of on-site ground water treatment restricts future use of the site for other purposes.

Implementability - The construction of a ground water extraction system would be fairly easily implemented. The construction and implementation of a chemical precipitation system and carbon adsorption system would also be relatively easy. Both chemical precipitation and carbon adsorption are well-proven technologies with minimal technical problems expected. These two treatment systems are not expected to pose difficulties in implementing future remedial actions or monitoring difficulties. Ongoing monitoring of the systems would be required to ensure carbon breakthrough does not occur, to maintain required chemical supplies, and to manage wastes produced by the systems as appropriate.

Ground water extraction and discharge of treated ground water to local surface waters will require compliance with New York Pollutant Discharge Elimination System requirements and New York Freshwater Wetlands Permit

Requirements. Because ground water extraction could potentially impact the water levels of adjacent wetlands, implementation of this alternative could be difficult administratively. Discharge of treated ground water to the wetland areas could be considered as a means of minimizing these impacts.

Reduction of Toxicity, Mobility or Volume Through Treatment - Alternative 4 provides a reduction of ground water toxicity through treatment and a reduction of contaminant mobility through pumping, in addition to the containment features previously described for Alternative 2. Chemical precipitation and carbon adsorption will treat currently existing ground water contaminants. In chemical precipitation, the metals are precipitated out of the ground water as a solid filter cake which, when stabilized, is expected to pass TCLP limits. In carbon adsorption, the organics are adsorbed onto the carbon. Due to the relatively small volumes of carbon required for this application, on-site thermal regeneration is not practical and the spent columns will be transported off-site for disposal.

Compliance with ARARs - For ground water treatment, chemical precipitation and carbon adsorption will be used to reduce contaminant levels below Ambient Water Quality Criteria prior to discharge at the site. The cleanup goals for ground water contaminant levels will consist of federal and state MCLs. Effluent from the treatment process must meet the NY State Pollutant Discharge Elimination System (6NYCRR 750-757) requirements before discharge to area surface waters. The effluent must also meet federal regulations under the Clean Water Act. Ground water extraction and subsequent treated effluent discharge would be conducted in compliance with applicable wetlands requirements.

The effectiveness of this alternative in maintaining ground water contaminant levels below federal and state MCLs after the operation of the pump and treat system is discontinued will require monitoring, since the waste will remain in-place.

Overall Protection of Human Health and the Environment - This alternative provides protection of human health and the environment by minimizing ground water contaminant migration through pumping and contaminant toxicity through treatment using chemical precipitation and carbon adsorption. The long-term effectiveness and permanence are expected to be good, with little long-term maintenance. Long-term monitoring will be required to verify the continued protection offered by the alternative once ground water treatment activities are discontinued.

Cost - The cost associated with Alternative 4 includes site clearing, grading, cap construction and maintenance, ground water extraction and treatment, and long-term monitoring costs. These costs include $3,439,000 in direct capital costs, $550,000 in indirect capital costs and $316,000 in annual operation and maintenance costs ($3,322,000 net present value). The present worth value of this alternative, including contingency, is estimated at $8,774,000. A detailed cost estimate is presented in Appendix A.

5.3.5 Alternative 4A - Site Use Restrictions, Capping, and Ground Water Extraction with On-Site Innovative Treatment

5.3.5.1 Description

For Alternative 4A, site use restrictions and capping would be as described for Alternative 2 in Section 5.3.2. Therefore, the description presented herein addresses the proposed on-site innovative ground water

treatment system. Figure 5-7 presents the proposed site layout for this alternative. Implementation of the following common elements, as described in Section 5.2, would also be required: Mobilization, Equipment Decontamination, Clearing, Run-on/Run-off Controls, Access Road Reconstruction, Ground Water Monitoring, Ground Water Extraction/Discharge, and Compliance with Wetlands Requirements.

Ground water would be extracted via ground water extraction wells, as described in Section 5.2, at an estimated combined rate of 10 gallons per minute. The extracted ground water would be pumped to an on-site treatment system consisting of a membrane microfiltration unit for inorganics removal and UV oxidation for organics removal. The treatment systems would be operated to reduce contaminant levels in extracted ground water to federal or state criteria in accordance with New York State Pollutant Discharge Elimination System (SPDES) requirements (NYCRR Parts 750 through 758) prior to discharge to surface water.

The membrane microfiltration treatment system used as a basis for the evaluation of this alternative is an innovative treatment system being developed by E.I. DuPont de Nemours & Company (Du Pont). The treatment system is currently included in the U.S. EPA's Superfund Innovative Technology Evaluation (SITE) program. The system is designed to remove solid particles from liquid wastes, forming filter cakes typically ranging from 40 to 60 percent solids. It consists of an automatic pressure filter (Oberlin) combined with Du Pont's special Tyvek filter material (Tyvek T-980) made of spun-bonded olefin. The filter material has 0.1 micron openings, therefore allowing the removal of smaller particles which may have passed through the 0.45 micron openings of the filters used in the field sampling program. A schematic of the system is presented in Figure 5-10.

The microfiltration unit operates in a cyclical manner. The waste feed enters an upper chamber and is pumped through the filter fabric. The fabric allows water and solids less than about one ten-millionth of a meter in diameter to pass through the openings in the fabric. Filtered solids accumulate on the fabric, forming a filter cake, while the filtrate accumulates in a lower chamber. Air is fed into the upper chamber at about 45 pounds per square inch and used to further dry the cake and remove any remaining liquid. When the cake has been dried, the upper chamber is lifted and the filter cake discharged. The entire system is enclosed and therefore can be used to treat wastestreams containing volatile organics.

Pilot tests using this technology have been conducted at the Palmerton Zinc Superfund site in Palmerton, Pennsylvania, where ground water is contaminated with dissolved heavy metals such as cadmium, lead and zinc. The tests produced a 35 to 45 percent-solids filter cake, and a filtrate with non-detectable levels of heavy metals (U.S. EPA, 1989). The filter cake also passed TCLP analysis to render it a non-hazardous waste (E.I. duPont de Nemours & Co., Inc., 1991).

UV oxidation would follow the membrane microfiltration unit. UV oxidation is a process in which UV light and hydrogen peroxide chemically oxidize organic contaminants dissolved in water. A layout of the proposed system is provided in Figure 5-11. Hydrogen peroxide is converted in the presence of UV light to hydroxyl radicals, which are powerful oxidizers. Concurrently, organic molecules absorb energy from the UV light, making them more receptive to the hydroxyl radicals. The combined UV light and hydroxy radicals promote rapid breakdown of organics into carbon dioxide and water without the creation of air emissions or residual waste streams. The oxidation unit will be operated to reduce the contaminant levels in ground water to federal or state

criteria in accordance with state discharge requirements. Self-contained units for the destruction of organics are manufactured by Peroxidation Systems, Inc., and are available in various configurations. For costing purposes, a unit similar to the Peroxidation Systems Model SSB-30 oxidation unit has been assumed.

Operation and maintenance of the unit consists of UV lamp replacement every four months and occasional replenishment of the hydrogen peroxide supply.

5.3.5.2 Criteria Assessment

The following criteria assessment addresses only the evaluation of the innovative ground water extraction and treatment components of Alternative 4A; the remaining components (capping and site use restrictions) were addressed during the assessment of Alternative 2, as presented in Section 5.3.2.2.

Short-Term Effectiveness - Short-term risks to workers under this alternative are not expected to differ significantly from those described for Alternative 4. No significant added risks to the adjacent community or the environment are anticipated as a result of extraction well or treatment system installation. Protection against contaminated ground water migration would be provided upon initiation of extraction and control of ground water gradients.

For Alternative 4A, the time required to meet remedial response objectives will depend on the time required to meet ground water quality standards through the operation of a pump and treat system. For the purposes of this evaluation, it has been assumed that the treatment of three pore volumes of ground water will provide adequate treatment. At the assumed extraction rate

of 14,400 gallons per day, ground water treatment would continue for a period of 12 years.

Long-Term Effectiveness and Permanence - Residual risks associated with long-term future use of the site are not expected to be significant based on restricted future use of the site. That is, implementation of on-site ground water treatment restricts future use of the site for other purposes.

The long-term risks associated with the residuals of ground water extraction and treatment by UV oxidation and membrane microfiltration are relatively small. Ground water treatment by UV oxidation results in the breakdown of organics into carbon dioxide and water. Therefore, risks associated with UV oxidation treatment residuals are expected to be minimal. Ground water treatment by membrane microfiltration results in the filtration of heavy metal particles from the ground water. Therefore, dissolved metals would not be removed by this treatment method. The filtered solids form a filter cake which, in past tests, has passed TCLP limits for disposal in non-hazardous landfills. The tests also produced a filtrate with non-detectable levels of heavy metals. Therefore, risks associated with membrane microfiltration treatment residuals are expected to be minimal. Because this remedial alternative does not permanently eliminate the contact between waste materials and the ground water table, the effectiveness of this alternative is difficult to predict once operation of the pump and treat system is discontinued.

Ground water treatment for Alternative 4A requires regular sampling and analysis of treatment system discharges, in accordance with New York SPDES requirements. Following discontinuation of operation of the pump and treat system, continued ground water monitoring for a period of five years has been

assumed. Because waste materials would remain in-place under this alternative, a five-year review of the action would be required (see Section 5.3.1.2).

Implementability - The construction of a ground water extraction system would be fairly easily implemented. The implementation of UV oxidation and membrane microfiltration on-site would be relatively easy, requiring transport and set-up of commercially offered systems. The availability of a membrane microfiltration system may be limited because of the limited number of vendors offering this technology. Because both treatment systems are relatively new, minor technical problems could be expected. Neither treatment system is expected to impact future remedial actions or to present exposure pathways which are not easily monitored.

Implementation of ground water extraction and discharge to area surface waters would require compliance with the substantive requirements of federal and state discharge requirements and wetlands regulations. Treatability studies would be required to ensure that the proposed remedial technologies could meet effluent limitations. Because ground water extraction could potentially impact the water levels of adjacent wetlands, implementation of this alternative could be difficult administratively.

Reduction of Toxicity, Mobility or Volume Through Treatment - Membrane microfiltration and UV oxidation will treat currently existing ground water contaminants. In membrane microfiltration, the metal particles are filtered out of the ground water as a solid filter cake, which has been shown to pass TCLP limits in some instances. However, no treatment of dissolved metals is provided. In UV oxidation, the organics are broken down into carbon dioxide

and water. Therefore, the overall toxicity of ground water contaminants is reduced. The mobility of the ground water is also reduced through pumping and through the containment features previously described for Alternative 2. The permanence of the reduction in ground water toxicity would have to be monitored upon discontinuation of the pump and treat system. Because the ground water would remain in contact with the waste materials, the potential for additional leaching of contaminants into the ground water would exist.

Compliance with ARARs - For ground water treatment, membrane microfiltration and UV oxidation will be used to reduce contaminant levels to below federal and state surface water quality criteria prior to discharge at the site. While membrane microfiltration will result in inorganic levels less than those observed in the filtered sample analyses during the RI (due to smaller filter openings in the microfilter), the ability of the treatment unit to meet cleanup criteria cannot be confirmed without conducting treatability studies. The cleanup goals for ground water contaminant levels will consist of federal and state MCLs. Effluent from the treatment process must meet the NY State Pollutant Discharge Elimination System (6NYCRR 750-757) requirements before discharge to area surface waters. The effluent must also meet federal regulations under the Clean Water Act. Ground water extraction and subsequent treated effluent discharge would be conducted in compliance with applicable wetlands requirements.

The effectiveness of this alternative in maintaining contaminant levels below federal and state MCLs once operation of the pump and treat system is discontinued will require monitoring, since the waste materials will remain in-place.

Overall Protection of Human Health and the Environment - This alternative provides control of risks posed by ground water contamination through extraction and treatment by membrane microfiltration and UV oxidation. The long-term effectiveness and permanence are expected to be good, with little long-term maintenance and monitoring, although the potential for additional ground water contamination once the extraction/treatment system is turned off exists.

Cost - The cost associated with Alternative 4A includes site clearing, grading, cap construction and maintenance, ground water extraction and innovative treatment, and long-term monitoring costs. These costs include $3,410,000 in direct capital costs, $545,000 in indirect capital costs and $267,000 in annual operation and maintenance costs ($2,884,000 net present value). The present worth value of this alternative, including contingency, is estimated at $8,207,000. A detailed cost estimate is presented in Appendix A.

5.4 Comparative Analysis of Alternatives

In this section, the strengths and weaknesses of the alternatives relative to one another are discussed for each of the analysis criteria. In each discussion, the alternative which provides the best overall performance in that category is discussed first, followed by the other alternatives discussed in the relative order in which they perform. These comparisons of alternatives are also presented in summary form in Tables 5-10 through 5-16.

While no recommendation for selection of an individual alternative is made within the Feasibility Study, a discussion of the basis for the final decision is appropriate. In selecting the remedy for the site, overall protection of

human health and the environment and compliance with ARARs (unless grounds for invoking a waiver are provided) are threshold criteria that must be satisfied by the selected alternative. Long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, short-term effectiveness, implementability and cost are primary balancing criteria, with the NCP placing special emphasis on long-term effectiveness and reduction of toxicity, mobility or volume through treatment. State and community acceptance, to be determined after comments on the completed RI/FS are received, are modifying criteria that may have significant input in the final remedy selection.

The comparative analyses for each of the evaluation criteria follow.

5.4.1 Short-Term Effectiveness

Those alternatives which provide short-term achievement of remedial response objectives while minimizing short-term risks and environmental impacts are considered to be the most effective. In general, all alternatives except the no action alternative require clearing of vegetation from the landfill area, road improvements or other activities involving disturbance of contaminated soils. These alternatives pose, at a minimum, non-cancer risks which exceed acceptable risk ranges to on-site remedial workers due to inhalation of contaminants adsorbed to fugitive dust. This pathway of exposure can be minimized through the use of personal protection equipment. Once remedial activities are completed, this exposure pathway ceases to exist for these alternatives. Therefore, the alternatives which offer reductions in the current risks posed by the site within the shortest time frame offer the greatest short-term protection against the principle threats.

The no action alternative can be considered to be the most effective alternative in the short-term. This alternative poses risks as described in the baseline risk assessment (Section 1.5). Because no remediation is proposed under this alternative, no disturbance of existing contamination occurs and no short-term risks are realized. It should be emphasized, however, that while no increases in risks result in the short-term, no protection against the principle site threats is achieved.

For alternatives that involve site remediation, Alternatives 2 and 2A provide the greatest short-term effectiveness. They pose the least amount of risk to on-site remedial workers and achieve protection against dermal contact risks within the shortest time frame. Alternative 2A is considered to be more protective than Alternative 2 because exposures to soil/waste contaminants are mitigated through capping and potential exposures to ground water contamination are reduced through the construction of a slurry wall. The slurry wall will lower the water table, potentially below the base of the waste materials, without requiring any handling of the contaminated ground water. Alternative 2 offers similar short-term risks but does not provide the same degree of protection against ground water contaminant migration.

Alternatives 4 and 4A also provide good short-term effectiveness. They pose additional risk to on-site workers due to the installation of ground water extraction wells within contaminated areas, but they also meet remedial response objectives within a limited time frame, with exposures to ground water contamination reduced through ground water pumping and on-site treatment. The additional handling of contaminated ground water and required discharge to surface water increases the potential risks and environmental impacts associated with remediation, and makes these alternatives less

effective in the short-term than Alternative 2A. These alternatives also have longer remedial time frames associated with achievement of cleanup goals.

5.4.2 Long-Term Effectiveness

The alternative which poses the least residual risk due to untreated waste or treatment residues, or the greatest capability for controlling these risks, is considered to provide the greatest long-term effectiveness and permanence. None of the alternatives actively address remediation of contaminants currently detected in surface water or sediment (other than contamination associated with leachate seeps). Therefore, all alternatives present some residual risk based on incidental ingestion and dermal contact with sediments under a recreational use scenario. These calculated risks, however, are within the acceptable risk ranges and are not considered to seriously impact the long-term effectiveness of the alternatives, especially with respect to those alternatives for which site access will be limited for an extended period based on the long-term operation of on-site remedial systems.

Alternative 2A provides minimal residual risk through the containment rather than treatment of on-site contaminants. The combination of the cap and slurry wall minimize contact with soil contaminants and potential exposure pathways associated with ground water contamination, although potential exposure to surface water/sediment will exist if access to the site is not fully controlled (e.g., if the site is used as a recreational area following capping). The slurry wall will minimize contact of the ground water table with in-place waste materials, thereby minimizing future contamination of ground water. These containment features are expected to be highly reliable with minor maintenance or monitoring; if they should fail, replacement or repair would not be exceptionally difficult. The fact that the slurry wall

will be located upgradient of the contaminated ground water area, and therefore will not be in contact with ground water contaminants, limits the potential for failure due to chemical degradation of the slurry wall materials.

Alternatives 4 and 4A provide comparable levels of long-term protectiveness. While treating the ground water and reducing dermal exposure risks through containment features, these alternatives do not provide for treatment of the source of contamination. Therefore the long-term effectiveness of these alternatives in maintaining reduced ground water contaminant levels following discontinuation of the pump and treat system operation is not guaranteed. The water table can be expected to return to a level within the waste materials when pumping is discontinued, thereby potentially allowing for future ground water contamination. These alternatives also require long-term management in the form of cap maintenance and ground water treatment system monitoring and operation. Because of the ongoing operation of the ground water treatment system, use of the site for recreation and the associated potential exposures are not considered to apply to these alternatives.

Alternative 2 would not treat the source of contamination or the contaminated ground water on-site, although it would provide protection against dermal exposures to soil contaminants through its capping containment feature. This alternative requires minimal long-term management in the form of cap maintenance and monitoring. Potential exposure to surface water/sediment contaminants will exist under this alternative if access to the site is not fully controlled (e.g., if the site is used as a recreational area following capping).

Alternative 1, the no action alternative, offers no long-term effectiveness in terms of protection against current risks associated with

dermal contact with soil contaminants or future ground water ingestion scenarios.

5.4.3 Implementability

Those alternatives which offer the greatest technical feasibility, administrative feasibility, and service and material availability are considered to be most implementable. Wetlands regulations will impact the implementation of all alternatives except the no action alternative to varying degrees. Alternatives involving ground water extraction and discharge to surface water (Alternatives 4 & 4A) will require compliance with regulatory requirements for surface water discharges. Alternatives 2, 2A, 4, and 4A would each require site use and ground water use restrictions. Implementation of such restrictions appears to be feasible in the State of New York.

Alternative 1, the no action alternative, is the most implementable because it requires only the installation of additional monitoring wells.

Alternatives 2 and 2A follow Alternative 1 in implementability, respectively. Capping construction methods are well developed and easily implemented. The construction of a slurry wall under Alternative 2A would also be relatively easy to implement, although existing site conditions could hamper construction.

Alternatives 4 and 4A are similar to Alternative 2, involving the construction of a cap, but also include the construction of a ground water extraction and treatment system. The construction of such a system would be relatively easy. Minimal technical problems would be expected in the implementation of Alternative 4. The innovative ground water treatment technologies included in Alternative 4A could pose additional technical problems. The lack of general availability of the innovative treatment

technologies could also limit the availability of treatment systems and experienced operational personnel.

5.4.4 Reduction of Toxicity, Mobility and Volume Through Treatment

Alternative 2A provides a reduction of contaminant mobility through its containment features. The alternative utilizes a cap and slurry wall to isolate in-place waste materials from exposure via direct contact and from infiltration and ground water migration. While the waste materials are not treated, their isolation limits the potential risks they pose.

Alternatives 4 and 4A reduce the toxicity of ground water through treatment and reduce the mobility of soil contaminants through containment. Alternative 4 may provide greater toxicity reduction through the treatment of dissolved inorganics. The reduction in ground water toxicity may not be permanent, however, due to the lack of treatment of the soil/waste matrix and the ability of the ground water table to return to a level within the waste materials upon discontinuation of operation of the pump and treat system.

Alternative 2 only reduces the mobility of the soil contaminants through containment measures. It does not address ground water contamination or limit additional contamination of ground water due to continued contact of waste materials with the water table.

Alternative 1 provides no reduction in toxicity, mobility of volume of contaminants of any media through treatment. Residual risks are identical to those identified by the baseline risk assessment. Future risks posed by the site will depend on future site usage.

5.4.5 Compliance with ARARs

Those alternatives which offer the greatest overall compliance with potential chemical-specific, location-specific and action-specific ARARs are

considered to offer the best performance under this criterion. A location-specific ARAR which may directly impact the implementation of alternatives at the site is the location of wetlands, which cover approximately 13 percent of the site. For all alternatives involving construction within or adjacent to wetland areas or ground water discharge to surface waters, compliance with the appropriate wetland and discharge regulations will be required.

It should be noted that under certain cases, compliance with ARARs may be waived. Several of the specific cases under which the waiver of ARARs could potentially be applicable to the Hertel Landfill site were previously noted in Section 5.3.1.2.

Alternatives 4 and 4A are expected to meet chemical-specific ARARs for the ground water. Maintenance of ARARs within the ground water once pump and treat operations are discontinued may not be possible due to the resumption of contact between the soil/waste matrix and the ground water. The innovative technologies employed under Alternative 4A may not be as effective in reaching ARAR-based cleanup levels due to their currently unproven overall capabilities. Action-specific ARARs will be achieved if, as proposed, the final cap and surface drainage features are constructed in accordance with New York Solid Waste Management Facility landfill closure regulations.

Alternatives 2 and 2A are not expected to attain all chemical-specific ARARs for contaminants detected in the ground water due to the lack of ground water treatment. For Alternative 2A, the elimination of ground water flow through the in-place waste materials may eventually result in reduced ground water contaminant levels but treatment of the currently detected contaminant levels will not be provided. Action-specific ARARs will be achieved if, as proposed, the final cap and surface drainage features are constructed in accordance with New York Solid Waste Management Facility landfill closure regulations.

Alternative 1, the no action alternative, is not expected to attain chemical-specific ARARs for the ground water matrix. No location-specific or action-specific ARARs would be applicable under the no action alternative.

5.4.6 Overall Protection of Human Health and the Environment

This criterion considers the previous criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs, and provides a final overall assessment of whether the alternative provides adequate protection of human health and the environment.

Alternative 2A provides short-term effectiveness through its limited remedial time frame and limited disturbance of contaminated areas, resulting in minimal short-term risks as compared to other alternatives which involve remedial actions. Long-term effectiveness is expected to be good due to the minimization of contact between the waste materials and the ground water table offered by the containment features of the remedial design. While ground water will not be treated to meet chemical-specific ARARs, the invocation of a waiver to ARAR compliance may be appropriate for this site. Through containment rather than treatment, this alternative is protective of human health and the environment.

Alternatives 4, 4A, and 2 follow Alternative 2A in overall protection to human health and the environment. All of these alternatives present minimal short-term risks during implementation and provide protection against the principle threats within a relatively short time frame. The alternatives utilize proven remediation technologies, with the exception of Alternative 4A, and are relatively uncomplicated in their design and implementation. While Alternatives 4 and 4A provide additional protection in the short-term through the pumping and treatment of ground water, the long-term effectiveness of

these alternatives is similar to Alternative 2, due to the ultimate resumption of contact between the soil/waste and ground water table. While these alternatives may not maintain compliance with ARARs, they will be protective of human health and the environment through limited site access, continued ground water monitoring and the required five-year review of the remedial decision.

Alternative 1, the no action alternative, is the least protective of human health and the environment. This alternative does not limit site access or future site development and, therefore, does not address the principle threats posed by the site.

5.4.7 Cost

A comprehensive analysis of present worth cost of the alternatives is presented below, followed by a cost sensitivity analysis.

5.4.7.1 Present Worth Comparative Analysis

Total present worth cost estimates for alternative implementation range from $2,509,000 to $13,238,000. The costs vary greatly between alternatives for both capital costs ($58,000 to $8,406,000) and, to a lesser degree, for present worth O&M costs ($2,033,000 to $3,322,000).

The lowest cost alternative is the no action alternative, which has an estimated total present worth cost of $2,509,000. The major cost component of this alternative is the net O&M cost ($2,033,000) which consists of thirty years of ground water sampling and laboratory analysis.

There are three alternatives with present worth costs ranging from $7,000,000 to $9,000,000. Alternative 2 can be implemented at a total cost of $7,182,000 with cap construction, a direct cost, as the major cost component.

Alternatives 4 and 4A are relatively comparable in cost, at $8,774,000 and $8,207,000, respectively. The major cost component for both Alternatives 4 and 4A is the net O&M cost, which consists of ground water treatment system maintenance, ground water sampling and laboratory analysis, and cap maintenance costs. Alternative 2A can be implemented at a total cost of $13,238,000, with slurry wall construction, a direct cost, as the major cost component.

5.4.7.2 Sensitivity Analysis

A sensitivity analysis was conducted to assess the effect that variations in specific assumptions made during alternative development and assessment can have on the total estimated remedial cost. The Hertel Landfill site remedial alternatives are impacted by uncertainties regarding discount factors over the life of the remedies, landfill cap construction cost, slurry wall construction cost, and ground water extraction rates. The assumed variations in each of these factors used to conduct the sensitivity analysis are described below. The resultant impacts to remedial costs are summarized in Table 5-17.

The discount rate can vary from the 5% rate used in the cost evaluation. Alternatives with large O&M cost components and extended remedial periods can be significantly impacted by a variation in the discount rate. The sensitivity analysis has been conducted assuming a variation in the annual discount rate, with total present worth costs estimated for each alternative at annual discount rates of 3% and 10%.

Landfill cap construction cost uncertainties are largely due to potential site-specific impacts on vendor quotes and potential variations in volumes of material required to construct the cap, due to the estimated areal extent of the landfill based on the RI investigations. The sensitivity analysis has

assumed landfill cap constructions costs vary by ±20% for Alternatives 2, 2A, 4 and 4A. The variation in cost impacted the cost of each alternative fairly equally, with the minimum and maximum costs falling within approximately $850,000 of each other.

Slurry wall construction cost uncertainties are also largely due to potential site-specific impacts on vendor quotes. The presence of subsurface boulders, the sloping topography of the site and the expense associated with a cement-bentonite slurry wall could result in variations to the estimated cost. The sensitivity analysis has assumed slurry wall construction costs vary by ±20%. This variation has been applied to the only alternative which includes a slurry wall, Alternative 2A. The minimum and maximum costs fall within a range of approximately $2,000,000.

Ground water extraction rate uncertainties exist due to variabilities in subsurface conditions which could affect the estimated extraction rate, and the ability of the alternatives to meet treatment goals within the estimated time frame. The sensitivity analysis has assumed that the ground water extraction rate could vary from 5 gpm to 20 gpm, and that the associated remedial timeframes could vary from twenty to six years, respectively. This variation has been applied to the alternatives for which ground water extraction and treatment is a component, namely Alternatives 4 and 4A.

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TABLE 2-1
PRELIMINARY IDENTIFICATION OF FEDERAL CHEMICAL-SPECIFIC ARARs AND TBCs
HERTEL LANDFILL FEASIBILITY STUDY

FEDERAL STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Ground Water--			
Safe Drinking Water Act (40 CFR 141.60-.63)	Max Contaminant Levels (MCL's)	MCL's directly apply to "public water systems", defined as systems with at least 15 connections which service a minimum of 25 persons.	Potential ARARs which address organic compounds and metals in ground water. Potentially applicable due to the location of a population of approximately 1,350 within 3 miles of the site who obtain their water supply from individual wells.
Safe Drinking Water Act (40 CFR 141.50-.51)	Max Contaminant Level Goals (MCLGs)	Non-enforceable health goals for public water systems, set at levels resulting in no known or anticipated adverse health effects.	Potential ARARs which address organics and metals in ground water. Potentially applicable due to the location of a population of approximately 1,350 within 3 miles of the site who obtain their water supply from individual wells.
Surface Water--			
Clean Water Act (Section 304)	Ambient Water Quality Criteria (AWQC)	Non-enforceable guidelines established for the protection of human health and/or aquatic organisms.	Potential ARARs which will affect the implementability of remedial actions involving effluent discharge.
Air--			
Clean Air Act (40 CFR 50)	National Ambient Air Quality Stardards (NAAQS)	Establishes maximum concentrations for particulates and fugitive dust emissions.	Potential ARARs for alternatives involving remedial actions which impact ambient air (i.e. incinerators, soil venting, etc.).

TABLE 2-2
PRELIMINARY IDENTIFICATIDN OF POTENTIAL STATE CHEMICAL-SPECIFIC ARARs AND TBCs
HERTEL LANDFILL FEASIBILITY STUDY

STATE STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Ground Water--			
NY State Water Quality Standards (6 NYCRR 703)	Ground Water Quality Criteria (GWQC)	Establishes ground water quality standards for various classes of GW in the State of NY.	Potential ARARs which address organic compounds and metals in ground water to prevent pollution of ground water and to protect the ground water for use as potable water.
NY State Safe Drinking Water Act (10 NCYRR 5)	NY Max Contaminant Levels (NY MCLs)	NY MCLs directly apply to all "public water systems" in NY.	Potential ARARs which address organic compounds and metals in ground water. Applicable due to the location of a population of approximately 1,350 within 3 miles of the site who obtain their water supply from individual wells.
NY State Drinking Water Supplies (Public Health Law 225-Subpart 5-1)	NY Max Contaminant Levels (NY MCLS)	NY MCLs directly apply to all "public water systems" in NY.	Potential ARARs which address organic compounds and metals in ground water, and the location of a population of approximately 1,350 within 3 miles of the site who obtain their water supply from individual wells.
Various	NY Technical and operational Guidance Series (TOGs) Water Quality Standards and Guidance Values (1.1.1)	Compilation of ambient water quality standards and guidance values for toxic and non-conventional pollutants for use in NYDEC programs, including SPDES permit programs.	Potential ARARs/TBCs which address organic and inorganic compounds and which could affect treatments which discharge to area surface waters.
Surface Water--			
NY Surface Water Quality Standards (6 NYCRR 701)	NY Surface Water Quality Standards	Establishes water quality standards for various classes of surface water.	Potential ARARs will affect treatments which discharge to area surface waters.

TABLE 2-2 (CONT.)
PRELIMINARY IDENTIFICATION OF POTENTIAL STATE CHEMICAL-SPECIFIC ARARs AND TBCs
HERTEL LANDFILL FEASIBILITY STUDY

STATE STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Air--			
(6 NYCRR 256 and 257)	Standards	cation system and air quality standards.	remedial activities.
	Sediment Criteria - December 1989	Guidance document used by the Bureau of Environmental Protection, Division of Fish and Wildlife, for evaluating contaminant levels in sediments.	Potential TBCs which address sediment contaminant levels and evaluation of these levels for risk management decisions.

TABLE 2-3
PRELIMINARY IDENTIFICATION OF POTENTIAL FEDERAL LOCATION-SPECIFIC ARARs AND TBCs
HERTEL LANDFILL FEASIBILITY STUDY

FEDERAL STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Wetlands--			
Executive Order 11990	Protection of Wetlands	Regulates activities conducted in a wetland area to minimize the destruction, loss or degradation of the wetlands.	Potential ARAR as approximately 15 to 20 per cent of the total site has been identified as potential wetlands.
Wetlands Construction and Management Procedures (40 CFR 6, Appendix A)	Protection of Wetlands	Sets forth EPA policy for carrying out the provisions of Executive Order 11900 (see above).	Potential ARAR as approximately 15 to 20 per cent of the total site has been identified as potential wetlands.
Clean Water Act, Section 404 (40 CFR 230; 33 CFR 320-330)	Prohibition of Wetland Filling	Prohibits the discharge of dredged or fill material to a wetland without a permit issued by the Corp of Engineers.	Potential ARAR as approximately 15 to 20 per cent of the total site has been identified as potential wetlands.
Wildlife--			
Fish and Wildlife Coordination Act (16 USC 661 et seq.)	Protection of Wildlife Habitats	Requires actions to protect fish or wildlife when diverting, channeling or modifying a stream.	Potential ARAR as a small stream crosses the site in a northeasterly direction, exits along the eastern property line, and discharges into Pancake Hollow Creek, 1,000 feet east of the site.
Farmlands--			
Farmland Protection Policy Act (7 USC 4201 et seq.)	Protection of Significant/ Important Agricultural Lands	Requires evaluation of direct and indirect effects of actions on remaining farms and farm support sources.	Potential ARAR as area contains significant agricultural lands; no farming is currently conducted on-site or on land bordering the site, however.
Cultural--			
Protection and Enhancement of the Cultural Environment (Executive Order 11593)	Protection of Property with Cultural Value	Regulates activities which affect properties of cultural value.	Potential ARAR - a cultural survey would be required to determine applicability to site.

TABLE 2-4

PRELIMINARY IDENTIFICATION OF POTENTIAL STATE LOCATION-SPECIFIC ARARs AND TBCs

HERTEL LANDFILL FEASIBILITY STUDY

STATE STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Wetlands--			
NY State Freshwater Wetlands Law (ECL Article 24 & 71 in Title 23)	Protection of Wetlands	Regulates activities conducted in a wetlands area to minimize the destruction, loss or degradation of the wetlands.	Potential ARAR as approximately 15 to 20 percent of the total site has been identified as potential wetlands.
NY State Freshwater Wetlands Permit Requirements Regulations (6 NYCRR Part 663)	Protection of Wetlands	Regulates the procedural requirements to be followed in undertaking different activities in wetlands and in areas adjacent to wetlands.	Potential ARAR as approximately 15 to 20 percent of the total site has been identified as potential wetlands.
Wildlife and Rivers--			
Endangered and Threatened Species of Fish and Wildlife Requirements (6 NYCRR 182)	Protection of Endangered Species	Restricts activities in areas inhabited by endangered species.	Potential ARAR as many fish and wildlife species inhabit the site.

TABLE 2-5
PRELIMINARY IDENTIFICATION OF POTENTIAL FEDERAL ACTION-SPECIFIC ARARs AND TBCs
HERTEL LANDFILL FEASIBILITY STUDY

FEDERAL STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
CERCLA (Title I Section 101,111)	National Contingency Plan (40 CFR 300)	Establishes funding and provisions for the clean-up of hazardous waste sites.	ARAR based on the site's placement on the National Priorities List.
Superfund Amendments and Reauthorization Act (42 U.S.C. 9601)	Clean-up standards/ Response Action	Treatments must provide permanent reductions in volume, toxicity and mobility of wastes and satisfy ARARs.	ARAR based on the site's placement on the National Priorities List.
Uniform Relocation Assistance & Real Property Aquisition Act (40 CFR 4.2)	General Relocation Requirements	Requirements for relocation payments and assistance.	Potential ARAR for alternatives which create need for temporary/permanent relocation of area residents.
Resource Conservation and Recovery Act (40 CFR 264 and 265)	Requirements for Hazardous Waste Treatment Facility Design and Operating Standards for Treatment and Disposal Systems	Outlines specifications and standards for design, operation, closure and monitoring of performance for hazardous waste storage, treatment and disposal facilities.	Potential ARARs for alternatives which utilize a surface impoundment, waste pile, landfill, land treatment or incineration for on-site disposal/treatment of wastes.
RCRA (40 CFR 257)	Criteria for Classification of Solid Waste Disposal Facilities and Practices	Presents criteria for use under RCRA in determining which solid waste disposal facilities pose a reasonable probability of adverse effects on health or the environment. Criteria specifically refer to floodplains, endangered species, pollution of surface water and/or ground water, disease, air and safety.	Potential ARAR applicable to the classification of solid waste disposal facilities.
RCRA (40 CFR 264) Subpart G	Closure/Post Closure Requirements	Establishes requirements for the closure and long-term management of a hazardous disposal facility.	Potential ARARs for alternatives which utilize a landfill for the ultimate disposal of hazardous waste materials and/or free liquids.

TABLE 2-5 (CONT.)
PRELIMINARY IDENTIFICATION OF POTENTIAL FEDERAL ACTION-SPECIFIC ARARs AND TBCs
HERTEL LANDFILL FEASIBILITY STUDY

FEDERAL STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
RCRA (40 CFR 264) Subpart F	Ground Water Protection	Ground water monitoring/corrective action requirements; dictates adherence to MCLs and establishes points of compliance.	Potential ARARs for alternatives which utilize a landfill for the ultimate disposal of hazardous waste materials and/or free liquids.
RCRA (40 CFR 268)	Land Disposal Restrictions	Identifies hazardous wastes that are restricted from land disposal and sets treatment standards for restricted wastes.	Potential ARARs which may limit the use of land disposal in remediating certain hazardous wastes.
Safe Drinking Water Act (40 CFR 144 and 146)	Underground Injection Control Requirements	Provides the general requirements, technical criteria and standards for underground injection wells, including prohibitions of unauthorized injection, prohibition of movement of fluid into underground sources of drinking water, and requirements for the discharge of hazardous wastes.	Potential ARARs for alternatives which utilize underground injection as a remedial method.
Clean Water Act (40 CFR 122-125)	National Pollutant Discharge Elimination System (NPDES) Permit Requirements	Permits contain applicable effluent standards (i.e., technology-based and/or water quality-based), monitoring requirements, and standards and special conditions for discharge.	ARARs for alternatives involving treatment methods which discharge effluents to area water bodies.
Clean Water Act (40 CFR 403)	Discharge to Publicly-Owned Treatment Works (POTW)	A national pretreatment program designed to protect municipal wastewater treatment plants and the environment from damage that may occur when hazardous, toxic or other nondomestic wastes are discharged into a sewer system.	ARARs for alternatives involving treatment methods which discharge effluents to POTWs.

TABLE 2-5 (CONT.)
PRELIMINARY IDENTIFICATION OF POTENTIAL FEDERAL ACTION-SPECIFIC ARARs AND TBCs
HERTEL LANDFILL FEASIBILITY STUDY

FEDERAL STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Clean Air Act (40 CFR 50)	National Ambient Air Quality Standards (NAAQS)-Particulates	Establishes maximum concentrations for particulates and fugitive dust emissions.	ARARs for alternatives involving treatment methods which impact ambient air (i.e. incineration, soil venting, etc.).
Clean Air Act (40 CFR 50)	New Source Performance Standards (NSPS)	Requires Best Available Control Technology (BACT) for new sources, and sets emissions limitations.	ARARs for alternatives involving treatment methods which impact ambient air (i.e., incineration, soil venting, etc.).
Clean Air Act (40 CFR 61)	Emissions Standards for Hazardous Pollutants (NESHAPS)	Establishes emissions limitations for hazardous air pollutants.	Potential ARARs for alternatives using treatments (i.e., incineration, etc.) which result in emissions to the air.
Occupational Safety and Health Act (29 CFR 1904)	Recordkeeping, Reporting and Related Regulations	Outlines recordkeeping and reporting requirements.	ARAR for all contractors/subcontractors involved in hazardous activities.
Occupational Safety and Health Act (29 CFR 1910)	General Industry Standards	Establishes requirement for 40-hour training and medical surveillance of hazardous waste workers.	ARAR for workers and the workplace throughout the implementation of hazardous activities.
Occupational Safety and Health Act (29 CFR 1926)	Safety and Health Standards	Regulations specify the type of safety equipment and procedures for site remediation/excavation.	ARAR for workers and the workplace throughout the implementation of hazardous activities.

TABLE 2-6
PRELIMINARY IDENTIFICATION OF POTENTIAL STATE ACTION-SPECIFIC ARARs AND TBCs
HERTEL LANDFILL FEASIBILITY STUDY

STATE STATUTE	REGULATION/GUIDANCE	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
NY State Pollutant Discharge Elimination System (6NYCRR 750-757)	NYSPDES Water Quality Toxic Effluent Standards, Limitations and Treatment Requirements	Establishes water quality standards, effluent limitations, standards of performance, toxic effluent standards and prohibitions, and pretreatment standards.	ARARs for alternatives involving treatments which discharge effluents to area surface or ground waters.
NY State RCRA Hazardous Waste Regulations (6 NYCRR 37D-372)	Standards for the Design and Operation of Hazardous Waste Treatment Facilities (Minimum Technology Requirements)	Outlines design specifications and standards of performance for disposal facilities and treatments.	Potential ARARs for alternatives which utilize landfill, incineration, tanks, containers, etc. for disposal of wastes.
NY State RCRA Hazardous Waste Regulations (6 NYCRR 373)	Closure/Post Closure Requirements	Establishes requirements for the closure (clean closure and waste-in-place closure) and long-term management of a hazardous disposal facility.	Potential ARARs for alternatives which utilize a landfill for the ultimate disposal of hazardous waste materials and/or free liquids.
NY State Solid Waste Regulations (6 NYCRR 360-361)	Solid Waste Management Requirements and Siting Restrictions	Requirements for landfill operation and closure, incineration, and other solid waste management activities.	Potential ARARs for capping alternatives and alternatives involving incineration of solid waste.
NY State Air Pollution Control Regulations (6 NYCRR 200-221)	General Air Quality and Air Emission Requirements	Establishes maximum ambient levels for criteria pollutants and establishes emissions limitations for sources which emit VOCs into the air.	Potential ARARs for alternatives involving remedial actions which impact ambient air.

TABLE 3-1 HERTEL LANDFILL SITE - SUMMARY OF GROUND WATER CONTAMINANTS DETECTED IN GROUND WATER SAMPLES ABOVE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND TO-BE-CONSIDERED REQUIREMENTS (TBCs), AND ASSOCIATED RISK-BASED CLEAN-UP LEVELS

	MAXIMUM CONCENTRATION EXCEEDING ARARs/TBCs IN:		FEDERAL ARARs/TBCs			NY ARARs/TBCs		
			1	2	3	4	5	6
PARAMETER	MONITORING WELLS (ppb)	LEACHATE SEEP (ppb)	MCL (ppb)	MCLG (ppb)	Ambient Water Quality Criteria (ppb)	Ground Water Quality Criteria (ppb)	NYMCL (ppb)	RISK-BASED CLEANUP LEVEL (ppb)
Benzene	6		5	0	0.66	ND	5	
Chlorobenzene	24	8	100	100	488	20	5	
Ethylbenzene	64		700	700	2,400	50	5	
Toluene	33		1,000	1,000	15,000	50	5	
Xylenes	240		10,000	10,000		50	5	
1,4-Dichlorobenzene	10		75	75	470	4.7	5	
Diethylphthalate	900				434,000	50	50	
2,4-Dimethylphenol	82				400	0.3	5	
Di-n-octylphthalate	69					50	50	
Naphthalene	39					10	50	
Phenol	72	21			3,500	1	50	
Arsenic	44.1/33.8		50	0	0.0022	25	50	0.486
Barium	1,980/732	3,580	1,000 (2,000)	2,000		1000	1000	
Cadmium		178	5	5	10	10	10	
Chromium	538/ND	316	100	100	50		50	112
Copper	846/ND	370	(1,300)	(1,300)	1000	1000	200	
Iron	893,800/116,000	526,000				300	300	
Lead	313/5.9	454	50 (5)	(0)	50	25	50	
Magnesium	133,000/55,500	83,600				35,000		
Manganese	121,000/27,900	25,300				300	300	2
Mercury		4.1	2		10	(2)	(2)	
Silver	266/ND		50		50	50	50	
Sodium	115,000/122,000						20,000	
Zinc	2,880/91.6	11,200					300	

1. MCL - Max Contaminant Level, Natl. Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, 7/1/90, (40 CFR 141): Phase II MCLs, 56 FR 3526 (Proposed MCL)
2. MCLG- Proposed Max Contaminant Level Goal, based on health considerations only, Amendments to SDWA, U.S. EPA, 7/1/90 (Proposed MCLG)
3. Derived from published EPA Ambient Water Quality Criteria (drinking water only), 45FR 79318-79379, November 28, 1980
4. NYSDEC 6NYCRR Part 703, Regulations for ground water (1/9/89).
5. NYSDOH 10NYCRR Part 5, Regulations for drinking water supplies (1/9/89).
6. Risk-based cleanup level derived from a future use residential scenario for the most sensitive receptor (adult) producing a compound specific 1E-05 risk level.

For inorganics, unfiltered / filtered analytical results are shown.

TABLE 3-2 HERTEL LANDFILL SITE - SUMMARY OF SOIL/SEDIMENT CONTAMINANTS DETECTED ABOVE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND TO-BE-CONSIDERED REQUIREMENTS (TBCs) AND ASSOCIATED RISK-BASED CLEAN-UP LEVELS

	MAXIMUM CONCENTRATION EXCEEDING ARARs/TBCs IN:			----NY ARARS/TBCs FOR SEDIMENTS-------						
						METALS 1			5	
				1	1				Observed	6
	SURFACE & SUBSURF. SOILS	STREAM/ WETLAND SEDIMENT	LEACHATE SEEP SEDIMENT	Aquatic Toxicity Basis	Human Health Basis	2 Criteria	Limits 3 of Tolerance	4 NJDEP Soil Action Level	On-Site Background Levels	SOIL RISK-BASED CLEANUP LEVELS
PARAMETER	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
Benzo(a)Anthracene		1.5	1		0.26					
Benzo(b)Fluoranthene			0.77		0.26					
Benzo(k)Fluoranthene		1.2			0.26					
Benzo(a)Pyrene		0.87			0.26					
Chrysene		1.7	0.93		0.26					
Indeno(1,2,3-CD)Pyrene		0.39			0.26					
Arsenic	109	30	14.5			5	33	20	4.8-109	0.06
Barium	4,490	6,230	302						37.3-1,300	
Cadmium	113	16.5	17.4			0.8	10	3	0.78-2.7	
Chromium		30.9	64.4			26	111	100	8.8-16	25
Copper	319	67.8	64.8			19	114	170	26	
Iron		137,000	83,300			24,000	40,000		12,000-69,800	
Lead	1,170	93.7				27	250	250-1,000	10.6-44.4	
Manganese		68,100	1,620			428	1,100		782-38,100	2
Mercury	1.6	0.7				0.11	2	1	<0.11	
Nickel	347	29	31.7			22	90	100	17.2-2,509	
Zinc	615	372	640			85	800	350	76.7-177	

1 - NYSDEC 1989: Sediment Criteria. Bureau of Environmental Protection. Division of Fish and Wildlife.

2 - Sediment Criteria for metals based on geometric mean of no effect levels and lowest effect levels (Persand, 1989).

3 - "Limits of Tolerance"- if exceeded in significant portions of the ecosytem, it is highly likely that biota are impaired and remediation should be considered necessary.

4 - Due to the lack of applicable New York soil criteria, NJDEP soil Action Levels are provided for comparative purposes.

5 - Reference Table 4-1, Remedial Investigation Report, Hertel Landfill Site, TAMS/TRC, February 1991.

6 - Risk based cleanup level derived from a future use residential scenario (children) producing a compound specific hazard quotient of 1 or less.

TABLE 3-3 HERTEL LANDFILL SITE - SUMMARY OF SURFACE WATER CONTAMINANTS DETECTED ABOVE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND TO-BE-CONSIDERED REQUIREMENTS (TBCs), AND ASSOCIATED RISK-BASED CLEAN-UP LEVELS

	MAXIMUM CONCENTRATION EXCEEDING ARARs/TBCs IN:		FEDERAL ARARs/TBCs			NY ARARs/TBCs		
			1	2	3	6	6	6
PARAMETER	SURFACE WATER (ppb)	LEACHATE SEEP (ppb)	MCL (ppb)	MCLG (ppb)	Ambient Water Quality Criteria (ppb)	Drinking Water Supply (ppb)	Fishing and Fish Propagation (ppb)	Fishing and Fish Survival (ppb)
Chlorobenzene		8	100	100	488	20	5	50
Bis(2-ethylhexyl)phthalate		5		0	21,000	4*	0.6	
Phenol		21			3,500	1	1	1
Aluminum	4,280	20,400					100*	
Barium		3,580	1,000 (2,000)	2,000		1,000		
Cadmium	37.1	178	5	5	10	10		
Chromium		316	100	100	50	50		
Copper		370	(1,300)	(1,300)	1,000	200		
Iron	190,000	526,000				300	300	300
Lead	54.9	454	50 (5)	(0)	50	50		
Magnesium	37,300	836,000				35,000		
Manganese	11,800	25,300				300		
Mercury	1.0	4.1	2		10	2	0.2*	0.2*
Vanadium		54.6					14	190
Zinc	347	11,200					30	
Cyanide		85.3					5.2**	22**

1. MCL - Max Contaminant Level, Natl. Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, 7/1/90, (40 CFR 141); Phase II MCLs, 56 FR 3526 (Proposed MCL)
2. MCLG- Proposed Max Contaminant Level Goal, based on health considerations only, Amendments to SDWA, U.S. EPA, 7/1/90 (Proposed MCLG)
3. Derived from published EPA Ambient Water Quality Criteria (drinking water only), 45FR 79318-79379, November 28, 1980
4. NYSDEC 6NYCRR Part 703, Regulations for ground water (1/9/89).
5. NYSDOH 10NYCRR Part 5, Regulations for drinking water supplies (1/9/89).
6. New York State Ambient Water Quality Standards and Guidance Values, NYSDEC 6 NYCRR Part 701 and 702, Regulations for Surface Water.

* Guidance value

** Standard for free cyanide

TABLE 3-4

GENERAL RESPONSE ACTIONS BY ENVIRONMENTAL MEDIA
HERTEL LANDFILL FEASIBILTY STUDY

GROUND WATER

- No Action
- Institutional Controls
- Containment
- Collection/Treatment/Discharge

SOIL/WASTE

- No Action
- Institutional Controls
- Containment
- Excavation/Treatment
- In Situ Treatment

TABLE 3-5

SOIL/WASTE MATRIX TECHNOLOGY SCREENING
HERTEL LANDFILL FEASIBILITY STUDY

▨ SCREENED ON BASIS OF TECHNICAL IMPLEMENTABILITY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
NO ACTION	NONE	NOT APPLICABLE	No action.	Required for consideration under the NCP.
INSTITUTIONAL CONTROL	SITE USE RESTRICTIONS	DEED RESTRICTIONS	Deed for site would be revised to include restrictions on future site use or development.	Potentially applicable.
		ACCESS RESTRICTIONS	Fencing of entire site and posting of warning signs to limit public access.	Potentially applicable.
CONTAINMENT	CAPPING	CLAY	Placement of compacted clay over contaminated soils and wastes.	Potentially viable.
		SYNTHETIC	Placement of low permeability synthetic membrane over contaminated soils and wastes.	Potentially viable.
		ASPHALT	Paving of contaminated soils and wastes with bituminous material.	Potentially viable.
		CONCRETE	Paving of contaminated soils and wastes with concrete.	Potentially viable.
		MULTI-LAYER CAP	Multilayer cap of compacted clay, synthetic membrane, drainage layer, topsoil, and vegetative cover.	Potentially viable.
	LANDFILL DISPOSAL	OFF-SITE LANDFILL	Excavation of contaminated soils and wastes with disposal at an off-site landfill licensed to accept such wastes.	Would require excavation of surface soils; waste materials; and subsurface soils.
		ON-SITE LANDFILL	Construction of landfill on-site, in accordance with current landfill construction requirements, for contaminated soil and waste disposal.	Would require excavation of surface soils; waste materials; and subsurface soils.
	STABILIZATION/ SOLIDFICATION (CHEMICAL FIXATION)	CEMENT-BASED	Soils are mixed with Portland cement, forming rigid concrete matrix.	Most suitable for immobilizing metals; may require secondary containment of end product. Not suitable for treatment of waste materials.
		POZZOLANIC	Silaceous material, lime and water mixed with contaminated soils to form rigid matrix.	May require secondary containment due to subsequent leaching of process water. Not suitable for treatment of waste materials.

TABLE 3-5 (Continued)

SOIL/WASTE MATRIX TECHNOLOGY SCREENING
HERTEL LANDFILL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
TREATMENT	ON-SITE THERMAL TREATMENT	ROTARY KILN INCINERATION	Soils and wastes pass through a refractory-lined rotating cylinder. Afterburner for exhaust gases.	Effective for destruction of organics. Does not treat inorganics.
		FLUIDIZED BED INCINERATION	Soil and waste contaminants thermally destroyed in bed of hot inert granular material fluidized by flow of air.	Effective for destruction of organics. Does not not treat inorganics
		INFRARED INCINERATION	Flux of near infrared radiation initiates and sustains pyrolysis of feed materials.	Effective for destruction of organics. Does not treat inorganics.
		MECHANICAL/THERMAL AERATION	Volatile compounds are removed from soils through heating and/or mechanical aeration.	Effective for destruction of volatile organics. Not suitable for treatment of waste materials.
	CHEMICAL/PHYSICAL/ BIOLOGICAL	SOIL WASHING	Use of an extractant solution to remove contaminants. Solutions used include water, surfactants, acids, bases, oxidizing or reducing agents.	Several different washing solutions would be required to treat all types of soil contaminants. Not applicable to treatment of waste materials.
		LANDFARMING	Aerobic biodegradation of contaminants in soils applied to the ground surface, with nutrient addition.	Effective for destruction of volatile organics. Ineffective for inorganic contaminants. Not applicable to treatment of waste materials.
		DECHLORINATION	Alkali metals or alkali metal/ polyethylene glycol used to strip chlorine atoms from hazardous halogenated hydrocarbons.	Effective for destruction of chlorinated organics. Ineffective for inorganic contaminants. Not applicable to treatment of waste materials.
		OXIDATION/ REDUCTION	Raising or lowering of molecular oxidation state to render contaminants less toxic.	May form more toxic or soluble degradation products, especially with inorganic contaminants. Not applicable to treatment of waste materials.
	OFF-SITE TREATMENT	VARIOUS	Soils and wastes transported off-site for treatment at a permitted facility (such as a hazardous waste incinerator) in accordance with current waste disposal regulations.	Effectiveness depends on treatment system used.

TABLE 3-5 (Continued)

SOIL/WASTE MATRIX TECHNOLOGY SCREENING
HERTEL LANDFILL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
IN SITU TREATMENT		BIODEGRADATION	Stimulation of indigenous bacteria or introduced strains, with nutrient addition.	Effective for destruction of organics, especially for fuel spill contaminants. Ineffective for inorganics. Not applicable to treatment of waste materials.
		SOIL VENTING	Soil aerated or vacuumed through use of air "wells" to remove volatile contaminants.	Ineffective for inorganic contaminants. contaminants. Not applicable to treatment of waste materials.
		RADIO FREQUENCY HEATING	Radio frequency waves heat soil and thermally decompose, vaporize, and distill hazardous constituents.	May be effective for organic contaminants. Not demonstrated on a large scale or on in situ municipal waste materials.
		DECHLORINATION	Alkali metals or alkali metal/ polyethylene glycol used to strip chlorine atoms from hazardous halogenated hydrocarbons.	Effective for destruction of chlorinated organics. Ineffective for inorganic contaminants. Not applicable to treatment of waste materials.
		OXIDATION/ REDUCTION	Raising or lowering of molecular oxidation state to render contaminants less toxic.	May form more toxic or soluble degradation products, especially with inorganic contaminants. Not applicable to treatment of waste materials.
		SOIL FLUSHING	Contaminated soils are flooded with water and the elutriated solution is collected.	Applicable to medium solubility organics. Ineffective for inorganics. Not applicable to treatment of waste materials.
		VITRIFICATION	Contaminated soils and waste materials are melted via an electric current, resulting in a glassy crystalline monolith.	Applicable for soils contaminated with a mixture of contaminants; in loosely packed rubbish, potential for underground fire exists.

TABLE 3-6

GROUND WATER TECHNOLOGY SCREENING
HERTEL LANDFILL FEASIBILITY STUDY

SCREENED ON BASIS OF TECHNICAL IMPLEMENTABILITY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
NO ACTION	NONE	NOT APPLICABLE	No action.	Fulfills NCP requirement for consideration of no action alternative.
	CONTINUED GROUND WATER MONITORING	NOT APPLICABLE	Continued ground water monitoring.	Fulfills NCP requirement for consideration of no action alternative; also identifies off-site contaminant migration.
INSTITUTIONAL CONTROL	GROUND WATER USE RESTRICTIONS	DEED RESTRICTIONS	Legal restictions on ground water use in the vicinity of the contaminated area.	Would prevent potential usage of contaminated water for potable water supply.
		ALTERNATE WATER SUPPLY	Provision of potable water to adjacent landowners currently using private wells.	Private wells are currently unaffected by contaminant migration; potential further migration could be tracked through continued ground water monitoring.
CONTAINMENT	CAPPING	CLAY	Placement of compacted clay over contaminated soils limits infiltration.	Potentially viable for limiting leachate production.
		SYNTHETIC	Placement of low permeability synthetic membrane over contaminated soils limits infiltration.	Potentially viable for limiting leachate production.
		ASPHALT	Paving of contaminated soils with bituminous material limits infiltration.	Potentially viable for limiting leachate production.
		CONCRETE	Paving of contaminated soils with concrete limits infiltration.	Potentially viable for limiting leachate production.
		MULTI-LAYER CAP	Multilayer cap of compacted clay and/or synthetic membrane, drainage layer, topsoil, and vegetative cover limits infiltration.	Potentially viable for limiting leachate production.
	VERTICAL BARRIER	SLURRY WALL	Vertical trench is excavated under a soil/bentonite slurry and backfilled with a low permeability material.	Depth to bedrock and fractured nature of bedrock limit effectiveness of barrier. Rocky nature of soil limits technical feasibility. Could minimize ground water flow through fill material in a containment scenario.
		SHEET PILING	Sheet piling is driven into soil to form barrier wall.	Unsuitable for rocky soils.

TABLE 3-6 (Continued)

GROUND WATER TECHNOLOGY SCREENING
HERTEL LANDFILL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
COLLECTION	EXTRACTION	EXTRACTION WELLS	Wells and pumping systems placed within contaminant plume for collection.	Potentially viable, proven technology.
		EXTRACTION-INJECTION WELLS	Injection wells or infiltration galleries placed upgradient of contamination and extraction wells for greater hydrodynamic control.	Reinjection of ground water into fill materials may mobilize other contaminants within waste.
		WELL POINTS	Manifolded system of extraction points connected to common collection source.	Potentially viable, proven technology.
		FRENCH DRAINS	Placement of trench with high permeability materials, used to divert ground water flow.	Potentially viable, proven technology.
TREATMENT	OFF-SITE	POTW	Extracted ground water discharged to local POTW for treatment.	No sanitary sewers at or near site limit feasibility.
		COMMERCIAL TREATMENT FACILITY	Extracted ground water discharged to licensed commercial facility for treatment and/or disposal.	Potentially viable.
	BIOLOGICAL	BIOREACTOR	Activated sludge process utilizes acclimated bacteria for aerobic degradation of contaminants.	Proven effective for organics.
	PHYSICAL	AIR STRIPPING	Transfer of volatile organic compounds to gaseous faction through mixing with large volumes of air in a packed column.	Applicable to volatile organic contaminants.
		CARBON ADSORPTION	Contaminants adsorbed to activated carbon by internal pores of carbon granules.	Applicable to volatile organic contaminants.
		RESIN ADSORPTION	Similar to carbon adsorption but synthetic resins are used.	Can be effective for organic removal; easily combined with ion exchange.
		REVERSE OSMOSIS	Removal of solutes from solution by a semi-permeable membrane under a high pressure gradient.	Used mainly for dissolved solids; metals and low level organics can cause clogging.
		ION EXCHANGE	Contaminants removed from aqueous phase by exchanging places with ions held by ion exchange material.	Effective for metals; can be used in conjunction with resin adsorption for organics treatment.
		PRECIPITATION	Contaminants removed by decreasing solubility.	Applicable to metals.

TABLE 3-6 (Continued)

GROUND WATER TECHNOLOGY SCREENING
HERTEL LANDFILL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS
		MEMBRANE MICROFILTRATION	Solid particles removed from liquids using pressure filter.	SITE program technology; applicable to ground water contaminated with heavy metals and landfill leachates.
	CHEMICAL	UV OXIDATION	An oxidizing agent such as hydrogen peroxide is mixed with the waste stream and exposed to ultraviolet light to oxidize contaminants.	Proven for treatment of chlorinated VOCs, semivolatiles & pesticides/PCBs in EPA SITE testing.
		DEHALOGENATION	Chemical agent is mixed with waste stream to remove halogen atoms from chlorinated hydrocarbons.	Primarily used for PCB transformer oils. Does not treat non-chlorinated hydrocarbons.
		OXIDATION/ REDUCTION	Raising or lowering of molecular oxidation state to render contaminants less toxic.	Potential for incomplete oxidation and production of toxic oxidation products. Not applicable to identified contaminants.
	IN SITU TREATMENT	BIODEGRADATION	Stimulation of indigenous bacteria or introduced strains to degrade organics by means of nutrient addition.	Aromatic hydrocarbons require anaerobic conditions while chlorinated compounds require anaerobic conditions.
DISCHARGE	ON-SITE DISCHARGE	INJECTION WELLS	Treated water is reinjected into water table via wells.	Potentially viable.
		INFILTRATION GALLERIES	Treated water is reinjected via subsurface drains.	Potentially viable.
		SURFACE WATER	Treated water is discharged directly into surface water.	Potentially viable.
	OFF-SITE DISCHARGE	STORM SEWER	Treated water is discharged indirectly to surface water body via storm sewer.	Storm sewers not available at site.
		SANITARY SEWER	Treated water is discharged indirectly to surface water body via sanitary sewer and POTW.	Sanitary sewers not available at site.

TABLE 3-7

SOIL/ WASTE MATRIX PROCESS OPTION SCREENING
HERTEL LANDFILL FEASIBILITY STUDY

* CHOSEN PROCESS OPTION

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION		EFFECTIVENESS	IMPLEMENTABILITY	COST
NO ACTION	NONE	NOT APPLICABLE	*	Allows contaminated soils and waste materials to remain as potential sources of ground water and surface water contamination.	Easily implemented.	No cost.
INSTITUTIONAL CONTROL	SITE USE RESTRICTIONS	DEED RESTRICTIONS	*	Limits further disturbance of existing contamination or introduction of additional contaminated materials.	Requires appropriate legal authority.	Low capital cost.
		ACCESS RESTRICTIONS	*	Limits human exposure to site; exposure to wildlife partially limited.	Easily implemented.	Low capital cost; low maintenance cost.
CONTAINMENT	CAPPING	CLAY		Susceptible to cracking.	Easily implmented; requires future land use restrictions.	Moderate capital; low maintenance.
		SYNTHETIC		Susceptible to surface water ponding.	Fairly easily implemented; requires future land use restrictions.	Moderate capital; moderate maintenance.
		ASPHALT		Susceptible to weathering and cracking.	Easily implemented; requires future land use restrictions.	Moderate capital; high maintenance
		CONCRETE		Susceptible to weathering.	Easily implemented; requires future land use restrictions.	Moderate capital; moderate maintenance.
		MULTI-LAYER CAP	*	Least susceptible to cracking or degradation; easily supports vegetative cover.	Fairly easily implemented; requires future land use restrictions.	Moderate capital; moderate maintenance.
	LANDFILL DISPOSAL	OFF-SITE LANDFILL	*	Removes soil contaminants and waste materials as a future source of continued contamination.	Difficult to identify an existing RCRA facility with sufficient capacity to accept contaminated materials.	Very high capital; low maintenance.
		ON-SITE LANDFILL		Soil contaminants and waste materials are not treated but are contained on-site in a more protective state.	Difficult to handle excavation of materials and construction of RCRA landfill facility simultaneously.	Very high capital; moderate O&M.
TREATMENT	ON-SITE THERMAL TREATMENT	ROTARY KILN INCINERATION	*	Effective for organic destruction; applicable to soils and waste materials.	Mobile units available; numerous commercial suppliers.	High capital; moderate O&M.
		FLUIDIZED BED INCINERATION		Effective for organic treatment; best suited for slurries and sludges.	Limited number of commercial suppliers.	High capital; moderate O&M.
		INFRARED INCINERATION		Effective for organic destruction; applicable to soils and waste materials.	Shirco brand no longer manufactured but previously purchased units available through hazardous waste remediation firms. Requires adequate electrical power source.	High capital; moderate O&M.
	OFF-SITE TREATMENT	VARIOUS	*	Treatment method determined by vendor on basis of contaminants and current regulations.	Availability of certain treatment units (e.g. incinerators) limited.	High capital; low O&M.
	IN SITU TREATMENT	VITRIFICATION	*	Effective for mixed contaminants.	Implementability complicated by presence of waste materials; limited number of suppliers.	High capital; low O&M.

TABLE 3-8

GROUND WATER PROCESS OPTION SCREENING
HERTEL LANDFILL FEASIBILITY STUDY

* CHOSEN PROCESS OPTION

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
NO ACTION	NONE	NOT APPLICABLE	Not effective in prohibiting or monitoring contaminant migration.	No implementation required.	No cost.
	CONTINUED GROUND WATER MONITORING	NOT APPLICABLE *	Would provide indication of off-site contaminant migration prior to impact of private wells.	Easily implemented.	Low capital; moderate O&M.
INSTITUTIONAL CONTROL	GROUND WATER USE RESTRICTIONS	DEED RESTRICTIONS *	Effective in limiting public ingestion of ground water contaminants, by eliminating installation of potable wells in contaminated areas.	Requires legal authority.	Low capital.
		ALTERNATE WATER SUPPLY	Effective in preventing public ingestion of ground water contaminants, should private wells ever be impacted by contaminant migration.	Requires legal authority and provision of an alternate water supply to adjacent homes with private wells.	High capital; low O&M
CONTAINMENT	CAPPING	CLAY	Limits infiltration; susceptible to cracking.	Easily implemented; future land use restrictions.	Moderate capital; low maintenance.
		SYNTHETIC	Limits infiltration; susceptible to surface water ponding.	Fairly easily implemented; future land use restrictions.	Moderate capital; moderate maintenance.
		ASPHALT	Limits infiltration; susceptible to weathering and cracking.	Easily implemented; future land use restrictions.	Moderate capital; high maintenance.
		CONCRETE	Limits infiltration; susceptible to weathering.	Easily implemented; future land use restrictions.	Moderate capital; moderate maintenance.
		MULTI-LAYER CAP *	Limits infiltration; least susceptible to cracking or degradation; provides means of methane control.	Fairly easily implemented; future land use restrictions.	Moderate capital; moderate maintenance.
	VERTICAL BARRIER	SLURRY WALL *	Effective in minimizing volume of ground water which comes in contact with waste materials under containment scenario.	Implementation complicated by presence of subsurface boulders, limited availability of water on-site, and lack of flat areas for backfill mixing and slurry preparation.	Moderate capital; low maintenance.
COLLECTION	EXTRACTION	EXTRACTION WELLS *	Effective; best suited for steep hydraulic gradients and miscible contaminants.	Easily implemented; discharge permit required.	Moderate capital; moderate O&M.
		WELL POINTS	Effective; best suited to shallow aquifers.	Easily implemented; discharge permit required.	Moderate capital; moderate O&M.
		FRENCH DRAINS	Effective; best suited to shallow aquifers.	Easily implemented; discharge permit required.	Moderate capital; moderate O&M.
	OFF-SITE	COMMERCIAL TREATMENT FACILITY *	Effective with identification of an appropriate treatment faacility.	Difficult to implement due to volumes of ground water produced during extraction process.	Moderate capital; highO&M.
	BIOLOGICAL	BIOREACTOR *	Proven effective for removal of organics, phenols.	Easily implemented.	Moderate capital; low to moderate O&M.

TABLE 3-8 (Continued)

GROUND WATER PROCESS OPTION SCREENING
HERTEL LANDFILL FEASIBILITY STUDY

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	I MPLEMENTABILITY	COST
TREATMENT	PHYSICAL	AIR STRIPPING	Generally effective for volatile organics.	Readily implemented; may require treatment of off-gases.	Moderate capital; O&M.
		CARBON ADSORPTION *	Effective for low solubility organics.	Readily implemented; requires on- or off-site regeneration of carbon.	Moderate capital; moderate O&M.
		RESIN ADSORPTION	Effective for organic removal.	Prior to implementation, identification of resin applicable to contaminants in ground water is required.	High capital; moderate O&M.
		ION EXCHANGE	Effective for inorganic removal.	Readily implemented.	Moderate capital; moderate O&M.
		PRECIPITATION *	Effective for inorganic removal; precipitate must be disposed of.	Readily implemented.	Low capital; moderate O&M.
		MEMBRANE MICROFILTRATION *	Effective in removing heavy metals, based on pilot tests.	Can be manufactured as mobile system.	Not well defined, due to innovative nature.
	CHEMICAL	UV OXIDATION *	Effective for treatment of volatiles and semi-volatiles; no emissions or waste by-products produced.	Readily implemented.	High capital; moderate O&M.
DISCHARGE	ON-SITE DISCHARGE	INJECTION WELLS	Effective with permeable soils and relatively low flow rates.	Readily implemented; requires compliance with discharge criteria.	Moderate capital; low O&M.
		INFILTRATION GALLERIES	Effective with permeable near-surface soils and at higher discharge rates.	Readily implemented; requires compliance with discharge criteria.	Moderate capital; low O&M.
		SURFACE WATER *	Effective for discharge of treated ground water.	Readily implemented; requires compliance with discharge criteria.	Low capital; low O&M.

TABLE 3-9

REPRESENTATIVE PROCESS OPTION SUMMARY
HERTEL LANDFILL FEASIBILITY STUDY

MEDIA	TECHNOLOGY	REPRESENTATIVE PROCESS OPTION
SOIL/WASTE MATRIX	No Action	Not applicable
	Institutional Control	Deed and access restrictions
	Capping	Multi-layer cap
	Landfill Disposal	Off-site landfill
	On-site Thermal Treatment	Rotary kiln incineration
	Off-Site Treatment	Various
	In Situ Treatment	In situ vitrification
GROUND WATER	No Action	Continued ground water monitoring
	Institutional Control	Deed Restrictions
	Capping	Multi-layer cap
	Vertical Barrier	Slurry wall
	Extraction	Extraction wells
	Off-Site Treatment	Commercial treatment facility
	Biological Treatment	Bioreactor
	Physical Treatment	Carbon adsorption Precipitation Membrane microfiltration
	Chemical Treatment	UV Oxidation
	On-Site Discharge	Discharge to surface water

TABLE 4-1

PRELIMINARY REMEDIAL ALTERNATIVE SUMMARY
HERTEL LANDFILL FEASIBILITY STUDY

Alternative 1	- No action, continued ground water monitoring
Alternative 2	- Site use restrictions, capping
Alternative 2A	- Site use restrictions, capping, slurry wall
Alternative 3	- Excavation of contaminated soil and waste materials with off-site disposal, ground water collection with off-site treatment
Alternative 4	- Site use restrictions, capping, ground water extraction with on-site physical treatment
Alternative 4A	- Site use restrictions, capping, ground water extraction with on-site treatment using UV oxidation/membrane microfiltration
Alternative 5	- Excavation and on-site incineration of soils and wastes, ground water extraction and on-site physical treatment
Alternative 6	- Excavation and off-site treatment of soils and wastes, ground water extraction and on-site biological treatment
Alternative 7	- In situ vitrification, and ground water extraction and on-site treatment using UV oxidation/membrane microfiltration

TABLE 4-2
RANGE OF REMEDIAL ALTERNATIVES
HERTEL LANDFILL FEASIBLITY STUDY

MEDIUM	TECHNOLOGY TYPE	NCP/GUIDANCE CRITERIA: DESCRIPTION	No Action	Containment with Little or No Treatment		Minimize Long-Term Management	Treatment as Primary Component				Innovative
			1	2	2A	3	4	4A	5	6	7
SOIL/WASTE	No Action	No action	*								
	Site Use Restrictions	Use of deed restrictions and fencing to limit access and use of site		*	*		*	*			
	Capping	RCRA multimedia cap over landfill area		*	*		*	*			
	Excavation/Landfill Disposal	Disposal of contaminated soils and waste materials at off-site landfill				*					
	On-site Thermal Treatment	Rotary Kiln							*		
	Off-Site Treatment	Various								*	
	In Situ Treatment	In Situ Vitrification									*
GROUND WATER											
	No Action	No Action	*								
	Capping	RCRA multimedia cap over landfill area		*	*		*				
	Vertical Barrier	Slurry wall			*						
	Extraction	Extraction wells				*	*	*	*	*	*
	Off-Site Treatment	RCRA facility				*					
	Biological Treatment	Bioreactors								*	
	Physical Treatment	Carbon adsorption/precipitation					*		*		
	Chemical Treatment	UV oxidation/membrane microfiltration						*			*

TABLE 4-3

PRELIMINARY REMEDIAL COST ESTIMATES
HERTEL LANDFILL FEASIBILITY STUDY

ALTERNATIVE	TOTAL PRESENT WORTH (Millions)
Alternative 1	
- No action, continued ground water monitoring	$2.5
Alternative 2	
- Site use restrictions, capping	$7.0
Alternative 2A	
- Site use restrictions, capping, slurry wall	$15
Alternative 3	
- Excavation of contaminated soil and waste materials with off-site disposal, ground water collection with off-site treatment	$190
Alternative 4	
- Site use restrictions, capping, ground water extraction with on-site physical treatment	$8.2
Alternative 4A	
- Site use restrictions, capping, ground water extraction with on-site treatment using UV oxidation/membrane microfiltration	$7.9
Alternative 5	
- Excavation and on-site incineration of soils and wastes, ground water extraction and on-site physical treatment	$120
Alternative 6	
- Excavation and off-site treatment of soils and wastes, ground water extraction and on-site biological treatment	$510
Alternative 7	
- In situ vitrification, and ground water extraction and on-site treatment using UV oxidation/membrane microfiltration	$110

TABLE 5-1

REMEDIAL ALTERNATIVES UNDERGOING DETAILED ANALYSIS
HERTEL LANDFILL FEASIBILITY STUDY

Alternative 1 - No action, continued ground water monitoring

Alternative 2 - Site use restrictions, capping

Alternative 2A - Site use restrictions, capping, slurry wall

Alternative 4 - Site use restrictions, capping, ground water extraction with on-site physical treatment

Alternative 4A - Site use restrictions, capping, ground water extraction with on-site innovative treatment (UV oxidation/membrane microfiltration)

TABLE 5-2

SUMMARY OF CANCER RISK ESTIMATES - ROAD IMPROVEMENTS AND CLEARING VEGETATION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST								1E-06	2E-06
INORGANICS									
Arsenic	8.04E-09	No	50	A	Lung	Air/HEAST	4E-07		
Chromium	2.13E-08	No	41	A	Lung	OCCUPA/HEAST	9E-07		

TABLE 5-3

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - ROAD IMPROVEMENTS AND CLEARING VEGETATION (ALTERNATIVES 2, 2A, 4 AND 4A)

HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)	TOTAL EXPOSURE HI
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST										1E+01	1E+01
INORGANICS											
Chromium	3.6E-05	No	6E-06	NA	Nasal mucosa atrophy	HEAST	300		6E+00		
Manganese	2.5E-03	No	4E-04	Medium	Increased prevalence of	IRIS	300	3	6E+00		
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL										9E-01	
INORGANICS											
Arsenic	9.0E-05	0.10	1E-03	NA	Keratosis and hyperpigmentation	NA/HEAST	1		9E-01		

TABLE 5-4

SUMMARY OF CANCER RISK ESTIMATES - CAP CONSTRUCTION (ALTERNATIVES 2, 2A, 4, AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST								7E-06	1E-05
INORGANICS									
Arsenic	4.29E-08	No	50	A	Lung	Air/HEAST	2E-06		
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL								5E-06	
INORGANICS									
Arsenic	2.82E-07	0.10	1.75	A	Skin	Water/IRIS	5E-06		

TABLE 5-5

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - CAP CONSTRUCTION (ALTERNATIVES 2, 2A, 4 AND 4A)

HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)	TOTAL EXPOSURE HI
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST										1E+01	1E+01
INORGANICS											
Chromium	3.6E-05	No	6E-06	NA	Nasal mucosa atrophy	HEAST	300		6E+00		
Manganese	2.5E-03	No	4E-04	Medium	Increased prevalence of	IRIS	300	3	6E+00		
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL										9E-01	
INORGANICS											
Arsenic	9.0E-05	0.10	1E-03	NA	Keratosis and hyperpigmentation	NA/HEAST	1		9E-01		

TABLE 5-6

SUMMARY OF CANCER RISK ESTIMATES: CHILDREN (ALTERNATIVES 2 AND 2A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK	TOTAL RISK
EXPOSURE PATHWAY: DERMAL CONTACT WITH SOILS - CHILDREN								2E-05	2E-05
INORGANICS									
Arsenic	1.1E-06	0.10	1.8E+00	A	Bladder,Liver,Lung	Water/IRIS	2E-05		

TABLE 5-7
SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES: CHILDREN (ALTERNATIVES 2 AND 2A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)	TOTAL HAZARD INDEX (HI)
EXPOSURE PATHWAY: DERMAL CONTACT WITH SOIL - CHILDREN										9E-02	1E-01
INORGANICS											
Arsenic	8.7E-06	0.10	1E-03		Keratosis and hyperpigmentation	NA/IRIS			9E-02		

TABLE 5-8
SUMMARY OF CANCER RISK ESTIMATES - WELL CONSTRUCTION (ALTERNATIVES 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST								2E-05	4E-05
INORGANICS									
Arsenic	1.34E-07	No	50	A	Lung	Air/HEAST	7E-06		
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL								2E-05	
INORGANICS									
Arsenic	8.81E-07	0.10	1.75	A	Skin	Water/IRIS	2E-05		

TABLE 5-9
SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - WELL CONSTRUCTION (ALTERNATIVE 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)	TOTAL EXPOSURE HI
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST										1E+01	1E+01
INORGANICS											
Chromium	3.6E-05	No	6E-06	NA	Nasal mucosa atrophy	HEAST	300		6E+00		
Manganese	2.5E-03	No	4E-04	Medium	Increased prevalence of	IRIS	300	3	6E+00		
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL										9E-01	
INORGANICS											
Arsenic	9.0E-05	0.10	1E-03	NA	Keratosis and hyperpigmentation	NA/HEAST	1		9E-01		

TABLE 5-10
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
SHORT-TERM EFFECTIVENESS

Alternative 1:	No action	No remedial activities conducted; therefore no short-term risks other than existing baseline risks result. Remedial response objectives not achieved
Alternative 2:	Site use restrictions, capping	Non-cancer risks to on-site workers exceed acceptable levels; personal protective equipment required Effective in limiting soil exposure risks within a short time frame; no protection against contaminated ground water migration
Alternative 2A:	Site use restrictions, capping and slurry wall construction	Non-cancer risks to on-site workers exceed acceptable levels; personal protective equipment required Effective in limiting soil exposure risks and continued contamination of ground water to a limited time frame
Alternative 4:	Site use restrictions, capping; Ground water extraction with on-site physical treatment	Non-cancer risks to on-site workers exceed acceptable levels; personal protective equipment required Effective in limiting soil exposure risks and migration of contaminated ground water to a limited time frame
Alternative 4A:	Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	Non-cancer risks to on-site workers exceed acceptable levels; personal protective equipment required Effective in limiting soil exposure risks and migration of contaminated ground water to a limited time frame

TABLE 5-11
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 1:	No action	Baseline risks remain unchanged
Alternative 2:	Site use restrictions, capping	Surface and subsurface soil/waste contaminants are untreated but contained; Long-term monitoring of containment area and ground water required; Potential long-term risks associated with contaminated ground water migration not addressed
Alternative 2A:	Site use restrictions, capping and slurry wall construction	Surface and subsurface soil/waste contaminants are untreated but contained; Long-term contact between ground water and waste materials minimized or eliminated, thereby limiting potential for contaminated ground water migration; Long-term monitoring of containment area and ground water required
Alternative 4:	Site use restrictions, capping; Ground water extraction with on-site physical treatment	Surface and subsurface soil/waste contaminants are untreated but contained; Contaminated ground water migration minimized through pumping and on-site treatment; Long-term monitoring of containment areas and ground water required; may not be effective in maintaining cleanup levels in ground water once pump and treat operations are discontinued
Alternative 4A:	Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	Surface and subsurface soil/waste contaminants are untreated but contained; Contaminated ground water migration minimized through pumping and on-site treatment; Long-term monitoring of containment areas and ground water required; may not be effective in maintaining cleanup levels in ground water once pump and treat operations are discontinued

TABLE 5-12
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
IMPLEMENTABILITY

ALTER-NATIVE	DESCRIPTION OF ALTERNATIVE	TECHNICAL FEASIBILITY	ADMINISTRATIVE FEASIBILITY	AVAILABILITY OF SERVICES AND MATERIALS
1:	No action	Installation of additional monitoring wells is feasible	No inter-agency coordination required	Suppliers of services and equipment readily available
2:	Site use restrictions, capping	Construction easily implemented; Cap could inhibit future remedial activites in capped area or could enhance activities such as ground water extraction	Requires compliance with wetlands protection regulations	Suppliers of services and equipment readily available
2A:	Site use restrictions, capping and slurry wall construction	Construction fairly easily implemented, although presence of boulders and slopes could complicate slurry wall construction; Cap could inhibit future remedial activites in capped area	Requires compliance with wetlands protection regulations	Suppliers of services and equipment readily available
4:	Site use restrictions, capping; Ground water extraction with on-site physical treatment	Construction easily implemented; Ground water treatment technologies easily implemented; Cap could inhibit future remedial activites in capped area	Requires compliance with wetlands protection regulations and authorization to discharge treated ground water to surface water	Suppliers of services and equipment readily available
4A:	Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	Construction easily implemented; Technical problems possible with ground water treatment system; Cap could inhibit future remedial activities in capped area	Requires compliance with wetlands protection regulations and authorization to discharge treated ground water to surface water	Suppliers of services and equipment for ground water treatment system limited

TABLE 5-13
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
REDUCTION OF TOXICITY (T), MOBILITY (M) OR VOLUME (V) THROUGH TREATMENT

Alternative 1:	No action	No reductions in T, M or V; Site conditions remain unchanged
Alternative 2:	Site use restrictions, capping	No reduction in T or V; M of ground water contamination is decreased through containment and prevention of leachate production; ground water table remains within waste materials
Alternative 2A:	Site use restrictions, capping and slurry wall construction	No reduction in T or V; M of ground water contamination is decreased through prevention of leachate production and minimization of contact between waste materials and ground water table
Alternative 4:	Site use restrictions, capping; Ground water extraction with on-site physical treatment	T of ground water reduced through treatment; M of ground water reduced through pumping; No reduction of T or V of soil/waste; M of soil/waste is decreased through containment; Permanence of ground water T reductions not well-defined since ground water table resumes contact with wastes upon discontinuation of pump and treat system
Alternative 4A:	Site use restrictions, capping; Ground water extraction with on-site innovative treatment	T of ground water reduced through treatment; M of ground water reduced through pumping; No reduction of T or V of soil/waste; M of soil/waste is decreased through containment; Permanence of ground water T reductions not well-defined since ground water table resumes contact with wastes upon discontinuation of pump and treat system

TABLE 5-14
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
COMPLIANCE WITH ARARs

NUMBER AND DESCRIPTION OF ALTERNATIVE	CHEMICAL-SPECIFIC	LOCATION-SPECIFIC	ACTION-SPECIFIC
1: No action	ARARs not attained for sediment, ground water or surface water; No applicable soil ARARs	Not applicable	Not applicable
2: Site use restrictions, capping	ARARs not attained for sediment or ground water; No applicable soil ARARs; Cap designed to prevent leachate seeps, thereby reducing surface water contaminant levels	Construction activities to comply with wetlands requirements	Cap design and surface water drainage design to comply with landfill closure requirements
2A: Site use restrictions, capping and slurry wall construction	ARARs not attained for sediment or ground water although minimization of contact between the ground water table and soil/waste may result in reduced ground water contaminant levels; No applicable soil ARARs; Cap designed to prevent leachate seeps, thereby reducing surface water contaminant levels	Construction activities to comply with wetlands requirements	Cap design and surface water drainage design to comply with landfill closure requirements
4: Site use restrictions, capping; Ground water extraction with on-site physical treatment	ARARs not attained for sediment; No applicable soil ARARs; Ground water treatment to attain ARARs; Maintenance of ARARs in ground water following discontinuation of pump and treat operations is not guaranteed; Cap designed to prevent leachate seeps, thereby reducing surface water contaminant levels	Construction activities to comply with wetlands requirements	Cap design, surface water drainage design and ground water discharge standards to comply with landfill closure requirements and NPDES requirements
4A: Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	ARARs not attained for sediment; No applicable soil ARARs; Ground water treatment expected to attain ARARs although innovative technologies not well proven; Maintenance of ARARs in ground water following discontinuation of pump and treat operations is not guaranteed; Cap designed to prevent leachate seeps, thereby reducing water contaminant levels	Construction activities to comply with wetlands requirements	Cap design, surface water drainage design and ground water discharge standards to comply with landfill closure requirements and NPDES requirements

TABLE 5-15
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 1:	No action	Baseline risks remain unchanged; Least protective alternative
Alternative 2:	Site use restrictions, capping	Provides soil/waste contaminant containment but risks associated with ground water contaminant migration not addressed; Effective in the short-term; Does not attain chemical-specific ARARs
Alternative 2A:	Site use restrictions, capping and slurry wall construction	Provides soil/waste contaminant containment; Long-term risks associated with ground water contaminant migration minimized through elimination of contact between the soil/waste and ground water table; Effective in the short-term; Does not attain chemical-specific ARARs
Alternative 4:	Site use restrictions, capping; Ground water extraction with on-site physical treatment	Provides soil/waste contaminant containment and treatment of contaminated ground water; Good short-term effectiveness; Long-term maintenance of ground water ARARs following discontinuation of pump and treat system may not be possible
Alternative 4A:	Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	Provides soil/waste contaminant containment and treatment of contaminated ground water; Short-term effectiveness dependent on effectiveness of innovative ground water treatment methods; Long-term maintenance of ground water ARARs following discontinuation of pump and treat system may not be possible

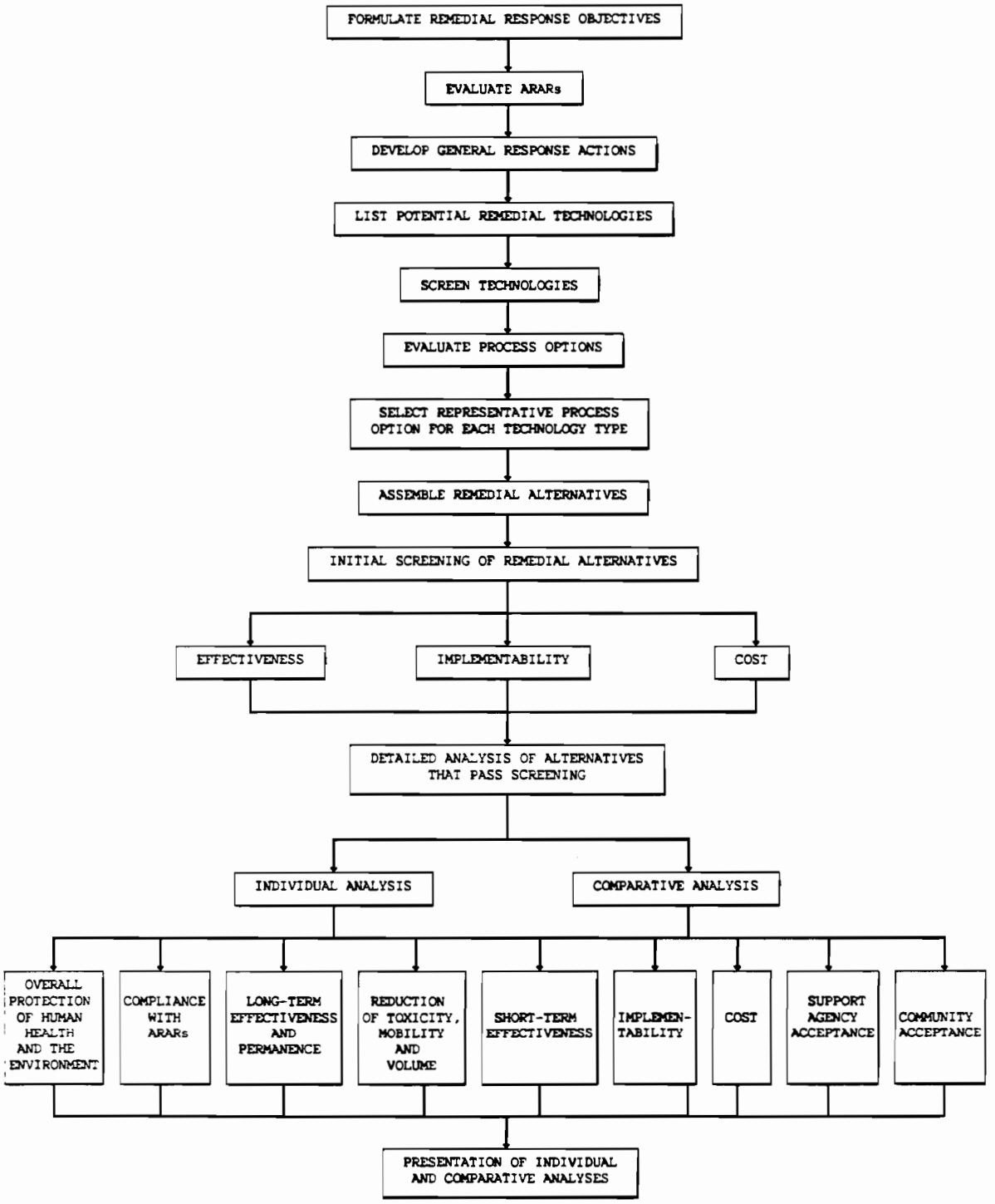
TABLE 5-16
HERTEL LANDFILL FEASIBILITY STUDY
COMPARISON AMONG ALTERNATIVES
COST

	Alternative	Duration	TOTAL CAPITAL COST	ANNUAL O&M COST	PRESENT WORTH - O&M COST *	TOTAL PRESENT WORTH **
1	No action	30 yrs - G.W. mon. (1)	$ 58,000	$ 132,000	$ 2,033,000	$ 2,509,000
2	Site use restrictions, capping	30 yrs - G.W. mon. (1) 30 yrs - cap maint.	3,482,000	163,000	2,503,000	7,182,000
2A	Site use restrictions, capping and slurry wall construction	30 yrs - G.W. mon. (1) 30 yrs - cap maint. 30 yrs - slurry wall maint.	8,406,000	171,000	2,626,000	13,238,000
4	Site use restrictions, capping; Ground water extraction with on-site physical treatment	17 yrs - G.W. mon. (1) 30 yrs - cap maint. 12 yrs - G.W. extr. & trtmt	3,989,000	316,000	3,322,000	8,774,000
4A	Site use restrictions, capping; Ground water extraction with on-site innovative treatment using UV oxidation and membrane microfiltration	17 yrs - G.W. mon. (1) 30 yrs - cap maint. 12 yrs - G.W. extr. & trtmt	3,955,000	267,000	2,884,000	8,207,000

* Based on 5% discount rate
** Includes 20% contingency on all components
(1) Includes 4 rounds of samples per year

TABLE 5-17
COST SENSITIVITY ANALYSIS
HERTEL LANDFILL FEASIBILITY STUDY

Item Varied (Minimum - Maximum)	Alternative	Total Present Worth Minimum Cost	Total Present Worth Maximum Cost
Discount Factor (10% - 3%)	1	$ 1,566,000	$ 3,180,000
	2	6,020,000	8,008,000
	2A	12,019,000	14,105,000
	4	7,385,000	9,026,000
	4A	6,866,000	8,237,000
Landfill Cap Construction Cost (-20% - +20%)	2	6,755,000	7,608,000
	2A	12,804,000	13,672,000
	4	8,340,000	9,208,000
	4A	7,773,000	8,641,000
Slurry Wall Construction Cost (-20% - +20%)	2A	12,078,000	14,398,000
Ground Water Remediation Pumping Rates (20 gal/min to 5 gal/min)	4	8,188,000	9,176,000
	4A	7,424,000	8,913,000



SOURCE: USEPA

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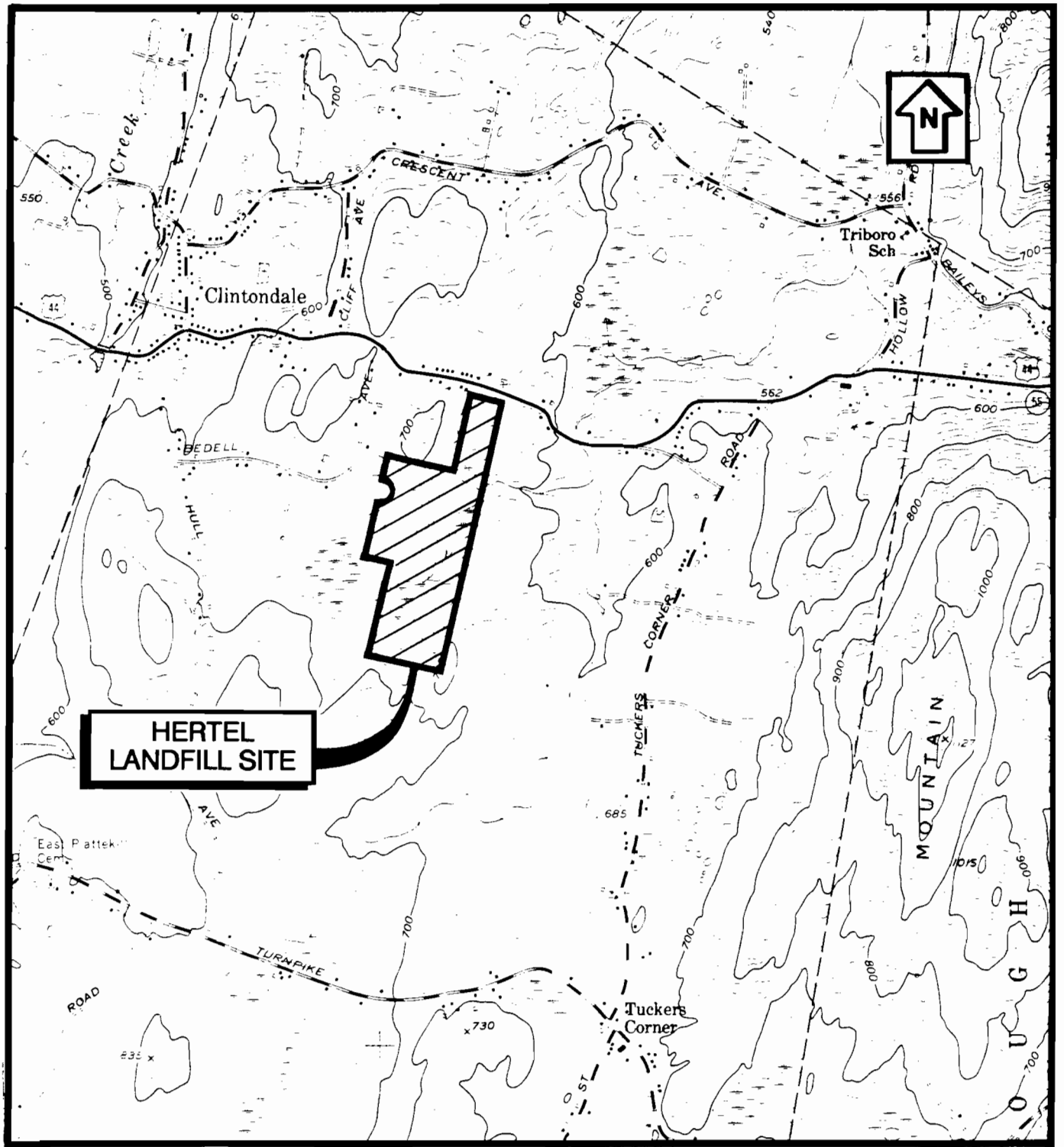
FIGURE 1-1.

FEASIBILITY STUDY APPROACH



NEW YORK

QUADRANGLE LOCATION

0 2000 FT

SCALE

From Clintondale, NY U.S.G.S. 7.5'
Topographic Map, 1957

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FIGURE 1-2.

SITE LOCATION MAP

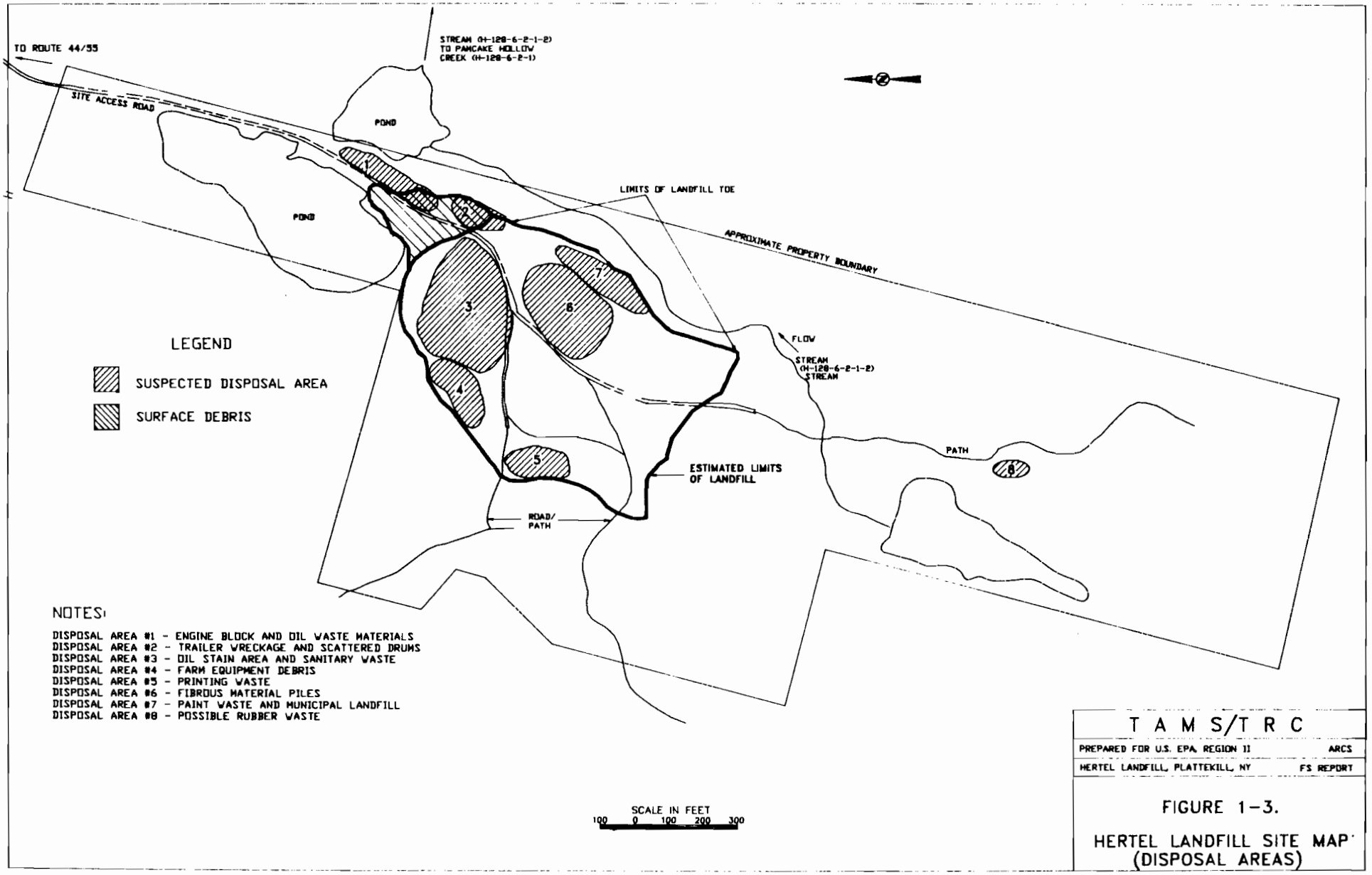
TO ROUTE 44/55
SITE ACCESS ROAD
STREAM (H-128-6-2-1-2) TO PANCAKE HOLLOW CREEK (H-128-6-2-1)
POND
POND
LIMITS OF LANDFILL TOE
APPROXIMATE PROPERTY BOUNDARY
FLOW
STREAM (H-128-6-2-1-2) STREAM
PATH
ESTIMATED LIMITS OF LANDFILL
ROAD/ PATH
LEGEND
SUSPECTED DISPOSAL AREA
SURFACE DEBRIS
NOTES:
DISPOSAL AREA #1 - ENGINE BLOCK AND OIL WASTE MATERIALS
DISPOSAL AREA #2 - TRAILER WRECKAGE AND SCATTERED DRUMS
DISPOSAL AREA #3 - OIL STAIN AREA AND SANITARY WASTE
DISPOSAL AREA #4 - FARM EQUIPMENT DEBRIS
DISPOSAL AREA #5 - PRINTING WASTE
DISPOSAL AREA #6 - FIBROUS MATERIAL PILES
DISPOSAL AREA #7 - PAINT WASTE AND MUNICIPAL LANDFILL
DISPOSAL AREA #8 - POSSIBLE RUBBER WASTE
SCALE IN FEET
100 0 100 200 300
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FIGURE 1-3.
HERTEL LANDFILL SITE MAP (DISPOSAL AREAS)

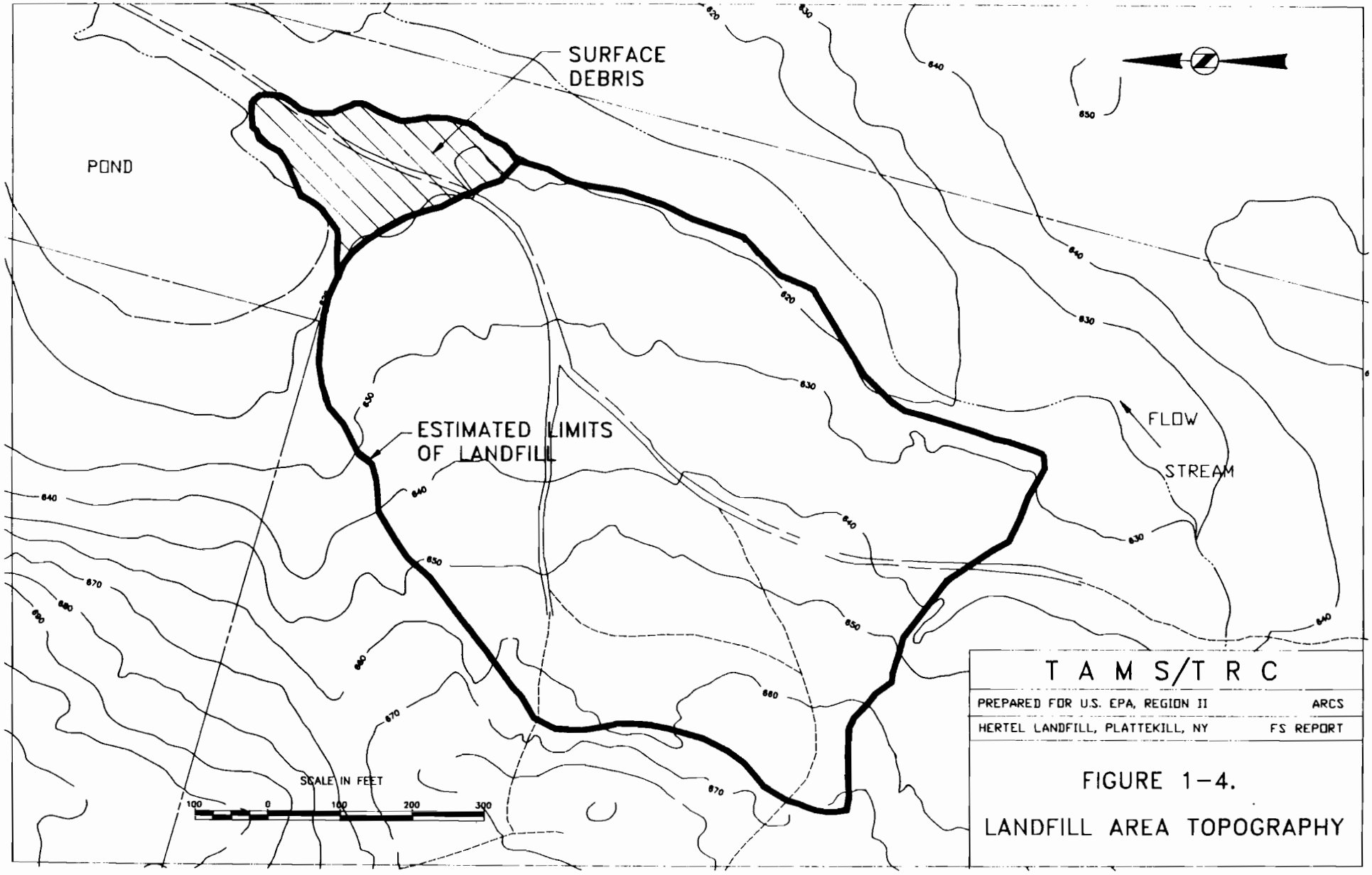
SURFACE DEBRIS
POND
ESTIMATED LIMITS OF LANDFILL
FLOW
STREAM
SCALE IN FEET
100 0 100 200 300
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FIGURE 1-4.
LANDFILL AREA TOPOGRAPHY

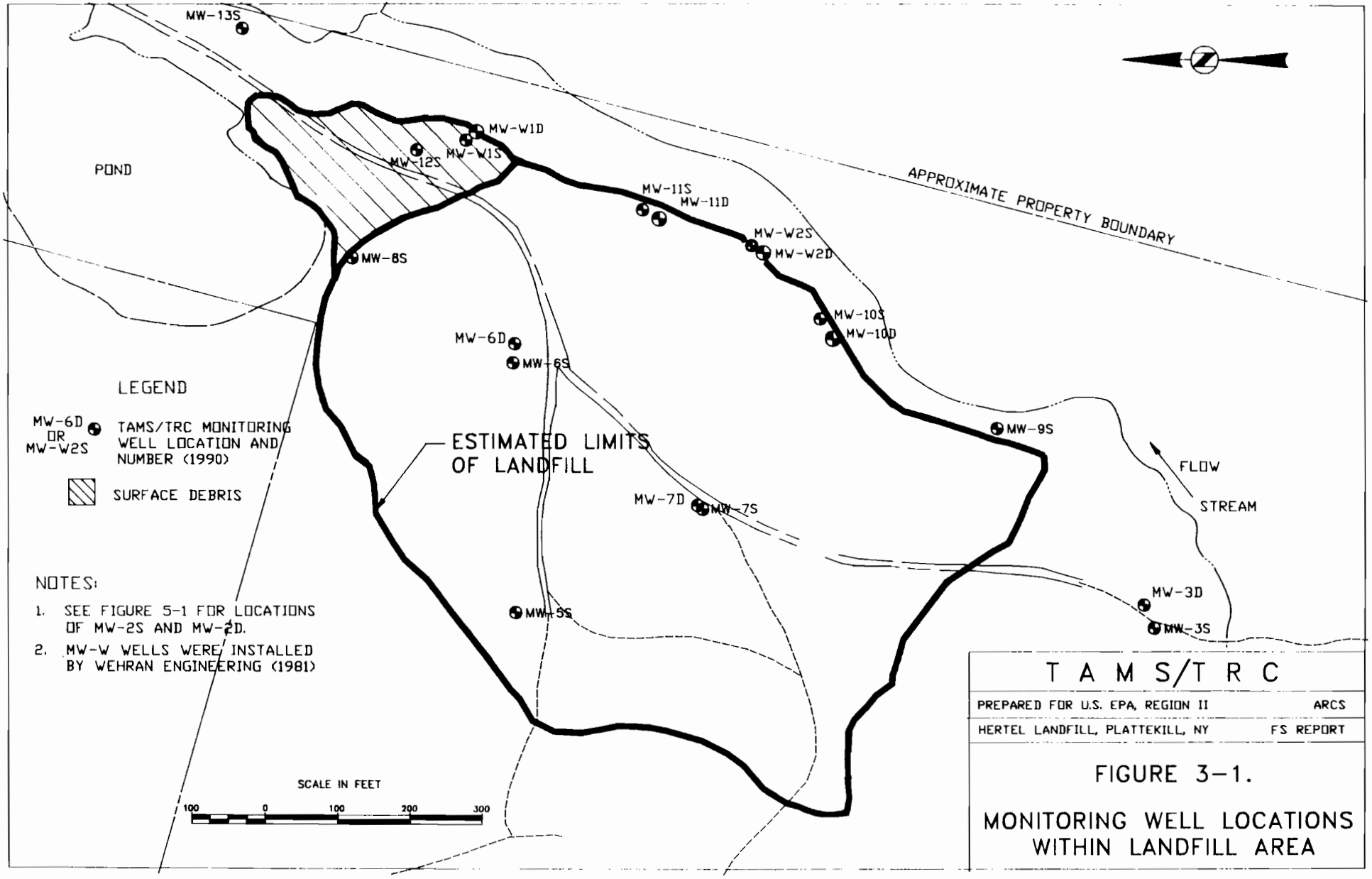
MW-13S
MW-W1D
MW-W1S
MW-12S
POND
APPROXIMATE PROPERTY BOUNDARY
MW-11S
MW-11D
MW-W2S
MW-W2D
MW-8S
MW-10S
MW-10D
MW-6D
MW-6S
MW-9S
LEGEND
MW-6D OR MW-W2S
TAMS/TRC MONITORING WELL LOCATION AND NUMBER (1990)
SURFACE DEBRIS
ESTIMATED LIMITS OF LANDFILL
FLOW
STREAM
MW-7D
MW-7S
MW-3D
MW-3S
MW-5S
NOTES:
1. SEE FIGURE 5-1 FOR LOCATIONS OF MW-2S AND MW-2D.
2. MW-W WELLS WERE INSTALLED BY WEHRAN ENGINEERING (1981)
SCALE IN FEET
100 0 100 200 300
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FIGURE 3-1.
MONITORING WELL LOCATIONS WITHIN LANDFILL AREA

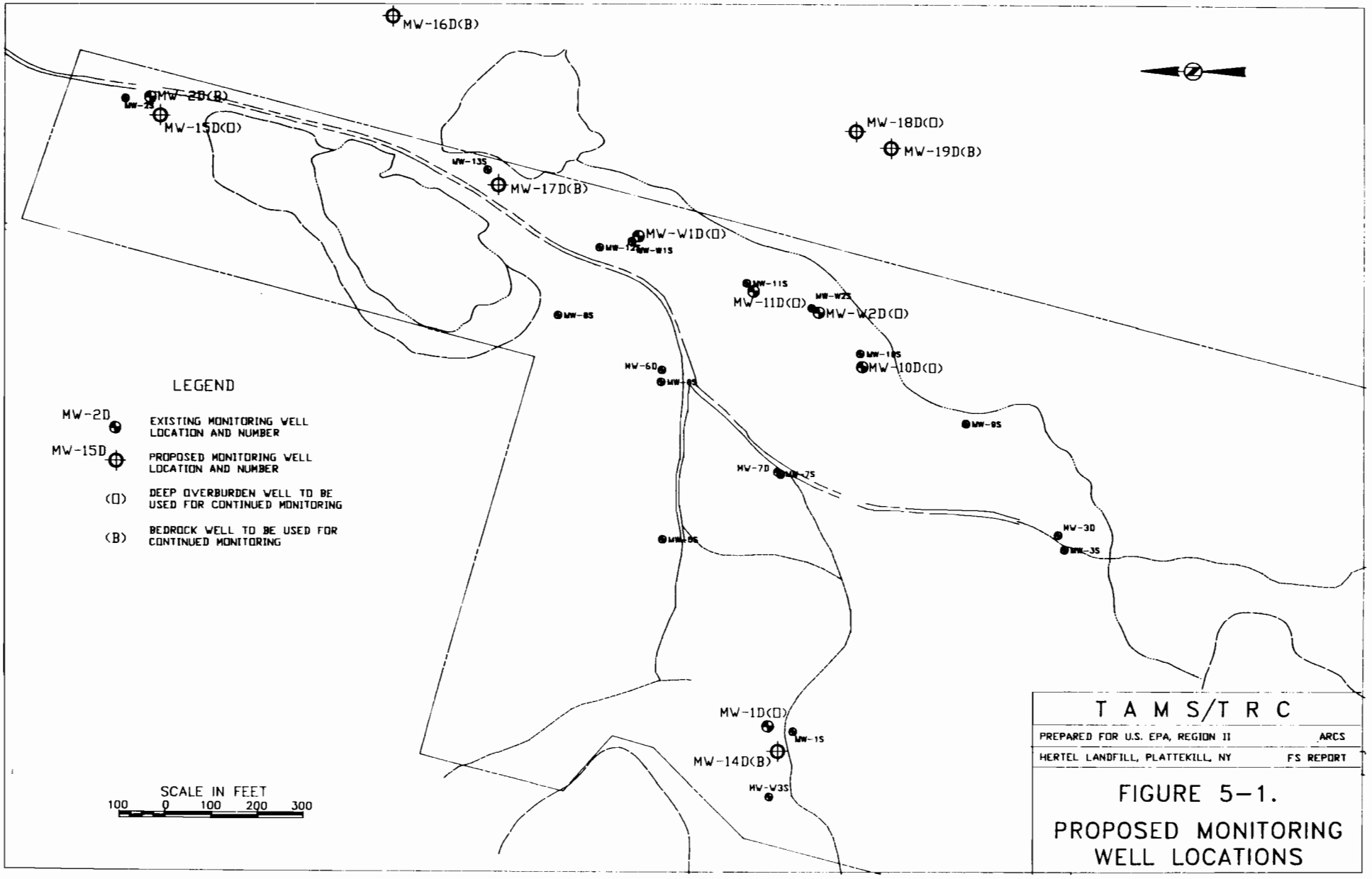
MW-16D(B)
MW-2D(B)
MW-15D(D)
MW-18D(D)
MW-19D(B)
MW-17D(B)
MW-W1D(D)
MW-11D(D)
MW-W2D(D)
MW-10D(D)
MW-6D
MW-7D
MW-3D
MW-1D(D)
MW-14D(B)
LEGEND
MW-2D
EXISTING MONITORING WELL LOCATION AND NUMBER
MW-15D
PROPOSED MONITORING WELL LOCATION AND NUMBER
(D)
DEEP OVERBURDEN WELL TO BE USED FOR CONTINUED MONITORING
(B)
BEDROCK WELL TO BE USED FOR CONTINUED MONITORING
SCALE IN FEET
100 0 100 200 300
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FIGURE 5-1.
PROPOSED MONITORING WELL LOCATIONS

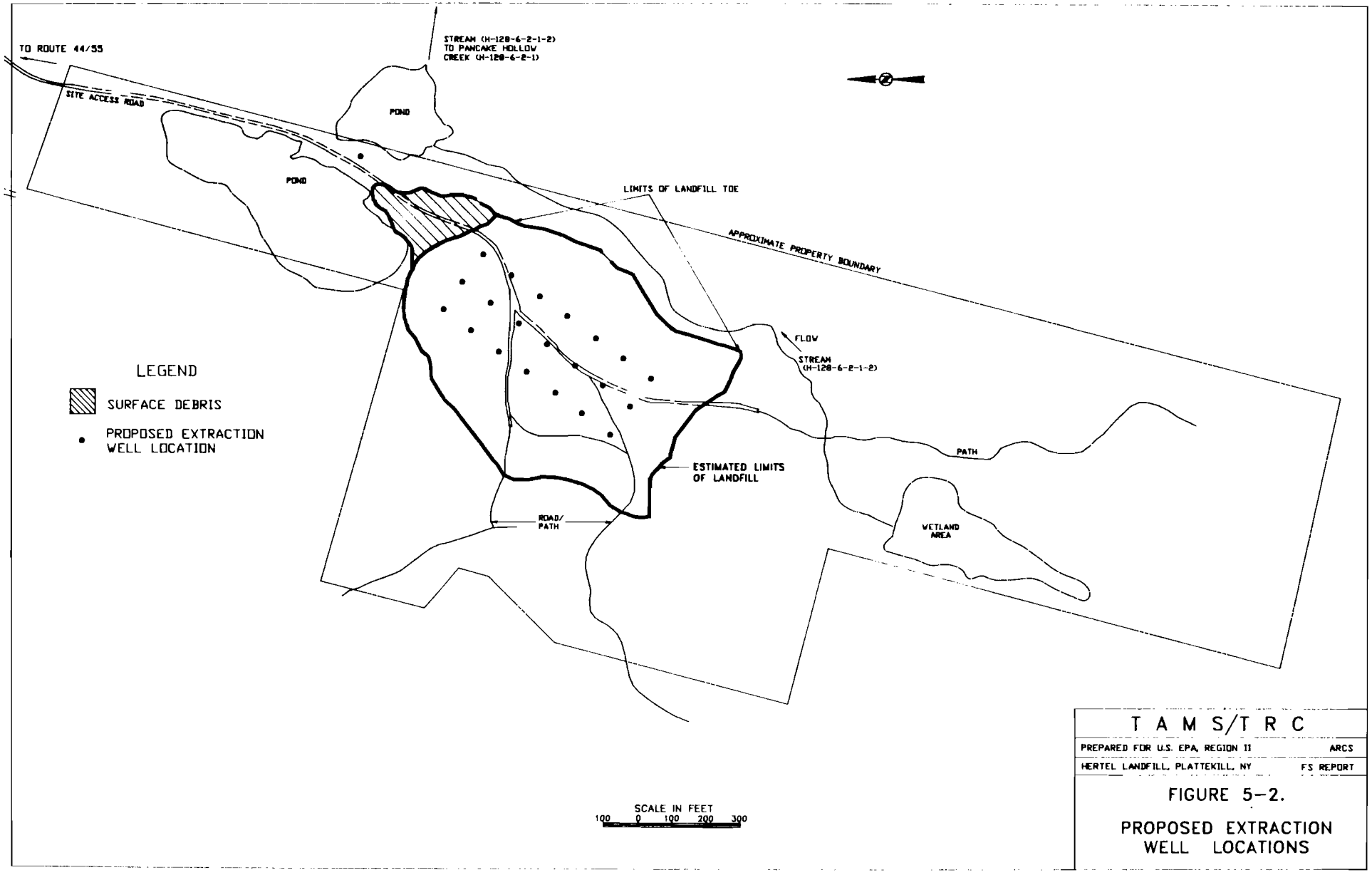
TO ROUTE 44/55
SITE ACCESS ROAD
STREAM (H-128-6-2-1-2) TO PANCAKE HOLLOW CREEK (H-128-6-2-1)
POND
POND
LIMITS OF LANDFILL TOE
APPROXIMATE PROPERTY BOUNDARY
FLOW
STREAM (H-128-6-2-1-2)
PATH
ESTIMATED LIMITS OF LANDFILL
ROAD/ PATH
WETLAND AREA
LEGEND
SURFACE DEBRIS
PROPOSED EXTRACTION WELL LOCATION
SCALE IN FEET
100 0 100 200 300
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FIGURE 5-2.
PROPOSED EXTRACTION WELL LOCATIONS

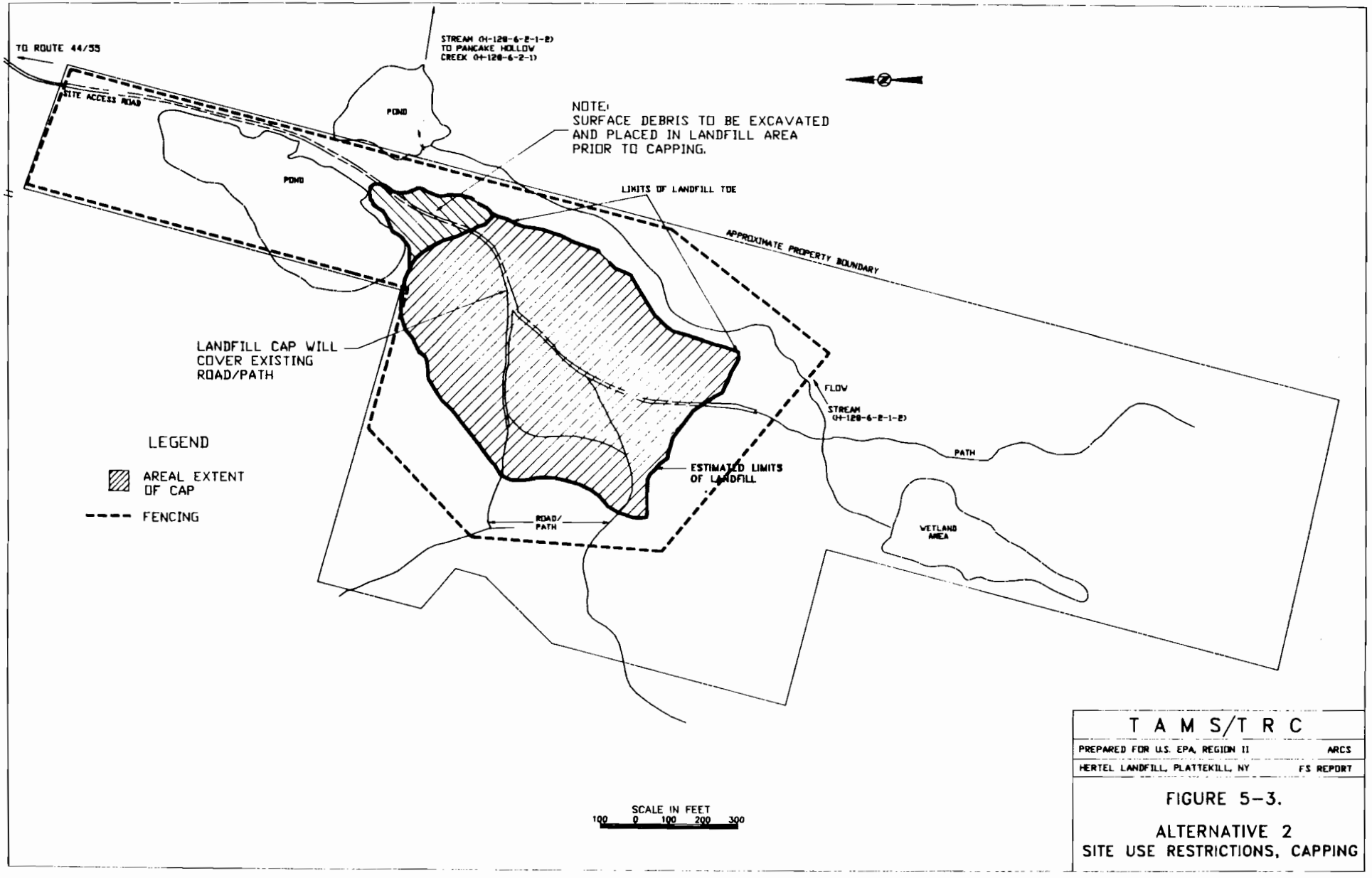

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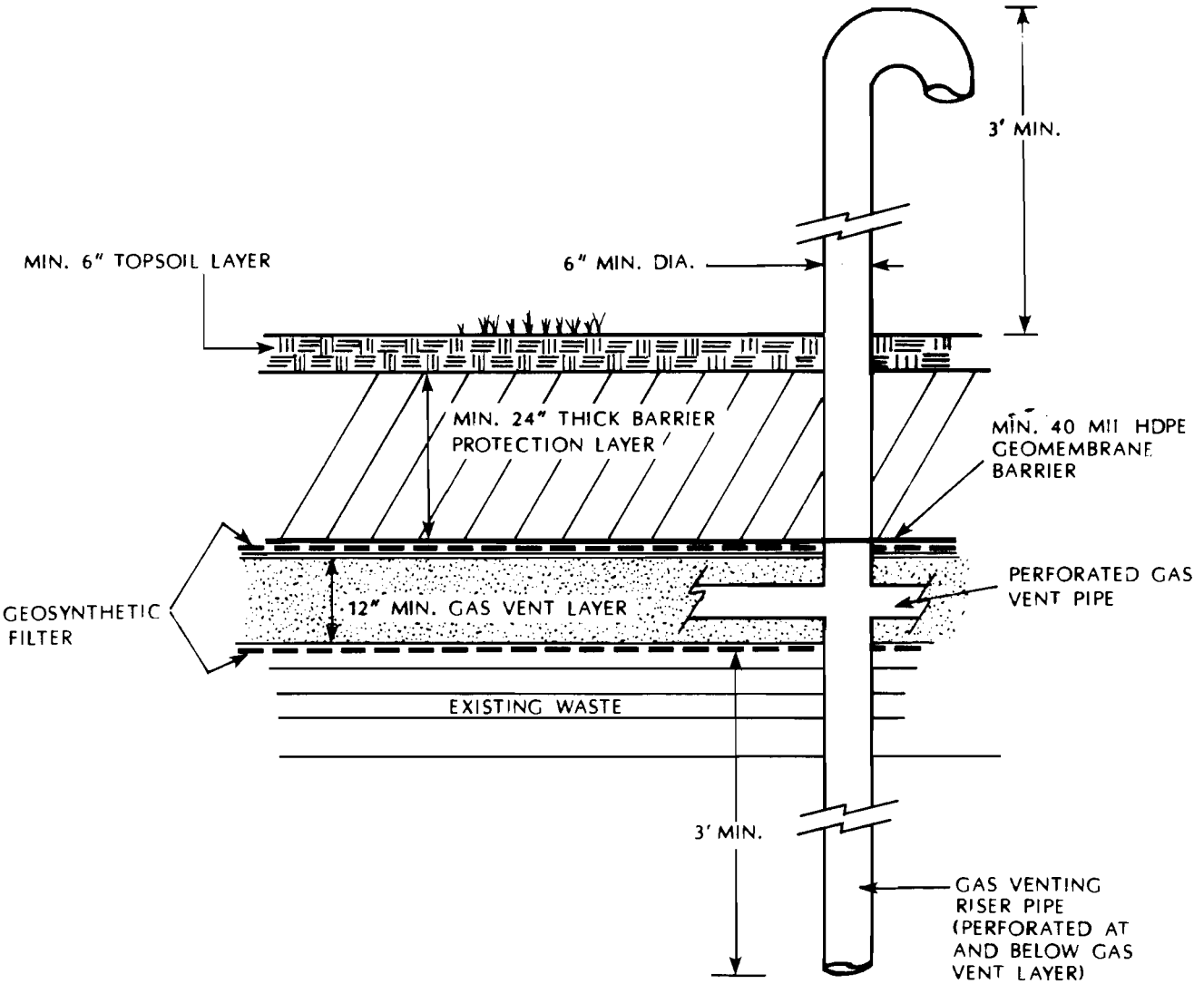
FIGURE 5-3.

ALTERNATIVE 2
SITE USE RESTRICTIONS, CAPPING



NOTE: MINIMUM RISER SPACING = ONE/ACRE FINAL COVER

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FIGURE 5-4.

FINAL CAP DETAIL

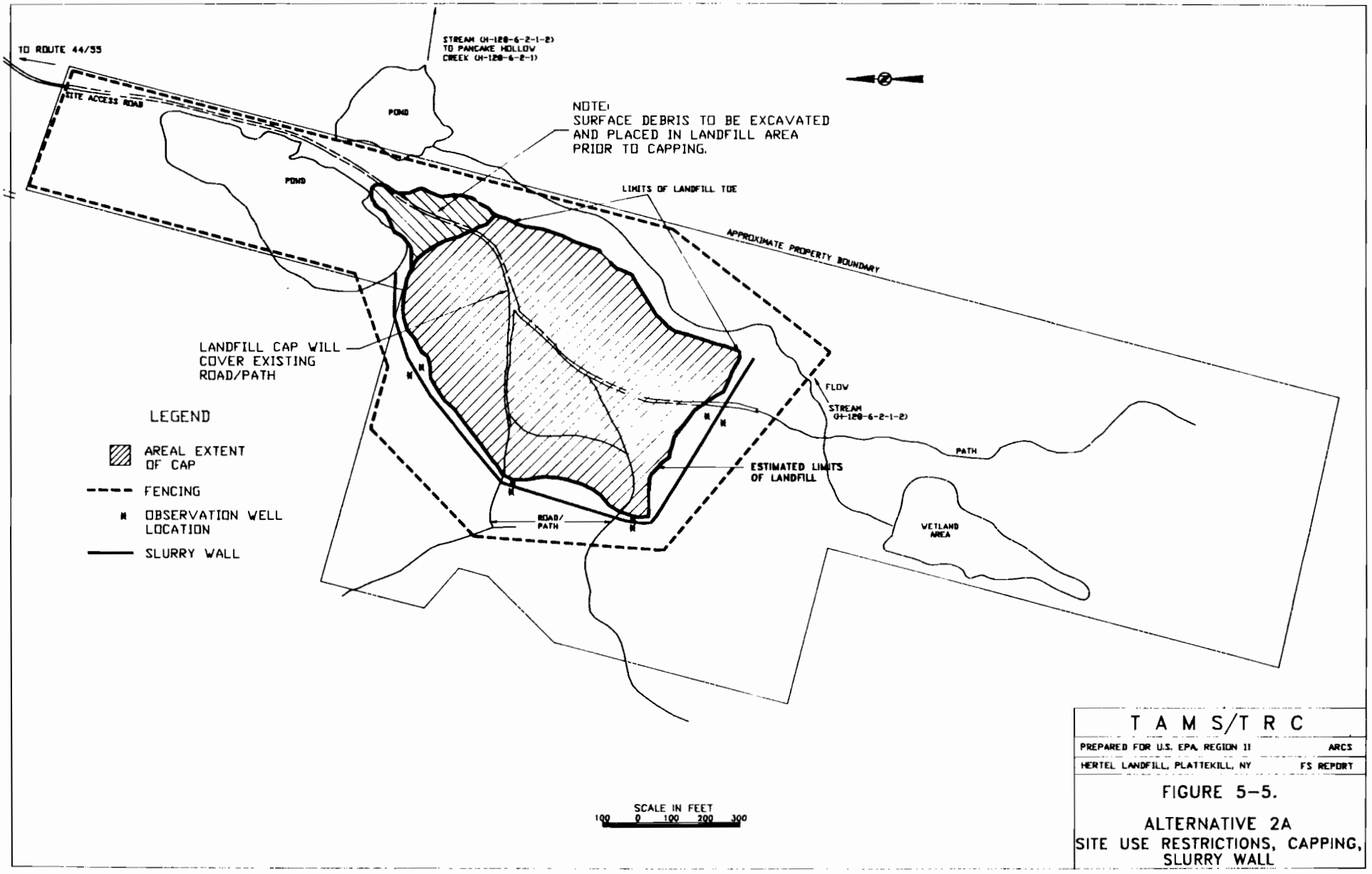

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FIGURE 5-5.

ALTERNATIVE 2A
SITE USE RESTRICTIONS, CAPPING, SLURRY WALL

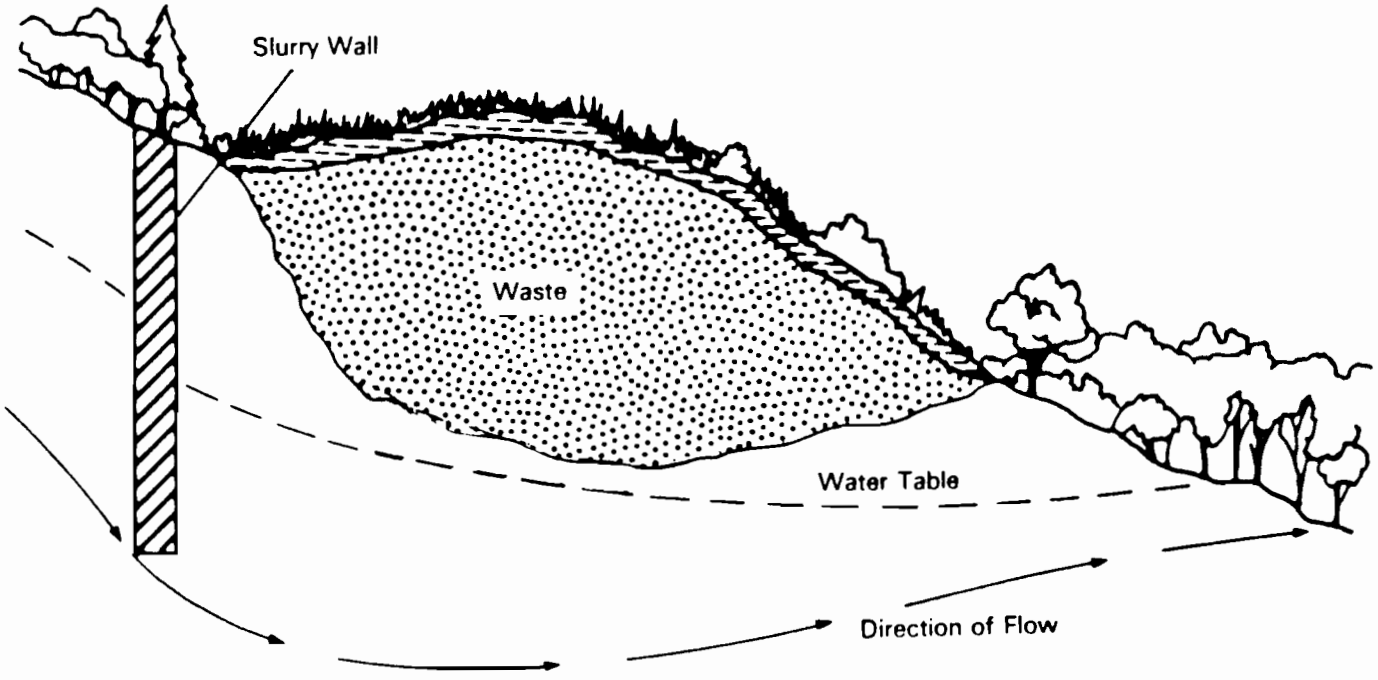

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FIGURE 5-6.

HYDROGEOLOGIC EFFECT OF AN UPGRADIENT SLURRY WALL

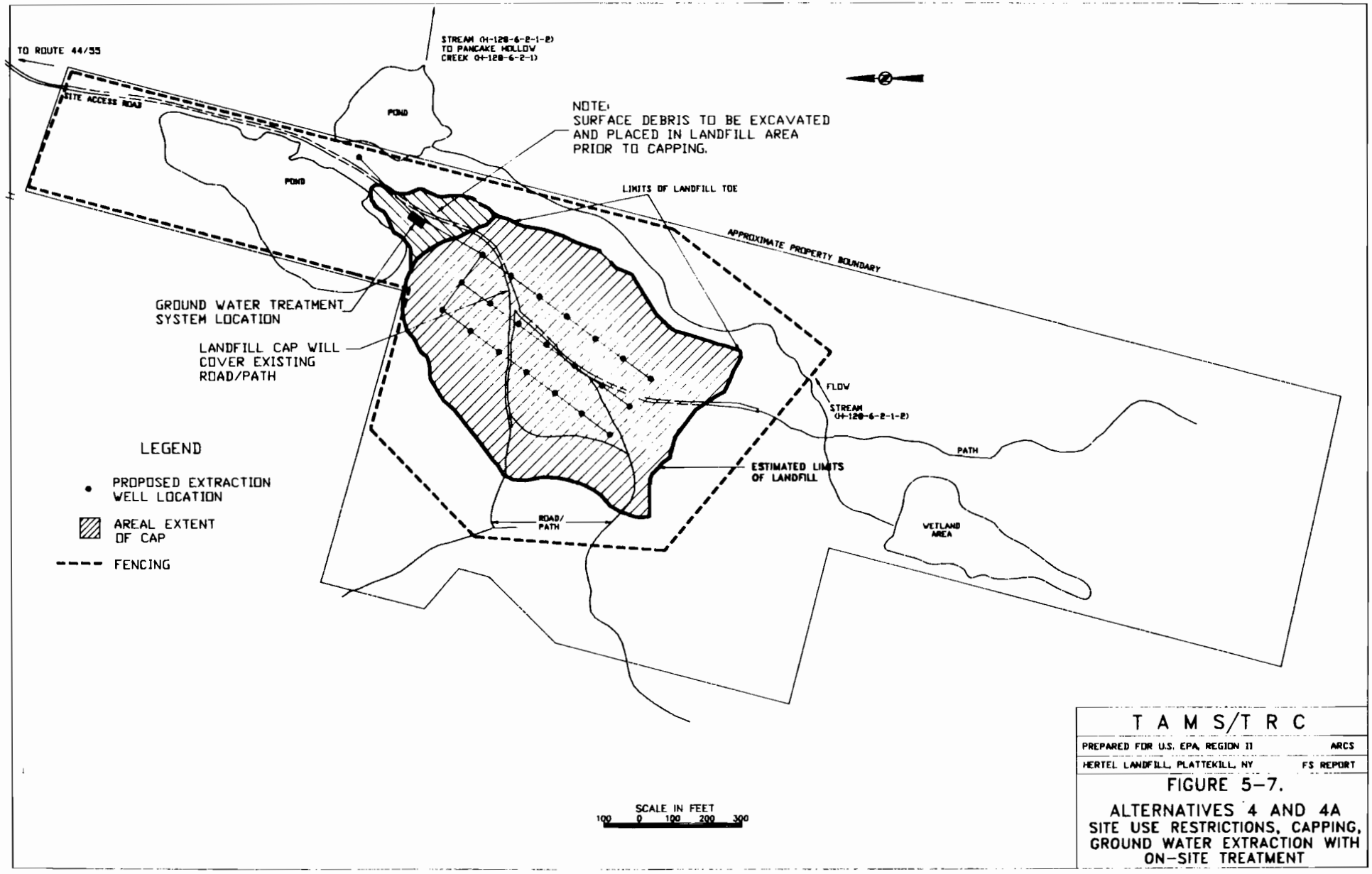

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FIGURE 5-7.

ALTERNATIVES 4 AND 4A SITE USE RESTRICTIONS, CAPPING, GROUND WATER EXTRACTION WITH ON-SITE TREATMENT

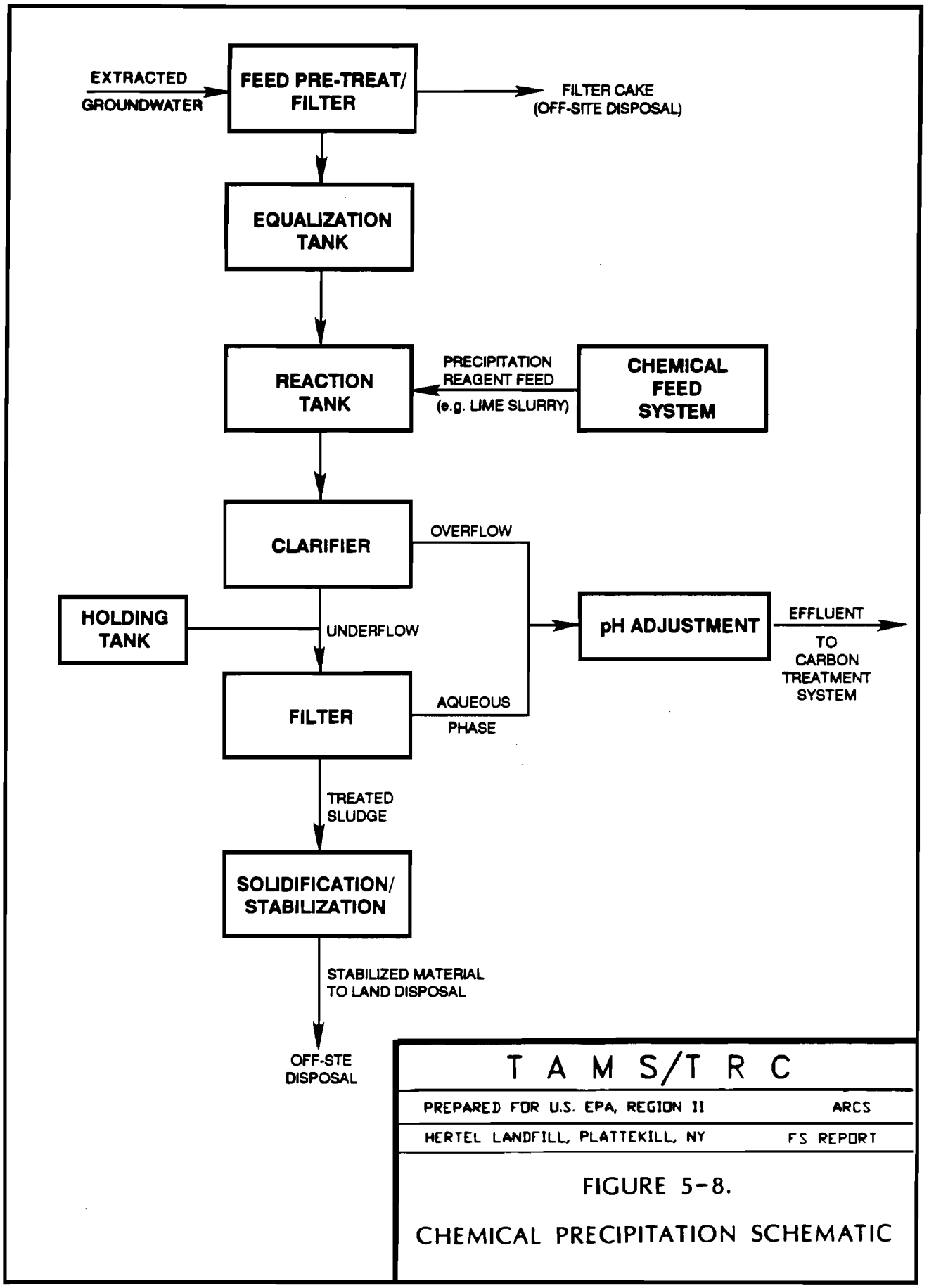

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FIGURE 5-8.

CHEMICAL PRECIPITATION SCHEMATIC

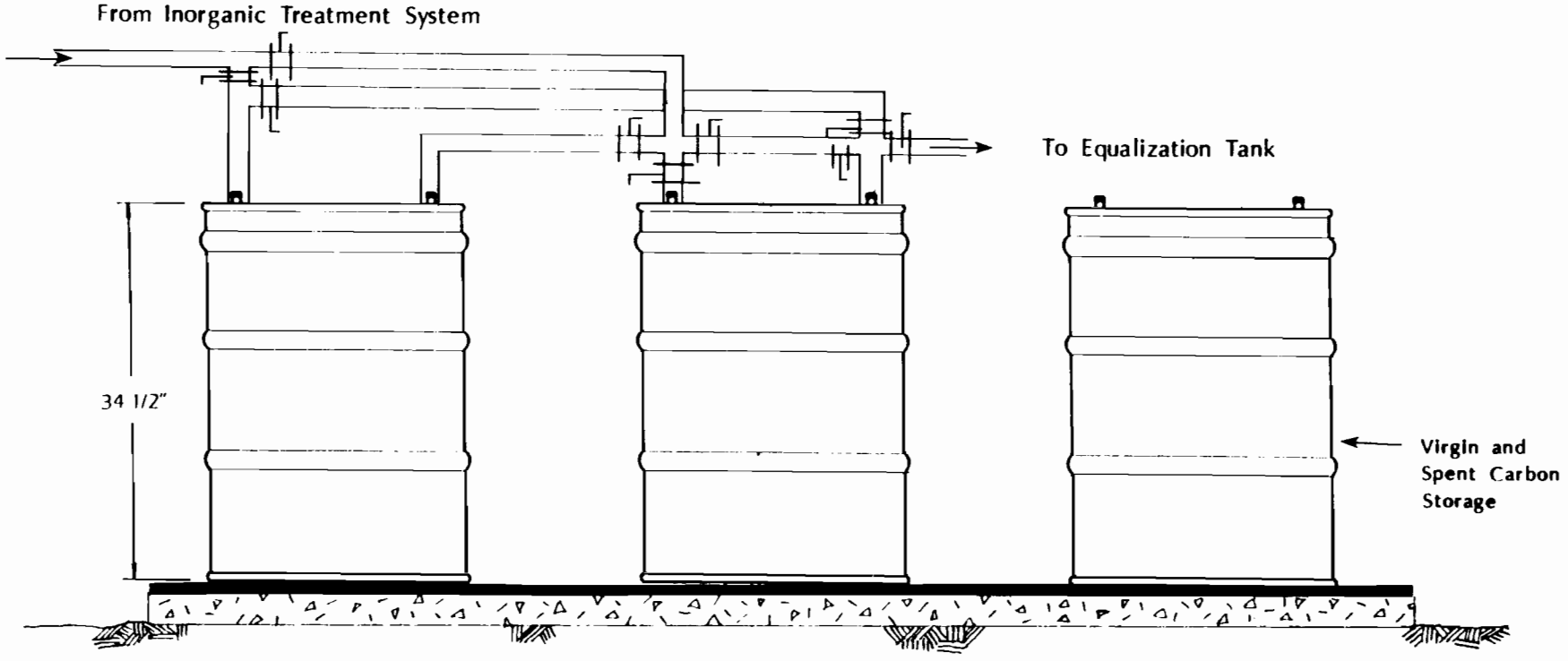

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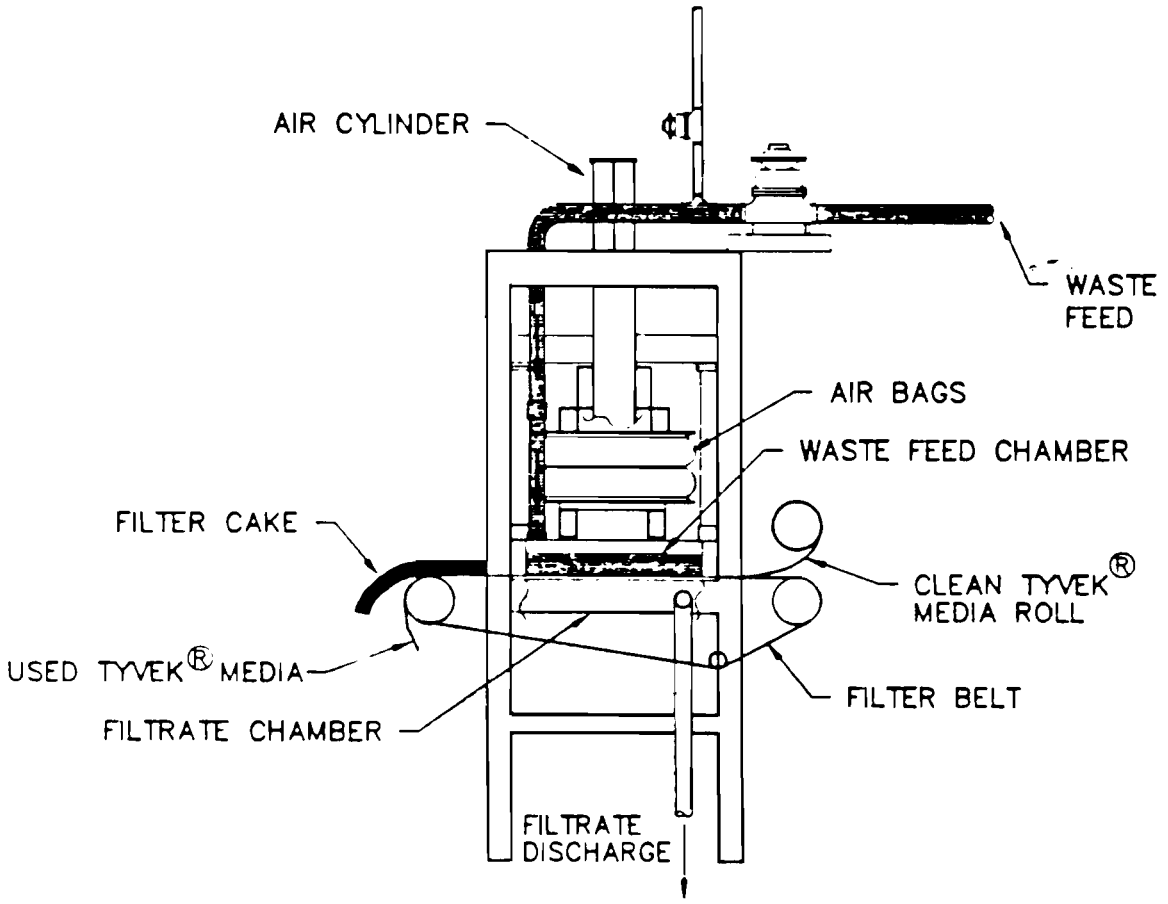
FIGURE 5-9.

CARBON TREATMENT
SYSTEM SCHEMATIC



SOURCE: USEPA

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FIGURE 5-10.

DUPONT/OBERLIN
MICROFILTRATION SYSTEM

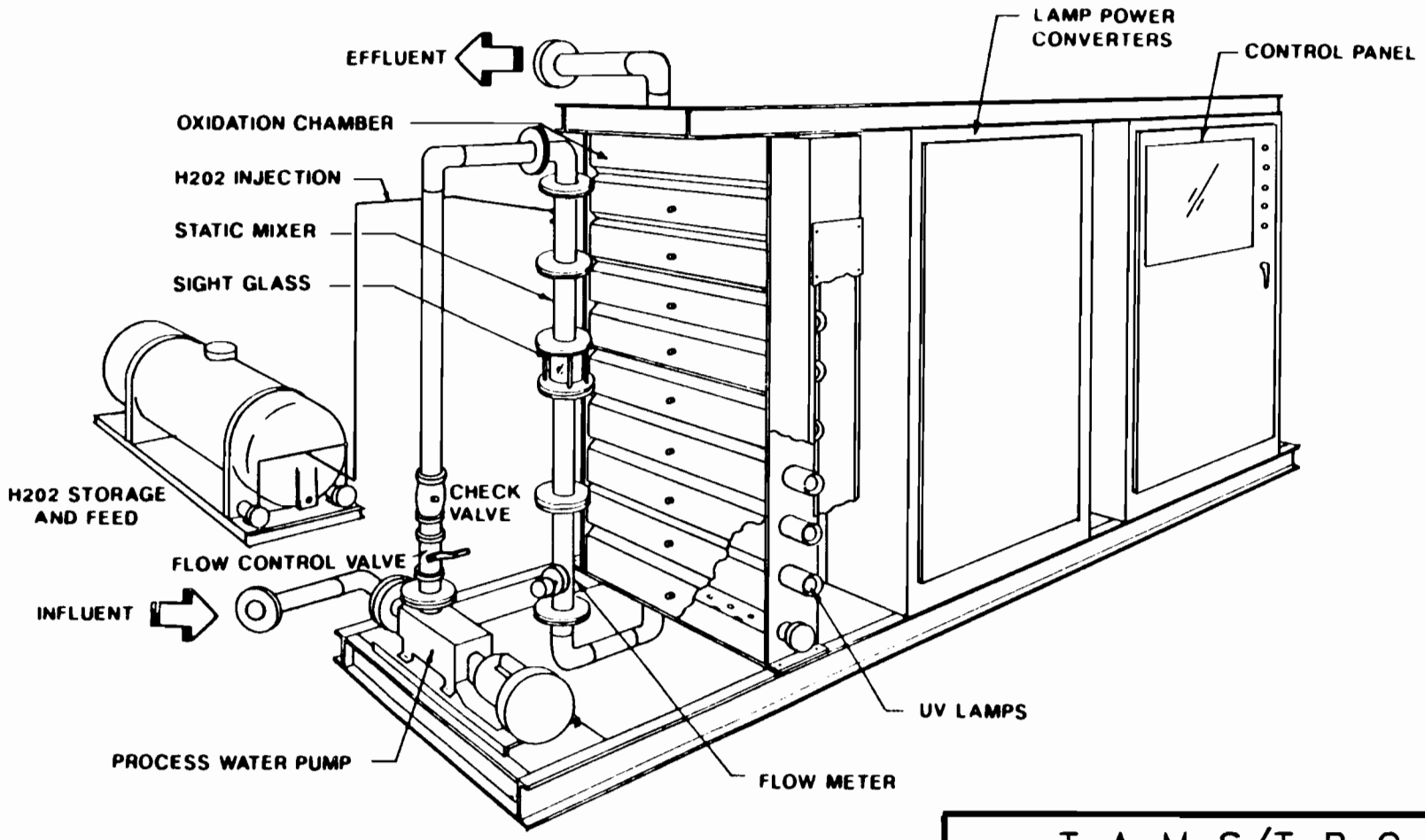

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FIGURE 5-11.

UV OXIDATION UNIT

SOURCE: HAGER ET AL., 1987

APPENDIX A

DETAILED COST ESTIMATES

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Alternative 1:
No Action

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1991 Unit Costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS - DIRECT										
Monitoring Well Installation										
(4 60-ft. bedrock wells - 2" diam., 2 30-ft. deep overburden wells - 2 ")										
-Well Construction & Matls. (Tubex)	300	ft	$125.00	1991	1	1.00	$125.00	$37,500.00		
-Health & Safety (17%)					8			$6,375.00		
-Mobilization	1	time	$8,000.00	1991	1	1.00	$8,000.00	$8,000.00		
Total Monitoring Well Cost										$51,875.00
Direct Capital Cost Subtotal										$51,875.00
CAPITAL COSTS - INDIRECT										
Engineering and Design (10%)					2			$5,187.50		
Legal and Administrative (2%)					2			$1,037.50		
Indirect Capital Cost Total										$6,225.00
TOTAL CAPITAL COSTS										$58,100.00

(1) - Calculated based on an assumed 5% interest rate.

Alternative 1:
No Action
(continued)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1991 Unit Costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
OPERATION AND MAINTENANCE COSTS										
-Ground Water Monitoring										
Annual Sampling (15 Wells)	15	samples	$200.00	1991	13	1.00	$200.00	$3,000.00	30	$46,116.00
Quarterly Sampling (12 Wells)	48	samples	$200.00	1991	13	1.00	$200.00	$9,600.00	30	$147,571.20
Analysis:										
TCL	63	samples	$1,800.00	1988	4	1.055	$1,899.00	$119,637.00	30	$1,839,059.96
TOTAL NET PRESENT VALUE OF O & M								$132,237.00		$2,032,747.16
SUBTOTAL COST										$2,090,847.16
CONTINGENCY (20%)										$418,169.43
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 1										$2,509,016.60

(1) - Calculated based on an assumed 5% interest rate.

Alternative 2:
Site Use Restrictions, Multi-Layer Cap

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS - DIRECT										
Monitoring Well Installation										
(4 60-ft. bedrock wells - 2" diam., 2 30-ft. deep overburden wells - 2 ")										
-Well Construction & Matls. (Tubex)	300	ft	$125.00	1991	1	1.00	$125.00	$37,500.00		
-Health & Safety (17%)					8			$6,375.00		
-Mobilization	1	time	$8,000.00	1991	1	1.00	$8,000.00	$8,000.00		
Total Monitoring Well Cost										$51,875.00
Security										
-Perm. Chain Link Fence	6,250	linear ft	$11.65	1991	5	1.00	$11.65	$72,812.50		
-Warning Signs	20	signs	$42.00	1991	5	1.00	$42.00	$840.00		
Total Security Cost										$73,652.50
Site Preparation										
Mob/Demob.	1	time	$590.00	1991	5	1.00	$590.00	$590.00		
Clearing	12.2	acres	$3,675.00	1991	5	1.00	$3,675.00	$44,835.00		
Grading	80,000	cu.yd.	$3.53	1987	6	1.083	$3.82	$305,839.20		
Fill Material	80,000	cu.yd.	$11.03	1991	5	1.00	$11.03	$882,400.00		
Access Road Reconstruction	7,200	sq.ft.	$15.20	1991	5	1.00	$15.20	$109,440.00		
Total Site Preparation										$1,343,104.20

(1) - Calculated based on an assumed 5% interest rate.

Alternative 2:
Site Use Restrictions, Multi-Layer Cap
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
Run-on/Run-off Controls										
-Ditching	2100	l.ft.	$1.70	1988	7	1.055	$1.79	$3,766.35		
-Sedimentation Basin	1	each	$10,000.00	1988	7	1.055	$10,550.00	$10,550.00		
Total Run-On/Run-Off Controls										$14,316.35
Multi-Layer Cap Construction										
-12" Gas Vent Layer	20,000	cu.yd.	$17.25	1991	13	1.00	$17.25	$345,000.00		
-40-mil HDPE Liner	530,000	sq.ft.	$0.80	1991	13	1.00	$0.80	$424,000.00		
-Filter Fabric (2 layers)	1,060,000	sq.ft.	$0.17	1991	13	1.00	$0.17	$180,200.00		
-24" Barrier Protection Layer	40,000	cu.yd.	$2.50	1988	7	1.055	$2.64	$105,500.00		
-6" Topsoil Layer	530	msf	$400.00	1991	5	1.00	$400.00	$212,000.00		
-Seed, Fertilizer, Mulch	530	msf	$43.00	1991	5	1.00	$43.00	$22,790.00		
-Vertical Gas Vent Pipes	15	each	$500.00	1988	7	1.055	$527.50	$7,912.50		
-Lateral Gas Vent Pipe	6,500	ft.	$6.00	1988	7	1.055	$6.33	$41,145.00		
-Health and Safety(17%)					8			$220,558.43		
Total Cap Construction Costs										$1,559,105.93
Equipment Decontamination										
-Rental of steam cleaner	4	months	$390.00	1991	5	1.00	$390.00	$1,560.00		
-Construct Decon Pit										
Excavate Pit	100	cu.yd.	$2.24	1987	5	1.083	$2.43	$242.59		
Polyethylene Tarpaulin	1200	sq.ft.	$0.31	1987	5	1.083	$0.34	$402.88		
-Tanker rental	1	each	$800.00	1989	9	1.036	$828.80	$828.80		
-Disposal	1	each	$1,100.00	1989	9	1.036	$1,139.60	$1,139.60		
Total Equipment Decon Costs										$4,173.87
Engineering Mgmt. Mob/Demob (1 Trailer)	6	months	$430.00	1991	5	1.00	$430.00	$2,580.00		$2,580.00

(1) - Calculated based on an assumed 5% interest rate.

Alternative 2:
Site Use Restrictions, Multi-Layer Cap
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
Dust Control										
- Water Tank Sprayer	800	hours	$7.10	1991	5	1.00	$7.10	$5,680.00		$5,680.00
Direct Capital Cost Subtotal										$3,054,487.84
CAPITAL COSTS - INDIRECT										
Engineering and Design(11%)					2					$335,993.66
Legal and Administrative(3%)					2					$91,634.64
TOTAL CAPITAL COSTS										$3,482,116.14
OPERATION AND MAINTENANCE COSTS										
-Ground Water Monitoring										
Annual Sampling (15 Wells)	15	samples	$200.00	1991	13	1.00	$200.00	$3,000.00	30	$46,116.00
Quarterly Sampling (12 Wells)	48	samples	$200.00	1991	13	1.00	$200.00	$9,600.00	30	$147,571.20
Analysis										
TCL	63	samples	$1,800.00	1988	4	1.055	$1,899.00	$119,637.00	30	$1,839,059.96
-Cap Maintenance										
Annual Inspection	1	each	$5,000.00	1988	7	1.055	$5,275.00	$5,275.00	30	$81,087.30
Mowing/Revegetation	530,000	sq.ft.	$0.04	1991	5	1.00	$0.04	$21,200.00	30	$325,886.40
Erosion Control	12.2	acres	$200.00	1982	12	1.247	$249.40	$3,042.68	30	$46,772.08
Repairs(total for 1 year)	1	each	$1,000.00	1988	7	1.055	$1,055.00	$1,055.00	30	$16,217.46
TOTAL NET PRESENT VALUE OF O & M								$162,809.68		$2,502,710.40

(1) - Calculated based on an assumed 5% interest rate.

Alternative 2:
Site Use Restrictions, Multi-Layer Cap
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
SUBTOTAL										$5,984,826.54
CONTINGENCY(20%)										$1,196,965.31
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 2										$7,181,791.85

(1) - Calculated based on an assumed 5% interest rate.

Alternative 2A:
Site Use Restrictions, Multi-Layer Cap, Slurry Wall

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS - DIRECT										
Monitoring Well Installation										
(4 60-ft. bedrock wells - 2" diam., 2 30-ft. deep overburden wells - 2 ")										
-Well Construction & Matls. (Tubex)	300	ft	$125.00	1991	1	1.00	$125.00	$37,500.00		
-Health & Safety (17%)					8			$6,375.00		
-Mobilization	1	time	$8,000.00	1991	1	1.00	$8,000.00	$8,000.00		
Total Monitoring Well Cost										$51,875.00
Security										
-Perm. Chain Link Fence	6,250	linear ft	$11.65	1991	5	1.00	$11.65	$72,812.50		
-Warning Signs	20	signs	$42.00	1991	5	1.00	$42.00	$840.00		
Total Security Cost										$73,652.50
Site Preparation										
Mob/Demob.	1	time	$590.00	1991	5	1.00	$590.00	$590.00		
Clearing	12.2	acres	$3,675.00	1991	5	1.00	$3,675.00	$44,835.00		
Grading	80,000	cu.yd.	$3.53	1987	6	1.083	$3.82	$305,839.20		
Fill Material	80,000	cu.yd.	$11.03	1991	5	1.00	$11.03	$882,400.00		
Access Road Reconstruction	7,200	sq.ft.	$15.20	1991	5	1.00	$15.20	$109,440.00		
Total Site Preparation										$1,343,104.20

(1) - Calculated based on an assumed 5% interest rate.

Alternative 2A:
Site Use Restrictions, Multi-Layer Cap, Slurry Wall
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
Run-on/Run-off Controls										
-Ditching	2100	l.ft.	$1.70	1988	7	1.055	$1.79	$3,766.35		
-Sedimentation Basin	1	each	$10,000.00	1988	7	1.055	$10,550.00	$10,550.00		
Total Run-On/Run-Off Controls										$14,316.35
Multi-Layer Cap Construction										
-12" Gas Vent Layer	20,000	cu.yd.	$17.25	1991	13	1.00	$17.25	$345,000.00		
-40-mil HDPE Liner	530,000	sq.ft.	$0.80	1991	13	1.00	$0.80	$424,000.00		
-Filter Fabric (2 layers)	1,060,000	sq.ft.	$0.17	1991	13	1.00	$0.17	$180,200.00		
-24" Barrier Protection Layer	40,000	cu.yd.	$2.50	1988	7	1.055	$2.64	$105,500.00		
-6" Topsoil Layer	530	msf	400	1991	5	1.00	$400.00	$212,000.00		
-Seed, Fertilizer, Mulch	530	msf	43	1991	5	1.00	$43.00	$22,790.00		
-Vertical Gas Vent Pipes	15	each	500	1988	7	1.055	$527.50	$7,912.50		
-Lateral Gas Vent Pipe	6,500	ft.	$6.00	1988	7	1.055	$6.33	$41,145.00		
-Health and Safety(17%)					8			$220,558.43		
Total Cap Construction Costs										$1,559,105.93
Slurry Wall Construction (1800 ft x 3 ft x 40 ft)										
-Mobil./Demob.	1	time	$590.00	1991	5	1.00	$590.00	$590.00		
-Backhoe (2 1/2 cu.yd. bucket)	8,000	cu.yd.	$2.69	1991	5	1.00	$2.69	$21,520.00		
-Bulldozer (300 H.P.)	8,000	cu.yd.	$2.82	1991	5	1.00	$2.82	$22,560.00		
-Cement-Bentonite Trench	72,000	sq.ft.	$30.00	1979	14	1.651	$49.53	$3,566,160.00		
-Health and Safety (14%)					8			$505,433.60		
-Water tank rental	2	months	$100.00	1991	5	1.00	$100.00	$200.00		
-Temporary road construction	8,800	sq.ft.	$3.29	1991	5	1.00	$3.29	$28,952.00		
-Pumping/Mixing equipment	2	months	$8,745.00	1991	5	1.00	$8,745.00	$17,490.00		
-Survey	12.2	acres	$225.00	1991	5	1.00	$225.00	$2,745.00		
Total Slurry Wall Construction Costs										$4,165,650.60

(1) - Calculated based on an assumed 5% interest rate.

Alternative 2A:
Site Use Restrictions, Multi-Layer Cap, Slurry Wall
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
Observation Well Installation										
(8 30-ft. deep overburden wells - 2")										
-Well Contruction & Matls.										
(Tubex)	240	ft	$114.00	1991	1	1.00	$114.00	$27,360.00		
-Health & Safety (17%)					8			$4,651.20		
Total Observation Well Cost										$32,011.20
Equipment Decontamination										
-Rental of steam cleaner	4	months	$390.00	1991	5	1.00	$390.00	$1,560.00		
-Construct Decon Pit										
Excavate Pit	100	cu.yd.	$2.24	1987	5	1.083	$2.43	$242.59		
Polyethylene Tarpaulin	1200	sq.ft.	$0.31	1987	5	1.083	$0.34	$402.88		
-Tanker rental	1	each	$800.00	1989	9	1.036	$828.80	$828.80		
-Disposal	1	each	$1,100.00	1989	9	1.036	$1,139.60	$1,139.60		
Total Equipment Decon Costs										$4,173.87
Engineering Mgmt. Mob/Demob	6	months	$430.00	1991	5	1.00	$430.00	$2,580.00		$2,580.00
(1 Trailer)										
Dust Control										
- Water Tank Sprayer	800	hours	$7.10	1991	5	1.00	$7.10	$5,680.00		$5,680.00
Direct Capital Cost Subtotal										$7,246,469.64

(1) - Calculated based on an assumed 5% interest rate.

Alternative 2A:
Site Use Restrictions, Multi-Layer Cap, Slurry Wall
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS - INDIRECT										
Engineering and Design(13%)					2					$942,041.05
Legal and Administrative(3%)					2					$217,394.09
TOTAL CAPITAL COSTS										$8,405,904.79
OPERATION AND MAINTENANCE COSTS										
-Ground Water Monitoring										
Annual Sampling (15 Wells)	15	samples	$200.00	1991	13	1.00	$200.00	$3,000.00	30	$46,116.00
Quarterly Sampling (12 Wells)	48	samples	$200.00	1991	13	1.00	$200.00	$9,600.00	30	$147,571.20
Analysis										
TCL	63	samples	$1,800.00	1988	4	1.055	$1,899.00	$119,637.00	30	$1,839,059.96
-Cap Maintenance										
Annual Inspection	1	each	$5,000.00	1988	7	1.055	$5,275.00	$5,275.00	30	$81,087.30
Mowing/Revegetation	530,000	sq.ft.	$0.04	1991	5	1.00	$0.04	$21,200.00	30	$325,886.40
Erosion Control	12.2	acres	$200.00	1982	12	1.247	$249.40	$3,042.68	30	$46,772.08
Repairs(total for 1 year)	1	each	$1,000.00	1988	7	1.055	$1,055.00	$1,055.00	30	$16,217.46
-Annual Slurry Wall Maintenance/ Monitoring	80	hours	$100.00	1991	13	1.00	$100.00	$8,000.00	30	$122,976.00
TOTAL NET PRESENT VALUE OF O & M								$170,809.68		$2,625,686.40
SUBTOTAL										$11,031,591.19
CONTINGENCY(20%)										$2,206,318.24
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 2A										$13,237,909.42

(1) - Calculated based on an assumed 5% interest rate.

Alternative 4:
Site Use Restrictions, Multi-Layer Cap,
Ground Water Extraction, On-Site Physical Treatment and Discharge to Surface Water

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	Present Value (O&M) (1)
CAPITAL COSTS - DIRECT										
Monitoring Well Installation										
(4 60-ft. bedrock wells - 2" diam., 2 30-ft. deep overburden wells - 2 ")										
-Well Construction & Matls. (Tubex)	300	ft	$125.00	1991	1	1.00	$125.00	$37,500.00		
-Health & Safety (17%)					8			$6,375.00		
-Mobilization	1	time	$8,000.00	1991	1	1.00	$8,000.00	$8,000.00		
Total Monitoring Well Cost										$51,875.00
Security										
-Perm. Chain Link Fence	6,250	linear ft	$11.65	1991	5	1.00	$11.65	$72,812.50		
-Warning Signs	20	signs	$42.00	1991	5	1.00	$42.00	$840.00		
Total Security Cost										$73,652.50
Site Preparation										
Mob/Demob.	1	time	$590.00	1991	5	1.00	$590.00	$590.00		
Clearing	12.2	acres	$3,675.00	1991	5	1.00	$3,675.00	$44,835.00		
Grading	80,000	cu.yd.	$3.53	1987	6	1.083	$3.82	$305,839.20		
Fill Material	80,000	cu.yd.	$11.03	1991	5	1.00	$11.03	$882,400.00		
Access Road Reconstruction	7200	sq.ft.	$15.20	1991	5	1.00	$15.20	$109,440.00		
Total Site Preparation										$1,343,104.20

(1) - Calculated based on an assumed 5% interest rate.

Alternative 4:
Site Use Restrictions, Multi-Layer Cap,
Ground Water Extraction, On-Site Physical Treatment and Discharge to Surface Water
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	Present Value (O&M) (1)
Run-on/Run-off Controls										
-Ditching	2100	l.ft.	$1.70	1988	7	1.055	$1.79	$3,766.35		
-Sedimentation Basin	1	each	$10,000.00	1988	7	1.055	$10,550.00	$10,550.00		
Total Run-On/Run-Off Controls										$14,316.35
Multi-Layer Cap Construction										
-12" Gas Vent Layer	20,000	cu.yd.	$17.25	1991	13	1.00	$17.25	$345,000.00		
-40-mil HDPE Liner	530,000	sq.ft.	$0.80	1991	13	1.00	$0.80	$424,000.00		
-Filter Fabric (2 layers)	1,060,000	sq.ft.	$0.17	1991	13	1.00	$0.17	$180,200.00		
-6" Topsoil Layer	530	msf	$400.00	1991	5	1.00	$400.00	$212,000.00		
-24" Barrier Protection Layer	40,000	cu.yd.	$2.50	1988	7	1.055	$2.64	$105,500.00		
-Seed, Fertilizer, Mulch	530	msf	$43.00	1991	5	1.00	$43.00	$22,790.00		
-Vertical Gas Vent Pipes	15	each	$500.00	1988	7	1.055	$527.50	$7,912.50		
-Lateral Gas Vent Pipe	6,500	ft.	$6.00	1988	7	1.055	$6.33	$41,145.00		
-Health and Safety(17%)					8			$220,558.43		
Total Cap Construction Costs										$1,559,105.93
Ground Water Extraction										
(22 30-ft. deep overburden wells - 6")										
-Well Construction and Materials (Tubex)	660	ft	$124.00	1991	1	1.00	$124.00	$81,840.00		
-Health and Safety(17%)					8			$13,912.80		
-Ejector Pumps	22	pumps	$4,264.00	1991	24	1.00	$4,264.00	$93,808.00		
Total Extraction Cost										$189,560.80
Piping To and From Treatment System										
-(2" diam. PVC in Trench)	2450	ft	$5.81	1991	5	1.00	$5.81	$14,234.50		$14,234.50

(1) - Calculated based on an assumed 5% interest rate.

Alternative 4:
Site Use Restrictions, Multi-Layer Cap,
Ground Water Extraction, On-Site Physical Treatment and Discharge to Surface Water
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
Ground Water Treatment System										
-Neutralization/Precipitation/ Filtration Unit	1	each	$126,520.00	1984	16	1.15	$145,498.00	$145,498.00		
-Piping	500	l.ft.	$2.60	1988	7	1.055	$2.74	$1,371.50		
-Equalization Tank	1	each	$12,500.00	1988	7	1.055	$13,187.50	$13,187.50		
-Filter Press	1	each	$20,800.00	1985	16	1.138	$23,670.40	$23,670.40		
Total Ground Water Treatment System Costs										$183,727.40
Equipment Decontamination										
-Rental of steam cleaner	4	months	$390.00	1991	5	1.00	$390.00	$1,560.00		
-Construct Decon Pit										
Excavate Pit	100	cu.yd.	$27.00	1991	5	1.00	$27.00	$2,700.00		
Polyethylene Tarpaulin	1200	sq.ft.	$0.31	1991	5	1.00	$0.31	$372.00		
-Tanker rental	1	each	$800.00	1989	9	1.036	$828.80	$828.80		
-Disposal	1	each	$1,100.00	1989	9	1.036	$1,139.60	$1,139.60		
Total Equipment Decon Costs										$6,600.40
Engineering Mgmt. Mob/Demob (1 Trailer)	6	months	$430.00	1991	5	1.00	$430.00	$2,580.00		$2,580.00
Dust Control										
- Water Tank Sprayer	800	hours	$7.10	1991	5	1.00	$7.10	$5,680.00		$5,680.00

(1) - Calculated based on an assumed 5% interest rate.

Alternative 4:
Site Use Restrictions, Multi-Layer Cap,
Ground Water Extraction, On-Site Physical Treatment and Discharge to Surface Water
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
Direct Capital Cost Subtotal										$3,438,757.08
CAPITAL COSTS - INDIRECT										
Engineering and Design(13%)					2					$447,038.42
Legal and Administrative(3%)					2					$103,162.71
TOTAL CAPITAL COSTS										$3,988,958.21
OPERATION AND MAINTENANCE COSTS										
-Ground Water Monitoring										
Annual Sampling (15 Wells)	15	samples	$200.00	1991	13	1.00	$200.00	$3,000.00	17	$33,822.00
Quarterly Sampling (12 Wells)	48	samples	$200.00	1991	13	1.00	$200.00	$9,600.00	17	$108,230.40
TCL Analysis	63	samples	$1,800.00	1988	4	1.055	$1,899.00	$119,637.00	17	$1,348,787.54
-Cap Maintenance										
Annual Inspection	1	each	$5,000.00	1988	7	1.055	$5,275.00	$5,275.00	30	$81,087.30
Mowing/Revegetation	530,000	sq.ft.	$0.04	1991	5	1.00	$0.04	$21,200.00	30	$325,886.40
Erosion Control	12.2	acres	$200.00	1982	12	1.247	$249.40	$3,042.68	30	$46,772.08
Repairs(total for 1 year)	1	each	$1,000.00	1988	7	1.055	$1,055.00	$1,055.00	30	$16,217.46

(1) - Calculated based on an assumed 5% interest rate.

Alternative 4:
Site Use Restrictions, Multi-Layer Cap,
Ground Water Extraction, On-Site Physical Treatment and Discharge to Surface Water
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	Present Value (O&M) (1)
OPERATION AND MAINTENANCE COSTS (continued)										
-Precipitation O&M	1	year	$26,500.00	1984	16	1.15	$30,475.00	$30,475.00	12	$270,099.92
-Chemical Costs(per gallon treated)	5,256,000	gal	$0.01266	1985	16	1.138	$0.01441	$75,723.61	12	$671,138.38
-Carbon Treatment O&M										
Carbon Supply	14	canisters	$450.00	1991	15	1.00	$450.00	$6,300.00	12	$55,836.90
Oelivery	4	each	$200.00	1991	15	1.00	$200.00	$800.00	12	$7,090.40
Spent Carbon Disposal	14	drums	$400.00	1991	15	1.00	$400.00	$5,600.00	12	$49,632.80
-Precipitate Transportation & Disposal	4	tons	$1,300.00	1991	22	1.00	$1,300.00	$5,200.00	12	$46,087.60
-Discharge to Surface Water Sampling And Analysis	24	samples	$850.00	1991	13	1.00	$850.00	$20,400.00	12	$180,805.20
-Filter Press O&M	1	year	$7,030.00	1985	16	1.138	$8,000.14	$8,000.14	12	$70,905.24
-Stabilization	4	tons	$250.00	1985	16	1.138	$284.50	$1,138.00	12	$10,086.09
TOTAL NET PRESENT VALUE OF O & M								$316,446.43		$3,322,485.71
SUBTOTAL										$7,311,443.92
CONTINGENCY(20%)										$1,462,288.78
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 4										$8,773,732.70

(1) - Calculated based on an assumed 5% interest rate.

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Alternative 4A:
Site Use Restrictions, Multi-Layer Cap,
Ground Water Extraction, On-Site Innovative Treatment and Discharge to Surface Water

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS - DIRECT										
Monitoring Well Installation										
(4 60-ft. bedrock wells - 2" diam., 2 30-ft. deep overburden wells - 2 ")										
-Well Construction & Matls. (Tubex)	300	ft	$125.00	1991	1	1.00	$125.00	$37,500.00		
-Health & Safety (17%)					8			$6,375.00		
-Mobilization	1	time	$8,000.00	1991	1	1.00	$8,000.00	$8,000.00		
Total Monitoring Well Cost										$51,875.00
Security										
-Perm. Chain Link Fence	6,250	linear ft	$11.65	1991	5	1.00	$11.65	$72,812.50		
-Warning Signs	20	signs	$42.00	1991	5	1.00	$42.00	$840.00		
Total Security Cost										$73,652.50
Site Preparation										
Clearing	12.2	acres	$3,675.00	1991	5	1.00	$3,675.00	$44,835.00		
Grading	80,000	cu.yd.	$3.53	1987	6	1.083	$3.82	$305,839.20		
Fill Material	80,000	cu.yd.	$11.03	1991	5	1.00	$11.03	$882,400.00		
Access Road Reconstruction	7,200	sq.ft.	$15.20	1991	5	1.00	$15.20	$109,440.00		
Total Site Preparation										$1,342,514.20

(1) - Calculated based on an assumed 5% interest rate.

Alternative 4A:
Site Use Restrictions, Multi-Layer Cap,
Ground Water Extraction, On-Site Innovative Treatment and Discharge to Surface Water
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	Present Value (O&M) (1)
Run-on/Run-off Controls										
-Ditching	2100	l.ft.	$1.70	1988	7	1.055	$1.79	$3,766.35		
-Sedimentation Basin	1	each	$10,000.00	1988	7	1.055	$10,550.00	$10,550.00		
Total Run-On/Run-Off Controls										$14,316.35
Multi-Layer Cap Construction										
-12" Gas Vent Layer	20,000	cu.yd.	$17.25	1991	13	1.00	$17.25	$345,000.00		
-40-mil HDPE Liner	530,000	sq.ft.	$0.80	1991	13	1.00	$0.80	$424,000.00		
-Filter Fabric (2 layers)	1,060,000	sq.ft.	$0.17	1991	13	1.00	$0.17	$180,200.00		
-24" Barrier Protection Layer	40,000	cu.yd.	$2.50	1988	7	1.055	$2.64	$105,500.00		
-6" Topsoil Layer	530	msf	$400.00	1991	5	1.00	$400.00	$212,000.00		
-Seed, Fertilizer, Mulch	530	msf	$43.00	1991	5	1.00	$43.00	$22,790.00		
-Vertical Gas Vent Pipes	15	each	$500.00	1988	7	1.055	$527.50	$7,912.50		
-Lateral Gas Vent Pipe	6,500	ft	$6.00	1988	7	1.055	$6.33	$41,145.00		
-Health and Safety(17%)					8			$220,558.43		
Total Cap Construction Costs										$1,559,105.93
Ground Water Extraction										
(22 30-ft. deep overburden wells - 6")										
-Well Construction and Materials (Tubex)	660	ft	$124.00	1991	1	1.00	$124.00	$81,840.00		
-Health and Safety(17%)					8			$13,912.80		
-Ejector Pumps	22	pumps	$4,264.00	1991	24	1.00	$4,264.00	$93,808.00		
Total Extraction Cost										$189,560.80
Piping To and From Treatment System										
-(2" diam. PVC in Trench)	2450	ft	$5.81	1991	5	1.00	$5.81	$14,234.50		$14,234.50

(1) - Calculated based on an assumed 5% interest rate.

Alternative 4A:
Site Use Restrictions, Multi-Layer Cap,
Ground Water Extraction, On-Site Innovative Treatment and Discharge to Surface Water
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
Ground Water Treatment System										
-Membrane Microfiltration Unit	1	each	$50,000.00	1991	25	1.00	$50,000.00	$50,000.00		
-Filter Aid System	1	each	$20,000.00	1991	25	1.00	$20,000.00	$20,000.00		
-UV Oxidation Unit	1	each	$59,950.00	1991	18	1.00	$59,950.00	$59,950.00		
-UV Oxidation Service Connection	1	time	$5,000.00	1991	18	1.00	$5,000.00	$5,000.00		
-Piping	500	l.ft.	$2.60	1988	7	1.055	$2.74	$1,371.50		
-Equalization Tank	1	each	$12,500.00	1988	7	1.055	$13,187.50	$13,187.50		
Total Ground Water Treatment System Costs										$149,509.00
Equipment Decontamination										
-Rental of steam cleaner	4	months	$390.00	1991	5	1.00	$390.00	$1,560.00		
-Construct Decon Pit										
Excavate Pit	100	cu.yd.	$27.00	1991	5	1.00	$27.00	$2,700.00		
Polyethylene Tarpaulin	1200	sq.ft.	$0.31	1991	5	1.00	$0.31	$372.00		
-Tanker rental	1	each	$800.00	1989	9	1.036	$828.80	$828.80		
-Disposal	1	each	$1,100.00	1989	9	1.036	$1,139.60	$1,139.60		
Total Equipment Decon Costs										$6,600.40
Engineering Mgmt. Mob/Demob (1 Trailer)	6	months	$430.00	1991	5	1.00	$430.00	$2,580.00		$2,580.00
Dust Control										
- Water Tank Sprayer	800	hours	$7.10	1991	5	1.00	$7.10	$5,680.00		$5,680.00
Direct Capital Cost Subtotal										$3,409,628.68

(1) - Calculated based on an assumed 5% interest rate.

Alternative 4A:
Site Use Restrictions, Multi-Layer Cap,
Ground Water Extraction, On-Site Innovative Treatment and Discharge to Surface Water
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS - INDIRECT										
Engineering and Design(13%)					2					$443,251.73
Legal and Administrative(3%)					2					$102,288.86
TOTAL CAPITAL COSTS										$3,955,169.26
OPERATION AND MAINTENANCE COSTS										
-Ground Water Monitoring										
Annual Sampling (15 Wells)	15	samples	$200.00	1991	13	1.00	$200.00	$3,000.00	17	$33,822.00
Quarterly Sampling (12 Wells)	48	samples	$200.00	1991	13	1.00	$200.00	$9,600.00	17	$108,230.40
TCL Analysis	63	samples	$1,800.00	1988	4	1.055	$1,899.00	$119,637.00	17	$1,348,787.54
-Cap Maintenance										
Annual Inspection	1	each	$5,000.00	1988	7	1.055	$5,275.00	$5,275.00	30	$81,087.30
Mowing/Revegetation	530,000	sq.ft.	$0.04	1991	5	1.00	$0.04	$21,200.00	30	$325,886.40
Erosion Control	12.2	acres	$200.00	1982	12	1.247	$249.40	$3,042.68	30	$46,772.08
Repairs(total for 1 year)	1	each	$1,000.00	1988	7	1.055	$1,055.00	$1,055.00	30	$16,217.46
-Membrane Microfiltration O&M	5,256	1000 gal	$4.00	1991	26	1.00	$4.00	$21,024.00	12	$186,335.71
-UV Oxidation O&M Cost	12	months	$4,796.00	1991	18	1.00	$4,796.00	$57,552.00	12	$510,083.38
-Filter Cake Transportation & Disposal	4	tons	$1,300.00	1991	22	1.00	$1,300.00	$5,200.00	12	$46,087.60
-Discharge to Surface Water Sampling And Analysis	24	samples	$850.00	1991	13	1.00	$850.00	$20,400.00	12	$180,805.20
TOTAL NET PRESENT VALUE OF O & M								$266,985.68		$2,884,115.06

(1) - Calculated based on an assumed 5% interest rate.

Alternative 4A:
Site Use Restrictions, Multi-Layer Cap,
Ground Water Extraction, On-Site Innovative Treatment and Discharge to Surface Water
(continued)

Item	Quantity	Units	Unit Price	Basis year	Reference	Escalation	1991 Unit costs	1991 Costs	Years (O&M)	(1) Present Value (O&M)
SUBTOTAL										$6,839,284.33
CONTINGENCY(20%)										$1,367,856.87
TOTAL PRESENT VALUE COST FOR ALTERNATIVE 4A										$8,207,141.19

(1) - Calculated based on an assumed 5% interest rate.

HERTEL LANDFILL
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APPENDIX B

EXPOSURE EQUATIONS, FUGITIVE DUST MODELING AND DOSE CALCULATIONS

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APPENDIX B

EXPOSURE EQUATIONS, FUGITIVE DUST MODELING
AND DOSE CALCULATIONS

FUTURE RECREATIONAL USE: CHILDREN PLAYING ON SITE (Alternatives 2 and 2A)

- Dermal Contact with Chemicals in Sediment

Equation:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical of Concentration in Soil (mg/kg)
CF = Conversion Factor (10^{-6} kg/mg)
SA = Skin Surface Area Available for Contact (cm^2/event)
AF = Soil to Skin Adherence Factor (mg/cm^2)
ABS = Absorption Factor (unitless)
EF = Exposure Frequency (events/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged - days)

Specific Parameter Values:

CS = Concentration of chemicals in soil
SA = 6,800 cm^2, based upon exposed arms, hands and legs
AF = 1.45 mg/cm^2, based upon commercial potting soil adherence to hands
ABS = 0.1 (organics), 0.01 (inorganics), except arsenic (0.1)
EF = 12 days/year, based upon weekly visits during the summer months
ED = 9 years
BW = 49 kg
AT = 3,285 days for non-cancer risks
25,550 days for cancer risks

- Ingestion of Chemicals in Sediment

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical Concentration in Soil (mg/kg)
IR = Ingestion Rate (mg soil/day)
CF = Conversion Factor (10^{-6} kg/mg)
FI = Fraction Ingested from Contaminated Source (unitless)
EF = Exposure Frequency (days/years)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged - days)

Specific Parameter Values:

CS = Chemical concentration in sediments
IR = 100 mg/day, which is typical for this age group.
FI = 1.0, assuming 100% of sediment ingestion occurs on site
EF = 12 days/year
ED = 9 years
BW = 49 kg
AT = 3,285 days for non-cancer risks
25,550 days for cancer risks

COMMON REMEDIAL ELEMENTS: ROAD IMPROVEMENTS AND CLEARING VEGETATION
(Alternatives 2, 2A, 4 and 4A)

- Dermal Contact with Chemicals in Soil

Equation:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical Concentration in Soil (mg/kg)
CF = Conversion Factor (10^{-6} kg/mg)
SA = Skin Surface Area Available for Contact (cm^2/event)
AF = Soil to Skin Adherence Factor (mg/cm^2)
ABS = Absorption Factor (unitless)
EF = Exposure Frequency (events/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged - days)

Specific Parameter Values:

SA = 6,300 cm^2 for hands, forearms, upper arms, head, neck and a portion of the trunk
AF = 1.45 mg/cm^2
ABS = 0.1 (organics), 0.01 (inorganics), except arsenic (0.1)
EF = 15 days/year
ED = 1 year
BW = 70 kg
AT = 15 days for non-cancer risks
25,550 days for cancer risks

- Ingestion of Chemicals in Soil

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical Concentration in Soil (mg/kg)
IR = Ingestion Rate (mg soil/day)
CF = Conversion Factor (10^{-6} kg/mg)
FI = Fraction Ingested from Contaminated Source (unitless)
EF = Exposure Frequency (days/years)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged - days)

Specific Parameter Values:

IR = 100 mg/day, based upon extensive contact with soil
FI = 1.0; all soil ingested comes from on-site sources
EF = 15 days/year
ED = 1 year
BW = 70 kg
AT = 15 days for non-cancer risks
25,550 days for cancer risks

- Inhalation of Airborne Chemicals Adsorbed to Dust

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CD \times CS \times IR \times ET \times EF \times ED}{BW \times AT}$$

where:

CD = Ambient Dust Concentration
CS = Contaminant Concentration in Soil (mg/kg)
IR = Inhalation Rate (m^3/hour)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Specific Parameter Values:

IR = 2 m^3/hour for adults under moderate exertion
ET = 8 hours/day
EF = 15 days/year
ED = 1 year
BW = 70 kg
AT = 15 days for non-cancer risks
25,550 days for cancer risks

CONSTRUCTION OF THE LANDFILL CAP (Alternatives 2, 2A, 4 and 4A)

- Dermal Contact with Chemicals in Soil

Equation:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical Concentration in Soil (mg/kg)
CF = Conversion Factor (10^{-6} kg/mg)
SA = Skin Surface Area Available for Contact (cm^2/event)
AF = Soil to Skin Adherence Factor (mg/cm^2)
ABS = Absorption Factor (unitless)
EF = Exposure Frequency (events/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged - days)

Specific Parameter Values:

SA = 6,300 cm^2 for hands, forearms, upper arms, head, neck and a portion of the trunk
AF = 1.45 mg/cm^2
ABS = 0.1 (organics), 0.01 (inorganics), except arsenic (0.1)
EF = 80 days/year
ED = 1 year
BW = 70 kg
AT = 80 days for non-cancer risks
25,550 days for cancer risks

- Ingestion of Chemicals in Soil

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical Concentration in Soil (mg/kg)
IR = Ingestion Rate (mg soil/day)
CF = Conversion Factor (10^{-6} kg/mg)
FI = Fraction Ingested from Contaminated Source (unitless)
EF = Exposure Frequency (days/years)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged - days)

Specific Parameter Values:

IR = 100 mg/day, based upon extensive contact with soil
FI = 1.0; all soil ingested comes from on-site sources
EF = 80 days/year
ED = 1 year
BW = 70 kg
AT = 80 days for non-cancer risks
25,550 days for cancer risks

- Inhalation of Airborne Chemicals Adsorbed to Dust

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CD \times CS \times IR \times ET \times EF \times ED}{BW \times AT}$$

where:

CD = Ambient Dust Concentration
CS = Contaminant Concentration in Soil (mg/kg)
IR = Inhalation Rate (m^3/hour)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Specific Parameter Values:

IR = 2 m^3/hour for adults under moderate exertion
ET = 8 hours/day
EF = 80 days/year
ED = 1 year
BW = 70 kg
AT = 80 days for non-cancer risks
25,550 days for cancer risks

INSTALLATION OF EXTRACTION WELLS (Alternatives 4 and 4A)

- Dermal Contact with Chemicals in Soil

Equation:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical Concentration in Soil (mg/kg)
CF = Conversion Factor (10^{-6} kg/mg)
SA = Skin Surface Area Available for Contact (cm^2/event)
AF = Soil to Skin Adherence Factor (mg/cm^2)
ABS = Absorption Factor (unitless)
EF = Exposure Frequency (events/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged - days)

Specific Parameter Values:

SA = 6,300 cm^2 for hands, forearms, upper arms, head, neck and a portion of the trunk
AF = 1.45 mg/cm^2
ABS = 0.1 (organics), 0.01 (inorganics), except arsenic (0.1)
EF = 250 days/year
ED = 1 year
BW = 70 kg
AT = 250 days for non-cancer risks
25,550 days for cancer risks

- Ingestion of Chemicals in Soil

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:

CS = Chemical Concentration in Soil (mg/kg)
IR = Ingestion Rate (mg soil/day)
CF = Conversion Factor (10^{-6} kg/mg)
FI = Fraction Ingested from Contaminated Source (unitless)
EF = Exposure Frequency (days/years)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged - days)

Specific Parameter Values:

IR = 100 mg/day, based upon extensive contact with soil
FI = 1.0; all soil ingested comes from on-site sources
EF = 250 days/year
ED = 1 year
BW = 70 kg
AT = 250 days for non-cancer risks
25,550 days for cancer risks

- Inhalation of Airborne Chemicals Adsorbed to Dust

Equation:

$$\text{Intake (mg/kg-day)} = \frac{CD \times CS \times IR \times ET \times EF \times ED}{BW \times AT}$$

where:

CD = Ambient Dust Concentration
CS = Contaminant Concentration in Soil (mg/kg)
IR = Inhalation Rate (m^3/hour)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged -- days)

Specific Parameter Values:

IR = 2 m^3/hour for adults under moderate exertion
ET = 8 hours/day
EF = 250 days/year
ED = 1 year
BW = 70 kg
AT = 250 days for non-cancer risks
25,550 days for cancer risks

MODEL ESTIMATES OF FUGITIVE DUST GENERATION

Emissions estimates were calculated for activities resulting in soil disturbance, such as heavy equipment operation and wind erosion which may occur over the site during the construction scenario.

The potentially significant components of fugitive dust at this site are:

1) wind erosion of dust from surfaces without vegetative cover,

2) dust from loading/unloading of excavated soil, and

3) emissions from vehicular traffic on unpaved roads.

Fugitive dust from wind erosion over exposed soil and from loading/unloading activities was calculated using (EPA, AP-42, 1985). Fugitive dust generation tables showing all model inputs, are presented in Tables C-1 through C-3. The data are summarized in Table C-4. The models are described below.

$$E = a \cdot I \cdot K \cdot C \cdot L \cdot V \cdot A \cdot T$$

where:

E = Emission rate (kg/day)

a = Fraction of total wind losses (wind erosion of soil) that remain suspended
I = Soil erodibility
C = Climatic factor
K = Soil roughness factor
L = Field length factor
V = Vegetative cover factor
A = Area of the site
T = Time conversion factor

Most of these values are specified in USEPA (1985) for worst-case treatments. The climatic factor is read from a map and multiplied by .01 as specified. The variables a and I are determined based on site soil characteristics. The following values were used to estimate the emission rates during road improvements and clearing vegetation across the landfill area:

a = 0.01
I = 134 tons $acre^{-1}$ yr^{-1}
K = 1 (worst-case for flat terrain)
V = 1 (no vegetative cover-worst case)
L = .7
C = 0.02
A = 13.2 acres
T = 1 yr/365 days

The wind erosion emission rate is presented in Table C-1.

The second component is due to loading/unloading of soils (excavating the landfill prior to incineration) due to excavation activities and can be accounted for by:

$$E = \frac{k \cdot (.0016) \cdot (U/2.2)^{1.3}}{(M/2)^{1.4}}$$

and

$$E_{ed} = V \cdot D \cdot E/T$$

where:

E = Emission factor due to loading/dumping (kg/Mg)
k = Particle size multiplier
U = Mean wind speed (m/s)
M = Soil moisture (%)
E_{ed} = Emission rate due to loading/dumping (kg/day)
V = Volume of soil excavated (m^3)
D = Density of soil (Mg/m^3)
T = Time conversion factor (days of excavation)

Using conservative assumptions and appropriate guidelines (EPA, AP-42, 1985):

k = .74
U = 4.56 m/s
M = 5%
V = 229,365 m^3
D = 1.5 Mg/m^3
T = 1,250 days

The emissions due to loading/dumping are presented in Table C-2.

Emissions due to vehicular traffic are also estimated by (EPA, 1988):

$$E_{VT} = \left[1.7 \cdot K \cdot \left(\frac{s}{12} \right) \cdot \left(\frac{S_p}{48} \right) \cdot \left(\frac{W}{2.7} \right)^{.7} \cdot \left(\frac{M_w}{4} \right)^{.5} \cdot \frac{(365-D_p)}{365} \right] \cdot D_{vt}$$

where:

E_{VT} = Emissions due to vehicular traffic (kg yr^{-1})
K = Particle size multiplier
s = Silt content of soil (%)
Sp = Vehicle speed (km/hr)
W = Vehicle weight (Mg)
M_w = Mean number of wheels
Dp = Day with >.254 mm of precipitation
D_{vt} = Vehicle miles (km yr)

Using conservative assumptions and suggested values (EPA, 1988):

K = 1.0
s = 28.5%
Sp = 10 km/hr
M_w = 6 (trucks)
Dp = 140 days
W = 10.0 Mg (truck)
D_{vt} = 407.4 km/yr (truck)

Table C-3 contains fugitive dust emission rates for vehicular activity over unpaved roads.

Total fugitive emissions are presented in Table C-4.

The dust concentration on site is calculated by:

$$Cs = \frac{E}{w \cdot W \cdot H} \cdot C_f$$

where:

Cs = Dust concentration on site (mg/m^3)
E = Total emission rate (kg/day)
w = Wind speed = 4.56 m/s
W = Width (entire site) = 198 m
H = Breathing height = 2 m
C_f = Factors for converting from days to seconds and from kg to mg

Total fugitive dust concentrations on site are shown in Table C-4.

The concentration of contaminant suspended in air is estimated by a simple ratio of contaminant concentration in soil to fugitive dust emissions:

$$A_c = CC \cdot C_s \cdot C_f$$

where:

A_c = Concentration of suspended contaminant (mg/m^3)
CC - Contaminant concentration in soil (mg/kg)
C_s = Dust concentration on site (mg/m^3)
C_f = Conversion factor (kg/mg)

TABLE B-1
WIND EROSION - DUST EMISSION RATE
HERTEL LANDFILL FEASIBILITY STUDY

VEGETATIVE COVER FACTOR (V')	UNSHELTERED FIELD WIDTH FACTOR (L')	CLIMATIC FACTOR (C)	SURFACE ROUGHNESS FACTOR (K)	SOIL ERODIBILITY (I) (ton/acre/year)	PORTION AS SUSPENDED PARTICULATES (a)	EMISSION FACTOR (E) (ton/acre/yr	CONVERSION FACTOR (kg/ton)	EMISSION FACTOR (E) (kg/acre/year)	TIME CONSTANT (year/day)	AREA (acres)	WIND EROSION EMISSION RATE (kg/day)
1	0.7	0.02	1	134	0.010	1.9E-02	907.18	1.7E+01	0.0027	13.2	6.07E-01

TABLE B-2
LOADING & DUMPING - DUST EMISSION RATE
HERTEL LANDFILL FEASIBILITY STUDY

MOISTURE CONTEN CONSTANT	MATERIAL MOISTURE CONTENT (M) (%)	WIND SPEED CONSTANT	MEAN WIND SPEED (U) (m/s)	PARTICLE SIZE CONSTANT	PARTICLE SIZE MULTIPLIER (k)	EMISSION FACTOR (E) (kg/Mg)	TIME (days)	DENSITY OF SOIL (D) (Mg/m3)	VOLUME OF SOIL EXCAVATED (m3)	LOADING/DUMPING EMISSION RATE (kg/day)
2	5	2.2	4.5	1.60E-03	0.74	8.3E-04	1250	1.5	229365	2.29E-01

TABLE B-3
UNPAVED ROAD EMISSIONS
HERTEL LANDFILL FEASIBILITY STUDY

EMISSION FACTOR (E) (kg/VKT)	PARTICLE SIZE MULTIPLIER (k)	PARTICLE CONSTANT	ROAD SURFACE SILT CONTENT (s) (%)	SILT CONSTANT	MEAN VEHICLE SPEED (S) (km/hour)	SPEED CONSTANT	MEAN VEHICLE WEIGHT (W) (Mg)	WEIGHT CONSTANT	MEAN NUMBER OF WHEELS (w)	WHEEL CONSTANT	DAYS OF PRECIPITATIO (p)	PRECIPITATION CONSTANT
1.59E-02	1.0	1.7	28.5	12.0	10	48.0	10.0	2.7	6	4.0	140	365

TABLE B-4
TOTAL FUGITIVE DUST CONCENTRATIONS
HERTEL LANDFILL FEASIBILITY STUDY

WIND EROSION EMISSION RATE (kg/day)	LOADING/DUMPING EMISSION RATE (kg/day)	UNPAVED ROAD EMISSOIN RATE (kg/day)	TOTAL EMISSION RATE (kg/day)	CONVERSION FACTOR (mg/kg)	CONVERSION FACTOR (day/sec)	BREATHING HEIGHT (m)	SITE WIDTH (m)	WIND SPEED (m/s)	DUST CONCENTRATION ON SITE (mg/m3)
6.07E-01	2.29E-01	7.28E-01	1.56E+00	1.00E+06	1.16E-05	2	198	4.5	1.02E-02
6.07E-01	0.00E+00	7.28E-01	1.33E+00	1.00E+06	1.16E-05	2	198	4.5	8.68E-03

UNPAVED ROAD EMISSIONS

VEHICULAR EMISSION RATE (kg/day)	DAYS OF TRAFFIC EVENT ON CONTAMINATED SOIL	VEHICULAR EMISSION PER EVENT (kg)	EMISSION FACTOR (E) (kg/VKT)	VEHICLE KILOMETER TRAVELED (VKT)
7.28E-01	5	3.64E+00	8.93E-03	407.40

APPENDIX B

INGESTION OF CHEMICALS IN SOIL
ROAD IMPROVEMENTS AND CLEARING VEGETATION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	INTAKE NONCANCER (mg/kg/day)	INTAKE CANCER (mg/kg/day)	CONC. IN SOIL (mg/kg)	INGESTION RATE (mg soil/day)	CONVERSION FACTOR (10E-6 kg/mg)	FRACTION INGESTED (unitless)	EXPOSURE FREQUENCY (days/year)	EXPOSURE DURATION (years)	BODY WEIGHT (kg)	AVG. TIME NONCANCER (days)	AVG. TIME CANCER (days)
SEMIVOLATILES											
Benzo(a)anthracene	6.16E-07	3.62E-10	0.4311	100	1.0E-06	1	15	1	70	15	25550
Chrysene	6.15E-07	3.61E-10	0.4302	100	1.0E-06	1	15	1	70	15	25550
Benzo(b)fluoranthene	9.79E-07	5.75E-10	0.6856	100	1.0E-06	1	15	1	70	15	25550
Benzo(k)fluoranthene	5.58E-07	3.28E-10	0.3908	100	1.0E-06	1	15	1	70	15	25550
Benzo(a)pyrene	3.43E-07	2.01E-10	0.2400	100	1.0E-06	1	15	1	70	15	25550
Indeno(123cd)pyrene	6.13E-06	3.60E-09	4.2918	100	1.0E-06	1	15	1	70	15	25550
Bis(2ethylhexyl)phthalate	9.12E-06	5.36E-09	6.3869	100	1.0E-06	1	15	1	70	15	25550
Naphthalene	9.42E-07	5.53E-10	0.6593	100	1.0E-06	1	15	1	70	15	25550
Fluorene	8.60E-07	5.05E-10	0.6017	100	1.0E-06	1	15	1	70	15	25550
Phenanthrene	1.20E-06	7.02E-10	0.8366	100	1.0E-06	1	15	1	70	15	25550
Anthracene	2.14E-07	1.26E-10	0.1500	100	1.0E-06	1	15	1	70	15	25550
Fluoranthene	1.93E-06	1.13E-09	1.3511	100	1.0E-06	1	15	1	70	15	25550
Pyrene	1.73E-06	1.01E-09	1.2083	100	1.0E-06	1	15	1	70	15	25550
Benzo(ghi)perylene	6.13E-06	3.60E-09	4.2918	100	1.0E-06	1	15	1	70	15	25550
Diethylphthalate	1.57E-07	9.23E-11	0.1100	100	1.0E-06	1	15	1	70	15	25550
Di-n-butylphthalate	8.02E-06	4.71E-09	5.6167	100	1.0E-06	1	15	1	70	15	25550
Di-n-octylphthalate	2.86E-07	1.68E-10	0.2000	100	1.0E-06	1	15	1	70	15	25550
Butylbenzylphthalate	3.43E-07	2.01E-10	0.2400	100	1.0E-06	1	15	1	70	15	25550
P-Cresol	4.86E-07	2.85E-10	0.3400	100	1.0E-06	1	15	1	70	15	25550
Phenol	6.13E-06	3.60E-09	4.2918	100	1.0E-06	1	15	1	70	15	25550
INORGANICS											
Aluminium	1.89E-02	1.11E-05	13255.5	100	1.0E-06	1	15	1	70	15	25550
Antimony	3.26E-05	1.91E-08	22.8	100	1.0E-06	1	15	1	70	15	25550
Arsenic	9.86E-06	5.79E-09	6.9	100	1.0E-06	1	15	1	70	15	25550
Barium	1.70E-04	9.96E-08	118.8	100	1.0E-06	1	15	1	70	15	25550
Beryllium	1.14E-06	6.71E-10	0.80	100	1.0E-06	1	15	1	70	15	25550
Cadmium	1.14E-06	6.71E-10	0.80	100	1.0E-06	1	15	1	70	15	25550
Calcium	2.46E-03	1.44E-06	1722.8	100	1.0E-06	1	15	1	70	15	25550
Chromium	2.61E-05	1.53E-08	18.3	100	1.0E-06	1	15	1	70	15	25550
Cobalt	1.79E-05	1.05E-08	12.5	100	1.0E-06	1	15	1	70	15	25550
Copper	5.16E-05	3.03E-08	36.1	100	1.0E-06	1	15	1	70	15	25550
Iron	3.47E-02	2.04E-05	24278.1	100	1.0E-06	1	15	1	70	15	25550
Lead	8.59E-05	5.04E-08	60.1	100	1.0E-06	1	15	1	70	15	25550
Magnesium	7.08E-03	4.16E-06	4954.3	100	1.0E-06	1	15	1	70	15	25550
Manganese	1.79E-03	1.05E-06	1250.2	100	1.0E-06	1	15	1	70	15	25550
Mercury	0.00E+00	0.00E+00		100	1.0E-06	1	15	1	70	15	25550
Nickel	3.01E-05	1.77E-08	21.1	100	1.0E-06	1	15	1	70	15	25550
Potassium	1.91E-03	1.12E-06	1334.6	100	1.0E-06	1	15	1	70	15	25550
Selenium	5.71E-07	3.35E-10	0.4	100	1.0E-06	1	15	1	70	15	25550
Sodium	2.74E-04	1.61E-07	191.5	100	1.0E-06	1	15	1	70	15	25550
Thallium	0.00E+00	0.00E+00		100	1.0E-06	1	15	1	70	15	25550
Vandium	2.40E-05	1.41E-08	16.8	100	1.0E-06	1	15	1	70	15	25550
Zinc	1.92E-04	1.12E-07	134.1	100	1.0E-06	1	15	1	70	15	25550
PESTICIDES/PCBS											
4,4-DDE	5.87E-08	3.45E-11	0.0411	100	1.0E-06	1	15	1	70	15	25550
4,4-DDT	5.87E-08	3.45E-11	0.0411	100	1.0E-06	1	15	1	70	15	25550

APPENDIX B

DERMAL CONTACT WITH CHEMICALS IN SOIL
ROAD IMPROVEMENTS AND CLEARING VEGETATION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	ABS. DOSE NONCANCER (mg/kg/day)	ABS. DOSE CANCER (mg/kg/day)	CONC. IN SOIL (mg/kg)	CONVERSION FACTOR (kg/mg)	SURFACE AREA SKIN (cm2/event)	ADHERENCE FACTOR (mg/cm2)	ABSORPTION FACTOR (unitless)	EXPOSURE FREQUENCY (days/year)	EXPOSURE DURATION (years)	BODY WEIGHT (kg)	AVG. TIME NONCANCER (days)	AVG. TIME CANCER (days)
SEMIVOLATILES												
Benzo(a)anthracene	5.63E-06	3.30E-09	0.4311	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Chrysene	5.61E-06	3.30E-09	0.4302	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Benzo(b)fluoranthene	8.95E-06	5.25E-09	0.6856	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Benzo(k)fluoranthene	5.10E-06	2.99E-09	0.3908	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Benzo(a)pyrene	3.13E-06	1.84E-09	0.2400	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Indeno(123cd)pyrene	5.60E-05	3.29E-08	4.2918	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Bis(2ethylhexyl)phthalate	8.33E-05	4.89E-08	6.3869	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Di-N-Octylphthalate	2.61E-06	1.53E-09	0.2000	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Butybenzylphthalate	3.13E-06	1.84E-09	0.2400	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
P-Cresol	4.44E-06	2.60E-09	0.3400	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Naphthalene	8.60E-06	5.05E-09	0.6593	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Fluorene	7.85E-06	4.61E-09	0.6017	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Phenanthrene	1.09E-05	6.41E-09	0.8366	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Anthracene	1.96E-06	1.15E-09	0.1500	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Fluoranthene	1.76E-05	1.04E-08	1.3511	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Pyrene	1.58E-05	9.26E-09	1.2083	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Benzo(ghi)perylene	5.60E-05	3.29E-08	4.2918	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Diethylphthalate	1.44E-06	8.43E-10	0.1100	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Di-n-butylphthalate	7.33E-05	4.30E-08	5.6167	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Phenol	5.60E-05	3.29E-08	4.2918	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
INORGANICS												
Aluminium	1.73E-02	1.02E-05	13255.5	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Antimony	2.98E-05	1.75E-08	22.8	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Arsenic	9.00E-05	5.29E-08	6.9	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
Barium	1.55E-04	9.10E-08	118.8	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Beryllium	1.04E-06	6.13E-10	0.80	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Cadmium	1.04E-06	6.13E-10	0.80	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Calcium	2.25E-03	1.32E-06	1722.8	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Chromium	2.39E-05	1.40E-08	18.3	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Cobalt	1.63E-05	9.58E-09	12.5	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Copper	4.71E-05	2.77E-08	36.1	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Iron	3.17E-02	1.86E-05	24278.1	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Lead	7.84E-05	4.60E-08	60.1	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Magnesium	6.47E-03	3.80E-06	4954.3	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Manganese	1.63E-03	9.58E-07	1250.2	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Nickel	2.75E-05	1.62E-08	21.1	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Potassium	1.74E-03	1.02E-06	1334.6	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Selenium	5.22E-07	3.06E-10	0.4	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Sodium	2.50E-04	1.47E-07	191.5	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Vandium	2.19E-05	1.29E-08	16.8	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
Zinc	1.75E-04	1.03E-07	134.1	1.0E-06	6300	1.45	0.01	15	1	70	15	25550
PESTICIDES/PCBS												
4,4-DDE	5.36E-07	3.15E-10	0.0411	1.0E-06	6300	1.45	0.10	15	1	70	15	25550
4,4-DDT	5.36E-07	3.15E-10	0.0411	1.0E-06	6300	1.45	0.10	15	1	70	15	25550

APPENDIX B

INHALATION OF CHEMICALS BORN ON DUST PARTICLES
ROAD IMPROVEMENTS AND CLEARING VEGETATION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	INTAKE NONCANCER (mg/kg/day)	INTAKE CANCER (mg/kg/day)	DUST CONC. ON SITE (kg/m3)	CONC. IN SOIL (mg/kg)	INHALTION RATE (m3/hour)	EXPOSURE TIME (hours/day)	EXPOSURE FREQUENCY (days/year)	EXPOSURE DURATION (years)	BODY WEIGHT (kg)	AVG. TIME NONCANCER (days)	AVG. TIME CANCER (days)
INORGANICS											
Aluminium	2.63E-02	1.54E-05	8.68E-06	13255.5	2	8	15	1	70	15	25550
Antimony	4.52E-05	2.66E-08	8.68E-06	22.8	2	8	15	1	70	15	25550
Arsenic	1.37E-05	8.04E-09	8.68E-06	6.9	2	8	15	1	70	15	25550
Barium	2.36E-04	1.38E-07	8.68E-06	118.8	2	8	15	1	70	15	25550
Beryllium	1.59E-06	9.32E-10	8.68E-06	0.8	2	8	15	1	70	15	25550
Cadmium	1.59E-06	9.32E-10	8.68E-06	0.8	2	8	15	1	70	15	25550
Calcium	3.42E-03	2.01E-06	8.68E-06	1722.8	2	8	15	1	70	15	25550
Chromium	3.63E-05	2.13E-08	8.68E-06	18.3	2	8	15	1	70	15	25550
Cobalt	2.48E-05	1.46E-08	8.68E-06	12.5	2	8	15	1	70	15	25550
Copper	7.16E-05	4.20E-08	8.68E-06	36.1	2	8	15	1	70	15	25550
Iron	4.82E-02	2.83E-05	8.68E-06	24278.1	2	8	15	1	70	15	25550
Lead	1.19E-04	7.00E-08	8.68E-06	60.1	2	8	15	1	70	15	25550
Magnesium	9.83E-03	5.77E-06	8.68E-06	4954.3	2	8	15	1	70	15	25550
Manganese	2.48E-03	1.46E-06	8.68E-06	1250.2	2	8	15	1	70	15	25550
Nickel	4.19E-05	2.46E-08	8.68E-06	21.1	2	8	15	1	70	15	25550
Potassium	2.65E-03	1.55E-06	8.68E-06	1334.6	2	8	15	1	70	15	25550
Sodium	3.80E-04	2.23E-07	8.68E-06	191.5	2	8	15	1	70	15	25550
Vanadium	3.33E-05	1.96E-08	8.68E-06	16.8	2	8	15	1	70	15	25550
Zinc	2.66E-04	1.56E-07	8.68E-06	134.1	2	8	15	1	70	15	25550
VOLATILES											
Carbon Disulfide	5.95E-09	3.49E-12	8.68E-06	0.0030	2	8	15	1	70	15	25550
Chlorobenzene	1.39E-08	8.15E-12	8.68E-06	0.0070	2	8	15	1	70	15	25550
Ethylbenzene	4.68E-08	2.75E-11	8.68E-06	0.0236	2	8	15	1	70	15	25550
Toluene	2.30E-08	1.35E-11	8.68E-06	0.0116	2	8	15	1	70	15	25550
Xylenes	8.37E-07	4.91E-10	8.68E-06	0.4218	2	8	15	1	70	15	25550
SEMIVOLATILES											
Bis(2-ethylhexyl)phthalate	1.27E-05	7.44E-09	8.68E-06	6.3869	2	8	15	1	70	15	25550
Di-N-Octylphthalate	3.97E-07	2.33E-10	8.68E-06	0.2000	2	8	15	1	70	15	25550
Butybenzylphthalate	4.76E-07	2.80E-10	8.68E-06	0.2400	2	8	15	1	70	15	25550
Phenanthrene	1.66E-06	9.74E-10	8.68E-06	0.8366	2	8	15	1	70	15	25550
Fluoranthene	2.68E-06	1.57E-09	8.68E-06	1.3511	2	8	15	1	70	15	25550
Pyrene	2.40E-06	1.41E-09	8.68E-06	1.2083	2	8	15	1	70	15	25550
Di-N-Butylphthalate	1.11E-05	6.54E-09	8.68E-06	5.6167	2	8	15	1	70	15	25550
Benzoic Acid	4.36E-07	2.56E-10	8.68E-06	0.2200	2	8	15	1	70	15	25550
Phenol	8.51E-06	5.00E-09	8.68E-06	4.2918	2	8	15	1	70	15	25550
p-cresol	6.75E-07	3.96E-10	8.68E-06	0.3400	2	8	15	1	70	15	25550
Diethylphthalate	2.18E-07	1.28E-10	8.68E-06	0.1100	2	8	15	1	70	15	25550
Fluoranthene	2.68E-06	1.57E-09	8.68E-06	1.3511	2	8	15	1	70	15	25550
Anthracene	2.98E-07	1.75E-10	8.68E-06	0.1500	2	8	15	1	70	15	25550
Fluorene	1.19E-06	7.01E-10	8.68E-06	0.6017	2	8	15	1	70	15	25550
Naphthalene	1.31E-06	7.68E-10	8.68E-06	0.6593	2	8	15	1	70	15	25550
Benzo(a)anthracene	8.55E-07	5.02E-10	8.68E-06	0.4311	2	8	15	1	70	15	25550
Benzo(a)pyrene	4.76E-07	2.80E-10	8.68E-06	0.2400	2	8	15	1	70	15	25550
Chrysene	8.54E-07	5.01E-10	8.68E-06	0.4302	2	8	15	1	70	15	25550
Benzo(b)fluoranthene	1.36E-06	7.99E-10	8.68E-06	0.6856	2	8	15	1	70	15	25550
Benzo(k)fluoranthene	7.75E-07	4.55E-10	8.68E-06	0.3908	2	8	15	1	70	15	25550

APPENDIX B

SUMMARY OF CANCER RISK ESTIMATES - ROAD IMPROVEMENTS AND CLEARING VEGETATION (ALTERNATIVES 2, 2A, 4 AND 4A)

HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST								1E-06	2E-06
INORGANICS									
Arsenic	8.04E-09	No	50	A	Lung	Air/HEAST	4E-07		
Beryllium	9.32E-10	No	8.4				8E-09		
Cadmium	9.32E-10	No	6.1	B1		OCCUPA/HEAST	6E-09		
Chromium	2.13E-08	No	41	A	Lung	OCCUPA/HEAST	9E-07		
Nickel	2.46E-08	No	8.4E-01	A	Respiratory tract	OCCUPA/HEAST	2E-08		
SEMIVOLATILES									
Bis(2ethylhexyl)phthalate	7.44E-09	No	1.4E-02				1E-10		
Butylbenzylphthalate	NA	No	ND	C		NF/IRIS	NA		
Benzo(a)anthracene	5.02E-10	No	6.1	B2		NA/IRIS	3E-09		
Benzo(a)pyrene	2.80E-10	No	6.1	B2	Stomach	Diet/IRIS	2E-09		
Chrysene	5.01E-10	No	6.1	B2	Respiratory tract	NA/IRIS	3E-09		
Benzo(b)fluoranthene	7.99E-10	No	6.1	B2		NA/IRIS	5E-09		
Benzo(k)fluoranthene	4.55E-10	No	6.1	B2		NA/IRIS	3E-09		
Dibenzo(a,h)anthracene	NA	No	6.1	B2		NA/IRIS	NA		
Indeno(123cd)pyrene	NA	No	6.1	B2		NA/IRIS	NA		
1,4-Dichlorobenzene	NA	No	2.4E-02				NA		
PESTICIDES/PCBS									
4,4'-DDD	NA	No	2.4E-01	B2	Lung, Liver, Thyroid	Diet/IRIS	NA		
4,4'-DDE	NA	No	3.4E-01	B2	Liver, Thyroid	Diet/IRIS	NA		
4,4'-DDT	NA	No	3.4E-01	B2	Liver	Diet/IRIS	NA		

APPENDIX B

SUMMARY OF CANCER RISK ESTIMATES - ROAD IMPROVEMENTS AND CLEARING VEGETATION (ALTERNATIVES 2, 2A, 4 AND 4A)

HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL								9E-07
INORGANICS								
Arsenic	5.29E-08	0.10	1.75	A	Skin	Water/IRIS	9E-07	
SEMIVOLATILES								
Bis(2ethylhexyl)phthalate	4.89E-08	0.10	1.4E-02	B2	Liver	Diet/IRIS	7E-09	
Butylbenzylphthalate	NA	0.10	ND	C		NF/IRIS	NA	
Benzo(a)anthracene	3.30E-09	0.10	ND	B2		NA/IRIS	NA	
Benzo(a)pyrene	1.84E-09	0.10	ND	B2	Stomach	Diet/IRIS	NA	
Chrysene	3.30E-09	0.10	ND	B2		NA/IRIS	NA	
Benzo(b)fluoranthene	5.25E-09	0.10	ND	B2		NA/IRIS	NA	
Benzo(k)fluoranthene	2.99E-09	0.10	ND	B2		NA/IRIS	NA	
Dibenzo(a,h)anthracene	NA	0.10	ND	B2		NA/IRIS	NA	
Indeno(123cd)pyrene	NA	0.10	ND	B2		NA/IRIS	NA	
1,4-Dichlorobenzene	NA	0.10	2.4E-02	B2	Liver	Gavage/HEAST		
PESTICIDES/PCBS								
4,4'-DDD	NA	0.10	2.4E-01	B2	Lung, Liver, Thyroid	Diet/IRIS	NA	
4,4'-DDE	NA	0.10	3.4E-01	B2	Liver,Thyroid	Diet/IRIS	NA	
4,4'-DDT	NA	0.10	3.4E-01	B2	Liver	Diet/IRIS	NA	

APPENDIX B

SUMMARY OF CANCER RISK ESTIMATES - ROAD IMPROVEMENTS AND CLEARING VEGETATION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL								3E-08
INORGANICS								
Arsenic	5.79E-09	No	1.75	A	Skin	Water/IRIS	1E-08	
Beryllium	6.71E-10	No	4.3	B2	Skin	Water/IRIS	3E-09	
Lead	5.04E-08	No	ND	B2	Renal	Oral/IRIS	NA	
SEMIVOLATILES								
Bis(2ethylhexyl)phthalate	5.36E-09	No	1.4E-02	B2	Liver	Diet/IRIS	7E-11	
Butylbenzylphthalate		No	ND	C		NF/IRIS	NA	
Benzo(a)anthracene	3.62E-10	No	11.50	B2		NA/IRIS	4E-09	
Benzo(a)pyrene	2.01E-10	No	11.50	B2	Stomach	Diet/IRIS	2E-09	
Chrysene	3.61E-10	No	11.50	B2		NA/IRIS	4E-09	
Benzo(b)fluoranthene	5.75E-10	No	11.50	B2		NA/IRIS	7E-09	
Benzo(k)fluoranthene	3.28E-10	No	11.50	B2		NA/IRIS	4E-09	
Dibenzo(a,h)anthracene	NA	No	11.50	B2		NA/IRIS	NA	
Indeno(123cd)pyrene	NA	No	11.50	B2		NA/IRIS	NA	
1,4-Dichlorobenzene	NA	No	2.4E-02	B2	Liver	Gavage/HEAST	NA	
PESTICIDES/PCBS								
4,4'-DDD	NA	No	2.4E-01	B2	Lung, Liver, Thyroid	Diet/IRIS	NA	
4,4'-DDE	NA	No	3.4E-01	B2	Liver,Thyroid	Diet/IRIS	NA	
4,4'-DDT	NA	No	3.4E-01	B2	Liver	Diet/IRIS	NA	

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - ROAD IMPROVEMENTS AND CLEARING VEGETATION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL										1E-01
INORGANICS										
Aluminum	1.9E-02	No	DI						NA	
Antimony	3.3E-05	No	4E-04	Low	Longevity, blood glucose and cholesterol				8E-02	
Arsenic	9.9E-06	No	1E-03	NA	Keratosis and hyperpigmentation				1E-02	
Barium	1.7E-04	No	5E-02	Medium	Increased blood pressure				3E-03	
Beryllium	1.1E-06	No	5E-03	Low	None observed				2E-04	
Cadmium	1.1E-06	No	ND	High	Proteinuria				NA	
Chromium VI	2.6E-05	No	2E-02	Low	No effects reported				1E-03	
Cobalt	1.8E-05	No	NF						NA	
Copper	5.2E-05	No	4.0E-02	NA	Local GI irritation				1E-03	
Lead	8.6E-05	No	NA	NA	Neurobehaioral effects				NA	
Manganese	1.8E-03	No	1E-01	Medium	CNS effects				2E-02	
Mercury	0.0E+00	No	3E-04	NA	Kidney effects				NA	
Nickel	3.0E-05	No	2E-02	Medium	Decreased body and organ weight				2E-03	
Selenium	NA	No	NF						NA	
Vanadium	2.4E-05	No	7E-03	NA	None observed				3E-03	
Zinc	1.9E-04	No	2E-01	NA	Anemia				1E-03	
Cyanide	NA	No	2E-02	Medium	Weight loss, thyroid effects, myelin degeneration				NA	
SEMIVOLATILES										
									NA	
Bis(2ethylhexyl)phthalate	9.1E-06	No	2E-02	Medium	Increased relative liver weight	Diet/IRIS	1000.00	1.00	5E-04	
Butylbenzylphthalate	3.4E-07	No	2E+00	Low	Effects on body; weight gain, testes, liver, kidneys	Diet/IRIS	100.00	1.00	2E-07	
									NA	
Benzo(a)anthracene	6.2E-07	No	NF			HEAST, IRIS			NA	
Benzo(a)pyrene	3.4E-07	No	NF			HEAST, IRIS			NA	
Chrysene*	6.1E-07	No	DI			HEAST			NA	
Benzo(b)fluoranthene	9.8E-07	No	NF			HEAST, IRIS			NA	
Benzo(k)fluoranthene	5.6E-07	No	NF			HEAST, IRIS			NA	
Dibenzo(a,h)anthracene	NA	No	NF			HEAST, IRIS			NA	
Indeno(1,2,3-c,d)pyrene	NA	No	NF			HEAST, IRIS			NA	
1,4-Dichlorobenzene	NA	No	ND			HEAST, IRIS			NA	
Diethylphthalate	1.6E-07	No	8E+00	Low	Decreased growth rate, food consumption rate, altered organ weights	Diet/IRIS	1000.00	1.00	2E-08	
Di-n-butylphthalate	NA	No	1E+00	Low	Increased mortality	Diet/IRIS	1000.00	1.00	NA	
Di-n-octylphthalate	2.9E-07	No	2E-02	NA	Elevated liver and kidney weights increased SGOT and SPGT	Diet/HEAST	1000.00		1E-05	
									NA	
Acenaphthene	NA	No	6E-01	Low	Hepatotoxicity	Oral/IRIS			NA	
Anthracene	2.1E-07	No	3E+00	Low	No observed effects	Gavage/IRIS			7E-08	
Benzo(g,h,i)perylene	NA	No	NF			HEAST/IRIS			NA	
Fluoranthene	1.9E-06	No	4E-01	Low	Neuropathy, liver weight changes hematological alterations and clinical effects	Gavage/IRIS			5E-06	
									NA	
Fluorene	8.6E-07	No	4E-01	Low	Decreased RBC, packed cell volume and hemoglobin	Gavage/IRIS				
p-Cresol	9.4E-07	No	NF			HEAST, IRIS			NA	
Naphthalene	9.4E-07	No	4E-02	NA	Ocular and internal lesions	Diet/HEAST			2E-05	
Pyrene	1.7E-06	No	3E-01	Low	Kidney effects	Gavage/IRIS			6E-06	
Phenanthrene	1.2E-06	No	DI			HEAST			NA	
Phenol	6.1E-06	No	0.60		Reduced fetal body weight	Gavage/HEAST	100			
PESTICIDES/PCBS										
4,4'-DDD	NA	No	NF			HEAST, IRIS			NA	
4,4'-DDE	NA	No	NF			HEAST, IRIS			NA	
4,4'-DDT	NA	No	5E-04	Medium	Liver lesions	Diet/IRIS	100	1.00	NA	

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - ROAD IMPROVEMENTS AND CLEARING VEGETATION (ALTERNATIVES 2, 2A, 4AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL										9E-01
INORGANICS										
Arsenic	9.0E-05	0.10	1E-03	NA	Keratosis and hyperpigmentation	NA/HEAST	1		9E-01
SEMIVOLATILES										
Bis(2ethylhexyl)phthalate	8.3E-05	0.10	2E-02	Medium	Increased relative liver weight	Diet/IRIS	1000	1	4E-02
Butylbenzylphthalate	3.1E-06	0.10	2E+00	Low	Effects on body; weight gain, testes, liver, kidneys	Diet/IRIS	100	1	2E-05
Benzo(a)anthracene	5.6E-06	0.10	NF			HEAST, IRIS			NA
Benzo(a)pyrene	3.1E-06	0.10	NF			HEAST, IRIS			NA
Chrysene	5.6E-06	0.10	DI			HEAST			NA
Benzo(b)fluoranthene	8.9E-06	0.10	NF			HEAST, IRIS			NA
Benzo(k)fluoranthene	5.1E-06	0.10	NF			HEAST, IRIS			NA
Dibenzo(a,h)anthracene	NA	0.10	NF			HEAST, IRIS			NA
Indeno(1,2,3-c,d)pyrene	NA	0.10	NF			HEAST, IRIS			NA
1,4-Dichlorobenzene	NA	0.10	ND			HEAST, IRIS			NA
Diethylphthalate	1.4E-06	0.10	8E+00	Low	Decreased growth rate, food consumption rate, altered organ weights	Diet/IRIS	1000	1	2E-06
Di-n-butylphthalate	NA	0.10	1E+00	Low	Increased mortality	Diet/IRIS	1000	1	NA
Di-n-octylphthalate	2.6E-06	0.10	2E-02	NA	Elevated liver and kidney weights increased SGOT and SPGT	Diet/HEAST	1000		1E-03
Acenaphthene	NA	0.10	6E-01	Low	Hepatotoxicity	Oral/IRIS			NA
Anthracene	2.0E-06	0.10	3E+00	Low	No observed effects	Gavage/IRIS			7E-06
Benzo(g,h,i)perylene	NA	0.10	NF			HEAST/IRIS			NA
Fluoranthene	1.8E-05	0.10	4E-01	Low	Neuropathy, liver weight changes hematological alterations and clinical effects	Gavage/IRIS			4E-04
Fluorene	7.9E-06	0.10	4E-01	Low	Decreased RBC, packed cell volume and hemoglobin	Gavage/IRIS			2E-04
P-Cresol	4.4E-06	0.10	5E-01	Medium	Decreased body weight, Neurotoxicity	IRIS	1000	1	9E-05
Naphthalene	8.6E-06	0.10	4E-02	NA	Ocular and internal lesions	Diet/HEAST			2E-03
Pyrene	1.6E-05	0.10	3E-01	Low	Kidney effects	Gavage/IRIS			5E-04
Phenanthrene	1.1E-05	0.10	DI			HEAST			NA
Phenol	5.6E-05	0.10	0.60		Reduced fetal body weight	Gavage/HEAST	100		9E-04
PESTICIDES/PCBS		0.10								
4,4'-DDD	NA	0.10	NF			HEAST, IRIS			NA
4,4'-DDE	NA	0.10	NF			HEAST, IRIS			NA
4,4'-DDT	NA	0.10	5E-04	Medium	Liver lesions	Diet/IRIS	100	1	NA

APPENDIX B

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - ROAD IMPROVEMENTS AND CLEARING VEGETATION (ALTERNATIVES 2, 2A, 4 AND 4A)

MERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RfD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RfD SOURCE/ BASIS	RfD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)	TOTAL EXPOSURE HI
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST										1E+01	1E+01
INORGANICS											
Antimony	4.5E-05	No	4E-04						1E-01		
Arsenic	1.4E-05	No	1E-03						1E-02		
Barium	2.4E-04	No	1E-03						2E-01		
Beryllium	1.6E-06	No	0.01						3E-04		
Cadmium	1.6E-06	No	1E-03						2E-03		
Chromium	3.6E-05	No	6E-06	NA	Nasal mucosa atrophy	HEAST	300		6E+00		
Manganese	2.5E-03	No	4E-04	Medium	Increased prevalence of respiratory symtoms and psycho-motor disturbances	IRIS HEAST	300 900 1	3	6E+00		
Mercury	NA	No	1E-04	NA	Neurotoxicty	NA/HEAST	30		NA		
Nickel	4.2E-05	No	2E-02						2E-03		
Vanadium	3.3E-05	No	7E-03						5E-03		
Zinc	2.7E-04	No	2E-01						1E-03		
Cyanide	NA	No	2E-02						NA		
VOLATILES											
Carbon Disulfide	NA	No	1E-01						NA		
Chlorobenzene	1.4E-08	No	5E-02	NA	Liver and kidney effects	HEAST	10000		3E-07		
Ethylbenzene	4.7E-08	No	1E+00						5E-08		
Toluene	2.3E-08	No	2E+00	NA	CNS effects, eyes and nose irritation	HEAST	100		1E-08		
Xylenes	8.4E-07	No	3E-01	NA	CNS effects, eyes and nose irritation	HEAST	100		3E-06		
SEMIVOLATILES											
Bis(2ethylhexyl)phthalate	1.3E-05	No	2E-02						6E-04		
Butylbenzylphthalate	4.8E-07	No	2E+00						2E-07		
Benzo(a)anthracene	NA	No	NF			HEAST, IRIS			NA		
Benzo(a)pyrene	NA	No	NF			HEAST, IRIS			NA		
Chrysene	NA	No	DI			HEAST			NA		
Benzo(b)fluoranthene	NA	No	NF			HEAST, IRIS			NA		
Benzo(k)fluoranthene	NA	No	NF			HEAST, IRIS			NA		
Dibenzo(a,h)anthracene	NA	No	NF			HEAST, IRIS			NA		
Indeno(1,2,3-c,d)pyrene	NA	No	NF			HEAST, IRIS			NA		
4-Dichlorobenzene	NA	No	2E-01	NA	Liver and kidney effects	HEAST	100		NA		
ethylphthalate	2.2E-07	No	8E+00						NA		
-n-butylphthalate	NA	No	1E+00						NA		
Di-n-octylphthalate	4.0E-07	No	2E-02						NA		
Acenaphthene	NA	No	6E-01						NA		
thracene	3.0E-07	No	3E+00						NA		
nzo(g,h,i)perylene	NA	No	NF			HEAST/IRIS			NA		
Fluoranthene	2.7E-06	No	4E-01						7E-06		
Fluorene	1.2E-06	No	4E-01						3E-06		
Cresol	6.7E-07	No	5E-01						1E-06		
phthalene	1.3E-06	No	4E-02						3E-05		
rene	2.4E-06	No	3E-01						8E-06		
Phenanthrene	NA	No	DI			HEAST			NA		
Phenol	NA	No	DI			HEAST			NA		
PESTICIDES/PCBS											
4,4'-DDD	NA	No	NF			HEAST, IRIS			NA		
4,4'-DDE	NA	No	NF			HEAST, IRIS			NA		
4,4'-DDT	NA	No	5E-04		Liver lession				NA		

APPENDIX B

INGESTION OF CHEMICALS IN SOIL
CAP CONSTRUCTION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	INTAKE NONCANCER (mg/kg/day)	INTAKE CANCER (mg/kg/day)	CONC. IN SOIL (mg/kg)	INGESTION RATE (mg soil/day)	CONVERSION FACTOR (10E-6 kg/mg)	FRACTION INGESTED (unitless)	EXPOSURE FREQUENCY (days/year)	EXPOSURE DURATION (years)	BODY WEIGHT (kg)	AVG. TIME NONCANCER (days)	AVG. TIME CANCER (days)
SEMIVOLATILES											
Benzo(a)anthracene	6.16E-07	1.93E-09	0.4311	100	1.0E-06	1	80	1	70	80	25550
Chrysene	6.15E-07	1.92E-09	0.4302	100	1.0E-06	1	80	1	70	80	25550
Benzo(b)fluoranthene	9.79E-07	3.07E-09	0.6856	100	1.0E-06	1	80	1	70	80	25550
Benzo(k)fluoranthene	5.58E-07	1.75E-09	0.3908	100	1.0E-06	1	80	1	70	80	25550
Benzo(a)pyrene	3.43E-07	1.07E-09	0.2400	100	1.0E-06	1	80	1	70	80	25550
Indeno(123cd)pyrene	6.13E-06	1.92E-08	4.2918	100	1.0E-06	1	80	1	70	80	25550
Bis(2ethylhexyl)phthalate	9.12E-06	2.86E-08	6.3869	100	1.0E-06	1	80	1	70	80	25550
Naphthalene	9.42E-07	2.95E-09	0.6593	100	1.0E-06	1	80	1	70	80	25550
Fluorene	8.60E-07	2.69E-09	0.6017	100	1.0E-06	1	80	1	70	80	25550
Phenanthrene	1.20E-06	3.74E-09	0.8366	100	1.0E-06	1	80	1	70	80	25550
Anthracene	2.14E-07	6.71E-10	0.1500	100	1.0E-06	1	80	1	70	80	25550
Fluoranthene	1.93E-06	6.04E-09	1.3511	100	1.0E-06	1	80	1	70	80	25550
Pyrene	1.73E-06	5.40E-09	1.2083	100	1.0E-06	1	80	1	70	80	25550
Benzo(ghi)perylene	6.13E-06	1.92E-08	4.2918	100	1.0E-06	1	80	1	70	80	25550
Diethylphthalate	1.57E-07	4.92E-10	0.1100	100	1.0E-06	1	80	1	70	80	25550
Di-n-butylphthalate	8.02E-06	2.51E-08	5.6167	100	1.0E-06	1	80	1	70	80	25550
Di-n-octylphthalate	2.86E-07	8.95E-10	0.2000	100	1.0E-06	1	80	1	70	80	25550
Butylbenzylphthalate	3.43E-07	1.07E-09	0.2400	100	1.0E-06	1	80	1	70	80	25550
P-Cresol	4.86E-07	1.52E-09	0.3400	100	1.0E-06	1	80	1	70	80	25550
Phenol	6.13E-06	1.92E-08	4.2918	100	1.0E-06	1	80	1	70	80	25550
INORGANICS											
Aluminium	1.89E-02	5.93E-05	13255.5	100	1.0E-06	1	80	1	70	80	25550
Antimony	3.26E-05	1.02E-07	22.8	100	1.0E-06	1	80	1	70	80	25550
Arsenic	9.86E-06	3.09E-08	6.9	100	1.0E-06	1	80	1	70	80	25550
Barium	1.70E-04	5.31E-07	118.8	100	1.0E-06	1	80	1	70	80	25550
Beryllium	1.14E-06	3.58E-09	0.80	100	1.0E-06	1	80	1	70	80	25550
Cadmium	1.14E-06	3.58E-09	0.80	100	1.0E-06	1	80	1	70	80	25550
Calcium	2.46E-03	7.71E-06	1722.8	100	1.0E-06	1	80	1	70	80	25550
Chromium	2.61E-05	8.19E-08	18.3	100	1.0E-06	1	80	1	70	80	25550
Cobalt	1.79E-05	5.59E-08	12.5	100	1.0E-06	1	80	1	70	80	25550
Copper	5.16E-05	1.61E-07	36.1	100	1.0E-06	1	80	1	70	80	25550
Iron	3.47E-02	1.09E-04	24278.1	100	1.0E-06	1	80	1	70	80	25550
Lead	8.59E-05	2.69E-07	60.1	100	1.0E-06	1	80	1	70	80	25550
Magnesium	7.08E-03	2.22E-05	4954.3	100	1.0E-06	1	80	1	70	80	25550
Manganese	1.79E-03	5.59E-06	1250.2	100	1.0E-06	1	80	1	70	80	25550
Mercury	0.00E+00	0.00E+00		100	1.0E-06	1	80	1	70	80	25550
Nickel	3.01E-05	9.44E-08	21.1	100	1.0E-06	1	80	1	70	80	25550
Potassium	1.91E-03	5.97E-06	1334.6	100	1.0E-06	1	80	1	70	80	25550
Selenium	5.71E-07	1.79E-09	0.4	100	1.0E-06	1	80	1	70	80	25550
Sodium	2.74E-04	8.57E-07	191.5	100	1.0E-06	1	80	1	70	80	25550
Thallium	0.00E+00	0.00E+00		100	1.0E-06	1	80	1	70	80	25550
Vandium	2.40E-05	7.51E-08	16.8	100	1.0E-06	1	80	1	70	80	25550
Zinc	1.92E-04	6.00E-07	134.1	100	1.0E-06	1	80	1	70	80	25550
PESTICIDES/PCBS											
4,4-DDE	5.87E-08	1.84E-10	0.0411	100	1.0E-06	1	80	1	70	80	25550
4,4-DDT	5.87E-08	1.84E-10	0.0411	100	1.0E-06	1	80	1	70	80	25550

APPENDIX B

DERMAL CONTACT WITH CHEMICALS IN SOIL
CAP CONSTRUCTION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	ABS. DOSE NONCANCER (mg/kg/day)	ABS. DOSE CANCER (mg/kg/day)	CONC. IN SOIL (mg/kg)	CONVERSION FACTOR (kg/mg)	SURFACE AREA SKIN (cm2/event)	ADHERENCE FACTOR (mg/cm2)	ABSORPTION FACTOR (unitless)	EXPOSURE FREQUENCY (days/year)	EXPOSURE DURATION (years)	BODY WEIGHT (kg)	AVG. TIME NONCANCER (days)	AVG. TIME CANCER (days)
SEMIVOLATILES												
Benzo(a)anthracene	5.63E-06	1.76E-08	0.4311	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Chrysene	5.61E-06	1.76E-08	0.4302	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Benzo(b)fluoranthene	8.95E-06	2.80E-08	0.6856	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Benzo(k)fluoranthene	5.10E-06	1.60E-08	0.3908	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Benzo(a)pyrene	3.13E-06	9.81E-09	0.2400	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Indeno(123cd)pyrene	5.60E-05	1.75E-07	4.2918	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Bis(2ethylhexyl)phthalate	8.33E-05	2.61E-07	6.3869	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Di-N-Octylphthalate	2.61E-06	8.17E-09	0.2000	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Butybenzylphthalate	3.13E-06	9.81E-09	0.2400	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
P-Cresol	4.44E-06	1.39E-08	0.3400	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Naphthalene	8.60E-06	2.69E-08	0.6593	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Fluorene	7.85E-06	2.46E-08	0.6017	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Phenanthrene	1.09E-05	3.42E-08	0.8366	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Anthracene	1.96E-06	6.13E-09	0.1500	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Fluoranthene	1.76E-05	5.52E-08	1.3511	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Pyrene	1.58E-05	4.94E-08	1.2083	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Benzo(ghi)perylene	5.60E-05	1.75E-07	4.2918	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Diethylphthalate	1.44E-06	4.49E-09	0.1100	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Di-n-butylphthalate	7.33E-05	2.30E-07	5.6167	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Phenol	5.60E-05	1.75E-07	4.2918	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
INORGANICS												
Aluminium	1.73E-02	5.42E-05	13255.5	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Antimony	2.98E-05	9.32E-08	22.8	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Arsenic	9.00E-05	2.82E-07	6.9	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
Barium	1.55E-04	4.85E-07	118.8	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Beryllium	1.04E-06	3.27E-09	0.80	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Cadmium	1.04E-06	3.27E-09	0.80	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Calcium	2.25E-03	7.04E-06	1722.8	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Chromium	2.39E-05	7.48E-08	18.3	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Cobalt	1.63E-05	5.11E-08	12.5	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Copper	4.71E-05	1.48E-07	36.1	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Iron	3.17E-02	9.92E-05	24278.1	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Lead	7.84E-05	2.46E-07	60.1	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Magnesium	6.47E-03	2.02E-05	4954.3	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Manganese	1.63E-03	5.11E-06	1250.2	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Nickel	2.75E-05	8.62E-08	21.1	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Potassium	1.74E-03	5.45E-06	1334.6	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Selenium	5.22E-07	1.63E-09	0.4	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Sodium	2.50E-04	7.82E-07	191.5	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Vandium	2.19E-05	6.86E-08	16.8	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
Zinc	1.75E-04	5.48E-07	134.1	1.0E-06	6300	1.45	0.01	80	1	70	80	25550
PESTICIDES/PCBS												
4,4-DDE	5.36E-07	1.68E-09	0.0411	1.0E-06	6300	1.45	0.10	80	1	70	80	25550
4,4-DDT	5.36E-07	1.68E-09	0.0411	1.0E-06	6300	1.45	0.10	80	1	70	80	25550

APPENDIX B

INHALATION OF CHEMICALS BORN ON DUST PARTICLES
CAP CONSTRUCTION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	INTAKE NONCANCER (mg/kg/day)	INTAKE CANCER (mg/kg/day)	DUST CONC. ON SITE (kg/m3)	CONC. IN SOIL (mg/kg)	INHALTION RATE (m3/hour)	EXPOSURE TIME (hours/day)	EXPOSURE FREQUENCY (days/year)	EXPOSURE DURATION (years)	BODY WEIGHT (kg)	AVG. TIME NONCANCER (days)	AVG. TIME CANCER (days)
INORGANICS											
Aluminium	2.63E-02	8.23E-05	8.68E-06	13255.5	2	8	80	1	70	80	25550
Antimony	4.52E-05	1.42E-07	8.68E-06	22.8	2	8	80	1	70	80	25550
Arsenic	1.37E-05	4.29E-08	8.68E-06	6.9	2	8	80	1	70	80	25550
Barium	2.36E-04	7.38E-07	8.68E-06	118.8	2	8	80	1	70	80	25550
Beryllium	1.59E-06	4.97E-09	8.68E-06	0.8	2	8	80	1	70	80	25550
Cadmium	1.59E-06	4.97E-09	8.68E-06	0.8	2	8	80	1	70	80	25550
Calcium	3.42E-03	1.07E-05	8.68E-06	1722.8	2	8	80	1	70	80	25550
Chromium	3.63E-05	1.14E-07	8.68E-06	18.3	2	8	80	1	70	80	25550
Cobalt	2.48E-05	7.77E-08	8.68E-06	12.5	2	8	80	1	70	80	25550
Copper	7.16E-05	2.24E-07	8.68E-06	36.1	2	8	80	1	70	80	25550
Iron	4.82E-02	1.51E-04	8.68E-06	24278.1	2	8	80	1	70	80	25550
Lead	1.19E-04	3.73E-07	8.68E-06	60.1	2	8	80	1	70	80	25550
Magnesium	9.83E-03	3.08E-05	8.68E-06	4954.3	2	8	80	1	70	80	25550
Manganese	2.48E-03	7.77E-06	8.68E-06	1250.2	2	8	80	1	70	80	25550
Nickel	4.19E-05	1.31E-07	8.68E-06	21.1	2	8	80	1	70	80	25550
Potassium	2.65E-03	8.29E-06	8.68E-06	1334.6	2	8	80	1	70	80	25550
Sodium	3.80E-04	1.19E-06	8.68E-06	191.5	2	8	80	1	70	80	25550
Vanadium	3.33E-05	1.04E-07	8.68E-06	16.8	2	8	80	1	70	80	25550
Zinc	2.66E-04	8.33E-07	8.68E-06	134.1	2	8	80	1	70	80	25550
VOLATILES											
Carbon Disulfide	5.95E-09	1.86E-11	8.68E-06	0.0030	2	8	80	1	70	80	25550
Chlorobenzene	1.39E-08	4.35E-11	8.68E-06	0.0070	2	8	80	1	70	80	25550
Ethylbenzene	4.68E-08	1.47E-10	8.68E-06	0.0236	2	8	80	1	70	80	25550
Toluene	2.30E-08	7.21E-11	8.68E-06	0.0116	2	8	80	1	70	80	25550
Xylenes	8.37E-07	2.62E-09	8.68E-06	0.4218	2	8	80	1	70	80	25550
SEMIVOLATILES											
Bis(2-ethylhexyl)phthalate	1.27E-05	3.97E-08	8.68E-06	6.3869	2	8	80	1	70	80	25550
Di-N-Octylphthalate	3.97E-07	1.24E-09	8.68E-06	0.2000	2	8	80	1	70	80	25550
Butybenzylphthalate	4.76E-07	1.49E-09	8.68E-06	0.2400	2	8	80	1	70	80	25550
Phenanthrene	1.66E-06	5.20E-09	8.68E-06	0.8366	2	8	80	1	70	80	25550
Fluoranthene	2.68E-06	8.39E-09	8.68E-06	1.3511	2	8	80	1	70	80	25550
Pyrene	2.40E-06	7.51E-09	8.68E-06	1.2083	2	8	80	1	70	80	25550
Di-N-Butylphthalate	1.11E-05	3.49E-08	8.68E-06	5.6167	2	8	80	1	70	80	25550
Benzoic Acid	4.36E-07	1.37E-09	8.68E-06	0.2200	2	8	80	1	70	80	25550
Phenol	8.51E-06	2.67E-08	8.68E-06	4.2918	2	8	80	1	70	80	25550
p-cresol	6.75E-07	2.11E-09	8.68E-06	0.3400	2	8	80	1	70	80	25550
Diethylphthalate	2.18E-07	6.83E-10	8.68E-06	0.1100	2	8	80	1	70	80	25550
Fluoranthene	2.68E-06	8.39E-09	8.68E-06	1.3511	2	8	80	1	70	80	25550
Anthracene	2.98E-07	9.32E-10	8.68E-06	0.1500	2	8	80	1	70	80	25550
Fluorene	1.19E-06	3.74E-09	8.68E-06	0.6017	2	8	80	1	70	80	25550
Naphthalene	1.31E-06	4.10E-09	8.68E-06	0.6593	2	8	80	1	70	80	25550
Benzo(a)anthracene	8.55E-07	2.68E-09	8.68E-06	0.4311	2	8	80	1	70	80	25550
Benzo(a)pyrene	4.76E-07	1.49E-09	8.68E-06	0.2400	2	8	80	1	70	80	25550
Chrysene	8.54E-07	2.67E-09	8.68E-06	0.4302	2	8	80	1	70	80	25550
Benzo(b)fluoranthene	1.36E-06	4.26E-09	8.68E-06	0.6856	2	8	80	1	70	80	25550
Benzo(k)fluoranthene	7.75E-07	2.43E-09	8.68E-06	0.3908	2	8	80	1	70	80	25550

APPENDIX B

SUMMARY OF CANCER RISK ESTIMATES - CAP CONSTRUCTION (ALTERNATIVES 2, 2A, 4, AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL								2E-07
INORGANICS								
Arsenic	3.09E-08	No	1.75	A	Skin	Water/IRIS	5E-08	
Beryllium	3.58E-09	No	4.3	B2	Skin	Water/IRIS	2E-08	
Lead	2.69E-07	No	ND	B2	Renal	Oral/IRIS	NA	
SEMIVOLATILES								
Bis(2ethylhexyl)phthalate	2.86E-08	No	1.4E-02	B2	Liver	Diet/IRIS	4E-10	
Butylbenzylphthalate		No	ND	C		NF/IRIS	NA	
Benzo(a)anthracene	1.93E-09	No	11.50	B2		NA/IRIS	2E-08	
Benzo(a)pyrene	1.07E-09	No	11.50	B2	Stomach	Diet/IRIS	1E-08	
Chrysene	1.92E-09	No	11.50	B2		NA/IRIS	2E-08	
Benzo(b)fluoranthene	3.07E-09	No	11.50	B2		NA/IRIS	4E-08	
Benzo(k)fluoranthene	1.75E-09	No	11.50	B2		NA/IRIS	2E-08	
Dibenzo(a,h)anthracene	NA	No	11.50	B2		NA/IRIS	NA	
Indeno(123cd)pyrene	NA	No	11.50	B2		NA/IRIS	NA	
1,4-Dichlorobenzene	NA	No	2.4E-02	B2	Liver	Gavage/HEAST	NA	
PESTICIDES/PCBS								
4,4'-DDD	NA	No	2.4E-01	B2	Lung, Liver, Thyroid	Diet/IRIS	NA	
4,4'-DDE	NA	No	3.4E-01	B2	Liver,Thyroid	Diet/IRIS	NA	
4,4'-DDT	NA	No	3.4E-01	B2	Liver	Diet/IRIS	NA	

APPENDIX B

SUMMARY OF CANCER RISK ESTIMATES - CAP CONSTRUCTION (ALTERNATIVES 2, 2A, 4, AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL								5E-06
INORGANICS								
Arsenic	2.82E-07	0.10	1.75	A	Skin	Water/IRIS	5E-06	
SEMIVOLATILES								
Bis(2ethylhexyl)phthalate	2.61E-07	0.10	1.4E-02	B2	Liver	Diet/IRIS	4E-08	
Butylbenzylphthalate	NA	0.10	ND	C		NF/IRIS	NA	
Benzo(a)anthracene	1.76E-08	0.10	ND	B2		NA/IRIS	NA	
Benzo(a)pyrene	9.81E-09	0.10	ND	B2	Stomach	Diet/IRIS	NA	
Chrysene	1.76E-08	0.10	ND	B2		NA/IRIS	NA	
Benzo(b)fluoranthene	2.80E-08	0.10	ND	B2		NA/IRIS	NA	
Benzo(k)fluoranthene	1.60E-08	0.10	ND	B2		NA/IRIS	NA	
Dibenzo(a,h)anthracene	NA	0.10	ND	B2		NA/IRIS	NA	
Indeno(123cd)pyrene	NA	0.10	ND	B2		NA/IRIS	NA	
1,4-Dichlorobenzene	NA	0.10	2.4E-02	B2	Liver	Gavage/HEAST		
PESTICIDES/PCBS								
4,4'-DDD	NA	0.10	2.4E-01	B2	Lung, Liver, Thyroid	Diet/IRIS	NA	
4,4'-DDE	NA	0.10	3.4E-01	B2	Liver,Thyroid	Diet/IRIS	NA	
4,4'-DDT	NA	0.10	3.4E-01	B2	Liver	Diet/IRIS	NA	

APPENDIX B

SUMMARY OF CANCER RISK ESTIMATES - CAP CONSTRUCTION (ALTERNATIVES 2, 2A, 4, AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST								7E-06	1E-05
INORGANICS									
Arsenic	4.29E-08	No	50	A	Lung	Air/HEAST	2E-06		
Beryllium	4.97E-09	No	8.4				4E-08		
Cadmium	4.97E-09	No	6.1	B1		OCCUPA/HEAST	3E-08		
Chromium	1.14E-07	No	41	A	Lung	OCCUPA/HEAST	5E-06		
Nickel	1.31E-07	No	8.4E-01	A	Respiratory tract	OCCUPA/HEAST	1E-07		
SEMIVOLATILES									
Bis(2ethylhexyl)phthalate	3.97E-08	No	1.4E-02				6E-10		
Butylbenzylphthalate	NA	No	ND	C		NF/IRIS	NA		
Benzo(a)anthracene	2.68E-09	No	6.1	B2		NA/IRIS	2E-08		
Benzo(a)pyrene	1.49E-09	No	6.1	B2	Stomach	Diet/IRIS	9E-09		
Chrysene	2.67E-09	No	6.1	B2	Respiratory tract	NA/IRIS	2E-08		
Benzo(b)fluoranthene	4.26E-09	No	6.1	B2		NA/IRIS	3E-08		
Benzo(k)fluoranthene	2.43E-09	No	6.1	B2		NA/IRIS	1E-08		
Dibenzo(a,h)anthracene	NA	No	6.1	B2		NA/IRIS	NA		
Indeno(123cd)pyrene	NA	No	6.1	B2		NA/IRIS	NA		
1,4-Dichlorobenzene	NA	No	2.4E-02				NA		
PESTICIDES/PCBS									
4,4'-DDD	NA	No	2.4E-01	B2	Lung, Liver, Thyroid	Diet/IRIS	NA		
4,4'-DDE	NA	No	3.4E-01	B2	Liver, Thyroid	Diet/IRIS	NA		
4,4'-DDT	NA	No	3.4E-01	B2	Liver	Diet/IRIS	NA		

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - CAP CONSTRUCTION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL										1E-01
INORGANICS										
Aluminum	1.9E-02	No	DI						NA	
Antimony	3.3E-05	No	4E-04	Low	Longevity, blood glucose and cholesterol				8E-02	
Arsenic	9.9E-06	No	1E-03	NA	Keratosis and hyperpigmentation				1E-02	
Barium	1.7E-04	No	5E-02	Medium	Increased blood pressure				3E-03	
Beryllium	1.1E-06	No	5E-03	Low	None observed				2E-04	
Cadmium	1.1E-06	No	ND	High	Proteinuria				NA	
Chromium VI	2.6E-05	No	2E-02	Low	No effects reported				1E-03	
Cobalt	1.8E-05	No	NF						NA	
Copper	5.2E-05	No	4.0E-02	NA	Local GI irritation				1E-03	
Lead	8.6E-05	No	NA	NA	Neurobehaioral effects				NA	
Manganese	1.8E-03	No	1E-01	Medium	CNS effects				2E-02	
Mercury	0.0E+00	No	3E-04	NA	Kidney effects				NA	
Nickel	3.0E-05	No	2E-02	Medium	Decreased body and organ weight				2E-03	
Selenium	NA	No	NF						NA	
Vanadium	2.4E-05	No	7E-03	NA	None observed				3E-03	
Zinc	1.9E-04	No	2E-01	NA	Anemia				1E-03	
Cyanide	NA	No	2E-02	Medium	Weight loss, thyroid effects, myelin degeneration				NA	
SEMIVOLATILES										
Bis(2ethylhexyl)phthalate	9.1E-06	No	2E-02	Medium	Increased relative liver weight	Diet/IRIS	1000.00	1.00	NA 5E-04	
Butylbenzylphthalate	3.4E-07	No	2E+00	Low	Effects on body; weight gain, testes, liver, kidneys	Diet/IRIS	100.00	1.00	2E-07	
Benzo(a)anthracene	6.2E-07	No	NF			HEAST, IRIS			NA	
Benzo(a)pyrene	3.4E-07	No	NF			HEAST, IRIS			NA	
Chrysene	6.1E-07	No	DI			HEAST			NA	
Benzo(b)fluoranthene	9.8E-07	No	NF			HEAST, IRIS			NA	
Benzo(k)fluoranthene	5.6E-07	No	NF			HEAST, IRIS			NA	
Dibenzo(a,h)anthracene	NA	No	NF			HEAST, IRIS			NA	
Indeno(1,2,3-c,d)pyrene	NA	No	NF			HEAST, IRIS			NA	
1,4-Dichlorobenzene	NA	No	ND			HEAST, IRIS			NA	
Diethylphthalate	1.6E-07	No	8E+00	Low	Decreased growth rate, food consumption rate, altered organ weights	Diet/IRIS	1000.00	1.00	2E-08	
Di-n-butylphthalate	NA	No	1E+00	Low	Increased mortality	Diet/IRIS	1000.00	1.00	NA	
Di-n-octylphthalate	2.9E-07	No	2E-02	NA	Elevated liver and kidney weights increased SGOT and SPGT	Diet/HEAST	1000.00		1E-05	
Acenaphthene	NA	No	6E-01	Low	Hepatotoxicity	Oral/IRIS			NA	
Anthracene	2.1E-07	No	3E+00	Low	No observed effects	Gavage/IRIS			NA	
Benzo(g,h,i)perylene	NA	No	NF			HEAST/IRIS			7E-08	
Fluoranthene	1.9E-06	No	4E-01	Low	Neuropathy, liver weight changes hematological alterations and clinical effects	Gavage/IRIS			NA	
Fluorene	8.6E-07	No	4E-01	Low	Decreased RBC, packed cell volume and hemoglobin	Gavage/IRIS			5E-06	
p-Cresol	9.4E-07	No	NF			HEAST, IRIS			NA	
Naphthalene	9.4E-07	No	4E-02	NA	Ocular and internal lesions	Diet/HEAST			NA	
Pyrene	1.7E-06	No	3E-01	Low	Kidney effects	Gavage/IRIS			2E-05	
Phenanthrene	1.2E-06	No	DI			HEAST			6E-06	
Phenol	6.1E-06	No	0.60		Reduced fetal body weight	Gavage/HEAST	100		NA	
PESTICIDES/PCBS										
4,4'-DDD	NA	No	NF			HEAST, IRIS			NA	
4,4'-DDE	NA	No	NF			HEAST, IRIS			NA	
4,4'-DDT	NA	No	5E-04	Medium	Liver lesions	Diet/IRIS	100	1.00	NA	

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - CAP CONSTRUCTION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	COI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL										9E-01
INORGANICS										
Arsenic	9.0E-05	0.10	1E-03	NA	Keratosis and hyperpigmentation	NA/HEAST	1		9E-01	
SEMIVOLATILES										
Bis(2ethylhexyl)phthalate	8.3E-05	0.10	2E-02	Medium	Increased relative liver weight	Diet/IRIS	1000	1	4E-02	
Butylbenzylphthalate	3.1E-06	0.10	2E+00	Low	Effects on body; weight gain, testes, liver, kidneys	Diet/IRIS	100	1	2E-05	
Benzo(a)anthracene	5.6E-06	0.10	NF			HEAST, IRIS			NA	
Benzo(a)pyrene	3.1E-06	0.10	NF			HEAST, IRIS			NA	
Chrysene	5.6E-06	0.10	DI			HEAST			NA	
Benzo(b)fluoranthene	8.9E-06	0.10	NF			HEAST, IRIS			NA	
Benzo(k)fluoranthene	5.1E-06	0.10	NF			HEAST, IRIS			NA	
Dibenzo(a,h)anthracene	NA	0.10	NF			HEAST, IRIS			NA	
Indeno(1,2,3-c,d)pyrene	NA	0.10	NF			HEAST, IRIS			NA	
1,4-Dichlorobenzene	NA	0.10	ND			HEAST, IRIS			NA	
Diethylphthalate	1.4E-06	0.10	8E+00	Low	Decreased growth rate, food consumption rate, altered organ weights	Diet/IRIS	1000	1	2E-06	
Di-n-butylphthalate	NA	0.10	1E+00	Low	Increased mortality	Diet/IRIS	1000	1	NA	
Di-n-octylphthalate	2.6E-06	0.10	2E-02	NA	Elevated liver and kidney weights	Diet/HEAST	1000		1E-03	
		0.10			increased SGOT and SPGT					
		0.10								
Acenaphthene	NA	0.10	6E-01	Low	Hepatotoxicity	Oral/IRIS			NA	
Anthracene	2.0E-06	0.10	3E+00	Low	No observed effects	Gavage/IRIS			7E-06	
Benzo(g,h,i)perylene	NA	0.10	NF			HEAST/IRIS			NA	
Fluoranthene	1.8E-05	0.10	4E-01	Low	Neuropathy, liver weight changes hematological alterations and clinical effects	Gavage/IRIS			4E-04	
Fluorene	7.9E-06	0.10	4E-01	Low	Decreased RBC, packed cell volume and hemoglobin	Gavage/IRIS			2E-04	
P-Cresol	4.3E-06	0.10	5E-01	Medium	Decreased body weight, Neurotoxicity	IRIS	1000	1	9E-05	
Naphthalene	8.6E-06	0.10	4E-02	NA	Ocular and internal lesions	Diet/HEAST			2E-03	
Pyrene	1.6E-05	0.10	3E-01	Low	Kidney effects	Gavage/IRIS			5E-04	
Phenanthrene	1.1E-05	0.10	DI			HEAST			NA	
Phenol	5.6E-05	0.10	0.60		Reduced fetal body weight	Gavage/HEAST	100		9E-04	
PESTICIDES/PCBS		0.10								
4,4'-DDD	NA	0.10	NF			HEAST, IRIS			NA	
4,4'-DDE	NA	0.10	NF			HEAST, IRIS			NA	
4,4'-DDT	NA	0.10	5E-04	Medium	Liver lesions	Diet/IRIS	100	1	NA	

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - CAP CONSTRUCTION (ALTERNATIVES 2, 2A, 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)	TOTAL EXPOSURE HI
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST										1E+01	1E+01
INORGANICS											
Antimony	4.5E-05	No	4E-04						1E-01		
Arsenic	1.4E-05	No	1E-03						1E-02		
Barium	2.4E-04	No	1E-03						2E-01		
Beryllium	1.6E-06	No	0.01						3E-04		
Cadmium	1.6E-06	No	1E-03						2E-03		
Chromium	3.6E-05	No	6E-06	NA	Nasal mucosa atrophy	HEAST	300		6E+00		
Manganese	2.5E-03	No	4E-04	Medium	Increased prevalence of respiratory symtoms and psycho-motor disturbances	IRIS HEAST	300 900 1	3	6E+00		
Mercury	NA	No	1E-04	NA	Neurotoxicty	NA/HEAST	30		NA		
Nickel	4.2E-05	No	2E-02						2E-03		
Vanadium	3.3E-05	No	7E-03						5E-03		
Zinc	2.7E-04	No	2E-01						1E-03		
Cyanide	NA	No	2E-02						NA		
VOLATILES											
Carbon Disulfide	NA	No	1E-01						NA		
Chlorobenzene	1.4E-08	No	5E-02	NA	Liver and kidney effects	HEAST	10000		3E-07		
Ethylbenzene	4.7E-08	No	1E+00						5E-08		
Toluene	2.3E-08	No	2E+00	NA	CNS effects, eyes and nose irritation	HEAST	100		1E-08		
Xylenes	8.4E-07	No	3E-01	NA	CNS effects, eyes and nose irritation	HEAST	100		3E-06		
SEMIVOLATILES											
Bis(2ethylhexyl)phthalate	1.3E-05	No	2E-02						6E-04		
Butylbenzylphthalate	4.8E-07	No	2E+00						2E-07		
Benzo(a)anthracene	NA	No	NF			HEAST, IRIS			NA		
Benzo(a)pyrene	NA	No	NF			HEAST, IRIS			NA		
Chrysene	NA	No	DI			HEAST			NA		
Benzo(b)fluoranthene	NA	No	NF			HEAST, IRIS			NA		
Benzo(k)fluoranthene	NA	No	NF			HEAST, IRIS			NA		
Dibenzo(a,h)anthracene	NA	No	NF			HEAST, IRIS			NA		
Indeno(1,2,3-c,d)pyrene	NA	No	NF			HEAST, IRIS			NA		
1,4-Dichlorobenzene	NA	No	2E-01	NA	Liver and kidney effects	HEAST	100		NA		
Diethylphthalate	2.2E-07	No	8E+00						NA		
Di-n-butylphthalate	NA	No	1E+00						NA		
Di-n-octylphthalate	4.0E-07	No	2E-02						NA		
Acenaphthene	NA	No	6E-01						NA		
Anthracene	3.0E-07	No	3E+00						NA		
Benzo(g,h,i)perylene	NA	No	NF			HEAST/IRIS			NA		
Fluoranthene	2.7E-06	No	4E-01						7E-06		
Fluorene	1.2E-06	No	4E-01						3E-06		
p-Cresol	6.7E-07	No	5E-01						1E-06		
Naphthalene	1.3E-06	No	4E-02						3E-05		
Pyrene	2.4E-06	No	3E-01						8E-06		
Phenanthrene	NA	No	DI			HEAST			NA		
Phenol	NA	No	DI			HEAST			NA		
PESTICIDES/PCBS											
4,4'-DDD	NA	No	NF			HEAST, IRIS			NA		
4,4'-DDE	NA	No	NF			HEAST, IRIS			NA		
4,4'-DDT	NA	No	5E-04		Liver lession				NA		

APPENDIX B

INGESTION OF CHEMICALS IN SEDIMENTS - CHILDREN (ALTERNATIVES 2 AND 2A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	INTAKE (NONCANCER) (mg/kg/day)	INTAKE (CANCER) (mg/kg/day)	CONC. IN SEDIMENTS (mg/kg)	INGESTION RATE (mg soil/day)	CONVERSION FACTOR (1E-6 kg/mg)	FRACTION INGESTED (unitless)	EXPOSURE FREQUENCY (days/year)	EXPOSURE DURATION (years)	BODY WEIGHT (kg)	AVERAGING TIME (NONCANCER) (days)	AVERAGING TIME (CANCER) (days)
SEMIVOLATILES											
1,4-Dichlorobenzene	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Benzo(a)anthracene	7.7E-08	9.9E-09	1.1500	100	1E-06	1.00	12	9	49	3285	25550
Benzo(a)pyrene	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Benzo(b)fluoranthene	5.4E-08	6.9E-09	0.7990	100	1E-06	1.00	12	9	49	3285	25550
Benzo(k)fluoranthene	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Bis(2ethylhexyl)phthalate	1.5E-07	1.9E-08	2.2300	100	1E-06	1.00	12	9	49	3285	25550
Butylbenzylphthalate	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Chrysene	6.8E-08	8.8E-09	1.0200	100	1E-06	1.00	12	9	49	3285	25550
Dibenzoanthracene	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Indeno(123cd)pyrene	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
TOTAL CARC PAH		2.6E-08									
1,2-Dichlorobenzene	8.1E-09	1.0E-09	0.1200	100	1E-06	1.00	12	9	49	3285	25550
2,4-Dimethylphenol	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
4-Methylphenol	4.0E-09	5.1E-10	0.0590	100	1E-06	1.00	12	9	49	3285	25550
Acenaphthene	1.9E-08	2.4E-09	0.2800	100	1E-06	1.00	12	9	49	3285	25550
Anthracene	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Benzoic acid	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Benzo(g,h,i)perylene	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Diethylphthalate	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Di-n-butylphthalate	4.0E-08	5.1E-09	0.5900	100	1E-06	1.00	12	9	49	3285	25550
Dioctylphthalate	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Fluoranthene	9.7E-08	1.2E-08	1.4400	100	1E-06	1.00	12	9	49	3285	25550
Fluorene	2.5E-08	3.2E-09	0.3700	100	1E-06	1.00	12	9	49	3285	25550
Naphthalene	7.4E-08	9.6E-09	1.1100	100	1E-06	1.00	12	9	49	3285	25550
Phenanthrene	9.6E-08	1.2E-08	1.4300	100	1E-06	1.00	12	9	49	3285	25550
Phenol	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Pyrene	9.6E-08	1.2E-08	1.4300	100	1E-06	1.00	12	9	49	3285	25550
INORGANICS											
Aluminum	1.2E-03	1.6E-04	18014.80	100	1E-06	1.00	12	9	49	3285	25550
Antimony	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
Arsenic	8.8E-07	1.1E-07	13.10	100	1E-06	1.00	12	9	49	3285	25550
Barium	3.3E-05	4.2E-06	486.40	100	1E-06	1.00	12	9	49	3285	25550
Beryllium	1.5E-07	2.0E-08	2.30	100	1E-06	1.00	12	9	49	3285	25550
Cadmium	6.6E-07	8.5E-08	9.80	100	1E-06	1.00	12	9	49	3285	25550
Calcium	1.3E-03	1.7E-04	19684.70	100	1E-06	1.00	12	9	49	3285	25550
Chromium	1.7E-06	2.2E-07	25.60	100	1E-06	1.00	12	9	49	3285	25550
Cobalt	7.2E-07	9.3E-08	10.80	100	1E-06	1.00	12	9	49	3285	25550
Copper	2.5E-06	3.3E-07	38.00	100	1E-06	1.00	12	9	49	3285	25550
Iron	7.1E-03	9.1E-04	105995.00	100	1E-06	1.00	12	9	49	3285	25550
Lead	6.0E-06	7.8E-07	90.00	100	1E-06	1.00	12	9	49	3285	25550
Magnesium	1.7E-04	2.2E-05	2547.60	100	1E-06	1.00	12	9	49	3285	25550
Manganese	6.8E-04	8.8E-05	10161.60	100	1E-06	1.00	12	9	49	3285	25550
Mercury	3.4E-08	4.3E-09	0.50	100	1E-06	1.00	12	9	49	3285	25550
Nickel	1.5E-06	1.9E-07	21.90	100	1E-06	1.00	12	9	49	3285	25550
Potassium	8.5E-05	1.1E-05	1271.50	100	1E-06	1.00	12	9	49	3285	25550
Selenium	3.0E-07	3.9E-08	4.50	100	1E-06	1.00	12	9	49	3285	25550
Silver	3.7E-07	4.7E-08	5.50	100	1E-06	1.00	12	9	49	3285	25550
Sodium	4.6E-05	5.9E-06	688.50	100	1E-06	1.00	12	9	49	3285	25550
Thallium	1.5E-07	2.0E-08	2.30	100	1E-06	1.00	12	9	49	3285	25550
Vandium	2.1E-06	2.7E-07	30.90	100	1E-06	1.00	12	9	49	3285	25550
Zinc	1.7E-05	2.2E-06	259.80	100	1E-06	1.00	12	9	49	3285	25550
Cyanide	4.0E-07	5.2E-08	6.00	100	1E-06	1.00	12	9	49	3285	25550
PESTICIDES/PCBS											
4,4-DDD	2.6E-09	3.4E-10	0.0390	100	1E-06	1.00	12	9	49	3285	25550
4,4-DDE	0.0E+00	0.0E+00	NA	100	1E-06	1.00	12	9	49	3285	25550
4,4-DDT	3.6E-09	4.7E-10	0.0540	100	1E-06	1.00	12	9	49	3285	25550

APPENDIX B

DERMAL CONTACT WITH CHEMICALS IN SEDIMENTS - CHILDREN (ALTERNATIVES 2 AND 2A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	ABSORBED DOSE (NONCANCER) (mg/kg/day)	ABSORBED DOSE (CANCER) (mg/kg/day)	CONCENTRATION IN SEDIMENTS (mg/kg)	CONVERSION FACTOR (1E-6 kg/mg)	SKIN SURFACE AREA (cm2/event)	ADHERENCE FACTOR (mg/cm2)	ABSORPTION FACTOR (unitless)	EXPOSURE FREQUENCY (events/year)	EXPOSURE DURATION (years)	BODY WEIGHT (kg)	AVERAGING TIME (NONCANCER) (days)	AVERAGING TIME (CANCER) (days)
SEMIVOLATILES												
1,4-Dichlorobenzene	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Benzo(a)anthracene	7.6E-07	9.8E-08	1.1500	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Benzo(a)pyrene	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Benzo(b)fluoranthene	5.3E-07	6.8E-08	0.7990	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Benzo(k)fluoranthene	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Bis(2ethylhexyl)phthalate	1.5E-06	1.9E-07	2.2300	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Butylbenzylphthalate	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Chrysene	6.7E-07	8.7E-08	1.0200	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Dibenzoanthracene	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Indeno(123cd)pyrene	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
TOTAL CARC PAH		2.5E-07									3285	25550
											3285	25550
1,2-Dichlorobenzene	7.9E-08	1.0E-08	0.1200	1E-06	6800	1.45	0.10	12	9	49	3285	25550
2,4-Dimethylphenol	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
4-Methylphenol	3.9E-08	5.0E-09	0.0590	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Acenaphthene	1.9E-07	2.4E-08	0.2800	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Anthracene	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Benzoic acid	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Benzo(g,h,i)perylene	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Diethylphthalate	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Di-n-butylphthalate	3.9E-07	5.0E-08	0.5900	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Dioctylphthalate	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Fluoranthene	9.5E-07	1.2E-07	1.4400	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Fluorene	2.4E-07	3.1E-08	0.3700	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Naphthalene	7.3E-07	9.4E-08	1.1100	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Phenanthrene	9.5E-07	1.2E-07	1.4300	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Phenol	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Pyrene	9.5E-07	1.2E-07	1.4300	1E-06	6800	1.45	0.10	12	9	49	3285	25550
INORGANICS												
Aluminum	1.2E-03	1.5E-04	18014.80	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Antimony	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Arsenic	8.7E-06	1.1E-06	13.10	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Barium	3.2E-05	4.1E-06	486.40	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Beryllium	1.5E-07	2.0E-08	2.30	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Cadmium	6.5E-07	8.3E-08	9.80	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Calcium	1.3E-03	1.7E-04	19684.70	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Chromium	1.7E-06	2.2E-07	25.60	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Cobalt	7.1E-07	9.2E-08	10.80	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Copper	2.5E-06	3.2E-07	38.00	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Iron	7.0E-03	9.0E-04	105995.00	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Lead	6.0E-06	7.7E-07	90.00	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Magnesium	1.7E-04	2.2E-05	2547.60	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Manganese	6.7E-04	8.6E-05	10161.60	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Mercury	3.3E-08	4.3E-09	0.50	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Nickel	1.4E-06	1.9E-07	21.90	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Potassium	8.4E-05	1.1E-05	1271.50	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Selenium	3.0E-07	3.8E-08	4.50	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Silver	3.6E-07	4.7E-08	5.50	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Sodium	4.6E-05	5.9E-06	688.50	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Thallium	1.5E-07	2.0E-08	2.30	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Vandium	2.0E-06	2.6E-07	30.90	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Zinc	1.7E-05	2.2E-06	259.80	1E-06	6800	1.45	0.01	12	9	49	3285	25550
Cyanide	4.0E-07	5.1E-08	6.00	1E-06	6800	1.45	0.01	12	9	49	3285	25550
PESTICIDES/PCBS												
4,4-DDD	2.6E-08	3.3E-09	0.0390	1E-06	6800	1.45	0.10	12	9	49	3285	25550
4,4-DDE	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
4,4-DDT	3.6E-08	4.6E-09	0.0540	1E-06	6800	1.45	0.10	12	9	49	3285	25550
VOLATILES												
1,1-Dichloroethane	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
1,2-Dichloroethene	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Benzene	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Carbon disulfide	2.3E-08	3.0E-09	3.5E-02	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Chlorobenzene	6.7E-08	8.7E-09	1.0E-01	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Chloroethane	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Chloroform	6.6E-09	8.5E-10	1.0E-02	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Ethylbenzene	8.6E-09	1.1E-09	1.3E-02	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Toluene	1.8E-08	2.3E-09	2.7E-02	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Trichloroethene	0.0E+00	0.0E+00	NA	1E-06	6800	1.45	0.10	12	9	49	3285	25550
Xylenes	7.0E-08	9.0E-09	1.1E-01	1E-06	6800	1.45	0.10	12	9	49	3285	25550

SUMMARY OF CANCER RISK ESTIMATES: CHILDREN (ALTERNATIVES 2 AND 2A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK
EXPOSURE PATHWAY: INCIDENTAL INGESTION OF CHEMICALS IN SOIL - CHILDREN								6E-07
INORGANICS								
Arsenic	1.1E-07	No	1.8E+00	A	Bladder,Liver,Lung	Water/IRIS	2E-07	
Beryllium	2.0E-08	No	4.30	B2	Skin	Water/IRIS	9E-08	
Lead	7.8E-07	No	ND	B2	Renal	Oral/IRIS	NA	
SEMIVOLATILES								
Bis(2ethylhexyl)phthalate	1.9E-08	No	1.4E-02	B2	Liver	Diet/IRIS	3E-10	
Butylbenzylphthalate	NA	No	ND	C	Liver	NF/IRIS	NA	
Benzo(a)anthracene	9.9E-09	No	11.50	B2	Liver	NA/IRIS	1E-07	
Benzo(a)pyrene	0.0E+00	No	11.50	B2	Stomach	Diet/IRIS	0E+00	
Chrysene	8.8E-09	No	11.50	B2	Stomach	NA/IRIS	1E-07	
Benzo(b)fluoranthene	6.9E-09	No	11.50	B2	Stomach	NA/IRIS	8E-08	
Benzo(k)fluoranthene	0.0E+00	No	11.50	B2	Stomach	NA/IRIS	0E+00	
Dibenzo(a,h)anthracene	NA	No	11.50	B2	Stomach	NA/IRIS	NA	
Indeno(123cd)pyrene	0.0E+00	No	11.50	B2	Stomach	NA/IRIS	0E+00	
1,4-Dichlorobenzene	NA	No	2.4E-02	B2	Liver	Gavage/IRIS	NA	
PESTICIDES/PCBS								
4,4'-DDD	NA	No	2.4E-01	B2	Lung,Liver,Thyroid	Diet/IRIS	NA	
4,4'-DDE	0.0E+00	No	3.4E-01	B2	Liver,Thyroid	Diet/IRIS	0E+00	
4,4'-DDT	4.7E-10	No	3.4E-01	B2	Liver	Diet/IRIS	2E-10	

SUMMARY OF CANCER RISK ESTIMATES: CHILDREN (ALTERNATIVES 2 AND 2A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK	TOTAL RISK
EXPOSURE PATHWAY: DERMAL CONTACT WITH SOILS - CHILDREN								2E-05	2E-05
INORGANICS									
Arsenic	1.1E-06	0.10	1.8E+00	A	Bladder,Liver,Lung	Water/IRIS	2E-05		
SEMIVOLATILES									
Bis(2ethylhexyl)phthalate	1.9E-07	0.10	1.4E-02	B2	Liver	Diet/IRIS	3E-08		
Butylbenzylphthalate	NA	0.10	ND	C	Liver	NF/IRIS	NA		
Benzo(a)anthracene	NA	0.10	ND	B2	Liver	NA/IRIS	NA		
Benzo(a)pyrene	NA	0.10	ND	B2	Stomach	Diet/IRIS	NA		
Chrysene	NA	0.10	ND	B2	Stomach	NA/IRIS	NA		
Benzo(b)fluoranthene	NA	0.10	ND	B2	Stomach	NA/IRIS	NA		
Benzo(k)fluoranthene	NA	0.10	ND	B2	Stomach	NA/IRIS	NA		
Dibenzo(a,h)anthracene	NA	0.10	ND	B2	Stomach	NA/IRIS	NA		
Indeno(123cd)pyrene	0.0E+00	0.10	ND	B2	Stomach	NA/IRIS	NA		
1,4-Dichlorobenzene	NA	0.10	2.4E-02	B2	Liver	Gavage/IRIS	NA		
PESTICIDES/PCBS									
4,4'-DDD	NA	0.10	2.4E-01	B2	Lung,Liver,Thyroid	Diet/IRIS	NA		
4,4'-DDE	0.0E+00	0.10	3.4E-01	B2	Liver,Thyroid	Diet/IRIS	0E+00		
4,4'-DDT	4.6E-09	0.10	3.4E-01	B2	Liver	Diet/IRIS	2E-08		

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES: CHILDREN (ALTERNATIVES 2 AND 2A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)
EXPOSURE PATHWAY: INCIDENTAL INGESTION OF SOIL - CHILDREN										1E-02
INORGANICS										
Aluminum	1.2E-03	No	DI			HEAST			NA	
Antimony	NA	No	4E-04	Low	Longevity,blood glucose and cholesterol	Water/IRIS	1000	1	NA	
Arsenic	8.8E-07	No	1E-03	NA	Keratosis and hyperpigmentation	NA/IRIS	ERR		9E-04	
Barium	3.3E-05	No	7E-02	Medium	Increased blood pressure	Water/IRIS	3	I	5E-04	
Beryllium	1.5E-07	No	5E-03	Low	None observed	Water/IRIS	100	1	3E-05	
Cadmium	6.6E-07	No	5.0E-04	High	Proteinuria	Water/IRIS	10	1	1E-03	
Chromium VI	1.7E-06	No	5E-03	Low	No effect reported	Water/IRIS	500	1	3E-04	
Cobalt	7.2E-07	No	NF			IRIS/HEAST			NA	
Copper	2.5E-06	No	6.1E-02	NA	Local GI irritation	NA/HEAST	NA		4E-05	
Lead	6.0E-06	No	NA	NA	Neurobehavioral effects	NA/IRIS	NA	NA	NA	
Manganese	6.8E-04	No	1E-01	Medium	CNS effects	Diet/IRIS	1	1	7E-03	
Mercury	3.4E-08	No	3E-04	NA	Kidney effects	NA/HEAST			1E-04	
Nickel	1.5E-06	No	2E-02	Medium	Decreased body and organ weight	Diet/HEAST	100	3	7E-05	
Selenium	NA	No	NF			IRIS/HEAST			NA	
Vanadium	2.1E-06	No	7E-03	NA	None observed	Water/HEAST	100		3E-04	
Zinc	1.7E-05	No	2E-01	NA	Anemia	NA/HEAST	10		9E-05	
Cyanide	4.0E-07	No	2E-02	Medium	Weight loss, thyroid effects, myelin degeneration	Oral/IRIS	500		2E-05	
SEMIVOLATILES										
Bis(2ethylhexyl)phthalate	1.5E-07	No	2E-02	Medium	Increased relative liver weight	Diet/IRIS	1000	1	7E-06	
Butylbenzylphthalate	NA	No	2E-01	Low	Effects on body weight gain, testes,liver,kidney	Diet/IRIS	1000	1	NA	
Benzo(a)anthracene	7.7E-08	No	NF			IRIS/HEAST			NA	
Benzo(a)pyrene	0.0E+00	No	NF			IRIS/HEAST			NA	
Chrysene	6.8E-08	No	DI			HEAST			NA	
Benzo(b)fluoranthene	5.4E-08	No	NF			IRIS/HEAST			NA	
Benzo(k)fluoranthene	0.0E+00	No	NF			IRIS/HEAST			NA	
Dibenzo(a,h)anthracene	NA	No	NF			IRIS/HEAST			NA	
Indeno(1,2,3-c,d)pyrene	0.0E+00	No	NF			IRIS/HEAST			NA	
1,4-Dichlorobenzene	0.0E+00	No	2.4E-02			IRIS/HEAST			0E+00	
Diethylphthalate	0.0E+00	No	8E-01	Low	Decreased growth rate, food consumption rate and altered organ weights	Diet/IRIS	1000	1	0E+00	
Di-n-butylphthalate	4.0E-08	No	1E-01	Low	Increased mortality	Diet/IRIS	1000	1	4E-07	
Di-n-octylphthalate	NA	No	2E-02	NA	Elevated kidney and liver weights, increased SGOT and SGPT	Diet/HEAST	1000		NA	
Acenaphthene	1.9E-08	No	6E-02	Low	Hepatotoxicity	Oral/IRIS	3000	1	3E-07	
Anthracene	0.0E+00	No	3E-01	Low	No observed effect	Gravage/IRIS	3000	1	0E+00	
Benzo(g,h,i)perylene	0.0E+00	No	NF			IRIS/HEAST			NA	
Fluoranthene	9.7E-08	No	4E-02	Low	Neuopathy,liver weight changes hematological alterations and clinical effects	Gavage/IRIS	3000	1	2E-06	
Fluorene	2.5E-08	No	4E-02	Low	Decreased RBC,packed cell volume and hemaglobin	Gavage/IRIS	3000	1	6E-07	
4-Methylphenol	NA	No	NF			IRIS/HEAST			NA	
Naphthalene	7.4E-08	No	4E-03	NA	Ocular and internal lesions	Diet/HEAST	10,000		2E-05	
Pyrene	9.6E-08	No	3E-02	Low	Kidney effects	Gavage/IRIS	3000	1	3E-06	
Phenanthrene	9.6E-08	No	DI			HEAST			NA	
Phenol	0.0E+00	No	0.60	Low	Reduced fetal body weight	IRIS	100	1	0E+00	
PESTICIDES/PCBS										
4,4'-DDD	NA	No	NF			IRIS/HEAST			NA	
4,4'-DDE	0.0E+00	No	NF			IRIS/HEAST			NA	
4,4'-DDT	3.6E-09	No	5E-04	Medium	Liver lesions	Diet/IRIS	100	1	7E-06	

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES: CHILDREN (ALTERNATIVES 2 AND 2A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)	TOTAL HAZARD INDEX (HI)
EXPOSURE PATHWAY: DERMAL CONTACT WITH SOIL - CHILDREN										9E-02	1E-01
INORGANICS											
Arsenic	8.7E-06	0.10	1E-03		Keratosis and hyperpigmentation	NA/IRIS	ERR		9E-02		
VOLATILES											
Carbon Disulfide	NA	0.10	1E-01	Medium	Fetal toxicity, Malformation	Inhalation/IRIS	100	1	NA		
Chlorobenzene	NA	0.10	2E-02	Medium	Histopathological changes in the liver	Oral/IRIS	1000	1	NA		
Ethylbenzene	NA	0.10	1E-01	Low	Liver and kidney toxicity	Oral/IRIS	1000	1	NA		
Toluene	NA	0.10	2E-01	Medium	Changes in liver and kidney	Gavage/IRIS	1000	1	NA		
Xylenes	NA	0.10	2E+00	Medium	Hyperactivity,decreased body weight	Gavage/IRIS	100	1	NA		
SEMIVOLATILES											
Bis(2ethylhexyl)phthalate	1.5E-06	0.10	2E-02	Medium	Increased relative liver weight	Diet/IRIS	1000	1	7E-04		
Butylbenzylphthalate	NA	0.10	2E-01	Low	Effects on body weight gain, testes,liver,kidney	Diet/IRIS	1000	1	NA		
Benzo(a)anthracene	7.6E-07	0.10	NF			IRIS/HEAST			NA		
Benzo(a)pyrene	0.0E+00	0.10	NF			IRIS/HEAST			NA		
Chrysene	6.7E-07	0.10	DI			HEAST			NA		
Benzo(b)fluoranthene	5.3E-07	0.10	NF			IRIS/HEAST			NA		
Benzo(k)fluoranthene	0.0E+00	0.10	NF			IRIS/HEAST			NA		
Dibenzo(a,h)anthracene	NA	0.10	NF			IRIS/HEAST			NA		
Indeno(1,2,3-c,d)pyrene*	0.0E+00	0.10	NF			IRIS/HEAST			NA		
1,4-Dichlorobenzene	0.0E+00	0.10	2.4E-02			IRIS/HEAST			0E+00		
Diethylphthalate	0.0E+00	0.10	8E-01	Low	Decreased growth rate, food consumption rate and altered organ weights	Diet/IRIS	1000	1	0E+00		
Di-n-butylphthalate	3.9E-07	0.10	1E-01	Low	Increased mortality	Diet/IRIS	1000	1	4E-05		
Di-n-octylphthalate	NA	0.10	2E-02	NA	Elevated kidney and liver weights, increased SGOT and SGPT	Diet/HEAST	1000		NA		
Acenaphthene	1.9E-07	0.10	6E-02	Low	Hepatotoxicity	Oral/IRIS	3000	1	3E-05		
Anthracene	0.0E+00	0.10	3E-01	Low	No observed effect	Gravage/IRIS	3000	1	0E+00		
Benzo(g,h,i)perylene	0.0E+00	0.10	NF			IRIS/HEAST			NA		
Fluoranthene	9.5E-07	0.10	4E-02	Low	Neuopathy,liver weight changes hematological alterations and clinical effects	Gavage/IRIS	3000	1	2E-04		
Fluorene	2.4E-07	0.10	4E-02	Low	Decreased RBC,packed cell volume and hemaglobin	Gavage/IRIS	3000	1	6E-05		
4-Methylphenol	NA	0.10	NF			IRIS/HEAST			NA		
Naphthalene	7.3E-07	0.10	4E-03	NA	Ocular and internal lesions	Diet/HEAST	10,000		2E-03		
Pyrene	9.5E-07	0.10	3E-02	Low	Kidney effects	Gavage/IRIS	3000	1	3E-04		
Phenanthrene	9.5E-07	0.10	DI			HEAST			NA		
Phenol	0.0E+00	0.10	0.60	Low	Reduced fetal body weight	IRIS	100	1	0E+00		
PESTICIDES/PCBS											
4,4'-DDD	2.6E-08	0.10	NF			IRIS/HEAST			NA		
4,4'-DDE	0.0E+00	0.10	NF			IRIS/HEAST			NA		
4,4'-DDT	3.6E-08	0.10	5E-04	Medium	Liver lisions	Diet/IRIS	100	1	7E-04		

APPENDIX B

INGESTION OF CHEMICALS IN SOIL
WELL CONSTRUCTION (ALTERNATIVES 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	INTAKE NONCANCER (mg/kg/day)	INTAKE CANCER (mg/kg/day)	CONC. IN SOIL (mg/kg)	INGESTION RATE (mg soil/day)	CONVERSION FACTOR (10E-6 kg/mg)	FRACTION INGESTED (unitless)	EXPOSURE FREQUENCY (days/year)	EXPOSURE DURATION (years)	BODY WEIGHT (kg)	AVG. TIME NONCANCER (days)	AVG. TIME CANCER (days)
SEMIVOLATILES											
Benzo(a)anthracene	6.16E-07	6.03E-09	0.4311	100	1.0E-06	1	250	1	70	250	25550
Chrysene	6.15E-07	6.01E-09	0.4302	100	1.0E-06	1	250	1	70	250	25550
Benzo(b)fluoranthene	9.79E-07	9.58E-09	0.6856	100	1.0E-06	1	250	1	70	250	25550
Benzo(k)fluoranthene	5.58E-07	5.46E-09	0.3908	100	1.0E-06	1	250	1	70	250	25550
Benzo(a)pyrene	3.43E-07	3.35E-09	0.2400	100	1.0E-06	1	250	1	70	250	25550
Indeno(123cd)pyrene	6.13E-06	6.00E-08	4.2918	100	1.0E-06	1	250	1	70	250	25550
Bis(2ethylhexyl)phthalate	9.12E-06	8.93E-08	6.3869	100	1.0E-06	1	250	1	70	250	25550
Naphthalene	9.42E-07	9.22E-09	0.6593	100	1.0E-06	1	250	1	70	250	25550
Fluorene	8.60E-07	8.41E-09	0.6017	100	1.0E-06	1	250	1	70	250	25550
Phenanthrene	1.20E-06	1.17E-08	0.8366	100	1.0E-06	1	250	1	70	250	25550
Anthracene	2.14E-07	2.10E-09	0.1500	100	1.0E-06	1	250	1	70	250	25550
Fluoranthene	1.93E-06	1.89E-08	1.3511	100	1.0E-06	1	250	1	70	250	25550
Pyrene	1.73E-06	1.69E-08	1.2083	100	1.0E-06	1	250	1	70	250	25550
Benzo(ghi)perylene	6.13E-06	6.00E-08	4.2918	100	1.0E-06	1	250	1	70	250	25550
Diethylphthalate	1.57E-07	1.54E-09	0.1100	100	1.0E-06	1	250	1	70	250	25550
Di-n-butylphthalate	8.02E-06	7.85E-08	5.6167	100	1.0E-06	1	250	1	70	250	25550
Di-n-octylphthalate	2.86E-07	2.80E-09	0.2000	100	1.0E-06	1	250	1	70	250	25550
Butylbenzylphthalate	3.43E-07	3.35E-09	0.2400	100	1.0E-06	1	250	1	70	250	25550
P-Cresol	4.86E-07	4.75E-09	0.3400	100	1.0E-06	1	250	1	70	250	25550
Phenol	6.13E-06	6.00E-08	4.2918	100	1.0E-06	1	250	1	70	250	25550
INORGANICS											
Aluminium	1.89E-02	1.85E-04	13255.5	100	1.0E-06	1	250	1	70	250	25550
Antimony	3.26E-05	3.19E-07	22.8	100	1.0E-06	1	250	1	70	250	25550
Arsenic	9.86E-06	9.64E-08	6.9	100	1.0E-06	1	250	1	70	250	25550
Barium	1.70E-04	1.66E-06	118.8	100	1.0E-06	1	250	1	70	250	25550
Beryllium	1.14E-06	1.12E-08	0.80	100	1.0E-06	1	250	1	70	250	25550
Cadmium	1.14E-06	1.12E-08	0.80	100	1.0E-06	1	250	1	70	250	25550
Calcium	2.46E-03	2.41E-05	1722.8	100	1.0E-06	1	250	1	70	250	25550
Chromium	2.61E-05	2.56E-07	18.3	100	1.0E-06	1	250	1	70	250	25550
Cobalt	1.79E-05	1.75E-07	12.5	100	1.0E-06	1	250	1	70	250	25550
Copper	5.16E-05	5.05E-07	36.1	100	1.0E-06	1	250	1	70	250	25550
Iron	3.47E-02	3.39E-04	24278.1	100	1.0E-06	1	250	1	70	250	25550
Lead	8.59E-05	8.40E-07	60.1	100	1.0E-06	1	250	1	70	250	25550
Magnesium	7.08E-03	6.93E-05	4954.3	100	1.0E-06	1	250	1	70	250	25550
Manganese	1.79E-03	1.75E-05	1250.2	100	1.0E-06	1	250	1	70	250	25550
Mercury	0.00E+00	0.00E+00		100	1.0E-06	1	250	1	70	250	25550
Nickel	3.01E-05	2.95E-07	21.1	100	1.0E-06	1	250	1	70	250	25550
Potassium	1.91E-03	1.87E-05	1334.6	100	1.0E-06	1	250	1	70	250	25550
Selenium	5.71E-07	5.59E-09	0.4	100	1.0E-06	1	250	1	70	250	25550
Sodium	2.74E-04	2.68E-06	191.5	100	1.0E-06	1	250	1	70	250	25550
Thallium	0.00E+00	0.00E+00		100	1.0E-06	1	250	1	70	250	25550
Vandium	2.40E-05	2.35E-07	16.8	100	1.0E-06	1	250	1	70	250	25550
Zinc	1.92E-04	1.87E-06	134.1	100	1.0E-06	1	250	1	70	250	25550
PESTICIDES/PCBS											
4,4-DDE	5.87E-08	5.75E-10	0.0411	100	1.0E-06	1	250	1	70	250	25550
4,4-DDT	5.87E-08	5.75E-10	0.0411	100	1.0E-06	1	250	1	70	250	25550

APPENDIX B

DERMAL CONTACT WITH CHEMICALS IN SOIL
WELL CONSTRUCTION (ALTERNATIVES 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	ABS. DOSE NONCANCER (mg/kg/day)	ABS. DOSE CANCER (mg/kg/day)	CONC. IN SOIL (mg/kg)	CONVERSION FACTOR (kg/mg)	SURFACE AREA SKIN (cm2/event)	ADHERENCE FACTOR (mg/cm2)	ABSORPTION FACTOR (unitless)	EXPOSURE FREQUENCY (days/year)	EXPOSURE DURATION (years)	BODY WEIGHT (kg)	AVG. TIME NONCANCER (days)	AVG. TIME CANCER (days)
SEMIVOLATILES												
Benzo(a)anthracene	5.63E-06	5.50E-08	0.4311	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Chrysene	5.61E-06	5.49E-08	0.4302	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Benzo(b)fluoranthene	8.95E-06	8.75E-08	0.6856	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Benzo(k)fluoranthene	5.10E-06	4.99E-08	0.3908	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Benzo(a)pyrene	3.13E-06	3.06E-08	0.2400	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Indeno(123cd)pyrene	5.60E-05	5.48E-07	4.2918	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Bis(2ethylhexyl)phthalate	8.33E-05	8.16E-07	6.3869	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Di-N-Octylphthalate	2.61E-06	2.55E-08	0.2000	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Butybenzylphthalate	3.13E-06	3.06E-08	0.2400	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
P-Cresol	4.44E-06	4.34E-08	0.3400	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Naphthalene	8.60E-06	8.42E-08	0.6593	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Fluorene	7.85E-06	7.68E-08	0.6017	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Phenanthrene	1.09E-05	1.07E-07	0.8366	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Anthracene	1.96E-06	1.92E-08	0.1500	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Fluoranthene	1.76E-05	1.73E-07	1.3511	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Pyrene	1.58E-05	1.54E-07	1.2083	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Benzo(ghi)perylene	5.60E-05	5.48E-07	4.2918	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Diethylphthalate	1.44E-06	1.40E-08	0.1100	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Di-n-butylphthalate	7.33E-05	7.17E-07	5.6167	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Phenol	5.60E-05	5.48E-07	4.2918	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
INORGANICS												
Aluminium	1.73E-02	1.69E-04	13255.5	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Antimony	2.98E-05	2.91E-07	22.8	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Arsenic	9.00E-05	8.81E-07	6.9	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
Barium	1.55E-04	1.52E-06	118.8	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Beryllium	1.04E-06	1.02E-08	0.80	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Cadmium	1.04E-06	1.02E-08	0.80	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Calcium	2.25E-03	2.20E-05	1722.8	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Chromium	2.39E-05	2.34E-07	18.3	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Cobalt	1.63E-05	1.60E-07	12.5	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Copper	4.71E-05	4.61E-07	36.1	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Iron	3.17E-02	3.10E-04	24278.1	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Lead	7.84E-05	7.67E-07	60.1	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Magnesium	6.47E-03	6.33E-05	4954.3	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Manganese	1.63E-03	1.60E-05	1250.2	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Nickel	2.75E-05	2.69E-07	21.1	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Potassium	1.74E-03	1.70E-05	1334.6	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Selenium	5.22E-07	5.11E-09	0.4	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Sodium	2.50E-04	2.45E-06	191.5	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Vandium	2.19E-05	2.15E-07	16.8	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
Zinc	1.75E-04	1.71E-06	134.1	1.0E-06	6300	1.45	0.01	250	1	70	250	25550
PESTICIDES/PCBS												
4,4-DDE	5.36E-07	5.25E-09	0.0411	1.0E-06	6300	1.45	0.10	250	1	70	250	25550
4,4-DDT	5.36E-07	5.25E-09	0.0411	1.0E-06	6300	1.45	0.10	250	1	70	250	25550

APPENDIX B

INHALATION OF CHEMICALS BORN ON DUST PARTICLES
WELL CONSTRUCTION (ALTERNATIVES 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	INTAKE NONCANCER (mg/kg/day)	INTAKE CANCER (mg/kg/day)	DUST CONC. ON SITE (kg/m3)	CONC. IN SOIL (mg/kg)	INHALTION RATE (m3/hour)	EXPOSURE TIME (hours/day)	EXPOSURE FREQUENCY (days/year)	EXPOSURE DURATION (years)	BODY WEIGHT (kg)	AVG. TIME NONCANCER (days)	AVG. TIME CANCER (days)
INORGANICS											
Aluminium	2.63E-02	2.57E-04	8.68E-06	13255.5	2	8	250	1	70	250	25550
Antimony	4.52E-05	4.43E-07	8.68E-06	22.8	2	8	250	1	70	250	25550
Arsenic	1.37E-05	1.34E-07	8.68E-06	6.9	2	8	250	1	70	250	25550
Barium	2.36E-04	2.31E-06	8.68E-06	118.8	2	8	250	1	70	250	25550
Beryllium	1.59E-06	1.55E-08	8.68E-06	0.8	2	8	250	1	70	250	25550
Cadmium	1.59E-06	1.55E-08	8.68E-06	0.8	2	8	250	1	70	250	25550
Calcium	3.42E-03	3.34E-05	8.68E-06	1722.8	2	8	250	1	70	250	25550
Chromium	3.63E-05	3.55E-07	8.68E-06	18.3	2	8	250	1	70	250	25550
Cobalt	2.48E-05	2.43E-07	8.68E-06	12.5	2	8	250	1	70	250	25550
Copper	7.16E-05	7.01E-07	8.68E-06	36.1	2	8	250	1	70	250	25550
Iron	4.82E-02	4.71E-04	8.68E-06	24278.1	2	8	250	1	70	250	25550
Lead	1.19E-04	1.17E-06	8.68E-06	60.1	2	8	250	1	70	250	25550
Magnesium	9.83E-03	9.62E-05	8.68E-06	4954.3	2	8	250	1	70	250	25550
Manganese	2.48E-03	2.43E-05	8.68E-06	1250.2	2	8	250	1	70	250	25550
Nickel	4.19E-05	4.10E-07	8.68E-06	21.1	2	8	250	1	70	250	25550
Potassium	2.65E-03	2.59E-05	8.68E-06	1334.6	2	8	250	1	70	250	25550
Sodium	3.80E-04	3.72E-06	8.68E-06	191.5	2	8	250	1	70	250	25550
Vanadium	3.33E-05	3.26E-07	8.68E-06	16.8	2	8	250	1	70	250	25550
Zinc	2.66E-04	2.60E-06	8.68E-06	134.1	2	8	250	1	70	250	25550
VOLATILES											
Carbon Disulfide	5.95E-09	5.82E-11	8.68E-06	0.0030	2	8	250	1	70	250	25550
Chlorobenzene	1.39E-08	1.36E-10	8.68E-06	0.0070	2	8	250	1	70	250	25550
Ethylbenzene	4.68E-08	4.58E-10	8.68E-06	0.0236	2	8	250	1	70	250	25550
Toluene	2.30E-08	2.25E-10	8.68E-06	0.0116	2	8	250	1	70	250	25550
Xylenes	8.37E-07	8.19E-09	8.68E-06	0.4218	2	8	250	1	70	250	25550
SEMIVOLATILES											
Bis(2-ethylhexyl)phthalate	1.27E-05	1.24E-07	8.68E-06	6.3869	2	8	250	1	70	250	25550
Di-N-Octylphthalate	3.97E-07	3.88E-09	8.68E-06	0.2000	2	8	250	1	70	250	25550
Butybenzylphthalate	4.76E-07	4.66E-09	8.68E-06	0.2400	2	8	250	1	70	250	25550
Phenanthrene	1.66E-06	1.62E-08	8.68E-06	0.8366	2	8	250	1	70	250	25550
Fluoranthene	2.68E-06	2.62E-08	8.68E-06	1.3511	2	8	250	1	70	250	25550
Pyrene	2.40E-06	2.35E-08	8.68E-06	1.2083	2	8	250	1	70	250	25550
Di-N-Butylphthalate	1.11E-05	1.09E-07	8.68E-06	5.6167	2	8	250	1	70	250	25550
Benzoic Acid	4.36E-07	4.27E-09	8.68E-06	0.2200	2	8	250	1	70	250	25550
Phenol	8.51E-06	8.33E-08	8.68E-06	4.2918	2	8	250	1	70	250	25550
p-cresol	6.75E-07	6.60E-09	8.68E-06	0.3400	2	8	250	1	70	250	25550
Diethylphthalate	2.18E-07	2.14E-09	8.68E-06	0.1100	2	8	250	1	70	250	25550
Fluoranthene	2.68E-06	2.62E-08	8.68E-06	1.3511	2	8	250	1	70	250	25550
Anthracene	2.98E-07	2.91E-09	8.68E-06	0.1500	2	8	250	1	70	250	25550
Fluorene	1.19E-06	1.17E-08	8.68E-06	0.6017	2	8	250	1	70	250	25550
Naphthalene	1.31E-06	1.28E-08	8.68E-06	0.6593	2	8	250	1	70	250	25550
Benzo(a)anthracene	8.55E-07	8.37E-09	8.68E-06	0.4311	2	8	250	1	70	250	25550
Benzo(a)pyrene	4.76E-07	4.66E-09	8.68E-06	0.2400	2	8	250	1	70	250	25550
Chrysene	8.54E-07	8.35E-09	8.68E-06	0.4302	2	8	250	1	70	250	25550
Benzo(b)fluoranthene	1.36E-06	1.33E-08	8.68E-06	0.6856	2	8	250	1	70	250	25550
Benzo(k)fluoranthene	7.75E-07	7.59E-09	8.68E-06	0.3908	2	8	250	1	70	250	25550

APPENDIX B

SUMMARY OF CANCER RISK ESTIMATES - WELL CONSTRUCTION (ALTERNATIVES 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL								6E-07
INORGANICS								
Arsenic	9.64E-08	No	1.75	A	Skin	Water/IRIS	2E-07	
Beryllium	1.12E-08	No	4.3	B2	Skin	Water/IRIS	5E-08	
Lead	8.40E-07	No	ND	B2	Renal	Oral/IRIS	NA	
SEMIVOLATILES								
Bis(2ethylhexyl)phthalate	8.93E-08	No	1.4E-02	B2	Liver	Diet/IRIS	1E-09	
Butylbenzylphthalate		No	ND	C		NF/IRIS	NA	
Benzo(a)anthracene	6.03E-09	No	11.50	B2		NA/IRIS	7E-08	
Benzo(a)pyrene	3.35E-09	No	11.50	B2	Stomach	Diet/IRIS	4E-08	
Chrysene	6.01E-09	No	11.50	B2		NA/IRIS	7E-08	
Benzo(b)fluoranthene	9.58E-09	No	11.50	B2		NA/IRIS	1E-07	
Benzo(k)fluoranthene	5.46E-09	No	11.50	B2		NA/IRIS	6E-08	
Dibenzo(a,h)anthracene	NA	No	11.50	B2		NA/IRIS	NA	
Indeno(123cd)pyrene	NA	No	11.50	B2		NA/IRIS	NA	
1,4-Dichlorobenzene	NA	No	2.4E-02	B2	Liver	Gavage/HEAST	NA	
PESTICIDES/PCBS								
4,4'-DDD	NA	No	2.4E-01	B2	Lung, Liver, Thyroid	Diet/IRIS	NA	
4,4'-DDE	NA	No	3.4E-01	B2	Liver,Thyroid	Diet/IRIS	NA	
4,4'-DDT	NA	No	3.4E-01	B2	Liver	Diet/IRIS	NA	

APPENDIX B

SUMMARY OF CANCER RISK ESTIMATES - WELL CONSTRUCTION (ALTERNATIVES 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL								2E-05
INORGANICS								
Arsenic	8.81E-07	0.10	1.75	A	Skin	Water/IRIS	2E-05	
SEMIVOLATILES								
Bis(2ethylhexyl)phthalate	8.16E-07	0.10	1.4E-02	B2	Liver	Diet/IRIS	1E-07	
Butylbenzylphthalate	NA	0.10	ND	C		NF/IRIS	NA	
Benzo(a)anthracene	5.50E-08	0.10	ND	B2		NA/IRIS	NA	
Benzo(a)pyrene	3.06E-08	0.10	ND	B2	Stomach	Diet/IRIS	NA	
Chrysene	5.49E-08	0.10	ND	B2		NA/IRIS	NA	
Benzo(b)fluoranthene	8.75E-08	0.10	ND	B2		NA/IRIS	NA	
Benzo(k)fluoranthene	4.99E-08	0.10	ND	B2		NA/IRIS	NA	
Dibenzo(a,h)anthracene	NA	0.10	ND	B2		NA/IRIS	NA	
Indeno(123cd)pyrene	NA	0.10	ND	B2		NA/IRIS	NA	
1,4-Dichlorobenzene	NA	0.10	2.4E-02	B2	Liver	Gavage/HEASI		
PESTICIDES/PCBS								
4,4'-DDD	NA	0.10	2.4E-01	B2	Lung, Liver, Thyroid	Diet/IRIS	NA	
4,4'-DDE	NA	0.10	3.4E-01	B2	Liver,Thyroid	Diet/IRIS	NA	
4,4'-DDT	NA	0.10	3.4E-01	B2	Liver	Diet/IRIS	NA	

APPENDIX B

SUMMARY OF CANCER RISK ESTIMATES - WELL CONSTRUCTION (ALTERNATIVES 4 AND 4A)

HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	CHRONIC DAILY INTAKE(CDI) (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST								2E-05	4E-05
INORGANICS									
Arsenic	1.34E-07	No	50	A	Lung	Air/HEAST	7E-06		
Beryllium	1.55E-08	No	8.4				1E-07		
Cadmium	1.55E-08	No	6.1	B1		OCCUPA/HEAST	9E-08		
Chromium	3.55E-07	No	41	A	Lung	OCCUPA/HEAST	1E-05		
Nickel	4.10E-07	No	8.4E-01	A	Respiratory tract	OCCUPA/HEAST	3E-07		
SEMIVOLATILES									
Bis(2ethylhexyl)phthalate	1.24E-07	No	1.4E-02				2E-09		
Butylbenzylphthalate	NA	No	ND	C		NF/IRIS	NA		
Benzo(a)anthracene	8.37E-09	No	6.1	B2		NA/IRIS	5E-08		
Benzo(a)pyrene	4.66E-09	No	6.1	B2	Stomach	Diet/IRIS	3E-08		
Chrysene	8.35E-09	No	6.1	B2	Respiratory tract	NA/IRIS	5E-08		
Benzo(b)fluoranthene	1.33E-08	No	6.1	B2		NA/IRIS	8E-08		
Benzo(k)fluoranthene	7.59E-09	No	6.1	B2		NA/IRIS	5E-08		
Dibenzo(a,h)anthracene	NA	No	6.1	B2		NA/IRIS	NA		
Indeno(123cd)pyrene	NA	No	6.1	B2		NA/IRIS	NA		
1,4-Dichlorobenzene	NA	No	2.4E-02				NA		
PESTICIDES/PCBS									
4,4'-DDD	NA	No	2.4E-01	B2	Lung, Liver, Thyroid	Diet/IRIS	NA		
4,4'-DDE	NA	No	3.4E-01	B2	Liver, Thyroid	Diet/IRIS	NA		
4,4'-DDT	NA	No	3.4E-01	B2	Liver	Diet/IRIS	NA		

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - WELL CONSTRUCTION (ALTERNATIVE 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL										1E-01
INORGANICS										
Aluminum	1.9E-02	No	DI						NA	
Antimony	3.3E-05	No	4E-04	Low	Longevity, blood glucose and cholesterol				8E-02	
Arsenic	9.9E-06	No	1E-03	NA	Keratosis and hyperpigmentation				1E-02	
Barium	1.7E-04	No	5E-02	Medium	Increased blood pressure				3E-03	
Beryllium	1.1E-06	No	5E-03	Low	None observed				2E-04	
Cadmium	1.1E-06	No	ND	High	Proteinuria				NA	
Chromium VI	2.6E-05	No	2E-02	Low	No effects reported				1E-03	
Cobalt	1.8E-05	No	NF						NA	
Copper	5.2E-05	No	4.0E-02	NA	Local GI irritation				1E-03	
Lead	8.6E-05	No	NA	NA	Neurobehaioral effects				NA	
Manganese	1.8E-03	No	1E-01	Medium	CNS effects				2E-02	
Mercury	0.0E+00	No	3E-04	NA	Kidney effects				NA	
Nickel	3.0E-05	No	2E-02	Medium	Decreased body and organ weight				2E-03	
Selenium	NA	No	NF						NA	
Vanadium	2.4E-05	No	7E-03	NA	None observed				3E-03	
Zinc	1.9E-04	No	2E-01	NA	Anemia				1E-03	
Cyanide	NA	No	2E-02	Medium	Weight loss, thyroid effects, myelin degeneration				NA	
SEMIVOLATILES										
Bis(2ethylhexyl)phthalate	9.1E-06	No	2E-02	Medium	Increased relative liver weight	Diet/IRIS	1000.00	1.00	NA 5E-04	
Butylbenzylphthalate	3.4E-07	No	2E+00	Low	Effects on body; weight gain, testes, liver, kidneys	Diet/IRIS	100.00	1.00	2E-07	
Benzo(a)anthracene	6.2E-07	No	NF			HEAST, IRIS			NA NA	
Benzo(a)pyrene	3.4E-07	No	NF			HEAST, IRIS			NA	
Chrysene*	6.1E-07	No	DI			HEAST			NA	
Benzo(b)fluoranthene	9.8E-07	No	NF			HEAST, IRIS			NA	
Benzo(k)fluoranthene	5.6E-07	No	NF			HEAST, IRIS			NA	
Dibenzo(a,h)anthracene	NA	No	NF			HEAST, IRIS			NA	
Indeno(1,2,3-c,d)pyrene	NA	No	NF			HEAST, IRIS			NA	
1,4-Dichlorobenzene	NA	No	ND			HEAST, IRIS			NA	
Diethylphthalate	1.6E-07	No	8E+00	Low	Decreased growth rate, food consumption rate, altered organ weights	Diet/IRIS	1000.00	1.00	2E-08	
Di-n-butylphthalate	NA	No	1E+00	Low	Increased mortality	Diet/IRIS	1000.00	1.00	NA	
Di-n-octylphthalate	2.9E-07	No	2E-02	NA	Elevated liver and kidney weights increased SGOT and SPGT	Diet/HEAST	1000.00		1E-05	
Acenaphthene	NA	No	6E-01	Low	Hepatotoxicity	Oral/IRIS			NA NA	
Anthracene	2.1E-07	No	3E+00	Low	No observed effects	Gavage/IRIS			7E-08	
Benzo(g,h,i)perylene	NA	No	NF			HEAST/IRIS			NA	
Fluoranthene	1.9E-06	No	4E-01	Low	Neuropathy, liver weight changes hematological alterations and clinical effects	Gavage/IRIS			5E-06	
Fluorene	8.6E-07	No	4E-01	Low	Decreased RBC, packed cell volume and hemoglobin	Gavage/IRIS			NA	
p-Cresol	9.4E-07	No	NF			HEAST, IRIS			NA	
Naphthalene	9.4E-07	No	4E-02	NA	Ocular and internal lesions	Diet/HEAST			2E-05	
Pyrene	1.7E-06	No	3E-01	Low	Kidney effects	Gavage/IRIS			6E-06	
Phenanthrene	1.2E-06	No	DI			HEAST			NA	
Phenol	6.1E-06	No	0.60		Reduced fetal body weight	Gavage/HEAST	100			
PESTICIDES/PCBS										
4,4'-DDD	NA	No	NF			HEAST, IRIS			NA	
4,4'-DDE	NA	No	NF			HEAST, IRIS			NA	
4,4'-DDT	NA	No	5E-04	Medium	Liver lesions	Diet/IRIS	100	1.00	NA	

APPENDIX B

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - WELL CONSTRUCTION (ALTERNATIVE 4 AND 4A)
HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL										9E-01
INORGANICS										
Arsenic	9.0E-05	0.10	1E-03	NA	Keratosis and hyperpigmentation	NA/HEAST	1		9E-01	
SEMIVOLATILES										
Bis(2ethylhexyl)phthalate	8.3E-05	0.10	2E-02	Medium	Increased relative liver weight	Diet/IRIS	1000	1	4E-02	
Butylbenzylphthalate	3.1E-06	0.10	2E+00	Low	Effects on body; weight gain, testes, liver, kidneys	Diet/IRIS	100	1	2E-05	
Benzo(a)anthracene	5.6E-06	0.10	NF			HEAST, IRIS			NA	
Benzo(a)pyrene	3.1E-06	0.10	NF			HEAST, IRIS			NA	
Chrysene	5.6E-06	0.10	DI			HEAST			NA	
Benzo(b)fluoranthene	8.9E-06	0.10	NF			HEAST, IRIS			NA	
Benzo(k)fluoranthene	5.1E-06	0.10	NF			HEAST, IRIS			NA	
Dibenzo(a,h)anthracene	NA	0.10	NF			HEAST, IRIS			NA	
Indeno(1,2,3-c,d)pyrene	NA	0.10	NF			HEAST, IRIS			NA	
1,4-Dichlorobenzene	NA	0.10	ND			HEAST, IRIS			NA	
Diethylphthalate	1.4E-06	0.10	8E+00	Low	Decreased growth rate, food consumption rate, altered organ weights	Diet/IRIS	1000	1	2E-06	
Di-n-butylphthalate	NA	0.10	1E+00	Low	Increased mortality	Diet/IRIS	1000	1	NA	
Di-n-octylphthalate	2.6E-06	0.10	2E-02	NA	Elevated liver and kidney weights increased SGOT and SPGT	Diet/HEAST	1000		1E-03	
Acenaphthene	NA	0.10	6E-01	Low	Hepatotoxicity	Oral/IRIS			NA	
Anthracene	2.0E-06	0.10	3E+00	Low	No observed effects	Gavage/IRIS			7E-06	
Benzo(g,h,i)perylene	NA	0.10	NF			HEAST/IRIS			NA	
Fluoranthene	1.8E-05	0.10	4E-01	Low	Neuropathy, liver weight changes hematological alterations and clinical effects	Gavage/IRIS			4E-04	
Fluorene	7.9E-06	0.10	4E-01	Low	Decreased RBC, packed cell volume and hemoglobin	Gavage/IRIS			2E-04	
P-Cresol	4.4E-06	0.10	5E-01	Medium	Decreased body weight, Neurotoxicity	IRIS	1000	1	9E-05	
Naphthalene	8.6E-06	0.10	4E-02	NA	Ocular and internal lesions	Diet/HEAST			2E-03	
Pyrene	1.6E-05	0.10	3E-01	Low	Kidney effects	Gavage/IRIS			5E-04	
Phenanthrene	1.1E-05	0.10	DI			HEAST			NA	
Phenol	5.6E-05	0.10	0.60		Reduced fetal body weight	Gavage/HEAST	100		9E-04	
PESTICIDES/PCBS		0.10								
4,4'-DDD	NA	0.10	NF			HEAST, IRIS			NA	
4,4'-DDE	NA	0.10	NF			HEAST, IRIS			NA	
4,4'-DDT	NA	0.10	5E-04	Medium	Liver lesions	Diet/IRIS	100	1	NA	

APPENDIX B

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - WELL CONSTRUCTION (ALTERNATIVE 4 AND 4A)

HERTEL LANDFILL FEASIBILITY STUDY

CHEMICAL	SUBCHRONIC DAILY INTAKE (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT	PATHWAY HAZARD INDEX (HI)	TOTAL EXPOSURE HI
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST										1E+01	1E+01
INORGANICS											
Antimony	4.5E-05	No	4E-04						1E-01		
Arsenic	1.4E-05	No	1E-03						1E-02		
Barium	2.4E-04	No	1E-03						2E-01		
Beryllium	1.6E-06	No	0.01						3E-04		
Cadmium	1.6E-06	No	1E-03						2E-03		
Chromium	3.6E-05	No	6E-06	NA	Nasal mucosa atrophy	HEAST	300		6E+00		
Manganese	2.5E-03	No	4E-04	Medium	Increased prevalence of respiratory symptoms and psycho-motor disturbances	IRIS HEAST	300 900 1	3	6E+00		
Mercury	NA	No	1E-04	NA	Neurotoxicty	NA/HEAST	30		NA		
Nickel	4.2E-05	No	2E-02						2E-03		
Vanadium	3.3E-05	No	7E-03						5E-03		
Zinc	2.7E-04	No	2E-01						1E-03		
Cyanide	NA	No	2E-02						NA		
VOLATILES											
Carbon Disulfide	NA	No	1E-01						NA		
Chlorobenzene	1.4E-08	No	5E-02	NA	Liver and kidney effects	HEAST	10000		3E-07		
Ethylbenzene	4.7E-08	No	1E+00						5E-08		
Toluene	2.3E-08	No	2E+00	NA	CNS effects, eyes and nose irritation	HEAST	100		1E-08		
Xylenes	8.4E-07	No	3E-01	NA	CNS effects, eyes and nose irritation	HEAST	100		3E-06		
SEMIVOLATILES											
Bis(2ethylhexyl)phthalate	1.3E-05	No	2E-02						6E-04		
Butylbenzylphthalate	4.8E-07	No	2E+00						2E-07		
Benzo(a)anthracene	NA	No	NF			HEAST, IRIS			NA		
Benzo(a)pyrene	NA	No	NF			HEAST, IRIS			NA		
Chrysene	NA	No	DI			HEAST			NA		
Benzo(b)fluoranthene	NA	No	NF			HEAST, IRIS			NA		
Benzo(k)fluoranthene	NA	No	NF			HEAST, IRIS			NA		
Dibenzo(a,h)anthracene	NA	No	NF			HEAST, IRIS			NA		
Indeno(1,2,3-c,d)pyrene	NA	No	NF			HEAST, IRIS			NA		
1,4-Dichlorobenzene	NA	No	2E-01	NA	Liver and kidney effects	HEAST	100		NA		
Diethylphthalate	2.2E-07	No	8E+00						NA		
Di-n-butylphthalate	NA	No	1E+00						NA		
Di-n-octylphthalate	4.0E-07	No	2E-02						NA		
Acenaphthene	NA	No	6E-01						NA		
Anthracene	3.0E-07	No	3E+00						NA		
Benzo(g,h,i)perylene	NA	No	NF			HEAST/IRIS			NA		
Fluoranthene	2.7E-06	No	4E-01						7E-06		
Fluorene	1.2E-06	No	4E-01						3E-06		
p-Cresol	6.7E-07	No	5E-01						1E-06		
Naphthalene	1.3E-06	No	4E-02						3E-05		
Pyrene	2.4E-06	No	3E-01						8E-06		
Phenanthrene	NA	No	DI			HEAST			NA		
Phenol	NA	No	DI			HEAST			NA		
PESTICIDES/PCBS											
4,4'-DDD	NA	No	NF			HEAST, IRIS			NA		
4,4'-DDE	NA	No	NF			HEAST, IRIS			NA		
4,4'-DDT	NA	No	5E-04		Liver lession				NA		

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APPENDIX C

GROUND WATER MODELING INFORMATION

APPENDIX C

GROUND WATER MODELING INFORMATION

A preliminary configuration of the proposed ground water extraction wellfield (as described in Section 5.2 of the FS), was determined using an analytical computer model (THWELLS, Version 2.0) based on the Theis equation for uniform non-steady flow in a homogenous, isotropic confined aquifer of uniform thickness and infinite in areal extent. The model further assumes the following:

- The pumping wells are fully penetrating and no water is stored in the well bores;
- Prior to pumping, the piezometric surface is horizontal over the entire area; that is, no regional flow is present;
- Water is released instantaneously from storage by the compaction of the aquifer matrix and by the expansion of the water itself; and
- Unlike unconfined conditions, none of the water stored in the aquifer is released by dewatering of the aquifer.

While the model is based on a confined aquifer, it is not expected to misrepresent the effects in an unconfined aquifer due to the similarity in behavior of confined and unconfined aquifers after pumping has continued for an extended period of time. The pumping response of an unconfined aquifer differs from that of a confined aquifer only during a short period which occurs only hours or, at the most, days after pumping has started. During this intermediate period, a "delayed-yield" recharge from the aquifer pores that were dewatered during the early stage of pumping will occur in a well screened in an unconfined aquifer. After 1,000 days, the time of the THWELLS simulation, an unconfined aquifer of this scale will have passed the delayed yield stage and resumed Theis-type response.

The model allows for only a horizontal piezometric surface and, therefore, could not be calibrated to existing hydraulic contours.

The effect of ground water extraction on surface water bodies (i.e., adjacent wetlands) was not specifically addressed. In the area of ground water contamination around well MW-13S, the criteria for determining the placement of the well(s) was that the zone of influence should reach to both wetland areas. Any extension of the zone would result in increased recharge from the wetland areas, causing an unnecessary increase in the amount of water extracted and treated, while only minimally increasing the zone of influence. As presently modeled, the drawdown in the area of the wetland west of the access road (wetland C) ranges to a maximum of 1.5 feet.

This model was used to provide a basis for the preliminary design of the ground water extraction system described herein and to provide a basis upon which to develop ground water extraction system costs. Additional evaluation of the ground water system will be required prior to final design of the ground water extraction system.

CALCULATION OF DRAWDOWN IN A HOMOGENEOUS, ISOTROPIC NONLEAKY
CONFINED AQUIFER WITH MULTIPLE PRODUCTION AND INJECTION WELLS

HERTEL LANDFILL FS - EXTRACTION WELLFIELD MODEL

********** INPUT DATA **********

TRANSMISSIVITY = 135 [gpd/ft]

STORAGE COEFFICIENT = .2

WELL NO. 1

X-COORDINATE = 100 [ft]
Y-COORDINATE = 100 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 2

X-COORDINATE = 200 [ft]
Y-COORDINATE = 100 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 3

X-COORDINATE = 300 [ft]
Y-COORDINATE = 100 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 4

X-COORDINATE = 400 [ft]
Y-COORDINATE = 100 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 5

X-COORDINATE = 500 [ft]
Y-COORDINATE = 100 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 6

X-COORDINATE = 600 [ft]
Y-COORDINATE = 100 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 7

X-COORDINATE = 100 [ft]
Y-COORDINATE = 200 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 8

X-COORDINATE = 200 [ft]
Y-COORDINATE = 200 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 9

X-COORDINATE = 300 [ft]
Y-COORDINATE = 200 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 10

X-COORDINATE	=	400 [ft]
Y-COORDINATE	=	200 [ft]
PUMPING/INJECTION RATE	=	325 [gpd]
TIME SINCE START PUMPING/INJECTION	=	1000 [day]

WELL NO. 11

X-COORDINATE	=	500 [ft]
Y-COORDINATE	=	200 [ft]
PUMPING/INJECTION RATE	=	325 [gpd]
TIME SINCE START PUMPING/INJECTION	=	1000 [day]

WELL NO. 12

X-COORDINATE	=	600 [ft]
Y-COORDINATE	=	200 [ft]
PUMPING/INJECTION RATE	=	325 [gpd]
TIME SINCE START PUMPING/INJECTION	=	1000 [day]

WELL NO. 13

X-COORDINATE	=	100 [ft]
Y-COORDINATE	=	300 [ft]
PUMPING/INJECTION RATE	=	325 [gpd]
TIME SINCE START PUMPING/INJECTION	=	1000 [day]

WELL NO. 14

X-COORDINATE	=	200 [ft]
Y-COORDINATE	=	300 [ft]
PUMPING/INJECTION RATE	=	325 [gpd]
TIME SINCE START PUMPING/INJECTION	=	1000 [day]

WELL NO. 15

X-COORDINATE = 300 [ft]
Y-COORDINATE = 300 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 16

X-COORDINATE = 400 [ft]
Y-COORDINATE = 300 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 17

X-COORDINATE = 500 [ft]
Y-COORDINATE = 300 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 18

X-COORDINATE = 600 [ft]
Y-COORDINATE = 300 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 19

X-COORDINATE = 700 [ft]
Y-COORDINATE = 100 [ft]
PUMPING/INJECTION RATE = 325 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

WELL NO. 20

X-COORDINATE =	700 [ft]
Y-COORDINATE =	200 [ft]
PUMPING/INJECTION RATE =	325 [gpd]
TIME SINCE START PUMPING/INJECTION =	1000 [day]

WELL NO. 21

X-COORDINATE =	700 [ft]
Y-COORDINATE =	300 [ft]
PUMPING/INJECTION RATE =	325 [gpd]
TIME SINCE START PUMPING/INJECTION =	1000 [day]

---------- DRAWDOWN IN [ft] ----------

Y	X-> -350	-300	-250	-200	-150	-100
-300	0.2197E+00	0.2761E+00	0.3425E+00	0.4190E+00	0.5054E+00	0.6006E+00
-250	0.2649E+00	0.3346E+00	0.4172E+00	0.5134E+00	0.6229E+00	0.7448E+00
-200	0.3144E+00	0.3991E+00	0.5006E+00	0.6199E+00	0.7573E+00	0.9117E+00
-150	0.3669E+00	0.4684E+00	0.5911E+00	0.7369E+00	0.9070E+00	0.1101E+01
-100	0.4208E+00	0.5401E+00	0.6859E+00	0.8613E+00	0.1069E+01	0.1309E+01
-50	0.4736E+00	0.6112E+00	0.7810E+00	0.9880E+00	0.1237E+01	0.1530E+01
0	0.5227E+00	0.6779E+00	0.8713E+00	0.1110E+01	0.1402E+01	0.1753E+01
50	0.5651E+00	0.7359E+00	0.9507E+00	0.1219E+01	0.1551E+01	0.1960E+01
100	0.5979E+00	0.7811E+00	0.1013E+01	0.1305E+01	0.1672E+01	0.2130E+01
150	0.6187E+00	0.8099E+00	0.1053E+01	0.1361E+01	0.1750E+01	0.2241E+01
200	0.6258E+00	0.8198E+00	0.1067E+01	0.1380E+01	0.1777E+01	0.2280E+01
250	0.6187E+00	0.8099E+00	0.1053E+01	0.1361E+01	0.1750E+01	0.2241E+01
300	0.5979E+00	0.7811E+00	0.1013E+01	0.1305E+01	0.1672E+01	0.2130E+01
350	0.5651E+00	0.7359E+00	0.9507E+00	0.1219E+01	0.1551E+01	0.1960E+01
400	0.5227E+00	0.6779E+00	0.8713E+00	0.1110E+01	0.1402E+01	0.1753E+01
450	0.4736E+00	0.6112E+00	0.7810E+00	0.9880E+00	0.1237E+01	0.1530E+01
500	0.4208E+00	0.5401E+00	0.6859E+00	0.8613E+00	0.1069E+01	0.1309E+01
550	0.3669E+00	0.4684E+00	0.5911E+00	0.7369E+00	0.9070E+00	0.1101E+01
600	0.3144E+00	0.3991E+00	0.5006E+00	0.6199E+00	0.7573E+00	0.9117E+00
650	0.2649E+00	0.3346E+00	0.4172E+00	0.5134E+00	0.6229E+00	0.7448E+00

Y	X-> -50	0	50	100	150	200
-300	0.7027E+00	0.8088E+00	0.9153E+00	0.1018E+01	0.1113E+01	0.1197E+01
-250	0.8765E+00	0.1014E+01	0.1154E+01	0.1288E+01	0.1413E+01	0.1522E+01
-200	0.1080E+01	0.1259E+01	0.1440E+01	0.1616E+01	0.1779E+01	0.1920E+01
-150	0.1315E+01	0.1545E+01	0.1780E+01	0.2010E+01	0.2221E+01	0.2404E+01
-100	0.1580E+01	0.1875E+01	0.2181E+01	0.2480E+01	0.2754E+01	0.2988E+01
-50	0.1869E+01	0.2247E+01	0.2647E+01	0.3039E+01	0.3394E+01	0.3692E+01
0	0.2171E+01	0.2654E+01	0.3184E+01	0.3708E+01	0.4163E+01	0.4537E+01
50	0.2460E+01	0.3067E+01	0.3790E+01	0.4537E+01	0.5082E+01	0.5567E+01
100	0.2703E+01	0.3423E+01	0.4358E+01	0.7038E+01	0.5974E+01	0.8250E+01
150	0.2862E+01	0.3652E+01	0.4649E+01	0.5703E+01	0.6395E+01	0.7029E+01
200	0.2918E+01	0.3732E+01	0.4790E+01	0.7594E+01	0.6621E+01	0.8961E+01
250	0.2862E+01	0.3652E+01	0.4649E+01	0.5703E+01	0.6395E+01	0.7029E+01
300	0.2703E+01	0.3423E+01	0.4358E+01	0.7038E+01	0.5974E+01	0.8250E+01
350	0.2460E+01	0.3067E+01	0.3790E+01	0.4537E+01	0.5082E+01	0.5567E+01
400	0.2171E+01	0.2654E+01	0.3184E+01	0.3708E+01	0.4163E+01	0.4537E+01
450	0.1869E+01	0.2247E+01	0.2647E+01	0.3039E+01	0.3394E+01	0.3692E+01
500	0.1580E+01	0.1875E+01	0.2181E+01	0.2480E+01	0.2754E+01	0.2988E+01
550	0.1315E+01	0.1545E+01	0.1780E+01	0.2010E+01	0.2221E+01	0.2404E+01
600	0.1080E+01	0.1259E+01	0.1440E+01	0.1616E+01	0.1779E+01	0.1920E+01
650	0.8765E+00	0.1014E+01	0.1154E+01	0.1288E+01	0.1413E+01	0.1522E+01

X-> 250	300	350	400	450	500

Y						
-300	0.1265E+01	0.1316E+01	0.1347E+01	0.1357E+01	0.1347E+01	0.1316E+01
-250	0.1611E+01	0.1677E+01	0.1718E+01	0.1731E+01	0.1718E+01	0.1677E+01
-200	0.2036E+01	0.2121E+01	0.2173E+01	0.2190E+01	0.2173E+01	0.2121E+01
-150	0.2552E+01	0.2660E+01	0.2726E+01	0.2748E+01	0.2726E+01	0.2660E+01
-100	0.3176E+01	0.3311E+01	0.3393E+01	0.3421E+01	0.3393E+01	0.3311E+01
-50	0.3926E+01	0.4093E+01	0.4192E+01	0.4226E+01	0.4192E+01	0.4093E+01
0	0.4821E+01	0.5023E+01	0.5140E+01	0.5181E+01	0.5140E+01	0.5023E+01
50	0.5871E+01	0.6137E+01	0.6241E+01	0.6319E+01	0.6241E+01	0.6137E+01
100	0.6877E+01	0.8892E+01	0.7290E+01	0.9095E+01	0.7290E+01	0.8892E+01
150	0.7375E+01	0.7720E+01	0.7816E+01	0.7936E+01	0.7816E+01	0.7720E+01
200	0.7628E+01	0.9670E+01	0.8080E+01	0.9890E+01	0.8080E+01	0.9670E+01
250	0.7375E+01	0.7720E+01	0.7816E+01	0.7936E+01	0.7816E+01	0.7720E+01
300	0.6877E+01	0.8892E+01	0.7290E+01	0.9095E+01	0.7290E+01	0.8892E+01
350	0.5871E+01	0.6137E+01	0.6241E+01	0.6319E+01	0.6241E+01	0.6137E+01
400	0.4821E+01	0.5023E+01	0.5140E+01	0.5181E+01	0.5140E+01	0.5023E+01
450	0.3926E+01	0.4093E+01	0.4192E+01	0.4226E+01	0.4192E+01	0.4093E+01
500	0.3176E+01	0.3311E+01	0.3393E+01	0.3421E+01	0.3393E+01	0.3311E+01
550	0.2552E+01	0.2660E+01	0.2726E+01	0.2748E+01	0.2726E+01	0.2660E+01
600	0.2036E+01	0.2121E+01	0.2173E+01	0.2190E+01	0.2173E+01	0.2121E+01
650	0.1611E+01	0.1677E+01	0.1718E+01	0.1731E+01	0.1718E+01	0.1677E+01

X->	550	600	650	700	750	800
Y						
-300	0.1265E+01	0.1197E+01	0.1113E+01	0.1018E+01	0.9153E+00	0.8088E+00
-250	0.1611E+01	0.1522E+01	0.1413E+01	0.1288E+01	0.1154E+01	0.1014E+01
-200	0.2036E+01	0.1920E+01	0.1779E+01	0.1616E+01	0.1440E+01	0.1259E+01
-150	0.2552E+01	0.2404E+01	0.2221E+01	0.2010E+01	0.1780E+01	0.1545E+01
-100	0.3176E+01	0.2988E+01	0.2754E+01	0.2480E+01	0.2181E+01	0.1875E+01
-50	0.3926E+01	0.3692E+01	0.3394E+01	0.3039E+01	0.2647E+01	0.2247E+01
0	0.4821E+01	0.4537E+01	0.4163E+01	0.3708E+01	0.3184E+01	0.2654E+01
50	0.5871E+01	0.5567E+01	0.5082E+01	0.4537E+01	0.3790E+01	0.3067E+01
100	0.6877E+01	0.8250E+01	0.5974E+01	0.7038E+01	0.4358E+01	0.3423E+01
150	0.7375E+01	0.7029E+01	0.6395E+01	0.5703E+01	0.4649E+01	0.3652E+01
200	0.7628E+01	0.8961E+01	0.6621E+01	0.7594E+01	0.4790E+01	0.3732E+01
250	0.7375E+01	0.7029E+01	0.6395E+01	0.5703E+01	0.4649E+01	0.3652E+01
300	0.6877E+01	0.8250E+01	0.5974E+01	0.7038E+01	0.4358E+01	0.3423E+01
350	0.5871E+01	0.5567E+01	0.5082E+01	0.4537E+01	0.3790E+01	0.3067E+01
400	0.4821E+01	0.4537E+01	0.4163E+01	0.3708E+01	0.3184E+01	0.2654E+01
450	0.3926E+01	0.3692E+01	0.3394E+01	0.3039E+01	0.2647E+01	0.2247E+01
500	0.3176E+01	0.2988E+01	0.2754E+01	0.2480E+01	0.2181E+01	0.1875E+01
550	0.2552E+01	0.2404E+01	0.2221E+01	0.2010E+01	0.1780E+01	0.1545E+01
600	0.2036E+01	0.1920E+01	0.1779E+01	0.1616E+01	0.1440E+01	0.1259E+01
650	0.1611E+01	0.1522E+01	0.1413E+01	0.1288E+01	0.1154E+01	0.1014E+01

X->	850	900	950	1000	1050	1100
Y						
-300	0.7027E+00	0.6006E+00	0.5054E+00	0.4190E+00	0.3425E+00	0.2761E+00
-250	0.8765E+00	0.7448E+00	0.6229E+00	0.5134E+00	0.4172E+00	0.3346E+00
-200	0.1080E+01	0.9117E+00	0.7573E+00	0.6199E+00	0.5006E+00	0.3991E+00
-150	0.1315E+01	0.1101E+01	0.9070E+00	0.7369E+00	0.5911E+00	0.4684E+00
-100	0.1580E+01	0.1309E+01	0.1069E+01	0.8613E+00	0.6859E+00	0.5401E+00
-50	0.1869E+01	0.1530E+01	0.1237E+01	0.9880E+00	0.7810E+00	0.6112E+00

0	0.2171E+01	0.1753E+01	0.1402E+01	0.1110E+01	0.8713E+00	0.6779E+00
50	0.2460E+01	0.1960E+01	0.1551E+01	0.1219E+01	0.9507E+00	0.7359E+00
100	0.2703E+01	0.2130E+01	0.1672E+01	0.1305E+01	0.1013E+01	0.7811E+00
150	0.2862E+01	0.2241E+01	0.1750E+01	0.1361E+01	0.1053E+01	0.8099E+00
200	0.2918E+01	0.2280E+01	0.1777E+01	0.1380E+01	0.1067E+01	0.8198E+00
250	0.2862E+01	0.2241E+01	0.1750E+01	0.1361E+01	0.1053E+01	0.8099E+00
300	0.2703E+01	0.2130E+01	0.1672E+01	0.1305E+01	0.1013E+01	0.7811E+00
350	0.2460E+01	0.1960E+01	0.1551E+01	0.1219E+01	0.9507E+00	0.7359E+00
400	0.2171E+01	0.1753E+01	0.1402E+01	0.1110E+01	0.8713E+00	0.6779E+00
450	0.1869E+01	0.1530E+01	0.1237E+01	0.9880E+00	0.7810E+00	0.6112E+00
500	0.1580E+01	0.1309E+01	0.1069E+01	0.8613E+00	0.6859E+00	0.5401E+00
550	0.1315E+01	0.1101E+01	0.9070E+00	0.7369E+00	0.5911E+00	0.4684E+00
600	0.1080E+01	0.9117E+00	0.7573E+00	0.6199E+00	0.5006E+00	0.3991E+00
650	0.8765E+00	0.7448E+00	0.6229E+00	0.5134E+00	0.4172E+00	0.3346E+00

CALCULATION OF DRAWDOWN IN A HOMOGENEOUS, ISOTROPIC NONLEAKY
CONFINED AQUIFER WITH MULTIPLE PRODUCTION AND INJECTION WELLS

HERTEL LANDFILL FS - SINGLE EXTRACTION WELL MODEL

********** INPUT DATA **********

TRANSMISSIVITY = 1400 [gpd/ft]

STORAGE COEFFICIENT = .2

WELL NO. 1

X-COORDINATE = 75 [ft]
Y-COORDINATE = 75 [ft]
PUMPING/INJECTION RATE = 720 [gpd]
TIME SINCE START PUMPING/INJECTION = 1000 [day]

---------- DRAWDOWN IN [ft] ----------

Y \ X->	-50	-45	-40	-35	-30	-25
-50	0.1726E+00	0.1742E+00	0.1758E+00	0.1774E+00	0.1790E+00	0.1806E+00
-45	0.1742E+00	0.1759E+00	0.1776E+00	0.1793E+00	0.1809E+00	0.1826E+00
-40	0.1758E+00	0.1776E+00	0.1793E+00	0.1811E+00	0.1829E+00	0.1846E+00
-35	0.1774E+00	0.1793E+00	0.1811E+00	0.1830E+00	0.1848E+00	0.1866E+00
-30	0.1790E+00	0.1809E+00	0.1829E+00	0.1848E+00	0.1867E+00	0.1887E+00
-25	0.1806E+00	0.1826E+00	0.1846E+00	0.1866E+00	0.1887E+00	0.1907E+00
-20	0.1822E+00	0.1843E+00	0.1864E+00	0.1885E+00	0.1906E+00	0.1927E+00
-15	0.1838E+00	0.1859E+00	0.1881E+00	0.1903E+00	0.1925E+00	0.1948E+00
-10	0.1853E+00	0.1875E+00	0.1898E+00	0.1921E+00	0.1944E+00	0.1968E+00
-5	0.1868E+00	0.1891E+00	0.1915E+00	0.1939E+00	0.1963E+00	0.1988E+00
0	0.1882E+00	0.1907E+00	0.1931E+00	0.1956E+00	0.1982E+00	0.2008E+00
5	0.1897E+00	0.1922E+00	0.1947E+00	0.1973E+00	0.2000E+00	0.2027E+00
10	0.1910E+00	0.1936E+00	0.1963E+00	0.1990E+00	0.2018E+00	0.2046E+00
15	0.1923E+00	0.1950E+00	0.1978E+00	0.2006E+00	0.2035E+00	0.2064E+00
20	0.1936E+00	0.1963E+00	0.1992E+00	0.2021E+00	0.2051E+00	0.2082E+00
25	0.1947E+00	0.1976E+00	0.2005E+00	0.2035E+00	0.2067E+00	0.2099E+00
30	0.1958E+00	0.1987E+00	0.2018E+00	0.2049E+00	0.2081E+00	0.2114E+00
35	0.1968E+00	0.1998E+00	0.2029E+00	0.2061E+00	0.2095E+00	0.2129E+00
40	0.1977E+00	0.2008E+00	0.2040E+00	0.2073E+00	0.2107E+00	0.2143E+00
45	0.1985E+00	0.2016E+00	0.2049E+00	0.2083E+00	0.2118E+00	0.2155E+00
50	0.1992E+00	0.2024E+00	0.2057E+00	0.2091E+00	0.2127E+00	0.2165E+00
55	0.1997E+00	0.2030E+00	0.2064E+00	0.2099E+00	0.2135E+00	0.2174E+00
60	0.2002E+00	0.2035E+00	0.2069E+00	0.2104E+00	0.2142E+00	0.2181E+00
65	0.2005E+00	0.2038E+00	0.2073E+00	0.2109E+00	0.2146E+00	0.2186E+00
70	0.2007E+00	0.2040E+00	0.2075E+00	0.2111E+00	0.2149E+00	0.2189E+00
75	0.2008E+00	0.2041E+00	0.2076E+00	0.2112E+00	0.2150E+00	0.2190E+00
80	0.2007E+00	0.2040E+00	0.2075E+00	0.2111E+00	0.2149E+00	0.2189E+00
85	0.2005E+00	0.2038E+00	0.2073E+00	0.2109E+00	0.2146E+00	0.2186E+00
90	0.2002E+00	0.2035E+00	0.2069E+00	0.2104E+00	0.2142E+00	0.2181E+00
95	0.1997E+00	0.2030E+00	0.2064E+00	0.2099E+00	0.2135E+00	0.2174E+00
100	0.1992E+00	0.2024E+00	0.2057E+00	0.2091E+00	0.2127E+00	0.2165E+00
105	0.1985E+00	0.2016E+00	0.2049E+00	0.2083E+00	0.2118E+00	0.2155E+00
110	0.1977E+00	0.2008E+00	0.2040E+00	0.2073E+00	0.2107E+00	0.2143E+00
115	0.1968E+00	0.1998E+00	0.2029E+00	0.2061E+00	0.2095E+00	0.2129E+00
120	0.1958E+00	0.1987E+00	0.2018E+00	0.2049E+00	0.2081E+00	0.2114E+00
125	0.1947E+00	0.1976E+00	0.2005E+00	0.2035E+00	0.2067E+00	0.2099E+00
130	0.1936E+00	0.1963E+00	0.1992E+00	0.2021E+00	0.2051E+00	0.2082E+00
135	0.1923E+00	0.1950E+00	0.1978E+00	0.2006E+00	0.2035E+00	0.2064E+00
140	0.1910E+00	0.1936E+00	0.1963E+00	0.1990E+00	0.2018E+00	0.2046E+00
145	0.1897E+00	0.1922E+00	0.1947E+00	0.1973E+00	0.2000E+00	0.2027E+00
150	0.1882E+00	0.1907E+00	0.1931E+00	0.1956E+00	0.1982E+00	0.2008E+00
155	0.1868E+00	0.1891E+00	0.1915E+00	0.1939E+00	0.1963E+00	0.1988E+00
160	0.1853E+00	0.1875E+00	0.1898E+00	0.1921E+00	0.1944E+00	0.1968E+00
165	0.1838E+00	0.1859E+00	0.1881E+00	0.1903E+00	0.1925E+00	0.1948E+00
170	0.1822E+00	0.1843E+00	0.1864E+00	0.1885E+00	0.1906E+00	0.1927E+00
175	0.1806E+00	0.1826E+00	0.1846E+00	0.1866E+00	0.1887E+00	0.1907E+00
180	0.1790E+00	0.1809E+00	0.1829E+00	0.1848E+00	0.1867E+00	0.1887E+00
185	0.1774E+00	0.1793E+00	0.1811E+00	0.1830E+00	0.1848E+00	0.1866E+00
190	0.1758E+00	0.1776E+00	0.1793E+00	0.1811E+00	0.1829E+00	0.1846E+00
195	0.1742E+00	0.1759E+00	0.1776E+00	0.1793E+00	0.1809E+00	0.1826E+00

X->	-20	-15	-10	-5	0	5
Y						
-50	0.1822E+00	0.1838E+00	0.1853E+00	0.1868E+00	0.1882E+00	0.1897E+00
-45	0.1843E+00	0.1859E+00	0.1875E+00	0.1891E+00	0.1907E+00	0.1922E+00
-40	0.1864E+00	0.1881E+00	0.1898E+00	0.1915E+00	0.1931E+00	0.1947E+00
-35	0.1885E+00	0.1903E+00	0.1921E+00	0.1939E+00	0.1956E+00	0.1973E+00
-30	0.1906E+00	0.1925E+00	0.1944E+00	0.1963E+00	0.1982E+00	0.2000E+00
-25	0.1927E+00	0.1948E+00	0.1968E+00	0.1988E+00	0.2008E+00	0.2027E+00
-20	0.1949E+00	0.1970E+00	0.1992E+00	0.2013E+00	0.2034E+00	0.2055E+00
-15	0.1970E+00	0.1993E+00	0.2016E+00	0.2038E+00	0.2061E+00	0.2083E+00
-10	0.1992E+00	0.2016E+00	0.2040E+00	0.2064E+00	0.2087E+00	0.2111E+00
-5	0.2013E+00	0.2038E+00	0.2064E+00	0.2089E+00	0.2114E+00	0.2140E+00
0	0.2034E+00	0.2061E+00	0.2087E+00	0.2114E+00	0.2142E+00	0.2169E+00
5	0.2055E+00	0.2083E+00	0.2111E+00	0.2140E+00	0.2169E+00	0.2198E+00
10	0.2075E+00	0.2104E+00	0.2134E+00	0.2165E+00	0.2196E+00	0.2227E+00
15	0.2095E+00	0.2126E+00	0.2157E+00	0.2190E+00	0.2223E+00	0.2256E+00
20	0.2114E+00	0.2146E+00	0.2180E+00	0.2214E+00	0.2249E+00	0.2285E+00
25	0.2132E+00	0.2166E+00	0.2201E+00	0.2237E+00	0.2274E+00	0.2313E+00
30	0.2149E+00	0.2185E+00	0.2222E+00	0.2260E+00	0.2299E+00	0.2340E+00
35	0.2165E+00	0.2202E+00	0.2241E+00	0.2281E+00	0.2322E+00	0.2366E+00
40	0.2180E+00	0.2218E+00	0.2258E+00	0.2300E+00	0.2344E+00	0.2390E+00
45	0.2193E+00	0.2233E+00	0.2274E+00	0.2318E+00	0.2364E+00	0.2412E+00
50	0.2204E+00	0.2245E+00	0.2289E+00	0.2334E+00	0.2382E+00	0.2432E+00
55	0.2214E+00	0.2256E+00	0.2300E+00	0.2347E+00	0.2397E+00	0.2449E+00
60	0.2222E+00	0.2265E+00	0.2310E+00	0.2358E+00	0.2409E+00	0.2463E+00
65	0.2227E+00	0.2271E+00	0.2317E+00	0.2366E+00	0.2418E+00	0.2473E+00
70	0.2230E+00	0.2274E+00	0.2321E+00	0.2370E+00	0.2423E+00	0.2479E+00
75	0.2232E+00	0.2276E+00	0.2322E+00	0.2372E+00	0.2425E+00	0.2481E+00
80	0.2230E+00	0.2274E+00	0.2321E+00	0.2370E+00	0.2423E+00	0.2479E+00
85	0.2227E+00	0.2271E+00	0.2317E+00	0.2366E+00	0.2418E+00	0.2473E+00
90	0.2222E+00	0.2265E+00	0.2310E+00	0.2358E+00	0.2409E+00	0.2463E+00
95	0.2214E+00	0.2256E+00	0.2300E+00	0.2347E+00	0.2397E+00	0.2449E+00
100	0.2204E+00	0.2245E+00	0.2289E+00	0.2334E+00	0.2382E+00	0.2432E+00
105	0.2193E+00	0.2233E+00	0.2274E+00	0.2318E+00	0.2364E+00	0.2412E+00
110	0.2180E+00	0.2218E+00	0.2258E+00	0.2300E+00	0.2344E+00	0.2390E+00
115	0.2165E+00	0.2202E+00	0.2241E+00	0.2281E+00	0.2322E+00	0.2366E+00
120	0.2149E+00	0.2185E+00	0.2222E+00	0.2260E+00	0.2299E+00	0.2340E+00
125	0.2132E+00	0.2166E+00	0.2201E+00	0.2237E+00	0.2274E+00	0.2313E+00
130	0.2114E+00	0.2146E+00	0.2180E+00	0.2214E+00	0.2249E+00	0.2285E+00
135	0.2095E+00	0.2126E+00	0.2157E+00	0.2190E+00	0.2223E+00	0.2256E+00
140	0.2075E+00	0.2104E+00	0.2134E+00	0.2165E+00	0.2196E+00	0.2227E+00
145	0.2055E+00	0.2083E+00	0.2111E+00	0.2140E+00	0.2169E+00	0.2198E+00
150	0.2034E+00	0.2061E+00	0.2087E+00	0.2114E+00	0.2142E+00	0.2169E+00
155	0.2013E+00	0.2038E+00	0.2064E+00	0.2089E+00	0.2114E+00	0.2140E+00
160	0.1992E+00	0.2016E+00	0.2040E+00	0.2064E+00	0.2087E+00	0.2111E+00
165	0.1970E+00	0.1993E+00	0.2016E+00	0.2038E+00	0.2061E+00	0.2083E+00
170	0.1949E+00	0.1970E+00	0.1992E+00	0.2013E+00	0.2034E+00	0.2055E+00
175	0.1927E+00	0.1948E+00	0.1968E+00	0.1988E+00	0.2008E+00	0.2027E+00
180	0.1906E+00	0.1925E+00	0.1944E+00	0.1963E+00	0.1982E+00	0.2000E+00
185	0.1885E+00	0.1903E+00	0.1921E+00	0.1939E+00	0.1956E+00	0.1973E+00
190	0.1864E+00	0.1881E+00	0.1898E+00	0.1915E+00	0.1931E+00	0.1947E+00
195	0.1843E+00	0.1859E+00	0.1875E+00	0.1891E+00	0.1907E+00	0.1922E+00

X->	10	15	20	25	30	35

Y						
-50	0.1910E+00	0.1923E+00	0.1936E+00	0.1947E+00	0.1958E+00	0.1968E+00
-45	0.1936E+00	0.1950E+00	0.1963E+00	0.1976E+00	0.1987E+00	0.1998E+00
-40	0.1963E+00	0.1978E+00	0.1992E+00	0.2005E+00	0.2018E+00	0.2029E+00
-35	0.1990E+00	0.2006E+00	0.2021E+00	0.2035E+00	0.2049E+00	0.2061E+00
-30	0.2018E+00	0.2035E+00	0.2051E+00	0.2067E+00	0.2081E+00	0.2095E+00
-25	0.2046E+00	0.2064E+00	0.2082E+00	0.2099E+00	0.2114E+00	0.2129E+00
-20	0.2075E+00	0.2095E+00	0.2114E+00	0.2132E+00	0.2149E+00	0.2165E+00
-15	0.2104E+00	0.2126E+00	0.2146E+00	0.2166E+00	0.2185E+00	0.2202E+00
-10	0.2134E+00	0.2157E+00	0.2180E+00	0.2201E+00	0.2222E+00	0.2241E+00
-5	0.2165E+00	0.2190E+00	0.2214E+00	0.2237E+00	0.2260E+00	0.2281E+00
0	0.2196E+00	0.2223E+00	0.2249E+00	0.2274E+00	0.2299E+00	0.2322E+00
5	0.2227E+00	0.2256E+00	0.2285E+00	0.2313E+00	0.2340E+00	0.2366E+00
10	0.2258E+00	0.2290E+00	0.2321E+00	0.2352E+00	0.2382E+00	0.2410E+00
15	0.2290E+00	0.2324E+00	0.2358E+00	0.2392E+00	0.2425E+00	0.2457E+00
20	0.2321E+00	0.2358E+00	0.2395E+00	0.2432E+00	0.2469E+00	0.2505E+00
25	0.2352E+00	0.2392E+00	0.2432E+00	0.2473E+00	0.2514E+00	0.2554E+00
30	0.2382E+00	0.2425E+00	0.2469E+00	0.2514E+00	0.2559E+00	0.2604E+00
35	0.2410E+00	0.2457E+00	0.2505E+00	0.2554E+00	0.2604E+00	0.2655E+00
40	0.2438E+00	0.2487E+00	0.2539E+00	0.2593E+00	0.2649E+00	0.2706E+00
45	0.2463E+00	0.2516E+00	0.2572E+00	0.2630E+00	0.2692E+00	0.2756E+00
50	0.2485E+00	0.2542E+00	0.2601E+00	0.2665E+00	0.2732E+00	0.2804E+00
55	0.2505E+00	0.2564E+00	0.2628E+00	0.2696E+00	0.2769E+00	0.2848E+00
60	0.2520E+00	0.2582E+00	0.2649E+00	0.2721E+00	0.2799E+00	0.2885E+00
65	0.2532E+00	0.2596E+00	0.2665E+00	0.2740E+00	0.2823E+00	0.2914E+00
70	0.2539E+00	0.2604E+00	0.2675E+00	0.2752E+00	0.2837E+00	0.2932E+00
75	0.2542E+00	0.2607E+00	0.2678E+00	0.2756E+00	0.2842E+00	0.2939E+00
80	0.2539E+00	0.2604E+00	0.2675E+00	0.2752E+00	0.2837E+00	0.2932E+00
85	0.2532E+00	0.2596E+00	0.2665E+00	0.2740E+00	0.2823E+00	0.2914E+00
90	0.2520E+00	0.2582E+00	0.2649E+00	0.2721E+00	0.2799E+00	0.2885E+00
95	0.2505E+00	0.2564E+00	0.2628E+00	0.2696E+00	0.2769E+00	0.2848E+00
100	0.2485E+00	0.2542E+00	0.2601E+00	0.2665E+00	0.2732E+00	0.2804E+00
105	0.2463E+00	0.2516E+00	0.2572E+00	0.2630E+00	0.2692E+00	0.2756E+00
110	0.2438E+00	0.2487E+00	0.2539E+00	0.2593E+00	0.2649E+00	0.2706E+00
115	0.2410E+00	0.2457E+00	0.2505E+00	0.2554E+00	0.2604E+00	0.2655E+00
120	0.2382E+00	0.2425E+00	0.2469E+00	0.2514E+00	0.2559E+00	0.2604E+00
125	0.2352E+00	0.2392E+00	0.2432E+00	0.2473E+00	0.2514E+00	0.2554E+00
130	0.2321E+00	0.2358E+00	0.2395E+00	0.2432E+00	0.2469E+00	0.2505E+00
135	0.2290E+00	0.2324E+00	0.2358E+00	0.2392E+00	0.2425E+00	0.2457E+00
140	0.2258E+00	0.2290E+00	0.2321E+00	0.2352E+00	0.2382E+00	0.2410E+00
145	0.2227E+00	0.2256E+00	0.2285E+00	0.2313E+00	0.2340E+00	0.2366E+00
150	0.2196E+00	0.2223E+00	0.2249E+00	0.2274E+00	0.2299E+00	0.2322E+00
155	0.2165E+00	0.2190E+00	0.2214E+00	0.2237E+00	0.2260E+00	0.2281E+00
160	0.2134E+00	0.2157E+00	0.2180E+00	0.2201E+00	0.2222E+00	0.2241E+00
165	0.2104E+00	0.2126E+00	0.2146E+00	0.2166E+00	0.2185E+00	0.2202E+00
170	0.2075E+00	0.2095E+00	0.2114E+00	0.2132E+00	0.2149E+00	0.2165E+00
175	0.2046E+00	0.2064E+00	0.2082E+00	0.2099E+00	0.2114E+00	0.2129E+00
180	0.2018E+00	0.2035E+00	0.2051E+00	0.2067E+00	0.2081E+00	0.2095E+00
185	0.1990E+00	0.2006E+00	0.2021E+00	0.2035E+00	0.2049E+00	0.2061E+00
190	0.1963E+00	0.1978E+00	0.1992E+00	0.2005E+00	0.2018E+00	0.2029E+00
195	0.1936E+00	0.1950E+00	0.1963E+00	0.1976E+00	0.1987E+00	0.1998E+00

X->	40	45	50	55	60	65
Y						
-50	0.1977E+00	0.1985E+00	0.1992E+00	0.1997E+00	0.2002E+00	0.2005E+00
-45	0.2008E+00	0.2016E+00	0.2024E+00	0.2030E+00	0.2035E+00	0.2038E+00

-40	0.2040E+00	0.2049E+00	0.2057E+00	0.2064E+00	0.2069E+00	0.2073E+00
-35	0.2073E+00	0.2083E+00	0.2091E+00	0.2099E+00	0.2104E+00	0.2109E+00
-30	0.2107E+00	0.2118E+00	0.2127E+00	0.2135E+00	0.2142E+00	0.2146E+00
-25	0.2143E+00	0.2155E+00	0.2165E+00	0.2174E+00	0.2181E+00	0.2186E+00
-20	0.2180E+00	0.2193E+00	0.2204E+00	0.2214E+00	0.2222E+00	0.2227E+00
-15	0.2218E+00	0.2233E+00	0.2245E+00	0.2256E+00	0.2265E+00	0.2271E+00
-10	0.2258E+00	0.2274E+00	0.2289E+00	0.2300E+00	0.2310E+00	0.2317E+00
-5	0.2300E+00	0.2318E+00	0.2334E+00	0.2347E+00	0.2358E+00	0.2366E+00
0	0.2344E+00	0.2364E+00	0.2382E+00	0.2397E+00	0.2409E+00	0.2418E+00
5	0.2390E+00	0.2412E+00	0.2432E+00	0.2449E+00	0.2463E+00	0.2473E+00
10	0.2438E+00	0.2463E+00	0.2485E+00	0.2505E+00	0.2520E+00	0.2532E+00
15	0.2487E+00	0.2516E+00	0.2542E+00	0.2564E+00	0.2582E+00	0.2596E+00
20	0.2539E+00	0.2572E+00	0.2601E+00	0.2628E+00	0.2649E+00	0.2665E+00
25	0.2593E+00	0.2630E+00	0.2665E+00	0.2696E+00	0.2721E+00	0.2740E+00
30	0.2649E+00	0.2692E+00	0.2732E+00	0.2769E+00	0.2799E+00	0.2823E+00
35	0.2706E+00	0.2756E+00	0.2804E+00	0.2848E+00	0.2885E+00	0.2914E+00
40	0.2765E+00	0.2823E+00	0.2879E+00	0.2932E+00	0.2979E+00	0.3016E+00
45	0.2823E+00	0.2891E+00	0.2958E+00	0.3024E+00	0.3083E+00	0.3131E+00
50	0.2879E+00	0.2958E+00	0.3040E+00	0.3121E+00	0.3198E+00	0.3263E+00
55	0.2932E+00	0.3024E+00	0.3121E+00	0.3222E+00	0.3323E+00	0.3415E+00
60	0.2979E+00	0.3083E+00	0.3198E+00	0.3323E+00	0.3458E+00	0.3591E+00
65	0.3016E+00	0.3131E+00	0.3263E+00	0.3415E+00	0.3591E+00	0.3790E+00
70	0.3040E+00	0.3163E+00	0.3307E+00	0.3481E+00	0.3698E+00	0.3982E+00
75	0.3048E+00	0.3174E+00	0.3323E+00	0.3506E+00	0.3741E+00	0.4073E+00
80	0.3040E+00	0.3163E+00	0.3307E+00	0.3481E+00	0.3698E+00	0.3982E+00
85	0.3016E+00	0.3131E+00	0.3263E+00	0.3415E+00	0.3591E+00	0.3790E+00
90	0.2979E+00	0.3083E+00	0.3198E+00	0.3323E+00	0.3458E+00	0.3591E+00
95	0.2932E+00	0.3024E+00	0.3121E+00	0.3222E+00	0.3323E+00	0.3415E+00
100	0.2879E+00	0.2958E+00	0.3040E+00	0.3121E+00	0.3198E+00	0.3263E+00
105	0.2823E+00	0.2891E+00	0.2958E+00	0.3024E+00	0.3083E+00	0.3131E+00
110	0.2765E+00	0.2823E+00	0.2879E+00	0.2932E+00	0.2979E+00	0.3016E+00
115	0.2706E+00	0.2756E+00	0.2804E+00	0.2848E+00	0.2885E+00	0.2914E+00
120	0.2649E+00	0.2692E+00	0.2732E+00	0.2769E+00	0.2799E+00	0.2823E+00
125	0.2593E+00	0.2630E+00	0.2665E+00	0.2696E+00	0.2721E+00	0.2740E+00
130	0.2539E+00	0.2572E+00	0.2601E+00	0.2628E+00	0.2649E+00	0.2665E+00
135	0.2487E+00	0.2516E+00	0.2542E+00	0.2564E+00	0.2582E+00	0.2596E+00
140	0.2438E+00	0.2463E+00	0.2485E+00	0.2505E+00	0.2520E+00	0.2532E+00
145	0.2390E+00	0.2412E+00	0.2432E+00	0.2449E+00	0.2463E+00	0.2473E+00
150	0.2344E+00	0.2364E+00	0.2382E+00	0.2397E+00	0.2409E+00	0.2418E+00
155	0.2300E+00	0.2318E+00	0.2334E+00	0.2347E+00	0.2358E+00	0.2366E+00
160	0.2258E+00	0.2274E+00	0.2289E+00	0.2300E+00	0.2310E+00	0.2317E+00
165	0.2218E+00	0.2233E+00	0.2245E+00	0.2256E+00	0.2265E+00	0.2271E+00
170	0.2180E+00	0.2193E+00	0.2204E+00	0.2214E+00	0.2222E+00	0.2227E+00
175	0.2143E+00	0.2155E+00	0.2165E+00	0.2174E+00	0.2181E+00	0.2186E+00
180	0.2107E+00	0.2118E+00	0.2127E+00	0.2135E+00	0.2142E+00	0.2146E+00
185	0.2073E+00	0.2083E+00	0.2091E+00	0.2099E+00	0.2104E+00	0.2109E+00
190	0.2040E+00	0.2049E+00	0.2057E+00	0.2064E+00	0.2069E+00	0.2073E+00
195	0.2008E+00	0.2016E+00	0.2024E+00	0.2030E+00	0.2035E+00	0.2038E+00

X->	70	75	80	85	90	95
Y						
-50	0.2007E+00	0.2008E+00	0.2007E+00	0.2005E+00	0.2002E+00	0.1997E+00
-45	0.2040E+00	0.2041E+00	0.2040E+00	0.2038E+00	0.2035E+00	0.2030E+00
-40	0.2075E+00	0.2076E+00	0.2075E+00	0.2073E+00	0.2069E+00	0.2064E+00
-35	0.2111E+00	0.2112E+00	0.2111E+00	0.2109E+00	0.2104E+00	0.2099E+00
-30	0.2149E+00	0.2150E+00	0.2149E+00	0.2146E+00	0.2142E+00	0.2135E+00
-25	0.2189E+00	0.2190E+00	0.2189E+00	0.2186E+00	0.2181E+00	0.2174E+00

-20	0.2230E+00	0.2232E+00	0.2230E+00	0.2227E+00	0.2222E+00	0.2214E+00
-15	0.2274E+00	0.2276E+00	0.2274E+00	0.2271E+00	0.2265E+00	0.2256E+00
-10	0.2321E+00	0.2322E+00	0.2321E+00	0.2317E+00	0.2310E+00	0.2300E+00
-5	0.2370E+00	0.2372E+00	0.2370E+00	0.2366E+00	0.2358E+00	0.2347E+00
0	0.2423E+00	0.2425E+00	0.2423E+00	0.2418E+00	0.2409E+00	0.2397E+00
5	0.2479E+00	0.2481E+00	0.2479E+00	0.2473E+00	0.2463E+00	0.2449E+00
10	0.2539E+00	0.2542E+00	0.2539E+00	0.2532E+00	0.2520E+00	0.2505E+00
15	0.2604E+00	0.2607E+00	0.2604E+00	0.2596E+00	0.2582E+00	0.2564E+00
20	0.2675E+00	0.2678E+00	0.2675E+00	0.2665E+00	0.2649E+00	0.2628E+00
25	0.2752E+00	0.2756E+00	0.2752E+00	0.2740E+00	0.2721E+00	0.2696E+00
30	0.2837E+00	0.2842E+00	0.2837E+00	0.2823E+00	0.2799E+00	0.2769E+00
35	0.2932E+00	0.2939E+00	0.2932E+00	0.2914E+00	0.2885E+00	0.2848E+00
40	0.3040E+00	0.3048E+00	0.3040E+00	0.3016E+00	0.2979E+00	0.2932E+00
45	0.3163E+00	0.3174E+00	0.3163E+00	0.3131E+00	0.3083E+00	0.3024E+00
50	0.3307E+00	0.3323E+00	0.3307E+00	0.3263E+00	0.3198E+00	0.3121E+00
55	0.3481E+00	0.3506E+00	0.3481E+00	0.3415E+00	0.3323E+00	0.3222E+00
60	0.3698E+00	0.3741E+00	0.3698E+00	0.3591E+00	0.3458E+00	0.3323E+00
65	0.3982E+00	0.4073E+00	0.3982E+00	0.3790E+00	0.3591E+00	0.3415E+00
70	0.4357E+00	0.4641E+00	0.4357E+00	0.3982E+00	0.3698E+00	0.3481E+00
75	0.4641E+00	0.6870E+00	0.4641E+00	0.4073E+00	0.3741E+00	0.3506E+00
80	0.4357E+00	0.4641E+00	0.4357E+00	0.3982E+00	0.3698E+00	0.3481E+00
85	0.3982E+00	0.4073E+00	0.3982E+00	0.3790E+00	0.3591E+00	0.3415E+00
90	0.3698E+00	0.3741E+00	0.3698E+00	0.3591E+00	0.3458E+00	0.3323E+00
95	0.3481E+00	0.3506E+00	0.3481E+00	0.3415E+00	0.3323E+00	0.3222E+00
100	0.3307E+00	0.3323E+00	0.3307E+00	0.3263E+00	0.3198E+00	0.3121E+00
105	0.3163E+00	0.3174E+00	0.3163E+00	0.3131E+00	0.3083E+00	0.3024E+00
110	0.3040E+00	0.3048E+00	0.3040E+00	0.3016E+00	0.2979E+00	0.2932E+00
115	0.2932E+00	0.2939E+00	0.2932E+00	0.2914E+00	0.2885E+00	0.2848E+00
120	0.2837E+00	0.2842E+00	0.2837E+00	0.2823E+00	0.2799E+00	0.2769E+00
125	0.2752E+00	0.2756E+00	0.2752E+00	0.2740E+00	0.2721E+00	0.2696E+00
130	0.2675E+00	0.2678E+00	0.2675E+00	0.2665E+00	0.2649E+00	0.2628E+00
135	0.2604E+00	0.2607E+00	0.2604E+00	0.2596E+00	0.2582E+00	0.2564E+00
140	0.2539E+00	0.2542E+00	0.2539E+00	0.2532E+00	0.2520E+00	0.2505E+00
145	0.2479E+00	0.2481E+00	0.2479E+00	0.2473E+00	0.2463E+00	0.2449E+00
150	0.2423E+00	0.2425E+00	0.2423E+00	0.2418E+00	0.2409E+00	0.2397E+00
155	0.2370E+00	0.2372E+00	0.2370E+00	0.2366E+00	0.2358E+00	0.2347E+00
160	0.2321E+00	0.2322E+00	0.2321E+00	0.2317E+00	0.2310E+00	0.2300E+00
165	0.2274E+00	0.2276E+00	0.2274E+00	0.2271E+00	0.2265E+00	0.2256E+00
170	0.2230E+00	0.2232E+00	0.2230E+00	0.2227E+00	0.2222E+00	0.2214E+00
175	0.2189E+00	0.2190E+00	0.2189E+00	0.2186E+00	0.2181E+00	0.2174E+00
180	0.2149E+00	0.2150E+00	0.2149E+00	0.2146E+00	0.2142E+00	0.2135E+00
185	0.2111E+00	0.2112E+00	0.2111E+00	0.2109E+00	0.2104E+00	0.2099E+00
190	0.2075E+00	0.2076E+00	0.2075E+00	0.2073E+00	0.2069E+00	0.2064E+00
195	0.2040E+00	0.2041E+00	0.2040E+00	0.2038E+00	0.2035E+00	0.2030E+00

X->	100	105	110	115	120	125
Y						
-50	0.1992E+00	0.1985E+00	0.1977E+00	0.1968E+00	0.1958E+00	0.1947E+00
-45	0.2024E+00	0.2016E+00	0.2008E+00	0.1998E+00	0.1987E+00	0.1976E+00
-40	0.2057E+00	0.2049E+00	0.2040E+00	0.2029E+00	0.2018E+00	0.2005E+00
-35	0.2091E+00	0.2083E+00	0.2073E+00	0.2061E+00	0.2049E+00	0.2035E+00
-30	0.2127E+00	0.2118E+00	0.2107E+00	0.2095E+00	0.2081E+00	0.2067E+00
-25	0.2165E+00	0.2155E+00	0.2143E+00	0.2129E+00	0.2114E+00	0.2099E+00
-20	0.2204E+00	0.2193E+00	0.2180E+00	0.2165E+00	0.2149E+00	0.2132E+00
-15	0.2245E+00	0.2233E+00	0.2218E+00	0.2202E+00	0.2185E+00	0.2166E+00
-10	0.2289E+00	0.2274E+00	0.2258E+00	0.2241E+00	0.2222E+00	0.2201E+00
-5	0.2334E+00	0.2318E+00	0.2300E+00	0.2281E+00	0.2260E+00	0.2237E+00

0	0.2382E+00	0.2364E+00	0.2344E+00	0.2322E+00	0.2299E+00	0.2274E+00
5	0.2432E+00	0.2412E+00	0.2390E+00	0.2366E+00	0.2340E+00	0.2313E+00
10	0.2485E+00	0.2463E+00	0.2438E+00	0.2410E+00	0.2382E+00	0.2352E+00
15	0.2542E+00	0.2516E+00	0.2487E+00	0.2457E+00	0.2425E+00	0.2392E+00
20	0.2601E+00	0.2572E+00	0.2539E+00	0.2505E+00	0.2469E+00	0.2432E+00
25	0.2665E+00	0.2630E+00	0.2593E+00	0.2554E+00	0.2514E+00	0.2473E+00
30	0.2732E+00	0.2692E+00	0.2649E+00	0.2604E+00	0.2559E+00	0.2514E+00
35	0.2804E+00	0.2756E+00	0.2706E+00	0.2655E+00	0.2604E+00	0.2554E+00
40	0.2879E+00	0.2823E+00	0.2765E+00	0.2706E+00	0.2649E+00	0.2593E+00
45	0.2958E+00	0.2891E+00	0.2823E+00	0.2756E+00	0.2692E+00	0.2630E+00
50	0.3040E+00	0.2958E+00	0.2879E+00	0.2804E+00	0.2732E+00	0.2665E+00
55	0.3121E+00	0.3024E+00	0.2932E+00	0.2848E+00	0.2769E+00	0.2696E+00
60	0.3198E+00	0.3083E+00	0.2979E+00	0.2885E+00	0.2799E+00	0.2721E+00
65	0.3263E+00	0.3131E+00	0.3016E+00	0.2914E+00	0.2823E+00	0.2740E+00
70	0.3307E+00	0.3163E+00	0.3040E+00	0.2932E+00	0.2837E+00	0.2752E+00
75	0.3323E+00	0.3174E+00	0.3048E+00	0.2939E+00	0.2842E+00	0.2756E+00
80	0.3307E+00	0.3163E+00	0.3040E+00	0.2932E+00	0.2837E+00	0.2752E+00
85	0.3263E+00	0.3131E+00	0.3016E+00	0.2914E+00	0.2823E+00	0.2740E+00
90	0.3198E+00	0.3083E+00	0.2979E+00	0.2885E+00	0.2799E+00	0.2721E+00
95	0.3121E+00	0.3024E+00	0.2932E+00	0.2848E+00	0.2769E+00	0.2696E+00
100	0.3040E+00	0.2958E+00	0.2879E+00	0.2804E+00	0.2732E+00	0.2665E+00
105	0.2958E+00	0.2891E+00	0.2823E+00	0.2756E+00	0.2692E+00	0.2630E+00
110	0.2879E+00	0.2823E+00	0.2765E+00	0.2706E+00	0.2649E+00	0.2593E+00
115	0.2804E+00	0.2756E+00	0.2706E+00	0.2655E+00	0.2604E+00	0.2554E+00
120	0.2732E+00	0.2692E+00	0.2649E+00	0.2604E+00	0.2559E+00	0.2514E+00
125	0.2665E+00	0.2630E+00	0.2593E+00	0.2554E+00	0.2514E+00	0.2473E+00
130	0.2601E+00	0.2572E+00	0.2539E+00	0.2505E+00	0.2469E+00	0.2432E+00
135	0.2542E+00	0.2516E+00	0.2487E+00	0.2457E+00	0.2425E+00	0.2392E+00
140	0.2485E+00	0.2463E+00	0.2438E+00	0.2410E+00	0.2382E+00	0.2352E+00
145	0.2432E+00	0.2412E+00	0.2390E+00	0.2366E+00	0.2340E+00	0.2313E+00
150	0.2382E+00	0.2364E+00	0.2344E+00	0.2322E+00	0.2299E+00	0.2274E+00
155	0.2334E+00	0.2318E+00	0.2300E+00	0.2281E+00	0.2260E+00	0.2237E+00
160	0.2289E+00	0.2274E+00	0.2258E+00	0.2241E+00	0.2222E+00	0.2201E+00
165	0.2245E+00	0.2233E+00	0.2218E+00	0.2202E+00	0.2185E+00	0.2166E+00
170	0.2204E+00	0.2193E+00	0.2180E+00	0.2165E+00	0.2149E+00	0.2132E+00
175	0.2165E+00	0.2155E+00	0.2143E+00	0.2129E+00	0.2114E+00	0.2099E+00
180	0.2127E+00	0.2118E+00	0.2107E+00	0.2095E+00	0.2081E+00	0.2067E+00
185	0.2091E+00	0.2083E+00	0.2073E+00	0.2061E+00	0.2049E+00	0.2035E+00
190	0.2057E+00	0.2049E+00	0.2040E+00	0.2029E+00	0.2018E+00	0.2005E+00
195	0.2024E+00	0.2016E+00	0.2008E+00	0.1998E+00	0.1987E+00	0.1976E+00

X->	130	135	140	145	150	155
Y						
-50	0.1936E+00	0.1923E+00	0.1910E+00	0.1897E+00	0.1882E+00	0.1868E+00
-45	0.1963E+00	0.1950E+00	0.1936E+00	0.1922E+00	0.1907E+00	0.1891E+00
-40	0.1992E+00	0.1978E+00	0.1963E+00	0.1947E+00	0.1931E+00	0.1915E+00
-35	0.2021E+00	0.2006E+00	0.1990E+00	0.1973E+00	0.1956E+00	0.1939E+00
-30	0.2051E+00	0.2035E+00	0.2018E+00	0.2000E+00	0.1982E+00	0.1963E+00
-25	0.2082E+00	0.2064E+00	0.2046E+00	0.2027E+00	0.2008E+00	0.1988E+00
-20	0.2114E+00	0.2095E+00	0.2075E+00	0.2055E+00	0.2034E+00	0.2013E+00
-15	0.2146E+00	0.2126E+00	0.2104E+00	0.2083E+00	0.2061E+00	0.2038E+00
-10	0.2180E+00	0.2157E+00	0.2134E+00	0.2111E+00	0.2087E+00	0.2064E+00
-5	0.2214E+00	0.2190E+00	0.2165E+00	0.2140E+00	0.2114E+00	0.2089E+00
0	0.2249E+00	0.2223E+00	0.2196E+00	0.2169E+00	0.2142E+00	0.2114E+00
5	0.2285E+00	0.2256E+00	0.2227E+00	0.2198E+00	0.2169E+00	0.2140E+00
10	0.2321E+00	0.2290E+00	0.2258E+00	0.2227E+00	0.2196E+00	0.2165E+00
15	0.2358E+00	0.2324E+00	0.2290E+00	0.2256E+00	0.2223E+00	0.2190E+00

20	0.2395E+00	0.2358E+00	0.2321E+00	0.2285E+00	0.2249E+00	0.2214E+00
25	0.2432E+00	0.2392E+00	0.2352E+00	0.2313E+00	0.2274E+00	0.2237E+00
30	0.2469E+00	0.2425E+00	0.2382E+00	0.2340E+00	0.2299E+00	0.2260E+00
35	0.2505E+00	0.2457E+00	0.2410E+00	0.2366E+00	0.2322E+00	0.2281E+00
40	0.2539E+00	0.2487E+00	0.2438E+00	0.2390E+00	0.2344E+00	0.2300E+00
45	0.2572E+00	0.2516E+00	0.2463E+00	0.2412E+00	0.2364E+00	0.2318E+00
50	0.2601E+00	0.2542E+00	0.2485E+00	0.2432E+00	0.2382E+00	0.2334E+00
55	0.2628E+00	0.2564E+00	0.2505E+00	0.2449E+00	0.2397E+00	0.2347E+00
60	0.2649E+00	0.2582E+00	0.2520E+00	0.2463E+00	0.2409E+00	0.2358E+00
65	0.2665E+00	0.2596E+00	0.2532E+00	0.2473E+00	0.2418E+00	0.2366E+00
70	0.2675E+00	0.2604E+00	0.2539E+00	0.2479E+00	0.2423E+00	0.2370E+00
75	0.2678E+00	0.2607E+00	0.2542E+00	0.2481E+00	0.2425E+00	0.2372E+00
80	0.2675E+00	0.2604E+00	0.2539E+00	0.2479E+00	0.2423E+00	0.2370E+00
85	0.2665E+00	0.2596E+00	0.2532E+00	0.2473E+00	0.2418E+00	0.2366E+00
90	0.2649E+00	0.2582E+00	0.2520E+00	0.2463E+00	0.2409E+00	0.2358E+00
95	0.2628E+00	0.2564E+00	0.2505E+00	0.2449E+00	0.2397E+00	0.2347E+00
100	0.2601E+00	0.2542E+00	0.2485E+00	0.2432E+00	0.2382E+00	0.2334E+00
105	0.2572E+00	0.2516E+00	0.2463E+00	0.2412E+00	0.2364E+00	0.2318E+00
110	0.2539E+00	0.2487E+00	0.2438E+00	0.2390E+00	0.2344E+00	0.2300E+00
115	0.2505E+00	0.2457E+00	0.2410E+00	0.2366E+00	0.2322E+00	0.2281E+00
120	0.2469E+00	0.2425E+00	0.2382E+00	0.2340E+00	0.2299E+00	0.2260E+00
125	0.2432E+00	0.2392E+00	0.2352E+00	0.2313E+00	0.2274E+00	0.2237E+00
130	0.2395E+00	0.2358E+00	0.2321E+00	0.2285E+00	0.2249E+00	0.2214E+00
135	0.2358E+00	0.2324E+00	0.2290E+00	0.2256E+00	0.2223E+00	0.2190E+00
140	0.2321E+00	0.2290E+00	0.2258E+00	0.2227E+00	0.2196E+00	0.2165E+00
145	0.2285E+00	0.2256E+00	0.2227E+00	0.2198E+00	0.2169E+00	0.2140E+00
150	0.2249E+00	0.2223E+00	0.2196E+00	0.2169E+00	0.2142E+00	0.2114E+00
155	0.2214E+00	0.2190E+00	0.2165E+00	0.2140E+00	0.2114E+00	0.2089E+00
160	0.2180E+00	0.2157E+00	0.2134E+00	0.2111E+00	0.2087E+00	0.2064E+00
165	0.2146E+00	0.2126E+00	0.2104E+00	0.2083E+00	0.2061E+00	0.2038E+00
170	0.2114E+00	0.2095E+00	0.2075E+00	0.2055E+00	0.2034E+00	0.2013E+00
175	0.2082E+00	0.2064E+00	0.2046E+00	0.2027E+00	0.2008E+00	0.1988E+00
180	0.2051E+00	0.2035E+00	0.2018E+00	0.2000E+00	0.1982E+00	0.1963E+00
185	0.2021E+00	0.2006E+00	0.1990E+00	0.1973E+00	0.1956E+00	0.1939E+00
190	0.1992E+00	0.1978E+00	0.1963E+00	0.1947E+00	0.1931E+00	0.1915E+00
195	0.1963E+00	0.1950E+00	0.1936E+00	0.1922E+00	0.1907E+00	0.1891E+00

X->	160	165	170	175	180	185
Y						
-50	0.1853E+00	0.1838E+00	0.1822E+00	0.1806E+00	0.1790E+00	0.1774E+00
-45	0.1875E+00	0.1859E+00	0.1843E+00	0.1826E+00	0.1809E+00	0.1793E+00
-40	0.1898E+00	0.1881E+00	0.1864E+00	0.1846E+00	0.1829E+00	0.1811E+00
-35	0.1921E+00	0.1903E+00	0.1885E+00	0.1866E+00	0.1848E+00	0.1830E+00
-30	0.1944E+00	0.1925E+00	0.1906E+00	0.1887E+00	0.1867E+00	0.1848E+00
-25	0.1968E+00	0.1948E+00	0.1927E+00	0.1907E+00	0.1887E+00	0.1866E+00
-20	0.1992E+00	0.1970E+00	0.1949E+00	0.1927E+00	0.1906E+00	0.1885E+00
-15	0.2016E+00	0.1993E+00	0.1970E+00	0.1948E+00	0.1925E+00	0.1903E+00
-10	0.2040E+00	0.2016E+00	0.1992E+00	0.1968E+00	0.1944E+00	0.1921E+00
-5	0.2064E+00	0.2038E+00	0.2013E+00	0.1988E+00	0.1963E+00	0.1939E+00
0	0.2087E+00	0.2061E+00	0.2034E+00	0.2008E+00	0.1982E+00	0.1956E+00
5	0.2111E+00	0.2083E+00	0.2055E+00	0.2027E+00	0.2000E+00	0.1973E+00
10	0.2134E+00	0.2104E+00	0.2075E+00	0.2046E+00	0.2018E+00	0.1990E+00
15	0.2157E+00	0.2126E+00	0.2095E+00	0.2064E+00	0.2035E+00	0.2006E+00
20	0.2180E+00	0.2146E+00	0.2114E+00	0.2082E+00	0.2051E+00	0.2021E+00
25	0.2201E+00	0.2166E+00	0.2132E+00	0.2099E+00	0.2067E+00	0.2035E+00
30	0.2222E+00	0.2185E+00	0.2149E+00	0.2114E+00	0.2081E+00	0.2049E+00
35	0.2241E+00	0.2202E+00	0.2165E+00	0.2129E+00	0.2095E+00	0.2061E+00

40	0.2258E+00	0.2218E+00	0.2180E+00	0.2143E+00	0.2107E+00	0.2073E+00
45	0.2274E+00	0.2233E+00	0.2193E+00	0.2155E+00	0.2118E+00	0.2083E+00
50	0.2289E+00	0.2245E+00	0.2204E+00	0.2165E+00	0.2127E+00	0.2091E+00
55	0.2300E+00	0.2256E+00	0.2214E+00	0.2174E+00	0.2135E+00	0.2099E+00
60	0.2310E+00	0.2265E+00	0.2222E+00	0.2181E+00	0.2142E+00	0.2104E+00
65	0.2317E+00	0.2271E+00	0.2227E+00	0.2186E+00	0.2146E+00	0.2109E+00
70	0.2321E+00	0.2274E+00	0.2230E+00	0.2189E+00	0.2149E+00	0.2111E+00
75	0.2322E+00	0.2276E+00	0.2232E+00	0.2190E+00	0.2150E+00	0.2112E+00
80	0.2321E+00	0.2274E+00	0.2230E+00	0.2189E+00	0.2149E+00	0.2111E+00
85	0.2317E+00	0.2271E+00	0.2227E+00	0.2186E+00	0.2146E+00	0.2109E+00
90	0.2310E+00	0.2265E+00	0.2222E+00	0.2181E+00	0.2142E+00	0.2104E+00
95	0.2300E+00	0.2256E+00	0.2214E+00	0.2174E+00	0.2135E+00	0.2099E+00
100	0.2289E+00	0.2245E+00	0.2204E+00	0.2165E+00	0.2127E+00	0.2091E+00
105	0.2274E+00	0.2233E+00	0.2193E+00	0.2155E+00	0.2118E+00	0.2083E+00
110	0.2258E+00	0.2218E+00	0.2180E+00	0.2143E+00	0.2107E+00	0.2073E+00
115	0.2241E+00	0.2202E+00	0.2165E+00	0.2129E+00	0.2095E+00	0.2061E+00
120	0.2222E+00	0.2185E+00	0.2149E+00	0.2114E+00	0.2081E+00	0.2049E+00
125	0.2201E+00	0.2166E+00	0.2132E+00	0.2099E+00	0.2067E+00	0.2035E+00
130	0.2180E+00	0.2146E+00	0.2114E+00	0.2082E+00	0.2051E+00	0.2021E+00
135	0.2157E+00	0.2126E+00	0.2095E+00	0.2064E+00	0.2035E+00	0.2006E+00
140	0.2134E+00	0.2104E+00	0.2075E+00	0.2046E+00	0.2018E+00	0.1990E+00
145	0.2111E+00	0.2083E+00	0.2055E+00	0.2027E+00	0.2000E+00	0.1973E+00
150	0.2087E+00	0.2061E+00	0.2034E+00	0.2008E+00	0.1982E+00	0.1956E+00
155	0.2064E+00	0.2038E+00	0.2013E+00	0.1988E+00	0.1963E+00	0.1939E+00
160	0.2040E+00	0.2016E+00	0.1992E+00	0.1968E+00	0.1944E+00	0.1921E+00
165	0.2016E+00	0.1993E+00	0.1970E+00	0.1948E+00	0.1925E+00	0.1903E+00
170	0.1992E+00	0.1970E+00	0.1949E+00	0.1927E+00	0.1906E+00	0.1885E+00
175	0.1968E+00	0.1948E+00	0.1927E+00	0.1907E+00	0.1887E+00	0.1866E+00
180	0.1944E+00	0.1925E+00	0.1906E+00	0.1887E+00	0.1867E+00	0.1848E+00
185	0.1921E+00	0.1903E+00	0.1885E+00	0.1866E+00	0.1848E+00	0.1830E+00
190	0.1898E+00	0.1881E+00	0.1864E+00	0.1846E+00	0.1829E+00	0.1811E+00
195	0.1875E+00	0.1859E+00	0.1843E+00	0.1826E+00	0.1809E+00	0.1793E+00

X->	190	195
Y		
-50	0.1758E+00	0.1742E+00
-45	0.1776E+00	0.1759E+00
-40	0.1793E+00	0.1776E+00
-35	0.1811E+00	0.1793E+00
-30	0.1829E+00	0.1809E+00
-25	0.1846E+00	0.1826E+00
-20	0.1864E+00	0.1843E+00
-15	0.1881E+00	0.1859E+00
-10	0.1898E+00	0.1875E+00
-5	0.1915E+00	0.1891E+00
0	0.1931E+00	0.1907E+00
5	0.1947E+00	0.1922E+00
10	0.1963E+00	0.1936E+00
15	0.1978E+00	0.1950E+00
20	0.1992E+00	0.1963E+00
25	0.2005E+00	0.1976E+00
30	0.2018E+00	0.1987E+00
35	0.2029E+00	0.1998E+00
40	0.2040E+00	0.2008E+00
45	0.2049E+00	0.2016E+00
50	0.2057E+00	0.2024E+00
55	0.2064E+00	0.2030E+00
60	0.2069E+00	0.2035E+00

65	0.2073E+00	0.2038E+00
70	0.2075E+00	0.2040E+00
75	0.2076E+00	0.2041E+00
80	0.2075E+00	0.2040E+00
85	0.2073E+00	0.2038E+00
90	0.2069E+00	0.2035E+00
95	0.2064E+00	0.2030E+00
100	0.2057E+00	0.2024E+00
105	0.2049E+00	0.2016E+00
110	0.2040E+00	0.2008E+00
115	0.2029E+00	0.1998E+00
120	0.2018E+00	0.1987E+00
125	0.2005E+00	0.1976E+00
130	0.1992E+00	0.1963E+00
135	0.1978E+00	0.1950E+00
140	0.1963E+00	0.1936E+00
145	0.1947E+00	0.1922E+00
150	0.1931E+00	0.1907E+00
155	0.1915E+00	0.1891E+00
160	0.1898E+00	0.1875E+00
165	0.1881E+00	0.1859E+00
170	0.1864E+00	0.1843E+00
175	0.1846E+00	0.1826E+00
180	0.1829E+00	0.1809E+00
185	0.1811E+00	0.1793E+00
190	0.1793E+00	0.1776E+00
195	0.1776E+00	0.1759E+00

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