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FEASIBILITY STUDY REPORT

BLOSENSKI LANDFILL SITE
CHESTER COUNTY, PENNSYLVANIA

EPA WORK ASSIGNMENT
NUMBER 37-3L49.0
CONTRACT NUMBER 68-01-6699

NUS PROJECT NUMBER S759

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EXECUTIVE SUMMARY

The Feasibility Study (FS) Report for the Blosenski Landfill Site has been prepared at the request of the United States Environmental Protection Agency (EPA) Region III under Work Assignment Number 37-3L49.0, Contract Number 68-01-6699. This study was prepared in accordance with the requirements of the National Oil and Hazardous Substances Contingency Plan (NCP) published pursuant to Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

Site Background

The Blosenski Landfill Site is located on 13.6 acres in West Cain Township, Chester County, Pennsylvania. It is surrounded by heavily wooded areas to the north and west, and by agricultural areas to the east and northwest. Approximately 30 residents live within a quarter-mile radius of the site.

The landfill was reportedly operated for the disposal of municipal and industrial wastes, beginning in the late 1940s. However, there is no specific information regarding activities at the site until its purchase by Joseph M. Blosenski, Jr., in the 1960s. From that time, until operations ceased in 1979, wastes accepted at the site for disposal included drummed industrial wastes, truckloads of sludge, and municipal and commercial refuse. Wastes were not segregated, and the site apparently was not lined.

Seven permits to operate the landfill were applied for in the 1970s but never granted. Several regulatory actions against the owner were issued by the Pennsylvania Department of Environmental Resources (PADER). A consent decree issued in 1979 to force site closure required the completion of groundwater and soil studies and remedial measures. In accordance with this, four monitoring wells were installed on site by PADER in 1982. During the winter of that year, 50 to 60 drums and a leaking tank truck were removed from the site. Samples

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taken by PADER and the USEPA Region III Field Investigation Team (FIT) have identified soil, surface water, and groundwater contamination with both organic and inorganic substances. These findings were verified by the results of the more recent remedial investigation (RI) performed at the site for the USEPA. The findings are discussed further in the following section.

Remedial Investigation Results

The RI was performed from the Fall of 1984 through the Spring of 1985 to assess the present and potential impacts of site-related contamination on the public health and the environment, and to provide a technical basis for developing appropriate alternative remedial actions for the site.

The RI reported that numerous organic and inorganic contaminants were detected in environmental media at the site. Regional data and site-specific observations indicate groundwater flow at the site is primarily through bedrock, although a localized, perched water table was identified in the eastern portion of the site. Volatile organic chemicals, the primary contaminants, have entered the water table and migrated beyond site boundaries. Advection of volatile contaminants occurs through regions of secondary permeability (fractures, faults, and bedding planes) in the underlying bedrock. The majority of volatile contaminants in the groundwater regime are migrating to the north of the site, reflecting the hydraulic gradient. It appears that these contaminants are then transported to the northwest via groundwater flow in a transmissive zone lying beneath the intermittent tributary to Indian Spring Run. Volatile organics were not detected in groundwater samples obtained to the north of this zone.

Chlorinated aliphatic compounds (primarily trichloroethene and 1,1,1-trichloroethane) were consistently detected in residential wells located to the south of the site. Factors that may induce migration of chemicals to the residential wells include the location of the source, the location and orientation of fractures, the densities of contaminants, hydraulic influences attributable to residential well pumping, and the depths of residential wells. The most probable source of the residential well contaminants lies in the vicinity of MW 2-1 on the southern portion of the site.

Two other sources of groundwater contaminants were identified: on the west side, near MW 3-1 (monocyclic aromatics); and on the east near TP-11 (monocyclic aromatics and chlorinated aliphatics).

Although detected at the site, semivolatiles, pesticides, PCBs, and inorganic substances are not migrating beyond the site boundaries. These relatively immobile chemicals appear to be confined to the immediate vicinity of the deposition areas.

Feasibility Study Objectives and Criteria

The overall purpose of the FS process is to provide an array of technically sound, cost-effective remedial action alternatives (RAAs) that control the source and manage the migration of contaminants, and provide protection to the public health, welfare, and the environment. In accordance with this, various cleanup objectives and criteria were established to provide a focus for the general response actions and technologies available for remediating the Blosenski Landfill Site. These objectives and criteria include

Cleanup Objectives	Cleanup Criteria
a. No action	a. Establish current potential risk levels and take no remedial action
b. Prevent an increase in the current potential risk associated with the site	b. Establish current potential risk levels and utilize remedial technologies to prevent an increase in potential risk levels

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Cleanup Objectives	Cleanup Criteria
c. Reduce the current potential risk associated with the site to acceptable levels	c. Reduce the current potential risk associated with the site to a target cleanup criteria of a 10^{-6} potential risk level, or other acceptable level.
d. Reduce the risk levels to those corresponding to background concentrations	d. Utilize remedial technologies to eliminate site contaminants

Screening of Remedial Action Technologies

Based on the above objectives and criteria, numerous source control and migration control technologies were screened to provide a limited number of technologies applicable for remedial actions at the site. Some of these technologies were removed from further consideration based on site-specific information gathered during the RI and on the basis of other comparative criteria. These other criteria include

- Technical performance
- Magnitude of costs
- Health and environmental impacts
- Institutional considerations

Applicable technologies identified during the RI, as well as those encompassing important treatment or disposal options, were discussed and evaluated. If the technology was found to be inapplicable for site-specific conditions or use, or if it was rejected on the basis of other criteria, it was dropped from further consideration. The remaining technologies were developed into candidate alternatives that meet the specific remedial action objectives and the criteria for evaluation of alternatives.

Development and Evaluation of Remedial Action Alternatives

To evaluate a wide range of remedial responses to this site, alternatives were developed to fall into one of five cleanup categories, which are described in the USEPA Guidance Document on Feasibility Studies Under CERCLA (EPA, June 1985). Each category represents a different degree of site remediation and is described as follows:

- No action.
- Alternatives that meet the CERCLA goals of preventing or minimizing present or future migration of hazardous substances and protecting human health and the environment, but do not attain all other applicable or relevant standards.
- Alternatives that attain all applicable or relevant public health and environmental standards, guidance, or advisories.
- Alternatives that exceed all applicable or relevant public health and environmental standards, guidance, and advisories.
- Alternatives specifying offsite storage, destruction, treatment or secure disposal of hazardous substances at a facility approved under the Resource Conservation and Recovery Act (RCRA). Such a facility must also be in compliance with all other applicable EPA standards.

The following paragraphs provide brief descriptions of the RAAs developed for each category. Table ES-1 summarizes the capital and present-worth cost for each RAA.

TABLE ES-1

COSTS OF REMEDIAL ACTION ALTERNATIVES ($1000s)

Remedial Action Alternative	Capital Costs (Range)	30-Year Present Worth Analysis (Range)
1. No action with monitoring	$80-130	$1,953-2,003
2. Soil cap, alternate water supply and long-term monitoring.	2,706 - 4,812	5,122 - 7,233
3. Multimedia cap, alternate water supply, groundwater extraction and treatment, and long-term monitoring.	8,481 - 13,037	13,150 - 17,706
4. Onsite landfill, alternate water supply, groundwater extraction and treatment, and long-term monitoring.	14,317 - 31,508	18,986 - 36,177
5a. Onsite incineration, multimedia cap, alternate water supply, groundwater extraction and treatment, and long-term monitoring.	26,113 - 32,207	47,858 - 53,952
5b. Onsite incineration, stabilization of residuals, alternate water supply, groundwater extraction and treatment, and long-term monitoring.	30,378 - 43,258	53,392 - 66,272
6. Excavation and offsite disposal of wastes in a RCRA-approved landfill, alternate water supply, groundwater extraction and treatment, and long-term monitoring, including the following:		
Option a: Excavation and offsite disposal of soils in a RCRA-approved landfill	89,388 - 257,503	93,858 - 261,973
Option b: Construction of multi-media cap over contaminated soils	44,815 - 123,782	49,484 - 128,451
Option c: Excavation and detoxification of contaminated soils	45,756 - 126,006	50,027 - 130,877

No Action Alternative

Remedial Action Alternative One - No Action with Long-term Monitoring

This is a baseline alternative to provide a comparison of the effectiveness of the other remedial alternatives against present and potential site risks, if the site remains remediated. Long-term monitoring is proposed as a means to detect any future changes in site conditions or contaminant migration.

Alternatives that Meet CERCLA Goals

Remedial Action Alternative Two - Onsite Capping of Contaminated Soils and Wastes; Extension of the Coatesville Water Authority Public Water Supply; and Long-term Monitoring

RAA Two involves leaving the existing contaminated wastes and soils in place, while covering them with a low permeability soil cap to reduce infiltration and prevent dermal contact. An alternate water supply will be provided to potentially affected residences by extending the Coatesville Water Authority's main line. Additional monitoring wells will be installed on site to detect any future contaminant migration via the groundwater.

Alternatives That Attain All Applicable Standards

Remedial Action Alternative Three - Onsite Multimedia Capping of Contaminated Soils and Wastes; Extension of the Coatesville Water Authorty Public Water Supply; Groundwater Extraction, Treatment, and Injection; and Long-term Monitoring

RAA Three is similar to RAA Two in that all site materials are left in place. However, a multimedia cap of 10^{-7} cm/sec permeability material plus a synthetic membrane is used in lieu of a soil cap. Groundwater extraction, treatment (via air stripping and carbon adsorption), and injection is added to remediate the groundwater. An alternate water supply and long-term monitoring are also provided in RAA Three.

Remedial Action Alternative Four - Construction of a Secured Onsite Landfill; Extension of the Coatesville Water Authority Public Water Supply; Groundwater Extraction, Treatment and Injection; and Long-term Monitoring

RAA Four involves excavating the approximately 400,000 cubic yards of contaminated soil and waste material, constructing a RCRA-approved landfill, and redepositing the materials on site. This alternative would thus completely encapsulate all contaminated materials and effectively isolate them from the environment. An alternate water supply, groundwater remediation, and long-term monitoring will be provided.

Alternatives That Exceed All Applicable Standards

Remedial Action Alternative Five - Complete Excavation of Contaminated Soils and Wastes; Onsite Incineration with Multimedia Cap Over Residuals; Extension of the Coatesville Water Authority Public Water Supply; Groundwater Extraction, Treatment and Injection; and Long-term Monitoring

RAA Five, like the previous alternatives, also involves complete excavation of contaminated materials. Prior to disposal on site, however, all wastes and soils are incinerated onsite using a mobile, rotary kiln system. Residual materials are backfilled, and a multimedia cap is placed over them to minimize infiltration. All organic contaminants in the soils and wastes will be destroyed via this process. An alternate water supply, groundwater remediation, and long-term monitoring complete this remedial action alternative.

Option to Remedial Action Alternative Five Complete Excavation of Contaminated Soils and Wastes: Onsite Incineration with Stabilization of Residuals; Extension of the Coatesville Water Authority Public Water Supply; Groundwater Extraction, Treatment, and Injection; and Long-term Monitoring

The option of stabilizing the incinerator residuals instead of placing them under a multimedia cap is also evaluated. A pozzolanic process using flyash and cement as additives is suggested for stabilization of the metals-laden residuals. The stabilized product would be backfilled on site, covered with a flow zone and topsoil, and vegetated. As in the first incineration alternative, an alternate water supply, groundwater remediation, and long-term monitoring will be provided.

Alternatives That Specify Offsite Disposal

Remedial Action Alternative Six - Excavation of Contaminated Waste Deposits and Disposal in an Offsite RCRA-Approved Landfill; the Option to Dispose, Contain, or Treat the Contaminated Soils that Underlie the Waste Deposits; Extension of the Coatesville Water Authority Public Water Supply; Groundwater Extraction, Treatment, and Injection; and Long-term Monitoring

RAA Six provides for excavation and offsite disposal of the site's waste materials in a secure, hazardous waste landfill. Three options are then provided for the contaminated soils underlying the wastes. In the first option, the soils are disposed off site, and the area backfilled with clean fill and revegetated. The second option provides for a multimedia cap over the in-place soils to reduce the amount of infiltration. The third option allows for a series of studies to evaluate the potential use of an innovative or emerging technology to detoxify the soils using a mobile soil washing system. The cleansed soils would be returned to the site as clean backfill and the cleaning fluids treated as necessary. For all three of these options, an alternate water supply, groundwater remediation, and long-term monitoring are provided.

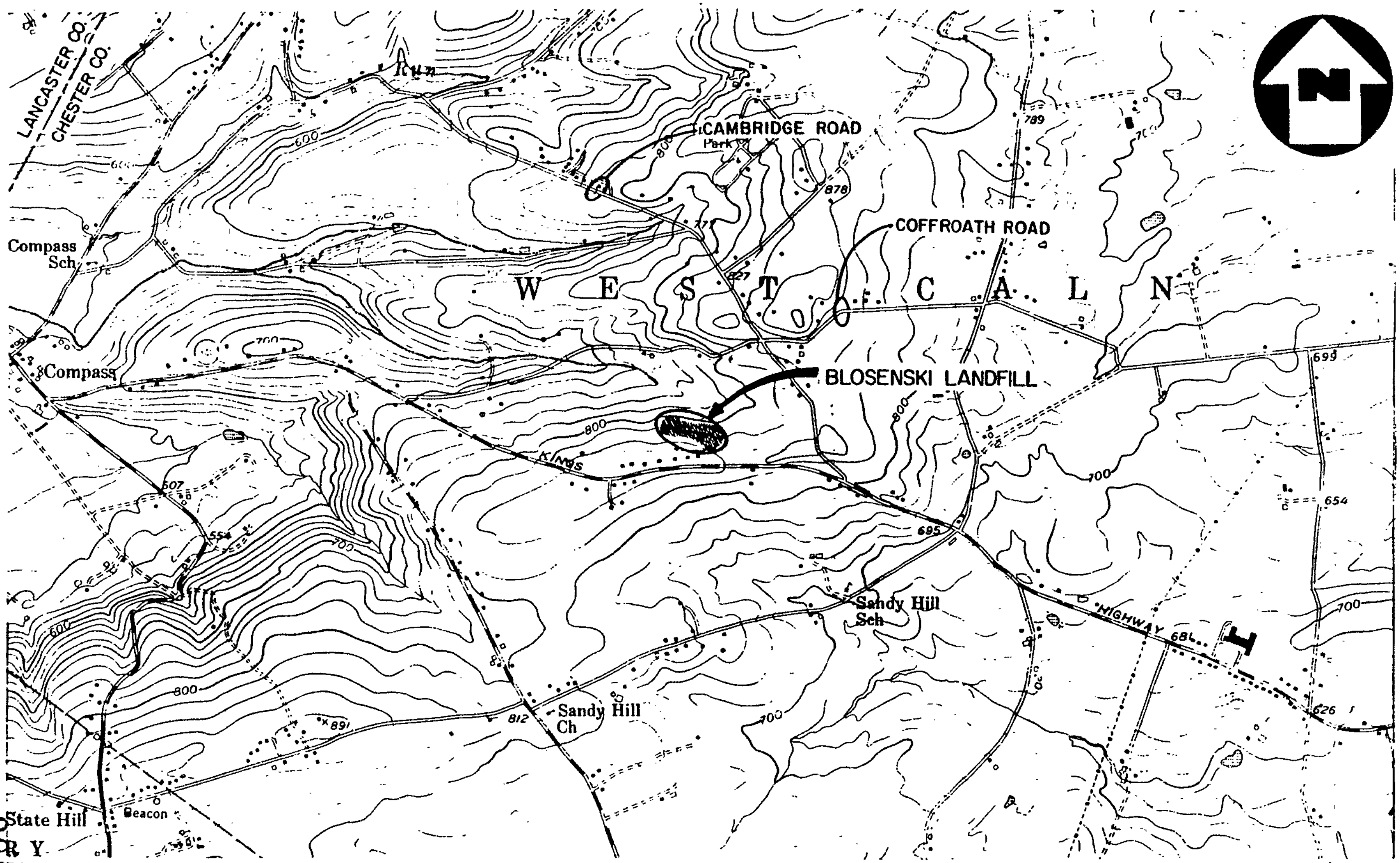
1.0 INTRODUCTION

1.1 Site Background

The Blosenski Landfill Site occupies approximately 13.6 acres in West Caln Township, Chester County, Pennsylvania. As shown in Figures 1-1 and 1-2, the landfill lies approximately 1000 feet north of State Route 340 (Kings Highway) and 2000 feet west of the intersection of King's Highway and Cambridge Road. It is surrounded by heavily-wooded areas to the north and to the west, and by agricultural areas to the east and northwest. A marshy area lies on the northeastern section of the site, and a ravine borders the site to the north and east. Approximately 500 feet north of the site, an intermittent tributary flows westward, about 2 miles, to Indian Spring Run. About 3.5 miles west of the site, Indian Spring Run joins Pequea Creek, which flows into the Susquehanna River approximately 30 miles southwest of the site. Approximately 30 residents live within a quarter-mile radius of the site.

Beginning in the late 1940s, the landfill was reportedly operated by Perry Phillips for the disposal of municipal and industrial wastes. However, there is no specific information regarding activities at the site until its purchase by Joseph M. Blosenski, Jr., in the 1960s. From that time, until operations ceased in 1979, wastes accepted at the site for disposal included drummed industrial wastes, truckloads of sludges, and municipal and commercial refuse. Wastes were not segregated, and the site apparently was not lined.

Seven permits to operate the landfill were applied for in the 1970s but never granted. Several regulatory actions against the owner were issued by the Pennsylvania Department of Environmental Resources (PADER). A consent decree issued in 1979 to force site closure required the completion of groundwater and soil studies and remedial measures. In accordance with this, four monitoring wells were installed on site by PADER in 1982. During the winter of that year, 50 to 60 drums and a leaking tank truck were removed from the site. Samples taken by PADER and the USEPA Region III Field Investigation Team (FIT) have identified



BASE MAP IS A PORTION OF THE U.S.G.S. HONEY BROOK, PA QUADRANGLE (7.5 MINUTE SERIES, 1955, PHOTOREVISED 1969 AND 1974). CONTOUR INTERVAL 20'.

FIGURE 1-1

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LOCATION MAP
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA

SCALE: 1"=2000'

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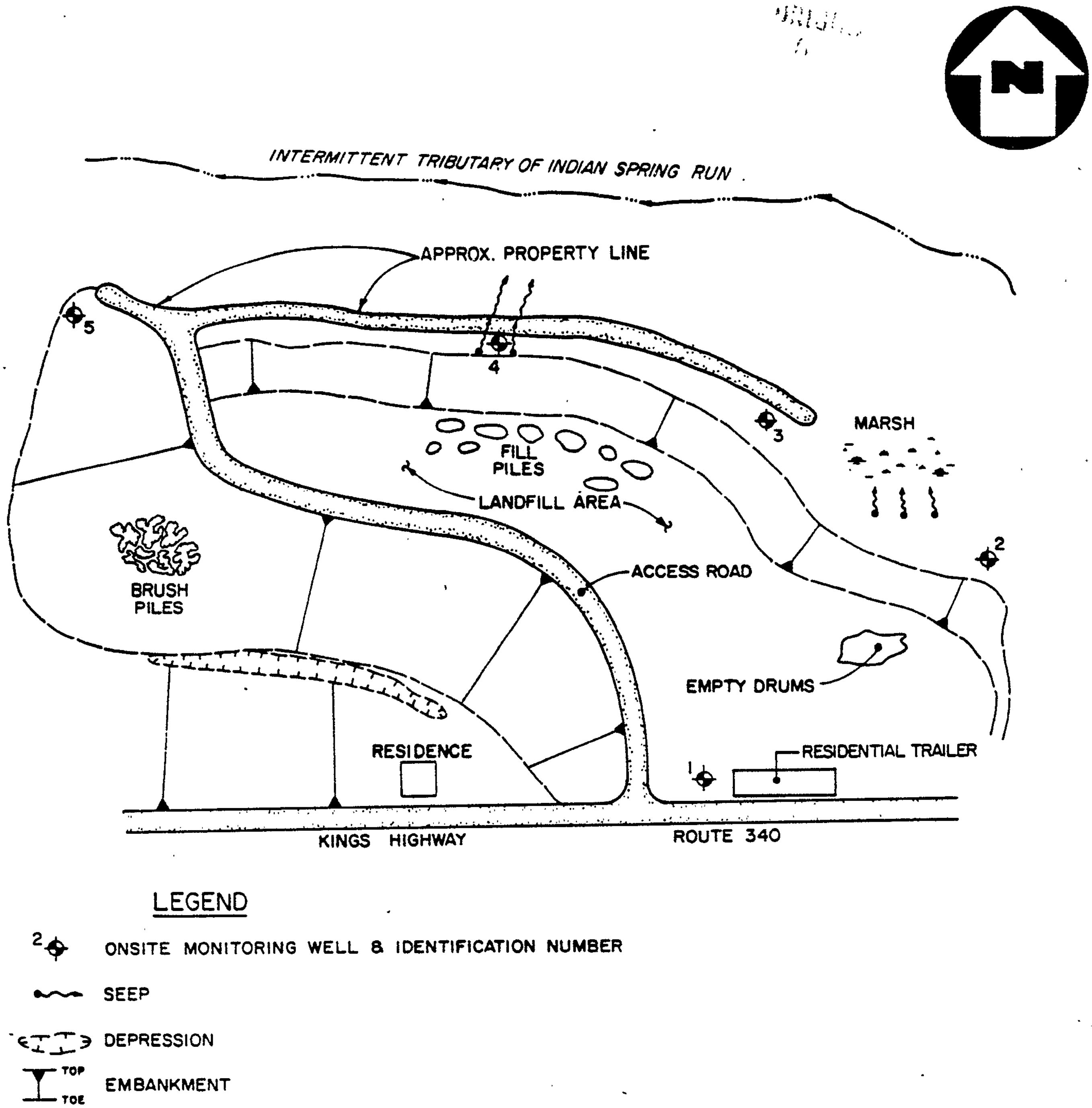

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FIGURE 1-2

SITE LAYOUT
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA
NOT TO SCALE

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soil, surface water, and groundwater contamination with both organic and inorganic substances. These findings were verified by the results of the more recent remedial investigation (RI) performed at the site for the USEPA. The findings are discussed further in the following section.

1.2 Remedial Investigation Results

The RI was performed from the Fall of 1984 through the Spring of 1985 to assess the present and potential impacts of site-related contamination on the public health and the environment, and to provide a technical basis for developing appropriate alternative remedial actions for the site. Results of the investigation of various onsite and offsite media indicate that the wastes disposed at the Blosenski Landfill Site are the apparent source of contamination found in the environmental media of the surrounding area.

1.2.1 Contaminants

Both organic and inorganic chemical constituents were found at the Blosenski Landfill Site. However, the data indicate that the primary contaminant problem is caused by volatile organic compounds in the groundwater and other media. Because volatile organics are relatively mobile in the hydrologic cycle, they are considered to be indicative of the subsurface migration mechanisms at the landfill.

Volatile organics, and their respective maximum concentrations, detected in monitoring well and residential well samples taken during the RI are as follows:

Chemical	Maximum Groundwater Concentration (ug/l)
benzene	11,000
toluene	600
ethylbenzene	54
total xylenes	78
chlorobenzene	34
1,1,1-trichloroethane	430

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Chemical	Maximum Groundwater Concentration (µg/l)
1,2-dichloroethane	74
1,1-dichloroethane	270
chloroethane	93
tetrachloroethene	5
trichloroethene	260
1,2-dichloroethene	890
1,1-dichloroethene	21
vinyl chloride	450
chloroform	270
methylene chloride	2,000
acetone	43,000
2-butanone	350
2-hexanone	21
4-methyl-2-pentanone	7

Data from residential wells surrounding the site indicates that volatile organic contaminants (primarily trichloroethene and 1,1,1-trichloroethane) have migrated off site via the groundwater.

Volatile organics were detected in surface and subsurface soils on the eastern, western, and central portions of the site near monitoring wells MW 2-1 and MW 3-1. Sampling did not identify site-related impacts resulting from volatile contaminants on the intermittent stream north of the site, perhaps due to dry weather conditions prevalent during the RI.

As compared to the levels of volatile organics contamination detected, environmental media at the site have relatively less contamination by semi-volatiles (acid and base/neutrals), pesticides, polychlorinated biphenyls (PCBs), and inorganic substances. The chemical and analytical results of the RI indicated that these substances appear to be confined to the immediate vicinity of their deposition areas (see RI Report, Section 6.6). Contaminants found in samples taken during the RI are summarized in Table 1-1.

TABLE 1-1

CONTAMINANTS AT THE BLOSENSKI LANDFILL SITE

		Concentration Range (No. of Observations/No. of Samples)							
Contaminant	CAS No.	Groundwater (µg/l)	Residential Wells (µg/l)	Surface Water (µg/l)	Sediment (µg/kg)	Subsurface Soil (µg/kg)	Test Pits (µg/kg)	Surface Soil (µg/kg)	Air (mg/m³)
acetone	67-64-1	860-43,000 (3/36)			180 (1/11)			120-850 (4/25)	0.030 (1/1)
2-butanone	78-93-3	70-350 (3/36)	23 (1/66)	27 (1/6)				47-1,000 (7/25)	
2-hexanone	519-78-6	12-21 (2/36)					100 (1/20)		
4-methyl-2-pentanone	108-10-1	7 (1/36)						110 (1/25)	
benzene	71-43-2	9-11,000 (18/36)	14 (1/66)				22-2,900 (4/20)	5-12 (4/25)	0.022 (1/1)
toluene	108-88-3	22-600 (7/36)			1 (3/11)	2-1,100 (14/20)	80-5,900,000 (4/20)	1-4,000 (9/25)	0.123 (1/1)
ethylbenzene	100-41-4	42-54 (3/36)					3-15,400,000 (7/20)	5-500 (10/25)	0.013 (1/1)
chlorobenzene	108-90-7	33-34 (2/36)							
total xylenes		5-78 (4/36)					25-61,000,000 (9/20)	10-1,100 (11/20)	0.028 (1/1)
styrene	100-42-5								0.013 (1/1)
1,1,1-trichloroethane	71-55-6	5-430 (15/36)	3.7-26 (7/66)					5-390 (6/25)	0.091 (1/1)

TABLE 1-1
CONTAMINANTS AT BLOSENSKI LANDFILL SITE
PAGE TWO

		Concentration Range (No. of Observations/No. of Samples)							
Contaminant	CAS No.	Groundwater (µg/l)	Residential Wells (µg/l)	Surface Water (µg/l)	Sediment (µg/kg)	Subsurface Soil (µg/kg)	Test Pits (µg/kg)	Surface Soil (µg/kg)	Air (mg/m³)
1,1-dichloroethane	75-34-3	5-270 (18/36)		5-9 (3/6)			120 (1/20)	20 (1/25)	0.011 (1/1)
1,2-dichloroethane	107-06-2	5-74 (4/36)							
chloroethane	75-00-3	10-93 (5/36)					2,030 (1/20)		
tetrachloroethene	127-18-4	5 (1/36)				3 (1/20)		5-110 (9/25)	
trichloroethene	79-01-6	5-74 (10/36)	3-260 (12/66)		5 (1/11)	8-860 (2/20)		1-8 (3/25)	0.066 (1/1)
1,2-dichloroethene	156-60-5	5-890 (19/36)	3-18 (3/66)	3 (1/6)				5-29 (5/25)	0.067 (1/1)
1,1-dichloroethene	75-35-4	6-21 (4/36)						5.6 (1/25)	0.009 (1/1)
vinyl chloride	75-01-4	6-450 (10/36)							
chloroform	67-66-3	6-270 (18/36)	2 (1/66)	4 (1/6)					0.053 (1/1)
methylene chloride	75-09-2	25-2,000 (3/36)			350-1,400 (2/11)	4-4,900 (9/20)		12-1,300 (12/25)	
carbon disulfide	75-15-0								0.015 (1/1)

TABLE 1-1
CONTAMINANTS AT THE BLOSENSKI LANDFILL SITE
PAGE FOUR

		Concentration Range (No. of Observations/No. of Samples)							
Contaminant	CAS No.	Groundwater (µg/l)	Residential Wells (µg/l)	Surface Water (µg/l)	Sediment (µg/kg)	Subsurface Soil (µg/kg)	Test Pits (µg/kg)	Surface Soil (µg/kg)	Air (mg/m^3)
benzo(a)anthracene	56-55-3							65-1,700 (9/25)	
benzo(b)fluoranthene	205-99-2						65-1,700	(9/25)	
benzo(k)fluoranthene	207-08-9						35-1,700	(5/25)	
benzo(g,h,i)perylene	191-24-2							120-660 (3/25)	
benzo(a)pyrene	50-32-8							9-1,700 (9/25)	
chrysene	218-01-9							220-1,700 (4/25)	
dibenzo(a,h)anthracene	53-70-3							31 (1/25)	
fluoranthene	206-44-0				16-18 (2/11)			18-3,200 (10/25)	
fluorene	86-73-7							22-660 (5/25)	
indeno(1,2,3-cd)pyrene	193-39-5							120-700 (3/25)	
naphthalene	91-20-3	10-50 (8/36)					260-710,000 (6/20)	21-5,000 (7/25)	

TABLE 1-1
CONTAMINANTS AT THE BLOSENSKI LANDFILL SITE
PAGE FIVE

		Concentration Range (No. of Observations/No. of Samples)							
Contaminant	CAS No.	Groundwater (µg/l)	Residential Wells (µg/l)	Surface Water (µg/l)	Sediment (µg/kg)	Subsurface Soil (µg/kg)	Test Pits (µg/kg)	Surface Soil (µg/kg)	Air (mg/m^3)
2-methylnaphthalene	91-57-6	10 (2/36)					17,000-80,000 (3/20)		
phenanthrene	85-01-8							42-1,800 (5/25)	
pyrene	129-00-0		10 (1/66)		11-12 (2/11)	39,600 (1/20)		8-2,200 (12/25)	
1,2-dichlorobenzene	95-50-1	10 (1/36)	7-8 (3/66)						
1,3-dichlorobenzene	541-73-1	10 (3/36)				39,600 (1/20)			
1,4-dichlorobenzene	106-46-7							330 (1/25)	
1,2,4-trichlorobenzene	120-82-1					39,600 (1/20)			
2,4-dinitrotoluene	121-14-2					39,600 (1/20)			
n-nitrosodimethylamine	62-75-9							66 (1/25)	
aniline	62-53-3	47-360 (2/36)							
bis(2-chloroethyl)ether	111-44-4					5,500 (1/20)			

TABLE 1-1
CONTAMINANTS AT THE BLOSENSKI LANDFILL SITE
PAGE SIX

Contaminant	CAS No.	Concentration Range (No. of Observations/No. of Samples) Groundwater (µg/l)	Residential Wells (µg/l)	Surface Water (µg/l)	Sediment (µg/kg)	Subsurface Soil (µg/kg)	Test Pits (µg/kg)	Surface Soil (µg/kg)	Air (mg/m^3)
bis(2-chloroisopropyl)ether	39638-32-9	10 (1/36)							
3,3'-dichlorobenzidine	91-94-1							700 (1/25)	
benzoic acid	65-85-0	50 (3/36)			210 (1/11)			380-8,000 (5/25)	
isophorone	78-59-1							36-660 (2/25)	
dibenzofuran	132-64-9							11-660 (4/25)	
PCB-1221	11104-28-2						1,900 (1/20)		
PCB-1232	11141-16-5						2,200 (1/20)		
PCB-1242	53469-21-9						4,200-11,000 (2/20)	10,000 (1/24)	
PCB-1254	11097-69-1						2,900-9,800 (2/20)		
PCB-1260	11096-82-5							53,000 (1/24)	
4,4'-DDT	50-29-3	0.10 (1/36)	0.10 (1/66)				300 (2/20)		

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TABLE 1-1
CONTAMINANTS AT THE BLOSENSKI LANDFILL SITE
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Contaminant	CAS No.	Concentration Range (No. of Observations/No. of Samples) Groundwater (µg/l)	Residential Wells (µg/l)	Surface Water (µg/l)	Sediment (µg/kg)	Subsurface Soil (µg/kg)	Test Pits (µg/kg)	Surface Soil (µg/kg)	Air (mg/m^3)
4,4'-DDE	72-55-9						980-1,800,000 (4/20)		
endosulfan I	959-98-8	0.05-0.50 (2/36)					1,200-60,000 (3/20)		
endosulfan II	33213-65-9	0.50 (1/36)							
endosulfan sulfate	1031-07-8						350-900 (2/20)		
endrin	72-20-8	0.50 (1/36)	0.10 (1/66)				700-2,500 (2/20)		
endrin aldehyde	7421-93-4						390-1,000 (2/20)		
heptachlor	76-44-8						550-3,500 (3/20)		
heptachlor epoxide	1024-57-3						1,300-17,000 (3/20)		
β-BHC	319-85-7	0.25 (1/36)					200-400 (2/20)		
γ-BHC	58-89-9						200 (1/20)		
δ-BHC	319-86-8	0.25-2.5 (6/36)					190-2,200 (4/20)		

TABLE 1-1
CONTAMINANTS AT THE BLOSENSKI LANDFILL SITE
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Contaminant	CAS No.	Concentration Range (No. of Observations/No. of Samples) Groundwater (µg/l)	Residential Wells (µg/l)	Surface Water (µg/l)	Sediment (µg/kg)	Subsurface Soil (µg/kg)	Test Pits (µg/kg)	Surface Soil (µg/kg)	Air (mg/m^3)
dieldrin	60-57-1		0.10 (1/66)						
chlordane	57-74-9						42 (1/20)		
toxaphene	8001-35-2						13,000 (1/20)		
arsenic	7440-38-2	10.6-14 (4/36)	11-15 (3/52)		2,100-13,000 (8/11)	6,800-8,500 (2/20)	5.8 (1/18)	50-23,000 (25/25)	
barium	513-77-9	(1.1)-1,240 (34/36)	(20.2)-158 (45/52)	28-395 (6/6)	38,000-185,000 (11/11)	42,000-400,000 (13/22)	43,000-482,000 (9/18)	10,500-842,000 (21/24)	
cadmium	7440-43-9	5.5-8.6 (5/36)	(0.14)-11 (10/52)	4.5-6.4 (2/6)	200-2,600 (9/11)	1,400-6,700 (13/20)	54-300 (2/18)	80-280,000 (18/24)	
chromium	7440-47-3	3.2-14 (10/36)	3.0-22 (6/52)	16-19 (2/6)	7,500-27,000 (11/11)	1,900-38,000 (18/20)	1,000-172,000 (6/18)	2,000-158,000 (21/25)	
copper	7440-50-8	3.5-11 (3/36)	12-928 (46/52)	15 (2/6)	6,000-17,000 (11/11)	9,900-52,000 (12/20)	(10,000)-1,500,000 (9/18)	3,500-5,860,000 (21/24)	
lead	7439-92-1	5.9 (1/36)	(1.5)-26 (17/52)	7.9 (1/6)	3,400-18,000 (11/11)	2,300-24,000 (12/20)	(2,000)-3,100,000 (17/18)	2,300-1,720,000 (25/24)	
mercury	7439-97-6	1.2-1.7 (2/36)	0.3-1.1 (5/52)			690-2,000 (7/20)	80-490 (6/18)	70-640 (18/24)	
nickel	7440-02-0	12-(32) (7/36)	4.5-267 (13/52)	7.1-49 (4/6)	5,500-18,000 (11/11)	5,900-28,000 (10/20)		3,300-437,000 (16/24)	

TABLE 1-1
CONTAMINANTS AT THE BLOSENSKI LANDFILL SITE
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		Concentration Range (No. of Observations/No. of Samples)							
Contaminant	CAS No.	Groundwater (µg/l)	Residential Wells (µg/l)	Surface Water (µg/l)	Sediment (µg/kg)	Subsurface Soil (µg/kg)	Test Pits (µg/kg)	Surface Soil (µg/kg)	Air (mg/m³)
silver	7440-22-4							900-5,000 (2/24)	
zinc	7440-66-6	8.5-834 (12/36)	(7.1)-224 (36/52)		19,000-102,000 (11/11)	6,700-53,000 (15/20)	20,000-14,500,000 (15/18)	600-38,000,000 (22/24)	

1.2.2 Pathways and Receptors

The RI identified the following five pathways for the transport of contaminants to potential receptors.

- Groundwater Movement - Transport of contaminated groundwater may occur via the generally northward hydraulic gradient or through fractures and joints in underlying bedrock. A perched groundwater zone in the southeast corner of the site may also play a role in groundwater contaminant migration.

- Leachate Production - Precipitation and infiltration may leach contaminants from waste pockets and contaminated soils into the groundwater and overburden material.

- Erosion and Runoff - Stormwater may cause erosion of contaminated surface soils resulting in the contamination of surface waters and sediments.

- Volatilization - Volatile organics could be introduced to ambient air by soil disturbances or favorable meteorological conditions.

- Particulate Transport - Respirable dust particles carrying insoluble contaminants may become airborne.

Potential receptors of contaminants at the Blosenski Landfill Site include the following:

- Local residents downgradient (whether by natural or pumping induced gradient conditions) of the site who use groundwater for drinking, showering, lawn watering, and other domestic uses.

- Onsite remediation workers who may come into contact with contaminated soil, water, or air during cleanup activities.

- Casual intruders who traverse the site and its environs, and thereby may come into contact with contaminated surface soils, surface waters, and sediments. They also may be exposed to windblown, respirable dust containing insoluble contaminants.

- Environmental receptors, including onsite terrestrial flora and fauna, aquatic biota in affected surface waters, and terrestrial fauna that use aquatic animals as a food source.

1.2.3 Public Health and Environmental Risks

By assimilating the information on contaminant effects, pathways, and receptors, the RI identified risks to the public health and the environment resulting from the Blosenski Landfill Site. Potential public health risks associated with the various contaminated media are summarized below.

- Groundwater - The major exposure path and subsequent potential public health risk at the site is through the ingestion and domestic use of contaminated groundwater. Although the two organics-contaminated residential wells are located upgradient of the site, fractured bedrock and well pumping may have drawn the mobile (volatile) compounds from the site. Contaminant concentrations found in these residential and monitoring well samples exceed health criteria such as USEPA Health Advisories (SNARLS) for 10-day acute effects and subchronic toxic effects, and for long-term chronic health impacts due to contaminant ingestion, as well as Safe Drinking Water Act Maximum Contaminant Levels (MCLs).

At the concentrations in the more contaminated residential well, the potential risk of exposures from volatilization of contaminants during shower usage exceeds the potential exposure from ingestion. The absorption of contaminants during bathing may be comparable to that from direct groundwater ingestion. At the contaminant concentrations found during the RI, ingestion of the groundwater carries a corresponding cancer risk in excess of 10^{-6}, based on the EPA's Unit Cancer Risk Preliminary Protective Concentration Limits (PPCLS). These risk levels are summarized in Table 1-2. At the mean concentrations for the carcinogens identified in the RI, the estimated corresponding total potential risk level, due to ingestion of water from the two contaminated residential wells is 2.6×10^{-2}, and is 1.8×10^{-2} for ingestion of water from contaminated monitoring wells. Since the residents with the contaminated wells are drinking bottled water, these risk levels are conservative.

- Surface Waters and Sediments - Surface waters and sediments have been relatively unaffected by organic contaminants from the site, and acute effects from ingestion, inhalation, or dermal exposure do not appear to be a major problem. However, levels of chloroform and nickel in surface waters exceeded the chronic health effects Ambient Water Quality Criteria (AWQC) for long-term ingestion. However, the surface waters are not known to be used as drinking water in the site vicinity. The AWQC for the protection of human health via ingestion of aquatic organisms were not exceeded for any identified contaminants.

- Surface and Subsurface Soils - There has been no identified route of exposure to contaminants in the subsurface soils. Mobile, volatile contaminants were found at relatively low concentrations in the soils. Therefore, they should not significantly affect the groundwater. Phthalate esters, pesticides, and PCBs were found at somewhat higher concentrations. However, they are less mobile than the volatiles and tend to adhere to soil particles, thus presenting a lesser threat to groundwater.

TABLE 1-2

ESTIMATED CARCINOGENIC RISK ASSOCIATED WITH INGESTION OF GROUNDWATER BLOSENSKI LANDFILL SITE

Contaminant	Monitoring Wells – Carcinogenic Risk/Person (a)			Residential Wells – Carcinogenic Risk/Person (a)		
	Mean Concentration	Minimum Concentration	Maximum Concentration (b)	Mean Concentration	Minimum Concentration	Maximum Concentration (b)
vinyl chloride CAS No. 75-01-4	1.0×10^{-4} @ 209 µg/l	3.0×10^{-6} @ 6 µg/l	2.2×10^{-4} @ 450 µg/l	ND	ND	ND
tetrachloroethene CAS No. 127-18-4	---	---	8.6×10^{-6} @ 5 µg/l	ND	ND	ND
trichloroethene CAS No. 79-01-6	2.0×10^{-5} @ 37 µg/l	2.7×10^{-6} @ 5 µg/l	4.0×10^{-5} @ 74 µg/l	3.2×10^{-5} @ 59 µg/l	1.6×10^{-6} @ 3 µg/l	1.4×10^{-4} @ 260 µg/l
1,1-dichloroethene CAS No. 75-35-4	4.6×10^{-5} @ 11 µg/l	2.5×10^{-5} @ 6 µg/l	8.8×10^{-5} @ 21 µg/l	ND	ND	ND
1,1,1-trichloroethane CAS No. 71-55-6	4.8×10^{-6} @ 105 µg/l	2.3×10^{-7} @ 5 µg/l	2.0×10^{-5} @ 430 µg/l	5.0×10^{-7} @ 11 µg/l	1.8×10^{-7} @ 3.7 µg/l	1.2×10^{-6} @ 26 µg/l
chloroform CAS No. 67-66-3	2.0×10^{-5} @ 101 µg/l	1.2×10^{-5} @ 6 µg/l	5.4×10^{-5} @ 270 µg/l	---	---	4.0×10^{-4} @ 2 µg/l
benzene CAS No. 71-43-2	4.3×10^{-3}@ 2914 µg/l	1.3×10^{-5} @ 9 µg/l	1.6×10^{-2} @ 11,000 µg/l	---	---	2.1×10^{-5} @ 14 µg/l
methylene chloride CAS No. 75-09-2	1.7×10^{-5} @ 941 µg/l	4.5×10^{-7} @ 25 µg/l	3.6×10^{-5} @ 2,000 µg/l	ND	ND	ND

TABLE 1-2
ESTIMATED CARCINOGENIC RISK ASSOCIATED WITH INGESTION OF GROUNDWATER
BLOSENSKI LANDFILL SITE
PAGE TWO

Contaminant	Monitoring Wells - Carcinogenic Risk/Person (a)			Residential Wells - Carcinogenic Risk/Person (a)		
	Mean Concentration	Minimum Concentration	Maximum Concentration (b)	Mean Concentration	Minimum Concentration	Maximum Concentration (b)
arsenic CAS No. 7440-38-2	$4.0x10^{-3}$ @ 9.4 µg/l	$4.5x10^{-3}$ @ 10.6 µg/l	$6.0x10^{-3}$ @ 14 µg/l	$5.4x10^{-3}$ @ 12.7 µg/l	$4.7x10^{-3}$ @ 11 µg/l	$6.4x10^{-3}$ @ 14 µg/l
cadmium CAS No. 7440-43-9	$1.3x10^{-3}$ @ 6 µg/l	$1.1x10^{-3}$ @ 5 µg/l	$1.3x10^{-3}$ @ 6 µg/l	$4.5x10^{-4}$ @ 2 µg/l	$2.2x10^{-5}$ @ 0.1 µg/l	$2.4x10^{-3}$ @ 11 µg/l
chromium(c) CAS No. 7440-47-3	$7.5x10^{-3}$ @ 6.4 µg/l	$3.7x10^{-3}$ @ 3.2 µg/l	$1.1x10^{-1}$ @ 14 µg/l	$1.9x10^{-2}$ @ 16.2 µg/l	$3.5x10^{-3}$ @ 3.0 µg/l	$2.5x10^{-2}$ @ 22 µg/l
nickel CAS No. 7440-02-0	$6.9x10^{-4}$ @ 21 µg/l	$3.9x10^{-4}$ @ 12 µg/l	$1.0x10^{-3}$ @ 32 µg/l	$1.2x10^{-3}$ @ 36 µg/l	$1.3x10^{-4}$ @ 4 µg/l	$8.8x10^{-3}$ @ 267 µg/l
Total Potential Risk	$1.8x10^{-2}$ (1 in 60)	$9.7x10^{-3}$ (1 in 100)	$1.3x10^{-1}$ (1 in 7)	$2.6x10^{-2}$ (1 in 40)	$8.4x10^{-3}$ (1 in 120)	$4.3x10^{-2}$ (1 in 23)

(a) Cancer risk assessments provided for chemicals for which evaluations have been conducted by EPA's Carcinogenic Assessment Group.

(b) Probability of exposure to a single detection of a contaminant in drinking water is low. Risk calculations for single detections were included in the maximum concentration category to assume a "worst case" scenario.

(c) Assumes all chromium present as the +6 ion.

Acute exposure, however, to subsurface contaminants could occur during a major soil disturbance.

The potential for exposure to surface soils is much greater than to subsurface soils through direct contact/dermal adsorption, dust inhalation, and accidental ingestion. Although acute effects are highly unlikely, except during soil disturbance, chronic effects may occur through direct contact with PCBs, phthalate esters, and polynuclear aromatics, or through inhalation of released volatiles.

- Source Areas - In the event of a major disturbance to identified source areas or buried drums, the potential for dermal exposures increases significantly.

- Air - Based on a qualitative measurement of volatilized contaminants within monitoring well MW 2-1, atmospheric concentrations of contaminants at the site would not be expected to exceed the City of Philadelphia's recommended guidelines for average yearly concentrations. Thus, health impacts would not be expected via inhalation. However, soil disturbance during site remediation may result in volatilization and the introduction of contaminated airborne dust particles. Monitoring and proper construction techniques will reduce these potential health impacts.

Environmental risks from the Blosenski Landfill Site include the following:

- Surface Waters and Sediments - Levels of contaminants found in surface waters and sediments are low. The RI data did not indicate any acute or chronic risks to aquatic biota.

- Soils and Groundwater - The RI data indicate that onsite soils and groundwater present a low, chronic risk to biota at this time.

1.3 Remedial Action Objectives and Criteria

The overall purpose of the Feasibility Study (FS) process is to provide an array of technically sound, cost-effective remedial action alternatives that control the source and manage the migration of contaminants, and to provide protection to public health, welfare, and the environment. To meet this overall purpose, specific cleanup objectives and criteria are necessary to providė a focus for the general response actions and technologies available for remediating the Blosenski Landfill Site.

Each of the contaminant pathways and potential receptors identified in the RI and discussed in the previous sections were evaluated under the following objectives and criteria:

Cleanup Objectives	Cleanup Criteria
a. No action	a. Establish current potential risk levels and take no remedial action
b. Prevent an increase in the current potential risk associated with the site	b. Establish current potential risk levels and utilize remedial technologies to prevent increase in potential risk levels
c. Reduce the current potential risk associated with the site to an acceptable level	c. Reduce the current potential risk associated with the site to a target cleanup criteria of a 10^{-6} potential risk level, or other acceptable level.
d. Reduction of risk levels to those corresponding to background concentrations	d. Utilize remedial technologies to eliminate site contaminants

The results of that evaluation process are discussed in the following paragraphs.

1.3.1 Contaminated Groundwater

The most significant potential public health risk associated with the site is to receptors who ingest, shower with, or use the contaminated groundwater in ways that promote direct dermal contact and/or inhalation of volatilized contaminants. Site contaminants have been found in domestic wells south of the site. The primary pathway for contaminant migration is through the highly fractured bedrock groundwater system that underlies the site. Volatile organic contaminants that enter the system move in fractures and along relict bedding joints with little or no attenuation or adsorption of the contaminants. The complex fracture system precludes accurate prediction of the specific flow path and flow rate of the contaminant plume. However, the regional groundwater system flows toward the north, and site contaminants may be discharged into an unnamed intermittent tributary of Indian Spring Run, north of the site. Indian Spring Run is classified by PADER as a protected stream for the propagation of cold water fish species. If site contaminants enter the stream, they could adversely affect stream biota.

The cleanup objectives of no-action and preventing further increase of risk are not appropriate to the groundwater contamination problem because of the high potential health risks associated with ingestion, inhalation, or contact with the groundwater contaminants. The objectives of reducing current potential risks to acceptable or background levels are acceptable and feasible, since corresponding contaminant levels associated with the site can be reduced by available technologies.

As defined by the National Contingency Plan (NCP, 40 CFR 300), and EPA's Guidance on Feasibility Studies Under CERCLA (USEPA, June 1985), an acceptable target cleanup criterion for the reduction of risk is a level of 10^{-4} to 10^{-7}. The target cleanup criterion used in this FS for reducing the public health risk to an acceptable level is the reduction of the volatile organic contaminants to their respective 10^{-6} risk levels. For the volatile organic contaminants found at this site, the 10^{-6} risk levels are the maximum contaminant levels (MCLs) as shown in Table 1-3.

TABLE 1-3

PROPOSED GROUNDWATER TREATMENT STANDARDS
BLOSENSKI LANDFILL SITE

Contaminant	Recommended Maximum Contaminant Level (RMCL)(1) (μg/l)	Maximum Contaminant Level (MCL)(2) (μg/l)
benzene	0	5
1,1,1-trichloroethane	200	200
1,2-dichloroethane	0	5
tetrachloroethene	0	NR
trichloroethene	0	5
vinyl chloride	0	1
chloroform	NR	NR
methylene chloride	NR	NR

Notes:

NR - Not reported.
(1) - RMCLs are solely health-based criteria.
(2) - MCLs are allowable lifetime exposures that result in a 1×10^{-6} risk, and reflect the technological and economic feasibility of removing the contaminant.

Source: USEPA, November 13, 1985. Federal Register, Vol. 50, No. 219.

The target clean-up criteria for the elimination of site contaminants is background concentrations of site contaminants in the groundwater system. In most cases this background level for volatile organics is zero. However, this level may not necessarily be analytically confirmable.

1.3.2 Contaminated Surface Soils and Sediments

The most significant potential public health risk associated with this pathway is to children, who may accidentally ingest contaminated soils if playing on the site, and to other casual intruders, who may come in dermal contact with the contaminated soils. The RI reported that there is no significant health risk associated with the level of surface contaminants found on site and in nearby sediments. However, there is potential for increased risk if the site erosion is allowed to continue.

The no-action and the prevent-increase-in-risk objectives are not appropriate to the contaminated soil pathway because of the future public health risk associated with migration of the soil contaminants. The reduction-of-risk objectives are feasible because the contamination levels can be reduced by available technologies.

An acceptable target cleanup criterion for reducing the potential health risk associated with the contaminated soil exposure pathways is a corresponding risk level of 10^{-6}. To attain a 10^{-6} risk, the following soil contaminants must be reduced to their respective concentration levels, shown below:

Dermal Contact (Casual Intruders)

3,3' Dichlorobenzidine	3 mg/kg
Polynuclear aromatics (Total)	0.5 mg/kg
PCB's (Total)	1 mg/kg

Soil Ingestion (Children)

3,3' Dichlorobenzidine	8 mg/kg
Polynuclear aromatics (Total)	1 mg/kg
PCB's (Total)	3 mg/kg

The elimination of site contaminants will require the reduction of all contaminants to concentration levels equal to or less than background levels. In most cases, this level is considered to be zero, and may not be analytically confirmable.

1.3.3 Respirable Contaminants

This pathway includes dust particles that contain sorbed contaminants, particles of nonvolatile contaminants, and volatilized site contaminants. The only appropriate objective in this category is to maintain the current risk levels during any future site remediation or atmospheric condition. Reduction and/or elimination of the potential health risk levels can be attained by meeting the objectives and target cleanup criteria of the other contaminant pathways. Therefore, they are not proposed as feasible objectives for remediation of this pathway. Standard accepted engineering practices and construction management techniques will properly address risk concerns during remediation activities.

Table 1-4 lists the general response actions that meet the cleanup objectives and criteria for the contaminant exposure pathways. In Section 2.0 of this report, these actions will be broken down into site-specific remedial technologies and screened for remediation applicability on the basis of technical feasibility, public health and environmental impacts, institutional issues, and costs.

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TABLE 1-4

SUMMARY OF REMEDIAL ACTION OBJECTIVES
AND GENERAL RESPONSE ACTIONS
BLOSENSKI LANDFILL SITE

Potential Pathways and Receptors	Preliminary Objectives	Target Cleanup Criteria	General Response Actions
I. Contaminated Groundwater • Receptors that consume or utilize contaminated groundwater • Environmental receptors in contact with groundwater discharges	A. Reduce risk to an acceptable level	• Develop technologies that establish corresponding health risk levels of 10^{-6}	• Containment utilizing capping and/or barrier walls • Groundwater pumping • Stormwater controls • Complete or partial excavation and disposal • Onsite treatment or offsite treatment utilizing incineration or innovative technologies • In situ treatment utilizing bioreclamation, soil flushing, neutralization and/or land farming • Onsite disposal or offsite disposal utilizing double lined or EPA approved landfills • Alternate water supply utilizing information from Focused Feasibility Study
	B. Reduce risk to no greater than existing background risk levels	• Public health risk levels no greater than existing background risk levels	• Groundwater pumping • Complete removal • Onsite or offsite treatment utilizing incineration or an innovative technology

TABLE 1-4
SUMMARY OF REMEDIAL ACTION OBJECTIVES
AND GENERAL RESPONSE ACTIONS
BLOSENSKI LANDFILL SITE
PAGE TWO

Potential Pathways and Receptors	Preliminary Objectives	Target Cleanup Criteria	General Response Actions
			• In situ treatment utilizing bioreclamation, soil flushing, neutralization and/or landfarming • Onsite or offsite disposal utilizing a double lined or EPA approved landfill • Alternate water supply
II. Contaminated Surface Waters and/or Sediments • Receptors that enter the site area (casual intruders, remediation workers, hunters) • Environmental receptor in contact with surface water and/or sediments risks	A. Reduce risks to an acceptable level, if necessary	• Develop technologies that establish corresponding health risk levels of 10^{-6}	• Containment utilizing capping • Stormwater controls • No action • Fencing on site
	B. Reduce risks to background level	• Public health risk levels no greater than existing background risk levels	• Technologies that stabilize or destroy site wastes and soil contaminants (see I.B. above)
III. Contaminated Vapors and/or Respirable Dusts • Receptors that enter the site area • Receptors adjacent to the site (residents near the site)	A. Reduce risks to an acceptable level, if necessary	• Develop technologies that establish corresponding health risk levels of 10^{-6}	• Containment utilizing capping • Proper construction methods during remediation actions • No action
	B. Reduce risks to background level	• Public health risk levels no greater than existing background risk levels	• Technologies that stabilize or destroy site wastes and soil contaminants (see I.B. above)

1.4 Feasibility Study Procedure

The FS process is intended to develop and evaluate remedial action alternatives for the site using data obtained during the RI and using other site-related information obtained from local, state, and Federal agencies. As a minimum, one alternative will be developed for each of the five cleanup categories described in the USEPA Guidance Document on Feasibility Studies Under CERCLA (USEPA, June 1985). These categories are described further in Section 3.0 and include the no-action alternative as a baseline alternative.

The methodology for preparation of this FS parallels the procedure outlined in the Guidance Document and the NCP. This procedure is as follows.

- Identify General Response Actions - General Response Actions (GRAs) were identified which address the site problems and contaminant pathways identified during the RI. Corresponding objectives and criteria to be used in evaluating technologies within each GRA were developed for each contaminant pathway.

- Identify and Screen Technologies - Technologies were identified for each GRA and screened against the site-specific cleanup objectives and criteria. Technologies not meeting the site cleanup objectives and criteria were eliminated from further consideration, whereas those remaining were screened by additional criteria. These additional screening criteria included technical feasibility; ability to adequately protect the public health, welfare, and the environment; cost considerations; and institutional constraints. The results of the technology screening are presented in Section 2.0 of this report.

- Develop Remedial Action Alternatives - Remedial Action Alternatives (RAAs) were developed from the remaining technologies in each GRA category. Alternatives judged to have significant adverse impacts or that were judged to be significantly higher in cost without providing significantly greater benefits were excluded from consideration. At least one RAA was provided for each of the five USEPA cleanup categories, as recommended in the Guidance Document. These RAAs are discussed in Section 3.0 of this report.

The resulting group of alternatives were evaluated according to the same criteria used to screen the technologies: technical feasibility, health and environmental impacts, costs, and institutional concerns. The results of the detailed evaluation process are discussed in Section 4.0 of this report. The RAAs evaluated in Section 4.0 are summarized in Section 5.0 to facilitate EPA's review and selection of the appropriate remedial action for the Blosenski Landfill Site.

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2.0 SCREENING OF REMEDIAL ACTION TECHNOLOGIES

2.1 Screening Criteria

This section describes the screening process used to identify the most appropriate or effective technologies for mitigating contamination problems at the Blosenski Landfill Site. A list of candidate technologies will be identified and evaluated to eliminate technologies that do not satisfy the appropriate cleanup objectives and meet technical and environmental criteria. This section summarizes the major justifications for retaining or eliminating the remedial technologies. Detailed background screening data are provided in Appendix A. The screening criteria consist of:

- *Satisfaction of site-specific objectives*
- Technical feasibility
- Health and environmental impacts
- Cost of implementation
- Institutional considerations

Technologies that pass the screening process will be retained for development into appropriate RAAs.

2.1.1 *Satisfaction of Remedial Action Objectives*

Only technologies that satisfy the appropriate remedial action objectives will be further screened by the remaining criteria. Those objectives listed in Section 1.3 will be the basis for choosing applicable remedial technologies. A technology may be technically feasible and cost attractive, but if it does not satisfy the appropriate cleanup objectives, it is considered inappropriate for the site.

2.1.2 Technical Feasibility

Technologies will be evaluated in terms of their ability to provide the desired remediation, such as containment, treatment, or disposal. Each technology will be evaluated based on the following technical criteria:

- Performance
- Implementability
- Reliability
- Safety

The performance of each technology will be evaluated in terms of its effectiveness in satisfying the cleanup objectives through applicable technical standards and criteria. Technologies should also provide remediation for an extended time, usually 30 years, without significant deterioration. The technologies should be implementable; that is, they should be constructable under the site conditions and in a timely manner. It is important for the technologies to be reliable, as determined by previous performance data under similar conditions. Ideally, the technologies should have infrequent operation and maintenance (O&M) requirements, which should be as simplified as possible when required. Each technology should also be implementable with minimum health effects, both to remedial workers and to the surrounding community. Consideration will be given to innovative technologies as they may be applicable to site conditions.

2.1.3 Health and Environmental Impacts

Each technology will be evaluated for its impact on both public health and the environment. Both beneficial and adverse impacts will be assessed for the technologies that address the site-specific problems and contamination pathways. The impacts associated with both implementation and post-closure activities will be considered.

2.1.4 Cost Evaluation

Costs will be determined, as required, to screen out technologies for which results of the other screening criteria are essentially the same. Cost estimates will include capital costs and O&M costs, which will be used to screen out technologies that provide similar degrees of remediation but cost significantly (e.g., an order of magnitude) more.

2.1.5 Institutional Considerations

The applicable Federal, state, and local standards, regulations, and ordinances will be addressed for each technology. Any indirect community or other impacts will also be discussed in this section, as applicable.

2.2 Candidate General Response Actions and Technologies

The possible technologies used to remediate a site can be classified into groups called General Response Actions (GRAs), each of which can be used to control a contaminated media or its migration pathway. Table 2-1 contains a comprehensive listing of GRAs and technologies that can be used for a hazardous waste site remediation. This list is provided to help ensure the consideration of all possible technologies.

2.3 Technology Screening Process

Table 2-1 of this report identifies various GRAs that may be applicable for contaminant source and migration control at the Blosenski Landfill Site. This section describes the screening process used to identify, within GRA categories, the appropriate or effective technologies for mitigating contamination under site-specific conditions. The technologies are examined based on their ability to meet the cleanup objectives listed in Section 1.3, their technical feasibility, health and environmental impacts, costs of implementation, and institutional criteria.

TABLE 2-1

GENERAL RESPONSE ACTIONS AND ASSOCIATED
REMEDIAL TECHNOLOGIES

General Response Actions	Remedial Technologies
No Action	- Some monitoring and analyses may be included
Containment	- Capping; dust control; addition of freeboard; groundwater containment barrier walls; bulkheads; gas barriers
Pumping	- Groundwater pumping; liquid removal; dredging
Collection	- Sedimentation basins; French drains; gas vents; gas collection systems
Diversion	- Grading; dikes and berms; stream diversion ditches, trenches, and diversions; terraces and benches; chutes and downpipes; levees; seepage basins
Complete Removal	- Tanks; drums; soils; sediments; liquid wastes, contaminated structures; sewers and water pipes
Partial Removal	- Tanks; drums; soils; sediments; liquid wastes
Onsite Treatment	- Incineration; solidification; biological, chemical, and physical treatment
Offsite Treatment	- Incineration; biological, chemical, and physical treatment (POTW or pretreatment facility)
In-situ Treatment	- Permeable treatment beds; bioreclamation; soil flushing; neutralization; land farming
Storage	- Temporary storage structures
Onsite Disposal	- Landfills; deep well injection
Offsite Disposal	- Landfills; surface impoundments; land application
Alternative Water Supply	- Bottled water; cisterns; above-ground tanks; deeper or upgradient wells; municipal water system; relocation of intake structure; individual treatment devices
Relocation	- Relocate residents, businesses, and habitat areas

Technologies that obviously are not appropriate for meeting the cleanup objectives, and technologies found not to be effective under site-specific conditions will not be evaluated further. Those passing the initial screening will be retained for development into appropriate remedial action alternatives.

2.3.1 No Action with Monitoring

Although not a remedial action technology per se, an evaluation of the no action alternative provides a baseline evaluation of current site conditions, against which the relative effectiveness of other remedial actions may be compared. The current extent of contamination was determined by sampling and analysis conducted during the RI.

The no action alternative will not reduce any exposure risks or potential impacts to public health and the environment. The addition of continued monitoring, however, will provide a mechanism to determine the trends of future contaminant concentrations and migration from the site. Samples should be taken periodically (every 3 to 12 months) and should include surface soil and groundwater samples. All samples should be analyzed for EPA Hazardous Substance List (HSL) compounds, including volatile organics, inorganics, pesticides, and PCBs.

2.3.2 Containment

2.3.2.1 Surface Capping

Two of the mechanisms that are contributing to contaminant migration from the Blosenski Landfill Site are leachate generation due to infiltration of rainfall, and erosion of contaminated soils or wastes caused by storm water runoff. These two mechanisms can be controlled by installing a protective cap that reduces the rate of infiltration and protects the contaminated media from the erosional effects of storm water. Surface capping is a technology that has been effectively utilized in industry and in the management of uncontrolled hazardous waste sites to control the contaminant migration mechanisms of infiltration and storm water runoff.

Potential surface capping materials include synthetic membranes, low permeabiity soils (clays, silty clays, clayey silts, and selected silts), local soil materials, asphalt materials, chemical stabilizers, or a multimedia cap constructed of low permeability soils and synthetic membrane layers. The following paragraphs discuss the application of the above capping materials and their relative applicabiity to the Blosenski Landfill Site.

- Synthetic Membranes

  Synthetic membranes are considered state-of-the-art for obtaining minimal infiltration rates as both liners and caps. A wide variety of polymeric and synthetic materials are available for use as liners and caps. Some of the more common types of synthetic membrane materials are high density polyethylene (HDPE), polyvinyl chloride (PVC), chlorinated polyethylene (CPE), chlorosulfonated polyethylene (CSPE), butyl rubber, and ethylene propylene rubber.

  The thickness of the synthetic membrane is determined in thousandths of an inch, or mils. Membranes range in thickness from 10 mils to over 100 mils. A January 1985 information package from the EPA Hazardous Site Control Division recommended that a synthetic membrane used in conjunction with 2 feet of compacted, low permeability soils to form a cap meeting RCRA specifications be at least 20 mils thick, and that 60 to 100 mils is frequently used by industry. The May 1985 Minimum Technology Guidance on Double Liner Systems for Landfills and Surface Impoundments--Design, Construction, and Operation recommends that a 30-mil membrane be utilized for liners that are protected by a blanket of soil from the effects of sun and weathering, and that a 45-mil membrane be utilized if the membrane was exposed or uncovered for a year or more.

  The selection of both the type of synthetic material and the thickness of a synthetic membrane will depend on the site-specific application of the membrane and the ability of the synthetic membrane to meet the objectives established for a remedial action alternative. The Blosenski Landfill Site has several characteristics that limit the effectiveness and reliability of a synthetic membrane cap alone. The site has been identified as a municipal solid waste (MSW) landfill along with the industrial waste and solvent disposal activities that the RI/FS has focused on. MSW is subjected to an anaerobic decomposition and degradation process when placed in a landfill. The process can cause settling and consolidation of the deposited MSW by as much as 30 to 50 percent over the life of the landfill. Synthetic membranes and the welds or seams that hold the panels of membrane together to form a cap are susceptible to failure when waste pockets settle. The synthetic membrane is stretched and elongated which reduces its ability to resist infiltration and if enough settling occurs, the membrane in that area could fail completely. There is also some concern that the site contaminants and their interaction with each other might degrade the synthetic material over time. The installation of the synthetic membrane and subsequent construction activities associated with completing or maintaining a remedial action exposes the membrane to equipment operations that could cause damage. Burrowing animals could also damage the synthetic membrane. The synthetic membrane also creates a low friction surface that makes it difficult to place cover materials or granular collection materials over the membrane in steep sloped areas. There have been incidences where materials have slid off a synthetic membrane after a rain storm. The rain waters infiltrated the cover materials, formed a phreatic zone along the interface, and created a failure plane.

A synthetic membrane cap for the Blosenski Landfill is not a good technology by itself. There are implementability, reliability, and durability problems that could cause failure or reduced performance of a synthetic membrane cap. The cap would not control the rate of infiltration and, without a protective zone of soil and vegetative cover, the storm water runoff from about 9.5 acres of impervious area would be difficult to control. The use of a synthetic membrane in conjunction with low permeability soils is a better technology that offers a backup impervious zone in case of membrane deterioration or failure. The additional cost of a multimedia cap is not an order of magnitude higher than a synthetic cap alone, and will be retained for further evaluation.

- Low Permeability Soils

Low permeability soils are considered to be soils that, when compacted, exhibit a permeability less than or equal to 1.0 x 10^{-7} cm/sec. Typically, these soils fall within the Unified Soils Classification System (USCS) classifications of clays, silty clays, clayey silts, and silts depending on their plasticity index and organic or inorganic determination. Low permeability soil caps, often called clay caps, are constructed of thick layers of compacted fine-grained soils. The soil is placed in loose lifts 6 to 12 inches thick and then machine compacted to a predetermined density. This process is repeated until a compacted layer of soil several feet thick is attained. The thickness of the cap is generally in the range of 2 to 3 feet. The amount of compaction required to attain a permeability within the range of 10^{-7} cm/sec is typically in excess of 90 percent of the soils maximum dry density as determined by standard or modified compaction tests.

It is extremely important to note that density and permeabilities that are attained in the laboratory are not likely to be duplicated in the field. The laboratory is a controlled environment and the purpose of the laboratory tests are to develop a standard for field construction activities. The laboratory test procedure for compaction testing utilizes impact energy to compact the laboratory soil samples, while most field compaction methods use kneading and/or static pressure. Standard practice for laboratory permeability testing utilizes the remolded soil sample that was subjected to the impact compaction method. It is not unrealistic to find that a properly constructed, low permeability soil cap will exhibit a permeability that is an order of magnitude greater than the laboratory permeability test results.

The selection of a suitable low permeability soil for use as an impervious cap will require extensive testing and evaluation. The soils in the area will have to be sampled and tested for grain size distribution, plasticity, permeability, compatibility with the chemical characteristics of the infiltration expected to occur at the site, and compactibility. However, the Blosenski Landfill site has one physical characteristic that is not compatible with the use of a compacted, low permeability soil cap as the singular means of reducing the amount of infiltration generated lechate. The MSW deposited at the site is not a suitable base for the construction of a compacted, controlled fill. The MSW exhibits an elastic rebound that will continually subject the placed, compacted material to a wave-like motion. The result is an inability to achieve the degree of compaction necessary to attain a 1.0×10^{-7} cm/sec permeability and numerous surface fractures in the plastic action of the soils.

A low permeability soil cap for the Blosenski Landfill Site is not a good technology by itself. The compaction forces needed to attain a 1.0×10^{-7} cm/sec permeability in a fine-grained soil cannot be achieved due to the elastic properties exhibited by MSW landfills. The elastic rebound will also cause surface tension cracks due to plasticity of the fine-grained soils. Soils with larger particles and less plasticity can be used to overcome the problems, but they will generally exhibit permeabilities within the range of 10^{-5} cm/sec. A soil cap with those properties is screened later in this section. The low permeability soils discussed above are also used in a later part of this section as part of a multimedia cap technology screening and, therefore, will be retained for further evaluation.

- Soil Cap

Soil caps are considered to be a thick layer of compacted, local soils that can be effective in reducing the amount of infiltration related leachate, but are primarily used to create a barrier between the site contaminants and receptors that might otherwise ingest or contact the surface contaminants. They are also used in controlling erosion related contaminant migration. Based on the soil information presented in the RI, the soils found near the Blosenski Landfill Site are generally of the Edgemont Series and consist of loams, silty loams, and silts. These textures of materials typically exhibit permeabilities within the range of 10^{-5} cm/sec.

In order to aid in evaluating the effectiveness of a soil cap constructed from local soils, the HELP computer model was run on all the potential cap materials discussed in this section and on the existing site conditions. Since regional climatological data and default soil data was used in the HELP simulations, the results of the computer simulations are presented as a relative percentage decrease in leachate production based on existing conditions. For example, the HELP model showed a 2-foot-thick soil cap with a permeability of 10^{-5} cm/sec to produce 99 percent less leachate than the existing site conditions.

The use of a 2-foot-thick soil cap with a permeability of 10^{-5} cm/sec is an effective technology to reduce leachate production and control contaminant migration caused by erosion. The compaction problems identified with the low permeability soil cap presented earlier will not adversely impact the silty, loamy soils used in this soil cap. The larger sized soil particles will not require the same amount of compaction force to attain maximum densities, and the plasticity of this texture of material should not create extensive or uncontrolled surface tension cracks. The desired permeability should be attainable in these types of field conditions. The additional cost of securing clay-like soils and compacting them to a lower density to attain similar permeability does not appear to be a feasible option for the soil cap technology. Local borrow should be less expensive to buy and to transport to the site if a nearby supplier can be found.

Although this technology does reduce the amount of leachate produced by the site, it does not effectively control the source in a manner that allows it to be considered a source control remedy. This technology should not be combined with other technologies that call for contaminant migration remediation unless another source control technology is also incorporated into the remedial action alternative.

- Multimedia Cap

Multimedia caps are a combination of low permeability soils and synthetic membranes in conjunction with an overlying layer of protective soil that can also support vegetation. In most cases, an infiltration collection and flow zone is added between the synthetic membrane and the protective soil cover. The combined effect of the low permeability soils and the synthetic membrane is not an overall decrease in the permeability of the cap, but rather a factor of safety in case one or the other impervious media fail or deteriorate.

The Blosenski Landfill Site is not suitable for capping with either the synthetic membrane or the low permeability soils alone. However, the site can be capped with a multimedia system which will compensate for the weaknesses of the individual materials. The soils will not attain a 10^{-7} cm/sec permeability, but the synthetic membrane will. The synthetic membrane can be damaged through waste settlement or construction activities, but the soils will have a tendency to mold and flex with the settlement and construction activities. There is also some evidence that the weight of the multimedia cap and the moisture retention capabilities of the synthetic membrane will create a consolidation effect on the soils, while keeping the soils at or above optimum moisture. This combined effect may decrease the relative permeability of the compacted soils and create a more uniform infiltration barrier.

The capital costs for a multimedia cap versus a synthetic membrane cap or a low permeability soil cap is not an order of magnitude higher. Preliminary cost estimates for the multimedia cap is about $3,000,000 and the cost for a low permeability cap is about $1,000,000 for a 9.5-acre site. The cost estimate for a synthetic membrane cap is expected to fall between these estimates. A multimedia cap for the Blosenski Landfill Site is a feasible technology that can be combined with other technologies to remediate the site. This technology can also be used as a source control remedy since it effectively reduces leachate production to near zero.

- Asphalt Cap

Asphalt caps may be constructed over a prepared subgrade to substantially reduce infiltration. However, asphalt liners are subject to cracking from subgrade failure. This is especially true for an area containing refuse, which is subject to subsidence from waste decomposition. Because of their structural instability, asphalt liners will not be retained for further evaluation.

- Chemically Stabilized Caps

Chemical stabilization involves excavating the present cover materials, mixing them with lime or bentonite, and replacing them, thereby forming a more impermeable cover material. These cemented soils are subject to cracking from freeze-thaw stresses and may deteriorate upon extended exposure to organic solvents vapors. Due to their long-term instability, chemically stabilized surface caps will not be retained for further evaluation.

2.3.2.2 Groundwater Barriers

One of the site objectives is to reduce the potential public health risks associated with consuming groundwater contaminants. A groundwater barrier can help to achieve this goal by containing the groundwater within the site and isolating it from the offsite receptors. Groundwater barriers can also be used to block groundwater movement so that it can be collected more easily. Highly fractured bedrock formations, however, reduce the effectiveness of groundwater barriers.

- Soil-Bentonite Slurry Wall

  A soil-bentonite slurry wall involves excavating a trench down to bedrock under a slurry of bentonite clay and water, then backfilling the trench with the original soil admixed with the slurry to form a low permeability boundary. The water table at the Blosenski Landfill is at or below the bedrock surface. Since slurry walls only extend down to bedrock, they would not be effective in reducing groundwater movement.

- Grout Curtains

  A grout curtain is a seal formed in soil or rock voids from suspension fluids that have been pressure injected and allowed to set up. It can be used to either contain groundwater or control its flow direction. However, containing groundwater in fractured bedrock would be difficult, due to the complex fracture network. The ability to check for a seal after grout installation is questionable. Also, the long-term effectiveness of a grout curtain exposed to dilute contaminant concentrations is questionable. Since the residential wells adjacent to the site are up to 150 feet deep, the grout curtain should extend to that same depth. Because of the depth of seal required, a grout curtain would be a very expensive technology. Preliminary estimates (Appendix A) indicate a cost of $3,000,000 for a 1400 foot wall extending 150 feet into bedrock that would be located between the contaminated wastes and the residences. For these reasons, a grout curtain will not be evaluated further.

2.3.3 Groundwater Collection

The groundwater contaminant concentrations beneath the site currently correspond to unacceptable potential health risk levels. One method of reducing the risks to acceptable levels is to collect the contaminated groundwater to reduce its migration off site. There are two general methods for collecting groundwater. One method is a passive system using collection drains to intercept the groundwater, and the other is an active system utilizing pumping to increase the flow and removal rates.

2.3.3.1 Subsurface Collection Drains

Subsurface collection drains work well in excavatable soil. At this site, groundwater is located within the bedrock which, based on RI data, is approximately 30 feet below the surface. The deepest residential well is believed to be approximately 150 feet deep. The collection drain would have to be at least this deep to reduce contamination passing beneath the drain. This would involve excavating approximately 120 feet of bedrock. The cost of this technology would be at least an order of magnitude greater than pumping and, therefore, will not be considered for further evaluation.

2.3.3.2 Groundwater Pumping

Pumping is the most widely used method of groundwater extraction. Because the groundwater flow at the site is influenced by fractures, additional aquifer testing should be performed during the design phase to optimize groundwater removal system design.

Groundwater pumping is feasible for the following reasons: (1) aquifer testing during the RI identified sustained yields with groundwater being intercepted in the deep monitoring wells; and (2) the residences have been able to extract groundwater on a long-term basis. Even though it is unlikely that all the fractures containing contaminants can be intercepted, the overall gradient can be controlled so that groundwater in the fractures between the well points will eventually flow toward the pumping well. Although groundwater pumping in fractured bedrock poses difficulties, it remains a proven and cost-effective technology for groundwater extraction.

Once the groundwater is pumped and treated, it must be discharged to the appropriate medium. The treatment plant effluent will meet drinking water standards (MCLs), so there should be little if any risk in contaminating the aquifer. Discharging to the intermittent stream was considered; however, this type of discharge would eventually infiltrate to the groundwater. Discharging to a dry stream might also cause problems with respect to erosion of contaminated sediments. For these reasons, injection to the aquifer was chosen as the discharge method.

Groundwater injection may be accomplished by using seepage basins or well points. Injection should be by wells because basins in soil have a potential for clogging at the surface, whereas injection wells bypass the soil and go straight to the bedrock aquifer. Also, clogging of the basins could cause the discharged water to migrate laterally which could flood low-lying areas. Injection wells can be installed at the same time that the well points are installed for groundwater pumping.

Injection wells should be located upgradient of the site to create a cycle of flow through the waste and enhance flushing of the contaminated groundwater. This can best be done by locating the wells between the site and the residences to the south. The depth of the wells should be approximately 100 feet to attain a sufficient recharge rate.

2.3.4 Surface Water Controls

Surface water diversion is an effective method of controlling the erosion of contaminated sediments associated with storm water runoff. Although contamination of surface water and sediments does not appear to pose an unacceptable risk, the possibility of future releases should be minimized. These releases can be minimized by utilizing proper erosion and sediment controls. Diversion structures are relatively minor technologies, which are used as ancillary measures to other remedial technologies. Structures such as berms, ditches, and sediment traps are relatively inexpensive items used on any type of construction activity. Therefore, surface water controls will be retained for further evaluation.

2.3.5 Contaminant Excavation/Removal

Excavation involves removing contaminated soils and wastes from their present location in preparation for onsite or offsite treatment or disposal. Since the source of contamination is actually removed, the residual risks associated with exposure to surface water and airborne migration are expected to be reduced to approximately background levels. Excavation will not reduce the risk associated with existing groundwater contamination. It will, however, reduce the future generation of leachate.

Excavation of waste materials may pose health and safety problems to the workers through direct contact or through volatilization of organic wastes. These hazards can be greatly reduced by using proper equipment and construction techniques. Excavation and/or removal will be retained for further evaluation.

2.3.6 Innovative Treatment Technologies

The purpose of this section is to present innovative and emerging technologies, screen them under the criteria and objectives established previously, and develop potential remedial technologies for use with other technologies as remedial action alternatives. For this report, an innovative technology is defined as a technology that has not been established specifically for the particular waste on which it is to be used However, it has proved successful in remediation of other wastes. An emerging technology is a technology that is still in the research stage and has not been utilized in industry.

The fractured bedrock that underlies the Blosenski Landfill Site has eliminated most of the innovative and emerging technologies reviewed for potential application as a remedial technology. Many of the technologies utilize in-situ treatment as part of their detoxification processes and require the controlled injection and extraction of solvents, microorganisms, nutrients, or chemicals. Therefore, the fractured bedrock cannot be considered a reliable or predictable media. A more complete list of the innovative technologies that were evaluated is included in Appendix A of this report.

One innovative technology that might be applicable is in-situ vitrification. This in-situ detoxification process utilizes electricity to create extremely high temperatures in the waste or soil. The high temperatures (2,000°F to 3,600°F) actually melt the soils or wastes, forming a pool of liquified material that cools and creates a glassified media. The theory behind the technology is that most contaminants are destroyed in the liquification process, the volatile materials are destroyed as they try to escape upward and encounter the 3,600°C liquified soil, and the remaining metals are stabilized within the glassified residual. Although this is a fascinating technology, it is not a technology that can be applied or tested at the site. The mass liquification of soils and wastes is too risky and there are too many unknowns. The potential risks are extremely high during the treatment process and the public perception of melting soils and wastes as a remedy for the site cannot be expected to be favorable.

Several other innovative technologies were reviewed and evaluated that did not utilize in-situ treatment processes. Typically, these technologies required the excavation of the media to be detoxified and the placement of the excavated materials into a treatment process. Discussion of the technologies that were evaluated under this scenario is included in Appendix A of this report.

The one technology that was thought to be feasible for additional study was a soil washing technolgoy. Although this technology was not suitable for use on the contaminated wastes, the use of a soil washing technology on the contaminated soils that underlie the wastes was selected for further study. This does not mean to imply that soils washing is a feasible technology for remediating the contaminated soils at the Blosenski Landfill Site. Rather, it is a promising technology for which additional testing and evaluation appears to be warranted at this time. An initial study and a pilot study is recommended as part of a remedial action alternative that utilizes another form of source control remedy, thus providing EPA the option to remediate the contaminated soils with a proven technology should the additional studies find that soil washing is not applicable to this site.

2.3.7 Groundwater Treatment

Groundwater treatment can be used prior to discharge of extracted and collected groundwater to reduce the contaminant levels. This would ensure the protection of the environment by reducing the impact of groundwater contaminants on receptors while restoring the natural groundwater resource. This technology would be used in conjunction with groundwater extraction and injection discussed previously.

In the long-term, the restoration of the groundwater quality to the NCP's acceptable risk levels of 10^{-4} to 10^{-7} or to background levels will provide a future potable water source for nearby residents. Because the groundwater adjacent to the landfill is used directly as a water supply via residential wells, the applicable standards are the maximum contaminant levels (MCLs) as promulgated under the Safe Drinking Water Act, or alternate contaminant levels (ACLs) determined by the regulatory agencies on a site-specific basis. The contaminants in the groundwater that exceed these standards are predominantly the volatile organics.

There are several types of proven technologies that can be used to remove volatile organics from water. Therefore, technical infeasibility will not eliminate the technologies from consideration. Any type of treatment process will require meeting discharge permit requirements as specified under the Federal Clean Stream Law (PL 1987, No. 394). The following unit processes are applicable in removing volatile organics to provide the desired degree of treatment.

2.3.7.1 Carbon Adsorption

Adsorption by activated carbon is suitable for removing a wide variety of contaminants including volatile organics, most acid extractables, and pesticides. These types of contaminants have been reduced to at least 10 ug/l in industrial applications. The environmental impacts of carbon adsorption are minimal, since the absorbed contaminants are contained within the spent contact chambers, which can be disposed of easily or regenerated. Carbon adsorption is generally more costly than other treatment processes. However, the resulting effluent is higher in quality. Carbon adsorption will be retained for further evaluation.

2.3.7.2 Biological Treatment

Groundwater at the Blosenski Landfill Site contains organic contaminants that may be biodegradable through biological treatment. Except for a few isolated samples, however, the concentration of organic compounds found in the groundwater is below the effluent concentration achievable by conventional biological processes. Also, most of the organic contaminants are volatile and would be emitted to the atmosphere through agitation caused by aeration equipment. Therefore, biological treatment will not be retained.

2.3.7.3 Precipitation, Flocculation, and Sedimentation

Precipitation, flocculation, and sedimentation are processes that have been used to treat various municipal and industrial wastewaters containing suspended solids and/or soluble metals. Due to the filtering action of the soil, the presence of suspended solids is generally not a problem in groundwater leachate at the Blosenski Landfill Site, and the metals concentrations at the site are generally below the National Primary Drinking Water Standards. However, precipitation, flocculation, and sedimentation may be required for pretreatment in a system for treatment of organic contaminants, such as carbon adsorption or air stripping.

2.3.7.4 Air Stripping

Air stripping has been demonstrated to remove various types of volatile organics, such as the chlorinated and aromatic hydrocarbons found in the groundwater at the Blosenski Landfill Site. Air stripping is a flexible process that can be designed to remove at least 90 percent of volatile organics. Air stripping is usually carried out in packed towers.

There is a possibility of exceeding ambient air standards due to volatilization of contaminants. However, this can be controlled by using proper operational equipment. The overall cost of air stripping is lower than for carbon adsorption, even though operational costs for air stripping (electricity) is higher. Air stripping will be retained for further evaluation.

2.3.7.5 Offsite Wastewater Treatment

The possibility of using a nearby publicly owned treatment works (POTW) for removal of groundwater contaminants was investigated. The main consideration is the cost effectiveness of designing and building an onsite treatment plant versus sending the wastewater to the nearest POTW. In this case, the nearest POTW is the City of Coatesville Treatment Plant, which is located approximately 6 miles from the site. Even if the plant has the required capacity, numerous institutional considerations must be made regarding community responsibility and future growth. POTWs are often reluctant to accept wastewaters that are not generated within their jurisdictional area. Nevertheless, treatment at a POTW should be retained for further consideration.

2.3.8 Onsite Storage

Storage measures merely transfer the wastes from one location to another and do not meet the objective of reducing corresponding risk to acceptable levels. Temporary storage measures, such as waste staging or stockpiling, may be required as part of the implementation of some of the remedial alternatives. Unless it is part of another technology, storage will not be considered.

2.3.9 Onsite Disposal

2.3.9.1 Onsite Landfill

An onsite, secured hazardous waste landfill is capable of satisfying the project objectives of achieving an acceptable potential risk level by controlling the contaminant pathways. A leachate collection system is used to prevent leachates from leaving the landfill.

A detailed geotechnical investigation prior to actual landfill design is of paramount importance. This investigation should include study of the potential for support failure due to settlement and shear failure. Difficult geologic conditions, which may be present at the Blosenski Landfill Site, do not of themselves preclude the feasibility of landfill installation. However, special installation techniques may be required. There is a possibility of a short-term, adverse environmental impact during the excavation and landfilling operations. This is a trade-off required to achieve the reductions in long-term releases. These potential releases during construction can be controlled with proper equipment and operational procedures.

Elements of the landfill, namely the bottom liner, surface cover, and leachate detection and collection system must meet applicable standards, including RCRA (40 CFR 264) and Pennsylvania Solid Waste Management Regulations (25 PA Code, Chapter 75). Because the volume of waste is large and the regulatory issues complex, this would be a very expensive technology. However, it is a reliable and effective method of controlling leachate generation and erosion of contaminated soils, and will be retained for further consideration.

2.3.9.2 Onsite Incineration

The rotary kiln incineration process is capable of destroying toxic organics and reducing the volume of waste. By destroying the organic materials, incineration removes the source of chemical contamination. Some of the waste materials, such as glass, construction debris, drums and heavy metals, may not be destroyed. These materials should be separated prior to incineration to improve the efficiency of incineration. The contaminated soil beneath the wastes could also be incinerated. The residuals from the incineration process can be landfilled on site, contained with a multimedia cap, or stabilized with a pozzolanic process. There is the possibility that the residual could be delisted and used as clean backfill on site.

The incineration of both hazardous and municipal waste has proven successful in terms of ultimate destruction and control of atmospheric releases. According to EPA, incinerators are capable of achieving a 99.99% destruction and removal efficiency of hazardous wastes (see FOCUS, May 1985).

The cost of incineration is quite high. However, onsite incineration costs less than offsite incineration due to the lack of packaging and transportation costs for onsite incineration.

The incineration of hazardous wastes involves substantial regulatory requirements. Any proposed onsite incinerator must conform to the regulations regarding incineration listed in Part 264 of the RCRA regulations. These regulations prescribe the allowable contaminant concentrations remaining in the residual soil and also being emitted to the atmosphere.

2.3.10 Offsite Disposal

2.3.10.1 Offsite Landfill

Offsite landfilling removes the source of contamination from the site, thereby eliminating the potential for long-term contaminant releases via groundwater, surface water, or air transport. However, there is a higher than background risk associated with excavation and loading the contaminated waste and soils. This technology also includes partial offsite disposal which may be limited to drums and other areas of concentrated wastes. The critical factor in this technology is the haul distance from the site to the disposal facility which will affect the costs and potential hazards associated with transporting the hazardous wastes. The potential hazards due to transporting the hazardous waste can be minimized by adherence to standard safety protocols and transportation regulations. This alternative will be retained for further analysis because it would eliminate the future source and migration of contaminants.

2.3.10.2 Offsite Incineration

Offsite incineration remediates the conditions at the site by removing the source of contaminants from the site. Offsite incineration can be accomplished more quickly than onsite incineration, provided the units are already on-line. The major drawback with offsite incineration is the high cost. The nearest incineration facility to the site is the Rollins facility in Bridgeport, New Jersey. To accept materials for disposal, the materials must be drummed prior to incineration. This results in increased costs which, when added to the cost for transportation and incineration, results in a unit cost of at least $1,500/ton. Because of these high costs, offsite incineration will not be retained for further evaluation.

2.3.11 Alternate Water Supply

The following alternate water supply systems were identified in a Focussed Feasibility Study (prepared for EPA by PRC Engineering, Inc.) as potentially acceptable replacements for the contaminated domestic wells.

- Installation of a new well to supply up to 10 residents within the site vicinity.

- Installation of a municipal water supply by extending the existing Coatesville Water Authority water lines.

Although other alternate systems were lower in costs, their reliability, technical assesment, public acceptance, and/or implementation criteria did not attain acceptable evaluations (Appendix A). A noncost comparison between the construction of a new well or the extension of the Coatesville Water Authority System shows that the extension alternative

- Is far more reliable

- Would be easier to implement

- Has little long-term maintenance burdens

- Would not pose abnormal health and safety risks during construction and operation

- Has a qualitatively lower potential health risk because it is a controlled and monitored system

- Should take less than a year to design and implement

The public acceptance of extending an existing proven system should be more favorable than developing a well system that may be perceived as having the potential to also become contaminated. Although the estimated present-worth costs for the extension of the Coatesville System is higher, it is an acceptable alternate water supply system relative to the overall remediation goals and objectives set for the Blosenski Landfill Site.

2.4 Feasible Remedial Action Technologies

The remedial action technologies have been screened in this section on the basis of the specific cleanup objectives, technical feasibility, health and environmental impacts, costs, and institutional criteria. A summary of the candidate technologies considered, and justification for their dismissal or retention is presented in Table 2-2. Each technology was evaluated not only in terms of theoretical feasibility but also in terms of whether the technology is applicable to the site specific conditions. The result is a list of the technologies considered suitable for combination into remedial action alternatives.

TABLE 2-2

SUMMARY OF REMEDIAL TECHNOLOGY SCREENING PROCESS
FOR THE BLOSENSKI LANDFILL SITE

General Response Action	Remedial Technologies Considered	Evaluation of Remedial Technologies	Retained for Further Evaluation
Containment	Synthetic membrane cap	Very effective in minimizing infiltration	Yes
	Clay cap	An effective and relatively inexpensive method of containing waste materials	Yes
	Asphalt cap	Subject to cracking when placed over wast:	No
	Chemically stabilized caps	Subject to deterioration by organic solvents	No
	Clay/synthetic caps	Very effective in preventing release of contaminants; may be required to meet Federal Regulations	Yes
	Slurry wall	Not effective for bedrock aquifer	No
	Grout curtains	Not as cost effective as pumping; long-term effectiveness is questionable	No
Groundwater Collection	Collection galleries	Not cost effective for this site	No
	Pumping wells	Only feasible method of groundwater collection for this site	Yes
Surface Water Controls	Dikes, berms, ditches	Minor technologies used in conjunction with other technologies	Yes
Removal	Partial/complete excavation	Controls pathways of contaminant migration by eliminating the source	Yes
Innovative Treatment Technologies	Permeable treatment beds	Not cost effective for this site	No
	Bioaugmentation	Much of the waste is not biodegradable	No
	Solidification	Not suitable for the amount of organics on site	No
	Chemical treatment	Not suitable for wide range of wastes on site	No
	Vitrification	Unproven, costly technology	No
	Soils Washing	Suitable in conjunction with other technologies	Yes

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TABLE 2-2
SUMMARY OF REMEDIAL TECHNOLOGY SCREENING PROCESS FOR THE BLOSENSKI LANDFILL SITE
PAGE TWO

General Response Action	Remedial Technologies Considered	Evaluation of Remedial Technologies	Retained for Further Evaluation
Groundwater Treatment	Activated carbon	Applicable for a wide variety of contaminant removal including volatile organics	Yes
	Biological treatment	Contaminant concentrations are not high enough to support microbes	No
	Precipitation, flocculation, sedimentation	Metal and suspended-solids concentrations are not a major site problem; however, may be required as pretreatment for other technologies	Yes
	Air stripping	Applicable for volatile organics removal	Yes
	Treatment at nearest POTW	Probably not cost effective as nearest treatment plant is 6 miles	Yes
Storage	Onsite storage	Not a long-term solution	No
Onsite Disposal	Onsite landfill	Capable of controlling pathways of contaminant migration; installation is expensive and regulatory issues are complex	Yes
	Onsite incineration	Capable of ultimate destruction of organic contaminants; installation is expensive and regulatory issues are complex	Yes
Offsite Disposal	Offsite landfill	Capable of eliminating source of contaminant migration	Yes
	Offsite incineration	Costs are much greater than onsite incineration	No
Alternate Water Supply	On-line filters	Difficult to determine if operating properly	No
	Bottled water	Does not reduce risk from bathing, washing clothes, and dishes	No
	Extension of public water line	Very reliable and publicly accepted	Yes
	Community deep well	Potential to become contaminated from the site	No

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3.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

3.1 Purpose of the Alternatives

As discussed in Section 1.0, the objectives of remedial actions at the Blosenski Landfill Site are to prevent further increase of risks, or to reduce the potential risks associated with site-related contaminants. These objectives address the following three site-specific contaminant migration and exposure pathways:

- Ingestion and domestic use of volatile, organics-contaminated groundwater.
- Direct contact with and erosion of contaminated soils and sediments.
- Inhalation of contaminated particulate matter released during site remediation.

The purpose of the alternative development process is to formulate RAAs that address one or more of these problems.

3.2 Procedures for Alternative Development

In this section, the technologies remaining after the technology screening process are used to develop RAAs for the Blosenski Landfill Site. The RAAs developed in this manner are therefore based on the technology or group of technologies that can best be expected to address the specific problems at the site.

Each of the remedial action technologies was initially proposed because it was judged to be applicable to the site problems, and it was retained on the basis of its technical effectiveness. Some of the proposed technologies, such as surface capping or onsite landfilling, address more than one problem because they would both contain the contaminant source and reduce further contaminant migration through soil, air, and groundwater. Other technologies, such as surface water controls or heavy metals precipitation and sedimentation, may not significantly remediate any problems by themselves but may be required in order for other technologies to be implemented effectively. For example, dikes and berms may be required to protect a landfill from surface water run-on. Similarly, organic contaminant water treatment systems may require pretreatment of metals concentrations for efficient operation. The site problems to be addressed, and the potentially applicable remedial response actions were presented in Table 1-4 Technologies subjected to the screening process, and the results of that screening, were presented in Table 2-2.

Only the technologies that address one or more of the remediation objectives and passed the screening process in Section 2.0 will be combined into RAAs. Implementable technologies will be combined only if their combination provides remediation above and beyond that provided by the individual technology alone.

3.3 Levels of Remediation to be Achieved

To evaluate the wide range of possible RAAs, it is useful to categorize the different alternatives according to the varying degrees of remediation they would provide. Five different cleanup categories of RAAs were identified in EPA's June 1985 Guidance on Feasibility Studies Under CERCLA. These five categories are listed in Table 3-1, in ascending order of cleanup provided. At least one RAA will be developed for each of these categories. By categorizing the alternatives in this manner, remediation objectives to be addressed by an RAA and the technical elements it is composed of are readily discernible. Furthermore, the changes in degree of cleanup achievable by changes in technical elements will also be apparent.

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TABLE 3-1

CATEGORIES OF REMEDIAL ACTION ALTERNATIVES

I. No action.

II. Alternatives that meet the CERCLA goals of preventing or minimizing present or future migration of hazardous substances and protecting human health and the environment, but do not attain other applicable or relevant standards.

III. Alternatives that attain applicable or relevant public health and environmental standards, guidance, or advisories.

IV. Alternatives that exceed applicable or relevant public health and environmental standards, guidance, and advisories.

V. Alternatives specifying offsite storage, destruction, treatment, or secure disposal of hazardous substances at a facility approved under RCRA. Such a facility must also be in compliance with other applicable EPA standards.

3.4 Formulation of Remedial Action Alternatives

In this section, each of the five cleanup categories is discussed with respect to the applicability of technologies toward achieving the goals of that category. Individual technologies that satisfy the site-specific goals of each category are identified. These technologies are then combined into appropriate RAAs applicable to the categories of cleanup.

3.4.1 No Action

No action means no site remediation will be performed to reduce the migration of contaminants from the site and any resulting impacts to the public health or environment. The only activity that would be proposed for this category is the continued monitoring of the site environment. This will prevent any possible direct contact with contaminants and will identify future changes in the concentrations or patterns of contaminants migrating off site.

3.4.2 Alternatives That Meet CERCLA Goals but do not Attain Other Applicable or Relevant Standards

This category includes alternatives based on technologies that can be used to contain contaminated soils and groundwater and, thereby, reduce exposure to them. This category may include alternatives that closely approach the level of protection provided by the applicable or relevant standards, although not necessarily meeting all requirements of those standards.

For an RAA to meet or exceed CERCLA goals, the identified contaminant sources or exposure routes must be addressed by that alternative. Therefore, alternatives in this category must be based on a combination of technologies that concurrently address contamination in the groundwater and in the soils. It was determined that only one alternative could be developed that would meet, but not necessarily exceed, CERCLA goals of preventing or minimizing present or future contaminant migration. This alternative is a combination of the following remedial technologies:

- Installing a non-RCRA-approved surface cap on the landfill
- Grading and revegetation for cap protection
- Providing an alternate water supply to affected residences
- Continued long-term monitoring

Implementation of these technologies together will minimize rainwater infiltration, leachate formation, and soil erosion, and eventually will reduce the levels of contaminants in and migrating through the groundwater. This will serve to lessen groundwater contamination, which may be directly attributable to the landfill. However, this alternative will not remove the contaminant sources, so alternate water supplies are included to prevent exposure through use of contaminated groundwater.

3.4.3 Alternatives That Attain Applicable or Relevant Public Health or Environmental Standards, Guidance, or Advisories.

The requirements of this category are more stringent than for the previous category. The standards to be met are designed to provide comprehensive control of contaminant sources and pathways of exposure. In addition to meeting RCRA requirements (40 CFR 264), RAAs in this category will also be subject to Pennsylvania Department of Environmental Resources (PADER) requirements (25 PA Code, Chapter 75).

Applicable technologies that can be combined to satisfy these requirements may include the following:

- Installation of a RCRA-approved surface cap

- Provision of an alternate water supply

- Construction of new, secured, onsite landfill
- Partial excavation and offsite disposal of onsite wastes
- Extraction and treatment of contaminated groundwater
- Installation of a groundwater-detection monitoring system that meets the requirements of 40 CFR Part 264.98
- Post-closure monitoring and maintenance that meets the requirements of 40 CFR Part 264.117

To meet RCRA requirements, the surface capping technology must be upgraded by adding a synthetic membrane, increasing thickness (and reducing permeability) of capping layers, and adding a drainage layer. Alternate water supplies will eliminate domestic water use exposures. Groundwater extraction and treatment will reduce contaminant concentrations. Partial excavation and offsite disposal of contaminated soil and wastes will remove contaminant "hotspots." Groundwater monitoring will determine the characteristics of future contaminant migration and permit satisfactory corrective action. RCRA specifications require that post-closure care must continue for 30 years after site closure, and must include monitoring and maintenance of the waste-containment systems in accordance with 40 CFR Part 264.

Two RAAs that would meet the requirements of this category were formulated. The first includes installing a multimedia cap, providing an alternate water supply to affected residences, and extracting and treating groundwater. The second includes construction of a new secured landfill on site instead of capping the wastes. Both of these alternatives require provision of a groundwater contaminant detection system and post-closure care and monitoring.

3.4.4 Alternatives That Exceed Applicable or Relevant Public Health and Environmental Standards, Guidance, and Advisories

This category of cleanup requires alternatives that provide more protection of the public health and environment than the previous categories. This is achieved by further isolating or removing the source from public and environmental exposure pathways. Technologies that together would satisfy these requirements include the following:

- Contaminated soil and waste excavation
- Incineration of contaminated soil and waste
- Multimedia capping of residual wastes
- In-situ stabilization of residual wastes
- Alternate water supply
- Groundwater extraction and treatment
- Installation of a groundwater detection monitoring system that meets the requirements of 40 CFR Part 264.98
- Post-closure monitoring and maintenance that meets the requirements of 40 CFR Part 264.117

Only one alternative was formulated that could meet the stringent requirements of this cleanup category. This RAA includes complete excavation and onsite incineration of contaminated wastes and soils, installation of a multimedia cap over the incinerator residues, provision of an alternate water supply, and extraction and treatment of groundwater. As an option, the residues may be stabilized in situ instead of being capped.

Onsite incineration will provide a means for destruction of the organics (including PCBs) in the contaminated soil. Although the multimedia cap will effectively contain the residues and minimize the possibility of leachate generation, in-situ stabilization will reduce future contaminant leaching, without the need for surface-cap maintenance requirements.

3.4.5 Alternatives Specifying Offsite Stoıage, Destruction, Treatment, or Secure Disposal of Hazardous Substances :t a Facility Approved Under RCRA

The technologies used to develop RAAs in this category completely remove the sources of contamination from the site. Therefore, they offer the highest degree of site remediation. Removal activities would also include restoration of the site to its natural condition. Some technologies, such as groundwater treatment and alternate water supplies, may still be necessary to reduce exposures and potential risks due to contamination that has already migrated from the source into the groundwater.

Technologies that are applicable to this category include the following:

- Excavation of all contaminated waste deposits
- Disposal of excavated waste deposits in an offsite, secured landfill currently in compliance with RCRA requirements
- Offsite disposal of residual contaminated soils
- Multimedia capping of residual soils
- Detoxification of residual soils
- Grading and revegetation
- Groundwater extraction and treatment

- Alternate water supply

- Installation of a groundwater monitoring system that meets the requirements of 40 CFR Part 264.98

- Post-closure monitoring and maintenance that meets the requirements of 40 CFR Part 264.117

The RAA formulated for this category combines basic waste removal with several options for final disposition of remaining onsite materials. The RAA includes partial site excavation to remove waste deposits, and disposal of those wastes in a secured, offsite location. Options for final disposition of residual onsite materials include: installing a multimedia cap over the excavated areas, detoxifying the residual materials, or disposing of them in a secured offsite location. The RAA also includes the provision of an alternate water supply, and the extraction and treatment of groundwater.

3.5 Summary of Alternative Development

In the alternative development process, several applicable remedial technologies were identified for each of five cleanup categories. These categories were presented in ascending order of cleanup, resulting in a building-block approach in which the simpler technologies were used for the lower levels of cleanup. To achieve a higher level of cleanup, more complex technologies were added to the simpler technologies. The technologies presented in each category were combined into RAAs that will meet the requirements of that level of cleanup. The RAAs generated for each category, as a result of the development process, are summarized below.

I. **No Action**

1. No remedial action will be implemented, but continued long-term monitoring will be performed.

II. Alternatives That Meet CERCLA Goals but Do Not Attain Other Applicable or Relevant Standards

2. Install a low-permeability soil cap over the landfill, provide alternate water supply to affected residences, and perform long-term monitoring.

III. Alternatives That Attain Applicable or Relevant Public Health or Environmental Standards, Guidance, or Advisories

3. Install a RCRA-specification multimedia cap, and provide an alternate water supply. Groundwater will be extracted and treated. RCRA groundwater-detection monitoring and long-term post-closure care and monitoring will be provided.

4. Construct a new, secured, onsite landfill and provide an alternate water supply. Extract and treat groundwater, and provide RCRA contaminant detection monitoring and post-closure care and monitoring.

IV. Alternatives That Exceed Applicable or Relevant Public Health and Environmental Standards, Guidance, and Advisories

5. Excavate and incinerate contaminated soils and wastes on site, and install multimedia cap over the residual wastes. Provide an alternate water supply, and extract and treat groundwater. Provide RCRA contaminant detection monitoring and post-closure care and monitoring. (Option: Provide in-situ stabilization of residual wastes instead of multimedia cap.)

V. Alternatives Specifying Offsite Storage, Destruction, Treatment, or Secure Disposal of Hazardous Substances at a Facility Approved Under RCRA

6. Excavate and dispose of contaminated waste deposits in an offsite, secured landfill currently in compliance with RCRA. Dispose, contain, or treat contaminated soil residuals underlying the waste deposits. Extract and treat groundwater, and provide an alternate water supply.

The above alternatives include continued monitoring of soil and groundwater contamination. All of the above alternatives, with the exception of the no action alternative, will require grading and revegetation. Groundwater extraction, treatment, and injection will be subject to state and local regulatory agency restrictions.

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4.0 EVALUATION OF REMEDIAL ACTION ALTERNATIVES

4.1 Evaluation Criteria

In this chapter, each RAA presented in Section 3.0 is described in detail and evaluated against both noncost and cost criteria. Noncost criteria include satisfaction of remedial action objectives, and technical, public health, environmental, and institutional considerations. Cost criteria include capital costs, operation and maintenance costs, and present-worth analyses. These cost and noncost criteria are utilized to evaluate the specific details included in each alternative to provide a basis for comparison of the alternatives.

4.1.1 Technical Evaluation

The technical evaluation assesses the feasibility of the remedial action alternative relative to site conditions. Each alternative is evaluated for the following criteria:

- Performance
- Operation and Maintenance
- Implementability
- Reliability
- Safety

The performance of each alternative is evaluated in terms of operation and maintenance requirements and demonstrated effectiveness under similar conditions. Evaluation of the implementability of alternatives considers such factors as the ability to actually construct each alternative, relative to site conditions, and the time required for construction. It is important that the alternatives considered are reliable as determined by previous performance data under similar conditions. The safety of the nearby residents and remedial action workers during the implementation is also considered. Supporting data and calculations used in the technical evaluations of the alternatives are presented in Appendix B of this report.

4.1.2 Public Health and Environmental Evaluation

The RAAs are evaluated for potential public health impacts both during and after implementation. Each alternative is assessed in terms of the extent to which it is expected to effectively mitigate contamination and minimi... adverse effects to public health and welfare. Both beneficial and adverse impacts of each alternative are considered.

The RAAs are also evaluated for environmental impacts during and after implementation. Each alternative is assessed in terms of the extent to which it is expected to effectively mitigate environmental exposure.

4.1.3 Institutional Evaluation

The impact of Federal, state, and local public health and environmental standards, regulations, guidances, advisories, and ordinances are addressed as applicable for each alternative. Community impacts and perceptions will also be considered as part of this evaluation.

4.1.4 Cost Evaluation

The costs associated with each alternative are evaluated to analyze the relative cost-effectiveness of each. Detailed supporting data for the cost estimates are presented in Appendix C. Sources for preparing construction cost estimates include

- Means Site Work Cost Data (Earthwork, Utility Piping Costs).
- Means Building Construction Cost Data (Demolition, Fencing Costs).
- Means Mechanical Cost Data (Mechanical, Piping Costs).

- Richardson - Process Plant Construction Estimating Standards (Equipment Electrical Costs).

- Vendors - Quotations for Specialty Items (Synthetic Liners, Clay Liners, Carbon Filters, Air Strippers, Incineration, Disposal Costs, etc.).

- EPA Handbook - Remedial Action at Waste Disposal Sites (EPA/625/6-85/006) for construction costs not found in Means or Richardson. These are used as a check against costs used in the alternative evaluation.

- EPA - Compendium of Costs of Remedial Technologies at Hazardous Waste Sites (Construction costs not found in Means or Richardson). These are used as a check against costs used in the alternative evaluation.

- Noyes Publications - Evaluation of Remedial Action Unit Operations at Hazardous Waste Disposal Sites. These are used for costs not found elsewhere.

The quantities generated for this FS are based on data compiled during the RI. The objective of the RI was to identify site contaminants, and to assess corresponding potential health risks and environmental impacts. As such, the data base required to do a detailed construction cost estimate was beyond the scope of the RI. Therefore, the cost estimates in this FS are presented as a range of values that reflect the sensitivity of remediation costs and quantities developed from the RI data base. Sensitivity factors are based on best engineering judgment and experience, and applied on an item-by-item basis as required.

The construction mark-ups utilized in Appendix C spreadsheets are defined as follows:

- Burden - 13 percent of labor cost; includes FICA, worker's compensation, unemployment insurance, and builder's risk insurance.
- Labor - 15 percent of base labor costs; includes administration.
- Material - 5 percent of material costs; includes administration and handling.
- Subcontractor - 10 percent of subcontract costs; includes administration and handling.
- Indirect (Labor) - 75 percent of total direct labor costs; includes supervision, travel, utilities, communications, medical supplies, data processing, bond premium insurance, guard service, temporary office and storage clerk, timekeeper, testing and analysis, maintenance, and cleanup.

Health and safety monitoring costs are applied to total construction costs on the following basis:

Total Construction Cost	Multiplier
$100,000 to 500,000	10 percent
$500,000 to 2,000,000	8 percent
$2,000,000 to 10,000,000	6 percent
$10,000,000 to 20,000,000	4 percent

Additionally, working level factors are included to account for levels of health and safety protection required to protect site remediation workers from potential adverse health risks. Site remediation work requiring a high level of protection (levels A or B) requires the use of cumbersome, expensive protective clothing and breathing air supplies, and invariably takes longer to complete than work requiring a lower level of protection. The following working level factors are utilized in Appendix C spreadsheets.

Worker Health and Safety Protection Level	Multiplier (Applied against Total Labor & Equipment Cost
A	4.0
B	2.5
C	1.7
D	1.15
Normal	1.0

The range of capital costs associated with each RAA is combined with the respective operation and maintenance costs and then subjected to a present-worth analysis. The analysis is based on a discount rate of 10 percent before taxes, and a zero percent inflation rate applied over a 30-year period. The present-worth analysis shows the cost of an RAA as a single figure representing the amount of money that, if invested in the base year and disbursed as needed, is required to cover all costs associated with the remedial action over its planned life. A computerized analysis is run on the lowest, baseline, and highest cost estimates developed for each RAA. A copy of the baseline present worth analysis computer output for each RAA is included in Appendix C.

4.2 Evaluation of Alternatives Providing No Remedial Action

4.2.1 Remedial Action Alternative One - No Action With Long-term Monitoring

The purpose of providing a no action alternative is to assess the existing or baseline conditions against which the other alternatives can be evaluated. Under a no action alternative, no measures will be taken to mitigate the potential health risks associated with contaminant migration. The contaminants will continue to migrate into the groundwater and surface water by leachate production and storm water runoff.

The most critical exposure pathway and subsequent health risk at the site is the ingestion and other domestic use of contaminated groundwater. Based on the RI analytical results, the mean and maximum carcinogenic risks from ingestion of organics in residential well water are 2.6×10^{-2} and 4.3×10^{-2}, respectively.

As this table shows, the risks from regular ingestion of the groundwater at the receptor wells presents an unacceptable risk at both the maximum and average contaminant concentrations. However, because many of the residents are currently using bottled water for drinking, these numbers are very conservative and present a worst-case scenario where bottled water is no longer in use. As long as bottled water is used for drinking, showering, and other domestic uses, contaminated groundwater should present no problem. If no action is taken at this site, it is likely that contaminant concentrations in the groundwater will increase because of the high levels of contaminants in the soil and in the perched water table, and risks will increase accordingly.

Dermal contact with contaminated soils also presents an exposure that will continue if no action is taken on site. Using worst-case assumptions (100 percent dermal absorption and maximum contaminant concentrations), total dermal carcinogenic risks will be high (1.9×10^{-2}). However, using average soil concentrations, total risks will be an order of magnitude lower (1.2×10^{-3}). Soil ingestion usually occurs between the ages of 2 and 6 when mouthing tendencies are greatest. For worst-case assumptions (a child will ingest 5 grams of soil per day for 1830 days) calculated risks for average and maximum surface soil concentrations are 7.0×10^{-4} and 1.1×10^{-2}, respectively. However, since these contaminated soils have been found only on site, and it is highly unlikely that young children will be playing at the landfill, these exposures are very conservative.

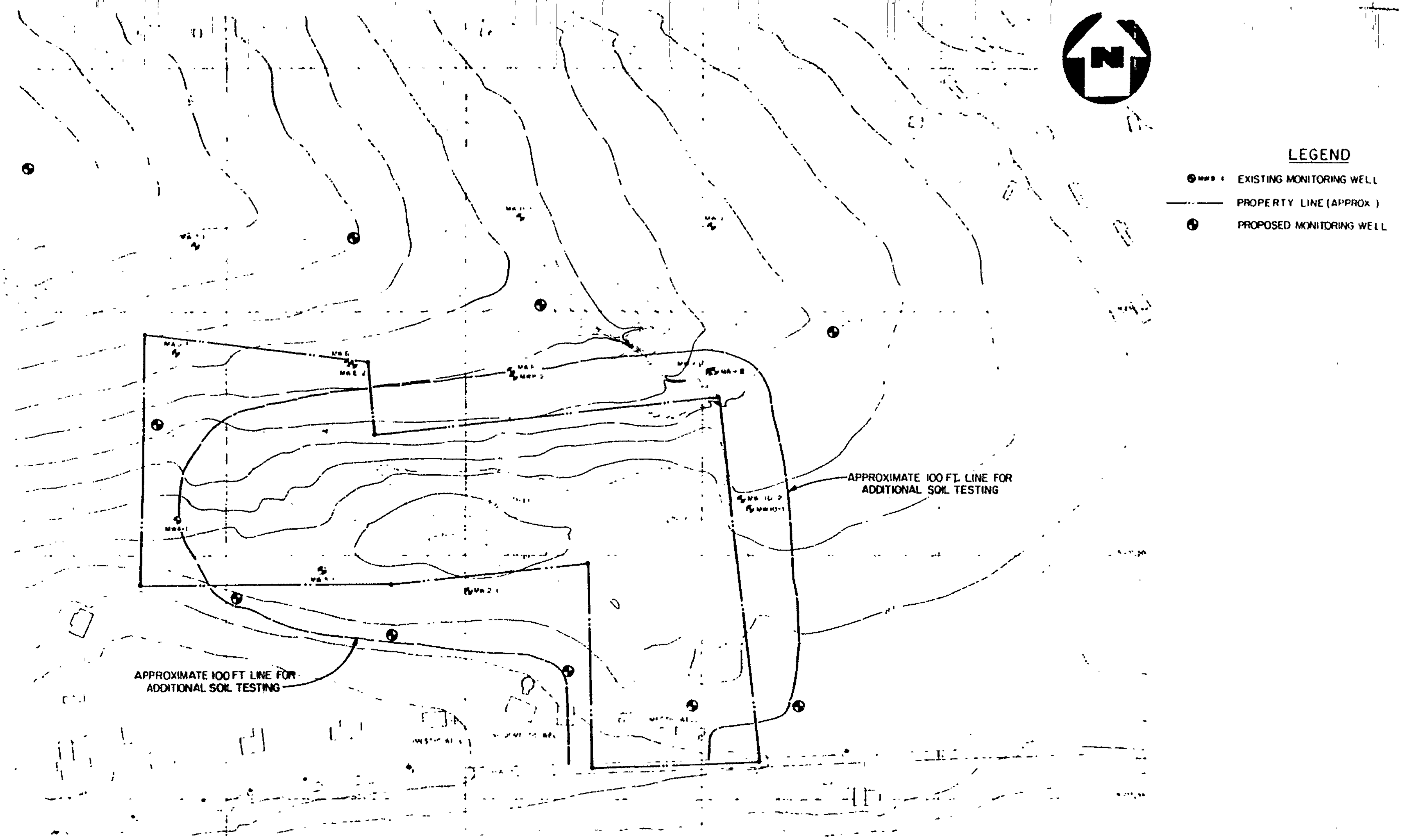
Fugitive dust is not a problem at this site for the following two reasons: the large amount of vegetative cover at the site, and the distance to the nearest receptors. Risks are very low (less than 1×10^{-20}) and are expected to remain so even under the no action scenario.

To determine the future levels of contaminants migrating from the waste source, a long-term monitoring program will be established. The source of contamination will also be monitored by taking onsite surface soil samples. The data collected from this program can also be used to form a data base for predicting rates of contaminant migration and decay.

The current risk to public health is directly related to the contamination levels in the groundwater, surface soils, and subsurface soils as determined by the RI. Considering the length of time the wastes have been buried at the site, these concentration levels are assumed to be at steady-state conditions and can persist throughout the long-term monitoring period of 30 years.

The rate of contaminant loading is complicated by many factors, such as fracture influenced groundwater flow rates, soil adsorption, and bacterial decay. However, it can be assumed that the rate of contaminant mobilization is proportional to the rate of leachate generation. This assumption permits estimating the reduction in contaminant movement by determining the reduction in leachate generation. Leachate generation under presently known conditions at the Blosenski Landfill Site was calculated during the RI by C.W. Thornthwaithe's Water Balance Method. Using a calculated runoff coefficient of 0.15, and assuming 2 feet of silty-sand surface soil, a poorly vegetated surface, and a 9.5 acre area of interest, leachate production was calculated to be 2.32 inches per year or approximately 80,000 cubic feet per year.

Under this alternative groundwater will be monitored to observe changes in aquifer contamination and to monitor potential public health risks. The monitoring wells constructed during the RI can be used for continued monitoring. In addition, ten new monitoring wells will be installed: four downgradient (north) of the site, one west of the site, and five upgradient (south) of the site just north of the adjacent residences (see Figure 4-1). These wells should extend approximately 40 feet into bedrock, which would put them at about the same depth as the existing monitoring wells. The adjacent residential wells, south of the site, should also be sampled concurrently with the monitoring wells. For costing purposes, it was assumed that



0 100 200 400
SCALE IN FEET

FIGURE 4-1

PROPOSED LONG-TERM MONITORING SAMPLE LOCATIONS
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA

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the monitoring wells and five residential wells would be sampled four times per year. Surface soil samples will be taken to determine variation in onsite surface contamination. For costing purposes it was assumed that surface soil samples would be taken twice a year.

Both groundwater and surface soil samples should be analyzed for EPA HSL organic and inorganic compounds. All analyses should be performed in accordance with EPA analytical protocols to ensure compatibility between the existing and additional results. For costing purposes, it was assumed that the sampling and analysis program would continue for 30 years.

4.2.1.1 Noncost Evaluation

- Technical Feasibility--Monitoring well sampling and subsequent laboratory analysis are an easily implementable and reliable means of providing information on contaminant migration, and are proven actions successfully used to monitor numerous sites. Care must be taken to use EPA-specified analytical and quality assurance procedures to ensure validity and compatibility of results. There are little or no operation and maintenance requirements associated with monitoring well sampling. Ten additional wells will be required for the monitoring program. Installation of these wells will take about three months, including the time required to procure a subcontractor and obtain permits. Monitoring wells installed under this alternative should have a useful life of at least 30 years.

- Health and Environmental Impacts--The no action alternative will do nothing to reduce the present potential health risks associated with groundwater ingestion, dermal contact with surface soils, and inhalation of volatiles. There is a possibility of worker exposure to contaminants during installation of the monitoring wells. However, this risk should be negligible due to the distance of these new wells from the source of contamination and the use of personal protective clothing and equipment.

Implementing the monitoring portion of the no action alternative should not create any negative environmental impacts. Generally, environmental sampling of this nature is an unobtrusive exercise, which, if conducted conscientiously, should not pose a threat to the surrounding environment.

- Institutional Issues--The no action alternative can be implemented without obtaining regulatory permits, other than those required for monitoring well installation. However, it will not satisfy any applicable environmental protection regulations, and it will be necessary to make arrangements for an agency to conduct the sampling, analysis, and interpretation of data.

4.2.1.2 Cost Evaluation

Most of the costs for the no action alternative are related to sampling and analysis. Capital costs for the no action alternative are estimated to be between $80,000 and $130,000. Annual sampling and analysis costs are estimated to be $197,700. The 30-year present worth of the costs for the no action alternative is estimated to range from $1,953,000 to $2,003,000.

4.3 Evaluation of Alternatives that Meet CERCLA Goals but do not Attain Other Applicable Standards

4.3.1 Remedial Action Alternative Two - Onsite Capping of Contaminated Soils and Wastes; Extension of the Coatesville Water Authority Public Water Supply; and Long-term Monitoring.

RAA Two was developed to provide a source control remedy that meets the CERCLA objective of reducing the likelihood of present or future threat from the hazardous substances found at the site. The technologies used to meet the objective of this alternative are as follows:

- Provision of a soil cap to reduce the public health risk associated with dermal contact or ingestion of the site's surface soil contaminants, and to reduce leachate generation.

- Installation of a municipal water supply and sealing of the domestic wells to reduce the potential health risks associated with consumption or utilization of contaminated groundwater.

- Implementation of a long-term monitoring program to provide data on the effectiveness of the remedial action and to detect any future contaminant migration from the site.

Site Preparation and Preconstruction Activities

Site remediation will be initiated with the construction of 10 additional monitoring wells and the establishment of a grid matrix soil sampling and testing study. The additional monitoring wells will supply important groundwater quality, geologic, and hydrogeologic information that is needed to assess the site's groundwater conditions over time. The information will also aid in the design and location of the extraction and reinjection system. The approximate location of the new monitoring wells and other site remediation construction items are shown on Figure 4-2.

The soil sampling and testing study is based on data that is obtained from a 100-foot grid matrix laid out around the perimeter of the existing surface and subsurface sampling points that have contaminant levels in excess of the levels corresponding to a 10^{-6} health risk. Initially the grid matrix is used for soil gas sampling and screening purposes. Subsequent soil sampling of the grid will aid in defining the horizontal extent of the multimedia cap. The soil sampling grid will be expanded in both directions as the field data is gathered and analyzed.

If a clean node is found within the grid system, then additional grid nodes will be established by the method of halves to define the horizontal extent of

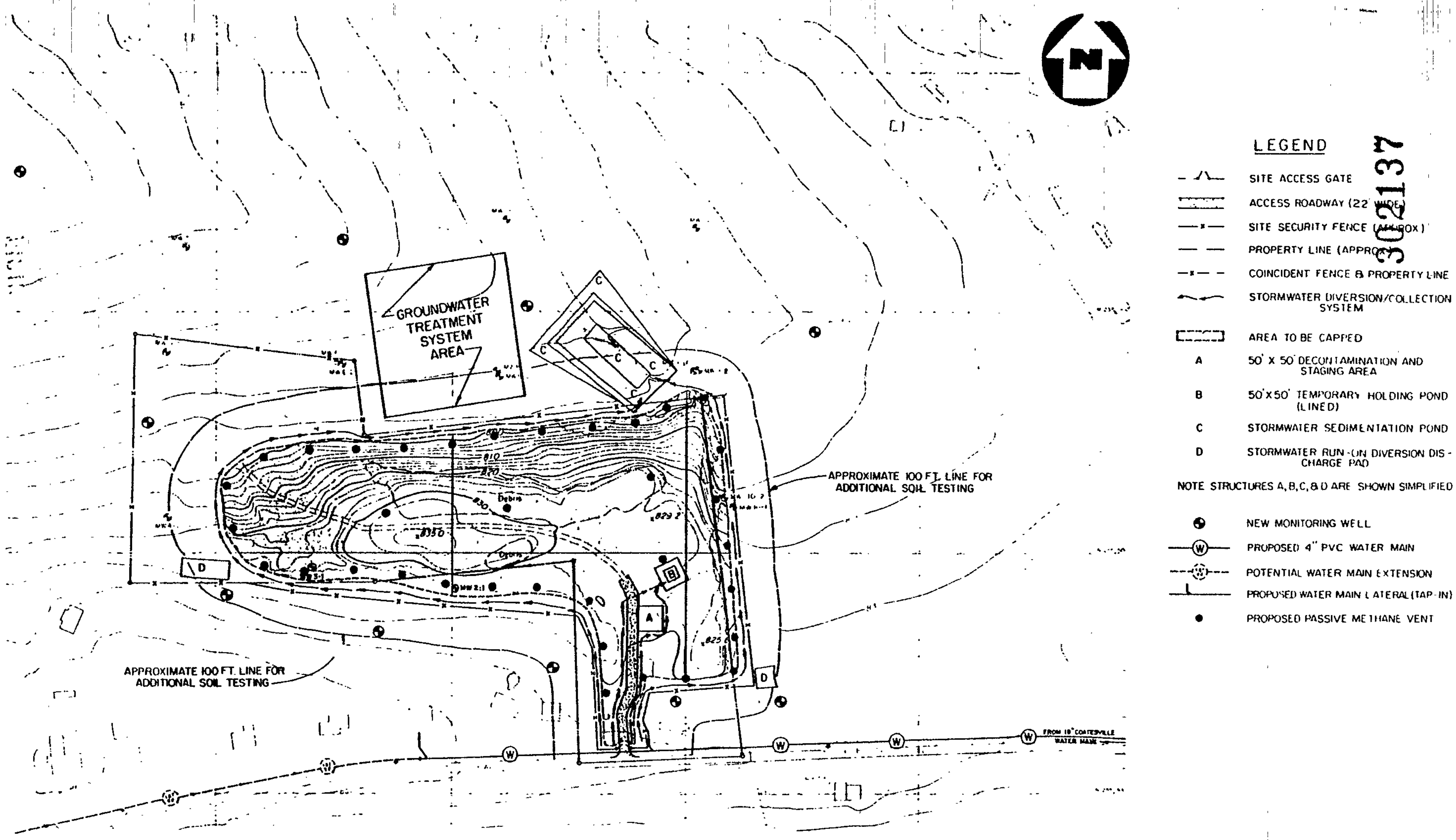

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FIGURE 4-2

APPROXIMATE LIMITS OF CAPPING
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA

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contamination to the nearest twenty-five feet. For example, if node A is found to be clean, then a node (A-100) will be established and sampled at 100 feet inward toward the site. If A-100 is contaminated, then a new node (A-50) will be established mid-point between A and A-100. If A-50 is clean, then the horizontal extent of contamination is assumed to be between A-100 and A-50. If A-50 is contaminated, then the horizontal extent of contamination is assumed to lie between A-50 and A-100. One more node, either A-25 or A-75 will be required to assure that the limit of the cap extends over all the contaminated media identified at the site.

Although the grid system may appear to be expensive and time consuming, there are existing field screening techniques such as soil gas screening and field trailers equipped with computerized testing equipment that reduce the cost and time for this type of study. The horizontal extent of capping is a critical health risk issue and a major construction cost item.

For costing purposes, the approximate limit of capping is set at the outermost RI sampling points that reported contaminants in excess of the concentrations corresponding to a 10^{-6} risk level. The approximate area of capping is 9.37 acres and is shown on Figure 4-2.

While the additional monitoring wells are being constructed and the soil study is being performed, the site-access road and decontamination pad can be built. A large volume of heavy truck traffic is expected during the construction of the multimedia cap. Approximately 81,600 tons of clay and soil will be required along with about 40,800 tons of crushed stone for the multimedia system. An all weather access road that allows steady truck traffic flow is required. A 22-foot wide road constructed of 2 foot crushed stone over a geotextile stabilization mat is used in this alternative, because the crushed stone roadcoarse is a low cost, low maintenance system that will support the anticipated truck flow while maintaining a barrier between the contaminated soils and the truck traffic.

The decontamination pad is a large concrete pad that intercepts the outgoing truck flow to permit decontamination of the vehicles and their tires. A concrete pad was selected, because of its potential durability under the anticipated truck traffic flow and the potential staging and/or decontamination of other heavy equipment that is needed to construct the multimedia cap. The pad will also house the decontamination equipment and a sump area to collect the decontamination water. A hydro-blaster system that utilizes high pressure jets of water to flush contaminants off the trucks or heavy equipment is proposed. The system will have an automated wash rack to decontaminate the trucks. The automated wash rack was selected over a manual wash system run by site workers because of the risks associated with site workers who would be continuously exposed to potentially contaminated waters and vapors during manual truck washing operations.

The waters from the truck washing process are collected in a sump area and then allowed to flow into a synthetically lined, earthen holding basin located near the pad. For costing purposes, the basin is lined with a 30 mil HDPE membrane. The collected truck wash water is not expected to be contaminated with significant concentrations of HSL materials that would require a liner, but the liner will add a degree of safety in case the collected waters do pose a problem. It also will prevent the saturation of the media in that area that could make liner construction difficult. Monitoring of the decontamination water collected in the basin will determine if the waters will require treatment or if they can be disposed in the site storm water control system. This alternative does not include costs for disposal or treatment of the water because of the small quantity of site contaminants expected to be picked-up by the trucks and heavy equipment, and the dilution that will occur within the decontamination system. The proposed treatment process for the extracted groundwater could also offer a low cost solution if contaminants are found at unacceptable concentrations.

The pad area will also house the site operations trailer, the field laboratory trailer, and the site workers decontamination trailer and dressing areas. Since the hydro-blaster equipment and the worker showers will require potable water, the pad area will also have a 10,000 gallon water storage tank.

As construction of the access road and the pad are being performed, the site's storm water controls can be installed. The controls consist of diversion swales to divert storm water run-on away from the site and discharge pads to reduce the diverted run-on's erosional effects; collection ditches to collect storm water run-off from the site and provide open channel flow to a collection point; and a sedimentation basin as the collection point to control discharges of the collected storm waters. The basin is constructed of clean, compacted soils, and is equipped with a valved, trickle-tube discharge outlet and an emergency spillway outlet. The valved outlet structure is a control measure to reduce the risk of discharging contaminated waters into the nearby surface waters. The basin is located beyond the limits of the site's property lines and may require the purchase of additional properties. The actual site location and materials of construction for the basin will require additional studies to ensure the structural integrity of the basin and the use of uncontaminated soils.

Soil Capping

Once the site storm water controls, access road, and decontamination pad are established, heavy equipment can begin moving onsite materials to provide positive drainage slopes and to reduce steep slope areas. The soils for the cap will be placed in loose lifts of between 4 and 12 inches, and then will be compacted with a sheepsfoot roller or other suitable compaction equipment, to attain a predetermined density at an acceptable moisture content. The actual construction and testing specifications will have to be prepared after the selected soil-cap material is tested and analyzed for slope stability and permeability characteristics. Soil or materials with a permeability within the range of 10^{-5} cm/sec are assumed applicable to this alternative. This is based on the HELP evaluation described in Section 2.0.

The estimated quantity of material required for the cap is 40,800 tons. This is based on utilizing a 2 foot thick cap as shown in typical in Figure 4-3. Additional site grading plans will be required during the design phase and the new soil quantities developed may vary from those estimated in this FS study. Also, the

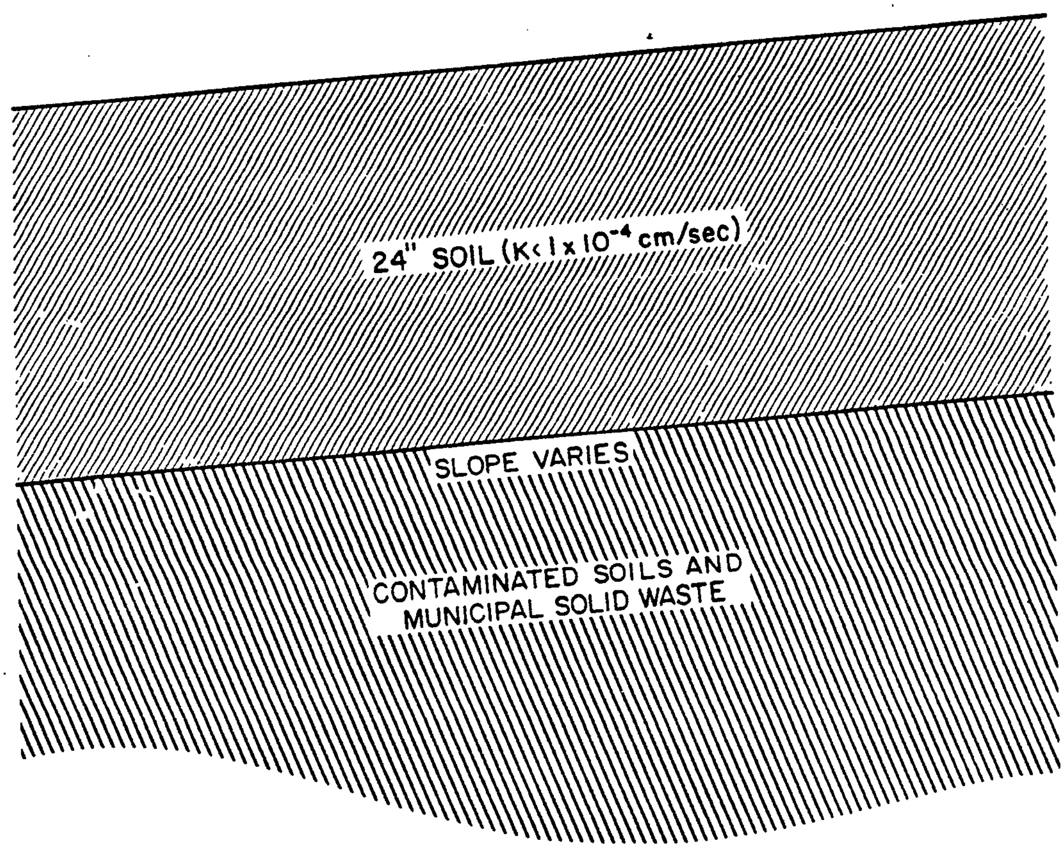

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FIGURE 4-3

TYPICAL SOIL CAP
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA

NOT TO SCALE

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additional soil sampling and testing may increase or decrease the limits required for the soil cap and the estimated soil quantities.

After completion of the compacted soil cap, the area will be graded to promote positive drainage and to reduce ponding of precipitation. The site will also be revegetated with a predetermined blend of grasses and ground cover plants will minimize erosional effects, supply sufficient root uptake and leaf foliage to decrease cap moisture content (maximum evapotranspiration rates), and have a shallow, root penetration zone to minimize encroachment of the cap. A chain link fence is then installed along the perimeter of the cap or property line, whichever extends the farthest.

Alternate Water Supply-Extension of Public Water Supply

RAA Two also utilizes an alternate water supply to replace the contaminated domestic wells found near the site. The alternate water supply system selected for all the remedial action alternatives associated with the Blosenski Landfill Site is a public water supply system. The system consists of a 4-inch branch line from the existing 18-inch water main of the Coatesville Water Authority. The approximate distance between the site and the water main is 3.5 miles. The line losses encountered over that distance coupled with a change in elevation requires that an in-line booster pumping station be incorporated into the preliminary design and cost estimate. In a Focused Feasibility Study prepared by PRC Engineering for the EPA, it was reported that the Coatesville system had an adequate supply of water to handle the additional load described in the study. The study costed and reviewed a system that replaced only the two domestic wells that have been found contaminated, and a system that replaced five domestic wells in the area. Since the proposed 4-inch branch line is oversized and can handle more than the five residents mentioned in the PRC Study, additional study during the design phase would be needed to determine the system routing, capacity, and service area that will best utilize the proposed alternate water supply. There is a potential to provide a public service and improve the public welfare of the area, while attaining the goals of the site remediation and optimizing the capital investment required under this alternative.

Individual system tap-ins will be required to transport the water from the branch line into the residences. The water can then be routed throughout the homes in the existing water distribution system. The domestic wells will be grouted and sealed with a concrete cap. Additional deed restrictions or other institutional devices are also required to reduce the risk of new wells being developed in the area and creating new health risks.

Upon completion of the 10 new monitoring wells described previously, a monitoring program will be initiated to provide additional information about the extent of groundwater contamination and the site's hydrogeology. After site capping is completed, the monitoring program will continue and adjustments made to supply pertinent information about the site conditions. For costing purposes, all 21 monitoring wells are assumed to remain in service for the next 30 years and will undergo quarterly sampling and analysis for HSL contaminants.

4.3.1.1 Non-Cost Evaluation

- Technical Feasibility--Capping is a frequently applied technology that has been demonstrated to significantly reduce infiltration and subsequent leachate generation. The HELP simulation indicated a 99 percent reduction in leachate generation as a result of a low permeability soil cap. Installation and maintenance are straightforward, although the expected design life may be less than 30 years. The major consideration for cap installation is the availability of a nearby borrow source with sufficiently impermeable materials. A clay supplier is located near the site, in Bechtelville, Pennsylvania.

  Extension of the Coatesville Water Authority line is also a straightforward process. Excavation of a trench, along King's Highway to the site area; installation of a 4-inch water line with the proper bedding material; inspection and testing procedures; frost protection; and backfilling, can be performed in an estimated 90 days.

- Health and Environmental Impacts--By reducing leachate generation volumes, the proposed cap would be expected to reduce groundwater contaminant concentrations over time. Because wastes will remain on site and groundwater will remain contaminated, however, potential exposure risks associated with groundwater contaminant migration would not be eliminated. Potential contact and ingestion risks associated with contaminated surface soils and airborne exposures would be drastically reduced, although background levels of soil contamination would not be achieved since the wastes are left in place.

Hazards remaining after covering the contaminated soil are dependent on the permeability and longevity of the cap. Consequently, although the cap will immediately eliminate the potential for dermal contact or ingestion of surface materials, there is a potential for future contact with site contaminants if the cap dries out or is disturbed in some way. Restriction of future land use should reduce the potential for cap disturbance.

During site preparation and cap installation, there is a potential for receptors (both remedial action personnel and nearby residents) to be exposed to site contaminants by inhalation of dust or volatiles, and by direct contact with contaminated soil. Because of the limited amount of soil disturbance expected during cap construction, health risks are not likely to be appreciable. Surface water runoff control measures, and proper construction and health and safety practices, will minimize the potential for short-term adverse impacts.

Provision of an alternate water supply for the affected residents should result in no additional impacts to either residents or remediation workers during construction. It will also reduce contaminated groundwater-related potential health risks to acceptable levels for those homes that tap into the system. Overall, corresponding potential risks are not eliminated entirely, however, as long as some homes remain on wells that possibly could become contaminated in the future. Long-term monitoring, therefore, would provide data to determine any changes in contaminant-related potential risks to these well users over time.

- Institutional Issues--Th. cap proposed under this alternative will meet CERCLA objectives for controlling contaminant migration and exposures, but will not meet RCRA specifications for the containment of hazardous wastes.

  Institutional issues related to installation of a public water supply are not expected to be complex. The City of Coatesville, of course, would have to approve the proposed connection. Construction of the system then must conform to state and local standards governing a public water supply. Implementation of this alternative would provide a visible public service that would improve the public welfare of the area.

4.3.1.2 Cost Evaluation

The details of costs associated with RAA Two are presented in Appendix C. Capital costs associated with all elements of this alternative are estimated to range from $2,706,000 to $4,812,000. The 30-year present worth of the costs is estimated to fall between $5,122,000 and $7,233,000. Note that a local vendor was contacted for material and delivery costs for clay-like soils and crushed stone aggregates. These costs are incorporated into the capital cost spreadsheets in Appendix C to provide a local cost basis for this alternative.

4.4 Evaluation of Alternatives that Attain All Applicable or Relevant Standards, Guidance, or Advisories

4.4.1 Remedial Action Alternative Three--Onsite Multimedia Capping of Contaminated Soils and Wastes; Extension of the Coatesville Water Authority Public Water Supply; Groundwater Extraction, Treatment, and Injection; and Long-term Monitoring

RAA Three was developed to provide a source control remedy and a management of migration remedy that meets the CERCLA objective of attaining applicable and relevant Federal public health or environmental standards. The intent of this alternative is to attain the objective of a potential health risk no greater than 10^{-6} associated with the site contaminants. This alternative is a combination of the following remedial actions:

- Installation of a multimedia cap to reduce the potential exposure risks associated with dermal contact or accidental ingestion of the site's contaminated surface soils, and to reduce the volume of leachate generated by the site.

- Installation of a public water supply and the sealing of the contaminated domestic wells to minimize the potential health risks associated with ingestion or utilization of the site's contaminated groundwaters.

- Implementation of a long-term monitoring program to observe future contaminant migration, and provide data on the effectiveness of site remediations performed.

- Installation of a groundwater extraction, treatment, and injection system to help restore the contaminated groundwater system as a natural resource.

Site remediation for this alternative will begin with construction of the ten additional long-term monitoring wells as described for RAA One, and shown in Figure 4-1. Site work will continue with site preparation activities as described for RAA Two. These activities include:

- Soil grid sampling to estimate actual extent of capping
- Site access road construction
- Decontamination, staging, and support area construction
- Storm water control installation
- Site regrading

The location of site remediation construction items are also shown on Figure 4-2.

After the site is regraded, the first zone of the multimedia cap is installed. This type of cap is shown in typical cross section in Figure 4-4 and is based on EPA's, January 1985, Hazardous Site Control Division guidance, and the EPA's, May 1985, Minimum Technology Guidance, EPA-530-SW-85014. The first zone is a 6-inch layer of permeable, granular material that will allow free flow of the gases generated by the capped waste materials. The gases are collected from the zone and vented into the atmosphere through a network of passive gas vents located at 100-foot intervals around the toe of the cap and at regular intervals throughout the capped area. The gases to be vented are assumed to be suitable for direct discharge into the atmosphere, based on the information and data presented in the RI. The vents will require periodic monitoring and evalution of the collected data to ensure that the gas emissions do not pose an unacceptable potential health risk.

The next layer of the multimedia cap is an impervious zone, consisting of a 30-mil synthetic membrane and a 2-foot thick layer of compacted low permeability soil material with a demonstrated permeability of at least 10^{-7} cm/sec. The two impervious materials placed together add a factor of safety over a single synthetic membrane or layer of low permeability soil.

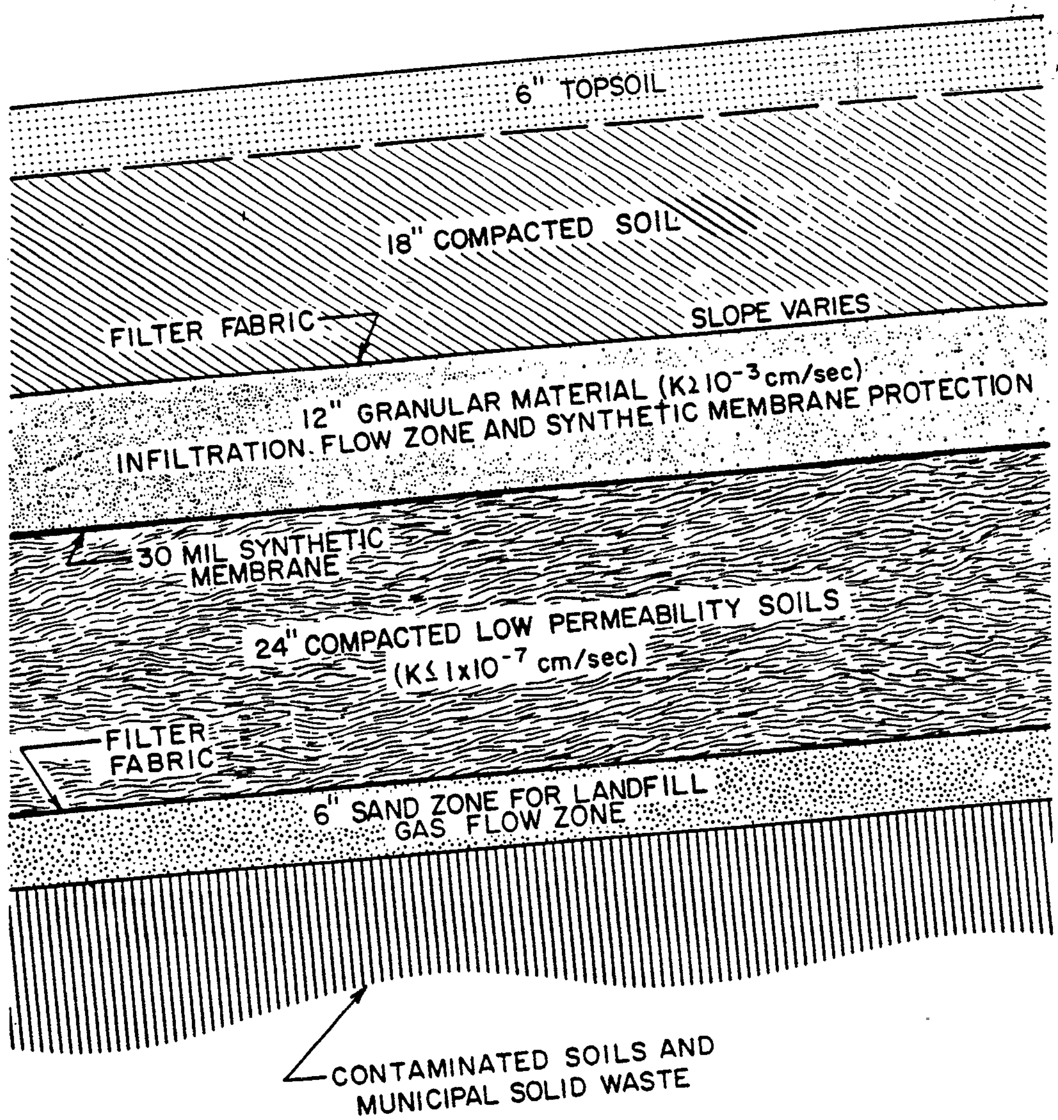

FIGURE 4-4

TYPICAL MULTIMEDIA CAP

BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA

NOT TO SCALE

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The impervious zone is included in this design to reduce leachate production caused by percolation and infiltration of precipitation through the site's cover soil and waste pockets. The infiltrated precipitation leaches contaminants from both the contaminated soils and waste deposits, and transports them into the fractured bedrock groundwater system. Controlling the infiltration will subsequently reduce the leachate generated by the site.

The final layer of the multimedia cap includes a 1-foot-thick flow zone of granular material to collect the infiltration that percolates down through the overlying 2-foot thick zone of cover soils. The flow zone also provides a suitable bedding zone for the underlying synthetic membrane. The granular material is usually sand or a well graded material that is relatively free of sharp rock fragments that could penetrate or rupture the synthetic membrane. The infiltration collection layer is sloped to provide positive drainage, and is designed to prevent excessive mounding of the collected waters. The collected infiltration water is discharged into the site's storm water collection system. The overlying soil layer consists of 2 feet of good quality soil capable of supporting vegetation and minimizing erosion.

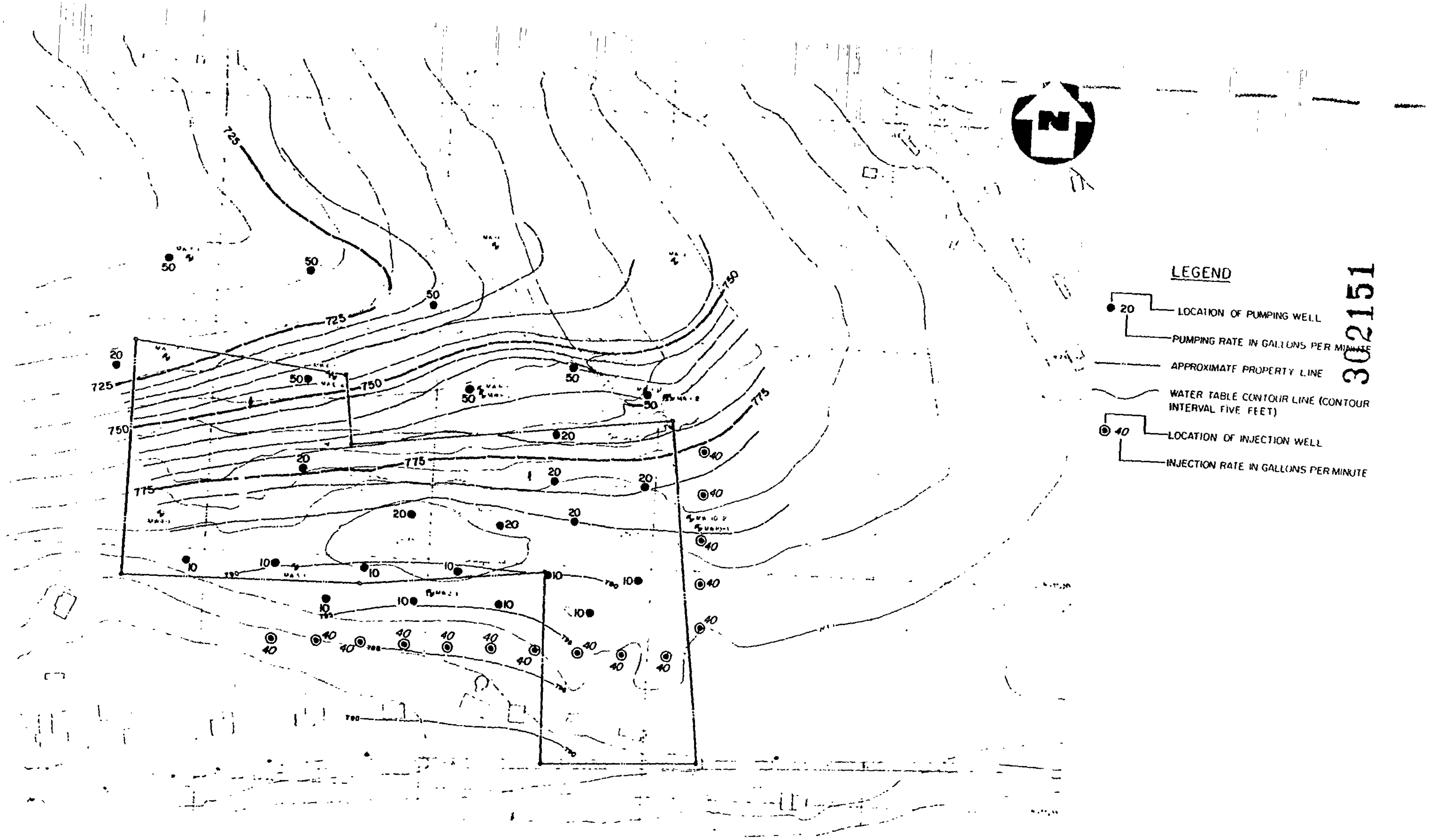
The multimedia cap will be constructed in layers as described above and shown in Figure 4-4. The entire cap then will be revegetated and a security fence installed to reduce site intrusion and vandalism. The site access road and decontamination pad will be removed and the multimedia cap installed in those areas. The logistics of demolishing the support facilities while still being able to perform site construction activities can be worked out in greater detail during the final design phase. For purposes of this study, however, it is assumed that the demolished materials can be disposed on site and then capped within the multimedia system during the final stages of site remediation work.

RAA Three also includes the provision of an alternate water supply to replace the contaminated domestic wells found near the site. As described for RAA Two, the alternate water supply system selected for all of the remedial action alternatives associated with the Blosenski Landfill Site is a public water supply system consisting of a 4-inch branch line from the existing 18-inch water main of the

Coatesville Water Authority. Individual system tap-ins will be required to transport the water from the branch line into the residences. The water can then be routed throughout the homes in the existing water distribution system. The domestic wells will be grouted and sealed with a concrete cap.

Groundwater remediation is also included as part of this alternative through the use of extraction wells, treatment of the extracted water, and subsequent reinjection of that water back into the groundwater system. Based on the RI results, the approximate area of contaminated groundwater to be remediated is estimated to extend from the residential wells south of the site, northward to the intermittent stream, and is as wide as the cleared area surrounding the site. Results of Prickett and Lonnquists' "Basic Aquifer Simulation" model indicate that the zone of pumping and injection influence extends northward from the residential wells immediately south of the site, parallel to and approximately 50 feet east of the tree line east of the site. It then goes westward along the intermittent stream, then extends southward along the site boundary back to the residences south of the site. Therefore, the zone of well influence overlaps and is greater than the known extent of contamination. This is evident by examining Figure 4-5. Note that the pumping and injection wells extend beyond the lateral boundary formed by the monitoring wells, with the exception of monitoring wells 11-1 and 12-1, where no contamination was found. Therefore, all areas of known contamination theoretically can be intercepted by the extraction wells. A long-term pumping test during the design phase is recommended to fine-tune the well locations to the onsite hydrogeologic conditions. The depth of contamination is estimated to be 150 feet, which corresponds to the approximate depth of the deepest residential wells. Based on an effective porosity of 0.005, the pore volume of contaminated groundwater is estimated to be 6,510,000 gallons.

A groundwater pumping system will be used at the Blosenski Landfill to extract contaminated groundwater from the aquifer underlying the site. The hydraulic gradients created by pumping will cause the contaminated groundwater to flow toward the well points and thus reduce its migration offsite. The uncontaminated



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PROPOSED GROUNDWATER PUMPING AND INJECTION WELL LOCATIONS
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA

FIGURE 4-5

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offsite groundwater will be pulled through the contaminated zone creating a flushing effect to remove the residual contaminants.

Pumping well withdrawal rates of 10 gpm on the south side of the site and up to 50 gpm on the north were estimated based on monitoring well hydraulic conductivity testing, site-specific hydrogeologic observations during the RI, and regional aquifer yields. Based on the location of potential receptors, contaminant "hot spot" locations and hydrogeologic site conditions, a 25-well extraction system (shown in Figure 4-5) was developed and then verified by the "Basic Aquifer Simulation" model. Assuming a pumping period of one year, the pumping yield was estimated to range from 372,000 to 878,000 gallons per day. Using the lower, more conservative pumping yield, the time required to extract one pore volume of contaminated groundwater is approximately 20 days. By extrapolation, the time required to extract a specific number of pore volumes by this system would be as follows:

Pore Volumes Removed	Required Pumping Period (Months)
1	0.7
2	1.3
5	3.3
10	6.7
20	13.3
50	33.3

The extraction wells (see Figure 4-6) are proposed to be about 150 feet deep, which corresponds to the depths of nearby residential wells. This should insure the interception of any contaminated groundwater which may be drawn in by the residential wells. Also, well depths of 150 feet should provide greater yields than were identified during the RIA by hydraulic conductivity testing of the monitoring wells, which averaged 70 feet deep. Each pumping well will have a 4-inch, 2-horsepower submersible pump that will feed into 4-inch and 6-inch collection headers for conveying the extracted groundwaters to the onsite treatment plant. The pumping wells will function intermittently with alternating discharge and

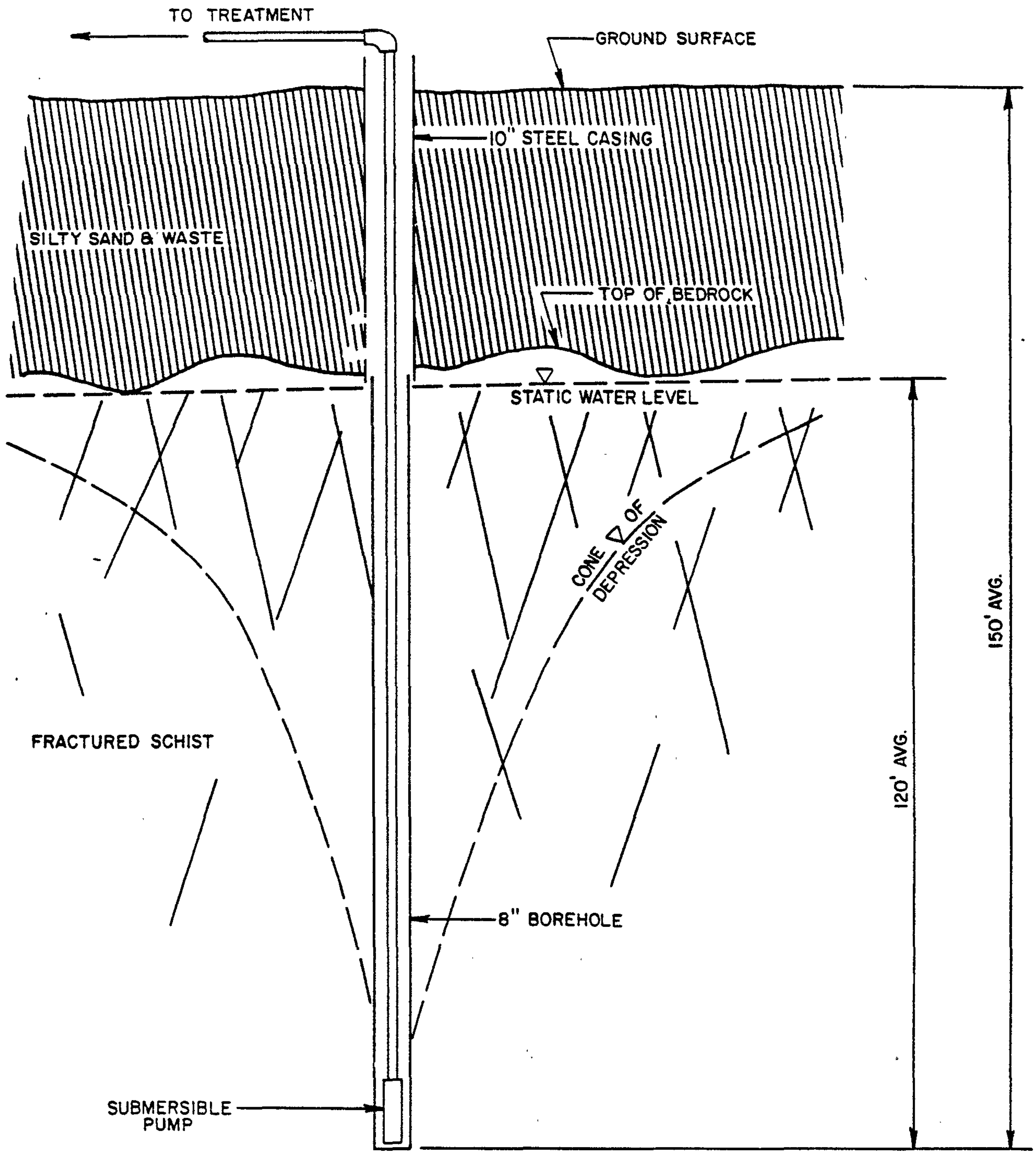

FIGURE 4-6

TYPICAL PUMPING WELL
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA
NOT TO SCALE

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recovery cycles. The pumps will be controlled by water-level-activated switches so that pumping will occur when the groundwater is between prescribed limits.

The groundwater will be pumped and treated until adequate aquifer flushing has occurred to reduce residual groundwater contaminant concentrations so as not to exceed a health risk of 10^{-6}. For the purposes of developing this alternative, the pumping period is assumed to be five years. Actual flushing volumes required should be determined during the design phase by an onsite pilot test, which will monitor contaminant concentrations during continuous pumping.

The groundwater treatment system will be designed to handle both organic and inorganic contaminants and will be located north of the site as shown in Figure 4-2. The first stage in the treatment system uses precipitation, flocculation, and sedimentation processes to pretreat the metals found in the groundwater that could interfere with the organics treatment process. The groundwaters will enter the treatment plant at 600 gpm and be mixed with lime to obtain a pH of 9-11, and to enhance the precipitation of the metal contaminants as metal hydroxides. Flocculating agents or polymers that aid in the coagulation of the metal hydroxides will also be added to optimize the flocculation rate and attain a high density hydroxide sludge. This process may be carried out in a single vessel known as a clarifier. For an influent to the treatment process of 600 gpm, a clarifier of approximately 30 feet diameter with an overflow rate of 1200 gpd/sf may be used. The clarifier is preceded by a flow equalization tank to prevent surges in flow rate and concentration, as shown in Figure 4-7. Overflow from the clarifier is further filtered through a gravity (mixed media) filter with a sand/anthracite coal bed to decrease the suspended solids content and assure maximum removal. The filter effluent is then neutralized to an acceptable pH (usually pH 9 or less for discharge) using sulfuric acid or another reagent before proceeding to the organics treatment system. The underflow from the clarifier is split so that a portion is returned to the unit to provide a seed for the newly-formed precipitate to agglomerate. The remainder is filtered through a plate and frame filter to produce a sludge of approximately 30 percent solids for disposal.

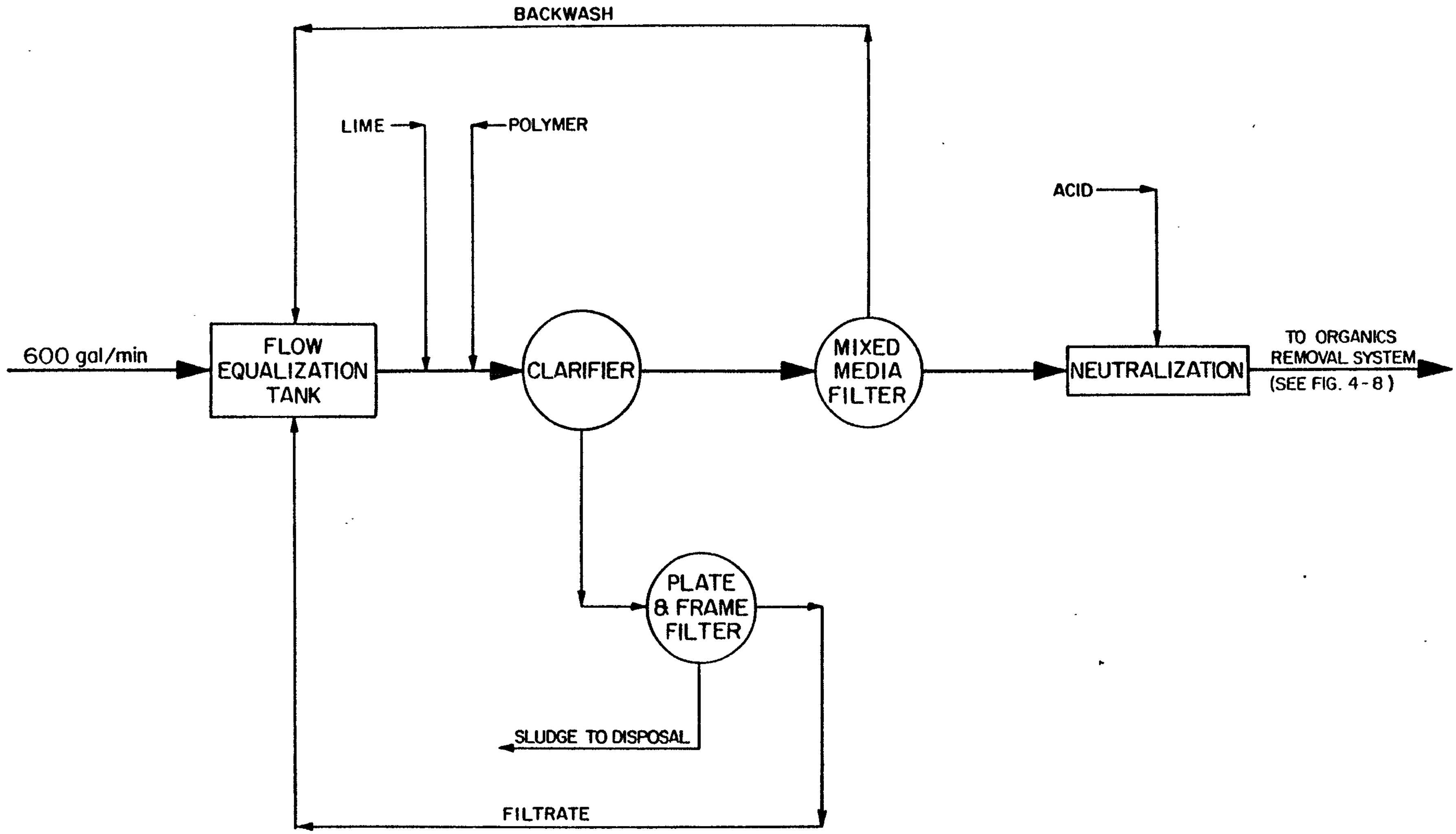

FIGURE 4-7

GROUNDWATER TREATMENT SYSTEM-METALS REMOVAL
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA
NOT TO SCALE

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After the groundwater has been treated for metals and the pH lowered, it is then treated for organic contaminants. Concentrations of organic contaminants identified in the groundwater during the RI are presented in Section 1.2, Table 1-1.

The removal of the organic chemicals found in the site's groundwater can be achieved through the use of an air stripping process to remove volatile organics, followed by carbon adsorption. As shown schematically in Figure 4-8, the effluent from the metals treatment process is fed into a 6-foot diameter tower that is filled with 30 feet of 2-inch Pall rings. Assuming a water flow rate of 600 gpm from the extraction wells, the air stripper will attain about 99 percent removal of most organic contaminants a 6,000 cfm air flow rate (air to water ratio of 75 to 1). The remaining organic contaminants are removed in a carbon adsorption system that contains 2 dual modules in series, consisting of 2 adsorbers that hold 20,000 pounds of carbon each. This system should remove most contaminants to less than 1 ppb in the effluent. Calgon Carbon Corporation (or other vendor) will set up and take down the system and provide the necessary carbon changeout. It was estimated that 4-6 truckloads (20,000 lb each) of carbon will be needed per year to attain the treatment objectives. The treated groundwater is returned to the groundwater system via 15 injection wells located south and east of the site. For costing purposes, the treatment system is assumed to operate for five years.

Although the groundwater remediation process will be initiated after completion of the multimedia cap, construction of the extraction wells will be completed before capping in the area of any of the proposed wells. This will permit proper booting and sealing around the well casing, while allowing future access to the wells and their connecting header system. Completion of the multimedia cap prior to implementation of the groundwater treatment system is preferred because of the heavy equipment operations related to the cap construction and subsequent damage it may do to the header/collector system.

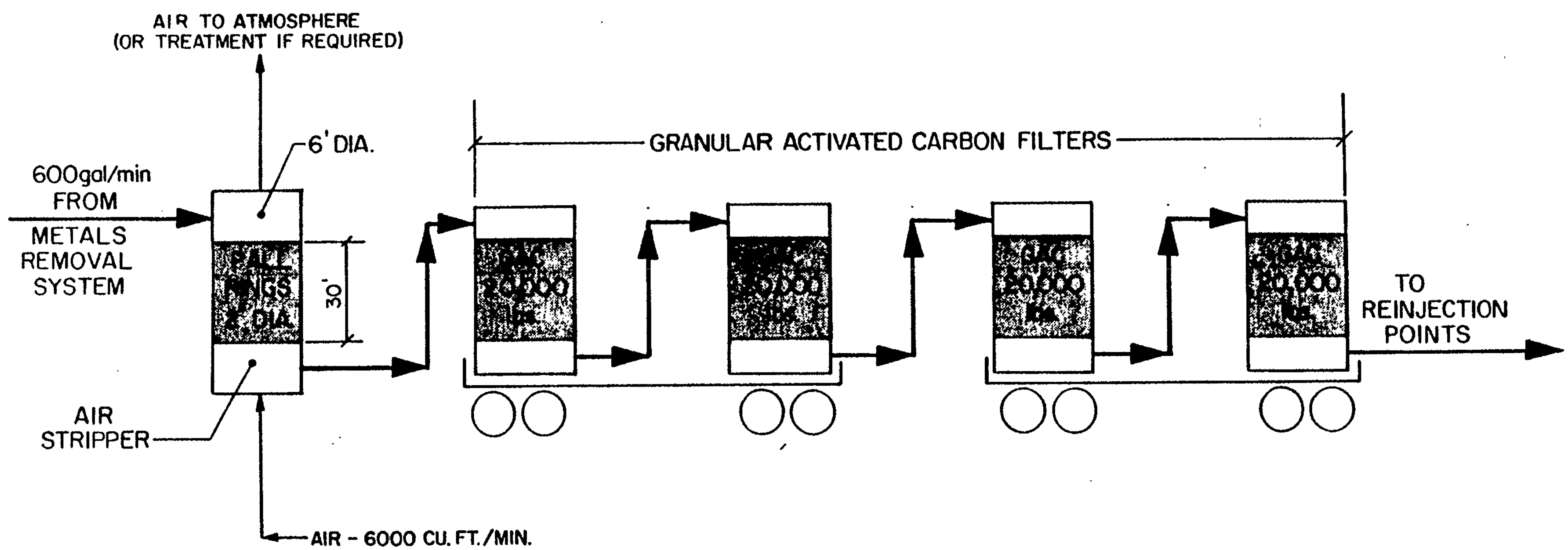

FIGURE 4-8

GROUNDWATER TREATMENT SYSTEM-ORGANICS REMOVAL
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA
NOT TO SCALE

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4.4.1.1 Non-Cost Evaluation

- Technical Feasibility--Multimedia caps have been utilized in numerous applications in industry and the management of uncontrolled hazardous waste sites to attain objectives similar to those set for the Blosenski Landfill Site. The multimedia cap can reduce the amount of leachate generated by the waste deposits to effectively zero. However, the effectiveness of the cap will be limited by the materials selected for cap components and the quality of the cap construction activities. Tests on both the synthetic membrane and the compacted clay have shown that they are suitable materials for the prevention of infiltration. However, tests have shown that improper lamination of the synthetic panels and the improper compaction of clay soils can reduce their overall permeability by several orders of magnitude.

Technically, the multimedia cap is an effective, useful, reliable remedial action that can be implemented quickly and has demonstrated beneficial results as soon as construction is completed. The site is suitable for capping following regrading of the northern slopes to aid in constructability. The cap materials are available in the immediate area of the site, including clay soils that have laboratory falling head permeability test results of approximately 10^{-7} cm/sec.

The alternate water supply is based on the extension of an existing public water supply. The useful life of a branch water supply line that is properly installed and constructed of durable materials will far exceed the 30 years used to evaluate the cost-effectiveness of the site's remedial action alternatives. Since their inception about 30 years ago, synthetic materials, such as the PVC selected for costing purposes in this alternative, have shown little or no decay or performance reduction under normal operating conditions.

One of the overriding factors in selecting the extended public water supply as the alternate water remedial action was the reliability, demonstrated performance, and implementability of the materials, construction activities, and technologies involved. The installation of water-supply lines to supply water fo, domestic utilization is performed around the world with extremely reliable results. The conditions found at the site do not appear to be a deterrent to installing and utilizing the extended public water-supply remedial technology. Excavation of a trench along King's Highway from the Coatesville Water Authority 18-inch water main to the residences with the contaminated domestic wells will not pose construction and logistical problems that have not been solved before in many similar situations. The installation of a 4-inch water line in the trench , using the proper bedding material, inspection and testing procedures, frost protection, and backfilling specifications can be performed in an estimated 90 days. The closure of the domestic wells does not pose a significant technical problem. Implementation of this remedial action can be performed by a large number of local contractors and the selection of a reliable contractor can be pursued through a simple bidding or procurement process.

The groundwater extraction and treatment system provides a feasible means of removing contaminants from the groundwater. However, the efficiency of extraction is subject to the uncertainty of localized well yields due to the fractured bedrock. Groundwater extraction is believed to be feasible for the following reasons: aquifer testing during the RI identified sustained yields with groundwater being intercepted on every monitoring well. These wells averaged 70 feet in depth. The proposed pumping wells will be 150 feet deep, so yield should be greater. Also, the residential wells are able to extract groundwater on a long-term basis and pumping wells function in the same manner as residential wells. Even though the hydraulic connection between individual recovery wells may be unpredictable, the overall gradient can be controlled so that the groundwater in fractures between the wells will eventually migrate toward the pumping well due to the pumping-induced gradient.

The extraction and injection wells operate simultaneously forming a hydrologic cycle. The extraction wells cause the formation of steep gradients which accelerate the groundwater flow from the upgradient injection wells to the downgradient extraction wells, as shown in Figure 4-5. This will enhance the flushing of the contaminated groundwater zone, and may decrease the length of treatment time required. The continued operation of the extraction wells will prevent the flooding and subsequent plume break-out downgradient of the site. At the same time, the offsite migration of groundwater from the upgradient injection wells will be minimized by the pumping-induced gradients.

The pumping and injection well arrangement indicated in Figure 4-5 is a preliminary estimate based on limited field testing. The uncertainty of the groundwater extraction rates is reflected in the estimated range of those rates (372,000 to 878,000 gpd). The extraction rates shown in the figure are based on an upper limit of 878,000 gpd.

The treatment process is expected to be effective in removing groundwater contaminants. Site-specific pilot testing and monitoring are required to assess the efficiency of the system prior to scale-up. A gaseous chlorinator may be needed once treatment commences if significant biological growth occurs on the packing media or GAC contactors. Pretreatment should ensure that total suspended solids are low enough to prevent plugging of the media. Significant operation and maintenance requirements are expected.

- Health and Environmental Impacts--The potential exposures and corresponding health risks associated with residual contaminants will be reduced after completion of the multimedia cap. The alternate objective of cleaning the site to the same levels as the identified background levels is not attainable because of the contaminants that will remain on site in the waste deposits and in the soils. A risk level greater than one in one million (10^{-6}) is not anticipated for this remedial action.

The risks associated with the ingestion or utilization of the contaminated groundwater are virtually eliminated, so long as the water supplied by the proposed extension is not contaminated. There is currently no reason to suspect that the waters of the Coatesville Water Authority do not meet the Federal Drinking Water Quality Standards. The chlorination issue raised in the alternate water supply Focused Feasibility Study can be remedied by the installation of an in-line chlorination unit near the point of consumption in the branch line. The domestic wells that currently are not showing signs of contamination will require constant monitoring to ensure that they are not pathways for contaminants and sources of potential health risks. Additional design studies on the extended water line and its potential service area may provide the data to support the expansion of the service area will include additional residences in the vicinity of the site. The more domestic well users that are placed on a controlled source of potable water, the lower the potential for additional receptors that may be placed at risk in the future. Construction of the cap and the alternate water supply will have the same implementation and residual risks as those described in RAA Two.

The potential hazards associated with implementation of the groundwater treatment alternative are volatilization and concentration of hazardous constituents with subsequent inhalation and direct contact during process construction. Potential exposures would be of a relatively short duration and are not expected to pose appreciable hazards to either human or environmental receptors. Volatile organics will also be emitted to the atmosphere during air stripping. The dilution and dispersal mechanisms of the atmosphere are expected to minimize the impact via inhalation. If warranted, however, the air stripper can be equipped with the appropriate air pollution control equipment to mitigate these effects.

Pumping and treatment of the contaminated groundwater will reduce the potential public health risk associated with the major contaminant migration pathway identified at the site. Long-term ingestion of the treated groundwater would be associated with a 10^{-6} risk or less, because the treatment level was determined by the Maximum Contaminant Levels (MCLs) MCL's are allowable lifetime exposures (with an associated risk of 10^{-6}) for a person consuming 2 liters of water per day. These levels do not, however, reflect the possible synergistic risks associated with the ingestion of two or more contaminants simultaneously.

The ultimate goal of the treatment system is to meet the Recommended Maximum Contaminant Levels (RMCLs), which state that there is no acceptable level for a carcinogen and, therefore, the recommended concentration is zero. However, that number cannot be verified by currently available analytical equipment. Safe Drinking Water Act Maximum Contaminant Levels (MCLs) may be achievable. Table 1-2 presented MCLs and RMCLs for the contaminants present in groundwater at the site.

- Institutional Issues--Institutionally, the proposed multimedia cap will meet the RCRA regulations for closure of a facility (Closure and Post-closure Care 40 CFR 264.310). The cap also meets the CERCLA goals of reducing the likelihood of present or future threat from substances associated with the site. The additional remedial actions associated with this alternative are combined to attain the applicable and relevant Federal public health or environmental standards.

There are, of course, continuous or frequent changes in the regulations and the interpretations of those regulations that may impact the use of this alternative. Two particular items that may impact the Blosenski Landfill Site and its subsequent remediation are the latest NCP regulation revisions and the proposed Solid and Hazardous Regulations currently under public review in the Commonwealth of Pennsylvania.

The institutional issues associated with the alternate water supply are not anticipated to be overly complex. The regulations governing the installation of a public water supply or extension of a public water supply system are found at the Federal, state, county, and local levels. The over-all review of the extension is a state and county issue with input from the local government and authorities, and guidance from the Federal authorities. Approval of the Coatesville Water Authority would be required, of course, prior to implementation.

Implementation of the groundwater extraction and treatment system will require approval of state and local officials. Air-pollution control equipment may be required on the air stripper to reduce gaseous emissions to acceptable limits. Permit requirements for air stripper emissions and groundwater injection must also be met.

4.4.1.2 Cost Evaluation

Details of costs associated with RAA Three are presented in Appendix C. The estimated range of capital costs for this alternative, based on a sensitivity analysis of the estimated quantities and unit costs is between $848,100 and $13,037,000. Operation and maintenance costs assume a 30-year life of the cap and monitoring system, but only five years of groundwater treatment. A local vendor was contacted for material and delivery costs for clay-like soils and crushed stone aggregates. These costs are incorporated into the capital cost spread sheets presented in Appendix C. The range of 30-year present worth costs is estimated to be between $13,150,000 and $17,706,000.

4.4.2 Remedial Action Alternative Four--Construction of a Secured Onsite Landfill; Extension of the Coatesville Water Authority Public Water Supply; Groundwater Extraction, Treatment, and Injection; and Long-term Monitoring

RAA Four was developed to provide a source control and management of migration remedy that meets the objective of attaining applicable and relevant Federal public health and environmental standards. Technologies used in this remedial action alternative include:

- Construction of an onsite landfill to encapsulate the onsite waste materials, thereby controlling contaminant migration via groundwater, surface water, and air transport.

- Provision of a public water supply to eliminate potential health risks associated with ingestion or utilization of contaminated groundwater.

- Extraction, treatment, and injection of groundwater to remediate the contaminated aquifer.

- Implementation of a long-term monitoring program to observe future contamination levels, and to provide information on the effectiveness of the remedial actions performed.

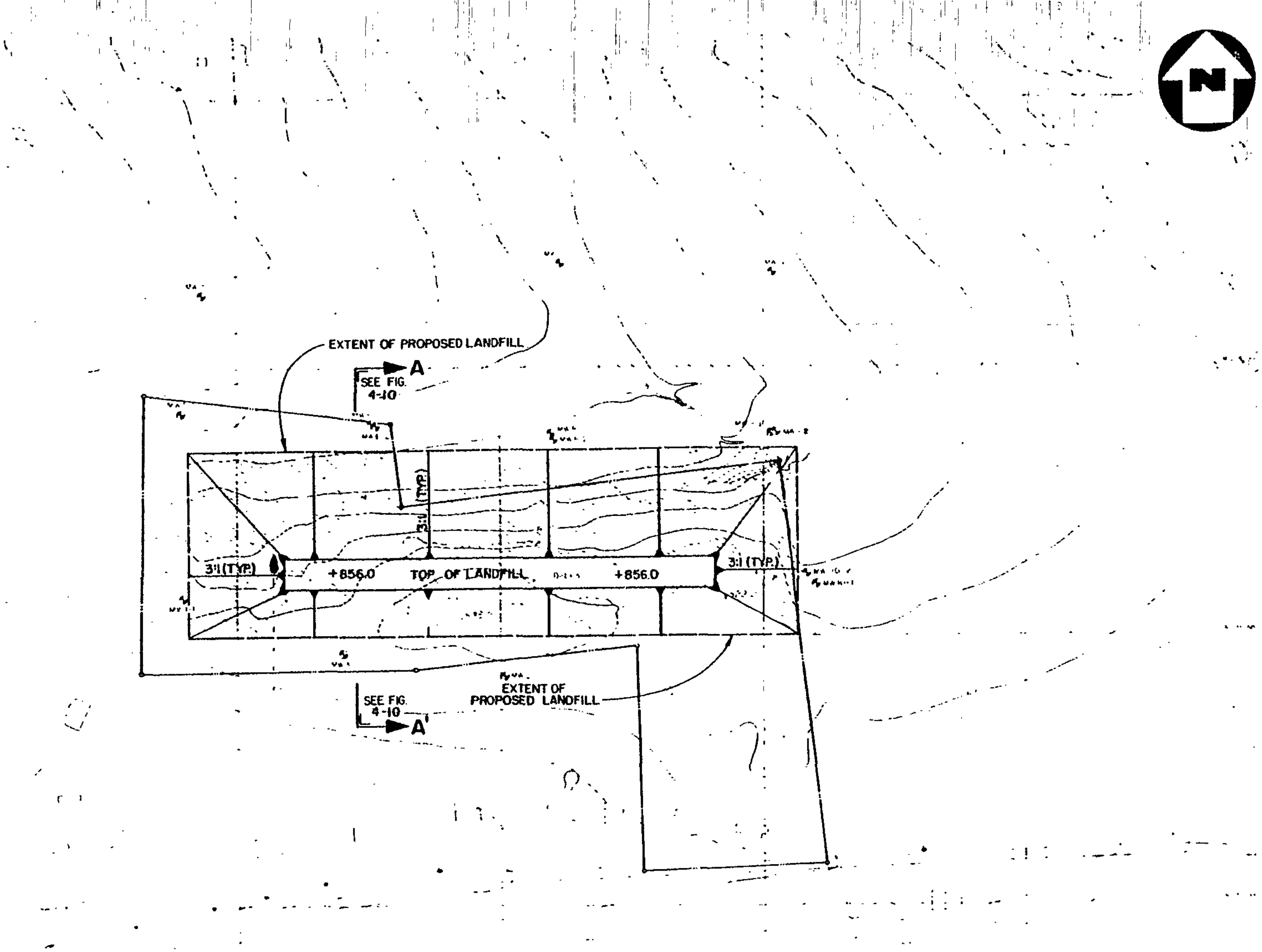
Extension of the Coatesville water supply; groundwater extraction, treatment, and injection; and long-term monitoring were described and evaluated in the preceeding RAA. Therefore, only the onsite landfill will be described and evaluated in detail in this section.

A secured hazardous waste landfill meeting RCRA specifications will be constructed to contain all contaminated materials encountered at the site. The total volume of wastes to be disposed of is estimated to be 385,000 cubic yards as determined by the RI sampling results, and by comparing current and pre-landfill topographic maps. This volume includes 185,000 cy of wastes and 200,000 cy of contaminated soils. The lateral extent of disposed wastes includes virtually all the cleared area of the site, except for approximately 1 acre on the western side of the site. All the contaminated soils in this area will be excavated and deposited into the landfill along with the dumped wastes. The depth of contaminated natural soils is estimated to be 15 feet, which is very close to the top of bedrock in the western portion of the site, and 5 to 10 feet above bedrock in the eastern portion. The actual extent of this excavation, which will directly affect the landfill capital cost, must be determined by additional sampling during the design and implementation phases of this RAA.

The proposed landfill will be located in roughly the same area as the existing landfill (see Figure 4-9). The proposed landfill is bounded by the monitoring wells which were installed for the RI and will be used during construction and after closure. The depth of the landfill is controlled by the top of bedrock and seasonal high water table. Installation of the landfill above the seasonal high water table reduces the possibility of subsurface infiltration. Due to the sloping nature of the site and groundwater elevations, the bottom of landfill elevation will range from 770 feet along the northern landfill edge, to 800 feet along the southern edge, (see Figure 4-10).

This landfill will be constructed in accordance with regulations specified in RCRA and its amendments. These regulations state that all new units must be double lined and have leachate collection systems above and between the liners. Leachate that may be generated must be collected and removed for proper treatment or disposal. A groundwater monitoring program must be provided to yield representative samples at background and compliance point locations both during operation and post-closure. The landfill proposed in this remedial action alternative is developed from information contained in the EPA, May 1985, Minimum Technology Guidance on Double Liner Systems, EPA-530-SW-85014 and the EPA Hazardous Site Control Division Guidance dated January 1985.

The bottom liner of the landfill cell will incorporate a three-foot layer of clay with a permeability not to exceed 10^{-7} cm/sec, overlain by a 30 mil flexible synthetic membrane (see Figure 4-11). A leachate detection zone will be installed over this liner to detect leaks from the primary liner system. This detection zone will consist of one foot of sand and/or gravel with a permeability exceeding 10^{-2} cm/sec, and perforated PVC drainage tile spaced at 100-foot intervals. Gravel used in this layer should be less than one-quarter inch in diameter to minimize the possibility of liner puncture by equipment loads during installation.



LEGEND

MONITORING WELL
PROPERTY LINE (APPROX.)
EXTENT OF PROPOSED LANDFILL
+856.0 FINISHED GRADE SPOT ELEVATION

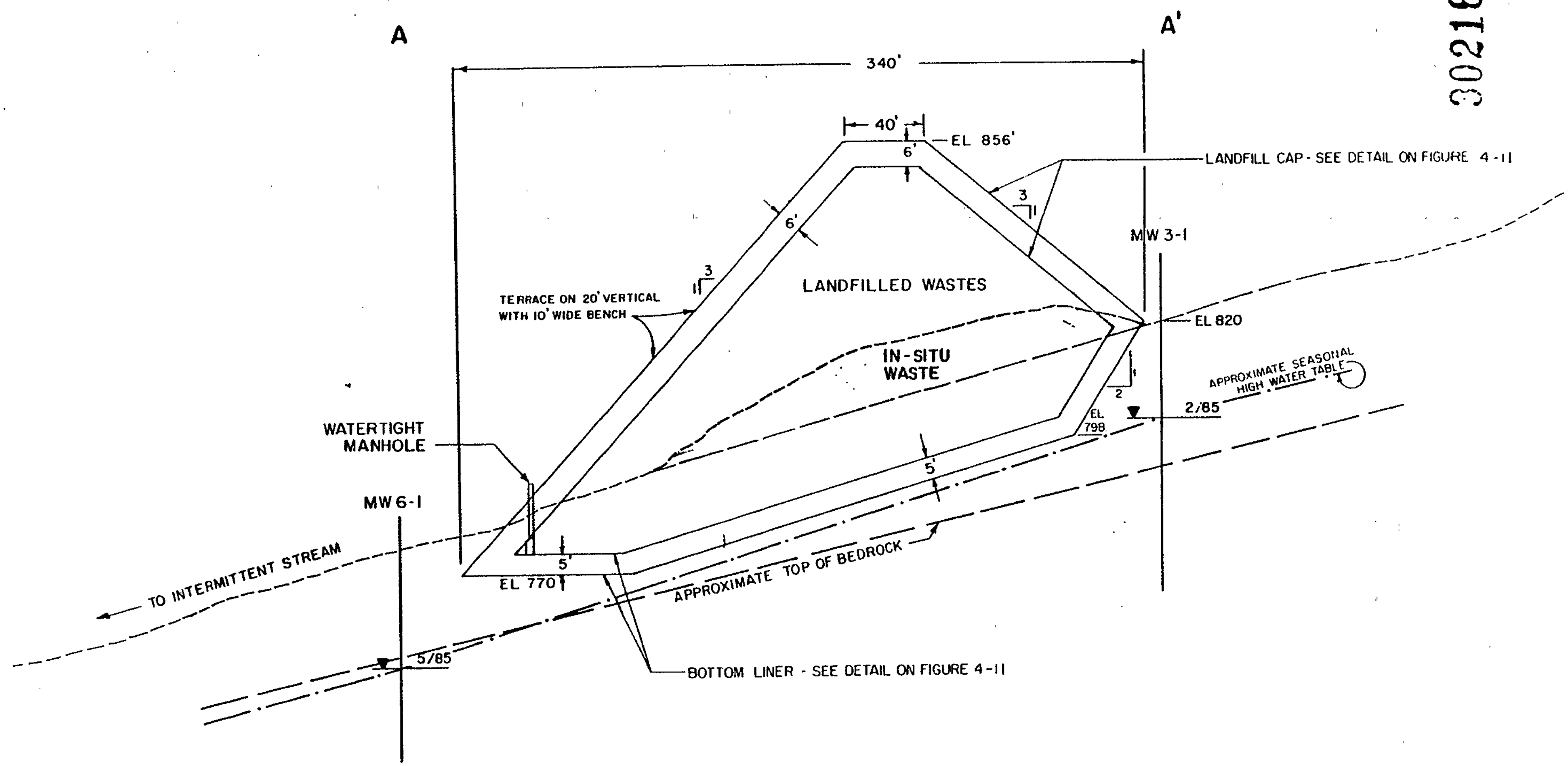
302166

0 100 200 400
SCALE IN FEET

PLAN OF PROPOSED ONSITE LANDFILL
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA

FIGURE 4-9

NUS CORPORATION
A Halliburton Company



CROSS SECTION A-A'; PROPOSED ONSITE LANDFILL
BLOSENSKI LANDFILL SITE, WEST CALN TWP, PA
NO SCALE

FIGURE 4-10

NUS CORPORATION
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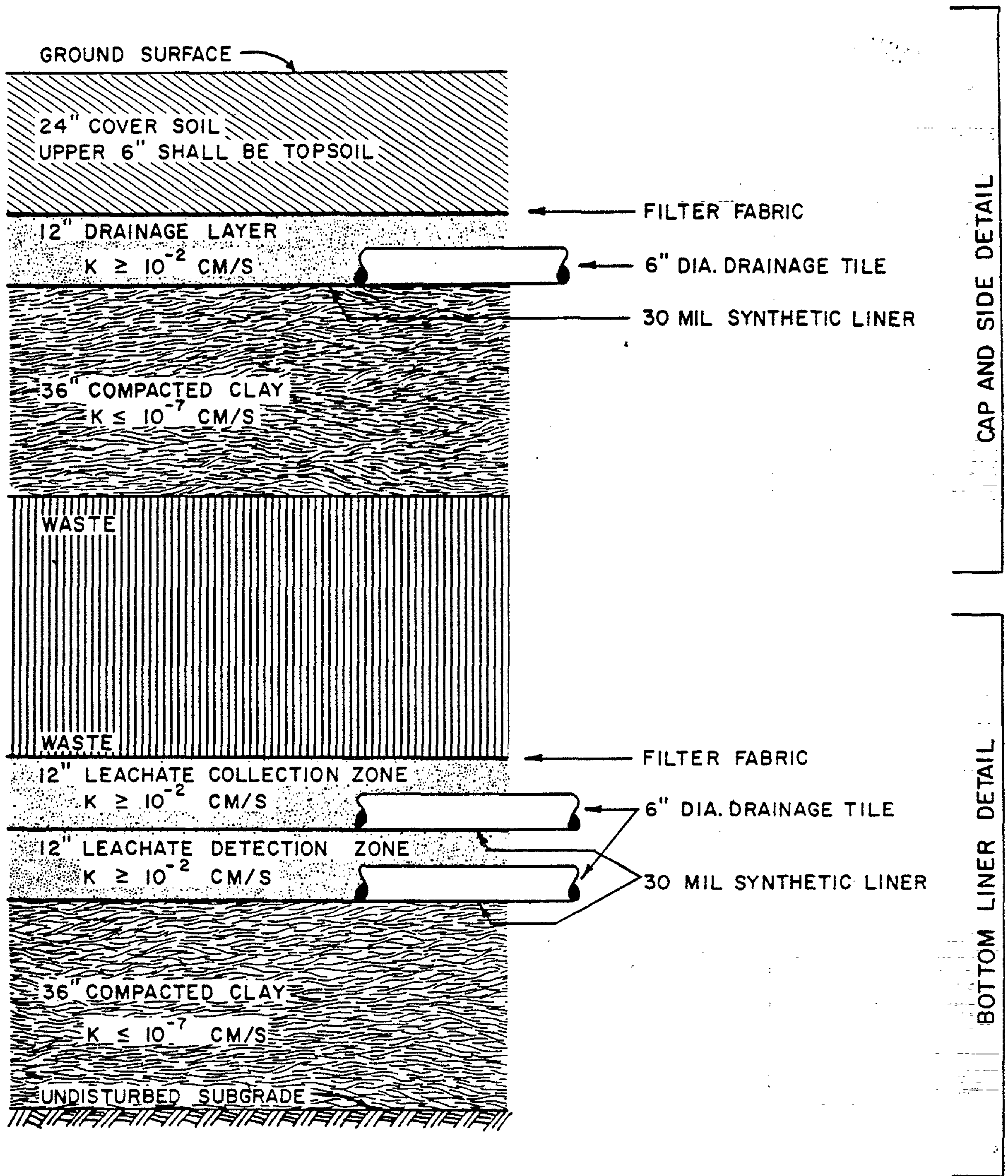

FIGURE 4-11

LANDFILL CAP AND BOTTOM LINER DETAILS
BLOSENSKI LANDFILL, WEST CALN TWP., PA

NOT TO SCALE

NUS CORPORATION
A Halliburton Company

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Another 30-mil flexible synthetic membrane (primary liner) will be placed above the leachate detection zone. The synthetic membrane material selected should be chemically compatible with the waste material and should not deteriorate upon contact with leachate. A 1-foot-thick, primary leachate collection zone with the same composition as the leachate detection zone will be placed above the primary liner to prevent buildup of static head on the primary liner. All the zones will have a slope of 2 percent to enhance drainage of collected leachate. A geotextile filter fabric will be placed above the primary collection zone to minimize the washing of fines from the wastes into the collection zone.

The landfill cover will be composed of a 3-foot layer of clay, with a permeability not to exceed 10^{-7} cm/sec, which will be overlain by a 30-mil-thick synthetic membrane of the same type used in the bottom liner. A 12-inch-thick granular drainage layer will overlie the synthetic membrane to collect and remove infiltrated rainwater. This drainage layer will contain PVC drainage pipe spaced at 100-foot intervals. A two-foot-thick layer of cover soil including 6 inches of topsoil will be the upper layer of the landfill cover. This cover layer will support vegetative growth and promote surface drainage. A filter fabric will separate the cover soil layer and the drainage layer.

A passive gas collection and removal system will be installed to remove volatile organic vapors and methane which may be generated within the landfill. This system will consist of granular drains spaced at 100-foot centers in the top of the waste layer, with vertical pipe vents extending through the cover to the atmosphere. These vents will be monitored to determine if significant concentrations are released that would increase potential risks to the public health or the environment.

The depth of the landfill will range from 20 to 70 feet, and the top of landfill elevation will be 856 feet. The top of the landfill will have a slope of 4 percent to enhance surface runoff. To minimize erosion side slopes of the landfill will be 3:1 (see Figure 4-11).

Because of the tremendous load imposed on the subsurface soils by the landfill, the structural stability of the landfill and the subsoil should be investigated. Additional design phase geotechnical testing will be required should this alternative be chosen. Settlement of the subsoil due to the landfill does not appear to be a problem for two reasons. First of all, there are only five feet between the bottom of the landfill and the bedrock, so there is not much material to be compressed. Secondly, this material will already be pre-loaded by the 20 to 30 feet of soil and wastes that will be excavated for the landfill. Another potential concern is slope stability. However, since the landfill loads will be spread out over such a large area, the resulting shear stress is only 1.1 KSF (Kips per square foot). A preliminary analysis of the onsite soils indicate an available shear strength of at least 2 KSF. Since the available shear strength is greater than applied shear stress, no slippage would be expected to occur.

Because of the large volume of wastes and contaminated soils and the limited available space, the landfill construction will occur in stages of approximately 2 acres. Each stage will consist of: (1) excavating and stockpiling the contaminated material; (2) backfilling the excavation with offsite borrow material for support; (3) installing the bottom liners and drainage systems; (4) spreading and compacting (filling) the contaminated wastes; and (5) installing the surface liner.

The waste filling operation should be started by compacting waste in the lower, northern side of the landfill and working uphill from there. The soil/waste material should be spread in 12-inch layers, then compacted to maximum compacted density. Successive lifts are placed on top of each other until the daily grade is reached. The final lift of the day should be covered with soil immediately to minimize any potential volatilization of contaminants. The onsite soil can be used as daily cover provided that it does not contain visible amounts of waste or contaminants.

Extension of the Coatesville water supply line will not be affected by constructing an onsite landfill, since the water line will be located completely off site. Long-term monitoring, which involves installing offsite monitoring wells, will not be affected by the landfill construction.

The groundwater extraction system will be somewhat affected by the landfill since seven of the proposed groundwater pumping wells shown in Figure 4-5 will be encroached upon. Four of these wells can be relocated outside the proposed landfill, so only 3 of the 25 originally proposed extraction wells will be eliminated. Therefore, the net effect on groundwater removal efficiency will not be significant. Also, since the landfill will be located near the center of the site, there will be sufficient space around the landfill perimeter to install additional groundwater extraction wells if found necessary. The groundwater treatment system will not be affected by the landfill since it will be located on the downgradient side.

4.4.2.1 Non-Cost Evaluation

- Technical Feasibility--Construction and operation of a RCRA-specification landfill is a relatively new technology. Its effectiveness is highly dependent upon proper installation techniques, particularly with the synthetic membrane and the sealing thereof. Installation of the various landfill components, such as compacted soil and synthetic membranes, are widely used and accepted construction techniques. Implementability of this landfill should not be a problem, provided that sufficient clay material can be obtained for the liners. A geotechnical evaluation of the proposed landfill site should be performed during the design phase to ensure that the additional loading from the liners and waste material will not cause excessive settlement and stability problems. Installation of this alternative should take approximately 2 years.

  A controlled hazardous waste landfill requires significant operation and monitoring systems. The leachate collection and detection systems require frequent inspection for leaks and clogging. The capping materials require periodic maintenance to prevent erosion and surface ponding.

- Health and Environmental Impacts--Installation of a landfill would greatly increase the exposure risk above that associated with a surface cap because all the contaminated soils will be excavated, stockpiled, and replaced. These activities can increase the risk of health effects to remediation workers because of higher probability of worker exposure to the contaminated waste. This exposure includes inhalation of contaminant vapors, ingestion of contaminant-laden particulates and direct skin contact with the waste. The risk of worker exposure and any resultant health effects is increased even more when the extended period of time required for completion of this activity is considered. These risks can be controlled through the use of appropriate personal protective equipment and construction techniques, such as waste covering and dust suppression.

Operation of the landfill will decrease the long-term risk of exposure and health effects to offsite receptors. The high degree of containment provided by a landfill built to RCRA-specifications isolates the wastes from surface water and groundwater contact, thereby greatly reducing contaminated surface water runoff, groundwater infiltration, and offsite contaminant migration.

Installation of a landfill, particularly excavation of the existing wastes, increases the potential for deleterious environmental effects during construction. The increased risk is a result of increased transfer of waste materials, with the result that wastes will be exposed to the environment for a greater period of time. Volatilization of organics is the most significant mode of contaminant transport. Erosion of contaminated soil can be minimized by using temporary dikes and sedimentation ponds.

- Institutional Issues--A controlled hazardous waste landfill must be double-lined and contain leachate collection and detection systems capable of removing leachate that may be produced. The landfill must be operated according to RCRA regulations listed under 40 CFR Part 264. A comprehensive groundwater monitoring program must be utilized during construction and after landfill closure according to Subpart F of Part 264.

4.4.2.2 Cost Evaluation

Installation of a controlled hazardous waste landfill includes many unknowns, such as actual amounts of contaminated soil, material costs, and site conditions during construction. The most critical factor is the volume of contaminated soil which directly affects the capital cost of the landfill. A sensitivity analysis was performed to determine the effects of variations on quantities of contaminated soils to be excavated, clay liners, and synthetic liner materials. These sensitivity factors range from -40 to +50 percent. The capital costs for this alternative range from $14,317,000 to $31,508,000. There is a significant amount of operation and maintenance costs associated with a landfill, including groundwater monitoring, maintenance of the leachate collection system, and maintenance of the cover soil and vegetation. The total present worth is expected to range from $18,986,000 to $36,177,000.

4.5 Evaluation of Alternatives That Exceed Applicable or Relevant Public Health and Environmental Standards, Guidance, and Advisories

4.5.1 Remedial Action Alternative Five--Complete Excavation of Contaminated Soils and Wastes; Onsite Incineration With Multimedia Cap Over Residuals; Extension of the Coatesville Water Authority Public Water Supply; Groundwater Extraction, Treatment, and Injection; and Long-term Monitoring.

This alternative was developed to provide remediation of the site in a manner which exceeds applicable and relevant federal public health and environmental standards, in accordance with EPA's Guidance on Feasibility Studies Under CERCLA and the National Contingency Plan. The intent of this alternative is to reduce the potential risk to the public health and environmental receptors via the pathways discussed in Section 1.2.2 of this report. The technologies comprising this remedial action alternative include:

- Excavation, incineration, and capping of the waste materials to reduce potential risks associated with dermal contact and accidental ingestion of surface materials, and to reduce organic leachate generation.

- Provision of an alternate water supply to minimize potential health risks associated with use or ingestion of contaminated groundwater.

- Extraction, treatment, and injection of groundwater to restore this natural resource, and to reduce future exposure risks to human and environmental receptors.

- Long-term monitoring of the site to detect any future contamination and provide information on the effectiveness of the remedial action.

This alternative employs complete excavation of contaminated soils and wastes. Site preparation activities are as described in previous alternatives. Unlike previous alternatives, however, the organic contaminants in the materials are destroyed (via incineration) before they are returned to the site for disposal. Some of the solid wastes, such as drums and scrap-metal, may require offsite landfill disposal. However, the volume of this material is not expected to be significant, and offsite unit disposal costs are not expected to exceed the unit incineration costs.

The incinerator residue, along with the inorganic-laden soils and wastes, is backfilled and compacted, and the multimedia cap described in RAA Three is placed on top of the residues. The area of the cap is assumed to be the same as that described for RAA Three (approximately 9.4 ac). Assuming overall volume reduction of 40 percent for the combined waste and soil materials after incineration (80 percent reduction for wastes and negligible reduction for soils), 231,000 cubic yards of residue will be disposed of in the area from which it was excavated see Appendix B). The general arrangement for onsite incineration and capping is shown in Figure 4-12.

The incineration process selected for this alternative is a mobile, rotary-kiln system designed by Best Environmental Services Technology, Ltd. A 0.5 ton/hr unit will be used initially for any test burns necessary to meet RCRA requirements and to determine the most efficient loading rates for site operation. The PADER has already approved the design. During this time, a second, larger unit (capable of processing 4 ton/hr of soils) would be built of similar design as the smaller unit. Since both units would have similar design and operating characteristics, no regulatory problems would be expected with this larger unit. It is estimated that this unit could be operating on site within one year after incineration commences with the first unit. Both units would be retained on site for a combined processing rate of 4.5 ton/hr for the duration of the project.

A process flow diagram for rotary-kiln incineration is shown in Figure 4-13. The kiln consists of a cylindrical, refractory-lined shell, mounted at a slight incline from the horizontal. Rotation of the shell causes mixing of the waste with the combustion air to expose the maximum amount of waste to the combustion process. Materials are oxidized at temperatures ranging from 1500-2000°F, and incombustible ash is discharged directly from the kiln. Combustion gases and vapors from the kiln are passed through a secondary combustion chamber (SCC) where they are further decomposed at 2000-2400°F. The flue gases exiting the SCC are monitored for the combustion components carbon monoxide, carbon dioxide, and oxygen to ensure a combustion efficiency of 99.9 percent. The gas then passes to a quench chamber, where it is cooled to approximately 900°F. Particulate removal is effected by a baghouse, electrostatic scrubber, or similar device. The acid gas is then neutralized in a mass transfer scrubber. An induced draft fan is used to draw the gases through the system and out of the stack, where they are analyzed for emission components such as sulfur dioxide, oxides of nitrogen, and total hydrocarbons. The overall destruction efficiency of the incinerator must be greater than 99.99 percent.

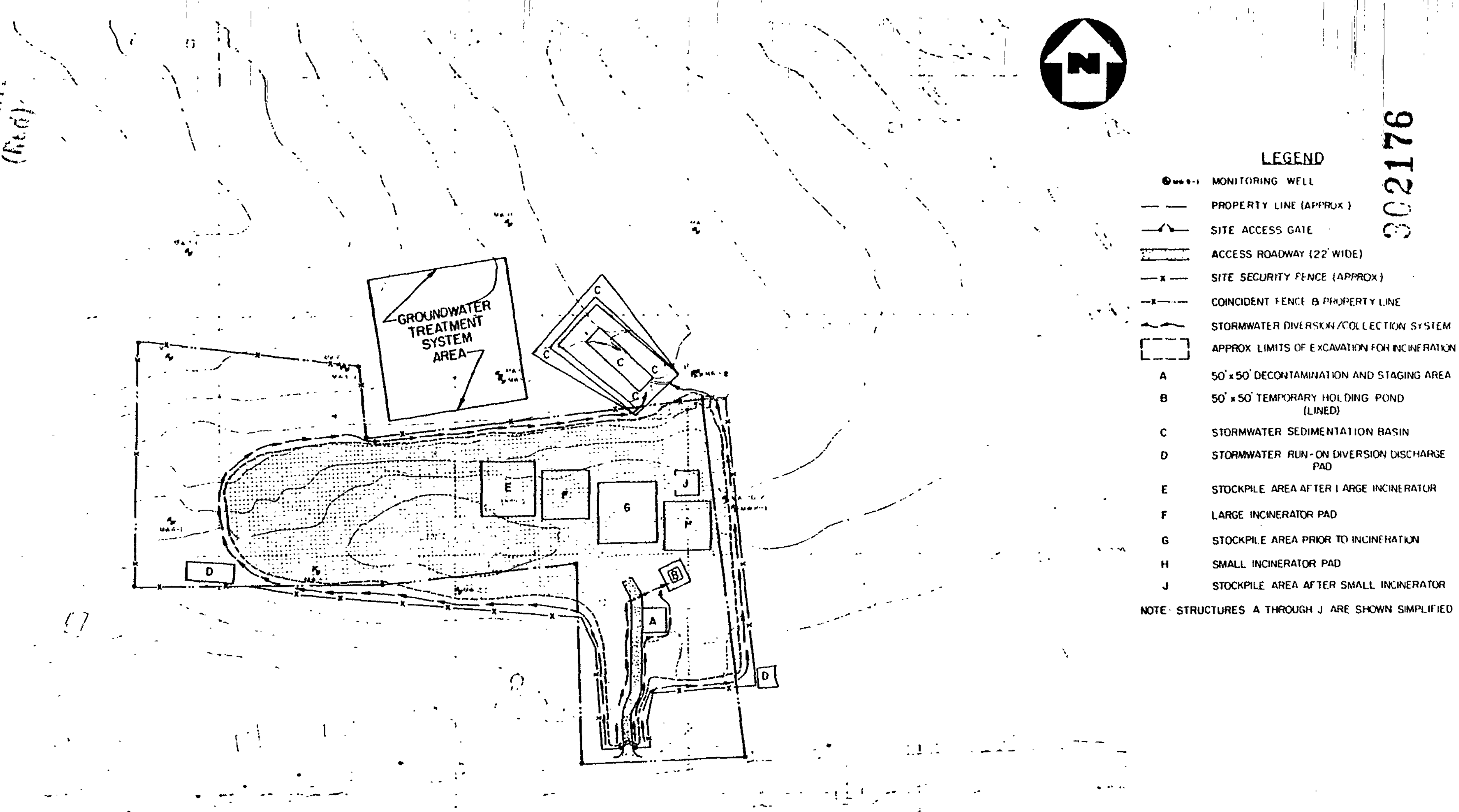

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FIGURE 4-12

GENERAL ARRANGEMENT FOR ONSITE INCINERATION
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA

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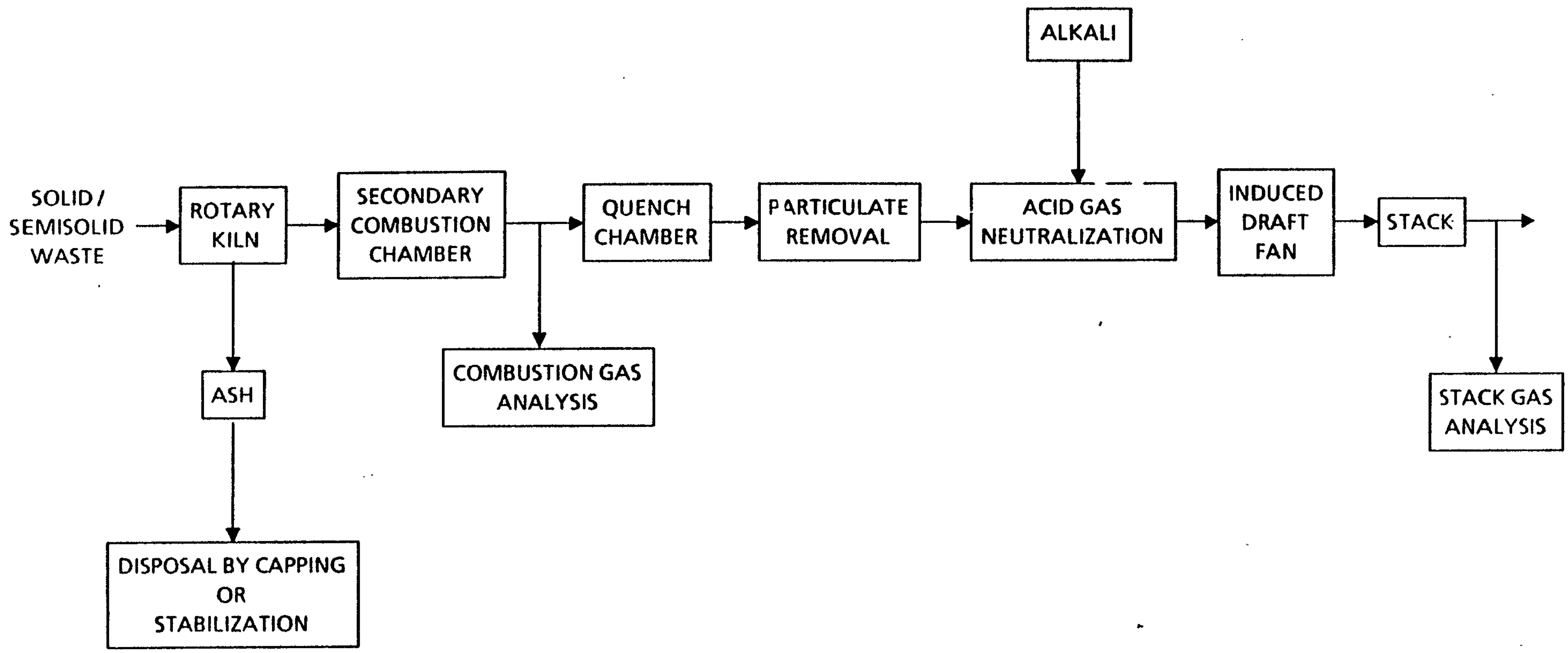

FIGURE 4-13

PROCESS FLOW DIAGRAM FOR ONSITE
ROTARY KILN INCINERATION OF SOLID WASTE
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA

NO SCALE

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4.5.1.1 Non-Cost Evaluation

Since incineration is the only technology introduced in this alternative that was not evaluated previously, it will be emphasized in the following evaluation.

- Technical Feasibility--Incineration is a proven technology for destroying hazardous organic compounds in soils and municipal wastes. It is therefore expected to be effective for the destruction of these materials at the Blosenski Landfill Site. Prior to commencement of incineration, however, pilot studies should be performed to determine the BTU content of the wastes/soils, percent ash, etc.

  This alternative as presented assumes that the residual incinerator ash will pass the EP Toxicity Test Procedure as described in 40 CFR Part 261, Appendix II. If so, it can thus be delisted as a hazardous waste under RCRA and may be disposed of on site under a multimedia cap as previously described. However, incineration will not destroy the heavy metals found in site materials. Because of the reduction in volume after incineration, the metals concentrations in the ash may actually be higher for a given unit mass of metals. This effect may be more pronounced in the waste materials than in the soils because of the greater volume reduction for wastes (approximately 80 percent) than for soils (negligible) after incineration.

  In light of this, various options to capping the incinerator residuals should be considered. Assuming that the residual soils pass the EP Toxicity Test Procedure and the wastes do not, the soils can remain on site and be capped while the waste materials (approximately 37,000 cy) can be disposed off site in a secure hazardous waste landfill. A preliminary cost estimate for this option indicates that $8.8 millon would be necessary in addition to the costs for the complete capping alternative.

If neither the wastes or the soils pass the EP Toxicity Test Procedure, and the entire 231,000 cy of residual materials must be disposed off site, this alternative becomes similar to RAA Six for excavation and offsite disposal (without incineration). The site would be backfilled with clean fill and revegetated, with an additional cost of $55.4 million over capping and leaving the ash on site.

A final option would be to build a RCRA landfill on-site to dispose of the entire 231,000 cy of ash. Preliminary calculations indicate that using a landfill of similar design as in RAA Four, an additional cost of $6.7 million would be incurred over the capping alternative.

Using the proposed incineration system outlined previously, approximately 16 years will be required to incinerate the 474,000 tons of soil and waste material. An alternative to this system would be to use multiple large (4 ton/hr) units to be built during the first year of remediation, or to design and build a unit with a higher throughput. While this could substantially reduce the time required for cleanup, it would proportionally increase the cost.

Various incineration alternatives were evaluated based on combinations of the 0.5 T/hr unit and the 4 T/hr unit, and are shown in Table 4-1 the proposed system accounts for approximately $24 million (present-worth) of the total remedial action alternative cost for 16 years of incineration. As the first table entry shows, using both incinerators, subsequent entries show systems using the small incinerator for 1 year only, and numerous larger incinerators for subsequent years. For 1 small incinerator (year 1 only) and 1 large incinerator, a time period of 18 years is required at a cost of $19.7 million. Using two large incinerators during subsequent years reduces the processing time to 9 years and increases the cost to $28.8 million. Various other combinations are presented in Table 4-1 with costs ranging as high as $63.8 million for 8 large incinerators completing the destruction in 3 years.

TABLE 4-1

ALTERNATIVES TO PROPOSED INCINERATION SYSTEM ($1000s)

System	Total No. Years (n)	(x 1,000) Capital $	Year 1 Annual O&M $	Years 2-n Annual O&M $	Total Present Worth $
0.5 T/hr for years 1-16* 1 x 4T/hr for years 2-16	16	$ 6,600	$720	$ 2,420	$24,053
0.5T/hr for year 1 only 1 x 4T/hr for years 2-18	18	6,600	720	1,700	19,717
0.5 T/hr for year 1 only 2 x 4T/hr for years 2-9	9	11,600	720	3,400	28,810
0.5T/hr for year 1 only 3 x 4T/hr for years 2-7	7	16,600	720	5,100	37,512
0.5T/hr for year 1 only 4 x 4T/hr for years 2-5	5	21,600	720	6,800	41,916
0.5T/hr for year 1 only 6 x 4T/hr for years 2-4	4	31,600	720	10,200	55,380
0.5T/hr for year 1 only 8 x 4T/hr for years 2-3	3	41,600	720	13,600	63,778

Notes: Assume 474,000T soils/wastes to be incinerated
For 0.5T/hr unit, Capital Cost = $1,600,000; Annual O&M = $720,000/year
For 4T/hr unit, Capital Cost = $5,000,000; Annual O&M = $1,700,000/year

* Proposed System

For the proposed system, the rate of excavation will exceed the rate of incineration. The waste will be stockpiled in a covered area to protect the material from precipitation and to allow for dewatering if needed. The waste will then be fed to the incinerator, and the residue again stockpiled on clean concrete pads until it can be disposed on site.

The areas where the incinerators and the residual ash will be placed (Areas E, F, H, and J on Figure 4-12) should be excavated and prepared for capping prior to the commencement of incineration. After all contaminated materials have been processed, the material under Area G in the figure can be processed, the equipment removed, and the cap completed.

- Health and Environmental Impacts--This alternative proposes using portable incinerators; therefore, only ancillary facilities will be constructed on site. The excavation of contaminated materials will pose the greatest exposure risk to onsite workers through inhalation of volatile contaminants or through direct contact. These risks can be controlled by the use of personal protective equipment and by air monitoring. Once the incinerators are on line, there may be some risk associated with spillage and volatilization of contaminated materials while being transferred to the incinerator. This risk can be minimized by using proper materials handling procedures and equipment, and by installing a concrete pad under the incinerators. Risks due to inhalation of incinerator emissions should be very low to the local public provided that the air emissions are maintained below the design emissions criteria. The flue gas from the incinerator will be passed through a baghouse or scrubber to reduce emissions to required environmental standards before being discharged to the atmosphere. The emissions will be sampled and analyzed for sulfur dioxide, nitrogen oxides, and total hydrocarbons. There should be little or no environmental impact as long as the air pollution control equipment is functioning properly.

ORIGINAL (RED)

The incineration process should destroy essentially all of the organic contaminants found in the onsite soils and wastes and thus reduce the risks due to the presence of these materials. However, incineration of PCBs may produce dioxins, which should be monitored during incineration. Also, incineration will not destroy the heavy metals found on site. The risks associated with the heavy metals may rise as a result of the effective increase in metals concentration as the waste volume decreases during incineration, and the fact that some metals (such as chromium) are more toxic in their oxidized state, which is facilitated during incineration.

The combination of incineration and capping should greatly reduce the amount of contaminants leaching into the groundwater and surface water. The groundwater treatment system will restore this natural resource and prevent risks to future public health and the environment, while the provision of an alternate water supply will eliminate any current public health risks.

Upon completion of incineration, the equipment will be removed, leaving behind only the capped residuals. These residual products (primarily ash) will be free of harmful constituents as a result of incineration. If scrubbers are used, sludges may also be produced. They must also be capped or stabilized. Capping or another stabilization method will prevent the airborne transport of the residual particles to offsite receptors.

- Institutional Issues--In addition to meeting any requirements for capping of the entire site, all institutional requirements associated with onsite incineration must also be considered. As stated previously, all PADER requirements for permitting must be maintained, in addition to meeting RCRA requirements. The hazardous materials obtained as ash from the kiln must be disposed in accordance with RCRA regulations, such as under a multimedia cap. All air pollution control equipment on the incinerators must be capable of reducing emissions to meet the National Ambient Air Quality Standards (NAAQS).

4.5.1.2 Cost Evaluation

The costs for this alternative were developed assuming that the EPA would incur the capital and O&M costs for both incinerators, as opposed to rental. Once removed from the site, the units could then be used for cleanup at similar CERCLA sites. As with the previous alternative, the amount of contaminated soil was varied to determine the resulting range in capital costs. The capital cost to purchase the two incinerators was varied by ±10 percent to account for vendor price fluctuation, while annual O&M costs were varied from -30 percent to +50 percent to account for the difficulty in predicting these costs at this time. The variation of these costs should be greatly reduced after field testing with the first incinerator. The resulting total capital costs for this alternative ranged from $26,113,000 to $32,207,000. The total 30-year present worth for this alternative is between $47,858,000 and $53,952,000.

4.5.2 Option to Remedial Action Alternative Five--Complete Excavation of Contaminated Soils and Wastes; Onsite Incineration with Stabilization of Residuals; Extension of the Coatesville Water Authority Public Water Supply; Groundwater Extraction, Treatment and Injection; and Long-term Monitoring.

This option to RAA Five utilizes stabilization of the incinerator residuals in lieu of the placement of a multimedia cap, and is provided to furnish decision-makers with another remedial action which will exceed applicable and relevant federal public health and environmental standards. Because of the similarity to the first option for incineration, this discussion will focus only on the stabilization of incinerator residuals (ash) versus capping them.

The stabilization process that warrants further investigation for the metals-laden residuals is a pozzolanic process utilizing fly-ash and cement as the additives. The process can be either a batch or continuous operation depending upon the quantities of materials to be stabilized. Placement of materials can also be performed by one of two methods. In one method, water and a dust control material are mixed with the ash, and the resultant material stockpiled. Periodically (every few months), the stockpiled material can be placed, compacted, and allowed to "set up" until it has a form similar to concrete. The second method involves placing the ash as it is discharged from the kiln, and periodically injecting the materials with the additives necessary for solidification. The second method is thought to be less expensive since there will be less materials handling involved. The determination of the most effective process for this site should be made by field or laboratory testing, should this action be implemented.

The solidified material should be covered with a flow zone consisting of a sand or gravel layer to prevent precipitation from collecting on top of the stabilized mass. The runoff will be collected by the erosion and sedimentation control system proposed for the site work. A layer of topsoil and vegetation above this layer should be used to prevent erosion of the area.

4.5.2.1 Non-Cost Evaluation

- Technical Feasibility--The solidification process should tie-up the metals in the ash to some extent, thus "fixing" them, although this should be verified during the design phase by laboratory analysis of a representative sample of ash. The resultant matrix should, however, be of high strength and low permeability (10^{-7} to 10^{-6} cm/sec), virtually eliminating leachate production. The material should "set up" to within 75-80 percent of its final state within 3 or 4 days, and achieve its final state within a few weeks. A maximum volume increase of 5-10 percent will result from the stabilization process, but the resultant material will be substantially more dense than the original materials because of a 25-30 percent weight increase.

- Health and Environmental Impacts--The reduction in permeability of the incinerated materials should have the same positive effects on the public health and the environment as the incineration and capping option. The amount of contaminants leaching into the groundwater and surface water will be significantly reduced, producing a corresponding reduction in potential exposure risks.

- Institutional Issues--State and Federal approval will have to be granted to allow disposal of incinerator ash on site by this method. The stabilized material will require delisting as a hazardous waste under RCRA by passing leachability testing in the laboratory.

4.5.2.2 Cost Evaluation

Costs for this option were developed similarly to the basic RAA Five. Differences in final costs are a result of replacing the costs for capping, backfilling, and compacting the incinerator ash (231,000 cubic yards) with the costs for stabilization (additives, mixing, spreading, and compacting costs provided by a vendor) and covering with the flow zone and topsoil materials included in this option. As such, the total capital cost for this option ranged from $30,378,000 to $43,258,000. The total 30-year present worth for this alternative ranges from $53,392,000 to $66,272,000.

4.6 Evaluation of Alternatives Specifying Offsite Storage, Destruction, Treatment, or Secure Disposal at a Facility Approved Under RCRA

4.6.1 Remedial Action Alternative Six-Excavation of Contaminated Waste Deposits and Disposal in an Offsite RCRA-Approved Landfill; the Option to Dispose, Contain, or Treat the Contaminated Soils that Underlie the Waste Deposits; Extension of the Coatesville Water Authority Public Water Supply; Groundwater Extraction, Treatment, and Injection; and Long-term Monitoring.

RAA Six was developed as a source control remedy and a management of migration remedy that meets the CERCLA category of an alternative that utilizes treatment or disposal at an offsite facility approved by the EPA. The intent of this alternative is to attain the objective of a potential health risk no greater than 10^{-6}

or a health risk no greater than background health risks for the area not influenced by the Blosenski Landfill Site. This alternative is a combination of the following remedial actions:

- Excavation of the contaminated waste deposits to eliminate the source of contaminants.
- Disposal, containment, or treatment of the residual contaminated soils that underlie the waste deposits to further reduce the potential risks that may be associated with dermal contact or ingestion of the site's remaining contaminated soils.
- Installation of a public water supply and the sealing of the contaminated domestic wells to minimize the potential risks associated with ingestion or utilization of the site's contaminated groundwaters.
- Installation of a groundwater extraction, treatment, and injection system to help restore the contaminated groundwater system as a natural resource.
- Implementation of a long-term monitoring program to observe future contaminant migration, and to provide data on the effectiveness of site remediation.

Site remediation will begin with a drilling program and the installation of 10 long-term monitoring wells, a test-boring and soil sampling program to define the limits of excavation, and the installation of the site access road, stormwater management controls, and decontamination pad. All of these actions have been described in detail in the previous remedial action alternatives.

The excavation of the site's waste deposits can begin after the above site preparation and investigation activities have been completed. The excavation process can proceed in a manner similar to normal excavation activities and common heavy excavation equipment can be used to perform most of the excavation. Extra care must be taken to reduce the potential health and safety problems associated with handling a large volume of material contaminated with HSL compounds. The amount of exposed waste should be kept at a minimum to make the excavation process safer and easier to manage.

RAA Six requires the removal of all the wastes deposited at the site. The horizontal extent of waste deposits is based on the information obtained during the RI and information interpreted from the historical photographs presented in the EPIC study. The actual extent of waste-depositing activities may differ from the approximate limits established for this study. Figure 4-14 shows the approximate horizontal limits of waste deposits, and Appendix B contains the topographic and cross-sectional information used in developing the estimated volume of wastes and contaminated soils.

Material handling during the excavation activities is critical to controlling the further migration of contaminants. A typicai waste excavation and handling scenario might include the following equipment and construction activities. Excavation of the waste deposits is initiated in a central area of the landfill to reduce the amount of stormwater run-off that might otherwise escape if a working face was initiated along the outer limits of the landfill. Equipment such as dozers, front-end loaders, and hydraulic hoes can excavate the wastes in a controlled manner. The excavated wastes are loaded into special waste handling containers known as roll-off boxes. The roll-off boxes are containers that are similar to the bed of a dump truck, except that they can be removed from the truck. The roll-off boxes can be loaded at the working face of the excavation, taken to a staging area by a truck, and dropped off. The truck can then return to the working face for another box of waste without having to be decontaminated. The trucks that will be hauling the wastes in the roll-off boxes to an offsite landfill can pick-up the full boxes at the staging area and proceed to the decontamination area. Since these trucks are not required to traverse the landfill or enter the excavation face, they

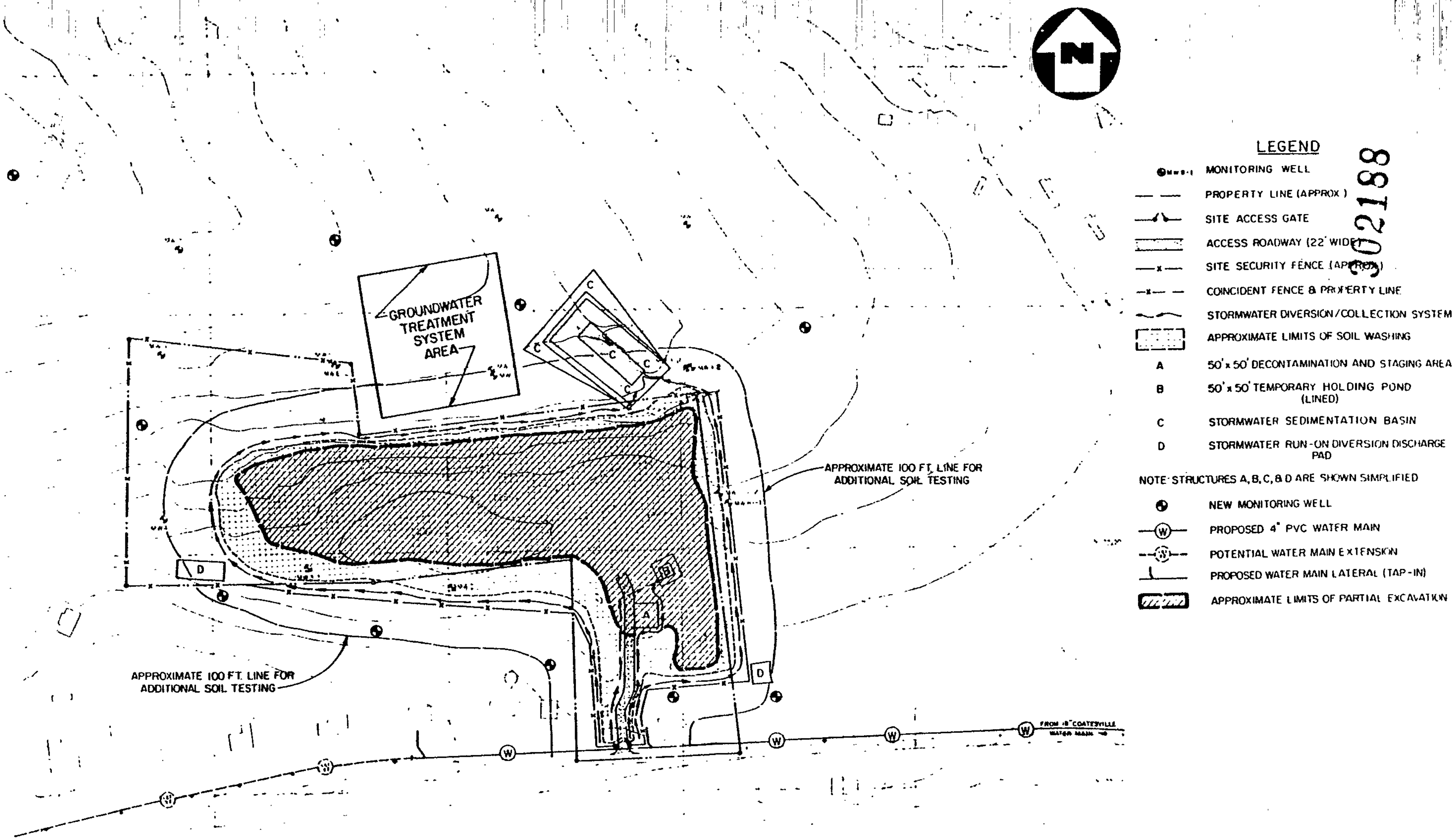

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FIGURE 4-14

0 100 200 400
SCALE IN FEET

NUS CORPORATION
A Halliburton Company

APPROXIMATE LIMITS OF PARTIAL EXCAVATION
BLOSENSKI LANDFILL SITE, WEST CALN TWP., PA

should be relatively clean and require minimal decontamination. The excavation process can also continue at a regular pace without delays caused by slow truck traffic.

Excavation of the waste deposits can continue in a similar manner until all of the wastes are removed. At that time one or more of the following options can be utilized to remediate the remaining contaminated soils.

Option A-Excavation and Disposal in an Offsite RCRA Approved Landfill

This option is a continuation of the above remedial action. Contaminated soils are excavated and taken off site for disposal in an approved landfill. The excavated areas are then backfilled with a clean soil from a local borrow area. The backfill is graded and compacted to match as best as possible the surrounding topography, and then the area is revegetated. The remaining remedial actions are constructed and a long-term monitoring program initiated.

Option B-Multimedia Capping of the Contaminated Soils

Option B would utilize the construction of a multimedia cap over the contaminated soils to reduce the amount of infiltration. Since the remaining contaminated soils are believed to be above the groundwater table, the amount of leachate generated by the site should be reduced to near zero. A typical section of a multimedia cap was presented in Figure 4-4 and a narrative discussion of the installation and purpose of each cap layer is presented in RAA Three. The remaining remedial actions of this alternative can be completed in conjunction with this option.

Option C-Soil Detoxification Study and Pilot Study Program

Option C consists of a series of studies to evaluate the potential use of an innovative or emerging technology to detoxify the contaminated soils. Since this is a relatively new area, and most of the technologies that might be utilized to detoxify the soils are not widely proven or tried in conditions similar to those found at the Blosenski Landfill Site, only the preliminary studies to evaluate the potential use of such a technology are presented in this option.

The screening of the innovative technologies in Appendix A and Section 2.3.6 of this report identified only one technology that might be applicable tc this site. The technology was modeled after the EPA Mobile Soil Washing System and would require the excavation of the contaminated soils prior to detoxification in the washing system. The EPA Mobile Soil Washing System passes the excavated soils through a mechanical screening process that breaks-up large clods of soils and retains large rocks. The screened soils are then passed through a rotating drum screen and soil scrubber, where mechanical agitation and water knifes are used to disperse the soil clumps and create a soil slurry. The soil slurry is then fed into a 4-stage counter-current chemical extractor. Each of the four stages consists of a mixing, froth-flotation cell connected in series with hydrocyclones that are used to centrifuge the slurry. The liquids and solids are separated and the soil particles are then subjected to repeated agitation in washing fluids. The soils are passed through several series of washings. After the soils are cleansed they are returned to the site as clean backfill and the cleaning fluids or wash water is subjected to treatment processes to remove the contaminants.

The site-specific characteristics of the soils and the contaminants will determine what types of cleaning fluids, surfactants, chelating agents, or solvents will be required to detoxify the soils. Since many of the chemical additives are extremely costly, the process also should include a means of recovering the raw materials that are fed into the soil detoxification process. There is also the distinct possibility that the different types of contaminants found at the site may require more than one treatment process to detoxify the soils.

The EPA also has the flexibility to utilize the other options presented within this RAA if the feasibility of an innovative soil detoxification technology is found to be inappropriate after additional testing. The excavation and disposa!, or the capping options could be initiated at a later date.

After completing the excavation of the waste deposits and selecting an option to remediate the contaminated soils, the groundwater remediation program can be initialized or incorporated into the soil remediation option. This remedial action has been discussed in detail in RAA Three.

The site will be graded and revegetated after completion of the remedial actions. A chain link fence is also recommended to reduce unwanted entry to the site and vandalism. The long-term monitoring system will be initiated and continued until it is determined that it is no longer needed. Monitoring is projected to last for 30 years for costing purposes only.

4.6.1.1 Non-Cost Evaluation

- Technical Feasibility--Offsite disposal will reduce the possibility of future groundwater contamination by removing the source from the site. Due to the large volume of material to be disposed of, it may be necessary to consider using several landfills provided they will accept the waste materials.

- Excavation and offsite disposal is a frequently used remedial action at hazardous waste sites. Little or no onsite maintenance activities are required for offsite disposal. No technical problems are foreseen in using this technology except for the possibility of equipment breakdown. The estimated time for completing this alternative is approximately two years.

  Option B will require the installation of a multimedia cap over the contaminated soils. The horizontal extent of capping is expected to be about the same as the horizontal extent of waste deposit excavation. Multimedia capping is a proven technology that has good reliability and can be expected to perform effectively for the next 30 years or more. Proper maintenance will increase the life expectancy of the cap materials and reduce the need for expensive repairs. A multimedia cap can be implemented at the site and the construction period could take less than 9 months depending on the weather conditions during controlled fill operation. The multimedia cap should have an immediate positive impact on the amount of leachate generated by the exposed contaminated soils.

Option C, the soil detoxification study, does not require extensive construction activities. However, a high level of technical expertise will be required to develop a thorough study and apply it to the actual field conditions. Since the exposed contaminated soils will be susceptible to filtration and leachate production, the shortest period of time possible must be used to develop, perform and evaluate the site-specific soil washing technology. The study should be well along even before the excavation of the waste deposits is initiated. Data from the initial soil investigation should be used to evaluate the applicability of the technology. The pilot study should be initiated as soon as a large enough area of contaminated soils is exposed. Ideally the soil washing technology should be ready for field application or rejected before the waste excavation is 50 percent complete rejected so that one of the other options can be initiated.

The exposed contaminated soils can not be left uncapped, untreated or in place for a lengthy period of time. The groundwater extraction, treatment, and injection system should be implemented as soon as the contaminated soils are under a source control remedy.

- Health and Environmental Impacts--Excavation of the site's waste deposits will increase the potential for exposure to site-related contaminants via dermal contact or inhalation during actual construction or excavation operations. Crushed drums with residual contaminants in concentrated levels were found in test pits excavated during the RI. There is the potential for uncovering drums in varying conditions with unknown contents during excavation. The exposure of the wastes to the environment will also permit contaminant migration via sediment transport, airborne fugitive dust emissions, and volatilization into the atmosphere. Past excavation operations at the site during the RI test pit excavation, and the lack of reported incidents associated with the disposal operations, are indications that the excavation may be carried out without endangering the residents. However, there is the potential for emergency evacuation of the nearby residents during the excavation, although the risks should be minimal due to the distance to the receptors. Onsite workers will require respiratory protection and protective clothing during implementation of this alternative.

The health risk levels associated with site-related contamination are reduced to an acceptable level under this alternative. In particular, the risks associated with the ingestion or utilization of the contaminated groundwater are virtually eliminated so long as the water supplied by the proposed extension is not contaminated. There is currently no reason to suspect that the waters of the Coatesville Water Authority do not meet the Federal Drinking Water Quality Standards.

Potential risks to environmental receptors are expected to be minimal. Surface water runoff control measures and proper construction practices will minimize the potential for offsite contaminant transport and short-term environmental impacts.

Excavation, capping or detoxification of the contaminated soils will greatly reduce the residual dermal and accidental ingestion risks. It is intended that excavation and detoxification will leave behind only soils whose concentrations result in less than a 10^{-6} risk.

- Institutional Issues--The offsite disposal facility must be authorized under RCRA to receive the identified contaminated soils and waste. In addition, the facility must currently comply with RCRA groundwater monitoring requirements, and must have no unauthorized surface or groundwater discharges of contaminants. A facility inspection and document/records review will be necessary to verify satisfactory compliance status. The nearest offsite landfill believed to be in current RCRA compliance is operated by CECOS International, and is located near Buffalo, New York, approximately 450 miles from the site. Implementation of this alternative may require development by the regulatory agencies of an Alternate Concentration Limit (ACL) for determining the acceptable contamination levels that may remain in the residual soils.

The excavated wastes would be manifested and transported to the RCRA disposal facility by licensed haulers in accordance with DOT (49 CFR Parts 170-199 and 390-397) and RCRA (40 CFR Parts 262 and 263) regulations. All necessary transportation licenses, permits, and manifests must also be obtained from PADER before this alternative may be implemented.

The multimedia cap is in compliance with RCRA Section 264.310 for closures of existing landfills. The groundwater extraction and remediation is in line with the Groundwater Protection Strategy and the injection wells will require consideration for permitting. The treatment system will require the necessary air emission permits and perhaps an NPDES permit if a controlled discharge of treated water is required during groundwater remediation activities. Permit requirements for groundwater injection must also be met.

The permit requirements for the soil detoxification studies are not apparent, and there is the possibility that a consent agreement or decree could be required to perform the studies. The soil detoxification technology if applied to the site in a fullscale system may require extensive permit requirement consideration.

4.6.1.2 Cost Evaluation

Costing for this alternative is highly dependent upon the volume of waste excavation, which in turn affects transportation and disposal costs. It was assumed that the materials would dewater sufficiently by gravity for transport and disposal, and that all of the wastes will be disposed of in one location, 450 miles from the site.

Option A

Capital cost estimates for this alternative option range from $89,388,000 to $257,503,000. The total 30-year present worth for this alternative is expected to be between $93,858,000 and $261,973,000.

Option B

Capital cost estimates for this alternative option range from $44,815,000 to $123,872,000. The total 30-year present worth for this alternative is expected to be between $49,484,000 and $128,451,000.

Option C

Capital cost estimates for this alternative option range from $45,756,000 to $126,006,000. The total 30-year present worth for this alternative is expected to be between $50,027,000 and $130,877,000.

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5.0 SUMMARY OF REMEDIAL ACTION ALTERNATIVES

Section 4.0 presented the detailed evaluation of the RAAs developed during the FS. These alternatives were developed through a lengthy screening process in which individual remedial technologies were screened and then combined into RAAs that would most effectively meet the objectives for site cleanup. Section 3.0 discussed the rationale of the FS by describing how the various technologies were combined to create different alternatives that satisfy various categories of site cleanup. These alternatives were then individually evaluated in Section 4.0 in terms of their technical feasibility, attendant public health risks, environmental concerns, institutional issues, and costs.

Table 5-1 was prepared to summarize the resulting alternatives in a manner consistent with the FS Guidance Document to facilitate comparison of the various features, effects, and limitations of the alternatives. The trade-off matrix presented in Table 5-1 summarizes: the technologies comprising the alternatives; technical, public health, and environmental advantages and disadvantages; institutional considerations; and community considerations. Table 5-2 is presented to provide a detailed summary and comparison of the cost elements associated with each remedial action alternative. The range of capital, annual O&M, and 30-year present-worth costs are presented in this table.

The data in Tables 5-1 and 5-2 are meant only to summarize salient points relating to each RAA. They are intended to be a supplement to information provided in the text, and the reader is advised to refer to Section 4.0 and the appendices for more detailed information regarding the alternatives summarized in the tables.

TABLE 5-1
REMEDIAL ACTION ALTERNATIVE TRADE-OFF MATRIX
BLOSENSKI LANDFILL SITE

Alternatives:	Technical Considerations: Advantages	Technical Considerations: Disadvantages	Public Health Considerations: Advantages	Public Health Considerations: Disadvantages	Environmental Considerations: Advantages	Environmental Considerations: Disadvantages	Institutional Considerations:	Community Considerations:
I. No Action Alternative 1. No Action with Monitoring.				- Mean groundwater contaminant concentrations associated with potential cancer risk of 10^{-2}.		- Continued migration via groundwater, surface water, and airborne transport.		- Unacceptable community reaction.
II. Alternatives That Attain CERCLA Goals But Do Not Attain Other Applicable or Relevant Standards								
2. Soil Cap, Alternate Water Supply, and Long-Term Monitoring.	- Relies on simple technology.		- Reduces potential risk associated with dermal contact, ingestion & inhalation.		- Reduces leachate generation. - Reduces surface soil erosion and airborne transport of contaminants.		- Requires approval from Coatesville Water Authority.	- Acceptable community reaction.

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TABLE 5-1
REMEDIAL ACTION ALTERNATIVE TRADE-OFF MATRIX
BLOSENSKI LANDFILL SITE
PAGE TWO

Alternatives:	Technical Considerations:		Public Health Considerations:		Environmental Considerations:		Institutional Considerations:	Community Considerations:
	Advantages	Disadvantages	Advantages	Disadvantages	Advantages	Disadvantages		
III. Alternatives Attaining All Applicable or Relevant Standards								
3. Multimedia Cap, Alternate Water Supply, Groundwater Extraction and Treatment, and Long-Term Monitoring.	- Relies on proven technologies.	- Efficiency of groundwater extraction is questionable due to fractured bedrock - Groundwater treatment entails extensive operation and maintenance.	- Same as above.		- Reduces surface soil erosion & airborne transport of contaminants - Reduces leachate generation - Reduces existing groundwater contamination.	- Potential transfer of volatile organics from groundwater to atmosphere.	- May require air pollution control equipment on air stripper to meet PADER requirements. - Requires permit for groundwater discharge. - Requires RCRA permit for capping of wastes. - Requires approval from Coatesville Water Authority.	- Acceptable community reaction.

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TABLE 5-1
REMEDIAL ACTION ALTERNATIVE TRADE-OFF MATRIX
BLOSENSKI LANDFILL SITE
PAGE THREE

Alternatives:	Technical Considerations: Advantages	Technical Considerations: Disadvantages	Public Health Considerations: Advantages	Public Health Considerations: Disadvantages	Environmental Considerations: Advantages	Environmental Considerations: Disadvantages	Institutional Considerations:	Community Considerations:
4. Onsite Landfill, Alternate Water Supply, Groundwater Extraction and Treatment, and Long-Term Monitoring.	- Relies on proven technologies.	- Efficiency of groundwater extraction is questionable due to fractured bedrock. - Effectiveness of landfill is dependent upon proper installation techniques. - Groundwater treatment entails extensive operation and maintenance.	- Reduces potential risk associated with dermal contact, ingestion, and inhalation.	- Increased exposure risk during implementation due to complete excavation.	- Eliminates future leachate generation. - Completely isolates the wastes from groundwater contact, surface water runoff, and airborne transport.	- Increased potential for airborne contaminants during implementation.	- Requires RCRA-permitted facility and comprehensive groundwater monitoring program. - Requires permit for groundwater discharge. - May require air pollution control equipment on air stripper to meet PADER requirements. - Requires approval from Coatesville Water Authority.	- Potential for community opposition to landfill.

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TABLE 5-1
REMEDIAL ACTION ALTERNATIVE TRADE-OFF MATRIX
BLOSENSKI LANDFILL SITE
PAGE FOUR

Alternatives:	Technical Considerations: Advantages	Technical Considerations: Disadvantages	Public Health Considerations: Advantages	Public Health Considerations: Disadvantages	Environmental Considerations: Advantages	Environmental Considerations: Disadvantages	Institutional Considerations:	Community Considerations:
IV. Alternatives Exceeding Applicable or Relevant Standards								
5a. Onsite Incineration, Multimedia Cap, Alternate Water Supply, Groundwater Extraction and Treatment, and Long-Term Monitoring.	- Relies on proven technology.	- Onsite (mobile) units not widely available. - Available units have relatively low throughput, resulting in a relatively long implementation period (16 yrs). - Incineration entails considerable operation and maintenance. - Efficiency of groundwater extraction is questionable due to fractured bedrock. - Groundwater treatment entails extensive operation and maintenance.	- Organic contaminants completely destroyed. - Reduces potential risk associated with dermal contact, ingestion, and inhalation.	- Increased exposure risk during implementation due to complete excavation. - Potential exposure risk of nearby residences due to incinerator stackgas emissions.	- Reduces inorganic leachate generation and eliminates organic leachate generation. - Reduces surface soil erosion and airborne transport of contaminants. - Reduces existing groundwater contamination.	- Potential transfer of volatile organics from groundwater to atmosphere. - Increased potential for airborne contaminants during implementation due to excavation, and due to incinerator stackgas emissions during operation.	- Same as above, plus incinerator emissions must conform to NAAQS.	- Potential for community opposition.

302202

TABLE 5-1
REMEDIAL ACTION ALTERNATIVE TRADE-OFF MATRIX
BLOSENSKI LANDFILL SITE
PAGE FIVE

Alternatives:	Technical Considerations: Advantages	Technical Considerations: Disadvantages	Public Health Considerations: Advantages	Public Health Considerations: Disadvantages	Environmental Considerations: Advantages	Environmental Considerations: Disadvantages	Institutional Considerations:	Community Considerations:
5b. Onsite Incineration, Stabilization of Residuals, Alternate Water Supply, Groundwater Extraction and Treatment, and Long-Term Monitoring.	- Same as above.	- Same as above.	- Same as above, plus: - Inorganic contaminants are "tied-up" in solid matrix.	- Same as above.	- Eliminates organic and inorganic leachate generation. - Reduces surface soil erosion and airborne transport of contaminants. - Reduces existing groundwater contamination.	- Same as above.	- Same as above, plus: - Solidified mass will need to be delisted as a hazardous waste under RCRA for disposal.	- Same as above.

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TABLE 5-1
REMEDIAL ACTION ALTERNATIVE TRADE-OFF MATRIX
BLOSENSKI LANDFILL SITE
PAGE SIX

Alternatives:	Technical Considerations: Advantages	Technical Considerations: Disadvantages	Public Health Considerations: Advantages	Public Health Considerations: Disadvantages	Environmental Considerations: Advantages	Environmental Considerations: Disadvantages	Institutional Considerations:	Community Considerations:
V. Alternatives Specifying Off-site Storage, Destruction, Treatment or Disposal								
6. Excavation of Waste Deposits with Offsite Disposal in a RCRA-Approved Landfill, Alternate Water Supply, Groundwater Extraction and Treatment, and Long-Term Monitoring, plus:	- Relies on simple technologies.	- Efficiency of groundwater extraction is questionable due to fractured bedrock. - Groundwater treatment entails extensive operation and maintenance.	- Eliminates long-term potential risk due to dermal contact, ingestion, and inhalation.	- Increased exposure risk during implementation due to excavation and transport of materials.	- Same as above.	- Potential transfer of volatile organics from groundwater to atmosphere. - Increased potential for airborne contaminants during implementation.	- Requires finding a RCRA-permitted facility to receive this large quantity of materials. - Requires manifestation of materials in accordance with RCRA and DOT regulations. - Requires permit for groundwater discharge. - May require air pollution control equipment on air stripper to meet PADER requirements. - Requires approval from Coatesville Water Authority.	- Potential for community disruption due to increased traffic during implementation. - *Favorable long-term community reaction expected.*

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TABLE 5-1
REMEDIAL ACTION ALTERNATIVE TRADE-OFF MATRIX
BLOSENSKI LANDFILL SITE
PAGE SEVEN

Alternatives:	Technical Considerations: Advantages	Technical Considerations: Disadvantages	Public Health Considerations: Advantages	Public Health Considerations: Disadvantages	Environmental Considerations: Advantages	Environmental Considerations: Disadvantages	Institutional Considerations:	Community Considerations:
Option A: Excavation and Offsite Disposal of Residual Soils.	- Relies on simple technologies.	- Efficiency of groundwater extraction is questionable due to fractured bedrock. - Groundwater treatment entails extensive operation and maintenance.	- Eliminates long-term potential risk due to dermal contact, ingestion, and inhalation.	- Increased exposure risk during implementation due to excavation and transport of materials.	- Same as above.	- Potential transfer of volatile organics from groundwater to atmosphere. - Increased potential for airborne contaminants during implementation.	- Requires finding a RCRA-permitted facility to receive this large quantity of materials. - Requires manifestation of materials in accordance with RCRA and DOT regulations. - Requires permit for groundwater discharge. - May require air pollution control equipment on air stripper to meet PADER requirements. - Requires approval from Coatesville Water Authority.	- Potential for community disruption due to increased traffic during implementation. - Favorable long-term community reaction expected.

302205

TABLE 5-1
REMEDIAL ACTION ALTERNATIVE TRADE-OFF MATRIX
BLOSENSKI LANDFILL SITE
PAGE EIGHT

Alternatives:	Technical Considerations: Advantages	Technical Considerations: Disadvantages	Public Health Considerations: Advantages	Public Health Considerations: Disadvantages	Environmental Considerations: Advantages	Environmental Considerations: Disadvantages	Institutional Considerations:	Community Considerations:
Option B: Install Multimedia Cap over Residual Soils.	- Relies on simple proven technologies.	- Efficiency of groundwater extraction is questionable due to fractured bedrock. - Groundwater treatment entails extensive operation and maintenance.	- Reduces potential risk associated with dermal contact, ingestion, and inhalation.	- Increased exposure risk during implementation due to excavation and transport of materials.	- Reduces surface soil erosion and airborne transport of contaminants. - Reduces leachate generation. - Reduces existing groundwater contamination.	- Potential transfer of volatile organics from groundwater to atmosphere.	- Requires finding a RCRA-permitted facility to receive this large quantity of materials. - Requires manifestation of materials in accordance with RCRA and DOT regulations. - Requires permit for groundwater discharge. - May require air pollution control equipment on air stripper to meet PADER requirements. - Requires approval from Coatesville Water Authority. - Requires RCRA permit for capping of wastes	- Potential for community disruption due to increased traffic during implementation. - Acceptable long-term community reaction expected.

TABLE 5-1
REMEDIAL ACTION ALTERNATIVE TRADE-OFF MATRIX
BLOSENSKI LANDFILL SITE
PAGE NINE

Alternatives:	Technical Considerations: Advantages	Technical Considerations: Disadvantages	Public Health Considerations: Advantages	Public Health Considerations: Disadvantages	Environmental Considerations: Advantages	Environmental Considerations: Disadvantages	Institutional Considerations:	Community Considerations:
Option C: Excavation and Detoxification of Contaminated Soils.		- Efficiency of groundwater extraction is questionable due to fractured bedrock. - Groundwater treatment entails extensive operation and maintenance. - Effectiveness, reliability and implementability of soil washing is unknown.	- Reduces potential risk associated with dermal contact, ingestion, and inhalation.	- Increased exposure risk during implementation due to complete excavation.	- Reduces existing groundwater contamination. - Reduces leachate generation. - Reduces surface soil erosion and airborne contaminant transport.	- Potential transfer of volatile organics from groundwater to atmosphere. - Increased potential for airborne contaminants during implementation.	- May require air pollution control equipment on air stripper to meet PADER requirements. - Requires permit for groundwater discharge. - Requires approval from Coatesville Water Authority. - Requires finding a RCRA-permitted facility to receive this large quantity of materials. - Requires manifestati a of materi 's in accordance with RCRA and DOT regulations. - Requires PADER approval for soil washing.	- Large amount of community disruption due to increased traffic during implementation. - Negative community reaction expected for unproven technology (soil washing).

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TABLE 5-2

REMEDIAL ACTION ALTERNATIVES COST SUMMARY ($1,000)
BLOSENSKI LANDFILL SITE

Remedial Action Alternative	Capital Costs			Annual Operation & Maintenance Costs Year No:				Present Worth Analyses (30 Yrs.)		
	Low	Base	High	1	2-5	6-16	17-30	Low	Base	High
1. No action with monitoring	80	100	130	197.7	197.7	197.7	197.7	1,953	1,973	2,003
2. Soil cap, alternate water supply and long-term monitoring	2,706	3,231	4,812	255	255	255	255	5,122	5,647	7,233
3. Multimedia cap, alternate water supply, groundwater extraction and treatment and long-term monitoring	8,481	9,559	13,037	825	816	276	276	13,150	14,228	17,706
4. Onsite landfill, alternate water supply, groundwater extraction and treatment and long-term monitoring	14,317	22,728	31,508	825	816	276	276	18,986	27,397	36,177
5a. Onsite incineration, multimedia cap, alternate water supply, groundwater extraction and treatment and long-term monitoring	26,113	29,424	32,207	1,503	3,194	2,654	234	47,858	51,169	53,952
5b. Onsite incineration, stabilization of residuals, alternate water supply, groundwater extraction and treatment and long-term monitoring	30,378	38,213	43,258	1,637	3,328	2,788	368	53,392	61,227	66,272

TABLE 5-2
REMEDIAL ACTION ALTERNATIVES COST SUMMARY ($1,000)
BLOSENSKI LANDFILL SITE
PAGE TWO

Remedial Action Alternative	Capital Costs			Annual Operation & Maintenance Costs Year No:				Present Worth Analyses (30 Yrs.)		
	Low	Base	High	1	2-5	6-16	17-30	Low	Base	High
6. Excavation and offsite disposal of wastes in a RCRA-approved landfill, alternate water supply, groundwater extraction and treatment and long-term monitoring, plus:										
Option a: Excavation and offsite disposal of soils in a RCRA-approved lar.dfill	89,388	173,265	257,503	804	795	255	255	93,858	177,735	261,973
Option b: Construction of multimedia cap over contaminated soils	44,815	84,118	123,782	825	816	276	276	49,484	88,787	128,451
Option c: Excavation and detoxification of contaminated soils	45,756	86,001	126,006	783	774	234	234	50,027	90,272	130,877

APPENDICES

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